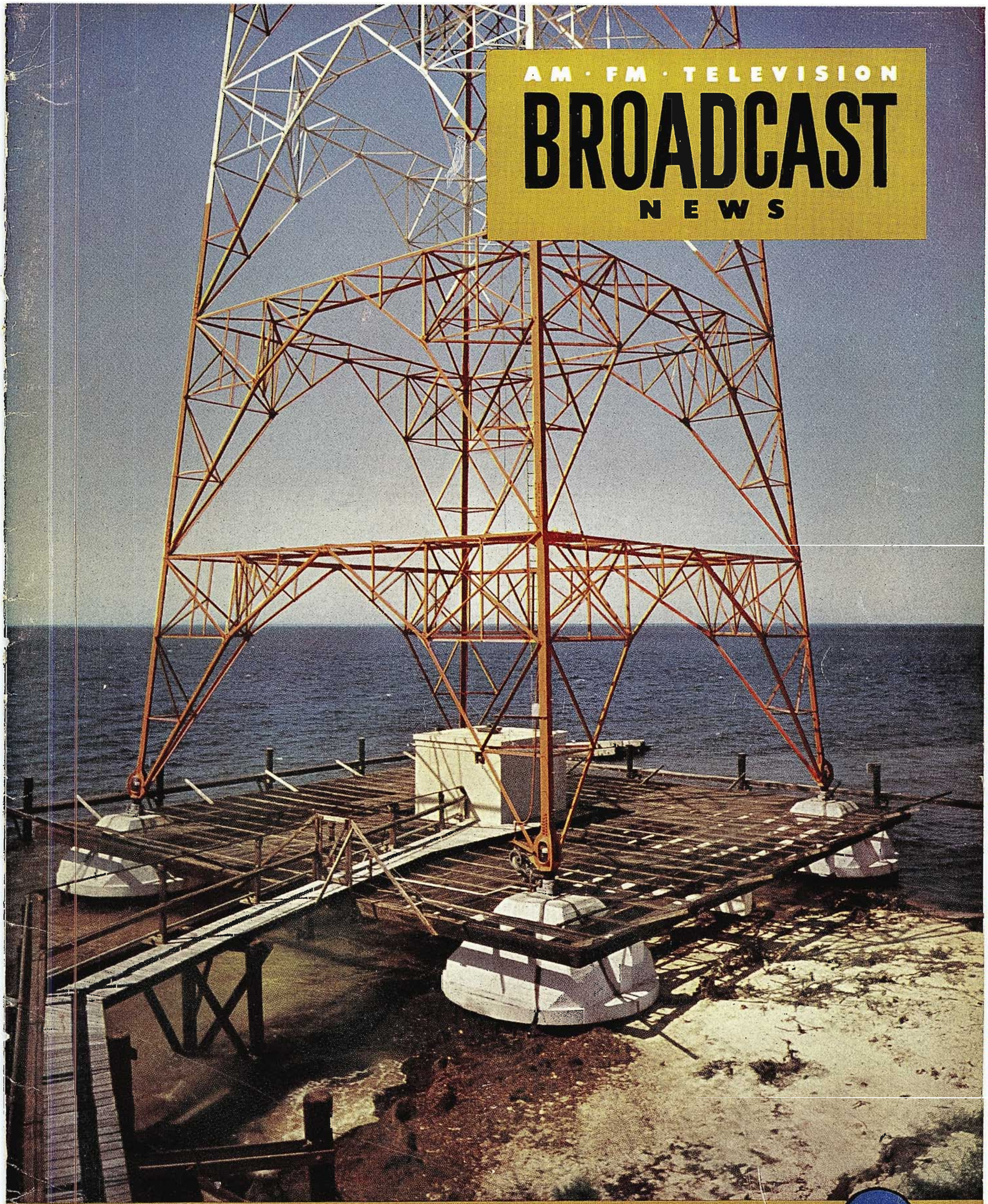
AM · FM · TELEVISION

BROADCAST NEWS

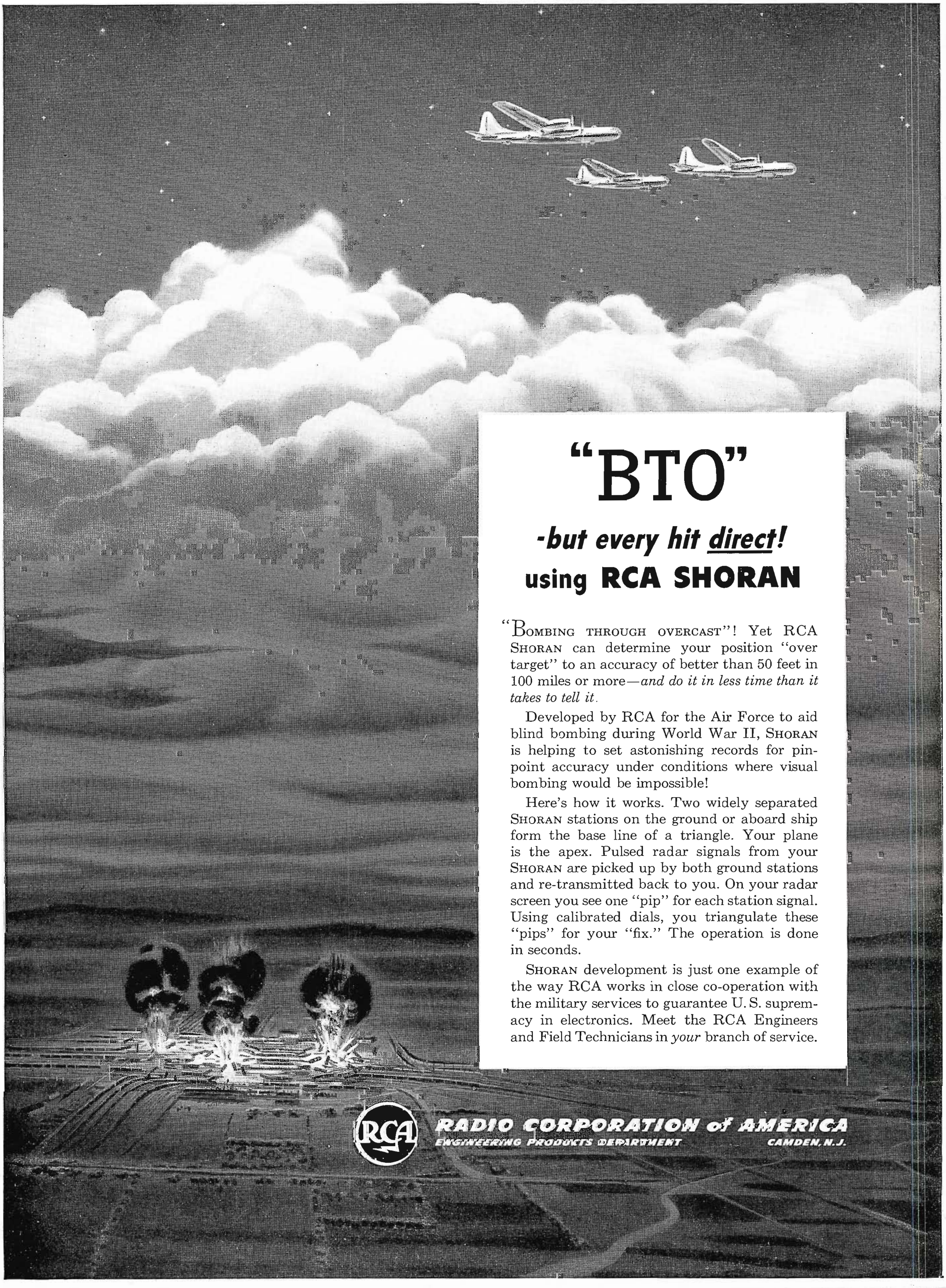


Towers and Tides . . . Pg. 12

Vol. No. 70

July-Aug., 1952

RCA


"BTO"
-but every hit direct!
using RCA SHORAN
"Bombing through overcast"! Yet RCA Shoran can determine your position "over target" to an accuracy of better than 50 feet in 100 miles or more—and do it in less time than it takes to tell it.
Developed by RCA for the Air Force to aid blind bombing during World War II, Shoran is helping to set astonishing records for pin-point accuracy under conditions where visual bombing would be impossible!
Here's how it works. Two widely separated Shoran stations on the ground or aboard ship form the base line of a triangle. Your plane is the apex. Pulsed radar signals from your Shoran are picked up by both ground stations and re-transmitted back to you. On your radar screen you see one "pip" for each station signal. Using calibrated dials, you triangulate these "pips" for your "fix." The operation is done in seconds.
Shoran development is just one example of the way RCA works in close co-operation with the military services to guarantee U.S. supremacy in electronics. Meet the RCA Engineers and Field Technicians in your branch of service.
RCA
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Broadcast News

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• • •

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M. L. GASKILL, E. C. MASON, Associate Editors

Contents

OUR COVER this issue shows the north tower ground system at WSUN. This very interesting installation is described in detail in the article starting on Pg. 8.

The cover picture is reproduced from a color photograph made especially for BROADCAST NEWS by the internationally famous photographer Charles J. Belden.

FOUR FIRSTS have been scored since our last issue. They were scored by TV stations who made unusual efforts not just to set records or to meet special dates, but rather because these stations really wanted to get "on-the-air" and get going with commercial TV operation. They are symbolic of a whole industry which for four years has been in a straightjacket that precluded even taking a large breath—much less the expansion it was so obviously ready for. Now that the log-jam is broken, new stations, but few (if any) new "firsts", will be popping almost every week.

We're sort of proud of the fact that all four of these stations are RCA equipped. We even immodestly admit to having had some part in their getting on the air so quickly. The stations, of course, had to do the major share of the work but RCA engineers, factory, shipping department and the RCA Service Company all helped somewhere along the way. It was a sporting challenge, and everyone who took part in the endeavor got a little fun out of it.

We're almost hesitant to list these "firsts"; however, to date, here is TV's post-freeze list.

FIRST POST-FREEZE TV STATION in any category was KFEL-TV, Denver, which hit the air July 18, just 7 days after receiving the first post-freeze construction permit. They went on the air with an RCA TT-500A Transmitter (500 watts), have already changed to an RCA 2 kw, will go to 10 kw the first of the year. Story of this installation is told on Pg. 34.

FIRST HIGH-POWER STATION, meaning transmitter power substantially greater than 5 kw, was WSAZ-TV, Huntington, which began operation with its RCA 20 kw Amplifier on August 4. The installation at WSAZ-TV is described in the article beginning on Pg. 13, by Leroy Kilpatrick, who planned and supervised the job.

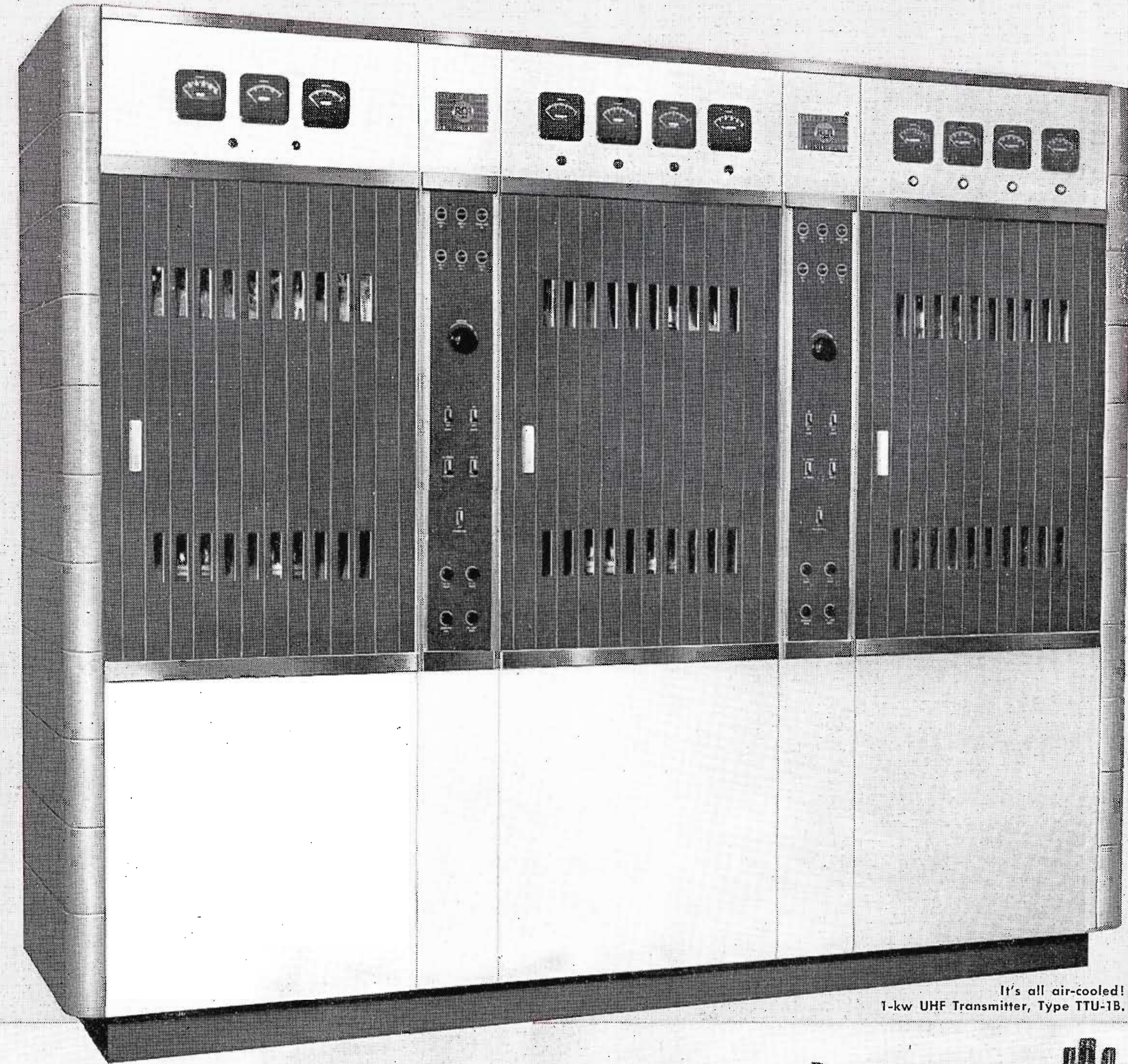
FIRST UHF TV STATION, that is, first commercial station, was KPTV, Portland, which went on the air on Channel 27, September 18th with test pattern, and on September 20th with program. Transmitter is the RCA TTU-1A from Bridgeport. Antenna is an RCA TFU-21BL from new production. Results at Portland have been surprisingly good. We'll have a complete report in our next issue. Meantime those wishing "preprints" of this report can get it by writing the editor.

FIRST HIGH-BAND VHF STATION since the freeze is KBTV, Denver which took the air with an RCA TT-2AH transmitter on October 12. Joe Herold, recently with us in a consulting capacity, is Manager of KBTV. He's "mighty busy" these days but we hope to have a story from him for the next issue.

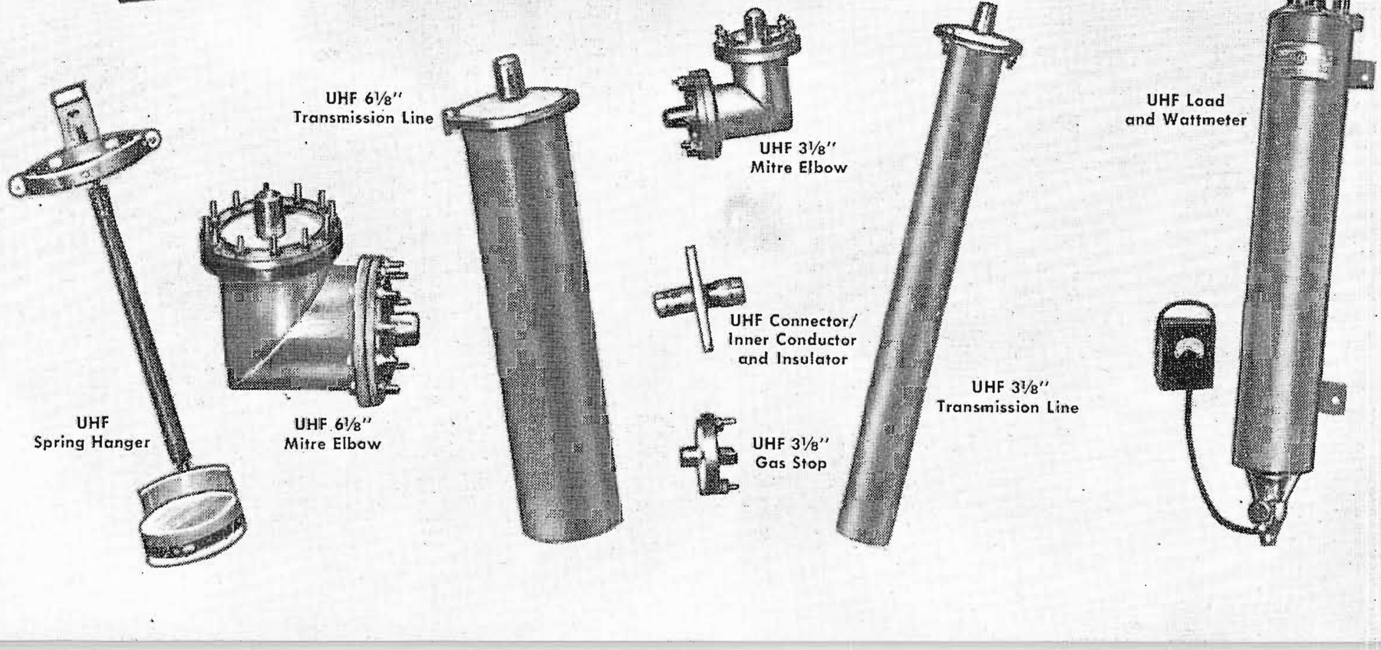
WE'RE LATE AGAIN with this issue. And we've exhausted all possible alibis—so we'll skip the reasons. In fact, we would skip the whole matter except that then we would get a lot of letters saying "how come we received the July-August issue in November". So sorry, so sorry, since we printed the cover back in August (it must have been the heat). But the last copy didn't go to the printer 'til October 15th. So the material herein is not as out of date as the cover would have you believe.

SUBSCRIBERS, of course, will eventually get the twelve copies they paid for—whether or not we get all six promised issues out this year.

Complete "Package"

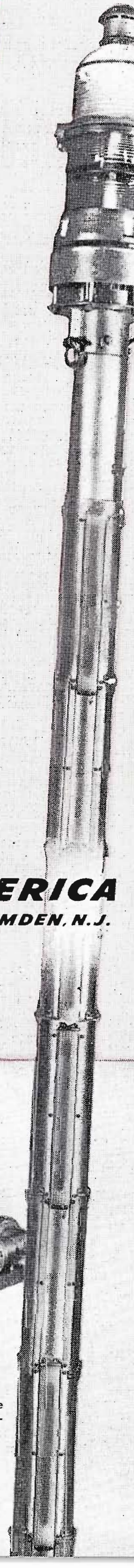


It's all air-cooled!
1-kw UHF Transmitter, Type TTU-1B.



for UHF

Transmitter Plants



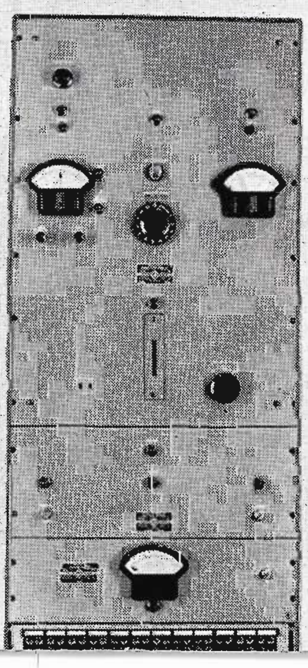
WITH THE UHF EQUIPMENT and accessories illustrated here, you can build a 1-kw UHF plant capable of delivering up to 20 kw, ERP. RCA has the transmitter. RCA has the antenna. RCA has the indispensable accessories needed to complete the installation—transmission line, mitred elbows, line transformers, spring hangers, dummy loads, wattmeters, frequency and modulation monitors, filterplexers, etc. In short, everything—from ONE responsible manufacturer!

What about a power increase later? The 1-kw transmitter can be used to drive an RCA 10-kw high-power amplifier.

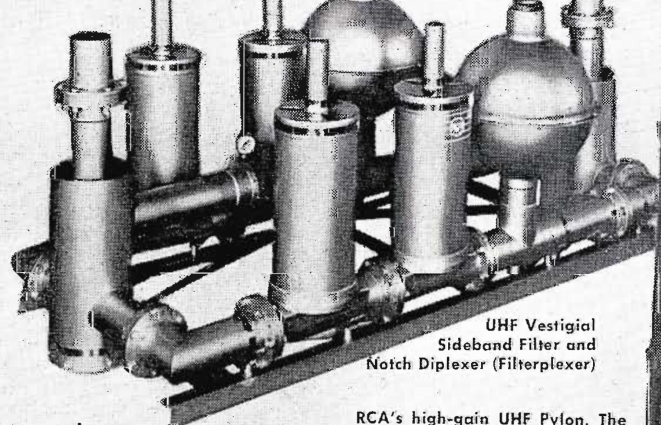
Like this 1-kw package, RCA has UHF combinations to meet power requirements—up to 1000 kw! Your RCA Broadcast Sales Representative can tell you what you'll need for the power you use—show you a practical plan for a minimum outlay. Call him today.

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

EVERY TECHNICAL ACCESSORY FOR A UHF TRANSMITTER PLANT

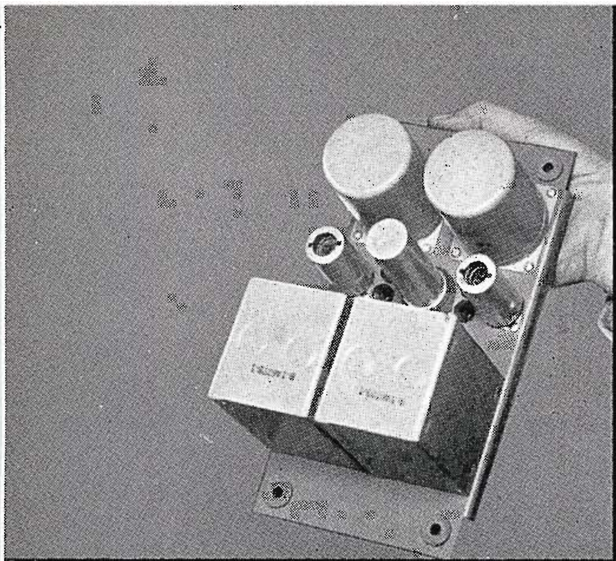


UHF Frequency and Modulation Monitors

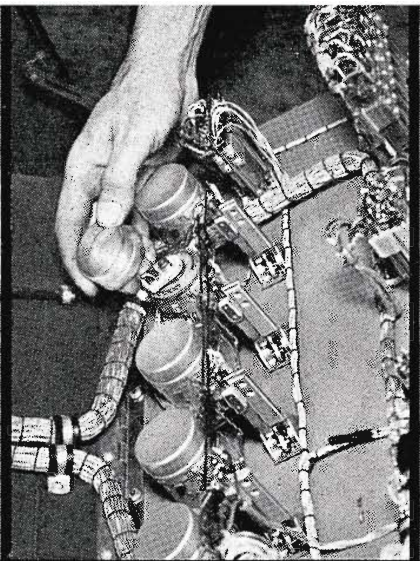


UHF Vestigial Sideband Filter and Notch Diplexer (Filterplexer)

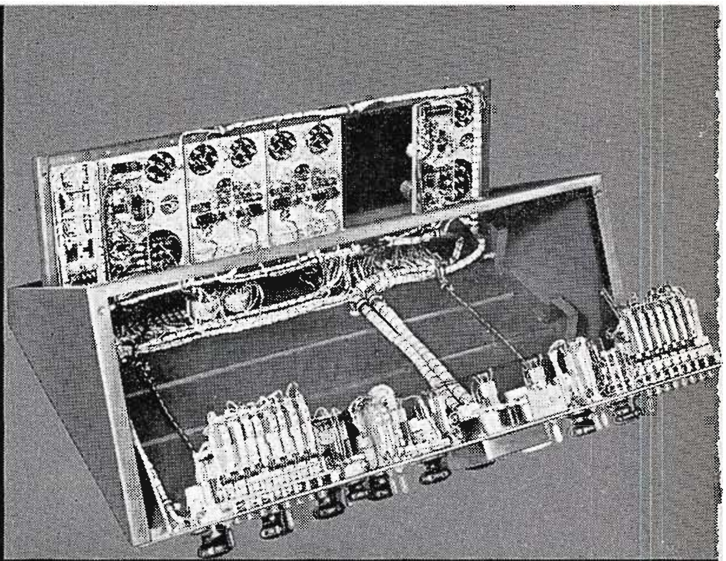
RCA's high-gain UHF Pylon. The most economical way known to produce high ERP.



New compact amplifiers—use low-noise, long-life, miniature tubes.



Every component is easy to get at for inspection and maintenance.



Accessibility, plus! New hinged control panel swings down; amplifier frame swings up.

9 EXTRA FEATURES of the

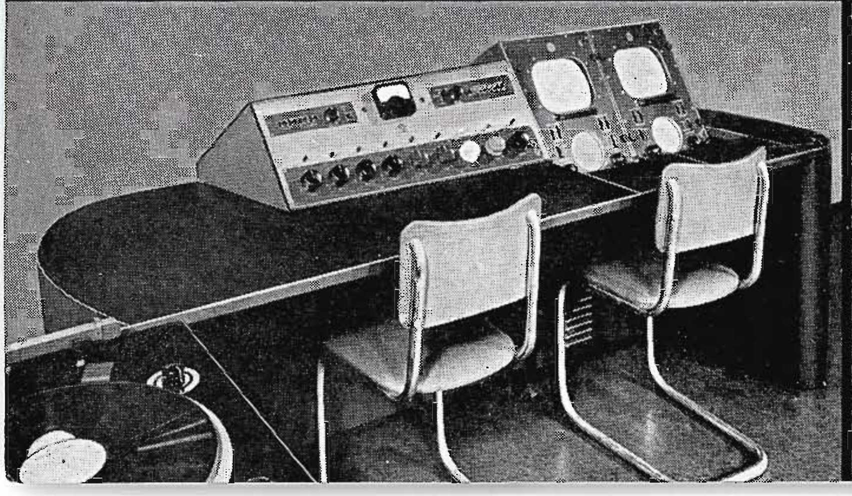
THE EASY WAY the BC-2B Consolette handles is due in great measure to the careful attention RCA engineers have given to construction details—and to a number of unique operating features (not found in their entirety in any standard consolette). Some of these advantages are pictured on these pages.

For example, see how easy it is to get at the amplifiers and components. Note how every inch of wiring can be reached without disturbing the installation. See how the consolette fits snugly into the control room—unobtrusively. See how the styling matches other RCA audio and video equipments.

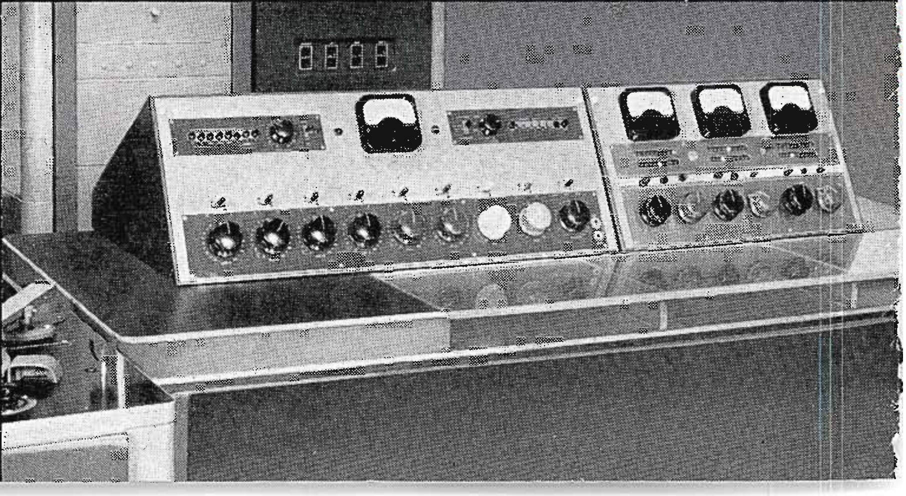
Based on more than 25 years of experience in building studio consolettes, type BC-2B is in our opinion a high point in consolette design. The instrument includes all essential elements needed by most AM-FM and TV stations. And every feature has been operation-proved—many in RCA deluxe custom-built equipment. *Type BC-2B is available at a "package" price!*

For details, call your RCA Broadcast Sales Representative.

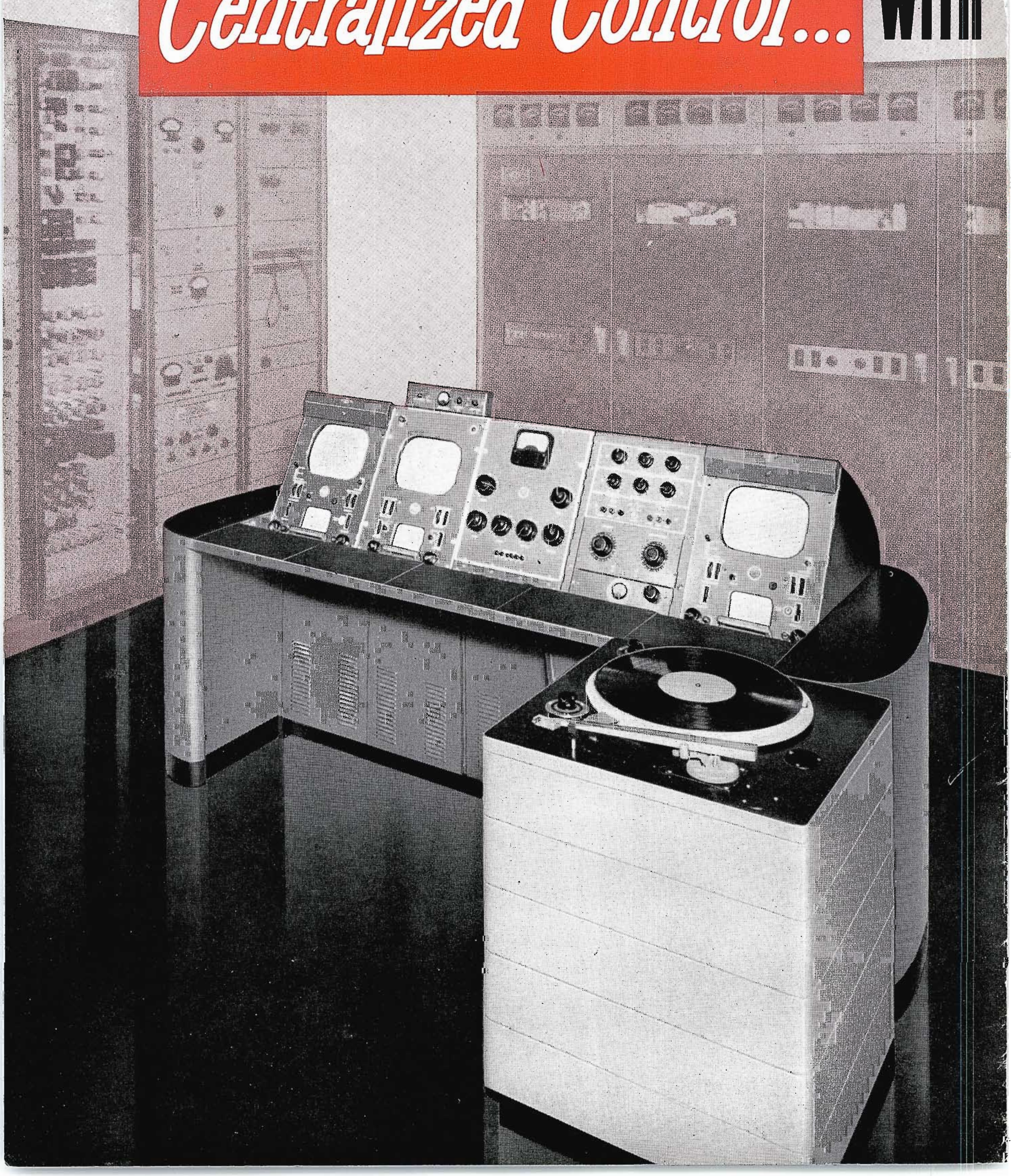
Type BC-2B is styled to match RCA video equipment—like this familiar video console.



. . . and it's styled to match other RCA audio equipment, too —like this master switcher, for instance.

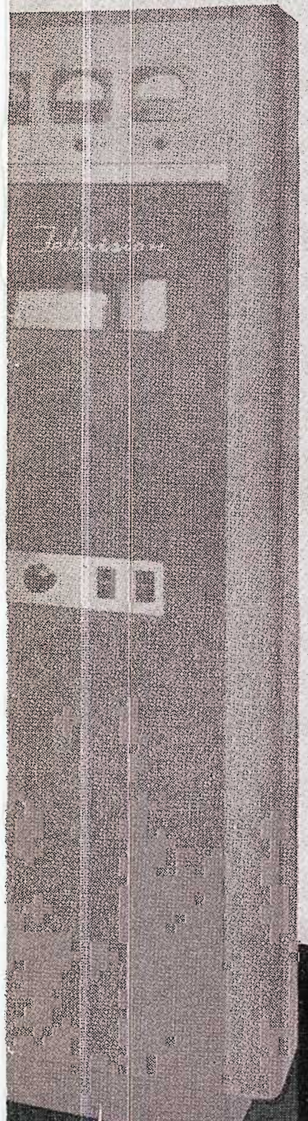


Centralized Control... with



"tailored" switching and monitoring

TC-4A Control Console combines Audio-Video Switching with Transmitter Control—makes it possible to centralize all operations at one position



Now you can do all (or any desired part) of your audio-video switching *right in your transmitter room . . .*

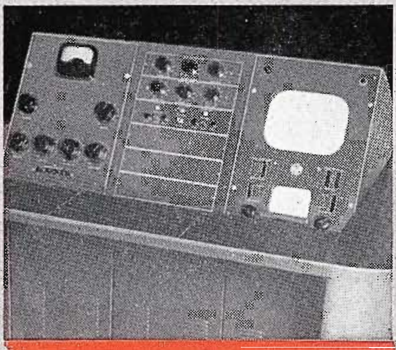
And you do not have to take a fixed group of units to do it. You can have whatever group of audio and video facilities you need to fit your particular requirements. Moreover, you can add further audio and video facilities as needed.

You get this economy and flexibility by building your equipment layout around the new TC-4A Control Console. The TC-4A is a two-section unit containing basic switching facilities for handling up to 8 audio and 8 video signals (remote or local). It can fade to black and "program-switch" network, remote, film, and local studio signals. Up to twelve signals can be monitored including transmitter operation.

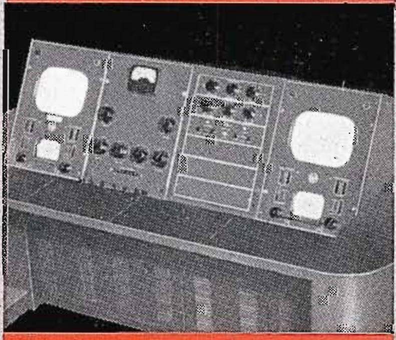
To this two-section unit you can add as many console sections (for "on-air" monitor, preview monitor, individual camera monitors) as you need to take care of your individual requirements. In this way you can build up a "centralized" control position from which one man can (if necessary) perform all operations.

Moreover, you do all of this with standard RCA units exactly like those used by the largest stations and the networks. Thus, if you decide later to expand to a multiple studio layout you can very easily rearrange these same units for that type of setup.

Remember . . . in TV it's good business to buy the best to begin with.

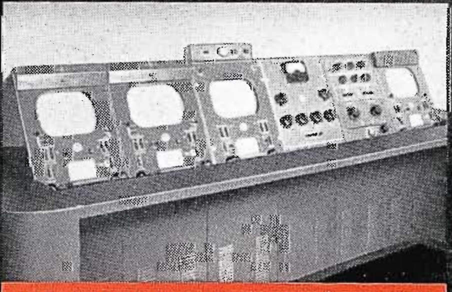


The basic TC-4A (left-hand and center sections) with a master monitor (right-hand section) as normally used at the transmitter (i.e., no video origination at this location).

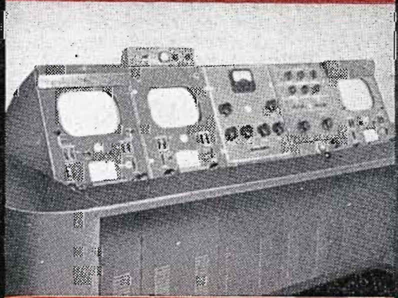


The same setup with a film camera control unit added (at the left) for programming of slides and films from the transmitter—or for small stations without "live" studios.

TC-4A Control Console (3rd and 4th units from left) combined with three monitor sections to provide complete station operating control from a position in the transmitter room. In this arrangement the first unit of the console (starting from the left) is the "live" camera control and monitor, the second is a film camera control, the third unit contains audio faders and audio and video switching, the fourth unit contains monitor switching and remotely located equipment controls, the fifth unit is the line master monitor. Audio and video amplifiers, power supplies, etc., are mounted on the racks at left (shown shaded). The transmitter in the background is the Type TT-2A 2 kw, VHF TV Transmitter. However, the same arrangement of controls and audio-video facilities can, of course, be used with any RCA TV transmitter, UHF or VHF, 500 watts to 50,000 watts (providing ERP's of 1 kw to 1000 kw).



TC-4A with master monitor unit, preview monitor unit, and two camera control units (one live and one film or two film). If desired, sections can be arranged U-shape or L-shape to fit available space.



Similar setup with two camera control units (one live and one film, or two film), such as used in the RCA "Basic Buy" for TV.

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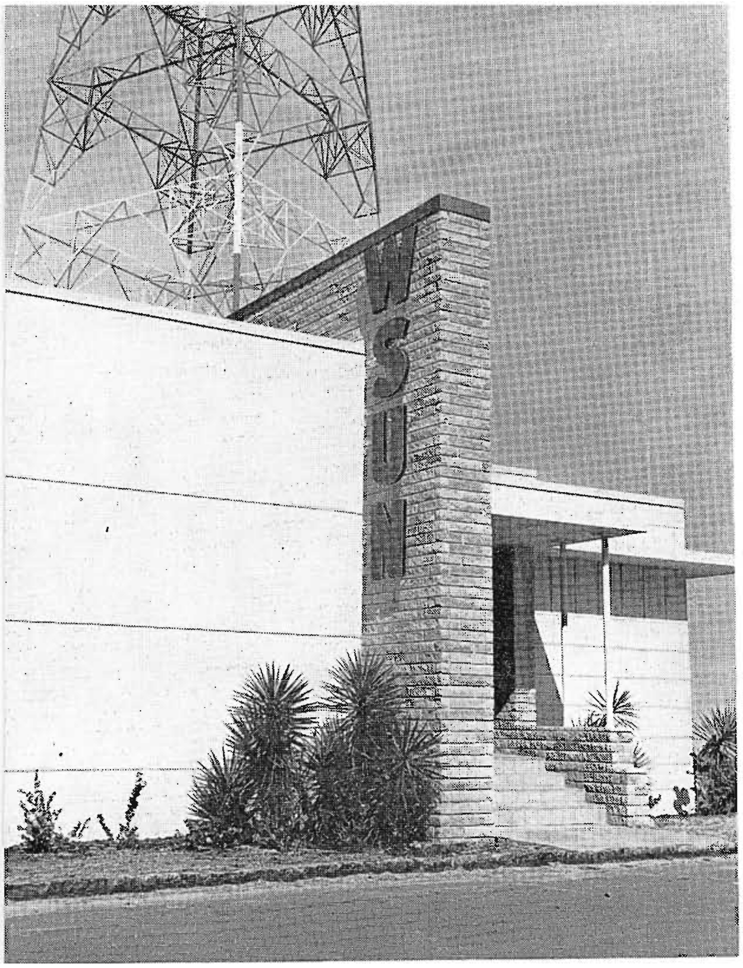


FIG. 1. Entrance to the WSUN transmitter building, with the northwest tower rising in the background.

NEW AM TRANSMITTER AND TOWERS AT WSUN

ST. PETERSBURG, FLORIDA

by MAURICE F. HAYES

In its twenty-fifth year of broadcasting, Radio Station WSUN has increased its coverage 50 per cent in the richest market area of Florida without increasing power. This was accomplished by installing an RCA BTA-5F 5-KW transmitter and two new 500-foot Blaw-Knox self-supporting towers at a new transmitter site more than a mile out in Tampa Bay.

Municipally Owned and Operated

WSUN is owned and operated by the City of St. Petersburg on the Florida West Coast—one of the few municipally owned and operated stations in the country.

Completion of the new transmitter and towers was the culmination of intense planning and effort under Ross E. Windom, Manager of the City of St. Petersburg, and George D. Robinson, Manager of WSUN. Robinson, known as "Major" to listeners up and down the Florida West Coast, has been connected with WSUN since 1935, and station manager since November of 1948.

Chief Engineer of WSUN since 1927 is Louis J. Link, under whose direction plans and requirements of the new transmitter installation were co-ordinated. The directional antenna system was designed by James C. McNary, Consultant. Construction of the transmitter building was done by the Construction Division of the City of St. Petersburg, under the direction of Paul C. Jorgensen, City Engineer, who also designed foundations for the towers. Erection of the two 500-foot Blaw-Knox self-supporting towers and construction of the tower foundations was done by the White Construction Company of St. Petersburg.

Chief Engineer, Louis J. Link, who was responsible for planning and directing the new WSUN installation.

WSUN began broadcasting in October of 1927. For the first thirteen years time was shared with station WFLA, using the same transmitter but operating from separate studios and business offices. The two stations alternated on week-days and shared time equally on Sundays. Air-time during the first year was four hours daily. This was increased to eight hours in the second year, continuing until May 17, 1930, when WSUN joined NBC, and air time was increased to 17½ hours daily. WSUN went to full-time operation, 7 days a week, January 23, 1941 . . . with continued operation from Bayview.

First Directional Antenna in U. S.

In May, 1930, WSUN moved from downtown Clearwater to Bayview, on Tampa Bay, with a new 5-KW installation which included a two-element directional antenna system designed by Raymond Wilmotte. This was the first directional antenna system to be used by a commercial broadcasting station in the United States. With the Bayview installation, WSUN began operation on 620 kc . . . and since that time 620 kc has become synonymous with solid coverage in Florida.

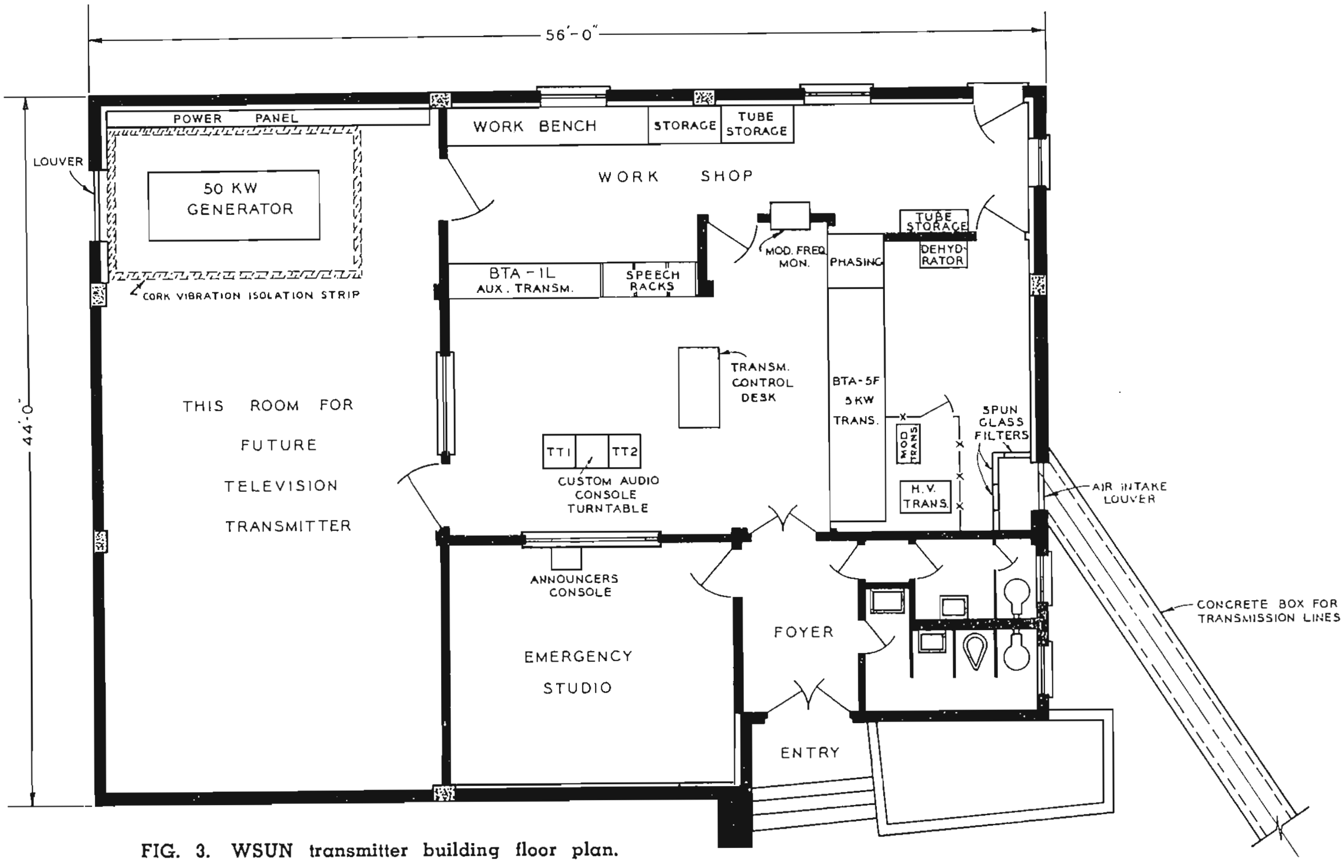


FIG. 3. WSUN transmitter building floor plan.

