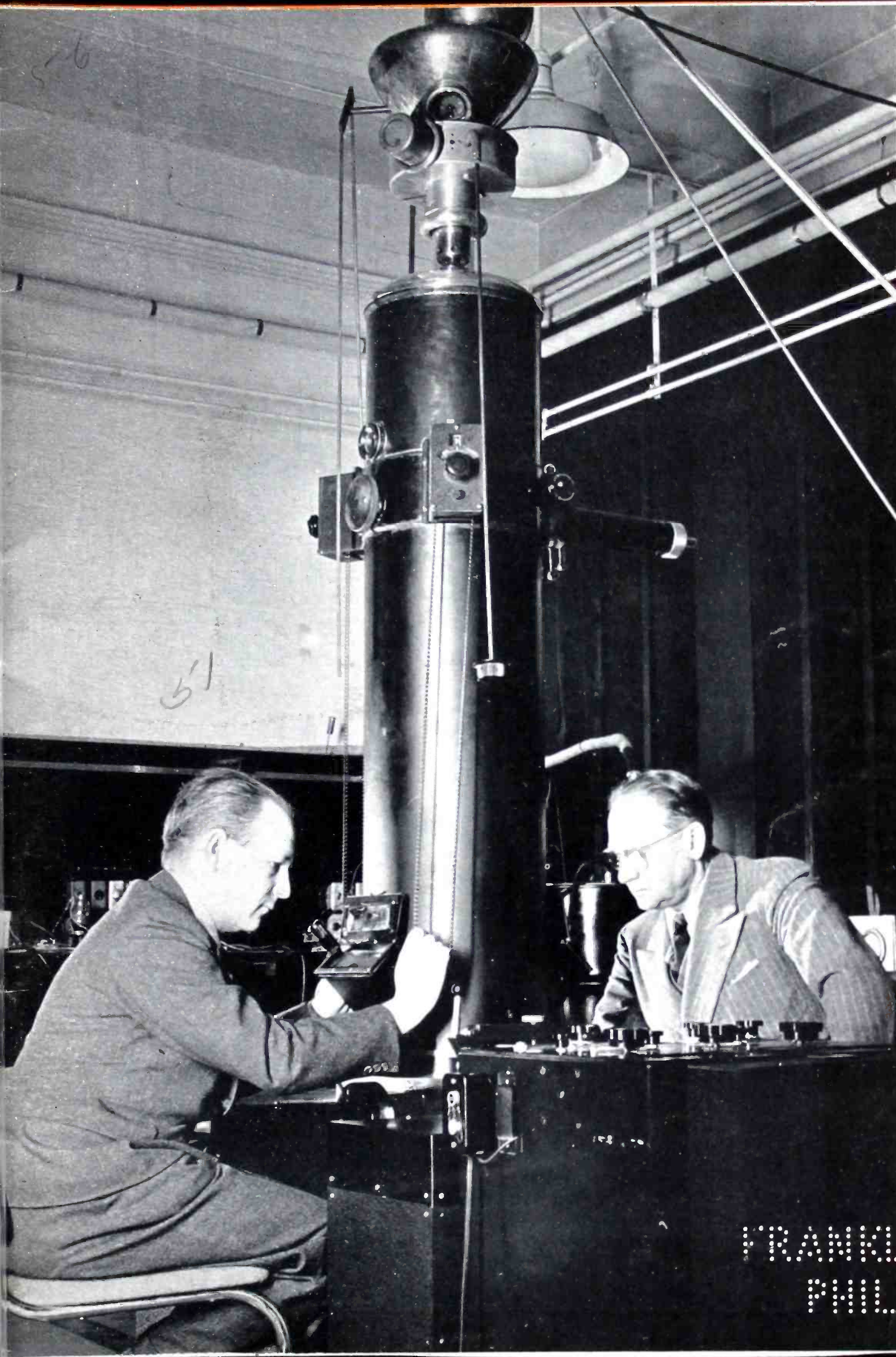
BROADCAST NEWS



In this Issue

★

◄ THE ELECTRON MICROSCOPE

★

FLASH-ARC CURRENTS IN TRANSMITTER TUBES

★

A STREAMLINED KILOWATT FOR WCAR

★

JULY - - - - 1940

RCA MANUFACTURING COMPANY, INC., CAMDEN, N. J.

RCA Manufacturing Company, Inc.

A Service of Radio Corporation of America

Camden, N. J.

"RADIO HEADQUARTERS"

ENGINEERING PRODUCTS DIVISION

J. L. SCHWANK, Manager

AVIATION RADIO EQUIPMENT
BROADCAST STATION EQUIPMENT
COMMUNICATIONS TRANSMITTERS
FARADON MICA CONDENSERS
FACSIMILE APPARATUS
MEASURING EQUIPMENT
PUBLIC ADDRESS AND SOUND SYSTEMS
POLICE RADIO EQUIPMENT
SPECIAL ELECTRONIC APPARATUS
TELEVISION TRANSMISSION SYSTEMS
U. S. GOVERNMENT APPARATUS

TRANSMISSION EQUIPMENT SALES

I. R. BAKER, Manager

Affiliated Company Contact.......C. L. Beach
Broadcast Transmitters......S. W. Goulden, T. W. Enis
Facsimile & Communications Transmitters
H. C. Vance
Faradon Condensers.......J. A. Fried
Measuring Equipment & Television Apparatus
T. A. Smith, H. E. Rhea
Speech Input Equipment....C. M. Lewis, W. L. Lyndon

---

1 **EASTERN DISTRICT**—Ben Adler, Manager and CBS Contact, 1270 Sixth Ave., New York City; R. P. May, Assistant; C. W. Slaybaugh, Assistant

MAINE	RHODE ISLAND	VIRGINIA	WEST VIRGINIA
NEW HAMPSHIRE	CONNECTICUT	DELAWARE	NORTH CAROLINA
VERMONT	NEW YORK	MARYLAND	
MASSACHUSETTS	NEW JERSEY	PENNSYLVANIA	

2 **CENTRAL DISTRICT** – A. R. Hopkins, Manager, 589 E. Illinois Street, Chicago, Illinois; A. Josephsen, Assistant; Dana Pratt, Assistant.

NORTH DAKOTA	NEBRASKA	MISSOURI	OHIO
SOUTH DAKOTA	WISCONSIN	IOWA	MICHIGAN
MINNESOTA	ILLINOIS	KENTUCKY	INDIANA
			KANSAS CITY (KANSAS)

3 **WESTERN DISTRICT**—W. H. Beltz, Manager, 1016 N. Sycamore Street, Hollywood, California; Edmund Frost, Assistant, 170 Ninth Street, San Francisco, California.

WASHINGTON	IDAHO	UTAH	MONTANA
OREGON	NEVADA	ARIZONA	WYOMING
	CALIFORNIA	HAWAII	ALASKA

4 **SOUTHWESTERN DISTRICT**—W. M. Witty, Manager, Santa Fe Building, Dallas, Texas; J. P. Taylor, Assistant

TEXAS	ARKANSAS	NEW MEXICO	KANSAS (Except Kansas City)
OKLAHOMA	COLORADO		LOUISIANA (Except New Orleans)

5 **SOUTHEASTERN DISTRICT**—D. A. Reesor, Manager, 530 Citizens' and Southern Bank Bldg., Atlanta, Ga.

TENNESSEE	GEORGIA	ALABAMA	NORTH CAROLINA
MISSISSIPPI	FLORIDA	SOUTH CAROLINA	

POWER TUBES **BROADCAST TRANSMITTERS**

POLICE TRANSMITTERS **POLICE RECEIVERS** **AVIATION RADIO EQUIPMENT**

TEST EQUIPMENT **SPECIAL COMMUNICATION EQUIPMENT** **FACSIMILE EQUIPMENT**

TELEVISION EQUIPMENT

BROADCAST NEWS

REG. U. S. PAT. OFF.

PAUL V. LUTZ, Editor

NUMBER 33 JULY, 1940

TABLE OF CONTENTS

Cover—Dr. V. K. Zworykin and Dr. L. Marton with the RCA Electron Microscope

RCA MANUFACTURING COMPANY, INC.

CAMDEN, NEW JERSEY, U. S. A

THE ELECTRON MICROSCOPE

A New Aid For Science Developed By The RCA Electronic Research Laboratories

ELECTRON optics, that is, the application of optical methods to the determination of electron behavior, although a relatively young field, has already had a very fruitful existence. Its importance in modern television, for example, is well known. Another extremely valuable contribution from this field is the electron microscope. The new microscope represents the greatest advance in microscopy since the invention of the compound microscope, and increases our ability to see the very small by about two orders of magnitude. In other words, detail in organic or inorganic matter, 20 to 100 times too small to be seen with a light microscope is made visible with the electron microscope.

The reason for the superiority of the electron microscope over all microscopes heretofore used is quite fundamental. It is due to the fact that it is impossible optically to resolve an object which is much smaller than the wavelength of the medium used for making observations. Thus, with blue light which has a wavelength of 4,000 Å,* or about 1.6×10^{-5} inches, it can be shown theoretically that the limit of resolution is 0.5×10^{-5} inches. This immediately sets a limit to the useful magnification which can be obtained with an optical instrument. If a micrograph of 1000 diameters is made with blue light, the finest detail appearing on the plate will be about 5 mils in size, a dimension which can just conveniently be seen with the unaided eye. Any further magnification will not make visible any further information, but will merely increase the size of the detail which is already visible at the lower magnification. Therefore the maximum useful magnification possible with a light microscope is between 1000 and 1500 diameters. The use of ultra-violet light, because of its shorter wavelength, increases this limit to about 2500 diameters. If even a shorter wavelength, for instance X-rays, could be used, it would be possible to increase the resolving power greatly, but lenses for focusing radiation in this part of the spectrum cannot be made. Electrons, however, do offer a means of obtaining very much higher resolving power. It was shown by de Broglie, Davisson and Germer, and others that electrons have wave properties. The effective wavelength of electrons depends upon their velocity, being given by:

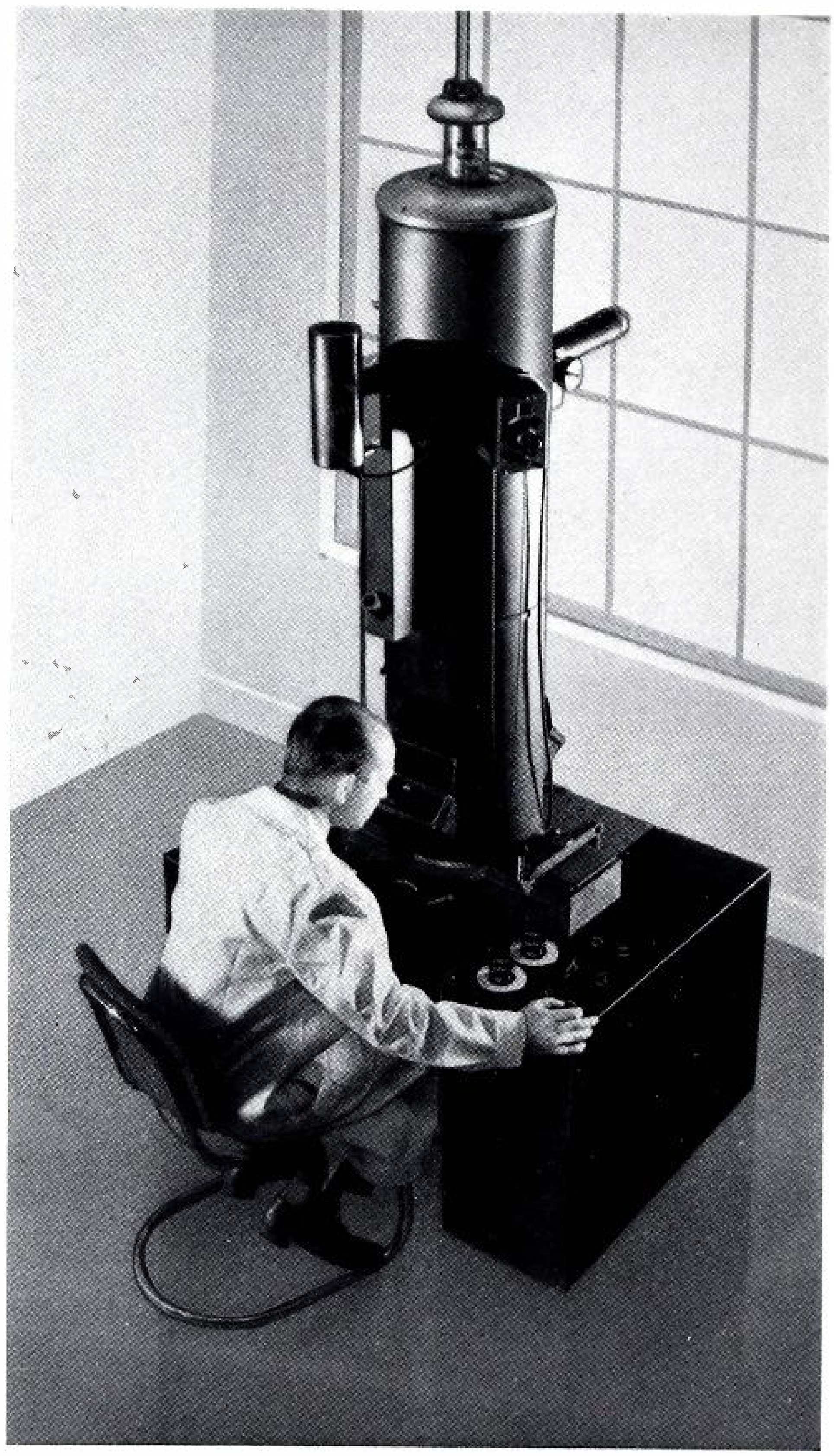


Fig. 1. The RCA Electron Microscope.

$$\lambda = \sqrt{\frac{150}{V}}$$

where V is the electron velocity in volts, and λ the wavelength in Angstrom Units.* An electron beam having a velocity corresponding to 100 kilovolts has on this basis a wavelength of 0.04 A. Obviously, if electron lenses for focusing such beams can be made, very much higher resolution is possible with electrons than with light. Electron optics shows us how electron lenses can be formed using either magnetic or electric fields. By suitably combining such lenses it is possible to build up an electron microscope having many times the useful magnification of the best light or ultra-violet microscope.

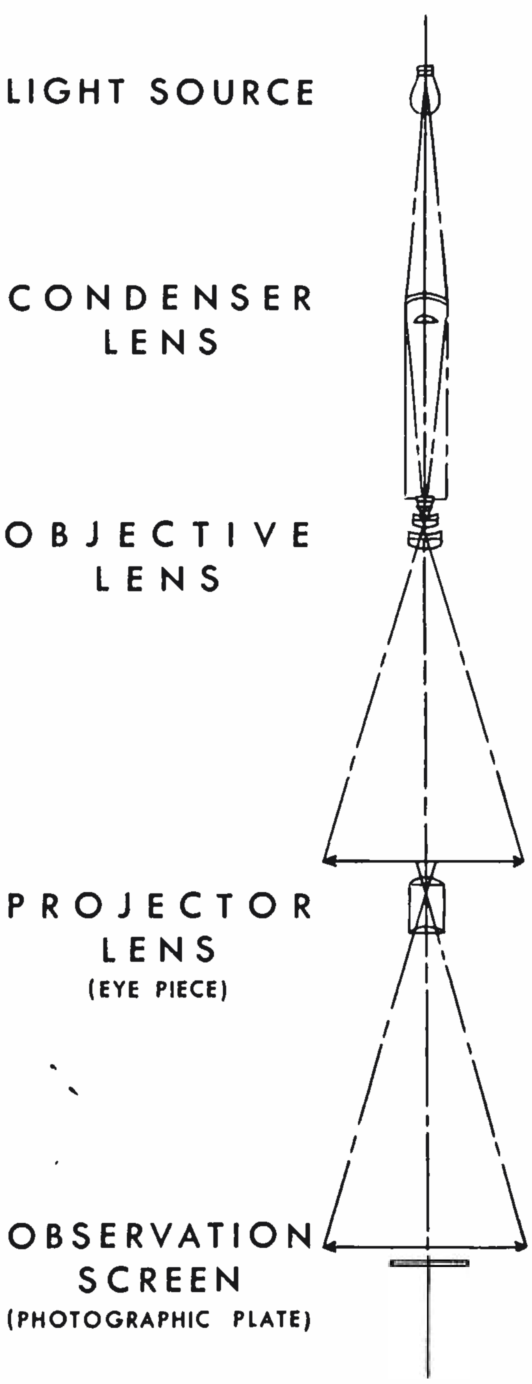
The electron microscope shown in Fig. 1 was constructed under the direction of Dr. V. K. Zworykin in the Electronic Research Laboratory of the RCA Manufacturing Company in Camden, N. J. This instrument, designed by Dr. L. Marton, aims not only at the obtaining of high resolutions, characteristic of electron microscopes, but also at being a practical tool for industrial and scientific research. In other words, it is so designed that it does not require an electronics specialist to operate it.

