COMMUNICATIONS

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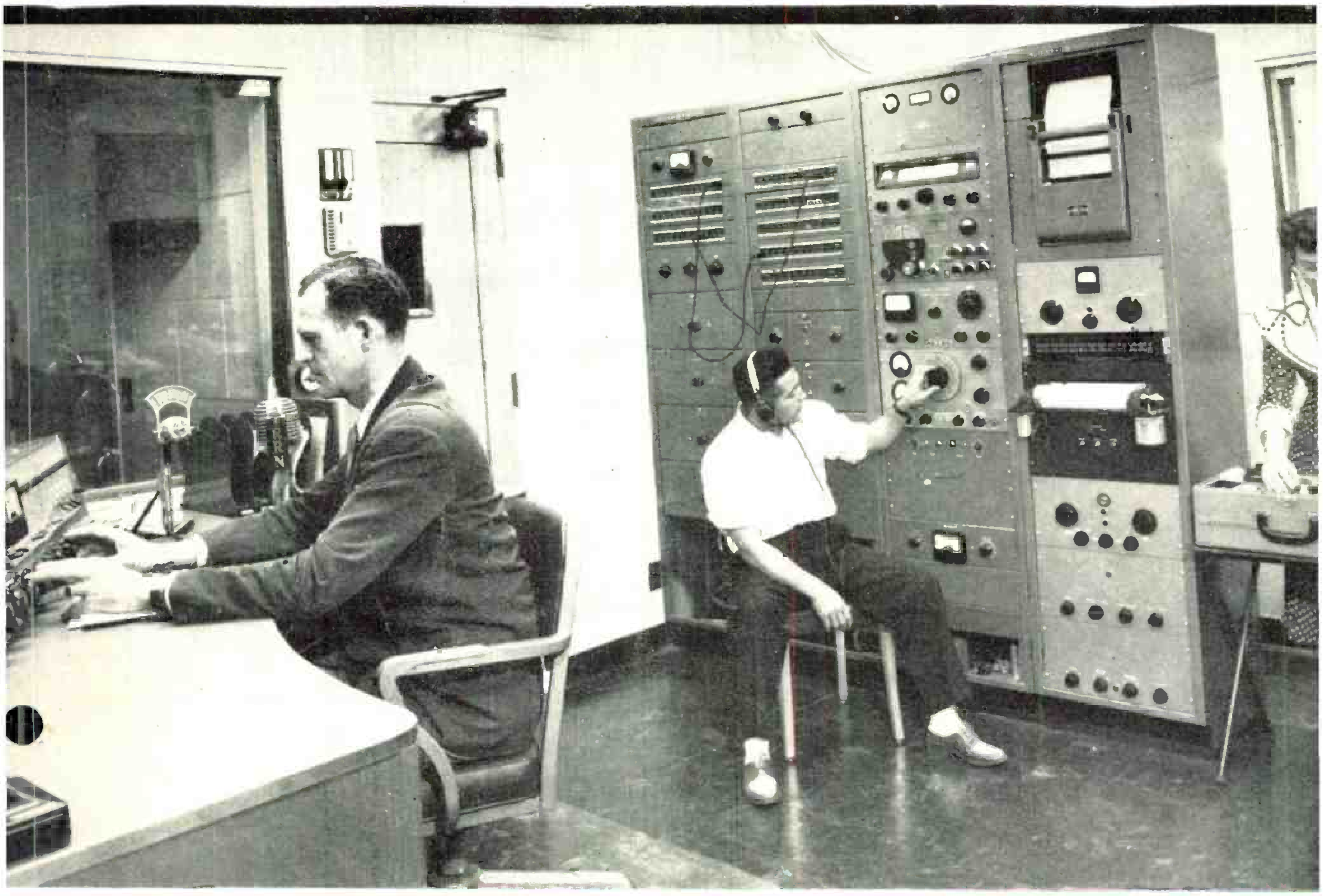
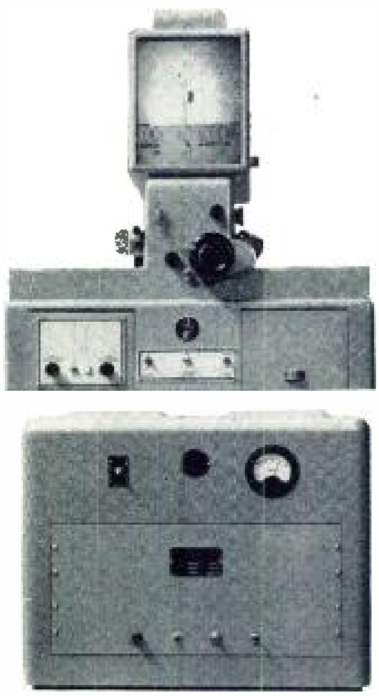


OCTOBER

★ TV CONTROL CONSOLE DESIGN
★ SIX-STATION F-M NETWORK SYSTEM
★ A REPORT ON TV MICROWAVE NETWORKS

1948

Applied Research Laboratories specifies Sorensen electronic voltage regulation



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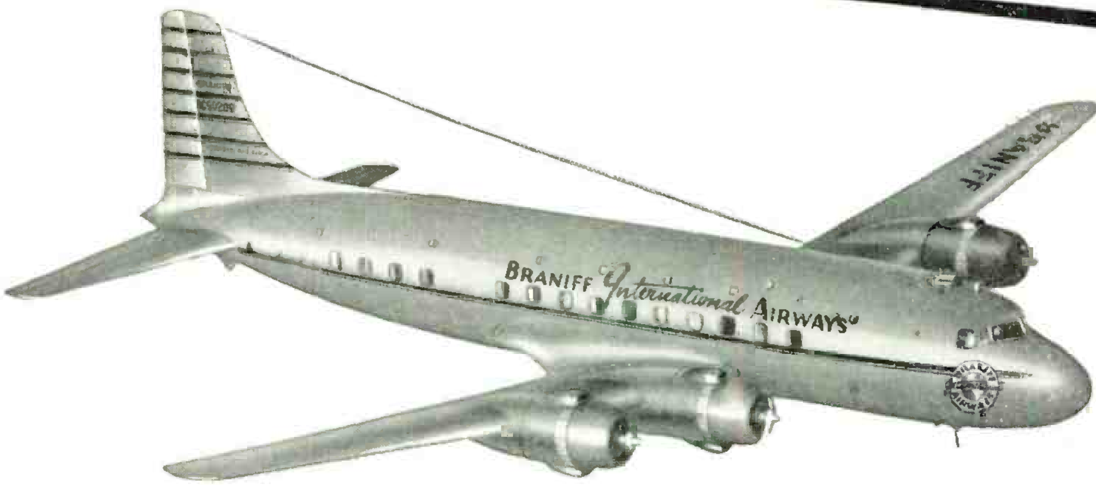

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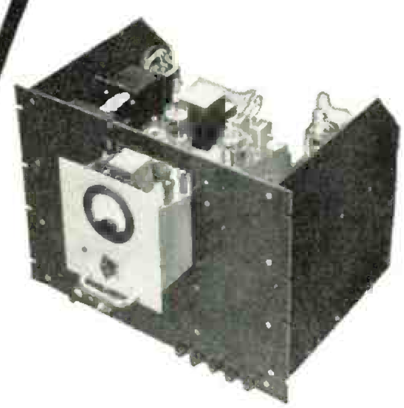

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Type 364A Transmitter
118-136 MC. Band

WILCOX
ELECTRIC COMPANY
KANSAS CITY 1, MISSOURI

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OCTOBER, 1948 VOLUME 28 NUMBER 10

COMMUNICATIONS

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COVER ILLUSTRATION

Master Control Room of the Rural Radio Network at Ithaca, New York. *(See Pages 12-15 for Complete Report on Network System.)*

ABC

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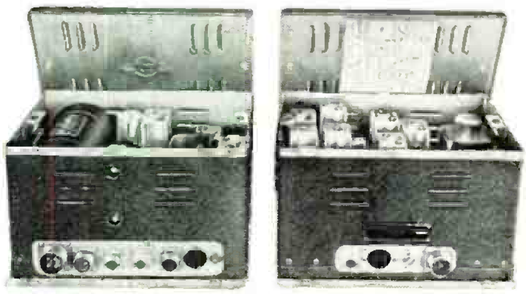
Since quick, *unfailing* service is the essence of Morro Limousine's business, Link Radio Corporation turns to Sylvania Lock-In Tubes to prevent communications interruptions. These tubes stay firmly in place in their sockets . . . have no soldered joints, few welded ones. Elements can't warp or weave. Connections are short and direct . . . getter located on top. Loss and leakage are reduced. See Sylvania Distributors or write Radio Tube Division, Emporium, Pa.



Transmitting and Receiving Units used by Morro Limousine Service, manufactured by Link Radio Corporation, New York.

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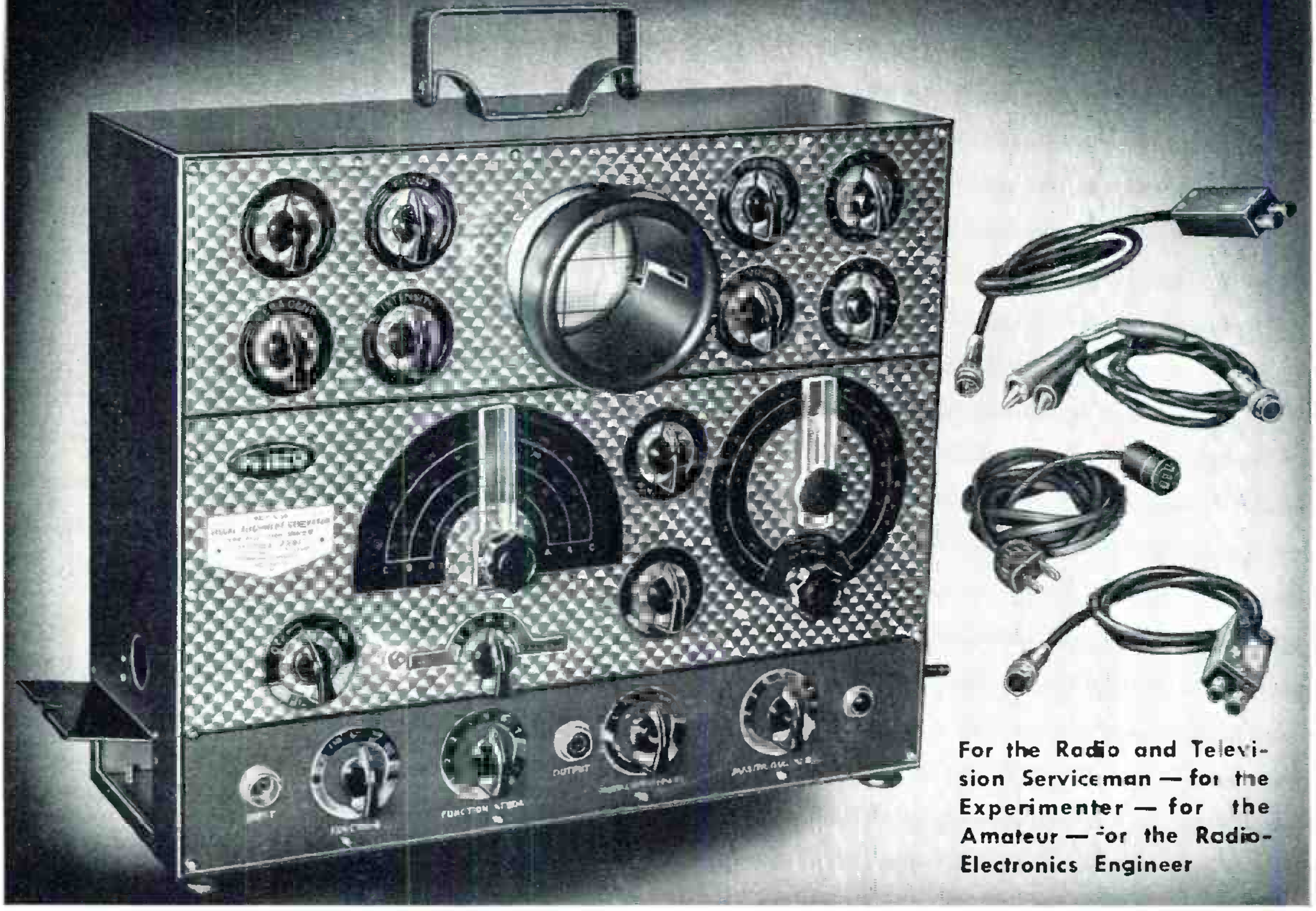

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COMMUNICATIONS

LEWIS WINNER, Editor

OCTOBER, 1948

The Washington TV Hearings

WASHINGTON, once again, has become quite an engineering news centre, with industrys' most learned providing the facts and figures. At the recent tv allocation hearing, during which the ultrahighs were being probed, the complex problem of the current and the future status of the higher bands was analyzed by the tops in the engineering world.

An excellent example of such reporting appeared in the comprehensive review by JTAC, the IRE-RMA group recently formed to advise the FCC. In a study of the subject, running to nearly 200 pages, such pertinent topics as factors essential to an allocations plan, establishment of u-h-f service contours, terrain factors, application of v-h-f transmission standards for color and high-definition monochrome services and equipment available, were detailed.

The report disclosed that the effective radiated power required to produce a 5,000-microvolt-per-meter contour at 40 miles at frequencies between 475 and 890 mc, assuming 500 feet and 30 feet for the transmitting and receiving antenna heights, respectively, would be 214 kw. This power, the report said, is far greater than is available at u-h-f today or in the foreseeable future. The report also went on to say that when it is further considered that the field strengths predicted by the Norton formula, which was used to make the preceding computation, are in excess of those measured in many locations, the required effective radiated power will be probably substantially greater than 214 kw. For example, the analysis continued, the average measured field strengths at 40 miles along two radials at 510 mc, in the Brown-Epstein-Peterson data, are 1/5 to 1/10 the predicted values. Assuming that these measurements are typical, the actual power level, required to deliver 5,000 microvolts-per-meter to 40 miles, would range from 5 to 20 megawatts erp, a higher amount of power than has ever been radiated in any broadcast service in any region of the spectrum.

To the best of their knowledge, the JTAC group stated, tubes available for u-h-f service could only provide up to 2 kw, erp.

Commenting on u-h-f power in a subsequent report, Harold E. Sorg, Eimac director of research, stated that tubes with peak output of 50 kw would be available for the low end of the high band within about a year, and with parallel circuits it might be possible to achieve up to 300 or 400 kw.

According to the JTAC report, eleven experimental transmitters were on the air testing u-h-f propagation on powers ranging from 100 watts to 5 kw. Major Armstrong was listed as having received a *cp* for a 50-kw 600-620 mc experimental station.

In another detailed study of the ultrahighs, T. T. Goldsmith, Jr., disclosed that DuMont had conducted substantial comparison measurements at 77.25 and 612 mc, the former station having an erp at 14.25 kw and the latter an erp of 80 watts, video peak. In an analysis of transmitter antenna gain, Goldsmith said that in the u-h-f region it is possible to construct omni-directional antennas having a considerably greater power gain for a given physical size than at v-h-f. However, he said, there appears to be a practical upper limit beyond which additional gain becomes undesirable; if the antenna directivity is very great and the antenna quite high, there may be insufficient signal in the area immediately below the antenna. Goldsmith also pointed out that the problem of phasing becomes very critical and it has been observed that the received signal from very highly directional antennas appears to fluctuate rapidly, especially at points close in under the antenna. It was disclosed that the exact upper limit of transmitting antenna power gain has not been determined, but probably lies between 10 and 20.

Goldsmith's investigation also indicated that whereas the u-h-f signal is much more sensitive to propagation vagaries than the v-h-f signals, it is possible to expect, as an average, approximately equal field strengths at the two frequencies for equal effective radiated power. Of course, this condition is not true in deeply shadowed areas where the u-h-f signal strength may be as low as 20% of the v-h-f signal strength.

Commenting on multipath, the report showed that ghost conditions (with transmissions originating in New York City) were considerably less severe at 612 mc than at 77.25 mc. A five-element Yagis was used for both transmission and reception at 612 mc. These antennas provided a power gain of approximately four, but were sufficiently broad so that any bad multipath conditions could be observed.

The general consensus of those at the hearings seemed to be that the present 12-channel system should be retained as the basis of black and white video service, but accelerated experiments should be conducted in the ultrahighs, particularly the lower u-h-f band, for early expansion of the tv channels.

TV Broadcasting Report

AN INFORMATIVE COMMENTARY on telecasting, providing pertinent construction cost data, has been prepared by NAB.

The report, which was mailed to members of the association, discloses that the average minimum construction expense involved in building a metropolitan station capable of handling network, film, remote and studio programs, was around $380,000.

According to the NAB study, eventual utilization of the 500-mc area must be assumed as an almost certain probability, but five to ten years will have probably elapsed before setting of standards and manufacturing of equipment will permit establishment of a commercial tv service in the u-h-f band.

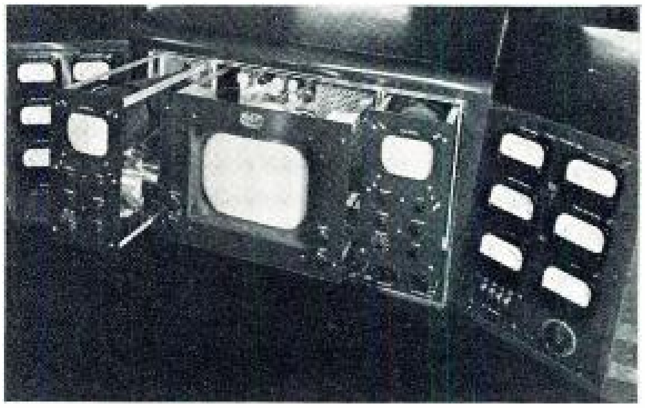
McNaughten to WFIL

NEAL MCNAUGHTEN, formerly assistant director of engineering at NAB, is now over at WFIL in Philadelphia as technical director.

Good luck to you, Neal, in this new post, where we know you will be eminently successful.—L. W.

(Left)
View of tv console, in which we have, at the left, the visual meter panel, at right aural meter, and in center waveform and picture monitor. Under the monitor is the switch panel to the rear of which are attached audio, transmitter and video switch units.

(Below)
Front view of console showing the slide panel construction of sections.



TV Control Console Design

by JOHN RUSTON

Television Transmitting Equipment Div.
Allen B. DuMont Laboratories, Inc.

THE CONTROLS AND MONITORING equipment of the early tv transmitters were generally incorporated in the transmitter itself or mounted on relay type racks. This arrangement provided the flexibility necessary while the transmitters were still in the experimental stage, but now that designs are becoming stabilized, much greater convenience of operation can be obtained by grouping the controls in a console such as is commonly used with broadcast transmitters.

General Requirements

Essentially the console must contain all controls and meters necessary for normal operation of the transmitter. This entails provision for switching the transmitter on and off, and for checking its performance, particularly the quality of the input and output signals. In addition as much provision as possible must be made for locating faults which may develop. However, the number of fault locating facilities is limited, since operation of the console must not be too complex.

In effect, there are two complete transmitters to be controlled, the aural and the visual, and the aural transmitter alone requires all the controls and monitoring equipment usually provided in a complete f-m transmitter console.

The essential switches, indicators and meters required for each of the two transmitters are: Filament on-off switch, filament pilot light, plate on-off switch, plate pilot light, final amplifier plate current meter, final amplifier plate voltmeter, transmission line r-f voltmeter, and carrier frequency meter.