Original Transmitter in Smithsonian Institute

The original WSUN transmitter is now a permanent exhibit in the Smithsonian Institute in Washington.

New Transmitter Dedicated by Don McNeill

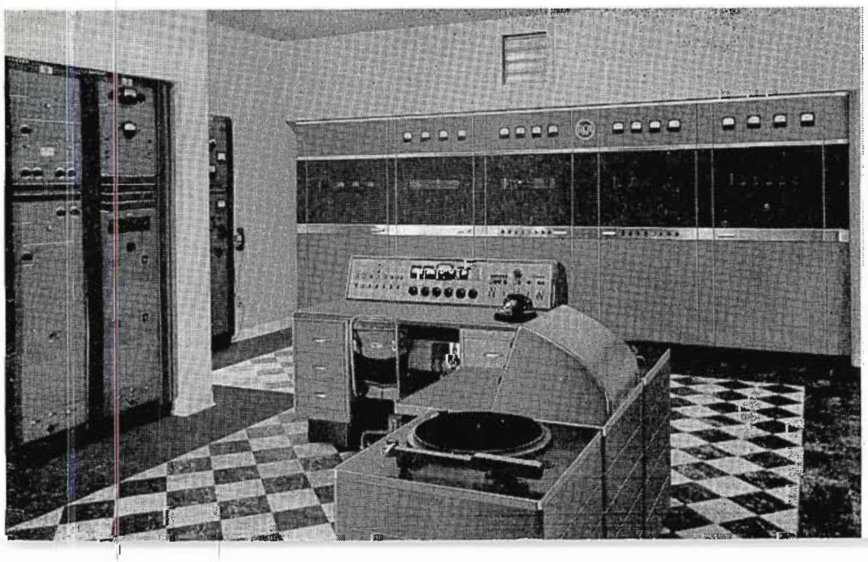
WSUN continued transmitter operation at Bayview until the move was made to the new transmitter installation near the end of the land-fill leading to Gandy Bridge which extends nearly three miles into Tampa Bay. The official dedication of the new installation was made January 22, 1952, by Don McNeill on the "Breakfast Club", an ABC network program which originated in St. Petersburg that day.

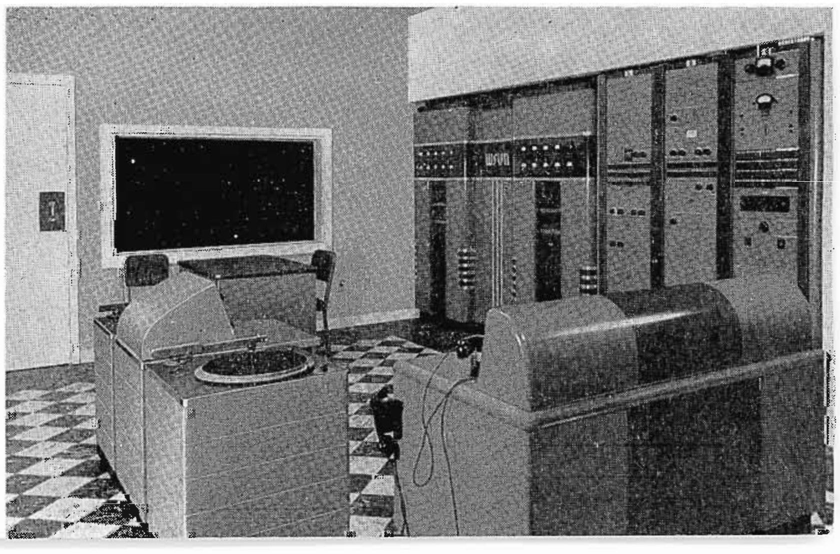
Transmitter Building Planned for TV

The two 500-foot Blaw-Knox towers straddle the highway leading across Gandy Bridge—midway between St. Petersburg and Tampa. The transmitter building is about 100 feet from the highway. It is 44 by 58 feet . . . with height above floor level about 17 feet. Rooms have 10-foot ceilings. The floors and flat roof are of reinforced concrete slab construction. The walls are concrete block, with four-foot attic and five-foot basement. All wiring between equipment and lighting circuits is run in galvanized conduit under the floor and through the attic. All conduit connections in and out of boxes use special ground lugs to insure solid ground back to the power panel, which in turn is connected through a copper bus to station ground. All reinforcing rods and structural steel are welded together and tied into the station ground. Metal plaster lath on all interior

FIG. 4. Transmitter control room showing RCA 5-KW BTA-5F. Phasing equipment in left cubicle. Transmitter control desk, turntables and special audio console in center foreground.

FIG. 5. Transmitter control room showing 1-KW auxiliary transmitter; speech racks and transmitter control desk. At left center, custom-built studio console with two 70-C turntables.





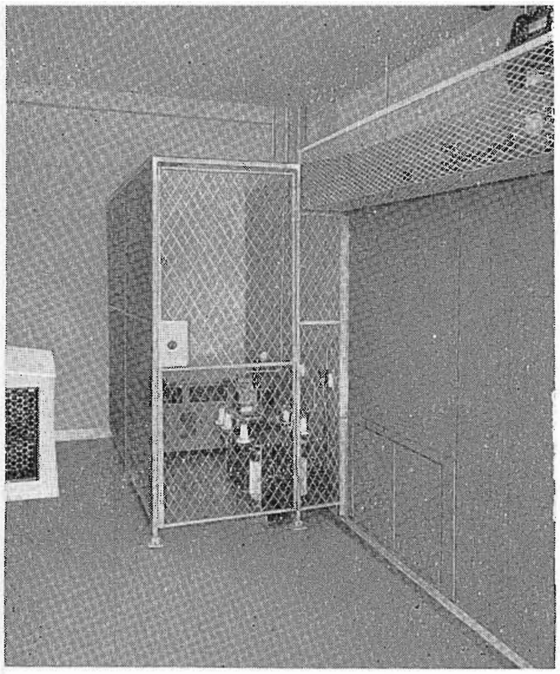


FIG. 6. Rear of transmitter enclosure showing metal guard for high-voltage bus, and inter-lock fence for plate and modulation transformers. Spun glass filters provide air intake through external louvres. Door to this room not interlocked, permits inspection during operation.

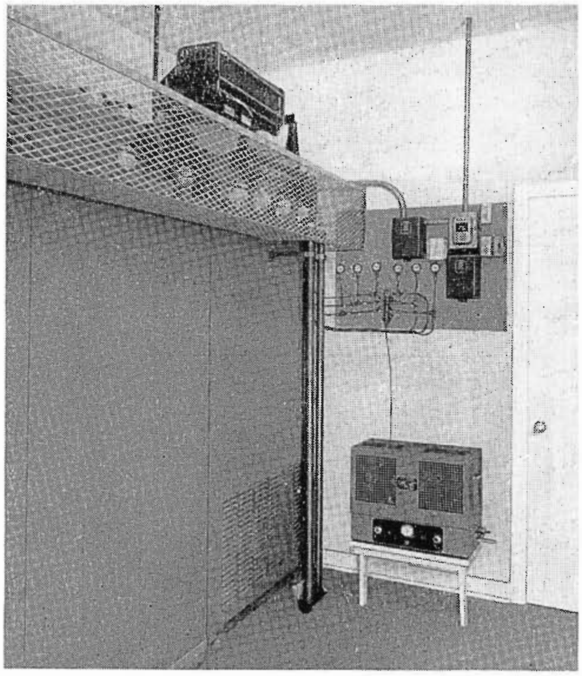


FIG. 7. Duplicate transmission lines to south tower from transmitter building interior. Also dehydrator and pressure gauges for co-ax lines. Note expanded metal cage around high-voltage bus. Dummy antenna load is shown in upper center.

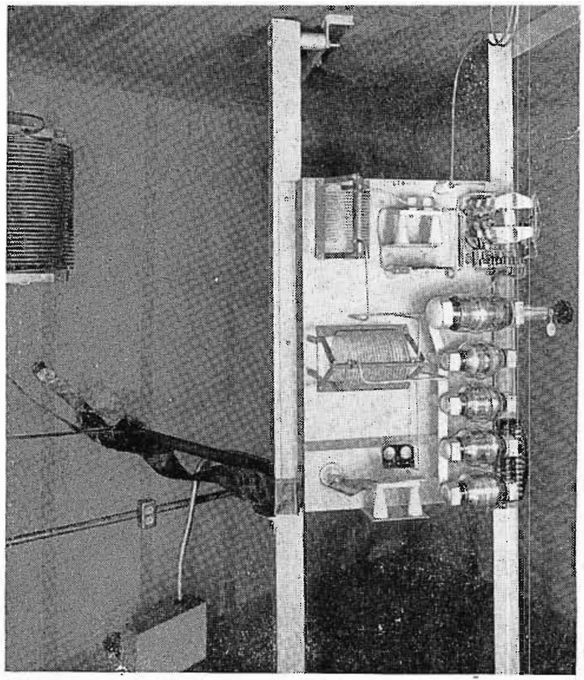


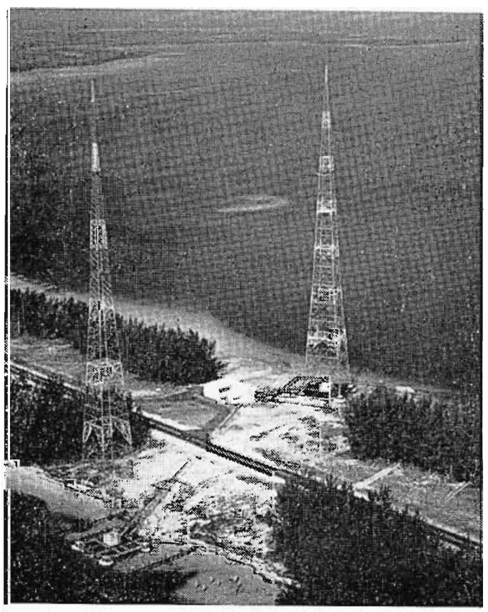
FIG. 8. View of north tower tuning house showing antenna tuning arrangement. Note furring strips bearing copper shielding screen on the walls and ceiling. Isolation coil may be seen at upper left.

walls is also welded together and tied into the station ground. In addition, the studio at the transmitter is double shielded with copper screen. This was done in anticipation of the installation of television equipment in the same building with AM equipment—and the probable use of TV cameras in the studio.

Behind the BTA-5F is a room eight feet wide, which acts to some extent as a plenum chamber. In this room are the modulation and plate transformers, as well as the dehydrator for the co-ax line. The door to this room is not interlocked. The high voltage bus behind the transmitter is protected by an expanded metal guard—with both transformers behind an interlocked fence. Louvres are provided in the outer wall for air intake, drawn through spun-glass filters. Transformers are so arranged that air is drawn across both. With the door not interlocked, and high voltage equipment behind a fence, inspection is easily accomplished at all times.

Installation includes a BTA-5F 5-KW and a BTA-1L 1-KW transmitter as auxiliary. Audio amplifiers, modulation and frequency monitors and other equipment are mounted in four racks. A special custom-built audio console and two 70-D turntables are provided for the studio. Microphones and cue speaker in studio are relay-controlled by a small announcer's console in studio. This same system is carried through in the main WSUN studios on the Municipal Pier in St. Petersburg. The entire transmitter building foundation rests on 28-foot 12-inch wooden pilings driven on 10-foot centers. Foundation footings are re-enforced-steel concrete and tied into these pilings. Transmitter installation includes a 50-KW auxiliary power generator. The 50-KW auxiliary generator rests on a separate foundation which is isolated from adjacent floor by a 4-inch cork vibration isolation strip. With this power plant, plus

FIG. 9. Aerial view showing complete WSUN tower-transmitter layout. Two 500-foot towers straddle over-water highway connecting St. Petersburg and Tampa.



the 1-KW transmitter, duplicate telephone lines from studio to transmitter in different cables, and with duplicate audio equipment—the chances for time "off-air" are reduced to the barest minimum.

The BTA-5F incorporates a provision for automatically reducing power to 1 KW should any transmitter fault continue. When this occurs the 1-KW auxiliary transmitter starts automatically. Both the studio and transmitter control room are acoustically treated.

The phasing cabinet is mounted to the left and in line with the front of the BTA-5F. In addition to the usual tuning controls on the front panel, there also are mounted the push-buttons for relay switching to day or night pattern, as well as switching from main to auxiliary transmitters. Push-button switching is provided to permit alternate use of duplicate transmission lines to south tower. A dummy load is provided and the transmitter switching is so arranged that with one transmitter connected to the antenna, the other is automatically connected to the dummy load.

The Antenna System

The new antenna system's two 500-foot Blaw-Knox self-supporting towers are spaced 565 feet apart. As noted in the

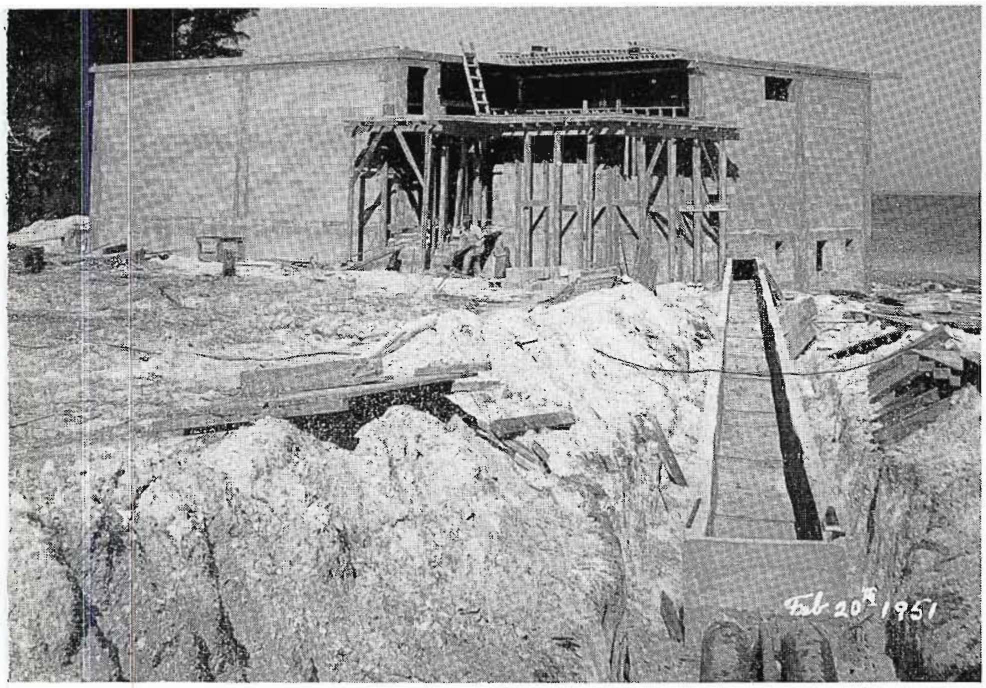


FIG. 10. Construction of WSUN transmitter building, from roadway between towers. Note pre-fabricated hollow concrete roof-joists, and, in foreground, cast-iron conduit and concrete trough for southeast tower lines leading to basement.

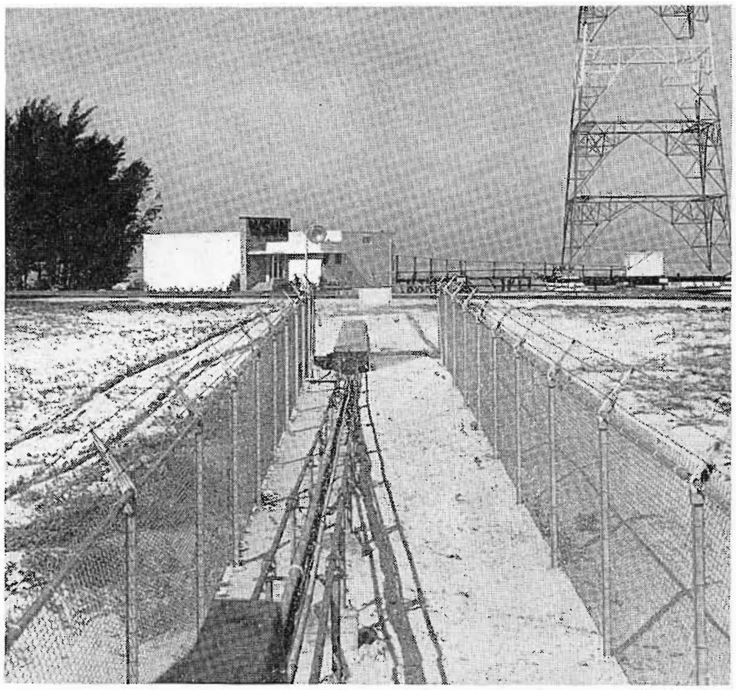
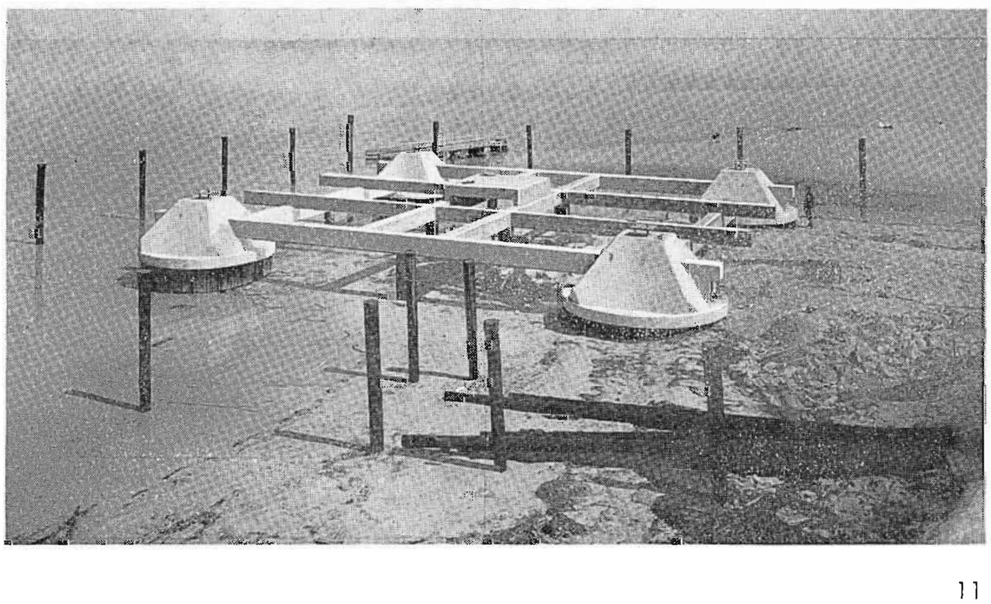


FIG. 11. WSUN transmitter building and northwest tower. In foreground, fence-enclosed duplicate south tower lines rising on roller-supports from concrete trough leading to tuning house.

accompanying photograph, both towers are set in the water—one on each side of the highway leading across Gandy Bridge. The actual location being about one and a quarter miles out in the open waters of Tampa Bay, permits an ideal ground system. This, of course, was an important reason for choosing this site. The southeast tower alone is used for daytime operation with the northwest tower floating. The northwest tower is cut in at night to form a directional pattern. The northwest tower, located near the transmitter building, will also support a TV antenna. The top section is so fabricated that the elements of a Super Gain TV antenna for channels 7 through 13 may be attached, with orientation such that a directional pattern may be obtained. A special platform is built on the northwest tower at a 300-foot level for mounting a "dish" antenna for studio-transmitter microwave TV relay. Both towers are fed with a 1⅝-inch co-ax line. A walkway on piling leading from the transmitter building supports the co-ax feed line to the northwest tower. The co-ax line to the southeast tower is in duplicate, with line switching provisions located in the phasing cabinets. Lines to the southeast tower are led through a 30 x 30-inch concrete trough provided with a removable metal cover. Lines continue under the roadway through 8-inch cast iron pipes and into another concrete trough on the other side of the road. On the other side of the roadway the lines are enclosed by a high steel fence and supported on rollers on galvanized pipe set in concrete. As the lines leave the concrete trough they are gradually raised five feet to reach the ground screen beneath the tower. This bend is quite gradual, along a total length of 127 feet. Only one 90 degree bend is used in the entire line; located below the transmitter in the basement of the transmitter building. The northwest line has only one 45 degree bend in its entire length. The tuning houses at both towers are ample in size—10' x 10' x 7' high.

Line terminating units are of the open panel type mounting, located near center of tuning houses. Tower feed leaves through a bowl insulator in the roof center. Half inch copper tubing was used to feed all four tower legs. Sampling loops for phase and night remote antenna current reading are located on towers about 100 feet above insulators. Isolation coils are installed in the tuning houses of each tower, behind the antenna tuning panels. DC arc protection is provided to kill the transmitter on heavy lightning hits.

FIG. 12. Foundations for northwest WSUN tower, tied together with reinforced concrete beams —supporting center foundation for tuning house. Note outrigger pilings for ground screen.



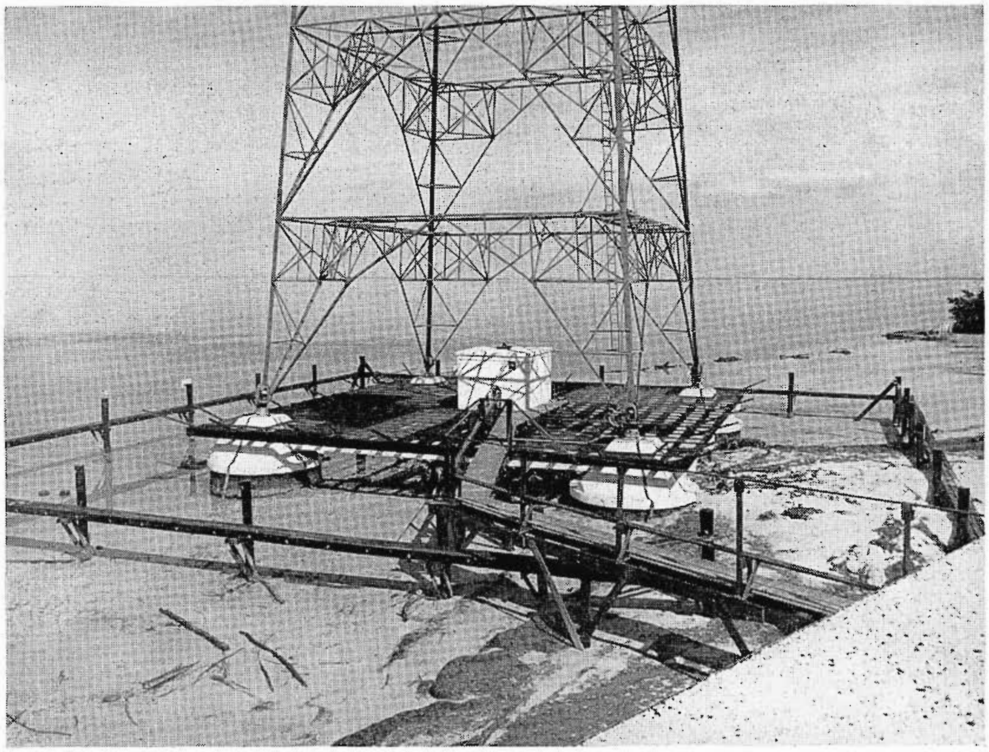


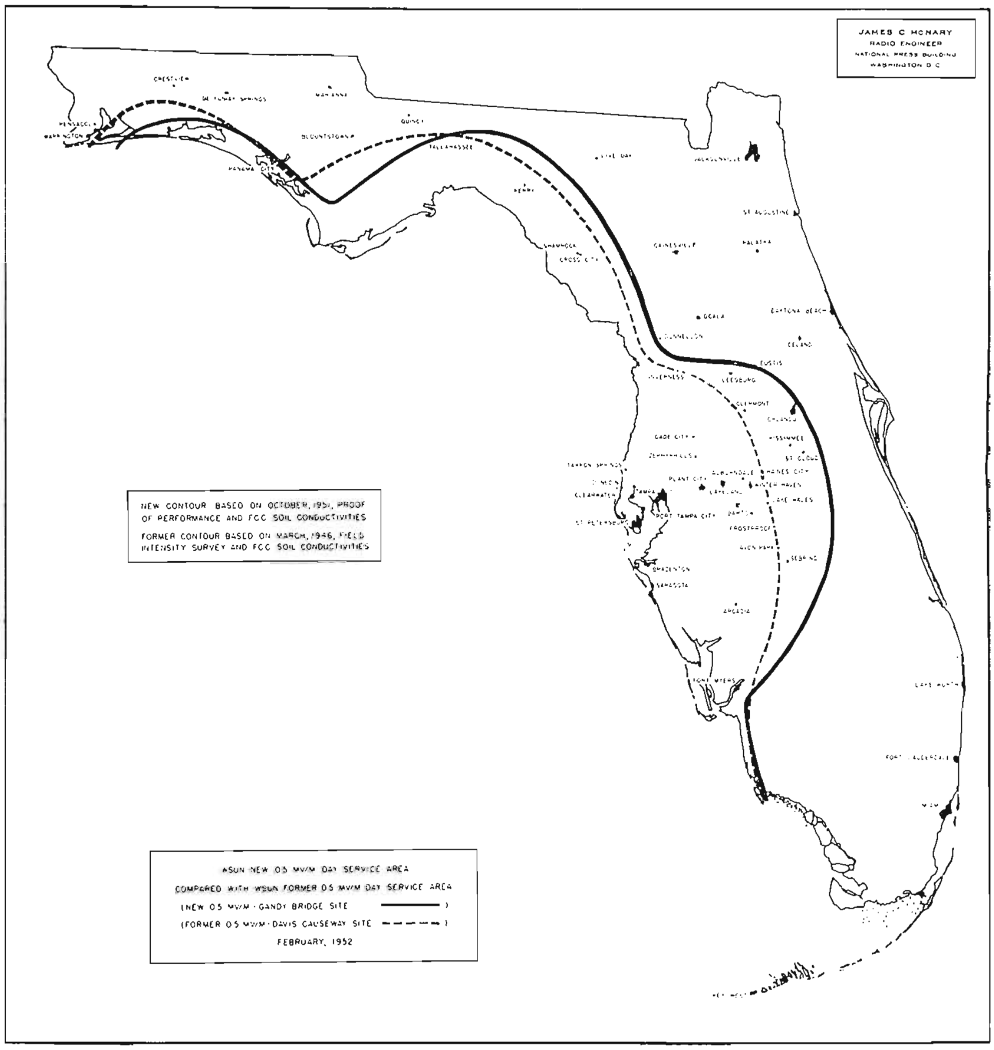
FIG. 13. Northwest WSUN tower from roof of transmitter building, showing details of heavy timber grid resting on concrete beams supported by foundations . . . outrigger pilings for ground screen. Also catwalk leading to transmitter building.

Towers and Tides

The foundation for the tower legs are tied together by a grid of reinforced concrete beams, which in turn support the tuning houses. This grid of concrete beams also supports a transverse grid of 3″ x 12″ creasoted timbers on 3-foot centers upon which the ground screen is laid. The ground system under the towers is about 10 feet above mean sea level. (Refer to front cover for view of tower base and ground system. This height was selected after extensive research on tides in Tampa Bay. Extra precautions were necessary because of the exposed location, and the possibility of high tides during stormy weather. It will be noted in Fig. 13 that an extensive outrigger was built around each tower. This was designed to stabilize the ground, since the rise and fall of tides might affect the antenna system. The outrigger consists of piling set on 20-foot centers, 35 feet outside and parallel to each of the four sides of the towers. A ⅜-inch copper wire run through eye-bolts on these pilings level with the timber grid is outer support of 120 radial wires connected to a bonding strip around each tuning house. Under each tower the ground screen was laid on these radials—silver brazed to the radials on 18-inch centers. All connections in the ground system are silver brazed. Radials run down each outrigger piling from the ⅜-inch outrigger wire and extend in a circle to a full 400 feet where possible. Along each side of the roadway passing between the two towers, the radials were cut off and silver brazed to 4-foot lengths of ⅝-inch copper ground rods driven 12 inches beneath the surface.

With the complete new installation of transmitter equipment and towers, plus the salt-water ground in the new site—field measurements prove WSUN has extended its .5 mv line by an average of 30 per cent to give 50 per cent better coverage of the thickly populated central area of Florida—one of the nation's fastest-growing retail market areas.

FIG. 14. .5 mv/m day service area contour for new installation versus former installation.



WSAZ IS *First* HIGH-POWER TV STATION

RCA Ships 25-KW Conversion Equipment For First Post-Freeze High-Power Installation

LEROY E. KILPATRICK
Chief Engineer, Station WSAZ-TV
Huntington, W. Va.

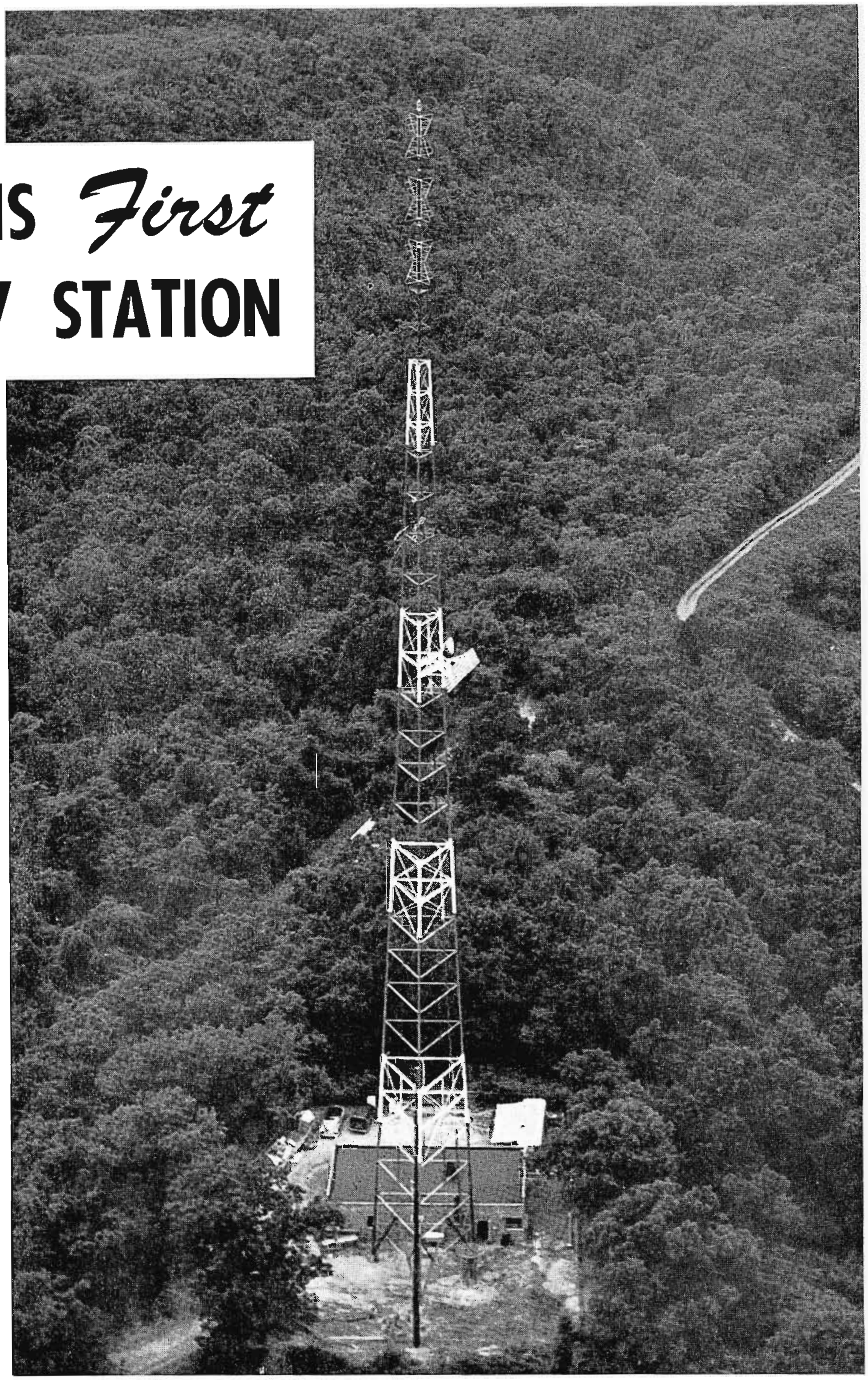


FIG. 1. WSAZ-TV tower with three-section Superturnstile for Channel 3.

The receipt and installation by WSAZ-TV of complete high power TV conversion equipment marked the beginning of a new era in post-freeze television. When operation began under full power on August 4, WSAZ-TV became the first post-freeze, commercial, high power television station for VHF.

WSAZ-TV had been previously serving the Huntington area on Channel 5, using a standard RCA TT-5A, 5-KW Transmitter. For some time, plans had been made for increased power, and application was filed for a construction permit on Channel 3. Granted a top priority rating, WSAZ-TV was one of 30 stations in the United States authorized to change channels as part of the FCC's schedule for post-freeze national expansion. The FCC plan envisages nearly 2000 TV stations in this country. Only 109 are operating to date.

The new conversion amplifier at WSAZ-TV makes it possible for people in the West Virginia-Kentucky-Ohio tri-state area to enjoy high quality television reception. The new equipment has increased by five times the station's former power. This means much clearer pictures in our present reception area, and greatly extended coverage even into parts of Tennessee and Virginia. Fringe areas particularly, have gained the benefits from this power expansion.

Shipment of Equipment

The WSAZ 25-KW Amplifier, television's most powerful broadcast equipment yet shipped for commercial use, left the RCA Victor plant in Camden by truck caravan. The equipment was shipped by a "Pony Express" truck of Service, Inc., and weighed approximately 7500 pounds. It consisted of aural and visual power amplifier and blower units, each weighing 1000 pounds; and aural and visual power supply and filter units, each of 1000 pounds. In addition, there were aural and visual control units, 900 pounds each; aural and visual transformers, each 800

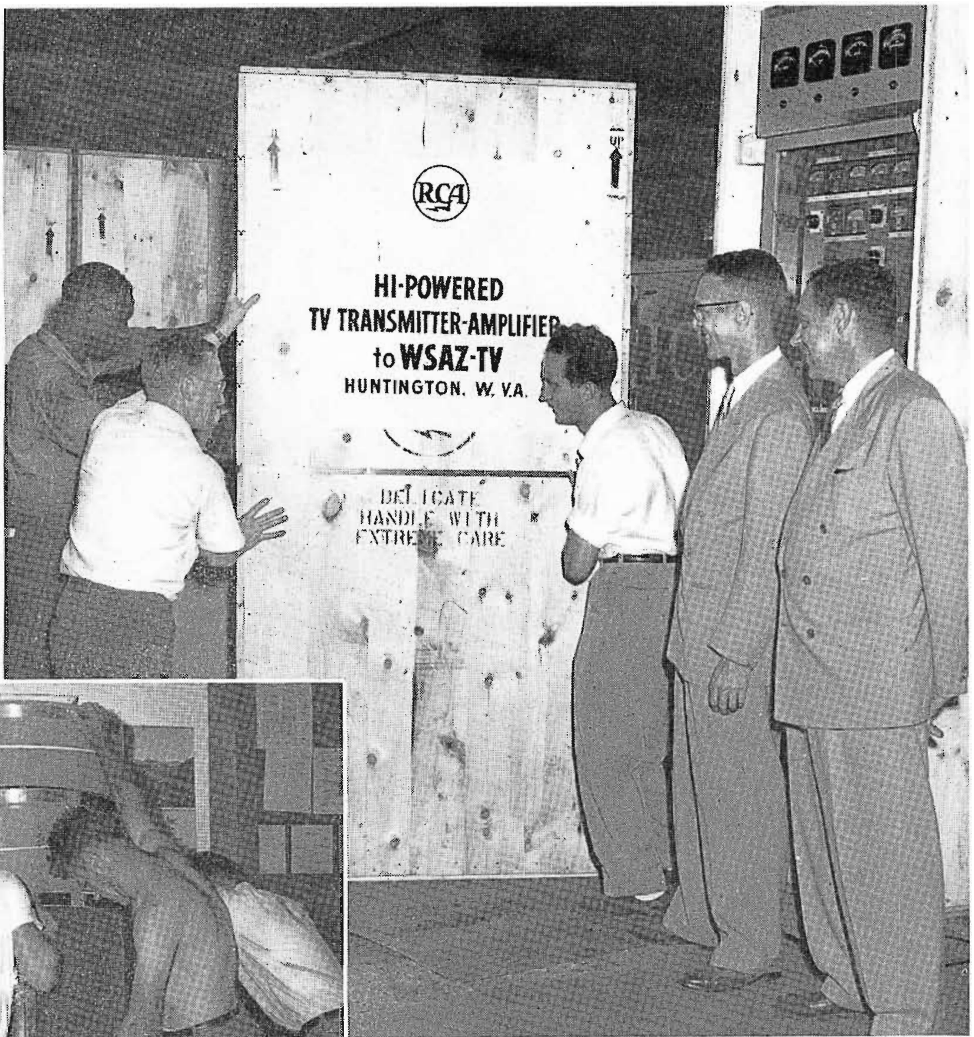


FIG. 2. Workmen handling TT-25AL Conversion Amplifier before its departure from Camden. Looking on with the author, Leroy E. Kilpatrick, Chief Engineer of WSAZ, is A. R. Hopkins (far right), General Sales Manager, Engineering Products Department.

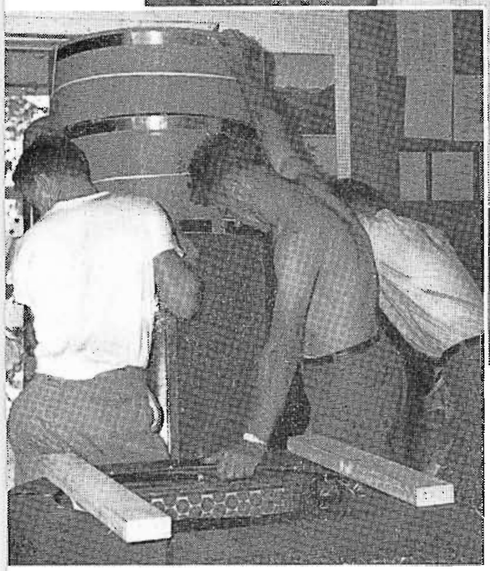


FIG. 3. Workmen lifting 25-KW Amplifier cavity onto base assembly (foreground).

pounds; a vestigial sideband filter; and tubes and accessories. A three-bay television bat-wing type antenna was also supplied in a separate shipment from the RCA Victor plant.

Planning the Transmitter Room Layout

During early planning stages, we were perplexed with the problem of inadequate space in our transmitter room. Due to the flexibility of the TT-25AL Conversion Equipment, we found that it could be easily located in front of our TT-5A Transmitter and at the ends, rather than the usual arrangement which will be used by most broadcasters with larger transmitter rooms. In these cases, the conversion amplifier equipment would be located at the rear, with power and control cabinets at each end, in line with the transmitter.

In our final arrangement of equipment, we employed a horseshoe layout with all equipment in the front. Planning had indicated that our problem of spacing would not be entirely eliminated although it would be greatly improved. This was found true after installation, and the layout flexibility in the equipment has provided all that we anticipated. The final location of the TT-5A Transmitter, Conversion Equip-

FIG. 4. Floor plan showing final arrangement of WSAZ 5-KW Transmitter, new 25-KW Amplifier and companion units. Note that new equipment was so placed that it was possible to install new ductwork as simple extensions of the existing ductwork. The only major alteration required was a shift to the right of a portion of the wall, providing adequate walk-around space.

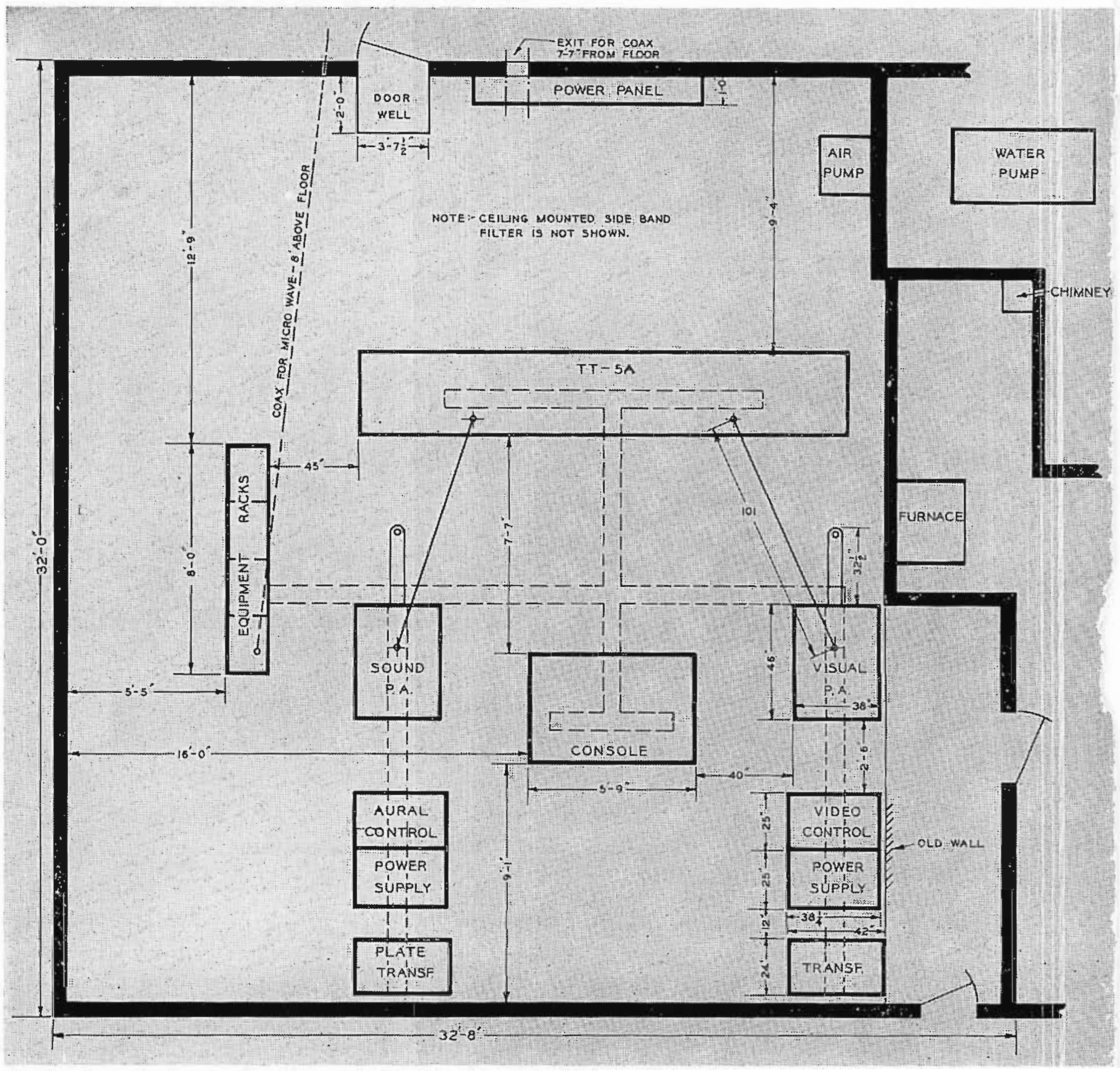


FIG. 5. This photo shows the location of the High-Power Amplifier units with respect to the supervisory console and the 5-KW Transmitter. Note that units are located so that operator at console has access to all essential controls.

ment, and associated Power and Control Cabinets is shown in the floor plan of Fig. 4. As will be noted in Fig. 4, a wall section was moved to provide adequate walk-around space near the console and power cabinets.