This microscope, although very different in appearance from the conventional microscope, is nevertheless quite similar in its general principle of operation. The schematic diagram shown in Fig. 2 illustrates the paths of light rays in a light microscope, as well as the electron trajectories in the new instrument. The electrons originate from a thermionic cathode located at the top of the microscope. These electrons are accelerated to a velocity of between 30 and 100 kilovolts by means of a specially designed gun. They are then converged onto the specimen by means of a magnetic electron lens in the form of an iron clad coil equipped with suitable pole pieces. It will be noticed that the role played by these elements is identical with that played by the light source and condenser lens in the optical instrument. In passing through the specimen the electrons are scattered to a greater or lesser amount, depending upon the density and thickness of different parts of the object under examination. After traversing the specimen the electrons are focused into an intermediate image by a second electron lens, which plays the same role as the objective in a light microscope. The electron objective has a restricted aperture, so that the number of electrons from a given point of the speciment going through the objective is an inverse function of the amount of scattering. Therefore the electron density in the intermediate image is less at points corresponding to dense portions of the specimen, and greater where the specimen is more tenuous. It should be noticed that this mechanism of image formation is somewhat different from that for a light microscope, since for the latter variation in absorption of light by the specimen, rather than scattering, produces the light and shade in the image.

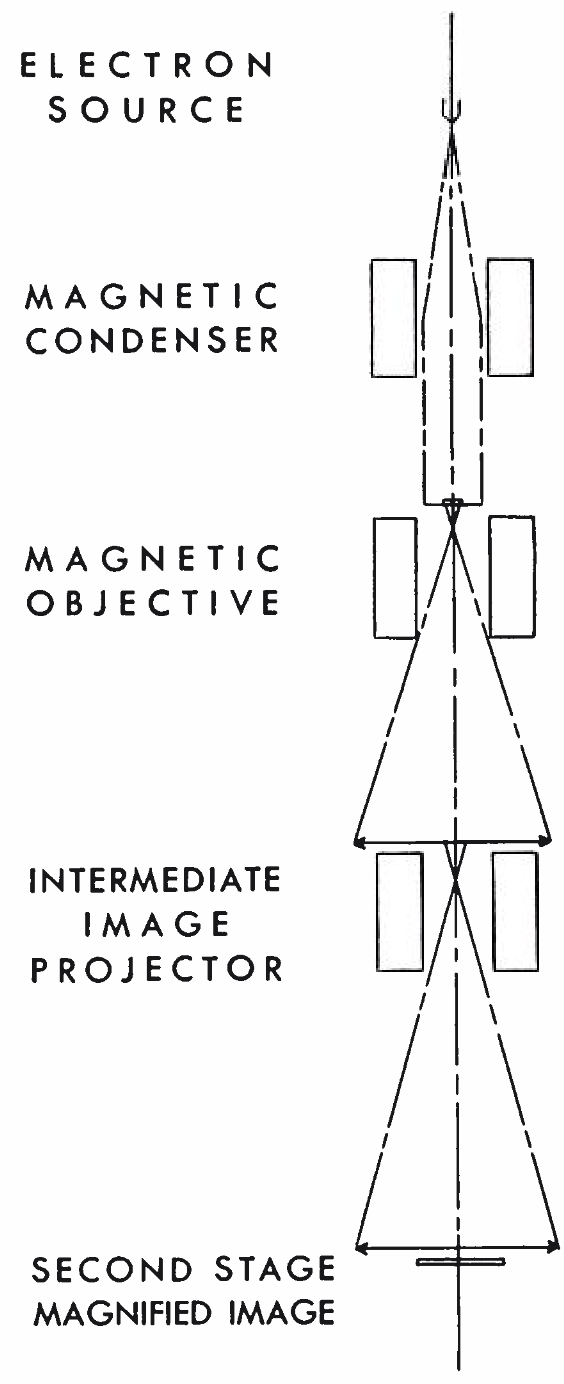
The electrons from the central portion of this magnified intermediate image go through a third magnetic lens which refocuses them into the final image. This final image is either made visible by allowing it to impinge upon a fluorescent screen, or is recorded on a photographic plate. While

(Continued on Page 24)

*1 Angstrom Unit—A = 10^{-8} cm.



A schematic diagram of a light microscope showing the paths of the light rays and the position of the images.



The electron microscope is similar in principle to the light microscope. Electron lens coils replace the glass lenses of the latter.

WAY DOWN YONDER IN NEW ORLEANS

RCA 50-D Installation Gives Added Coverage in Southern States

By J. D. BLOOM
Chief Engineer, WWL

WWL, the radio station of Loyola University, New Orleans, first took to the air March 31, 1922, being the first radio station in the State of Louisiana. At that time it was operating on a power of only 5 watts, gradually increasing through the years until on October 2, 1932 it went on the air with what was then the latest in RCA equipment in a 10,000 watt station operating on a shared channel.

In order to give greater service to the public of the Gulf South, much time and money was expended to rearrange the broadcast spectrum in order to facilitate WWL operating on full time on the same cleared channel of 850 KC. Shortly thereafter WWL put in an application to increase their power to the existing maximum of 50,000 watts. This permission was granted almost three years later in December 31, 1937.

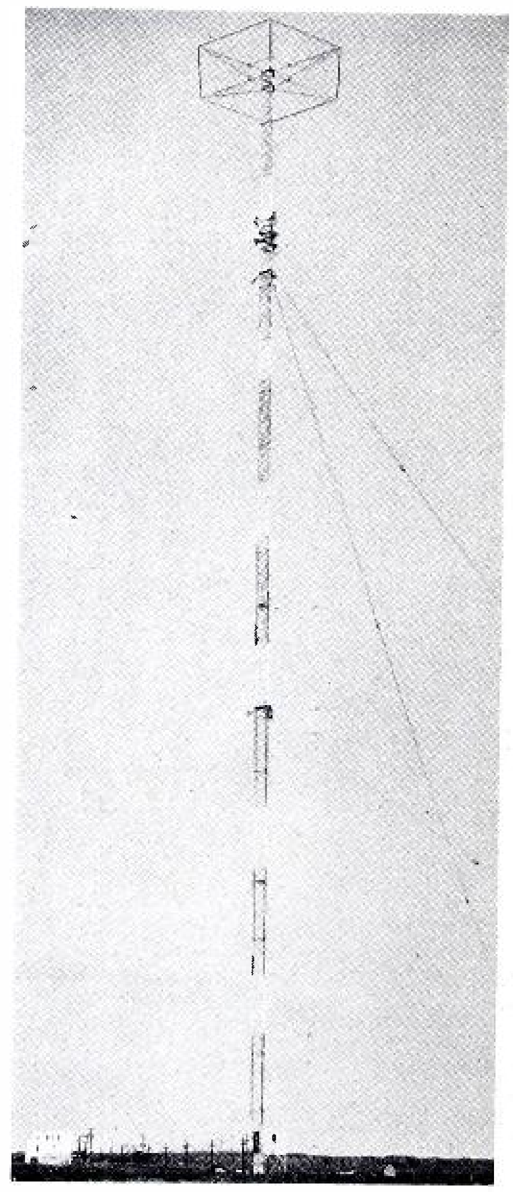

W. H. Somerville, General Manager.

Location

One of the most outstanding consulting radio engineers in the country, was called in to conduct a site survey for the new station, finally deciding upon a location on the border of Lake Pontchartrain, approximately eight miles west of the city limits. This site proved an increase in field intensity from 30 to 60% in different directions. However, the location was on the edge of a peat bog, making construction problems very difficult, racking the minds of the most outstanding construction engineers New Orleans had to offer. The final result was, that a building has been designed and constructed, supported by 55 piles, each pile 50 feet long, resting on a clay strata with a known thickness of 10 feet. The tower base rests on 20 piles with anchorages utilizing 13 piles each, 9 of which are vertical and four driven on an angle to counteract the horizontal strain impressed upon the anchorages by the guy wires of the tower.

Due to the fact that the location is directly on the air line between New Orleans' famous Shushan Airport and Beaumont, Houston and points West, it was necessary to shorten the tower from the desired height of 615 feet to 400 feet. To compensate the loss of height a special tower was designed utilizing every latest known principle of modern radio engineering including an insulated point 60 feet from the top and a "hat" on the top, 60 feet in diameter. Extremely high winds being occasionally encountered in this section of the country, additional insurance was procured by designing the tower for a 130 mile gale, which is much greater than any record of the weather bureau in Washington.

In purchasing a transmitter, WWL chose the RCA high efficiency output circuit transmitter which includes the most modern streamlined appearance. It has the additional facility of being operable on 5 KW in case of trouble in the last stage or, in case of complete power failure by using an auxiliary motor generator in the building. As an additional precaution against any remote possibility of floods, the operating floor of the building, as well as the base of the tower, are some 9 feet above the surrounding terrain. The building, having a solid concrete front wall, is capable of withstanding any wash that may be caused by the waves coming in from the lake some 500 feet in front.


WWL's Top Hat Antenna.

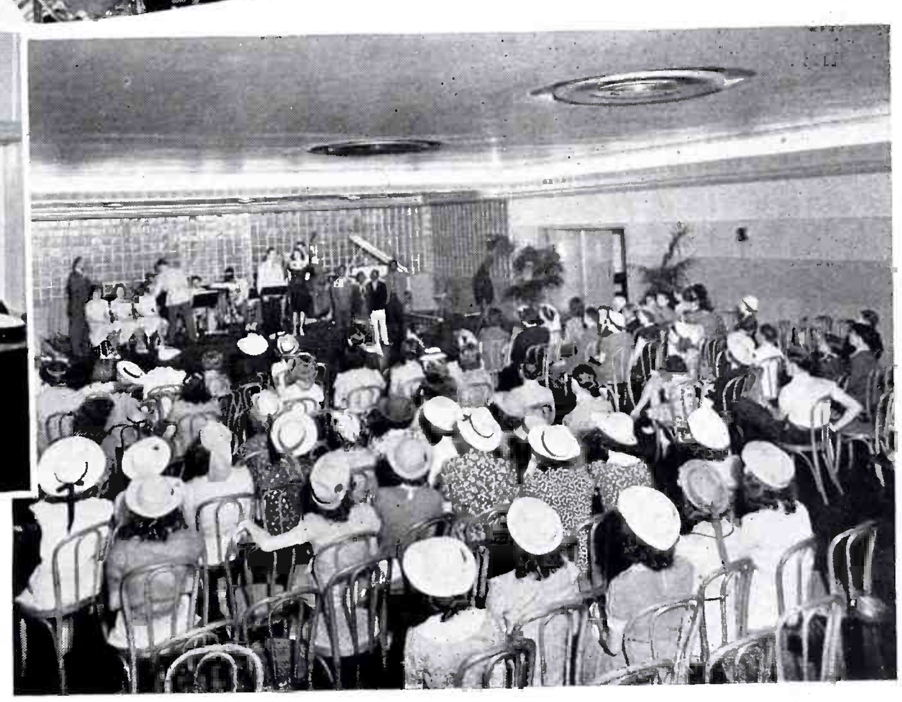
WWL COVERS THE LOWER MISSISSIPPI VALLEY AND THE GULF REGION

Above: Transmitter House—WWL.

Above: Program on the air in Studio B.

Left: WWL covering the 1940 Mardi Gras.

Above: Control Room for Studios A & B, Equipped with 80-AX Desk.



Right: An important feature —WWL's Dawnbusters.

THE STANDARD VOLUME INDICATOR AND REFERENCE LEVEL

By R. M. MORRIS
National Broadcasting Company, Inc.

Continued from the Previous Issue.

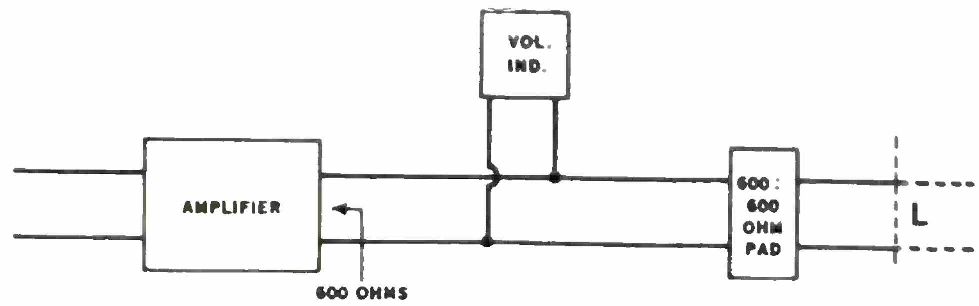


Fig. 3. The volume indicator reading, minus the loss of the pad, is considered the volume at Point L.
NOTE: In some cases the impedance of the loop or circuit may differ from 600 ohms by such an amount as to require a correction to the actual volume indicator reading.

Program Transmission and Telephone Loops

The standardization on the type characteristics and use of the new volume indicator and the 1 milliwatt reference level and 600 ohm impedance indicated the desirability of further standardization as regards practices to be employed when transmitting (or receiving) broadcast programs from telephone loops. A committee was formed including members from the Long Lines Department of the A T & T Co., the Columbia Broadcasting System, the Mutual Broadcasting System, and the National Broadcasting Company to determine standardized methods of measurement on loops and general operating practices.*

The maximum volume level to be transmitted to loops is +8 vu and, in the interest of a high signal-to-noise ratio, is the level which should be used wherever possible. (See figures 2, 3, and 4.) Certain equipment, particularly field amplifiers, in consideration of weight, power supply and other factors, is not designed to transmit a level as high as +8 vu. In these instances the level transmitted should be either +4 vu or a level of 0 vu. The telephone company intends, when notified in advance, insofar as possible, to make the necessary adjustments at the receiving end of the loop to accommodate either of these two lower levels.

Line amplifiers should be connected to the telephone loop through a 6 db (or higher loss) 600-600 ohm pad to provide a more constant resistance termination for the amplifier and also to permit location of a volume indicator on the output terminals of the amplifier for volume measurements.

*The results of the committees' work have been published in the form of of general operating procedures entitled "The Standard Volume Indicator and Program Loop Transmission."

Scales

The volume indicator is provided with two scales both of which have the same markings except that greater emphasis is given to those of interest to the particular user. The "A" scale is most suitable for transmission measurements and emphasis is given to the vu markings by the size of the numerals and their location above the pointer arc, while the 0-100 markings are below the pointer arc. The "B" scale is most suitable for use in broadcast studios and emphasis is given to the 0-100 markings by the size of the numerals and their location above the pointer arc with the vu markings below the arc. "Peak checking" between broadcasting stations and the telephone company will be accomplished by use of the 0-100 scales of the volume indicators.