The aural transmitter also requires a deviation meter for indicating modulation, and an a-c line meter should be provided, with a switch for measuring the voltage of each of the three phases supplying the transmitters and the single phase supply to the auxiliary equipment. In addition, switching and monitoring facilities are required for the video and audio signals.

Master Control Requirement

In the case of sound transmitters, master control facilities are not usually required on the console since all program switching is performed at the studio. But in the case of a television transmitter, its location at a high elevation makes its site a good position to install the link receivers for remote pickups. It may therefore be undesirable to have to *pipe* remote pickup to the studio for program switching and then back to the transmitter again; hence, arrangements must be made in the console for switching the transmitter video and audio inputs to a number of different lines and provide for monitoring the signal on any of the remote lines so that levels may be adjusted before switching to the air.

By having this master control at the transmitter, it is unnecessary to retain a full staff at the studio during extended periods of remote pickup transmission.

Video Signal Monitoring

To evaluate the quality of the composite video signal used for television transmission, it is necessary to use three units:

(1) A *line* waveform monitor which displays the video waveform on a c-r-t the horizontal sweep being linear and synchronized at half the line frequency of the video signal, i.e., 7875 sps (sweeps per second).

(2) A *frame* waveform monitor similar to *(1)* but with its sweep frequency equal to half the *field* frequency of the video signal, i.e., 30 sps.

(3) A *picture* monitor capable of high resolution.

The video inputs of the two waveform monitors are usually connected in parallel, and since their horizontal sweeps are half-line and half-frame frequencies, a line sync pulse and a frame sync pulse appears at the centers of their respective traces. By means of suitable scales in front of the c-r-t screens, the relative magnitudes of the sync pulses and picture content can be noted and any irregularities in the composition of the video signal can be observed. The picture content of the video signal cannot be interpreted on the waveform monitors, so the picture monitor is required for this purpose. This shows faults such as lack of definition, ghosts, white saturation, poor contrast, etc.

To check the operation of the visual transmitter, it must be possible to

General Problems Involved in the Design of TV Transmitter Consoles: Master Control Requirements, Video Signal Monitoring; Bridging Connections; Terminating Connections; Percentage Modulation Measurement; Video and Audio Circuitry; Metering and Switching, and Mechanical Layout.

monitor the video input to the transmitter and also the video signal which appears as a modulated r-f voltage on the transmission line to the antenna. It is desirable to monitor intermediate points in the transmitter and also off a monitoring receiver which picks up the signal *off the air*. Hence, switching must be provided in the video inputs to the monitors and since the range of frequencies in the video signals is from 30 cps to 6 mc, problems arise in this connection which are not present when switching audio circuits.

Bridging Connections

Video signals are usually transmitted in coaxial cables of 75-ohm surge impedance; therefore, if such a line is to be bridged by a monitoring connection, the bridging impedance must be high compared with 75 ohms at all frequencies up to 6 mc. Two waveform monitors and one picture monitor have to be bridged across the line and their total input capacity together with the capacity of connecting cables and switches cannot be reduced below about 150 mmfd which has an impedance of about 170 ohms at 6 mc. Connection of this capacity across the video input to the transmitter would affect the frequency response and introduce reflections.

By using the potential dividing circuit of Figure 1, the effect of the bridging capacity can be reduced to a negligible amount. The inductance *L* and capacity *C* are adjusted so that the effective impedance between the point *A* and ground is almost a pure resistance at frequencies up to 6 mc, the theory of this operation being similar to the use of peaking coils in the plate circuits of video amplifiers for correcting high-frequency response. The addition of the 80-ohm resistor provides a correct resistive termination for the 75-ohm video line. The monitor input switches must be connected to point *A* and when a monitor is disconnected it must be replaced by an equivalent capacity. During the instant of switching, assuming non-shorting type switches are used, the capacity to ground, from point *A*, will be reduced momentarily, but this will only have a slight effect on the high-frequency response in the video line and is not noticeable in the picture. By using this bridging circuit across the line, the monitors can be switched to monitor any video line without having any appreciable effect on the signal in the line. The only requirement is that the monitors and switch shall be located fairly close to the termination of the line to avoid excessive capacity in the connecting cables.

An alternative method of bridging a video line is to use a bridging amplifier or cathode follower. The grid of an amplifier tube can be switched to a video line without introducing appreciable impedance change and the monitors can then be connected to the output of the amplifier. Any switching surges or impedance mismatch caused when the monitors are switched to

Figure 1
Potential dividing circuit (*A*) which reduces effect of bridging capacity to a negligible amount.

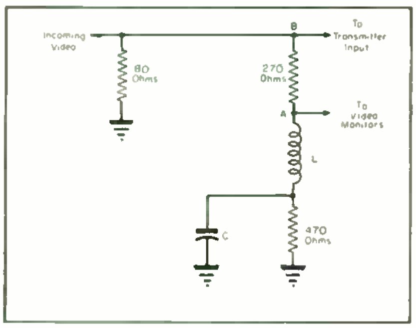
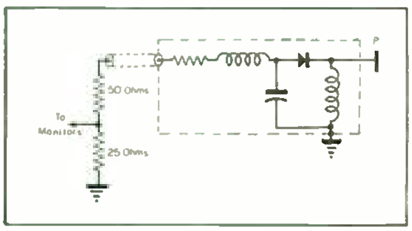
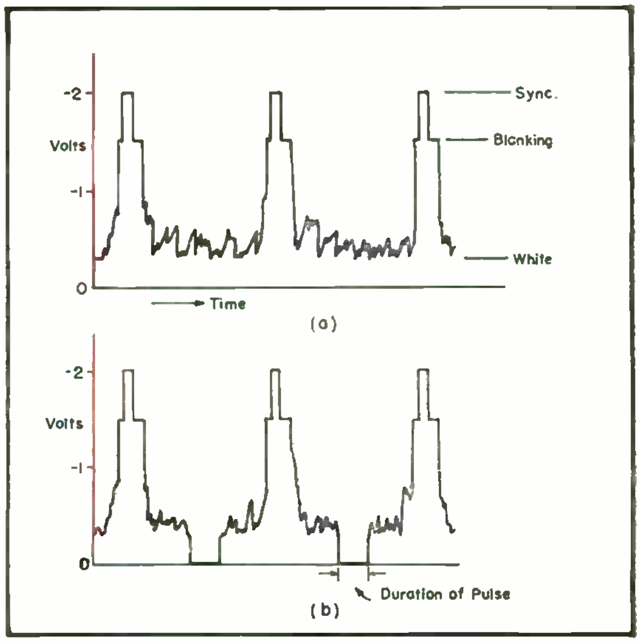


Figure 2
Simple detector circuit used for video monitoring signals in the transmitter (*P* is pickup wire)



Figures 3a and b

Composite video signal waveforms. In *a* appears a plot of the video signal without interruptions obtained from the Figure 2 detector circuit. In *b* appears a trace obtained as the result of the interruptions in the video signal resulting from the circuit shown in Figure 4 on page 10.



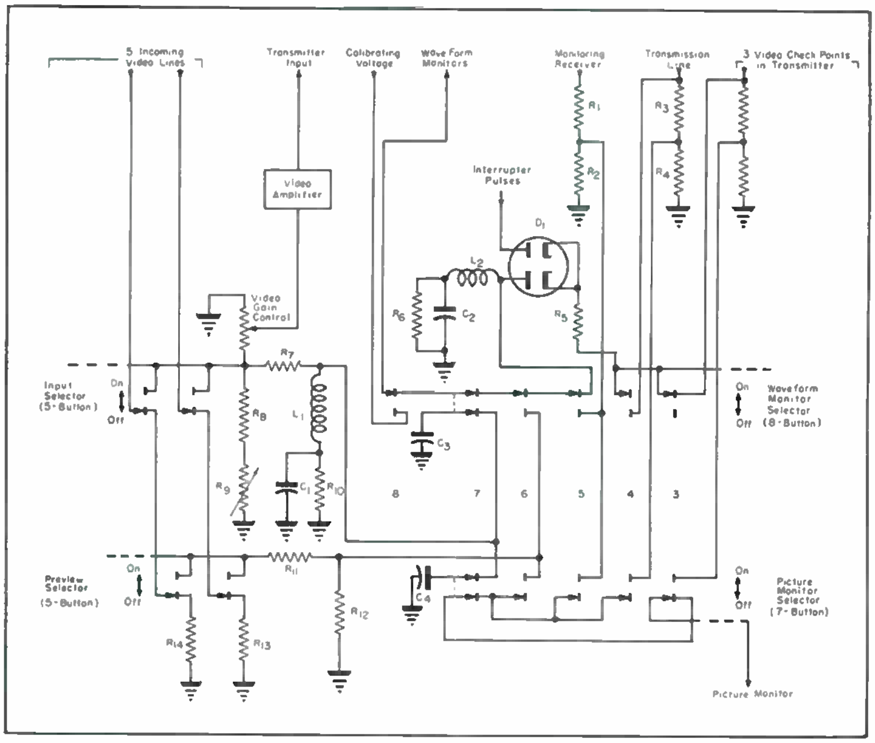


Figure 6
Complete schematic of the video section of the console.

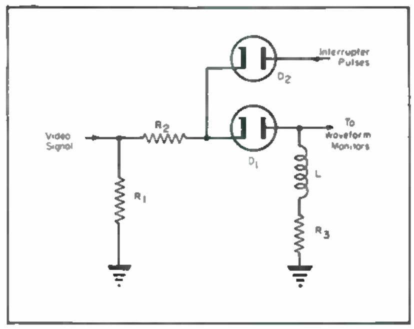
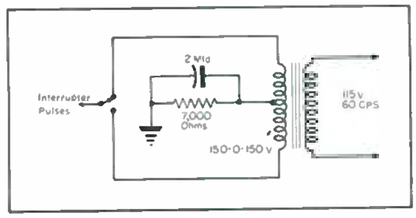


Figure 4
A video signal interrupter circuit.

Figure 5
Circuit for producing interrupter pulses. Changeover switch shifts phase of pulses 180° so that they can be prevented from coinciding with the vertical sync pulses.



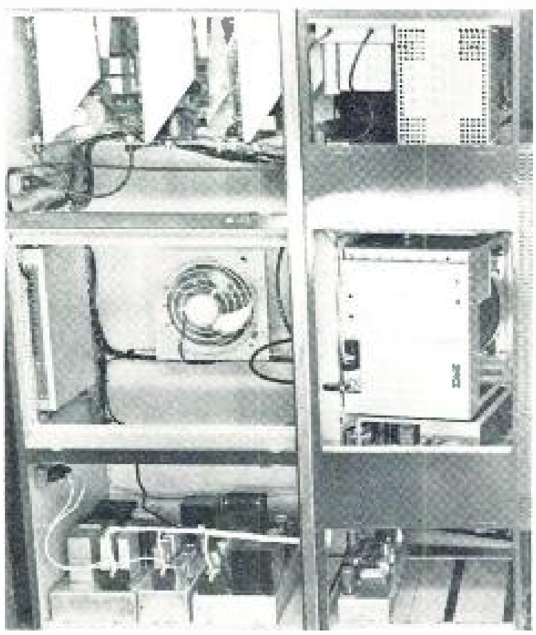
the amplifier output are isolated from the video line.

Terminating Connections

The bridging connections described are used only on the video input to the transmitter or where connection of monitors to a video line must not influence the signal in the line. At other monitoring positions in the transmitter a video signal is produced solely for supplying the monitors and the coaxial lines conveying these signals to the console must be terminated with 75 ohms. Video monitoring signals can be obtained in the transmitter by using the simple detector circuit shown in Figure 2. The pickup wire *P* is placed close to the r-f circuit to be monitored and by moving the position of *P* the amplitude of the video signal can be adjusted to the required value of about 2 volts peak-to-peak. The potential divider shown is used to terminate the video line at the console, the monitor being switched across the 25-ohm section and thus receiving a signal of ⅔ volt peak-to-peak. The connection of the monitor capacities across the 25 ohms will not influence the frequency response to the monitor inputs excessively and any switching surges are of no consequence since the video line is connected only to the monitors.

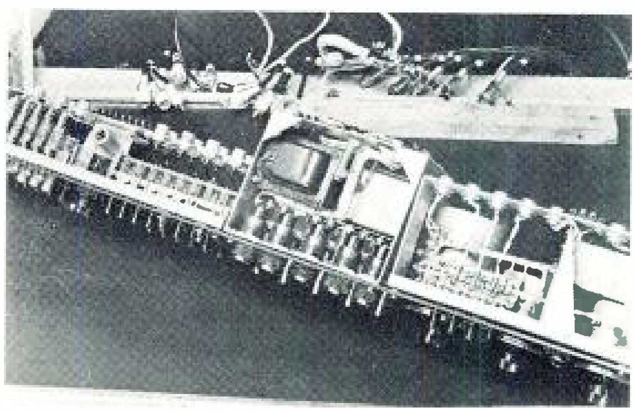
Percentage Modulation Measurement

The video signal obtained from the detector circuit of Figure 2 is shown in Figure 3*a*. At any instant the height of the curve above the zero volts line corresponds to the instantaneous amplitude of the r-f signal. Hence, if the sync tips represent 100% modulation, the modulation percentages corresponding to the blanking and white



(Left)
Rear view of console with covers removed.

(Below)
Switch panel with covers removed.



levels can be measured from the curve. However, since the waveform monitors are a-c coupled devices, only the a-c component of the curve is shown on the screens; therefore, some method must be found for establishing the level of the zero voltage line. A commonly used method is to connect the contacts of a vibrator across the video line so that it is periodically short circuited; however, this system is not very satisfactory since the contact resistance of the vibrator is rather uncertain. Unless this contact resistance is small compared with 75 ohms, an effective short circuit is not obtained. A more reliable electronic method is shown in Figure 4. Since the video signal is negative with respect to ground, it is conducted by diode D_1 and fed to the monitor input, its amplitude being reduced in the ratio $R_3/R_2+R_3+R_4$ where R_4 is the diode a-c resistance. The plate of diode D_2 is normally maintained at a potential more negative than the video signal so that it passes no current. At intervals, positive pulses are applied to the plate of D_2 and they are conducted by the tube and return to ground via R_2 and R_1. For the duration of a pulse, the cathode of D_1 becomes positive, D_1 ceases to pass current, and the voltage input to the monitors is zero. Hence, a series of interruptions occur in the video signal and we obtain the trace shown in Figure *3b* on the *frame* waveform monitor screen. The level of zero voltage is established by the bottom of the interrupting pulses. The a-c resistance of the diode D_1 will vary somewhat with voltage, so R_2 and R_3 are made as large as possible in order that the monitor input voltage shall be directly proportional to the video line voltage. As in the case of the monitor bridging circuit, a peaking coil *L* is connected in series with R_3 to correct the high-frequency response at the monitor input.

It is convenient to make the pulse frequency equal to a multiple of the video *frame* frequency since then the interrupting pulses remain stationary with respect to the sync pulses on the frame waveform monitor screen. This condition is met by the pulse generating circuit of Figure 5 as the frame frequency of the video signal is locked at half the a-c line frequency. The changeover switch in Figure 5 shifts the phase of the pulses 180° so that they can be prevented from coinciding with the vertical sync pulses.

Video Circuit

Figure 6 shows the complete video schematic of the console.[1] Push button switches are used throughout since they avoid passing through intermediate positions when operated. The input selector switch connects the transmitter video input to any of five incoming lines which would consist of (for example) two lines from the studio, two from remote pickup receivers and one from a test pattern generator. The input line selected is connected to the video gain control, which is a 100-ohm composition type potentiometer, and resistances R_8 and R_9 enable the effective terminating resistance on the line to be adjusted to exactly 75 ohms. The cable connecting the gain control to the video amplifier must be of low capacity since it cannot be terminated in the amplifier. The four incoming lines not connected to the transmitter input are terminated by 75-ohm resistors, R_{13}, etc., at the preview selector switch which connects any one of these lines to the monitor selector switches. The signal coming in on any line can thus be previewed before it is put on the air. The two monitor selector switches connect, respectively, the picture monitor and the two paralleled waveform monitors to the following positions:

Buttons 1, 2 and 3...Video monitoring points in the transmitter.
Button 4...Video detector coupled to antenna transmission line.
Button 5...Monitoring receiver.
Button 6...Preview selector switch.
Button 7...Transmitter video input.

An additional button *(8)* on the waveform monitor switch connects a 60-cps calibrating voltage, which can be adjusted by a potentiometer, and is measured by a meter calibrated in peak-to-peak volts.

In order that a quick calibration check may be made at any time, button 8 is of the non-latching type, i.e., when pressed, it does not release any other button and it returns to the *off* position when the finger is removed.

Buttons *1*, *2* and *3* on the picture

(*Continued on page 30*)

[1] DuMont TA-129-A

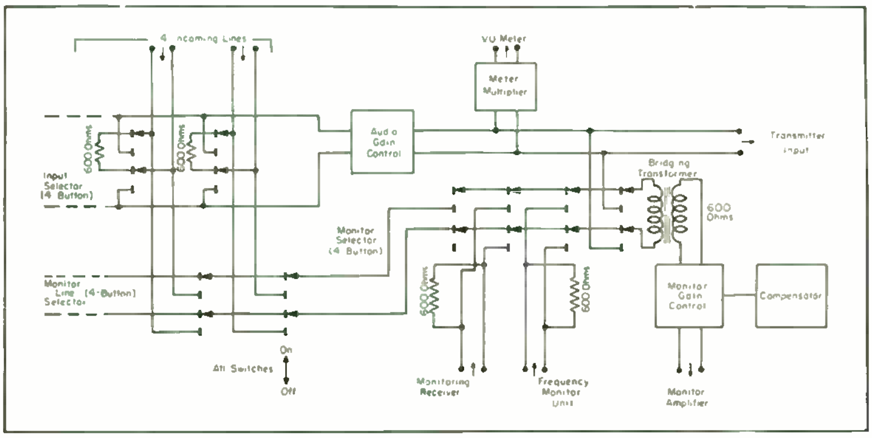
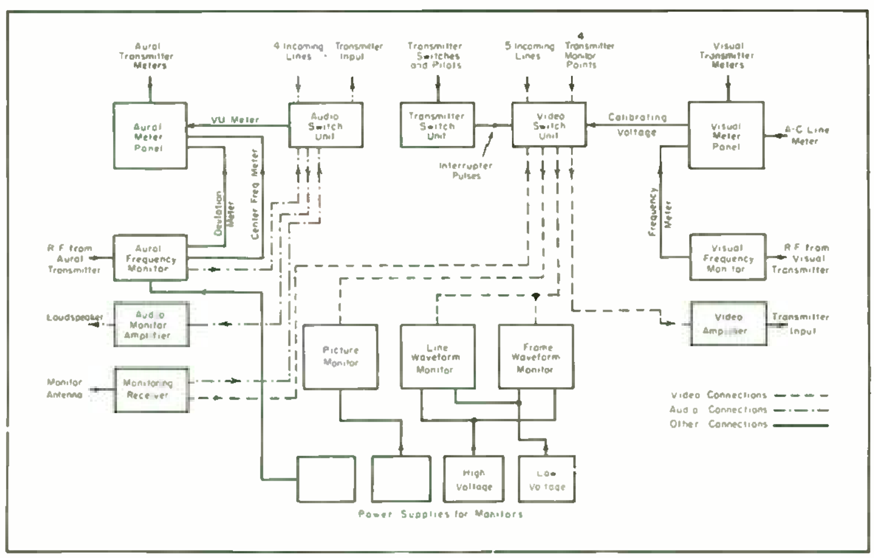


Figure 7
Schematic of the audio portion of the console.

Figure 8
Block schematic of the complete console.



