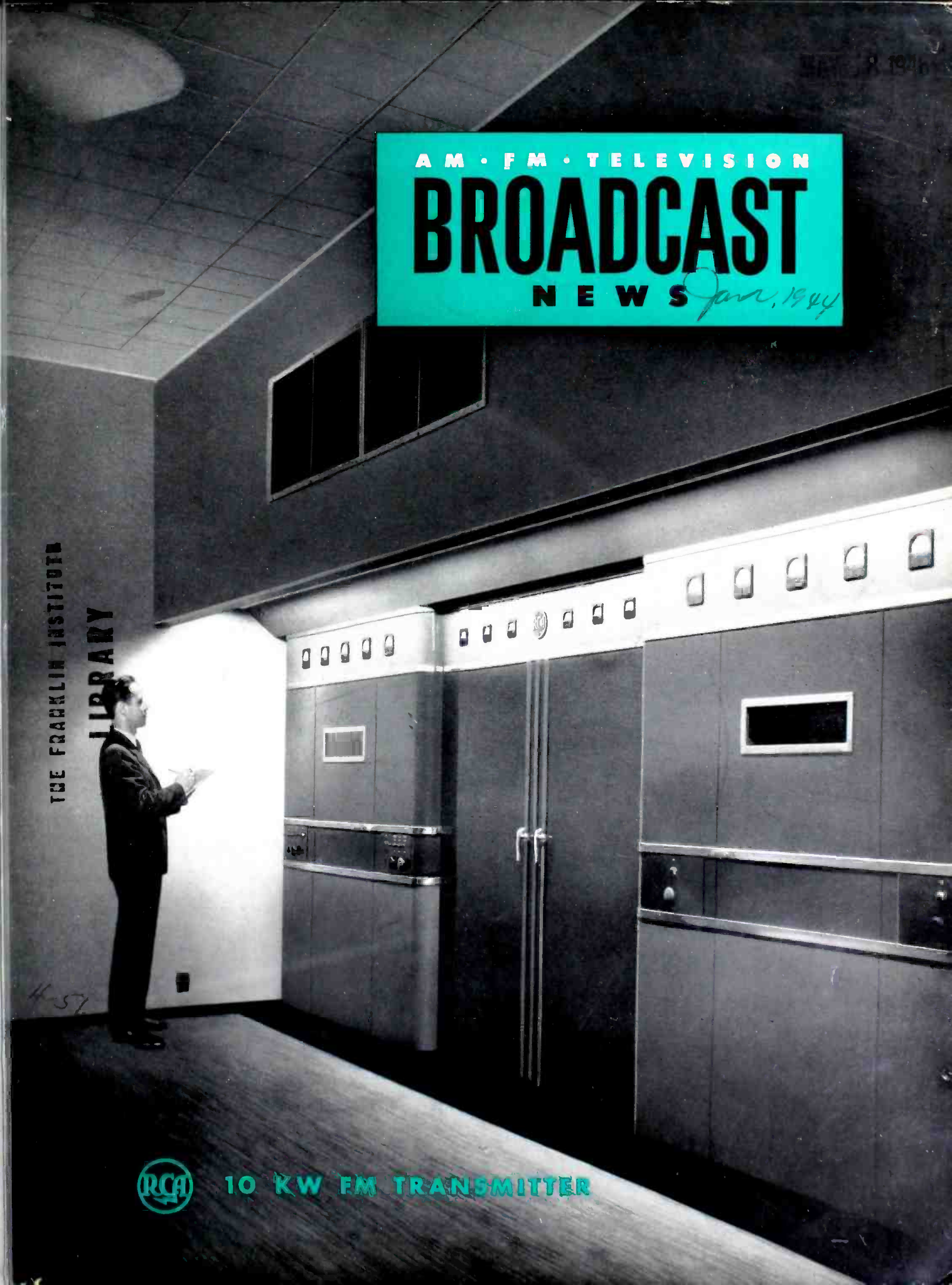
AM · FM · TELEVISION

BROADCAST NEWS

Jan. 1944



10 KW FM TRANSMITTER

CAMDEN PLANT, RCA Victor Div.

"E" Flag . . . . Jan. 26, 1942
★1st Star . . . . July 23, 1942
★2nd Star . . . . Jan. 23, 1943
★3rd Star . . . . July 23, 1943

JOHN P. TAYLOR, Editor NOLA G. PUGLIESE, Ass'n't Editor

Broadcast News

AM · FM · TELEVISION

. . .

Published by the

RADIO CORPORATION OF AMERICA

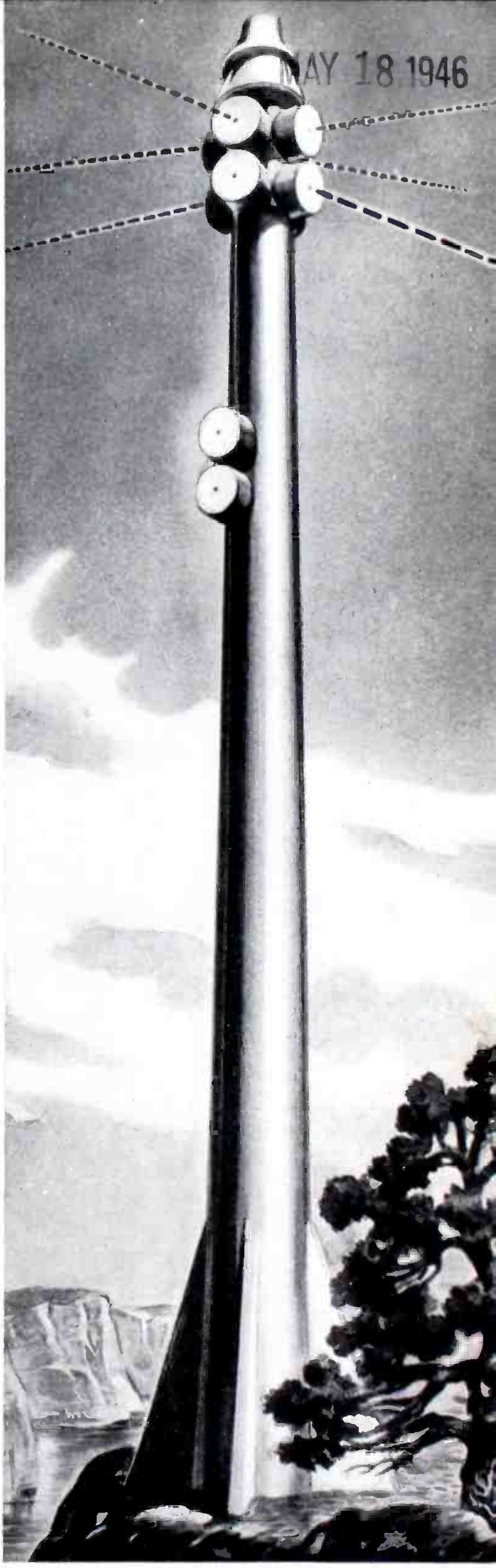
RCA VICTOR DIVISION..CAMDEN, NEW JERSEY

NUMBER 38 JANUARY, 1944

Contents

Cover: RCA 10 KW FM Transmitter at NBC, New York

Back Cover: The Antenna Towers and Transmitter House of WFBR, Baltimore



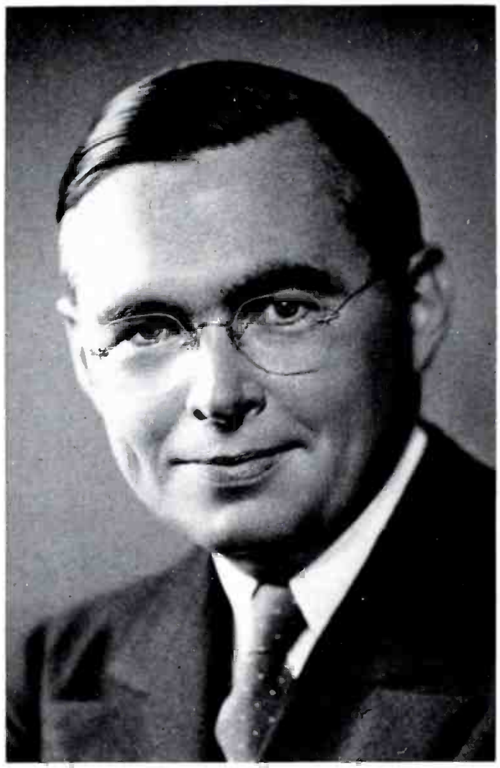
"LIGHTHOUSE" RELAY FOR TELEVISION

An artist's conception of one of the automatic, unattended radio relay stations which Mr. Ralph R. Beal of RCA Laboratories has suggested may, before long, tie together television stations from coast-to-coast.

THE DEVELOPMENT OF THE TELEVISION MARKET
in the Postwar Period

by **THOMAS F. JOYCE**

Abstract of a paper given before the American Television Society and the Advertising Club of New York, Nov. 10, 1943, New York City



THOMAS F. JOYCE
Manager, Radio, Phonograph, and Television Department
RCA Victor Division

Television broadcasting, obviously, cannot become a substantial, self-supporting, profitable advertising medium until television receivers are in hundreds of thousands—yes, millions of homes. There are many different views concerning the speed with which television will go forward after the war. The technical and economic problems of building stations in key cities, of interconnecting those stations by network facilities, and of making available audience-building television programs are problems that constitute a real challenge to the engineering, manufacturing, business management, entertainment, and advertising brains of the United States.

There are some who say that the problems are so vast that they are virtually insoluble. There are others who are more optimistic—and look forward to the day when television broadcasting programs will be as common in the home as radio broadcasting programs are today. It is the views of the latter group that I present tonight.

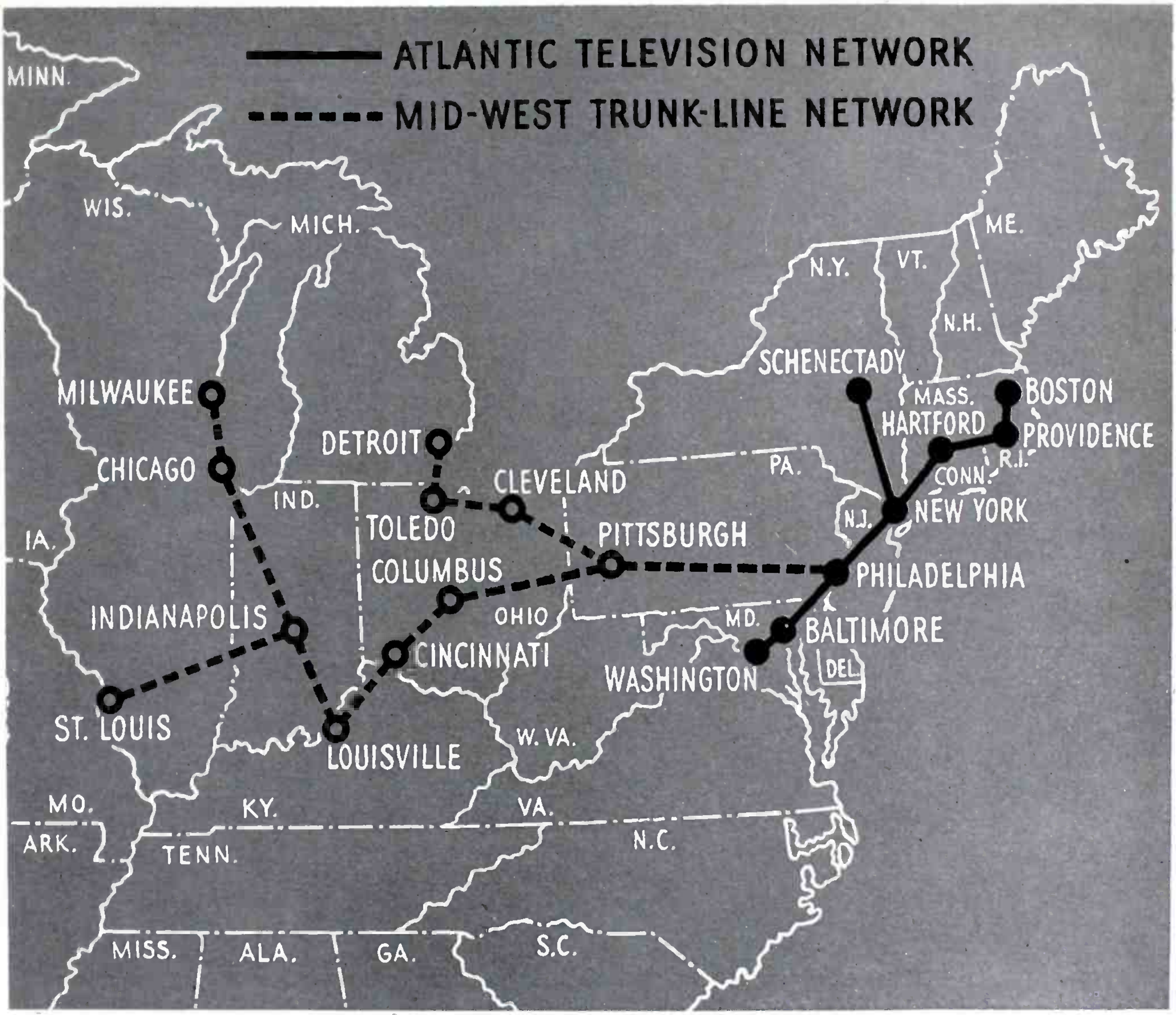
To make television a nation-wide broadcasting service will involve the investment of millions of dollars in studios and transmitters to be located in the key cities of the United States; and more millions of dollars for the building of network facilities and the production of suitable television advertising programs. Television cannot succeed without these services—but the answers to these problems would rapidly develop if the biggest problem of all were solved—namely, *an acceptable low cost radio television receiver*. This is the number one problem of the postwar television industry.

Given a good low cost television receiver that is within the buying range of the average American home, then broadcasting facilities and program service will develop with a speed which will amaze even the most ardent friends of television.

Why do I say this? Because:

1. Existing radio station owners are smart enough to know that if acceptable television receivers can be produced for the mass market, television audiences will build at a rapid rate. This means that the operators of a television station will not have to wait an indeterminate number of years before they have television audiences large enough to produce substantial advertising revenue with which to pay operating costs and show some profit.
2. The application for television licenses by 100 or more prospective operators across the United States, which I believe the advent of an acceptable low cost television receiver would bring forth, would have a salutary effect on the price of television transmitters and studio equipment. It would mean that manufacturers—instead of building one, two or three transmitters at a time—would build, possibly, 20 to 25 at one time. The lower prices made possible by this semi-quantity production as compared with the cost of tailor-made equipment would encourage still more enterprising business men to go into the television broadcasting business. Lest you think that this estimate of 100 or more television transmitters is over-optimistic, may I call your attention to the fact that the number of television broadcasting stations in existence, plus the applications on file with the Commission for experimental and commercial television broadcasting permits, total about 50.
3. The business interests erecting television transmitters in the key cities of the United States would create a tremendous pressure for the development of network facilities. Again, some enterprising organization will see that the combination of the rapid development of television facilities in a number of key cities of the United States and a mass market price for the television receivers would in the course of two or three years create an economic foundation for the profitable operation of network facilities, thus firmly establishing chain network television. These network facilities will also be available for frequency modulation programs and facsimile.
4. The big national advertisers would recognize that the existence of low price television-receivers would assure the rapid development of a vast home television audience. Future television advertisers will want to get in on the ground floor with television programs. The programs put on by these sponsors will be good programs—even though in the first two or three years the cost of television advertising per unit of circulation may be greater than advertising in already established advertising media. These marketing leaders know that television will be not only the greatest advertising force in the world—but the greatest sales force as well. For the first time it will be possible for the manufacturer or distributor of merchandise actually to demonstrate his product or products in millions of homes simultaneously and at extremely low cost. That is more than effective advertising. That is effective selling.

Is there any foundation for believing that this is the way that television is going to develop in the postwar period? I believe that there is.



Recently, we made a survey in 11 cities of a cross-section of the public by age, income and sex. Among the questions we asked were:

Would you or your family consider buying a radio and television receiver if the price were $400.00?

10.3% answered "yes."

To those who said "no," we asked:

"Well, would you buy if the price were $300.00?"

The cumulative percentage became 19.9%.

To those who still said "no," we asked:

"Well, would you buy if the price were $250.00?"

The cumulative percentage became 34.3%.

To those who still said "no," we asked:

"Well, would you buy if the price were $200.00?"

The cumulative percentage became 61.3%.

From the foregoing, the conclusion seems inescapable that when, in the postwar period, the radio industry produces *a good television receiver in the $200 price range*, a very high percentage of the homes of the United States will be ready to buy television receivers as soon as service is available to them. Such a receiver, I believe, is possible—based on 1940 labor and material costs, and assuming no excise taxes. Of course, the postwar price would be increased by the factors of inflation and excise taxes.

We have prepared some estimates of the probable postwar rate of market development for television once there has been a complete agreement on standards approved by FCC which would give the industry the "green light" without any "ifs." It has been assumed for estimating purposes that there will be no changes in the standards or in the place which television occupies in the broadcasting spectrum, which might substantially delay the start of television or bring about more complicated engineering and manufacturing—thus making improbable, at least in the immediate postwar period, a $200.00 television receiver as previously described.

I have followed with interest all of the statements by the Chairman of the Federal Communications Commission, James Lawrence Fly, on postwar television. I believe that I am correct in interpreting his thinking as being in favor of the rapid postwar development of television. Mr. Fly, who has given careful thought and study to television, has been quoted in the public press as saying at the joint meeting of I.R.E. and R.M.A. in Rochester, New York, in the fall of 1942 as follows:

> "We can confidently predict a great expansion of the television and frequency modulation broadcast and general communications services, and planning for their proper development is definitely in order."

The report in RADIO AND TELEVISION WEEKLY, of October 6, 1943 on a talk given by Chairman Fly before the Advertising Club of Boston is as follows:

Largely because of the development of television and frequency modulation, the radio industry "will not be a postwar problem child that we shall have to worry over." The industry will take up "no small amount" of the unemployment slack after the war, he forecast.

The estimated postwar television market projections that follow are based on television as we know it today and assuming that it can go forward without undue delay in the postwar period:

Television broadcasting facilities exist in New York, Philadelphia, Albany-Schenectady, Chicago and Los Angeles. I believe that a television station in Cincinnati could begin broadcasting shortly after the war when the needed equipment to complete this station is made available.

The foregoing cities, assuming no radical change in broadcasting standards or allocations, would logically be the first television market. This first television market has 25,907,600 people, 7,140,922 wired homes and 28.46% of the U. S. buying power. Television coverage of only 10% of these homes would in itself constitute a very important new advertising medium, particularly when one considers that the effectiveness of television advertising per unit of circulation will undoubtedly be many times greater than that of any other form of advertising. Ten percent would represent 741,000 homes with television, or a probable postwar audience of over 7,000,000 people. In my opinion this could be attained approximately two to three years after the full commercialization of television. Three of these markets, New York, Philadelphia and Albany-Schenectady, have already broadcast television programs originating at a central source—that is, NBC, New York. Thus, the nucleus of television network operation has already begun.

We can assume further that within three or four years after the commercial resumption of television, Washington, D. C.; Baltimore, Maryland; Hartford, Connecticut; Providence, Rhode Island; and Boston, Massachusetts will have television transmitters. These cities, together with Philadelphia, New York, Schenectady and Albany, could be interconnected with a television network circuit about 600 miles long. This network circuit would make television broadcasting service available to 33,336,000 people, 9,379,039 wired homes, representing 36.62% of the total U. S. buying power.

An additional 1,300 miles of network circuits could link the Middle West with the Atlantic Seaboard, bringing television service to Pittsburgh, Cleveland, Cincinnati, Detroit, Chicago, St. Louis and Milwaukee. This would make television broadcasting service available to an additional 10,725,400 people living in these key cities—bring the total market served by about 2,100 miles of network facilities to 44,061,500 people and 47% of the U. S. purchasing power.

This trunk line television network just outlined, with the secondary networks that would be off-shoots from it, would serve the 19 state-area bounded by Illinois and Wisconsin on the West and Virginia and Kentucky on the South. There are approximately 70,000,000 people in this area. It represents approximately 62% of the purchasing power of the country. All of this development can be expected to take place approximately five years after the full commercialization of television.

In approximately five years after the commercial resumption of television, television transmitters located in 157 key cities of the United States should be making television program service available to a primary market consisting of 72,159,000 people, 17,252,000 wired homes, or 59.6% of the total and 61.5% of the United States purchasing power. An additional ten million people should have television available to them by secondary television network developments. When television service is available to this area, television receiver sales should be at the rate of approximately 2,500,000 units per year at an average retail price, *based on* 1940 *costs*, of about $200.00.

POST-WAR TELEVISION—How the post-war home television receiver may look. An experimental large-screen television receiver designed by RCA Laboratories for home use. The picture on the translucent screen is 13½ by 18 inches. The screen is retractable and slides down into the cabinet when not in use. The picture as it originally appears on the face of a kinescope is projected through a lens to the mirror on the underside of the cabinet's uptilted lid, from which point it is reflected to the viewing screen. The scene shown on the screen (which, in this instance, was "dubbed-in") gives an idea of how large the projected picture will appear.

REMOTE TELEVISION PICKUP — *Monitoring and switching equipment used by NBC in the rodeo broadcast and other remote pickups is shown mounted in the truck as actually used in this broadcast. With this equipment the cameras (as many as four) may be located up to 500 feet away.* *For further details see the article beginning on Page 20 of this issue.*

It would also be reasonable to expect that by the end of the fifth year, after the full commercialization of television, the engineers of the industry should be able to develop a low cost automatic rebroadcasting television transmitter which could be located in the areas which are outside the broadcasting scope of the television transmitters located in the 157 key cities of the United States. This transmitter would be automatically turned on at the beginning of the network broadcasting day and automatically turned off when the program service for the day was completed. Once a month, or as often as required, a service engineer would visit such an automatic rebroadcasting transmitter to keep it in peak operating condition.

Such a development will make it economically feasible to bring television service ultimately to practically every home in the United States. Assuming such a development takes place, and we have every reason to be confident that it will, then it would not be unreasonable to assume that within ten years after the full commercialization of television, television service would be available to 23,700,000 wired homes or 80% of the wired homes of the United States. This would represent a population of about 100,000,000 people and approximately 82% of the total U. S. buying power. Television industry sales at this point should be, approximately, 3,500,000 units per year for a total retail billing of between six hundred million and seven hundred million dollars ($600,000,000 and $700,000,000). This billing, together with replacement tubes for existing receivers, service, transmitter sales, television advertising revenue, etc., will make television the billion dollar industry that many have prophesied it will be.

There have been many predictions concerning all of the great new things which will be available to the American public when the war is over. Television will not spring forward as an industry the day the fighting ceases. It may be a year or two or three years after the war before television is ready to go forward on a commercial basis. That depends upon the character of the recommendations made by the Radio Technical Planning Board and the action taken by the Federal Communications Commission on the recommendations by that Board. Of this, though, we can be certain—that the generations that come after the war will take home television service just as much for granted as the present generation takes for granted the radio set which, at the push of a button, makes available the finest entertainment and educational programs of the United States and, instantaneously, brings us voices and music from across the seven seas. Today, we only hear those programs. Tomorrow, we will see them as well as hear them.

WISH INDIANAPOLIS

WISH... *is a dream*

The engineer's dream above is the master control room at WISH. The streamlined transmitter installation and the factory-assembled test equipment racks on the following pages are also those of WISH. This station is an outstanding example of the value of careful planning and the use of equipment of coordinated design.

by STOKES GRESHAM, JR. Chief Engineer

THE MASTER CONTROL ROOM

The WISH master control room equipment includes four complete program channels, each having all the necessary amplifiers—including pre-amplifiers, booster amplifier, line amplifier, and monitoring amplifier—required for operation independent of the rest of the system. These amplifiers, the associated switching and control relays, and the audio monitoring and test equipment are mounted in six streamlined cabinet-type racks. All switching is accomplished by push-button controls located on the master control desk. Circuits are arranged so that in ordinary operation no patch cords are required. Normalled jacks are provided, however, in the input and output of all amplifiers, the output of all microphones and turntables, and in all incoming and outgoing telephone circuits. Together with numerous "multiples" these add up to a total of 1056 jacks. They allow any unit in the system to be patched-out and another substituted in less time than it takes to tell about it. The racks, with all equipment, were completely assembled and wired at the factory with all inter-rack wiring being brought to terminal boards at the bottom of each rack. The back of these racks is as neat as the front!

The master control desk is similar in design to those now used in many RCA-equipped stations but has, in addition, a number of special features incorporated to meet the particular requirements of WISH. There are five separate panels on this desk, each being associated with a particular function of the control system. Referring to the illustration and reading from left to right, these are (1) the Studio "A" control panel, (2) the MCR-NET-REM control panel, (3) the master channel monitoring and switching panel, (4) the Studio "B" control panel, and (5) the Studio "C" control panel.

The Studio "A" control panel has four microphone input positions, one spare input position, and mounted in line with the input attenuators, a master attenuator. An off-on switch is associated with each microphone position. An output switch provides for audition, rehearsal, or program. In the rehearsal position the output is not fed to the office and studio monitoring bus.

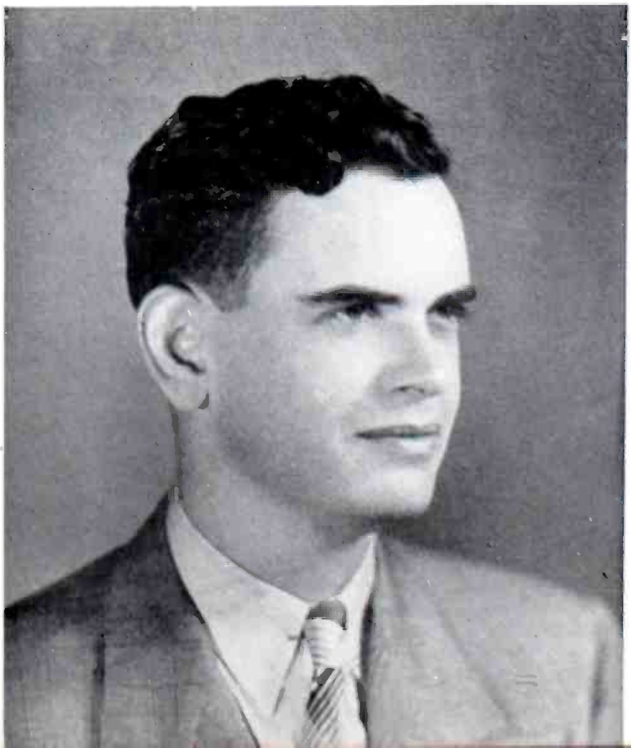
The Studio "C" control panel, located at the right of the desk, is similar to that of Studio "A" except that it has three, instead of four, microphone positions. On each of these panels, and that of Studio "B," in addition to those previously mentioned, controls are provided for cue selection and volume to speakers in the respective studios. On the "A" and "C" studio panels there are selector and volume controls for two ceiling mounted MCR speakers. All selector switches, including those in the offices, are provided with eighteen program sources.

