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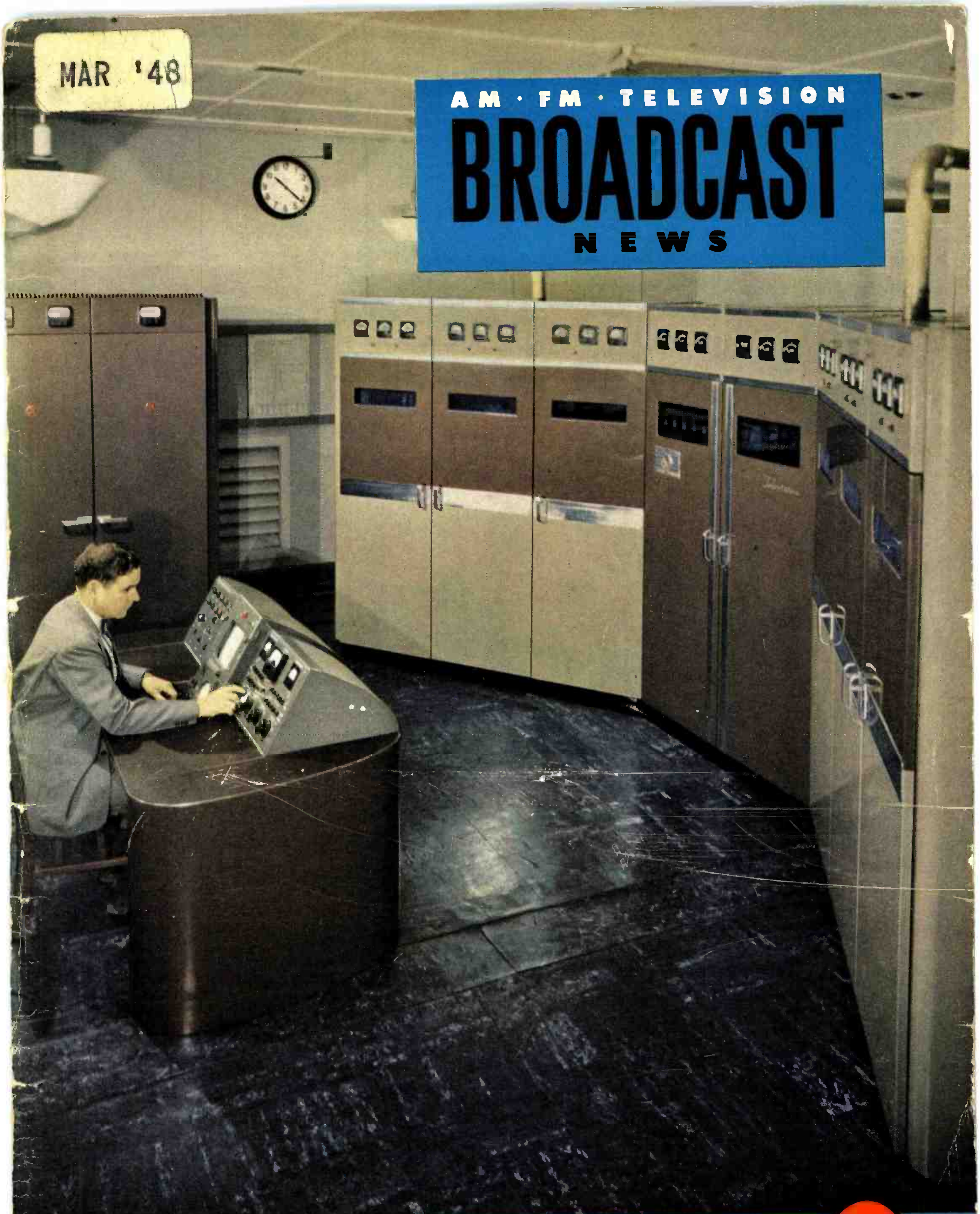
BROADCAST NEWS



THE TT-5A TRANSMITTER ..... See pg. 4

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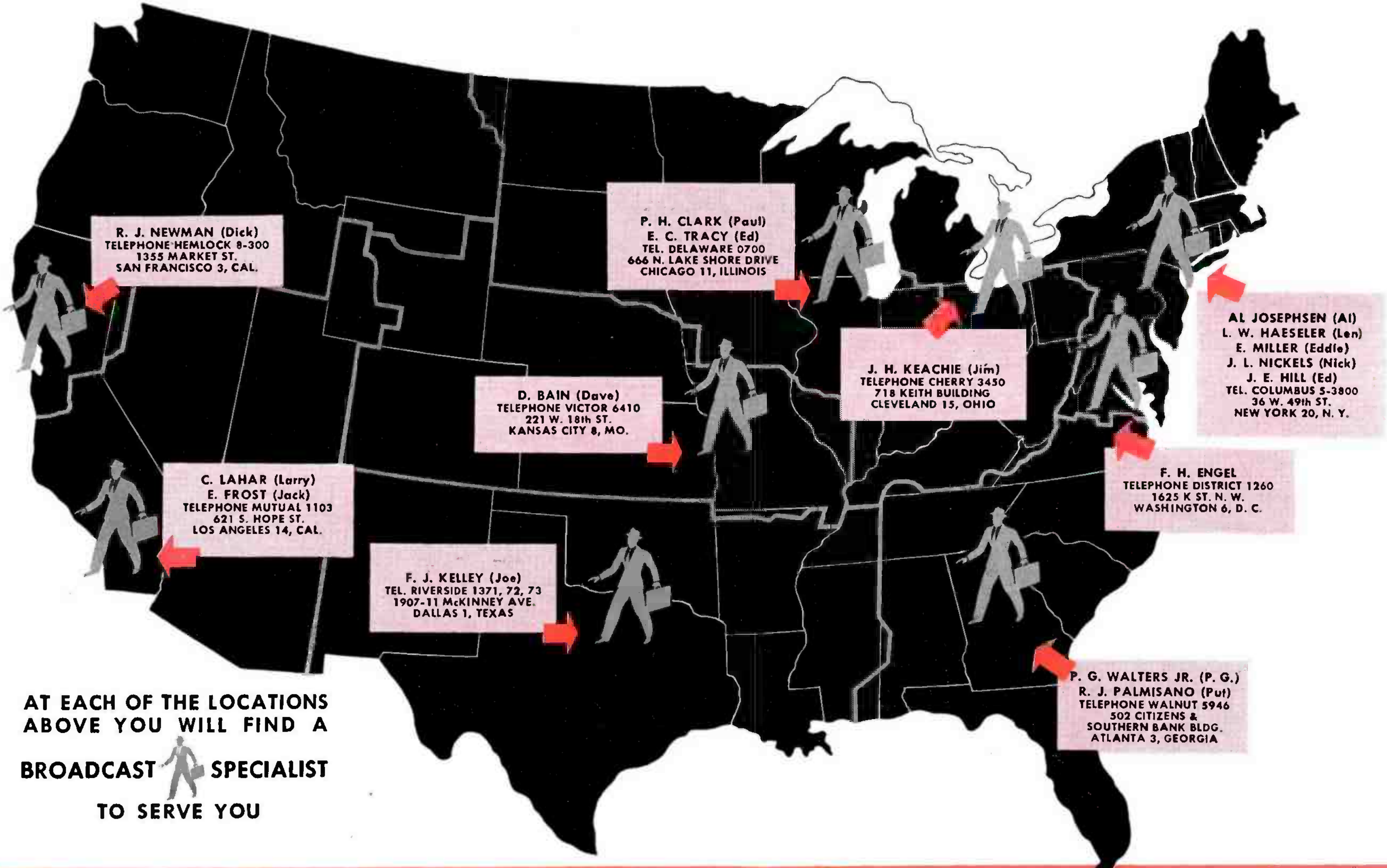

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Broadcast News

AM · FM · TELEVISION

Published by the

RADIO CORPORATION OF AMERICA

ENGINEERING PRODUCTS DEPARTMENT . . . CAMDEN, NEW JERSEY

NUMBER 48 MARCH, 1948

Subscription Rate $2.50 per year. Single copy 50c.

JOHN P. TAYLOR, Editor JUDY J. ALESI, Ass't Editor

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Contents

OUR COVER for this issue is a color picture of the TT-5A Transmitter in the control room of our own television station, W3XEP. Photo was made by Jim Gaynor, Manager of RCA Victor's Photographic Department, and valued counselor to BROADCAST NEWS on its many photographic problems.

W3XEP is a television station most of you have never heard of—not because it's new (which it isn't), nor because we're not proud of it (we are), but rather because it is not operated for publicity purposes. W3XEP is the experimental television station operated by our engineering department for the sole purpose of developing and testing television transmitting equipment. Located in our engineering laboratories in Camden, N. J., it was first licensed (as W3XAD) in 1930. In fact, it might be considered to be even older in that it is a direct descendent of RCA's first station W2XBS (see page 27) which was constructed in New York in 1928, and which was dismantled in 1930 when RCA's television development program was moved to Camden. W3XEP has operated on more frequencies than anyone can remember, with power from a few watts to twenty kilowatts, with single sideband transmission, double sideband transmission, vestigial sideband transmission, low-level modulation, high-level modulation, AM audio, sideband filters, no sideband filters—in fact, with practically every type of television transmission which has been seriously considered. Thus, although its total number of hours on the air is not so great as that of some others, and its record is consistent only in that every log entry is "experimental transmission," W3XEP, nevertheless, can probably boast of more real "firsts" than any TV station on the air. W3XEP's equipment is constantly changing. It's had more than a dozen transmitters—including commercial, as well as experimental models. Recently the old TT-1A (a prewar commercial model) which, much modified, had served during the war years, was removed and a brand-new and shiny TT-5A installed in its place. It almost seems a shame to give engineers such a nice new transmitter. Right now they are making some special tests on it. That's fine—but soon, we know from past experience, they'll start "modifying" it, and a year or so from now it won't be a nice shiny transmitter—in fact, it will probably look more like a bread-board layout for a modernistic rat's nest. But that, believe it or not, is the way we progress. When it comes time, several years from now, to design a new commercial model, most of the ideas that go into it will have come out of that rat's nest. So, if you come to Camden, and they show you W3XEP and it's all haywire—believe us, the commercial model is not shipped that way.

TT-5A's get the limelight in this issue. And well they might, for it looks now as if this may be the most popular broadcast transmitter—AM, FM, or TV—that we (or anyone else, for that matter) ever built. More than twenty-five have been shipped. More are on order.

THE 8D21 TUBE is the real secret of the TT-5A. This tube, which RCA tube engineers in Lancaster and RCA transmitter engineers in Camden have been testing and perfecting over an eight-year period, is undoubtedly the "design of the future"—the prototype of tomorrow's transmitter tubes. Read about it on page 16.

WE WELCOME BACK, in this issue, one of our favorite contributors, Mr. Raymond F. Guy, Manager of NBC's Radio Frequency and Allocations Engineering Section. Ray's initials ("R. F.") must have been portentous, for since 1930, he has been Mr. R-F in person at NBC. Originally with Westinghouse (in the early days of WJZ) he transferred to RCA in 1924 and became a member of the famed Technical and Test group at RCA's Van Cortland Park Laboratory. In 1930, O. B. Hanson, Chief Engineer of NBC, selected him to head the radio frequency engineering section of NBC. Since that date Mr. Guy's staff has planned and supervised every NBC transmitter installation—AM, FM, and TV. And, if you think he didn't personally take a hand in these jobs, you don't know Ray! He's no armchair engineering executive—but a two-fisted practicing engineer—one of the best in the business. He's right proud of his WNBW/WRC-FM installation—and, for our money, that means it's good. Read about it on page 20. Incidentally, he likes the TT-5A, and that doesn't make us unhappy.

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Overwhelming acceptance of RCA equipment marks the swift progress of television from coast to coast.

Already a substantial percentage of broadcasters and newspapers have ordered RCA transmitters. Most of these stations are being *completely* RCA equipped, from super-sensitive cameras to high-gain antennas.

Many of these telecasters are already on the air with regular programs—or on an experimental basis. Other stations are receiving shipments of RCA equipment that will put them on the air very soon. And by the end of 1948, high-definition *RCA television* should be within the reach of 49,000,000 people.

Why is *RCA television* so far in the lead? Here are a few of the reasons: (1) Everything needed to get on the air is in quantity production at RCA *now;* (2) All equipments embody the very latest technical advances in the art; (3) Designs are flexible . . . "add-a-unit" construction makes them equally applicable to the very small or the very large station; (4) Facilities can be gradually and *economically* expanded as television audiences grow . . . without obsolescence of original equipment; (5) Equipment is easy to operate and reliable.

As you know, television is moving fast. What are *your* plans? Will you be the first to bring this new public service to your community . . . utilize its tremendous audience impact for newscasting, advertising, and circulation building? We'll be glad to help you get started with complete planning information and cost data. Write Dept. 19-C.

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RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

TT-5A TELEVISION TRANSMITTER

by C. D. KENTNER
Television Engineering Section

The TT-5A Television Transmitter, shown at right and on the front cover, is in reality two transmitters built in a single housing. One of these is a 5 KW picture transmitter, while the other is a 2.5 KW sound transmitter. The two are designed to work together from a common control center, but otherwise are complete units capable of operating independently. These transmitters, operated in combination, provide for picture and sound transmission (correctly related as to frequency and amplitude ratio) on any of the 12 metropolitan channels assigned to television. The use of a radically new tube in the output stages (of both sound and picture transmitters) permits operation with full power output on all channels.

As much as practical, the two transmitters (sound and picture) in the TT-5A are identical. The power amplifier stages are similar and use the same type of tube. The main power supplies are alike. The driver stages are necessarily somewhat different in that the sound r-f chain begins with a standard RCA FM exciter unit, whereas the picture transmitter employs a crystal-controlled oscillator. However, even then low power stages are arranged in the same manner and located in corresponding positions. This similarity in the two transmitters simplifies maintenance, reduces the required number of spare tubes, and effects manufacturing economies which make it possible to provide matching cabinets which are sturdier and more attractive than might otherwise be possible.

The electical circuits are arranged and connected so that emergency service work can be done on one transmitter while the other is on the air, even to changing the power amplifier tube of either transmitter.

DESCRIPTION OF THE MECHANICAL FEATURES

In describing the TT-5A Transmitter to broadcast engineers, we may save time by pointing out the many respects in which it is similar to RCA deluxe style AM transmitters. This is particularly true in regard to styling, type of construction and other mechanical features. In fact, the resemblance of the TT-5A to current RCA AM and FM transmitters is such that many BROADCAST NEWS readers, seeing the TT-5A Transmitter for the first time on the cover of this issue, will probably not realize immediately that it is a TV transmitter.

The entire TT-5A Transmitter is housed in eight steel frame units bolted to a base frame. The base structure is divided so that the eight cabinets can be placed either in a straight line or in several possible U-arrangements (Figure 3). The width and height of these units, as well as their style and coloring (two shades of umber gray with chrome trim) is the same as that of RCA FM transmitters so that when FM and TV transmitters are placed in the same operating room, they present a matching appearance. For ease in shipment, handling and installation, the transmitter is packaged in relatively small units.

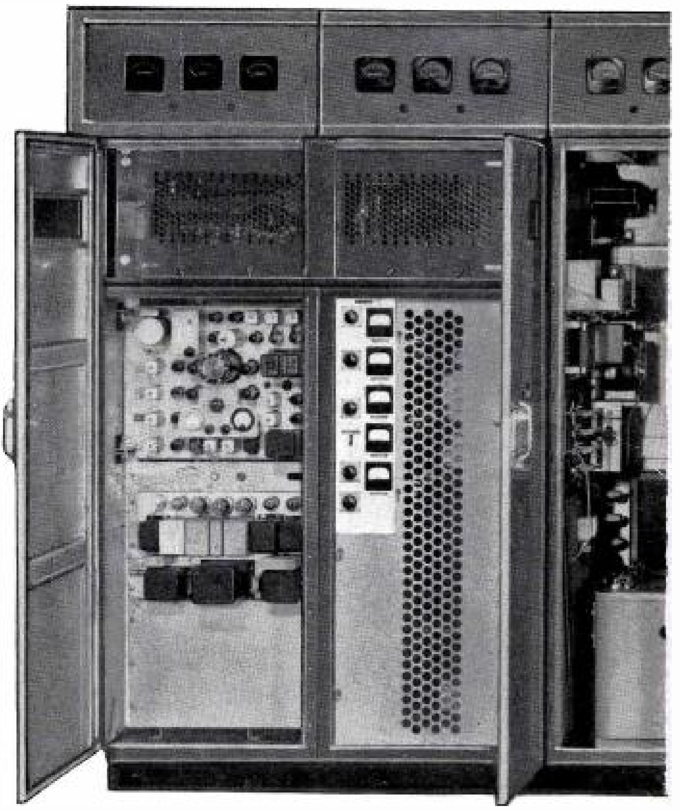


FIG. 1. *TT-5A Transmitter with front doors open to show accessibility. Frames 1 and 2 house the sound transmitter; frame 3, the*

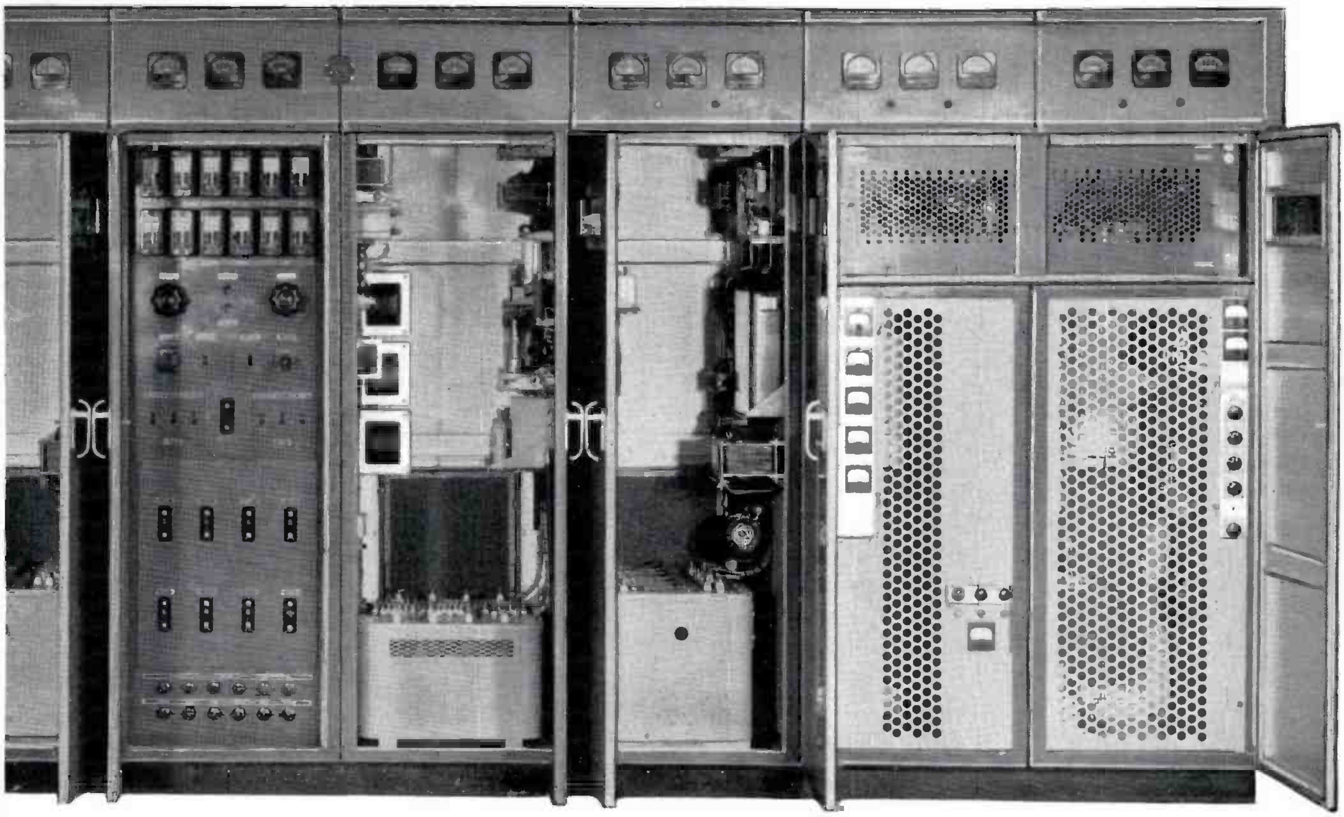
The largest unit, uncrated, measures 25 x 38 x 80 inches and weighs approximately 600 pounds. A bulk wiring material kit is supplied as part of the equipment, and cabinet inter-connecting wires are designed to be run through the base structure to the various conveniently located terminal boards. Only external connections need be considered when planning the installation as long as continuity is maintained along the front surface of the cabinets comprising the transmitter.

"Walk-in" type construction is employed throughout; subassemblies are mounted on vertical side panels providing easy access through both front and rear interlocked doors. Where possible, components are surface-mounted, and wiring is exposed for speedy circuit tracing and servicing. Individual air inlet openings with removable filters near the bottom of the rear door of each compartment assure a clean, dust-free air supply to the interior of the transmitter. Small blowers installed inside the cabinets supply adequate ventilation, warm air being expelled by a 500 cfm exhaust fan in the top of each of the cabinets.

The water circulating system is furnished complete as a unit, and may be located remotely from the transmitter in an adjoining room or on the floor below. The unit is a closed system and therefore does not require an external water supply. Connections to each PA cabinet can be made via either a trench terminating beneath the transmitter, or through access holes in the rear.

USE OF HIGH LEVEL MODULATION

In designing the electrical circuits of the TT-5A Transmitter, one of the most important decisions to be made was on the question of high-level modulation versus low-level modulation.



power supplies for the sound transmitter. Frame 4 is a centralized control panel for both transmitters. Frames 5 and 6 contain the picture power supplies, while frames 7 and 8 house the picture transmitter. Each frame also has a full length rear door so that accessibility to each compartment is a maximum.

In the early days of broadcasting, most transmitters were low-level modulated. The difficulties encountered in tuning and in maintaining stability in the Class B stages of these transmitters, as well as their low efficiency, are well-remembered by most broadcast engineers. Today nearly all AM transmitters are high-level modulated.

In television transmitter design the two systems of modulation have about the same relative advantages. We have found that it is easy, as well as economical, to amplify the video signal to the level required for modulating the final stage. By so doing we have completely eliminated the difficulties inherent in the broad-band linear stages which it would otherwise have been necessary to use.

Various circuit features of the TT-5A have been borrowed from standard broadcast practice. In particular we have made use of the highly-developed control circuit designs, which have been an outstanding feature of RCA AM transmitters. A centralized control unit, arranged and wired in "Switchboard" fashion, is one of these features. Complete protection for personnel and equipment is another.

Switches are of the circuit-breaker type, grouped on the control panel for quick identification. High-power circuits are doubly protected by high-speed overload relays backed up by thermal circuit-breaker switches. Similar circuit-breaker switches are used to connect water-coolers, blowers, filament and low-power circuits to the power line. A detailed description of the arrangement and operation of the audio, video and r-f circuits of the TT-5A will be found on following pages.

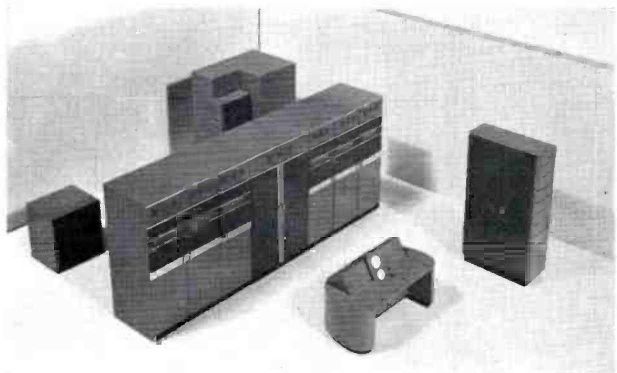


FIG. 2. *Standard arrangement of the TT-5A Transmitter components.*

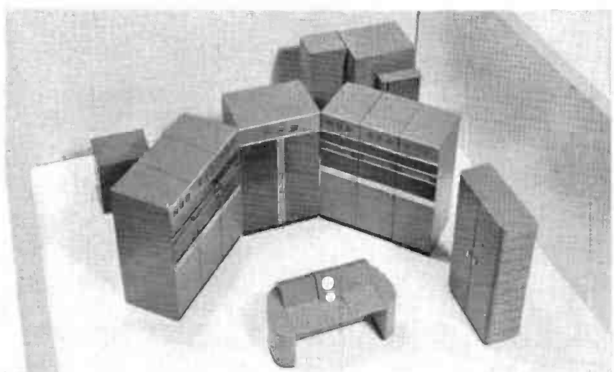
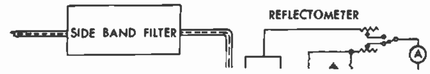


FIG. 3. *An alternative arrangement of the TT-5A Transmitter units.*



ADVANTAGES OF HIGH-LEVEL MODULATION

Of the various modulation methods, RCA has chosen high-level grid modulation as being the most practical, efficient and economical, particularly for powers of the order of 5 kilowatts. It affords much greater simplicity in driver circuit design and adjustment than do low-level modulation methods. Moreover, slight maladjustment of the driver stages feeding a modulated power amplifier has no detrimental effect on picture quality, as long as correct drive to the P.A. is maintained.

It may be of interest to discuss briefly the underlying principles involved. It is manifestly true that the ultimate objective is to feed to the radiating system an r-f signal modulated by picture sidebands of an amplitude compatible with the rated output power. This sideband energy must be obtained by amplification of the low level output of the line amplifier. This amplification can be accomplished either by broad band r-f amplifiers or broad band video amplifiers. The *same picture energy amplification must be accomplished in either case.* It is our thinking that the picture signal should be built up at video frequencies to as high a value as possible with simple, straight forward tubes and circuits, and without getting into water-cooled tubes for the modulator stage. Combining video on carrier is then made at this level. In the TT-5A it works out that this point occurs at the grid of the final stage. For higher powers, a single linear would be used. Thus, video band pass characteristics are accomplished in circuits with fixed constants, requiring no adjustments, as contrasted to the low level system where the band pass is entirely a matter of tank circuit tuning.

VIDEO MODULATOR

The picture amplifier and modulator unit, Figure 7, consists of two video amplifier stages, the modulator stage, sync expander, sync separator, sync amplifier and a d-c insertion diode. Three RCA 6AG7 tubes in parallel comprise the first video stage. Input level can be controlled either at the transmitter or from the console. Control of the gain from the console is provided by a reversible motor which drives the gain potentiometer.

From the first amplifier, video signals pass through a high-frequency compensating network to the second video amplifier, consisting of two RCA 807 tubes connected in parallel. To compensate for the loss in sync-pulse amplitude in the succeeding modulator and power amplifier stages, an RCA 6AG7 tube is connected in parallel with these 807's. As the 6AG7 has high transconductance (and sharp cut-off) it is used to expand the synchronizing pulse. This is done by using the plate current of the tube to increase the combined plate currents through the amplifier load during the pulse interval. The 6AG7 tube can provide an increase in pulse amplitude of approximately 30 percent without increasing the amplitude of the picture signal. Its plate current is controlled by a potentiometer in the screen.

Six RCA 4E27 tubes in parallel modulate the grids of the power amplifier. The modulator plate load is a constant-resistance network consisting of four high-frequency sections and three low-frequency sections. This network maintains a constant impedance of 500 ohms over the entire video band. The section of the plate load, permitting excellent frequency response down to and including d-c.

A "clamp" type d-c restorer circuit is used in the modulator stage. This circuit, which actually employs a sync separator (RCA 6J5), a sync amplifier-inverter (RCA 6AC7) and a biasing and restorer tube (RCA 6H6), partially disables the modulator tubes during the last part of the horizontal blanking signal immediately after the sync interval. This clamping action reduces to negligible amplitude spurious low-frequency signals such as microphonics, power supply surges and 60-cycle hum introduced in preceding stages.

The horizontal sync separator is transformer-coupled to the sync amplifier and phase inverter. The transformer is tuned by associated tube and stray capacities so that one-half cycle at its resonant frequency has a duration of approximately two microseconds. Highly dampled by core losses and to some extent by circuit losses, the transformer dissipates its stored energy in the form of a pulse which is then amplified and inverted by the 6AC7. Phase inversion is necessary to make the 6H6 clamp the modulators on the rear portion of the horizontal blanking signal. Thus, modulator bias is automatically corrected to the same predetermined value for each blanking pulse, and in effect, the d-c component restored.

For test purposes, it is desirous that the transmitter be capable of being modulated with a signal which is symmetrical above and below the axis, such as sine wave, video sweep or square wave. This type of signal is unorthodox for a television transmitter and requires special adjustments which differ from those for a standard composite television waveform. This adjustment is termed "mid-characteristic" operation, and the changeover from normal "d-c restorer" operation is accomplished by an "AC-DC" switch. With this switch in the "AC" position, the grids of the second video amplifier, the sync amplifier, and the modulator stage tubes are returned to a manually adjusted bias source and the clamping circuit tubes are biased to cut-off.

An RCA 6AG7, coupled through a resistance attenuator to the output of the picture modulator, functions as a phase inverter, producing video signals of negative polarity for the monitor in the console.

POWER SUPPLIES

Plate and screen voltages for the picture r-f portion of the transmitter are furnished by power supplies located in frames 5, 6 and 7 of the transmitter. By equally dividing the power supply components between these three frames, overcrowding was avoided, resulting in easiest accessibility to all components.

Frame 6 houses, in addition to the 5000-volt supply for the plates of the power amplifier, a regulated 800-volt d-c supply which furnished screen voltage to the power amplifier, and a 1500-volt supply for the plates and screens of the oscillator stage, the frequency multipliers and drivers. The driver plate transformer is in frame 5, and the voltage dividers for this supply are in frame 7. The 5000-volt and the 1500-volt power supplies both use 3-phase, full-wave rectifier circuits, the 5000-volt supply employing six RCA 8008 rectifiers and the 1500-volt phase, full-wave rectifier circuit. A knife switch is provided for changing the primary circuit of the high-voltage transformer from a delta to a wye connection for tune-up operation.

Modulator plate voltage is supplied from a 1000-volt supply using six RCA 8008 rectifiers. From voltage dividers in this supply, 600 volts d-c is fed through an electronic voltage regulator and applied to the modulator screens and to the plate and screens of the video amplifiers. A 300-volt d-c supply furnished bias voltages for both the video and r-f stages of the transmitter.

An electronically-regulated, single-phase full-wave rectifier supplying 1100 volts d-c provides the negative reference voltage which opposes the variable (with d-c component) positive voltage at the modulator plates. This bias supply is connected between the plates of the modulators and the grids of the power amplifier through the high frequency portion of the constant-resistance network.

PICTURE TUNING

As previously mentioned, the power amplifier of the RCA TT-5A is the only broad-band stage in the transmitter. All r-f stages up to and including the grid of the final stage are tuned by means of meter observations in 30 to 45 seconds. (In the case of the Channel 6 to 13 transmitter, this may be somewhat longer unless the two extra stages have previously been neutralized.) The video stages are fixed and need no tuning. The operator can follow either of two procedures. If time is limited and he wishes to get on the air as quickly as possible, he will switch in a "tune-up" crystal provided for this purpose in the oscillator (approx. 1.6 mc. higher in frequency than the normal crystal), tune up the r-f chain, *tune the PA output by meter readings*, and adjust the output coupling to give pre-determined meter readings. The purpose of the tune-up crystal is to allow the PA to be tuned up so that its pass band is symmetrical about the carrier. The normal crystal is then switched in, the exciter stages touched up again for the normal frequency, and the excitation voltage on the final stage adjusted. The transmitter is then ready for modulation, and the tuning will be found close enough to give a good picture. For more accurate settings, the video sweep is fed into the picture input of the transmitter (after switching the transmitter to "sine-wave" modulation) and the signal is demodulated by the "sweep diode" of the WM-13A. Its output may be presented either on an oscilloscope or the console CRO and will show the band pass characteristic. All the necessary adjustments to the PA plate may be made by observations of this presentation. In addition, any desired record can be made by transcribing from the scope.

A full complement of meters and indicator lamps mounted along the top front panel of the transmitter provide for quick observation of the performance of the various circuits. Separate panel meters are provided for the grid and cathode circuits of the driver stages and for the grid, screen and plate circuit of each power amplifier. The meters are easily readable with scales and pointers being finished in highly contrasting white on black background.

Switches for separate control of the sound and picture transmitters are mounted on a control panel behind a non-interlocked door. Tuning controls for the sound and picture driver circuits are brought out to the front of interlocked screen doors behind non-interlocked front doors of the respective cabinets.