FIG. 6. Shown at right in this photo (not visible in Fig. 5) are the visual power and control cabinets and the operator's console. The aural power and control cabinets (not visible) are located at the opposite end, just behind the console.

Installing the Conversion Equipment

During the installation of the new power amplifier, the chief problem we faced was that of making a rapid changeover with no loss in air time. This work started shortly before the antenna change (see below) and proceeded simultaneously with the antenna changeover from Channel 5 to 3.

Changeover required that the following operations be performed overnight without loss of scheduled program service for the following day. Sign-off time was approximately midnight and sign-on around 11:00 a.m. the next day.

(A) Transmitter Equipment Installation

1. Installation of new tuning kits and crystals in both sound and picture transmitters.

2. Removal and modification of both Balun Units.

3. Retuning of sound and picture transmitters, re-neutralizing of driver stages, re-broadbanding of picture P. A. stage and power output check.

4. Completion of the coaxial line run from the new 25-KW Diplexer to the antenna lines at the point where they entered the building, including the 90-degree phasing section.

5. Air test and frequency checks of both carriers.

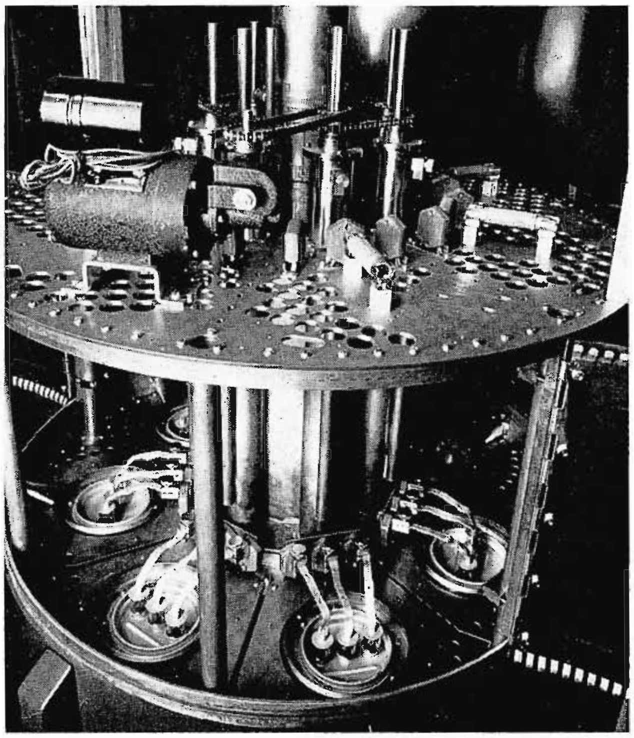


FIG. 7. Shown here is a close-up view of one of the WSAZ-TV High Power Amplifiers with all access doors open. Note that the cluster of seven air-cooled 5762 triodes and other components can be easily reached.

(B) Antenna Equipment Installation

(1) Channel 5 antenna was removed from tower during the night and

(2) placed on a telephone pole.

(3) Transmitter was then fed into this antenna.

(4) Channel 3 antenna was raised to tower and checked out.

The quality after changeover was found to be unchanged and the new antenna, VSWR, was excellent, showing 1.03 at picture carrier and 1.11 at sound carrier. These are the VSWR values taken from the TT-25AL reflectometers when first connected to the new antenna.

Both sets of radiators gave almost identical traces and the opening of a gate in a wire fence caused variations in the scope pattern showing that the antenna really had a better impedance match than curves had indicated. When mounted on the tower the match proved to be excellent. Reports were received over a wide area indicating increased signal strength and the elimination of "snow" from the pictures in the fringe areas.

Description of WSAZ Conversion Equipment

The WSAZ-TV 25-KW Conversion Equipment consists of a linear amplifier for the visual carrier and a Class C amplifier for the aural carrier, plus the necessary power and control cabinets for the aural and visual equipment.

Our new equipment employs air-cooled tubes and transformers, metering for all amplifier tubes and high speed a-c and d-c overload protection. R-F circuits are single-ended. The vestigial sideband characteristics are determined by a fixed-tuned sideband filter.

Each amplifier consists of a single power stage utilizing a cluster of seven air-cooled 5762 triodes in a grounded-grid circuit. Tank circuits are completely air-cooled. Diode monitors allow tuning and monitoring at both the 5-KW and 20-KW levels. The equipment contains the necessary auxiliaries such as bias supplies and control and protective circuits.

The amplifiers are housed in cylindrical cabinets which provide accessibility to all tubes as well as their circuit components. Air-cooling is provided from a blower incorporated in the base of each amplifier. Power supply as well as control and distribution facilities are housed in individual cabinets which match the TT-5A. There are two cabinets for the aural section and two for the visual section.

The visual amplifier is sufficiently broadbanded to prevent any substantial degradation of the 5-KW picture in passing through the amplifier. A reflectometer is included in both the aural and visual transmitters to provide direct readings of standing wave ratio and percentage of deviation from assigned power. The conversion am-

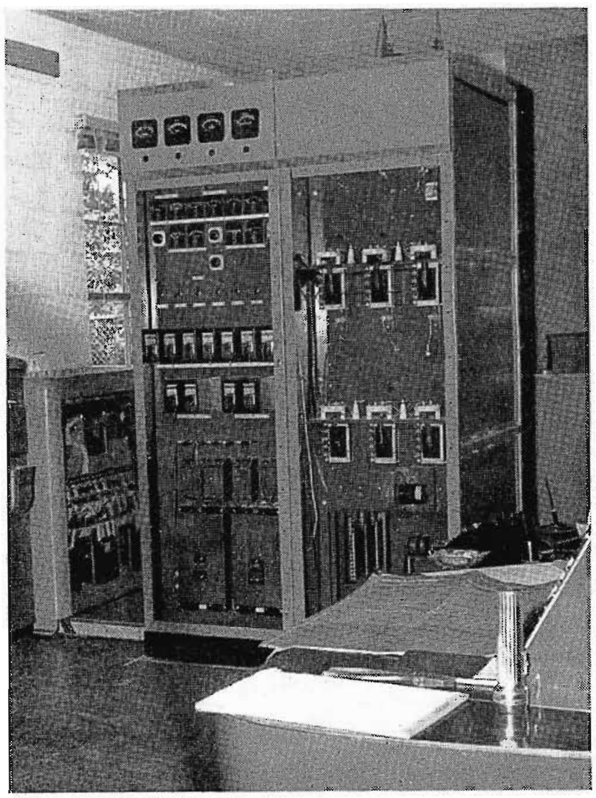


FIG. 8. Shown at right are the aural control and power supply cabinets which house control and distribution equipment. Note that standard RCA broadcast transmitter cabinets matching the TT-5A Transmitters are employed. Cabinet doors have been removed to show relays and controls.

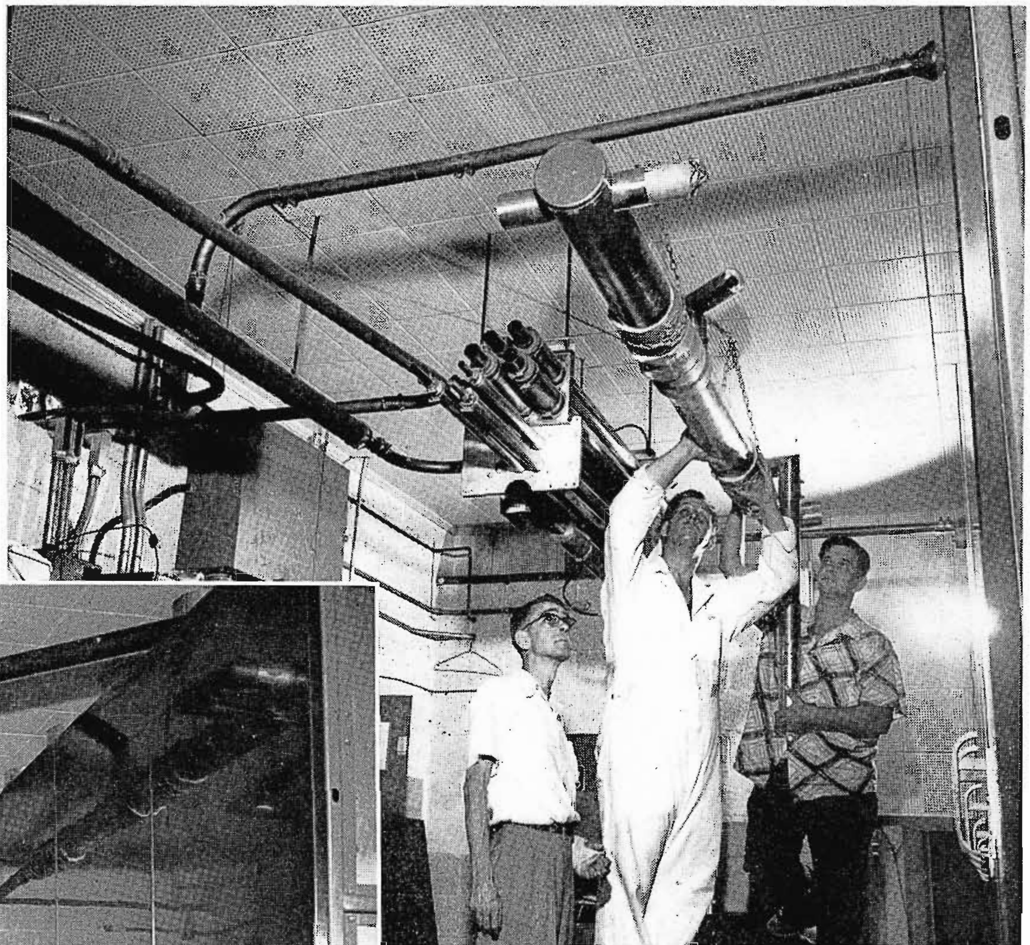
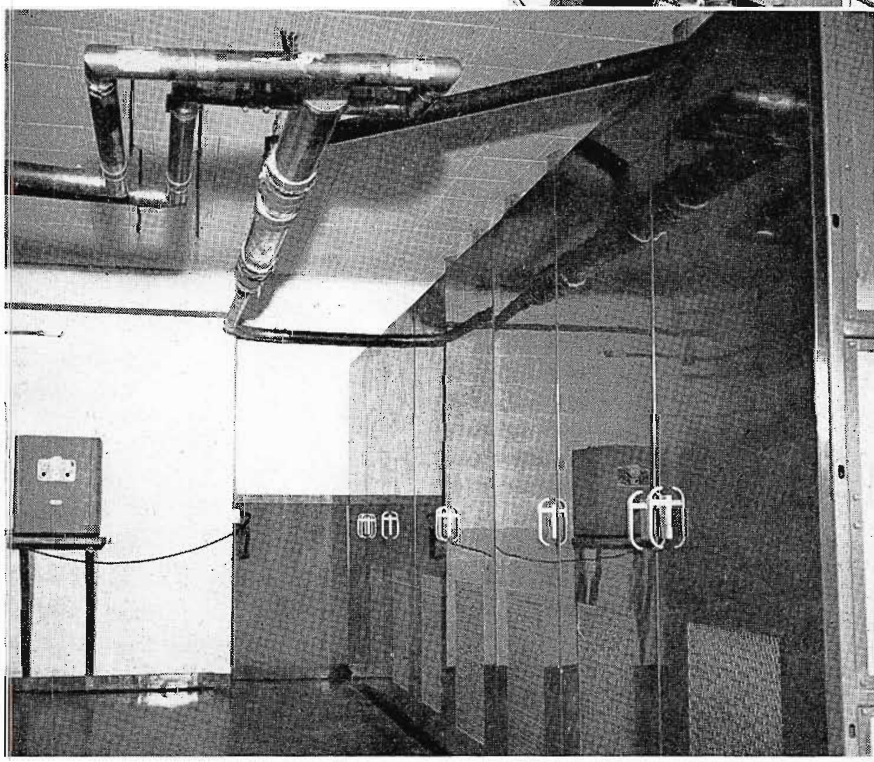


FIG. 9. Shown in this photo are Chief Engineer Leroy E. Kilpatrick, Studio Supervisor John Clay, and Transmitter Supervisor Merlin Pitts planning the installation of the new 25-KW Diplexer. Note that the old 5-KW Sideband Filter, Diplexer and Phasing Line for Channel 5 operation are still in place.

FIG. 10. Shown here is the 25-KW Diplexer completely installed and ready for high power operation. Note that it was possible to feed the TT-5A driver into the antenna system by simply changing two co-axial runs.



plifiers require 208/230-volt, 3-phase, 60-cycle power, and have a power factor of approximately 0.90.

TV and AM Future Studio Planning

At present, WSAZ AM studio programs originate at 912½ 3rd Avenue in Huntington. TV studio programs are "microwaved" from the West Virginia building 14th floor to the WSAZ transmitter/tower site.

As a part of the WSAZ-TV expansion and planning and in keeping with the increase in station power, future AM and TV studio facilities will be centralized and combined in a single, modern studio building.

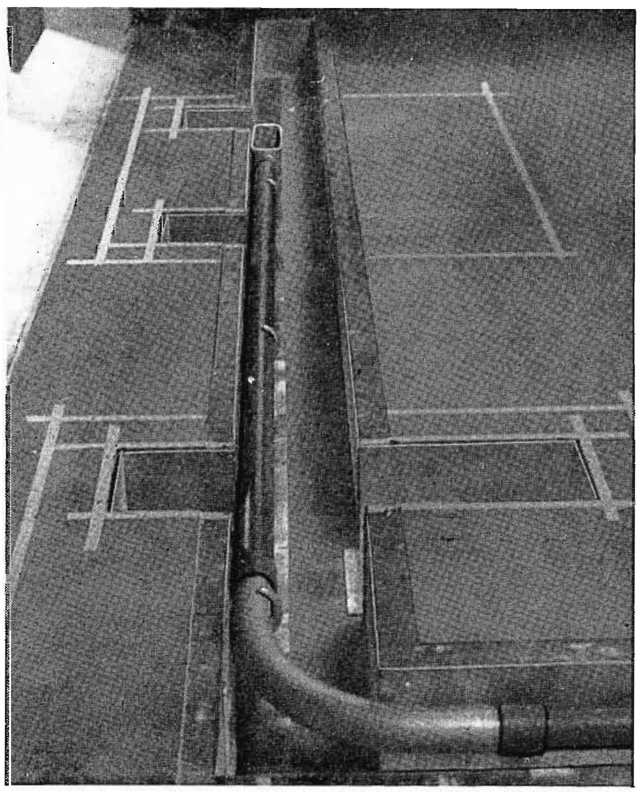
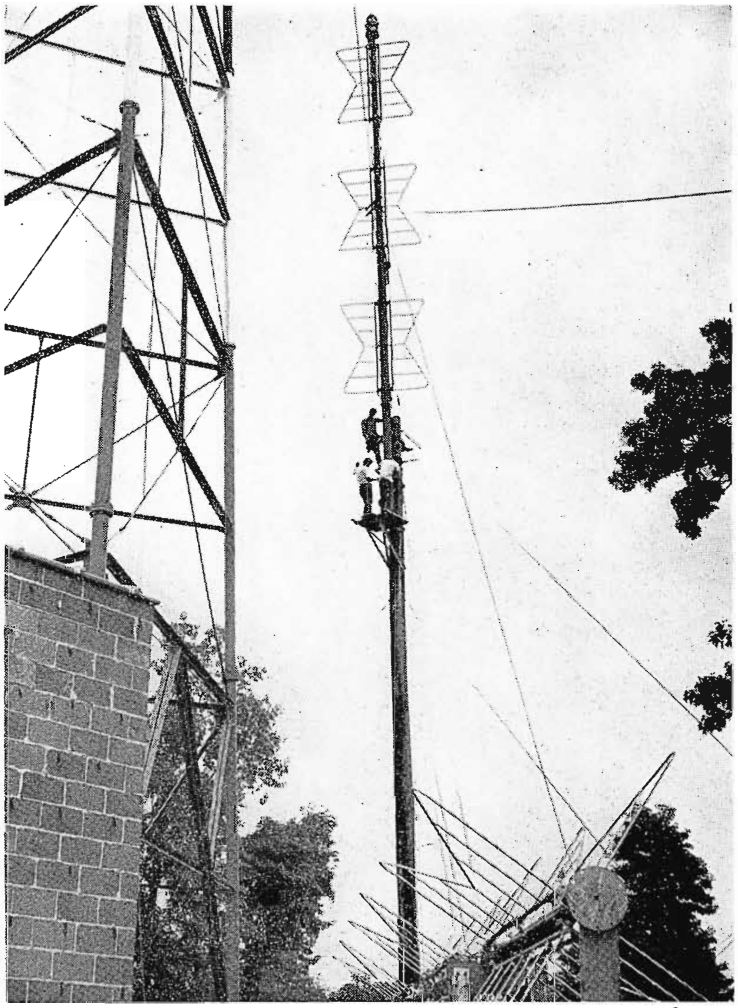


FIG. 11. View of the ductwork for the TT-25AL installation. Masking tape was found to serve very well for floor layout work. The conduit is for the three-phase power wiring. All other wiring has been cabled and placed in the trench. Steel covers finish the enclosure.



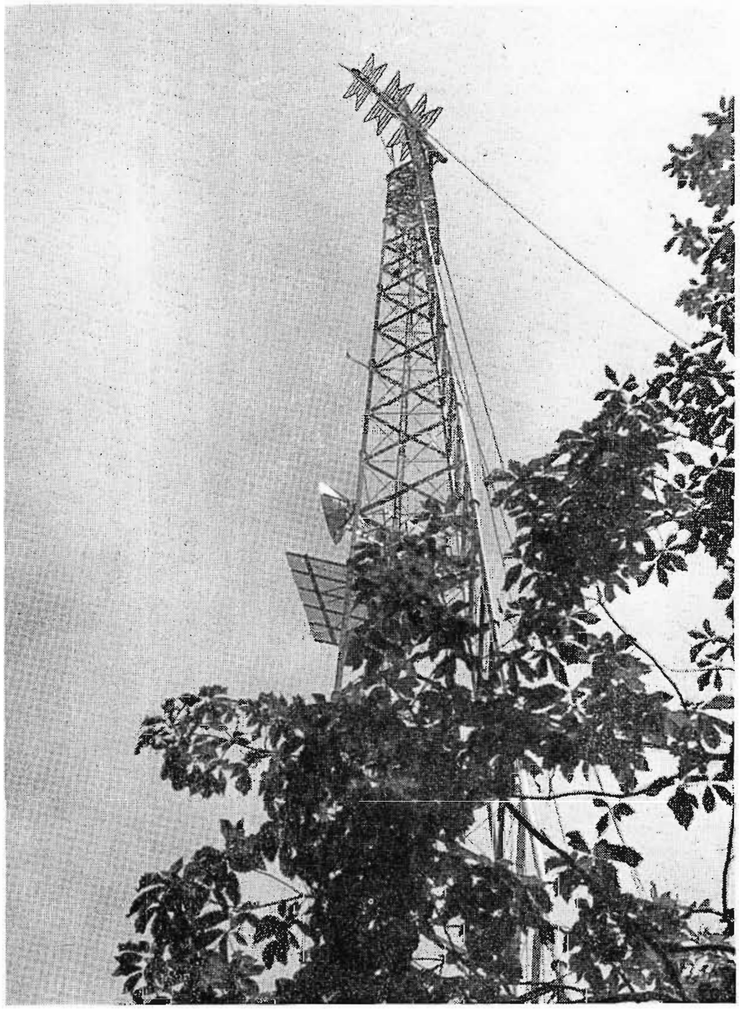
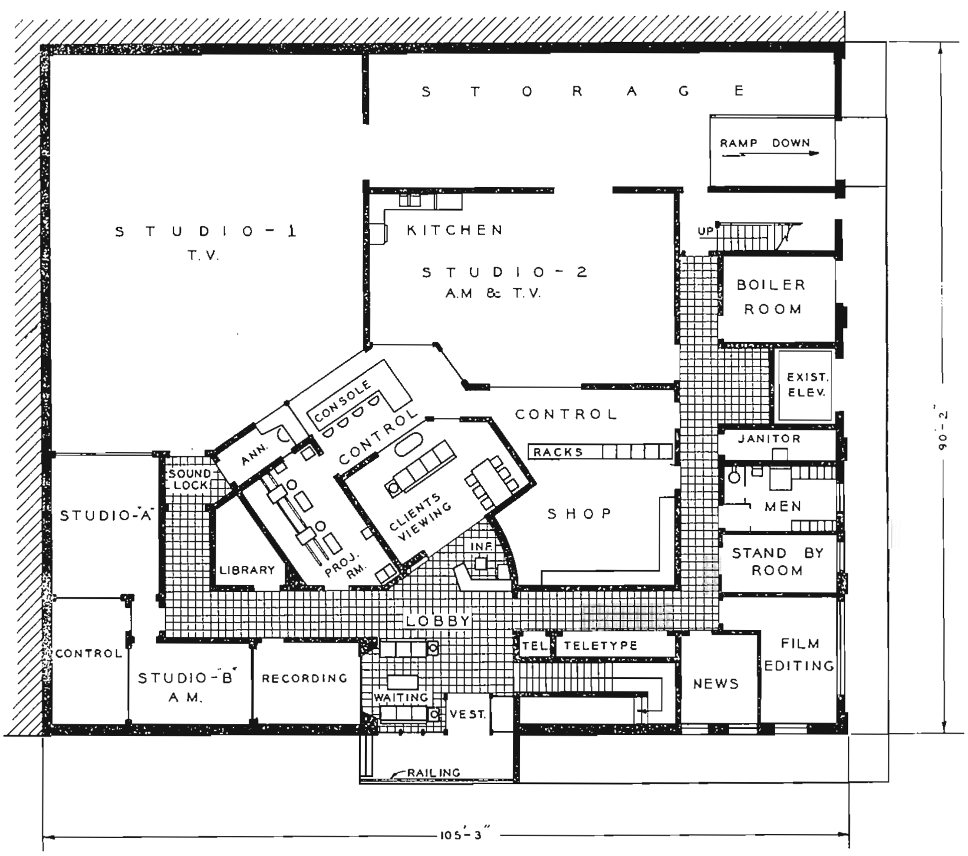


FIG. 12 (upper left). View showing Channel 5 antenna being lowered on temporary supporting pole. This is a 60-foot power pole guyed four ways at two levels. During the time required to set the Channel 3 antenna and complete the coaxial line runs this antenna was used for normal broadcast. RG-17/u was used as feed line.

FIG. 13 (above). View of the WSAZ Channel 5 antenna just before being mounted atop the supporting tower. Visible in this view is the microwave unit used to receive studio programs from downtown Huntington.



Plans submitted by the Austin Company, Engineers and Builders, for the proposed new WSAZ studio building are shown in the illustrations of Figs. 14, 15 and 16. The new building when completed will provide WSAZ with an efficient and centralized two-studio layout. One of the TV studios (Studio 2) will serve as a combination AM and TV studio and will include complete kitchen facilities for food or cooking commercials. Video control monitors will be located to provide visibility into both TV studios, announce booth and projection

FIG. 14. At left is plan of first floor of the proposed WSAZ-TV studio layout.

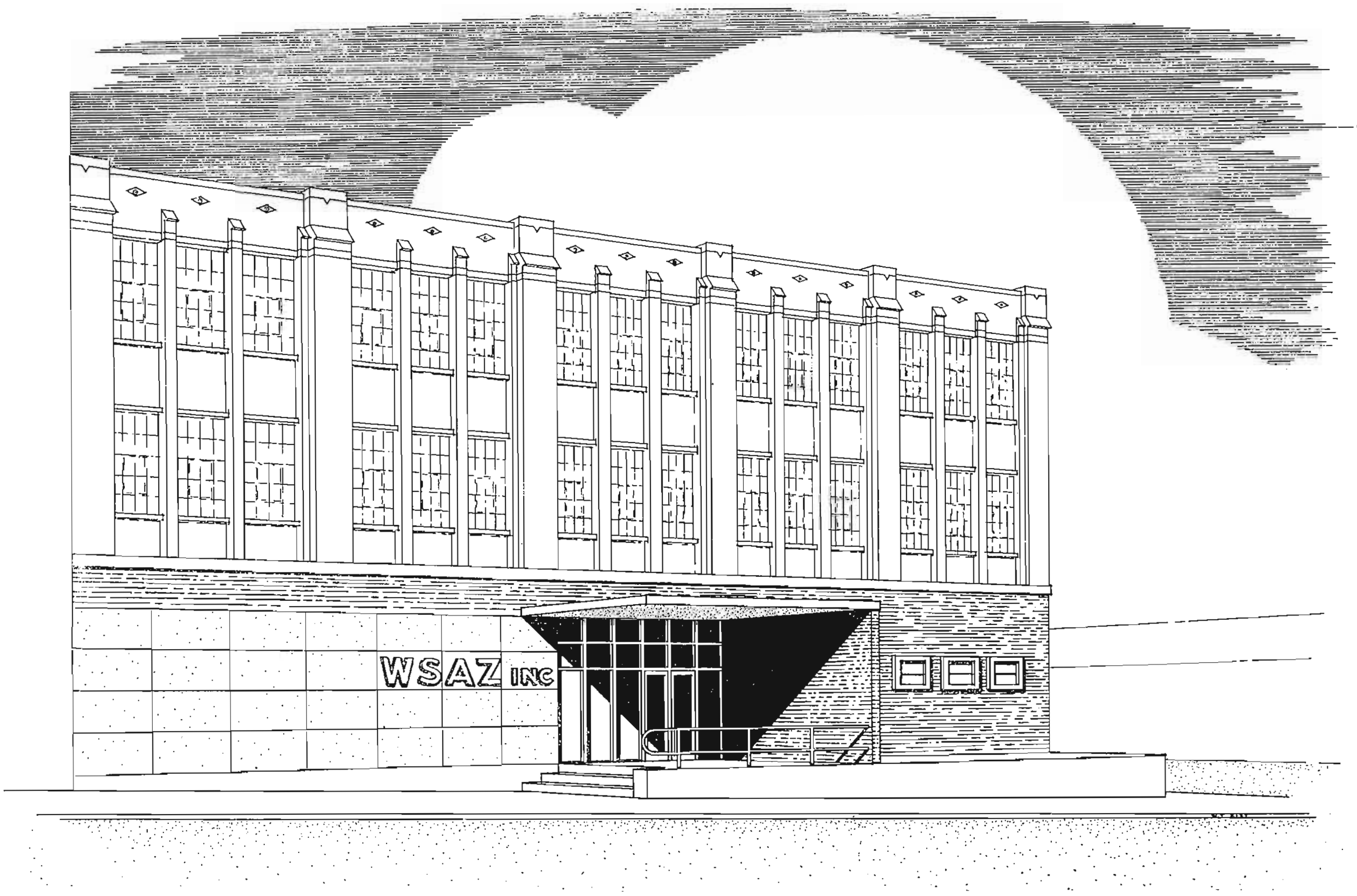


FIG. 15. Artist's conception showing appearance of the front of the future WSAZ Studio building.

room. Just to the rear of the video console will be located a client's observation lounge which will provide visibility into the main Television Studio, No. 1; the AM Studio, No. 2; and into the control room. Also located on the first floor will be ample property and storage facilities with a ramp at one end and generous entrance doors at the other end leading into both TV Studios. This arrangement will provide smooth traffic flow during arrangements of shows.

Also to be situated on the first floor are Studios "A" and "B" and a separate recording room for AM programming. As a supplement to the Television film projection room, a separate film editing room is planned. General management, sales, publicity, production and programming offices will be located on the second floor (Fig. 16).

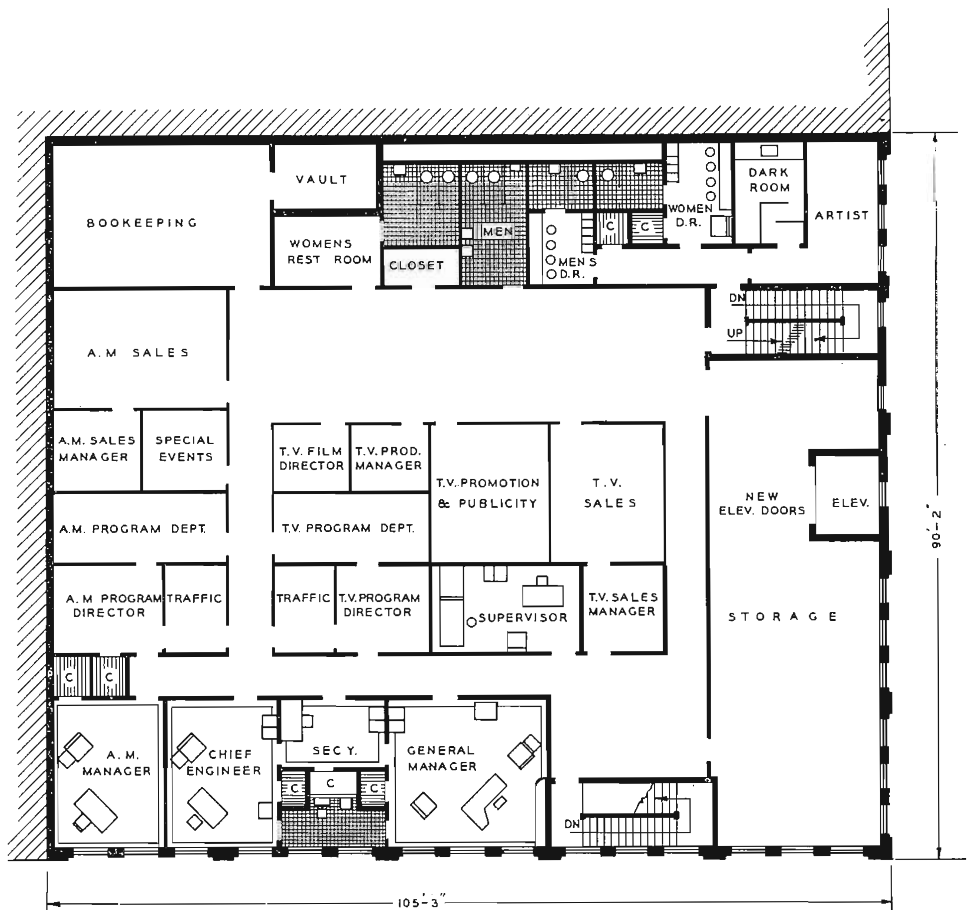
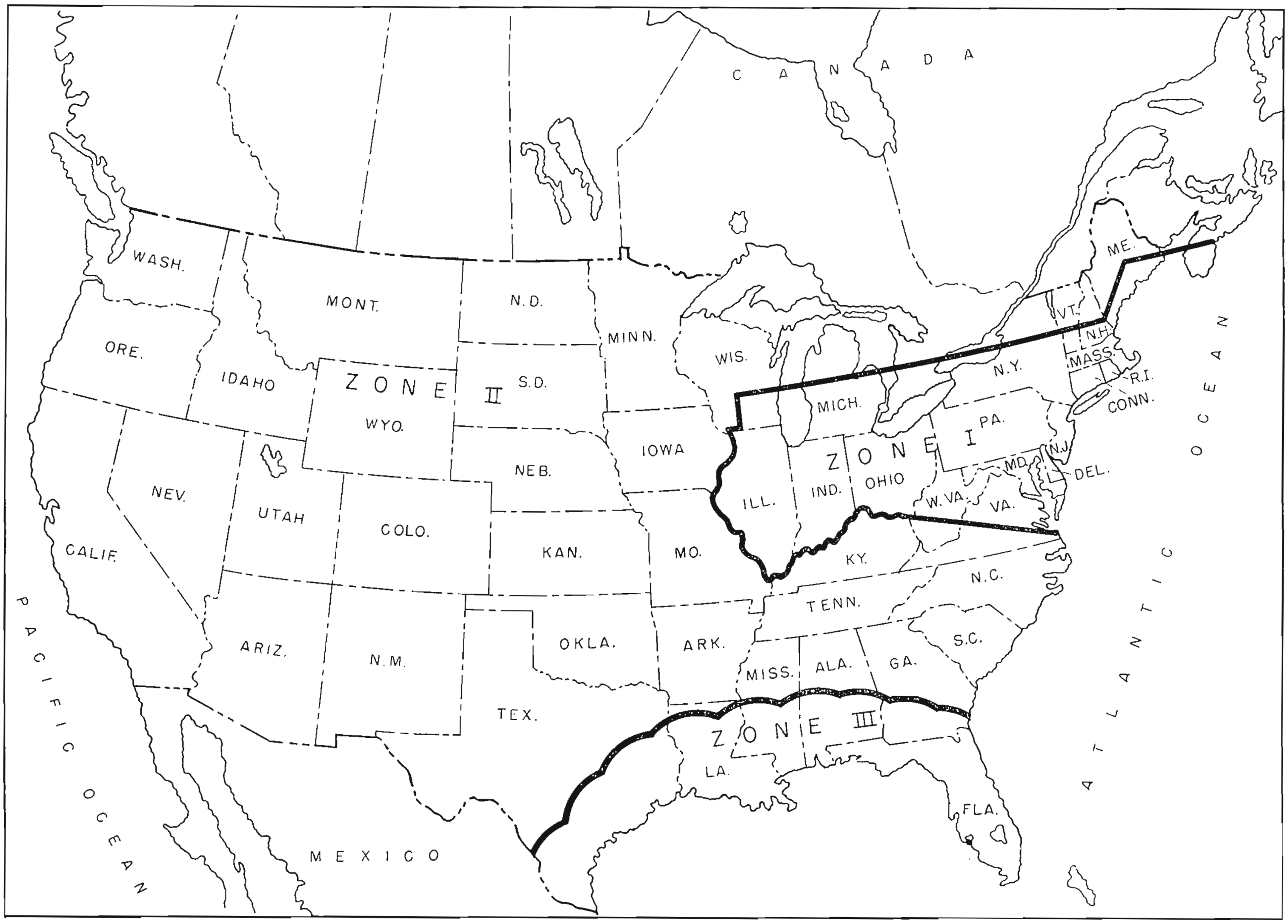


FIG. 16. Second-floor plan of proposed studio building showing management, sales, and office facilities.



Television zone map showing three areas in which standards differ.

HOW TO ESTIMATE VHF OR UHF COVERAGE*

By FREDERICK W. SMITH
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As a result of three years of technical hearings and research, the Federal Communications Commission has recently adopted extensive revisions of the Standards of Good Engineering Practice and the Rules and Regulations Concerning the Television Broadcast Service.[1] These revisions provide for the allocation of television broadcast stations in the band from 470 to 890 megacycles, and "unfreeze" the expansion of television service on a national basis which has been held in abeyance since 1948.

The new rules make available 70 channels in the uhf band between 470 and 890 megacycles for television broadcasting, in addition to the twelve vhf channels presently available between 54 and 216 megacycles. Of the important changes to be made in the engineering standards, one of the most significant is an upward revision of the maximum effective radiated power that may be transmitted by television broadcast stations, which will make possible substantial increases in the service radii of existing stations.

The maximum and minimum powers that will henceforth be used in television broadcasting depend on transmitting antenna height and the population of the city to be served as shown in Fig. 1. For channels 2 to 6 (54 to 88 mc) a maximum of

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* Courtesy of ELECTRONICS and the McGraw-Hill Publishing Company.

20 db above 1 kw (dbk) of power may be transmitted for antenna heights of 1,000 feet or less; for channels 7 to 13 (174 to 216 mc) 25 dbk for antenna heights of 1,000 feet or less; and for channels 14 to 83 (470 to 890 mc) 30 dbk for antenna heights of 2,000 feet or less. For greater antenna heights, radiated power of a station must be derated as shown in Fig. 1, according to the particular zone of the country in which the transmitter is to be located. The zone divisions established by the FCC are shown in the map.

It will be noted that in the new standards, transmitted effective radiated power (erp) is expressed in terms of decibels above a reference level of one kilowatt or dbk. The maximum levels of 20, 25, and 30 dbk, therefore, represent power levels of 100, 316, and 1,000 kilowatts, respectively. Likewise, the FCC will henceforth specify field strength levels in terms of decibels above a reference level of one microvolt per meter or dbμ. This convention has the advantage that transmission-line losses and antenna gains may be directly subtracted and added to transmitter power output levels. A power increase of one decibel at the transmitter will result in an increase of a decibel in received field strength.

Coverage Prediction

Under the old standards that have been superseded, the coverage of television stations was described in terms of contours based on a median field strength of 5.0 and 0.5 millivolts per meter. In the new standards, the coverage of television stations is expressed in terms of two grades of service, which are defined in Table I. The grade A and B service classifications are essentially specifications of the extent of signal penetration that will prove to be satisfactory to the average urban or rural observer equipped with an average television receiving system, both from a subjective and a time-availability standpoint. According to

FIG. 1. Maximum and minimum power vs. antenna height for all channels and zones.

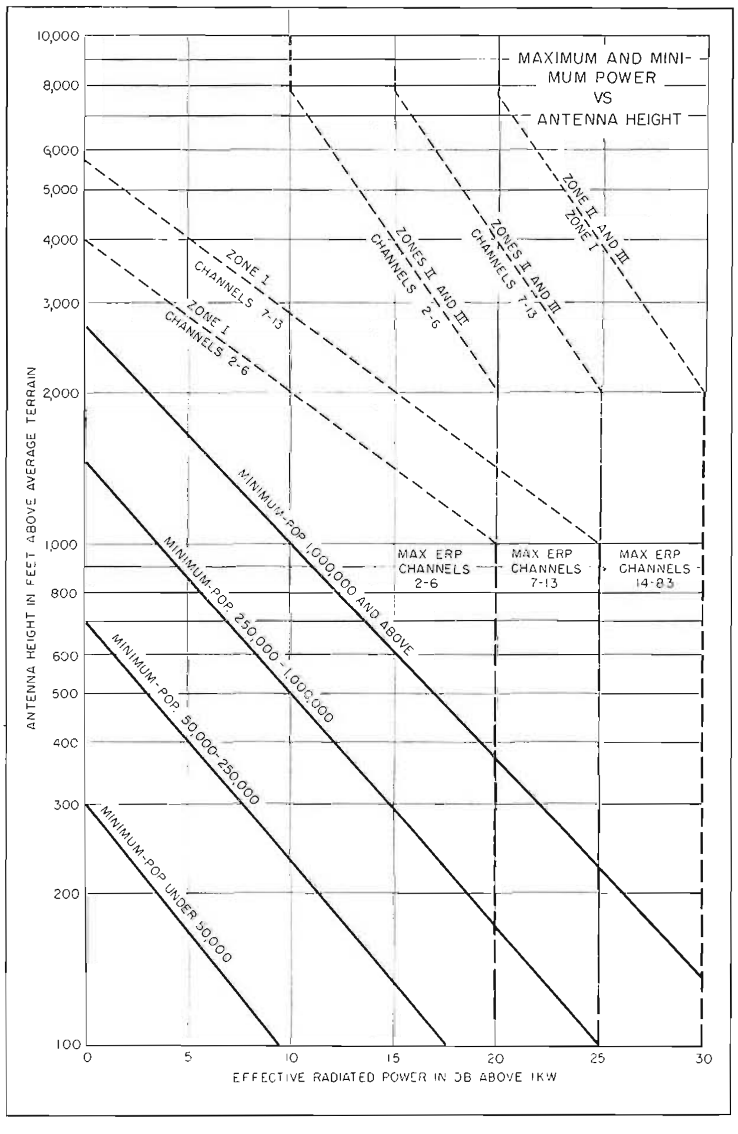
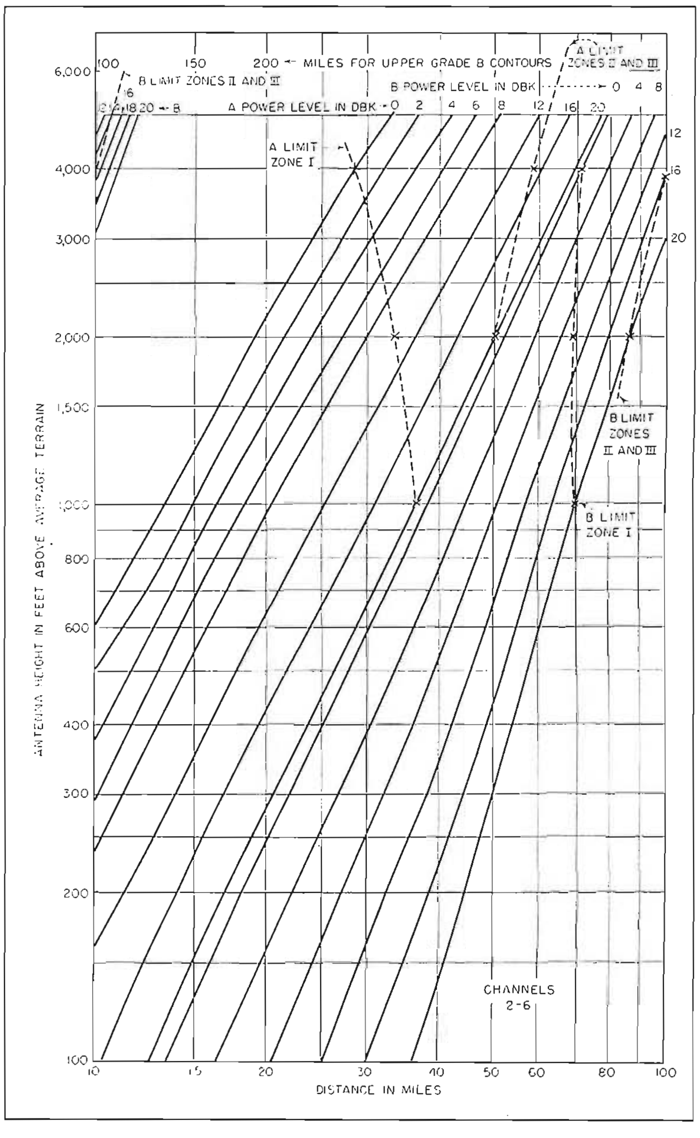


FIG. 2. Grade A and B contour distance for channels 2 through 6.



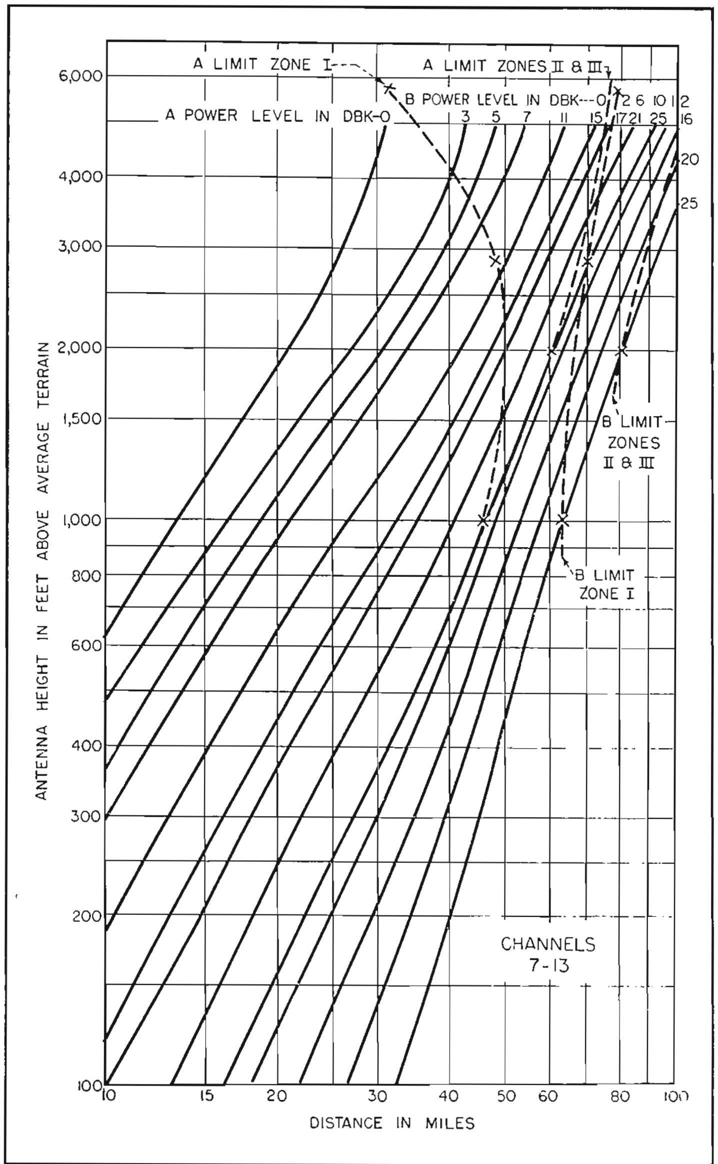


FIG. 3. Grade A and B contour distances for channels 7 through 13.