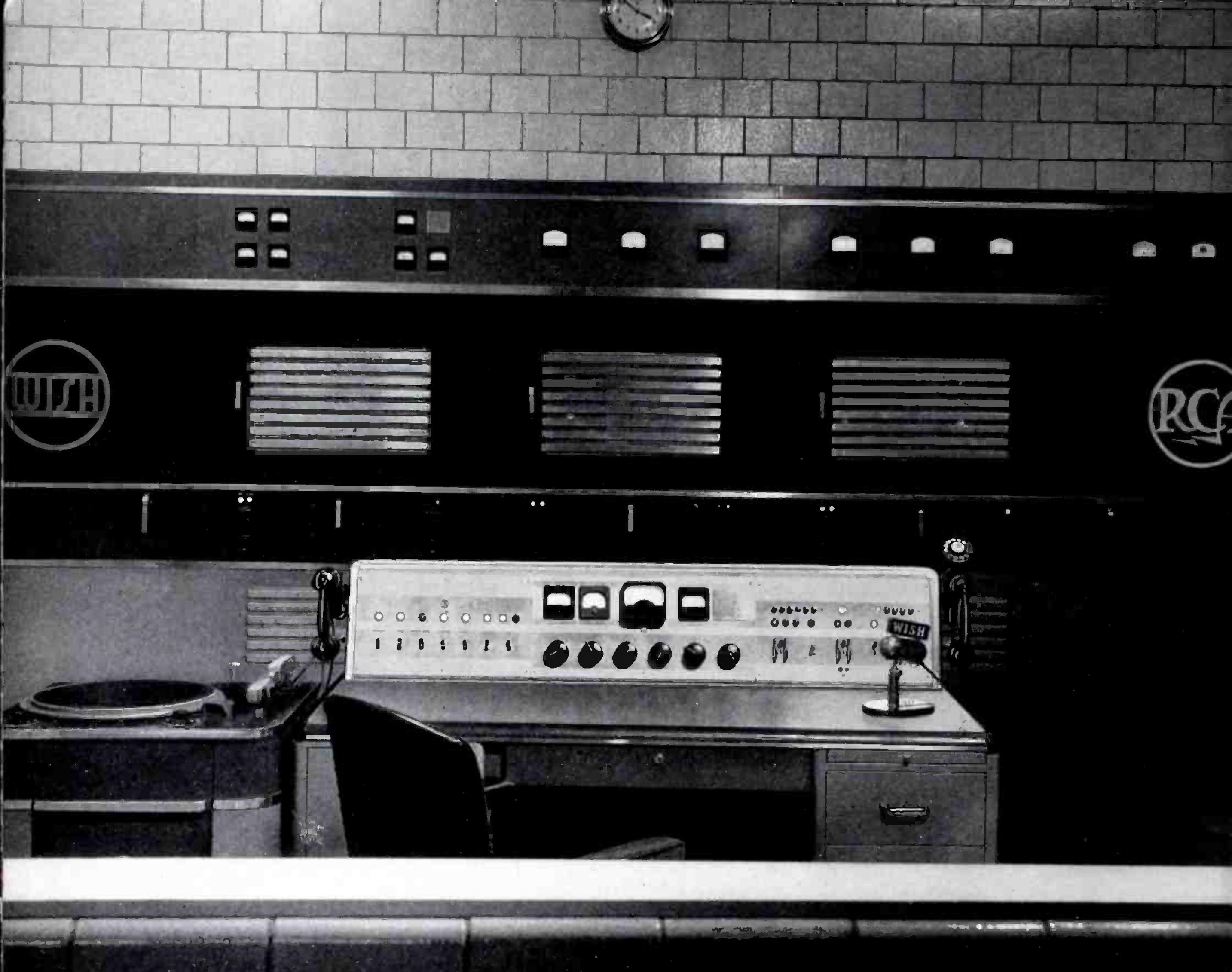
The Studio "B" control panel has two microphone input positions, a turntable input position, and a spare. These controls operate in conjunction with an announcer's control console in Studio "B." The latter includes the mixers for the two turntables located in this studio, a starting switch for each turntable, and a control for the announcer's microphone.

The MCR-NET-REM control panel provides facilities for mixing of the control room microphone, two remotes, Blue Network, and the two turntables which are in the master control room. These inputs may be used in various combinations or operated independently. Also included on this control panel are key switches and push-buttons for cueing and talkback to five remote points, and two override circuits, one for "call-ins" from remotes and one providing for Studio "B" or master control room "override" of any of the four program channels. The latter is indispensable in fading programs to make station breaks, or in originating sound effects or theme music in Studio "B" or master control room.

The master switching panel contains a master attenuator, a selector switch, and a volume indicator for each of the four channels. The selector switches are of the push-button type, mechanically interlocked and so arranged that the input of any of the four master channels can be bridged across the output of any one of the three studios, the master control room, the network, or either of two remote positions. The other switch positions are spare and off. The transmitter is fed by a five-position push-button switch which selects the output of any one of the four program channels or connects the Blue Network line directly to the transmitter. The latter can be used in case of power failure or when it is desired to operate without an operator at the studios.

STOKES GRESHAM, JR., Chief Engineer





THE TRANSMITTER AND CONSOLE

The modernistic WISH transmitting plant was designed especially to house the streamlined 5-DX transmitter and the phasing equipment, supervisory console, turntables, speech input and test equipment used with it. The interior was laid out by the writer with the idea of utilizing to the best advantage all the available floor space. The transmitter is built into a wall enclosure, the door in the end panel of the transmitter giving access to the rear. The phasing equipment is located in a separate room at the right of the transmitter. All essential switching and monitoring can be accomplished from the supervisory console. A 70-C1 turntable is located next to the supervisory console for use in testing and emergency program.

Wiring between units of the 5-DX transmitter and interconnections to the speech racks, test equipment, supervisory console, and phase branching controls is carried in a readily accessible duct in the concrete floor. All interwiring was made with lead cable. Modulation transformer and reactor, high voltage filter rack, and associated equipment are located at the rear of the transmitter proper. The high voltage transformer is located outside the building.

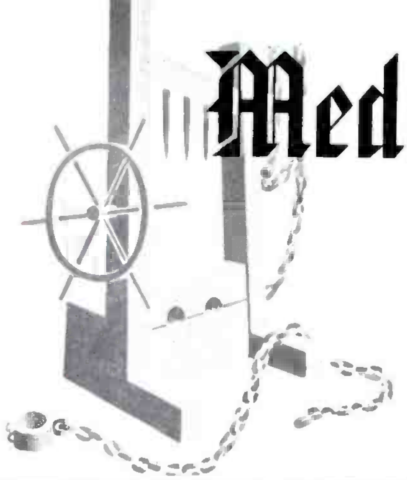
WI

TEST AND MONITORING EQUIPMENT

SH

The test equipment, monitoring equipment, and audio equipment at the WISH plant are assembled in three cabinet-type racks which are located to the right of the supervisory console as shown in the illustration above. This equipment, which includes duplicate audio channels, limiting amplifier, modulation, phase and frequency monitors, beat frequency oscillator, and test equipment, is unusual in that it was entirely factory-assembled and wired. In most stations this part of the plant equipment is a hodgepodge of different types of units in an assembly which, like Topsy, "just growed." The WISH equipment is composed of units of coordinate design, assembled in the factory, provided with a full set of monitoring jacks like a de luxe studio installation, and wired according to "custom-built" standards. All of the units match in color, and they match the transmitter and console not only in color but also in styling. This whole installation is a particularly good example of the trend toward integrated systems which are factory-assembled, factory-wired, and factory-tested, but which, because they are "custom-built," can still provide for individual station requirements and the personal preferences of station engineers.

Medieval Torture . . . 1943



The notorious Iron Maiden of the medieval torture chamber, together with such devices of torment as the wrack, the wheel, and thumbscrews, had nothing on the ingenious devices which engineers have developed to put vital radio and sound equipments through their pre-battle paces.

Throughout the busy plants of RCA these modern "torture chambers," resembling the dungeons of medieval castles, give vent daily to scenes of harrowing trials by water, fire, submersion, and shock.

The "victims"? Ultimately, the Axis; but presently, our weapons of war—communication equipment, aircraft radio equipment, battle announce systems.

The "executioners"? Skilled radio engineers who, like ther medieval predecessors, take delight in putting their "victims" through the paces.

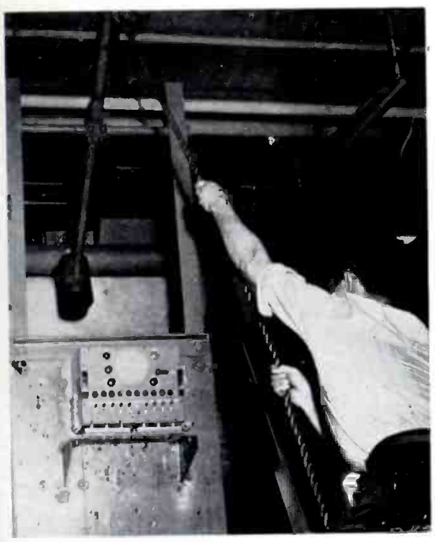
ALTITUDE: 40,000 FEET inside this new RCA plastic altitude chamber. Aircraft radio equipment takes a ride, and as the pressure drops inside the sealed, transparent walls, expert eyes observe every part of the radio mechanism. Defects in design, details of faulty construction that would remain hidden until actual high-altitude flights can be noticed at a glance RIGHT ON THE GROUND.

RCA's torture chambers grew out of the demands of the armed forces for equipment that could withstand strenuous use under all conditions of climate and battle. These requirements call for rigid, uncompromising tests to insure that such equipment, destined for service in the air, on the land, and on and under the sea, meets the high specifications set by the services.

These modern torture chambers house many ingenious devices especially contrived by the services and RCA engineers to simulate battle conditions which the equipment may be called on to withstand and through which it must operate perfectly. Since this equipment may see service on any continent and any of the seven seas, RCA's engineers are confronted with the responsibility of designing equipment which can be depended upon in almost any combination of operating conditions.

The torture devices (more politely called "test equipment") permit engineers to observe how the equipment will withstand punishment, how a particular unit or its material will stand up under virtually any battle or climatic condition existent anywhere on the globe.

READY FOR THE "GREEN HELL" is the radio apparatus tested in the RCA laboratory "sweat-room" in which equipment is exposed to steam-saturated atmosphere at 60° C. (140° F.) and 95% humidity. Heat-laden moisture is a deadly enemy of electrical installations; yet the radio apparatus of America's fighting planes and bombers MUST function perfectly in landing fields and dispersal areas hacked from the "green hell" of Pacific jungles. Equipment tested in this manner is prepared for the ordeal of rain-drenched Guadalcanal or New Guinea.



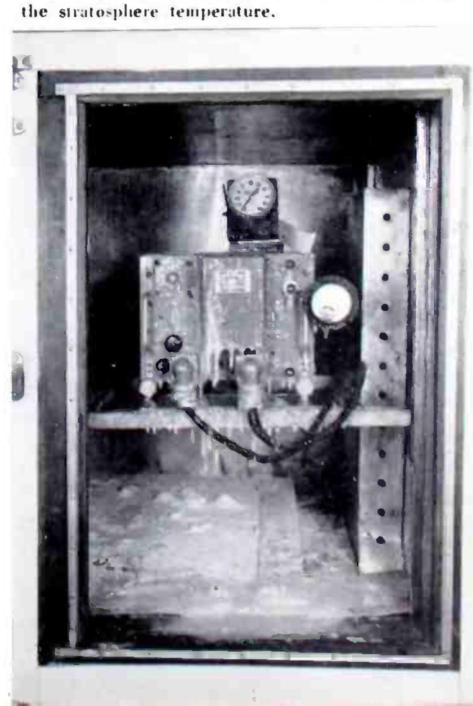
GUN RECOIL PUNISHMENT is dealt out by the repeated blows of a solid steel sledge-hammer in this so-called "shock" test. The sledge-hammer is made to deliver blows of great weight against the back of the board to which the apparatus is shown fastened.

"20,000 LEAGUES UNDER THE SEA" is reproduced by this pressure tank developed to test RCA equipment destined for under-water duty. The equipment being tested is "submerged" in 600 feet of water for twelve hours and under pressure equivalent to 300 pounds per sq. in.

ARCTIC REHEARSAL . . . . . . AT 76° BELOW and RCA equipment is prepared for today's battlegrounds which have advanced into the sub-stratosphere—where even over the equator temperatures are scores of degrees below zero. Anticipating the problems of tuning controls freezing, sensitive relays jamming, electrical adjustments changing and wires snapping, RCA recreates this intense cold in its laboratories, cold that is 9° lower than the stratosphere temperature.

200 MILES IN A JEEP . . IN TEN SECONDS, three thousand times a minute the radio equipment atop this machine lives through an acceleration that would cause the toughest young airplane pilot to "black out" in dive bombing. In a few minutes it lives through the jars and vibrations it would receive on ten round trips from Washington to Chungking.

ACROBATIC GYRATIONS are provided by this device which is called the "tumbler" test. In rotating the box the piece of equipment inside is dropped over 1,000 times. It is then checked to see that it still performs satisfactorily. Subsequent demands of battle conditions are adequately met by equipment which has passed this rigid test.



Let's Look at the Record

THE STORY OF RCA RESEARCH AT WAR

by LOREN F. JONES

In this war, as in no other, victory will depend upon the properly timed development, production, and use of highly complicated weapons and devices. Never before has an army or navy been so dependent upon elaborate technical equipment. Never before has the required equipment been so predominantly radio-electronic in its nature.

When the largest industrial radio research organization in the country swung into full war research, the results were bound to be very valuable and highly intriguing. No details of this work can be published now, of course, but a few ideas on the approach to the job, the magnitude of the work, and the broad field which it encompasses may serve as a brief "preview" of the full story which will someday be told at greater length.

A TECHNICAL WAR

We are faced with an enemy which has devoted much effort and talent to the production of advanced types of conventional weapons and to the development of unique new weapons employing radio principles. For example, the Germans have been very clever in developing and using magnetic mines, submarine underwater detectors, and the like. The United Nations have been faced with the necessity of developing countermeasures for enemy weapons, as well as designing and producing their own offensive weapons.

Due to secrecy restrictions, even many engineers do not realize the surprising extent to which radio and similar equipment are used in this war. Few realize that a bomber carries well over $10,000 worth of such equipment. The radio engineer is the man responsible for the design, the production, and the successful operation of this equipment. As the offensive progresses, the contribution of radio-electronics will become even more apparent; the radio engineer's importance even more significant.

BILLIONS FOR RADIO

The large number of qualified scientists and engineers in the United States makes this country the natural center for the development of new weapons and devices. Through the efforts of the Army, the Navy, and the OSRD, working in cooperation with hundreds of academic and small laboratories and with the several great industrial laboratories, developments of the greatest importance have been completed and others are being intensively worked upon. In the field of radio and electronics, the developments completed in the last two years have already resulted in Army and Navy orders which, according to WPB, will require the rate of production of electronic equipment to be stepped up to four billion dollars annually by the end of December, 1943. Research and development is constantly producing new devices which will be of the utmost importance both strategically and in volume of production.

Under the pressure of war, the total time from the inauguration of research to the quantity production of finished units is appreciably less than during peacetime. Even so, research is by its very nature frequently a long time process. It must be planned and conducted well in advance of design, production, installation, and operation. Fortunately, our research directors are accustomed to such planning. Thus when the war was still primarily a defensive war in 1940, RCA began concentrating its research on new offensive weapons, confident that within several years these weapons would be of highest importance.

RCA'S PREWAR WAR RESEARCH

The great amount of research we have conducted on subjects of interest to the Army and Navy has made it possible for us to produce military equipment of superior design. During the ten years before Pearl Harbor, RCA furnished millions of dollars worth of military equipment to the Army and Navy. In some radio fields RCA is the largest producer in the U. S. A.

Prior to Pearl Harbor, government funds released for research were extremely limited. To maintain its position as one of the largest suppliers of military equipment and to investigate technical fields which RCA was convinced were of military importance, RCA financed a large part of its prewar research, and still finances enough to assure initiative and freedom of action.

Most of the developments which RCA sponsored and financed during the several years prior to Pearl Harbor—developments which have proved invaluable in this war—cannot be mentioned for reasons of secrecy. One device developed in 1937 was a type of apparatus believed to have been the first air-borne apparatus of this type in the world—of which millions of dollars worth were ordered before Pearl Harbor. Our leadership in this field is such that even today most of the equipment of this general type procured by the Army and Navy is of RCA design.

IN ANTICIPATION

Early in 1939, in view of the world situation, RCA greatly increased its research and development efforts on war devices. This seemed the only proper thing to do, and subsequent developments have justified this farsighted decision. The research and development program was promptly coordinated throughout all of RCA and, as the war drew nearer, many other steps were taken to prepare for greatly increased activities. Some, such as the calling in of broadcast representatives from the various districts throughout the country, resulted in a temporary loss of business, but subsequent developments throughout the world have proved the importance to our country of these early actions.

ORGANIZATION

RCA's research and development work is conducted in thirteen separate laboratories located in ten different cities. These laboratories are operated by RCA Laboratories, RCA Communications, the National Broadcasting Company, the Radiomarine Corporation, RCA License Laboratory, and the six plants of the RCA Victor Division. The overall research and development program of these thirteen laboratories is closely correlated and coordinated to prevent duplication and assure maximum speed and efficiency. Negotiation of research contracts is centered in Camden. Every

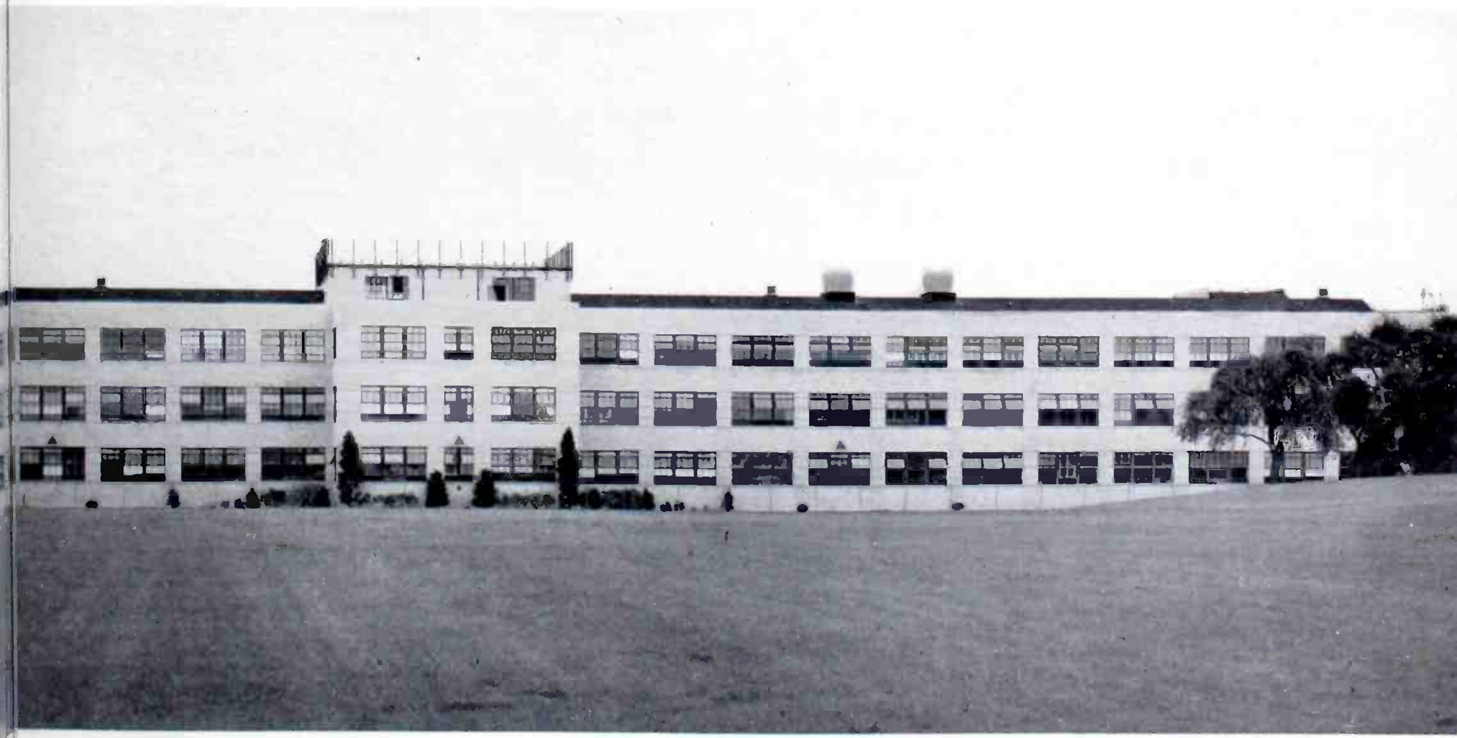


FIG. 1 *Main building of RCA Laboratories at Princeton. Here much of RCA's research is centered.*

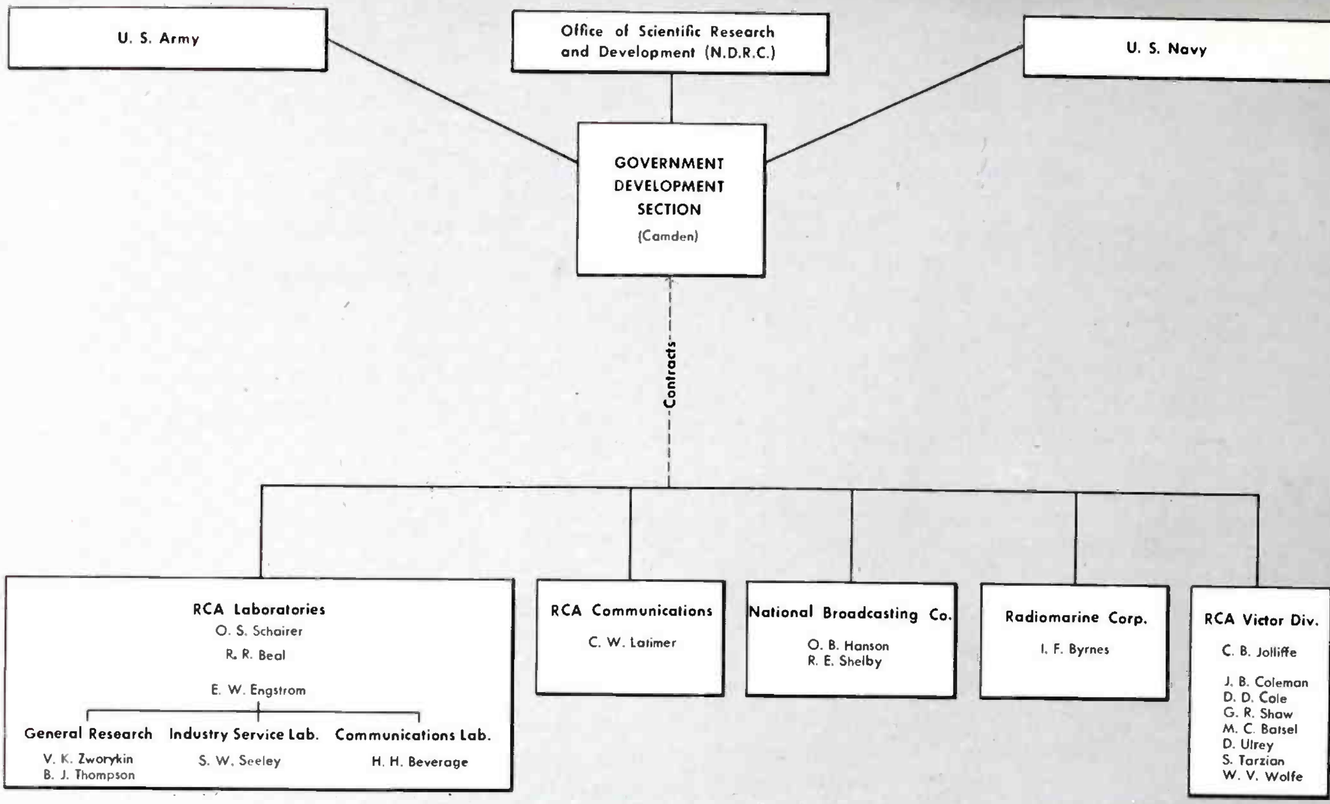


FIG. 2 *Organization of thirteen RCA laboratories in ten cities for war research and development. Through committee membership and technical discussions, direct liaison is maintained between RCA engineers and government laboratories.*

effort is made to see that each laboratory and, in fact, every one of the hundreds of engineers and scientists in RCA is working in the field to which he is best adapted. In addition to carefully preventing duplication within itself, RCA has co-operated fully in supplying information and help to other manufacturers, where specifically requested by the Government, in order to expedite production and prevent duplication of effort in the industry. This kind of cooperation has not only enabled the Government to see to it that the specific information required has been available to those needing it, but also that secret information would not be given out except as required and deemed necessary.

Fig. 2 shows the research and development organization of RCA. Unfortunately, it is not possible to show in a simple chart the various steps which take place from the time a research project is begun until the finished product comes off the production line. Of these steps, research, per se, is but one. Research in general covers only that part of the project in which it is sought to show that the essential idea is practical and can be made to work. Following research comes development, the stage in which the ideas demonstrated by research are put into practice and reduced to forms suitable for application to actual problems. The development engineers work in the laboratories of the various manufacturing plants where they have the necessary daily contact with design engineers and with the production and servicing of specific types of equipment. In these positions they can most readily transform the general results of research into practical apparatus. Following development comes the third step, production design, in which the actual blueprints of the final model are produced. And, finally, there is a fourth step, production, in which the idea which first originated in research months or even years before comes to life and rolls from the plant in tens, hundreds, or thousands, as the case may be. In wartime, research

E. W. ENGSTROM *DR. H. H. BEVERAGE* *STUART W. SEELEY*

LEADERS OF RCA RESEARCH

and development must be so speeded up that in many cases they overlap and even merge. For this reason the two are usually considered together.

Mr. O. S. Schairer is Vice President in charge of RCA Laboratories; Mr. Ralph R. Beal is Assistant to the Vice President. Research work proper is under the direction of Mr. E. W. Engstrom with Dr. H. H. Beverage, Dr. V. K. Zworykin, and Mr. B. J. Thompson as associate directors. The new laboratories at Princeton constitute the largest single research unit. The work carried on at Princeton covers the whole field of radio and electronics. Included are projects on all types of tubes, AM and FM reception, AM and FM transmission, facsimile, television, sound, RF heating—in fact, on every facet of the radio art.

The group of tube engineers under Mr. Thompson have contributed some outstanding new tubes of great military use. Their earlier developments, such as acorn, beam deflection, and television tubes, are well known. Equally well known is the prewar work of Dr. Zworykin's large electronic research department. Work on microwave devices is directed by Dr. Irving Wolff, well known to broadcasters for his developments of early loudspeakers, later famed for microwave developments.

Dr. George H. Brown, known to all broadcast engineers for his outstanding contributions to broadcast antenna design, is directing work on radio antennas, radio-frequency heating, and other subjects. Dr. Harry Olson, who directs a special group, is well known for his development of the velocity microphone, of speakers handling from milliwatts to kilowatts, and of unidirectional microphones. He has written several books, of which the best known is "Elements of Acoustical Engineering." There are other groups in the Princeton organization, each under the guidance of an experienced scientist.

The research and development work at the RCA License Laboratory is directed by Stuart W. Seeley, who is known by every receiver engineer in the country.

At the several RCA Communications locations Dr. H. H. Beverage, a world-recognized authority on transmission and reception phenomena, directs a variety of projects relating to communications and other subjects.

AFTER THE WAR

RCA, along with other progressive manufacturers, recognizes the problem as well as the obligation to minimize unemployment after the cessation of hostilities and to develop those techniques, equipments, and services which will be most in demand and will contribute the most to employment. Essential to this end will be the carrying on of extensive research in a number of technical fields. Plans are constantly kept up to date for conducting such research and for utilizing its results in the form of specific designs. Personnel are not available at this time for extensive work in non-military fields, but as the end of the war approaches, such research will become more and more possible.

Several of the devices already developed during this war were believed to be impossible only several years ago, even by the most optimistic scientists. Before the end of the war, additional seemingly impossible developments may come out of the RCA research and engineering departments and into the factory. As time goes on the various RCA laboratories will become increasingly recognized as the outstanding source in this country of radio-electronic research and development. Research can never be predicted. Its very essence is the free play of skilled imagination. One certainty is that RCA's extensive research program will constantly contribute importantly to the economy and effectiveness of all forms of radio.