The use of a steady-state "line-up" procedure between the broadcasting and telephone companies will permit adjustments to be made so that the volume indicators in the respective companies are in agreement. The necessity for this "line-up" procedure is occasioned largely by the departure of the loop impedance from 600 ohms and the change in its magnitude with frequency.

The impedance of non-loaded equalized telephone loops of usual length is substantially constant at a value of about 700-900 ohms up to about 800 cycles. The impedance then decreases with frequency to a value of about 200-300 ohms at 8000 cycles. In some cases, the telephone company recommends the use of 4:1 coils

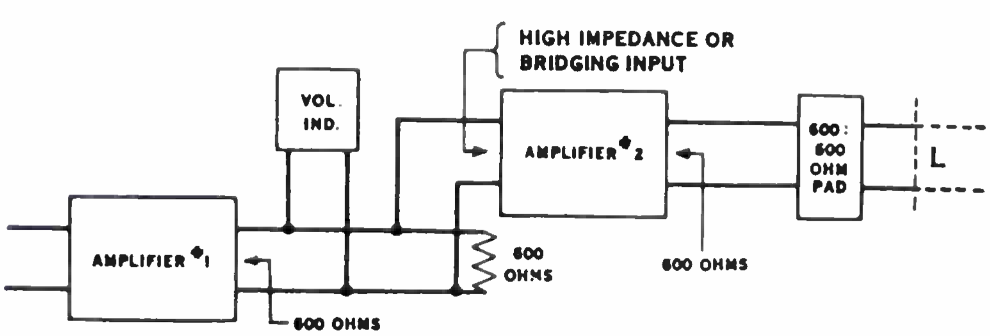


Fig. 2. Measurement of Volume Level transmitted to Program Loops. The indication of the volume indicator plus the gain of the amplifier 2, minus the loss of the pad, is considered the volume at Point L.

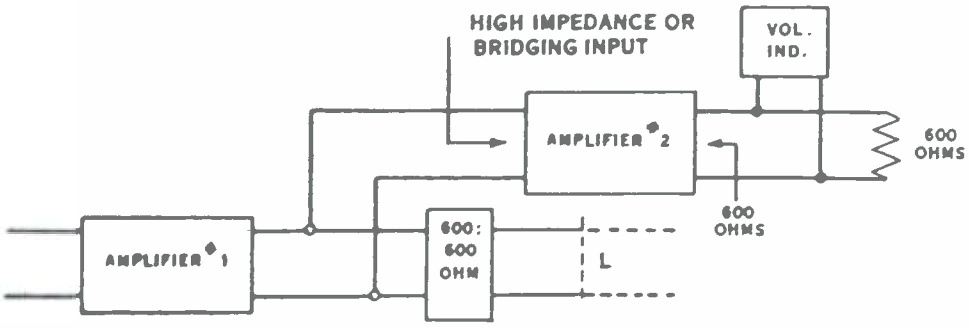


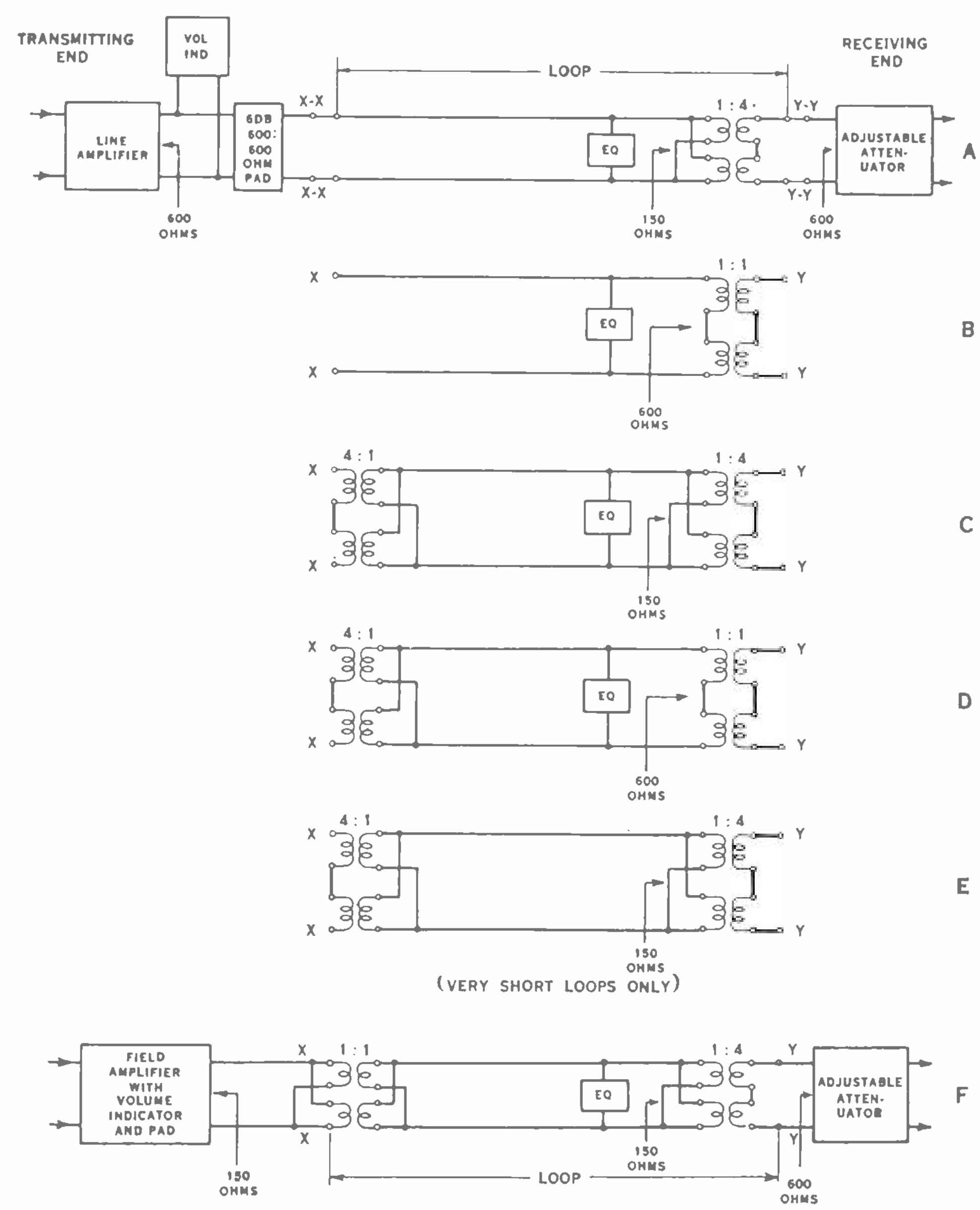
Fig. 4. The volume indicator reading minus the gain of amplifier No. 2, less the loss of the pad, gives the volume at Point L.

(600 to 150 ohms) to facilitate the equalization of the loop, in which case the loop impedance is, in effect, raised (approximately) by the impedance ratio of the coil. When the loop is fed directly the "line amplifier" and isolating pad or attenuator may face an impedance at a certain frequency of 400 ohms but when a 4:1 coil is used the impedance which it faces may be in the order of 1800 ohms. (Figure 6.)

The usual broadcast plant employs one or more volume indicators on the circuits "before" the line amplifier and one on the output terminals of the line amplifier, which is connected through a 600-600 ohm pad of 6 db (or more) loss to the loop. The line amplifier gain is adjusted to the proper value by termination of the amplifier in 600 ohms. However, when used to transmit programs to the loop, the impedance terminating the amplifier may be considerably higher than 600 ohms over the frequency range (up to 700-800 cycles) in which the greatest amount of energy is usually present. The volume indicator connected to the output of the line amplifier will, therefore, indicate "higher" than those connected before the line amplifier, as the isolation of the 6 db output pad is not sufficient to wholly eliminate the departure of loop impedance from 600 ohms. In the case of loops with no coils, the adjustment of the volume indicator, which is necessary, is less than 0.4 db. Where coils are provided, the required adjustment may be as high as 1.0 to 1.5 db. In this latter case the adjustment necessary is beyond the range available on the adjustable resistors usually provided with the volume indicator. There are then three alternatives: (1) remove the 4:1 coils and equalize the loops at 600 ohms (if this can be accomplished satisfactorily by the telephone company): (2) provide sufficient adjustable loss by means of a resistive network associated with the instrument; or (3) use an instrument located in the circuit "before" the line amplifier for "checking peaks." (See Figure 5.)

Assuming the adjustment can be made, a 400 or 500 cycle tone will then be sent through the system (connected to the loop) adjusted in level so that all volume indicators on the circuit in the broadcast plant are deflected to the 100 division mark. The necessary adjustments in the equipment at the telephone company will then be made within a range of one db so that the volume indicator at that point is in agreement with those at the broadcasting company. The 400 or 500 cycle tone is used because it is in this frequency range that the greatest amount of energy is usually contained in average program material and further the frequency is sufficiently low that objectionable cross-talk to other circuits will be avoided. It should then be possible to check peaks during program transmission and readily determine any circuit irregularities.

(Continued on Page 35)



EQUIPMENT ARRANGEMENTS
ON NON-LOADED EQUALIZED LOOPS

Fig. 5.

MEASUREMENTS OF FREQUENCY MODULATED FIELD INTENSITIES

RCA 301-A Instrument Being Widely Used

By B. W. ROBINS

Front view of the 301-A HF Field Intensity Meter.

MEASUREMENTS of coverage of frequency-modulated transmitters have heretofore been made during periods of no modulation, since the readings of field intensity instruments, intended for amplitude-modulated signals, are affected by the band-width of the i-f amplifier. When carrier only is present, the conventional field intensity instrument will provide accurate readings for frequency-modulated stations, but during periods of appreciable modulation the transmitted energy is distributed over a wider portion of the spectrum. Hence, a field intensity meter which does not accept the full band width used by the frequency-modulated station, will read low. This is not always a serious handicap, since it is usually possible to make readings during program pauses, but it is sometimes more convenient to be able to read at any time.

The RCA Type 301-A Field Intensity Meter has been widely used for surveys on ultra high frequency transmitters. Since its frequency range extends from 18 to 120 megacycles it also covers the bands used for frequency modulation. The band-width of the i-f amplifier, however, is considerable less than the width of band often transmitted by f-m stations. Therefore, the 301-A will indicate a decreasing field strength as the modulation is increased, for the reasons given above. One obvious remedy is to increase the band passed by the i-f amplifier to the point where the flat-topped portion of the response includes the transmitted band, but this change involves extensive alteration of the 301-A and seriously reduces its selectivity.

A much simpler remedy, which is reasonably accurate, is to change the detector time-constant so that the meter approaches a peak-reading condition instead of average. This method gives fairly accurate results leaving the i-f amplifier unchanged. The attached curves, Fig. 1, show the difference this change makes in indication. Thus, with a deviation of 50 kc., (band-width of 100 kc.) the original detector circuit is down 35% whereas the peak detector is down only 3.5%.

To make the detector peak-reading it is necessary to increase the diode resistor, R-33, and to increase the shunt condenser, C-55. The recommended values to be used are 10 megohms for R-33 and 0.5 mfd. for C-55. If the logarithmic recording feature is not to be used the 10-megohm resistor may be a fixed resistor. However, if it is necessary to retain this feature, it must be

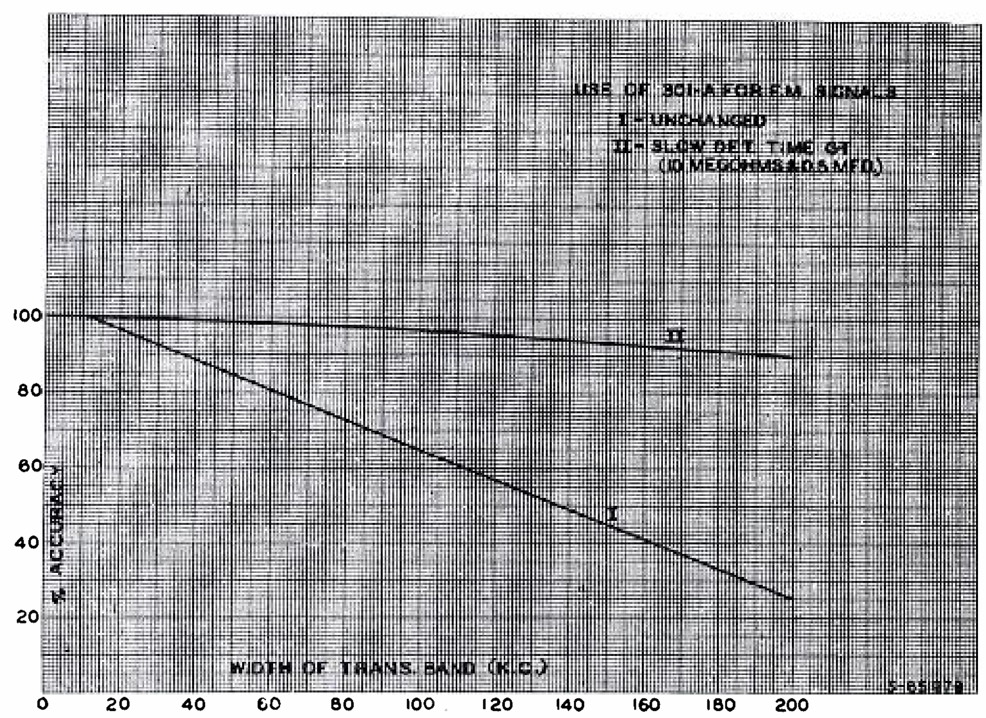
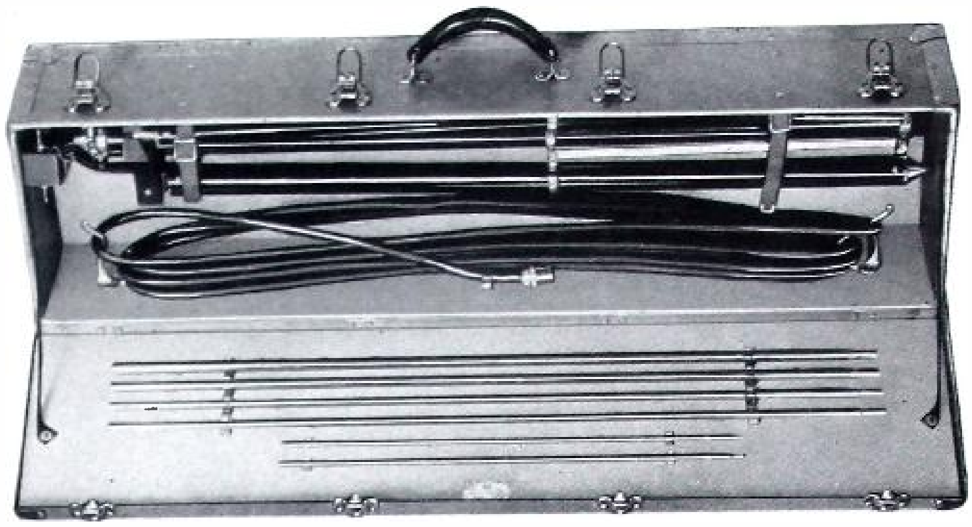


Figure 1.