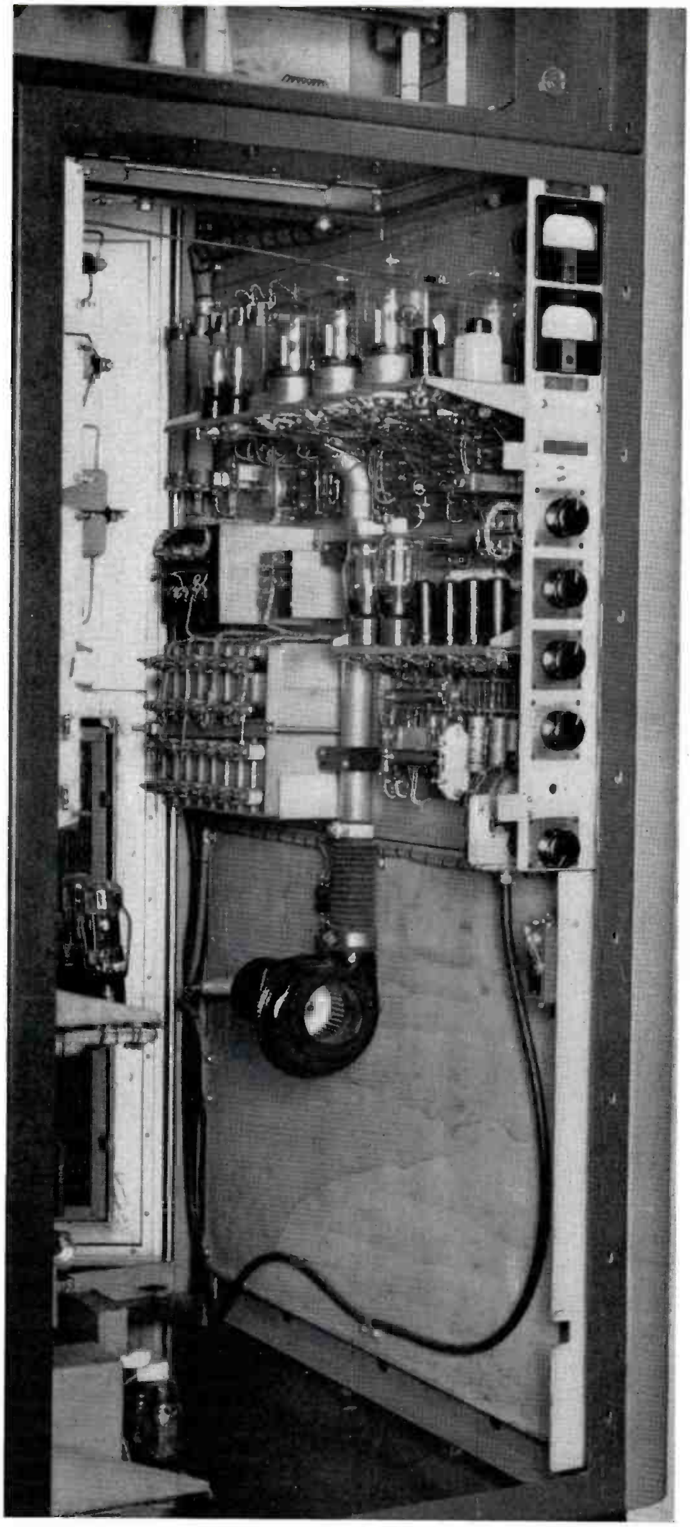


FIG. 7. *The complete video and modulator unit is shown here. This compact and relatively simple unit consists of three straightforward video stages (the last one of which provides all the video power required to fully modulate the 8D21 in the picture p.a.) plus the sync separator and expander circuits required in all video transmitters. By providing this simple foolproof unit, it is possible to use high-level modulation and thereby eliminate the chain of Class B linear stages which are necessary in "low-level" transmitters.*

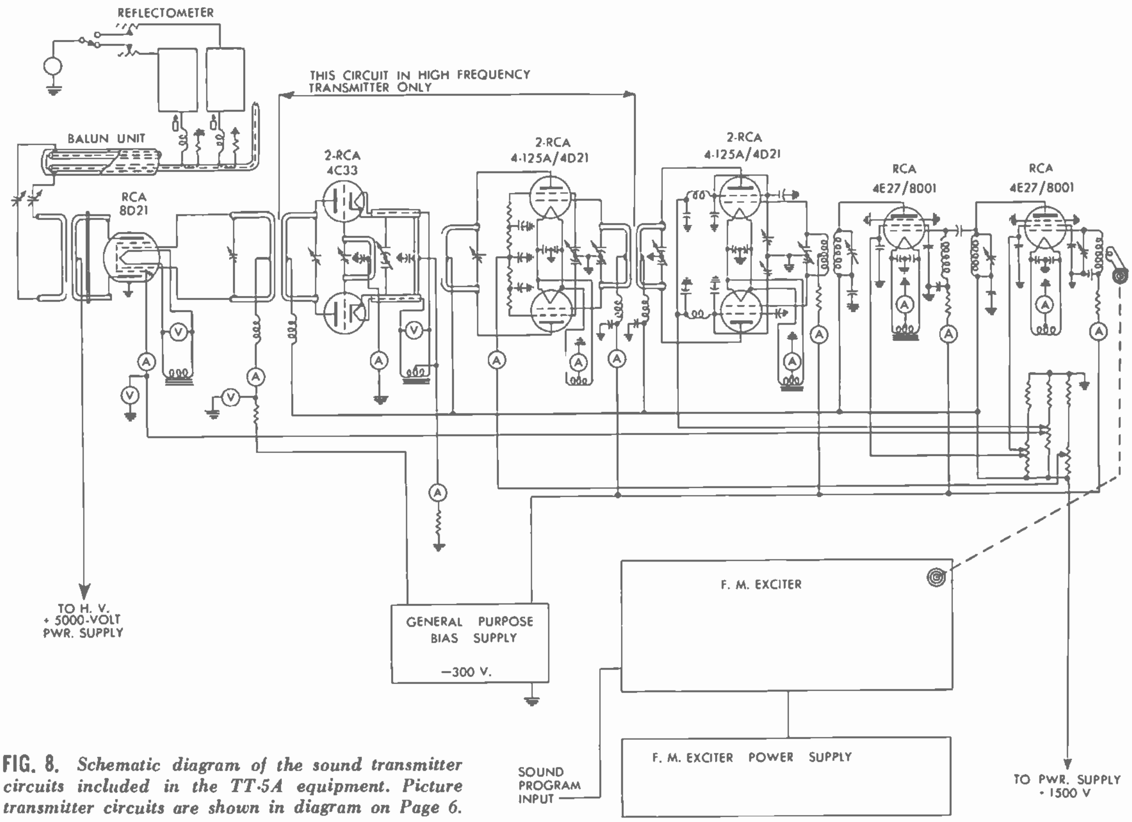


FIG. 8. *Schematic diagram of the sound transmitter circuits included in the TT-5A equipment. Picture transmitter circuits are shown in diagram on Page 6.*

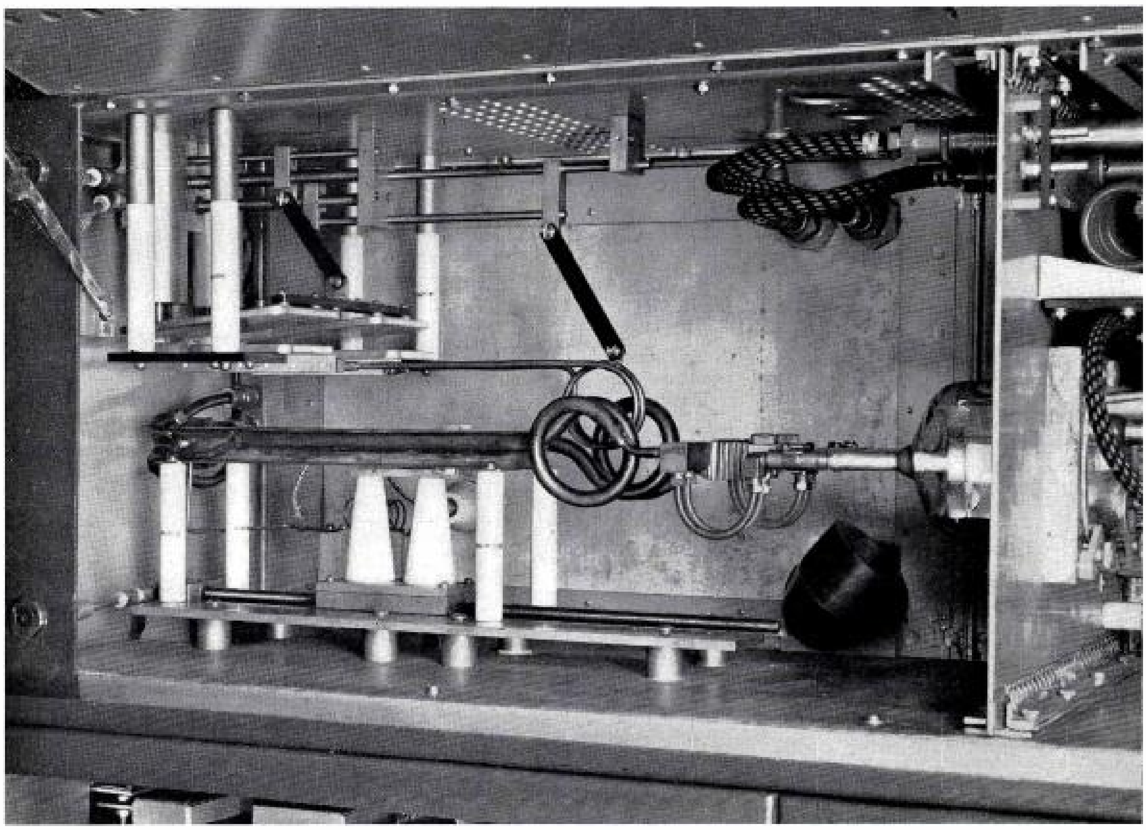


FIG. 9. *Closeup view of the plate circuit of the sound power amplifier. (The picture p.a. is identical except reversed left to right.) Tuning is accomplished by flexible shaft couplings to calibrated controls at the left-front. These controls are located behind the front doors, which on these frames are not interlocked.*

FIG. 10. (right) *Open view of frames 1 and 2 containing the sound transmitter. The lower part of frame 1 (left) contains a standard RCA FM exciter unit. The lower part of frame 2 (right) contains the intermediate stages, while the power amplifier is arranged horizontally across the top part of the two frames. In this illustration H. E. Gihring (right), manager of RCA Television Transmitter Engineering Section, explains operation of sound transmitter to Henry Rhea, formerly manager of RCA Television Equipment Sales, now manager of WOWH, Clinton, Illinois.*

SOUND CHANNEL

The tube complement and circuits of the sound driver and power amplifier are identical to those of the picture driver and power amplifier. Of course, the carrier frequency for the sound channel is higher by 4½ mc., and since a "direct-FM" exciter is used, the carrier frequency is not generated by a crystal oscillator, and the power amplifier is not modulated directly as is the case in the picture channel. But the important advantages of crystal control are also obtained in the sound channel by the use of that well-known FM exciter used in RCA's dependable "BTF" series of FM broadcast transmitters. The circuit employed retains the advantage of simplicity and fewer tubes, while at the same time it provides good fidelity and the frequency stability of crystal control. (Figure 8.)

AUDIO POWER SUPPLIES

The FM exciter unit obtains its operating voltages from a regulated power supply using 3 RCA 5U4G rectifiers in a full-wave single-phase circuit. A selenium bridge-type rectifier supplies 19 volts d-c to operate the filaments of the two reactance tubes, the modulated oscillator and the first frequency multiplier tube.

A 1500-volt d-c supply, identical to the picture supply, furnished plate and screen voltages to the r-f driver chain. The screen grid voltage of the power amplifier tube is taken from a voltage divider in the output of the supply. The rectifier and filter of this supply are in frame 3, the power transformer in frame 1, and the output voltage divider in frame 2.

The power amplifier plate voltage is furnished by a 5000-volt mounted in frame 3. This supply is identical to that used for the picture power amplifier. Operation on either high or low power is provided by a switch which changes the connections of the plate transformer from a delta to a wye circuit.

The normal sound input to the transmitter is pre-emphasized according to the standard 75-microsecond pre-emphasis curve. For listening purposes, a 75 microsecond de-emphasis network is included in the console behind the master monitor control panel. When S1112 is in the "IN" position, the de-emphasis network functions for the signal to the sound monitor amplifier when the transmitter input push-button is depressed. When S1112 is in the "OUT" position, the transmitter input signal appears at the sound monitor amplifier without de-emphasis. Since the de-emphasis network is a dissipative network, the level at the sound monitor gain control will increase about 20 db. when the switch is changed from "IN" to "OUT." The VU meter reading of the input level is not affected by the de-emphasis network or by S1112.

VESTIGIAL SIDEBAND FILTER

Use of a vestigial filter at the output of the power amplifier assures that the undesired portion of the lower sideband will be definitely suppressed without any possibility of reinsertion. This is true because this system of sideband suppression does not depend upon the precise adjustment of tuned, low-level band pass stages as do low-level suppressing methods. Moreover, use of the filter permits high-level modulation, which in turn simplifies adjustment of the entire transmitter, and permits better overall linearity in the picture channel.

The vestigial sideband filter, grouped with a diplexer unit (furnished with the antenna) and dummy load rack, is shown in Figure 11, at left. Its height and depth is the same as that of the transmitter. Its width is 36 inches.

Connected directly to the output of the picture transmitter, the filter absorbs the relatively small amount of sideband energy (75 watts max. at 5 KW) falling outside the 6-megacycle television channel. The filter offers a constant input impedance over the entire double sideband.

Electrically, the sideband filter is a combination of two m-derived filters employing low-loss coaxial line. One of these filter units is a properly terminated low-pass line which effectively absorbs reflections of the lower sidebands. The other filter unit provides the sloping characteristic for the lower end of the high sideband. From here, the picture signal passes to a

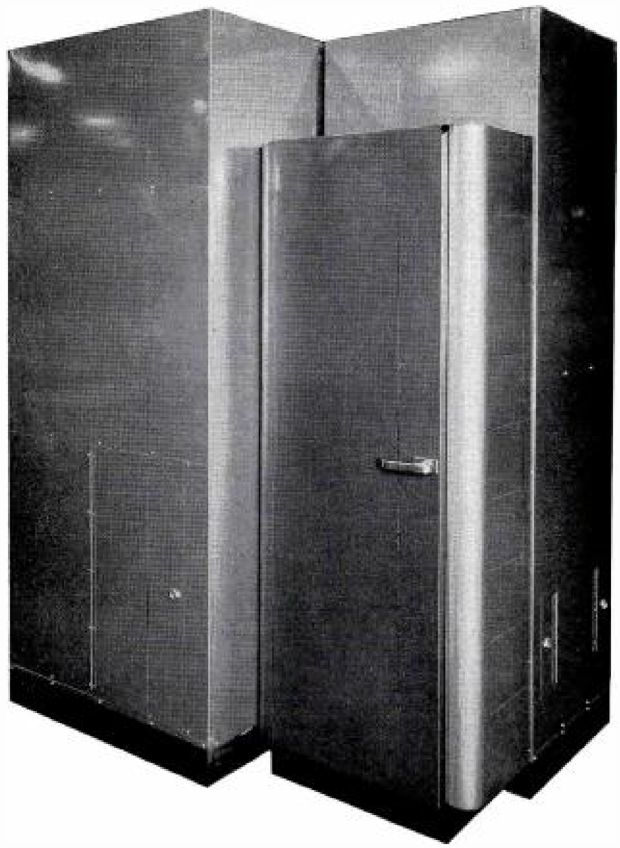


FIG. 11. (above) *This assembly includes the dummy load, right front; the diplexer, in the tall narrow cabinet at right rear; and the sideband filter in the large cabinet at the right. All three are fixed-tuned units which once properly installed and tuned, require no further attention.*

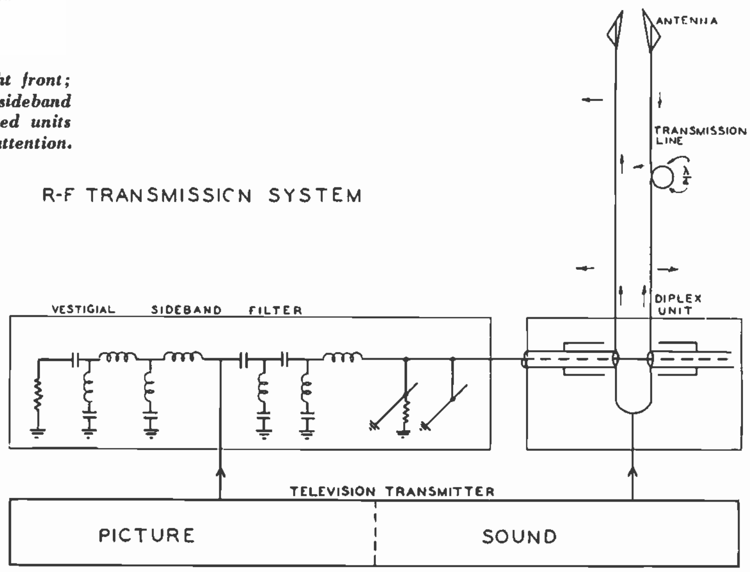


FIG. 12. (right) *This diagram shows how the sound and picture transmitters are connected by means of the diplexer unit to the elements of a single antenna. The sideband filter inserted in the output lead of the picture transmitter consists of two M-derived sections (one a high-pass filter, and the other a low-pass filter) plus a notching filter.*

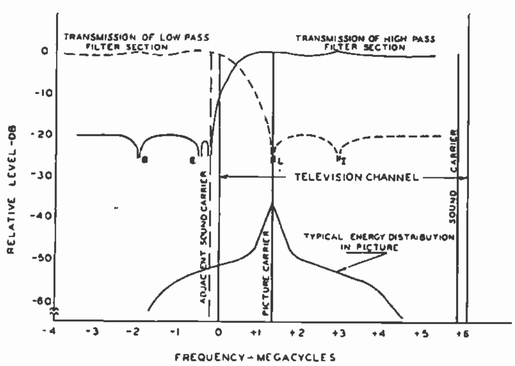


FIG. 13. (left) *This response-frequency diagram illustrates the action of the filter. The low-pass filter section (at the left in the diagram above) is terminated in a resistor. The lower sidebands pass through this filter and are absorbed in the resistor. The high-pass filter section (at the right in the above diagram) provides the sloping characteristics required for the lower end of the high sideband (in vestigial sideband transmission). A notch filter (the two terminated lines at the far right of filter diagram above) provides high absorption at the frequency of the sound carrier in the next lower channel.*

notch filter. The notch filter is a system of resonant coaxial transmission lines allowing the absorption of a single frequency. This filter gives positive insurance against interference with the sound channel of the next lower television channel. (Figure 12 and Figure 13.)

By folding the various lines and rigidly supporting them in a metal frame, it is possible to build an assembly requiring only 10 square feet of floor space. Finished in two-tone umber gray to match the transmitter cabinet, the sideband filter presents a very pleasing appearance. It is designed to stand vertically near the picture transmitter. Each unit is tuned for the desired specific channel before shipment, and no further adjustment is required. (Figure 15.)

DUMMY LOAD

The dummy load is designed to terminate the output of either the picture or sound transmitter and allow absolute measurement of the power output of either transmitter.

Matched to the 72-ohm transmission line, the dummy load is a high attenuation coaxial line, the inner conductor of which is a water-cooled resistor. Power output is measured by the calorimeter method making use of two thermometers and a flow meter.

The load, power measuring equipment, and flow meter are housed in an attractive cabinet finished to match the transmitter. When the load is to be used, it is taken from the cabinet and connected to the transmission line. Utilizing the transmitter water-cooling system, two 15-foot water hoses carry the water between the cabinet and load. The flow meter is provided with an interlock to shut off the transmitter if water fails to circulate. The transmission line is equipped with quick disconnect fittings allowing the load to be put in operation in only a few minutes.

Terminated by the dummy load, the standing wave ratio on the 72-ohm transmission line will be 0.85 or better.

TRANSMISSION LINE

A 72-ohm, 3-inch diameter ungassed line is supplied for connection between the picture and sound transmitters, the vestigial sideband filter and the diplex unit. The line is of the coaxial type using ceramic insulators spaced at one-foot intervals, to support the inner conductor. Use of a transmission line of this size provides a margin of safety on voltage gradient, and thus the portion of line within the transmitter building can be used without gas.

All elbows and couplings are solderless and are assembled by means of external clamps that provide dust-tight connections. The inner conductor connectors are of the "spring-loaded" type, allowing the inner conductor to slide for a short distance and thus compensate for differential expansion. For this reason, no expansion joints are required.

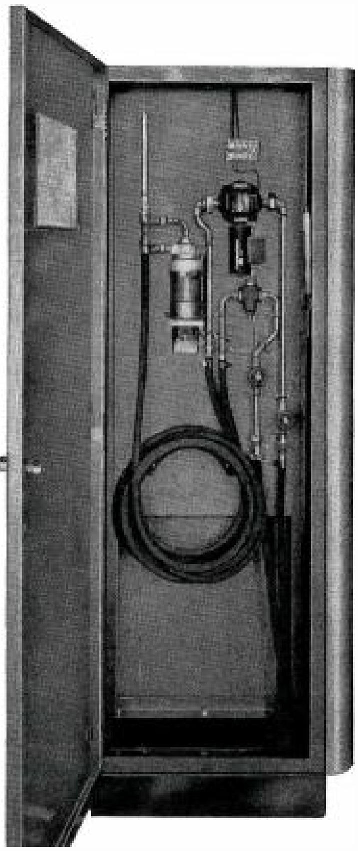


FIG. 14. *Inside of the dummy load cabinet. This unit consists essentially of a water-cooled resistor which terminates a 72-ohm line connected to the transmitter output.*

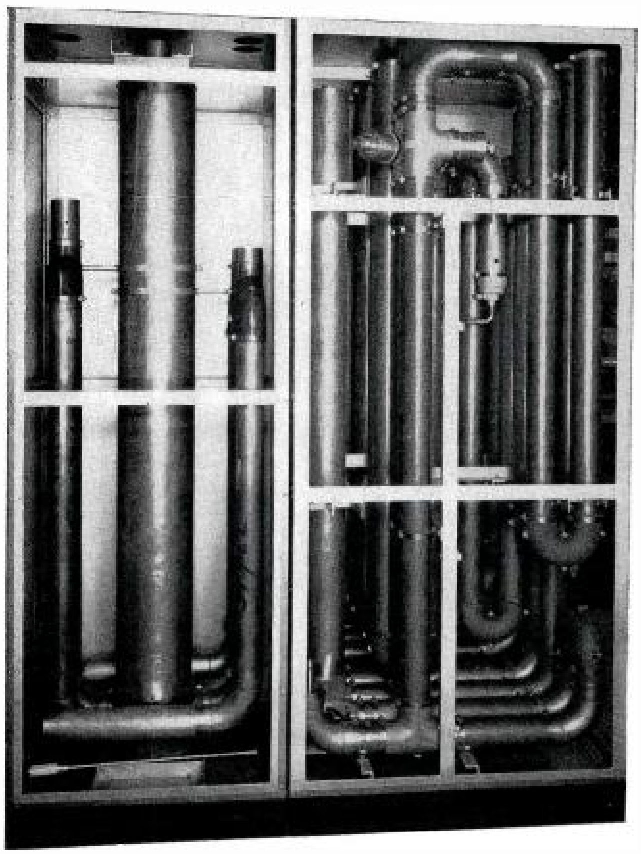


FIG. 15. *Diplexer (left) and sideband filter (right) with sides removed to show the folded back coaxial lines which make up the capacitances and inductances used (see diagram Figure 12).*

FIG. 16. *The control console furnished with the TT-5A is one of the outstanding features of this transmitter. From this vantage point the operator has complete finger-tip control over both the operating and monitoring functions of the transmitter. In the center of the console is a standard RCA TM-5A Monitor containing a 10-inch picture tube, for observing the transmitted picture, and a 5-inch CR tube, for monitoring the wave form. Both may be switched to the incoming line for checking purposes. At the sides of the monitor unit are two sloped panels (on opposite page) containing all of the usual transmitter starting and operating controls.*

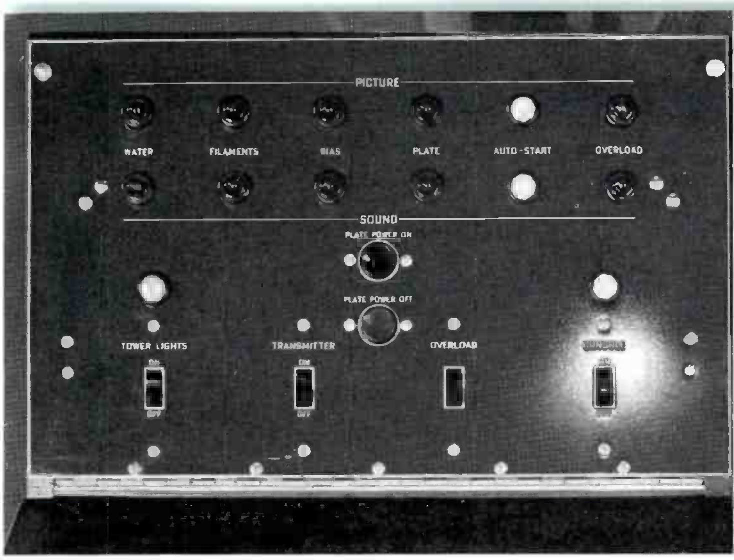


FIG. 17. *Lefthand control panel. Start-stop controls, tower lights, etc., plus signal lights indicating operating status are mounted on this panel.*

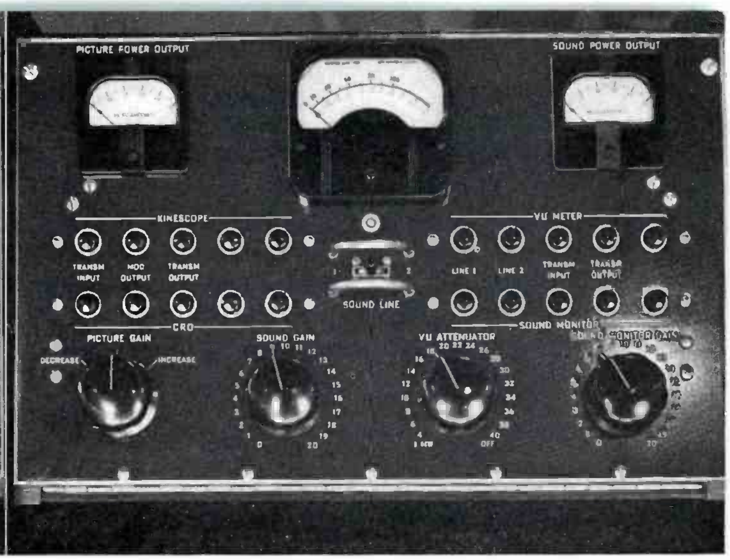


FIG. 18. *Righthand control panel. Input audio and video controls, kinescope and CR switching, VU meter and sound and picture output meters are mounted on this panel.*

CONSOLE

The RCA TT-5A console has been constructed as an attractively styled control center, where the operator has complete finger-tip control over both the operating and monitoring functions of the transmitter. In the console are the essential starting and stopping switches, gain controls, indicator lamps and output meters for transmitter operation, plus complete monitoring facilities for control of both picture and sound signals. Spare push-button switches provide for the use of remote picture and sound monitors.

Manual as well as automatic sequence starting is provided. While under automatic operation, repeated overloads produce a 3-shot recycling sequence which will automatically return the transmitter to the air up to three times. If such overloads persist, the transmitter is automatically shut down. A special hold-in circuit instantly returns the transmitter to the air after momentary line failures, thus avoiding the normal 30-second delay required for the plate time-delay relay to close.

Monitoring of the sound channel is provided by a vu meter and speaker circuit. The desired sound level can be maintained at will, and relative indications of r-f power output from the sound transmitter are given by an output meter also located in the console. The monitoring speaker, as well as the vu meter, can be switched by push-buttons to either the input or the output of the audio channel. Two spare push-buttons provided for switching to either of two input lines, and another spare push-button for both the meter and the speaker are provided for remote monitors or other optional use.

Just as the console provides adequate means for control over the sound signal, it offers comparable facilities for the control of the picture signal. Picture gain can be controlled manually, and power output indications are likewise obtainable on a panel meter in the console. Moreover, facilities for observation of the picture and for analysis of its waveforms are provided in a compact, easy-to-operate master monitor.

The master monitor is identical to RCA's studio monitor and contains a 10-inch kinescope, 5-inch CRO tube, video amplifiers, a sync separator and sweep circuits. The 10-inch tube serves for observation of the picture, and the 5-inch CRO tube reproduces the picture waveform. For measuring purposes, a calibration circuit is provided which establishes a definite voltage level on the oscilloscope screen. The CRO is synchronized (by the separator circuits of the kinescope) at half the sweep frequency of the kinescope. Therefore, two cycles of either horizontal or vertical sync pulses (as selected) appear on the CRO tube screen. The monitor can be operated with composite picture and sync input, or driven by separate picture and sync voltages. The grid circuit of the CRO tube in the monitor is accessible to apply pulse voltages for measurement. Depth of modulation can also be measured. All circuits are easily accessible for servicing.

In use, the few operating controls of the master monitor require only a minimum of adjustment. Upon starting, adjustment of the "hold", focus and brightness controls is of course required, but thereafter only slight readjustment of the brightness and focus control may become necessary as tubes age or room lighting conditions change. Aluminum backing on the screen of the kinescope produces a very brilliant picture.

As mentioned before, detected signals from the sideband filter can be fed to the master monitor in the console to provide composite black and white pictures as well as waveform displays of the signal being transmitted. Detection of the r-f signals for feeding to the picture tube is performed by the RCA WM-12A Picture Demodulator, while video signals for waveform display are provided by the RCA WM-13A Modulation Monitor.

Both these instruments are high-quality superheterodyne receivers, tunable to any one of the 12 Metropolitan television channels. A stage of r-f amplification, two stages of picture i-f (25.75 mc.), a diode crystal second detector and two stages of video amplification are employed in each instrument. The WM-13A has additional components, such as an auxiliary diode crystal rectifier, two stages of sync. amplification and separation, and keyer stages.

The germanium crystal rectifier of the WM-13A with its input connected to pick up r-f from the transmission line, and its output connected through a low-pass filter to the oscilloscope, provides for observation of the transmitter frequency-response characteristics. A single switching system employing a remotely controlled relay allows the selection of either the crystal or the superheterodyne outputs. Synchronized by vertical sync pulses separated from the composite video signal, the keyer of the WM-13A produces a rectangular pulse of a duration equal to the flyback time of the oscilloscope sweep. This pulse is used to stop the local oscillator of the WM-13A for the pulse duration; and since the oscilloscope sweep frequency is half the picture frame frequency, the resultant display on the oscilloscope screen will be a horizontal base line referencing zero output.

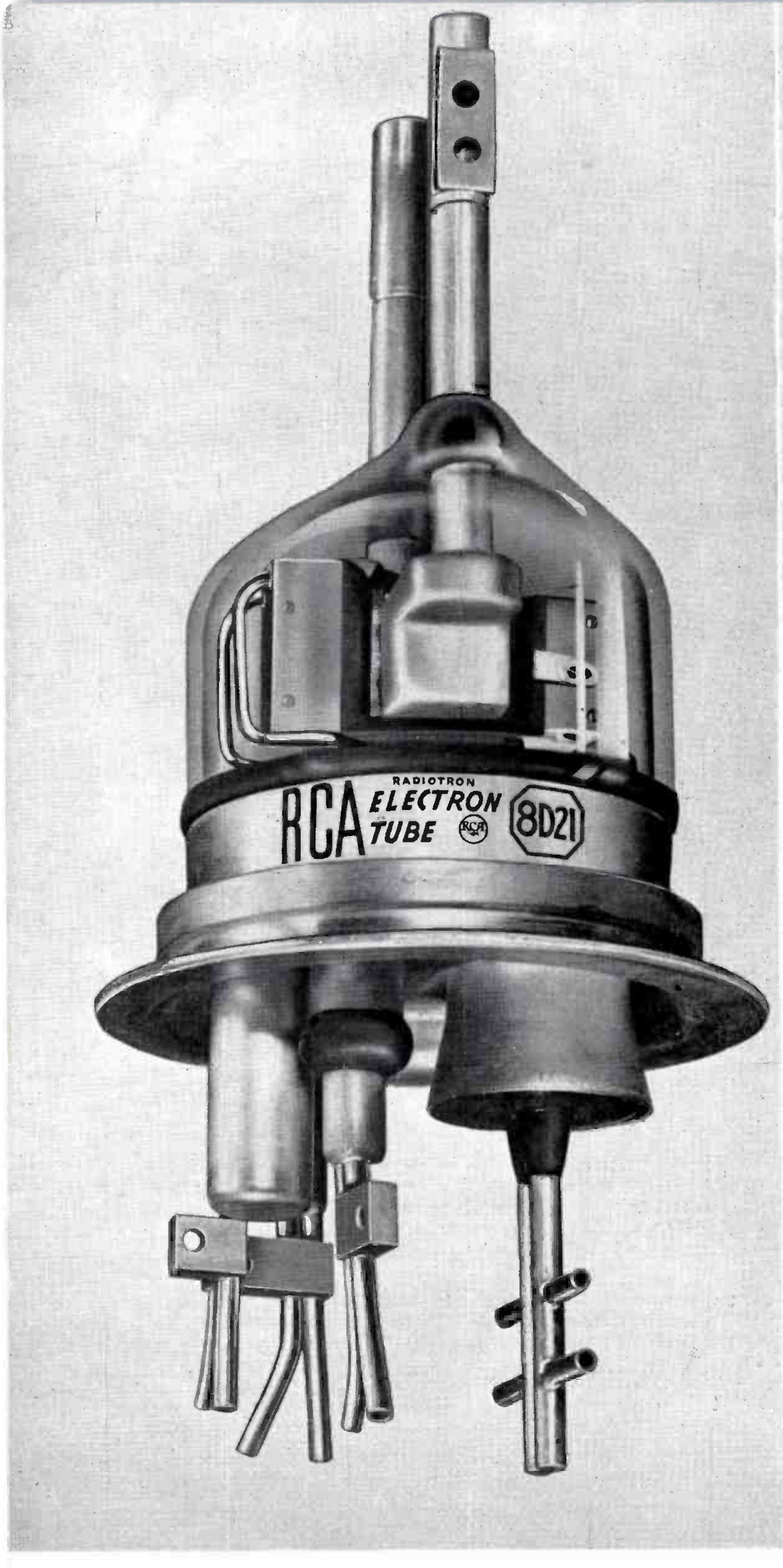
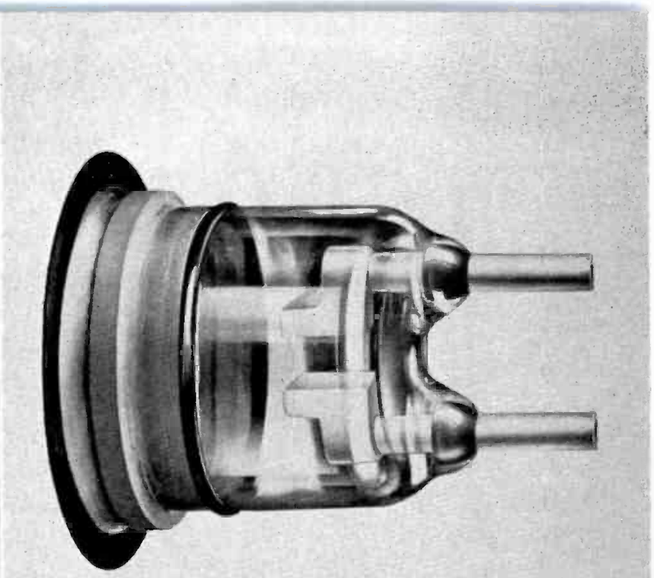


FIG. 2. Finished 8D21 showing how the anode-dome assembly (with anode terminals of tetrodes No. 1 and No. 2 projecting from top) is welded to metal header which supports the internal structure of tube. Directly below metal header and to the right are the control-grid terminals of tetrodes No. 1 and No. 2. To left of center, the terminal for the No. 2 grids; and to the extreme left, the filament terminals. The tube is fitted with a special cathode and beam-confining electrodes, and, because of the cathode structure used, must be operated in a horizontal position with plane of the control grids below horizontal plane of the filament leads.



ANODE ASSEMBLY

FIG. 2. The glass-to-metal seal structure of anode assembly: The two anodes are soldered to the ends of supporting tubes which form the elements of a transmission line and also function to carry the water to and from the anodes, thereby providing cooling for the glass-to-metal seals.

THE RCA 8D21

HIGH POWER AT VERY HIGH FREQUENCIES

A significant step forward in the development of power tubes for television occurred last spring with the introduction of the RCA-8D21 by the RCA Tube Department. An internally neutralized, push-pull tetrode of advanced design, the 8D21 features high power capability at very high frequency. This is accomplished by the use of a compact, high-current-density structure in which all electrodes are water-cooled close to the active electrode areas, including the anodes, control grid, scren grids, and filament mounting blocks.

When used as a class C, grid-modulated, push-pull r-f power amplifier in television service, the 8D21 has a maximum plate-voltage rating of 6000 volts, a maximum total plate input of 10,000 watts, and a maximum total plate dissipation of 6,000 watts. The tube may be operated with maximum rated input up to 300 megacycles.