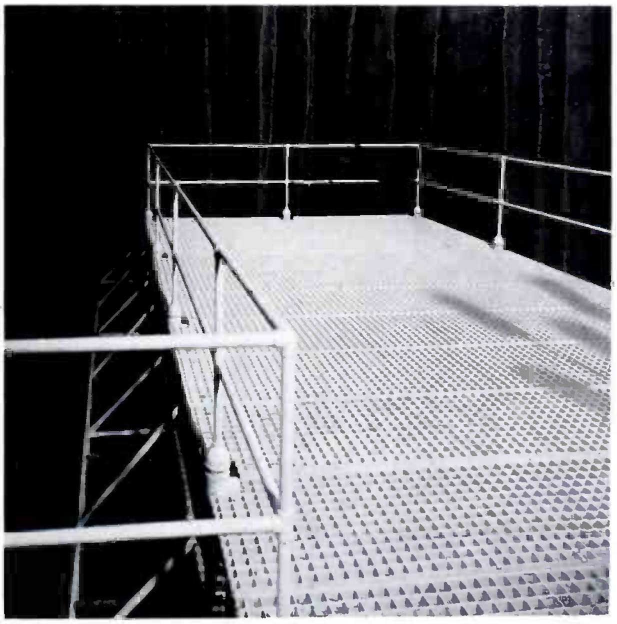


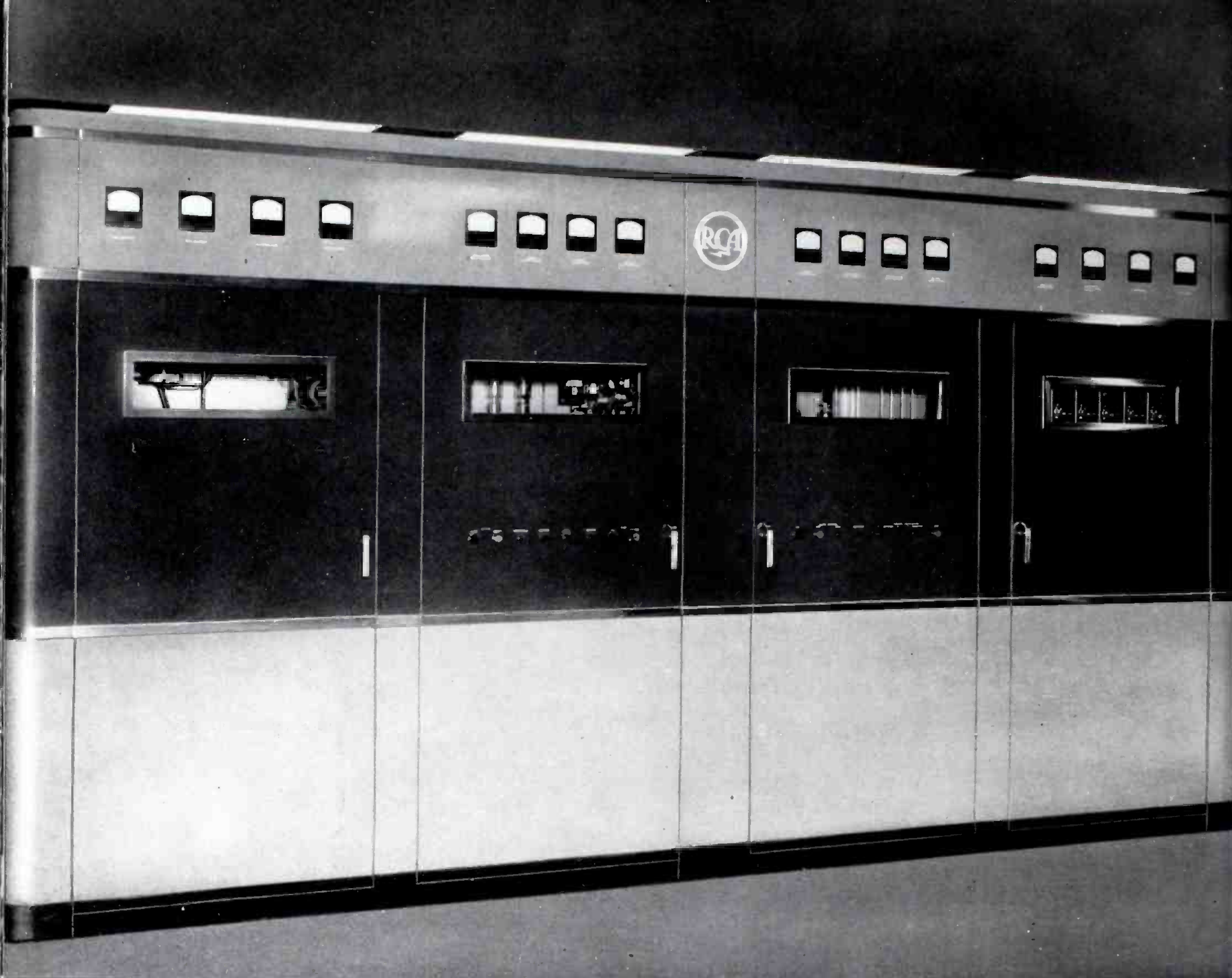
FIG. 3 *The sound room at Princeton. The felt baffles are eight feet deep. Noise level is so low that one hears thermal agitation originating within one's ears. The room is so devoid of reflections (absorption coefficient is 99.7) that microphone and loudspeaker directivity measurements made within it are as accurate as those made in free space.*

DR. V. K. ZWORYKIN

B. J. THOMPSON

DR. GEORGE H. BROWN

DR. IRVING WOLFF



5-E BROADCAST TRANSMITTER

The newest in a famous line—successor to the 5-D/5-DX transmitter, the most popular 5 KW broadcast transmitter ever built. One of the new features is an arrangement whereby speech input and phasing equipment can be mounted behind matching extensions of the "unified" front. The curved ends of the basic unit shown above can be removed and an extra front unit added to the right end which is wide enough to accommodate two speech racks. A second unit, wide enough for a standard phasing cabinet, can be added to the left end. The KMPC installation shown on Page 39 is an illustration.

Walk-In (From-the-Front) Construction

The basic 5-E is shown here without the unified front. The four compartments, from left to right, contain the power amplifier, the low-power stages, the modulator and rectifier, and the control circuits. Doors in the front (see above) give access to each of these. The only external units are the modulation transformer and the plate transformer. If desired, these can be mounted on top of the transmitter (or in the basement), in which case the equipment can be set flush against the back wall of the building.

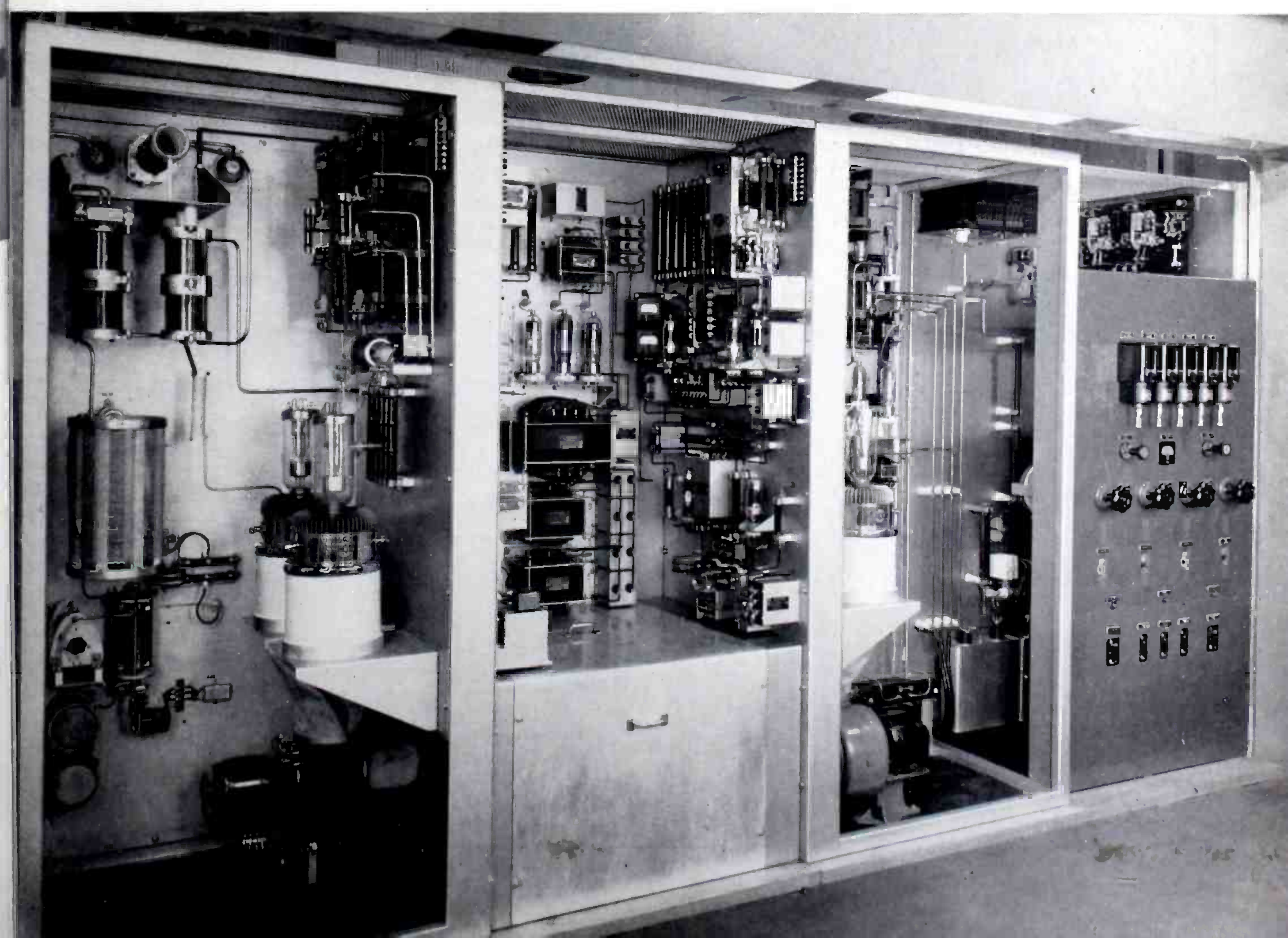
THE 5-E AN ENGINEER'S TRANSMITTER

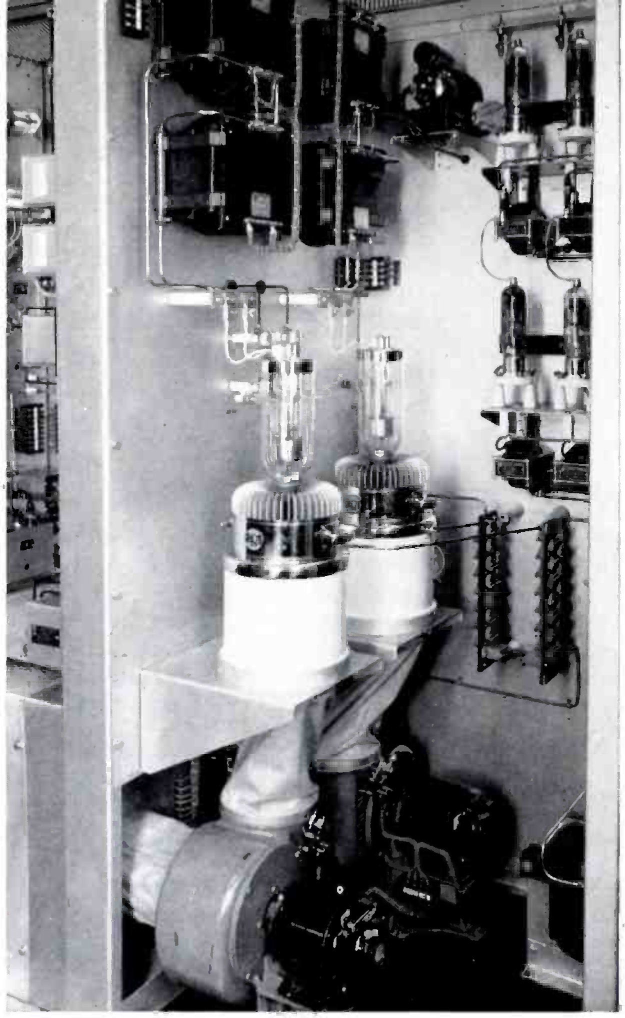
by J. E. EISELEIN · PRODUCT MANAGER, SPECIAL APPARATUS DEPARTMENT

The 5-E is an engineer's transmitter. It includes the features they particularly want—arranged, in so far as possible, in the way they want them arranged. For a decade RCA 5 KW broadcast transmitters have been outstanding. They have enjoyed an acceptance, particularly among station engineers, which has been unapproached by any design of any make.

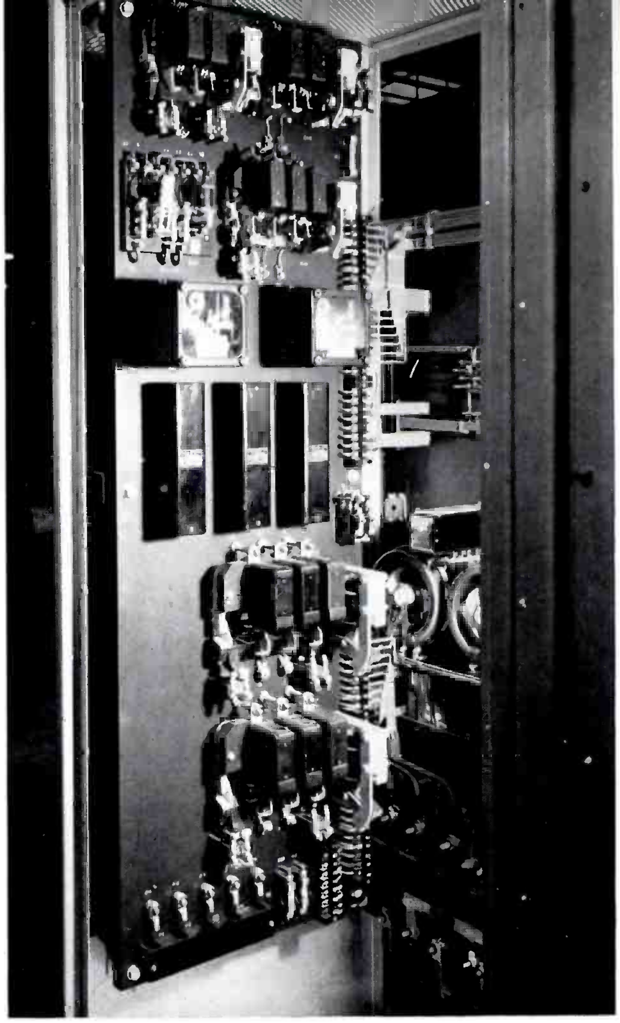
In the process of planning these 5 KW installations with station engineers, and in testing and placing them on the air, RCA engineers have had an unequalled opportunity to learn the problems of 5 KW stations, to find out what station engineers thought they needed and would like to have incorporated in a 5 KW transmitter. Through this intimate association, RCA engineers have become real experts—experts in fact and in application, as well as in theory. Each new design in the 5 KW series, from the 5-A through the 5-B, the 5-C, the 5-D, and 5-DX, has seen new improvements added as the result of practical field experience combined with laboratory development. In the 5-E this evolution has reached a new peak. A completely new design, the 5-E has many new features, features which station engineers have asked for. This transmitter was built for them!

The 5-E transmitter has been designed for either 5 KW or 10 KW operation. Only the modulation components are different; changeover can be accomplished in a few hours. All parts are conservatively rated and have been largely standardized so that a few spares go a long way. Accessibility is even greater than in the 5-DX, and all access is from the front. Installation is simple, as only plate and modulation transformers are external. The unified front is a separate unit in itself, wired to convenient terminal boards requiring only jumper connections. Inter-unit wiring runs in one of the channels which form the transmitter base. There are many other new ideas, some of which are illustrated and described on the following two pages.



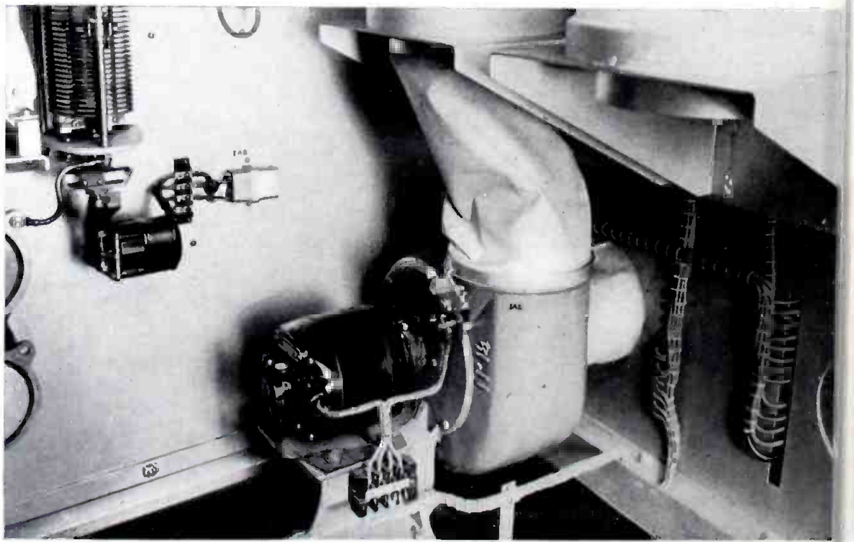


ACCESSIBILITY Separate blowers for each tube simplify duct work and assure adequate cooling air. A single plenum chamber from which all blowers draw air has a single dust-filter, easily removed for cleaning. Blower motors are accessible for servicing. Blower impeller blades can be easily reached for cleaning from plenum chamber.

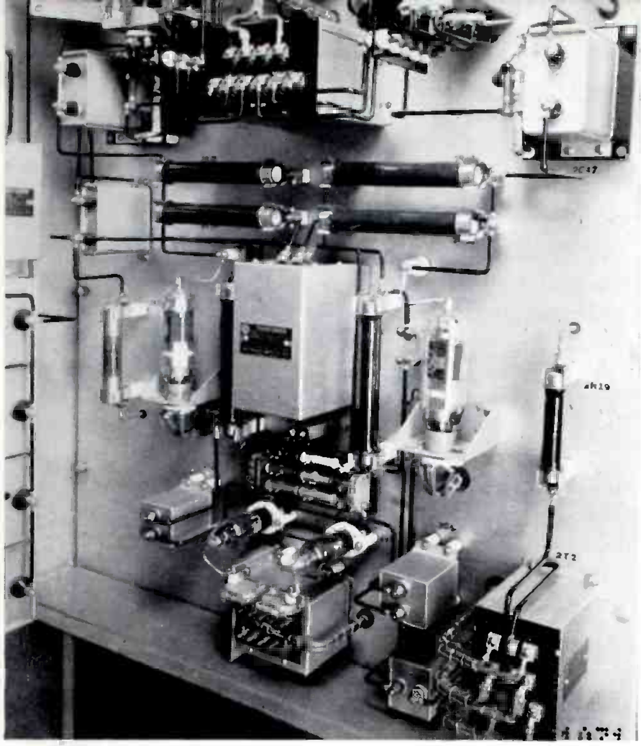


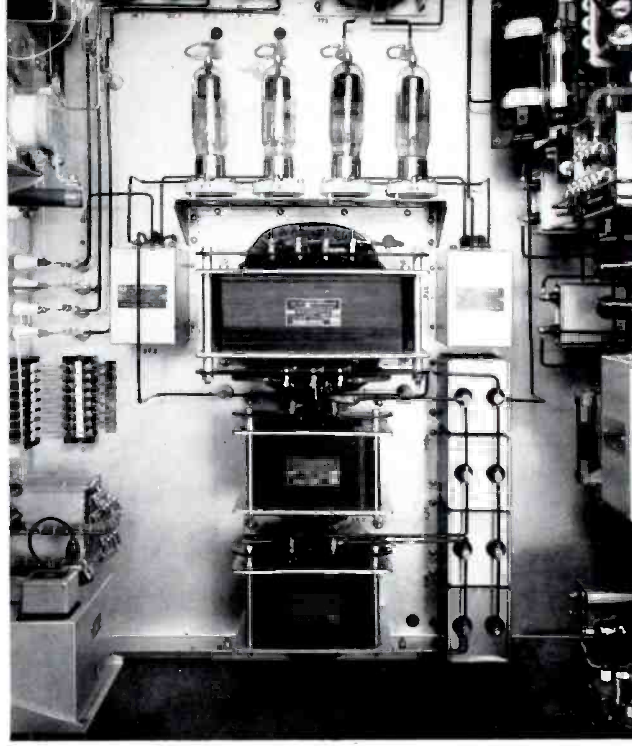
BRAIN CENTER RCA transmitters for years have incorporated automatic operational and protective controls. If the controls are set for automatic operation a four-step relay will operate to reapply full power after a first and second overload, but on a third recurrence, power is automatically reduced. If the fault persists for a fourth overload, power is removed completely.

5-E continued



MOTOR-DRIVEN TUNING There are no complicated mechanical drives to variable tuning elements. Preset tuning and fixed neutralization reduces variables to two: grid drive and vernier output control. These are provided for by variable inductors driven by husky motors controlled by push-buttons on the panel.



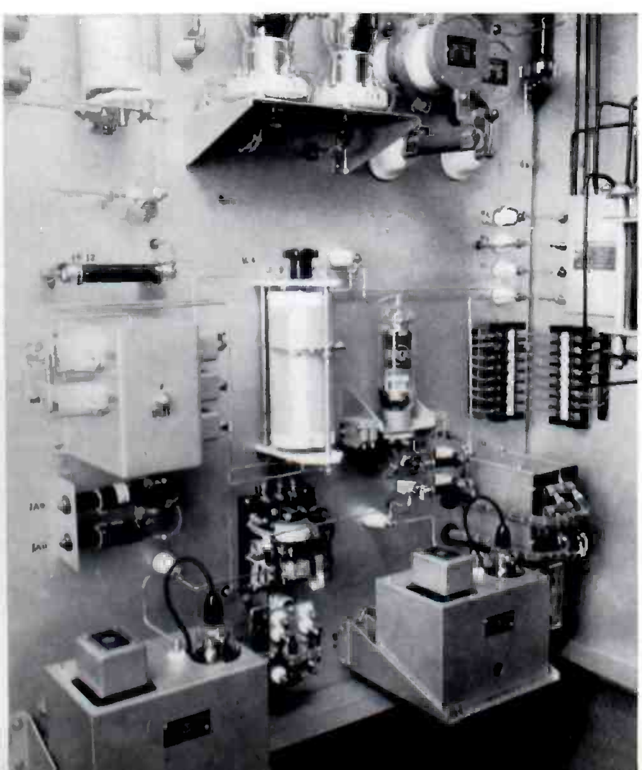


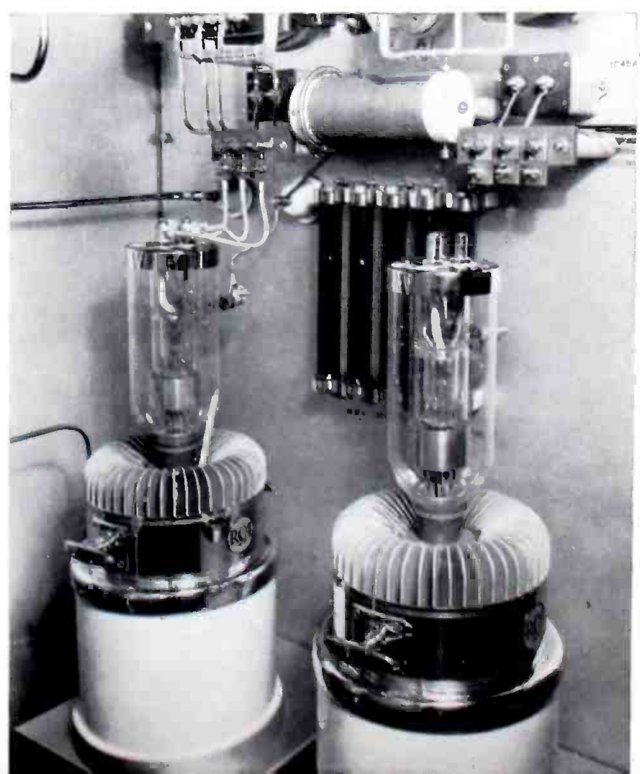
CONVENIENCE Low-power stages of the 5-E. Wiring is in the clear, easily followed. Terminals are accessible, easily checked. Any component can be removed without moving others. Only three types of tubes are used in the audio and modulator stages; only seven types in the whole transmitter.

SIMPLICITY Low-voltage plate and bias rectifiers mounted on back wall of center unit. These and a high-voltage plate rectifier supply all required voltages. One type of tube—the new RCA-8008 Mercury Vapor Rectifier—is used in all three, thereby reducing the number of spare tubes required.

PUSH-BUTTON XTAL CHANGE A single push-button controlled toggle-action relay which will hold its position with or without power is provided for changeover between crystal units. Another relay automatically blocks out the oscillator for a few mille-seconds when a control button is pressed. This is useful for parasitic check.

SPARE TUBE In the power amplifier compartment there is an extra socket which for 5 KW operation can be used to store a spare RCA-892-R tube. For 10 KW operation this extra tube is connected in parallel. Only minor additions are required for 10 KW output. Use of RCA-892-R tubes in both modulator and p.a. simplifies replacement problems and reduces tube costs.





TELEVISION *Remote Pickup* EQUIPMENT

by H. E. RHEA *TELEVISION EQUIPMENT SECTION*

☆ ☆ ☆

Programming is one of the important problems confronting the television industry. Until "network television" on a large scale becomes a reality, it may well be the biggest problem. Realizing this, prospective station owners are giving much thought to ways and means of providing suitable programs. The availability of remote television pickup equipment which has proved satisfactory under a wide range of operating conditions should be an important factor in this consideration.

Programs for telecasting involve techniques and problems which differ from those of sound broadcasting. Impressions conveyed by sight are usually more vivid than those created by sound; and monotonous, uninteresting programs more quickly become tiresome and boring to the listener or viewer. On the other hand, the expensive settings, the talent, and the long rehearsals required for "live-talent" studio shows rule these out as the solution to the local program problem. Most stations could not bear the financial burden of producing such programs during the necessary development stage; and yet a large number of stations, regularly telecasting, is a prerequisite to the establishment of television on a "paying" basis. It is apparent, therefore, that a source of entertaining programs, at reasonable cost, is essential if television service is to be other than a purely network development.

Broadly speaking, television programs will be divided into three general classifications: film, studio, and remote pickup, the latter two being live-talent shows. From an economic standpoint, remote pickups offer the most promise. Little, if any, rehearsal is necessary; lighting is seldom a problem; and generally the extra expense entailed by televising an event which ordinarily is being staged for other purposes is a small item.

Nearly all types of sporting events are naturals for telecasting material. Sports, almost without exception, are designed to provide entertainment through the sense of sight, and impressions conveyed by other senses are, at best, artificial and makeshift. Prize fights, for example, are staged for the sole purpose of extracting cash from the pocket of the fan who is convinced that the cash outlay is more than justified by the stimulation and entertainment he receives from *seeing* the combatants ferociously

CAMERA

CAMERA CONTROL

POWER SUPPLY

(he hopes) pummel each other into oblivion. He may pay $50 for a ringside seat instead of $5 for a stool out in the suburbs because the closer seat provides a better view and hence more entertainment value. Television can carry ringside seats to persons fifty miles away at comparatively little expense to the station owner. The same applies to baseball, football, hockey, tennis, and other games.

Other public events offer similar possibilities. Concerts, operas, night club floor shows, spot news events—all are naturals for television. The opportunities for telecasting remote pickup programs which are both entertaining and inexpensive are almost unlimited.

In order to take advantage of such opportunities, portable field equipment must form a part of the station's facilities. The equipment should be packaged in small, light-weight cases, capable of being transported in a station wagon. However, portability alone is not enough; there are other considerations of equal importance. The feature of easy carrying is valueless if, for example, the design and packaging are accomplished in a manner which requires hours for setting up the equipment after the location is reached. Setup time must be kept to a minimum so that no time will be lost in picking up unexpected news events and similar programs. Quality too is important. Even the most entertaining program can be ruined by inferior transmission. Some sacrifice may be possible and even desirable; but, in general, field equipment must produce pictures comparable to studio quality. Of further importance in preventing loss of detail is the radio frequency relay link which must have adequate band width and sufficient range to permit pickups at a considerable distance from the main studio and transmitter location.

Simplicity of operation is a necessity. Sight broadcasting need not be complicated and in field work it is especially important that the demands on the operating personnel be small. Following action and switching from one scene to another deserve the most attention.

A point that must not be overlooked is that the field equipment should be so designed that it can be used if necessary in the main studio for live-talent shows from that location. In some instances, it will supplement fixed studio equipment; in others, especially in the case of small stations which are starting on a modest scale, it can take the place of fixed studio equipment

FIG. 1. *Equipment for remote television pickup using a single camera.*

TRANSMITTER

SHAPING UNIT

PULSE UNIT

until such times as the station facilities are expanded. When main studio units are added, the portable equipment can then be assigned to full-time field use.

In the design of the RCA television field equipment all of the above factors were carefully considered. Much thought was given to the packaging arrangement. Several such arrangements are possible. One would make each camera chain a completely self-contained unit—i.e., associated control equipment built into the camera itself. The only other individual boxes would be the transmitter and a monitor-switching unit. Such a system would have some advantages but it would necessitate bulky cameras and require duplicate synchronizing generators which, if not exactly in step with one another, would cause momentary loss of synchronizing when switching from one camera to another.

A modification of this arrangement would be to have a common synchronizing generator, with each of the camera units otherwise completely self-contained. Again, however, the cameras would be relatively bulky and previewing of each camera before switching by the operator would not be possible unless additional monitoring units were provided.

For these reasons it was decided to break the apparatus up into a larger number of units, incorporating in each camera only those circuits necessary to the functions of the pickup tube and, of course, a signal pre-amplifier. The important camera control circuits are housed in a separate case with a monitor which permits previewing at a central location with the other camera monitors and the switching unit. This arrangement results in the most compact camera unit and provides the most flexibility from the standpoint of camera scene selection. In addition, another important advantage results. In the event of obsolescence of one or two circuits, the changes necessary to bring the equipment up to date can probably be accomplished by the addition of only one or two new units.

The RCA television field equipment consists of the following units:

- Cameras (one to four, as desired)
- Camera Controls (one for each camera)
- Camera Power Supply (one for each camera)
- Master Monitor-Switching (one)
- Master Monitor Power Supply (one)
- Synchronizing Pulse Generator (one)
- Synchronizing Shaping (one)
- Relay Transmitter (one)
- Relay Transmitter Power Supply (one)

All of these units are relatively small in size (approximately suitcase size) except for the transmitter. They are light enough to be carried without difficulty and the whole group will go easily into a station wagon. At the scene of pickup, they are easily set up and connected by means of interconnecting cables supplied as part of the equipment. Ordinarily, the cameras are set up close to the scene of action, and the camera control units, synchronizing generator and master monitor are grouped at a central location where the scene selection is accomplished by the program director. In some instances, of course, the equipment can be as much as 500 feet away. The antenna is mounted on a high pole or building in order to provide line of sight transmission, and the relay transmitter is generally located near the antenna so that the transmission line can be kept short. A relay receiver, intended for use with this equipment, is designed for standard rack mounting.