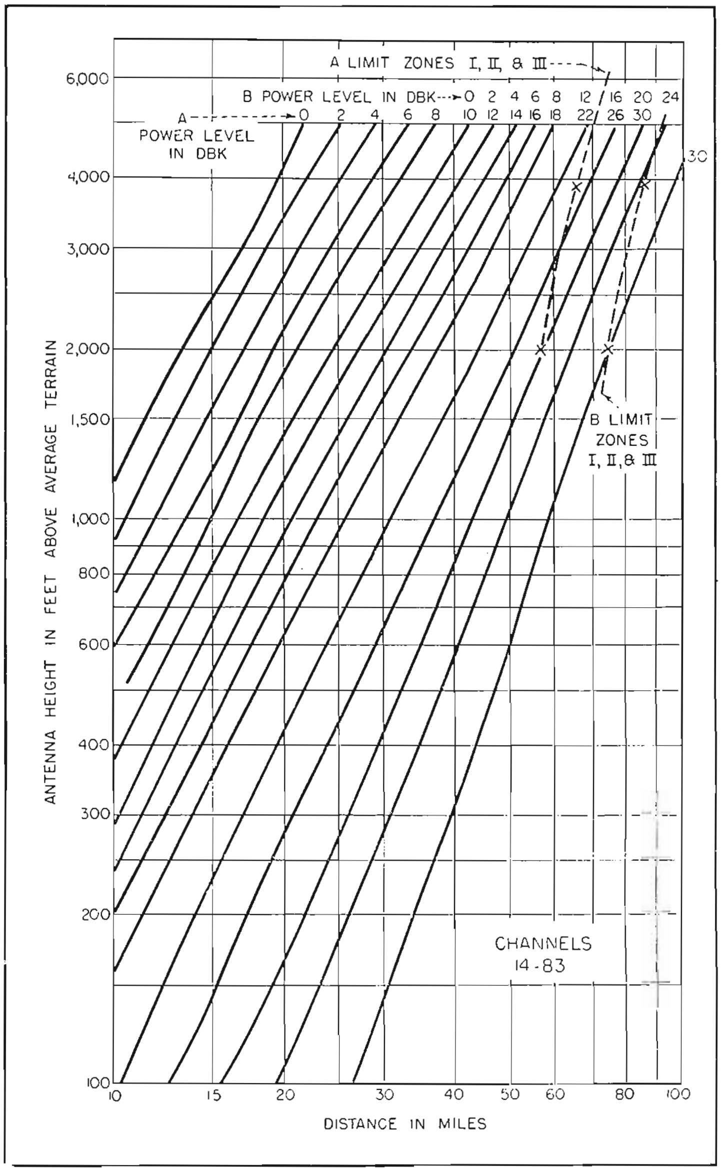


FIG. 4. Grade A and B contour distances for channels 14 through 83.

the propagation characteristics of uhf and vhf, and considering the performance capabilities of the average television receiver and receiving antenna system, if the field-strength levels specified in Table I are provided, then the requirements for Grade A and B service will be met.

Another innovation is the inclusion in the standards of television field-strength curves that are based on a statistical analysis of the service rendered by the existing television stations. These replace field-strength charts, such as those in the old standards, or previously published elsewhere,[2] which were based on the theoretical propagation to be expected over a smooth, spherical earth, and which did not take into account the statistical effects of terrain losses, or provide median field strengths. Figs. 2, 3 and 4 represent condensed versions of these curves and are arranged to permit convenient and rapid computation of the distances to the Grade A and B service contours when the antenna height above average terrain and the effective radiated power of a station in dbk are known.

Typical Case

Figs. 2, 3 and 4 are used as follows: Assume that an antenna site has been selected for a station to be located in Zone II, and that the radiation center of the

Table I—Required Median Field Strength in db Above 1 μv/m (dbμ) at Outer Limits of Service

Grade of Service	Channels 2-6	Channels 7-13	Channels 14-83
A	68	71	74
B	47	56	64

antenna will be 1,500 feet above mean sea level. A topographic map, such as prepared by the U. S. Geological Survey, is then secured and eight or more radials are drawn on it, each extending to a distance of ten or more miles from the proposed transmitter location, as described in the FCC standards. One or more of these radials must extend through the major city or cities to be served. A profile graph for each of these radials is then constructed, which also shows the elevation of the antenna radiation center, as shown in Fig. 5. This represents a hypothetical profile that might be obtained along a N 30° E radial from a proposed television site.

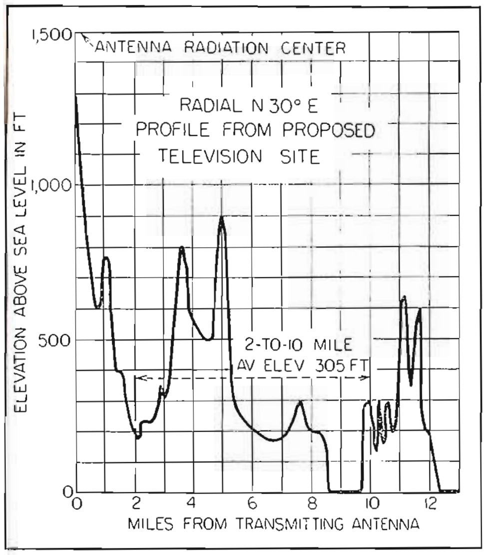


FIG. 5. Representative radial showing method of determining average elevation.

Once such a profile has been obtained, average elevation of the profile graph of the radial for the eight-mile distance between two and ten miles from the proposed transmitter location is determined by means of a planimeter or by averaging successive points in the interval.

In the case of the radial profile graph shown, this proves to be 305 feet above mean sea level. The height of the radiation center of the antenna above the average elevation of the radial between two and ten miles, the antenna height above average terrain, is 1,500 feet minus 305 feet, or 1,195 feet. This height is taken as 1,190 feet because the FCC specifies antenna height to the nearest 10 feet, taking the lower alternative for midway figures. The antenna height above average terrain is usually taken as 100 feet where it proves to be less than 100 feet or negative.

According to Fig. 2, the coverage for an effective radiated power of 20 dbk on channel 2 at this site, and along this particular radial, will be about 40 miles, A, and 73.5 miles, B. If the station were to be located in Zone I, the coverage limit would be set by the maximum power curve in Fig. 1 as indicated by the dashed lines ("A Limit Zone I" and "B Limit Zone I" in Fig. 2) and would be 36 miles, A, and 69.5 miles, B.

The complete contours for the station are then secured by repeating the above process for each of the radials and by marking off the distances obtained for all of the radials on a suitable map. A smooth curve that joins the appropriate points then represents the contour at which the specified service is obtained. If the coverage map is to be submitted to the FCC as part of an application for construction permit, the contours should be constructed on the Sectional Aeronautical Chart for the area.

The effective radiated power of a television station is the sum of the transmitter power output in decibels above one kilowatt, and the transmitting antenna gain over a half-wave dipole in decibels, less the loss in decibels incurred in the diplexer, triplexer (if used), and transmission-line feed system. When the transmitter power output rating already incorporates the diplexer loss, the latter need not be considered.

References

[1] Sixth Report and Order; Amendment of the Rules, Regulations and Engineering Standards Concerning the Television Broadcast Service, Appendix D, Federal Communications Commission, Washington 25, D. C., April 14, 1952.

[2] F. W. Smith, Calculating UHF Field Intensities, ELECTRONICS, p. 110, Oct. 1950.


KLEENEX

THE EMPIRE STATE TELEVISION ANTENNA SYSTEM

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The Empire State Building has dominated the New York skyline since 1929. In 1930 television broadcast frequencies were shifted from the 2 Mc. region to the then new and relatively unknown ultra high frequency region now known as the VHF band. Since the behavior of these frequencies approached that of light, the importance of "line of sight" transmission from relatively high locations was recognized. In line with this thinking, some preliminary tests were made with low power oscillators by the RCA Victor Division on various New York buildings, including the Empire State Building, which confirmed this conclusion. Accordingly, the National Broadcasting Co. installed equipment on the Empire State Building and began television broadcasting in 1931, using a 1 KW transmitter.

When television broadcasting emerged as a major industry after the war, the superiority of the Empire State Building as a transmitting site became even more apparent not only because of its absolute height but also because it is the tallest structure in the area, thus minimizing the possibility of "ghosts" or secondary images reflecting from lower buildings. The reflected field from the lower buildings is low in amplitude compared to the field from the higher antenna. When the situation is reversed, however, the reflected field from a higher building, compared to the direct field from a lower antenna, can become comparable so that "ghosts" appear in the picture.

Meanwhile, as television broadcasting spread to other cities, a number of cases resulted where transmitting antennas were installed fairly close to each other. One of these was on the Civic Opera Building in Chicago in which the National and the American Broadcasting Company antennas were only 150 feet apart. On the top of Mt. Wilson near Los Angeles, quite a number of stations operated in close proximity to each other with no difficulty.

Hence, when the opportunity presented itself for the multiple use of the Empire State Building as a television center, several facts had become established.

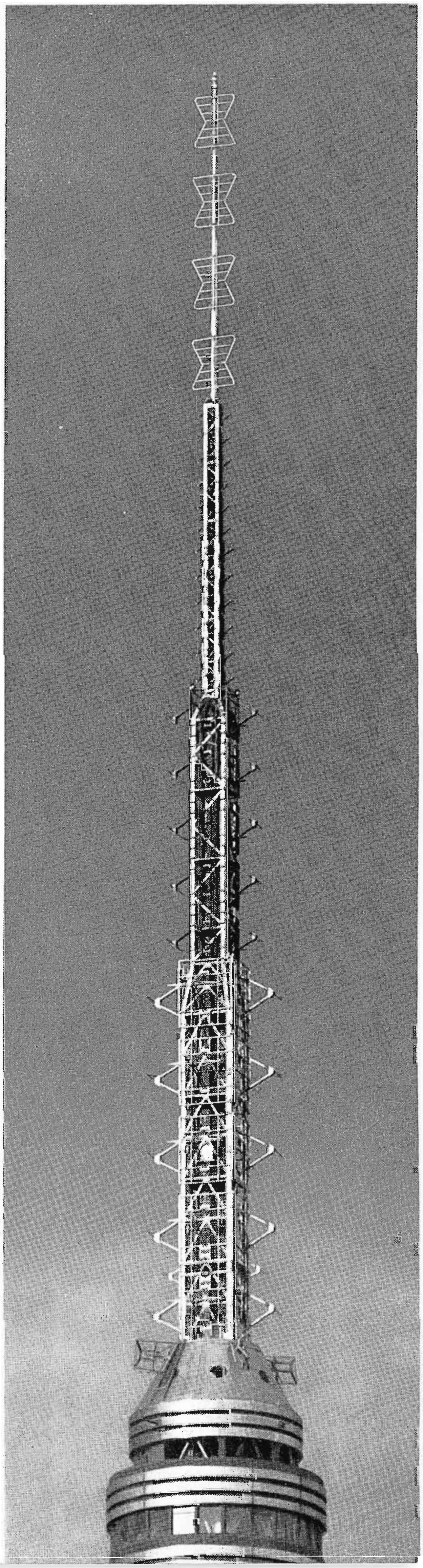
1. The desirability of the Empire State Building as a transmitting site.
2. The fact that multiple operation seemed feasible based on previous experience.

Once the decision had been made to use the Empire State Building for a multiple antenna site, many factors had to be considered, including administrative, legal, etc., as well as technical factors. A Primary Committee was established consisting of F. G. Kear representing Empire State, Inc. and all other licensees, and O. B. Hanson representing the National Broadcasting Company as the original licensee. Robert L. Kennedy was designated as alternate for F. G. Kear and Raymond F. Guy as alternate for O. B. Hanson. This committee was assigned the task of formulating the plans and conducting tests and generally controlling the work. The technical factors included both mechanical as well as electrical considerations. The architects, Shreve, Lamb and Harmon; the consulting structural engineers, Edwards & Hjorth; and the general contractors, Starrett Brothers and Eken; all of whom had been associated with the building when it was first built, were called into consultation by the Primary Committee to consider the height of a tower that could be placed on the building.

RCA Victor Division antenna engineers were consulted on the electrical factors, including the number of antennas and the coupling between them.

After preliminary investigations indicated that the project appeared feasible, a contract was entered into between the Primary Committee and the RCA Victor Division, and work was started.

(LEFT). High over Manhattan, three workmen perch on the WNBT array, as a fourth climbs the remaining portion of WPIX below.



(RIGHT). Shown in full height, the Empire State Television Antenna.

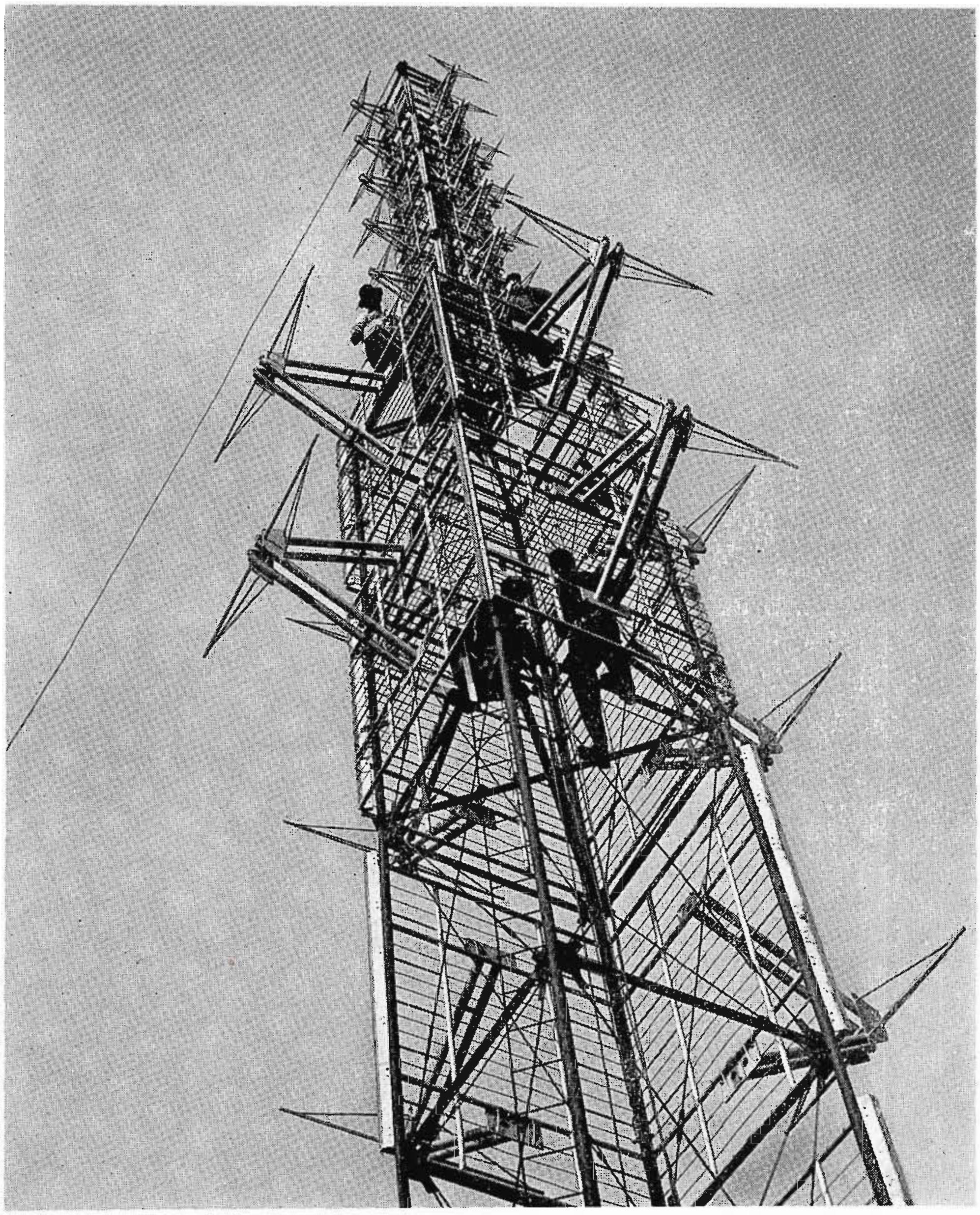


FIG. 1. View of Supergain Structure showing the Channel 5-7 Test Tower.

General Requirements

In designing the Empire State television antenna system, special consideration was given to the following factors:

1. Provision for five television and three FM services.
2. Coupling effects between the eight antennas involved.
3. Bandwidth sufficient for television transmission.
4. Maximum gain in the aperture available.
5. Horizontal pattern suitable for area to be covered.
6. Power handling capability to permit 100 KW effective radiated power for the television services.

To satisfy the first requirement, it was apparent that the antennas for the various stations had to be either above each other or adjacent to each other or some combination thereof including the possibility of multiple use of one antenna for two or more channels. Various methods were considered—even the possibility of a 60-foot diameter ring on which all antennas could be mounted. Such approaches were finally abandoned for appearance as well as for structural reasons, and vertical stacking was chosen.

The next consideration was the height of the structure above the building. This was decided by the architects as approximately 200 feet. It was apparent that many of the design problems were interrelated. Since gain is roughly proportional to height measured in wavelengths, for vertically stacked omni-directional antennas,[1] the problem of using the aperture available to the best possible advantage required considerable study. Interleaving the antennas, diplexing two stations into one antenna as well as placing some of the services on the building proper were all considered and most of them were rejected for one reason or another. Interleaving or diplexing could result in complex situations should one station need to work on its antenna while the other station is operating. Furthermore, each of the lessees expressed a preference for operating his own antenna system. Locating the antennas on the building proper would lower the height above terrain and result in a more complex antenna. The question was satisfactorily resolved by stacking all five TV antennas involved on the tower and allotting equal gain to each, with the exception of Channels 7 and 11 in the upper VHF band where the gain was 20% higher. The three FM services were to be obtained by other means such as interleaving, diplexing or triplexing.

The actual gain obtainable was contingent upon coupling between antennas since the closer the spacing between antennas, the greater the gain.

All aspects of the problem were studied in detail and target specifications were evolved as follows:

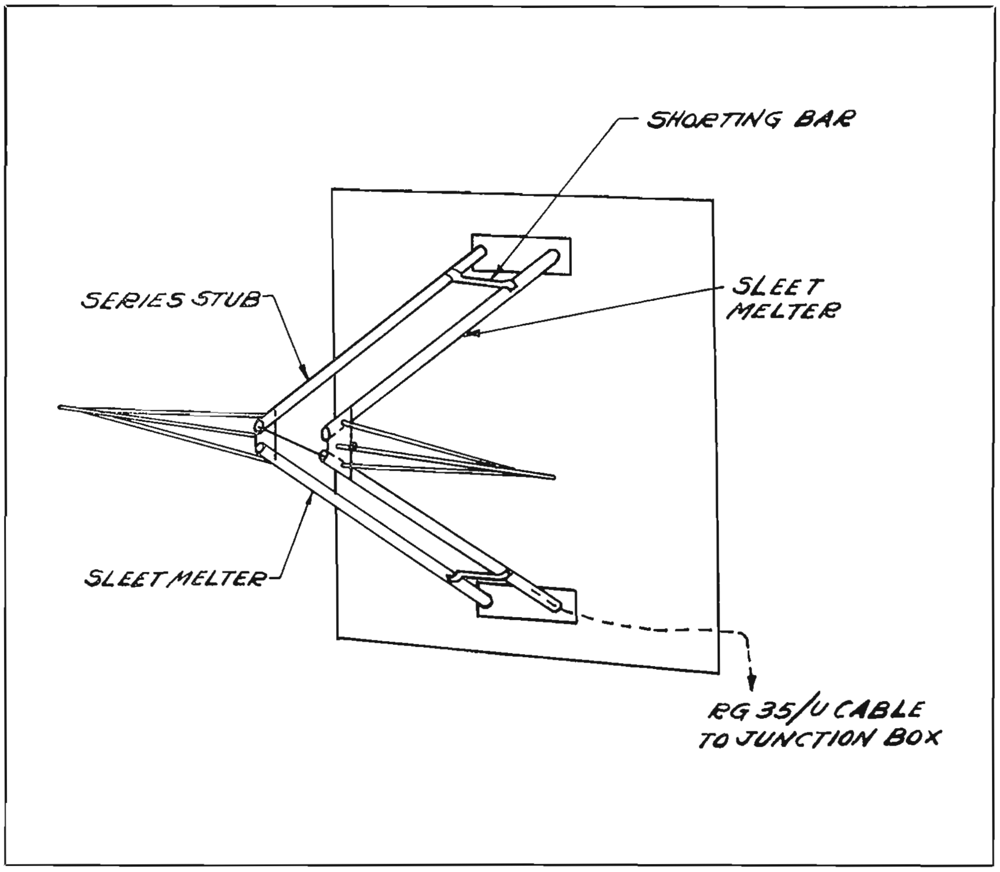
1. Coupling: —26 db. or less between any two antennas.
2. Input Voltage Standing Wave Ratio: 1.1:1 over the visual band; 1.5:1 over the aural band.
3. Gain: Directive gain of 4 relative to a thin one-half wavelength dipole for Channels 2, 4 and 5 antennas, and a gain of 5 for Channels 7 and 11 antennas.
4. Circularity: ±2 db.
5. Power Handling: Possibility of transmitting 100 KW ERP.

The choice of these specifications, the method of test and the results are described below.

Choice of Antenna Type

Since time was an important consideration, it was desirable to use an antenna on which basic development work was not required. Two commercial types of television antennas available were the Superturnstile and the Supergain. The Superturnstile antenna is widely used for single station installations but is not suited mechanically for stacking eight antennas. The Supergain antenna, however, with its one-half wavelength square construction offers suitable structural support for the antennas above and also offers space for the transmission line, feed system, junction boxes, power equalizers, sleet melting equipment, lighting circuits and communication lines. The Supergain antenna consists of a series of half wavelength dipoles mounted on the four sides of a tower one-half wavelength square as shown in Fig. 1. The dipole is

FIG. 2. Sketch of Screen and Dipoles.



fed by a single RG-35/U cable which passes through one of the supporting legs (Fig. 2). The outer conductor is connected to one side of the dipole and the inner conductor to the other side. The flare of the dipole is for bandwidth reasons. While the flare for broad-band dipoles in free space is in the opposite direction, experiments have demonstrated that this is not true when a reflecting screen is used. The distance btween the dipole and the reflecting screens is about 0.3 wavelength for bandwidth requirements. The reactance component of the antenna is balanced out by means of a series stub consisting of a short piece of solid dielectric cable which is placed in one of the other legs. The triangular supporting structure is primarily for strength. The supporting structure is electrically isolated from the dipole by means of a shorting bar placed approximately one-quarter wavelength from the dipole. The two other supporting legs have heating units mounted in them for deicing. This de-ices the spaces between the dipoles where ice would have the maximum effect on impedance.

Each dipole is fed by means of a cable which terminates in a common junction box (Fig. 3). The common impedance at the junction box is $\frac{1}{n}$ of the dipole impedance if n is the number of dipoles. Immediately below the junction box, a two-stage transformer is used to match the common junction box impedance to the main transmission line impedance of 51½ ohms.

Since the number of elements used in the Empire State television antennas were less than those used in previous designs, and also since the feed cables used were larger because of power handling requirements, it was necessary to develop special junction boxes. The problem of easily disconnecting the cables from the junction box, maintaining gas pressure and still maintaining excellent impedance characteristics was a major development in itself. Fig. 3 indicates the type of connection used.

A more detailed description of the Supergain antenna has been given in a previous paper.[2]

Coupling

Possible coupling resulting in crosstalk or other disturbances was one of the major considerations in the design of the antennas. Little or no previous experience was available except the fact that some 80 Superturnstile antenna installations had worked successfully without any trace of crosstalk where the isolation between the visual and aural transmitters was of the order of 20 db. This was true of transmitters with both triode and tetrode tubes in the output circuit. In order to allow for a difference in power levels and as an additional safety factor another 6 db was added, thus making the target specification for coupling —26 db between any of the antennas at the carrier frequencies involved. In setting this specification, only coupling between antennas was considered since radiation from an antenna to another transmitter or interference between transmitters is a function of shielding and cannot be minimized by antenna design. Similarly, harmonics could not be considered since these are generated in the transmitter and could be controlled at that point.

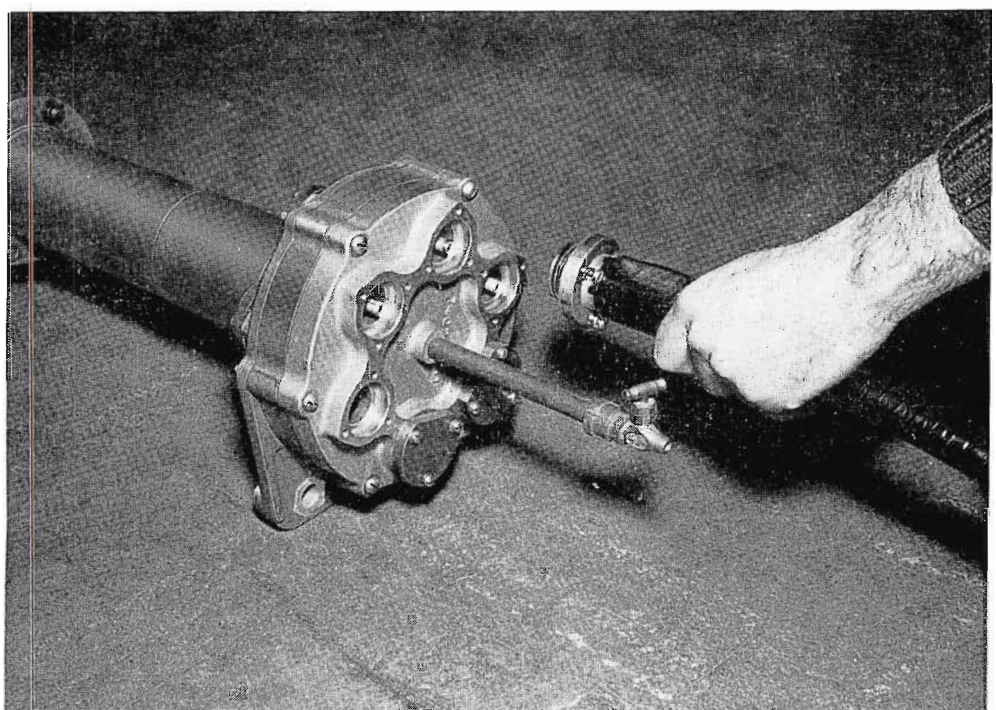


FIG. 3. One of the Junction Boxes and Feedlines Developed for the Empire State Antenna.

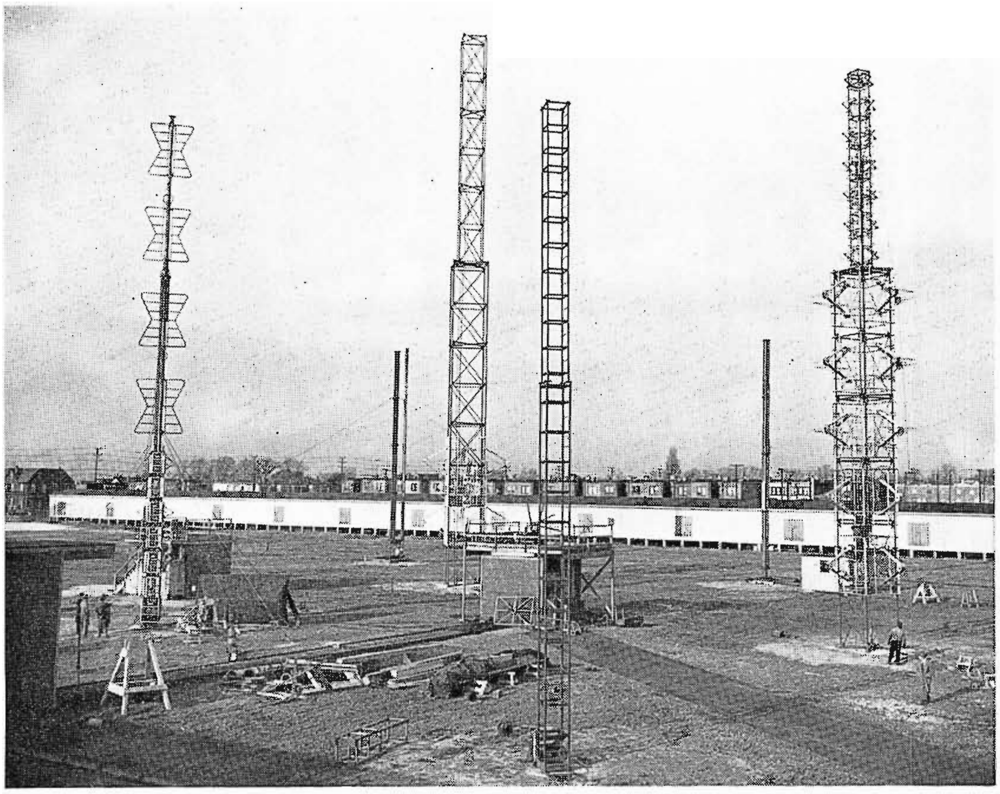


FIG. 4. General View of Test Towers used for Empire State Antennas. Each Tower Accommodates Two Adjacent Antennas.

To check the impedance of each antenna and the coupling between them, it seemed desirable at first to duplicate the entire 217-foot structure at the test location. Since this was not feasible for a number of reasons, one of which was the difficulty of working on the structure and making tests, the next best procedure was adopted in which adjacent pairs of antennas were tested on four towers, Figs. 1 and 4. The highest tower using this method is of the order of 100 feet for the channel 2 and 5 combination.

However, such coupling tests could not be completed until the antennas were available and adjusted for impedance. Since the tower design for the Empire State Building had to proceed immediately, some assurance was necessary in advance of the final tests that the target specifications for coupling could be met. This was obtained by two approaches: namely, by calculation and by tests with single screens.

The method of calculation was arrived at by Mr. R. W. Masters.* The formula for coupling between antennas is as follows:

$$\frac{P_r}{P_t} \leq \left(\frac{\lambda}{4\pi R}\right)^2 \frac{G_t\ G_r}{n_t\ n_r}$$

where equality, under the assumptions, obtains for $n_r = n_t = 1$.

where P_t is the power applied to the transmitting antenna.

P_r is the power received by the receiving antenna.

R is the distance between the antennas.

G_r, G_t are the directive gains of the adjacent end bays of the neighboring antennas in each other's directions relative to an isotrope.

n_t is the number of bays of the transmitting antenna.

n_r is the number of bays of the receiving antenna.

A number of assumptions were necessary to arrive at this formula.

1. That the field magnitude varies in proportion to inverse distance.
2. That the major contribution to coupling comes from the two adjacent end bays.
3. That the radiators are matched to the branch feed cables.
4. That no coupling exists between the N-S and E-W elements of the antenna.

The coupling between the closest pair of half bays at the longer of the two wavelengths; namely, channels 5 and 7 at the channel 5 carrier under the above assumptions was —17 db. However, since the power is not all concentrated in the adjacent bays but is fed equally to all bays, another 10 db can be easily obtained. Hence, from this viewpoint, the necessary decoupling could be achieved.

As an additional check, combinations of single screens were checked with various separations. This experiment was performed in the same manner as the subsequent measurements on the complete antenna for which the following procedure was used.

* With Ohio State University Research Foundation, engaged by RCA as consultant for this project.

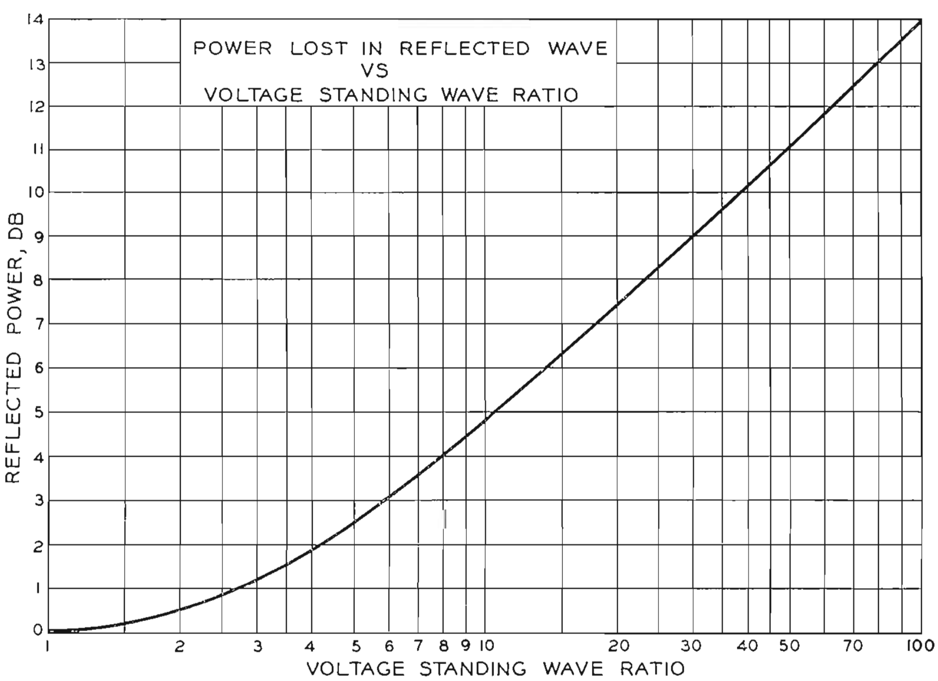


FIG. 5. Correction Chart Used in Coupling Tests.

FIG. 6. Typical Decoupling Data for Channels 5 and 7. Field Rotation of Both Antennas in Same Direction (Normal Condition).

IN:	Channel 5 Upper Group	Channel 5 Upper Group	Channel 7 Visual	Channel 7 Aural
OUT:	Channel 7 Visual	Channel 7 Aural	Channel 5 Upper Group	Channel 5 Upper Group
Frequency				
77.25 Mc.	65.8 db.	55.7 db.		
79.0	54.1	50.7		
81.75	46.5	46.2		
175.25			51.2 db.	51.2 db.
177.0			52.6	52.6
179.75			51.3	50.2

Above data adjusted for mismatch loss.
Quarter-wave phasing section in E-W halves.

An antenna was driven at a known level at its own frequency and the received power level in the adjacent antenna was measured. The mismatch in the antenna occupying the receiving position was often quite high because the frequency of the incoming signal was outside the design range of the antenna. By properly accounting for the additional power scattered by the receiving antenna as a result of an impedance mismatch between it and its transmission line, it was found that the measured crosstalk values could be adjusted to substantial equality for both directions of transmission. The adjustment amounted to the same thing as experimentally matching the receiving antenna to its line before measuring the crosstalk. Fig. 5 gives the required correction as a function of voltage standing wave ratio which the receiving antenna would set up on its line if used as a transmitter. The tests between single co-channel radiators spaced 0.65 wavelength apart indicated an isolation of about 18 db, and greater values for dissimilar elements up to 40 db for channels 5 and 7 screens placed in close proximity.

Since agreement was obtained between calculated and measured results on single screens, and since it appeared that an additional margin could be obtained when the power was divided into a complete antenna rather than into two adjacent bays, the tower design proceeded on the basis of the close spacing used in our experiments in order to obtain the maximum gain possible.

In the meantime, the antennas for Channels 11, 7, 5, 4 and 2 were fabricated and placed on the towers and adjusted for impedance. Coupling tests were then made by the method outlined above. Typical results are shown in Figs. 6 and 7. In all cases, the specification of —26 db has been met or bettered.

Gain

Gain was initially calculated by assuming a thin dipole, one-half wavelength long .3 wavelength in front of an infinite screen. This resulted in an element pattern. The array factor for the number and spacing of elements decided upon was then determined and multiplied by the element pattern. The resulting pattern was then integrated over a sphere to obtain the gain of the configuration.

FIG. 7. Typical Decoupling Data for Channel 7-11. In the upper table, fields are rotating in the same direction for both antennas; in the lower table, fields are in opposite direction.

IN:	Channel 7 Visual	Channel 7 Visual	Channel 7 Aural	Channel 7 Aural	Channel 11 Visual	Channel 11 Visual	Channel 11 Aural	Channel 11 Aural
OUT:	Channel 11 Visual	Channel 11 Aural	Channel 11 Visual	Channel 11 Aural	Channel 7 Visual	Channel 7 Aural	Channel 7 Visual	Channel 7 Aural
Frequency								
175.25 Mc.	48.9 db.	36.9 db.	36.9 db.	48.9 db.				
177.0	55.1	36.6	36.6	48.3				
179.75	59.3	36.8	35.5	51.9				
199.25					42.8 db.	31.8 db.	32.6 db.	48.8 db.
201.0					45.0	30.9	31.3	44.5
203.75					41.7	30.7	30.4	59.0

IN:	Channel 7 Visual	Channel 7 Visual	Channel 7 Aural	Channel 7 Aural	Channel 11 Visual	Channel 11 Visual	Channel 11 Aural	Channel 11 Aural
OUT:	Channel 11 Visual	Channel 11 Aural	Channel 11 Visual	Channel 11 Aural	Channel 7 Visual	Channel 7 Aural	Channel 7 Visual	Channel 7 Aural
Frequency								
175.25 Mc.	36.9 db.	52.4 db.	40.2 db.	36.4 db.				
177.0	37.1	58.1	40.1	36.6				
179.75	36.3	51.3	41.1	35.3				
199.25					32.0 db.	50.6 db.	54.8 db.	31.3 db.
201.0					31.1	49.5	48.0	30.9
203.75					30.3	52.8	42.4	30.8

Quarter-wave phasing section in E-W half of Channel VII and N-S half of Channel XI antennas.
Above data adjusted for mismatch loss looking into the individual halves of antenna.

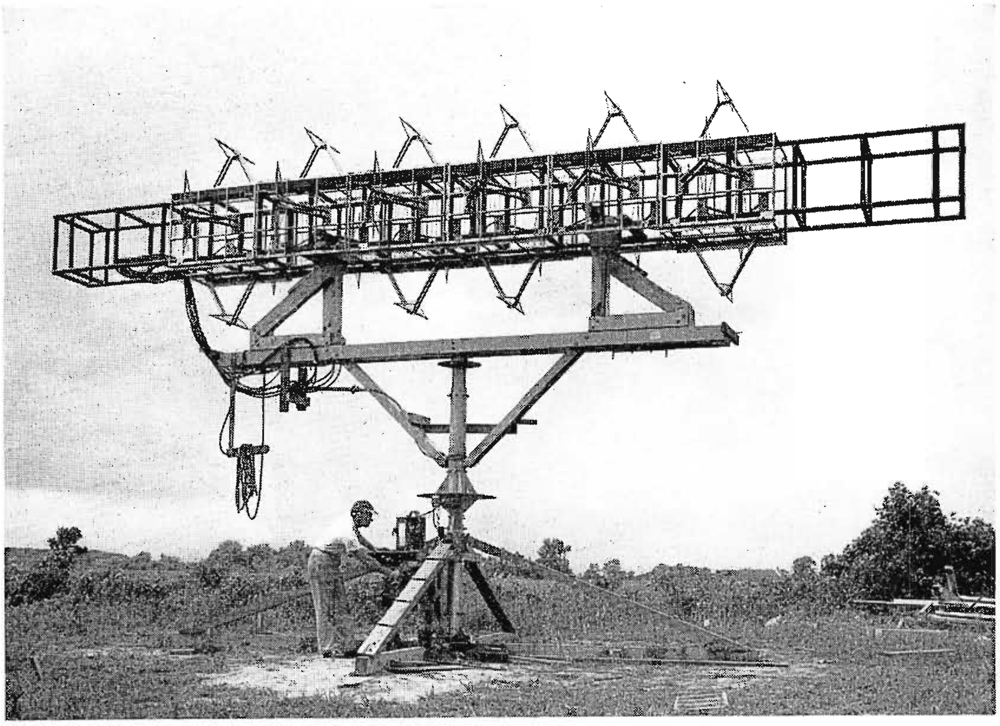


FIG. 8. Method of Determining Vertical Pattern.

This calculation makes a number of assumptions which gave a slightly optimistic result. Safety factors were allowed for these assumptions and the final measured gain checked quite closely. Subsequently, more precise methods were developed for the calculation of gain, especially for antennas using quadrature feed systems. These will be covered in future papers.

On the basis of the above calculations, it was determined that a directive gain with respect to a thin half-wave dipole of 4 and 5 could be achieved for Channels 2, 4 and 5 and Channels 7 and 11 respectively. These values were specified as target gains.

The experimental determination of gain was made by measuring the principal plane pattern of the Channel 7 antenna as shown on Fig. 8.

In this commonly accepted method, the antenna is mounted on its side and the dipoles radiating parallel to the ground are energized. For operating convenience, the antenna is used as a receiving antenna which will give correct results in accordance with the reciprocity theorem. The vertical pattern is obtained by rotating the antenna and recording the received signal. A great number of precautions were taken to assure correct results. This information was then scaled to the other channels. The exact procedure for determining gain is as follows:

1. Record the field pattern of the horizontally polarized field component in the principal vertical plane.
2. Square this pattern to obtain a power distribution and plot it against the cosine of the vertical angle, θ, (measured from the array axis) on rectangular coordinate paper.
3. By means of a planimeter, or other methods, find the area under the plotted power pattern and under the circumscribing rectangle which shares the same base line as the pattern plot.
4. The directive gain in the maximum direction relative to an isotropic radiator is the ratio of the rectangular area to the area under the pattern plot.
5. The gain thus found is divided by 1.641, which adjusts it to gain relative to a one-half wavelength thin dipole.

Gain measurements for a great number of conditions were necessary; for instance, the tower offset between Channels 5 and 7 had to be simulated to determine its effect. The same was true of the tapered dome of the Empire State Building with respect to the Channel 2 antenna. As pointed out later, the Channel 2 and 5 antennas were split into two separate antennas of two and three bays each for the purpose of providing emergency antenna service. The gain for each of these conditions as well as the combined antenna had to be determined. During the investigation, the Channel 7 antenna was rephased, at the request of the station, reducing the horizontal gain to obtain a higher field close to the antenna. Later, it was determined that the best method of providing FM service was the location of FM dipoles between the Channel 2 dipoles. The effect of these dipoles on this antenna was also determined. While some of these changes resulted in a second-order effect, nevertheless, the problems merited investigation to insure no serious changes developing at a later date.

Fig. 9 tabulates the results of gain measurements for various conditions. The direc-

FIG. 9. Results of Gain Measurements for Various Conditions.

	TELEVISION													FM		
Channel	11		7		7		5		4		4	2		97.1 Mc.[1]	95.5 Mc.	101.1 Mc.
			Equally Phased		Rephased				Equally Phased		Re-phased					
	Visual	*Aural*	*Visual*	*Aural*	*Visual*	*Aural*	*Visual*	*Aural*	*Visual*	*Aural*	*Visual*	*Visual*	*Aural*			
Antenna Directivity Gain	5.40	5.55	5.59	5.74	3.94	4.04	4.17	4.50	4.48	4.79	3.95	4.00	4.43	6.24	.707	.707
Upper Portion	—	—	—	—	—	—	1.45	1.57	—	—	—	2.49	2.75	—	—	—
Lower Portion	—	—	—	—	—	—	2.52	2.72	—	—	—	1.61	1.78	—	—	—
Feed Cable Eff. %	95	95	94.4	94.4	94.4	94.4	95.4	95.2	97.2	96.7	97.2	95.1	94.8	96	94.8	94.8
Power Equalizer Eff. %	—	—	—	—	—	—	98.9	98.1	—	—	—	97.2	96.9	—	—	—
Net Gain	5.12	5.28	5.28	5.42	3.72	3.80	3.93	4.21	4.36	4.63	3.85	3.71	4.06	6.00	.67	.67

[1] Triplexed on the Channel 4 antenna.