Measuring 12 inches in overall length and 5¾ inches in diameter, the 8D21 has an eight-stranded, U-shaped, thoria-coated, tantalum-ribbon filament capable of large emission densities. The tube is internally neutralized, eliminating the need for external neutralization. Additional features are low inter-electrode capacitances, internal shielding between input and output circuits, internal bypassing of screens to filament to maintain the r-f potential of the screens at ground potential, and relatively short internal leads with consequent low inductances.

Because of electron-optical principles incorporated in its design, the 8D21 has high power sensitivity resulting in low driving-power requirements.

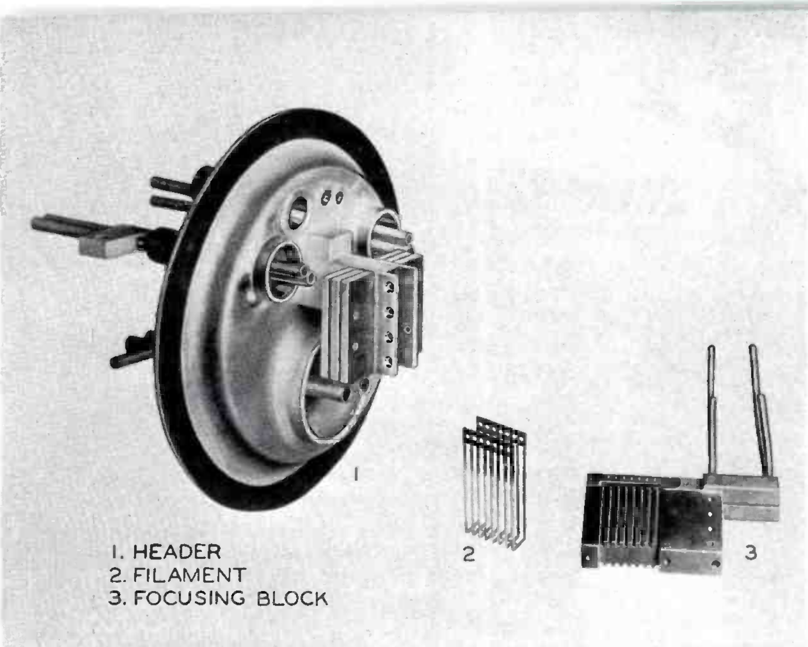


FIG. 3. 8D21 header before assembly. Identified parts are:

1. Metal header showing water-cooling connections for control grids, screens, and filament mounting and focusing block, and in the center, the supporting structure for the focusing block and the screens.

2. Filament: Each side of the 8-stranded, U-shaped, thoria-coated, tantalum-ribbon structure functions as the filament for one tetrode section.

3. Focusing Block: On this water-cooled mounting block the filament-type cathode is mounted. The ribs of the block act as focusing elements to form electron beams which pass between the aligned control grid and screen-grid to each anode.

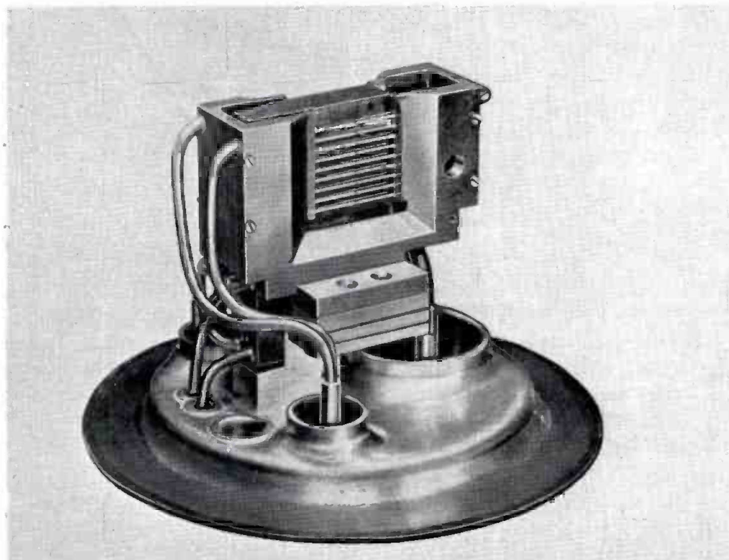
FIG. 4. Grid and anode parts of the 8D21. Identified as:

1. Control grid with water-cooled supporting tube attached.

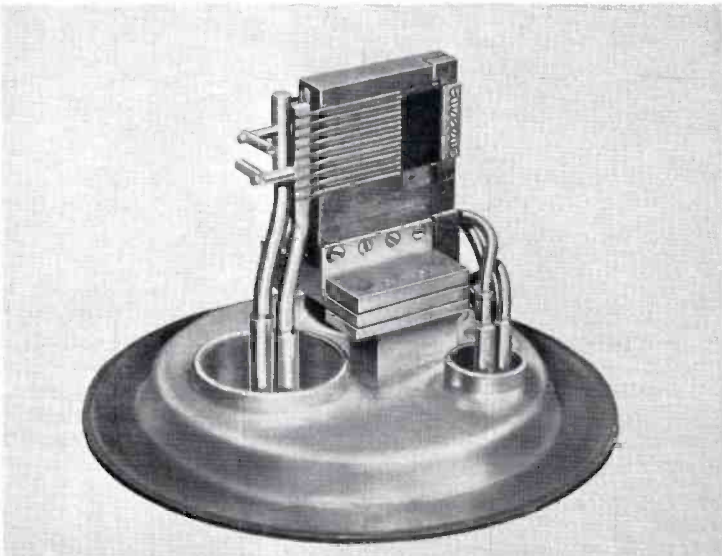
2. Screen grids of the two tetrode sections are combined in a box-like assembly (with water-cooled tubes attached) which surrounds and shields the control grids and filament block.

3. Neutralizing Tab: Neutralization is provided by the capacitance between a tab and an anode, the tabs being directly supported by elements soldered to the control grids.

4. Anode Face: Fits into anode support assembly and has an exposed area of approximately one square inch.



HEADER WITH FILAMENT,
GRID Nº 1, AND GRID Nº 2 IN POSITION



HEADER WITH FILAMENT
AND GRID Nº 1 IN POSITION

FIG. 5. The screen-grid assembly is mechanically clamped to the filament structure and insulated from it by mica, the clamping structure forming a bypass capacitor between screen grid and filament structure. This method of assembly permits inspection and accurate alignment and spacing of the filaments, control grids, and screen grids before the anode dome is attached to the metal header.

FIG. 6. Molybdenum control-grid bars are soldered to water-cooled supporting tubes, which in turn, are supported by the glass seal. The supporting arms for the neutralizer tabs are mounted directly on the grid water-cooled tubes as shown, and project through the screen-grid assembly which surrounds the cathode and the control grids.

FIG. 1. *The 8D21 tubes in the TT-5A transmitter are mounted on "tube plates" which can be easily removed whenever it is necessary to make a quick tube change.*

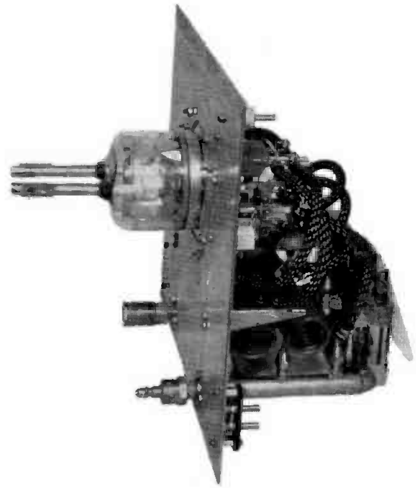


FIG. 2. *A spare tube, mounted on a tube plate, and with most of the water connections made, is kept ready for quick insertion.*

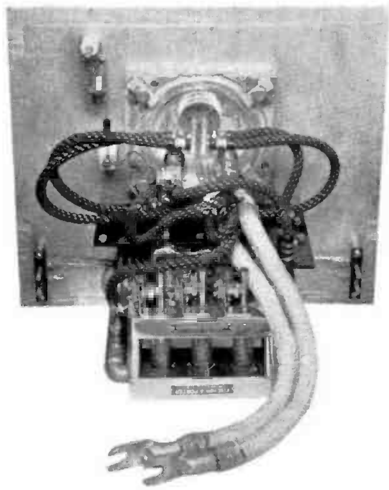


FIG. 3. *This "header-end" view of the 8D21 tube plate shows how the filament, grid and screen grid water connections are made.*

QUICK CHANGING OF 8D21 TUBE

by E. H. POTTER
Television Transmitter Section
Engineering Products Department

An ingenious method provides for rapid changing of the 8D21 tubes used in the final stages of the sound and picture amplifiers of the TT-5A transmitters. The 8D21 tube, as pointed out on previous pages, introduces a new principle of construction which results in a very high power handling capability (approximately ten times that of other tubes of comparable size). This is made possible by a highly-efficient cooling system in which all of the tube elements—filaments, plates, grids and common screen grid—are cooled by a constant stream of water which flows *through* them.

For uhf operation, the small-sized elements which internal cooling makes possible are of great advantage because of the much lower inter-electrode capacities which result. Such great advantage, however, is seldom gained without some drawback—which, in this case, is the multiplicity of water connections. There are actually fourteen water connections; i.e., input and return for each of the seven elements in the dual-tetrode. If all of these connections had to be made each time a tube was changed, it would indeed be a time-consuming and clumsy operation.

In order to overcome this difficulty, and provide a quick and easy means of changing tubes in case of failure during programs, the 8D21's in the TT-5A are mounted on removal plates (Figure 2). By this simple device the ten water connections to the header end of the tube can be made in advance on a spare tube mounting plate (Figure 2). The original 8D21's had three-sixteenths diameter tubes for all connections to which rubber hoses were clamped. To change the four anode hoses would have taken considerable time, so a water connector block was developed which clamped to the outside of each anode lead (Figure 6), leaving the ends of the anodes free for r-f connections.

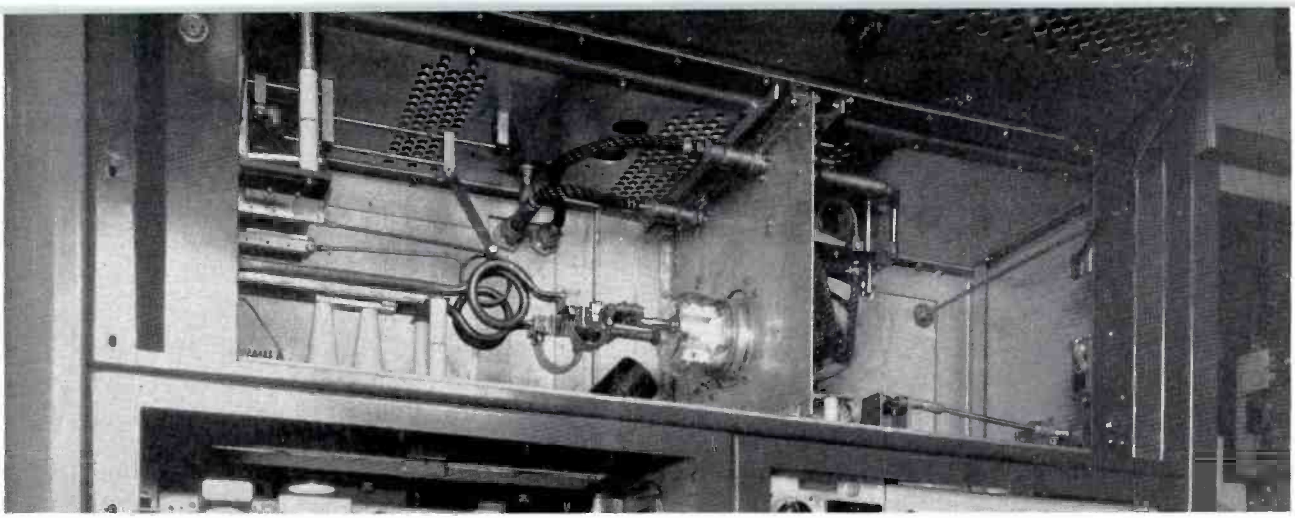


FIG. 4. *The sound power amplifier section of the TT-5A with 8D21 tube plate in place and all connections made. Only water connections which must be opened in order to remove the tube plate are the quick-disconnect fasteners on the two flexible leads at the top and the clamp-type connectors on the anodes. All four can be removed in a matter of seconds.*

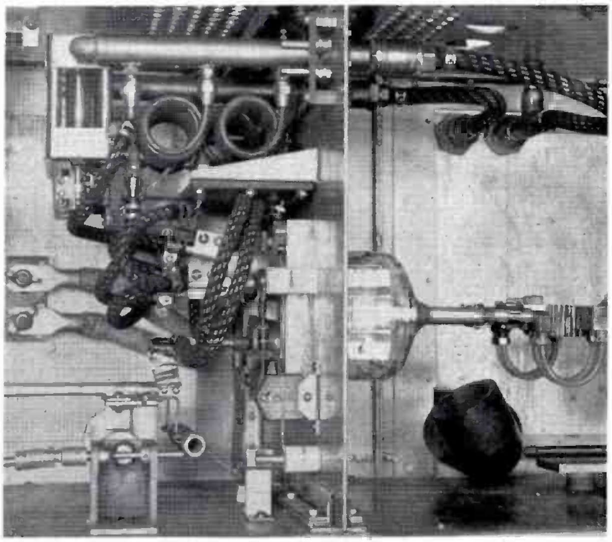


FIG. 5. *The 8D21 tube plate in the picture power amplifier section. The Saran insulating coils and water flow interlocks at the top left are permanently mounted on the tube plate.*

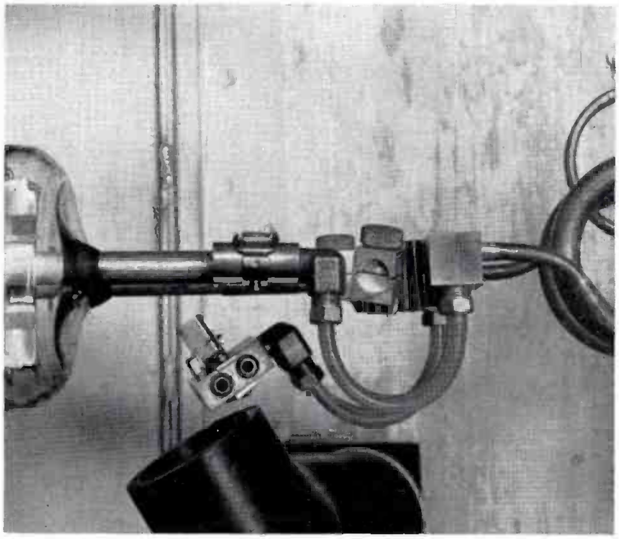


FIG. 6. *Closeup of anode leads with water-connector block of far lead removed and bent downward, while r-f connector of near lead is loosened and turned frontward.*

The anode cooling water is carried to and from each anode through the anode tank coil and then through short semi-flexible loops to the water connector blocks. These flexible loops are made of Saran tubing, and allow for expansion due to heating and for necessary tolerances. The water connector blocks have two short pieces of tubing to locate the assembly on the flat side of the anode, and suitable gaskets to seal against leakage of water, as the input water is at a pressure in excess of sixty pounds per square inch, and there is also some pressure on the return side. The block is held on, and pressure applied to seal the gaskets, by a clamp which hooks over the top and bottom edges of the flat surfaces of the anode itself. RF connections are made by block connectors which clamp to the end of the anodes, and by short flexible straps to the anode tank coil.

The tube plate has means to secure and locate the tube to place and ground the tube header. The cooling water flows through the grids and filaments in series. This means that there are three water circuits on the header end so a three element water flow indicator and flow alarm meter (Figure 3) is mounted on the tube plate to prevent application of power, or shut off the power, in case of low pressure, disconnection of a hose or stoppage of flow in any of the elements. As the grids and screen grid have high voltages to ground, a length of water column is provided by winding a piece of Saran tubing into a coil, and mounting these between the input header and connecting hoses, and between the hoses and flow meter connections. The input and return water are connected to the tube plate by quick-disconnect fittings which have internal valves that prevent water leakage when they are removed.

The screen grid and water flow interlock circuits are automatically connected when the tube is inserted. To change a tube, the operator has to: (1) loosen two wing nuts to disconnect the filament leads; (2) remove two pinch-type grid r-f connectors; (3) break the two quick-disconnect water connectors; (4) unclamp the two anode water connectors; (5) unfasten the anode r-f connections, and pull out the tube plate. A tube is inserted in the reverse manner. The whole change can be made in less than two minutes including the time to open the interlocked doors. The same tube plate will fit in either end of the transmitter, so it is necessary to have only one spare tube mounted.

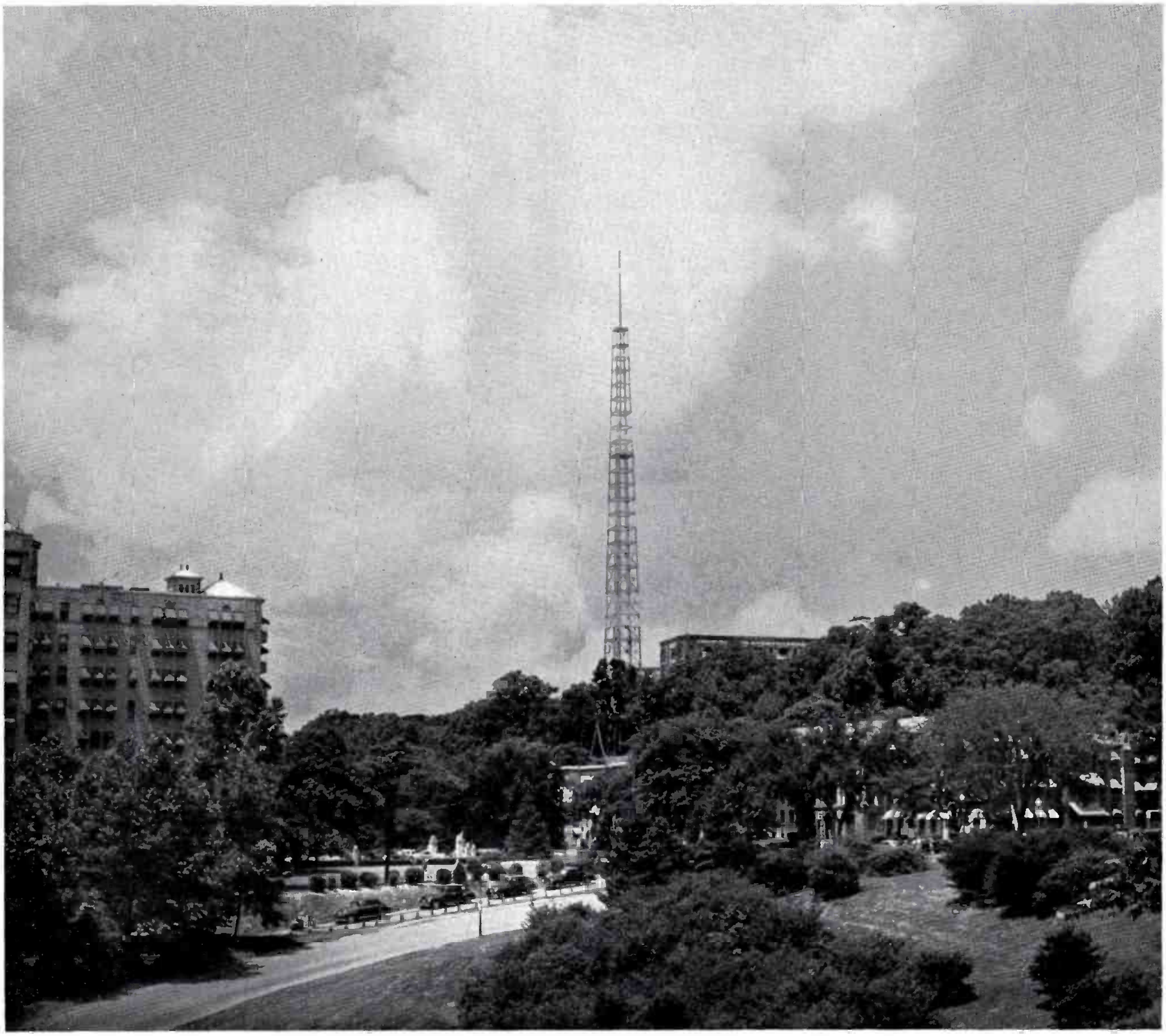
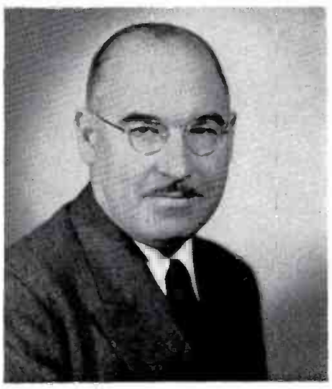


FIG. 1. *The "triplexed" antenna of WNBW and WRC-FM is mounted on a 350-foot tower adjacent to the Wardman Park Hotel.*

WNBW and WRC-FM, NBC, WASHINGTON

by RAYMOND F. GUY
Manager, Radio and Allocations Engineering
National Broadcasting Company, Inc.

MEET THE AUTHOR



Left—*Ray Guy, one of radio's real pioneers has been continuously engaged in broadcast engineering since 1921 when he joined the staff of the then-building WJZ. Since 1930 he has been responsible for the design, construction and engineering of all of NBC's broadcast, television, short-wave and uhf facilities.*

The completion and dedication of WNBW, NBC's Washington television transmitter, represents the fruition of plans made ten years ago. NBC's Empire State Building plant in New York City was initially built in 1932, replacing a 500-watt medium frequency mechanical scanning transmitter which had operated in New York City since 1928. The Empire State plant was built for the purpose of developing television, field testing it and ultimately becoming its commercial television and uhf broadcasting site. It was made available also to Major Armstrong for FM developmental work during an eighteen month period when the television system was being converted to electronic scanning,

FIG. 2. *The BTF-3C FM Transmitter and the TT-5A Television Transmitter are located in a first floor wing of the hotel.*

and later was used for NBC's field tests of frequency modulation broadcasting. During the years from 1932 it witnessed a succession of television developmental projects which culminated in 1941 in WNBT becoming the first commercial television station in the world. Plans to build a second station in Washington had been undertaken at that time and WNBW was scheduled to be completed in 1942, as the second of NBC's television stations. This program was halted because of the war emergency, but was resumed immediately thereafter. The plant was completed and placed in regular operation in May, 1947 and formally dedicated on June 19, 1947. It was the first station to be commercially-licensed in the postwar period and also the first television station to be so licensed in the nation's capital. It has since continued to serve an enthusiastic and rapidly growing audience with television fare originated locally and also in other cities, such as Baltimore, New York, West Point, Philadelphia, etc.

The early construction and dedication of these stations was a reflection of the confidence that television was ready to be launched as a great new public broadcasting service. It now appears that 1948 will be a $500,000,000 year for this robust new industry, with more and better programs, scores of new stations, new inter-city relay facilities, many new television cities and greater opportunities to exercise the ingenuity and enterprise which has given the United States the best broadcasting in the world. To further implement NBC television plans, RCA TT-5A Transmitters have been delivered for the NBC plants in Los Angeles, Chicago and Cleveland and construction has been started, aimed toward completion as soon as possible. A new TT-5A Transmitter has also been delivered and installed at WNBT, New York.

A description of the NBC television and FM stations in Washington may be of interest to the readers of Broadcast News. The transmitters occupy the ground floor of one wing of the huge Wardman Park Hotel about two miles northwest of the Capitol Building. Adjacent to the apparatus room, and less than fifty feet distant, is the base of the antenna tower which rises

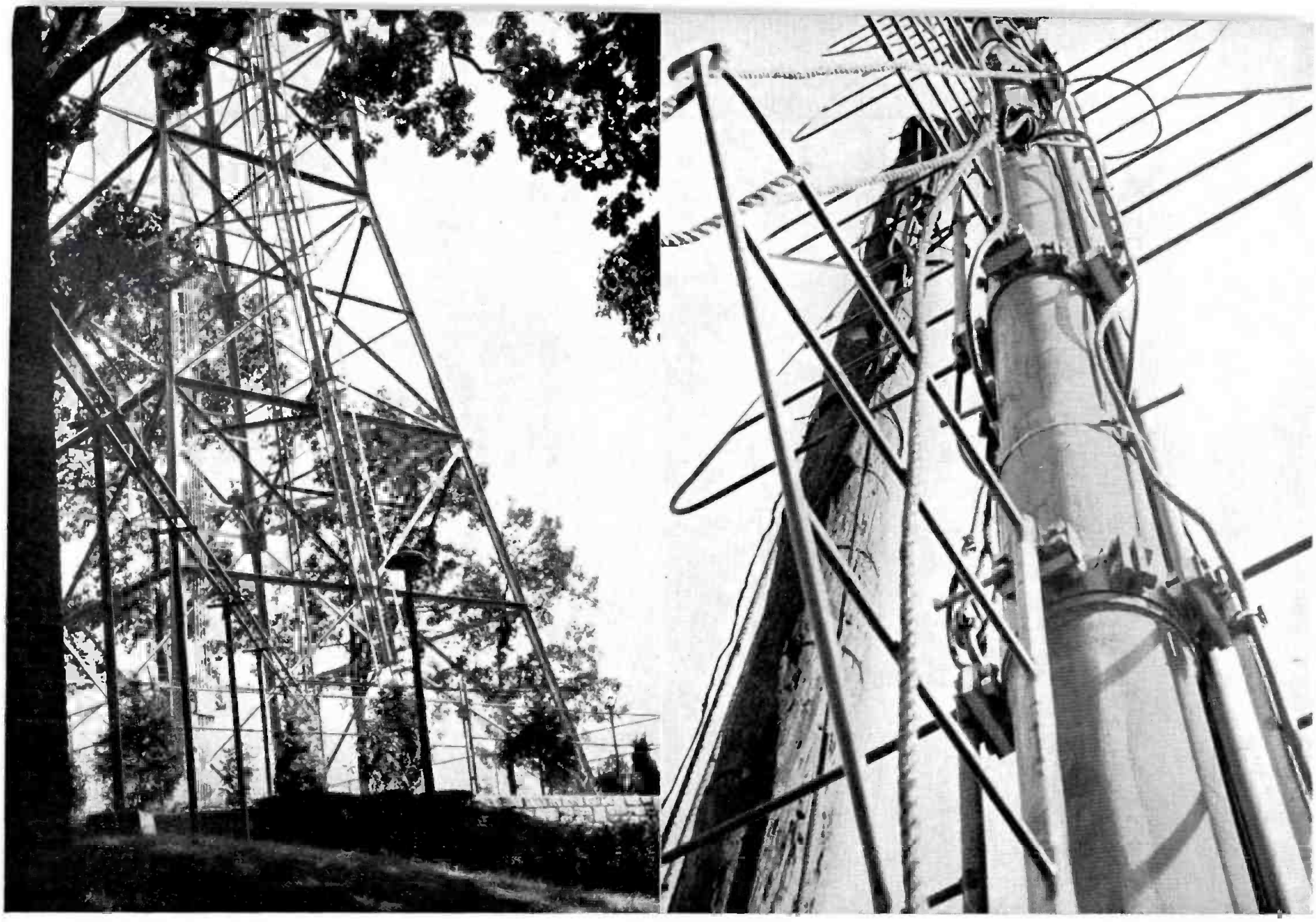


FIG. 3. *The base of the antenna tower (left above) which supports the WNBW/WRC-FM antenna is less than fifty feet from the building. The view at the right above shows the 3-section superturnstile being swung into place.*

350 feet to a commanding height above the terrain it serves. The antenna is an RCA super turnstile having four sets of batwings in the vertical plane. Figure 1 is a photograph of the tower at the base, showing the transmission lines and other details.

The triplexed use of the single antenna for simultaneous radiation of WNBW picture signals, WNBW sound signals and WRC-FM signals is a noteworthy development utilized here for the first time, so far as the writer knows. An identical system is about to be installed at the NBC TV-FM plant now being built atop the Civic Opera Building in Chicago.

The Washington antenna power gain for television is about 5 and for FM is about 6.2. The outputs of the picture and sound transmitters are combined and channelled through coaxial network sections into common transmission lines in a diplexer unit. Thereafter, the combination of those two signals with the WRC-FM signal into the same common transmission lines is accomplished by a separate triplexing unit. From the transmitter room, where these units are located, the three signals, channelled in common dual transmission lines, go to the antenna hundreds of feet overhead. The design factors provided to prevent currents from one transmitter leaking back to others and causing cross-talk, were met in practice and found to be more than adequate.

The antenna structure, complete with its beacon, lines and fittings was assembled on the ground and tested for performance and gas-tightness, following which it was raised and secured intact. In planning this operation, it was found feasible to raise the completed structure on the inside of the tower by temporarily removing certain horizontal braces and top hamper. Assembly on the ground is normally more economical than doing so aloft and has the added advantage that the project engineer in charge may test and inspect all parts mechanically and electrically at leisure and safely. The need for dangerous, difficult and expensive work aloft is minimized or eliminated. Those experienced in such matters can attest to the multitude of unpredictable minor difficulties which can, and usually do, complicate such operations. Figure 3 shows details of the gin pole and antenna after the latter had been raised and secured.

Early in the planning of this station the need was foreseen for a receiving location for radio-relayed microwave broadcasts from remote pickup points. To meet this need the tower supporting the antenna included, at the 210-foot level, a platform capable of supporting a load of 800 pounds. This platform is 12 feet square and provides straight line-of-sight transmission paths for microwave reception from all points in and around the District of Columbia. Power circuits, inter-communication circuits and coaxial cable circuits are provided between the platform and the control room and an enclosed ladder extends to the ground. RCA microwave receivers are used on the platform up to the point where the 110 mc i-f is transmitted through the coaxial cable down to the control room where the remainder of the receiver is located. Transmission at 110 mc has two advantages.

FIG. 4. *The two transmitters are mounted in line as shown in this view and that of Figure 2 (which was taken from the opposite end of the room). Entrance is through the French doors at the far end.*

The transmission of 7000 mc carrier frequencies would involve special types of circuits and be attended by transmission losses. Transmitting at video frequencies was considered to introduce problems which might be difficult to solve because of interference from broadcasting and other stations with carrier frequencies in the video band. This platform has proven very satisfactory and there is now in design a receiving antenna which may be remotely oriented, by driving mechanisms, from the control room. This device is to have remote indicators so that the antenna may be oriented towards any location at which pickups may be made, without the need for personnel climbing to the platform.

The RCA BTF-3 FM Transmitter and the TT-5A Television Transmitter are installed in a straight line-up of units, made from one end of the room, as shown in Figure 2. The FM transmitter is farthest from the camera and separated from the television transmitter by the slightly projecting column. Along the front of the units an over-hanging drop curtain faced with acoustic treatment conceals indirect fluorescent lighting fixtures with cast flat lens panels which focus the light toward the transmitter fronts.

Figure 4 shows the room photographed from the opposite end. The door at the end of the transmitter curtain provides access to the control room immediately beyond. Entrance to the transmitter suite is through the French doors. At the right of the main entrance doors, a large plate glass window enables visitors to

FIG. 5. *This viewing room, conveniently located near the entrance provides a place where visitors may observe the outgoing program in comfort.*

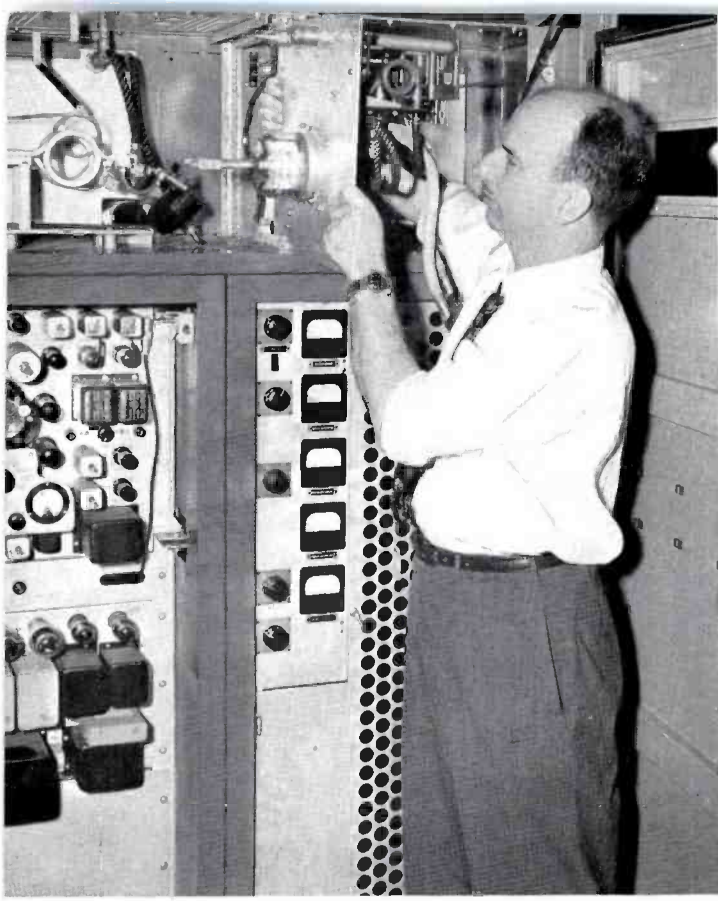


FIG. 6. *F. C. Everett, installation supervisor, inserting the 8D21 tube plate in the sound power amplifier of WNBW's TT-5A Transmitter.*

FIG. 7. *Lining up the flying spot generator built by NBC engineers for use in generating test patterns.*

observe the control room. At the left of the doors there is a viewing room, as shown in Figure 5. Because of the tremendous interest in television and the location of the station in one of Washington's largest hotels, large numbers of guests visit the station. This was anticipated and the viewing room was provided so guests could comfortably observe the outgoing programs in surroundings similar to those of a living room. A projection-type receiver and two table-model receivers provide ideal viewing.

Project engineer F. C. Everett of the headquarters Radio and Allocations Engineering staff, under whose immediate supervision the plant was designed and built, is shown in Figure 6 installing an 8D21 power tube assembly preparatory to equipment tests of the television transmitter.