F-M Broadcast Network With Radio Links

Six-Station Network, Operating On 153.59 Mc, Formed by Ten Farm Organizations in N. Y. State, Linked by Radio Relay Covering Nearly 118,000 Farms Or About 76% of the Farms in State. Each Station Uses 250-Watt Setup With Four-Bay Pylon with Power Gain of Six.

by DONALD K. de NEUF
Chief Engineer
Rural Radio Network

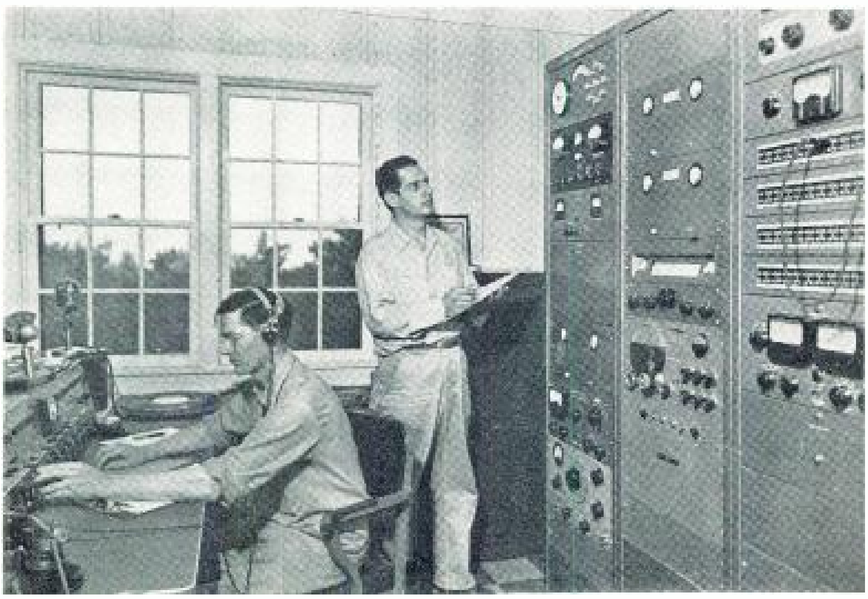
THE RURAL RADIO NETWORK of six stations, which recently went on the air was formed by ten leading farm organizations of New York State because of inadequate coverage by a-m facilities. The majority of stations are and always have been located adjacent to metropolitan and suburban areas as a natural development in serving the most important audience from an advertising standpoint. Consequently, large areas in the rural section do not receive adequate signal strengths, especially at night, to avoid selective fading, co-channel interference, and summer static. Furthermore, the program structure of the majority of stations which are receivable in the rural areas is naturally designed primarily for city and suburban listeners. There is a large amount of program material desired by farm listeners to which non-rural stations cannot afford to devote broadcast time. Although the rural listeners have tastes similar to city people and many of the same interests, the intimate concern of the farm family is with matters such as weather, so vitally important to the farmer, the prices of farm products, disease reports and control, fertilization, and a wide variety of other agricultural information essential to present day scientific farming. The time of the day that such material is broadcast is also highly important and makes up another element of difference between broadcasts to the rural areas as compared with broadcasts to urban areas.

Wireless Network

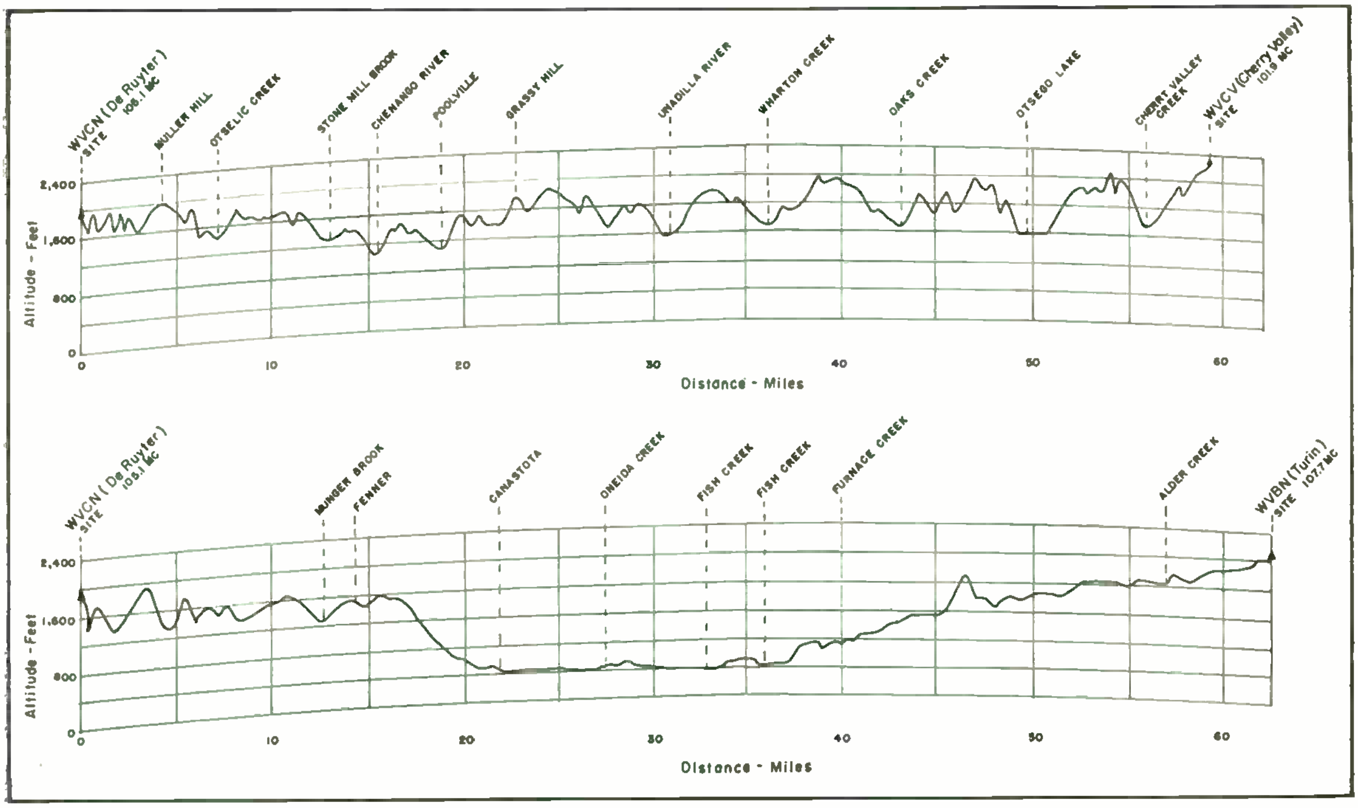
With the foregoing objectives in mind, the obvious answer to providing service to these rural areas was by means of a series of f-m broadcast stations. To meet requirements, these stations would naturally have to be located in the center of each rural area to be served and the greatest possible height above average terrain was an important element in achieving satisfactory coverage. At the same time, it would be necessary to provide some means whereby all six stations would be programmed simultaneously on a network basis. Wire lines connecting the six stations together were out of the question. They do not exist in such areas and the cost of providing such facilities would reach an astronomical figure. It was, therefore, decided that it would be necessary to locate each station in a manner which would permit it to relay to or from the adjacent station. In plotting the actual location of such stations, two separate elements were involved. The geographical position of each station with regard to its adjacent station was important from a relaying standpoint, as well as consideration of achieving a satisfactory f-m broadcast service area by each station.

Locations for each of the six stations was established on this basis with the

Operating room of one of the network stations. Equipment and layouts at all of the stations are identical. Apparatus in top panel in the left hand rack is used for the collection of weather information.



Microwave dishpan antenna atop the Ithaca Savings Bank Building which is used to beam programs to Connecticult Hill where they are channeled to the six stations in the network chain.



Above and below, topographical profiles between each of the stations in the Rural Radio Network.

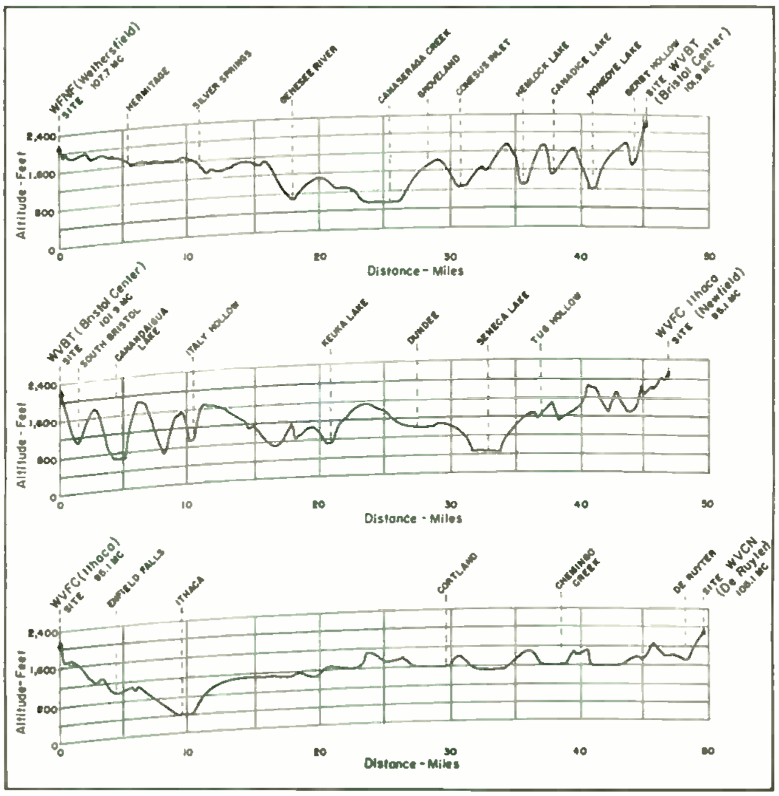
least possible compromise in achieving the two requirements simultaneously.

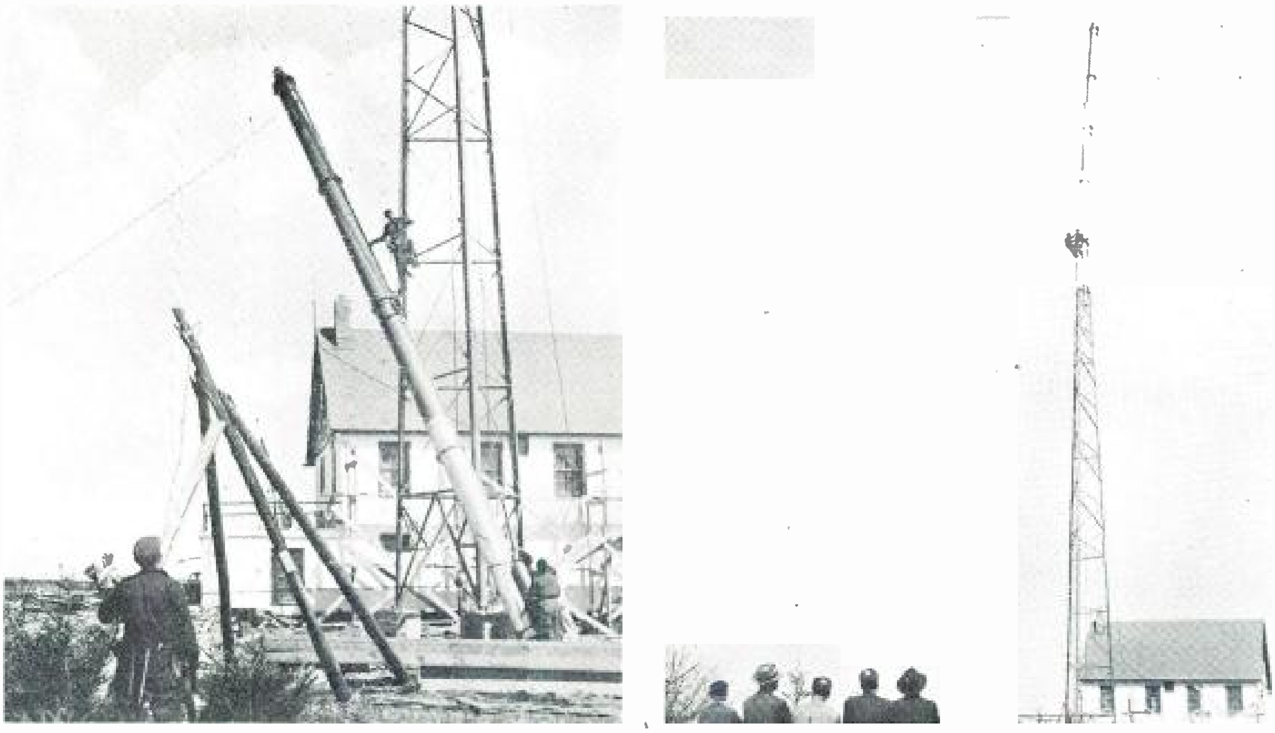
On page 15 appears a map of the loation of each of the stations involved, its approximate 50--microvolt contour, distance between stations, and the elevation above sea level of each station. It will be noted that an optical path exists between adjacent stations of the network. The overall 50-microvolt service area contour embraces nearly 118,000 farms, or about 76% of the farms in New York State. There is an appreciable overlap in the service area of each station with that of its adjacent station.

Mountaintop Construction

On October 15, 1947, the six stations received their construction permits.

Construction of the buildings and roads at five sites was commenced and carried through during the entire winter season. The carrying out of the project at this time of the year on 2,000-foot mountaintops in some of the most remote parts of the State offered a wide variety of problems and an opportunity to use considerable imagination and ingenuity. High winds, temperatures below zero, and heavy snowfalls complicated both accessibility and construction. Telephone service at such remote locations was non-existent. When it eventually became available at a few locations, it was only on the basis of rural party-line service already overloaded with as many as fifteen subscribers to a line. Consequently, one of the first tasks was to establish a radiotelephone communication system between the points involved and the field jeeps to permit the transmission and reception of information, instructions, emergency service orders, and the like to be carried on relating to installation, testing, and operation. It is not an exaggeration to state that without the use of such facilities the





Erection of the first pylon antenna at the De Ruyter station.

project now completed would have been almost a physical impossibility.

Inauguration of Network

The network with five stations went on the air June 6, 1948, with the sixth station at Turin under construction and scheduled to commence operations in the early Fall. The construction of the Turin station was postponed until late Spring because heavy snow falls in the northern part of New York State made building operations completely impracticable during the winter season.

Choice of Equipment

The operating rooms of the six stations are identical. Each station employs, at present a 250 watt transmitter[1], with a 4-section pylon antenna[2] affording a power gain of 6, supported by a 100′ steel tower. The effective radiated power of each station is 1,300 watts.

Crystal-Controlled Receivers

Each station also has crystal-controlled fixed-frequency receivers[3] for relaying purposes, and sixteen-element parasitic 34-db gain arrays are utilized for relay reception. Measurements are made daily over the network to maintain a distortion standard of 1% or less, and a signal-to-noise ratio of 60 db or better.

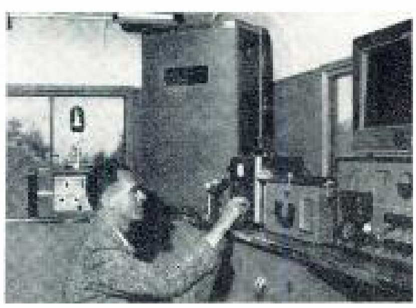
Recording Facilities

Each station is also equipped with dual turntables,[1] recorders[4a] and a small studio permitting the origination of local programs over the network, although the master studios in Ithaca

[1]G.E. [2]RCA. [3]REL 670-L. [4]RCA. [4a]Presto. [5]Smith-Meeker.

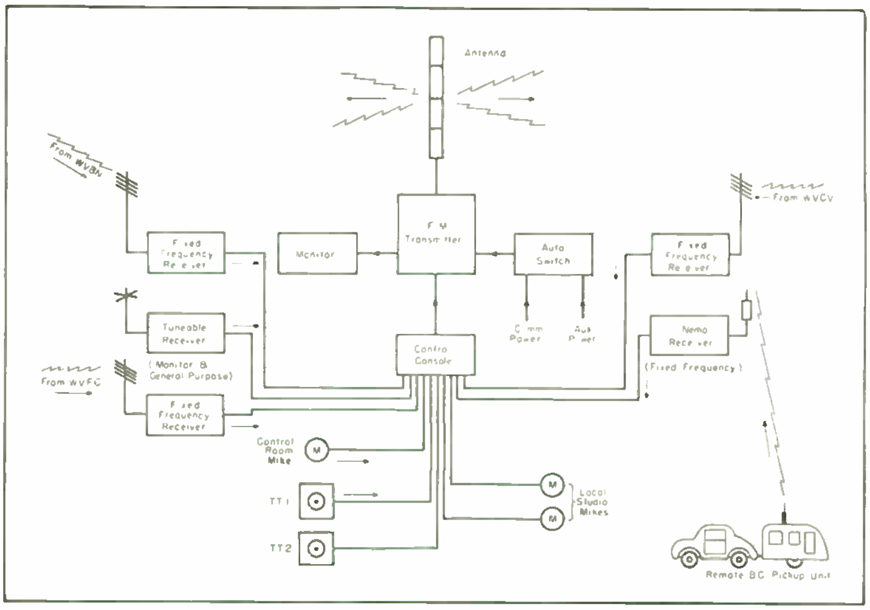
Donald K. de Neuf at facsimile equipment now being tested in an experimental multiplexing system.

Trailer unit used for remote broadcast pickup. Programs are relayed by way of a 50-watt transmitter operating on 153.59 mc. A wire recorder is included in this van for program material which does not call for live transmission. Truck also has a 35-watt p-a system for use at public gatherings such as farm meetings and fairs.



The Rural Radio Network mobile truck.

ted the majority of the programs. The relaying stations are equipped with emergency power in the form of 15-kw gasoline generators[5] with automatic switching facilities from commercial power. The Turin station is an exception in that it generates all of its power by means of 15-kw diesel units[5] in duplicate. Accessibility at this location is difficult during the winter season, and fuel for heating and the diesels is accommodated by 12,000-gallon storage facilities, sufficient to operate the station continuously for a period of four months. Dormitory and kitchen facilities for the station personnel are provided.



Block diagram of receiver and transmitter arrangement at WVCN. This setup is also used at the other stations.

Remote Area Locations

The stations, located in remote areas on mountain tops are in a unique position to collect weather information. Consequently, in cooperation with the U. S. Weather Bureau, each station is being equipped with a set of meteorological instruments[6] and the information derived will be reported daily over the network to the Weather Bureau office in Albany. The instruments consist of wind velocity and direction indicators, thermometers, hygrometers, barometers, and precipitation gauges. Some of the indicators on this equipment may be seen on the top panel of the left hand rack in the view on page 12.

Broadcast Operations

The network master control room is located in Ithaca as are the network studios. Programs are fed from this location to the master station of the network located on Connecticut Hill, by means of a 940.5-mc *stl* transmitter,[7] a distance of 9.5 miles. The receiver output of this circuit is fed through a control console and a limiting amplifier[8] to the f-m broadcast transmitter. Each station through a similar console is enabled to switch the network to operate in either direction, or to originate local programs.