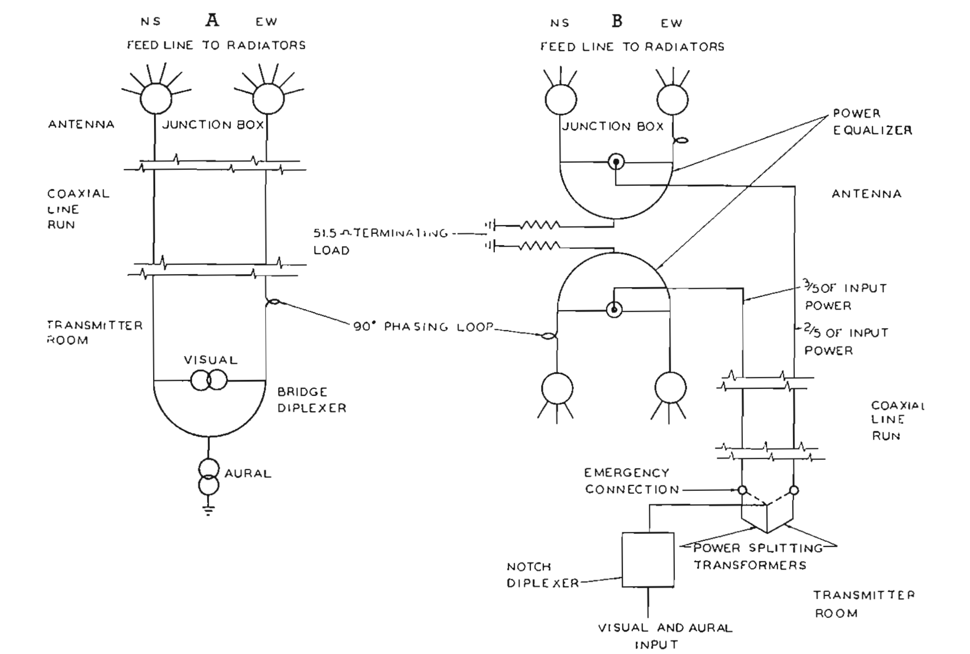


FIG. 10. Schematic Portrayal of Antenna System Showing Inner Conductors Only.

10a. Bridge Diplexer Feed System Chosen by Stations on Channels 4, 7 and 11.

10b. Notch Diplexer Feed System with Split Antenna Arrangement for Emergency Service Chosen by Stations on Channels 2 and 5.

tive gain, as well as the net gain, is given. The net value takes into account losses in the RG-35/U feed cable between the junction box and the radiator and also in the power equalizer. The power equalizer and its function are more fully discussed in the paragraph under broad-banding. The diplexer and the coaxial line efficiencies are not charged to the net antenna gain. For most commercial antennas, the net gain is specified. For the Empire State antenna system, however, the directive gain was specified. It will be seen that the target values of directive gain were achieved in the apertures that were available.

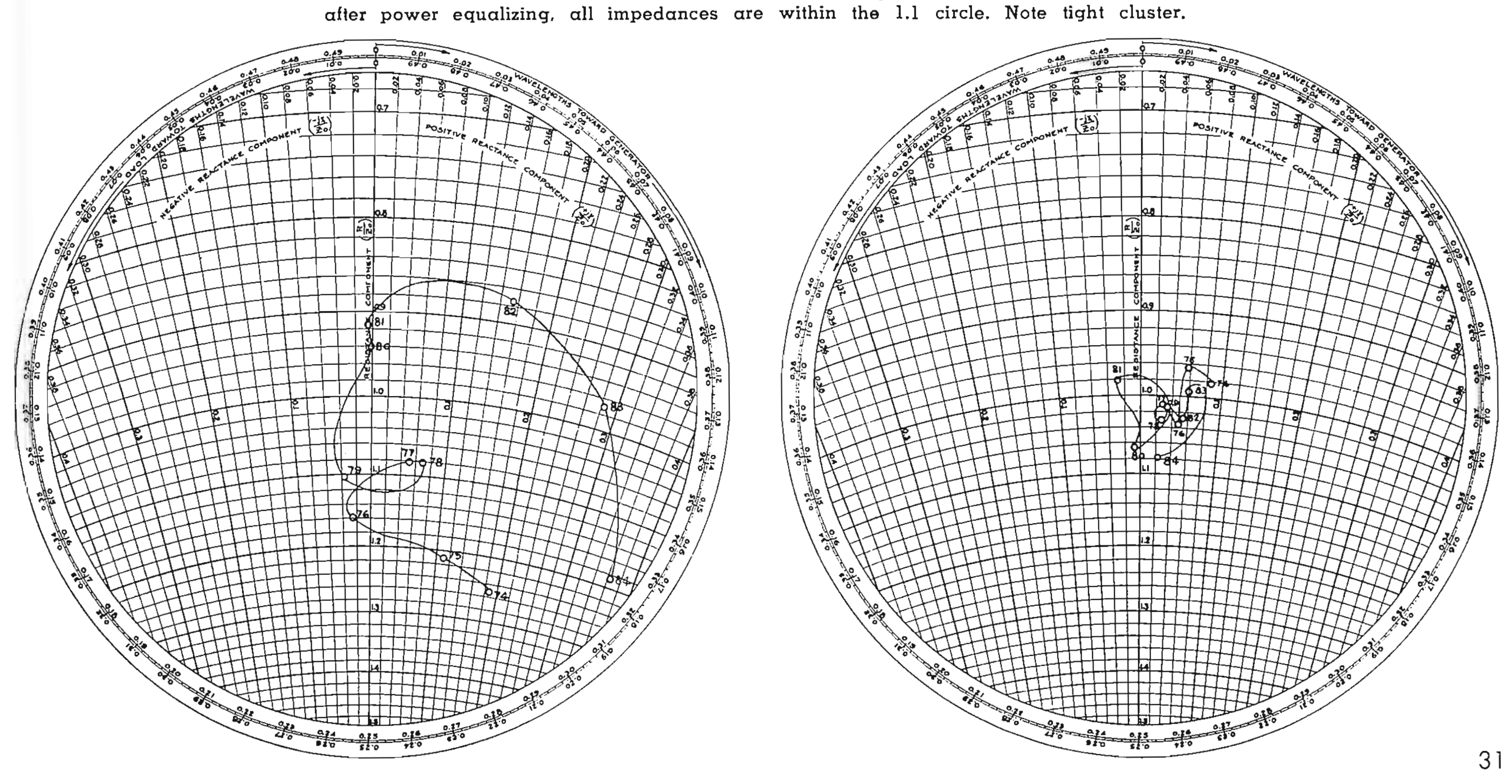
Bandwidth

While previous experience with the Supergain antenna indicated that the required bandwidth could be achieved, the problem was interrelated with effects due to the close proximity of the antennas, the necessity for different spacings between radiators to achieve the required gain, special junction boxes to handle the power, and a new type of feed cable. Since it was necessary to erect adjacent pairs of antennas on towers to determine the amount of coupling, as discussed earlier, the opportunity presented itself to make a thorough check of bandwidth under all of the special operating conditions required.

Since several possibilities presented themselves, the five stations were given a choice of feed systems. Stations on Channels 4, 7 and 11 chose the bridge diplexing arrangement shown in Fig. 10a; while stations on Channels 2 and 5 chose the notch diplexing arrangement with the bridge power equalizer shown in Fig. 10b. An additional variation offered was chosen by Channels 2 and 5 in which the upper and lower portions of the antenna were treated as two separate antennas with separate feed systems, power equalizers and coaxial lines. This permitted emergency operation with one portion of the antenna operating independently of the other.

As a result of experience with many television installations, it was known that the voltage standing wave ratio (VSWR) over the visual band had to remain within the limits of 1.1 to 1 to obtain satisfactory operation. This value was indicated as one of the target specifications.

FIG. 11. Smith Chart Indicating Improvement Due to Power Equalizer for Channel 5 Antenna. It will be noticed that before power equalizing the max. VSWR is 1.45, and after power equalizing, all impedances are within the 1.1 circle. Note tight cluster.



Since the Channel 4 Superturnstile antenna and the Channels 7 and 11 Supergain antennas had broad-band characteristics sufficient to achieve the necessary VSWR over the band, the standard bridge diplexing method was used. The operation of the bridge diplexer is well known, having been described in a previous article.[2] For Channels 2 and 5, power equalizing is desirable to achieve the required bandwidth since at the lower frequencies the percentage of bandwidth with respect to the transmitted frequency is greater. The power equalizer inherently improves the VSWR over the band by trapping reflected energy from the antenna. Fig. 11 indicates a Smith Chart plot of a portion of the Channel 5 antenna before and after power equalizing. The improvement is quite obvious. A more detailed description of this device is given in a previous article.[3] The amount of energy absorbed for reasonable VSWR's is negligible. For instance, if the VSWR is 1.22, the reflection coefficient is 10%, and only 1% of the power is dissipated.

In the split antenna arrangement, two coaxial lines are brought into the transmitter room where they are combined by a power splitting transformer which by transformation, splits the power from the transmitter to each portion of the antenna as required. The visual and aural signals are combined in a notch diplexer which is a frequency selective network permitting simultaneous operation of visual and aural transmission into one antenna system without interference.

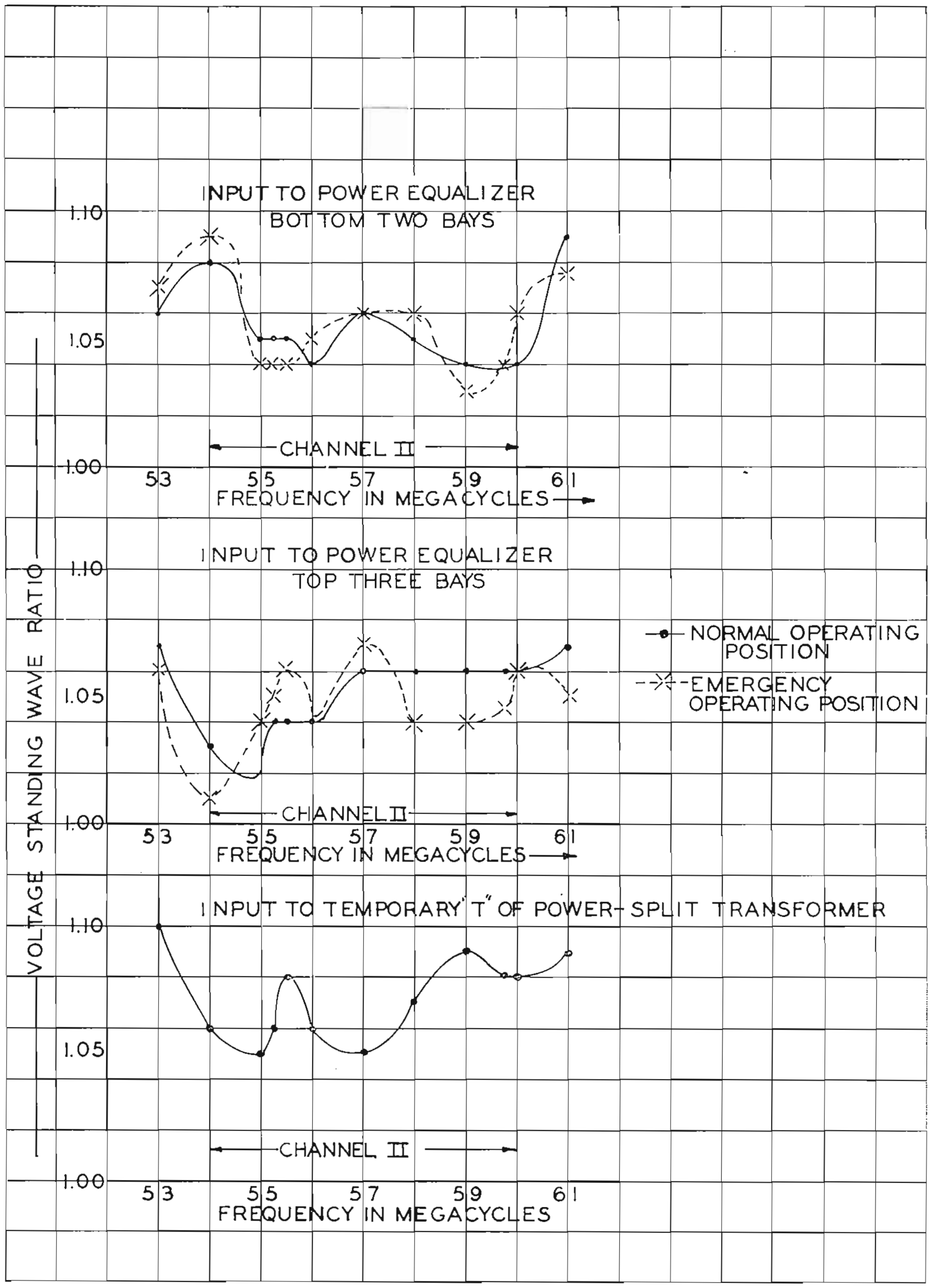


FIG. 12. Voltage Standing Wave Ratio Curves vs. Frequency for Channel 2.

Maximum Power Rating of Components

Feed cable max. VSWR	1.20
Feed cable VSWR derating factor	0.950
Feed cable temperature derating factor	0.788
Feed cable total derating factor	0.749
Feed cable power capacity before derating	1400 Watts
Feed cable power rating after derating	1049 Watts
Feed cable average power, visual, for 100 KW ERP	479 Watts
Feed cable average power, aural, for 100 KW ERP	396 Watts
$\frac{\text{Power Carried}}{\text{Rated Power}}$ of feed cable for 100 KW ERP	0.835
*Average power output of transmitter for 100 KW ERP	24.8 KW
**Maximum ERP possible within limit of feed cables	120 KW

* Assumes that diplexer handles 25 KW.
** Assumes that diplexer handles 30 KW.

FIG. 13. Typical Calculations Establishing the Power Rating of the Feed Cable.

The VSWR over the band was measured for a number of conditions including the N-S and E-W portions of each antenna before diplexing or power equalizing; and also the upper and lower portions of each antenna individually and combined by the power split transformer. Fig. 12 is a typical chart of VSWR vs. frequency for various conditions for Channel 2.

Circularity

Since the Empire State Building is substantially in the center of the service area, omni-directional coverage was satisfactory. The specification for circularity was ± 2 db. which was demonstrated with a single set of screens at Channel 7. The work was carried on in a manner similar to the vertical pattern work previously described.

Power Handling

One of the requirements for the Empire State antenna was the ability to obtain an effective radiated power of 100 KW from the antenna. This decision was made and the antenna substantially built before the later proposals were made by the F.C.C. Since there were relatively few elements (sixteen or twenty on the low band, and twenty-four on the high band) and since the gain was proportionately low, each feed cable had to handle a relatively large power. Investigation revealed that RG-35/U cable was satisfactory for the purpose. Fig. 13 indicates a typical calculation which establishes deratings for VSWR and temperature above ambient for which the cable rating is made.

FM Considerations

Three FM services were desired in addition to the five television services. Of these, the one for NBC, on 97.1 Mcs. was triplexed on the Channel 4 antenna by methods previously described.[4]

Two other services for 95.5 Mcs. and 101.1 Mcs. were required. A number of experiments were made to find a location where the FM dipoles, which are similar to the Supergain dipoles, could be located with negligible effect on the impedance and pattern characteristics of the television antenna. These experiments indicated that the best location was in the Channel 2 array. The method employed is shown in Fig. 14. Both FM frequencies were diplexed into the single set of four radiators. A VSWR of 1.03 was achieved for both frequencies, using a transformer designed for specific matching at the two carrier frequencies.

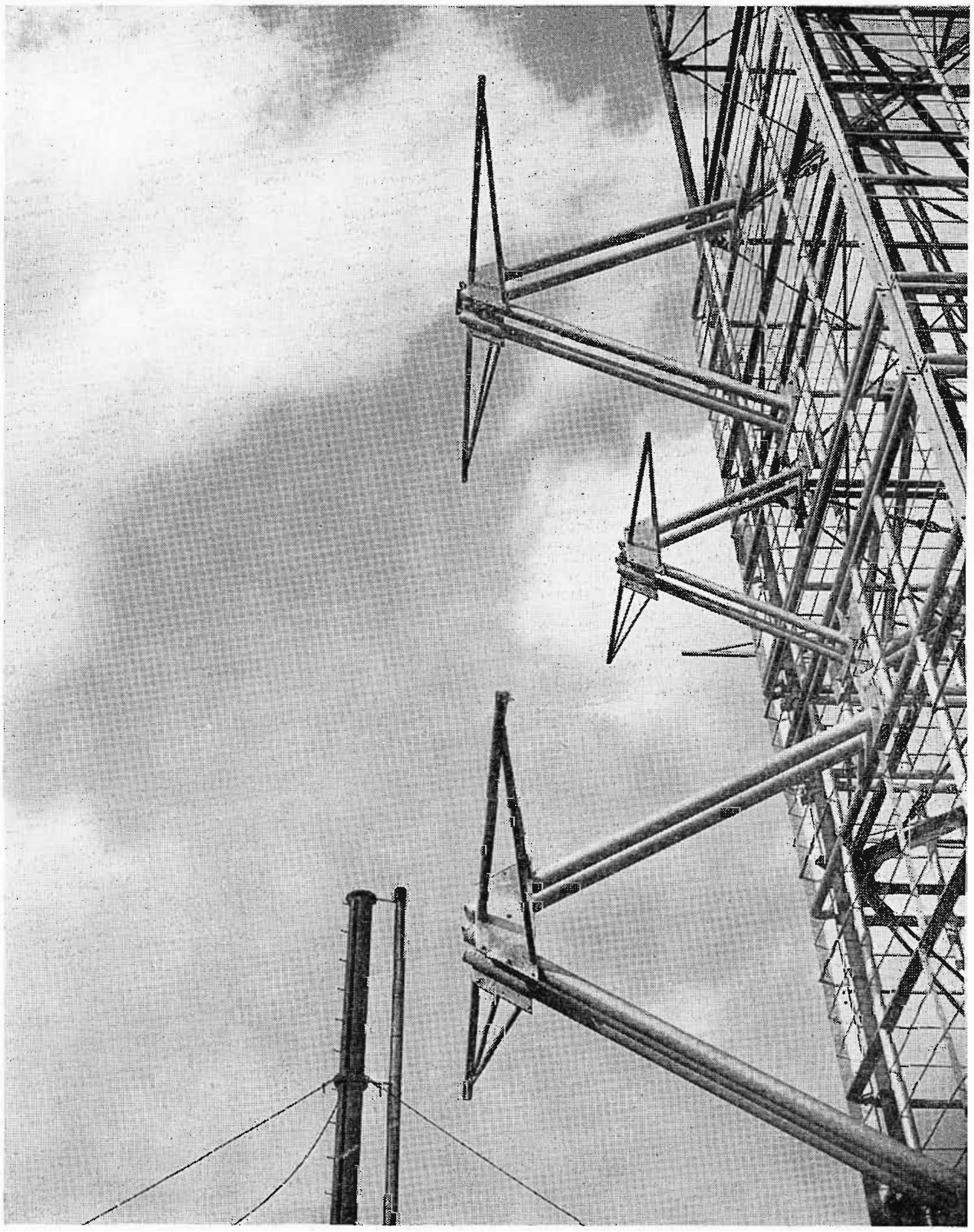


FIG. 14. FM Dipole Located in the Channel 2 Array.

Gain was measured by using a set of Channel 7 screens to simulate the Channel 2 antenna. The FM dipoles were then scaled to 320 Mcs. The gain, determined by the method previously described, taking into account the fact that the circularity was not optimum, for the FM frequency on the Channel 2 tower was .707 over a half-wave dipole.

Acknowledgment

The work described herein on the Empire State antennas is the work of many men. L. J. Wolf is responsible for much of the supervision and planning. R. W. Masters, formerly associated with RCA and presently engaged as a consultant to RCA for this project, is responsible for the basic theoretical work on Superturnstile and Supergain antennas. In addition, 14 other engineers were engaged on various parts of the project.

Bibliography

1. S. A. Schelkunoff, "Electromagnetic Waves," p. 352, Section 9.15.
2. L. J. Wolf, "High Gain and Directional Antenna for TV Broadcasting," Broadcast News, Vol. 58, March-April, 1950.
3. R. W. Masters, "A Power Equalizing Network for Antennas," Proc. IRE, Volume 37, p. 735, July, 1949.
4. L. J. Wolf, "Triplex Antennas for Television and FM," Electronics, Vol. 20, p. 88, July, 1947.

DENVER'S NEW KFEL-TV IS FIRST "POST-FREEZE" STATION

RCA Air Shipment of TV Equipment Aids KFEL-TV to Go "ON-AIR" One Week After Construction Permit

Television's *first post-freeze station,* KFEL-TV, went on-the-air during mid-July, just one week after receipt of their formal construction permit. This unprecedented record was made possible by the cooperation of many people and firms, by several years of planning and coordination by the station's management, and through all expedition possible under law by the Federal Communications Commission. In fact, the station was in operation months in advance of what had been considered the earliest possible date.

Gene O'Fallon, Manager of KFEL-TV stated, "The Radio Corporation of America, suppliers of our present temporary and of our permanent television equipment, clinched this early starting date by a public service job for the city of Denver which is unbelievable even now. Only its technical skills, manufacturing facilities and complete willingness to go all out to expedite this event have made it possible."

FIG. 1. Shown at the assembly of Superturnstile Antenna on Lookout Mountain are Tom G. Morrissey, Chief Engineer of KFEL-TV, and E. T. Griffith, Operations Coordinator of Broadcast Sales, Engineering Products, RCA.

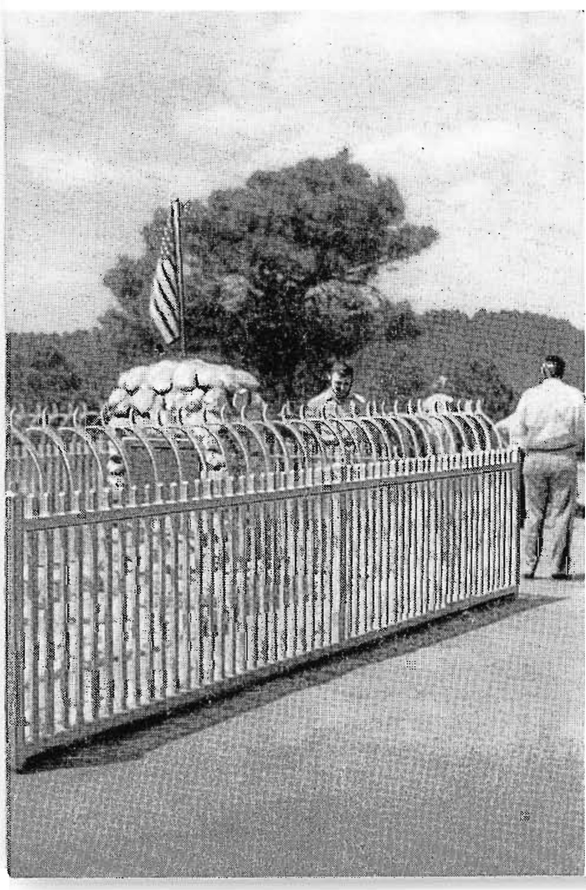


FIG. 2. Buffalo Bill's grave lies only a hundred yards from Denver's first TV station.

Site Near Buffalo Bill's Grave

Early planning of this station began in 1948 when a license to operate an experimental, ultra high frequency transmitter was granted. An exhaustive search indicated a location on Lookout Mountain, near Buffalo Bill's grave, as a theoretically ideal site for a television transmitter. It was a perfect answer to such problems as complete line-of-sight blanketing of metropolitan Denver, available power and water supply, and year-round accessibility by road. Its desirability was confirmed by extensive experiments, using WØXEL's transmitter from this location and, in October of 1948, the site was purchased. The "quonset-type" building which now houses the transmitter was built in 1951.

KFEL's original application for Channel 2 was filed during the "freeze" in February of 1951. The corporation acquired the building which now houses the studios at 546 Lincoln Street in March of 1952 and promptly remodeled it for studios.

A contingent order for the station's transmitter was placed with RCA in January of 1951, and when installed at KFEL-TV, will be RCA's most modern and efficient 2-kw transmitter, the TT-2AL. This will be done by adding a 2-kw amplifier to the TT-500A.

Immediately following the lift of the television "freeze order" on May 24, 1952, KFEL's amended application for Channel 2 was filed, complying with the terms announced by the commission for the filing and consideration of new applications. Following the July 11th announcement, KFEL plunged into action. Telephone conferences with RCA gave hope of having a temporary 500 watt transmitter on the air in less than ten days providing a Special Temporary Authority for operation could be secured, and the supply and construction schedules

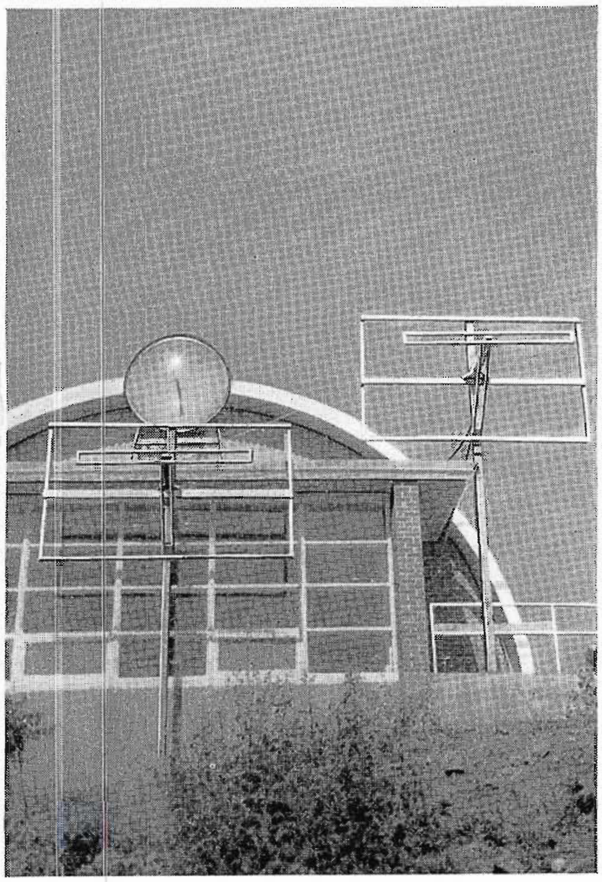


FIG. 3. Transmitter building showing microwave reflector which receives signal from studios downtown.

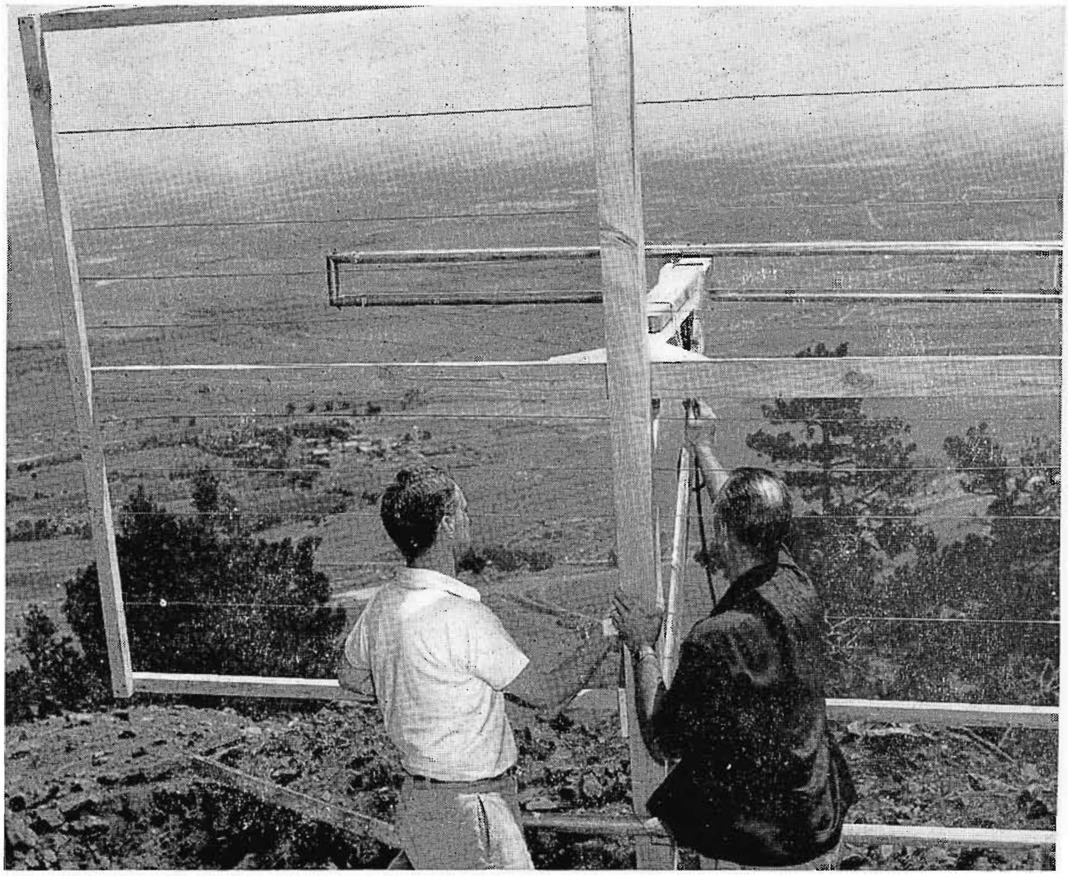


FIG. 4. Temporary visual antenna that was built on the spot while three-section Superturnstile was being assembled.

met. The station management immediately filed by telegram an application for Special Temporary Authority to operate KFEL-TV.

4½ Ton Air Shipment

Over four and one-half tons of heavy and delicate equipment were rushed to Denver by specially chartered planes of the Flying Tigers Lines. An idea of the extreme speed and dispatch used in handling the order is realized in that the first plane was headed west less than 24 hours after the order came in. Additional airborne shipments via Flying Tigers Lines included RCA Victor TV Receivers and various parts and accessories. Also flown to the scene were E. T. Griffith, Operations Coordinator from RCA, and Ray Colvin, Field Representative from RCA Service Company to cooperate with KFEL Engineers, Tom Morrissey, Scotty Cullen, John Senneff, and Eddie Roman.

On July 17, the Commission considered the application, and at a special emergency meeting, the request was granted, and by 8:15 p.m., July 18, the first test pattern from Denver was on the air—the first new television station in four years.

Five Stages of Installation Planning

The construction of the permanent transmitter and antenna is proceeding without delay in a series of four stages.

STAGE ONE . . .

Transmitter—RCA Type TT-500A, 500 W visual power and 250 W aural output.

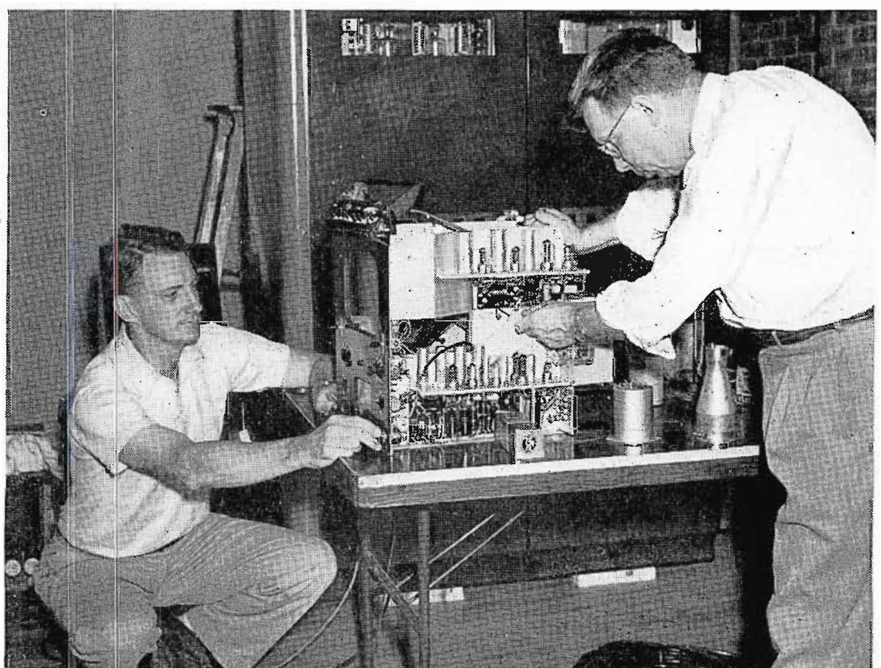


FIG. 5. Tom Morrissey and Ray Colvin, RCA Service Company Field Representative with Master Monitor in transmitter shack. In background is TT-500A.

FIG. 6. One of several chartered planes rushed to Denver, unloading RCA equipment.

FIG. 7. The three-section Superturnstile and two-section FM Pylon Antennas being transferred from plane to truck at Stapleton Airport, Denver.

FIG. 8. (l. to r.) Griffith, Morrissey and Colvin with antennas ready for transport to Lookout Mountain. The two-section FM Pylon is being used temporarily to attain height until tower is available (see "Stage Four" below).

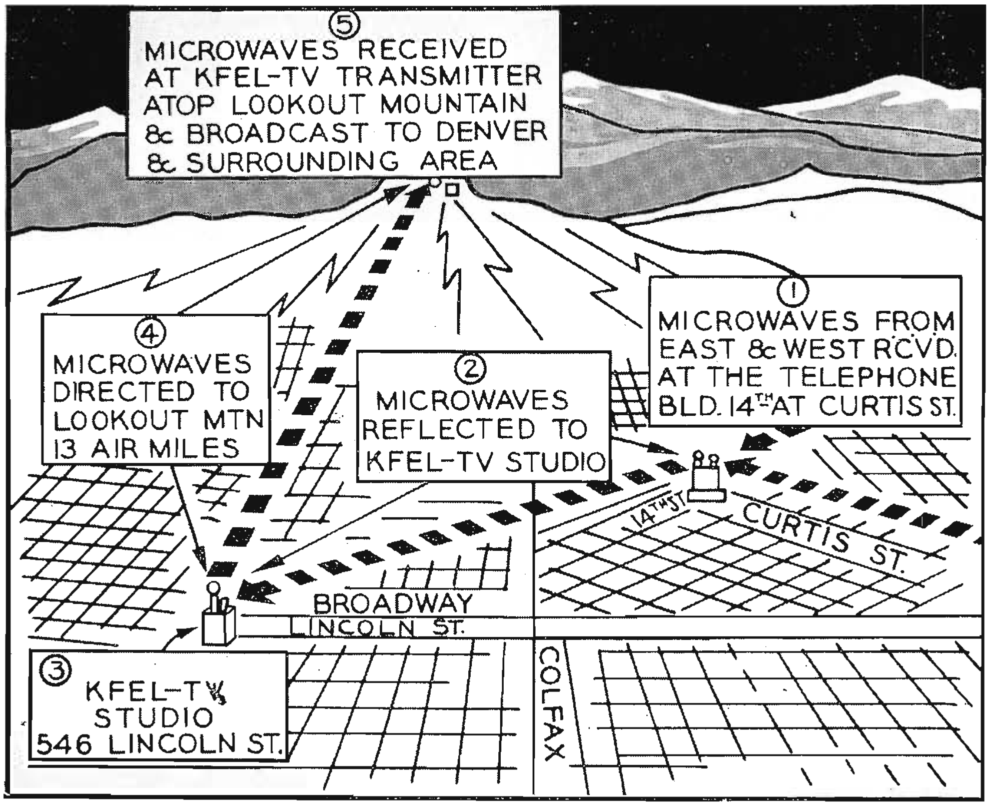


FIG. 11 (above). Artist's sketch showing microwave relay system.

Antenna—Composite aural and visual dipole transmitting antennas approximately 25 feet above ground, 647 feet above average terrain.

Transmission Line—50 feet of RG-8/U to each antenna.

STAGE TWO . . .

Two KW Amplifier to be added to the RCA Type TT-500A Transmitter making it a standard RCA Type TT-2AL Transmitter with visual power output 2 KW and aural output 1 KW.

Antenna—RCA Type TF-3C, 3-Section Superturnstile, overall height 77 feet, center of antenna 53 feet above ground, 680 feet above average terrain.

Transmission Line—80 ft., 1⅝" rigid coax line, dual run using bridge diplexer.

STAGE THREE . . .

Transmitter Location—Same (Lookout Mountain).

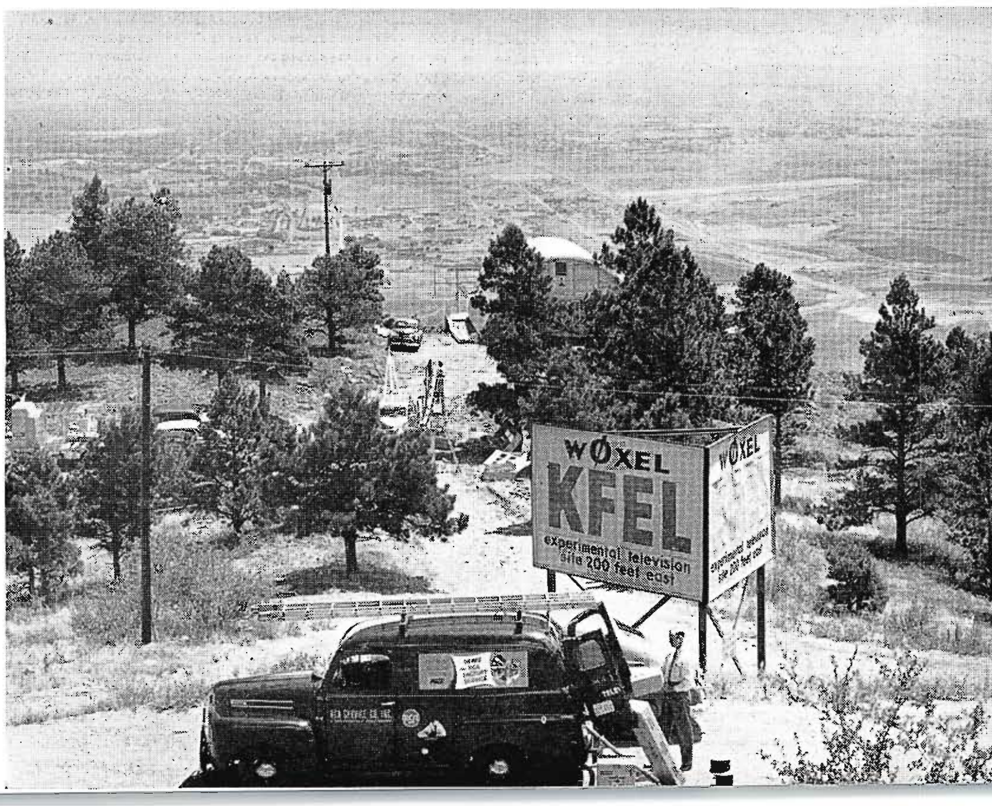
Transmitter—RCA Type TT-2AL, 2 KW visual power and 1 KW aural output.

Antenna—RCA Type TF-6AL, 6-Section Superturnstile Antenna mounted on top of 100-foot supporting tower as specified in Application File No. BPCT-691, as granted. Center of antenna will be 778 feet above average terrain.

Transmission Line—175 feet RCA Type MI-19113 Rigid Coaxial Transmission Line, 3⅛"—same as specified in Application File No. BPCT-691, as granted.

Date for Operation—Sept./Oct., 1952.

It is to be Noted that the installation and operation planned for Stage Four is as



◀ FIG. 12. The installation as viewed from Buffalo Bill's grave, with city of Denver in the distance.

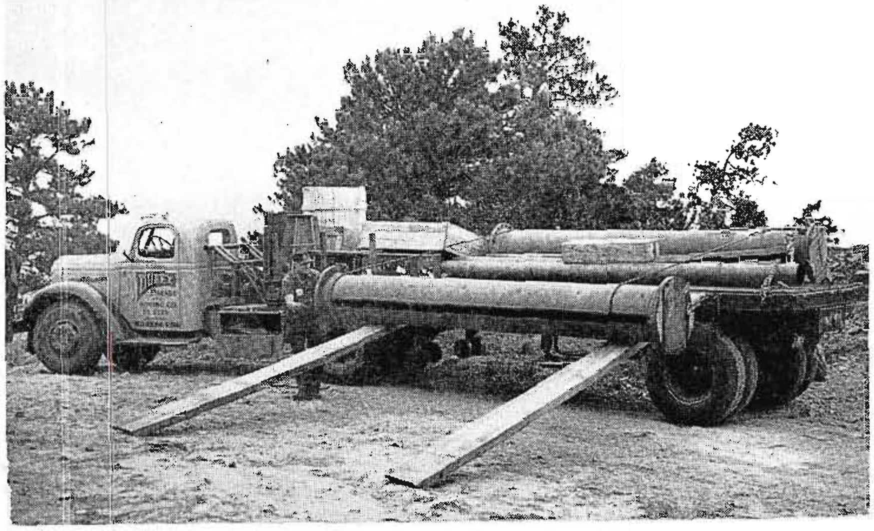


FIG. 9. Part of the two-section FM Pylon being unloaded at the site.

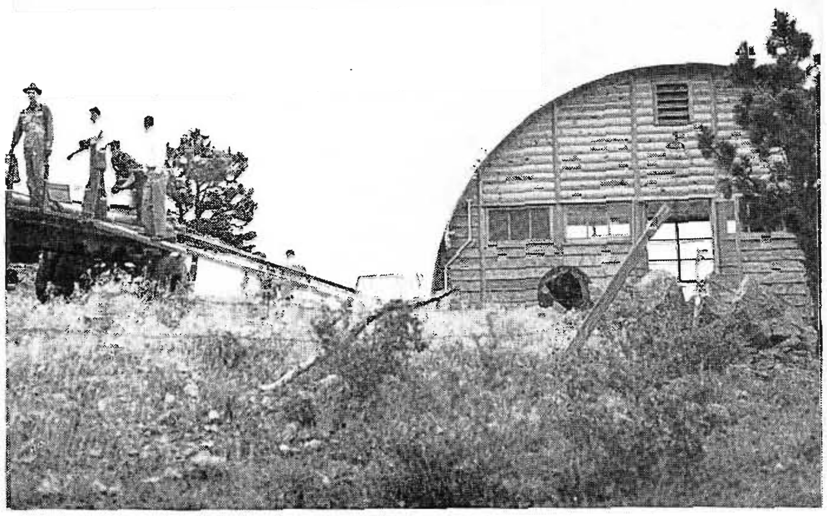


FIG. 10. Rear view of transmitter building. Antenna was installed in lower right foreground.

specified in Application No. BPCT-691 except for the transmitter to be used.

STAGE FOUR . . .
Final construction in accordance with the specifications in Application File No. BPCT-691, as granted, with visual ERP of 56.5 KW (17.5 dbk) at an antenna height of 778 feet above average terrain. Completion expected latter part of January or early February, 1953.

The accompanying map shows the coverage afforded by the present temporary transmitter and antenna. Grade A service is afforded to most of Denver, and Grade B, a less satisfactory and weaker signal, may be available in the arc indicated by the "GRADE B" line. Successive advances in power and antenna quality will extend this pattern greatly with each one of the five successive steps in the permanent construction. KFEL-TV is pleased to announce its temporary affiliation with the television network of the National Broadcasting Company, and will have available to it on occasion programs from other networks as well.

Additional key personnel already named by Gene O'Fallon, Manager of KFEL-TV, and Frank Bishop, Managing Director, for the initial operation of KFEL-TV include: Bill Conklin, National Sales Manager for both AM and TV operation; Robert A. Hart, Jr., local TV Sales Manager; Duncan Ross, TV Traffic Manager; Harry Mack, Director and Producer; and Joy Shepard, Administrative Supervisor. Also named to the TV production staff are Don Arthur, Harry Honstein, Warren Huskie, Al Eirish and Morey Jones who have completed nearly eight months training in KFEL's TV workshop.