Where a single camera is used, only six units (not counting camera) are required. These are the camera control and its power supply, the two synchronizing units, and the relay transmitter and its power supply. The arrangement of these units is illustrated in Figure 1. When more cameras are used, additional camera control units and a master control unit for mixing and switching are required. Thus a three camera layout requires

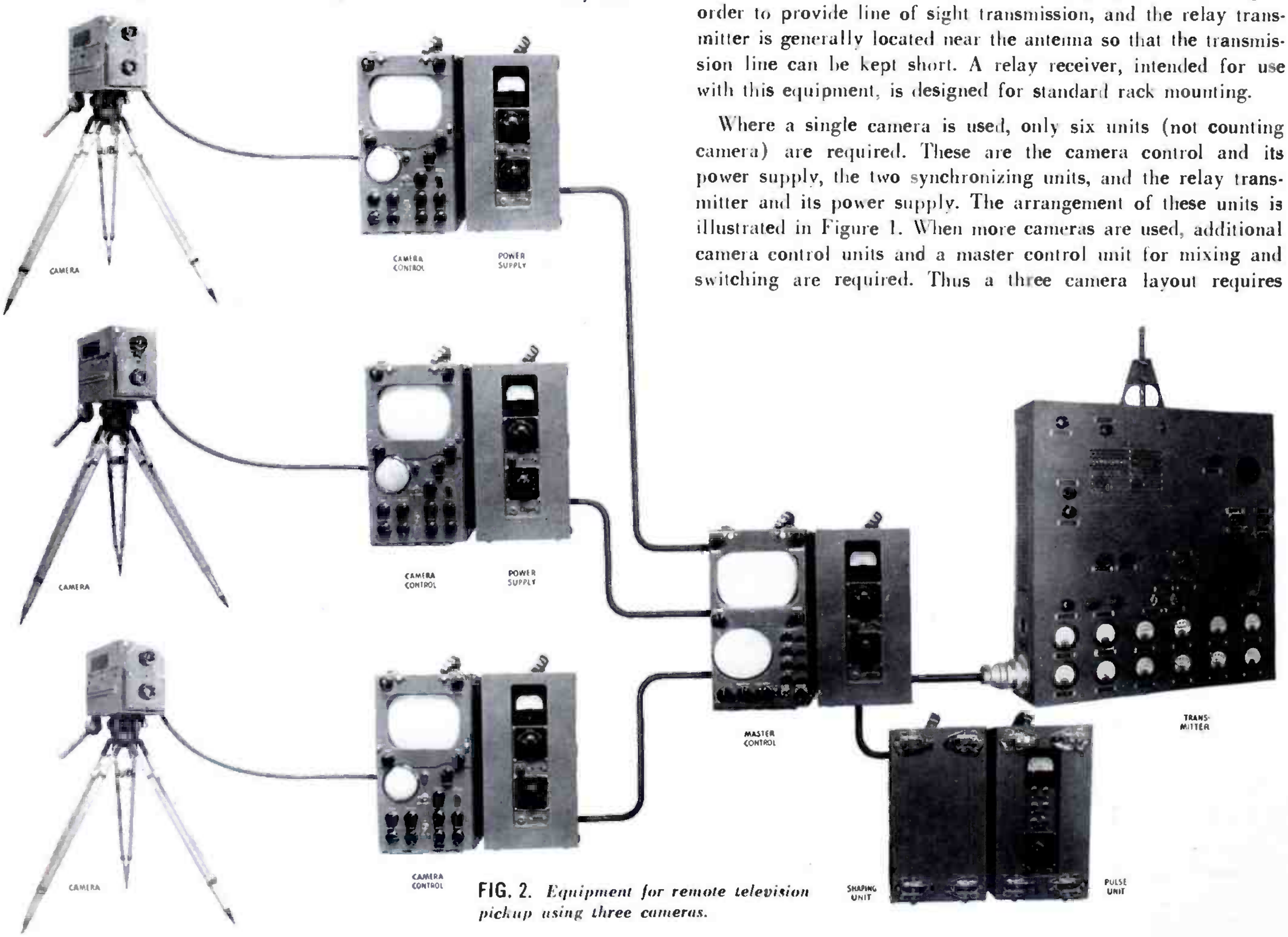
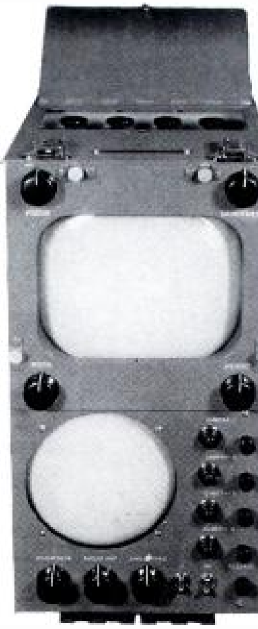


FIG. 2. *Equipment for remote television pickup using three cameras.*

three camera control units, each with power supply; a master monitor unit with power supply; the two synchronizing units; and, of course, the transmitter and its power supply. An idea of such a setup is given in Figure 2.

CAMERA—The orthicon-type pickup tube is employed because its greater sensitivity permits operation under conditions of low illumination. Lenses of various focal lengths can be used, thus permitting wide angle operation where the scene covers a large area or close-ups of distant objects, according to the desire of the program director. Lenses are quickly interchangeable. An especially important feature is the provision of an excellent view finder which permits accurate focusing by the cameraman and easy following of the action. The scene area in the view finder is greater than that in the television picture and as a result the cameraman can spot happenings of interest outside the picture area and redirect the camera to the point of most interesting action. A panning and tilting head on the standard movie tripod allows great freedom of movement in pointing the camera. As much as 500 feet separation is possible between the centrally located camera control unit and the camera. For example, the camera can be located on the sideline of the playing field while the control-monitor units are placed at a convenient spot in the grandstand. The camera unit complete with tripod and head weighs approximately 150 pounds, but disassembles into several packages for easy carrying.



MASTER CONTROL UNIT
Push-buttons are used to select the camera pickup to be transmitted.

CAMERA CONTROL—This unit contains the control circuits for the camera and incorporates a 7" high quality viewing monitor as well as a 3" oscilloscope which allows accurate adjustment of signal level. Camera driving pulses are generated in the camera control unit and transmitted to the camera through the camera cable, which as stated above may be as much as 500 feet in length. A video amplifier which is incorporated in the camera control unit feeds signal by coaxial cable to the master monitor. Both of these units are of suitcase size and are light in weight. Carrying handles are provided for convenience.

POWER SUPPLIES—One of these supplies is used for each camera and camera control chain and an additional one is required for the master monitor unit. The power input is 110 volts, 60 cycle, single phase. The total current drain for a camera and camera control chain is only 8.5 amperes, and therefore may be obtained from almost any standard outlet. The master monitor switching unit requires approximately 5.1 amperes. The supplies are all electronically regulated to eliminate line voltage fluctuation effects.

MASTER MONITOR-SWITCHING—Included in this unit are the switching circuits, the synchronizing mixer stage and the video line amplifier. Multiple inputs are provided so that the outputs of several camera chains can be accommodated. Push-button switches are provided for selecting the camera signal which it is desired to transmit. There is a 7" high quality viewing monitor and a 5" oscilloscope for adjusting signal level and synchronizing ratio. The output of the video line amplifier is connected by means of coaxial cable to the transmitter input. A close-up view of this unit is shown in Figure 3.

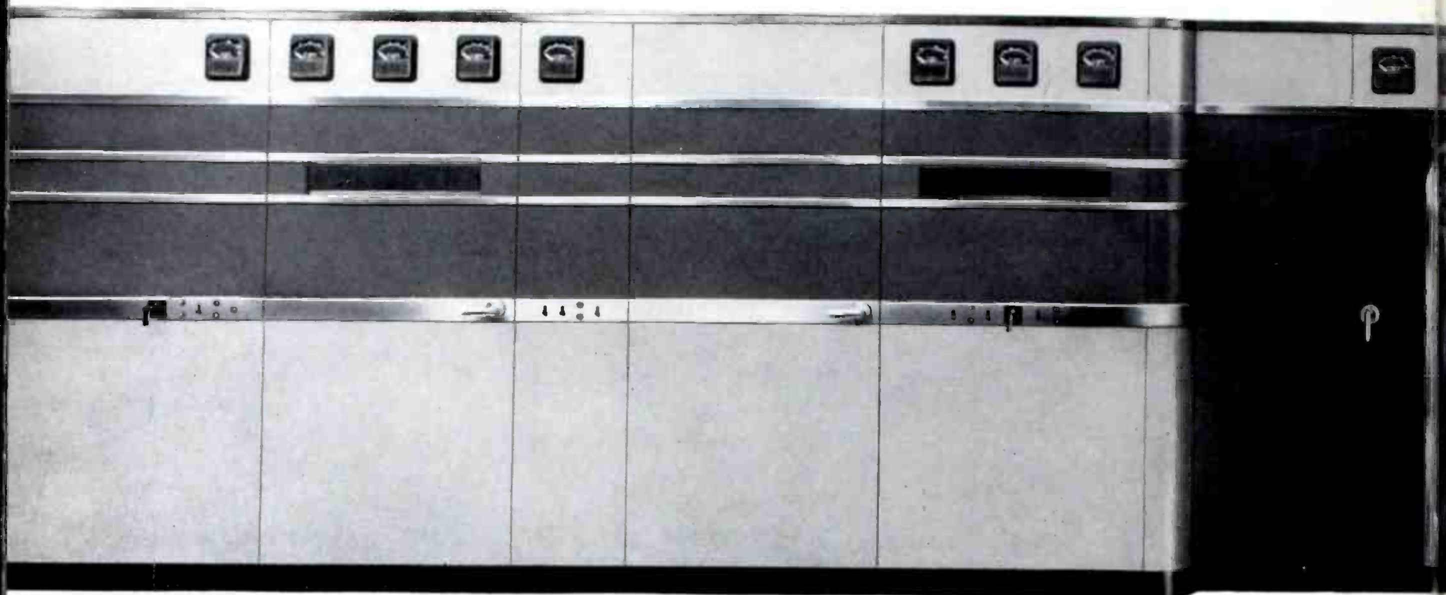
SYNCHRONIZING GENERATOR—The generator is comprised of two separate cases. The first case contains the master pulse generator. It is provided with a self-contained electronically-regulated power supply and requires an input of approximately 3 amperes. Highly stabilized oscillators are utilized in order to obtain the best possible synchronizing. The second case includes circuits for generating the blanking and synchronizing voltages from the master pulses. Power for these circuits is obtained from the self-contained power supplies in the pulse unit. It is possible for several cameras to be operated from a common synchronizing generator.

TRANSMITTER—This unit was designed to provide sufficient power output to permit operation over a five to ten mile range, line of sight. Less power and consequently less range would result in an unreasonable restriction of area in which remote pickups can be made. The transmitter operates on an ultra-high frequency band which permits the employment of highly directional antennas. The band width is sufficient to permit reproduction of the finest detail in the camera picture. The video input to the transmitter is accomplished by means of a coaxial cable connected to the master monitor unit. This cable can be several hundred feet in length, thus permitting setting up the transmitter at some distance from the control equipment so that the r-f transmission line to the antenna can be kept as short as possible without interfering with the line of sight transmission requirement. A diode detector is provided in order to permit monitoring the r-f signal output.

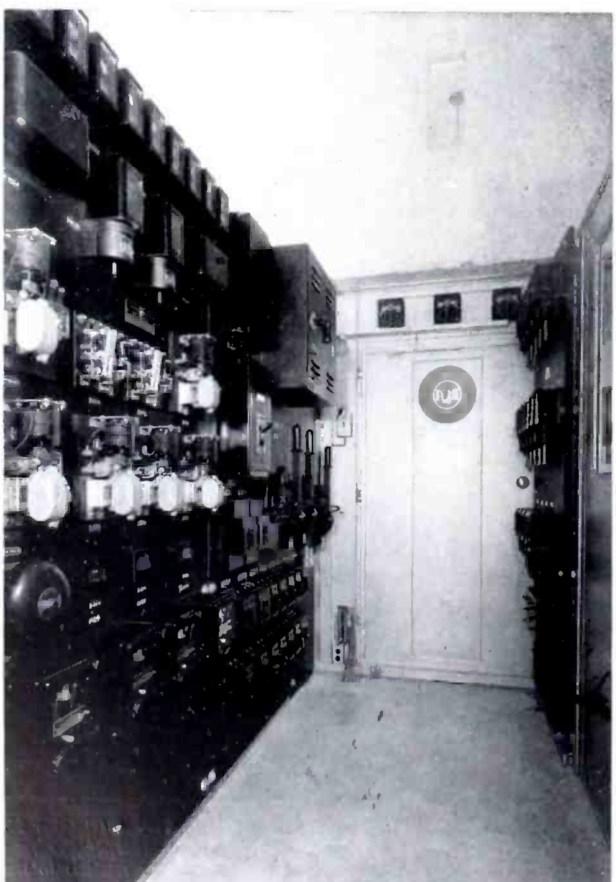
RECEIVER—This is of the superheterodyne type and like the transmitter has wide band amplifiers so that no loss in detail is incurred. AVC circuits are provided in order to minimize the effects of signal fluctuations. The receiver is ordinarily located in the main studio or transmitter building and is designed so that it can be mounted in a standard rack. Highly directional antennas are employed.

RCA field television systems have been successfully employed in the field for a considerable period of time. Among the programs that have been put on the air by means of this equipment are ceremonies at the New York World's Fair, baseball games, football games, ceremonies at motion picture premieres, hockey games, basketball games, operas, religious services, circuses, a panoramic view of New York City from an aeroplane, conventions, and many others.

TELEVISING THE RODEO *from Madison Square Garden (October 25, 1943). Programs picked up by NBC, using equipment of the type described in this article, are regularly rebroadcast by stations in the Philadelphia and Albany-Schenectady areas.*



CONTROL CIRCUITS *All control relays, contactors, and distribution switches are centralized on panels in the control compartment located behind the middle door of the transmitter. This door is not interlocked so that it may be entered during operation for check-ups on the operation of the control circuits. The window at the right provides a view of the rectifier compartment.*



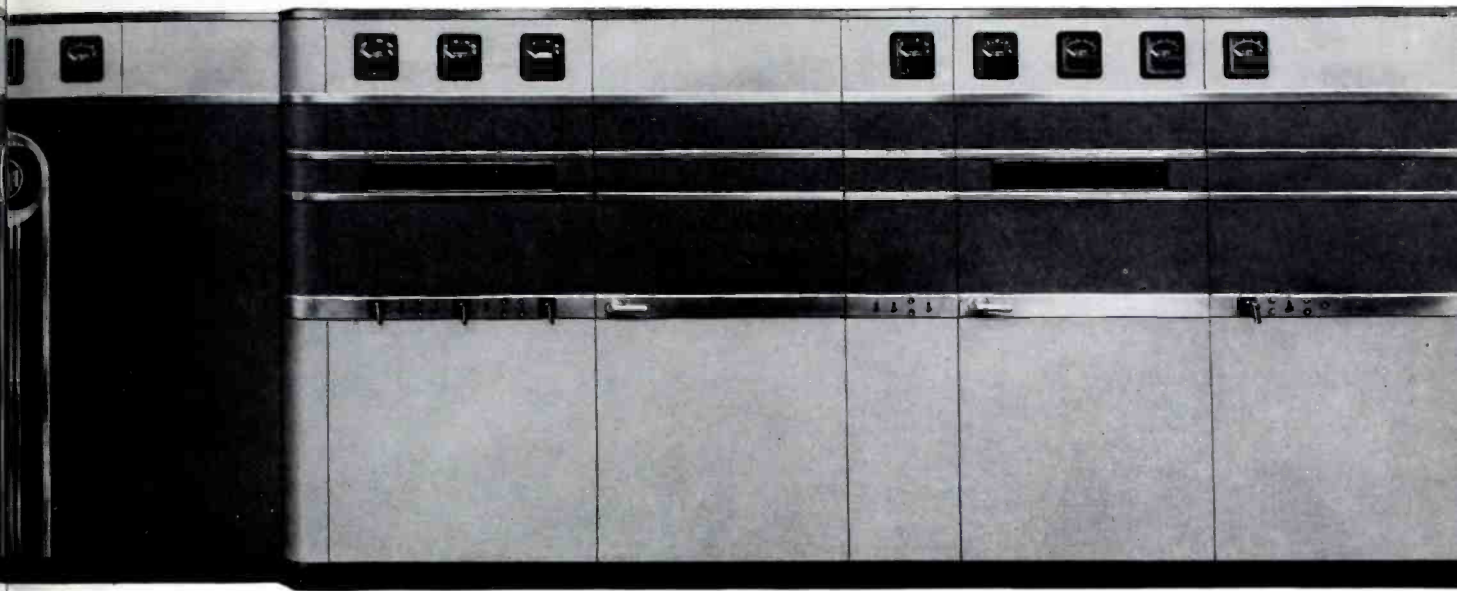
THE 5

A NEW T
FOR INTERNATION

The 50 KW transmitter shown above is being manufactured in quantity by RCA for the use of the United Nations all over the world. Development was started about a year before Pearl Harbor when it became evident that high-power international broadcasting would become increasingly important both here and abroad. Today twelve of these transmitters are in operation, providing educational and entertainment services, as well as accurate news and information to the populations of many countries. By the end of 1943, another two will have been installed and, during 1944, another group of ten.

Already on the air are stations at Rio de Janeiro, Brazzaville in French Equatorial Africa, Leopoldville in the Belgian Congo, and in England. Under way are stations in Australia, Canada, the USSR, and a group of stations in this country under OWI direction. Two of the stations in this country will be operated by the Columbia Broadcasting System and three by the National Broadcasting Company.

The proved circuit design features of the RCA 50-E Broadcast Transmitter were applied to the 50 SW. Rectifier and audio circuits are alike and the basic simplified control circuits are similar. Radio frequency circuits, of course, are entirely new, for the requirements of international broadcasting introduced problems not usually encountered in domestic medium-frequency

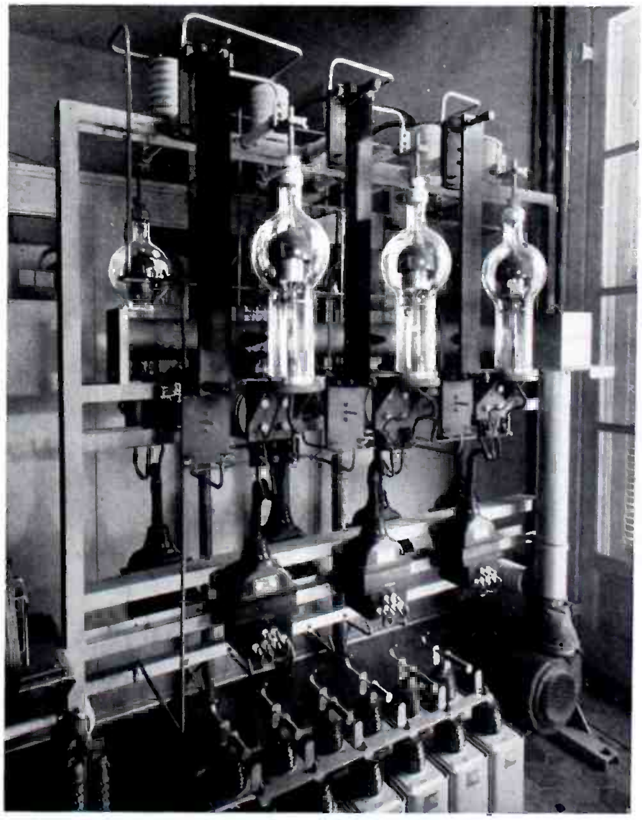


0 SW

ANSMITTER

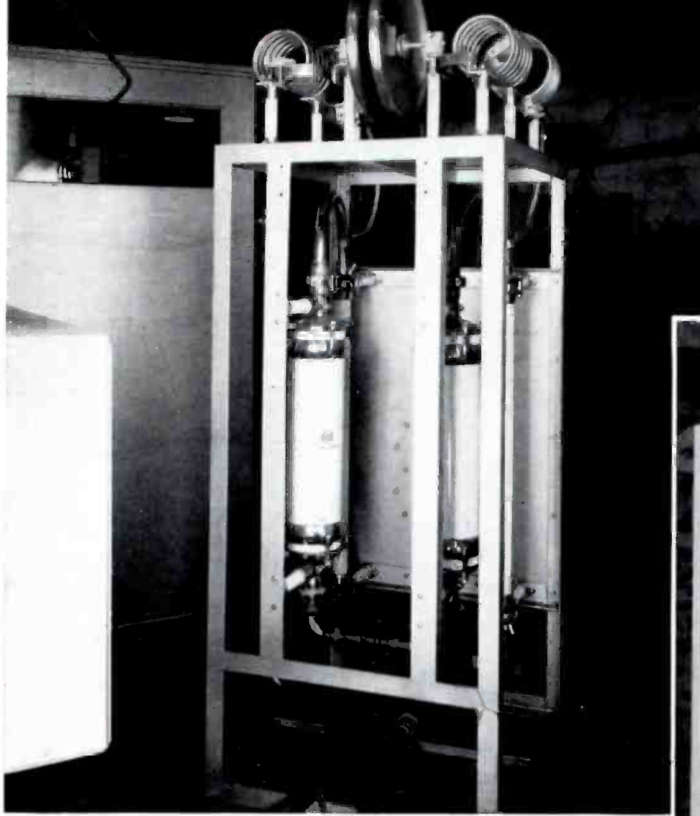
L BROADCASTING

HIGH-VOLTAGE RECTIFIER *DC power from the 1.5 kv., 5 kv., and 10 kv. rectifiers may be switched to either of the radio frequency units. The high-voltage (10 kv.) rectifier, shown in the illustration, is similar to that used in the RCA 50-E Broadcast Transmitter. A spare tube, with filament on, is constantly ready for use. It can be switched in to replace any of the six regular tubes. A bias rectifier on the modulator is the only additional d-c power supply required for operation of the complete transmitter.*

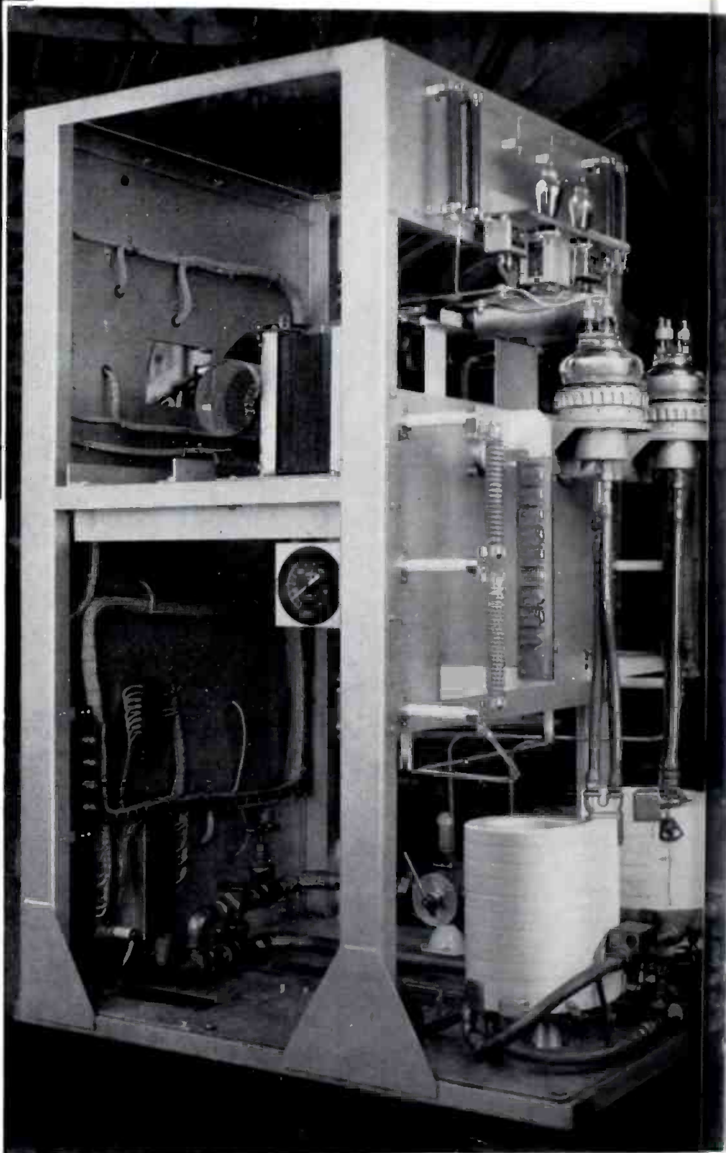


transmitters. For instance, it is very desirable to be able to set up or change frequencies quickly to any spot in the range from 6 to 22 megacycles. In the 50 SW this is provided for by including two radio frequency channels, each complete from crystal to output amplifier stage and each contained in a separate compartment with separate interlocking systems so that one may be entered for work while the other is on the air. A single power supply and a single modulator unit are so arranged that they may be switched to either radio frequency unit, the changeover requiring no more than five seconds.

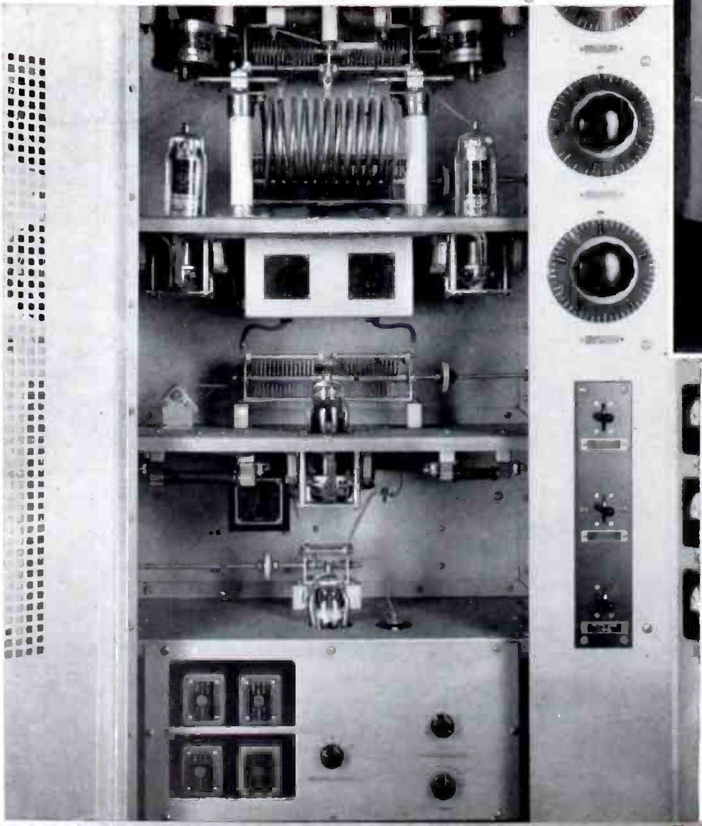
The modulator and power supply units are arranged in the center with the two radio frequency channels at the left and right. The farthest doors on each side provide access to the fronts of the exciter units as is illustrated in one of the smaller pictures on the next page. The innermost doors on each side lead into the two R-F compartments. The high-power stages are arranged in line behind the exciters so that these doors open into a space which runs along the side of each amplifier. The center door opens into a control compartment which is shown in the illustration at the left. From this control compartment there is an interlocked door leading into the rectifier compartment. A number of photographs taken inside these compartments are shown in the following pages.



DUMMY ANTENNA The portable assembly illustrated at the left is capable of dissipating the full 75 KW (50 KW modulated 100%) output from the transmitter. It can be set up for any resistance between 300 and 600 ohms at any frequency between 6 and 22 megacycles. It is particularly valuable for use during initial adjustment on a new operating frequency.