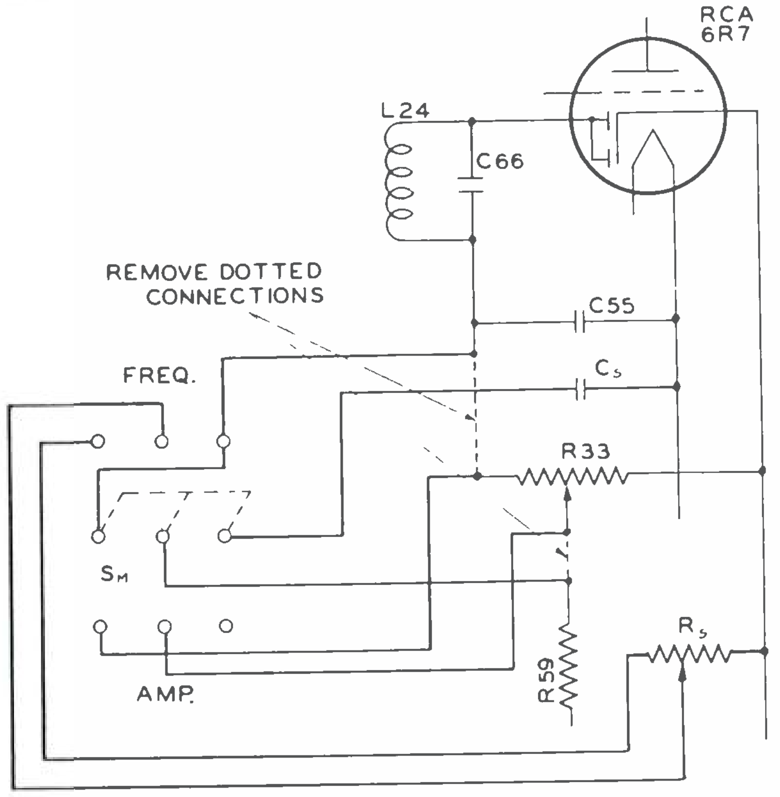
a potentiometer. A switch may be incorporated for adapting the instrument either for amplitude- or frequency-modulated signals. Fig. 2 shows how to make the necessary changes.

It should be noted that when the diode resistance is drastically increased in this manner the over-all sensitivity is increased somewhat, and all zeroing and calibration must be made with the resistance in the circuit.

As to identification of a signal, quite satisfactory intelligibility can be obtained by slightly mistuning the field intensity meter so that the transmitted band is converted from frequency to amplitude modulation by the slope of one side of the i-f resonance curve, and demodulated in the detector. Naturally, very little audio can be heard when the detector is in a peak-reading condition, it being necessary to have the meter in its original state when listening. When using this peak-reading method, any extraneous noise picked up is very disturbing to the results, that is, unless the signal to noise ratio is reasonably high, the method is not very satisfactory. The reason for this is that high-amplitude noise peaks of very short duration have little effect on the average voltage present, but have a considerable effect on the peak voltage.

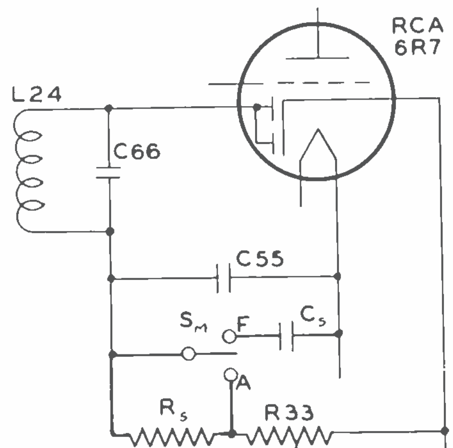


The Telescoping Antenna used with the 301-A.



Ⓐ CONNECTIONS WHEN RECORDING IS REQUIRED.
ADDED PARTS
S_M - 3P.D.T. SWITCH
C_s - 0.5 MFD. CONDENSER
R_s - 10 MEGOHM POTENTIOMETER

MX-243729



Ⓑ CONNECTIONS WHEN RECORDING IS NOT REQUIRED.
ADDED PARTS
S_M - S.P.D.T. SWITCH
C_s - 0.5 MFD. CONDENSER
R_s - 10 MEGOHM RESISTOR

Figure 2.

30 EVERY 60 MINUTES

RCA-811's and 812's are sealed and pumped free of air in a spectacular run through the famous SEALEX machine.

811's and 812's pass through the sealing-exhausting process in 16 steps. Air is removed from the tubes by means of two mechanical pumps, followed by four mercury pumps and by another mechanical pump. Occluded gas from the glass parts of the tube is removed by flames which blast the bulbs to near melting point. Occluded gas from the metal parts is removed by heating them to incandescence in terrific r-f fields. Finally, the tube "getter" is flashed to absorb, in conjunction with the famous Zirconium-Coated Anode, any last trace of gas.

IT'S A 5-DX FOR WOI

Iowa State College Picks 5 KW Unit

By PROFESSOR W. I. GRIFFITH

IOWA State College was actively engaged in the radio field for many years before the advent of broadcasting. The Electrical Engineering Department, under Professor F. A. Fish, maintained a highly efficient amateur station operating under the call letters 9YI. This station was in operation prior to 1914. The 240 cycle note of the synchronous spark transmitter was well known throughout the middlewest before the beginning of voice transmission.

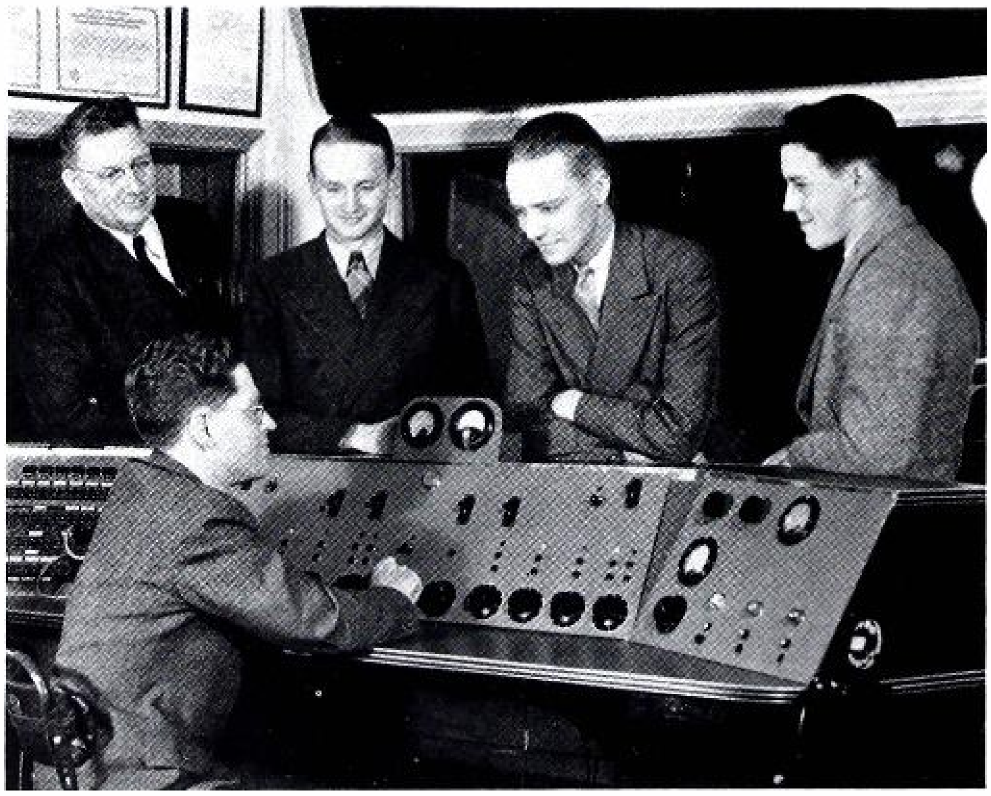
When the first regular broadcasts from KDKA had demonstrated the possibilities of this means of communication, the Electrical Engineering Department determined to construct a broadcasting station. Mr. Harmon B. Deal, a graduate of Massachusetts Institute of Technology, was chosen to supervise the project. He was assisted by one of the engineering students, A. G. Woolfries, now Chief Announcer of the station. Early in October of 1921 work was begun on a fifty watt set—a "super-power" outfit for the time. Plans were later changed to increase this output to 100 watts. With this power, the transmitter first went on the air the evening of November 21, 1921, using a wave length of 375 meters and the call letters 9YI. The following April (1922) the call WOI was assigned by the Radio Division of the Department of Commerce.

Almost immediately upon its inception, the station inaugurated a schedule of service reports consisting largely of weather forecasts and livestock market news. The forecasts were sent by commercial wire from the United States Weather Bureau. The market reports were copied from a long wave code broadcast by NAJ, the government station at the Naval Training School, near Chicago. This service from NAJ was continued for nearly three years, after which it was supplanted by commercial telegraph reports. In July, 1926, the United States Department of Agriculture leased wire service was made available.

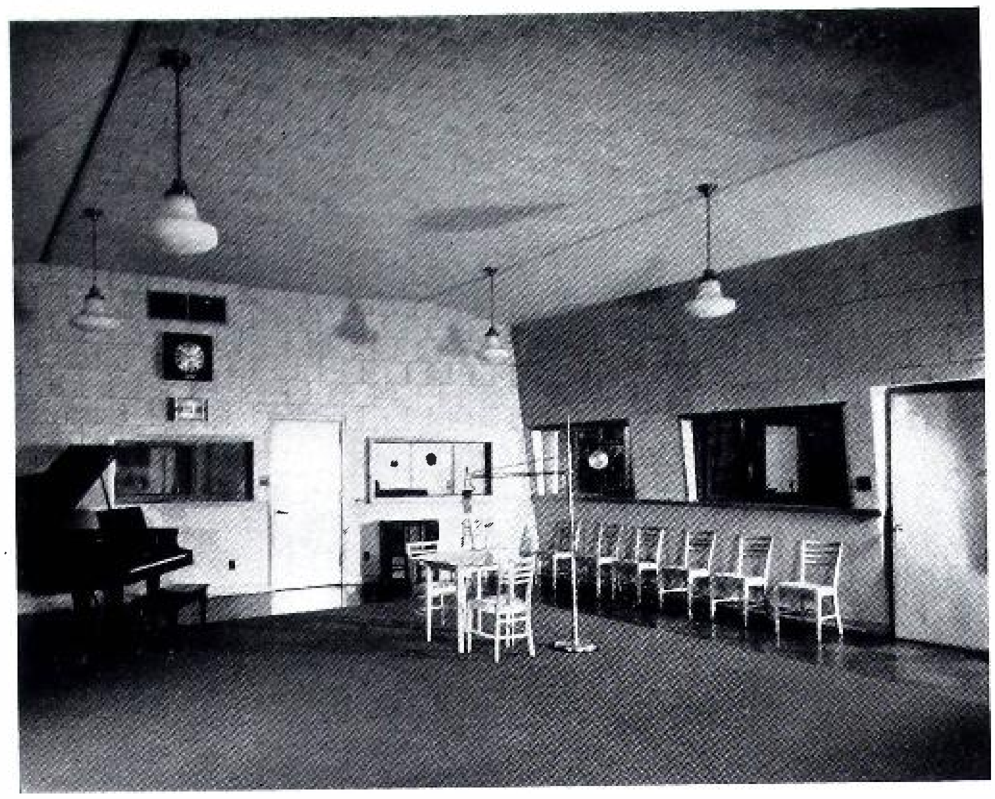
The 100 watt transmitter proved inadequate to cover the state, so plans were made for a more powerful set. In December, 1923, WOI put into service a 500 watt transmitter—again the "last word" in equipment and power; This outfit gave a fair coverage of the central portion of the state, and was heard in all parts of Iowa under favorable conditions. A small studio was secured—the "new" double button microphones were installed—the schedule was expanded — WOI rapidly forged to the front in midwest radio circles.

Constant expansion within the station soon brought a demand for additional room for studio and transmitter. As a result, a large laboratory adjoining the original quarters was made available. In 1924, this was partitioned into a suite of rooms and the studio moved to its present location. Late the same year, a new 500 watt transmitter was put into service. Provision was made for increasing this power to 750 watts when the necessary permission had been obtained. This permission was forthcoming in August, 1925.

WOI was assigned a frequency of 1110 kilocycles in January of 1925. It soon became aparent that the effective coverage area of the station had been materially reduced. To offset this, a 5000 watt transmitter was designed and built by the station staff headed by Mr. Ralph Knouf, an I. S. C. graduate who had been employed by the General Electric Company. The new transmitter went into operation in January 1927. Again WOI boasted one of the most powerful and up-to-date sets in



Engineer L. L. Lewis, seated at the control panel. Standing back of the control console from left to right: Prof. W. I. Griffith, Director of WOI; Clyde Hoyt; John Miller and Clement Arnold.



Large Studio—Broadcasting Station WOI.

the country. Automatic crystal control of the frequency was one feature which then was used by only eight other stations. In June, 1927, another change in frequency put WOI on the 1130 k.c. channel. This high frequency was made still more undesirable by severe interference from nearby stations on adjacent channels.

The general re-assignment which took place in November, 1928, brought a welcome change to WOI. The station was placed on the 560 k.c. channel to share daylight time with KFEQ, St. Joseph, Missouri. Although the power was reduced to 3500 watts, the resultant coverage was vastly superior to that obtained on the higher frequency. Relations with KFEQ were most friendly, but that station, of commercial necessity, sought a full time license. The latest change, made in November, 1929, licensed the station to operate with 5000 watts power on the 640 k.c. channel. This is the frequency assigned to KFI, Los Angeles, and to WHKC, Columbus, Ohio. WOI operates, as a result, only during daylight hours. While a certain amount of night time would be acceptable, it is felt that the present assignment is generally satisfactory and every effort is being made to utilize these facilities to the utmost.

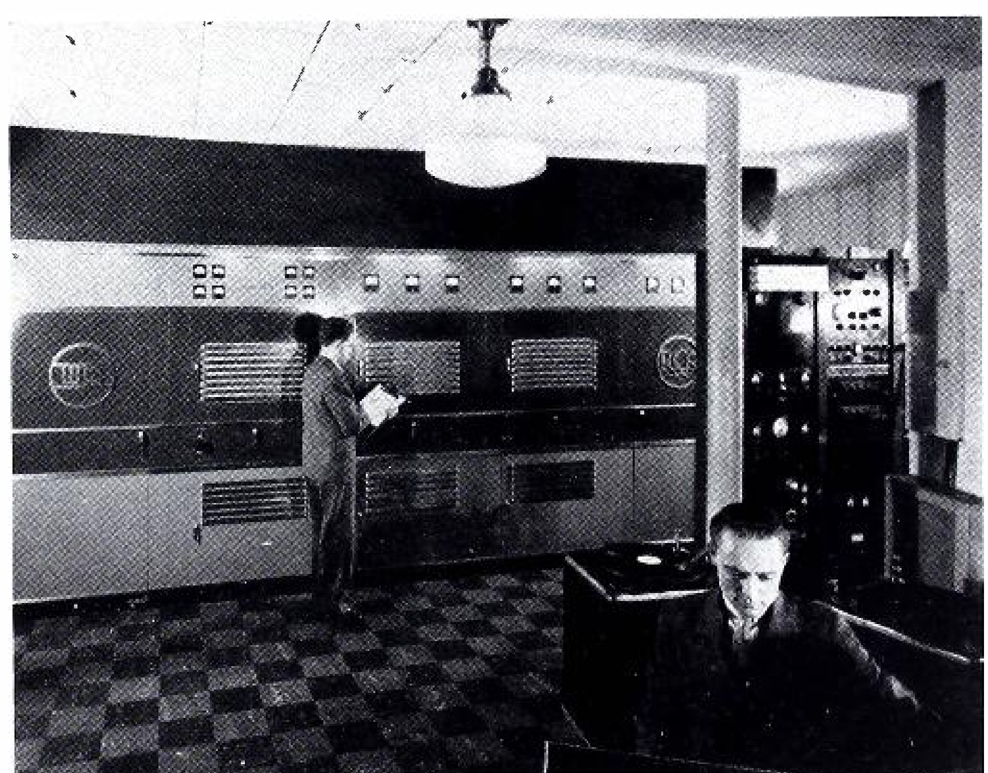
For some time it had been evident that WOI was not making the most efficient use of its assigned frequency. This was partly for the reason that the flat top antenna suspended between the water tank and the chimney, located near the buildings of the Mechanical Engineering Department, was not as efficient as necessary to comply with the regulations of the Federal Communications Commission in radiating the signals of WOI.