Figure 7 shows an engineer lining up a flying spot scanning unit provided at WNBW for generation of test pattern signals. This unit was provided in order that it would not be necessary

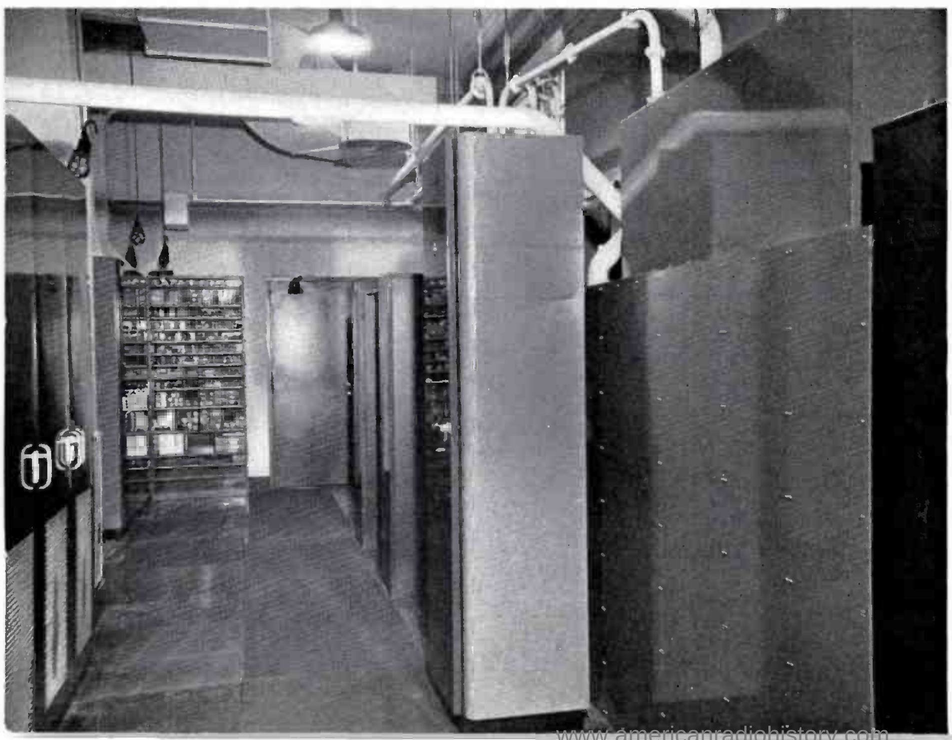


FIG. 8. (left) *View of the area in back of the two transmitters. The rear doors of the transmitters are at the left of the aisle while the sideband filter, diplexer, triplexer, and dummy antenna are at the right. Spare tube storage racks are at the far end of the room.*

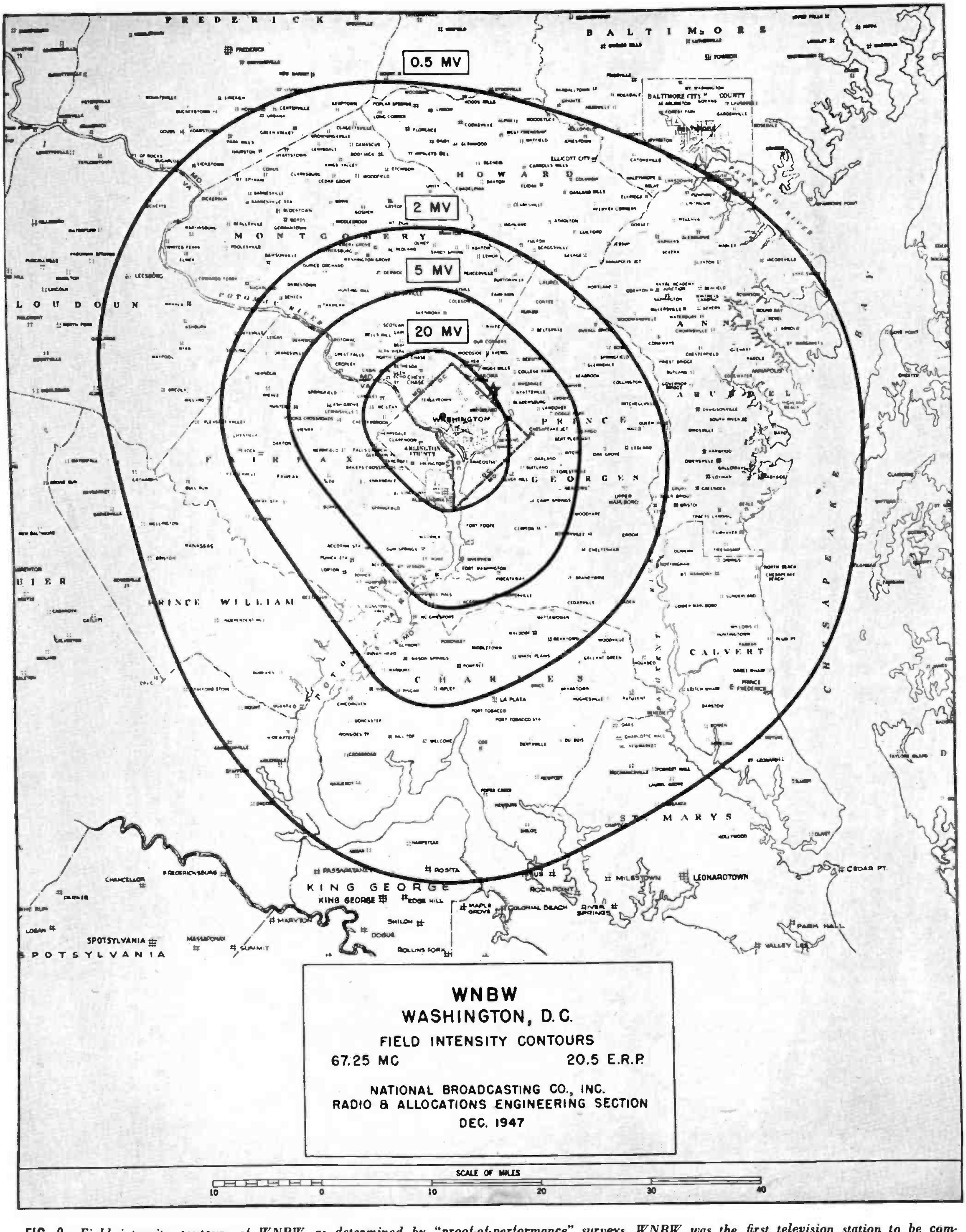


FIG. 9. *Field intensity contours of WNBW as determined by "proof-of-performance" surveys. WNBW was the first television station to be commercially licensed in the postwar period. The above survey map was one of the exhibits attached to the application for commercial license. Method of making it is described in the accompanying article.*

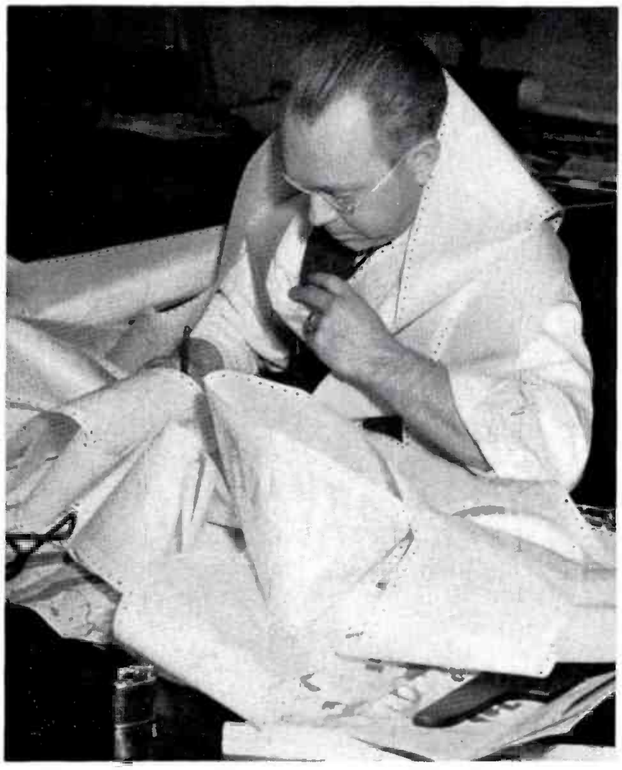


FIG. 10. *Map shown in Figure 9 is based on an analysis of recorded readings for a large number of radials. Engineer shown here is really "wrapped up" in his work.*

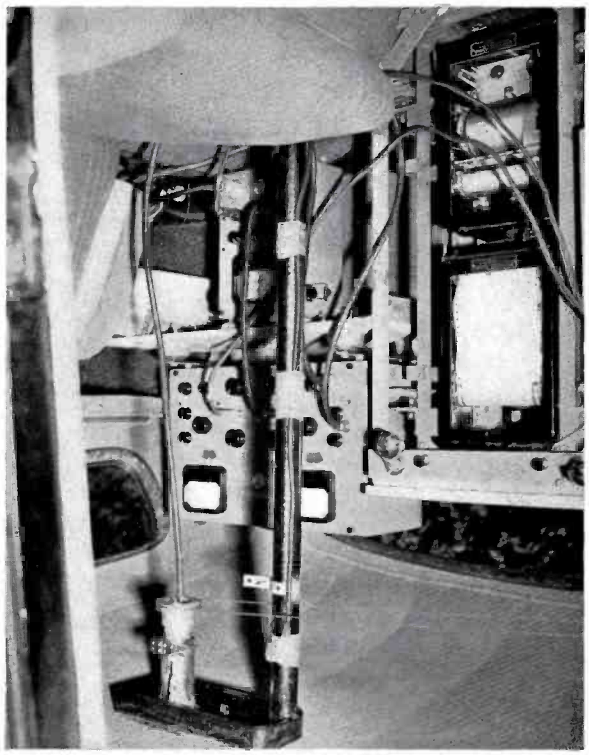


FIG. 11. *Equipment used in making survey recordings is shown here. The RCA 301-B Field Intensity Meter (center, rear) feeds an Esterline-Angus recorder in the rack at left.*

to staff the studio plant at times when only test patterns were being transmitted.

The equipment at the rear of the transmitters is shown in Figure 8. The transmitter rear doors are at the left of the aisle. The vestigal sideband filter, diplexer, triplexer and dummy antenna are shown at the right, connected by short transmission lines which are painted white. The two lines to the antenna leave through the blower room walls at the end of the room as shown, continue straight out of the rear wall and with a single 45° bend go overhead to the base of the tower, as shown on Figure 1. Special care was exercised to reduce to a minimum the number of bends in these lines and to cut them to identical lengths because such design details minimize discontinuities and internal reflections which show up as picture transients.

Figure 9 shows the field intensity contours of WNBW as determined by the proof-of-performance surveys. A single survey normally requires the time of two men for two weeks in the field and about four man months in the preparation of the report. Of these four months, about three are required to analyze the recorder tapes. Figure 10 shows an unhappy engineer battling the tapes at the end of three weeks, with nine to go. The television contours were established by measuring black level transmission. A correction factor was then applied to bring the values up to synchronizing peak levels.

The RCA field intensity meter used by NBC had been modified in years gone by to measure television sync peaks directly by the addition of a cathode coupled stage and special circuits. However, the automobile traffic on the usable highways around the large cities is great and fields from passing automobiles produce false high measurements which cannot be satisfactorily discounted in the analysis of the tapes. Therefore, the conventional receiver circuits were used in conjunction with black level transmission from the station.

Figures 11, 12 and 13 show pictures of one of the measuring cars used by NBC for field work. Figure 11 shows the method of mounting the recorders and one of the receivers. Figure 12 shows the method of mounting the dipole and AM loop. In this figure the vanes on the AM loop to correct for car directivity had been removed. Figure 13 shows the clutch between the drive shaft and recorder mechanism and the Vernier mileage counter.

For making FM proof measurements the bandwidth of the receiver is increased to 200 kc and conventional methods are used. It is important in making such measurements that one man be assigned to the recording equipment and another man assigned to driving the car, charting land marks, etc.

The WNBW transmitter was the first of the TT-5A type to be installed and placed in operation. Its reliability, overall design and excellence of performance have been a source of great satisfaction to NBC engineers who have, over a period of many years, collaborated with its RCA designers through the developmental period of television transmitters and systems. Some idea of the progress in two decades may be gained by observing in Figure 14 the combined transmitter, studio, scanning apparatus and stage of the experimental television station W2XBX built and placed in operation twenty years ago at 411 Fifth Avenue in New York City. "Felix the Cat," television's first star performer revolved slowly and endlessly for the entertainment of three receiving station owners. The transmitter was built under the immediate supervision of T. A. Smith, a co-worker with your humble servant in the RCA Laboratories in New York City.

FIG. 12. *The equipment shown in Figure 11 is mounted in this field car, one of several belonging to the NBC Allocations Staff. Dipole antenna projects from the roof of the car.*

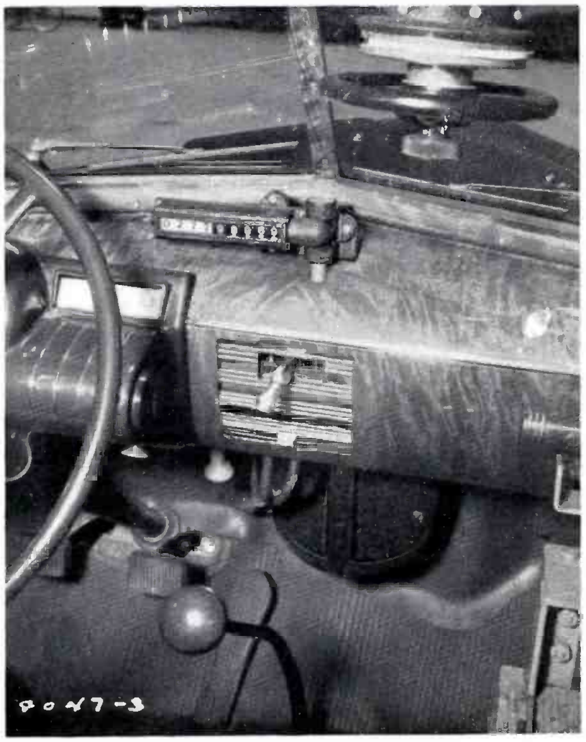
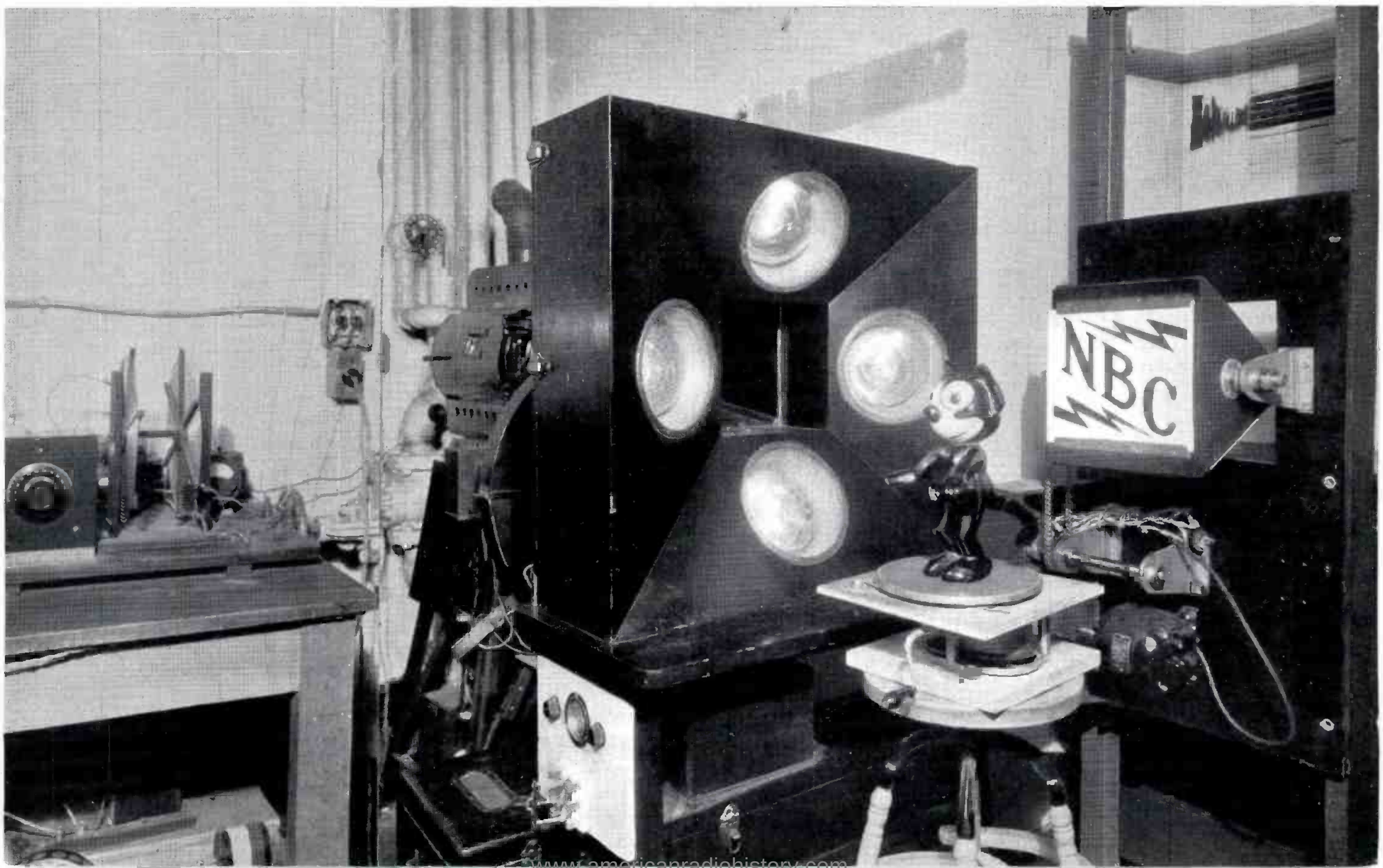
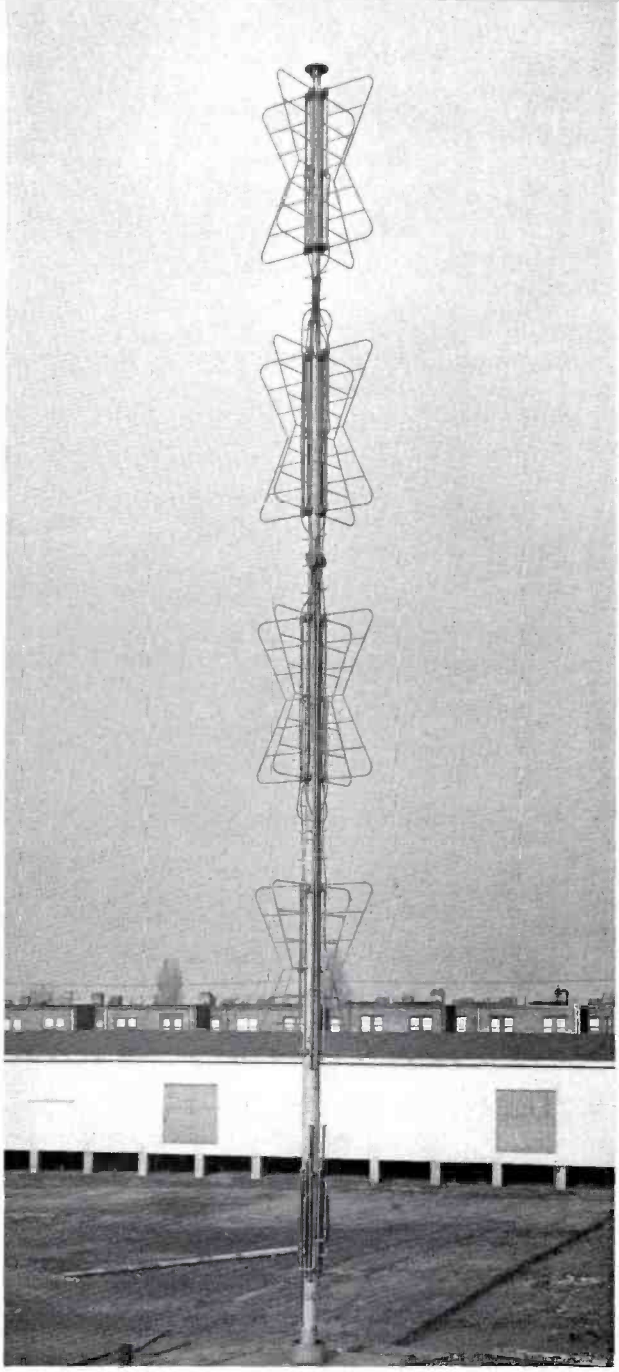


FIG. 13. *In order to coordinate recorder readings with the location of the car, the recorder chart mechanism is geared to the speedometer drive shaft. Clutch is shown in this view.*

FIG. 14. (below) *WNBW is a far cry from RCA's first television station, W2XBX installed at 411 Fifth Avenue (New York) more than twenty years ago. The view below shows the whole "works" at W2XBX, the studio, scanner, and transmitter (on table at left)—even the chief actor "Felix the Cat."*





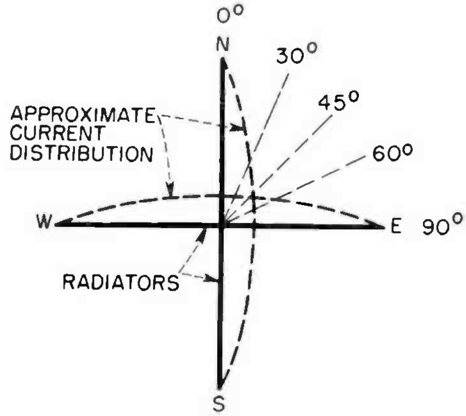


FIG. 1. (above) *Horizontal plane through radiators connected in turnstile arrangement.*

(Left) *The Superturnstile antenna at WNBW/WRC-FM uses four radiator sections, arranged for triplexing to serve simultaneously the FM transmitter and both visual and aural transmitters. This photo was taken when the antenna was set up for test at Camden.*

TRIPLEXED ANTENNA SYSTEM at WNBW/WRC-FM

by L. J. WOLFE
Television Transmitter Section
Engineering Products Department

The television and FM transmitters of the National Broadcasting Company, radio stations WNBW and WRC-FM at Washington, operate simultaneously into the same Superturnstile antenna system. This results in a considerable saving in the size of the antenna and in the cost of the supporting tower. The full power gain of the antenna is realized for each service, hence no increase in transmitter power is required for this kind of antenna operation.

The quadrature feed to the Superturnstile antenna makes possible the simultaneous or diplex operation of the visual and aural signals from the television transmitter into the antenna. The Superturnstile antenna has an input impedance characteristic which is sufficiently broad for the F-M transmitter to be readily coupled in through a triplexing arrangement.

SUPERTURNSTILE RADIATOR THEORY

The turnstile type of antenna consists of crossed pairs of radiators, each being approximately a half-wave in length. The pairs are mounted at 90 degrees, as in Figure 1, and fed in quadrature with currents that are equal in magnitude, but 90 degrees apart in phase.

The field in any direction from either of the radiators is approximately proportional to sin A, where A is the angle from the radiator. Thus, the maximum radiation from radiator E-W is transmitted in the north and south directions (where sin A is unity), while no field is transmitted from radiator N-S. Similarly, maximum radiation from radiator N-S is transmitted in the east and west directions, while none is transmitted east or west from radiator E-W.

In the northeast direction, the transmitted field is the resultant of radiation from both sets of radiators. Here sin A is 0.707 for each; these are added in 90 degrees quadrature since the currents are in quadrature, so the resultant is unity. For 30 degrees and 60 degrees the values added in quadrature are 0.5 and 0.866, again giving unity. Similarly, for other angles and other quadrants the radiated field is also close to unity.

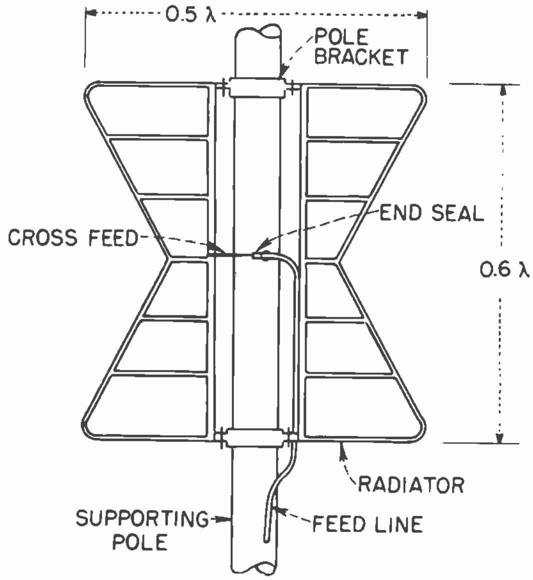


FIG. 2. *One pair of Superturnstile radiators mounted on steel pole. Other pair is at right angles to these, using same pole brackets.*

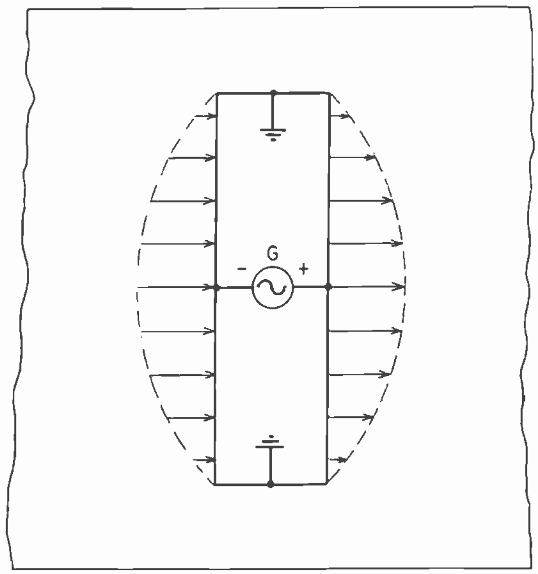


FIG. 3. *Currents and voltages in the region of half-wave slot in large conducting plane simulating Superturnstile.*

RADIATOR CONSTRUCTION

The basic Superturnstile radiator consists of an open framework of steel rods and tubes, with dimensions as shown in Figure 2. Two of these radiators mounted at right angles on a tubular supporting steel pole form a radiating system that has a pattern and gain equivalent to two parallel dipoles spaced a half wavelength apart.

A pair of Superturnstile radiators may be considered as a large plane surface containing a slot. Figure 3 shows a flat conductor of large area, with a rectangular slot approximately a half-wave long. A generator *G* applies a-c voltage having an instantaneous polarity (as shown by the plus and minus signs) to the two terminals. Set up along the sides of the slot, a voltage will have a magnitude as represented by the distance of the dotted lines from the sides of the slot. The ends of the slot will be at ground potential. Currents will flow in the plane surface with a magnitude and instantaneous direction at the sides of the slot approximately as shown by the arrows. These currents will flow on both sides of the plane surface and will radiate equally on each side. This condition will be unaffected by openings in the plane surface as long as these openings are small compared with a wavelength.

RADIATOR FEED

The radiators (Figure 2) are mounted so that contact to the supporting pole is made at places of zero potential, hence are attached directly without the necessity of any sort of insulator. The feedline for a pair of radiators is brought from the pole onto the radiator over one of the two connecting brackets. At the center of the radiator, the feedline is brought around the pole, half way to the other radiator. The inner conductor connects to the other radiator through a cross-connection strap. Thus, with the outer conductor of the feedline connected to one radiator, and the inner conductor to the other radiator, a balanced feed results. The only insulation needed is that of the end seal on the end of the feedline.

The antenna described has four identical Superturnstile radiator sections. With these, the television power gain is approximately 5, and the F-M power gain is approximately 6.4 as compared to that of a half-wave dipole (without allowance for transmission line loss). The F-M gain is higher because the height in wavelengths is greater for frequency modulation than it is at the television frequency.

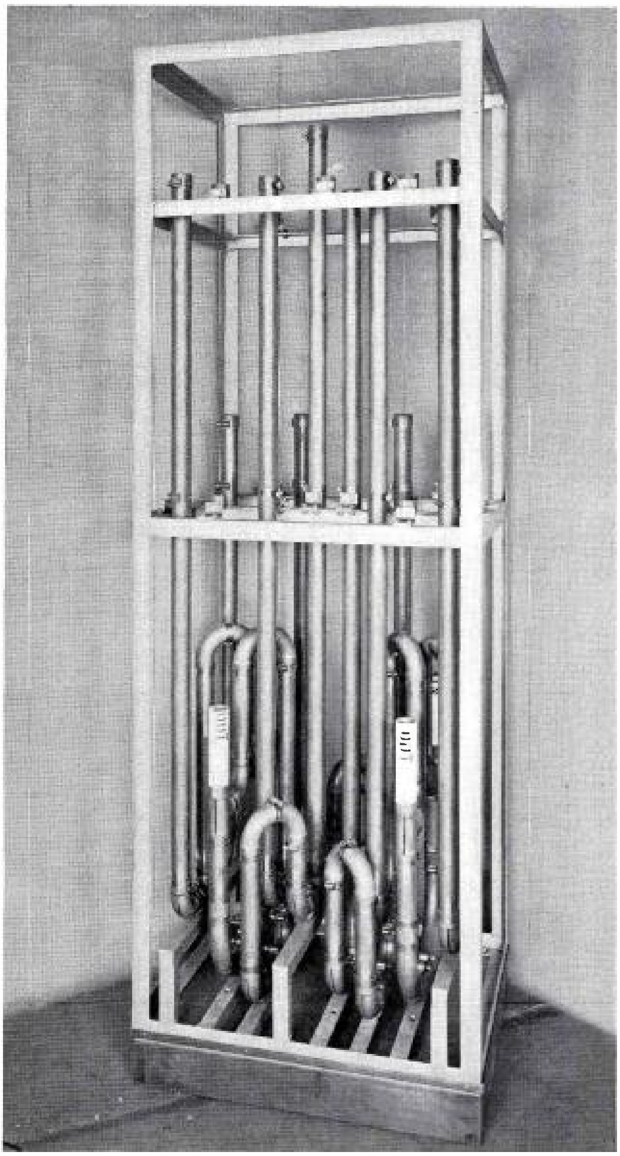
TRANSMISSION LINE

The transmission line between transmitter room and antenna consists of a pair of 3⅛-inch, 51½-ohm coaxial lines designed with conductors and insulators in accordance with RMA recommendations. Special design precautions have been taken to make certain that the lengths of line can be coupled in a satisfactory manner, and to eliminate electrical discontinuities at elbows and connections.

The 20-foot lengths of line are supplied with flanges brazed in place. These flanges are bolted together to join sections of line at installation, using O ring gaskets to keep the line pressure-tight. Differential expansion between the steel tower and the copper outer conductor of the transmission line is provided for by means of spring-hung tower brackets which permit the line to expand and contract vertically. The line is secured at the top of the tower so that the expansion occurs entirely at the bottom of the tower. Differential expansion of the inner conductor with respect to the outer conductor is allowed for at each flanged connection; the inner conductor connector is of the push-type which allows the inner conductors to slide a slight amount as required.

Electrical discontinuities are minimized as far as possible at bends by providing elbows with a radius which is large compared to the line diameter.

Inasmuch as the E-W and N-S radiators of the antenna are fed in quadrature, the two transmission lines must be kept alike, so that the two lines will maintain at the antenna the correct phase relationship set up at the transmitter. This is accomplished by making the two lines identical as regards lengths of line sec-



(Left) *Triplexing unit in transmitter room, showing the half and quarter-wave stub sections of coaxial line that are used to keep the signals in their proper paths.*

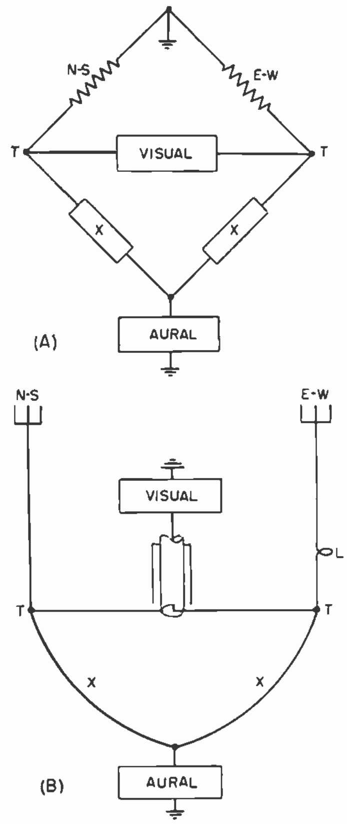


FIG. 4. (right) *Fundamental bridge-type diplexing circuit (A) and practical application (B) to visual-aural diplexing system of television transmitter. Circuit lines represent inner conductors of coaxial lines.*

tions and placement of elbows. The quadrature phase relationship is introduced at the diplexer by making one line 90 degrees longer than the other.

The diplexing unit consists of a Wheatstone bridge type of network which provides a means of feeding the visual and aural energy of the television transmitter into the antenna without detrimental cross-coupling effects.

DIPLEXER

In the fundamental diplexing circuit of Figure 4A, the resistors represent the loads due to the radiators N-S and E-W respectively. The visual power amplifier feeds push-pull to terminals T. The aural power amplifier feeds via a single-ended line through reactances X to terminals T. The two transmitter sources are uncoupled from each other as long as the two loads and the two reactances are equal respectively. Thus, no cross-feed between transmitter sources will exist, even for modulation sideband components which are nearly identical in frequency.

The physical realization of the bridge circuit is indicated in Figure 4B. Each connection line represents the inner conductor of a coaxial transmission line. The outer conductors are not shown except for the cylindrical balun sleeve on the connection to the visual transmitter. The visual transmitter feed is single-ended, hence is changed to a double-ended feed by means of this balun. The visual feed is push-pull at terminals T, whereas the aural feed is push-push at these same terminals. Loop L represents the extra quarter-wavelength of line that provides the quadrature feed of the E-W radiators with respect to the N-S radiators.

Elements X are transmission lines which are each a quarter-wave long at the midvisual frequency, which totals a half-wave in length. This length of a half-wave on terminals T shunts a high impedance across the visual input circuit. Conversely, terminals T are at the same potential with reference to each other at the aural frequency, hence no aural power can couple into the visual transmitter input.

This bridge-type circuit is particularly useful for coupling the visual and aural power amplifiers since the transmitter frequencies are quite close together. The reactance of the circuit elements changes very little from one frequency to the other, hence has no serious detuning effect on either power amplifier.

TRIPLEXING SYSTEM

The triplexing unit allows the power from the F-M transmitter to be coupled onto the line to the antenna, with the correct phase relationships, without cross-coupling to the television transmitter. Since the television and F-M frequencies are separated by a greater percentage than are television visual and aural frequencies, frequency-selective circuits are used in the triplexer.

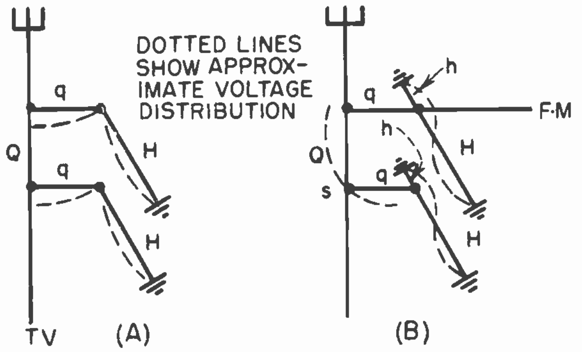


FIG. 5. (above) *Fundamental circuit of triplexer (A) showing use of two frequency-selective tuned elements, and method of adding stub elements (B) for coupling an FM transmitter. Circuit lines represent inner conductors of coaxial lines, and ground symbol indicates shorting plug-in line.*

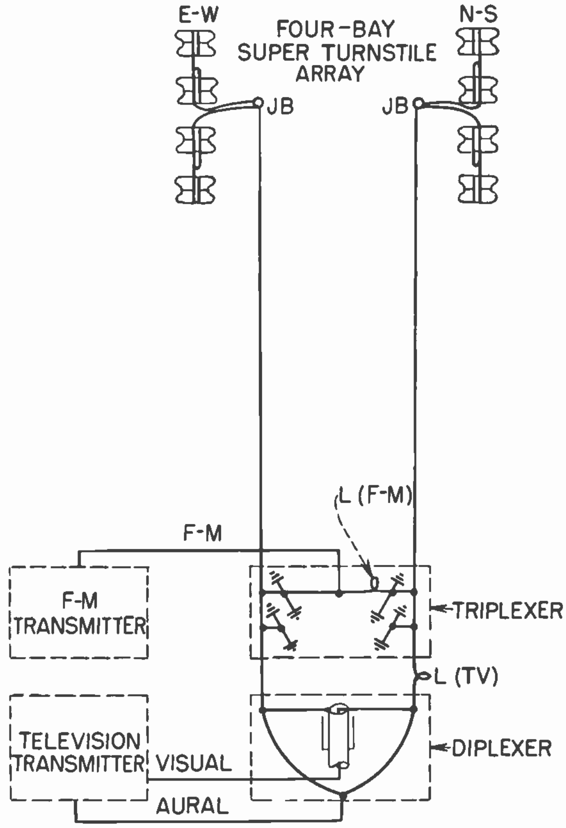


FIG. 6. (right) *Complete triplexing system, with N-S and E-W radiators shown separately to clarify connections. Circuit lines are inner conductors of coaxial lines.*

Figure 5 illustrates the fundamental triplexing circuits used. The television transmitter *TV* feeds the antenna load directly as in Figure 5A, with two half-wave circuits *H*, connected to the main line through two quarter-wave circuits *q* which are separated a quarter-wave apart along the main line. Each branch (consisting of an *H* and a *q* in series) is three-quarter-wave long, hence presents a high impedance to the main line. The characteristic impedance of these branch line elements is chosen so that this high impedance is presented to the main line over a band which is at least six megacycles wide.