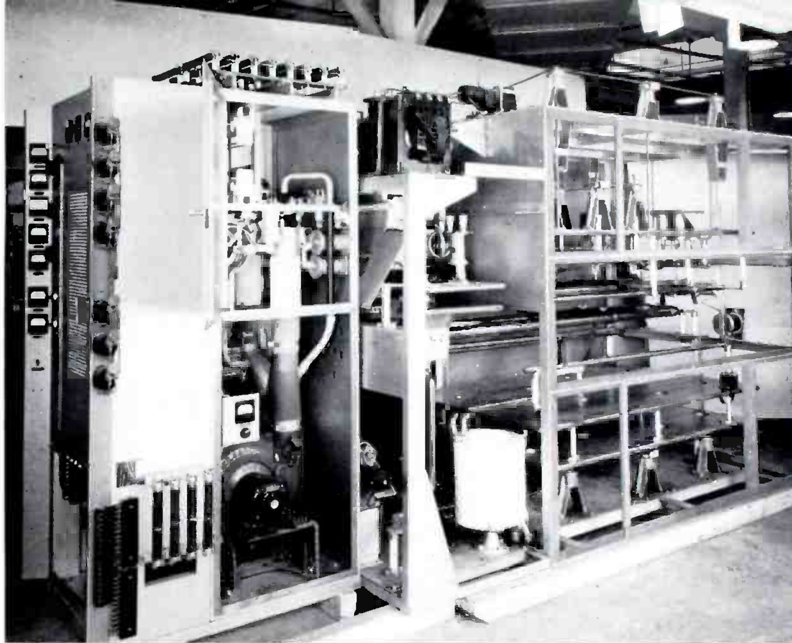


MODULATOR High-level class "B" modulation of the 50 KW carrier is provided. The low-power audio system is similar to that used in the RCA 50-E transmitter and in the 5-E transmitter described elsewhere in this issue. A cathode-follower driver, along with highly stabilized feedback circuits, provides low-distortion operation. The modulator unit proper, shown in the illustration, uses two RCA-880's, the same type of tube as used in the power amplifier.

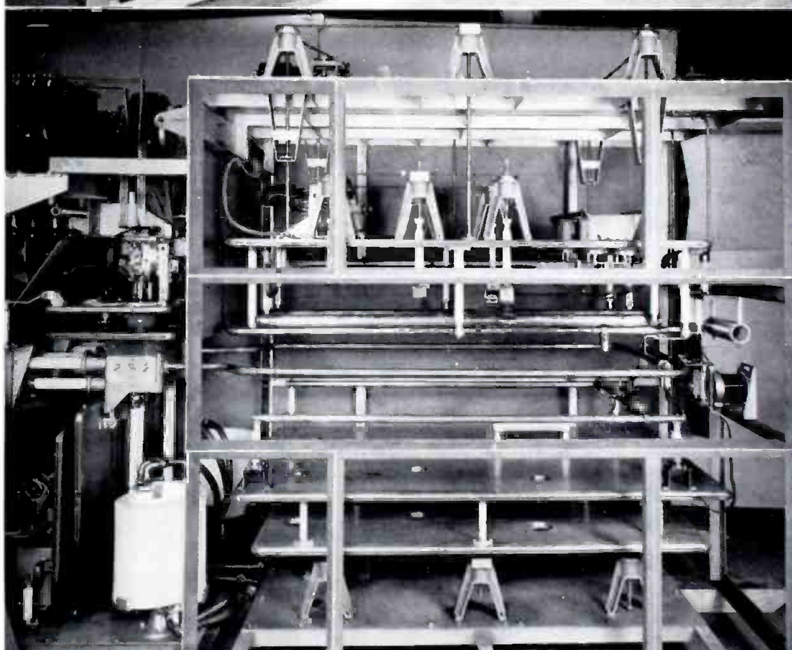


EXCITER There are four crystal positions in each R-F channel. The crystal oscillator is followed by a doubler, three intermediate stages, and a driver stage using two RCA-827-R air-cooled Radiotrons. Low-power intermediate stages are tuned and reset by means of tap switches and variable capacitors. Excitation ratios are controlled by capacity dividing circuits. Adjustment is simplified by the lack of transmission lines for inter-stage coupling.

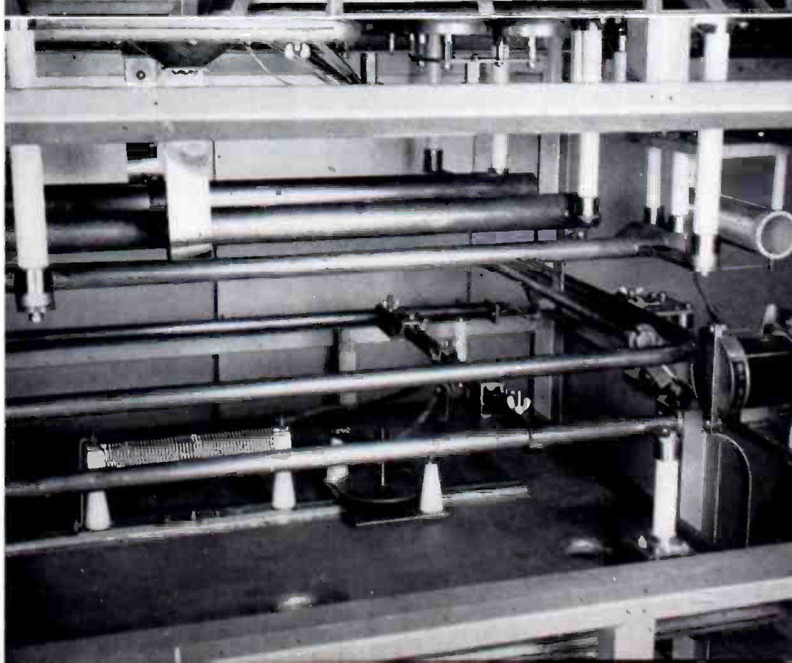
POWER AMPLIFIER The power amplifier proper is made up in two units for easy installation. The front section, which butts against the rear of the exciter unit, contains the two RCA-880 power amplifier tubes with associated water insulating coils, variable tank capacitor, variable neutralizing capacitor, filament transformers, and seal air blower. Cooling water is supplied directly to the tube jackets through short ceramic pipes of small cross-section, thus reducing radio frequency power loss in the water to a negligible amount. A motor-driven variable tank capacitor is used for tuning over a small frequency range. It consists of a single hinged plate at ground R-F potential operating in conjunction with two differentially variable plates which are attached directly to the tube jackets. The differential variation is utilized for balancing the plate currents of the two tubes in push-pull. Spurious frequency circuits are minimized by the lack of any inductance between the plates of the tubes and the capacitor plates. The same holds true for the fixed neutralizing capacitor plates which are attached directly to the tube jacket.

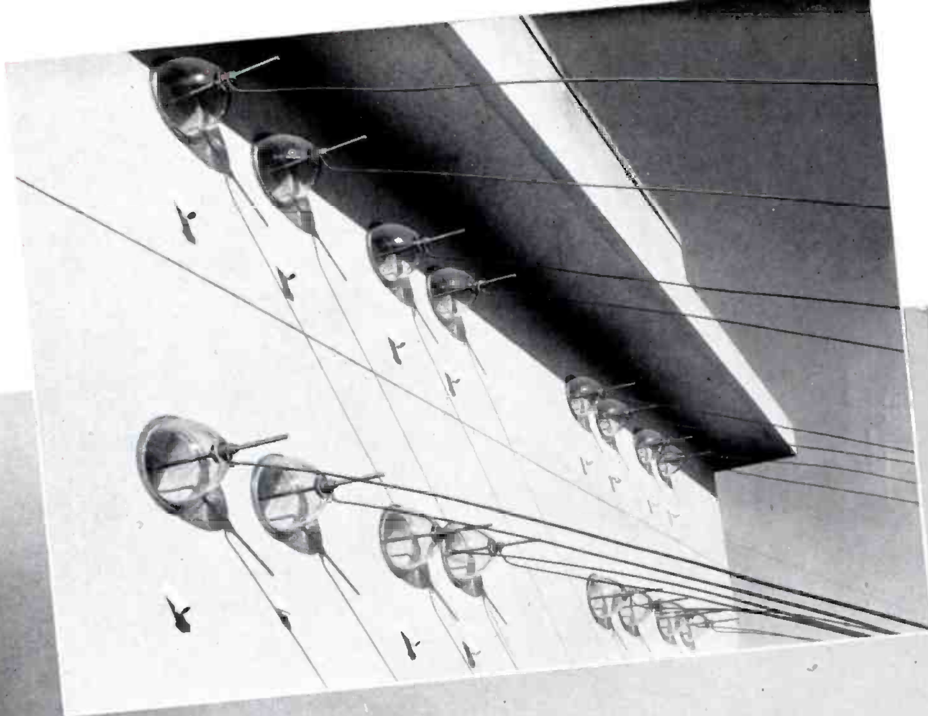


TANK CIRCUIT The rear section of the power amplifier unit contains the tank coils and output circuits. A rectangular coil made up of 1″ copper pipe covers the frequency range from 6 to 14 megacycles. Two turns are required for the lower frequency range. The lower turn is variable by means of a motor-driven control so that the tank capacitor tuning range can be augmented by variable inductance as well. Above 14 megacycles, the 1″ copper pipe coil is replaced by a hairpin-type inductor of 2″ copper pipe which serves to cover the range from 14 to 22 megacycles. A shorting bar on the hairpin is set at the proper point for the frequency desired.



OUTPUT COUPLING The output tuning circuit uses inductors similar to the tank circuit and a motor-driven balanced variable capacitor to form a parallel tuned tank coupled to the plate tank. Output to a 300 to 600 ohm balanced transmission line is taken directly from the two hot plates of the variable capacitor. A motor-driven arrangement provides means for raising or lowering the complete assembly of output coupling coils and variable capacitors, thus allowing for a variation of output coupling without affecting either the output circuit or plate tank tuning. This feature allows for quick compensation during operation when sudden weather changes cause variations in the transmission line impedance. All five motor tuning control keys are located on the front panel where the controlled effect can be noted on panel instruments.

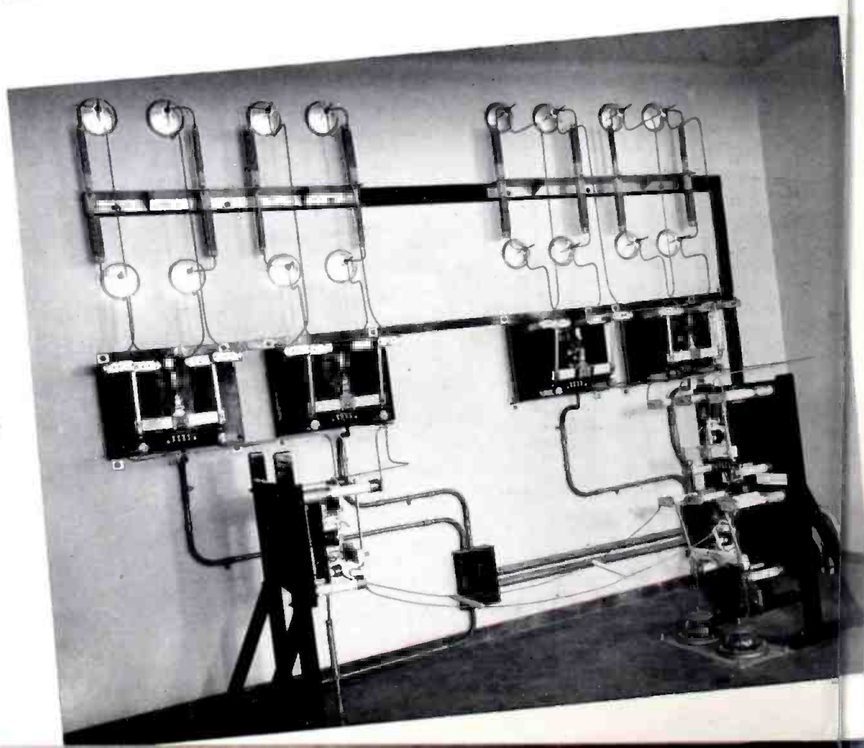




TRANSMISSION LINES—*Each of Radio Nacional's eight antennas is fed by a transmission line from the main building. This interesting view shows these lines as they emerge from the building.*

WAR WEAPONS IN LAND OF CARNIVAL—*Panoramic view of the group of Radio Nacional's eight antennas rising against majestic backdrop of Brazil's mountains. Five of these antennas are directional and three non-directional. Two directional antennas (16 and 25 meters) are beamed to the United States, two others (16 and 25 meters) to Europe, and a fifth (25 meters) to Asia: while the remaining three non-directional antennas operate on the 16, 25 and 31 meter bands. This group is suspended on six 105' galvanized steel towers.*

ANTENNA SWITCHING—*This group of relays and switches allows the output of the transmitter to be connected to any of the eight antenna transmission lines. Switching is controlled by push-buttons in the transmitter room.*



O BRASIL FALA ...BRAZIL SPEAKS

Through Radio Nacional's New RCA 50 kw Transmitter, Now Writing New Chapter of Global Broadcasting in Global War

by W. J. REILLY
INTERNATIONAL DEPARTMENT

O Brasil fala—Brazil speaks, as the Portuguese puts it—through a new and powerful voice, that of Radio Nacional of Rio de Janeiro.

Since it went on the tropic air on last New Year's Eve with its 50 KW short wave RCA transmitter, this voice of the United Americas has helped to write a new chapter on global broadcasting in a global war.

Conceived as a link among the Americas and a weapon to join with United States short wave stations against potent Axis radio coverage of Latin America, Radio Nacional has fulfilled its missions and has won front rank as an international broadcaster.

A few kilometers outside of Rio, the eight antennas of Radio Nacional rise against the mighty sweep of Brazil's mountains and clouds as war weapons that are meeting a daily challenge.

War wrote many new conditions for RCA and its Brazilian associates on this job. While the equipment for Radio Nacional was being shipped out of the United States, the Atlantic seaboard was under heavy submarine attack. The task was completed under hazards which added to the drama of the engineering script.

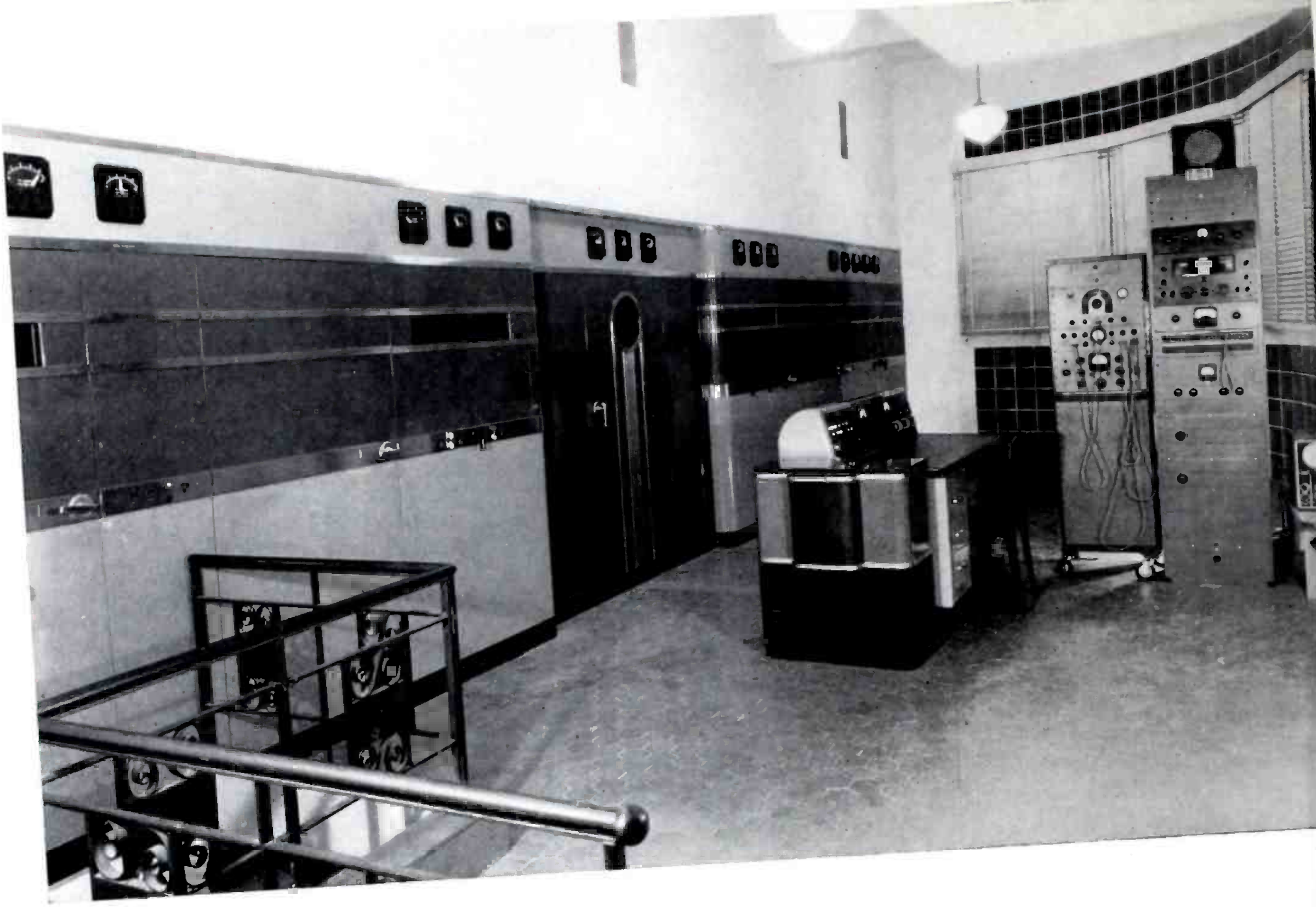
The installation at Radio Nacional was made by the International Department of the RCA Victor Division of Radio Corporation of America through its subsidiary company, RCA Victor Radio, S. A., of Rio de Janeiro. John F. Dawson, RCA engineer, was the installation supervisor.

The initial broadcast of the station paid tribute to the skill with which the RCA mission was carried out, to which RCA added due acknowledgment of the close cooperation of the competent Brazilian technicians who worked on this assignment.

Radio Nacional is a unique operation. The station was founded September 12, 1937. The short wave transmitter went on the air December 31, 1942. Of its eight antennas, five are directional and three are non-directional. Two directional antennas (16 and 25 meters) are beamed to the United States, two more of these are beamed to Europe and a fifth (25 meter) to Asia. The three remaining non-directional antennas operate on the 16, 25 and 31 meter bands.

South America's most powerful station today, Radio Nacional is under the direction of the Brazilian Government. This direction is exercised through the DIP, the Departamento de Imprensa e Propaganda. The station has a Department of Political and Cultural Propaganda to which are related all activities dealing with the broadcasting of cultural and political subjects.

The special technique of Nacional's broadcasting is one applied exclusively by Brazilian experts. It is based on a close study of Axis as well as American broadcast methods and it is designed first, to cover the Portuguese and Spanish speaking worlds in both hemispheres; and second, to give other nationalities an understanding of the culture and the power of Brazil and the other republics of the Americas.



VOICE OF A GOOD NEIGHBOR—*Front view of the RCA 50 KW transmitter at Radio Nacional with the console table, monitoring and measuring equipments, limiting amplifier, line amplifier and speech input equipment for emergency operations.*

Radio Nacional has been heard around the world, in English, Spanish and Portuguese. Letters to the station from Europe, Africa, Asia, Australia and the Americas attest to its transmitting power and the appeal of its carefully prepared programs. These programs include news, sports, a wealth of music, a radio novel, army and navy bulletins, and special broadcasts for Great Britain, Portugal, the United States and Canada, and Spanish America. Good production and first class engineering sustain Nacional's counter-attack against Axis propaganda.

A 25 KW transmitter broadcasts for Nacional on standard wave. Both transmitters are used for internal coverage of the vast domain of Brazil and the short wave station for the overseas broadcasts.

Radio Nacional's short wave broadcasts are on the following frequencies: PRL-7, 9,520 kc, 30.86 m.; PRL-8, 11,720 kc, 25.60 m.; PRL-9, 17,850 kc, 16.91 m.

Radio Nacional's streamlined studios are housed on the 21st and 22nd floors of the building of "A Noite," leading Brazilian daily.

The station is completely RCA equipped. This includes de luxe RCA speech input equipment, racks, turntable and recording equipment. There are three control booths for the total of seven studios. One of these, the Radio Theatre seating 486 persons, is used for special performances. Fifteen Type 44-BX RCA Velocity Microphones are used in the main studio along with six of other types with de luxe boom and program stands.

One of the special performances in the Radio Theatre was the opening broadcast beamed in English to the United States. The principal speakers on the program were Oswaldo Aranha, Minister of Foreign Affairs for Brazil, and Jefferson Caffrey, United States Ambassador to Brazil. It was this program which revealed the presence in South America of Lieutenant Commander Walter Winchell who acted as master of ceremonies.

A toast proposed by Winchell, in which Mr. Aranha joined, said: "Yours, sir, is the glass which represents your country. Mine is the glass which represents my country.

"The toast: Never above you; never beneath you; always beside you."

The opening broadcast, featuring Brazilian symphonic and popular music, with the messages from the diplomats gave a dress rehearsal of the programs to follow and was the first of many heard from Radio Nacional in the United States.

RCA sponsors a daily fifteen-minute broadcast of Associated Press news over Radio Nacional. This is called "Your RCA Foreign Correspondent," another link between RCA and the good neighbor republic.

As Radio Nacional expresses it, it is dedicated "to the service of civilization, to the purpose of good neighbor relations, to the sacred cause of freedom. It is a new and strong voice, reaffirming the great principles of the age."

BROADCAST NEWS is pleased herewith to give its readers a pictorial presentation of Radio Nacional, in conjunction with the basic description of the RCA 50 KW transmitter, which appears elsewhere in this issue.

STREAMLINED—*General view of the streamlined Radio Theatre with a seating capacity of 486. This Radio Nacional studio is mainly used for stage broadcasts and also for special performances in the main studio. This is isolated from the auditorium by a one-piece pane of glass at the back of the curtain.*

AUDIO EQUIPMENT—*Inside view of the main control booth where the Radio Nacional programs for the long and short wave transmitters go through for distribution. All the equipment is of the RCA de luxe type. This is one of three control booths for seven studios.*

FM NOISE LEVEL and AM NOISE LEVEL

★

How to make the noise level measurements required for "proof of performance" of FM installations

Of the measurements required in proving in an FM installation, those of FM noise level and AM noise level are to the average station engineer the most confusing. Actually, with the equipment available in most FM stations, these measurements are quite easy to make and providing the engineer understands what he is trying to do, they can be made in a relatively short time. Such understanding requires, first of all, a clear picture of what is meant by the terms "AM noise level" and "FM noise level."

WHAT IS MEANT BY "FM NOISE" AND "AM NOISE"

The difference between "FM noise" and "AM noise" can be quite simply explained if we think in terms of the carrier output of the FM transmitter. The so-called *"FM noise"* is caused by noise voltage components which *frequency modulate* the carrier output. Any noise component in the program voltage fed to the transmitter will obviously do this. Any extraneous voltage picked up in the audio circuits of the transmitter itself will have the same effect. The carrier output of the transmitter, therefore, will be caused to vary in frequency not only by the program voltage, but also by these noise voltage components. In the receiver these will be "demodulated" along with the program and will appear as noise background to the program. It is this noise which is referred to as the "FM noise." It is usually measured in terms of decibels below the level corresponding to 100% frequency modulation of the carrier. Relatively this FM noise level has the same position in frequency modulation as the background noise level we ordinarily think of in amplitude modulation. If the benefits of frequency modulation are to be retained, it is obviously necessary that this noise level be kept very low. The present requirements of the FCC specify that it be 60 db. below 100% modulation level.

"AM noise" is caused by noise voltage components which *amplitude modulate* the carrier output of an FM transmitter. Theoretically, the carrier output of an FM transmitter is constant; actually, this is never quite so because of factors such as the use of a-c on the filaments of the tubes which causes a slight ripple voltage to be superimposed on the carrier output. Such a ripple voltage is, in fact, an amplitude modulation of the carrier. It has been shown that this amplitude modulation can, under some circumstances, result in noise in the output of an FM receiver. This is due to unbalance in the demodulator circuits and other deficiencies which cause receiver performance to depart from theoretical predictions. The importance of this AM noise will depend on its magnitude. It is obvious, therefore, that some limit must be placed on amplitude noise modulation if high standards are to prevail. For purposes of convenience, this amplitude noise modulation is usually stated in terms of its relation to 100% amplitude modulation of the carrier output. It is this ratio, usually expressed in decibels below 100% modulation level, which is referred to as the "AM noise level."*

EQUIPMENT REQUIRED

The most important item of equipment required for making FM and AM noise level measurements is a noise meter such as the 69-B or the 69-C. It would be possible to make these measurements by using an r-m-s reading voltmeter to determine the

68-A Beat Frequency Oscillator

76-B Studio Input Equipment

absolute voltage levels, but the results required can be obtained both more conveniently and more accurately with a standard noise meter. In using the 69-B and 69-C Noise Meters for transmitter measurements it is usual first to adjust the output meter to read full-scale for 100% modulation of the transmitter. This establishes a reference point. After this adjustment has been made, the modulation is removed and by manipulation of the calibrated gain control, the residual noise level can be read directly in decibels below 100% modulation. (In measuring "AM noise" the reference point must be established by means of an auxiliary voltage, as noted below.) The 69-B and 69-C instruments were designed specifically to make measurements in this manner and they are capable of providing results of high accuracy when carefully used.

A source of audio voltage for modulating the transmitter during the preliminary adjustments is required. In most stations the 68-A or 68-B Beat Frequency Oscillator is standard equipment. The availability of such a device will be assumed in the following discussion. The other equipment required, including the 322-A FM Modulation Monitor, will necessarily be present in any FM installation.

MEASUREMENT OF FM NOISE LEVEL

The arrangement of equipment required to make FM noise level measurements is shown in Figure 1. Since the FCC requires an overall measurement of noise level, the test measurements should include the studio speech input equipment and the studio-transmitter link. In order to use the 69-C Noise Meter in measuring the FM noise level it is first necessary to demodulate the r-f energy which is picked up from the output of the transmitter. Obviously, any noise present in the demodulator will be read by the 69-C and it is, therefore, necessary to have a demodulator circuit which in itself has a noise level considerably lower than that to be measured. This may be difficult to obtain. Special laboratory-type receivers having noise levels lower than this have been built but at present are not available to most stations. Moreover this method of measuring FM noise is accurate only if the discriminator in the monitor unit gives a substantially perfect balance for AM noise; otherwise both AM and FM noise will be measured. Under the circumstances, the best demodulator available for most stations will be that incorporated in their FM modulation monitor. To use the 322-A in this way the output audio terminals are connected directly to the audio input terminals of the 69-C, the overall arrangement of the equipment being as indicated in Figure 1. The actual steps in making the required measurements are as follows:

1. A 1000 cycle note furnished by the 68-A oscillator is fed into the main studio speech input equipment from whence it goes through the S-T link to the plant and the input of the FM transmitter. The 322-A monitor is left coupled to the transmitter as per usual, but the audio frequency output of the monitor is connected to the 69-C Noise Meter (instead of the usual audio monitoring channel).
2. With the various gain controls set at approximately normal operating positions, the 68-A oscillator is adjusted so that 100% modulation of the transmitter, as indicated by the 322-A monitor, is obtained.
3. While maintaining 100% modulation the 69-C Noise Meter is adjusted for full-scale deflection in the usual manner.
4. The oscillator is turned off and the input terminals of the studio speech input equipment shorted. The noise level in decibels below 100% modulation can then be read directly from the 69-C Noise Meter.