Plans and specifications were prepared by Radio Engineer W. E. Stewart with the assistance of other college staff members for a 400 foot vertical antenna and a 2000 foot coaxial cable leading from the WOI transmitter in Engineering Annex to the site of the antenna north of the Agricultural Engineering Building.

The contract for the 5 kilowatt transmitter was awarded to the RCA Manufacturing Company of Camden, New Jersey. A construction permit was filed with the Federal Communications Commission and permission granted to proceed with the installation.

The new transmitter was installed, tested and put in service September 23, 1939. It has proven to be much more reliable, economical and efficient that the old composite transmitter. Because the use of the new transmitter did not depend on the old transmitter at all, it was possible to change from one to the other without loss of time in the service to listeners.

The new studios and offices were occupied October 23, 1939 and again WOI feels that it is well equipped as mechanical facilities are concerned, until such time as the art of broadcasting shall have developed further than at present.



Engineer L. L. Lewis, standing near the RCA 5-DX. Senior operator John Miller seated at control panel.

RCA TELEVISION FIELD PICKUP EQUIPMENT

Description Of Units Designed For Remote Pickups

By HENRY E. RHEA

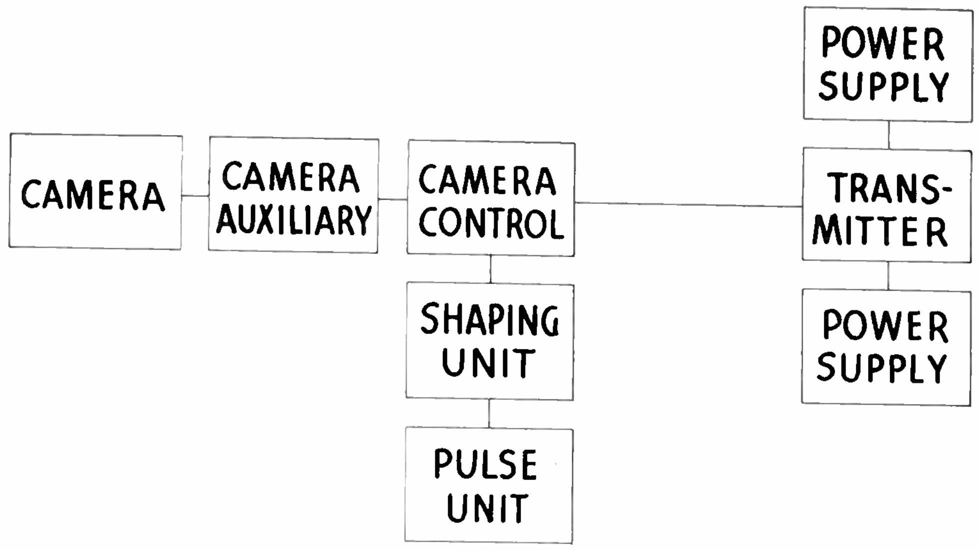
As a preliminary step towards utilization of the tremendous television program possibilities offered in the field outside the studio, the RCA Television Field Pick-Up Equipment was developed and introduced. Paralleling in versatility, performance, and ruggedness the standard line of RCA portable broadcast equipment, the new television field apparatus opens new doors to the infant industry of sight by radio. Remote pickups, previously subjected to serious limitations because of bulky equipment requiring two ten ton trucks for transportation and housing, now expand in scope to include practically all types of athletic contests, theatrical performances, and spot news events.

Employing units only a small fraction in size and weight of former apparatus, the field pickup line of equipment has made possible telecasts from planes in the air and from ships at sea.

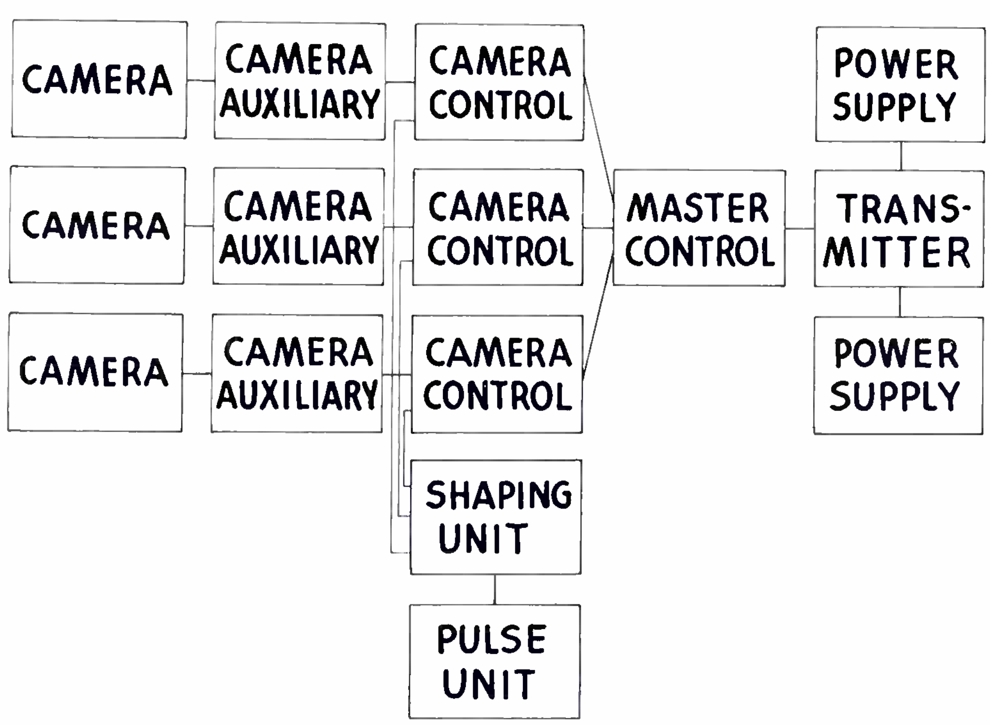
The complete television studio and transmitting system has been broken down into suitcase size units varying in weight from forty to sixty-five pounds to facilitate rapid and easy transportability. A single camera chain is comprised of seven of these units, exclusive of the camera; a two camera chain can be assembled by the addition of three suitcases plus a camera; while a three camera system embodies still two more suitcase units and a third camera.

Provisions have been made for each camera to be fed through various lengths of camera cable up to a maximum of five hundred feet. Thus it is possible to obtain about a fifth of a mile separation between any two cameras. In the multiple camera system, a Master Control Unit is provided for selecting the output from any camera to feed to the transmitter. Push buttons located on the front panel make possible rapid switching from one camera to another, and a new design seven inch Kinescope is incorporated for monitoring the outgoing signal.

The camera utilizes the new 4" Iconoscope, in place of the standard 6" tube normally employed in studio equipment, in order to keep the size of this key unit to an absolute minimum. In addition, many of the circuit components customarily housed in the camera have been removed and included in the Camera Auxiliary, a suitcase size unit connected to the camera by means of an eight foot cable and which can be mounted near the camera in a semi-permanent position. The camera proper mounts on a field type tripod equipped with a standard Mitchell head. The result is a light, compact camera that is capable of rapid tilting and panning for greatest ease of following the fast action that occurs in athletic contests and other outdoor events.



SINGLE CAMERA SYSTEM



THREE CAMERA SYSTEM

Loading Field Equipment in an automobile trunk compartment.

The camera is designed to employ lenses having focal lengths from 6½" to 19" to permit both wide and narrow angle shots. This improves the utility of the system by greatly increasing the variety of scenes.

The Camera Auxiliary connects through the long camera cable to the Camera Control which contains all the Iconoscope and video control circuits. A front view is shown in the accompanying figure. High and low voltage power supplies, shading circuits, Iconoscope and Kinescope deflection amplifiers and video amplifiers are all included in the Camera Control unit. A seven inch Kinescope monitors the output which may be fed either directly to the transmitter or to a Master Control for switching, and a two inch cathode ray oscilloscope is self-contained in the unit to enable the operator to set voltage levels and adjust shading.

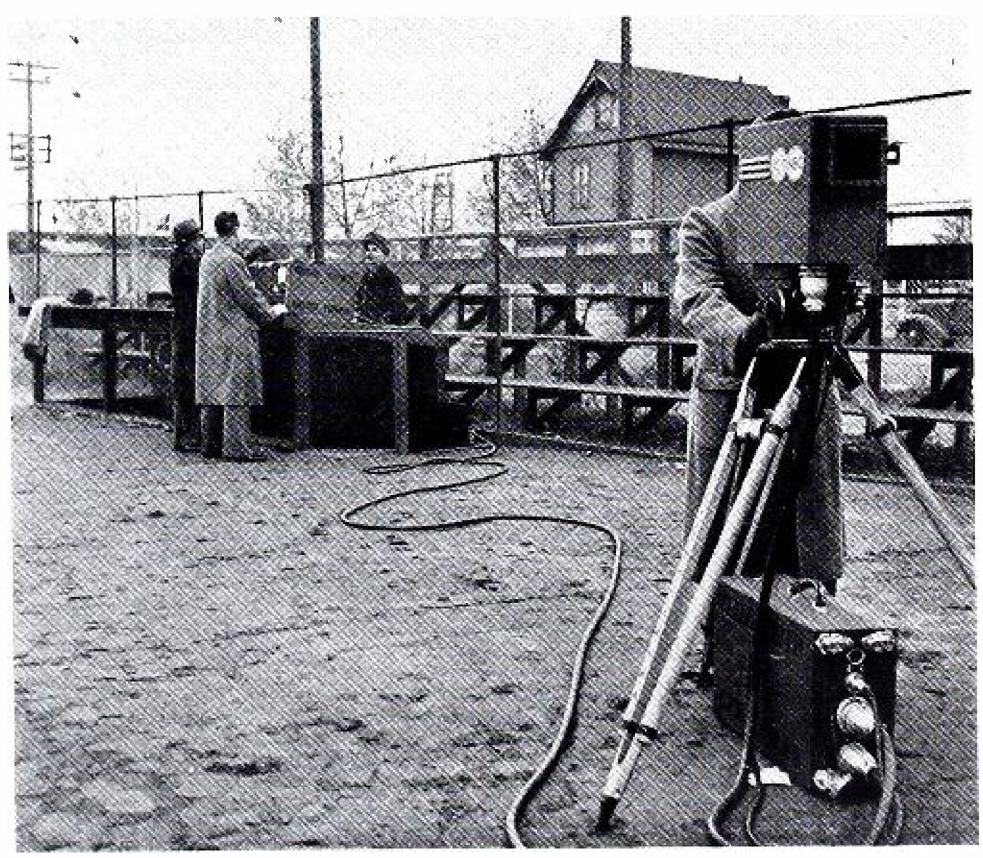
The Master Control Unit is designed to handle the outputs from three camera chains for selection of signal to be fed to the transmitter.

A push button switch on the front panel switches the various video inputs to the output line and simultaneously lights warning signals located on the particular camera and Camera Control units which are "on the Air." Line monitoring facilities are provided by means of a seven inch Kinescope and a two inch cathode ray oscilloscope. A video line amplifier also contained in the Master Control unit is capable of feeding up to five hundred feet of low loss coaxial cable, thus making possible consiberable separation between the transmitter and the main control apparatus.

The synchronizing generator is made up of two individual units; the Impulse Generator which produces the master pulses for control of the timing of all the blanking and synchronizing signals, and the Shaping Unit which forms the composite signals from the master pulses. The former unit contains the power supply for the entire generator. Provision is made in the Impulse Generator for rigid lock-in of the vertical synchronizing with the alternating current power source.

The mechanical design of the entire line of television field equipment has been expressly intended to meet the conditions of easy component accessibility and maximum ruggedness. The chassis are all integral parts of the cases of the various units and are

(Continued on Page 35)



Camera set up in a typical operating position.

NEW 1000 WATTERS FOR THE NORTHERN CANADIAN MINING REGIONS

Two RCA Type 1-G Transmitters Installed

By WM. K. MARKS
Technical Supervisor, Northern Broadcasting & Publishing Co.

NORTHERN Ontario, Canada's richest gold mining area, boasts of being served by one of the most modernly equipped and progressive radio chains in the Dominion, made up of stations at Timmins, Kirkland Lake and North Bay in Ontario and Val D'Or, Quebec, operated by the Broadcast Division of the Northern Broadcasting and Publishing Company Limited. For the past seven years, this area has been served by three 100 watt stations located at North Bay, Kirkland Lake and Timmins, but in order to keep up with the rapid growth of the country, the fall of 1939 saw the installation of two new RCA 1-G watt transmitters at Kirkland Lake and Timmins, complete with vertical radiators and all the trimmings. These transmitters were manufactured in the RCA Victor plant at Montreal and were arranged for operation on 25 cycle power supply. Service was also extended across the border into Northern Quebec with the addition of another 100 watt station at Val D'Or, where one of the new RCA 76B Consolettes adequately handled the audio requirements.

The Northern Broadcasting and Publishing Company has its head offices in Timmins and is headed by Roy H. Thomas, president, with Jack K. Cooke as general manager of the Broadcast division. Wm. K. Marks has recently been appointed technical supervisor for the Company, at the same time acting as chief engineer for CKGB at Timmins. Edgar Ryan has recently taken over as chief engineer for CJKL at Kirkland Lake, and Allan Taylor, who supervised installation work at Timmins last fall, is capably in charge of CFCH North Bay.

Building radio stations in the heart of Northern Ontario's rocky timberland produces many annoying problems not usually encountered elsewhere, the first being the almost impossible job of locating a suitable site. The usual procedure of choosing a site by the use of field strength measurements to determine where the best ground conductivity prevails is impractical and the points taken into consideration are, in order of importance, accessibility by road in winter, suitable terrain, and nearness to power and telephone lines.

There are no sites that combine all four of the above requirements. To begin with, the search, in the case of Kirkland Lake was limited to three possible directions due to lack of road accommodations, and of course, by the maximum and minimum allowable distance we could locate from the city. After several weeks of black flies and broken axles, not to mention the odd bit of fishing on the side, what appears to be an ideal location is chosen only to find that it is the unsellable claim of an over-optimistic prospector, who thinks he is going to start another gold rush.

After a great deal of compromising, a site was finally located 8½ miles by road, south of Kirkland Lake, where work commenced on the clearing and preparation of some 40 acres of dense bushland on July 1st. This operation alone, which required the services of 25 expert bushmen, two caterpillar tractors equipped with bulldozers, a team of horses, and considerable dynamite, took six weeks. Power and telephone lines had to be built through two miles of rocky bushland.

The antenna system at CJKL consists of a 296' Lingo vertical, operating at a one-sixth wave radiator on 560 kilocycles. For a ground system, 120 fourtenths wave radials, each 700 ft. long (making a total of more than 15 miles of No. 8 bare copper wire) had to be buried by hand in trenches made with a heavy road plough and tractor. In many places huge outcroppings of solid rock, and also swamps, made it impossible to bury the wires, so they were left lying on the surface. Thousands of stumps were blasted and pulled out of the way to clear the path for those radials fortunate enough to be bedded down.

Located approximately in the center of the property was a miniature plateau of sand and rock outcroppings, 100 ft. across and elevated about 25 ft. above the surrounding terrain, upon which it was found necessary to locate the tower. Six inches of surface soil was scraped away, leaving solid bedrock for a perfect tower foundation. Four of the eight guy-wire anchorages were conveniently located in bedrock, while the others were standard concrete foundations set in sandy loam.