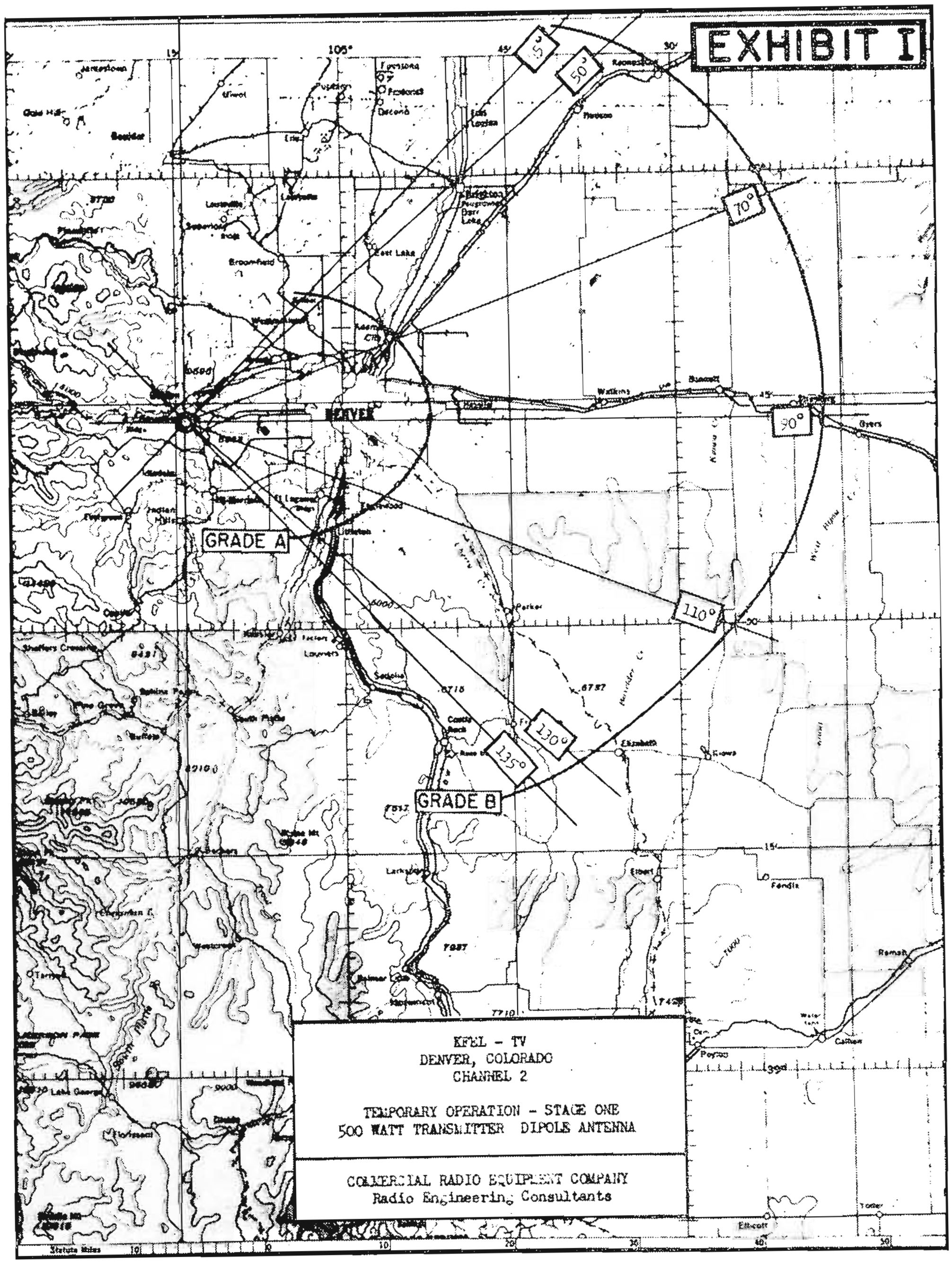


FIG. 13. Map of present television coverage of Denver and distant flat country eastward. The outer arc will be progressively extended within the next six months, giving a strong signal to distant communities.

TV ENGINEERING REQUIREMENTS FOR FCC APPLICATIONS

By
IRL NEWTON
Product Administration Section
Broadcast Antenna Equipment

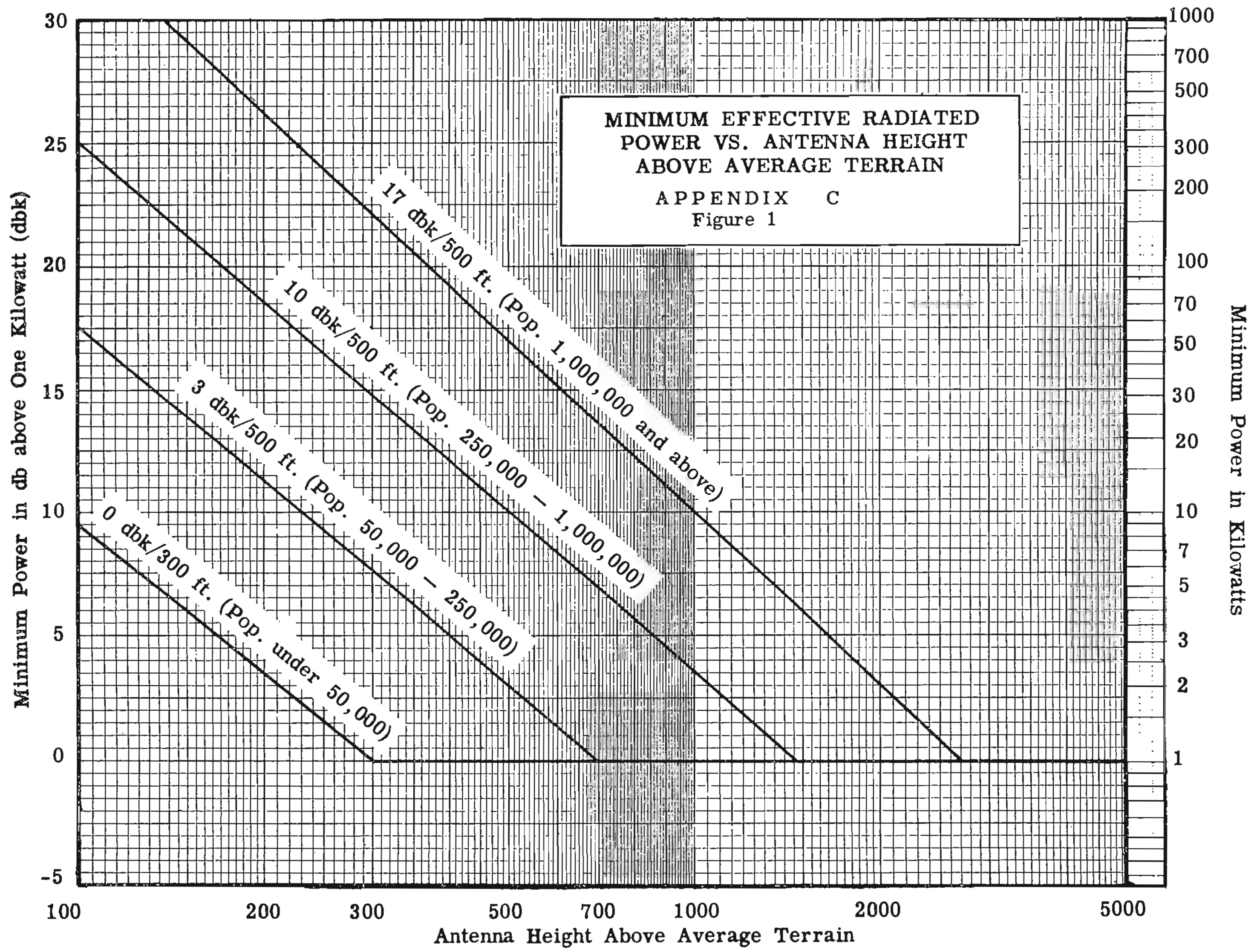
Most AM and FM Broadcast Stations planning for Television, and existing TV Stations planning expansion, are well versed in the requirements of formal FCC applications. However, some groups planning TV Station construction may be less familiar with these requirements. This article is intended to be helpful in reviewing engineering requirements for the initiated and in clarifying the technical considerations for the uninitiated. For both classes of TV planners, familiarity of their technical staffs with the rules and requirements will aid them in making the necessary and correct planning decisions concerning site locations, equipment to be used, station layout and other factors.

TECHNICAL REQUIREMENTS

FCC Form 301 must be filed with the Federal Communications Commission to obtain a Construction Permit for a Television Station, and Form 302 must be filed with the Commission to obtain a station license after construction has been completed. Normally, the technical sections of the forms are prepared by an Engineering Consultant. The service of a qualified Consultant is highly desirable due to the many phases of TV Station planning that require access to FCC files and up-to-the-minute records plus the necessity of detailed and intimate familiarity with the FCC Rules, Interpretations, and Procedures.

However, it is also important that the station technical director or chief engineer be cognizant of the information required by the FCC in order to fully understand the functions of the Consultant and to permit intelligent station planning and compliance with the FCC Rules and Regulations.

FIG. 1. These curves of antenna height versus power represent typical data for communities of 50,000 to 1,000,000 and above.



In Form 301, Sections V-C and V-G contain a number of questions concerning the technical phases of its proposed operation. These must be answered carefully and correctly. The questions are discussed below in the proper numerical sequence beginning with Section V-C.

FORM 301 SECTION V-C

1. Purpose of authorization applied for:

   Indicate by check mark whether for the construction of a new station or indicate the nature of the changes proposed if for the modification of an existing station or an outstanding Construction Permit.

2. Facilities requested:

   The upper and lower frequency limits of the various Television channels are listed in Section 3.603 of the FCC Rules and Regulations. The Channel Number requested must be a channel assigned to the city specified in the Table of Assignments (Section 3.606). If no channel is assigned to the city, and the city does not qualify under the 15 mile rule or if authorizations have already been made on the channels listed in the Table of Assignments, a prior petition must be filed with the FCC for Amendment of the Table of Assignments. Such petitions must be submitted in accordance with Section 3.609 and comply with the separations set forth in 3.610.

   The Effective Radiated Power and Antenna Height above average terrain must agree with the entries under 9(a) and 12, respectively.

3. (a) Antenna Structure:

   Section 3.685 of the "Rules" reads in part as follows:

   (g) Applications proposing the use of television broadcast antennas within 200 feet of other television broadcast antennas operating on a channel within 20 percent in frequency of the proposed channel, or proposing the use of television broadcast antennas on channels 5 or 6 within 200 feet of FM broadcast antennas, must include a showing as to the expected effect, if any, of such proximate operation.

   (h) Where simultaneous use of antennas or antenna structures is proposed, the following provisions shall apply:

   (1) In cases where it is proposed to use a tower of a standard broadcast station as a supporting structure for a television broadcast antenna, an appropriate application for changes in the radiating system of the standard broadcast station must be filed by the licensee thereof. A formal application (FCC Form 301) will be required if the proposal involves substantial change in the physical height or radiation characteristics of the standard broadcast antennas; otherwise an informal application will be acceptable. An application may be required for other classes of stations when the tower is to be used in connection with a television station.

   (2) When the proposed television antenna is to be mounted on a tower in the vicinity of a standard broadcast directional array and it appears that the operation of the directional antenna system may be affected, an engineering study must be filed with the television application concerning the effect of the television antenna on the directional pattern. Readjustment and field intensity measurements of the standard broadcast station may be required following construction of the television antenna.

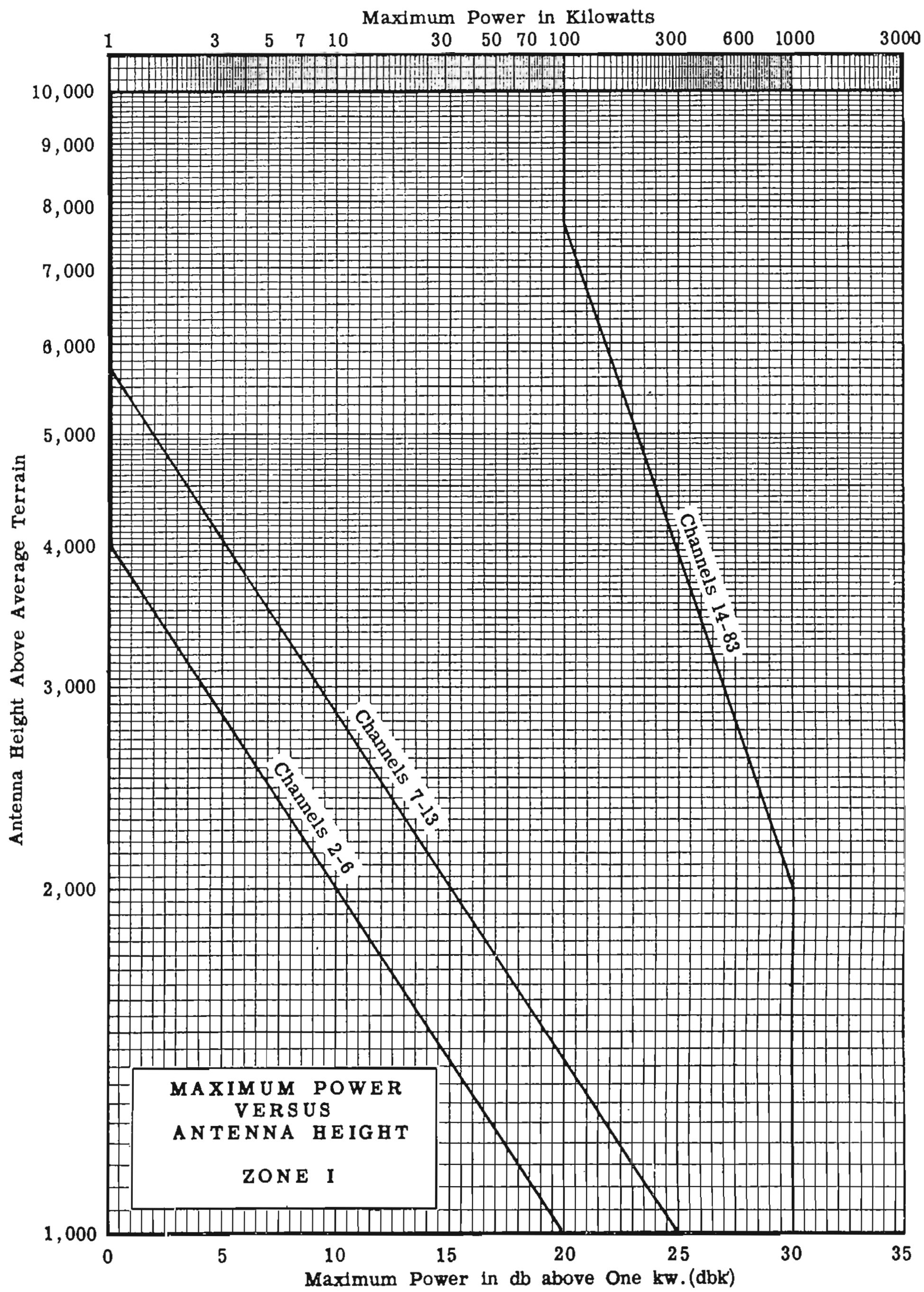


FIG. 2. Zone I, maximum power versus antenna height curves for Channels 2-13 (VHF) and 14 to 83 (UHF).

Ground level elevations may be obtained from the U. S. G. S. Topographical Maps. The height of the antenna radiation center is the physical center of the TV radiating elements if uniform power distribution is used. If a split feed system and non-uniform power distribution is employed (such as RCA TF-12AL, TF-12AM, TF-12AH superturnstile antennas or custombuilt supergain antennas) the height of the radiation center will not be the same as the physical center. This data may be obtained from the manufacturer. See the RCA publication "Application Data and Filing Information for Television Stations."

3. (b) Antenna Data

The antenna specifications may be obtained from the manufacturer's literature. For RCA antennas see "Application Data and Filing Information for Television Stations." If gain is expressed in power gain, the gain in db may be obtained by the equation:

Gain in db $= 10 \text{ Log}_{10}$ power gain

Normally the visual and aural signals are diplexed and the same antenna employed.

A directional antenna may not be used for the purpose of reducing minimum mileage separation requirements but may be employed for the purpose of improving service or for the purpose of using a particular site. The following requirements apply:

(1) The ratio of maximum to minimum radiation in the horizontal plane may not exceed 10 db. (Maximum field ratio 3.162/1).

(2) The minimum ERP in any horizontal direction may not be less than the applicable minimum in Table I under Question (2).

(3) The maximum ERP in any horizontal or vertical direction may not exceed the applicable maximum in Table II under Question (2).

(4) The radiation above the horizontal must be as low as the state of the art permits and may not exceed the value in the horizontal in the same vertical plane.

Applications proposing the use of directional systems must be accompanied by the following:

(1) Complete description of the proposed antenna system.

(2) Orientation of array with respect to true north; time phasing of fields from elements (degrees leading or lagging); space phasing of elements (in feet and degrees); and ratio of fields from elements.

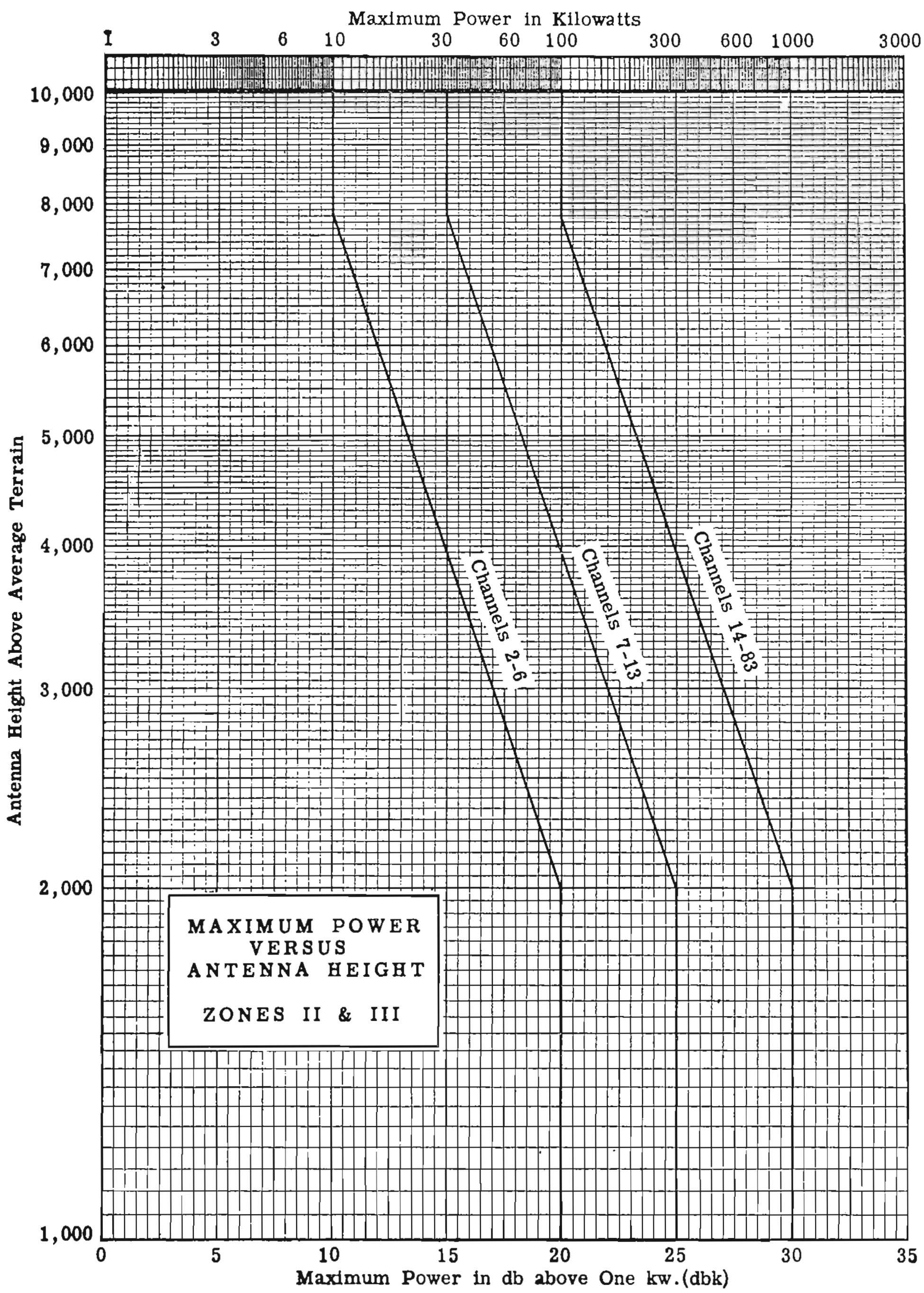
(3) Horizontal and vertical plane radiation patterns showing the free space field intensity in millivolts per meter at one mile and the effective radiated power, in dbk, for each direction. The method by which the radiation patterns were computed or measured shall be fully described, including formulas used, equipment employed, sample calculations and tabulations of data. Sufficient vertical plane patterns shall be included to indicate clearly the radiation characteristics of the antenna above and below the horizontal plane. The horizontal plane pattern shall be plotted on polar coordinate paper with reference to true north. The vertical plane patterns shall be plotted on rectangular coordinate paper with reference to the horizontal plane.

(4) Name, address, and qualifications of the engineer making the calculations.

4. Transmitters

The rated power should be obtained from manufacturer's specifications. If

FIG. 3. Zone II and III maximum power versus antenna height curves for VHF and UHF channels.



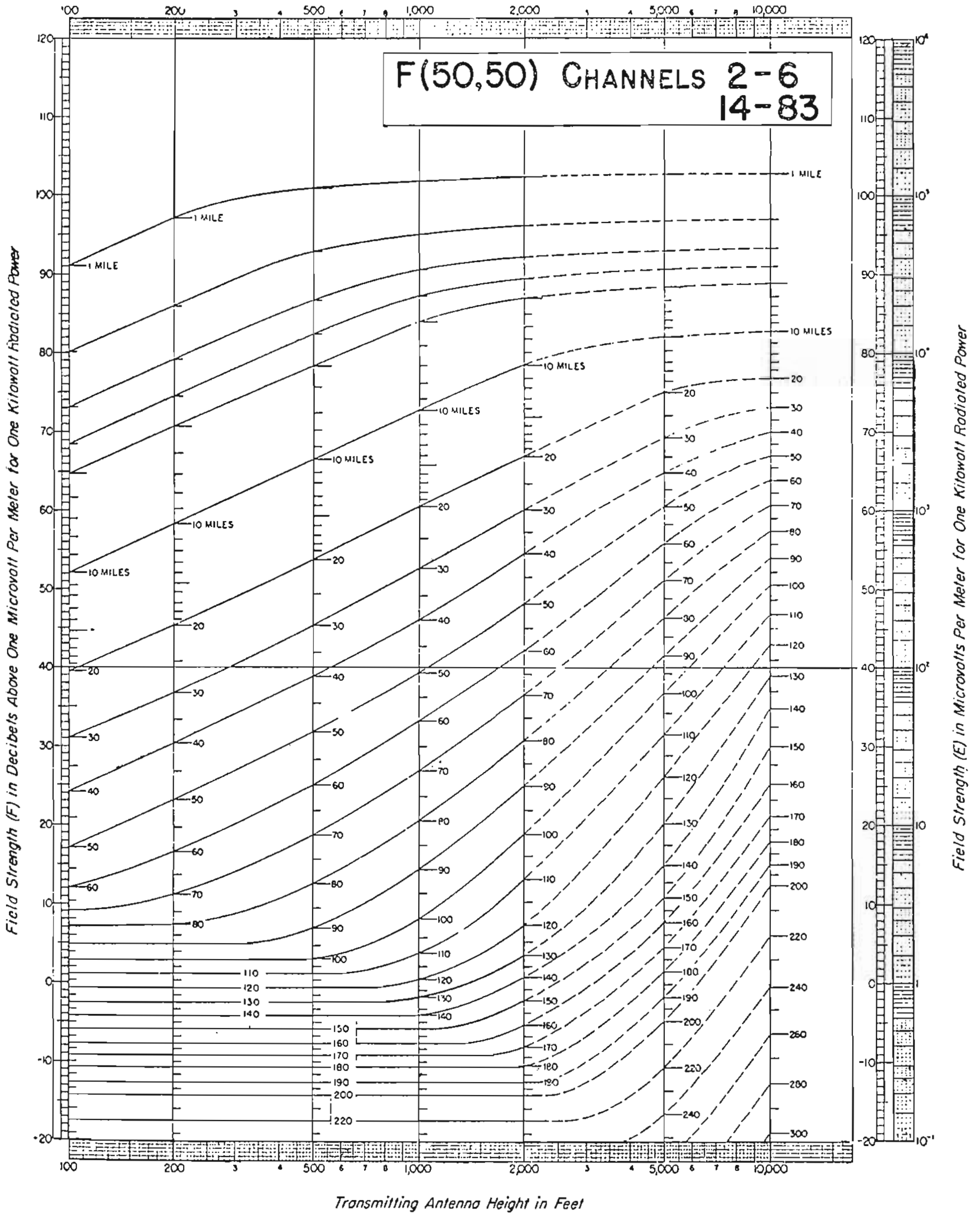


FIG. 4. Television Channels 2-6, 14-83. Estimated field strength exceeded at 50% of potential receiver locations for at least 50% of the time at a receiving antenna height of 30 feet.

given in watts or kilowatts only, dbk may be obtained by:

$$\text{Power in dbk} = 10 \log_{10} \frac{\text{Power in KW}}{1.0}$$

All RCA transmitters except the TT-500B, TT-2AL and TT-2AH are rated for an aural output of 60% of the visual peak power. These exceptions are rated at 50%.

The power output of RCA transmitters is determined with a load and wattmeter. The transmitter is operated into an RCA dummy load with a standard black television picture. Power is measured by a voltmeter cartridge coupled to the transmission line. Reflectometers incorporated in the visual and aural portions of the transmitter are then calibrated directly in terms of power readings from the dummy load. During normal operation power is maintained by transmitter output adjustment to maintain constant reflectometer readings. The method of power control is different with various transmitters and is on file with the F. C. C.

In accordance with F. C. C. Rule 3.689 the aural power will be measured by the indirect method using the efficiency factor established by the manufacturer as shown in the Transmitter Instruction Book.

5. Modulation Monitors

   Specifications from manufacturer's literature.

6. Frequency Monitors

   Specifications from manufacturer's literature.

7. Technical Description of Monitors if not Approved Types.

8. Transmission Line:

   The transmission line make, type no., size and whether coaxial or waveguide is determined by frequency, required efficiency to achieve desired ERP and cost considerations. The length is the horizontal run from the diplexer to the base of the tower plus the length up the tower to the antenna terminal point where the antenna gain is rated. Db loss of the line may be determined from the manufacturer's specifications. See RCA "Application Data and Filing Information for Television Stations."

9. Proposed Operation

$$\begin{matrix}\text{Effective Radiated} \\ \text{Power in dbk}\end{matrix} = \begin{matrix}\text{Transmitter} \\ \text{Power in dbk}\end{matrix} - \begin{matrix}\text{Multiplexer} \\ \text{Loss in db}\end{matrix} - \begin{matrix}\text{Transmission} \\ \text{Line loss in db}\end{matrix} + \begin{matrix}\text{Antenna} \\ \text{Gain in db}\end{matrix}$$

$$\text{Power in dbk} = 10 \log_{10} \text{Power in KW}$$

$$\text{Power in KW} = \text{Antilog}_{10} \frac{\text{Power in dbk}}{10}$$

If a directional is employed, the RMS value should be used. However, a showing of maximum value is required under 3(b).

RCA transmitter visual output is specified at the output of the sideband filter (or filterplexer, if used). Visual losses of the diplexer and aural losses of the diplexer or filterplexer are specified in "Application Data and Filing Information for Television Stations." The RCA filterplexer is a combination vestigial sideband filter and non-reflecting constant impedance notch diplexer. The filterplexer is used with all RCA UHF transmitters for single line feed to the antenna and is optional equipment for VHF transmitters. For VHF, a bridge diplexer is used for dual transmission lines.

Multiplexer Losses:

	Visual	*Aural*
MI-19028/19390 Diplexer	.004 db	.004 db
MI-19028C/19391 Diplexer	.004 db	.004 db
MI-19179 VHF Filterplexer		
Channel 2-6	*	.223 db
Channel 7-13	*	.706 db
MI-19086 UHF Filterplexer	*	.457 db

* Visual losses included in transmitter ratings.

10. RCA studio and other equipment is designed for compliance with the Commission's Rules.

11. (a) Maps

Topographic maps for most areas may be obtained at a nominal cost from:

U. S. Geological Survey
Department of Interior
Washington 25, D. C.

A state index of the available maps may be obtained from the same source.

(b) Profile Graphs.

Profile graphs of the terrain from 2 to 10 miles must be supplied for 8 or more radials from the transmitter location. Eight or more uniformly space radials (with at least one passing through the principal city) should be plotted on a U. S. G. S. Topographical Map if available. I. U. S. G. S. maps are not listed for the pertinent area, the best available maps should be used. The profile graph for each radial should be plotted by contour intervals of from 40 to 100 feet and where the data permits, at least 50 points of elevation should be used for each radial. The graphs should indicate the topography accurately and should be plotted with the distances in miles as the abscissa and the elevation in feet above mean sea level as the ordinate. Each graph should indicate the elevation of the antenna radiation center and the source of the topographical information.

If topographical maps are not available, topographical information may be obtained along roads generally along the radials from the transmitter site by mounting a sensitive altimeter in an automobile.

12. Radial Tabulations.

The average elevation of each radial from two to ten miles may be determined from the profile graphs with a planimeter or by averaging the median value of mile or half mile segments.

The height of the antenna radiation center above average elevation of the radial is the height of radiation center above sea level (Question 3a) minus the radial 2-10 mile average elevation determined above.

The ERP in each radial direction is equal for a non-directional antenna (computed under Question 9a). For a direction antenna the value should be taken from the horizontal pattern for each azimuth bearing of the individual radials.

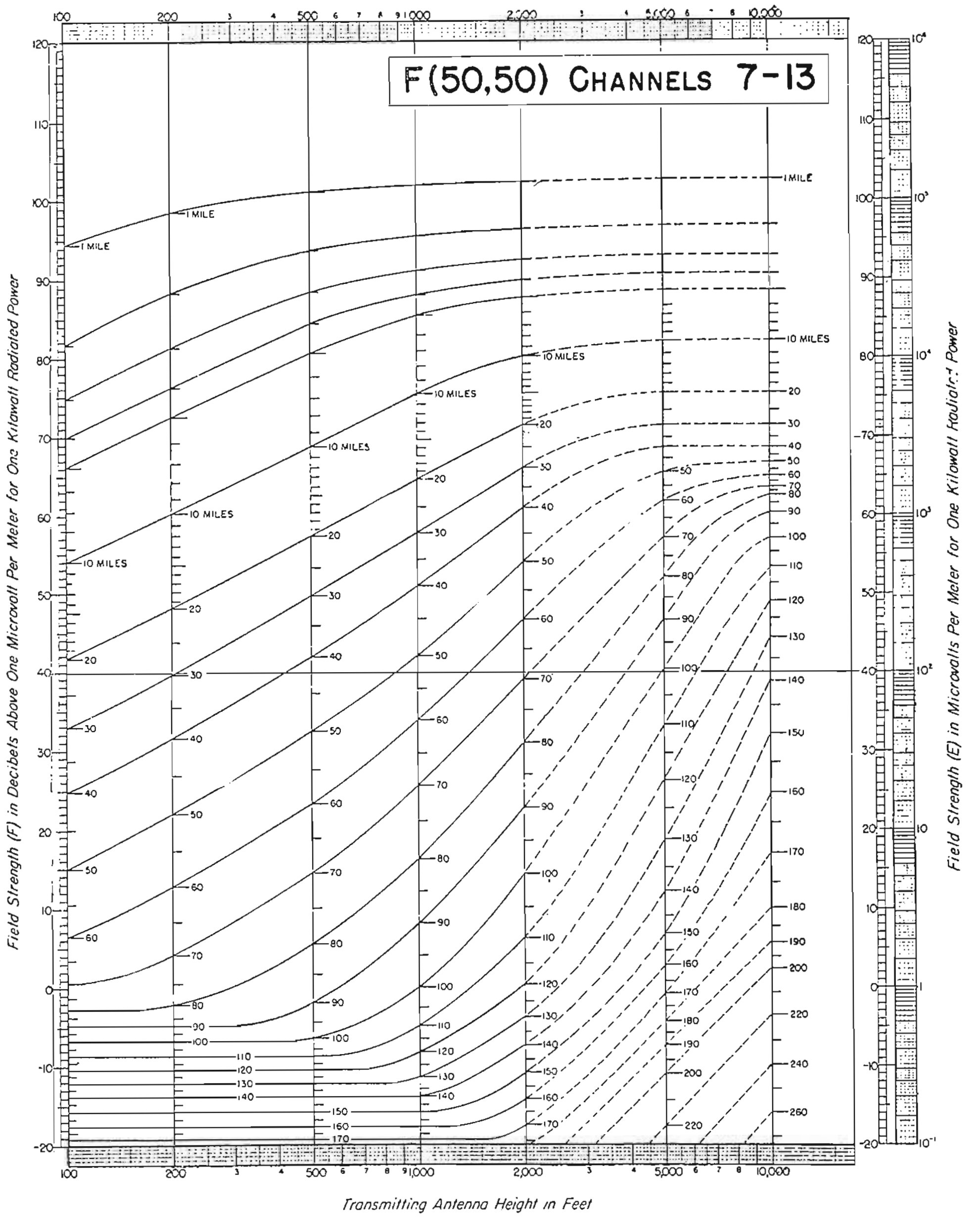


FIG. 5. Television Channels 7-13. Estimated field strength exceeded at 50% of the potential receiver locations for at least 50% of the time at a receiving antenna height of 30 feet.

The distances to the Grade A and Grade B contours are determined from figures 5 and 6 Appendix C of the "Rules."

The required field intensities, F(50,50), in dbu for Grade A and Grade B contours are:

Channel	*Grade A*	*Grade B*
2-6	68 dbu	47 dbu
7-13	71 dbu	56 dbu
14-83	74 dbu	64 dbu

Example: Channel 7, ERP 17 dbk, antenna radiation center above average terrain for radial A 2000 feet.

The equivalent contour for Grade A service on the one kilowatt curve will be 71 dbu − 17 db = 54 dbu: along the 2000 feet elevation line of Fig. 6 —54 dbu is at a distance of 50 miles.

In cases where the terrain in one or more directions from the antenna site departs widely from the average elevation of the 2 to 10 mile sector, the prediction method may indicate contour distances that are different from what may be expected in practice. For example, a mountain ridge may indicate the practical limit of service although the prediction method may indicate otherwise. In such cases the prediction method should be followed, but a supplemental showing may be made concerning the contour distances as determined by other means. Such supplemental showing should describe the procedure employed and should include sample calculations. Maps of predicted coverage should include both the coverage as predicted by a supplemental method, and by the regular method. When measurements of area are required, these should include the area obtained by the regular prediction method and the area obtained by the supplemental method. In directions where the terrain is such that special problems may arise, a supplemental showing of expected coverage must be included together with a description of the method used in predicting such coverage. In special cases, the Commission may require additional information as to terrain and coverage.

13. Coverage Maps.

Sectional Aeronautical Maps for any part of the country may be obtained from:

U. S. Department of Commerce
Washington 25, D. C.

Maps for the surrounding area are generally available at most municipal airports. However, the maps without overlay normally must be obtained from Washington.

The transmitter location, the radials used in 11(b) and (12) and the Grade A and B contours should be plotted.

14. Photographs.

Obtain locally. Normally facing 4 directions with the proposed tower location in the lower center of each photograph.

15. Proposed Location.

Geographical coordinates may be obtained by scaling between latitude and longitude lines on the U. S. G. S. topographical map.

16. Studio Location.

17. Minimum value of field intensity over the principal city. The minimum permissible values are:

Channel	*dbu*
2-6	74
7-13	77
14-83	80

The depression angle below the horizon should be determined from the antenna height and distance to pertinent parts of the city. The dbu value should be determined from Fig. 5 or 6 using the value of ERP for the correct depression angle for the antenna vertical pattern proposed.

18. Minimum Separation Requirements.

See Sections 3.610 and 3.611 of the "Rules."

FORM 301 SECTION V-G

1. Location of antenna.

Should agree with Section V-C Question 15.

2. Features of surrounding terrain.

List any elevations within 2000 feet which are 1/3 or more of the antenna height above ground.

3. Establish Airways.

May be determined from sectional aeronautical maps.

4. Airports.

May be determined locally and confirmed by reference to sectional aeronautical maps and reference to C. A. A. list of all airports available at any municipal airport or C. A. A. office.

5. Description of Antenna System.

Type of TV antenna and supporting tower. If a part of an AM directional complete details must be supplied and an application filed for modification of AM license (see Question 3a Section V-C). A vertical plan sketch with tower dimensions and sea level elevations blank will be supplied on request for any RCA TV Antenna.

Table I — Minimum Power

Population of City (Excludes Adjacent Areas) (1950 Census)	*Minimum Effective Radiated Power for the Antenna Height Shown (or Equivalent Grade A Coverage)*
1,000,000 and above	17 dbk (50 kw) at 500 feet
250,000 to 1,000,000	10 dbk (10 kw) at 500 feet
50,000 to 250,000	3 dbk (2 kw) at 500 feet
Under 50,000	0 dbk (1 kw) at 300 feet

No station will be licensed for an ERP of less than 0 dbk* (1.0 kw) even though a lower power would comply with "Equivalent Coverage Requirements."

Compliance with "Minimum Equivalent Coverage" is determined from Figure 1, Appendix C of the "Rules."

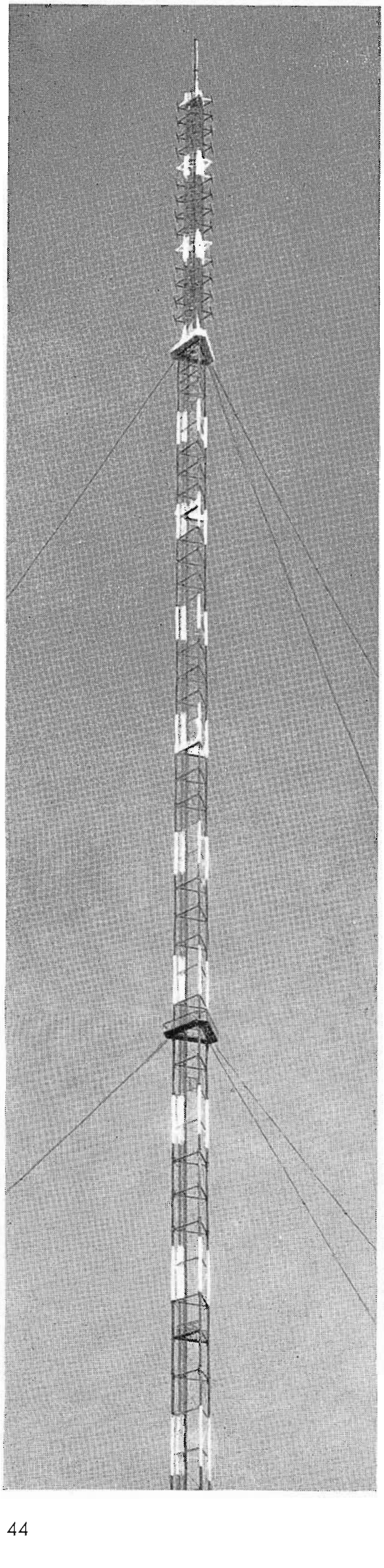
In addition to the above minimum power requirements, each application must comply with minimum city coverage requirements discussed under Question 17.

* Dbk is power level in decibels referred to one kilowatt.

Table II — Maximum Power

Channel No.	*Maximum Effective Radiated Power* *ERP*	*Zone I height*	*Zone II & III height*
2-6	20 dbk (100 kw)	1000 ft.	2000 ft.
7-13	25 dbk (316 kw)	1000 ft.	2000 ft.
14-83	30 dbk (1000 kw)	2000 ft.	2000 ft.

If the antenna height above average terrain exceeds the above heights, the maximum permissible ERP is reduced in accordance with Figures 2a and 2b Appendix C of the "Rules."



WSB-TV

ATLANTA, GEORGIA

BY

BOB HOLBROOK & **H. E. KING**

Assistant Chief Engineer, WSB-TV — RCA Engineering Products Department

On September 30, 1951, the WSB-TV engineering staff, headed by Chief Engineer, C. F. Daugherty, put into operation an RCA Television Antenna system, mounted atop the world's tallest television tower. This was accomplished in order to change the operation from Channel 8 to Channel 2. Originally the antenna and tower facilities had been installed by WCON. The total height from the ground up, including an RCA 14-Section Supergain Antenna and an RCA FM Pylon, is 1062 feet, see Fig. 1.

The Atlanta tower is the first television tower ever built to exceed 1000 feet, the first designed exclusively for TV and FM service and the first to utilize an RCA Supergain TV Antenna,[1] with a high gain of 11.0. Surprisingly, this "tallest TV tower" is located in a populated city area close to downtown Atlanta. The site is a thirteen acre plot located at the approximate geographical center of Atlanta. The ground elevation at this point is 973 feet above sea level—bringing the total tower height to 2035 feet above sea level.

A guyed Ideco tower of triangular construction, 14 feet on each side up to the 800-foot level and 7 feet up to the tower top supports the four-sided Supergain Antenna.

Performance Results of Supergain Antenna

Measurements and listener reports have confirmed the advantages of the high tower and high gain antenna installed at WSB-TV. In keeping with the WSB slogan, it helps WSB-TV "cover Dixie like the dew."

Fig. 7 depicts the field strength measurements made on the WSB-TV installation, with 50 KW of effective radiated power. The 0.5 millivolts/meter or 54 dbu and the 5.0 millivolts/meter or 74 dbu contour lines are shown. The average radius of the 54 dbu and the 74 dbu contour is approximately 50 miles and 22 miles, respecively, values which check very closely with the coverage predicted by the FCC for this power. The indicated circularity of the antenna is good although as usual is affected by ground conditions such as the variations in the southwest direction on the 5 millivolt/meter contour and in the northern direction on the 0.5 millivolt/meter contour.

Fig. 4 shows the horizontal pattern obtained by helicopter. This measurement was made at distances of about a mile to avoid distortions from ground reflections. The horizontal circularity measured about ±2.7 db. A desirable feature of an antenna is to provide constant field strength over the service range. This assures adequate signal strength without overloading the receivers close to the antenna. Some receivers overload when the signal at the input terminals of the receiver exceed 200 millivolts. Fig. 11 shows a typical radial measurement which illustrates that the signal strength is reasonably constant for the first few miles. Excessively high signal strengths are not encountered close to the antenna as is a normal characteristic for low gain antennas, but instead the signal for the WSB-TV high gain antenna remains about the same out to eight miles.

The industry has expressed considerable interest in how much signal is available in the first null of the vertical pattern of the antenna. One of the reasons for making

[1] "High Gain and Directional Antennas for Television Broadcasting", L. J. Wolf, BROADCAST NEWS, Vol. No. 58, p. 46.

FIG. 1. Towering 1062 feet above downtown Atlanta, is the world's first tallest TV tower and RCA antenna installation.

FIG. 2. Assembling reflecting screens and dipole radiators to special outriggers, which convert the triangular tower to a square in order to mount the 4-sided Supergain antenna.

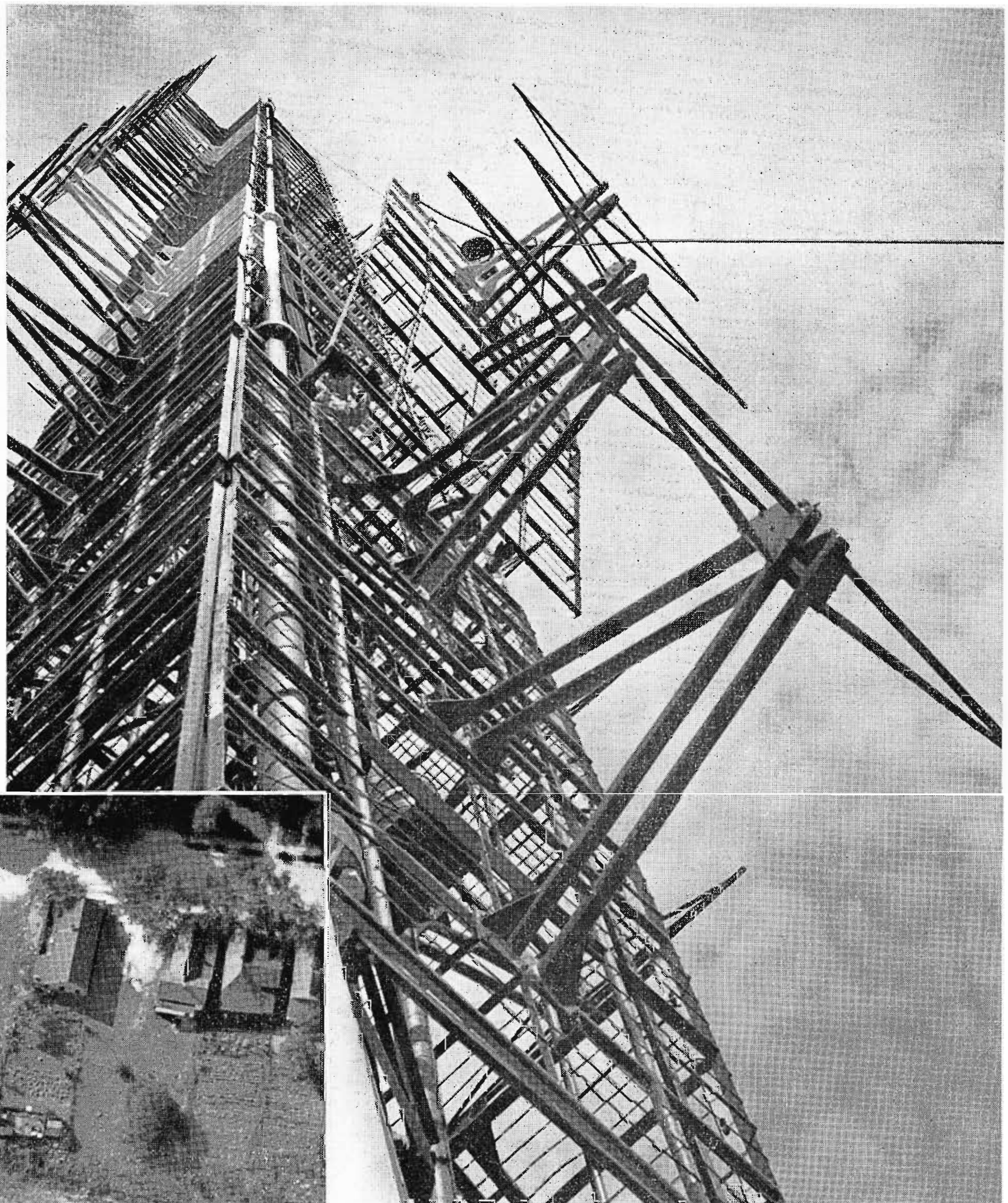
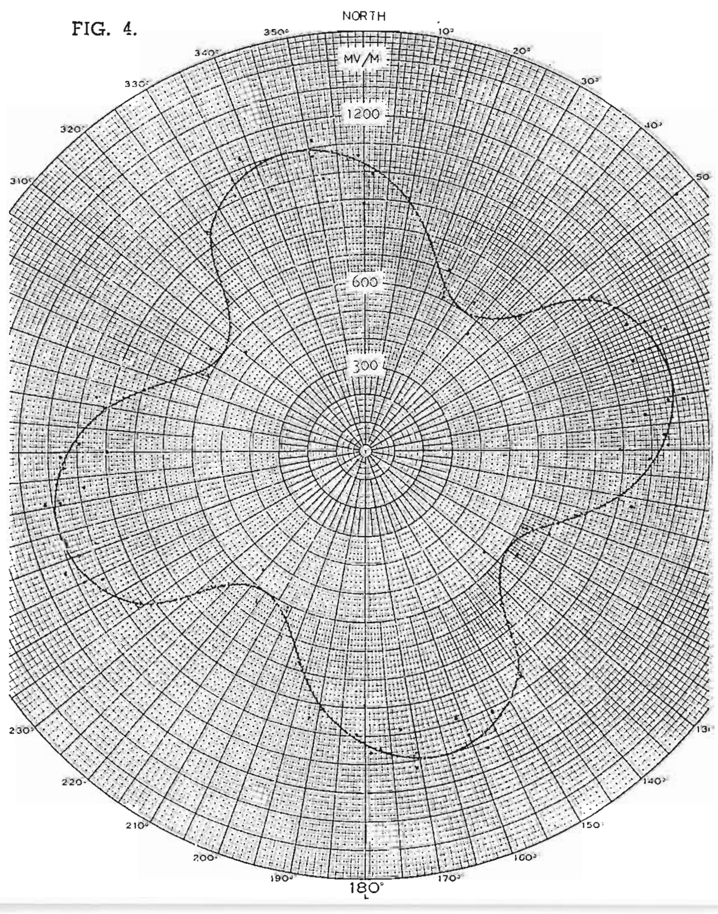


FIG. 3. Howard King, RCA Antenna Engineer, scales the FM Pylon which is mounted above the Supergain Antenna. Obviously, the cameraman must have been a little higher—but what's a few more feet at this height?