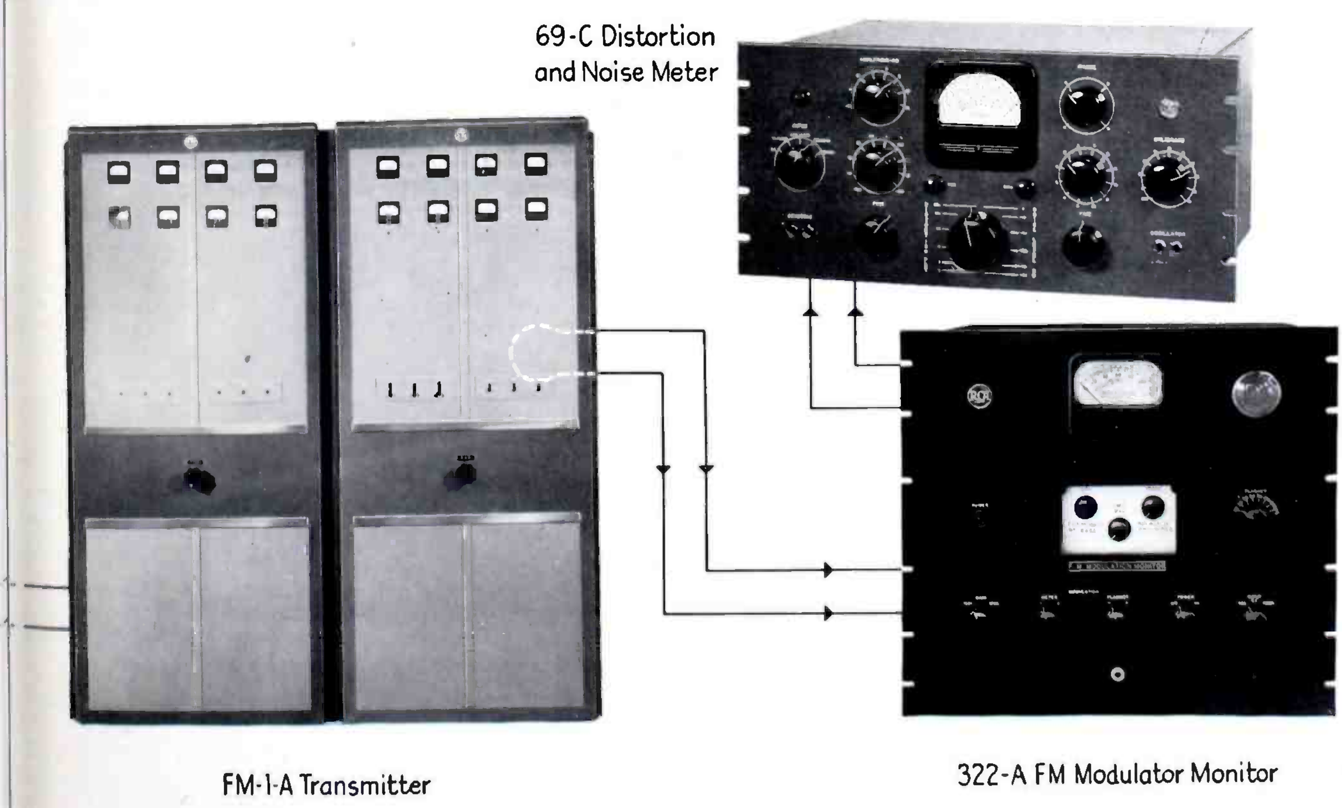


FIG. 1. *Arrangement of equipment for making measurements of FM noise level on FM transmitter installations.*

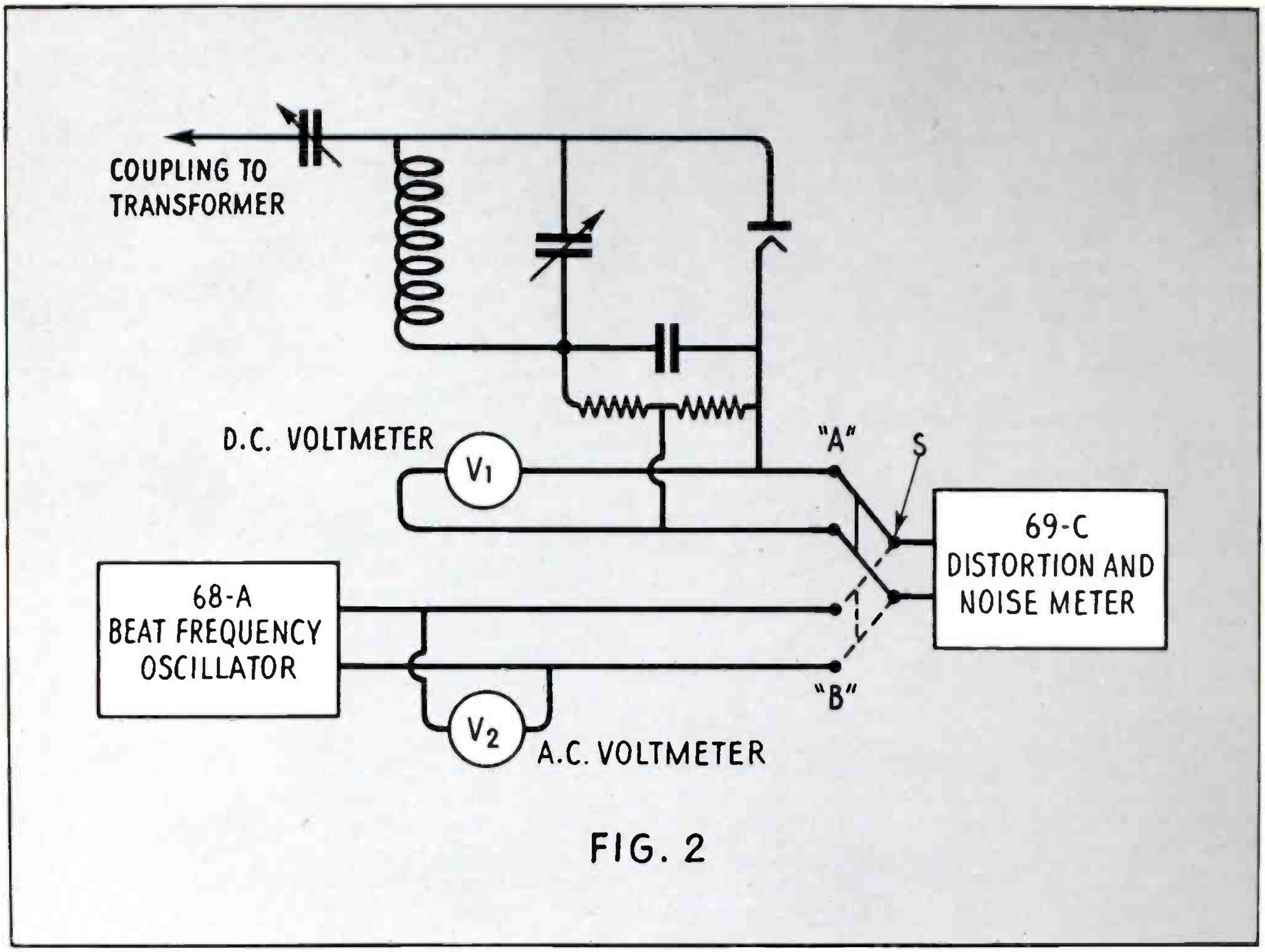


FIG. 2. *Schematic diagram illustrating method of measuring AM noise level of FM transmitter installations.*

MEASUREMENT OF AM NOISE LEVEL

In measuring the AM noise level in terms of what would correspond to 100% AM modulation of the transmitter, there is the problem that it is, of course, not possible to amplitude modulate the carrier output to 100%. It is, therefore, necessary to substitute some other means of obtaining the required calibration of the 69-C Noise Meter. The arrangement shown in Figure 2 can be used for this purpose. A diode rectifier having a 600 ohm output is used to rectify a small amount of r-f energy picked up from the output of the transmitter. Across the 600 ohm output resistor of this rectifier there appears a d-c voltage which is proportional to the carrier output of the transmitter. If the carrier output of the transmitter were amplitude modulated, there would appear in addition an a-c voltage which would be proportional to the percentage modulation. If the carrier output were amplitude modulated 100%, this a-c voltage would be equal to .707 times the d-c voltage. We can take advantage of this fact in setting up an external calibration of the 69-C Noise Meter. This is done by using an audio oscillator of 600 ohms output so adjusted that there appears across the output an a-c voltage equal to .707 times the rectified d-c voltage measured above. This voltage is fed into the 69-C Noise Meter and the latter adjusted for full-scale deflection. It has thus been calibrated and is ready for use in measuring the AM modulation level which appears across the output of the diode rectifier. The actual steps in making the measurements are as follows:

1. A diode rectifier as shown in Figure 2 is coupled to the output of the transmitter. In the case of the RCA FM-1-B or FM-10-A transmitters, one-half of the audio monitor circuit can be used for this purpose.

2. With switch "S" in the "a" position, the d-c output voltage of the diode rectifier is measured by means of voltmeter V-1.

3. Switch "S" is thrown to the "b" position and the output of the 68-A oscillator adjusted so that voltmeter V-2 indicates an a-c voltage equal to .707 times the d-c voltage measured under "2" above. The 69-C Noise Meter is then adjusted for full-scale deflection in the usual manner.

4. Switch "S" is returned to the "a" position and the noise level as indicated by the 69-C Noise Meter is taken as the measurement of the AM noise level.

WARTIME OPERATION of the 5-D and 5-DX TRANSMITTERS

Some Ideas on Things that Can Be Done to Make the Equipment Last Longer, Reduce the Likelihood of Failures, and Overcome More Quickly the Failures that Do Occur

by J. H. KEACHIE*

Wartime operation has considerably increased the hazards of broadcasting. For the technical staff the greatest of these is the difficulty of reconciling the obvious desirability of not being "off-the-air" at a crucial moment with the equally obvious necessity of making present equipment do for the duration. With long hours of operation (24 hours a day, in some cases), technical staffs made up largely of new and inexperienced personnel, tube deliveries slow, replacement parts uncertain, and new equipment virtually non-existent, the problem is difficult. Moreover, as more trained men enter the service, spare parts are used up, and manufacturers' stock piles are depleted, the situation may well become worse. The danger of major time losses is imminent. The things which can be done to reduce the likelihood of failures—and to insure quick return to the air in case failures do occur—must be done now.

There are some routine procedures, such as a systematic maintenance schedule, a periodic check of filament voltages, and a carefully kept up stock of spare parts, which have always been "good practice" but which in the past have too often been carelessly and ineffectually carried out. There are other good ideas, such as starting tube filament voltages (tungsten filaments only) at below rated voltage, which help in prolonging life but which in peacetime were often overlooked. There are possibilities, too, in the substitution of one tube type for another, in operating without a full tube complement or with other components shorted out, which may in an emergency keep the station on the air. All of these things have been discussed and advocated at various times in the past; recently they have been dusted off and reviewed in a whole series of articles. Most of these articles, however, have been of general nature and, hence, of limited usefulness. The comments which follow refer specifically to two types of equipment—the 5-D transmitter and the 5-DX transmitter (de luxe model) which are similar as to circuit and circuit components.

SYSTEMATIC MAINTENANCE

A routine maintenance program carried out at definitely scheduled periods has been a recommendation which RCA engineers have been making for years. Most of the 5-D and 5-DX station owners are proud of their installations and have kept them in tip-top shape. For this reason it may seem unnecessary to speak again of the desirability of regular and complete maintenance checks. However, the subject is of such importance that it must not be overlooked. Proper maintenance will increase useful life and anticipate and prevent many outages and component failures that occur due to neglect. A few of the particular things to be done will bear repeating.

Dirt in equipment will cause a multitude of troubles. This is frequently overlooked until voltage insulation here and there is reduced and damaging arcs and leakage exist. Power consumption under such conditions will slowly increase and thus reduce performance characteristics until the vicious circle which has been started becomes destructive to tubes and equipment. The higher relative humidity in summer months will tend to make such destructive conditions worse. A source of dry air under pressure is handy for blowing out inaccessible corners, general cleaning out of dead insects, and the like. Ceramics and other similar components can best be polished with a dry cloth. Cleaning with carbon tetrachloride may be required to loosen the dirt accumulation.

Forced air-cooling is employed on the RCA Type 5-D final power amplifier, modulator, and main rectifier tubes. The associated motors and blowers require very little attention. The motor bearings (front and rear) should be oiled once every 1500 hours of operation but not excessively. Excessive oil soon covers the motor windings and may cause early motor failure. Excess oil may also find its way to and deposite itself as a thin film on the blower fan blades. This film will collect particles of dirt and dust until the blower efficiency drops dangerously low and causes the airflow interlocks to remove voltages on the tubes. The blower blades should be cleaned at least once a year and inspected every second month for dirt accumulation and tightness of the "Allen" head set screws holding the blade assembly to the motor shaft.

All moving parts, such as contactors, switches, and relays, should be given a thorough inspection once every sixty days under normal trouble-free equipment use. All contacts, both moving and stationary, should be cleaned, rounded off, and polished. Relays and contactors all have moving parts and therefore require occasional tightening of all nuts and bolts. Clean contacts that are not overloaded will not heat and oxidize, but dirty contacts create a vicious circle which becomes increasingly worse as time goes on until the contact is ruined beyond repair. Relay contact arms should be inspected to make sure reasonable contact pressure is exerted to prevent sustained or intermittent arcing.

The contact finger arms on the overload and time delay relays are normally adjusted to give a firm wiping action at the contact surfaces for all modes of operation. These contacts will gradually destroy themselves if such action does not exist and in the meantime cause other contactors involved to "chatter" and create needless wear and tear. Both front and back contacts are equally important and should be kept clean, rounded, and free of sharp-pitted spots.

Because of heat convection and high static voltage conditions, the dust in a transmitter room is continually circulating through and depositing on the equipment; so all stations should make sure the incoming air is kept clean. Good air filters are built into the doors and supplied as a part of the RCA Type 5-D transmitters but unless these are renewed as they become loaded with dirt, the blowers will simply draw air from around them until the actual airflow through the forced air-cooled tubes decreases to a point where the air interlocks operate to remove plate and filament voltages.

FIG. 1. *5-DX transmitter at WSYR, Syracuse. Cabinet for spare tubes and components is at the right; monitoring equipment and emergency transmitter at the left.* ▶

* Broadcast Transmitter Sales.

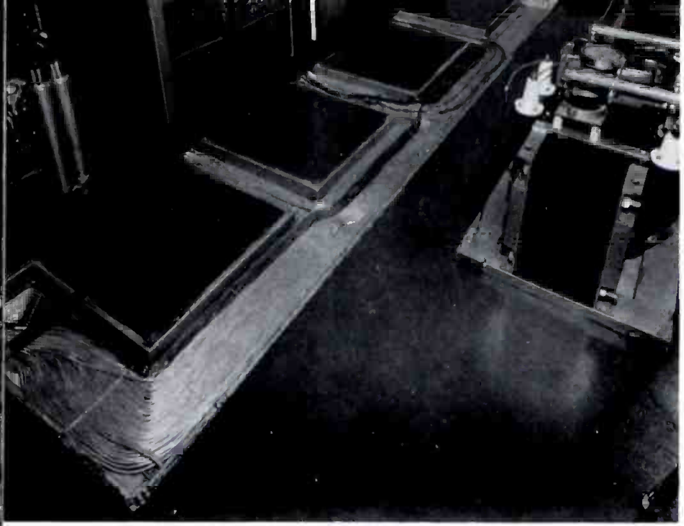


FIG. 2. *Careful installation and wiring done according to carefully laid out specifications pay dividends by greatly reducing the likelihood of wiring breakdown. A closeup of the wiring ducts at WSYR, Syracuse.*

★ ★ ★

AVAILABILITY OF REPLACEMENT PARTS

A paramount question among broadcast station owners and engineers is the availability of replacement parts when the need arises. In many instances critical materials required for the war effort have not been available for commercial replacement parts. The policy of RCA for a number of years past has been to stock replacement parts to cover all expected contingencies connected with RCA equipment; but today, in almost all cases, these stock supplies can be replenished only with great difficulty. Delivery time is often excessive even though a good priority is furnished. This situation is well known and generally understood. The best solution under these difficult circumstances is to have the defective units returned for salvage and rebuilding, thereby using a minimum of raw material. Such rebuilding sometimes costs more than completely new fabrication, but it does provide a method of maintaining an emergency stock which is in line with requirements of the war effort. Moreover, this policy allows the company to keep its stocks at a point where shipments can be made without threat to the availability of material for emergency shipments. Obviously such action is not required on all items, but generally speaking, all transformers (both power and audio), reactors, most capacitors, and units involving aluminum shields, etc. are included. Return of defective units of these types also automatically prevents overstocking or hoarding of spare parts by anyone, with the accompanying tendency to eliminate or cripple the common emergency supply source of replacement parts. Radio broadcasting stations have been given a quasi-essential national defense ranking to prevent crippling of the essential service they render. Every order for replacement parts of such material should be accompanied by the priority available. This will insure delivery with the least delay since all orders must be handled on a priority basis.

SUBSTITUTION OF TUBE TYPES

In case of an emergency caused by a shortage of certain tube types, delay in expected shipments, or an unusual run of failures, the elimination or substitution of tubes in both the audio and radio frequency sections of the 5-D offers a number of possibilities. The audio amplifiers of the 5-D are of the push-pull type throughout. Each amplifier, with the exception of the modulator, employs a common un-bypassed cathode resistor. Therefore, if the grid of one tube is not directly excited by an audio signal and the other grid is, a signal will automatically appear in the plate circuit of both tubes. With this in mind, it is seen that emergency operation can be continued with only one 1603 tube in the first audio amplifier. At the same time and on the same side of the push-pull system, an 807 in the second audio amplifier can also be removed and operation still continued. Readjustment in audio input level will be required to maintain 100% modulation under these conditions. A reduction in the number of third audio amplifier (845) tubes will require a reduction from 100% modulation equivalent to the number of 845's eliminated. Care must be taken under such circumstances not to exceed 1250 volts between the 845 filament and plate elements and to increase the cathode resistor to provide the normal grid bias of about 195 volts (filament to ground). Operation with only one 891-R modulator tube is possible providing the bias voltage is reduced to give essentially class "A" operation of the tube (plate dissipation limit 3.5 kilowatts—plate voltage times plate current). Under such conditions, full 100% operation will be possible on low-power (1 KW output), but on high-power the modulation level must obviously be considerably less.

If no usable Type RCA-1603 or substitute tubes, such as the RCA-6C6 or RCA-77, are available, then the normal 1603 grid leads can be connected directly to the RCA-807 grids. The overall feedback need not be removed unless desired for some apparent reason. If feedback is connected back to the same *side* of the push-pull system as when the 1603 tubes were in use, it will be regenerative and cause the audio system to oscillate. The 1603 grid terminals must therefore be reversed at a convenient point or crossed over to eliminate such oscillation. Operation will then be normal except for the audio voltage amplification lost in eliminating the 1603 amplifier. The normal RCA-807 grid connections need not necessarily be removed. Normal program modulation (100%) can be maintained by increasing the audio input level about 20 db. under this condition. A shortage of RCA-807 type tubes at a given location can be relieved by substituting with Type RCA-6L6 or RCA-828 tubes. (6L6 tubes will require different socket connections.) The Type 6C6, 77 and 6L6 are used in many home and commercial radio receivers and should in an emergency be readily available for such substitutions. Further reference to the Radiotron Tube Handbook will reveal numerous other possible emergency tube replacements. In any event, when tubes are substituted or only one is used in a normal push-pull audio amplifier, discretion should be used to ascertain that excess d-c voltages do not exist on the tube elements due to less current flowing through the voltage dropping and audio load resistors.

INTERCHANGE OF 891-R AND 892-R

The normal RCA Type 5-D transmitter spare tube complement includes two RCA-891-R modulator tubes and one RCA-892-R tube for the final r-f power amplifier. The RCA-891-R modulator tubes in this class of service are lightly loaded and have a high normal life expectancy. Under average program conditions the RCA-891-R modulator plate input power runs approximately 1600 watts per tube, while the RCA-892-R power amplifier plate input normally runs about 6350 watts for 5 kilowatts r-f antenna output power. This means that a station is more likely to stop broadcasting for want of an 892-R tube replacement than an 891-R. In case of such an emergency it is possible to replace the RCA-892-R with an RCA-891-R directly without a single change except for switching to low-power (1 KW output). Operation with an RCA-891-R in the power amplifier with 5 kilowatts output is not recommended. The r-f grid driving power required for either tube is essentially the same, but the r-f grid voltage swing is quite different. When using either type tube in the final r-f power amplifier, it may be necessary in an emergency to operate with lower than recommended grid driving power and voltage. The principal effects to be expected from this operation will be reduced amplifier operating efficiency and a reduction in positive modulation capabilities. (The negative modulation peaks will not be affected.)

REDUCTION OF FILAMENT VOLTAGE

Since transmitting tubes are frequently difficult to obtain, the importance of obtaining maximum tube life is obvious. For some types of tubes greatly increased life will be gained if the tube filament voltages are reduced to a point just above that which creates undesired distortion or carrier shift in the output signal of the transmitter. Tubes utilizing pure tungsten filaments, such as the RCA-891-R and RCA-892-R, are definitely in this class.

For example, RCA-891-R tubes are still being operated after 18,000 hours' service as modulators in the RCA Type 5-D Transmitter with a filament voltage of only 18 volts (18% below normal rating of 22 volts). This does not usually permit 100% modulation at 7500 c.p.s. (and 6350 watts input) without exceeding 3% distortion; however, the average program level at this frequency probably never exceeds 25% modulation, so from a listener's viewpoint performance remains normal. The two halves of the RCA-892-R filaments in the r-f power amplifiers are operated 90° out of phase to give a maximum rated filament voltage of 15.5 volts (11 volts per strand). New RCA-892-R tube filaments can be operated in the 5-D transmitter at 14.5 volts to start, this filament voltage being gradually increased with age to offset lowered filament emission as evidenced by increased "carrier shift" or reduced positive modulation capability. Such tubes as the RCA-845 and RCA-805 have thoriated-tungsten type filaments, the life of which is also ordinarily ended by a decrease in electron emission, but these should *never* be operated either above or below *rated* filament voltages. The difference between pure tungsten and thoriated-tungsten filament tubes is that decreased emission on the latter can be restored in some cases by operating the filament at normal voltage for ten minutes or longer without plate, grid, or screen voltages. This reactivation process can be accelerated by raising the filament voltage not more than 20% above rated normal for a few minutes. Sometimes a few hundred hours of additional useful life can be obtained after reactivation of thoriated-tungsten filament tubes which have failed (filament still intact) after normal service. The other type tubes used in the 5-D series of broadcast transmitters, such as the RCA-1603, RCA-807, RCA-802, RCA-866, and RCA-872, are of either the coated-filament or heater-cathode types and should at all times be operated at rated filament voltage regardless of their age, for after giving normal service or after having been operated at excessive voltages, they will become inoperative due to loss of filament emission and can in no way be restored to do the same useful work; hence, their life must be considered terminated.

OPERATION WITHOUT FEEDBACK SYSTEM

Still another part of the 5-D and 5-DX equipments which can be temporarily removed is the feedback system. In these transmitters overall "negative" feedback is obtained by feeding back a portion of the modulator voltage to the RCA-1603 audio input grids. If conditions arise which require operation without this feedback, the best procedure is to connect a four mfd. (or larger) capacitor from terminal CC5 and another like capacitor from terminal CC6 to ground. This will allow the 1603 tubes to function at normal net bias voltage. Terminals CC5 and CC6 can be grounded to remove feedback quickly if desired, as the principal effect is merely to reduce the amplification gain of the first (RCA-1603) audio amplifier. Without overall feedback, the audio input level must be reduced accordingly to prevent excess modulation. Noise and distortion are, of course, increased somewhat in operating without feedback. For this reason operation without the feedback system is not recommended for longer than the period necessary to effect repairs.

FIG. 4. *Control room for two of the smaller studios of Radio Nacional, Rio de Janeiro. (See also Page 28.)*

EMERGENCY OPERATION AT 250 WATTS

In case of a major breakdown in the final r-f amplifier (RCA-892-R stage) or the high-power modulator, the exciter section of the 5-D transmitter can easily be adapted for operation as a self-contained low-power transmitter. Only a few minor circuit changes are required in order to make the exciter unit (Type 250-F) the equivalent of the standard Type 250-D transmitter. An output of 250 watts fully modulated is thus made available. No added circuit components are required with the exception that tubes will be needed for the two low-power audio amplifier stages (two RCA-843's and two RCA-845's).

The 250-F unit thus converted for operation as a 250-D transmitter can be operated from a 110 or 220 volt single phase supply. This means that in case of failure of one or two phases of the main power supply, the 250-F can still operate from the remaining phase. It also offers an attractive possibility for emergency operation in case of complete power failure, since it is relatively easy to obtain an auxiliary gasoline-driven power unit capable of supplying the approximately 1600 watts of 110 volt a-c required to keep the 250-F in operation. Some stations already have power units of this type held in reserve for just such emergencies. Others have power units in their mobile pickup trucks which could be used for the purpose.

PRECAUTION PAYS DIVIDENDS

The various operating combinations, substitutions, and general "getting-along-without-it" ideas above are only some of the more obvious things that can be done with the 5-D and 5-DX equipments, which flexibility is in turn due to the extremely conservative design. Over the course of the last few years—during which period the 5-D and 5-DX transmitters were by all odds the most popular equipments in the 5 KW category—there were occasionally questions as to the necessity of this conservatism, questions as to whether so many stages were really needed, questions as to the necessity of using over-size components, and so on. The present emergency has given a definite answer. It is safe to say that today no 5-D or 5-DX station owner regrets the extra expense that was involved in making these equipments just about as failure-proof as possible. And certainly none regrets the completeness—the extras—which in case failures do occur usually allows these to be "patched out" so that operation can be resumed with a minimum loss of time.

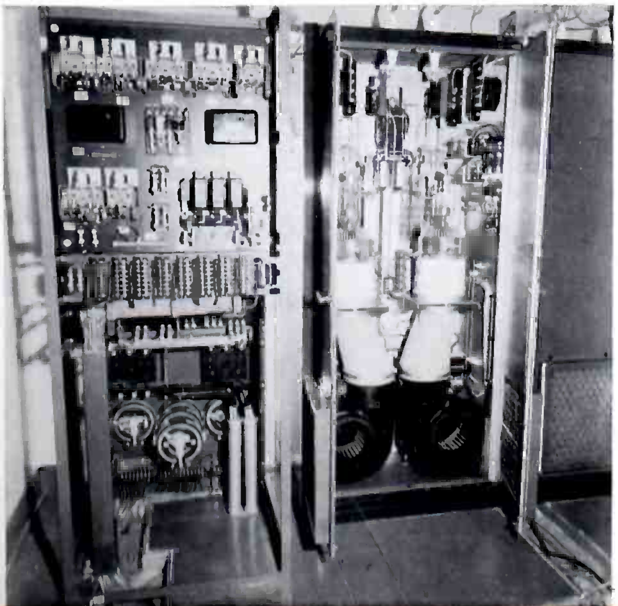
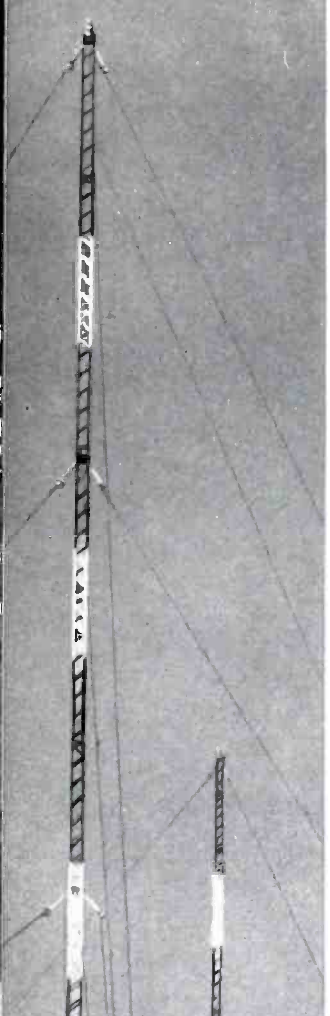


FIG. 3. *Spotlessly clean equipment is one mark of a well-maintained station. Rear view of the power control unit of the 5-DX transmitter at WSYR, Syracuse.*



K ★ M ★ P ★ C

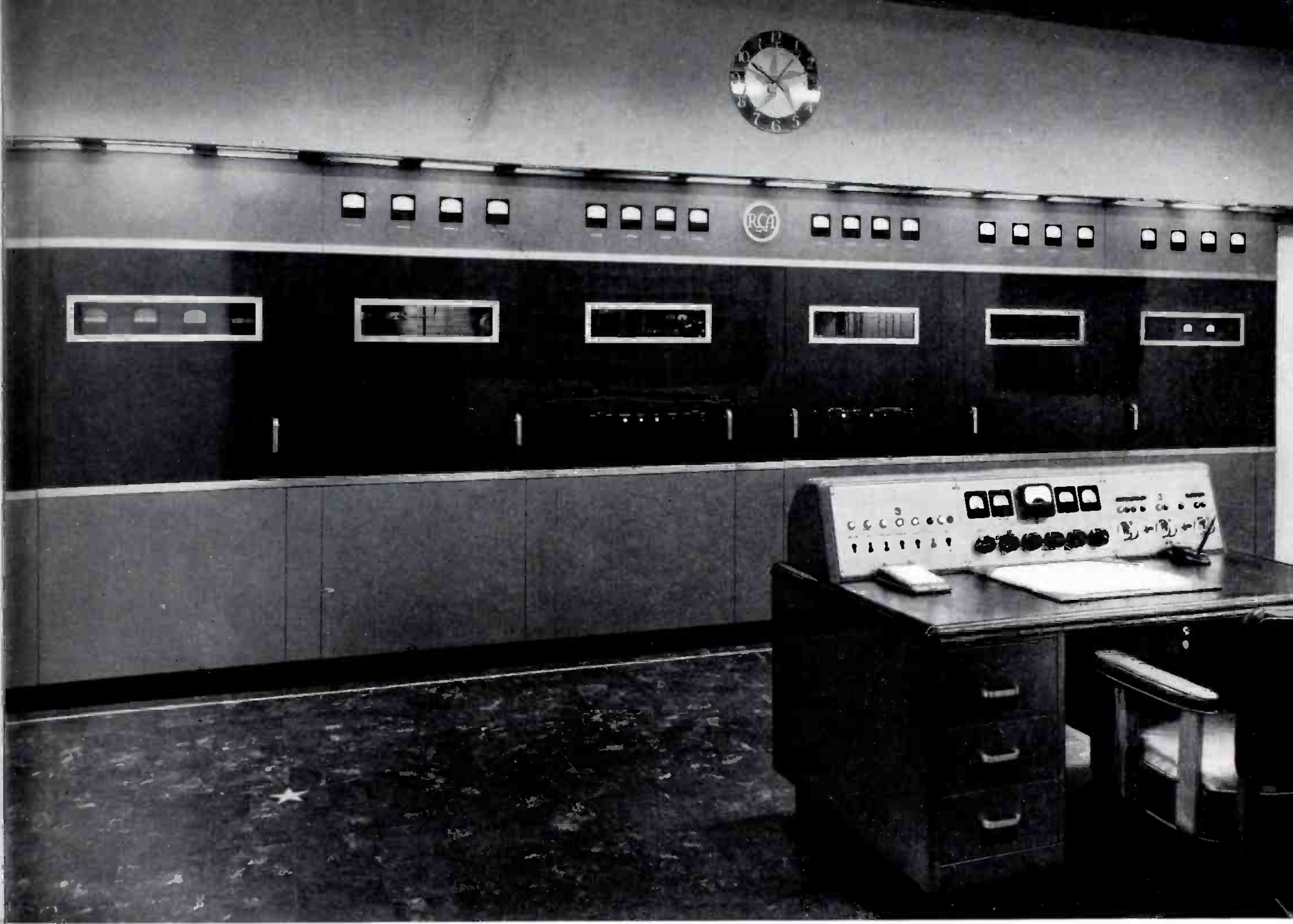
"STATION OF THE STARS"

Beverly Hills . . . California . . . KMPC . . . Station of the Stars . . . it all sounds glamorous. And it is! But of more interest to the broadcast engineer is the story behind the glitter, a story of a tough technical problem, an ingenious solution, and a beautiful installation job.