Nemo Unit

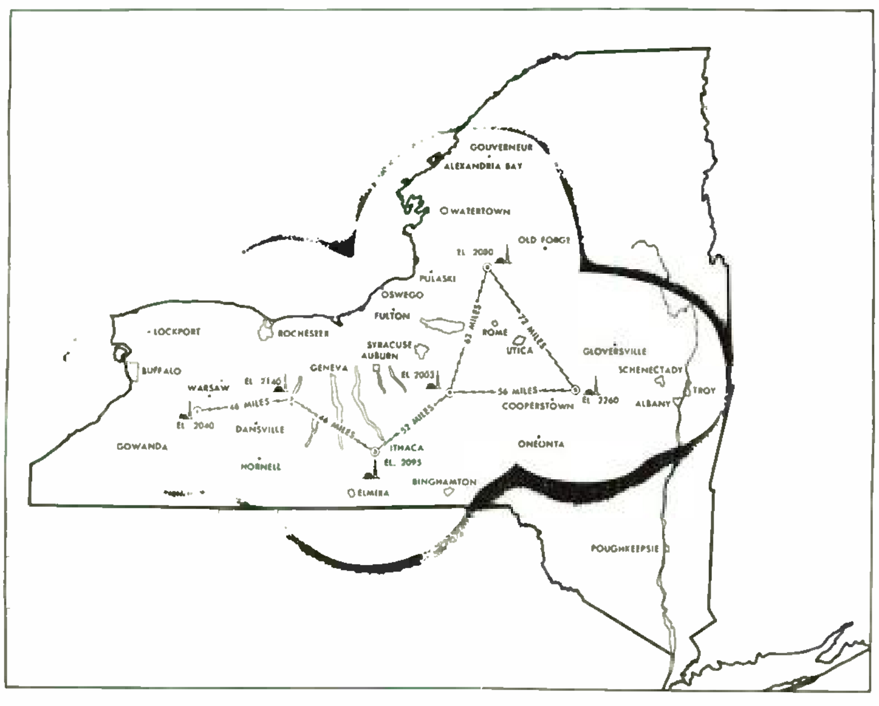
A *Nemo unit*[9] consisting of a trailer hauled by a 4-wheel drive jeep is utilized for remote broadcast pickups. Programs are relayed by means of a 50-watt transmitter operating on 152.75 mc. This unit is equipped with a 3-kw gas-driven generator to supply power at locations where no commercial power is available, or when a power failure occurs. A wire recorder[10] is included for program material which does not call for live transmission. A 35-watt p-a system is installed in the unit for use at public gatherings such as farm meetings and fairs.

Muliplex Tests

Experimental multiplexed facsimile tests are now being prepared, utilizing a frequency-shift subcarrier which does not impair the f-m aural broadcast standard of 50-15,000 cycle quality. This subcarrier operates within the frequency range of 22.5 kc (black) to 27.5 kc (white).

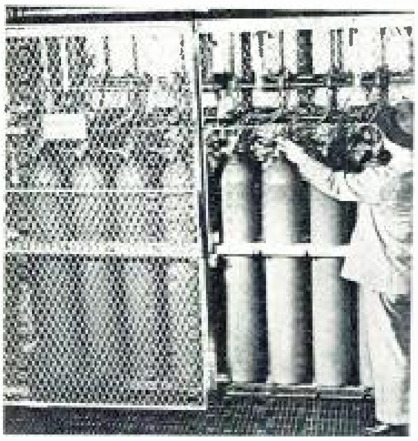
[6]M. C. Stewart. [7]G.E. [8]Langevin Progar. [9]G.E. [10]Brush.

Approximate service areas of the f-m stations in the Rural Radio Network. At point *1* is WFNF, operating on 107.7 mc. in Wethersfield; *2*, WVBT on 101.9 mc, Bristol Center; *3*, WVFC, 95.1 mc. Newfield; *4*, WVCN, 105.1 mc. De Ruyter; *5*, WVCV, 101.9 mc, Cherry Valley; and *6*, WVBN, 107.7 mc, Turin. Relay pickup points are indicated by the wireless line.



Microwave Tower Automatic Fire Protection System

Remote control fire-fighting station located near the cylinder source. From this point additional banks of cylinders can be released manually to combat fire that might persist in upper levels after initial automatic discharge.



Main and reserve banks of cylinders, each containing 50 pounds of carbon dioxide which are located on a steel grate platform below the 16th level

Labs, Workshops and Conference Room Atop 300-Foot Tower Protected by Built-In Carbon Dioxide Extinguishing System.

by S. G. FRECK

Manager, Industrial Division
Walter Kidde and Co., Inc.

FIRE CONTROL, ever an important factor, is particularly essential in laboratories where extremely delicate and valuable equipment is stored.

Cognizant of this problem, the staff of the FTL microwave tower at Nutley, N. J., provided for an extinguishing system to protect seven separate levels, three large enclosed landings and several platforms, beginning 212 feet above the ground, where are housed microwave equipment installations, workshops and conference rooms.

Protecting these work levels normally accessible only by an enclosed elevator, with their special hazards, is an automatic carbon dioxide extinguishing system[1].

Beneath the first operating level, the sixteenth, on a steel grid platform are thirty-two 50-pound cylinders of carbon dioxide, manifolded together for discharge in banks of eight main and eight reserve to the levels above (or sixteen main and sixteen reserve to the large conference room on the 20th floor) in case of fire. The carbon dioxide is stored in the cylinders as a liquid, under 850 pounds per square inch pressure.

Nerves of the automatic extinguishing system are twenty heat actuators strategically located throughout the laboratories, workshops, and conference room on the seven levels. Excessive temperature rise due to fire in any of these areas would set off these heat actuators, trip a *Lowe* release and ring an alarm.

A time delay mechanism allows less-than-a-minute interval for personnel to evacuate the tower work levels before automatic valves on the storage cylinder heads open. Released carbon dioxide rushes, under its own power, through rigid piping and is automatically directed to wide dispersal discharge nozzles located on the particular floor level where fire has broken out. When it leaves the nozzles, the carbon dioxide turns into an inert gas and expands to 450 times its stored volume. Discharging gas pressure automatically operates trips to close doors leading to all levels. There are fifty-eight discharge nozzles in the total area protected and they are so placed that they will totally flood the fire space.

Carbon dioxide is an ideal extinguishing agent for electrical fires, as it is a non-conductor of electricity, will not harm the most delicate equipment, and it leaves no messy residue.

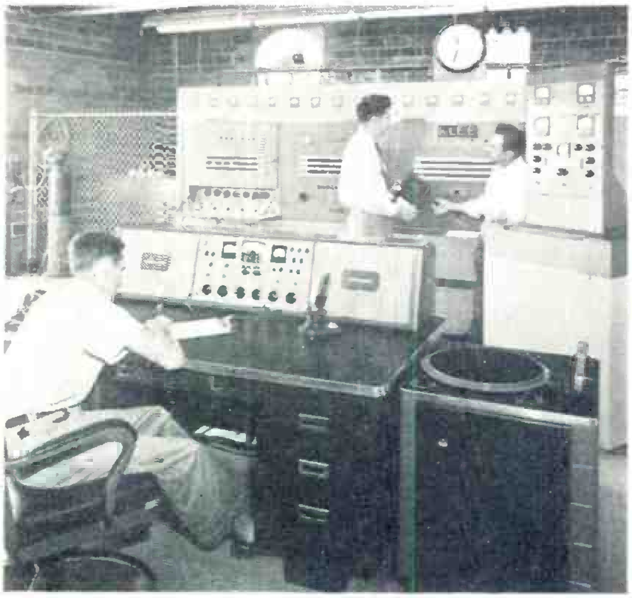
If a fire persists in any space in the tower after automatic discharge of the initial eight or sixteen cylinder bank, additional banks of eight cylinders can be discharged manually at remote control stations near the cylinder source, or on separate levels near entrance doorways.

[1]Designed and installed by fire protection engineers of Walter Kidde & Company.

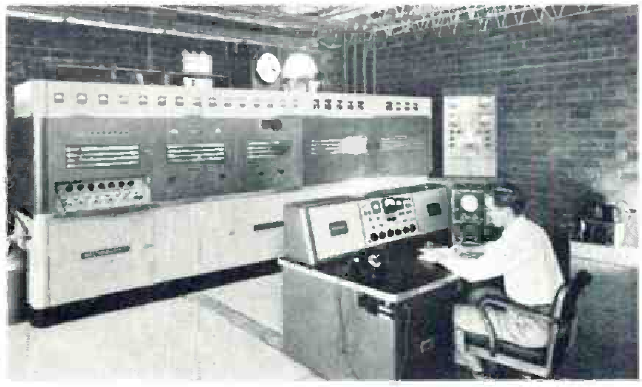
(Right)
The FTL microwave tower where automatic fire protection system has been installed.

(Left)
Heat actuators at either end of 20th floor conference room ceiling which can set off alarm in case of fire. Fire-killing carbon dioxide discharges through multi-jet nozzles concealed behind circular ventilating ducts.

The KLEE 5-KW A-M



(Left)
General view of the layout at the station. G. H. Henderson, transmitter operator, is at the control console. At right foreground is a turntable[1] which is used to provide emergency transcription facilities as well as test transcriptions. To the right of the control console is a phase monitor,[2] mounted on wheels, which enables the operator to move the monitor close to the control console so that the meters may be easily read. The phase monitor can be turned completely around while phasing adjustments are being made to the extreme right-hand transmitter cubicles. To the right of the KLEE nameplate is Paul Huhndorff and to the left, R. E. Sively of Westinghouse.



Right: Another view of the transmitter[3] room. In this view G. F. Rushing, transmitter operator, is at the control console. The 'scope was used initially because of the delayed delivery of the modulator. However, the 'scope has been found very handy in providing additional information about the carrier and is now used in conjunction with the modulation monitor.

THE TRANSMITTING SITE, ever the major item in an a-m installation, requires careful evaluation for directional coverage possibilities. In selecting the location for our station, for instance, we were interested in centering the lobe on the Houston metropolitan area, and therefore chose a point 14 miles due north of the city because our 4-tower directional array provided a strong southward lobe (25 millivolts per meter), centered on the Houston metropolitan area.

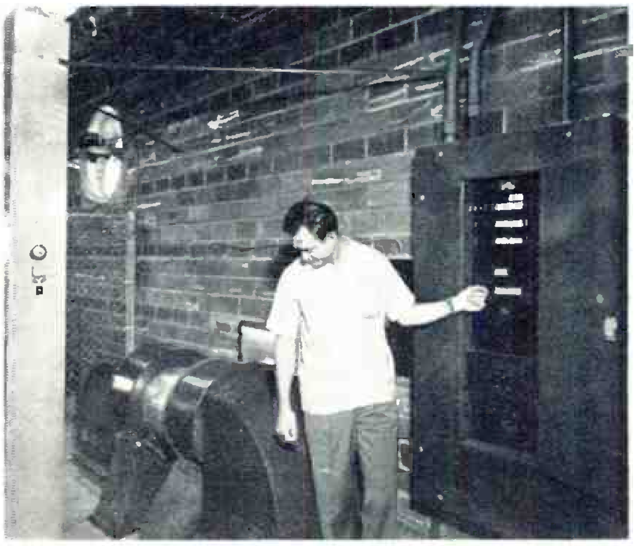
Antenna System

Our antenna system, which consists of four 400′ towers in an in-line arrangement, was completely prefabricated[1] in Fort Worth and hauled to Houston by truck. The towers are of steel girder type construction, 20″ square and sectionalized in 20′ sections. Prior to the erection of the antenna system all four concrete sub bases were poured. During a period of approximately 30 days, the base pedestal insulators were mounted and the first tower sections hoisted into

[1]Prefabrication by Johnnie Andrews Tower Construction Co.
[2]Conducted by Steve Kershner and William Frienmuth of A. D. Ring and Co., Washington, D. C.
[3]Federal.

High voltage power cage. In the right foreground is a dry type plate transformer with modulation transformer and choke located adjacent. Power cage is enclosed, interlocked, grounded, and bonded for safety reasons.

H. F. Weinzel, transmitter supervisor, energizing the air blower circuit. Note the inspection window and standoff insulators in the vertical section of the air duct. Incidentally, a dual blower system is provided, one blower being in use and one a spare. The intake air for the blowers is taken directly from the outside of the building through an airmaze type filter.



Installation in Houston, Texas

Transmitter Site Selection Procedure. . . . Use of Four 400-Foot Towers In-Line Antenna System. . . . Phasing Methods Adopted. . . . Dummy Antenna Employed in Tests. . . . Application of Measurement Techniques Such as 'Scope for Modulation Monitoring. . . . Maintenance Practices Followed.

by **PAUL HUHNDORFF** and **R. E. SIVELY**

Chief Engineer, KLEE — Westinghouse Electric Corp.

place. Then the upper sections were hoisted into place. The towers were guyed throughout their length.

The antenna patterns were adjusted by setting up the computed ratios and phase angles as indicated by the phase monitor. When these values were essentially in accordance with the computed values, cross minima measurements were made to determine the position of the minima. Adjustments were then made and the patterns were essentially in accordance with the computed patterns.

Non-directional measurements were then made to determine the efficiency of the non-directional radiators. The south tower was used as a nondirectional radiator and its base impedance was found to be 404 + j 83.5 ohms.

Proof of Performance

In the proof of performance tests two field intensity meters and two station wagons were used to make measurements at various points. One of the station wagons was equipped with a mobile telephone unit furnished by the local telephone company.

The null points were adjusted to a fine point by talking to one man at the transmitter phasing control, while one man in a station wagon was driving back and forth to the null point.

Phasing

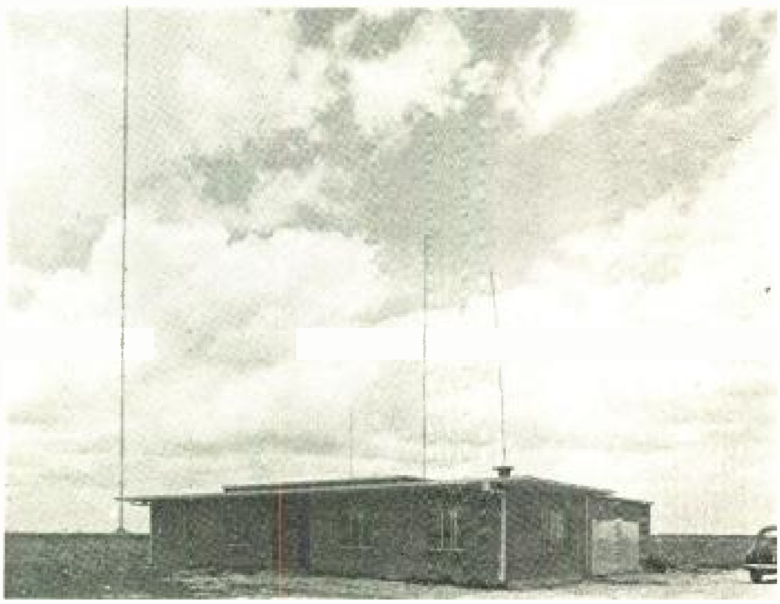
Many hours were spent in phasing the station by taking field strength measurements in the null point to find out how many degrees deviation can be allowed and still remain in the licensed value. Some tower phasing is very critical and a 1° to 1½° or 2° phase shift will create a large change in the nulls. This was all done prior to the 24-hour operational duty to find out the stability of the phasing design.

It was also found that changes in seasons from wet to dry have a definite

(Continued on page 33)

Overall view of the terrain surrounding the KLEE transmitter. Towers, triangular in shape and approximately 400′ tall, are guyed. An f-m antenna has been installed on tower 2 for future f-m operation.

Below: Transmitter building with towers 3 and 4 in background. Building is of concrete slab foundation, with brick walls and plaster interior, and is substantially fire-proof. Included in the transmitter building is a small apartment used by one of the transmitter operators.



RCA 70C2 universal head. RCA WM 30A.
E. F. Johnson phasing equipment.
Westinghouse 5 HV-1 5-kw transmitters.

TUBE *Engineering News*

Design and Application Data on Single Resonator, Reflex-Type, Klystrons.

Two Klystron oscillators of the single-resonator, reflex type, 2K26 and 2K56, intended primarily for use as local oscillators in microwave receivers, have been announced by RCA. They are also useful as frequency-modulated sources in low-power transmitters for relay applications, as local oscillators in microwave spectrum analyzers, and as pulse-operated oscillators for testing circuit response.

The 2K26 is designed for operation in the 6,250- to 7,060-mc range, whereas the 2K56 is designed for operation in the 3,840- to 4,460-mc range. Both types have a power output of about 100 milliwatts.

In both tubes the resonant cavity and its associated mechanical tuning mechanism are integral parts of the tube.

The mechanical tuning provides a method of making broad adjustments of frequency. The 2K26 can be electrically tuned to give about a 55-mc vernier adjustment of the frequency, while the 2K56 can be electrically tuned to give about a 35-mc vernier adjustment of the frequency.

When using the 2K26 as a c-w oscillator, class C, at 6.660 mc (operating mode *A*[1]), with a ¾"x1½" wave guide, the d-c resonator voltage is 300; d-c resonator current 25 ma; d-c reflector voltage range[2] –65 to –120; d-c reflector current less than 7 microamps; half-power electronic-tuning frequency change[3] 55 mc, and power output 120 milliwatts.

Installation and Application

Bases are standard octal base modified to pass the coaxial output line. A suitable socket can be obtained by taking an octal socket, removing clip from pin *4* positon, and drilling the pin opening sufficiently large to admit coaxial output line and the surrounding transducer coupling. The tube may be mounted in any position and must be rigidly fastened by a suitable clamp on the base of the socket mounting. Such a clamping arrangement will guard against any excessive strain on the coaxial output line, since bumping or continued pressure on the output line will damage the tube. The tube must not be clamped above the shoulder of the header skirt.

The *coaxial output line* of the 2K26 is coupled to a ¾" x 1½" wave guide through a wide-band coaxial transducer coupling unit.

This transducer or its electrical equivalent must be used to insure tube interchangeability and satisfactory tuning characteristics. In addition, the standing-wave ratio at the coupler should not exceed 0.8 db (1.1 voltage-standing-wave ratio).

Shielding of the reflector and the resonator voltage leads as close to the tube as possible is essential to avoid modulation of the tube output by any external voltages.

The *cathodes* of the klystrons are usually operated at a negative potential with respect to ground. Consequently, the heater transformer must be insulated to withstand the maximum acceleration voltage of the tube. The cathode may be connected to one side of the heater or the center tap of the heater transformer secondary. When cathode and heater are connected together, connections to the cathode must be made directly to the cathode contact on the tube socket and not to the heater lead. When the cathode and heater are not connected together, the heater-cathode voltage should not exceed 50 volts.

In most applications the positive side of the power supply is at ground potential. Consequently, the shell which is integral with the resonator is at ground potential. In some applications the shell is not at ground potential. Therefore, to protect the user from coming in contact with the high voltage, it is essential that the klystrons be surrounded by a grounding shield and mechanically tuned with an insulated tool.

The *reflector electrode* is connected to a small cap on the top of the tube. The power supply connected to the top cap must be insulated to withstand the total acceleration and reflector voltage. The reflector voltage must never become positive with respect to the cathode.

The *mechanical tuning mechanism* of the tubes are designed to permit an occasional adjustment of frequency. They are not recommended for use where continual or frequent adjustment of frequency is required.