The circuits associated with the F-M transmitter are added as in Figure 5B. Circuits *H* are extended by stub sections *h*. The lower *h* stub is adjusted so that the combination of reactances presents a low impedance, or short-circuit at terminal *S* at the frequency of transmitter *F-M*. The upper *h* stub is adjusted so that the input impedance, looking to the antenna from *F-M*, is also matched at the F-M frequency. The voltage magnitudes under this condition are represented by the dotted lines.

COMBINED DIPLEX AND TRIPLEX SYSTEM

In the complete system, as used at stations WNBW and WRC-FM, a four-section Superturnstile antenna is used as shown diagrammatically in Figure 6. The E-W and N-S radiators are fed from junction boxes *JB*. The feedlines from the junction boxes are all the same length, so the radiators will all be fed in phase. Each junction box assembly contains a series line transformer, to match the 51½-ohm transmission line to the impedance of the four feedlines in parallel.

The twin transmission lines going down the tower are equal in length between the junction boxes and the triplexer so the phase relationship between lines, as established at the transmitter, will be maintained at the antenna. The lines are carefully installed so that the elbows in the two lines are equally spaced from the triplexer.

The triplexer is located in the transmitter room, with the two transmission lines passing through it to the diplexer. The internal circuit of the triplexer consists of matched pairs of transmission line elements.

The F-M feed into the triplexer divides as shown, with one side going through a phasing loop. This loop is a quarter-wavelength at the F-M frequency and provides the correct quadrature phase required to give a circular pattern from the turnstile antenna. Only the F-M feed is through this loop; the quadrature loop for television is separate. This arrangement provides a convenient method of maintaining the correct quadrature feeds for the two systems, even though the frequencies are different.

The diplexer terminates the two separate antenna transmission lines. One line between triplexer and diplexer is made a quarter-wave longer than the other at the television frequency. This quadrature length is separate from the F-M loop, hence sets the correct phase relationship for television independently of the F-M requirement.

The diplexer contains the visual input circuit, consisting of a single-ended circuit with a balun to convert to double-ended feed. The balun is suitably compensated to be broad-band so that it does not introduce any appreciable discontinuity over the television channel. The aural input circuit is single-ended and connects to a point where no visual voltage exists, so there is negligible coupling between visual and aural power amplifiers.

Acknowledgement is made to the members of the Television Broadcast Antenna Group of RCA Victor Division, who designed this equipment, and to the engineers of the Radio Facilities Group of the National Broadcasting Company, who bore the brunt of getting the first equipment installed.

WOPI's MILE HIGH FM INSTALLATION

3 KW Transmitter Using 3-Bay Super-Turnstile Antenna Installed During Sub-Zero Weather

EDITOR'S NOTE: *This story of WOPI-FM is a saga of pioneering and persevering which should be "must" reading for all FM applicants with mountain-top aspirations. In it you will find two things of great helpfulness. These are: first, a preview of problems to be met in mountain-top installations and second, some ideas on how these problems can be licked.*

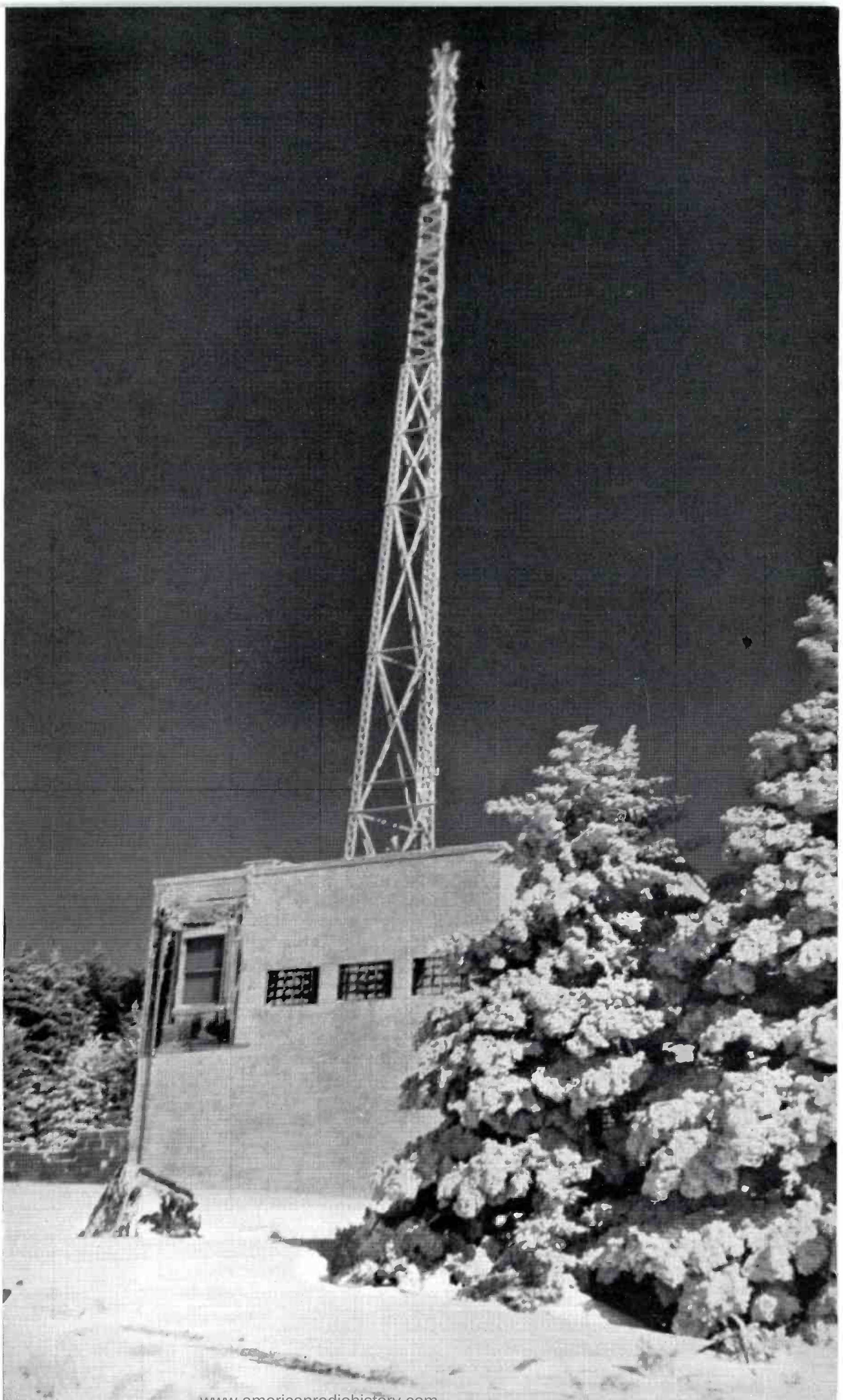
WOPI-FM did it the hard way—in a hurry, in the midst of shortages, and with winter coming on. Those who follow may find it somewhat easier. But, many of the same problems will always be encountered wherever buildings, antenna structures. power, water, heat, and living accommodations must be provided and maintained at remote and difficult spots.

WOPI-FM, located on Whitetop Mountain, 5,643 feet above sea level and 33 air-line miles east of Bristol, Tennessee-Virginia, was one of the first postwar FM stations to go on the air. Their construction permit was granted August 15, 1946. Five days later, ground was broken on Whitetop Mountain—and just a little over three months later, Christmas Day 1946, to be exact, WOPI-FM was on the air.

Three months doesn't sound like much of a record, and it wouldn't be for a station erected on the flat (or "under the mountain," as we mountain men say); but, just try it on top of a five-thousand-foot mountain with winter coming on. WOPI's construction problems were practically numberless. The closest power lines were 6 miles from the transmitter site and only single-phase, at that, while 3-phase was necessary for operation of the FM transmitter. All material and equipment had to be trucked from 20 to 150 miles over roads that were often impassable. Winds of 50 to 90 miles an hour were encountered during the erection of the transmitter tower with temperatures of 5 degrees below zero and snow accumulations of 10 to 15 feet. Since the nearest living quarters were 8 miles away, the transmitter building had to be designed to house the engineers as well as equipment.

The first problem was to build a road to the transmitter site. This was done with a bulldozer, hauled up by truck. The bulldozer cleared a road for 500 feet from the main mountain road, then cleared the transmitter site. While this was going on, an 8-man crew dug a 48-inch ditch 700 feet down the mountain and tapped a spring for the water supply. The spring was then cemented into a 24-foot square basin and a 300-gallon concrete tank was erected 20 feet below in order for the water to flow by gravity. The final phases of the operation included laying pipe to the transmitter site and the erection of an 11,000-gallon steel and concrete reservoir.

Additional workmen built a steel and concrete septic tank and laid a 200-foot sewage line from it to the transmitter building. All material for these operations, as stated previously, had to be hauled a minimum of 20 to 40 miles, with some material



View from WOPI-FM's transmitter building atop Whitetop Mountain near Bristol, Tennessee-Virginia.

Midwinter view of WOPI-FM's transmitter building and ice-coated three-bay Superturnstile antenna.

Inspecting WOPI-FM's newly installed BTF-3B Transmitter. Left to right: P. G. Walters, RCA Southeastern Regional Office; W. E. Tucker, RCA Engineer; W. A. Wilson, President and General Manager, WOPI and WOPI-FM.

View of the studio control room of WOPI-FM. Through the control room observation window can be seen the power panel of the transmitter.

coming from 900 miles away. The per-load cost averaged $18.75 to $200.00, with total hauling cost estimated at $5,000.

Plans for the transmitter building had meanwhile been drawn up. It was to be a two-story, three-car garage apartment, constructed of concrete, steel and cinder blocks. It would have two bedrooms, dinette, studio control room, transmitter room and bath on the second floor, with heating unit, power unit and room for two cars on the first floor. A foundation, 35 by 36 feet, of concrete, floor of 4-inch concrete, with 6 inch steel and concrete slabs was used for the second floor. As completed, the second story has inlaid asphalt and cork block flooring, black square linoleum wainscoting in the hall, bathroom and dinette, and fluorescent lighting throughout.

The completed first floor contains a 50-KW, 3-phase, Diesel engine, furnace, laundry tray, washer and storage room, with space left over for a jeep and passenger car. The jeep proved to be a happy thought, for it was the only thing that could get through the heavy snows. And even the jeep couldn't make it for 10 days during the peak of the winter, food and other supplies having to be dropped by plane.

A fuel oil stoker furnishes hot-water heat for the building, with fuel supplied from five 550 gallon tanks buried 100 feet from the building. Two additional tanks, holding 5,000 gallons each, supply the Diesel, which furnishes the 3-phase power for the RCA BTF-3B transmitter.

The local power company erected poles and strung lines for 6 miles to furnish electricity for heating and cooking—the diesel being capable of taking over the job in an emergency. The diesel, by the way, had to be mounted on a separate concrete floor and mounted on 3½ inches of cork to surmount vibration difficulties.

The antenna, erected by a special crew brought in for the job, is a 150-foot Truscon self-supporting steel tower supporting an RCA 3-bay super-turnstile radiator, standing 2,210 feet above the average terrain (116 feet above the very top of the mountain). Hundreds of tons of steel, rock and cement, taking about

18 hours to pour, went into the foundation. At the time the antenna was erected, the reservoir was still under construction, so all water had to be hauled 2½ miles by truck. Weather conditions were so severe while the antenna was going up that on several occasions crew members had to climb to the aid of the one working on the tower and help him down.

Installation of the 3⅛-inch transmission line from transmitter to the bottom of the turnstile, a distance of 250 feet, was another stickler. This line, larger than would ordinarily be needed with a radiated power of 10,400 KW, was used to allow further power increase without having to replace the co-ax line. Because of heavy winds and ice the horizontal run of 100 feet had to be anchored securely. This problem was solved by having it rest on specially-treated 2- x 8-inch planks bolted to 6 poles sunk about 4 feet in the ground, each with two heavy duty guy wires. The co-ax line is boxed to prevent damage from falling ice from the tower. While the line was being installed, the weather closed in again, bringing a coating of ice with it, and high winds that at one time worked the inside conductor of the transmission line loose at the juncture of the line and turnstile.

The audio equipment and operating console are located in the studio control room, with the transmitter room immediately adjacent. The high altitude made it necessary to have the blower fans, which cool the amplifier tubes, run at twice the ordinary speed, so as to give a sufficient volume of the rarified air.

On Christmas Day, 1946, WOPI-FM went on the air. First broadcasts were with a 26-inch temporary antenna and a reduced power of 3,000 watts of radiated power. The short antenna made r-f power show up everywhere in the building. Lights kept burning after they were turned off, metal strips around the console became warm and you could develop a high fever by merely standing near the antenna. However, this situation ceased on January 4, 1947, when WOPI-FM began using the turnstile antenna and full radiated power of 10,400 watts.

WOPI-FM now has a 25-watt, 214-mc ST link in the Bristol studios, which permits constant broadcast of commercial programs during the 12-hour broadcast period, from 10:00 A.M. to 10:00 P.M. Listener reports indicate excellent coverage up to 100 miles, with reception reported (very satisfactory) from as far as 200 air-line miles away.

TYPICAL LOG, AS REPORTED BY WARREN GILPIN, ENGINEER WOPI-FM

WEDNESDAY, DECEMBER 25, 1946: Checked diesel, tower lights, lines and flasher. Fuel line stopped up at 12:12 P.M., went off air same time, back on at 12:25 P.M. Time clock would not work, cleared trouble 1:30 P.M., on air 6 hours, 47 minutes. Lowest temperature 18 above. Had two visitors.

THURSDAY, DECEMBER 26, 1946: Electrician worked on house lights. Power company men fixed line to house from last pole and guyed all poles. Power off 10:21 to 11:30 A.M. Off air between 10:21 and 10:41 to change to local power. (This has since been corrected with necessary switching arrangements between outside power and diesel power). Grounded transmitter to outside ground. Checked water pump at spring, found O.K. On air 6 hours. Noise on arm of turntable feed back, therefore cueing on air. (All programs originating from FM control room at this time, as we were using temporary antenna, which caused radio frequency all through building.)

FRIDAY, DECEMBER 27, 1946: Electrician installed box to switch from Appalachian Power to local diesel power. Carpenters changed lines on diesel and caused me to leave the air at 6:25 P.M.—returned to the air at 6:59 P.M. Installed lines would not feed diesel properly. Washing machine shorted out basement light, found trouble and cleared. Had eight visitors.

SATURDAY, JANUARY 4, 1947: (Co-ax line completed and in service on this date). On air 6 hours. Covered part of transmission line to prevent ice falling on cable . . . covered hole in roof, where lines enter. Electrician here and finished most of his work. Automatic voltage control on diesel causes voltage to vary from about 200 to 225 volts constantly. Am now using manual control, works fine, but have to watch it most of the time. Stopped one leak in transmission line, but there are others. Weather not permitting me to locate all of them.

FROM LOG KEPT BY GENERAL MANAGER IN BRISTOL

JANUARY 31, 1947: Furnace out. Engineer met plumbers at foot of mountain. Found stack-stat defective. Changed hot water tank intake from boiler to intake of cold water line. This corrected most of trouble as the hot water tank was pulling the hot water out of the boiler . . . Mailed stack-stat to Konnarock.

FEBRUARY 2ND: General Manager left for Whitetop 9:45 A.M., returned 9:30 P.M. Took plumbers to work on furnace. Installed new stack-stat, put furnace in operation . . . 106 miles.

FEBRUARY 4TH: Furnace out. One radiator frozen and busted . . . suggested they install stove in basement and build good fire so will thaw pipes. Cold water pipes not frozen, will check at 3:00 P.M. Unable to locate electrician. Plumbers at Chilhowie (34 miles from Bristol) will go up today on air check at 10:00 A.M. Two engineers from Bristol left at 7:20 P.M. for Whitetop. 10 degrees below zero . . . arrived at transmitter at 10:20 P.M. Announcer had left in jeep . . . did not want to chop wood and build fire. (This man was discharged on arrival in Bristol).

FEBRUARY 5TH: 8:45 A.M., Furnace out. Oil all over floor in basement. Engineer up since 3:00 A.M. mopping floor. Below freezing in building. 1:20-1:30 P.M. WOPI-AM and WOPI-FM used two-way communication pertaining to safety of personnel.

FEBRUARY 6TH: Furnace men repair furnace; now working okay. One radiator disconnected because of pipes busted. Weather bad—heavy snow and zero. Continue on air. Engineer Gilpin announcing. Two engineers from Bristol still on mountain.

(This goes on and on. On February 21, we find the following):

FEBRUARY 21ST: Temperature 6 degrees above zero . . . snow has hard crust about quarter-inch thick . . . drifts high, did not go down road today. Worked on turntables. Broke ice on water, have only three thousand gallons (reservoir). Ice about a quarter-inch thick. Water pressure okay.

FEBRUARY 22ND: 6 degrees above zero. Two of the three guy wires on pole 2 (second pole from the building) pulled loose. Insulated wire swinging into top wire on pole. Will soon wear thru and short . . . only one guy wire left. Will probably break during night. Wind is blowing badly. Pole already leaning. Programs came thru okay . . . when signed off at 9:00 P.M. temperature three above zero. Snow drifts up to eight feet near building. Unable to get out with jeep. Have food enough for about a week. Water for two weeks.

FEBRUARY 24TH: Emergency power line arching to ground on pole at pump. Notified power company, and etc. and etc. 5:35 P.M. snow continues to drift ten to twelve feet . . . really snowed in.

Right here things get worse and worse, and on February 27th food had to be dropped by two planes . . . then fuel oil ran out . . . this right at the very worst of the bad weather.

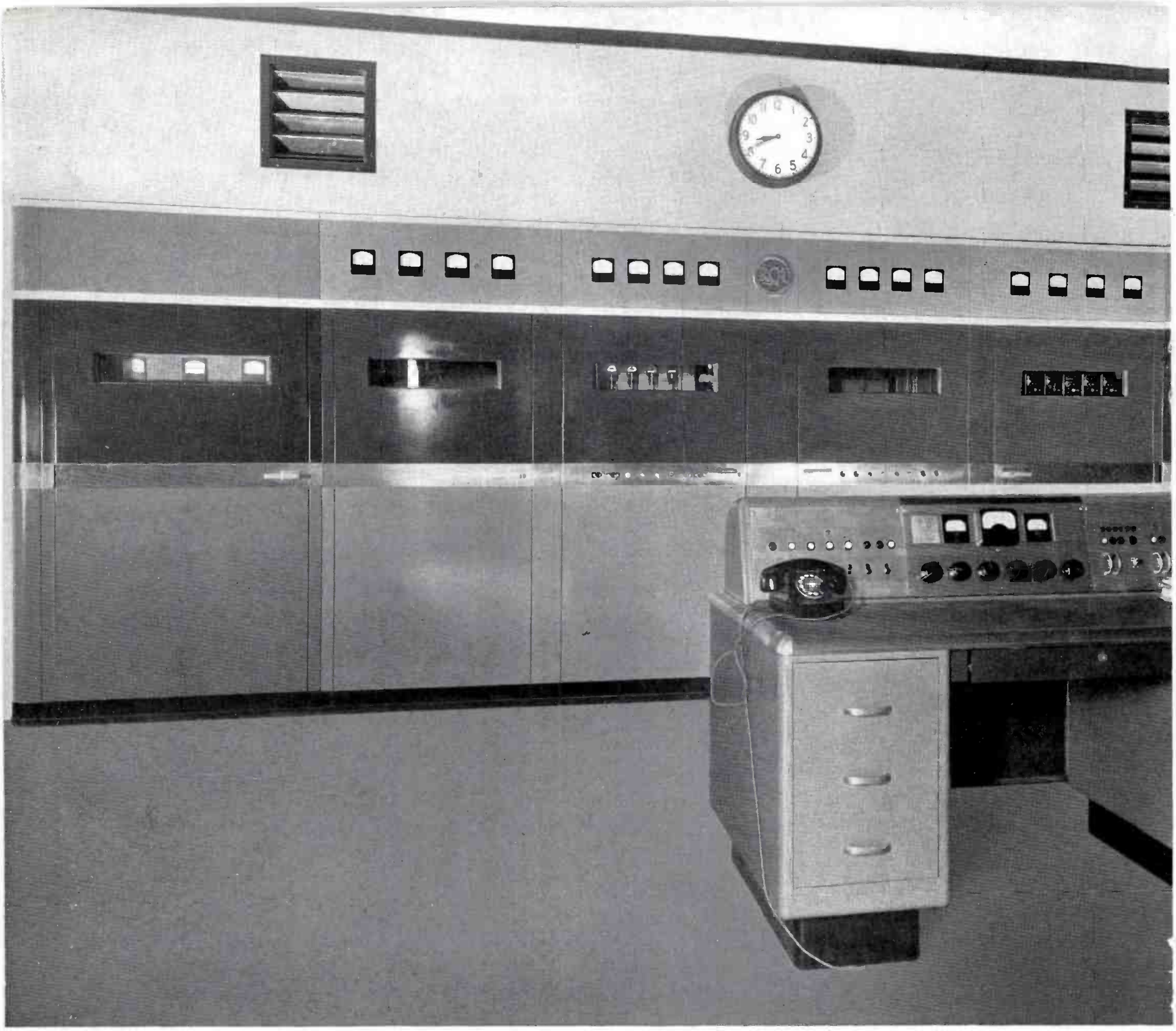
ON MARCH 7TH we find that they "got as far as the lodge with the jeep, which stuck in a drift—drift 100 feet long—dug for an hour and had to leave it—would try it again tomorrow."

MARCH 12TH: Announcer and lodge keeper got jeep out and went to foot of mountain . . . for mail and supplies.

These reports continue throughout the winter months.

* * *

All of these difficulties should be eliminated in the future as the entire installations have been made more permanent. There should be very little if any of these troubles during future winter months. Transmission line has been installed on a permanent basis, have installed additional radiators, arranged for ample supply of fuel oil, rearranged water pipes and made many improvements necessary to operation at such an out-post and to combat the rigorous climate.



KGKL

San Angelo, Texas

960 KC

1000/5000 Watts

KGKL, one of the brighter "Stars Over West Texas", is now operating with full power of 5000 watts by day, 1000 watts during the night, at the favorable dial position of 960.

With its American Broadcasting Company affiliation plus its Texas State Network tie-in, KGKL is now able to bring to thousands of additional listeners in the rich trading areas of the Great Southwest many radio shows they have formerly been unable to hear.

The new RCA 5F transmitter installation, while giving advertisers and listeners the benefit of the latest technical developments in radio, also, in the case of KGKL, dramatizes the growth and progress of a station that began its career of public service 19 years ago with a power of only 25 watts.

Under the supervision of its president, Mr. Henry C. Ragsdale, KGKL first went on the air in San Angelo on December 4, 1928. Mr. Ragsdale has been the station's president continuously since that time. KGKL's chief engineer, Mr. Frank Jones, built the first transmitter and has been with the station since its inception.

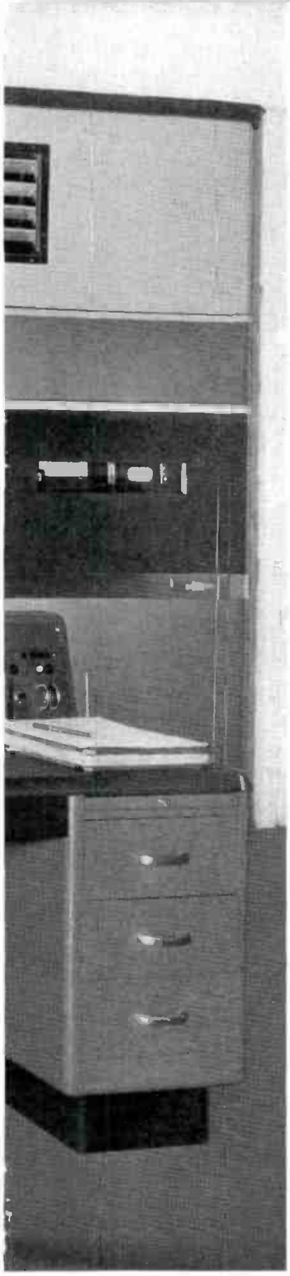


FIG 1. (Left)—*KGKL's BTA-5F 5-kilowatt transmitter installation with control console in the foreground. The matching extension cabinets on either end of the transmitter contain, on one side, the antenna phasing components; and on the other, the test and measuring, and speech input equipment.*

FIG. 2 (Right, Above)—*KGKL's new transmitter building harmonizes with the architectural style of the Southwest. The directional antenna array with its 250-foot towers forms an impressive back drop for visitors to the new station.*

FIG. 3. (Right)—*Harry Ragsdale, president of KGKL, Inc., breaks ground for the new transmitter plant which was completed and on the air in less than eight months. Pictured, left to right, are: Bill Meiners, plant superintendent; Frank Jones, chief engineer; Mr. Ragsdale; Doyle Maddux, architect; and Lewis Seibert, manager.*

In fact, in 1926 Frank built one of the first transmitters in San Angelo, which went on the air with a power of 15 watts. It was licensed as station KGFI and continued in operation in San Angelo until 1929. KGKL's station manager is Lewis O. Seibert, a veteran of the Texas State Network.

Located on a 30 acre tract near San Angelo, the transmitter plant is marked by twin 250-foot antenna towers, which serve as a guide for visitors to the new station. Building of the present transmitter plant began October 1, 1946 with Mr. Ragsdale turning the first spadeful of earth. Construction proceeded apace, and by June the building was completed, (the antenna system was also completed and tested during this time), the transmitter installed, tested, and put on the air.

The transmitter (Figure 1) is a standard RCA Model BTA-5F, having extension cabinets on each end. The extension cabinet on the left side (looking at the front) houses the antenna phasing and branching equipment, while the cabinet on the right contains the test, measuring, and speech input equipment.

These transmitter extension cabinets are of interest from the viewpoint of appearance as well as utility. The front panels of the two units are similar in color scheme and finish to those of the basic transmitter and therefore lend a clean-cut unified appearance to the installation, thus adding tone to the station.

In the case of the left hand extension cabinet housing the phasing components, an interlocking door at the left side of the cabinet allows operating personnel to walk inside for inspection and maintenance. Controls for the phase and amplitude of the current in each tower of the directional array are mounted on a sub-panel behind the front door. On the right hand extension cabinet the front door allows ready access to the test, measuring, and audio equipment mounted therein. Using extension cabinets results in an economy of space, reduces wiring connections, and improves the overall appearance of the transmitter installation. KGKL is also busy in the FM field, having began construction of an FM station to be operated in connection with its present AM plant.

FIG. 1. *WKY's mobile unit—built to permit coverage of an entire state—is a 29 passenger bus body, custom-converted by the bus manufacturer according to plans drawn by WKY's engineering staff. Complete facilities and comfort for traveling are outstanding features.*

WKY's MOBILE STUDIO

by
JACK LOVELL
Chief Engineer WKY
Oklahoma City, Okla.

During the years WKY has been operating mobile transmitters, we have tried to visualize a unit that would meet the conditions we have encountered on our various coverages.

In this part of the country we think nothing of making a run of 150 miles or more to cover some important event or disaster. Therefore, mobility and comfort are perhaps the two most important items in a unit that's built to cover an entire state.

With these thoughts in mind, we contacted the Flxible Company of Loudonville, Ohio. They immediately pulled one of their 29 passenger buses from the production line and began making such changes and modifications as we specified.

Considering the comfort angle, we specified a vehicle in which seating space is provided for carrying the regular driver, two or three engineers and as many announcers and special events men as necessary. Studio space will allow seating for eight people for a speech program, or up to six musicians, if necessary.

While the bus was being custombuilt by Flxible, WKY began securing equipment and material needed to make technical installation; this being done in our own plant.

The remote studio is powered by a Buick motor which is housed in the bus luggage compartment along with an Onan 2kw 60 cycle, gasoline engine generator. The latter has proved to be extremely dependable, having been operated under all extremes of temperature without failure.

Transmitting facilities in the unit control room setup include an RCA ACT-150

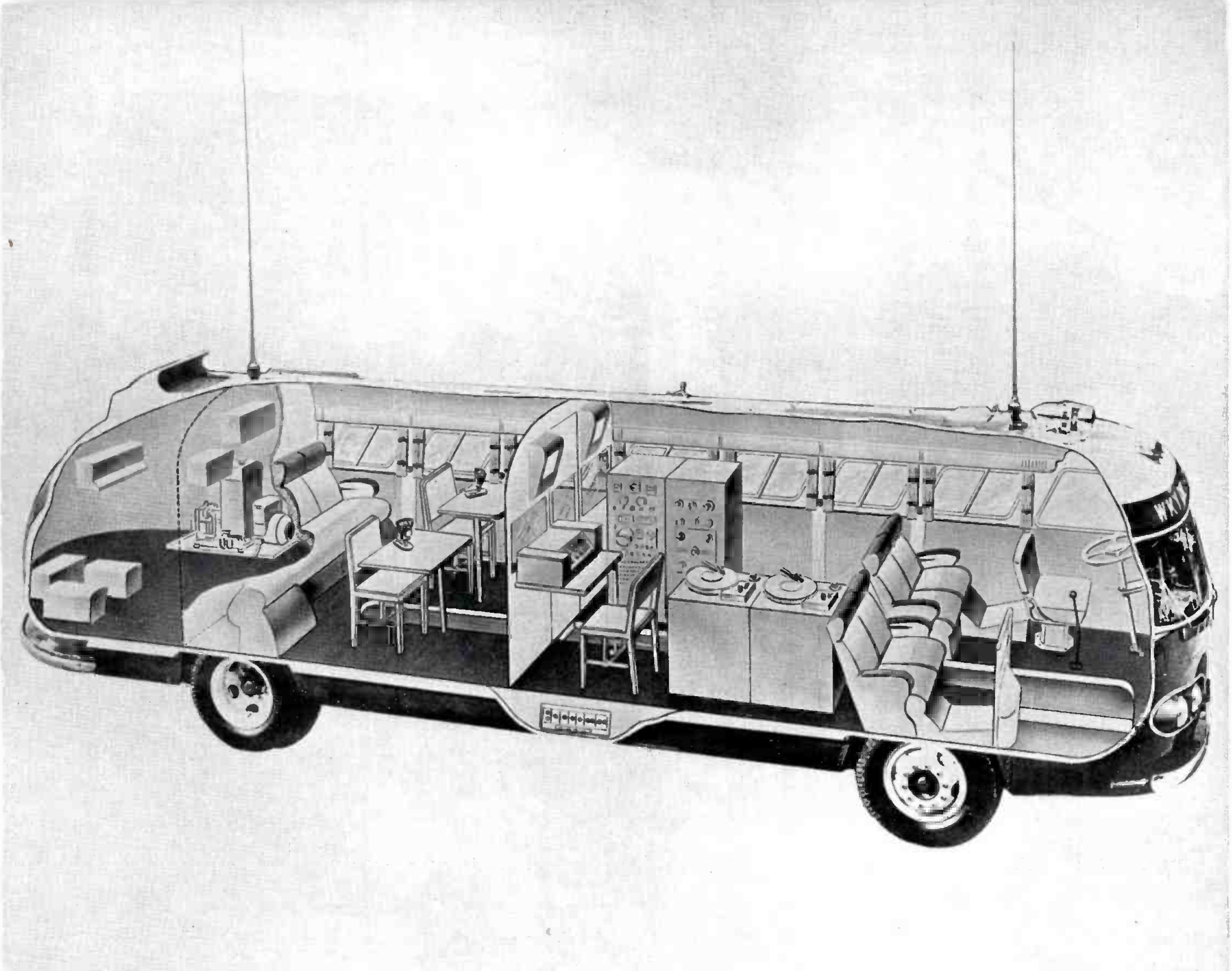


FIG. 2. *Cutaway view of WKY's mobile unit—completely equipped control room with studio-type console, shortwave transmitter and recording equipment is located immediately behind driver's section. To the rear of the control room is a luxuriously-fitted sound-treated studio seating eight people.*

relay transmitter (1600kc to 2800kc) and a pack transmitter (30-40mc). A 150mc FM relay transmitter is being added in the near future.

Receiving facilities include five receivers; three for standard broadcast, cue transmitter, pack transmitter and for monitoring any broadcast station, state highway patrol, FM broadcast or any frequency between 550kc and 125mc. A receiver for the Oklahoma City police department's FM station and one regular automobile broadcast receiver, are included.

Dual 16-inch RCA turntables with RCA recorders are standard control room equipment. In this installation, where vibration cannot be eliminated, we have installed regular advance ball units on cutter heads. Vacuum equipment was not installed due to space limitations.

Studio type speech input equipment was installed providing the remote studio with four microphone channels, two turntable channels or any combination of receiver remote or turntable setup that is needed.

A Bell System mobile telephone is standard equipment and in the two months that it has been in use it has proved to be an absolute necessity for well-rounded coverage. As soon as available in this territory, we will change over to the highway type, as furnished by the Bell System. This will give WKY regular telephone service to the unit just about anywhere in the state.

We also have our own cue transmitter of 40 watts output. This cue transmitter, used in conjunction with the Bell telephone, should give complete protection wherever the unit is located.

The back third of the remote studio is a maroon and gray appointed studio, sound treated, with two Pullman-type tables, four microphone outlets, portable chairs and seating for five across the back.

An adequate antenna system is always a problem with equipment of this kind and it is usually a compromise in the end. For transmission, we use two types. One is a standard Premax collapsible which extends to 30 feet above the unit. This is used at fixed locations only.