KMPC operates with a power of 10 KW, day and night, on 710 kc. This operation, which was made possible by the North American Regional Agreement, carries with it the necessity of protecting WOR, New York, and KIRO, Seattle, to their 0.5 mv/m, 50% sky wave contours. Protecting these stations, both 50 KW's, while at the same time obtaining the desired coverage of the Southern California market, presented a real problem. The directional antenna system which solved this problem was designed and installed by L. C. Sigmon,[1] Chief Engineer of KMPC, and R. M. Pierce,[2] Chief Engineer of WGAR. (KMPC is affiliated in management with WGAR, Cleveland, and WJR, Detroit.) Since a new site and a new transmitter were involved, Lloyd and Morrie went on to make the new KMPC one of the finest installations in the country.

Finding a transmitter site in the Los Angeles area was extremely difficult because of the wide distribution of population and the nature of the terrain. The site chosen for the new KMPC is in the San Fernando Valley north of Los Angeles. This selection made it possible to use a pattern which directed a strong lobe directly toward downtown Los Angeles. A three-tower array is used. Spacing and phasing are such that the signal in the "nulls" is approximately 10 mv/m while the signal throughout an angle of 110° is not more than 40 mv/m. A continuously operated field intensity meter is mounted on a pole a mile and a half from the transmitter in the direction of one of the nulls. By means of a leased telephone line, this meter can be read at the transmitter.

The KMPC phasing equipment was designed by RCA engineers. The phasing circuits located in the main building include a matching input network and two phase shifting net-



KMPC TRANSMITTER ROOM—*The 10-E transmitter, the phasing equipment for the three-tower antenna array, and the speech input and monitoring equipment are all mounted behind the single "unified-front" type enclosure shown above. The operator's console and a monitoring speaker mounted in the ceiling are the only other items of equipment in the transmitter room. The extra panel units which make this ultra-streamlined installation possible are optional accessories with the 5-E and 10-E transmitters.*

works. The third line requires no phase shift network at this point. All three towers are fed by lines running directly from the main building. Since one tower exhibits critical characteristics, means are provided for both local and remote control of tuning elements affecting both matching and phasing. This system has been in operation a little over a year and has operated very satisfactorily.

THE TRANSMITTER

The transmitter installation at KMPC is just about the ultimate in streamlining. There are no separate phasing cabinets, no ungainly speech racks, no isolated items of test equipment to clutter up the transmitter room. All of the equipment is mounted behind a single "unified-front" enclosure. By this means connections are kept shorter, installation costs reduced, and a neat, businesslike appearance achieved.

The transmitter, a 10-E, is described at some length in another article appearing in this issue. As noted in that article, the modifications required in changing a 5-E (power output 5 KW) to a 10-E (power output 10 KW) are relatively minor and consist for the most part of changing over a few components. (The extra tube socket is already in place.)

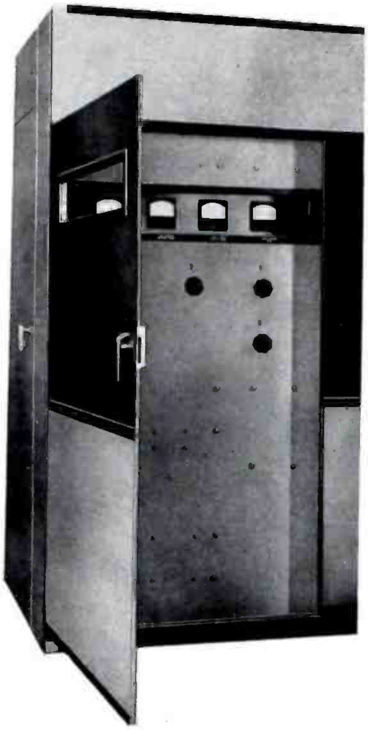
Referring to the picture above, the transmitter proper constitutes the four center panels of the installation, each panel having a door for access to the interior of the unit. At the left of these four basic units is an additional unit containing the phasing equipment and at the right a similar unit containing the speech input and test equipment. The panels of these two extra units are identical to those of the basic transmitter.

The phasing and speech equipment cabinets are standard units available as optional equipment with the 5-E/10-E transmitter. The curved end sections of the basic transmitter are readily removable to permit the insertion of these units. In addition to the greatly improved appearance, there is also a functional advantage. The phasing unit, for instance, is adjacent to the power amplifier unit. A 12" length of bus bar serves as the necessary r-f connection. The speech input cabinet, while somewhat further from the low-power audio stages, is nevertheless located so that interwiring can be run in the channel in the base of the transmitter. The only duct necessary is that to the control console.

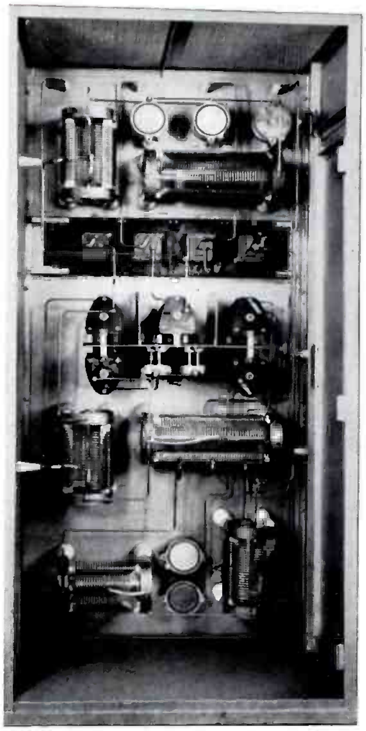
The transmitter is finished in two shades of gray-blue and provided with chromium trim strips. All important controls are duplicated on the operator's console which, incidentally, is the only piece of equipment in the transmitter room. The fireproof brick and concrete building carries out the modern motif of the installation. Matching or complimenting colors are used throughout. The floor of the transmitter room, for instance, is blue asphalt tile. In daytime, light is furnished by windows on three sides of the room and at night by fluorescent lights in the ceiling and in recesses above the transmitter panels. KMPC has probably achieved one of the best-looking 10 KW installations made to date.

[1] Now Captain, H. Q. Services of Supply, Signal Corps, U. S. Army.

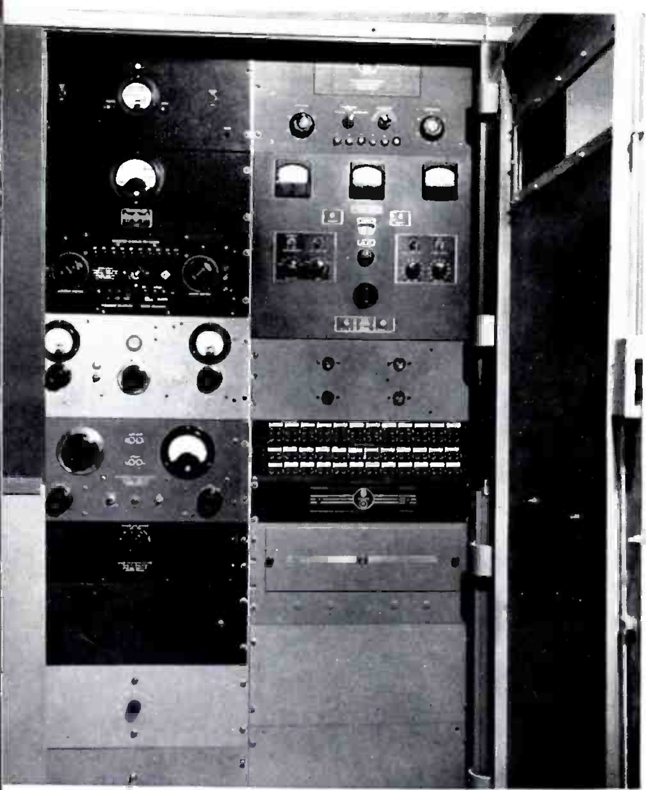
[2] Now Chief Engineer, Psychological Warfare Branch, Allied Force Headquarters, Algiers.



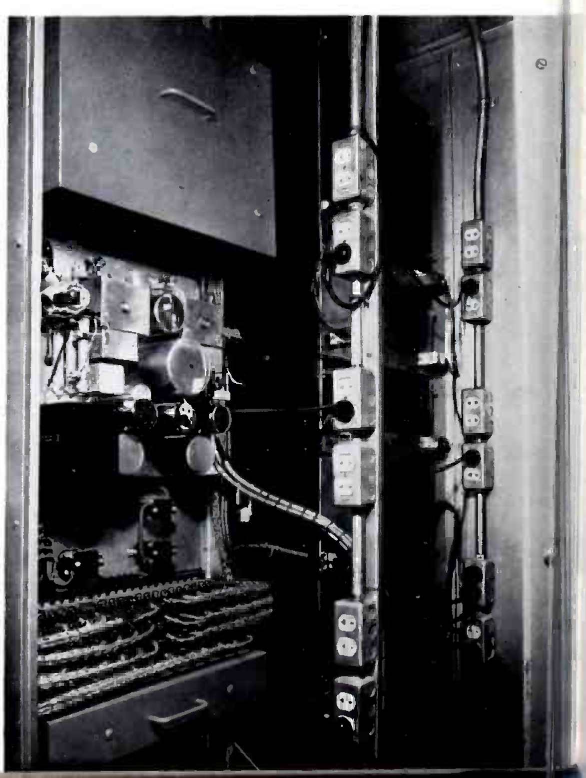
INTERIOR of the phasing cabinet at KMPC. This was taken with the rear wall removed in order to show the arrangement of components. As installed, the back is permanently affixed so that the unit may, if desired, be mounted against or close to the back wall of the building. Entrance to this cabinet for purposes of inspection and maintenance is by means of a hinged door in the side, which may be seen in this picture. The cabinet is deep enough for a man to enter and work on the equipment without cramping.



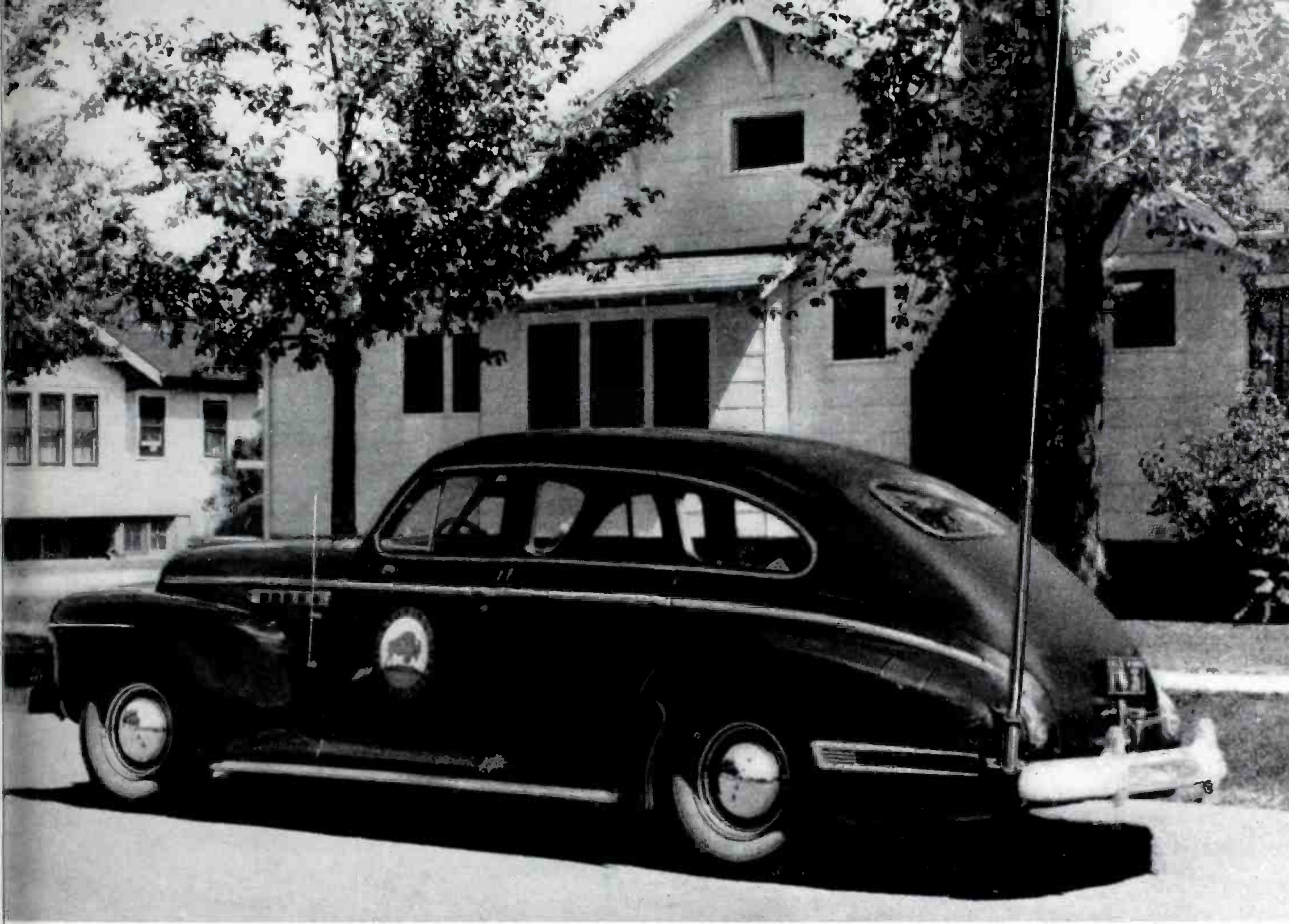
PHASING equipment controls at KMPC. This is the view presented when the extreme left door of the transmitter enclosure is opened. Inadvertent operation of these controls is avoided by placing them behind the door. The meters can be read through the viewing window. In earlier installations, phasing equipment was mounted in a separate unit, usually located apart from the transmitter. The phasing equipment cabinet, available as an optional accessory with the 5-E/10-E transmitter, actually saves space and reduces wiring connections as well as improving appearance.



SPEECH input and test equipment at KMPC. This is the view presented when the furthest right door of the transmitter enclosure is opened. In most stations this equipment presents a rather motley appearance, so that mounting it behind a door like the one furnished as an optional accessory with the 5-E/10-E transmitter greatly improves the appearance of the whole installation. Meters of the frequency and modulation monitors, which are the only ones of concern during routine operation, can be observed through the glass viewing window. The door, of course, is not interlocked and can be opened during operation.



REAR view of the speech input and test equipment cabinet at KMPC. This cabinet is wide enough for two racks of equipment, is 36 inches deep, and is provided with a hinged door on the side. (The back is left clear so that the whole transmitter may, if desired, be mounted against the back wall of the building.) Angles, with standard mounting holes, are provided at the front of the cabinet so that speech units may be mounted as standard racks. With units of ordinary depth there is room to enter the cabinet for inspection and maintenance operations.



Highway Patrol Radio... Wyoming!

by H. C. HILL

RCA Police Radio Section

Radio systems for State Highway Patrols present individual problems which can be solved only by a careful consideration of all the factors involved in each particular case. These factors are much the same in each instance, but the relative weight to be given to each varies with the situation. Particularly striking is the difference between the small, heavily populated eastern states and the large western states. Not only do the latter involve very much larger areas, but as a rule the personnel available to cover these areas is considerably less. In some western states a police radio system on a scale comparable to those used in the east would require more men to operate it than are presently employed in the whole state police force. Another difficulty arises in the choice of locations. Because of the cost of lines and the difficulties of maintenance, the location of transmitters and receivers at remote points (such as on mountains) is usually out of the question, and the cities where the transmitters must perforce be located are often widely separated and unevenly distributed. Because of such considerations it is likely that the best solution will not be the standardized type of system which "armchair" engineering would indicate. In cost instances this solution can be arrived at only by an actual "on-the-spot" study, reinforced in many cases by actual tests. Such a procedure was followed in determining the equipment to be installed for the Wyoming State Police.

The Wyoming Highway Patrol, operating as a unit of the State Highway Department, is charged not only with the responsibility of patrolling the highways of the state, but also functions as a state police force, with all the powers and responsibilities of such an organization. The Patrol, though small by comparison with some other similar organizations to be found in more densely populated sections of the country, is nevertheless very efficient. Composed of eighteen carefully selected and trained men, under the very capable direction of Captain Wm. R. Bradley, the Patrol

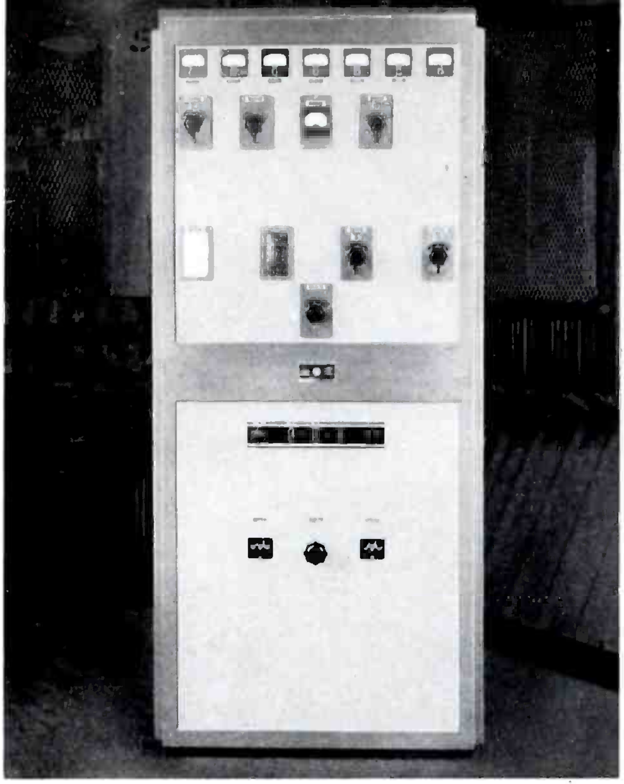


FIG. 1. *Front view of the RCA 1000 watt transmitter installed at Casper, Wyoming, for the Wyoming Highway Patrol.*

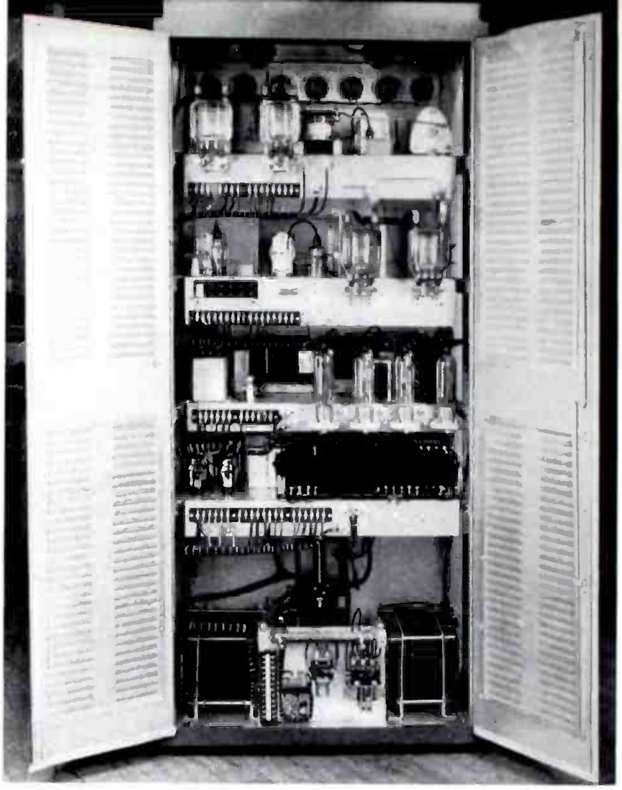


FIG. 2. *Rear view of the 1000 watt transmitter shown in Fig. 1. The tube lineup is similar to that used in 1000 watt broadcast transmitters.*

is responsible for an area of approximately 98,000 square miles. Cordial relations between the Patrol and other departments result in a fine spirit of cooperation throughout the state. This cooperation, as will be evident, has also proved mutually advantageous in the operation of the state-wide radio system.

In addition to the limited manpower available, other factors which had to be considered in planning this installation were the rugged terrain and the rather extreme weather conditions experienced in Wyoming during winter months.

An examination of maps and records prepared by the Patrol indicated that the traffic across the state was predominantly along Highway 30 which parallels the Union Pacific Railroad across the extreme southern portion of the state. Obviously the Patrol radio stations, to accomplish their purpose most efficiently, would have to be located in a manner providing complete coverage of these main arteries of travel, as well as others extending over the state.

Limited radio service had been available for about a year prior to June, 1941. In cooperation with the Sheriff's Department of Laramie County and the municipal Police of Cheyenne, the Highway Patrol had purchased a 500 watt medium-frequency transmitter operated by the City of Cheyenne as a municipal police station on 2382 kc. with service taken by Sheriff Department cars and Highway Patrol mobile units. Talkback was on 33,220 kc, which although entirely satisfactory from the standpoint of the city's requirements and those of the Sheriff's Department, definitely limited the state's scope of operation. While talkback was reasonably satisfactory in certain directions, "shadow effects" from intervening mountains seriously affected such operation in others.

The foregoing indicates that something of a problem was presented. Under ordinary circumstances and with average conditions as to terrain, the first recommendation would have been ultra-high frequency operation, preferably using frequency modulation. This, however, would have required transmitting and receiving stations to be located on the highest elevations in order to secure the necessary coverage. In addition, numerous unattended relay stations would have been necessary to eliminate "dead spots" resulting from mountains and canyons lying between transmitting locations. Since such locations are inaccessible during at least four months of the year because of snow, they would present a serious maintenance problem. If a failure occurred during these periods, the system would be worthless. The line charges, too, would have been prohibitive. Also the state officials indicated that to have the transmitting equipment located on state-owned property would be highly desirable. This would definitely have been impractical with ultra-high frequency due to the locations of Highway Department warehouses.

It does not seem to be generally recognized that the Federal Communications Commission permits operation of mobile transmitters by state police on the frequency assigned for their fixed medium-frequency transmitters. In the case of Wyoming, this assigned frequency is 1642 kc. It was obvious that such operation would offer many advantages if it were possible to obtain the desired results from mobile units. Moreover, since the car transmitters and receivers would be on the same frequency, car-to-car operation—a tremendous asset to state police—would be possible.

Accordingly, a standard 22 watt ultra-high frequency transmitter was modified to operate on 1642 kc. At this lower frequency no trouble was experienced in obtaining an output of 25 watts for the same amount of input power used on ultra-high frequency. From the first it was realized that the most difficult problem to be solved in connection with medium-frequency mobile operation would be in providing a mobile antenna for operation on 1642 kc that would give the greatest possible efficiency and still not be so large physically as to be unwieldy and conspicuous.

The car antenna finally adopted is shown in Figure 3. The bottom end of this antenna consists of a four-foot long section about one and one-half inches in diameter which is close-wound for full length with #16 enameled wire. Attached to the top end of this "loading" section is a seven-foot whip which can be removed when the cars are driven into the garage for servicing. As designed, these antennas have an electrical length slightly over a quarter wave at 1642 kc. It is only necessary to place a variable capacitor in series with the antenna lead to tune out the inductive reactance and provide a resistive load to the transmitter. A further advantage of this tuned antenna is that it provides greatly improved receiver performance.

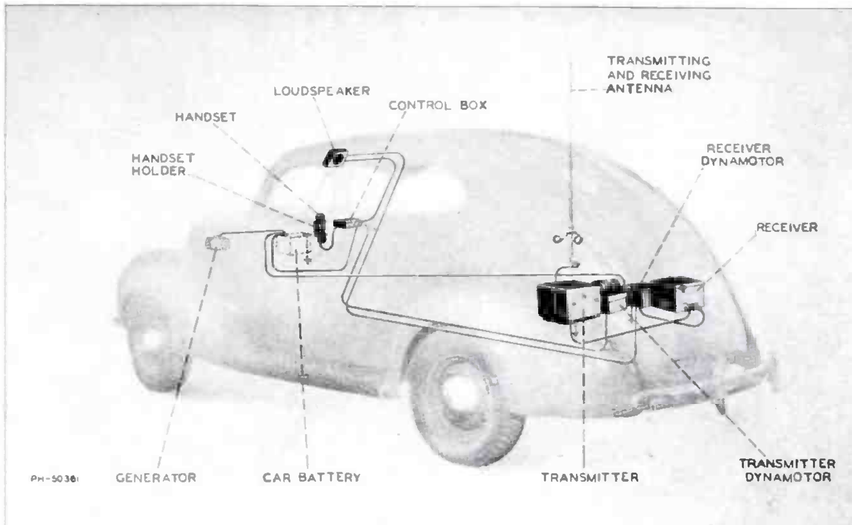


FIG. 4. *Diagrams showing the placement of the various items of equipment in a radio patrol car. This diagram shows the whip used for H.F. installations. This was replaced by the antenna shown in Fig. 3 for the Wyoming installation.*

Permission was obtained from the state and the Federal Communications Commission to conduct tests to determine exactly what results could be obtained. Operating with the experimental call W7XGV on 1614 kc, as authorized by the Commission, a series of tests was made. Receiver locations at Cheyenne were set up, with a means of measuring relative signal strength, and the mobile unit was dispatched in each direction out of Cheyenne with instructions to the operators to state their position every five miles. These tests were run in July, and an effort was made to conduct them during thunder-storms, on clear days, and at night. Careful records were kept of signal strength and readability. Since the object of the tests was to determine the degree of satisfactory operation which could be expected under strictly average conditions, no effort was made to provide an elaborate receiving setup. Satisfactory signal strength was obtained in all directions for an average distance of sixty miles, irrespective of mountains, canyons, or other natural obstacles. The extreme range obtained was 110 miles west of Cheyenne. The tests were repeated, with almost the same results, at Casper.

FIG. 3. *Closeup of the special car antenna developed for the Wyoming Patrol. The four-foot loading section is shown here. A seven-foot whip (removable) fits in the top of this section.*

Mobile operation of this type having been proved not only feasible but desirable, recommendations for a complete system were prepared. On the basis of these recommendations, RCA was authorized to proceed with the installation.

In addition to the mobile transmitters in the cars, the equipment installed by RCA consisted of a 1000 watt station transmitter at Casper and 300 watt transmitters at Sheridan, Rawlins, and Rock Springs. These, with a 500 watt transmitter at Cheyenne, complete the system. The transmitters work into quarter-wave towers; the ground systems consist of 180 radials, these radials being as long as property boundaries permitted, which in most cases was about a quarter wavelength. Open-wire transmission lines were used in all cases because of climatic conditions and ease of servicing. All operation is by remote control. The transmitters are located in Highway Department warehouses and are controlled by telephone lines from the Municipal Police Departments at Casper, Sheridan, and Rock Springs; operation of the Rawlins station is by the Sheriff's Department. In this manner, the manning problem is effectively solved, and the several Police and Sheriff's Departments have at their disposal a degree of radio service which might otherwise have been impossible.

After a year of operation, excellent performance is reported. Talkback from state cars to fixed locations over distances in excess of 75 miles is not unusual, and under favorable circumstances satisfactory contact has been established over several hundred miles. Car-to-car operation is consistent up to fifty miles in daytime. While the locations for the fixed stations were selected for best coverage of the highways mentioned, actual results have greatly exceeded expectations. Under practically any condition it is possible for a car in any portion of the state to hear at least two of the fixed stations in the daytime and, of course, all of them at night.

GOOD TUBES FOR OLD . . . .

HOW RCA REBUILDS POWER

As a special wartime service to broadcasters we have been rebuilding power tubes of the popular 5 KW series, which includes the 891, 891-R, 892, 892-R, and the older 207. Through the medium of this rebuilding program broadcast stations using these tube types are able to get "a tube-for-a-tube" and thereby are assured of maintaining their present operating stock of tubes.