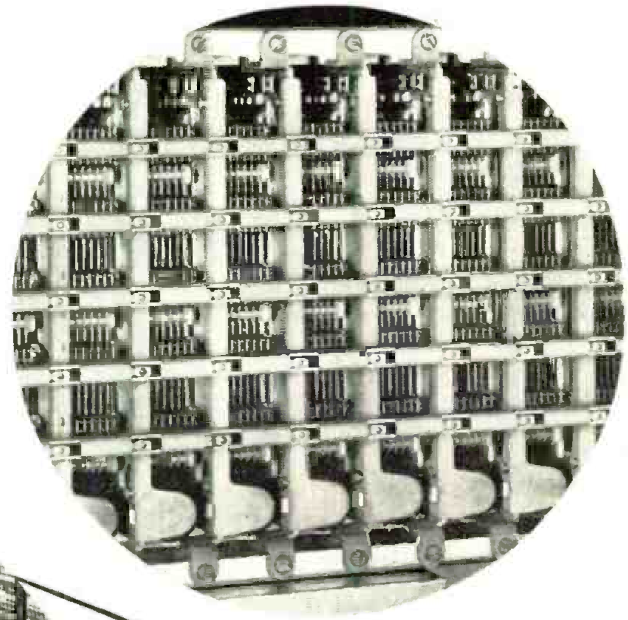
Klystrons of the reflex type that include a resonator as an integral part of the tube are broadly tuned by changing the resonator-gap spacing. One wall of the resonator is a flexible diaphragm which is the flat disk (where the diameter of the tube changes) just below the reflector cap. The smaller tube diameter, which is the cylindrical portion of the tube surrounding the reflector electrode, is supported on one side by a tuner back-strut which acts as a hinge. The other side is supported by a tuner bow on which the frequency adjustment screw is mounted.

[1]Voltage modes are regions within the total range of the reflector voltage in which oscillations will occur. Oscillations will not occur in the regions between modes. Mode *A* has been chosen because it represents the best compromise between optimum power output and a wide electronic tuning range.

[2]Adjusted for maximum power output at the given operating frequency.

[3]Change in frequency between the two half-power points when the reflector voltage is varied above and below the point of maximum power output corresponding to the given frequency.

T W X



Switches in small offices do a distant operator's bidding.

IT TALKS WITH FINGERS

For those who want to talk, Bell Laboratories scientists developed the telephone. For those who prefer the typewritten message, they developed TWX – Teletypewriter Exchange Service.

Fingers on a keyboard send your message to be typed by one or scores of other teletypewriters selected at your request from the 21,000 instruments connected to the Bell System's nationwide TWX network.

As in telephone service, your TWX connection is set up through switching systems, manual or mechanical, as best may serve. And over long distances your message travels economically with many others on the same pair of wires. All these technics are products of Bell Telephone Laboratories research in the telephone art.

TWX is today a vital link in the nation's chain of communication. And year by year it benefits from the steady growth of the telephone system which carries it.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.

A Report On Microwave TV Networks

There are two ways to interconnect tv stations for network operation or for handling of programs originating outside the transmitting studio. These are microwave radio systems operating on frequencies where the channel-width requirements represent a small percentage of the operation frequency, or the use of coaxial cable with booster points located sufficiently close together to permit passing the required bandwidth without excessive attenuation. A wide variety of methods are already in use or destined to come into use during the early future using microwaves and coaxial cable facilities.

In one system a tv transmitting station is picked up in a conventional manner on a receiver and then the video is transferred by microwaves the rest of the way. This eliminates the need for the first station in the microwave relay setup. New Haven, Connecticut, picks up New York in this manner on a hilltop within New York's and New Haven's horizon. The program is then transferred to a simple microwave transmitter at that point and the program is sent direct to the transmitter in New Haven for rebroadcast. General Electric uses a similar method, but with additional microwave relay points for transferring WNBT programs from New York to Schenectady.

The A. T. & T. system between Washington and Boston with a choice of way points uses microwave relay facilities between Boston and New York. At New York, coaxial cable is plugged in for the route to Washington. The system is expanding in both microwave relay stations and coaxial cables and will eventually become nationwide in coverage.

Interconnecting microwave relay systems such as the Philco and NBC microwave networks are another network arrangement. Philco owns a system between New York and Philadelphia which operates on about 1,400 mc. It continues to Washington, D. C., with a Baltimore way-point over NBC microwave facilities on about 7,000 mc.

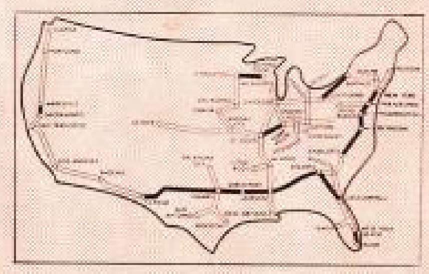
The Western Union microwave relay system for handling large numbers of multiplex channels also can accommodate two wide-band television channels of about 4½ mc bandwidth. These channels are common carrier facilities for the tv field similar to that available from the Bell System.

Microwaves have had to overcome a head start by coaxial cables. The magnitude of the Bell system coaxial cable program is illustrated in Figure 1. In late 1946, a total of 2,700 miles of coaxial cable was in existence. New construction was continuing at the rate of nearly 3,000 miles per year. Not all of these coax lines are yet available for the handling of tv programs until additional provisions and satisfactory booster station separations are provided. The current progress in new coaxial cable construction is subject to modification and re-determination as microwaves demonstrate their suitability to do the job technically better and financially less costly. Figure 2 shows the latest Bell System television network routes planned or already existing in the United States, no distinction being made between microwaves and coaxial cables in providing program relaying facilities. A basic charge of $35 per airline mile per month for eight consecutive hours of operation is currently the rate for the use of these facilities. Service beyond eight consecutive hours daily is at the rate of $2 per hour per airline mile on a monthly basis. A flat charge of $500 per month per terminal connection has also been set. In the case of service between New York and Philadelphia involving an airline distance of 83 miles, the charges are $2,905 per month for eight hours of consecutive operation per day, plus $1,000 per month for two terminal connections. Every additional hour per day costs $186 per month.

For occasional use, the charge for the first hour between New York and Philadelphia is $1 per hour per airline mile plus $200 per terminal connection and $10 per hour for the use of each station. This adds up to $503

Figure 1 (Below)

Coaxial routes which microwave relay systems augment or parallel. The solid line indicates coaxial cable now under construction or installed, and the open lines indicate coaxial construction planned for the next few years. *(Courtesy Bell System)*.



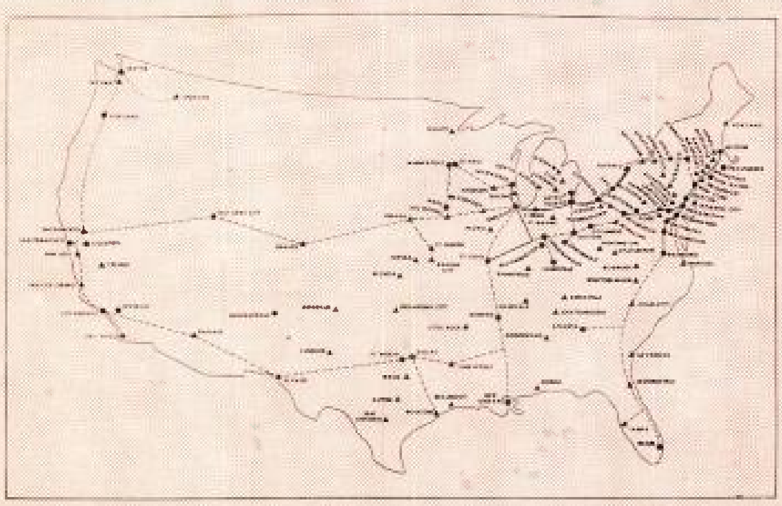


Figure 2 (Left)

Existing and currently proposed coaxial cable and microwave relay routes of the Bell System, as of June 1948. This does not include non-television network facilities involving narrower channel bands. Tv stations and networks now available are indicated by solid line and dots. Stations and routes to be installed in 1949 and 1952 are indicated by dashed lines and triangles. *(Courtesy A. T. & T. Long Lines Department.)*

Recently Completed Survey Provides Pertinent Data on Coax/Microwave Costs, Present and Possible Routes in Middle West, South and Far West Areas, and Detailed Analysis of Boston-N. Y. Link, Equipment Used and Its Operation.

by SAMUEL FREEDMAN

New Developments Engineer
DeMornay-Budd, Inc.

for a program occurring only once and lasting one hour. Each additional hour within the same month, where the terminal stations have been set up in accordance with the foregoing, costs $103 or minus the two terminal station charges of $200 each. Transmission over video channels are for one-way only. An additional channel and separate station connections are used for transmission in the other direction.

The technical superiority of microwaves lies in its ability to handle a wider bandwidth with greater separation between repeater-booster stations. At the present time, coaxial cable can handle the required bandwidths only by keeping the repeater-booster stations closer together. The present practice is to keep the booster points eight miles apart. With such spacings, it is currently feasible to handle tv programs with a 2.7-mc bandwidth. To use a wider bandwidth, the attenuation becomes excessive between the eight-mile coaxial booster points. A coax cable can handle any bandwidth provided increased attenuation with increase in bandwidth is compensated by closer spacings of coax booster points for the amount of signal level introduced into the cable. The Bell System limits their microwave network to the 2.7 mc bandwidth so that they may interconnect with the coax cable system.

When the subject of relative cost per channel arises, there are many interesting factors which can be cited for both coaxial cable and microwave relay stations. A coaxial cable as buried in the ground actually comprises several coaxial cables within the same sheath. An example is the eight coaxial tube lines, each a channel in itself, involving a material cost of a dollar per foot for the overall cable, or about $5,000 per-mile-material cost. This, however, is a fraction of the overall cost for a coaxial cable system. To this figure must also be added the cost of repeater-booster stations every eight miles, right of way, burying the cable underground in a variety of terrain and special equipment for handling video programs. When all elements of cost are included, the cost can go as high as $50,000 per mile. The figure varies greatly in different areas.

On the other hand, experiences with the New York-to-Boston microwave radio system may indicate that microwaves are not markedly cheaper than coaxial cable per video channel. This may be true because of the completeness of installation and elaborate provisions for assuring completely reliable performance. This system has all repeater stations housed in excellent buildings costing about $60,000 each and paved access roads which cost about $30,000 per station. In addition there are the excellent vantage points acquired for locating the stations, power lines, order and alarm wires, emergency power, miscellaneous utilities, etc., all of which have been costly. All equipment is duplicated so that communication is unimpaired when any unit is in need of maintenance or repair.

A typical repeater-booster station between New York and Boston is shown in Figure 3. These stations are designed for unattended operation, made feasible by a landline alarm sys-

Figure 3
Unattended microwave relay station for renewing the horizon and signal strength, typical of the seven intermediate stations on hilltops between New York and Boston. Waveguides extend up through the roof to elevated antenna platform supporting four horn-type metal lens antennas. Two are beamed to the direction of Boston and two are beamed towards New York. *(Courtesy A. T. & T. Long Lines Department).*

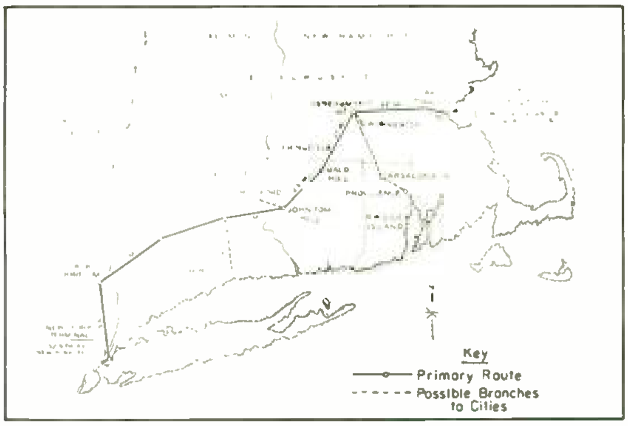


Figure 4
Route of the microwave relay system between Boston and New York. Changes in direction at each point minimizes the possibility of the sharply beamed signals being picked up from more than the adjacent station, should beyond horizon communication be possible. *(Courtesy Bell Telephone Labs.)*

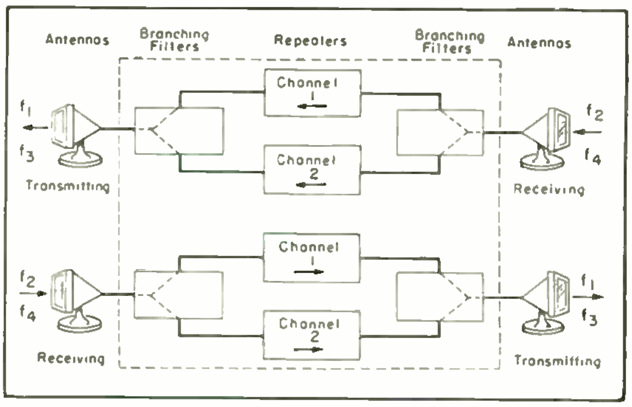


Figure 5
Repeater and branching filter setup used in microwave net setup. *(Courtesy Bell Telephone Labs.)*

NEW! BATTERY-OPERATED!

-hp- 204A AUDIO OSCILLATOR

Range:	2 cps to 20 kc
Distortion:	1%
Output:	5 v into 10,000 ohms
Response:	Flat within ± 1 db

-hp- 404A VACUUM TUBE VOLTMETER

Range:	2 cps to 50 kc
Voltage:	.001 to 300 v, 11 ranges
Accuracy:	± 3% to 20 kc
Input:	10 meg., 20 uufd shunt

Portable, light-weight, completely hum-free, weather-proofed, designed for general use where power sources are not available—that's the new *-hp-* 204A Audio Oscillator and 404A Vacuum Tube Voltmeter. Now — *anywhere, anytime* — you can accurately make geophysical, remote broadcast line, carrier current, strain gauge, telemetering circuit, telephone and telegraph, motion picture sound, marine and aircraft circuit measurements. And in the laboratory, these instruments make possible completely hum-free measurements.

-hp- 204A Audio Oscillator

Like other *-hp-* oscillators, the new *-hp-* 204A is easy to use, requires no zero setting. Tuning is direct or by a 6:1 vernier control. Frequency range of 2 cps to 20 kc is covered in 4 decade ranges. Five flashlight and three 45 v "B" batteries are easily accessible, mounted in rubber-lined anti-corrosion case, balanced for over 60 hours life. In average use they need be replaced only once every three months. Entire instrument is mounted in a welded dural case with splash-proof cover. All components are instantly accessible for servicing. Neon on-off pilot light shows when oscillator is operating. Size 10½" x 10½" x 11". Weight 24 lbs.

-hp- 404A Vacuum Tube Voltmeter

The new *-hp-* 404A battery voltmeter is designed for a-c measurements from 2 cps to 50 kc, at voltages from .001 to 300 v. The 404A is modeled after the *-hp-* 400A voltmeter, but has 10 times the sensitivity. Input impedance is high (10 megohms), and accuracy is within ± 3%, 2 cps to 20 kc, ± 7% to 50 kc. The instrument is also useful as a hum-free amplifier, with standardized gain up to 60 db. Operation is virtually independent of battery, temperature or humidity changes.

A linear meter reads rms sine wave values, with continuous db readings from −62 to +52 db. 11 voltage ranges selected with a single switch; no other adjustments necessary during operation. Neon on-off warning light, welded dural case, splash-proof cover. Size 7½" x 10½" x 9". Weight 14 lbs. approx.

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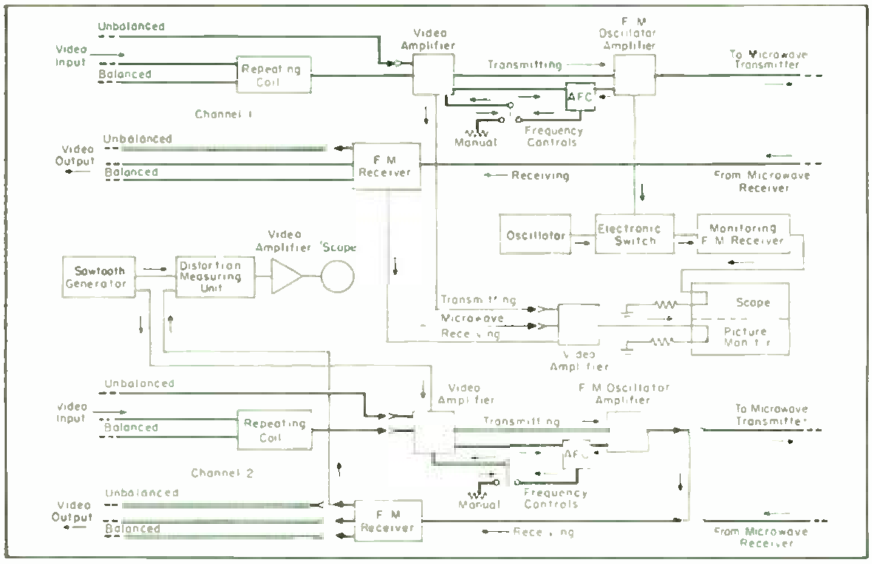


Figure 7

Block schematic of terminal, including monitoring and distortion measuring circuits. *(Courtesy Bell Telephone Labs.)*

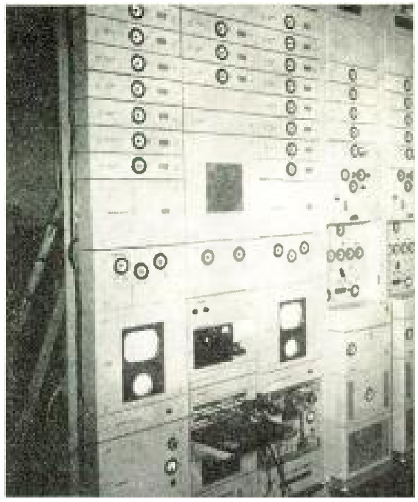


Figure 6

Duplicate monitoring and communication equipment bays plus coaxial-radio interconnection bay, typical of the New York-Boston terminus points. *(Courtesy A. T. & T. Long Lines Department.)*

tem with step-by-step provisions to indicate at a distant maintenance center what the conditions are at the unattended relay station. An example is a 14-function step-by-step selector system, which in the case of the Jackie Jones mountain station, makes known at the Southfield, N. Y., maintenance center (12 miles away) which of the following typical conditions may exist:

(*1*) The opening of the door to make possible entry into the building.
(*2*) Temperature conditions (high or also low) and on which specific floor in the building.
(*3*) Equipment functioning or nonfunctioning.
(*4*) Failure of outside commercial power.
(*5*) Whether interim emergency power from batteries and a converter is in use.
(*6*) Whether main auxiliary gas-driven generator has started up, reached a stable operating condition and taken over the load from the interim emergency power.

The stations normally operate on outside electrical power. When power fails, there often is a gap of time before the gas engine generator warms up and dependably functions. To prevent an interruption of even a few minutes, a bank of storage batteries automatically operate a converter-converter setup capable of providing sufficient power within two seconds after the outside power fails. In the meanwhile, the gas engine generator starts up and is allowed to reach a stable operating condition in about eight minutes. It then automatically takes over the load indefinitely until outside power is restored or as long as sufficient fuel is available in the storage tanks. The converter-converter then ceases to function.

It is still too early to arrive at the full cost of the system since it was the first full-scale trial of microwave relaying under actual operating conditions. Many of the economic and technical aspects of microwave relaying as a means of providing circuits for tv, multiplex telephony and various broadband services had to be determined. It is conceivable that the system to date may exceed in cost what coaxial cable might have involved between the same cities. This could have been brought about by the great interest in the subject, large amount of engineering time devoted to microwave planning and the fact that only two channels were provided in capital facilities that could accommodate several. It is generally anticipated that microwave relays should be cheaper than coaxial cable in connection with future systems. This should be particularly true on the next stage of expansion which is now commencing between New York and Chicago. This new system is expected to accommodate about six channels of wide-band communication with no marked increase in cost per station for buildings, real estate, access roads, power lines and utilities.