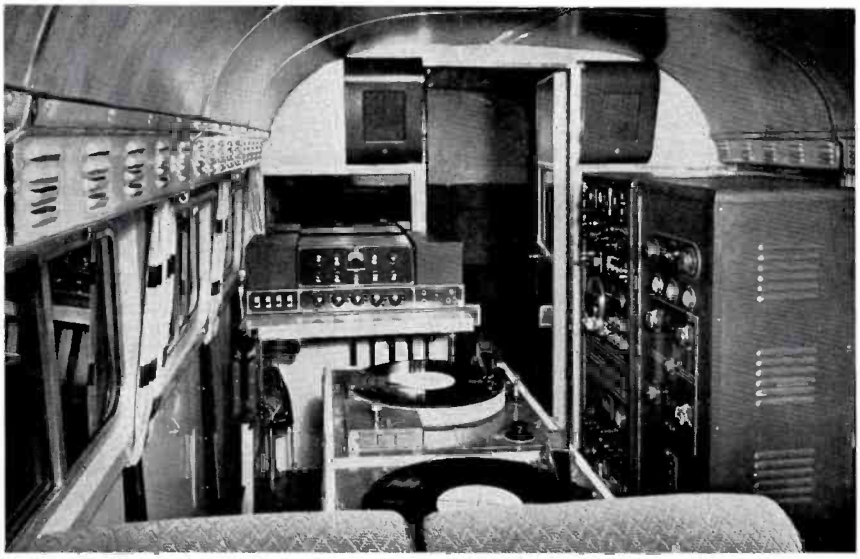
For mobile operation, we have a flat top. First, we checked with the state highway department to find the clearance height of the lowest highway bridge in the state and then built the flat top to clear.

As yet, we have not had an opportunity to measure the field strength of the two antennas. Measurements in the past have indicated there is very little difference.

It has been our experience in the past that regardless of the power output of the mobile unit, selection of the pickup point, where possible, is very important. Receiver antennas on the WKY unit are regular spring-mounted whips. Provision has also been made for a long single wire, if needed.

A 50-watt public address system is permanent equipment as are anchors for placing two horns on top of the unit. Two tripods are carried and sufficient cord is available for the remote location of two or all four of the horns.

RF pickup, due to long mike leads running from the unit, was eliminated by installing RF chokes in all mike lines where entrance is made on each side of the unit. This entrance is made through the regular mike receptacles in a specially-built outlet box that also contains PA output lines and telephone lines, either incoming or outgoing, depending on whether we are tying into the telephone company lines or into our own telephone line to some remote pickup point.



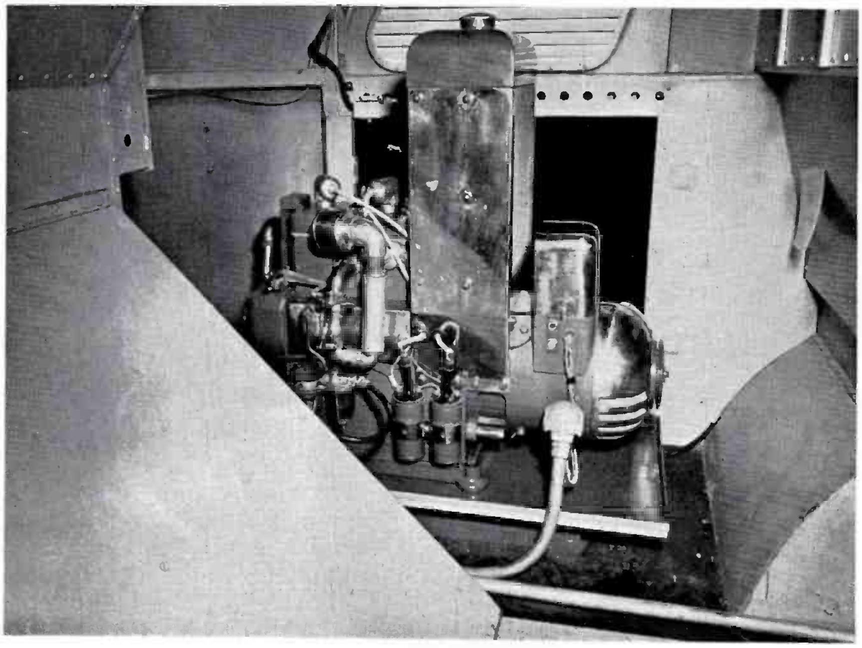


FIG. 3. (right, top) *View looking toward the rear from the driver's position. Racks at right contain two transmitters, five receivers. Console, at rear, is a standard studio-type. Turntables (foreground) and all other equipment, except console, are standard RCA units.*

FIG. 4. (right, center) *The "studio" is equipped with two Pullman-type tables, four microphone outlets, portable chairs, and seating for five across the back (see cutaway view).*

FIG. 5. (right, bottom) *The power plant, housed in the bus luggage compartment, is a 2 KW, 60-cycle gasoline engine generator.*

WACE and WACE-FM

Pictures on this page show the AM and FM transmitter installations of WACE and WACE-FM, the Regional Broadcasting Company of Chicopee, Massachusetts.

WACE, which operates with 1 KW daytime on 730 KC, is located in Chicopee, three miles north of Springfield, Massachusetts. Studios of WACE and WACE-FM are maintained in Springfield and Holyoke, as well as in Chicopee. Personnel of the station includes: John S. Lloyd, General Manager; Ralph J. Robinson, Chief Engineer; Terry Colwell, Program Director; and Harold Schumacker, Assistant Chief Engineer.

WACE-FM is located on Mt. Tom in a modern 32-foot by 64-foot fireproof brick building, constructed on the site of the old Summit House (which was destroyed by fire several years ago). The new building is shared by three FM stations (WACE-FM, WHYN-FM, and WMAS-FM), an arrangement which not only made this fine site available to all, but also made possible a number of economies, in that the cost of building power lines, access road, and other physical facilities could be divided among the three. Two of the transmitters (WACE-FM and WHYN-FM) are located in the same room and use a common technician.

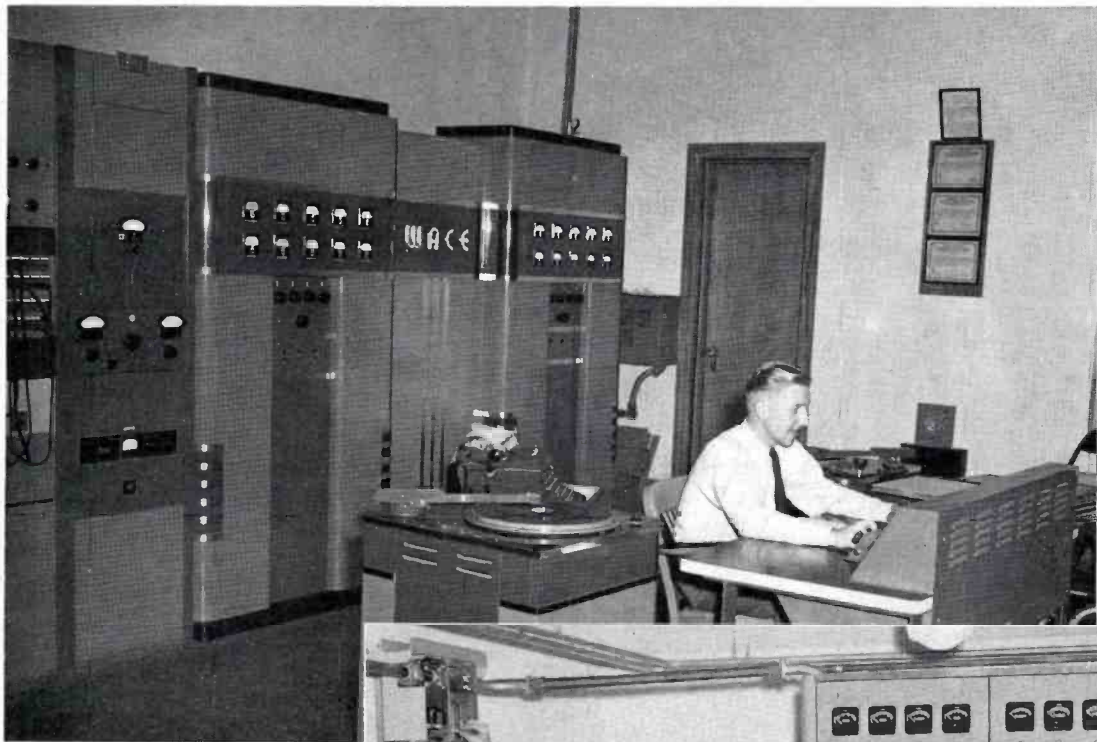


FIG. 1. (left) *WACE's AM installation in Chicopee Falls. Transmitter is a 1 KW RCA Type 1-K, operating on 730 KC daytime. Technician on duty is Walter Ciak.*

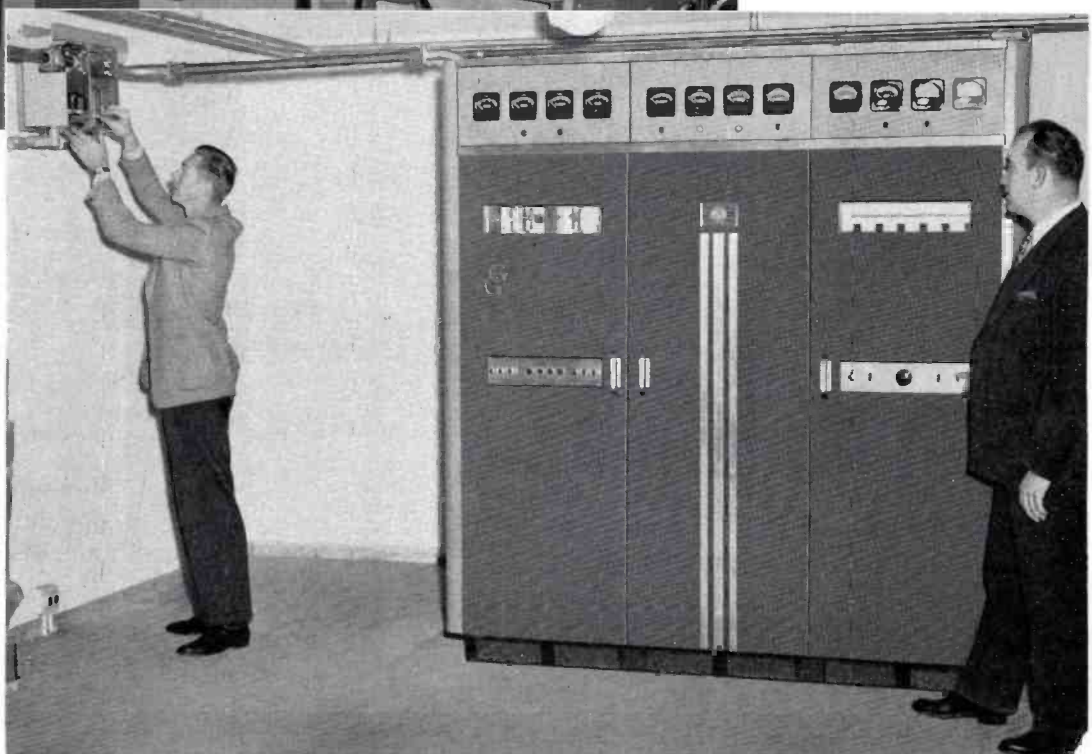


FIG. 2 (right) *WACE-FM's installation on Mt. Tom. Transmitter is a 3 KW RCA Type BTF-3B. This picture shows Hal Schumacker, WACE's Assistant Chief Engineer (left) making final check on harmonic filter under direction of Ralph J. Robinson (right), WACE and WACE-FM Chief Engineer.*

WTMJ-TV ON THE AIR

MILWAUKEE JOURNAL TELEVISION STATION OPERATING COMMERCIALLY SINCE DEC. 3

FIG. 1. *WTMJ-TV's new television equipment includes complete RCA Microwave Equipment for relaying remote programs to the studio.*

For 17 years the Journal Company, Milwaukee, Wisconsin, had been looking forward to the day when it would actually bring television to Milwaukee. That day came on December 3, 1947, after many years of research and experimental work in television by Journal engineers.

The dream of television became a reality in Milwaukee when WTMJ-TV, The Milwaukee Journal television station, began regular broadcasts December 3 on channel 3. The station, first in the state of Wisconsin, operates five days a week, Wednesdays through Sundays, with about 20 hours a week of programs. Shows are put on both in the afternoon and evening with about two hours each time. Equipment is all RCA.

The Journal Company began working with television in 1930. The first application for a license was filed on May 5 of that year and a transmitter was readied for experimental broadcasts. On September 4, 1931, The Journal Company received a license for experimental station W9XD.

In 1938, as a result of difficulties encountered in carrying on research work, the tempo was slowed for a few years. Then in 1941, a construction permit was granted for experimental television station W9XMJ, and later the same year a permit was granted for commercial television station WMJT.

Television was near at hand for Milwaukee when the war broke, but the Defense Communications Board put out an order freezing television construction. However, The Journal prepared itself to be in the best position to resume activities when conditions permitted.

Radio City was designed as the first structure to house all three types of broadcasting—AM, FM, and Television. When Milwaukee's Radio City was completed in 1942 as the most modern plant of its kind in the nation, its largest studio was especially reserved for television. Also built at the same time was a television control, a transmitter building and a 300-foot tower for television. During the war, the television studio was used for WTMJ programs. The tower was used for shortwave pickups and FM.

ADVANCE PLANNING

Actual detailed operational planning for WTMJ-TV started at the close of the war, when the green light went on for technical equipment. Early in 1947 assurances of equipment delivery had reached a point where The Journal felt it was safe to start actual operational planning. At that time a complete 19-page outline called Developmental Plans for the Milwaukee Journal Television Station WTMJ-TV was prepared.

This long-range plan was the result of months of extensive study of the entire television picture—a study which included extended visits to television centers and other stations.

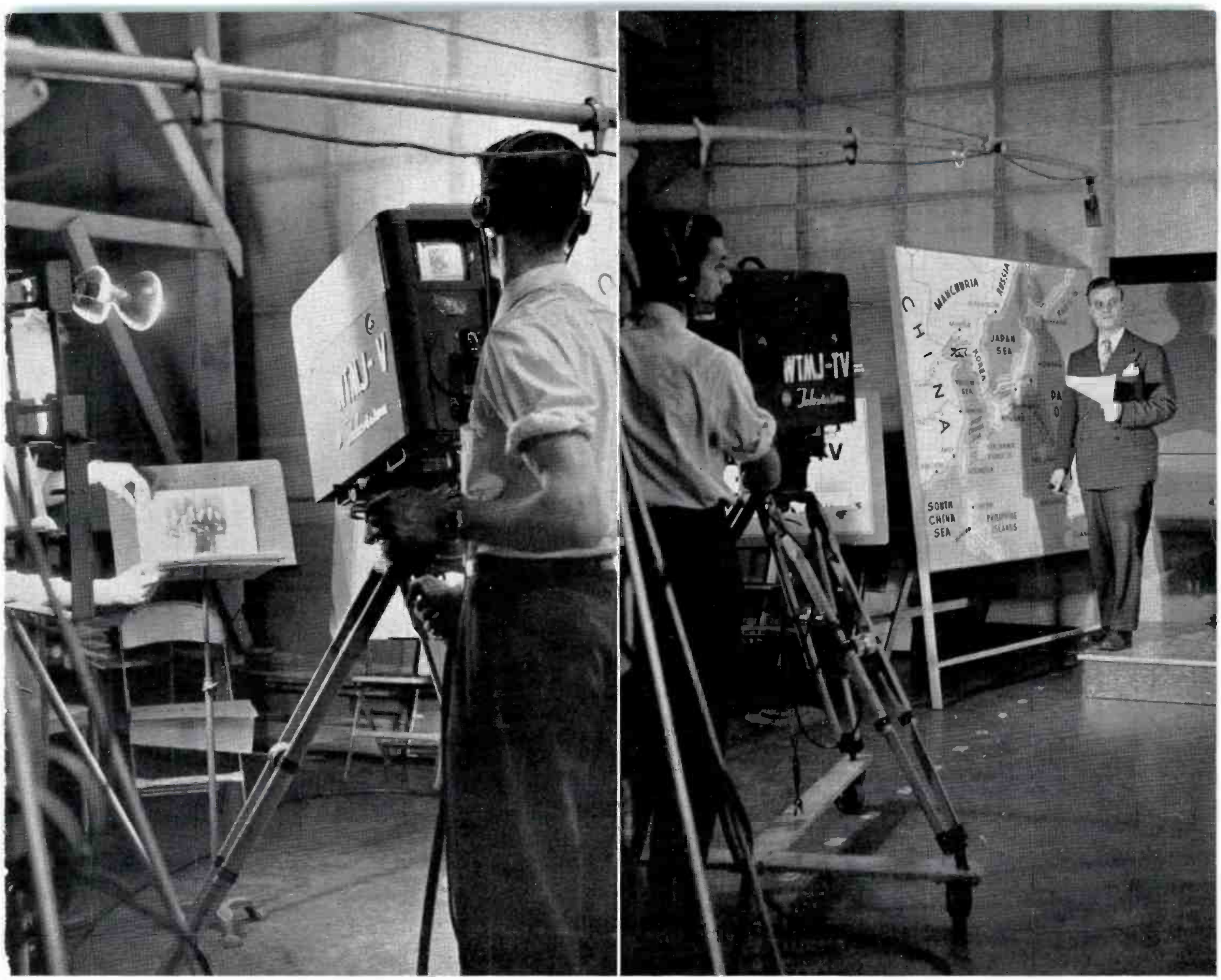


FIG. 2. *Two image-orthicon field camera chains are included in WTMJ-TV's equipment. At present these are used for both studio and field use. Additional cameras which have been ordered will be installed for permanent studio use.*

Included in the plan were detailed operational schedules for program, technical, and personnel work projects and requirements, leading up to T-Day and following T-Day. The plan set up a goal to work for with deadlines to observe, and with nothing left to haphazard chance that could be foreseen and accomplished in advance.

TECHNICAL OPERATIONS SCHEDULE

The timetable for technical operations was as follows:

- Aug. 1-31: Assembly and installation of the main transmitter.
- Sept. 1-15: Preliminary testing of the main transmitter.
- Sept. 15-30: On-the-air tests of the main transmitter.
- Sept. 1-30: Preliminary field testing of relay pickup transmitter.
- Sept. 1-30: Installation of film camera chain and 16mm projector.
- Sept. 1-30: Outfitting of studio.
- Oct. 1-30: Continued checking of main transmitter operation.
- Oct. 1-30: Continued testing of field pickup equipment from various points in the Milwaukee area.
- Oct. 1-Nov. 15: Technical operations of the studio for programs, experiments, and demonstrations.

This timetable worked out quite well.

EQUIPMENT

An RCA 5 kilowatt television transmitter arrived early in July and was unpacked at Radio City on July 9. The antenna, an RCA 3-element super turnstile, arrived in August and was assembled. The antenna was tested at Radio City by R. G. Beerbauer, RCA field engineer, before it was hoisted to the top of the tower early in September. The job of raising the nearly two-ton antenna to its position on top of the 300-foot tower caused excitement around Radio City as people watched the tedious work.

WTMJ-TV operates with 5 kilowatts video power and 2½ kilowatts audio. With a gain of four afforded by the antenna,

FIG. 3. *WTMJ-TV's studio control room. Video operators sit at camera controls on lower level. On upper tier are program director (left), technical director (center) and audio operator (right). The program director has a good view of the studio through the window at his left.*

the station radiates an equivalent power of 16 kilowatts video and 8 kilowatts audio.

Other new RCA equipment besides the transmitter and antenna includes two image orthicon field camera chains for remote pickups and simple studio shows, microwave relay equipment, a film-camera chain, and a studio synchronizing generator. The station at present has to depend on two portable cameras for all of its broadcasts. Studio-type cameras will be obtained in 1948. Future plans include the building of a new 500-foot tower within a few years.

PROGRAM TRAINING SCHEDULE

While technical advance operations were being carried out, a similar schedule for training the program staff was undertaken. This schedule was as follows:

Aug. 15-30: Interviews and contact work regarding performing rights and copyright clearance for live shows and film, and the development of talent for the various items of effort listed immediately following.

Sept. 1-30: Preliminary work with film.

Sept. 15-24: Checking studio installations and preparation for Gimbel Brothers demonstration.

Sept. 24-27: Demonstration at Gimbel Brothers store.

Oct. 1-Nov 30: Experimental remote pickups, two or three a week, approximately 18 hours of time weekly.

Oct. 1-Nov. 15: Experimental work with live studio programs, approximately 12 hours a week. During this same period we worked in the studios with local advertising agencies and key advertisers approximately 3 hours per week. This gave the agencies an opportunity to become familiar with television technique.

Oct. 15-Nov. 15: One Television Night per week, each show with its rehearsal to take about 5 hours of time. These demonstrations will be presented at Radio City auditorium studio for select groups.

Nov. 15-30: Final rehearsals for the air shows to start December 3. Public demonstrations, as noted above, were another part of the plan.

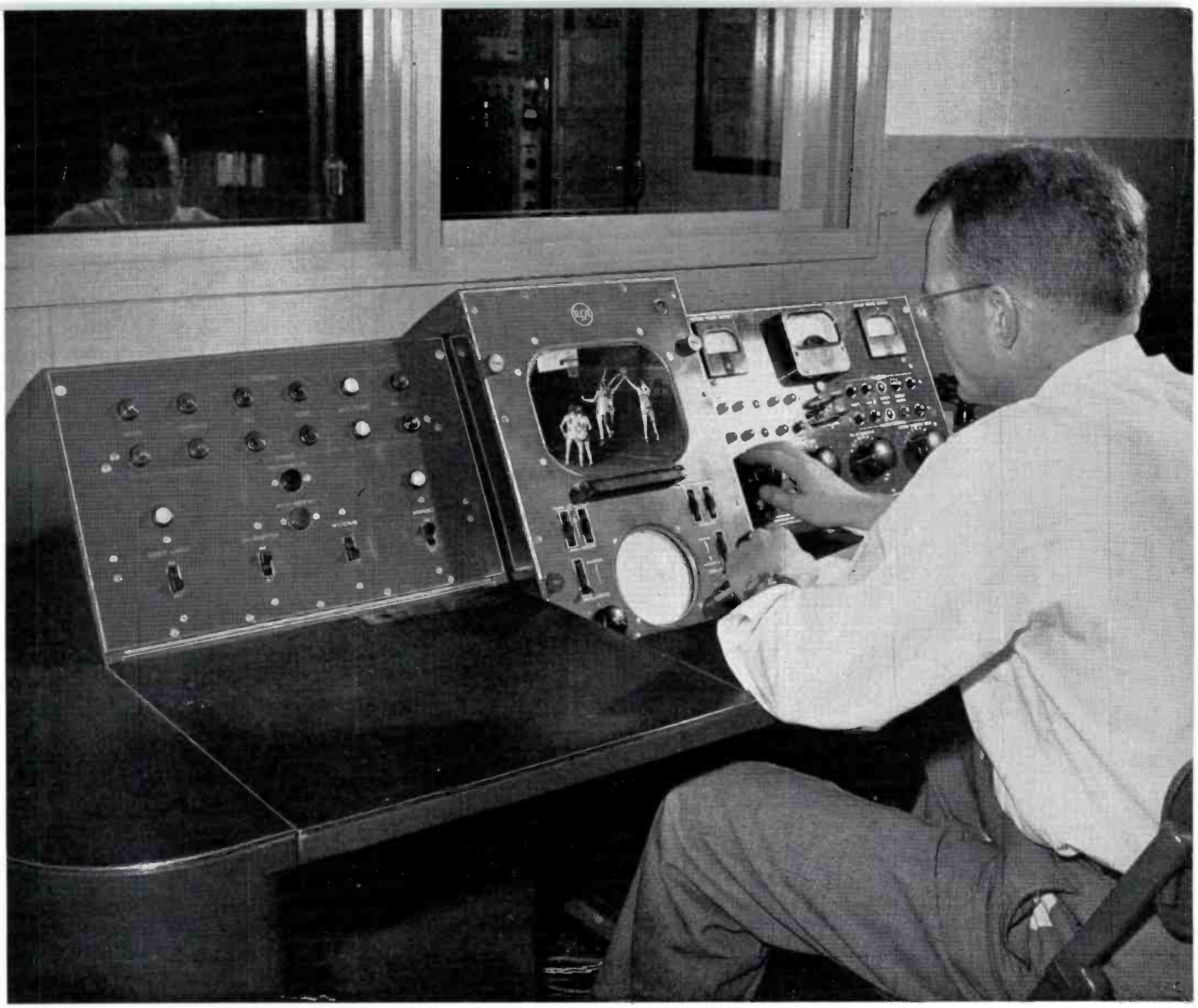


FIG. 4. *Transmitter control console at WTMJ-TV. The transmitter operator, seated at the console, has complete finger-tip control of the RCA TT-5A transmitter which may be seen through the window. Complete sound and picture control and monitoring is provided.*

PROMOTION CAMPAIGN

In its promotion campaign to acquaint Milwaukee with television, months before the station was to go on the air, WTMJ-TV started demonstrations at the Home Show held at the Milwaukee Auditorium last March. Television cameras and equipment were set up and people attending the show had the opportunity of seeing themselves on television receivers also put up around the auditorium. Some 140,000 people attended the show.

Demonstrations followed at department stores and at Radio City. More than 500,000 people watched television demonstrations put on by WTMJ-TV before the station went on the air. For more than a month before the station began regular broadcasts, test programs were put on the air to test equipment giving training to personnel and to enable dealers to demonstrate sets.

As a result of WTMJ-TV's careful planning *and practicing*, the station began regular operations on December 3 without the usual last minute difficulties and with a minimum of operational faux paus.

"T-Day" programs began at 8:00 P.M. with a half-hour dedication program. This included short talks by William E. Walker, assistant to the Governor, representing Governor Oscar Rennebohm of Wisconsin; Milton McGuire, President of the Milwaukee Common Council; Niles Trammell, President of NBC; and Walter J. Damm, Vice President and General Manager of Radio, the Journal Company.

Other programs on the opening night included Schusters's Open House, sponsored by the Ed Schuster Company department stores; a Barbershop Quartet program, sponsored by the A. Gettelman Brewery; a night club show, sponsored by RCA dealers; and an NBC television newsreel, sponsored by Gimbel Brothers department store. A sports review with highlights of the 1947 football season was presented by the Wadhams division of the Socony-Vacuum Oil Company. Also on opening night a Wisconsin apparel manufacturers' show of Wisconsin-made apparel was sponsored by the Boston Store. Because the sales department had also been out working before T-Day, many of these programs were not just one-time novelty shots—but the start of regular contracts at card rates, many of them extending for 13 weeks or more. WTMJ-TV is indeed off to a good start.

JOHN VASSOS, *eminent author, designer, and painter, established RCA's Functional Design Department before the war. Well known for his outstanding contributions to broadcast station and equipment design, he is now designing consultant to RCA as well as a number of other large industrial concerns.*

STEWART W. PIKE, *manager of RCA's Functional Design (sometimes called "Styling") Department, is an architect by profession. He is assisted by a staff that includes artists, metal craftsmen, and draftsmen. This group works directly with the design engineers, "styles" all of the apparatus produced by the Engineering Products Department.*

PLANNING THE TRANSMITTER BUILDING

by

JOHN VASSOS and STEWART W. PIKE

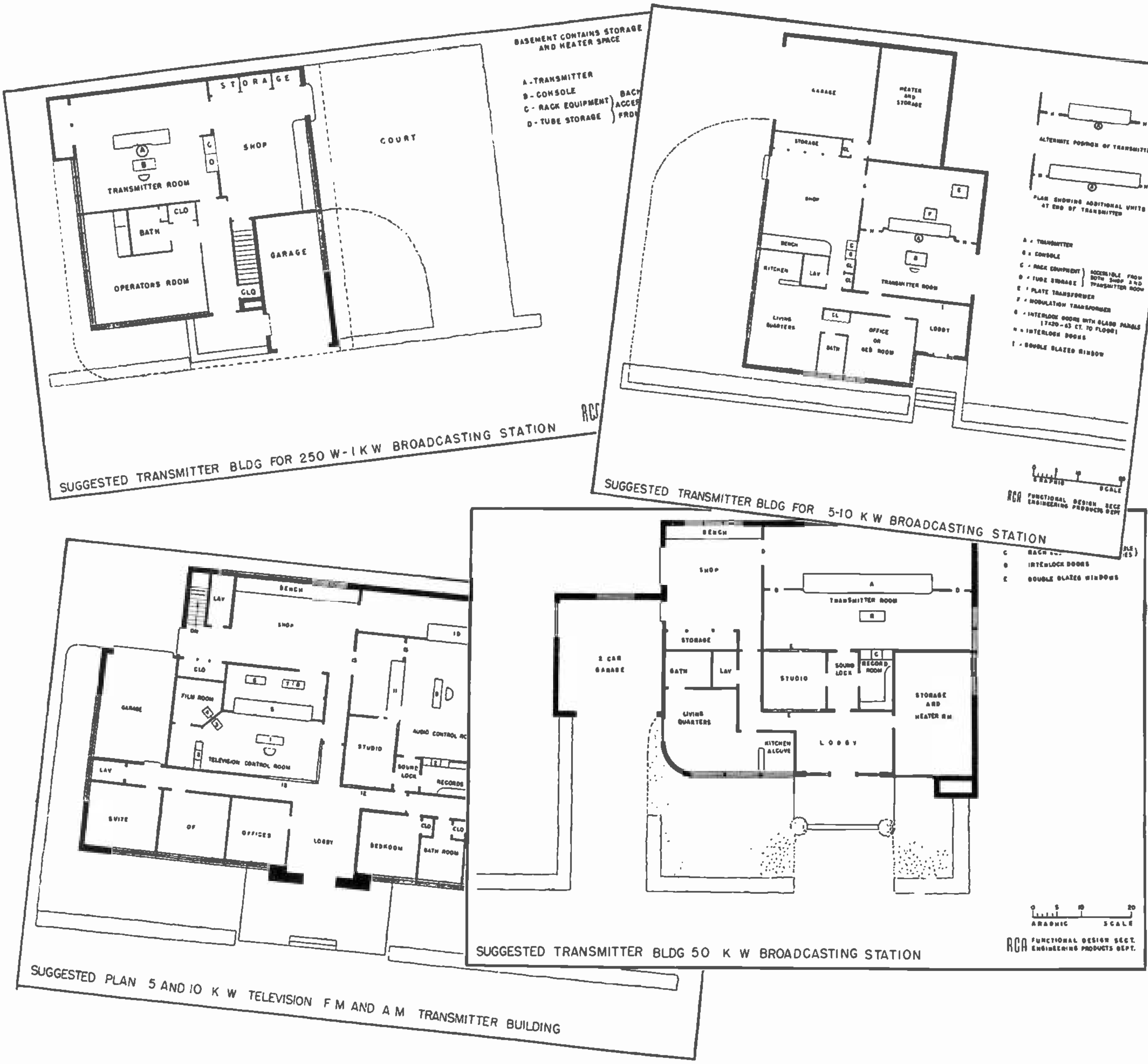
The Radio Corporation of America inaugurated in 1938 a service of assisting broadcasters with their installations of transmitting equipment, not only from the aspect of the electronics involved, but also in the actual physical layout of all components that are necessary in operating such stations. The results of this service have been beneficial to the point where demands for this type of information have been so overwhelming that now for the first time RCA is offering their experience and thinking in the layout of typical transmitting stations in a complete line of buildings covering all the various types and sizes of transmitting equipment.

At the first glance, when one views this program, it appears simple and easy to encompass. With a deeper study, however, one realizes the complexity of the units and requirements for the various functional components; thus general information, which is readily accessible to the prospective builder of a broadcast transmitting station, is most welcome.

Because of the fact that these unique buildings are usually placed in remote locations, it is necessary to house and care for the station personnel. Provision must be made, even in the smallest stations, for the comfort and convenience of the executive-in-charge so that having an assignment in this remote location will not be unpleasant. Thus, minimum living requirements, in the form of a small apartment are usually provided; however, the real analysis and the solution of the buildings offered in this group, lies in the arrangement and proper evaluation of the transmitting unit itself. As the transmitter is the heart of the broadcast equipment, this highly important device is deserving of the most prominent and considerate position in the scheme. The room housing the transmitter is usually known as the tranmitter control room and must be so planned as to do just what the name implies. The relation of the various pieces of equipment which are to operate in conjunction with the transmitter must be such that all will be readily visible and accessible to those operating the station. In some cases there is a small studio adjacent to the control room for the purpose of continuing service during emergencies by the use of transcribed programs. In small stations, this function is often provided in the control room itself.

The transmitter control room should be of ample size and have all equipment located so that it is easily maintained. It should have the generous aspect that is due its importance. In most of the schemes shown, it is contemplated that the transformers will be housed in the basement below the transmitter control room; however, the transmitter control room, in nearly all cases is large enough to include the transformers, if desired. In the matter of rooms adjacent to the transmitter control room, besides the possible emergency studio, there is the shop, which is an integral part of the operation of the station in that it is here that repairs are made easily and with the utmost dispatch. It is desirable to have access from the shop to that portion of the transmitter control room behind the transmitting equipment so that there is as little disturbance as possible in the operating area. In order not to disturb the operation in the control room. that portion of the rack mounted auxilliary equipment, which is located in the transmitter control room is often mounted in the wall—so that the rear of the racks is accessible from the adjoining shop.

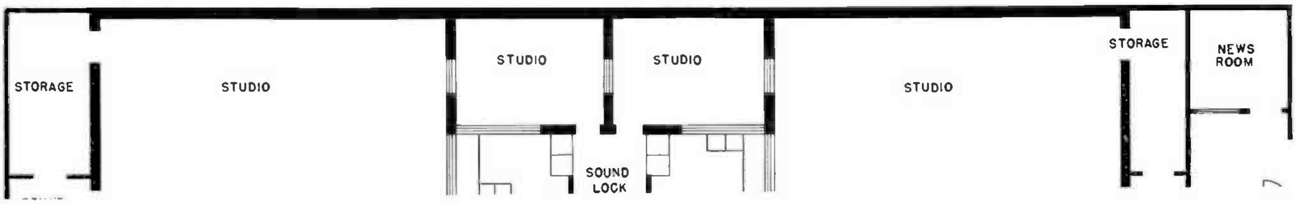
Good lighting in all the proposed structures is recommended and air conditioning is most highly desirable in tropical areas. It is a well-known fact that a building, which is well planned, doesn't cost any more than a poorly planned one. As a matter



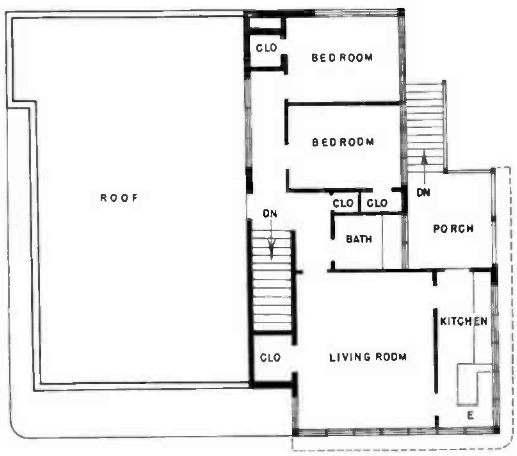
of fact, it is economically less expensive. There is no question that the morale of the crew maintaining the transmitter building is kept at a very high level when the surroundings are conducive to pleasant working.