A secondary but also important consideration is that providing the old tubes are returned in reasonably good condition, most of the metal parts can be salvaged. This means that a corresponding amount of strategic war material is saved. In cases where the elements themselves can be cleaned up and reused there is also a saving in valuable manpower.

The success attained with these rebuilt tubes is due to the careful rebuilding program followed—a program which goes much further than most attempts of this kind. The tubes are not just taken apart and the defective element replaced—rather they are rebuilt from scratch. The "picture story" presented here shows the successive steps in the process.

1 *The glass envelope is carefully cut open by means of an electrically heated wire and application of a damp cloth.*

2 *The feather-edge of the old anode is removed and replaced with a new, thick copper cone which is machined to give a feather-edge identical with that of the original cone.*

3 *Rebuilt anode with new, thick copper cone ready for machining to obtain new feather-edge for glass-to-metal seal.*

4 *The old filament stem assembly is completely renovated. If the glass stem is cracked, the tungsten leads are salvaged and used to rebuild a new stem assembly.*

Old filaments are removed and the leads sand-blasted. Old arc welding materials are ground off; filaments and quartz bead assembly are replaced.

5

6 *The completed rebuilt filament stem with new filament installed.*

7 *The grid assembly is sand-blasted, the grid cap polished, and the grid vacuum fired.*

8 *The grid structure is then mounted on the filament sub-assembly.*

. . . TUBES

9

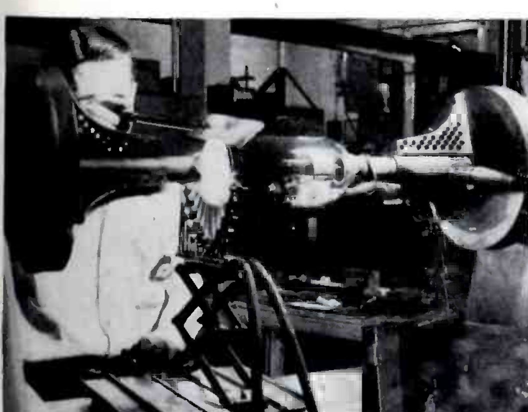
The refinished filament-grid unit is ready to be assembled with the rebuilt anode and glass envelope.

10

The old anode, with its new feather-edged copper cone, is sealed or welded to a new glass envelope. This large, glass-to-metal seal is made in a glass-lathe. Carefully controlled gas flames heat the rotating glass and metal parts while a skilled craftsman molds the glass around the feather-edge of the metal cone, producing an actual weld or fusion of the glass and metal. The resulting joint must be mechanically strong and vacuum-tight. The glass must be annealed carefully to eliminate any glass-strains which might later result in a crack in the glass.

11

Checking the alignment of the filament-grid and anode-envelope assemblies before the glass filament stem is sealed to the glass envelope.

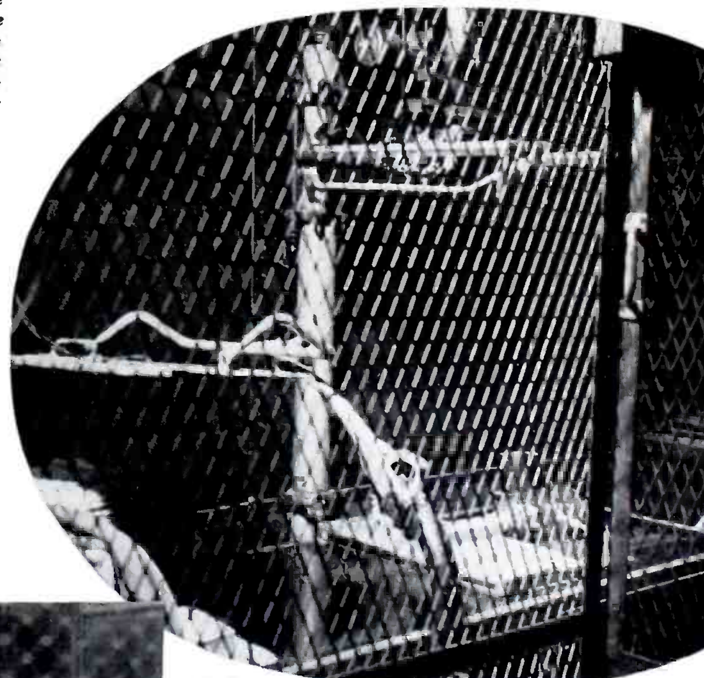


12

Again mounted in a glass-lathe, the glass envelope and filament-grid stem are sealed together, shaped and annealed.

13

The rebuilt tube is X-rayed to make sure that all internal elements are correctly aligned. Due to safety regulations, this picture was taken through the protective grille work. The tube rests on a small table with the X-ray tube beneath it and the special camera above.



14

Spot-knocking or high-voltage treating the rebuilt tube after its exhaust. This burns off any infinitesimal points on the internal parts and assists in eliminating any minute traces of gas (air) which might be occluded internally. A controllable voltage of from 25,000 to 50,000 volts is applied through a current-limiting resistance. Tube pictured through safety glass has good vacuum as is evidenced by high voltage arc across outside of glass envelope although the external distance is many times the internal element spacing.

After initial tests the tubes are set aside and "seasoned" a week or more and then retested to insure against extremely slow air leaks which might not be noticeable during initial test.

Water-cooled tubes are then ready for shipment. Tubes which are to be air-cooled are then installed in heavy copper radiators, their anodes soldered in the radiator with special high-melting point solder. After the soldering operation, it is necessary to give them another high-voltage test before shipment.

"ATTENTION MEN!
This is the Chaplain speaking..."

THE STORY OF BATTLE ANNOUNCE BY F. S. LeROY

The engine telegraph jangles, then stops at full speed ahead. The flagship seems to pause for a second as if gathering strength, then leaps at the darkness as her screws start to bite. Tension mounts as the wail of the blowers rises to a wild crescendo. On the bridge, officers stand tense and alert, waiting for the shock of the first salvo. Stealthily the forward turrets start to turn, their jutting guns anxiously groping like fingers of death in the smooth velvet of the night.

The gun crews at the secondary batteries, swaying in unison with the heavy roll of the ship, stand ready by their guns. Peering intently into the murk of darkness ahead, the lookouts, nervously gripping the guard rail, strain for a glimpse of the approaching Jap ships. The enemy's fleet is rapidly drawing nearer, formidable in their ponderous weight of guns and planes. Except for the barely audible muttering of the talkers at the telephones on the bridge, the muted roar of the funnels aft and the occasional clang of a gun breech being locked, the ship seems hushed as though holding her breath for the moment when she would hurl a blanket of steel and flame into the hulls of the enemy ships.

Below decks, in the dull blue glow of battle lanterns, men move restlessly at their stations. In all compartments tension is great. Ever since the call to battle stations had sounded over the loudspeaker system, officers and crew alike have been awaiting expectantly for the signal that the enemy is in range. To the crews in the handling rooms each minute seems an eternity. The knowledge that an unseen torpedo, an armor piercing shell, might at any moment come crashing and tearing in upon them in a roaring devastation of flame and twisted metal causes the most hardened of them to tense in anticipation. In the suspense of waiting, taut nerves become even tighter. The strain of merely waiting is reflected in the faces of those to whom action, when it comes, will be a relief.

Their naked torsos gleaming with sweat, the men in the fire rooms nervously but carefully adjust and readjust each valve, check each gauge and control to make sure that the last ounce of steam will be ready when needed for the racing turbines. On these men in the engine rooms, the magazines, the interior control and plotting rooms, and many other protected but isolated compartments, depends the real fighting efficiency of the ship. Unseen and unseeing, on them rests the greater burden of fighting on the blind side—sometimes in dimly lighted compartments, more often in the darkness.

Suddenly over the loudspeaker system throughout the ship comes a clear crisp voice:

"Attention men! This is the Chaplain speaking! In a few minutes we will be in contact with the enemy. With the Captain's permission we have arranged to give you men down below periodic reports on the progress of the battle as we see it from our vantage point in the lookout station. I believe this is the first time such a feat has ever been attempted, and I hope all of you will pardon any necessary interruptions we may have from time to time. Now, stand by for further announcements."

The effect of this announcement was instantaneous. As the speaker's voice died away, taut nerves relaxed, and men once again breathed with unrestricted lungs.

For the first time in history, a "blow-by-blow" description of an actual Naval battle in progress was given over an amplifying system to the sweating men in the interior sections of an American warship in combat! From the moment the first salvo of the bombardment was fired, until the last of the fleeing Jap ships had disappeared from sight and range of the guns, the announcer kept up a steady stream of comments on every incident that occurred within his sight. During one phase of the battle, his usually calm voice became tinged with excitement as he warned: "Stand by for torpedo on the starboard beam" and described the movements of a Jap torpedo which was even then headed direct for the ship. Those men working in compartments below the water line on the side nearest the approaching torpedo heaved a sigh of relief as a once more calm voice announced that it had passed harmlessly within yards of the stern.

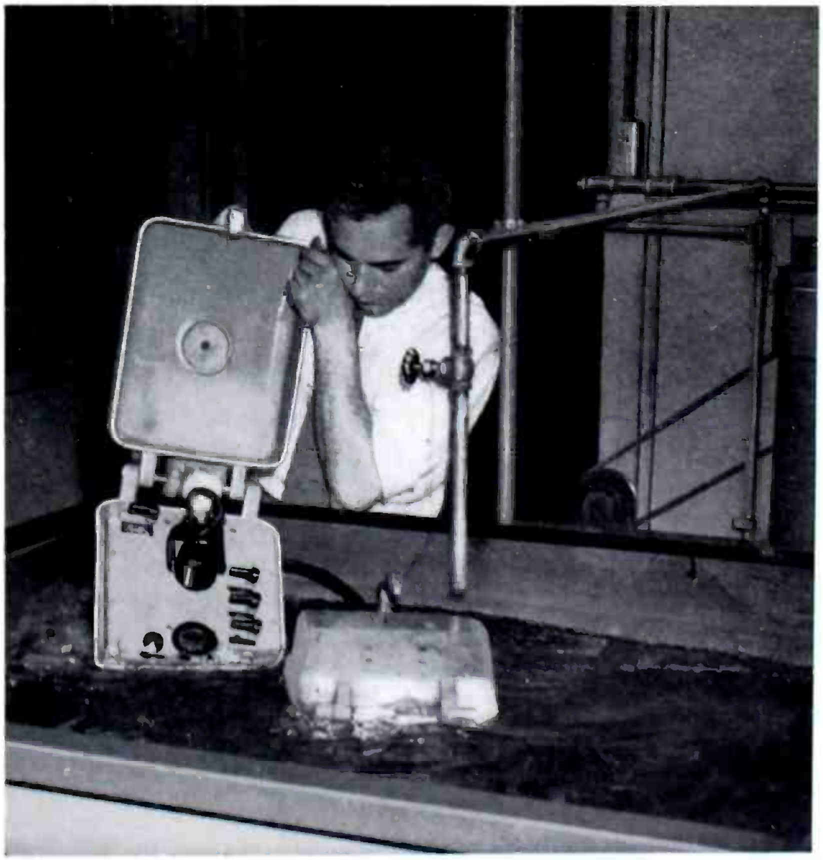
For military reasons the factual events of the story related above have been altered slightly; however, the point of interest is the fact that for the first time on any Naval vessel an audio amplifier and loudspeaker system had been used as a means of keeping up the morale of the men who never have a chance of seeing the actual combat. It had never been intended for this purpose. However, it might be pointed out that the system used was not an ordinary public address system such as is commonly used just to amplify the voice of the speaker.

For years sound equipment manufacturers have been collaborating with the Navy Department in the development and design of sound amplifying equipment which would be suitable for use on Naval ships of all types and under all conditions. Keeping pace with developments and improvements along other lines, the lowly public address system has gradually evolved into a highly efficient and complex equipment, having a number of functions to perform and capable of performing them continuously under any of the conditions to which a Naval vessel is subject. The sound amplifying or announcing system, as it is commonly known, now in use by the Navy has become an integral part of each ship's intercommunication system.

Definitely the announcing system is playing a vital part in the success of our Navy in this war. Other uses are constantly being found for voice and sound amplifying equipment. From the simple audio amplifier and speaker of a few years ago, there has been developed one of the most efficient means of communication ever used on Naval vessels.

During the early days of our Navy, and up to a very few years ago, all orders—with few exceptions—necessary for the operation of the ship were transmitted to the crew by word of mouth. The bosun's mate on watch preceding each call with a distinguishing, shrilling of his bosun's pipe would pass through all sections of the ship hoarsely repeating the orders of the moment.

On the modern ship, a younger counterpart of the old time but picturesque bosun's mate now stands facing a small microphone, presses a switch and sends his call penetrating in an instant



RCA *battle announce equipment being subjected to the submersion test. Equipment of this type must be waterproof and rugged; must operate without failure under the most difficult conditions.*

THROUGH *the use of battle announce equipment, developed and built by RCA, the traditional bosun's job is made easy. Picked up by the announce microphone and amplified by RCA sound equipment, the bosun's whistle blares forth from bullhorns on the superstructure and from smaller speakers throughout the ship.*

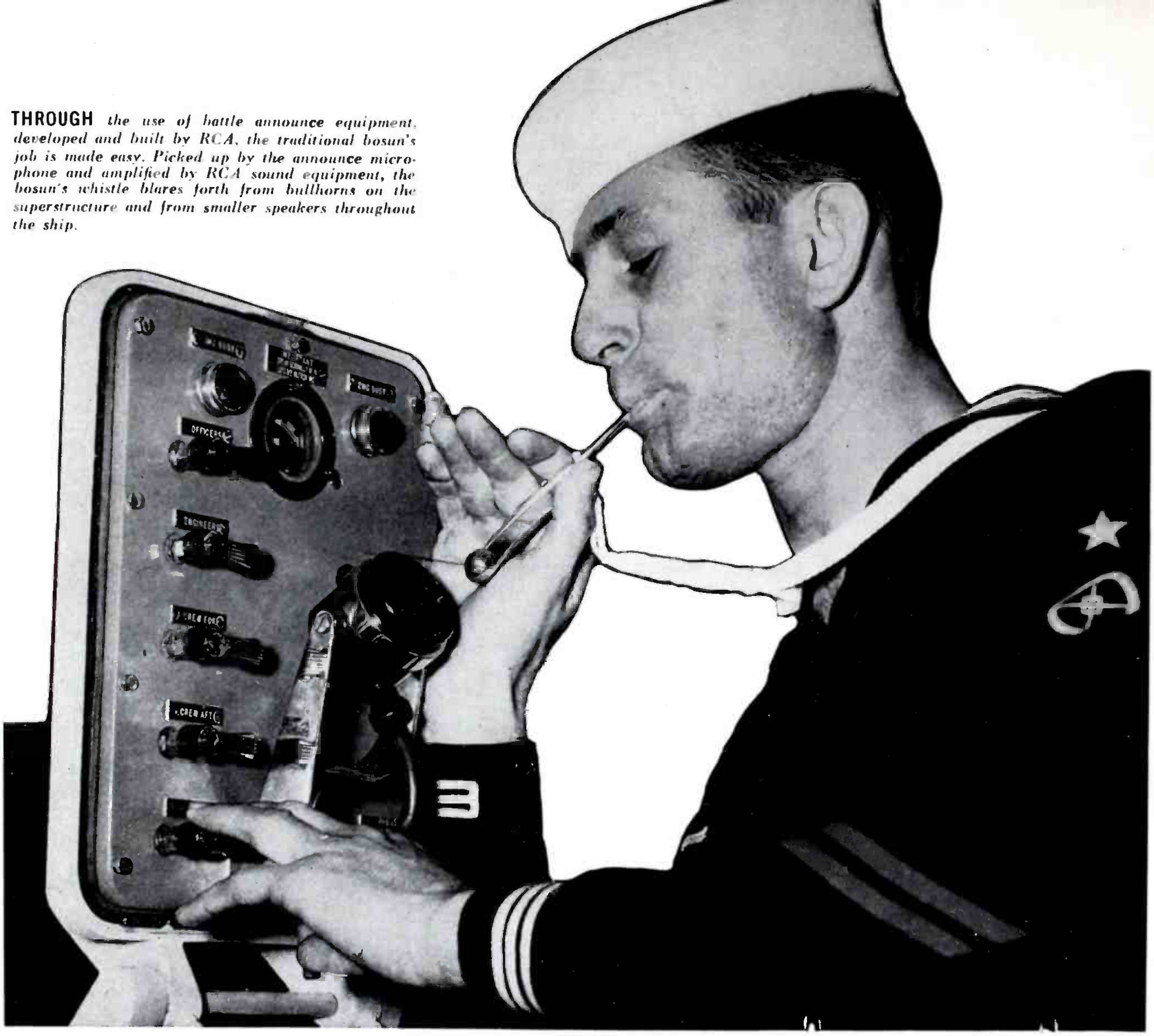


Photo Courtesy Colliers

to all sections of the ship. By means of another switch, a simulated bell or gong tone, electronically produced, sounds throughout the ship calling all men to battle stations. Other signals are, when necessary, produced by merely touching a button. Similarly bugle calls and crew announcements are given over the system.

With the advent of airplanes as a fighting weapon in the Navy and the carriers to transport them, the announcing system was still further developed to provide a means of transmitting orders to pilots about to take off and, in some cases, to land on the carrier flight deck. Giant speakers or "bullhorns" and more powerful amplifiers were developed. These equipments are capable of reproducing and transmitting intelligible speech over great distances at tremendous power. In landing operations, these high-power announcing systems have proved very effective in directing the landing forces leaving the ships in landing craft and on the beaches.

While the primary purpose of the announcing system is to transmit orders and instructions, as well as alarm signals to all members of the crew in all parts of the ship, the extent of its possibilities is limited only by the ingenuity of the men assigned to operate and maintain it. This is typical in the true incident related above which took place in a Naval battle in the Pacific area.

The announcing system equipment has been supplemented for certain purposes by a system of telephones which generate their own operating power by the mere act of someone's talking into them. Thus should the source of electrical power so essential for the operation of all other equipment be damaged or otherwise disrupted, communication between strategic points can still be maintained. A feature of this type telephone system is that usually the individual units are not permanently installed but can be quickly disconnected from any circuit, transported to any other desired location and reconnected without difficulty. Thousands of these telephones are already in use on all classes of ships. Thousands more will be supplied to vessels now under construction.

The U. S. Navy has a tougher job in this war than in any war in history. Battle lines are spread all over the seven seas. Upon the success of one ship may depend the victory of an entire squadron or fleet. We feel that the final defeat of the enemy will be helped in no small measure by the continued effectiveness of the RCA Sound Systems used by our Naval forces.

ABOUT.. Our Replacement and Repair Services

What we can do; how you should order; where you should send equipment; and answers to other questions about a very important service

REPLACEMENT PARTS SERVICE

For quite a long time, in fact practically since we started making broadcast transmitters, we have made a point of maintaining an adequate stock of spare parts. We have always felt that it was important that a broadcast station engineer be able to order spare or replacement parts with the knowledge that he would receive them quickly and at a reasonable cost—and that when they arrived they would be *the right parts* for the job. In order that this would be possible, instruction books containing complete parts lists have been furnished with all RCA transmitters and speech input equipments. These lists contain information identifying all of the components in these equipments and the stock numbers of all those normally maintained in spare parts stock at Camden. Using these lists, a broadcast engineer can wire the stock number of a needed replacement to Camden and in a matter of hours it will be on the way. It is a service of which we are proud and, we think, justly so.

As the war has gone on, replacement parts have become more and more difficult to obtain. Stations have used up not only their own supply of components but also that of local parts dealers. At the same time transmitters which were once new and shiny have had many thousands of hours of additional use. As they age the need for replacements increases. These factors have placed a heavy demand on our replacement stock which, together with the difficulty of obtaining materials and components, has made it very difficult to keep this stock at a satisfactory level. Our spare parts section, however, has made a special effort to keep the broadcast parts stock in as good a condition as possible. As a result we are still able to fill a good proportion of such orders. Where the parts cannot be replaced, they can often be repaired as noted below.

HOW TO ORDER REPLACEMENT PARTS

All orders for replacement parts should be addressed to Replacement Parts Department, Bldg. 1—2, RCA Victor Division, Radio Corporation of America, Camden, N. J., with the exception of those stations located in the Chicago area, who should send their orders to RCA Victor Division, Radio Corporation of America, 589 E. Illinois Avenue, Chicago, Illinois.

Broadcasters are permitted to avail themselves of this spare parts service, under WPB regulations, when the item to be replaced (or repaired) is required for regular or emergency operation of their station. Please note, however, that under WPB Limitation Order L-265, we cannot ship any part without receiving a priority of A-1-a or higher.

Under Order P-133, as amended November 17, 1943, any equipment you now desire to purchase for maintenance, repair and operating supplies should be marked "AA-1—MRO—P-133", if, in your opinion, you are entitled to order such equipment under MRO; and should be certified in accordance with the certification of Priorities Regulation No. 3, which reads:

CERTIFICATION

"The undersigned purchaser hereby represents to the seller and to the War Production Board that he is entitled to apply or extend the preference ratings indicated opposite the items shown on this order, and that such application or extension is in accordance with Priorities Regulation No. 3 as amended with the terms of which the undersigned is familiar."

______________________ (Name of Purchaser)	______________________ (Date)
______________________ (Address)	By______________________ (Signature and Title of Duly Authorized Officer)

There is no limitation on the dollar value of the equipment that may be ordered for maintenance, repair and operating supplies under P-133 as amended.

Please note that P-133 as amended no longer contains a provision for purchasing new or capital equipment. If such equipment is desired, you should apply to the nearest office of WPB on their Form WPB-541 (formerly PD-1-A) and ask them for the rating required in order that we may effect shipment.

RETURN OF DEFECTIVE UNITS WHEN ORDERING REPLACEMENTS

In many cases we will wish you, when purchasing replacement parts, to return the defective unit. The reason for this is that even where your order is accompanied by a high priority, it may be difficult for us to replace the unit in our stock. Even when this is possible, the delivery may be very long. By having the defective unit returned for salvage and rebuilding, the amount of new material required is reduced and the time to replace stock is shortened. A secondary advantage is that this policy tends to prevent over-ordering or hoarding of spare parts by anyone—a practice which, of course, would reduce the common emergency source of replacement parts. *Note, however, that no parts of any kind, nor any equipment, should be sent in until instructions for return have been received.*

EMERGENCY STANDBY SERVICE

To expedite handling of orders requiring immediate attention (as, for instance, in the case of a failure which has caused shut-down of a station) we maintain at the Camden plant an Emergency Standby Service. Telegrams requiring such handling should be addressed to the Company, Attention: Emergency Standby Service. In telephoning, call Camden 8000 and ask for "Emergency Standby Service." Regular standby men are on duty from 8:00 A.M. until 10:45 P.M. (EWT) except Sundays from 10:00 A.M. to 5:00 P.M.; telephone operators at all hours.

REPAIR SERVICE

In addition to the regular replacement parts service, we have for a number of years maintained a service repair shop with complete facilities for the repair of any type of RCA equipment. The work done by this shop has gradually widened in scope and increased in importance. Right now it is of particular importance because it provides a method whereby broadcast stations can keep their most severely treated types of equipment—equipment which in most cases cannot be replaced—in usable condition. Such items as transcription pickups, cutter heads, microphones, loudspeakers, Faradon condensers—in fact, almost any item of RCA broadcast equipment—may be returned for repair. The length of time required for such repairs will depend, of course, upon the extent of the damage, the availability of repair materials and the then existing load on our repair facilities.

HOW TO SEND EQUIPMENT FOR REPAIR

Before returning any equipment for repair you should obtain an authorization by writing to the Return Apparatus Control Section, Bldg. 18—6, RCA Victor Division, Radio Corporation of America, Camden, N. J. Parts sent without such authorization are very likely to become lost. When authorization is received, fasten the return tag on the equipment and pack the material carefully. Use the lower part of the return goods form as a packing slip and the upper part as a shipping label.

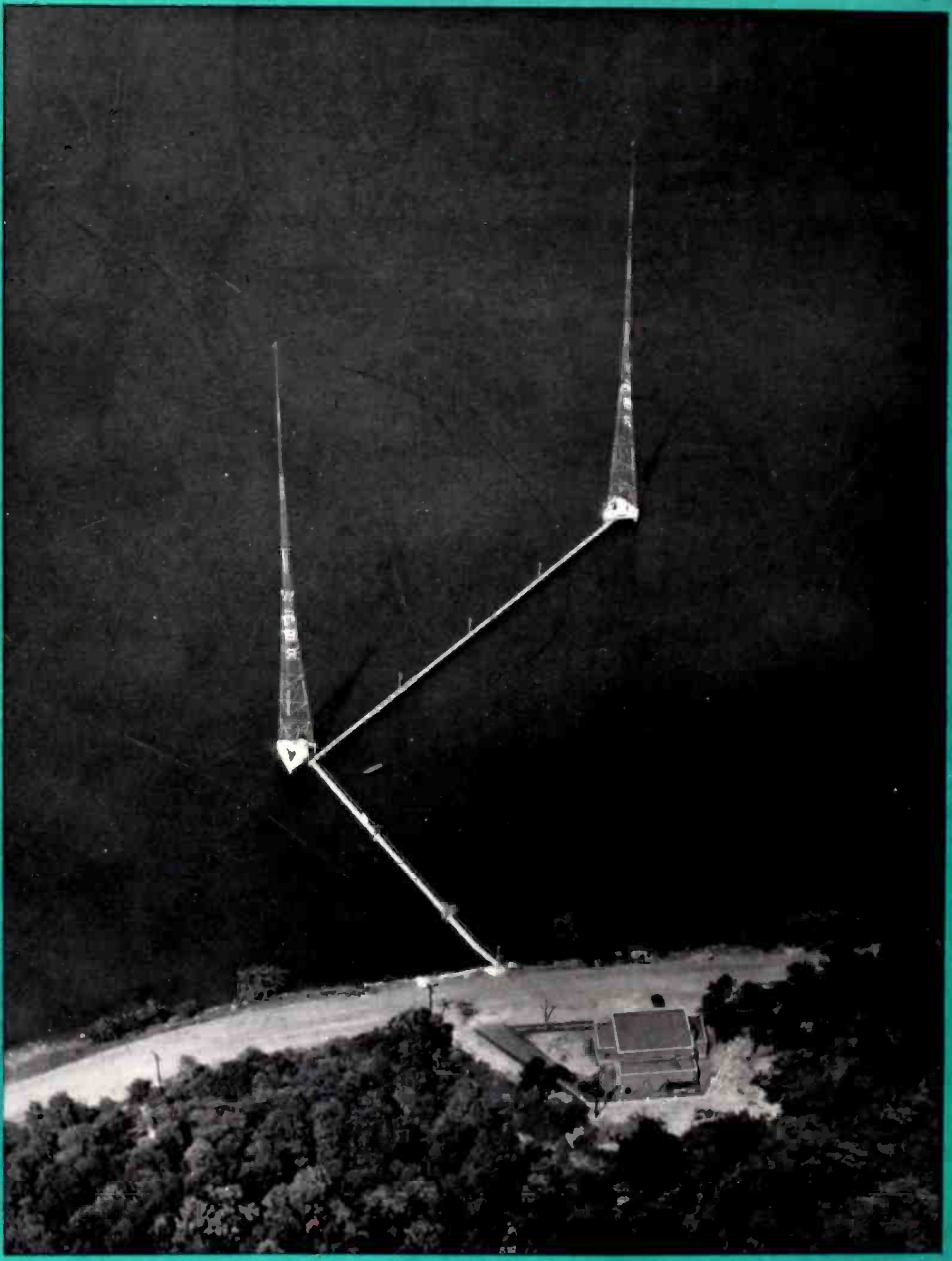
In addition to the Camden repair shop we have recently installed a Chicago service shop with facilities for repairing microphones, pickups and the like. It is suggested that stations in the Chicago area contact the Return Apparatus Control Section, RCA Victor Division, Radio Corporation of America, 589 E. Illinois Avenue, Chicago, Illinois, when they have equipment of this type needing repair. In many instances the necessary repairs can be made in Chicago with a considerable saving in time.

REVOLVING STOCK OF TRANSCRIPTION HEADS

For some time we have not been in a position to fill new orders for transcription heads. We have, however, a small stock of repaired heads which we maintain on a "revolving" basis. We can fill orders for replacement from this stock *providing* the purchaser agrees to return his defective head to us in exchange.

When ordering a replacement pickup on an emergency basis you should indicate on your original order that you will return to us your defective head, which will then become our property and which after repair will go back into the "revolving" stock to replace the one sent you. In shipping you the replacement, we will bill you the regular price of a pickup. After the defective pickup has been returned and the cost of reconditioning determined, we will issue credit for the difference.

It is our hope that broadcasters, when they understand how this plan works, will recognize that it is the only means by which we could hope to take care of emergency replacements.



Towers and transmitter building, WFBR, Baltimore.

Printed in U. S. A.

1S8461