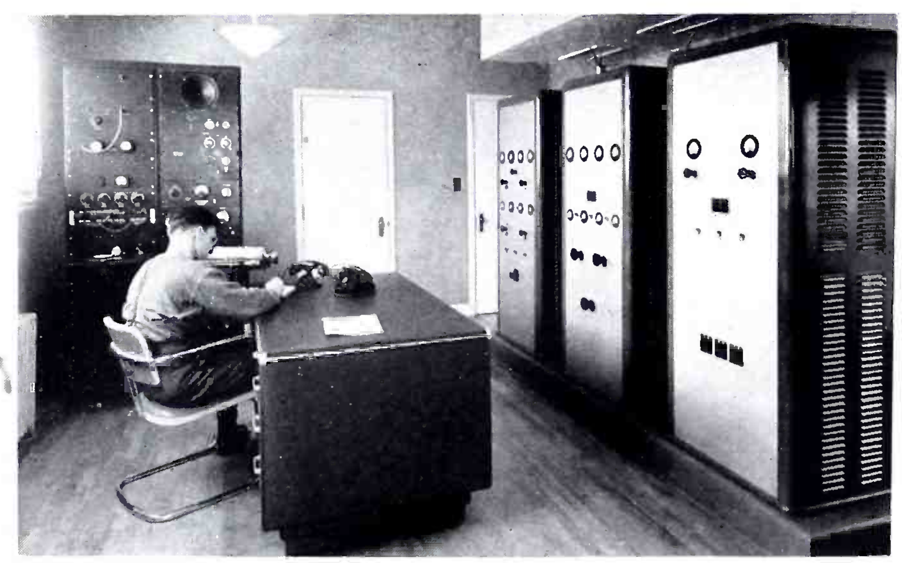
A four-wire open type transmission line transfers the radio frequency power from the transmitter house to the antenna tuning house, a distance of 410 ft. up a steep rocky incline, where several of the supporting poles had to be set on bed rock and cribbed with cement. In view of the extremely wide variations of temperature which prevail in this country, where, during the course of a year, temperatures as low as —50° and as high as 105° are not uncommon, exacting care was taken when constructing the transmission lines in allowing for

(Continued on Page 34)

CARRYING PROGRAMS TO ONTARIO AND QUEBEC

Above: CJKL—Kirkland Lake, Ontario, showing RCA 1-G Transmitter.

Left: Vertical Radiator and Station Building at CJKL, Kirkland Lake, Ontario.



Right: RCA 1-G Transmitter at CKGB, Timmins, Ontario.

Left: CKGB in the northland at Timmins, Ontario.

FLASH-ARC CURRENTS IN TRANSMITTER TUBES

By J. C. WALTER

In the following paragraphs empirical methods of analysis are discussed which may be applied to the general problem of determining maximum instantaneous currents existing during tube flash-arcs in high power transmitters.

Such analysis is essential to the correct selection of overcurrent protective relays and current limiting resistors, and should be of interest to all engineers engaged in the design or operation of high power installations.

While the examples shown are for large components of the so-called super-power class, and are specifically based on a high level modulation system, the method of analysis may be readily adapted to any power class or circuit arrangement. The two most interesting cases are given, i. e., flash-arc faults in Modulator and Power Amplifier tubes, together with simplified diagrams of circuits and fault current characteristics.

Arc-Over in Modulator Tube

In this type of fault short circuit current flows until the breaker trips, and the value of the surge current is limited almost entirely by the series plate resistors. Fig. 1 shows the current path during an arc-over.

Surge currents during arc-overs put a very heavy load on the rectifier and filter, and the load current may be treated as though it were a keying wave of zero frequency.

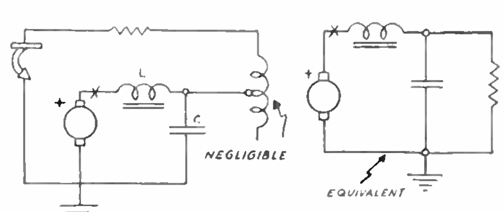


Fig. 1.

As the short-circuiting arc is established, filter condenser C starts to discharge into the load, dropping its voltage by an amount which may be expressed as "percentage dip" with respect to normal full voltage. As the condenser voltage falls, the rectifier starts charging the condenser through the series inductance of the filter reactor L, until finally full voltage is again present across the condenser. The rectifier is now supplying all the load current, and will continue to do so until the breaker trips and opens the power feed. At this point the condenser starts again to discharge itself through the load until the arc is extinguished by the drop in voltage.

The shape of the discharge current is therefore somewhat as shown in Fig. 2.

Lee[1] has shown that the ratio of "dip" to full voltage may be approximated by the following expression:

$$\left[\frac{ed}{E_b} = X\epsilon^{-.785x} \right]$$

Where

$$X = \frac{1}{R}\sqrt{\frac{L}{C}}$$

In a typical case,

$E_b = 12000$ volts

$R = 21$ ohms

$C = 90 \times 10^{-6}$ farads

$L = 0.15$ henries

and

$$X = \frac{1}{21}\sqrt{\frac{0.15 \times 10^6}{90}} = 1.94$$

$$X\epsilon^{.785x} = 1.94\epsilon^{-(.785 \times 1.94)}$$

$$= 1.94\epsilon^{-1.53} = 0.426$$

$$e_d = 0.426E_b = 0.426 \times 12000$$

$$= 5000 \text{ volts}$$

[1] Rueben Lee, "Radiotelegraph Keying Transients" Proc. I. R. E., Vol. 22, February, 1934.

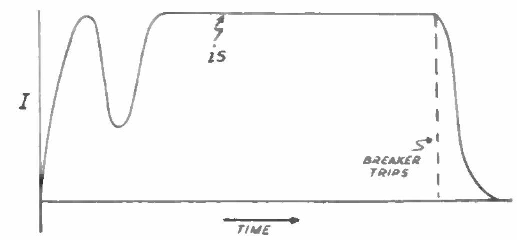


Fig. 2.

$$\text{Load current} = \frac{E_b - e_d}{R}$$

$$= \frac{7000}{21} = 333. \text{ amp.}$$

The "period" of the dip is approximately the RC constant of the load R and condenser,

$$RC = 21 \times 90 \times 10^{-6}$$

$$= 0.00189 \text{ sec.}$$

Since the breaker requires at least 0.0833 sec. to trip (1 cycle relay time + 4 cycles breaker tripping time), it is seen that the load current will rise very quickly to a value

$$^{m}i_s = \frac{E_b}{R} = \frac{12000}{21} = 571 \text{ amp.,}$$

then fall to 333. amp. after 0.0189 sec., then rise again to 571 amp., remaining there until the breaker clears. After the breaker has cleared, the current falls to zero in the time required to discharge the condenser.

From the foregoing it is seen that the "effective" value of the load current is not greatly affected by the dip, and that during most of the time required to trip the breaker the current is limited only by the resistance of the circuit.

Arc-Over in Power Amplifier Tube

In this case, the discharge path contains considerable inductance as shown in the diagram of Fig. 3, and the load current will be oscillatory since $R^2C < 4L$.

When the arc is established, load current starts to build up through inductance L_m. (The con-

(Continued on Page 30)

A STREAMLINED KILOWATT FOR WCAR

Pontiac, Mich. Installation Is RCA-All-The-Way

By WILEY D. WENGER
Chief Engineer, WCAR

WE are mighty proud of the new installation at Pontiac, and if the pictures shown herewith don't convince you that you'd be too—then we ask you to read a bit further while we set forth a few reasons why.

Service Against Odds

The installation is RCA—ALL the way, from microphones to antenna and the transmitter was assembled in the new building two days before beginning regular broadcasts, and has operated with no failures or interruptions due to mechanical failures.

The Studio console was literally jerked from the production line, received the afternoon before going on regular schedule, and has never failed to feed program on schedule.

We think that, in itself, is something not only for us, but the manufacturer to be proud of, for, when you consider the plaster, dirt, cold damp air and other possibilities for failure that existed during the first week's operation, the equipment would have to be good to stand the gaff. Smudge pots ran in adjoining rooms, doors were sealed with cardboard, and the transmitter took to the ether like a baby to its bottle, and never let out a whimper. During this time construction had been a hardship on the technical staff, and Stearns wore five pairs of socks and three pairs of pants while soldering radials under the 230 foot Truscon antenna. The installation was made by the light of an extension, and heat was furnished by a couple of borrowed spot heaters. Permanent wiring was piped in the night we began equipment tests, and a furnace was placed in operation to heat a great portion of the air over our site, two days later.

We were told that the wall board could have such wide cracks because the humidifier didn't work on the furnace for some time—but it hasn't made a single unit pull apart in the little 1G.

Styling and Design

The building perhaps looks rather familiar to many of you who have seen the various bits of styling by John Vassos and Lynn Brodton — it was in the main — sketched out by Mr. Brodton as a housing for the floor plan which we wanted to include, and resembles the original sketch with the exception of a skylight of glass brick which was eliminated because of practical considerations in construction and cost. The architect was Mr. L. J. Heenan, of Pontiac, and the color schemes were worked out by him and our Vice-President, Mr. Earle C. Kneale.

The fundamental things we kept in mind in making the entire plant could be listed as follows: Appearance, Ease of Maintenance and Economy.

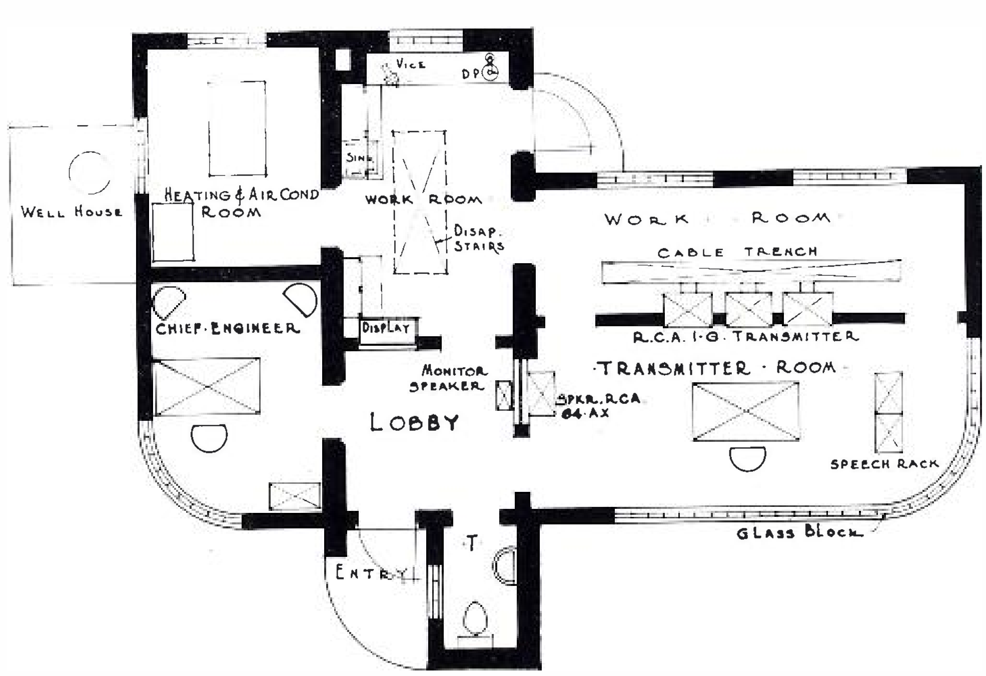
Fundamentals kept in mind in the design of the entire layout have so far proved worthwhile—such as accessibility, appearance, low operating cost, trouble free operation.

We also held to certain obvious fundamentals, when drawing up our plans, and you will note them in the photos. We wanted a work room with good light and plenty of drawer space, a storage room for the various bits that accumulate over a period of time. We were convinced that the glass brick would give us plenty of free daylight, and seal the building up tight from harmful dust and dirt and cold. We think we have leaned over backwards in trying to visualize our needs for floor space and still have not gone beyond a reasonable amount for walls and roofs.

The building is heated, and will be cooled, with a small air conditioning unit, which burns oil and cools with water from our 130 foot well. All air is filtered, which enters the building or recirculates through the furnace, so we don't expect trouble from dirt and bugs.

To prevent upsetting the air conditioning unit, a small blower and thermostat arrangement comes on at eighty degrees behind the transmitter, and blows the heated air out through the roof. It shuts off when the tem-

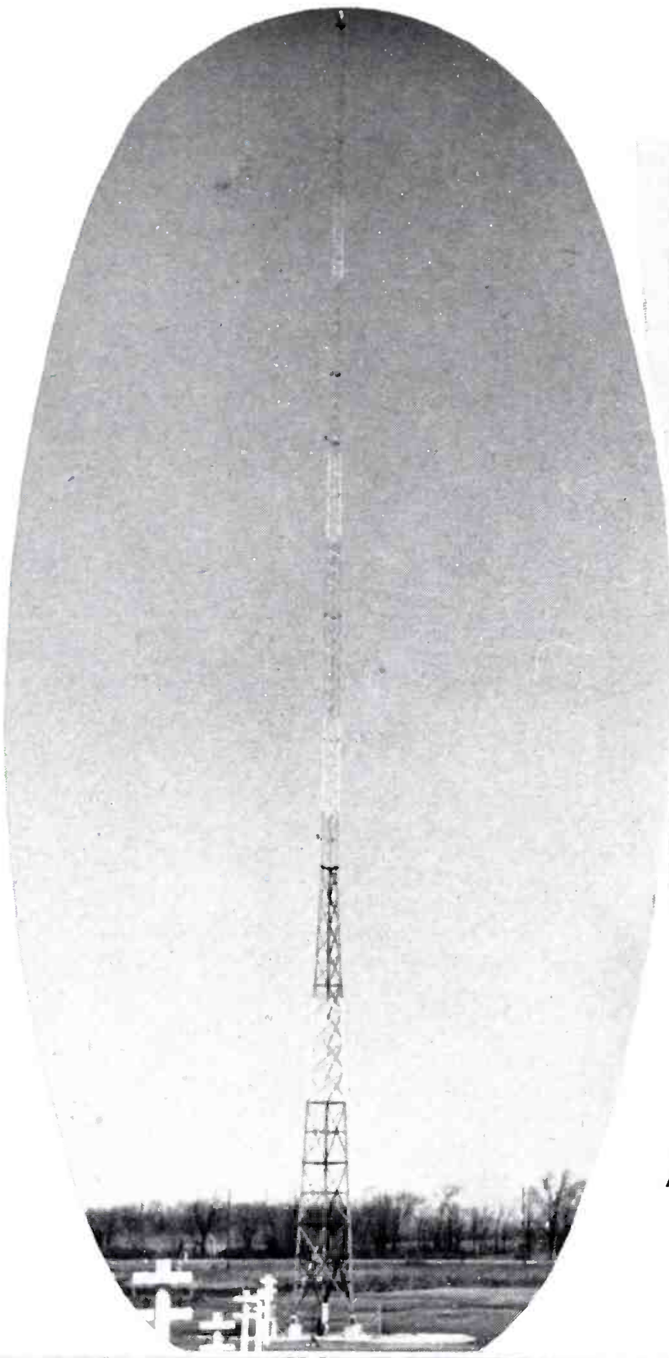
(Continued on Page 22)



Floor Plan WCAR.