The suggested architectural facade is only made to give a starting point to the local architect who will eventually make the final plans in re-expressing the same form of element construction and perhaps give it local flavor. Its details, materials and color for a tropical setting will be light, but as we go further up north, deeper color and stone texture will be desirable. The real contribution of this group of buildings lies in the arrangement and relationship and the organized functional planning that will provide maximum efficiency for the power rating of the station and an intelligent solution of the immediate needs of the personnel. Thus we have planned buildings suitable for everything from a 250-watt broadcasting station to a giant television and FM transmitter installation. Some of these plans are shown on the following pages. Others are being prepared. Eventually all will be available in the form of an architectural brochure which makes provision for adding, from time to time, the various new developments as they are introduced.

It has been the policy of the RCA Engineering Products Department to assist, at all times, their clients and prospective station builders, not only with the electronic problems, but in every phase possible. The Functional Design Section is also often called upon to draw up a complete workable plan for a proposed future transmitting station. It is not surprising that the cosmopolitan response to this service has included, not only our Latin American neighbors, but it has reached the far corners of Asia, Middle East, and Europe and in many instances, the entire recommendations have been followed as well as the electronic specifications. (See following pages.)



2ND FLOOR



BASEMENT CONTAINS STORAGE AND HEATER SPACE

FIG. 3. *Studio control booth and announce position at KFBK. In the foreground is an RCA 76-B2 Consolette with a 44-BX microphone suspended over it. At the right of the consolette are two 70-B Turntables built into a convenient dual housing. Announcer sits at 74-B microphone just beyond turntables. Window at left looks into master control room (a partial view of which is shown on the opposite page). Window at rear looks into large studio.*

FIG. 4. *KFBK's RCA Type BTF-1C FM Transmitter is installed in a separate glass-enclosed room just off of the master control room. In the closeup view shown at the right, Stan Sronce, Chief Engineer of KFBK, is making the final adjustments.*

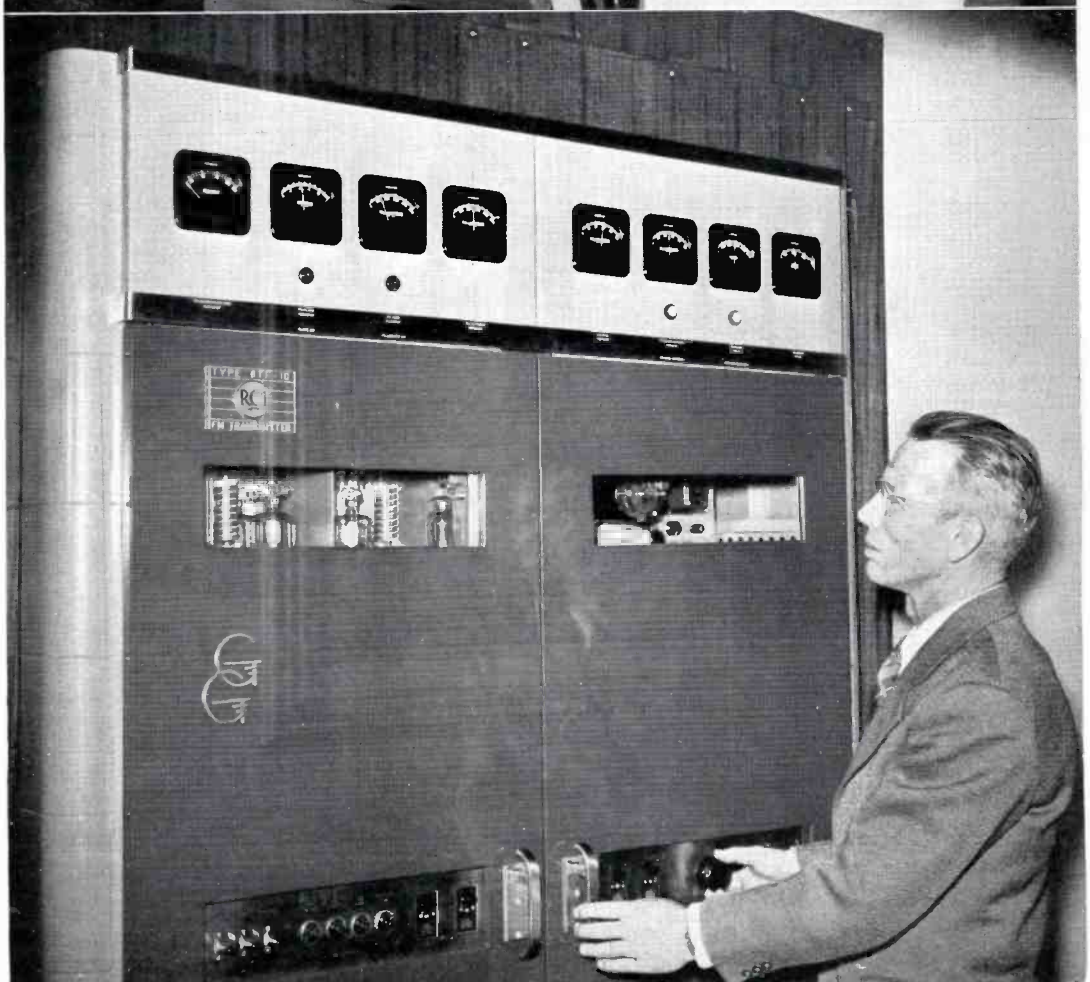


FIG. 1. *Mr. Harold L. Dewing, President of WCVS and WCVS-FM has reason to be proud as he surveys his newly installed BTF-3B FM transmitter. Note how the well-planned transmitter room layout makes every piece of equipment convenient to the operator.*

WCVS and WCVS-FM
Springfield, Illinois

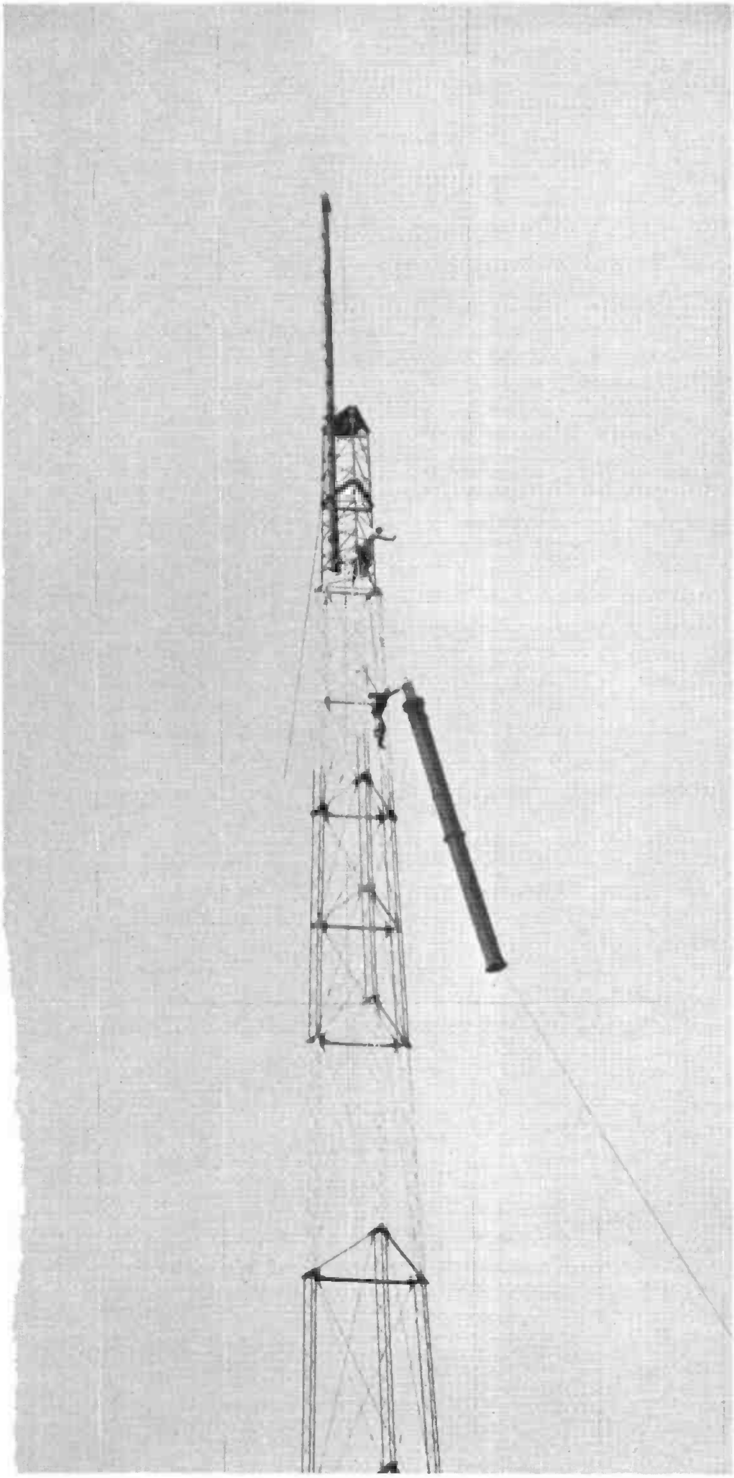
WCVS, formerly WCBS, Springfield, Illinois, is now on the air with both AM and FM, using the very latest in transmitting equipment. The 250 watt AM transmitter is the efficient and economically operated 250-L; while the FM portion of the station is represented by the 3 KW grounded-grid type BTF-3B transmitter. The FM output is fed into a two-section RCA high-gain Pylon antenna.

Mr. Harold L. Dewing is President of WCVS and WCVS-FM. The station is an affiliate of the American Broadcasting Co., and also associated with the Illinois State Journal and Register.

Construction of the new station facilities was begun in 1946, and within a year both the AM and FM plants were in business. The AM portion of the station was completed during 1946; and the Spring of 1947 saw the completion of the FM section including the installation of the Pylon antenna.

The physical layout of the WCVS transmitter room will be of considerable interest to those new stations contemplating dual (AM-FM) operation. The equipment arrangement as shown in Figure 1 points to a neatly compact and functional layout with practically finger-tip control. While economical in use of floor space, the arrangement allows access to the rear of all components, including the test and measuring rack and speech input equipment.

WCVS-FM plans a power increase to 10 kilowatts in the near future. In the case of its present 3 KW transmitter, the add-on amplifier feature will simplify the problem of expansion. (In grounded-grid amplifier design each successive power increase is made by simply adding an amplifier to the next lower-powered unit). Also, since the added units are of matching height and dimensions the completed installation will have a finished and unified appearance.



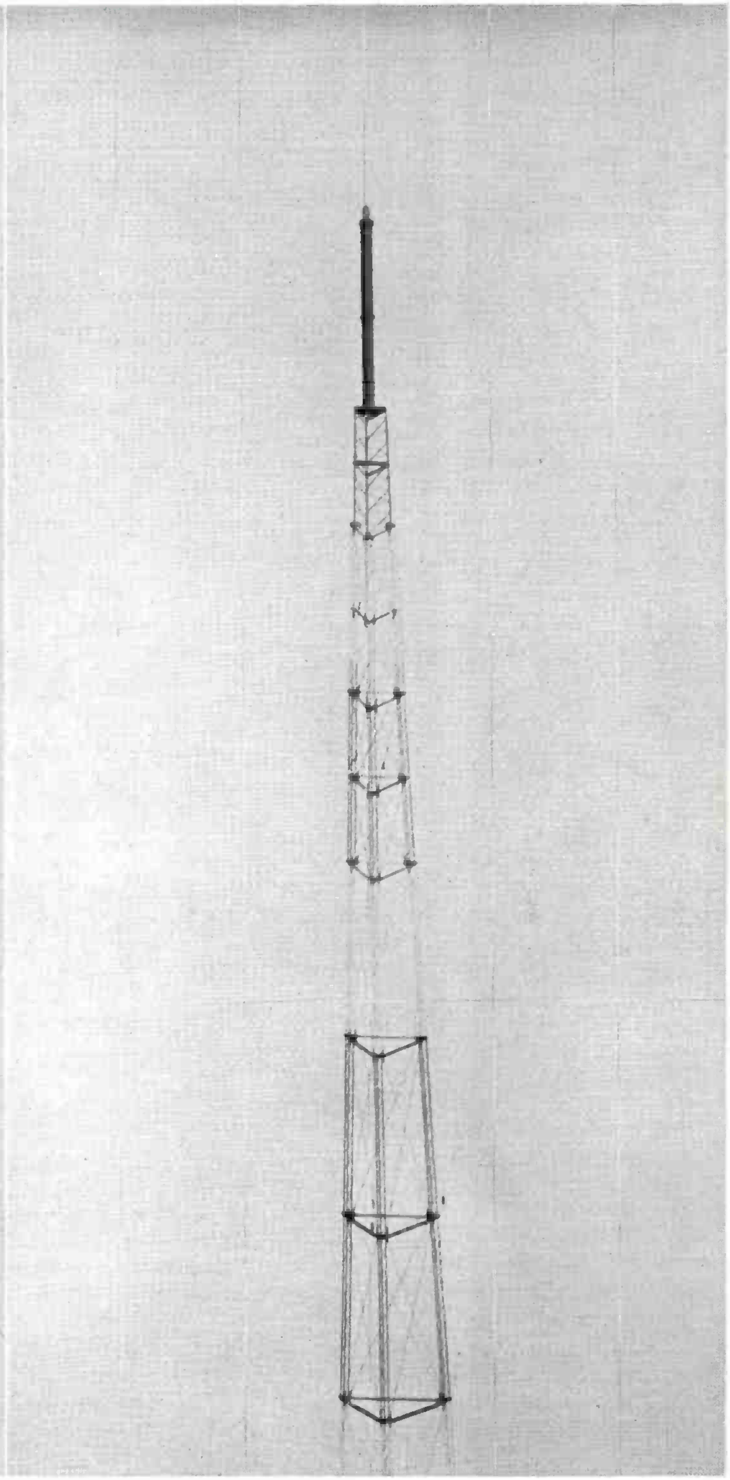


FIG. 2. (above) *The two-section pylon antenna in the process of being hoisted to the top of the antenna tower where it will be mounted into place. Mounting is a rather simple operation because of the fact that the transmission line and harness were already installed and bolted into place while the antenna was on the ground. The Pylon's characteristic open-slot is sealed against weather and foreign matter by being covered (also done on the ground) with a polycthylene strip.*

FIG. 3. (above) *Here the Pylon is mounted on the transmitter tower and secured firmly into place. The light weight and convenient size make it easy to handle in the air. Once mounted, the only connection to be made is the connection to the main feed line at the base, the transmission harness midpoint connection having already been made on the ground. Note the comparatively small area of the pylon and the complete absence of any cris-cross radiating frame-work.*

View of the New WKBH Transmitter Building with its Two-Element Directional Antenna Array.

WKBH, LA CROSSE, WISCONSIN

Station WKBH, La Crosse, Wisconsin, of which Mr. Howard Dahl is president and general manager and Mr. Alvin Leeman is chief engineer, has been operating since September 1946 with 5000 watts. The new installation, which increased the power from one to five KW, utilizes an RCA 5F transmitter and a 2-element directional array.

The transmitter building shown in the photograph above is 40 by 60 feet in size and is of brick construction. The transmitter is mounted in a partition wall of the operating room. The RCA 300-C phase monitor and the frequency monitor are installed in a similar manner at another end of the operating room.

The floor plan shown in Figure 2 points to an unusually commodius and well planned layout. Along with living quarters for one engineer, the building is equipped with air conditioning, oil burner, and all necessary shop facilities including a lathe.

The operating room is lighted by 32 forty-watt lamps mounted in eight ceiling fixtures, which assure evenly distributed lighting to relay racks, control console, and transmitter panel meters.

The ventilation system assures an ample flow of filtered air throughout the transmitter room at all times. Note the shutter indicator shown above the transmitter (Figure 1). This indicator shows the position of the butterfly valve which mixes exhaust and intake air to the transmitter in winter time so that the intake air is held at a temperature of 70° Fahrenheit. A large dial-type thermometer not visible in illustrations shown here is mounted in a symmetrical position above the left-hand side of the transmitter panel.

FIG. 1. (above) *Howard Dahl, left, President and General Manager of WKBH. Alvin Leeman, right, Chief Engineer, WKBH.*

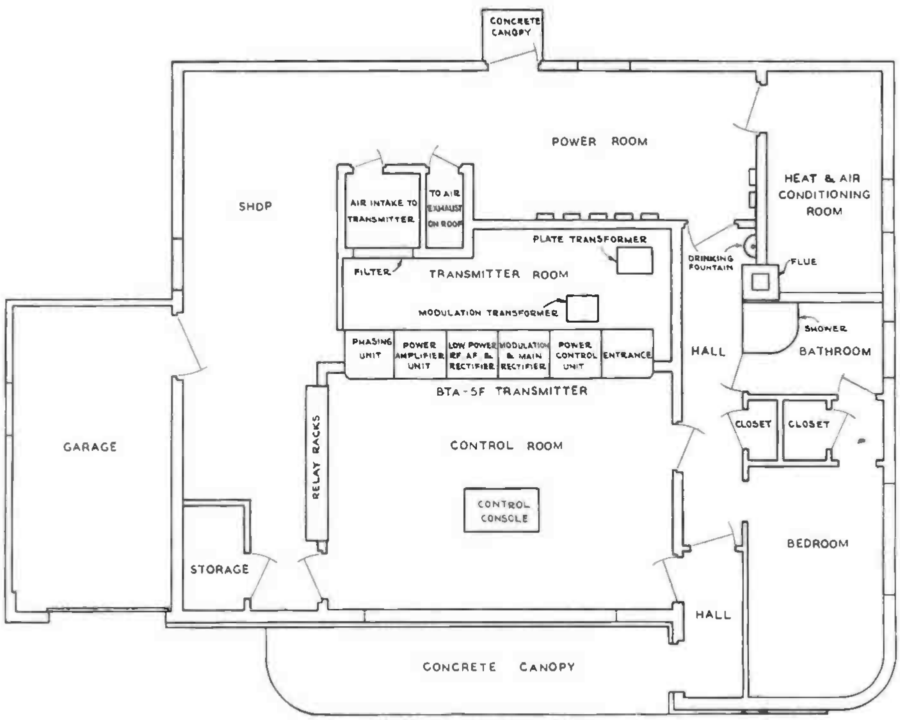


FIG. 2. (right) *Floor plan layout of transmitter building.*

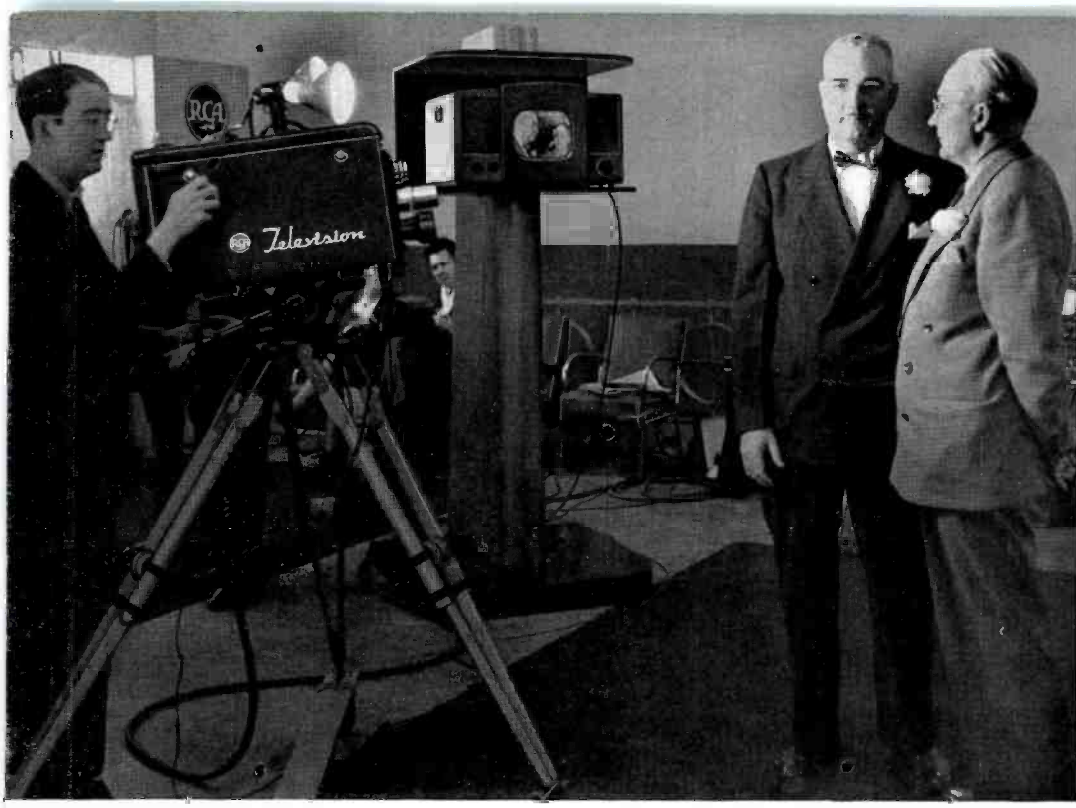


FIG. 1. (Left)—"Seeing themselves in television" has been the unusual experience of thousands of persons throughout the country during television demonstrations by RCA. The receiver shown here is a standard television receiver (Model 630 TS) modified for use as a video extension monitor. The coaxial cable input to the receiver can be seen just below the receiver in the photo.

HOW TO CONVERT A STANDARD TELEVISION RECEIVER INTO A DIRECT-VIEWING VIDEO EXTENSION MONITOR

by EDWARD K. PRICE, Engineering Products Department

In broadcast stations it is standard practice to feed program audio to monitor loudspeakers installed at such points as executive offices, client's lounges, and engineering maintenance shops. Similarly, in television stations, the video program along with its associated audio can be fed to appropriately located picture monitors around the station. One method of providing this service is to modify a standard television receiver and use it as a video monitor, driven or fed by coaxial cable from terminal equipment in the control room; or where used in the field, from the camera pickup equipment itself.

At this stage of television development there are a number of other uses for video extension monitors which are of interest. For instance, such monitors can be effectively used in promoting television in localities new to the art ("see yourself being televised"). Other applications in which they have proved particularly useful include educational television (demonstration of surgical techniques, laboratory experiments, etc.)[1] and televising of conventions[2] where those who cannot get into the crowded meeting room can, through the medium of extension monitors, both hear and see the speakers as well as the floor proceedings.

One of the most useful applications of a video extension monitor is to provide the announcer on a sports telecast with a means of viewing the transmitted picture. This is very desirable as otherwise there is nothing to prevent the announcer from describing action on which the camera may not be focused. Conversely, use of a video monitor can assure the telecast announcer that a particular scene he is describing is in the angular field of the camera; i.e., the announcer sees "what the viewer sees."

In some cases the announcer sits where he can see the master monitor unit. However, in most setups it is unnecessary and often impractical to set up camera control equipment close to the point where the cameras and announcer are located. Space limitations in press booths and similar camera locations, frequently allow for only a minimum of equipment and personnel. Thus, the camera control and master monitor units are usually installed in the mobile unit or in some other location remote from the cameras. This makes it desirable to supply the telecast announcer with his personal extension monitor. This can be done quite simply by utilizing the standard receiver conversion described below.

The monitor described here is simply a standard table model (RCA type 630 TS) receiver with the r-f sections de-energized, the picture and sound signals being fed into the first video and first audio stages respectively. Although the television announcer will not normally use the monitor receiver loudspeaker, the audio circuit modification makes the monitor a more flexible device and adaptable to other uses. And, of course, its flexibility is further enhanced if it can be readily converted back to a normal off-the-air receiver. This is accomplished here by the provision of a two-pole double-throw switch which we can call the "air-line" switch. Throwing the switch to the "line" side effectively takes plate and screen voltage off the r-f sections of both video and audio, connects the external video signal to the first video input, and puts a dummy load on the r-f B-plus circuits.

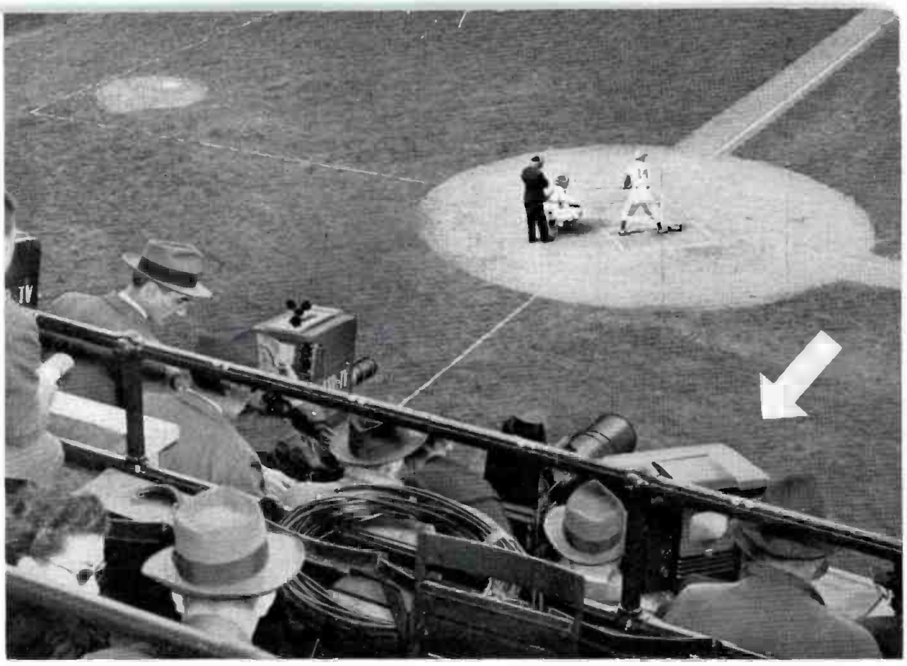


FIG. 2. (Right, upper)—*Arrow points to a converted seven-inch screen television receiver (RCA Model 621 TS) used as a monitor for the KSD-TV sport telecast announcer at Sportsman's Park, home of the St. Louis Cardinals and Browns. With "one eye" on the monitor the announcer can be assured that any action or unusual play he describes is in the angular field of the camera.*

FIG. 3. (Right, center)—*Claude Haring, popular WPTZ sport telecaster, describes a baseball game at Shibe Park, Philadelphia. His video monitor (lower right foreground) is conveniently located beneath his announcing desk and is well shielded from reflected sunlight, thus ensuring a clear picture. Note the title-card easel with lengthened pages so that the hand will be out of the field of the camera during the changing of titles.*

FIG. 4. (Right, lower)—*Harold Burke, General Manager of WBAL-TV, Baltimore, watching a golf match on a converted (630 TS) receiver installed in his office. Both picture and sound are fed to the monitor receiver from the terminal equipment in the studio.*

Throwing the switch to the "air" side re-energizes the r-f sections and puts the receiver back into normal off-the-air operation. Figure 7 shows an underside view of the receiver chassis and the mounting of the "air-line" switch. A rear view of the receiver (Figure 8) shows the coaxial feed and 75 ohm termination connected to a "tee" fitting. The sound input plug is shown on the left side of the picture.

Connection to the video signal source is made, in the case of the field pickup equipment, at the Auxiliary Monitor output connection of the Switching Unit. This output supplies approximately two volts peak-to-peak composite signal, which is sufficient for normal operation of the receiver video section. Where a video monitor or several monitors are to be used (as in the offices of a television station), the receivers can be connected in parallel, using "tee" fittings and terminating the last receiver in 75 ohms. In this case the signal would be fed to the line from the distribution amplifier rack.

Acknowledgment is made to the television field group of the RCA Service Co. for technical material used in this article.

References

[1] "Televising an Operation", Broadcast News, Vol. No. 45, Page 36.
[2] "Taylor, J. P., "Televising a Convention", Broadcast News, Vol. No. 45, Page 24.

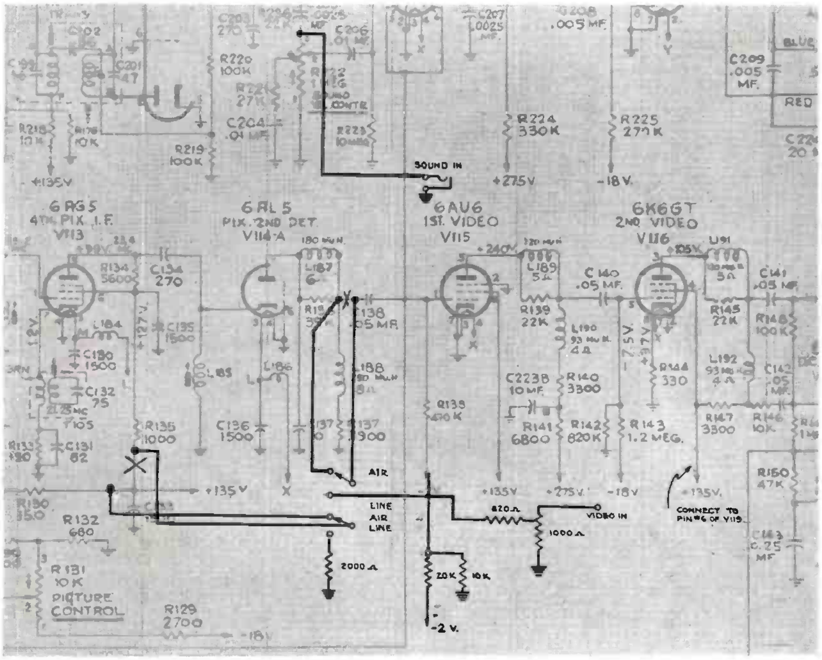


FIG. 5. (Above)—*Partial schematic diagram of Model 630 TS receiver with video and audio modifications shown in heavy lines.*

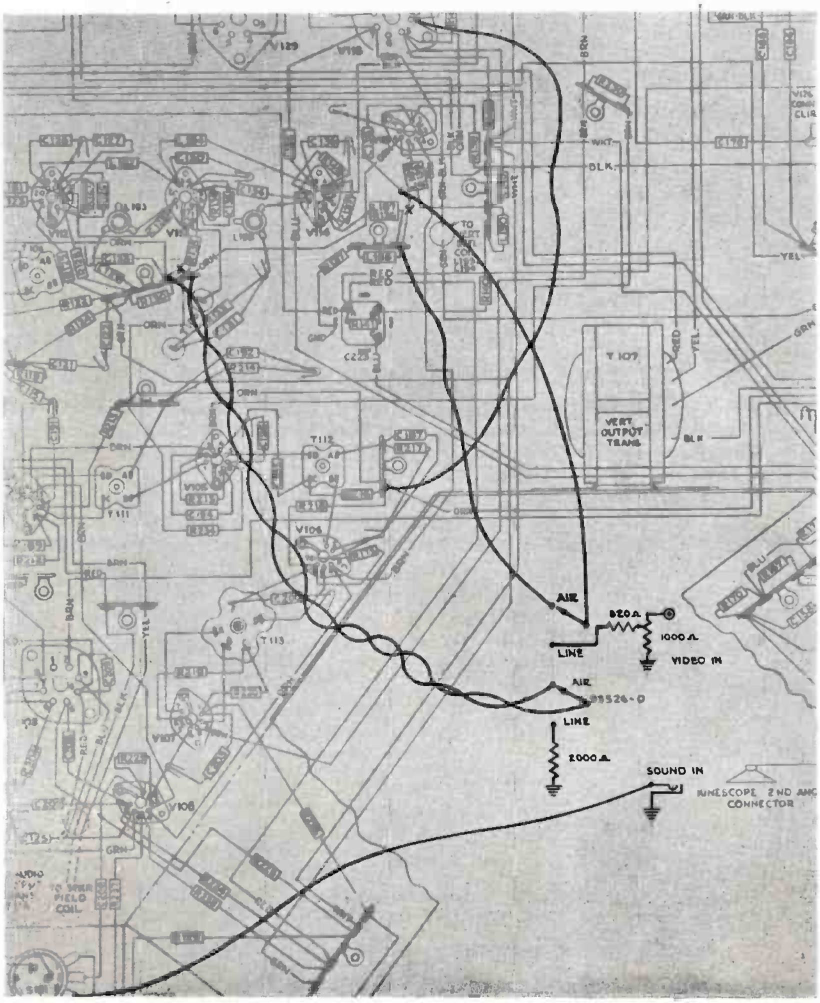


FIG. 6. (Left)—*Partial chassis wiring diagram of Model 630 TS receiver showing physical connections in modification.*

CONVERSION PROCEDURE

(a) Drill chassis and mount "Air-line" switch. See Figure 7.

(b) Drill chassis and mount video input connector. See Figure 7.
Above 2 components have been located on 630 TS receiver for most direct connections.

(c) Drill chassis and mount audio-jack.

(d) Drill chassis and mount 1000 ohm input potentiometer.

(e) Cut wiring at junction of L187-R136, L118, and C138.
Connect the capacitor side to arm side on the switch. Make connection between "air" side of switch and junction of L187-R136 and L118. Make connection between "line" side of switch and video input connector. Use type RG/59u, 70 ohm coaxial cable or similar type low capacity shielded cable.

(f) Connect shielded cable from jack to high side of volume control R222.

MODIFICATION COMPONENTS

820 ohm resistor ¼ watt.
20,000 ohm resistor ¼ watt.
10,000 ohm resistor ¼ watt.
2,000 ohm resistor 20 watt.
1,000 ohm potentiometer (carbon).
Switch—Centralab #1409 2 pole—double-throw or equivalent.
Coaxial cable: RG/59u, or equivalent low capacity shielded cable.
Coaxial input fitting — Amphenol type SO 239, CHP 49194.
Coaxial cable fitting — Amphenol type PL 259, CPH 49190.
Coaxial "Tee" fitting — Amphenol type M 358, CPH 49199.
Standard type audio jack.
75 ohm line termination.

(g) Refer to chassis wiring diagram of Model 630 TS receiver. Cut 135 volt bus at junction of R130 and R135 (Figure 6). Note one orange 135 volt lead between tie-points of R135 and R213. Note another orange lead between R130 and terminal B of C224. Unsolder and swap these orange leads at the birdie tie-points. This enables switch to cut off B plus from R.F. and I.F. sections on "line" operation.

(h) Referring again to chassis wiring diagram, note orange 135 volt lead between R216 and pin #6 of V119 (synch. separator stage). Unsolder this lead at tie-point and R216, and solder to terminal #4 of V116 (2nd video amplifier). This connection supplies voltage for operation of synch. circuits during "line" operation.

(i) Install 2000 ohm, 20 watt dummy load resistor between "line" side of switch and ground.