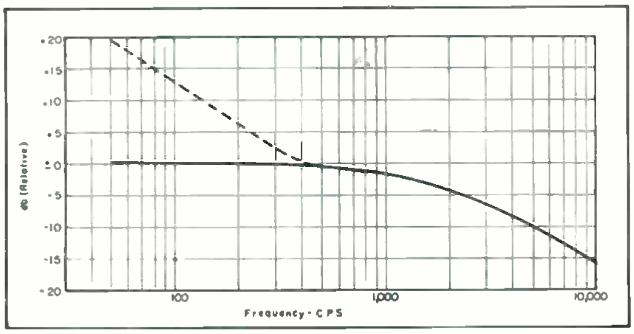
The average microwave repeater separation is about four times that of the coaxial repeater in the eastern part of the United States. When the mountainous regions west of Nebraska are reached, it can become over ten times further apart than coaxial cable. In such areas, accessibility is frequently a problem and it will be less convenient to install and service coaxial booster points at eight-mile intervals.

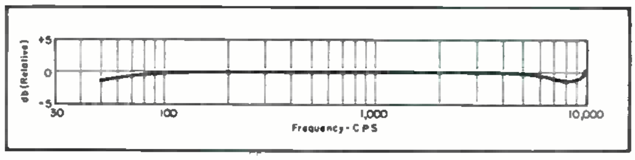
If the remote possibility of reflections from density stratifications of the atmosphere may be ignored, microwave stations can be spotted through most of the region between the Nebraska-Wyoming line clear to the Pacific coast at elevations exceeding 8,000 feet even along highways and areas convenient to public utilities. Such elevations can provide independent radio horizons in the order of 125 miles. Between two stations, these horizons may be added to give a total of about 250 miles airline coverage. Under such conditions, the very idea of coaxial cables becomes uneconomic when compared to microwaves. Even if microwave relay systems were to cost as much or more than coaxial cables between cities on the eastern seaboard or on the flat midwestern plains, it would still enjoy a great overall cost advantage on a nationwide basis.

The opportunities existing in the western part of the United States to do outstanding work with microwave relay systems are both plentiful and convenient. For example, one needs to be neither off a paved road or isolated from a modern community and utilities in order to enjoy elevations such as 8,835 feet near Laramie, Wyoming, looking downward through the plains of Nebraska or downward and upward to the west, north and south. The same holds true at 8,000-foot Laguna Mountain in southern California with a breath-taking view of the Salton Sea and the Imperial Valley towards the Arizona border, or from 6,200-foot Mt. Wilson with a horizon encompassing all of southern California to the Mexican border. Relative elevations also exist to provide unusual performances. For example, in southern California lies Mt.

(Continued on page 34)

Figures 1 (below) and 2 (left)
The frequency response of a reproducer may be found by reproducing a 33⅓ rpm vinyl tone record and measuring the frequency response with the output level of the preamp adjusted to be below the overload point. For this purpose the circuit of Figure 3 presented in the July issue discussion can be used. With this circuit and the frequency response measured with the compensator in the *flat* position, a curve similar to that shown in Figure 1 should be obtained. A second frequency run can be made with the compensator in the orthacoustic position. This run should provide a curve similar to the solid line indicated in the Figure 2 plot. The dashed line illustrates the low frequency response of a compensator designed for a typical magnetic pickup.





Broadcast Transcription-Reproducing System *Maintenance Procedures*

by RALPH G. PETERS

Proper Use of Isolation Transformer and Recording Stylus. Sources and Cures for Hum and Rumble. How to Handle Transcription Discs.

Isolation transformers are an important item in preamp equipment used in transcription-recording systems, providing circuit symmetry.

Some preamps use a center tap ground on the input transformer and if the pickup head or the compensator also has a ground on one side, this additional ground would obviously disturb the circuit and distortion would ensue. To avoid this difficulty, one of several things would be necessary; the center tap ground could be removed from the amplifier and the ground circuit would then be dependent upon that which exists in the compensator. In such a case, care would have to be exercised to see that the polarity of the tie line which connects the compensator with the amplifier is correct. Possibly the best method of overcoming the dissymmetry of the ground circuits is the use of an *isolation* transformer. For the normal range of magnetic pickups, a 1:1 ratio transformer which has an impedance ratio of about 200-200 or 500-500 ohms should be used. The better isolation transformers have *humbucking* construction, and an electrostatic shield which is to be connected to ground. The use of the isolation transformer permits grounds to be placed on the center tap or either leg of the primary or secondary as required.

Reproducing Stylus

Another important transcription-recording item is the reproducing stylus.

For optimum results, present standards require the use of a stylus tip radius between .0023″ and .0025″. Styli having tip radii in excess of .0025″ will give rise to excessive scratch; a tip radius smaller than .0023″ will permit the stylus to ride the bottom of the groove with a consequent increase in distortion on certain types of records.

Worn styli will greatly increase the distortion and surface noise and in addition will lessen the life of the transcription disc.

Permanent styli are usually either diamond or sapphire; it has been found that the life expectancy of the diamond styli is much greater than the softer sapphire. Many cases of distortion have been traced to the use of styli which have been deformed by the abrasive action of shellac recordings.

The examination of styli for wear should be made by means of a high-powered microscope or by the shadowgraph. Most reproducer manufacturers are in a position to supply this service. It is recommended that reproducers having styli suspected of being deformed or chipped be returned to the manufacturer for examination and possible replacement.

Hum

Hum is still quite a bugaboo in recording work.

The low output signal level of reproducers often leads to hum difficulties. Each hum problem invariably represents an individual case.

One of the most common causes is the lack of a good ground. The ground should connect to the motor and the frame of the turntable, and should include the frame of the reproducing tone arm.

The compensator used with magnetic pickups usually contains an inductance which may be susceptible to hum pickup. When the compensator is mounted in the turntable housing, the position of the compensator should be determined by trial, in an effort to locate the compensator in a position which will result in a minimum hum pickup.

The usual source of the interfering hum field is the turntable motor. However, it is well to keep in mind that other external fields may have to be taken into consideration particularly in cases where the position of the playback turntable is fixed. Hum pickup has resulted from the close proximity of electric lights, clocks, and other a-c operated equipment used in the immediate vicinity of the turntable. Some reproducing tone arms have a matching transformer located on the tone arm, and when the tone arm changes its position during the playing of recordings, it is possible for the tone arm to assume a position in which

(*Continued on page 36*)

[1]From maintenance manual, *Maintenance Procedure For the Broadcast Transcription System*, prepared by research engineers of NBC Radio-Recording Division.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

Personals

Life Member J. McWilliams Stone, president of Operadio, has been named on the convention and banquet committee of the RMA *silver anniversary* convention which will be held in Chicago, in association with the Radio Parts Show, during the week of May 19 at the Hotel Stevens in Chicago. JMS was a director on the first RMA board of directors in 1924. . . . Life member Orrin E. Dunlap, Jr., vice president in charge of advertising and publicity of RCA, is the author of a new book entitled *Understanding Television—What It Is and How It Works*. The book, published by Greenberg of New York City and selling for $2.50, covers such interesting phases of tv as the developments which led up to the present-day design, production, operation of the tv camera, relay stations, etc. . . . VWOA life member Haraden Pratt, vice president, chief engineer and director of Mackay Radio and Telegraph Company and vice president and director of FTR, whom we regret to report has been ill for many months and confined to his home in Long Island, recently received the President's Certificate of Merit for outstanding services during the recent war. . . . Everyone was shocked to hear of the death of honorary member K. B. Warner of ARRL fame. . . . Veteran member George E. Sterling, who is now a FCC Commissioner, was honored by the Institute of Radio Engineers with a fellowship award, in recognition of his outstanding contributions to the profession. GS has been a very active man these days attending a number of vital hearings in Washington, the most recent of which were concerned with high-band tv and general mobile service. GS also attended the first demonstration of facsimile multiplex at WFIL in Philadelphia, the system employing the developments of veteran member John V. L. Hogan. . . . JVLH was host at this demonstration which was given by his company Radio Inventions, Inc., in affiliation with the Philadelphia Inquirer f-m station. Describing the demonstration during which sound programs were transmitted simultaneously with facsimile, JVLH said that he hoped that the system would become generally available soon so that any f-m broadcaster would be able to use it. During the test, which was conducted on 102.1 mc, an 8-page edition of the Philadelphia Inquirer including news, pictures, comics, and also features, was transmitted. The page was 8 inches wide and reproduction appeared at the rate of approximately 3½ linear inches per minute. . . . Also in attendance at the demonstration was VWOA honorary member Commodore Edward M. Webster, who is currently an FCC Commissioner. EMW has also been a mighty active man these days, sitting in on the variety of hearings in Washington and serving on many advisory governmental posts concerning general communications and marine radio, in which he is a specialist.

At the WFIL-FM demonstration of simultaneous transmission of frequency modulation and facsimile. Left to right, VWOA veterans John V. L. Hogan and FCC Commissioners E. M. Webster and George Sterling.

Nominations

The VWOA Board of Directors met in New York on September 21 and nominated Wm. J. McGonigle for president; A. J. Costigan for first vice president; Haraden Pratt for second vice president; Wm. C. Simon for secretary; H. T. Hayden for assistant secretary and C. D. Guthrie for treasurer.

For the eight-man board of directors, twenty names were submitted: Ludwig Arnson, Geo. H. Clark, Harry L. Cornell, Arthur J Costigan, R. J. Iversen, Paul Godley, John A. Lohman, C. D. Guthrie, Ben Beckerman, Henry T. Hayden, Wm. J. McGonigle, Tom H. Mitchell, Fred Muller, Charlie J. Pannill, E. N. Pickerill, Jack R. Poppelle, Haraden Pratt, Arthur J. Rehbein, Geo. F. Schecklin, and Wm. C. Simon.

According to Article III, concerning the nomination and election of officers and board of directors (Section I). . . . "Following the November meeting the board of directors will receive petitions in writing, signed by not less than thirty members entitled to vote, setting forth the name of the candidate and the office for which it desired he be nominated. The petitions shall be considered by the board of directors and shall be included in the final list of nominees when submitted at the final December meeting."

The Industry Offers

AMPERITE STUDIO-TYPE RIBBON MICROPHONE

A studio ribbon microphone, type R80L and R80H, which is said to have a frequency range of 40 to 14,000 cps; output —56db; harmonic distortion less than 1%; discrimination with angle —60 to 10,000 cycles, less than 1/10th that of a diaphragm microphone, has been announced by Amperite Co., Inc., 561 Broadway, New York 12, N. Y.

Unit is shock-mounted in rubber. Available in 200 ohms output, 50 ohms on special order. Also available in hi impedance.

* * *

COMCO MOBILE EQUIPMENT

Two-way radiotelephone f-m mobile equipment, model 275-C, has been announced by the Communications Co., Inc., 300 Greco Avenue, Coral Gables, Florida.

Designed for police, taxicab, fire department, railroad, and other mobile applications in the emergency services operating in the 152-162 mc band and is also available for other services operating above 30 mc.

Single unit construction, 13" x 11" x 5", self-contained. Weight, 20 pounds.

Transmitter power output, 8 to 10 watts.

Total standby (receiver and transmitter) 6 amperes; when transmitting, 13 amperes.

Over one watt audio output from receiver.

Receiver is a single conversion, crystal controlled, superhet utilizing 2 r-f stages, mixer, 3 i-f stages, dual cascade limiter, discriminator, squelch, audio amplifier, crystal oscillator, and frequency multiplier. Capacitor tuning is used throughout the receiver. An i-f frequency of 4.32 mc is used.

Spurious response and image rejection is said to be all down —75 db; frequency stability, better than 0.005%; sensitivity, less than 0.75 microvolts required for full audio output; signal-to-noise ratio, less than 0.75 microvolt required for 20 db quieting of residual set noise, positive squelch operation on signal less than 0.25 microvolt.

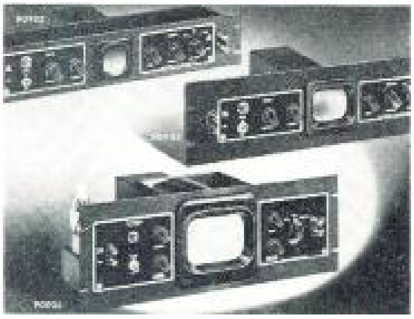
Transmitter utilizes speech amplifier, crystal oscillator, phase modulator, 4 frequency multiplier stages, and a final amplifier. A single ended circuit is used in the final amplifier.

Spurious radiation is said to be —75 db below fundamental carrier level; a-f response; ±2 db between 300 to 3,000 cycles (1,000-cycle reference) exclusive of preemphasis; response increases with increasing audio frequency at a rate of 6 db per octave above 1,000 cycles. F-M with direct crystal control (phase modulation). Modulation deviations said to be ±15 kc at 3,000 cycles equal to 100% modulation; total harmonic distortion, less than 8% from 300 to 500 cycles and 5% from 500 to 3,000 cycles.

MILLEN BASIC 'SCOPES

Rack panel 'scopes for two-, three- and five-inch tubes, respectively, No. 90902, No. 90903 and No. 90905, have been announced by James Millen Manufacturing Co., Inc., Malden, Mass.

Trapezoidol monitoring patterns are secured by feeding modulated carrier voltage from a pickup loop directly to vertical plates of the c-r tube and audio modulating voltage to horizontal plates. By the addition of such units as sweeps, pulse generators, amplifiers, servo sweeps, etc., the original basic 'scope unit may be expanded to serve many applications.



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FTR F-M STUDIO-TO-TRANSMITTER LINK

A 940-952-mc studio-to-transmitter link, type FTL-11-A, for f-m broadcasting has been developed by Federal Telecommunication Labs.

Distortion in the over-all system is said to be less than 0.5 per cent between 50 and 15,000 cycles, with the noise level 65 db below 100% modulation.

The transmitter consists of a direct frequency modulated, crystal-controlled klystron oscillator with a power output of approximately 3 watts. Transmitter monitoring facilities include provision for power and frequency measurements, vacuum tube metering, and aural monitoring.

The receiver is a single superhet utilizing the same type klystron as employed in the transmitter as a local oscillator. Pre-selection is incorporated. Has afc which is said to maintain the relative stability of the receiver and transmitter within 0.01 per cent.

* * *

BROWNING LAB F-M/A-M TUNER

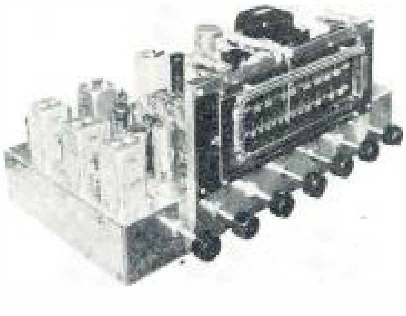
An f-m/a-m tuner, model RJ-20, with two tuners, independent except for audio amplifier, incorporated on one chassis, has been announced by Browning Laboratories, Inc., Winchester, Mass.

The f-m section is of the superhet type using the Armstrong system with dual limiters. A standard deemphasis circuit removes h-f pre-emphasis applied at the transmitter. Sensitivity of the f-m section is said to be such that 20 db of quieting is produced with as little as 6½ microvolts of signal; 32 db of quieting occurs with 10 microvolts and full 15-kc audio response is maintained.

The a-m section is a superhet using a tuned r-f stage. The i-f transformers used are variable in bandwidth from 8 to 18 kc. A panel control permits selection of bandwidth.

Audio signals from either channel are fed through two cascaded triode audio amplifiers, between which is located a frequency selective type treble-bass control system.

Audio output from the tuner is at 20,000 ohms making it possible to feed most amplifier inputs without critical matching problems.



SORENSEN HIGH CAPACITY VOLTAGE REGULATORS

Two 5- and 10-kva voltage regulators have been announced by Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.

Regulators are available in either 115-volt or 230-volt models. According to the manufacturer, the incoming line voltage may vary between 95 and 125 volts or 190 and 250 volts a-c without affecting the regulation accuracy of 0.5%, and a simultaneous load change from 10% to 100% of rating will not affect the regulation accuracy in any way.

The harmonic distortion produced by these units is said to never exceed 5% in standard models and 3% in S models.

Catalog S-348 contains full details on regulators.

* * *

ASTATIC CERAMIC ELEMENT MICROPHONES

A ceramic element microphone, the *Cardinal*, with a felt padded back which lets it lie flat on desk or table, where it may be talked across, has been announced by the Astatic Corp., Conneaut, Ohio. Accessories include a squat base that serves as a desk stand, adapter for attachment to all conventional floor stands and a hang-up bracket for mobile communications, etc.

Microphone is said to have substantially flat response from 30 to 10,000 cps; output level, 62 db. Recommended load impedance, 5 megohms.

* * *

HELIPOT DUODIAL

A multi-turn dial, the *Duodial*, which consists of a primary knob-dial geared to a concentric turns-indicating secondary dial, has been announced by the Helipot Corp., 1011 Mission St., South Pasadena, Calif. When used with helically-wound devices, such as the *Helipot*, the *Duodial* registers both the angular position of the slider contact on any given helix and the position of the slider along the helical winding. The unit is so designed that, as the primary dial is rotated through each complete revolution, the secondary dial moves one division on its scale.

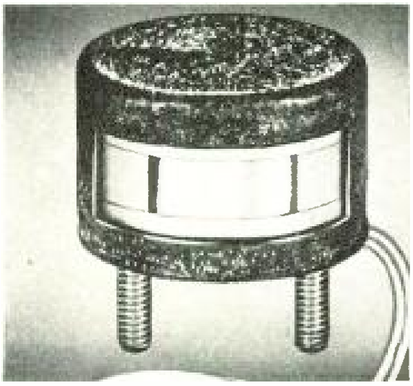
Dial available in turns-ratio of 10:1, 15:1, 25:1, and 40:1 (ratio between primary and secondary dials).

INDIANA STEEL PRODUCTS MAGNETIC TAPE RECORDING HEAD

A magnetic tape recording head, model TD-704, for use in high impedance circuits, providing optimum results with a track .200" wide, has been announced by The Indiana Steel Products Co., Inc., 6 North Michigan Ave., Dept. A-17, Chicago 2, Illinois.

Using tape with a coercive force of 300 oersteds at a speed of 7½" per second, the operating bias level at 40 kc is 1.7 ma and the audio signal current for standard recording level (as defined by RMA standards) is 0.15 ma. Recorded in such manner, the signal output from the high impedance playback winding is 5 millivolts. Impedance at 1,000 cps is 1,000 ohms.

By using a laminated core structure, the 40-kc bias field strength is made substantially the same as the audio field strength for equal current. This reduces the bias requirements to less than 0.1 volt-ampere, for a tape having a coercive force of 300 oersteds. A high permeability shield minimizes electrostatic and magnetic pickup. Overall dimensions are ⅞" x ⅞" x ⅝" deep.



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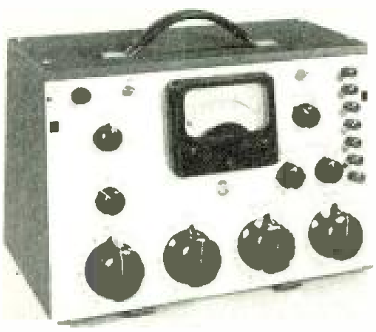
AUDIO FACILITIES EQUIPMENT

Above: A portable tone generator, for use in equalizing remote telephone lines, which features an *RC* type circuit allowing selection of ten frequencies from 50 to 15,000 cps. Below: Portable remote three-channel amplifier using type 1620 indirectly heated tubes. Each channel is said to offer an overall gain of 92.5 db. (*Courtesy RCA*)



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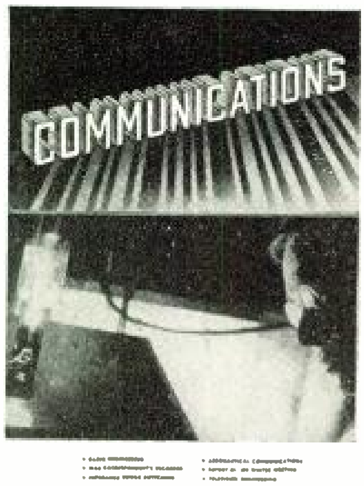

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Employed by ....
Nature of Business ....
(State if Manufacturer, Broadcast Station, etc.)
Your Title ....
Your Department ....