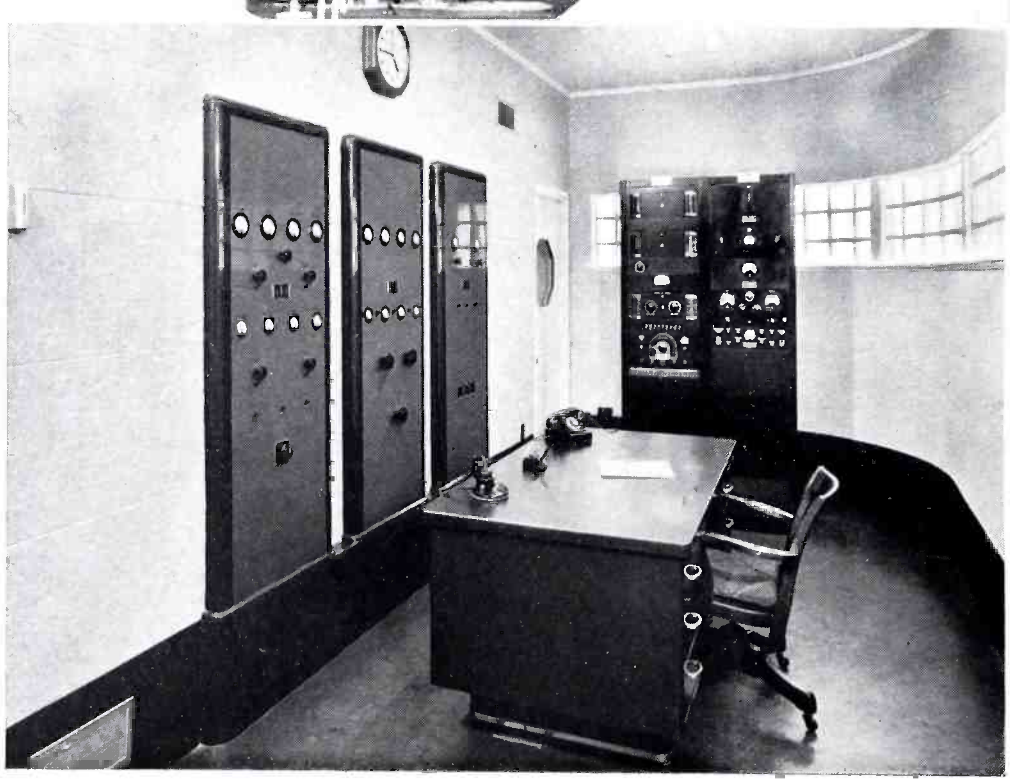
WCAR—STREA

Above: Elevated control room.



Left: WCAR's Antenna.

Above: Chief engineer's office.

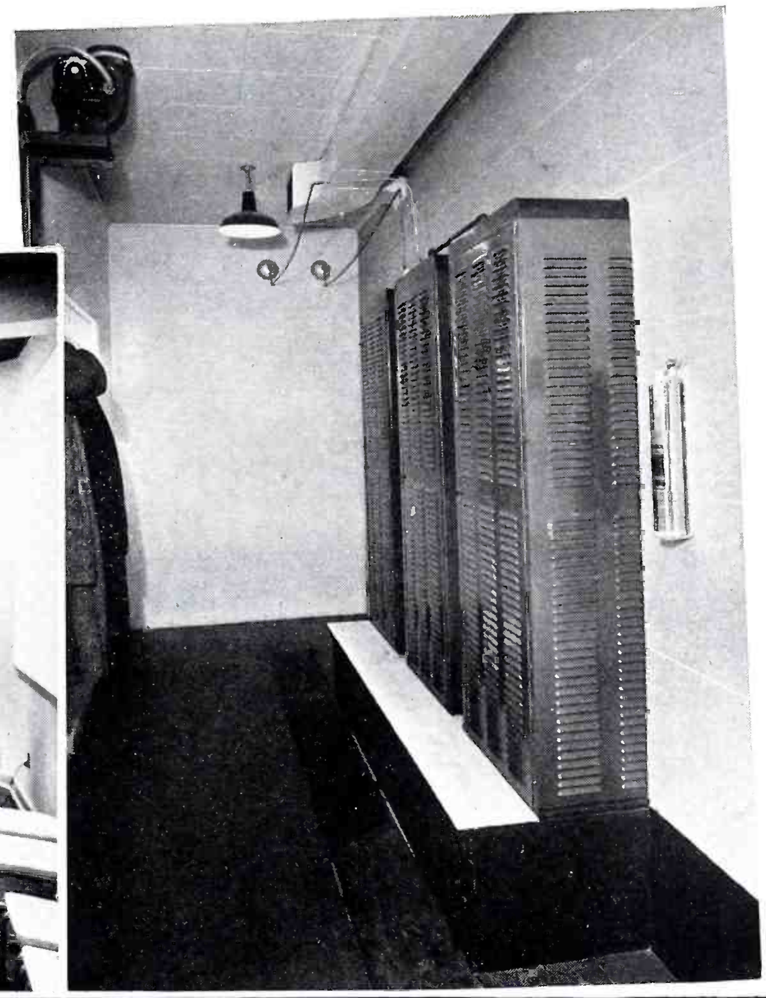


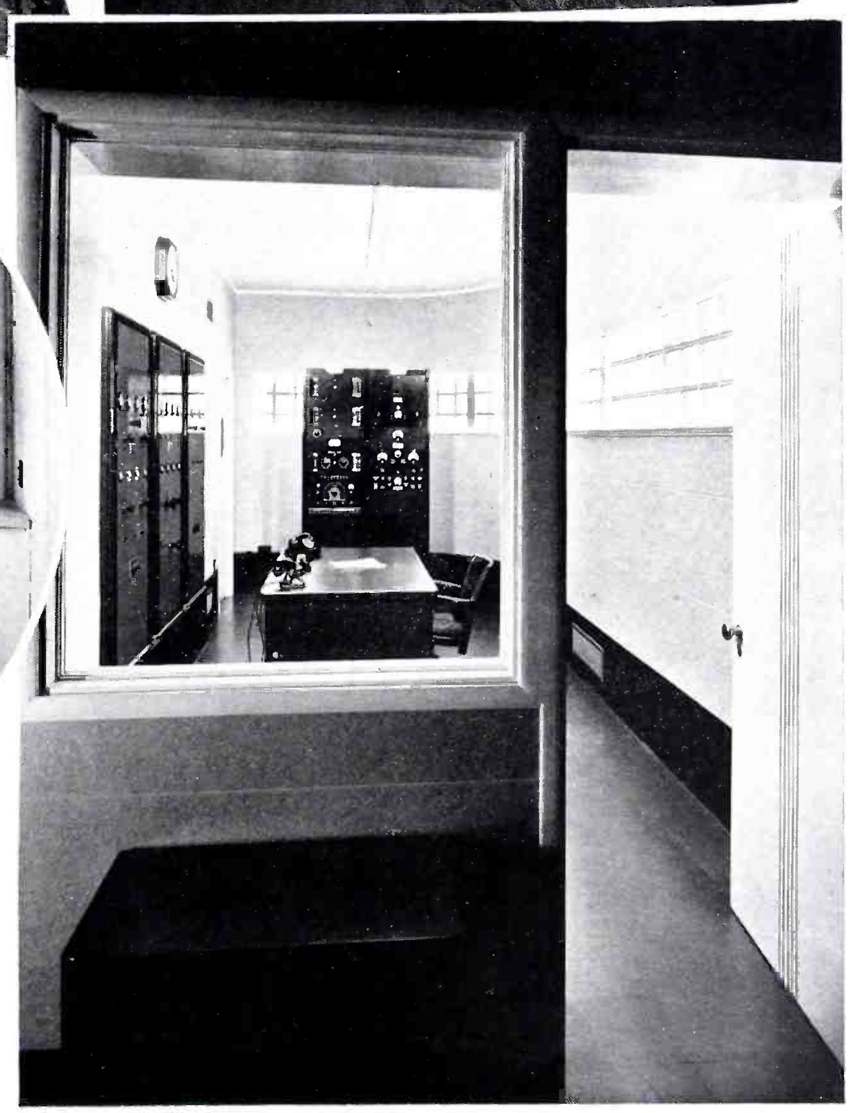
Left: Front view of the transmitter.

LINED BY RCA

Right: Rear view of the transmitter.

Below: One of the Studios at WCAR.





Above: Work shop—WCAR.

Right: Transmitter as seen from lobby.

NEW BROADCAST FREQUENCY MONITOR

Type 311-A Meets Important Station Need

By J. M. BRUMBAUGH

THE RCA Manufacturing Company is offering a new broadcast carrier frequency monitor, developed after an exhaustive investigation in the laboratory to produce an instrument which would more than meet the F.C.C. requirements for accuracy and stability. This monitor, type 311-A, offers to the broadcaster all reasonable assurance against infraction of the new frequency maintenance rule (Sec. 3.59 of Rules Governing Standard Broadcast Stations) by reason of the close checks which can be made on the station frequency. Since a tolerance of ±20 cycles is established for all new stations after January 1, 1940, and for all broadcast stations after January 1, 1942, it is important for stations to have adequate means for assuring compliance with the regulations. A frequency monitor of greater accuracy than the transmitter is essential. The RCA 311-A instrument not only meets the specifications for such service but exceeds them in performance and, in fact, provides accuracy which could only be obtained by primary standards a few years ago.

Single Unit

As shown in the accompanying photograph, the complete monitor is contained in a single unit, with r-f, audio and power supply elements on a standard 19" x 15¾" panel. A double heat chamber is employed; the inner chamber containing the monitor-oscillator crystal, and being temperature controlled by a mercury thermostat. The latter breaks only the grid-circuit power of a relay tube and requires no attention. The outer chamber contains the remaining oscillator-circuit components (except the tube), and is controlled by a bi-metallic thermostat of high sensitivity. The crystal chamber operates at approximately 70 degrees C., ensuring proper regulation at the highest ambient temperatures which would be expected under operating conditions. Two safety thermostats are included, which would operate to prevent serious overheating in the event that the regular control system should fail. The regulation of the complete oven is such as to maintain the crystal temperature at better than 0.1 degrees C for a range of more than 45 degrees C in ambient temperature.

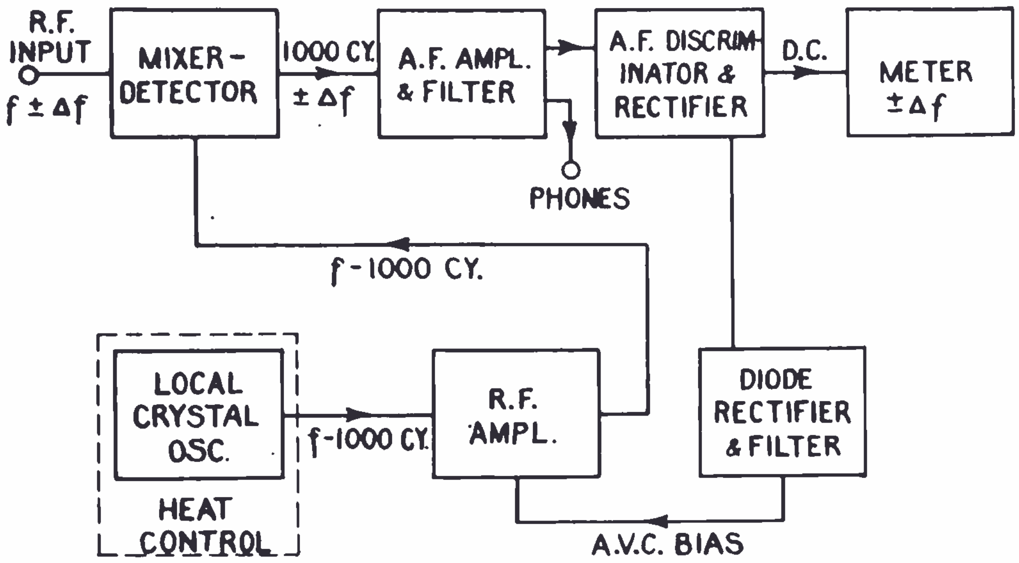
The "V" cut crystal employed has a temperature coefficient of less than 2 parts per million per degree C, and is mounted in a holder which has been specially designed for high stability. The crystal oscillator circuit is of the aperiodic, or untuned type, the frequency of which is more completely determined by the crystal alone than in the case of tuned oscillators. Relatively low power level in the crystal circuit, made possible by an r-f amplifier, and regulation of plate voltage also contribute to frequency stability.

The audio frequency-indicating system is of a simpilfied type, using only one tuned circuit and thus minimizing the probability of error due to changes in circuit elements. Moreover, the inductor and capacitor used have very low temperature coefficients and high stability.

Front panel view of the 311-A Frequency Monitor.

Indicating Meter

The indicating meter is a large instrument, giving a total scale length of approximately four inches on both the ±20 cycle and ±100 cycle scales. Controls on the front panel include the circuit-power switch, the meter range switch (which selects either of the above mentioned scales), and three push buttons which check, by deflection of the indicating meter to certain markings; (a) proper r-f input signal level, (b)



Block Diagram of the 311-A.

correct setting of a balancing adjustment for the a-f discriminator diode, and (c) proper level of the beat-frequency audio signal in the discriminator circuit. Although they should need very little attention in operation, manual adjustments for these three quantities are provided on a sub-panel, and are readily accessible through a small door in the front panel. These controls are thus not subject to accidental disturbance, and resultant false indication therefrom. An incorporated a.v.c. circuit maintains the a-f level practically constant for all normal operating conditions. A 'phone jack, for aural indication, is also provided on sub panel. The vernier frequency adjustment is located in the outer heat oven, and can be reached by means of a bakelite tuning tool on removal of a plug button.

Operation

The principle of operation of the instrument is indicated on the accompanying block diagram, and may be summarized briefly as follows:

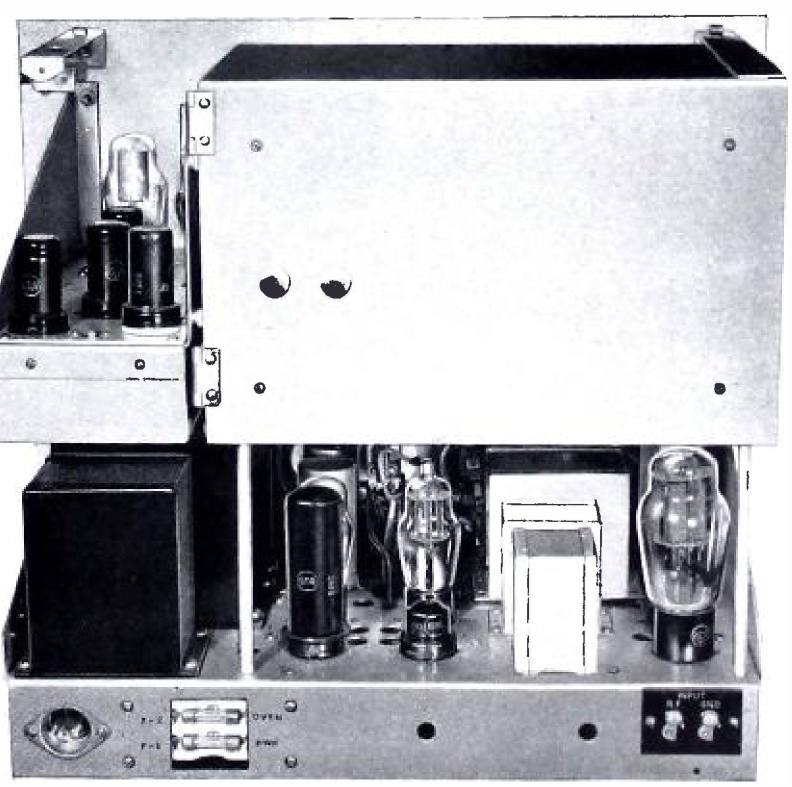
The local crystal oscillator supplies voltage through an r-f amplifier to a mixer circuit, into which is also fed a voltage from the transmitter. The local oscillator is set to operate 1000 cycles below the carrier frequency; and its signal, controlled in amplitude by the a.v.c. bias on the r-f amplifier, is the smaller of these two components which create the beat signal in the detector. The output of the detector, having a frequency of approximately 1000 cycles, passes through an r-f filter to a broadly-tuned 1000 cycle amplifier stage. This filter stage serves to reduce errors due to hum modulation on the carrier and other types of distortion, and also to drive an a-f power stage. The latter is transformer-coupled to the R, L & C circuit of the discriminator.