FIG. 4.



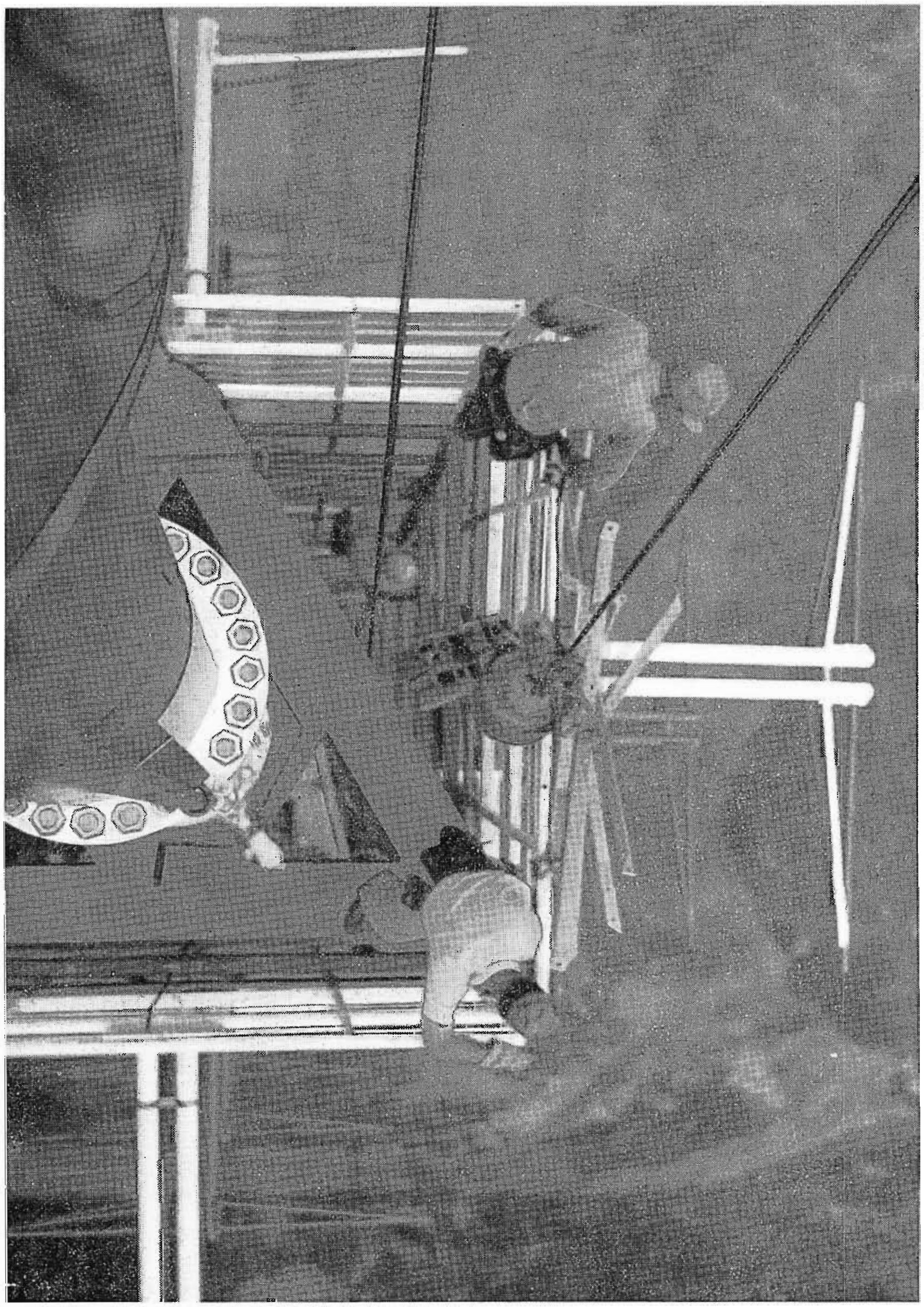


FIG. 5. Riggers add finishing touches to the RCA Supergain structure. Note the methods used to mount the FM Pylon and the Supergain Antenna to the triangular tower.

the measurements such as the one shown in Fig. 11, was to determine the intensity of the signal in the null. For the WSB-TV antenna, the first null of the antenna occurs at about 1.9 miles from the base of the antenna, but without special reference this null might be overlooked because ground measurements are erratic as a result of terrain effects and minimums of similar field strength were recorded on this radial from 4.8 to 5.8 miles. There is considerable signal radiated at the angle normally referred to as the null. On this particular radial, the minimum was 20 millivolts which is a signal considerably in excess of that required for city coverage. There has been no evidence of inadequate signal strength or presence of ghosts in the null area. The antenna is designed for beam tilting but the performance has been so satisfactory that this feature of the antenna has not been explored.

Mounting a Four-sided Antenna on a Three-sided Tower

Since WSB-TV requires an omnidirectional horizontal radiation pattern, it was necessary to place four screens and dipoles on the triangular Ideco tower. This was easily accomplished by having special outriggers built to support the screens (see Fig. 2). These outriggers essentially transform a triangular tower to a square tower to accommodate the 4-sided antenna array. The Supergain Antenna lends itself perfectly in placing a 4-sided antenna on a triangular tower, thus still maintaining good symmetry from the ground to the top of the FM-Pylon. See Figs. 2 and 5.

Advantages of High Tower and High Gain Antenna

The foregoing performance results and measurements obtained on the WSB-TV Antenna, confirm the advantages of using a high gain antenna and a high tower.

The advantages of height for TV antennas is indicated by the F.C.C. predicted

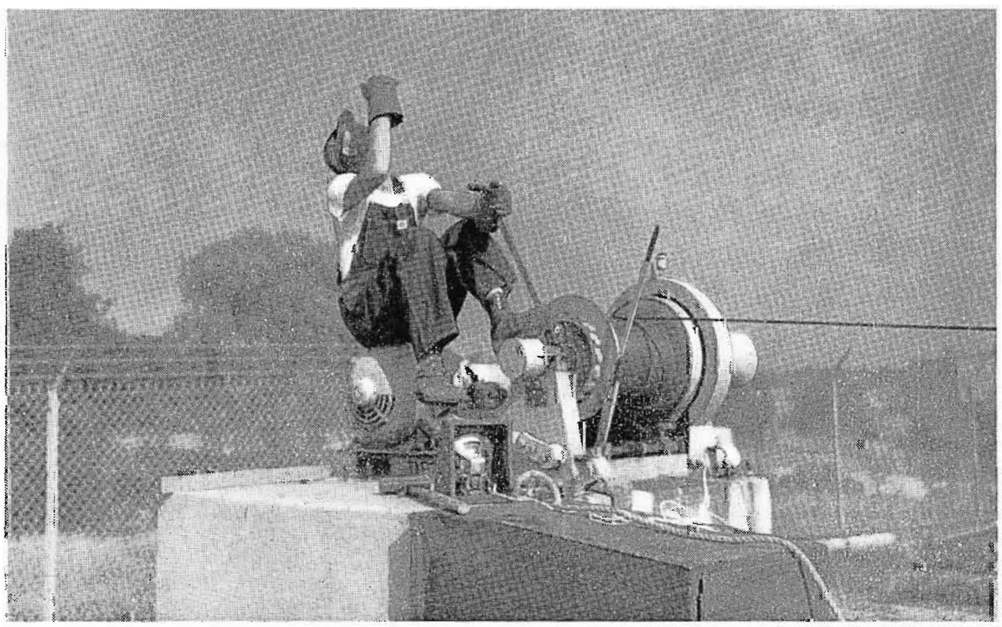


FIG. 6. An electric-motor-driven winch is used to haul a single-man-capacity hoist to the upper levels of the tower. See Fig. 8.

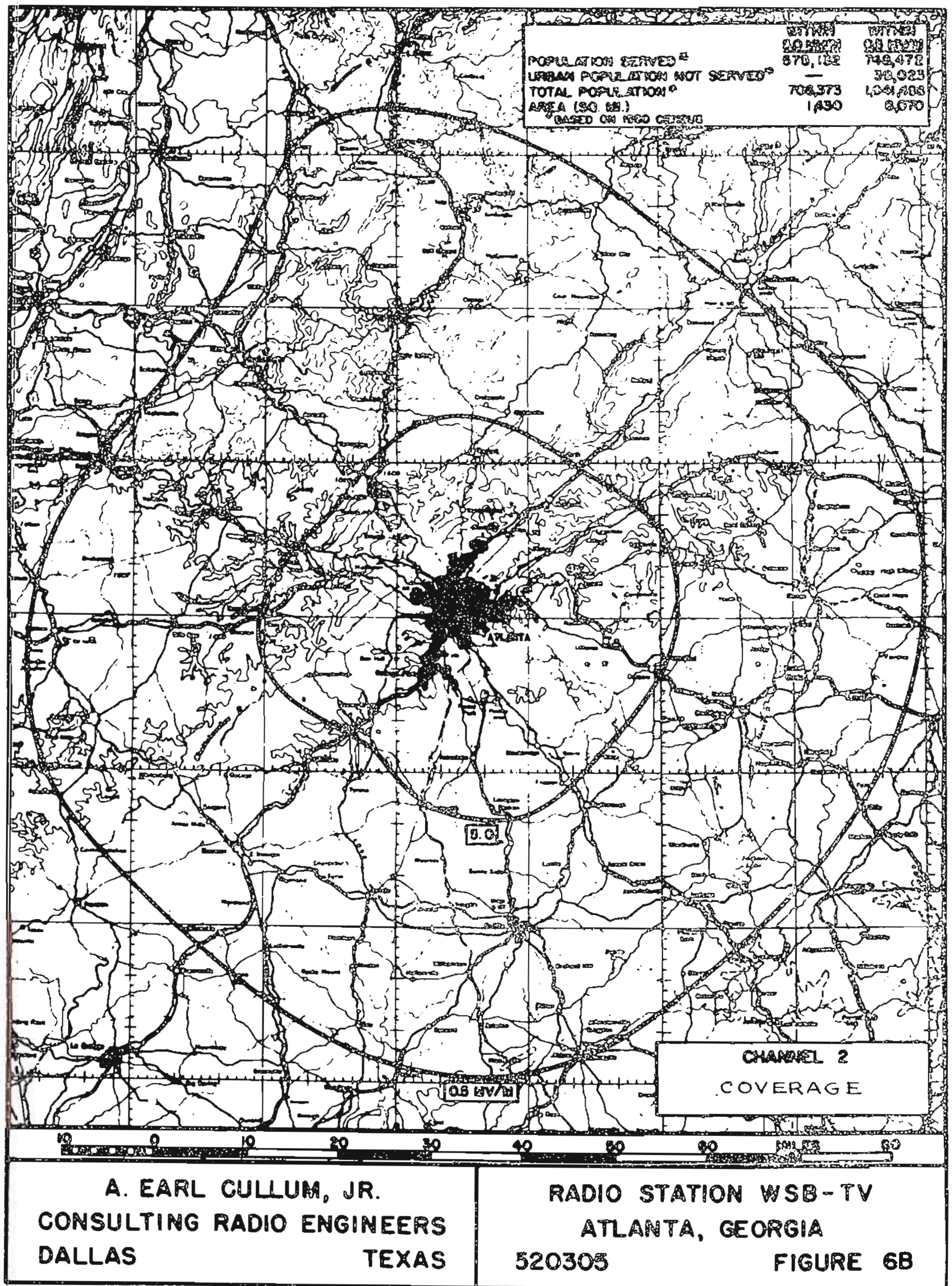


FIG. 7. Contour lines for 0.5 mv/m (59 dbu) and the 5.0 mv/m (74 dbu) are shown. The average radius is approximately 50 miles and 22 miles respectively, which meets the predictions of the FCC.

coverage data. For Class B coverage and with 100 KW ERP, the coverage is extended from 57 miles to 70 miles when the antenna height is increased from 500 feet to 1000 feet. To obtain the same increase in range by increasing power, it would be necessary (with a tower of only 500 feet) to increase Effective Radiated power from 100 KW to 630 KW. With power ceilings being in effect, the only increase in range that can be obtained is by increasing antenna height.

The high tower can be used for land marks, geographical interest, and as aircraft direction land marks. The high tower also provides greater latitude for television microwave relay operation. Local remotes may be beamed to the tower with a completely unobstructed path. The high tower provides potential for commercial microwave relay. This may be pursued in the future.

Tower and Antenna Inspection and Maintenance

Inspection, maintenance and other activities on the antenna, because of its great height, necessitate a means of quickly ascending the structure with ease. For this purpose, a hoist accommodating one man at a time has been built to go up the tower to the 800-foot level. At this level, the hoist stops just beneath the uppermost platform which is accessible by climbing about 15 feet up a ladder through an opening leading to the platform. The hoist is

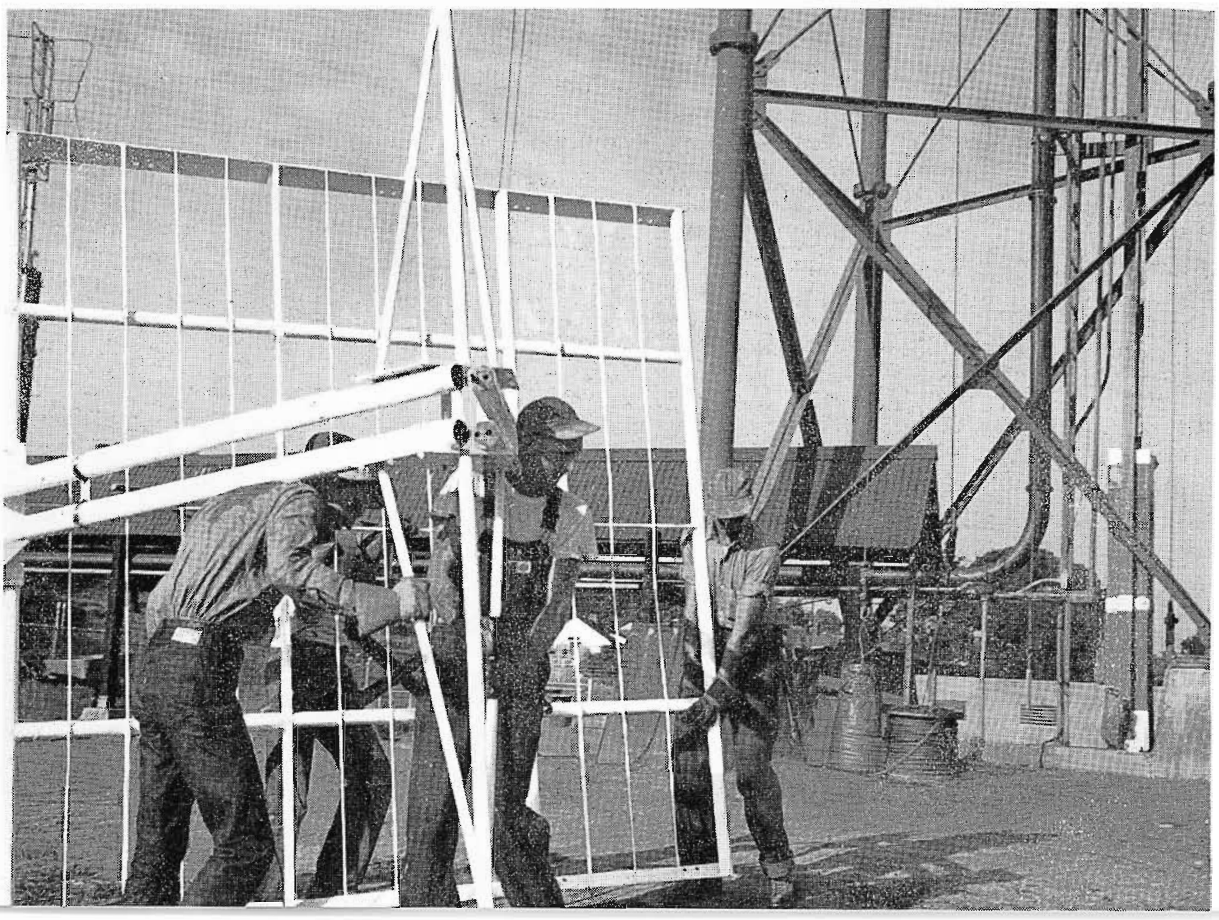


FIG. 8. In addition to efficient handling of screens and dipoles by the riggers, there are a few other points of interest in this picture: The one-man-capacity hoist which ascends between a twin-girder track with the cable attached to its top is shown at lower right. A peaked-roof shed is built to provide protection of the 6⅛" transmission lines from falling ice.

FIG. 9. The first time an RCA camera has ever been used atop a 1000-foot TV tower. On this occasion while strictly set up as an experiment, a major fire broke out in the area. A telephoto lens was snapped in place and WSB scooped the story—delivering scene to televiewers.

guided between two girder-like tracks running the full 800-foot height, and it is raised and lowered by means of a cable which is taken up or unreeled by an electric motor driven winch. See Figs. 6 and 8. Facing the hoist is a hand ladder that runs the full 800-foot height. The ladder is accessible to the hoist by merely stepping out of the hoist on to the ladder. A platform is also located at the 400-foot level.

Tower Data

Tower	1062 feet above ground 2035 feet above sea level 430,000 lbs. total weight
Tower Foundations	14 feet under ground contains 15,800 lbs. reinforcing steel, 284,000 lbs. concrete
Tower Legs ..	15 feet on each side 10¾ inches in diameter 1⅛ inches wall thickness 28 feet in length 5,000 lbs. weight each
Top Guy Wires	2¼ inches in diameter Attached at 800-foot level
Bottom Guy Wires	1¼ inches in diameter Attached at 400-foot level

FIG. 10. Photograph of junction box showing ½" air-dielectric copper coaxial feed lines which feed the individual dipoles. Also junction box transformer of 3⅛" copper line which connects to one of the combining tees as shown in Fig. 12.

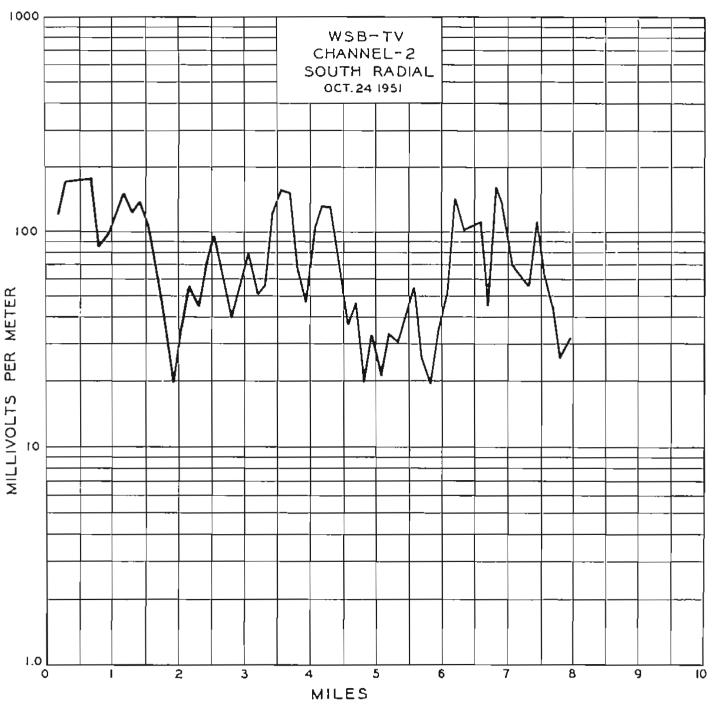
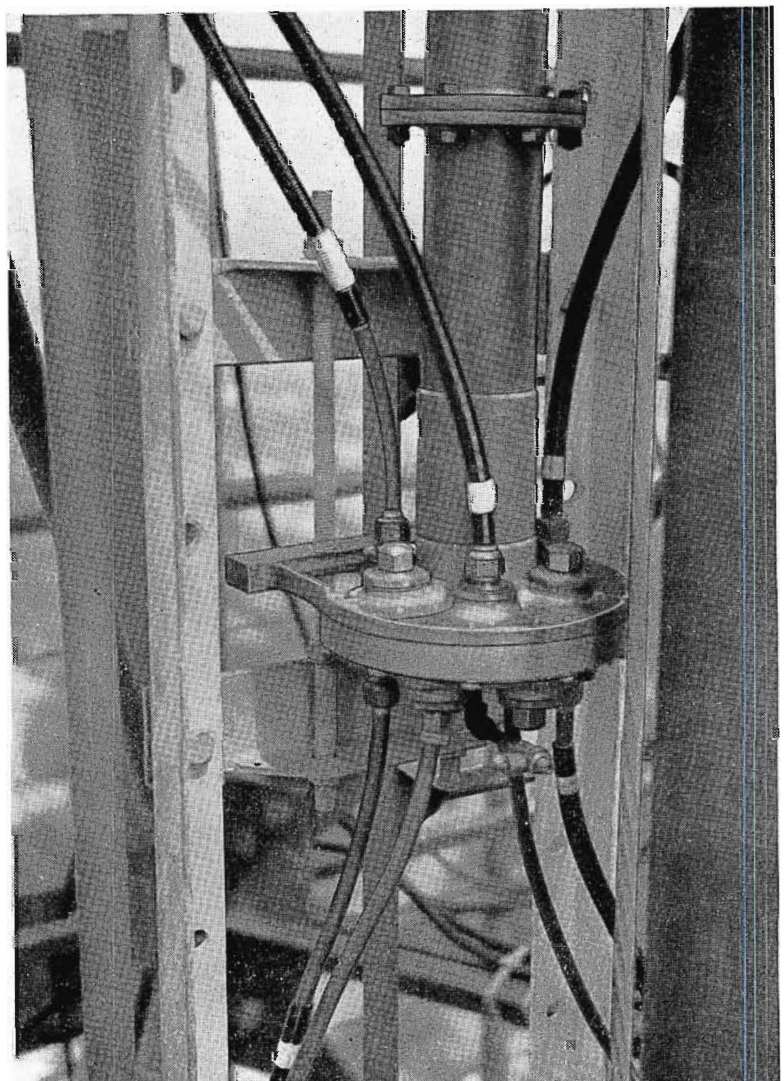


FIG. 11. For 50-KW ERP a plot of a radial in the southern direction is shown. Note that excellent close-in coverage is maintained, as well as coverage considerably distant from antenna site.



Guy Anchors. . 16,000 lbs. reinforcing steel
515,000 lbs. concrete

Paint . . . . 125 gallons required for one coat

Tower Lights. . Requires approximately 10,000 watts

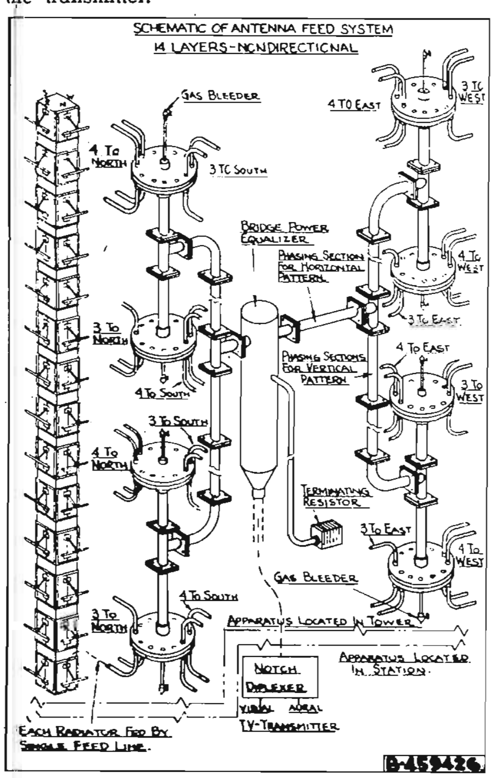
Tower and guys are galvanized to prevent rust.

Top of tower designed to move only 28 inches in a wind of 120 m.p.h.

The Supergain Antenna

The Supergain Antenna (as shown in Fig. 13) is essentially a broadside array of half-wave dipoles, backed up by a reflecting screen, stacked vertically to yield the desired gain. Fig. 12 shows schematically the installation of the WSB-TV 14 bay Supergain Antenna. To incorporate an omnidirectional pattern, four dipoles (90 degrees apart) are placed around a tower. The dipoles are stacked vertically about 0.77 λ, which was an optimum choice for both impedance and gain. In the horizontal plane, the reflecting screens are spaced half-wave apart, or approximately nine feet, in the case of Channel 2.

FIG. 12. Diagram shows the assembly of the 14-bay WSB-TV Supergain antenna. Each radiator is fed by a single feed line, all identical in length, to maintain equal phasing. Note that both N-S and E-W feeds provide for a phasing section that can be used to tilt the vertical pattern. Only one transmission line connects the antenna to the Constant-Impedance Notch Diplexer located near the transmitter.



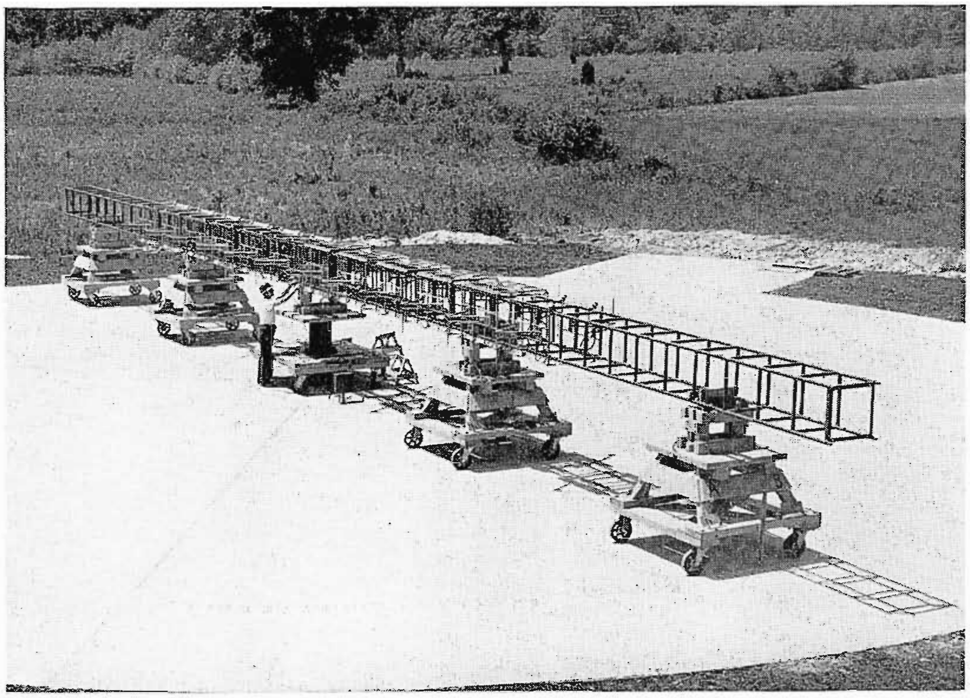


FIG. 13. Supergain and Superturnstile Antennas are tested on this specially built turntable. Antennas up to a length of 140 feet can be mounted, and rotated to determine their radiation characteristics. Transmitting site is located approximately 2400 feet across an open level field.

Feed lines which have equal lengths coming from the junction boxes, are used to feed the matched dipoles, thus assuring equal power and phase in each radiator. The various tees are made to provide the proper power division to the various junction boxes, and with broadband characteristics to maintain constant impedance. The N-S and E-W feeds are fed in quadrature to make use of the power equalizer.[2] The antenna is made versatile by allowing for beam tilting facilities should it be desired in the future. The power equalizer, which is the input to the antenna system, is fed by only one 6⅛" coaxial transmission line from the Constant-Impedance Notch Diplexer.

The voltage standing wave ratio of RCA Supergain Antennas has a 1.1 to 1 specification over the entire Channel 2 band. With the use of the power equalizer[2] an unusual large bandwidth can be obtained thus making the antenna electrically stable under varying weather conditions.

A power gain of 11.0 was achieved by using 14 bays of dipoles in the aperture of 184.33 feet. The method of arriving and checking the gain figures will now be described.

[2] R. W. Masters, "A Power Equalizing Network for Antennas", Proceedings of the IRE, p. 735, July 1949.

Gain Definition

A review of some of the fundamental definitions of "gain" may be helpful in grasping the concept of power gain.

Directive gain is the absolute directivity of an antenna. The ratio of the maximum radiation intensity of the source under consideration to the maximum radiation intensity of a half-wave length dipole is defined as directive gain. The word pattern gain is synonymous with directive gain.

The definition of directive gain in the preceding paragraph is based entirely on the shape of the radiated power pattern. The losses due to feed lines, power equalizers, etc., are not accounted for. A quantity called either the net antenna gain or power gain is introduced which does involve these losses. In the RCA publications, the antenna gain or power gain is the figure specified. Losses in the main transmission line leading from the transmitter to the antenna system are not reflected in the power gain figures.

Theoretical Determination of Gain

The Supergain Antenna employs identical radiating sources connected to radiate maximum energy in the horizontal direction. It is well known that the field of an array at a sufficiently large fixed distance is the product of the array factor multiplied by a function representing the field of

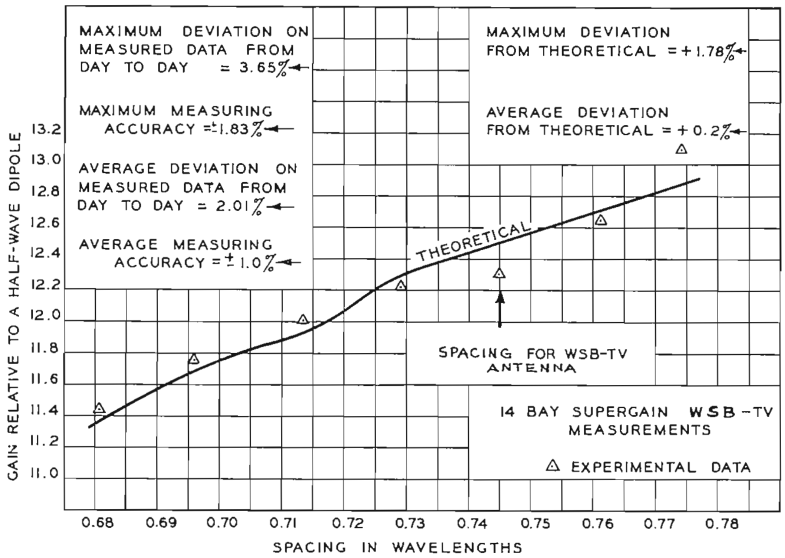


FIG. 14. Directive gain of a 14-bay Supergain antenna is shown for various spacings. The solid line shows the variation of the theoretical directive gain with spacing, while the discrete points indicate the measured data. Each point represents several measurements, and the accuracy of these data is approximately ±1.83%. The average of all the maximum deviations of the measured results was 2.01%, or indicates that an average measuring of ±1.0% is possible. The maximum deviation of any one point from theoretical is at 0.744 λ, or +1.78%. However, the average deviation of all the points from the theoretical is 0.2%. For all practical purposes the theoretical value of directive gain can be used for the practical case.

one of the sources. The array factor is the pattern of the array with sources replaced by isotropic radiators. For uniform arrays, this factor is a simple equation of a trigonometric expansion. The element pattern prescribing the individual sources will be the same for all the sections.

The Supergain dipoles are spaced approximately 0.3 wavelength in front of the reflecting screen in the horizontal plane. For the element pattern in the theoretical calculations, the assumption was made whereby an infinitely thin half-wave dipole was placed 0.3 wavelength in front of an infinitely large reflecting screen. The array characteristics of N parallel identical elements equally spaced and with equal currents and phase is

$$A = \frac{N \sin X}{N \sin X}$$

where N = number of elements

$$X = \frac{D}{2} \times \cos \phi$$

D = spacing in electrical degrees

ϕ = angle from the zenith axis

It is reasonably proper to assume the dipoles are fed with equal-phase and power because all the feed lines are cut to the same length, the dipoles are matched to the feed lines, and the dipoles are all made physically identical.

Vertical field patterns for the 14 bay WSB-TV antenna are plotted in Figs. 15 and 16 using the method described in the previous paragraph.

Experimental Determination of Gain

Various methods to check the theoretical gain figures can be done with scale models or with the actual antenna.

First, absolute field strength measurements can be made of the antenna under test. This is unsatisfactory because of the many obstructions and terrain effects that distorts the readings. Comparison must be made to the FCC propagation curves which was determined upon smooth terrain.

Second, the substitution method. A calibrated dipole is placed at the center of the antenna and power is fed alternately into the antenna and the dipole while comparative readings are taken. This standard dipole comparison is better than the absolute field strength determination, but again only a fair degree of accuracy can be obtained after a complete survey.

These two methods described for measuring the power gain have been found to be comparatively unreliable.

Third, the best method to determine the directive gain of an antenna, is to measure the vertical radiation pattern, since pattern gain is a function of the vertical directivity of the antenna. This can be accomplished either by the use of a complete antenna or a scale model since pattern work can usually be scaled quite accurately. In this method, the antenna under test is used as a receiving antenna, is mounted on its side and pivoted about its mid point. A transmitting point is located far enough away so that the length of the test antenna is negligible compared to the distance between the transmitting and receiving sites. Rotating the test antenna determines the amplitude and angle of all the lobes. This information can be plotted and a gain determination made by means of a planimeter.

The gain computations can be made from the vertical field pattern measured in one direction, if the horizontal pattern is omnidirectional. In broadside arrays, similar to the Supergain antenna, that have nominally circular horizontal plane patterns, principal plane patterns represents an average value as determined from the study of the horizontal pattern.

Obviously, this third method cannot be applied after the antenna is installed. In many cases, it cannot even be applied on the actual antenna since the rotation of a Supergain Antenna 186 feet in length becomes a major engineering feat. Hence, such work is usually done by means of scale models. RCA has recently built a special turntable which will make it possible to rotate antennas up to 140 feet in length, as shown in Fig. 13.

A ±3% accuracy was considered necessary for WSB-TV's Supergain Antenna, which is a difficult achievement for this type of measurement. This requirement dictated the need for the measurement of the vertical radiation pattern, under ideal laboratory conditions.

The antenna test site is located at the Marlton-Medford Airport,[3] in New Jersey,

[3] "Pattern-testing the TFU-24B UHF Antenna," E. H. Shively, BROADCAST NEWS No. 69, p. 42.

and its adjacent property, making it possible for the transmission path to be across an open-level field. The test antenna was mounted approximately eleven feet above the ground, the height being determined by a few preliminary experiments to determine when the standing waves in space of the incoming electro-magnetic waves would be negligible.

Standard RCA type Channel 7 Supergain dipoles and screens were used to scale down from the WSB-TV Supergain operation. The same spacing in terms of wavelengths were used as on the 14 bay Channel 2 Supergain Antenna. The dipoles were assembled and fed in the same manner as in the actual antenna.

By rotating the boom about its vertical pivot, the value of field strength as a function of vertical angle was obtained from the horizontal sweep through one revolution. A half-wave dipole, placed in a corner-reflector comprising the transmitting antenna and standing about ten feet off the ground, was placed across a field about 2400 feet away, in a vertical position parallel to the dipoles of the measured array which was used as a receiving antenna. The output from the array under test was fed into a receiver and Esterline-Angus recording meter. The angular position information was transmitted from the pedestal to the recorder by a pair of synchros geared to rotate with a ratio of 36-to-1, with respect to the pedestal. At the recorder, the gearing was arranged to provide a two-degree angular displacement per division in abscissa on the Esterline-Angus recording charts.

Results of Gain Data

From the vertical field pattern, the average pattern gain can be determined by taking the surface integral of the normalized, squared, voltage field pattern and comparing the result with that of a half-wave dipole. Although the measured pattern is for a plane normal to the dipoles, it also holds true for all other directions, since the azimuth pattern of 4 dipoles mounted around a tower is essentially circular.

Figs. 15 and 16 (curves of vertical field pattern) show a comparison of the measured field pattern and the theoretical field pattern for 14 bays of Supergain dipoles with each element spaced 0.745 apart, or equivalent to WSB-TV Channel 2 picture carrier frequency. The measured data represents an average of several readings. Note that Fig. 15 (main lobe curve) shows only the first 15° from the main lobe, and Fig. 16 (showing side lobes) reveals the remaining portion of the quadrant.

Directive gain vs. spacing of the elements in terms of wavelengths is illustrated in Fig. 14 (gain vs. spacing curve). The solid line represents the theoretical curve while the points indicate the experimental data. The maximum deviation on the measured data, from day-to-day is 3.65% or the minimum measuring accuracy one can state is ±1.83%. The average deviation on the measured data is 2.01% or the average measuring accuracy is approximately ±1.0%. Note also that the maximum deviation of the experimental gain figures from the theoretical value is plus 1.78%, and the average deviation from the theoretical is plus 0.2%.

The fact that the measuring accuracy is well within reason and coincides closely with the theoretical prediction (Fig. 15 and Fig. 16) indicate that the theoretical directive gain figures for Supergain antennas, for all practical purposes, can be used to represent the directive gain in practice.

From the directive gain the net antenna gain is determined by multiplying the directive gain by the efficiency of the antenna components. This reduces the directive gain from 12.5 to the net antenna gain of 11.0 at the visual carrier.

Tests made on scaled models, under controlled laboratory conditions, clearly indicates that pattern measurements are reliable, and therefore, one can accept these curves (Figs. 15 and 16) to be identical to that found at WSB-TV. Seeking the gain values by other means such as field strength measurements and the substitution method is comparatively unreliable as compared to scale model measurements.

Acknowledgment

The WSB-TV antenna was recommended by Earl A. Cullem, Jr., consulting engineer. The antenna itself was designed and built by the Engineering Products Department of the RCA Victor Division. Special credit should go to Mr. L. J. Wolf who supervised the details of the project and Mr. D. W. Balmer who coordinated the mechanical aspects of the job.

FIG. 15. Comparison of the theoretical and measured vertical field pattern for the WSB-TV antenna. Note the close resemblance between the theoretical and the measured data. The main lobe is plotted on an expanded abscissa scale because of the narrow beam width. For the remaining portion of the quadrant refer to Fig. 14.

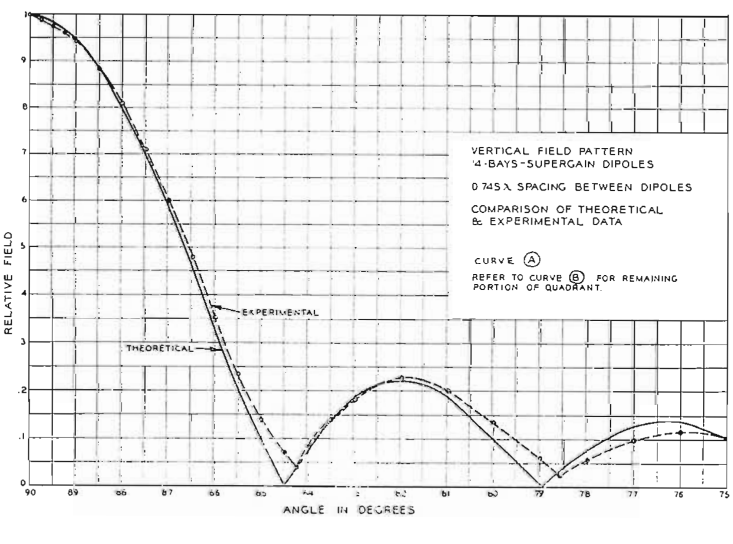
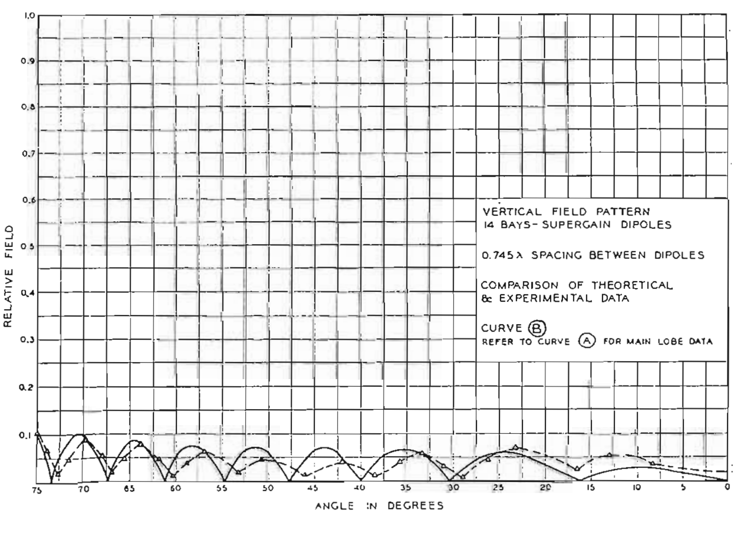


FIG. 16. Comparison of the theoretical and measured vertical field pattern for the WSB-TV antenna. Note that the location and the amplitudes of the side lobes for the theoretical and measured data have a very close relation. For the configuration of the main lobe see Fig. 13.



HOW TO APPLY POLARITY DIPLEXING TO MICROWAVE RELAY SYSTEMS

By C. A. ROSENCRANS
TV Terminal Engineering

There are times when the operators of television broadcast stations employing several microwave circuits would find it to their advantage if their microwave equipments were all operated in the same channel. Some rather special setups can be operated in this manner with no change in the existing equipment. For example, a station operating both an S.T.L. and a remote pickup circuit may find it possible to operate them both on the same frequency by observing the following conditions—first, that the remote receiver be located near the studio (the S.T.L. transmitter), and second, that the remote receiver be located at least 100 feet to the rear of the S.T.L. transmitter. Remote pickups requiring multiple hops may also be operated in the same manner if the repeater is more or less in line with the terminal transmitter and receiver and there is roughly a 100-foot separation between the repeater receiver and repeater transmitter. However, other system arrangements usually have required the use of more than one channel for successful operation.

FIG. 1 (at left). Standard RCA TTR transmitter showing feed line for normal (horizontal) polarization. Note in this photo that the RCA relay transmitter is mounted on a new all-metal, lightweight tripod suitable for field use.