Name ....
Address ....
City-State ....
Occupation ....
Employed by ....
Nature of Business ....
(State if Manufacturer, Broadcast Station, etc.)
Your Title ....
Your Department ....

Name ....
Address ....
City-State ....
Occupation ....
Employed by ....
Nature of Business ....
(State if Manufacturer, Broadcast Station, etc.)
Your Title ....
Your Department ....

Business or professional classifications are required to complete our records. Each subscriber should write one of the following classifications in space indicated. Use separate sheet of paper for additional names.

CHIEF ENGINEER ENGINEER EXECUTIVE
PURCHASING AGENT DEPARTMENT MANAGER

State your classification if not listed.

This Group Sent In By—

Name ....
Address ....

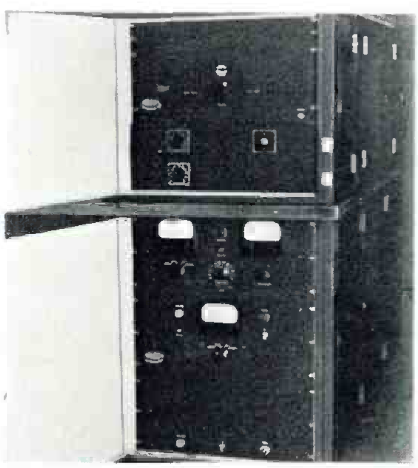
TV Console

(*Continued from page* 11)

monitor switch are also non-latching since the picture obtained from check points in the transmitter is used only as a *stage* by *stage* inspection of transmission characteristics.

The previously described bridging circuit is used for connecting button *7* on the monitor switches to the transmitter video input. The connection is made across the video gain control and each monitor is replaced by its equivalent capacity (C_3 or C_4) when removed from the bridging circuit. Periodic interruptions in the video signal to the waveform monitors, in order to establish the zero voltage reference level, are produced by components R_5, R_6, L_2, C_2 and D_1 of Figure 6. This circuit is similar to that illustrated in Figure 4, and the interrupting pulses are provided by a transformer; resistor and capacitor as shown in Figure 5. An on-off switch is provided for the interruptions in addition to a phase change switch. The selector switches are wired so that the interruptions are inserted in the video signal to the waveform monitors only when buttons *1, 2, 3* or *4* of the waveform monitor switch are pressed, since only the video signals connected to these buttons have d-c components. The cables carrying the video monitoring signals to the switches are terminated by potential dividers (R_1+R_2, etc.) of 75 ohms total resistance. The connections to the picture monitor switch are tapped across about 25 ohms (R_2, etc.), whereas the connections which are switched via the waveform monitor switch to the interrupter circuit are made direct to the video lines, i.e., the interrupter circuit introduces attenuation of the signal. In this way, the input capacity of the picture monitor is connected across a low resistance and the attenuation of high frequencies is small. Also, by adjusting the values of resistors in the various potential dividers feeding the monitor switches, it can be arranged so that the amplitude of the signal connected by each push button is about the same; therefore, it is not necessary to re-adjust the video gain control on the monitors each time a button is pushed. By making all switch contacts non-shorting, none of the other monitor input signals can be momentarily connected to the transmitter input bridging circuit during switching. When operating the input selector switch, two input lines are momentarily connected to the transmitter input, but providing the sync pulses in the two inputs are in phase, there will be no loss of synchronism in the picture.

Right side of cnosole with doors open showing tuning indicator at top, and center frequency deviation meters and kc deviation meters at bottom.



Audio Circuit

The complete audio schematic is shown in Figure 7, the switching and monitoring being, in general, similar to the video. Thus, the input selector switch connects any of four incoming lines through a gain control to the transmitter input, the monitor line selector switch enables the signal on any incoming line to be monitored, and the monitor selector switch connects the monitor amplifier input to any of four positions:

(*1*) Line monitor switch
(*2*) Monitoring receiver
(*3*) Frequency monitor unit, which monitors the transmitter output
(*4*) Transmitter audio input

A bridging transformer between the monitor gain control and the monitor selector switch makes the effective impedance, bridged across the audio lines, high compared with the line impedance of 600 ohms, so that no noticeable change of level occurs in an audio line when it is bridged. All audio lines coming in to the console are terminated by 600-ohm resistors. The incoming line connected to the transmitter input is terminated by the audio gain control which is a balanced ladder network and the other three incoming lines are terminated by resistors on the input selector switch. The monitor-gain control is a 600-ohm network used with a six-position tone-compensating switch. The relative bass response of the signal going to the monitor amplifier is increased as the setting of the gain control is reduced in order to compensate for normal hearing *fall-off* characteristics. The amount of bass boost is variable by means of the compensating switch. All switch contacts are non-shorting type, and as in the video circuit, no unwanted signals can be momentarily connected to the transmitter input during switching.

Transmitter Metering and Switching

The meters and switches provided on the console for each transmitter have already been listed. The final amplifier plate voltmeter and current meter and the transmission line voltmeter are all 1-ma d-c meters with one terminal grounded, the necessary series and shunt resistances being in the transmitter. The switches operate contactors in the transmitter and the pilot lights are connected to a 220-volt primary supply for the filaments and plates. The carrier frequency and deviation meters are connected to frequency-monitor units mounted in the console and fed with r-f from the transmitter outputs. Each frequency monitor unit contains a temperature-controlled crystal producing a frequency, which, after multiplication is mixed with the transmitter carrier frequency. The resulting frequency of 150 kc is measured by a pulse-counting method and any variation from the correct value is indicated on a center zero meter. The maximum deviation

(*Continued on page 32*)

TV Console

(*Continued from page* 31)

of the sound carrier when modulated is indicated on the deviation meter.

Mechanical Layout

The electrical circuits are built into separate units as shown in the block schematic of Figure 8 and connections to the units are made with terminal strips or plugs and sockets. Careful shielding of the audio and video circuits is necessary to prevent cross talk and r-f pickup. All audio cables are twin-conductor shielded type and connections are made to the units by shielded plugs and sockets. The audio switch unit is enclosed by an aluminum cover as is also the back of the *vu* meter and multiplier. The video switch unit is also enclosed by an aluminum cover and all video cables are coaxial type and connected to the units by coaxial plugs and sockets.

The console is constructed in four sections which can be separated for shipping. The lower section is similar to an office desk with a disappearing typewriter, drawers, space for telephone, speaker etc. The upper section has a sloping front with the visual meter panel on the left, the aural meter panel on the right and the waveform and picture monitors in the center. Under the monitors is the switch panel to the rear of which are attached the audio, transmitter and video switch units, the controls and switches projecting through the panel. The switch panel and meter panels can be detached from the console by removing mounting screws and the cableforms are long enough to enable the panels to be brought forward for maintenance. The waveform and picture monitors can be pulled out on runners without detaching the connecting cables.

The transmitter switches and pilot lights with the console on-off switch and pilot are grouped at the center of the switch panel, the video switches and gain control at the left and the audio controls at the right. The video and audio transmitter input push buttons are red and each has a red indicator light above it to tell the operator which incoming lines are *on the air* and to warn him not to operate these switches accidently.

Additional features on the front panels include: Indicator lamps for the frequency monitor crystal heaters, dimmer controls for the meter lights on each panel, polaroid dimmers on the transmitter pilot lights, a modulation indicator light which flashes when the deviation exceeds a predetermined percentage (range 0.160%), and space for extra switches such as room lights, etc.

External connections to the console are brought up through one hole in the center of the base to a junction box where video, audio and r-f connections are made with plugs and sockets and power connection with terminal blocks.

All units not mounted in the front of the console are mounted on standard 19" relay racks located behind doors at the sides and rear. This permits the same units to be used in rack-mounted transmitter control equipment when a console is not desired, and provides access to the rear, side and front of all these units. Forty inches of spare space is allowed on the racks for additional amplifiers, equalizers, etc.

•

5 Kw A-M

(*Continued from page 19*)

effect on base current values. However, base current ratios have kept within tolerance by adjustment in the main transmitter phasing unit. Frequent checks of phase monitor give the story on correct phasing. The phasing monitor is also checked periodically with field strength measurements.

Dummy Antenna

Before the tower installation was completed and in order to make various tests on the transmitter, six 1,000-watt lamps in series were used as a dummy antenna load. This arrangement of lamps closely approximated the antenna impedance and enabled various tests without actually having a true antenna connected to the transmitter. The various tests were being made during the daylight hous and of course it was not desirable to actually have radiation from the towers at this time.

Use of 'Scope

Because a modulation monitor was not available at the time the station went on the air, we requested and received permission to go on the air with a 'scope in place of the monitor. It was found that the use of the 'scope actually gave the operator a truer picture of the carrier output because the 'scope was actually more sensitive than the modulation monitor meter.

The modulation monitor has since been delivered; however, our engineers continue to use the 'scope in conjunction with the modulation monitor to get a truer picture of the carrier output.

Maintenance

For the first four months of operation KLEE operated from 6 A.M. to 12 midnight. However, since that time we have gone on a day and night, 24-hour per day schedule, every day except Sunday. From midnight Sunday and 5:30 A.M. Monday morning, routine maintenance is practiced. Routine maintenance normally consists of dusting out the transmitter cubicle as well as making a routine inspection and testing of all other auxiliary equipment.

TV MOUNTAIN TESTS

Tv receiving antenna atop the Castle at the summit of Whiteface Mountain in New York State being used to pick up signals from WRGB at Schenectady, 120 airline miles away. (*Courtesy General Electric.*)

Microwave Links

(*Continued from page 25*)

Whitney and Death Valley, the highest and lowest locations in the United States in close proximity to each other. In that region one laboratory enjoys an exclusive area for testing pilotless aircraft and missiles which exceeds in square miles all of the state of Rhode Island. Distances are great with most of the terrain characterized by mountains and deserts. It is primarily a job for microwaves. Coaxial cables can only get through under great physical difficulty and high cost both initially and for subsequent operation-maintenance. In fact, consideration has already been given to the use of microwaves for bridging gaps caused by rivers, mountain gorges and rugged rocky terrain in extending the coaxial cable system already started in the western part of the United States. Microwaves can enjoy locations of sufficient radio coverage as to be able to permit spotting of relay stations in the vicinity of paved roads, settled communities and existing public utilities. It will be entirely feasible to zig-zag the radio route to take advantage of such practical advantages. In addition, these changes of direction will safeguard against the picking up ot distant repeater points, in addition to the signal from the adjacent repeater point, during periods of exceptional propagation paths.

Figure 4 shows the indirect route followed between New York and Boston. The advantages of taking other than the shortest and straightest route between cities are:

(*a*) Makes possible a change of direction at every station which may exceed in bearing the amount of antenna beam width. This minimizes the possibility of picking up the same transmission from more than one point at each repeater and thus avoiding the problem of coping with the same initial signal having several components with delayed characteristics. This is further minimized by alternating frequencies at each repeater point.

(*b*) Takes advantage of the most suitable elevations.

(*c*) Provides an alternative in the event property owners will not undertake reasonable negotiations for the necessary real estate.

The microwave relay system between New York and Boston is currently the best engineered and most costly network in the United States. It operates in the 3,700-4,200-mc band, each channel having been designed to handle a signal band extending from 30 cycles up to 4½ mc. In laying out this system, engineers recognized the fact that depth of fading increases with path length. They also recognized that if their frequency of operation was too high, there will be more attenuation during periods of rainfall as well as increased fading. On the other hand, if the frequency employed was too low, the antennas would be less directive for a given dimension. As a compromise, they chose the 3,700- to 4,200-mc band. Other considerations were:

Repeater Spacings: A maximum of about 35 miles was chosen even though longer line-of-sight paths might be readily obtainable. The seven relay sites shown in the map of Figure 4 were selected, with an average length of 27½ miles, the longest being 35 miles and the shortest (near Boston terminus) being 11 miles.

Factors Determining Location: Three considerations influenced the selection of each relay site, namely:

(a) Not too far from adjacent relay site in order to decrease fading.
(b) Not too close to adjacent relay site in order to minimize the number of repeaters.
(c) Not too inaccessible or expensive for roads, power lines and telephone wires.

Four broad-band channel r-f bands (each about 10 mc wide) are employed in this setup. These are centered at 3,930, 3,970, 4,130 and 4,170 mc and are used as pairs. One pair is required for each two-way channel. Whenever the signal goes through a repeater, however, a frequency change is made of 40 mc, as shown in Figure 6. This procedure prevents interference between the high-level outgoing and the low-level incoming signals. There is never a high-level and a low-level signal of the same frequency at any one repeater station. Each repeater in the system is required to introduce sufficient gain to offset the loss in the preceding radio path. At each repeater station, equipment is provided for converting the received microwave signals into an intermediate frequency of 65 mc. It is amplified at that frequency and then translated back to the microwave range for transmission over the next link on a frequency 40 mc removed.

A block diagram of the terminal equipment which includes monitoring and distortion measuring circuits is shown in Figure 7. This permits the terminal operators to check the quality of the picture signal at various points within the terminal during a tv transmission. A picture monitor displays the picture at each terminal as it would appear in a home tv receiver.

Monitoring-Equipment Bays

In the monitoring and equipment bays (Figure 6), there are five equipment bays. From left to right, the first bay contains picture monitoring equipment, second bay contains distortion measuring equipment plus landline-coaxial connections, third bay is a duplicate of the first so that one may be kept in ready reserve, fourth bay is a complete channel transmitter-receiver, while the fifth bay is a duplicate of the fourth in reserve as a spare. In the case of relay stations, the first three bays are omitted. Instead, there are four bays identical to the fourth or fifth bay. Two are used for actual communication relaying (one in each direction) while the other two are available in reserve as spares.

[**To Be Continued**]

Maintenance

(Continued from page 26)

hum pickup may be encountered. In this case the remedy is to isolate the source of hum field. Shielding with mu-metal sometimes is found to be very effective.

Another item which should receive some consideration is the *off-on* switch associated with the turntable motor. This switch should be of the mercury type or if it is of the spring contact variety. the contact should be kept clean so that no arcing will result. This will reduce the possibility of clicks. etc.. when the motor is started and stopped.

Rumble

Another common problem in the transcription-reproducing setup is rumble, the low-frequency noise which is usually transmitted to the pickup through the agency of the turntable.

Among the causes of rumble are worn bearings in the drive motor. worn surfaces on the drive wheels and in those cases where ball bearing type speed reduction mechanisms are used. flat surfaces which may be present in the speed changing mechanism ball bearings. One other cause of rumble is the failure of the drive motor shock mount mechanism to provide sufficient isolation. which may be due to a variety of causes among which are rubber isolation blocks becoming oil-soaked and losing their resiliency or the mounting screws being so tightly compressed that the shock mounting mechanism is made inoperative. Rumble may also be caused by excessive building vibration.

Transcription Discs Care

While much has been said on the subject in the past, there are many direct indications that recording discs do not receive the proper care. The time and effort required to keep records clean. to house them in the protective envelopes, and to use reasonable care in reproducing them, will be amply repaid, in the reduction of scratched records, and the increased life of the record libraries.

Transcription records are pressed from materials which are good electrical insulators and as such may accumulate high electrostatic charges when the surface is rubbed by various other insulating materials. The act of removing a transcription pressing from its protective envelope will sometimes generate a relatively high electrostatic charge. In dust-laden atmosphere. these charged records have a tendency to attract a large amount of dust and lint to their surfaces. Attempts to remove this dust by brushing the surface with soft cloths, etc., may be defeated by the charge which results from the act of rubbing; this difficulty can be avoided by slightly dampening the cleaning cloth and rubbing lightly on the surface of the record to remove the accumulated dust. Records which have accumulated a large amount of grit and dust may be cleaned by using a very mild soap solution and an extremely soft sponge. Care should be exercised to keep the label dry during the cleaning operation. The soap solution should be removed by means of clear water.

It will be found helpful to clean existing records and to return them to their protective envelopes and arrange for the handling of the records in such a way that they are exposed for an absolute minimum of time. In this way much of the cleaning which may be required can be entirely eliminated.

Fingerprints on vinylite cause harm by creating a film to which dirt particles easily adhere. These particles in turn cause scratch and ticks when the disc is reproduced. Therefore it is recommended that the discs be handled by pressure from the palms of the hands exerted on the edges. As an alternative the disc may be handled with one hand by hooking the thumb over the edge of the disc and supporting the center (or label section) of the disc by means of the fingers.

Vinylite transcription discs, although tough, are subject to scratching by abrasive particles. Consequently, the stacking of discs when not in their envelopes should be avoided. Neither should they be placed on nor slid across hard surfaces such as tables or desk tops. A good practice is to keep the discs in their envelopes at all times except when being reproduced. After use, they should be replaced in their storage cabinet and the door or drawer closed. These precautions are especially important in locations lacking air-conditioning or in areas where unusually high concentration of dust or grit exist in the atmosphere.

Since vinylite is a thermoplastic, the discs can be deformed by heat and sustained pressure. Therefore, they should not be kept in the vicinity of steam pipes, radiant heaters, etc. Likewise, exposure to intense sunlight for long periods of time should be avoided. Deformation can be incurred by stacking discs over an irregular surface such as the edge of a desk or on top of paper clips, lead pencils, etc.

Transcriptions are intended for use with professional type reproducers which exhibit a weight at the stylus tip of approximately one ounce or less. More recent trends in reproducers are to utilize weights in the vicinity of from ½ to ¾ ounce. These lighter reproducers, providing they are also designed with a stylus and moving element of very low mass and good compliance, permit an almost unlimited number of playings from a transcription without appreciable degradation. However, as previously mentioned, satisfactory reproduction cannot be realized if the discs are marred by abrasions or by styli misshapen by the abrasive wear incurred when reproducing shellac discs.

There have been instances where transcriptions have been injured by back cueing for spotting purposes. The injury is manifest by high surface scratch and ticks during the opening grooves of the program material. This is brought about by back cueing when using heavy reproducers containing improper styli. Back cueing, which is almost universally used for program spotting on transcription discs causes no harm providing the reproducer weight on the disc is not in excess of one ounce and the stylus tip is of proper dimensions and in good condition.

News Briefs

INDUSTRY ACTIVITIES

The 1948 Rochester Fall Meeting of members of the IRE and RMA engineering department will be held at the Sheraton Hotel, Rochester, N. Y., November 8, 9 and 10.

Technical Session Program

Monday, November 8

A Television Station Selector Using Die Stamped Inductances; A. D. Sobel, A. W. Franklin Mfg. Corp.
A Discussion of Image Sharpness in Photography and Television; O. H. Schade, RCA.
Application of Subminiature Tubes; R. K. McClintock, Sylvania Electric.
The Transitrol, An Experimental AFC Tube; J. Kurshan, RCA Labs.
A New Low-Noise, Low-Microphonic Miniature Tube; C. R. Knight and A. P. Haase, G. E.

Tuesday, November 9

Developments in Germanium Crystals; Stuart T. Martin and Harold Heins, Sylvania Electric.
A Television Distribution System for Laboratory Use; Joseph Fisher, Philco.
A Direct Coupled Video and AGC System for Television Receivers; H. R. Shaw, Colonial Radio.
A Pulse-Cross Generator for Television Receiver Production; R. P. Burr, Hazeltine Electronics.