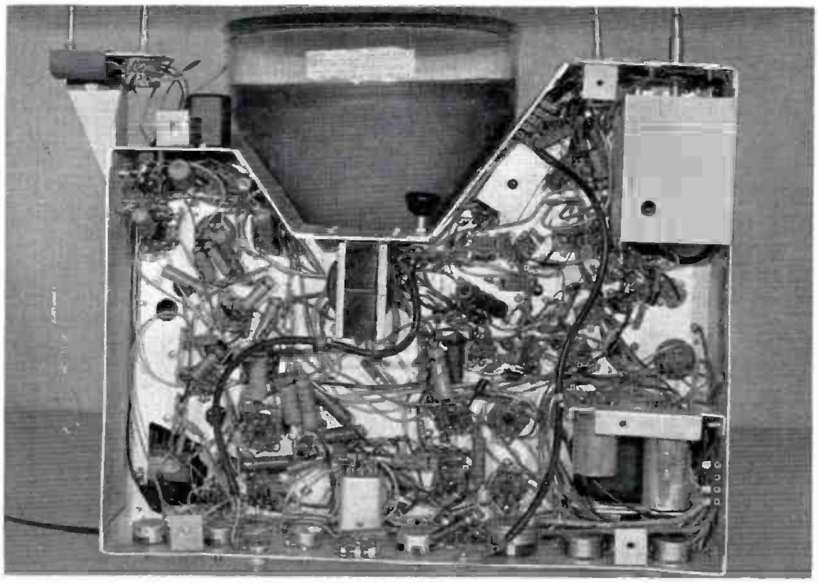


FIG. 7. (Right, upper)—*Bottom view of Model 630 TS television receiver modified as a video extension monitor. "Air-line" switch is shown in upper center mounted on chassis frame next to vertical output transformer. Video input connection is shown at lower left and audio input at lower right.*

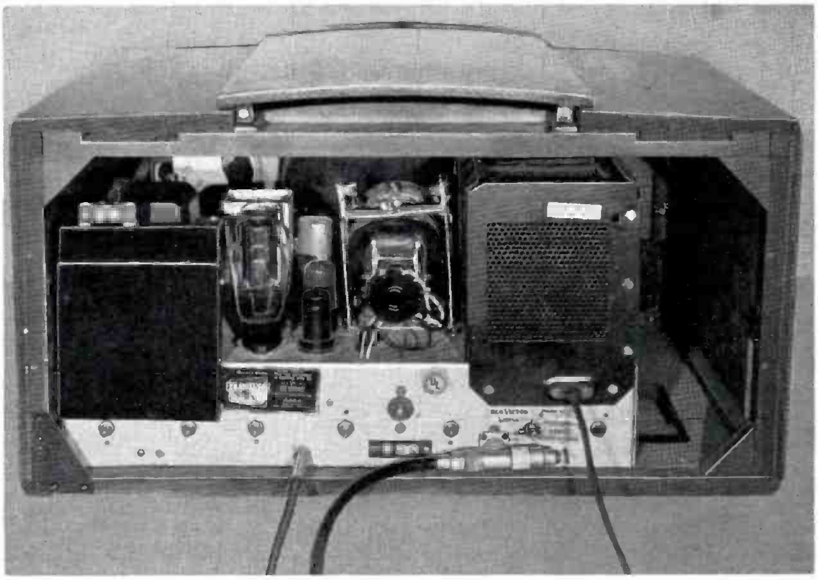


FIG. 8. (Right, center)—*Rear view of Model 630 TS receiver showing video and audio input connections. At lower right can be seen coaxial cable video input connection to one end of the "Tee" type fitting, with the 75 ohm termination connected to the other end. Audio input feed is shown at lower left.*

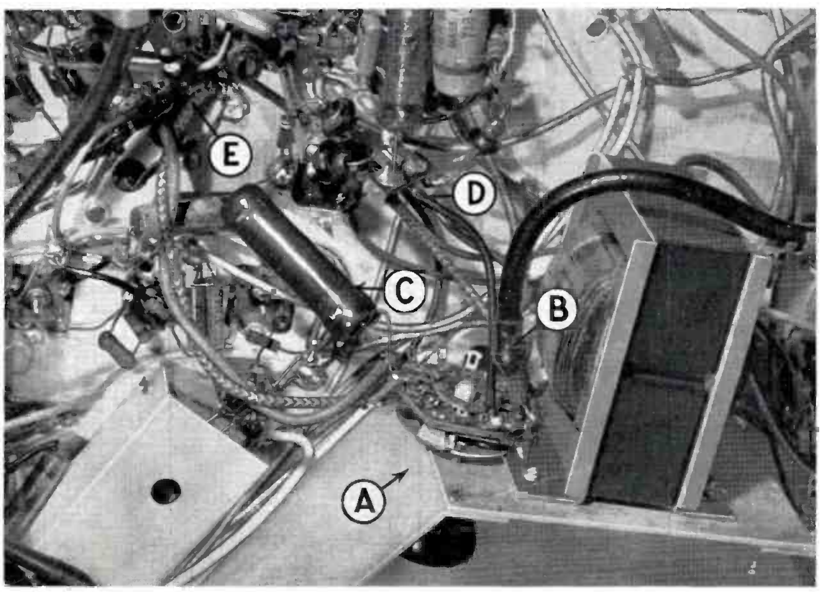


FIG. 9. (Right, lower)—*Bottom view. close-up of 630 TS video section modification components as follows: (A) "Air-line" Switch; (B) Coaxial Cable (RG-59/U) input to switch; (C) 2000 ohm 20 watt duming load resistor; (D) video input to C 138 (see figure 6); (E) 135 volt bus and junction of R130 and R135 (see figure 6).*

WBEN-TV NEARLY READY

BUFFALO EVENING NEWS STATION MAKING EQUIPMENT TESTS

The Buffalo Evening News and its AM station, WBEN, among the nation's pioneers in ultra-shortwave broadcasting and radio facsimile in the '30's, inaugurated Buffalo's first FM service in 1946 and will be first with television in the Western New York area.

WBEN-TV, which has been allocated television channel No. 4 (66-72 megacycles), went on the air February 27th with test patterns and is due to start regular commercial telecasting about May 1st.

The first step in construction plans was the erection of the television antenna atop otel Statler in downtown Buffalo, where the AM studios and the FM studios and transmitter already are housed. The 72-foot TV antenna, with an effective height of 385 feet above street level, was completed in the fall of 1947 in advance of inclement weather. The transmitter installation is well under way on the 18th floor of the Statler and studios are rapidly taking shape. The RCA Type TT-5A transmitter will deliver 5 kilowatts video power and 2½ kilowatts audio power to the television antenna.

WBEN-TV has also ordered two RCA studio Image-Orthicon camera chains and portable mobile truck with two field cameras for pickups of sports events, dramatic and musical productions and other special events. Two 16mm film projectors have been delivered. A slide and opaque projectors also will be used.

WBEN-TV, like WBEN-FM, will operate as a department of WBEN. The overall executive and engineering supervision that has existed in the station will be broadened to include the new activities. Thus, FM and Television will gain the benefit of the experience of the WBEN executive planning personnel. The programming is being planned by J. Woodrow Magnuson, television director of WBEN-TV, and a staff now composed of former AM personnel of WBEN.

Buffalo got a foretaste of television when WBEN-TV, with RCA mobile equipment,

FIG. 1. *Lana Turner visited the WBEN-TV transmitter on a November trip to Buffalo. Photo shows Technical Director Ralph Kingsley (left) explaining the intricacies of the control panel to the film star. Station Manager C. Robert Thompson is in center.*

FIG. 2. (right) *WBEN-TV's three-bay RCA super-turnstile antenna is mounted on a 50-foot pole atop the Hotel Statler in downtown Buffalo.*

sponsored the television booth at the Midwest Sports and Boat Show in a Buffalo armory last year. A "Miss Television" was selected after nightly competition and the station awarded her an all-expense trip to New York, where she appeared on WNBT. As a promotion stunt, spectators appearing before the Buffalo television cameras at that time were given cards as "television pioneers."

Ralph J. Kingsley, technical director of AM, FM, and TV at WBEN, says that WBEN-FM lays down good signals within a radius of 45 miles. With added antenna height and higher gain on the television antenna, the TV signals are expected to approximate the FM signal. Howard J. Bergmann is transmitter and control-room supervisor of WBEN-TV.

WBEN-TV will telecast professional basketball, hockey and boxing from Buffalo's 14,000-seat Memorial Auditorium and professional football from the 40,000-seat Civic Stadium via radio relay. The top of the Hotel Statler will make an ideal location for the television receiver link equipment.

WBEN-FM, which broadcast sponsored play-by-play accounts of Buffalo's pro football in 1947, is now carrying American League hockey games and the Buffalo Philharmonic Orchestra concerts in full. The station is a unit of the Continental-FM network and was one of its early members.

FIG. 3. (left) *Another view of WBEN-TV's antenna on the Hotel Statler. Tip of the antenna is 412 feet above street level (effective height of center, 385 feet).*

FIG. 4. (right) *Howard J. Bergmann, transmitter and control room supervisor of WBEN-TV, studies the 22-foot long blue print of the station's transmitter installation. WBEN-TV is one of more than fifty TV stations installing RCA TT-5A Transmitters.*

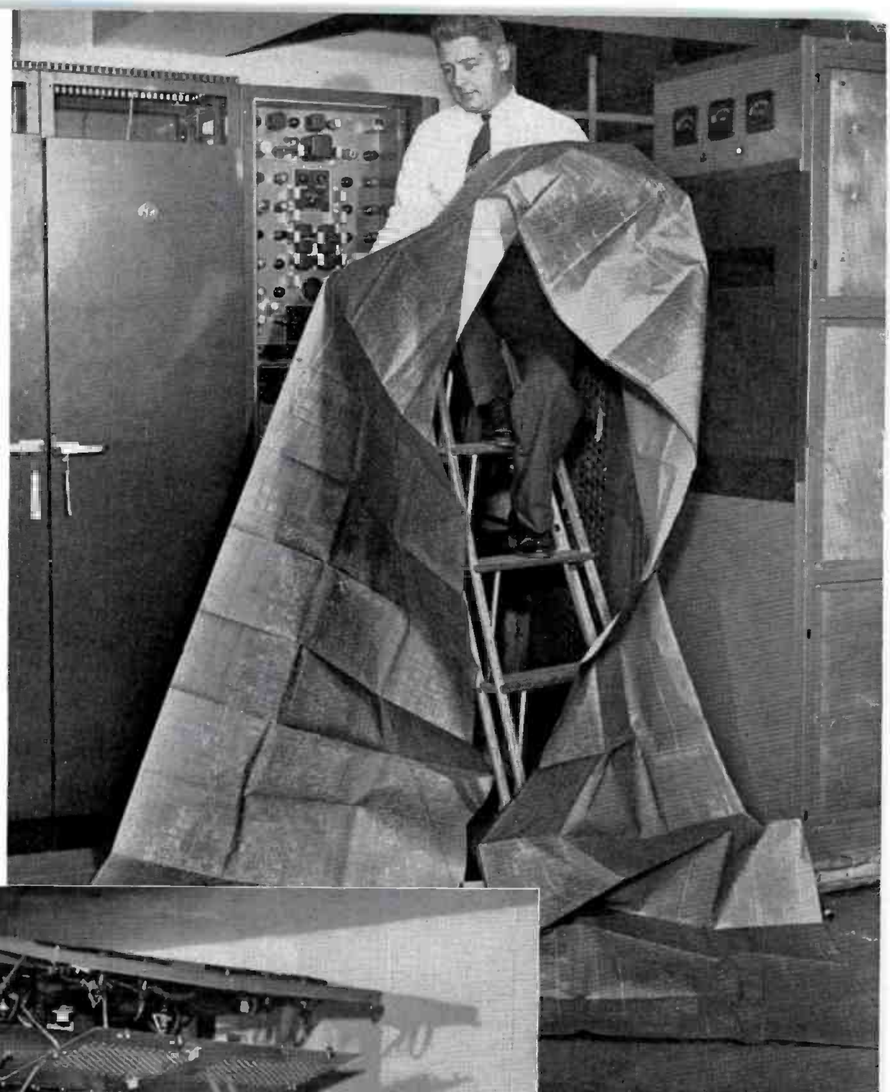
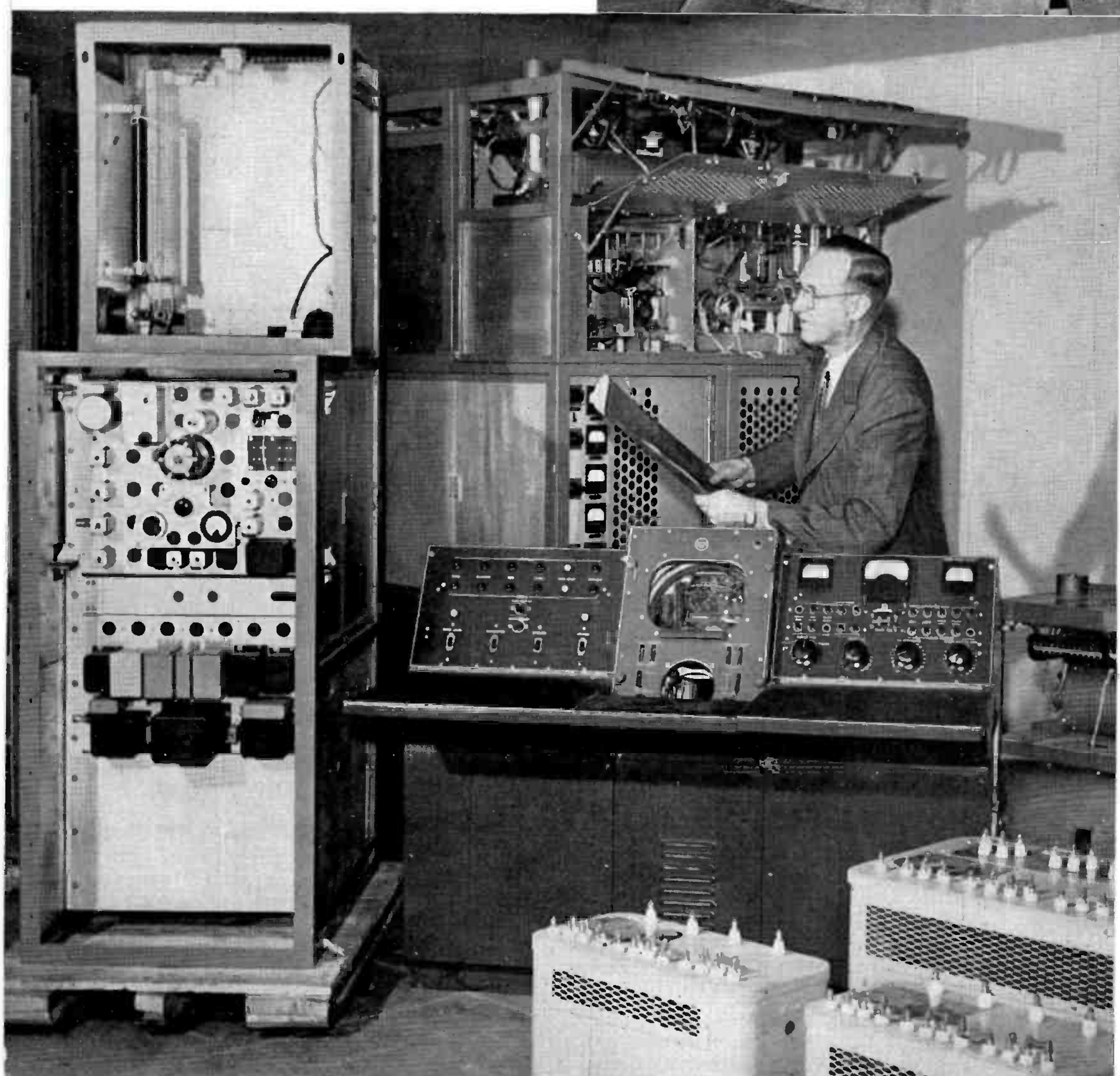


FIG. 5. (below) *Ralph J. Kingsley, technical director of WBEN's AM, FM and TV stations, supervised the construction of the TV installation on the 18th floor of Hotel Statler, Buffalo. At the moment this photograph was made, there seemed to be some question that things would even fit together. However, that they eventually did is proven by the picture on the preceding page.*



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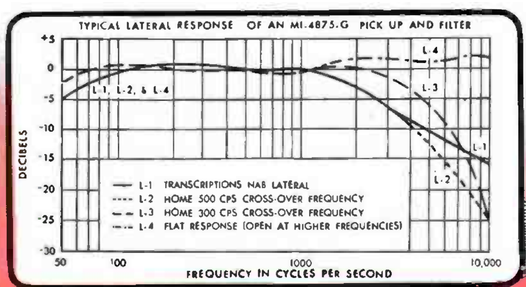

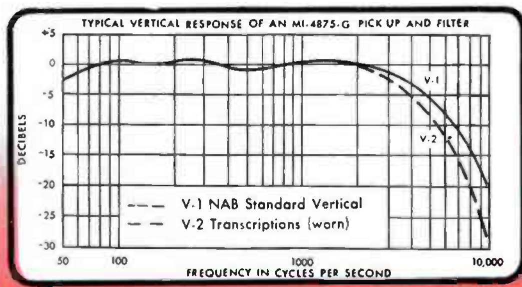

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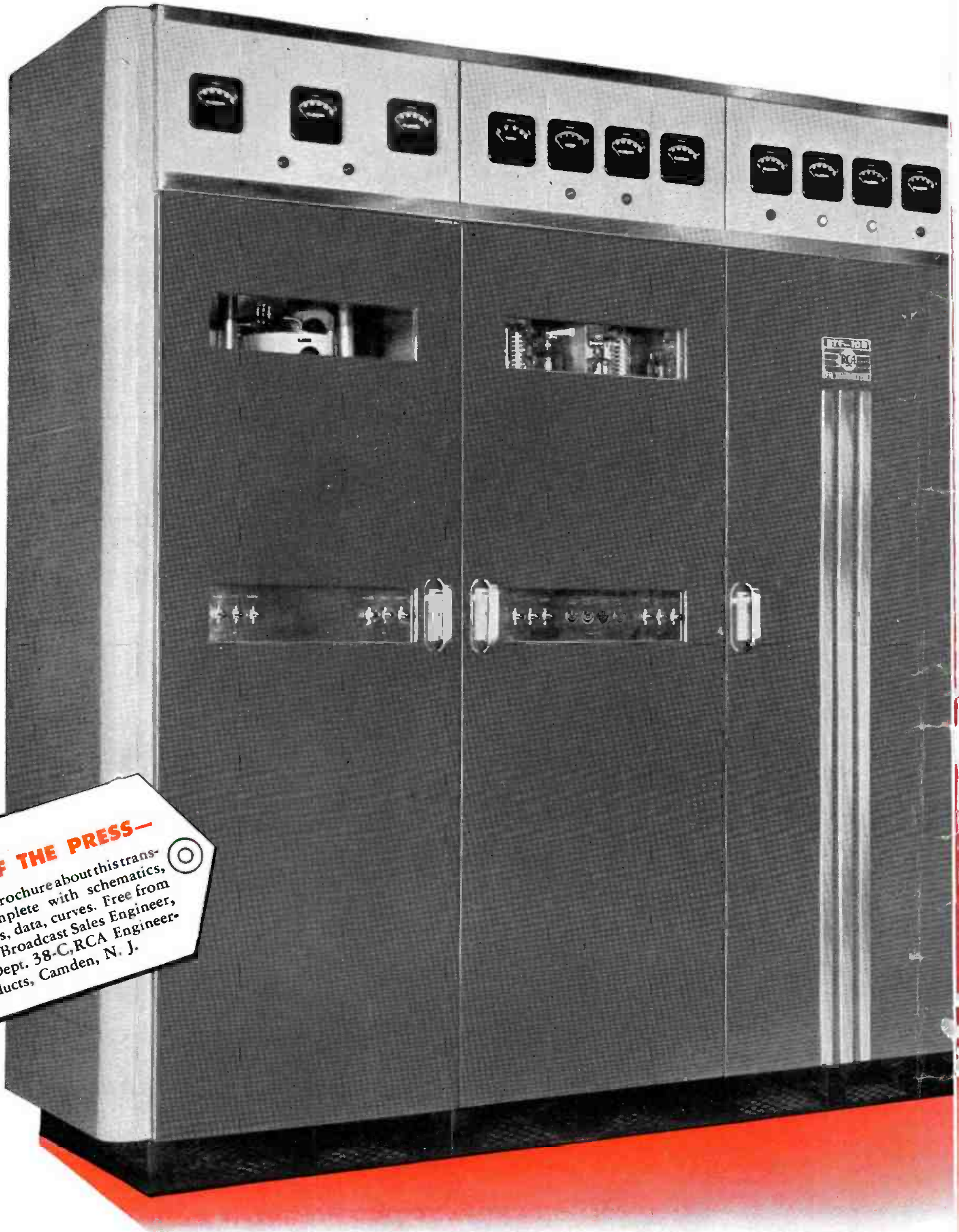

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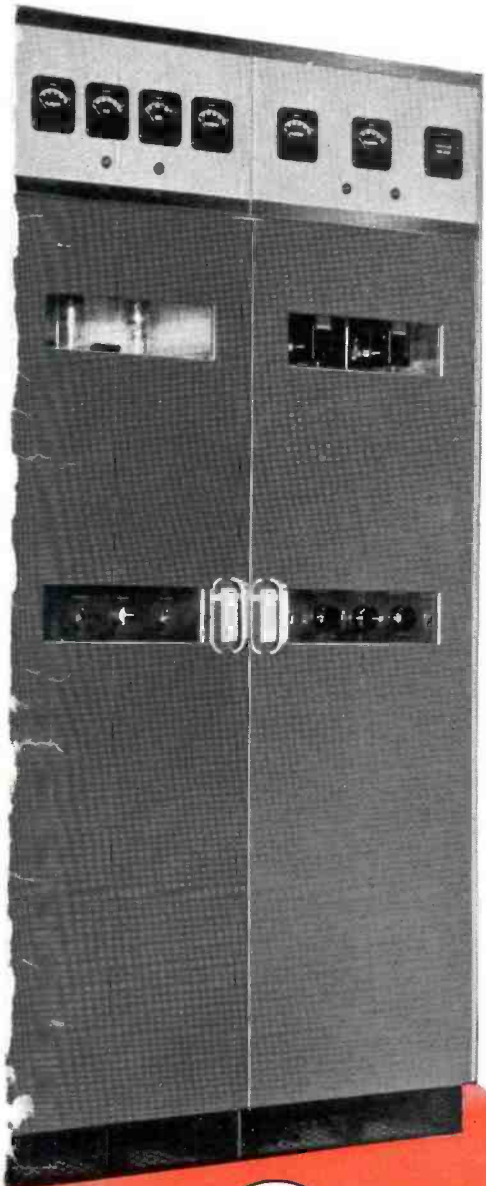

Reason No. 1 . . . It Uses Smaller, Less-Expensive Tubes. Because Grounded-Grid circuits are used throughout . . . in driver stages as well as final, the extra power of the driver stages (ordinarily wasted) automatically adds to the output of the power amplifier. Thus, the final power amplifier is not required to furnish as much power—and smaller, less-expensive tubes can be used in it.

Reason No. 2 . . . It Uses Fewer Tubes. Because "Direct-FM" circuits are used in the exciter . . . and because one main rectifier supplies all high voltages, the BTF-10B uses substantially fewer tubes than most 10-kw designs. There are only 39 tubes, total. And only 23 of these are required for emergency operation. (The other 16 are control tubes whose failure will not take the transmitter off the air).

Reason No. 3 . . . It Takes Less Power. Because it uses fewer tubes, because the final amplifier tubes are smaller (use less filament power), and because the amplifiers all operate at high efficiency, *the power consumption of the BTF-10B is only 22.5 kilowatts.*

Reason No. 4 . . . It Requires Fewer Spares. Because the last three stages of this transmitter use the same type tube, the RCA-7C24, and because the overall number of tubes used is relatively small, the total *number of tube types required is only 14.* This greatly reduces the number of spares you must keep on hand.

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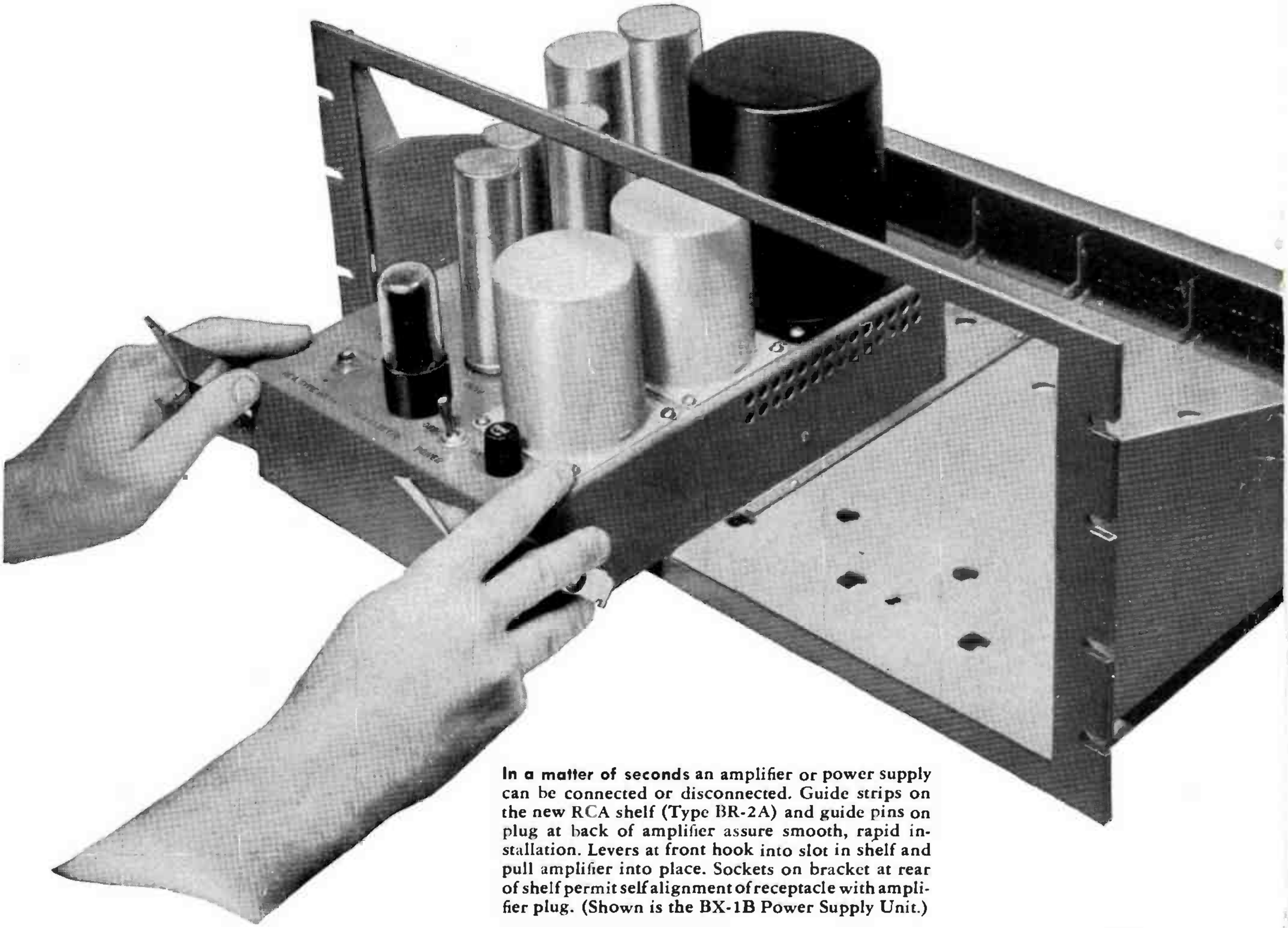
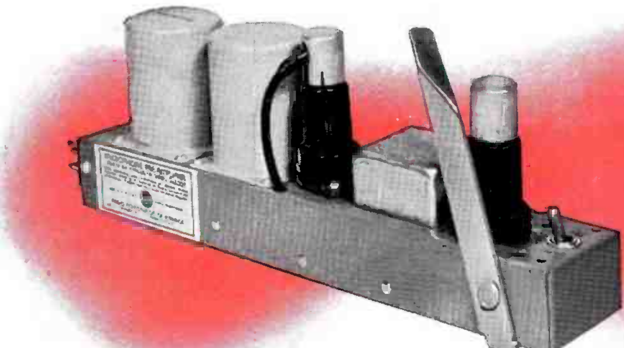


In a matter of seconds an amplifier or power supply can be connected or disconnected. Guide strips on the new RCA shelf (Type BR-2A) and guide pins on plug at back of amplifier assure smooth, rapid installation. Levers at front hook into slot in shelf and pull amplifier into place. Sockets on bracket at rear of shelf permit self alignment of receptacle with amplifier plug. (Shown is the BX-1B Power Supply Unit.)



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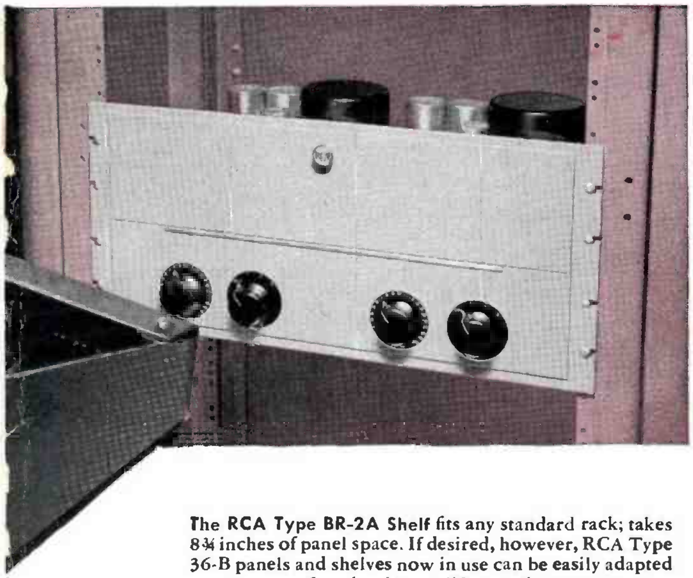
Two-stage Preamplifier (Type BA-1A)—ideal for use as a microphone preamplifier, turntable preamplifier, booster amplifier, or low-level isolation amplifier. *High gain:* 40 db. *High output:* +10 db. *Low noise level:* −80 db. *Low distortion:* 0.5% rms, 50 to 7500 cycles. *Isolation factor:* approx. 90 db; over 100 db with special Volume Control Kit. *Frequency response:* ±1 db, 30 to 15,000 cycles. *Small size:* six units will fit on a 36-B or new BR-2A shelf!

Price $105.00

Booster Amplifier (Type BA-2C)—A two-stage unit having applications similar to those for the BA-1A; also valuable where a high-gain amplifier between announce microphone and limiting amplifier is required. *High gain:* 50 db. *Low noise level:* −68 db. *Low distortion:* 0.75% rms, 40 to 15,000 cycles. *Frequency response:* ±1.5 db, 30 to 15,000 cycles. *Compact:* two units can be mounted on one 36-B or BR-2A shelf. Features plug-in capacitors and built-in power supply.

new convenience and speed



The RCA Type BR-2A Shelf fits any standard rack; takes 8¾ inches of panel space. If desired, however, RCA Type 36-B panels and shelves now in use can be easily adapted for plug-in amplifier service.

All units available for immediate delivery

As easy to install or remove as an electronic tube! Pull a lever near the front of the amplifier and the plug on the rear of the unit is smoothly withdrawn from its socket—automatically disconnected from the supply voltage. No longer is it necessary to crawl around to the back of hard-to-get-at racks and unsolder or unscrew countless connections. System changes can be made quickly; minutes can be slashed from inspection, servicing, and testing time.

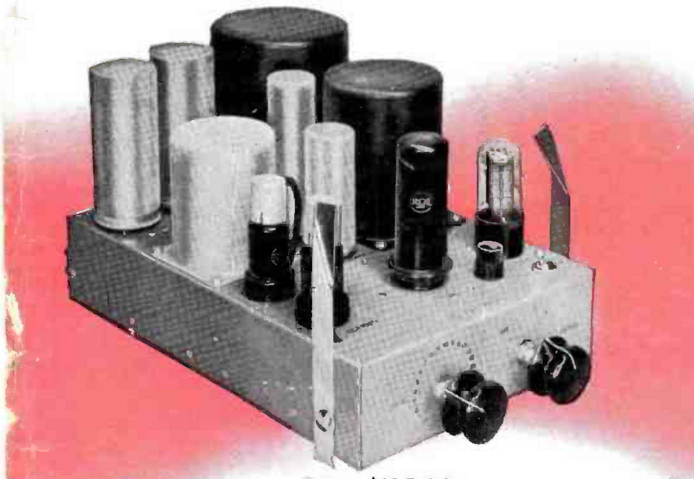
This new RCA line now includes the four amplifiers and one power-supply unit shown. Others will be added in the near future. New, carefully selected characteristics make these units ideal for a large number of studio jobs.

All units use the same standard plug. To assure maximum convenience, a new shelf (Type BR-2A) has been designed. With a few easy changes, however, the conventional RCA Type 36-B panel and shelf can be used, if desired. The necessary accessories are available for this purpose.

Here, we believe, is a real opportunity to modernize your amplifier system—a quick, convenient way to get better performance at low cost. New descriptive leaflets are yours for the asking. Amplifier prices (less tubes) to broadcast stations are shown below. Write: Dept. 19-AB, Audio Equipment Section, Radio Corporation of America, Camden, N. J.

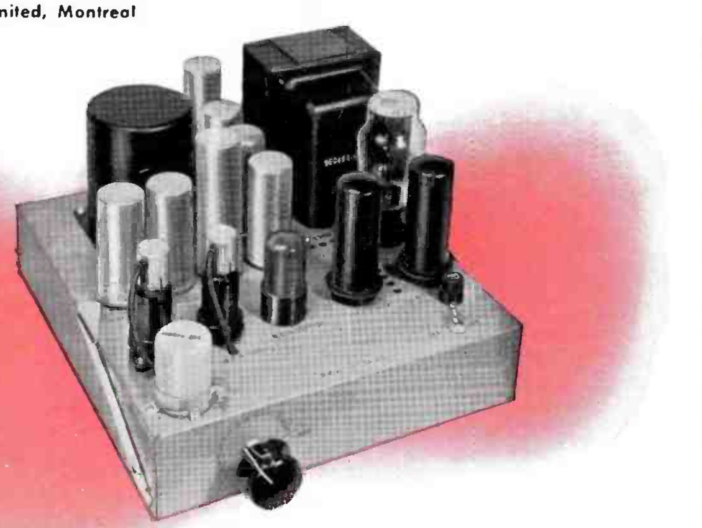
BROADCAST EQUIPMENT
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal



Price $125.00

Program Amplifier (Type BA-3C)—one of the most versatile on the market. Ideal as a program, line, or booster amplifier; a high-level isolation amplifier; a cueing or monitoring amplifier, or a driver amplifier (for high-power recording amplifiers, etc.). *High gain:* 65 db for matching input, 27 db for bridging input. *Low noise level* (with maximum gain): -52 db. *Low distortion:* less than 0.5 to 1% rms, depending on output level. *Frequency response:* ±1 db, 30 to 15,000 cycles.



Price $120.00

Monitoring Amplifier (Type BA-4B)—Designed for operation at microphone levels. High output of 12 watts is sufficient to drive several speakers or, in some applications, a recording head. Other uses include application as line amplifier for portable and mobile transmitters. *High gain:* 105 db. *Low noise level:* -20 db (with maximum gain); -40 db (with minimum gain). *Low distortion:* less than 3% at 12 watts. *Frequency response:* ±2 db, 30 to 15,000 cycles.