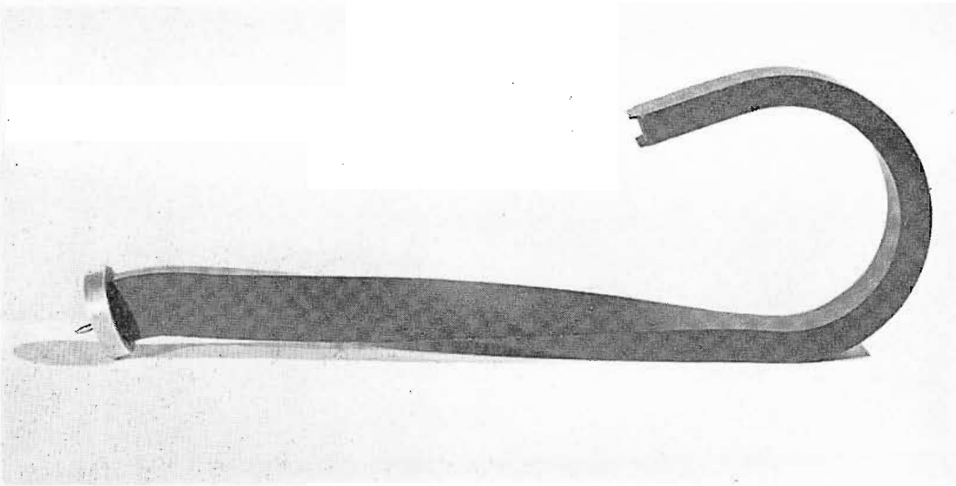


FIG. 2 (above). The "twisted" feed line for RCA TTR Relay equipments designed to provide vertical polarization. This is interchangeable with the standard feed line which is shown in Fig. 1.

The propagation characteristics and antenna patterns associated with microwave transmission systems lend themselves to the applications of a system of diplexing we have called "polarity diplexing". This offers an effective solution to some system problems. In its simplest form, two signals having the same frequency are transmitted along the same path to two receivers. One antenna is arranged to radiate a vertically polarized wave and the other a horizontally polarized wave. Matching antennas are employed at the receivers. Under ideal conditions, the cross-talk between the two systems, even though they are operating at the same frequency, may have an extremely small value.

Practically, however, cross-talk levels lower than —20 db may be difficult to obtain, although in a carefully arranged setup, a —30 db level might be expected. Several factors enter the problem and may greatly influence the results obtained. First, the radiation from an antenna system employing a parabolic reflector (Fig. 1) will not be entirely of one polarity. There will be found a small component polarized at 90° to the main field. Second, in the case of a portable setup, it will be found rather difficult to orient the two transmitting antennas so that the fields are exactly 90° to each other, as well as make the normal elevation and azimuth adjustments.

The results obtained will also be modified by the presence of any reflecting system in the transmission path. A plane reflector may generate a cross polarized signal unless its horizontal or vertical axis is exactly parallel to the wave front of the incident wave.

Experimentally, Bob Connor, of KLAC, found it possible to obtain satisfactory operation with the RCA TTR and TRR equipments through the use of a combination of polarity diplexing and a small frequency separation. Each transmitter is shifted slightly from the normal adjustment; one moved about 3 mc. higher in frequency and the other moved 3 mc. lower. This results in an effective frequency separation of 6 mc., which, together with the diplexing, results in an effective cross-talk level of —30 db or better and consequently, negligible interference. Successful operation has been obtained during the last nine months, using this technique applied to an S.T.L. circuit. Experimental antenna-feeds similar to that shown in Fig. 2 have also been supplied to other users of the RCA equipments.

FIG. 1. Air-cooling is a "must" in Laredo where temperatures reach a maximum for the United States.

KVOZ...

"The Voice of Laredo," Texas

KVOZ, "The Voice of Laredo", Texas made its debut on April 8, 1952 with a new RCA BTA-250M Transmitter. Since then, it has been serving approximately a quarter of a million people . . . both American and Mexican.

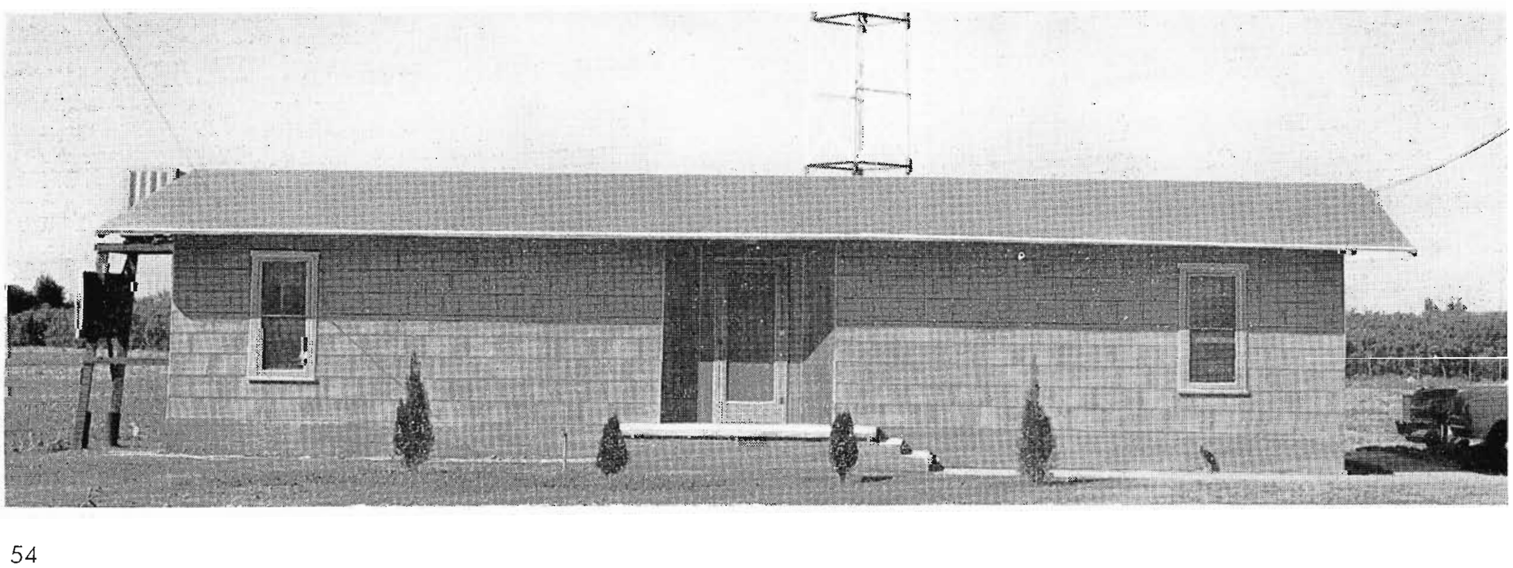
The city of Laredo lies at the lower end of Texas on the Rio Grande about 150 miles inland from the Gulf of Mexico and has a population of more than 53,000. The city of Nuevo Laredo (Nuevo meaning new) lies just across the Rio Grande and has a concentrated population of 70,000 English-speaking Mexicans. A bridge connecting the two cities permits residents from either city to commute by foot or motor to either side.

KVOZ is an affiliate of the Mutual Broadcasting System and the Keystone Broadcasting System—operating 16 hours a day. The transmitter and studio are located in a single, efficiently-planned building. Mounted with its front door flush with the control room wall, the BTA-250M Transmitter permits rear accessibility from the workshop which is adjacent to the control room. So little space is required by the transmitter that virtually the entire building is available for studios, office, storage and other functional space.

Control room equipment consists of a speech rack flush-mounted with the wall, an audio consolette, a boom-mounted microphone, and two RCA 70-B Turntables which, despite their vintage, are still doing a fine job.

Chief Engineer Frank Manuel reports that the new RCA transmitter is doing a magnificent job. Normally, the climate in

FIG. 2. Front view of the KVOZ transmitter building and studios.



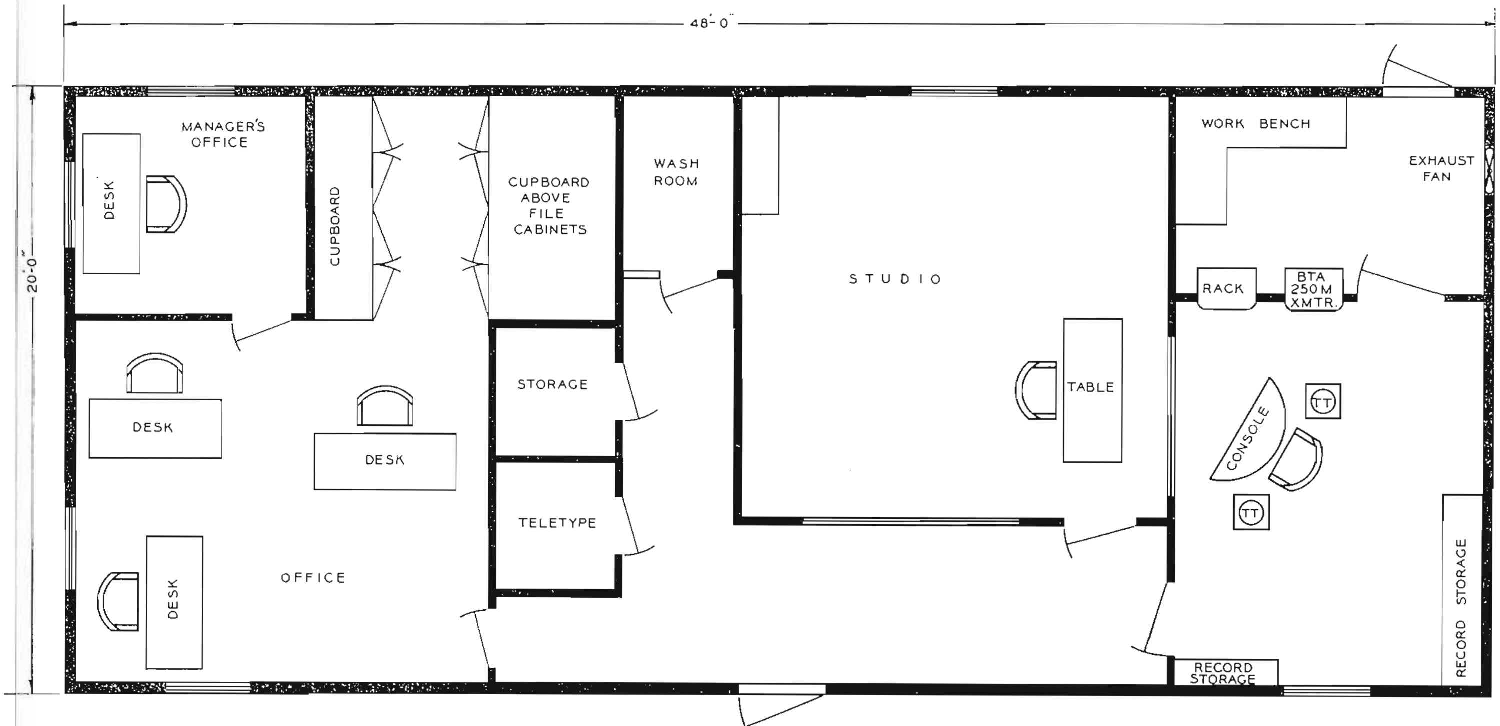


FIG. 3. Floor plan showing KVOZ layout—the RCA 250 watt transmitter occupies virtually "no space".

Laredo is warm and dry. Temperatures regularly reach within a degree or two of the maximum for the United States. A simple evaporative cooler, piped into the control room has been highly satisfactory in keeping personnel comfortable and the equipment within normal operating limits. This is attributed to the inherent cool-running characteristic of the BTA-250M with its fewer tubes. The transmitter is quiet, too—an essential in combo operation.

Last May, a heavy rainfall created a period of phenomenal coverage . . . at which time, listeners as far away as Monterey, Mexico (150 miles) reported good reception. Also, signals as far away as five miles south of Uvalde, Texas (120 miles away) were heard regularly during this period.

The antenna system consists of a quarter-wave grounded type self-supporting Blaw-Knox vertical. It is shunt fed and matched to a 52 ohm coaxial line. The ground system incorporates a screen of copper strip placed below the antenna in a square of approximately 20 feet, also buried radials of No. 10 copper wire.

KVOZ's entire operational staff, made up of Chief Engineer Frank Manuel; Bill Douthitt, Commercial Manager; Hector Garcia and Bob Pearson, Disc Jockeys; Elia Salazar, Secretary; Mrs. Evelyn Jones, Copywriter and Program Director; and Burney Jones, General Manager, is a typical example of successful operation with a low-power station due to efficient planning, imagination, and aggressiveness.

FIG. 4. Burney Jones, General Manager, who personally installed the BTA-250M—with only the aid of laborers for lifting.

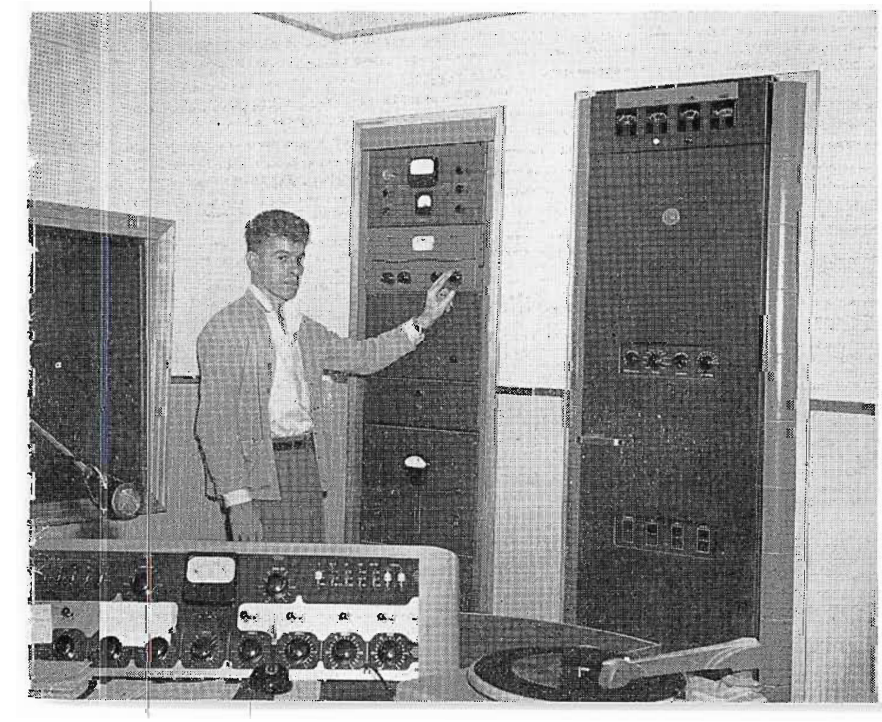
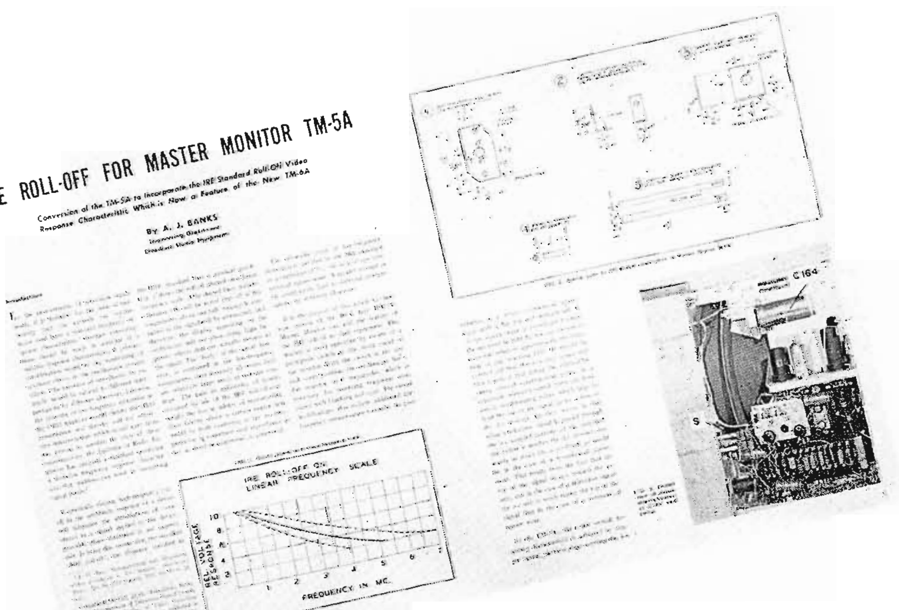


FIG. 5. Bob Pearson, Disc Jockey, conducts "Tunes for 'Teens" show—using RCA 70-B turntables which are still doing a fine job.

MOBILE TV FOR DOMINICAN REPUBLIC

The first mobile television unit for the Dominican Republic's growing broadcast-TV facilities in Rockefeller Plaza prior to shipment. The TV van was equipped by RCA for use by "La Voz Dominicana," Dominican Republic broadcasting company owned by Gen. J. Arismendi Trujillo. Shown here (l. to. r.) Humberto Garcia, RCA distributor for the Republic; Felix Bernardino, Dominican Republic Consul-General in New York; Meade Brunet, Vice President of RCA and Managing Director, RCA International Division; R. Bournigal, Assistant to Mr. Bernardino; (back row) C. W. Slaybaugh, Manager, Broadcast and Television Equipment, and E. A. Laport, Chief Engineer, both of RCA International Division; and Harvey Klemfuss, Dominican Republic Information Center director.


IRE ROLL-OFF FOR MASTER MONITOR TM-5A

By A. J. BANKS

TO OBTAIN YOUR COPY OF "IRE ROLL-OFF FOR MASTER MONITOR TM-5A" . . .

Write **Radio Corporation of America, Broadcast Equipment Sales Section, Engineering Products Department, Building 15-6, Camden 2, New Jersey**

Free . . .

TO TELEVISION BROADCASTERS

A six-page pamphlet describing modification of the TM-5A Master Monitor necessary to incorporate the IRE Standard Roll-Off Video Response Characteristic which is now a feature of the new TM-6A. IRE Roll-Off is the oscillator frequency response specified by IRE Standard (50 IRE 23.S1) for measuring television signal levels.

The information included in this pamphlet is complete with mechanical sketches, pictorial identification of components, circuit schematics and curves. A complete parts list with components specified is also included.

RCA BROADCAST REPRESENTATIVES ASSUME NEW POSITIONS IN FIELD

J. A. RENHARD

J. A. Renhard, newly appointed Broadcast Field Sales Representative with headquarters at Seattle, will now serve Broadcasters of the Pacific Northwest area. Jules graduated from the University of Washington in 1929 with a B.S. degree in E. E.

From student engineer at General Electric, Jules started with RCA in 1930 as Supervisor in Student Engineering Training and Personnel. Quality Control, Design and Development work in aircraft and police radio followed, and until 1942 he was active in the then fledgling field of Sonar.

After 3½ years of World War II as Product Manager of Test and Measuring Equipment, Jules was placed in charge of Broadcast Antenna Phasing Equipment. His next assignment was Technical and Commercial Representative in Washington, D. C. In this capacity, Jules served Consulting Engineers, Radio Attorneys and the FCC on broadcast and communications equipment matters.

DAVID BAIN

David Bain, of the Product Administration Department, recently assumed his new position as Washington Sales Manager, Broadcast Equipment, in Washington, D. C., succeeding J. A. Renhard.

A member of IRE, "Dave" is well known in the Broadcasting industry, having served in turn as Chief Engineer with stations WTAL in Tallahassee, Fla.; WRTD at Richmond, Va.; and WBML in Macon, Ga. He came to RCA in October, 1945, following three years service with the Navy's Bureau of Ships, for which he designed aircraft radar.

Since 1945, Dave served as Broadcast Field Representative in the Kansas City and Chicago regional offices of the Engineering Products Department, and later was assigned to Transmitter Sales at the Camden home office. Since January of 1951, he has been Product Manager of Broadcast Audio.

JOSEPH M. WALTERS

Joseph M. Walters of Atlanta, Ga., is now Broadcast Sales Representative in the Atlanta office, where he is serving Broadcasters in the territory of Florida and parts of South Carolina and Georgia.

Joe has been active in the field of broadcasting and electronics for some time and in 1937 and 1938 was Engineer at WSIX, Nashville and then Chief Engineer at KPAC, Port Arthur, Texas. In 1941, he joined the Federal Communication Commission and was assigned to the Washington, D. C. and Florida offices.

In the U. S. Navy in 1942 Joe trained in Sonar, Sound, and Radar, and was an officer instructor on shakedown ships and Officer-in-Charge of a Sonar laboratory at Key West. Joe received his B.S. degree at Alabama Polytechnic Institute in 1949, and previously attended Port Arthur College and the University of Tennessee. He holds memberships with Eta Kappa Nu, AIEE, IRE, and ARRL.

In 1946, Joe became Studio Supervisor of WNAO, Raleigh, N. C., where he remained for the next two years. In 1950, he joined RCA as a Commercial Engineer and later became Mobile Communications Sales Coordinator.

HAM FORUM

BROADCAST RADIO AMATEUR DEPARTMENT

CQ S. A. AND ASIA

Latest word from Phil Baldwin, WHDH Chief, tells us their new 200-watt club station, WITOP, is nearing that 75-meter fone W-A-S W-A-C target we mentioned a few issues back. They have worked 37 states, 22 foreign countries and all continents but South America and Asia, all on 75 fone! *Splendid work, fellas . . . maybe a reflector behind that ¼ wave whip would help you with the others.*

We think this is one for the records . . . Walt Filson, W2BEI, RCA Engineering, has had over 1600 contacts with G6BY . . . over 600 with GM8MN. Many of these were made on 75 with great regularity before band condx became so poor. . . . Russ Morgan, CN8FZ, lays down a husky signal in the states these days. Russ is with RCA Service Company in French Morocco . . . look for him weekends on 14004, 14190, and on the high end around 14,320.

We received a nice letter from an interested reader—Robert E. Fay, W7NNQ, C. E. of KBKW, Aberdeen, Washington. Can you give us some details on your activities, Bob?

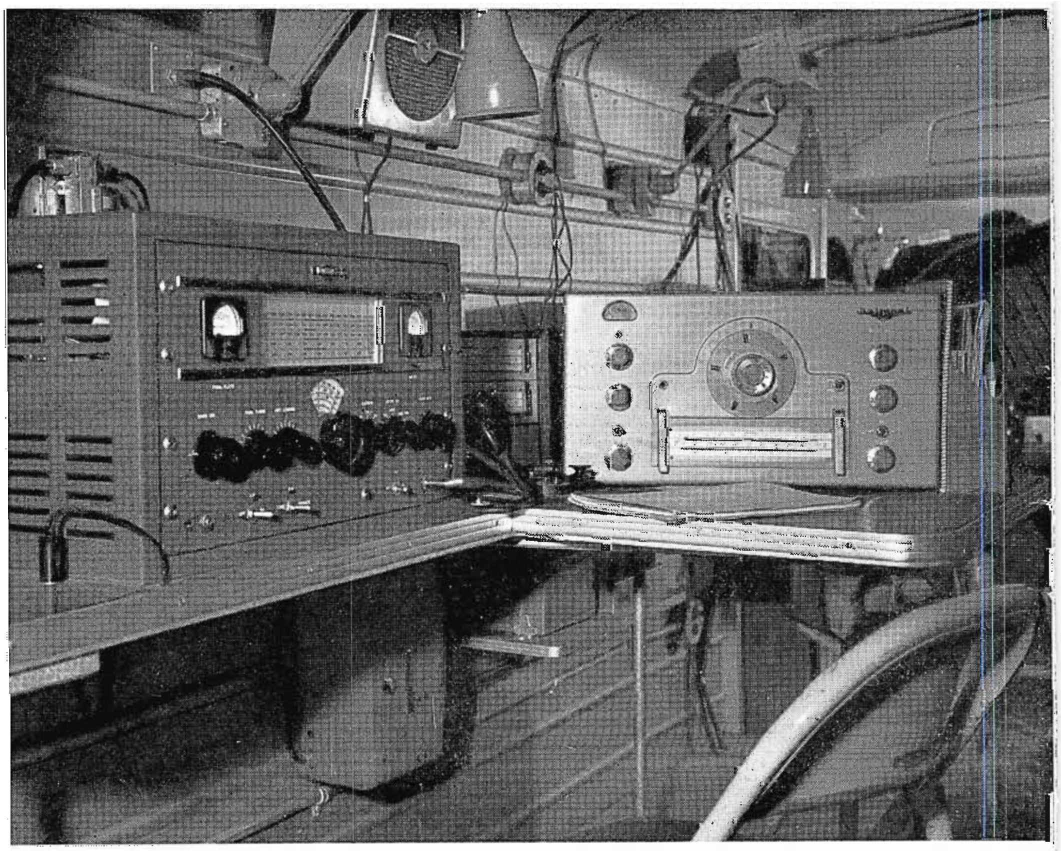
75-METER NET

For the lighter side, tune in the 75-meter Needle Net, which convenes around 7 p.m. daily. . . . Dale Kentner, W2ZX, RCA Broadcast Engineer, and a relatively new "needler" in the 6-year old net extends invitations to any and all newcomers to join in. Only qualification, Dale explains, is to be able to take it—and give it! No need for tfc handling experience . . . the Needle Net devotes itself exclusively to the settling of world problems . . . other Needle Net members include Kenneth Cox, W3VNF, Homer Lotier, W2WVN, operating engineers at WWDC, Washington, D. C., W2MI, W2FMQ, W2AWR, W2AQP, and W2LIR.

DELUXE MOBILE STATION OF THE MILWAUKEE AMATEUR RADIO CLUB

The fine pictures you see on these pages are views of the deluxe mobile radio equipment owned and operated by the Milwaukee Radio Amateurs' Club, Inc. The photos were taken by Kenneth Eggert, W9MOT, club V. P., and forwarded to us by H. Charles Kaetel, W9SNK, Transmitter Engineer at WISN, and Director of Mobile Activities at the club.

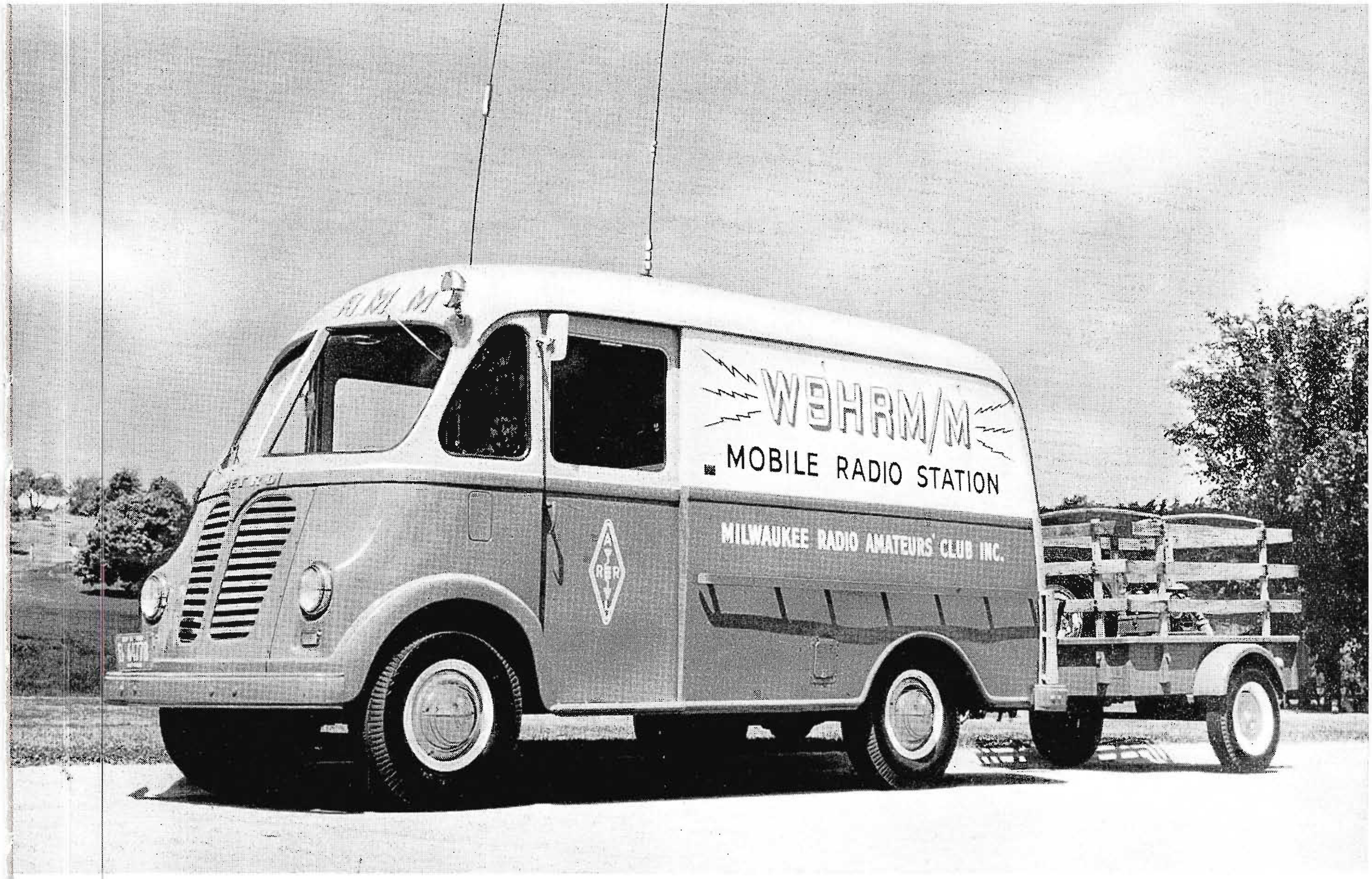
You could meet a new face each time you work W9HRM/M, because the club has 250 members, including an OA4, two W1's, a W2, W3, W5, KL7/9 and several WN9's. Beside W9SNK, three other



View looking toward driver's seat shows the 32V2 transmitter, left, and HRO receiver. Antenna tuner can be seen above HRO.

Address correspondence to:

HAM FORUM
Marvin L. Gaskill (W2BCV)
Associate Editor, Broadcast News
RCA, Camden, New Jersey

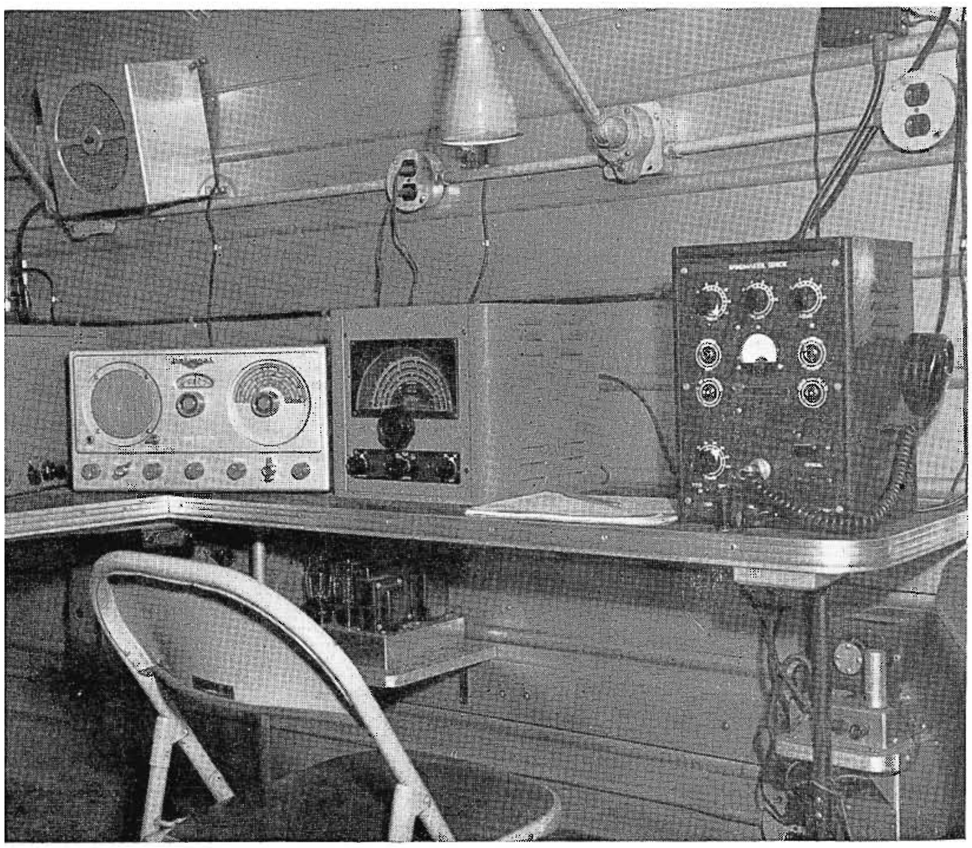


Club's QSL is a beautiful 4-color reproduction of above on a large postcard, with station data and interior views printed on opposite side.

club members, William Gainer, W9SO, Ralph Green, W9WCR, and Emmanuel Irving, W9GQO are Engineers at WISN.

The 1½-ton truck was purchased and equipped by the club. The equipment consists of 50-watt and 150-watt transmitters, four receivers (one a police receiver), whip and ground-plane antennas, and a trailer containing a 2½ kw. gas driven generator.

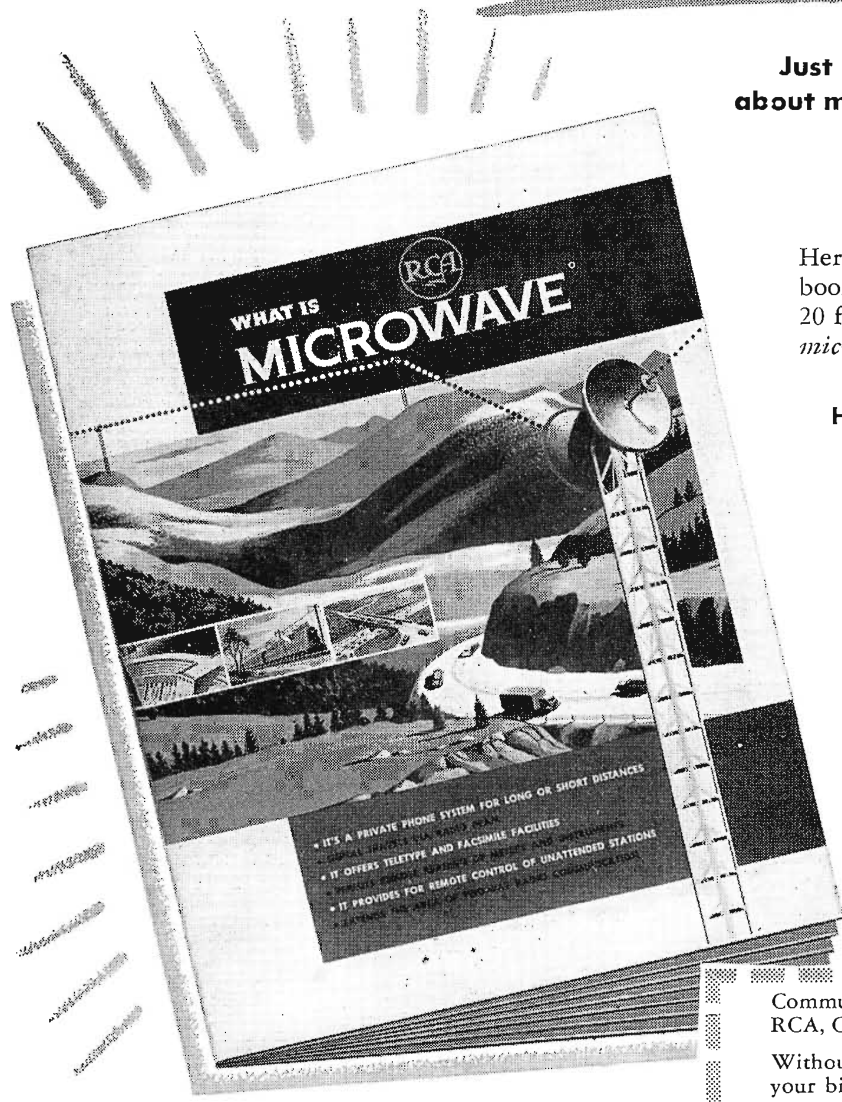
This equipment can be seen in the photos. Not shown, however, are two 40-foot portable stainless steel masts which can be set up on site to provide a doublet or any desired type of antenna. The three receivers facilitate network operations with other club members in automobiles.



Just behind driver's seat are the NC-57B and VHF-152 receivers and Bandmaster transmitter. All AC is in conduit with ample outlets.

FREE to communications men . . . this big, new, illustrated book:

"What is MICROWAVE?"



Just off the press! Jam-packed with facts about microwave . . . what it is, how it works, *what it can do for you!* For your FREE copy, mail coupon now

Here's the beautiful, brand-new "how-and-why" book about microwave you've been waiting for . . . 20 fact-packed pages that *show you exactly how microwave can help you in your operations.*

Here are 5 of the many subjects covered:

1. The 4 basic advantages of microwave.
2. 5 actual case histories showing microwave at work for . . .
   - a big power utility.
   - a long-distance pipe line.
   - a fish and game commission.
   - a 300-mile turnpike.
   - a 1000-mile Western Union system.
3. How microwave operates a pumping station by remote control.
4. What goes into a typical microwave system.
5. How RCA helps you install your microwave system.

Are you keeping up-to-date on microwave?

Microwave is one of the most versatile communications tools developed in the 20th century. No wonder industry has been so quick to adopt it for power lines, pipe lines, highways, railroads, and similar applications. You just can't afford *not* to be up-to-date on microwave. So get *your own copy* of this big new FREE book . . . mail handy coupon . . . RIGHT NOW!

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Communications Section, Dept. 129G
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Without obligation, please send me my own FREE copy of your big brand-new book, "WHAT IS MICROWAVE?".

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Please give me additional information on microwave for the application following:

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RADIO CORPORATION of AMERICA


TELEVISION'S ONLY
2 KW VHF
TRANSMITTER
RCA
IT'S ALL
AIR COOLED

for 2 to 20 kilowatts ERP*

If you plan to start TV station operations with a modest equipment investment . . . and still be sure you get adequate signal coverage . . . this new "2 kw" is a logical, economical solution to your problem. Initial equipment expense is lower than that of most TV stations on the air today. And tube costs are low—*because all the tubes are standard types.*

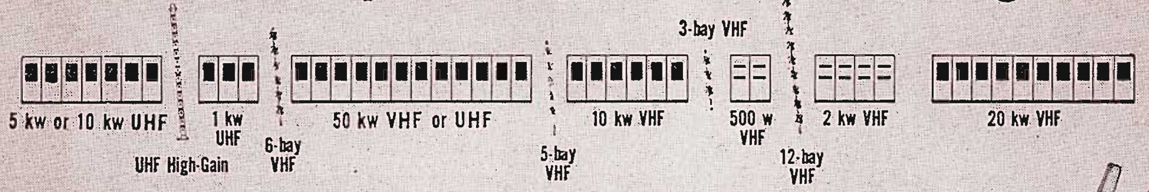
Used with RCA's popular and inexpensive high-gain 3-section Super Turnstile Antenna, this transmitter produces 5 kilowatts ERP—at the lowest cost per radiated kilowatt in TV history. Used with RCA TV antennas of higher gain, this transmitter provides up to 20 kw ERP!

Why not ask your RCA Broadcast Sales Specialist to help you with your planning. He can tell you precisely what you'll need to go on the air—and how to do it at lowest cost. Make use of his "know-how." Call him today.

ANNOUNCING—a 64-page book on RCA's new line of TV broadcast equipment for all channels, 2 to 83! An indispensable reference for station planning. *Available only from your RCA Broadcast Sales Specialist.*

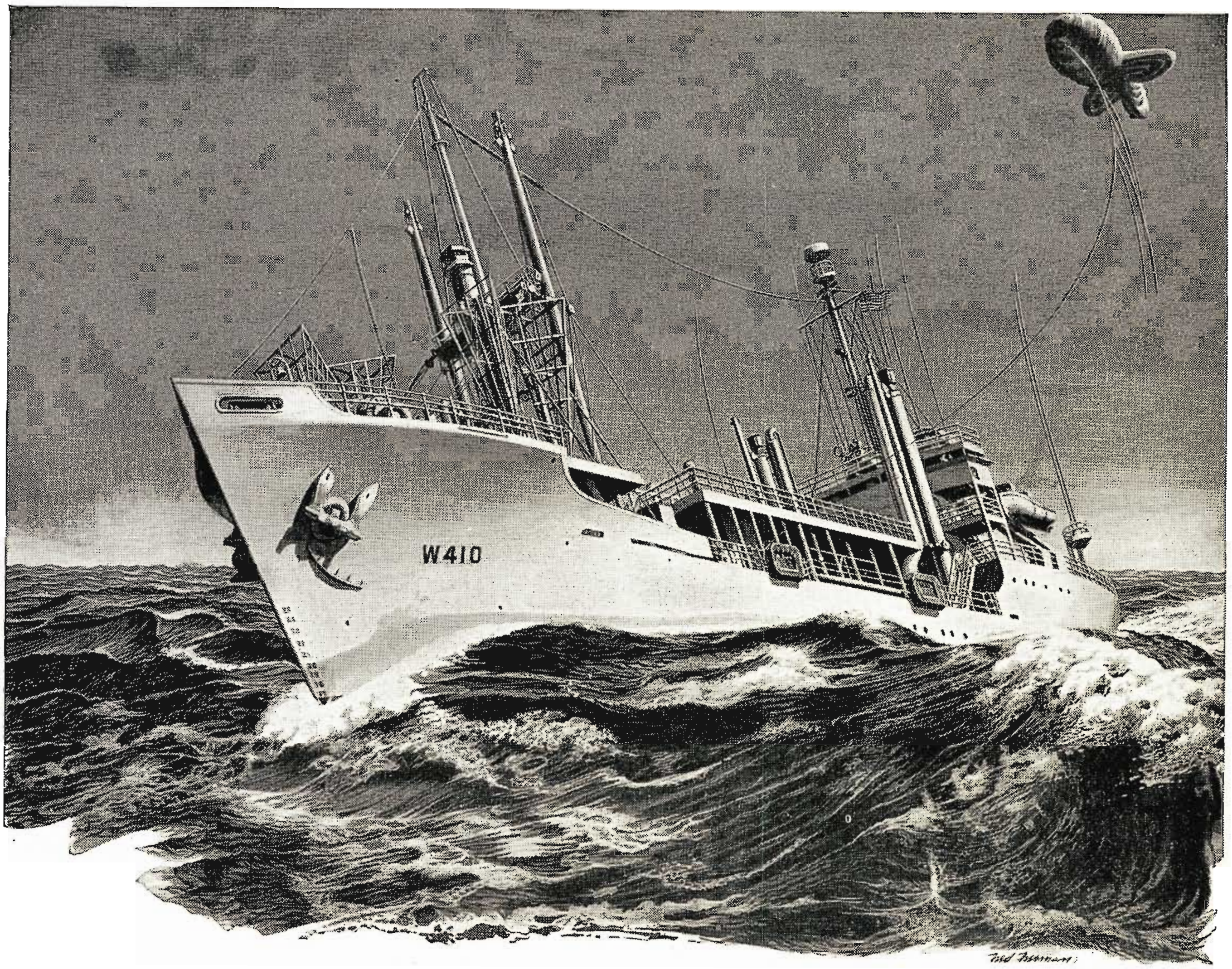
*Effective radiated power

For maximum power (UHF or VHF)—go RCA!



The heart of the "2 kw"—
the forced-air-cooled triode, RCA-5762

This service-proved triode features sturdy internal construction—and a very efficient plate radiator. The tube takes less than half the air flow previously needed for a tube having the same power-handling capability. And it's available through any RCA Tube Distributor!



The *U.S.C.G. Cutter Courier*—armed with Truth, not guns—will use its RCA transmitter to beam messages of hope to Iron Curtain countries, and will also be a good-will ambassador to the free nations.

Freedom's clear voice goes to sea

When broadcasting Freedom's message to Iron Curtain countries, transmitters must contend with deliberate radio interference, created to "jam" the air. Aboard the Truth Ship *Courier,* a powerful RCA transmitter fills most of one cargo hold, while a second hold contains Diesel generators which produce 1,500,000 watts of electrical power. Amidship, a special deck is the launching platform for a barrage balloon which carries the antenna high aloft.

In operation, the *Courier's* radio voice will follow regular schedules, so that listeners—often tuning in at serious risk—will know when broadcasts are coming through. These people are seeking to learn the Truth, and want to hear it despite the thousand jamming stations built in an effort to keep Freedom's messages from penetrating the Iron Curtain.

Development of broadcast equipment for use on land and sea is only one example of RCA pioneering in research and engineering. It is your assurance of finer performance in all products and services of RCA and RCA Victor.

* * *

See the latest in radio, television, and electronics in action at RCA Exhibition Hall, 36 West 49th Street, N.Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N.Y.

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