Wednesday, November 10

Lightweight Pickup Design for Microgroove Recording Playing; B. P. Haines, Elmo Voegtlin, C. D. O'Neill and R. S. Cranmer, Philco.
Symposium—What Constitutes High Fidelity; Harvey P. Fletcher, Bell Telephone Labs. John K. Hilliard, Altec Lansing and C. J. LeBel, Consultant.
High Quality Audio System for Radio Receivers; R. S. Anderson and B. E. Atwood, Stromberg-Carlson.
Front Ends of Television Receivers; J. O. Silvey, G. E.
A Picture-and-Sound-Modulated Generator for Television Receiver Production; W. R. Stone, Hazeltine Electronics.

The 1948 National Electronics Conference will be held at the Edgewater Beach Hotel, Chicago, on November 4, 5, and 6.

Subjects to be covered include *The Transistor—Its Properties and Characteristics*, by Walter H. Brattain, Bell Telephone Labs; *Application of Miniature-Circuit Techniques to the Sound Level Meter*, H. H. Scott, Hermon Hosmer Scott, Inc.; *Corona Interference with Radio Reception in Aircraft*, M. M. Newman, Lightning and Transients Research Institute; *Optimum Selectivity in Superregenerators*, Donald Richman, Hazeltine Electronics; *Terminal Equipment for Pulse-Time Multiplex*, A. M. Levine, D. D. Grieg, Federal Telecommunication Labs; *The Dyotron Tube as a Very High-Frequency Oscillator*, R. A. Dehn, G. E.; *A New Type of Slotted Line Section*, W. Bruce Wholey, and W. Noel Eldred, Hewlett-Packard; *Microwave Slotted Sections*, Stanley A. Johnson, Polytechnic Research and Development; *Tunable Waveguide Cavity Resonators for Broadband Operation of Reflex Klystrons*, W. W. Harman, Stanford University; *A Periodic Waveguide Travelling Wave Amplifier for Medium Powers at Microwaves*, G. C. Dewey, Federal Telecommunication Labs, Inc.; *The Locked Oscillator in Television Reception*, Kurt Schlesinger, Motorola; *Master Television Antenna and Signal Distribution Systems for Large Buildings*, R. D. Duncan, Jr., RCA; *Development of a Large Metal Kinescope for Television*, J. Kelar, H. P. Steier, C. T. Lattimer, and R. D. Faulkner, RCA; *Large Screen Television*, R. V. Little, Jr., RCA; *Circuit Design for Reduction of Hum*, Arthur F. Dickerson, G. E.; *Radio Direction Finding System Analyzer*, E. C. Jordan and J. J. Myers, University of Illinois; *Open-ended Waveguide Radiators*, R. E. Beam, M. M. Astrahan, H. F. Mathis, Northwestern University; *Measurement of Phase of Radiation Around Antennas*, John N. Hines and Charles H. Boehnker, Ohio State University Research Foundation; *The Measurement of Antenna Impedance Using a Receiving Antenna*, Donald G. Wilson, University of Kansas; *A High-Gain Cloverleaf Antenna*, P. H. Smith, Bell Telephone Labs.

A three-day symposium on h-f measurements has been planned by the AIEE Subcommittee on H-F Measurements of the Instruments and Measurements Committee jointly with the IRE and the National Bureau of Standards to be held on Jan. 10, 11 and 12 in Washington.

Four sessions are being planned on the following subjects: Frequency Measurements; Power, Voltage, Current, Attenuation Measurements; Impedance, Dielectric and Magnetic Measurements, Millimeter Techniques (optical type gratings, artificial dielectrics using dispersed metals, special problems); and Noise, Field Intensity, Antenna Measurements.

The meetings will be held in the auditorium of the Department of Interior.

Cornell-Dubilier Electric Corp. recently purchased for $200,000 the business, goodwill, trademark, patents and inventory of The Electronic Laboratories, Inc., 24 West 24th Street, Indianapolis, Indiana. C-D acquired a recently improved and new design of heavy duty vibrator and vibrator power supply which they will market in addition to light duty vibrators, a development of the C-D engineering labs.

FTR had an exhibit on the main floor of the Music Hall at the recent APCO Conference held in Houston.

On display were the latest developments in mobile radiotelephone equipment for emergency service.

Ward Leonard Electric Co., Mount Vernon, New York, have moved their Rochester branch office, formerly located in the Lincoln Alliance Bank Bldg., to 66 South Street, Rochester 7, New York. Ken Savage remains district manager.

Clarostat Mfg. Co., Inc., are moving their office and plant facilities to a five-story block long plant in Dover, N. H.

Raytheon Manufacturing Co., Waltham, Mass., has granted RCA and its subsidiaries a license under radar patents owned by Raytheon.

These radar patents were issued to Submarine Signal Company, Raytheon's marine affiliate, and cover development work begun in the early '30s.

PERSONALS

C. C. Richelieu, secretary and general manager of WDLB and WDLB-FM, Marshfield, Wisconsin, has resigned to accept a post as general sales manager of the Simplex Time Recorder Company at Gardner, Mass. Richelieu, former radio engineer with the CAA in Washington, and currently director of the Central Division of the ARRL, was district sales manager for the state of Wisconsin for Simplex prior to his coming to WDLB last February.

Richelieu will be succeeded by Robert Dehling, commercial manager of WDLB for the past two years.

Will Whitmore, advertising manager of Western Electric since May 1945, has been appointed radio advertising manager of the American Telephone and Telegraph Company. **W. M. Reynolds,** publications manager of Western Electric since 1946, will have charge of Western Electric's advertising.

W. Whitmore

W. M. Reynolds

G. V. Bureau has joined the power tube division of Amperex Electronic Corporation, Brooklyn, N. Y. He was formerly associated with the cathode ray tube division of North American Philips Company, Inc.

G. V. Bureau

C. Russell Cox, formerly sales manager and chief engineer of Andrew Corp., Chicago, has been appointed to a newly created office of director of sales and engineering for Andrew. **Walter F. Kean,** who has headed Andrew's broadcast consulting division since its formation in 1944, assumes new duties as Andrew sales manager. **John S. Brown** moves from assistant chief engineer to chief engineer.

C. Russell Cox

John S. Brown

Walter F. Kean

Thirty members of the IRE were presented with the President's Certificate of Merit recently as a testimonial to their outstanding services in technological research and development during World War II: Henry B. Abajian, L. H. Terpening Co.; George W. Bailey, IRE; Wilmer L. Barrow, Sperry Gyroscope Co.; H. H. Benning, Aircraft Radio Corp.; Harold H. Beverage, RCA; K. C. Black, Aircraft Radio Corp.; Hendrik W. Bode, Bell Telephone Labs; Ralph Bown, Bell Telephone Labs; Herbert E. Bragg, National Defense Research Committee; Henri Busignies, FTL; John F. Byrne, Airborne Instruments Lab; F. C. Cahill, Airborne Instruments Lab; F. S. Cooper, Haskins Labs, Inc.; W. F. Davidson, Consolidated Edison Co.; H. D. Doolittle, Machlett Labs; John N. Dyer, Airborne Instruments Lab; Donald G. Fink, McGraw-Hill; E. G. Fubini, Airborne Instruments Lab; Raymond L. Garman, General Precision Equipment Corp.; R. L. Havens, Watson Scientific Computing Lab; L. Grant Hector, Sonotone Corp.; William H. Martin, Bell Telephone Labs; James H. Moore, A. T. & T.; Haraden Pratt, American Cable and Radio Corp.; J. C. Schelleng, Bell Telephone Labs; William P. Short, FTL; Hector R. Skifter, Airborne Instruments Lab; Ernst Weber, Polytechnic Institute of Brooklyn; H. A. Chinn, CBS, and O. S. Duffendack, Philips Labs.

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CORRECTION

In the September issue of Communications, the incorrect illustrations were presented with the descriptions of the G-R 1304-A beat-frequency oscillator and the Browning Lab. TAA-16 amplifier.

Below appear the correct illustrations:

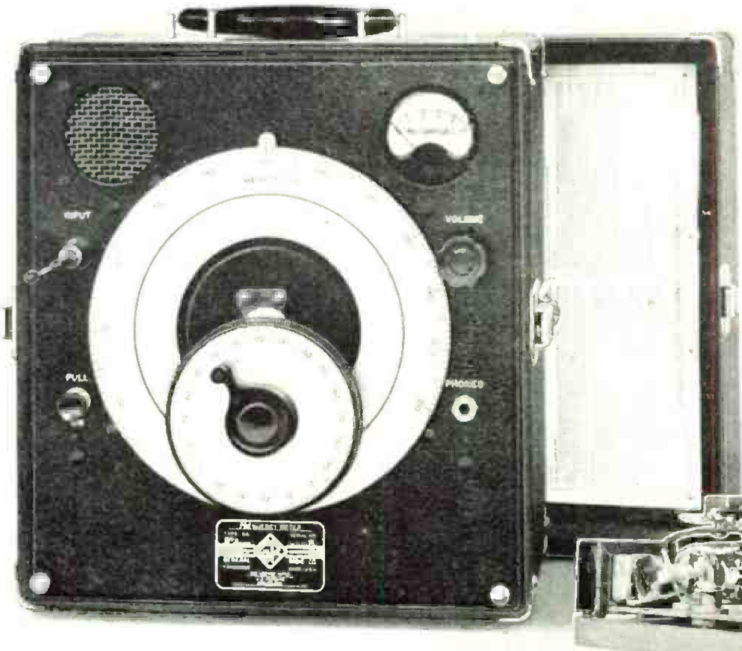
G-R 1304-A beat frequency oscillator.

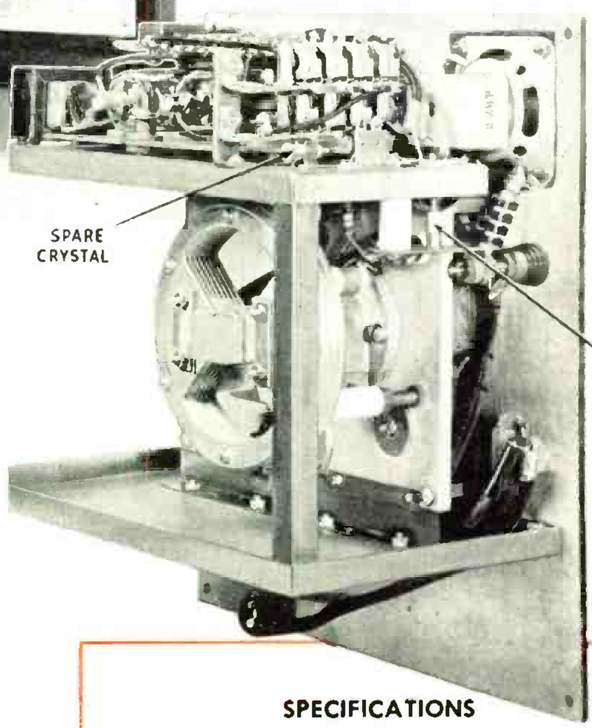
Browning Lab. TAA-16 amplifier.

ADVERTISERS IN THIS ISSUE

COMMUNICATIONS INDEX

OCTOBER, 1948





FREQUENCY MEASUREMENTS TO 3,000 Mc

Full advantage of the simplicity of the heterodyne method of frequency measurement is taken in this frequency meter. With a fundamental range of 100 to 200 megacycles, accurate frequency measurements may be made between 10 and 3,000 megacycles.

The tuning circuit is our butterfly type with no sliding contacts, obviating many of the difficulties encountered in the usual tuning elements used in u-h-f-equipment.

A standard plug-in silicon crystal is used as the detector, followed by a three-stage audio amplifier. The band width of the amplifier is 50 kc to permit visual beat indication even if the signal under measurement is unstable.

For very strong signals beat indication may be obtained either aurally from the built-in dynamic loud speaker or visually from the panel meter. For weak signals a telephone jack is provided for headset detection.

Normally no direct connection to the signal under measurement is required, the retractable 'antenna' providing the necessary coupling. On weak signals, terminals are provided for additional pick-up if necessary.

This instrument is finding wide application both in the laboratory and in the field where a portable, self-contained, stable and accurate heterodyne frequency meter is needed for measurements over a very wide range of high and ultra-high frequencies.

TYPE 720-A HETERODYNE FREQUENCY METER $340

SPECIFICATIONS

FREQUENCY RANGE — fundamental range of instrument is 100 to 200 Mc; by harmonic methods measurement range is 10 Mc to 3,000 Mc.

CIRCUIT — our butterfly tuning unit used in the oscillator; crystal detector (with spare); 3-stage audio-frequency amplifier.

BEAT INDICATORS — built-in dynamic loud speaker and panel meter for aural and visual beat indication; telephone jack for headset indication from weak signals.

ACCURACY — over-all accuracy is ± 0.1%

CALIBRATION — main dial calibrated in frequency, each division being 1 Mc; one-half turn of vernier dial corresponds to approximately 1% change in frequency over entire tuning range.

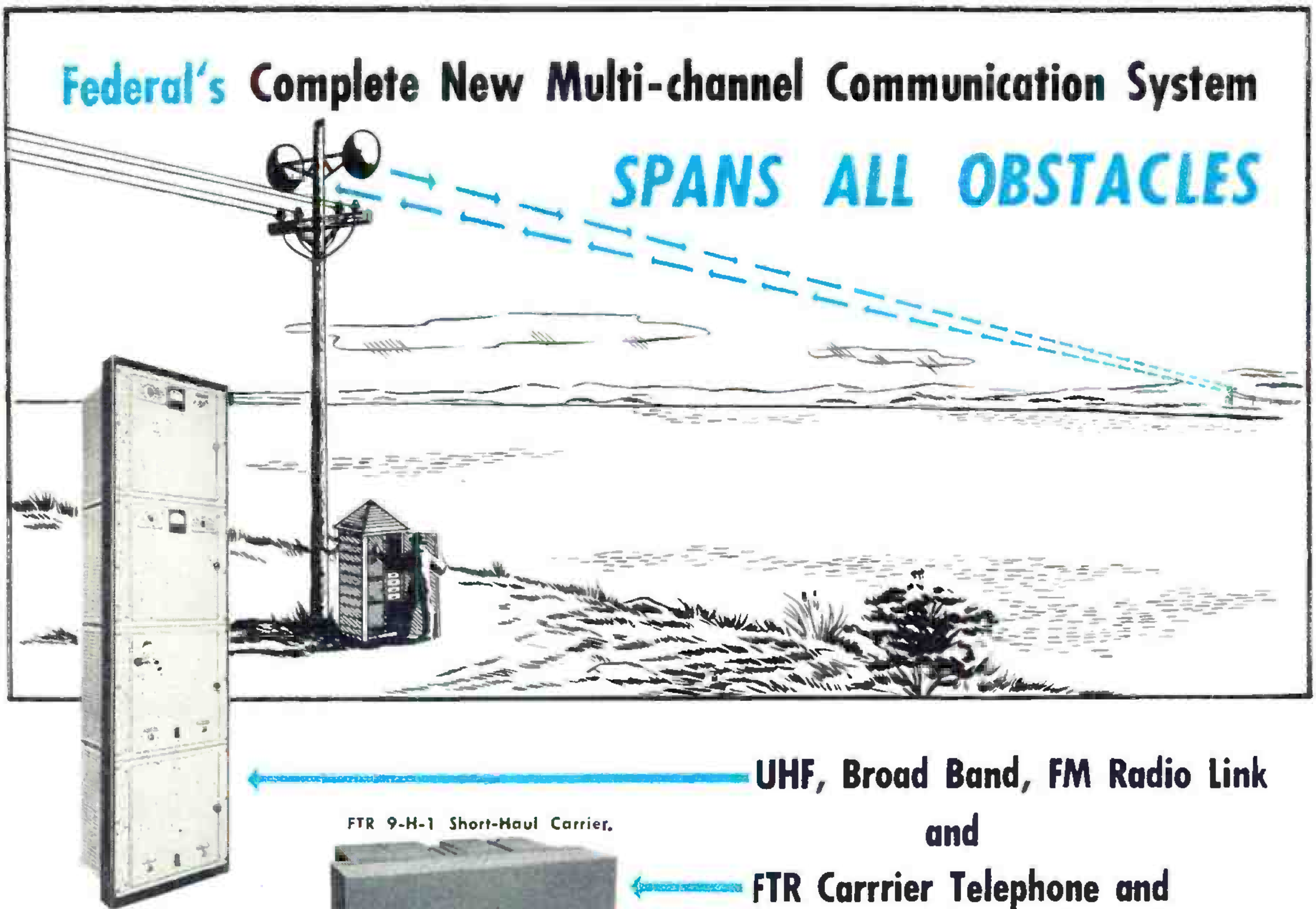
PORTABILITY — instrument weighs only 27½ pounds complete with batteries. Separate a-c power supply may be ordered for a-c operation.

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 — 920 S. Michigan Ave., Chicago 5 — 950 N. Highland Ave., Los Angeles 38

Federal's Complete New Multi-channel Communication System

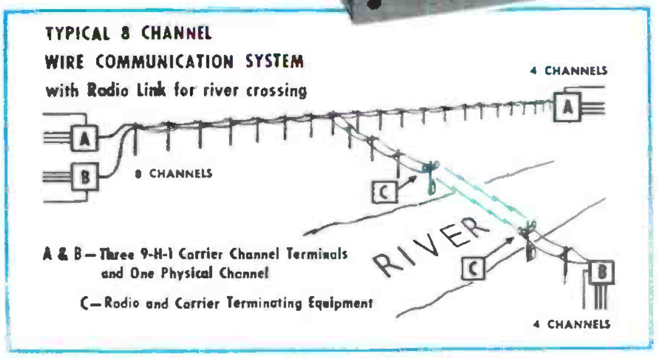
SPANS ALL OBSTACLES

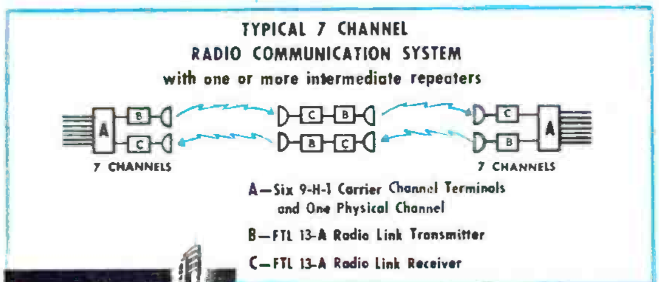


FTL 13-A
Radio Link

FTR 9-H-1 Short-Haul Carrier.

UHF, Broad Band, FM Radio Link
and
FTR Carrrier Telephone and Telegraph Equipment





offer you new flexibility and economy for multi-channel wire or radio systems

Federal's new UHF broad band radio link, for multi-channel telephone and telegraph service, can be used as a complete communication system—or as an intermediate link in cable or open wire systems. It is especially designed to provide economical communication over mountainous, swampy, or soft terrain where pole lines are costly or impractical—and for spanning wide rivers, lakes, bays or inlets.

The FTL-13A radio link equipment has a total usable communication bandwidth from 200 to 60,000 cycles. It operates in the 890 to 960 Mc UHF band, offering the economy of low transmitter power and highly efficient directive antennas.

Write Federal today for complete information on this new type of communication system. Dept. 110.

FTR
An IT&T Associate

Federal Telephone and Radio Corporation

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KEEPING FEDERAL YEARS AHEAD... is IT&T's world-wide research and engineering organization, of which the Federal Telecommunication Laboratories, Nutley, N. J., is a unit.

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