The inductive and capacitive elements of the discriminator circuit (including series resistances), across which are connected the two discriminator diodes, are adjusted to have numerically equal impedances at 1000 cycles. It is thus evident that, for this frequency, the two diode currents will cancel in the "cycles" meter and produce no deflection. When the transmitter carrier deviates from its assigned frequency, producing an a-f above or below 1000 cycles, different voltages will be supplied to the two diodes, resulting in an unbalanced current in the "cycles" meter. The latter is a zero-center instrument, and is calibrated in cycles "high" or "low" from assigned carrier frequency.

In order to obtain a reasonably linear scale on the meter, and hold the deviation calibration, it is necessary to maintain constant a-f current in the R, L & C circuit. The a.v.c. circuit, obtaining voltage from a resistance element of this discriminator circuit, controls the amplitude of the local oscillator, or smaller signal at the detector (and thus the a-f amplitude) so as to maintain substantially constant current over the deviation range. A manual control is provided, as previously mentioned, for close adjustment in critical readings.

The monitor's wide range of off-frequency indication minimizes the possibility of false indication in the event of a jump in carrier frequency. On the ±100 cycle scale, the meter will read off-scale to 500 cycles low and 1200 cycles high, while on the ±20 scale this range is from at least, 800 cycles low, to several

(Continued on Page 25)


Rear view of the 311-A Frequency Monitor.

WCAR

(Continued from Page 17)

perature has dropped back to a preset value, and so long as the doors at each end of the transmitter units are kept closed, the building is little affected by the heat dissipated by them.

The equipment installed, besides the RCA 1-G includes two racks containing the limiting amplifier power supply, monitoring amplifier, limiting amplifier and jack terminations, equalizer and line supply terminations. Thus all audio equipment fills one rack, and circuits are so normalled through, that the monitoring amplifier may be used as an emergency unit for program, or the speakers may be patched through to any circuit desired.

Racks

The right hand rack consists of all monitoring equipment requiring RF voltage feeds, and from top to bottom they are RCA Frequency monitor, and deviation meter. Modulation monitor and the 69-B Distortion Meter had not been installed when the photos were taken.

Along the back inside of each rack cabinet is mounted a 6 foot strip of multi-connection 110 AC outlets, with slots for 110 volt plugs each six inches.

Speakers are provided in the control room, (which is an RCA 64AX) in the Chief Engineer's office, lobby and work room.

The flooring is done in asphalt mastic tile. The floors are light blue in all rooms but the workshop, which is marbled brown, and the wall trimming is done in dark blue. This can be seen as an edging under the transmitter mounting base. The lobby floor contains the design of our letter heads—signifies the Earth, Day and Night, and ether waves penetrating the whole.

As the visitor enters the lobby, he views the display cabinet containing various tubes used in our modern unit, as compared with earlier types, and gets a clear view of the entire transmitter room, as shown in the photo. Lighting in the transmitter room consists of one strip of fluorescent tubing 12 feet long, but is never required during normal daylight, due to the long narrow glass brick window which travels the entire length of the room.

Behind the speech rack, along the blue tile border, is provided a 110 volt strip outlet for scopes, irons, etc. and the same handy gadgets are found mounted above the workbench, in the Chief Engineer's office and upstairs under the windows of the "Storage" space. Benches can be built along the windows of the second floor, where experimental, or repair work requiring unsightly equipment can be done. One tube of fluorescent lighting illuminates the workbench and workshop room.

Looking out one of the small plate glass windows to be found in the front door, one views the green grass lawn which was formerly a small golf course. It extends past the tower—on out to busy Telegraph road — and since there is heavy traffic going by, we have placed four flood lights to light the cement block building from sunset till midnight.

Some day, we may landscape our enormous front yard, which was formerly a golf course but for the present we have built a "Service Road" in from the highway behind the plant, with a parking area for engineers and visitors. We wanted to keep it as close to the county road as practicable to keep the cost and maintenance down. Power lines and telephone cable were run in overhead, since they could come down the fence line, and be nearly five hundred feet away from the radiator.

Transmission Line

The transmission line is 422 feet long, and was made an open wire line, so, as someone else once said, "We can look out the front window, and see if it's still there." The cost of the line was kept low, by buying poles from a dealer in posts for cabins and fences, trimming them off with a draw knife and painting them, and putting the whole line in ourselves. The Antenna tuning unit is mounted away from the tower, on 4 x 4 posts and a platform, large enough so that test and measuring equipment can be placed in front of it. The lighting choke comes up from buried conduit, in a metal box built to house it.

The antenna is under lock and key at the fence gate—the fence going around the base and being equipped with barbs on a projection.

Under the pole line is buried a four inch copper strap, along with two conduits which contain pairs for a phone line, a remote meter, and lighting wires. The strap runs directly into the inter-wiring trench of the transmitter and right on through to the 6 inch well casing, which in turn goes down through the 130 feet of clay (the blue wet kind). All reinforcement steel, copper lintels, drain pipes etc., are bonded with similar four inch strap to the main buss to ground.

With the above equipment, we pump a beautiful signal into Pontiac and more of the surrounding territory than we had expected.

The material which we feed into this streamlined job, originates in the Riker building in downtown Pontiac, and there we find almost an entire floor devoted to Pontiac's new industry —WCAR.

The front portion and one side are devoted to executive offices, sales, continuity, and "Clients Audition" room. Off the main corridor, one enters the "Public Observation Room," which gives a view into Studio A and the control room.

Programs where public view is not desired, are conducted in Studio B which is to the operator's left. In the rear corner of the studio layout is a "Cut in" booth, which can be used for news and breaks, when both studios are in use.

Along a corridor and next to the outside windows, are the program offices, Secretary, Program Director, News room, Announcers' room, and Music Library. All these latter are isolated from public travel.

NEW COMMUNICATIONS RECEIVER

RCA AR-77 Has "Stay-Put" Tuning

By EDWARD BRADDOCK

(Continued from the last issue)

Stability of Tuning Adjustments

Stay-put tuning is a great relief from the common fault of most receivers — frequency drift. Considerable attention has been given in the AR-77 to remove, or compensate for, the causes of frequency drift. Reduction in the amount of heat generated in and around the chassis, which causes circuit constants to change, has been accomplished by (a) an over-sized power transformer so that losses are minimized; (b) elimination of needless audio power output. Through use of the new ultra-efficient Polystyrene insulation at strategic places keep the circuit losses and detuning effect of humidity at a minimum.

A temperature compensated trimmer condenser in the h-f oscillator circuit stabilizes the frequency from effects of temperature, especially for the initial changes when the receiver is first turned on.

Voltage Regulation of the plate supply to the oscillator and first detector circuits prevents the frequency of these circuits from being changed by the effects of sudden shifts in line voltage.

Accurate reset of "logged" stations is greatly enhanced by use of the Vernier index scale provided for both the main tuning and the calibration-spread dials. The arbitrary scale of 0-200 on the outer edge of each dial and the Vernier index allows the operator to read accurately to one part in 2000. Where close settings of the dial are necessary, this scale will be found very helpful. For example, to have the calibrated bandspread read accurately, the main tuning dial should always be reset to the same point within one-tenth of a division—such close setting is practical on the AR-77. By plotting a curve from points taken during standard frequency transmissions, close interpolations can be made for frequency settings.

Convenience of Controls

The two tuning controls have $2\frac{3}{8}$-inch diameter knobs with knurled circumferences permitting easy rotation with the index finger while the hand rests on the desk. Long periods of tuning are thus possible without fatigue. The B. F. O. switch simultaneously removes the A. V. C. bias and turns on the oscillator for c-w telegraph reception.

The rack mounting panel for the AR-77 has two phone jacks which can be connected so one "bridges" the output line and the other "lifts" the line enabling the operator to make adjustments of one receiver in diversity connection without disturbing the program. This arrangement is serviceable also for uses where only one receiver is employed.

The most frequently used controls are placed along the lower edge of the panel within easy reach. The standby and audio volume controls have been placed at each end so they may be reached quickly without confusion. Bar-type knobs are employed on the accessory controls where the angular position may be determined at a glance to observe the settings. Technical symbols or abbreviations have been used to identify the controls. Such identification serves as a ready "cue" to their function and enhances the appearance of the panel by keeping the lettering at a minimum.

Size, Shape and Color

The metal cabinet is shaped with curved vertical corners at the front for graceful appearance. The overall dimensions are: width, $20\frac{1}{8}$"; height, $10\frac{1}{2}$"; depth, $11\frac{5}{8}$". All dial scale openings are grouped together on a recessed sub-panel behind a nonbreakable window to give a pleasing focal point during the tuning operations.

The top of the cabinet is flat and free from any projections so other equipment may be placed on top of the receiver if desired. A hinged lid permits easy access to the interior. A removable cover on the bottom of the cabinet eliminates the need of removing the chassis for alignment or servicing.

The headphone jack is reached by an opening in the right side of the cabinet. All terminals are mounted on the exposed rear apron of the chassis which facilitates quick installation.

(Continued on Page 35)

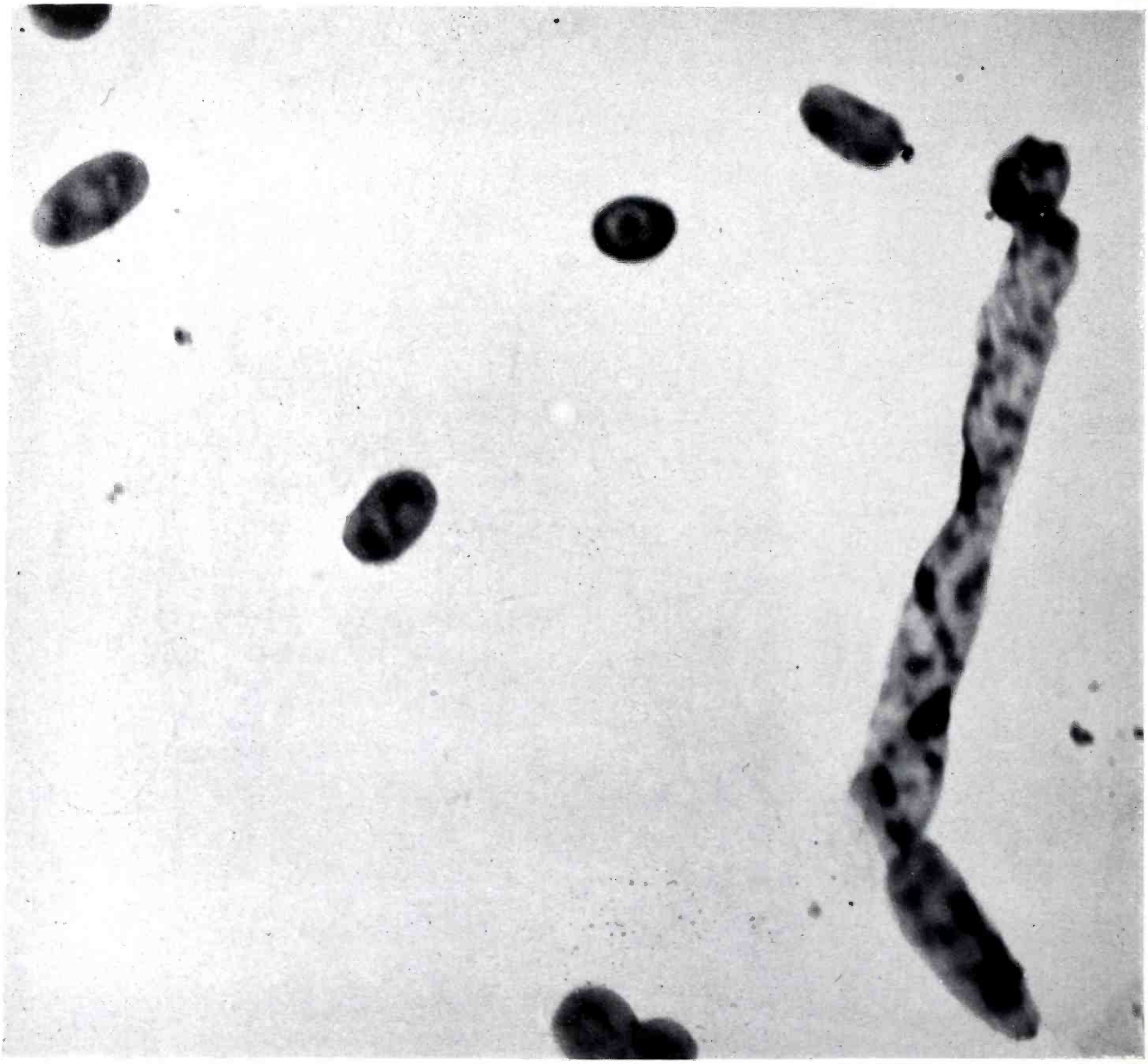
The RCA AR-77 Table Model Communications Receiver.

ELECTRON MICROSCOPE

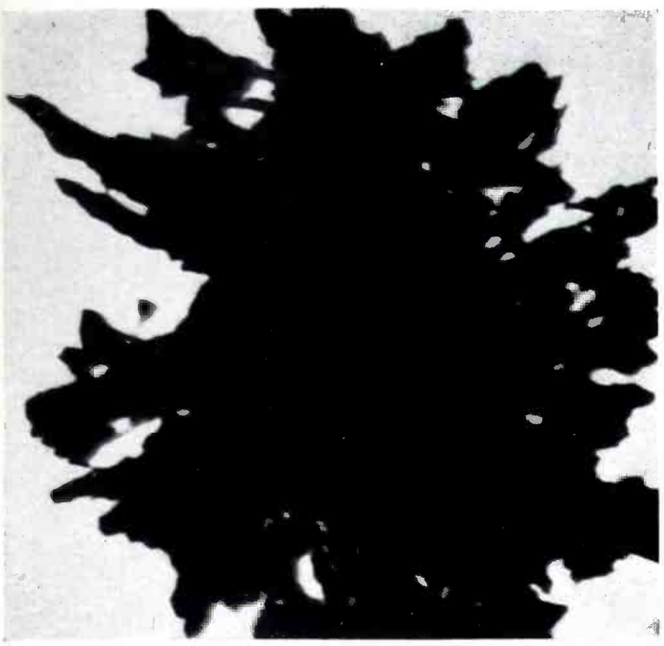
(Continued from Page 3)

the electronic magnification of the microscope is 25,000 diameters, the useful magnification is greater than this. When recorded photographically there is more detail than can be resolved with the unaided eye. Hence, to take full advantage of the enormous capabilities of the instrument, the photograph must be enlarged optically.

The instrument shown in the photograph stands about eight feet high, and the brass cylinder forming the main chamber is nearly a foot in diameter. In order to permit the free passage of electrons, the main chamber is maintained at a very low pressure. Because of this, unless special provisions are made, the procedure of changing specimens or photographic plates would be very lengthy, as it would necessitate evacuating a large volume each time. In the instrument illustrated, air locks are provided at the object chamber and the photographic chamber to permit making these changes without breaking the main vacuum. With this arrangement it is possible to change either the plate or the specimen in about two minutes, or, in other words, the time required is hardly more than that required for the same operation with a high power optical micrographic outfit.



Whooping cough bacteria. Magnification 27,000 diameters. Electron-micrographs made with the RCA Electron Microscope.



Commercial iron oxide particles as used for the finest polishing operation. Magnification 15,000.

FREQUENCY MONITOR

(Continued from Page 21)

thousand cycles high. Beyond these frequencies, moreover, false indication is evidenced by low "A.F. Check" indication, and inability to readjust the corresponding control.

As may be seen on the block diagram, the local oscillator is completely isolated from carrier signal by an r-f amplifier. The separated inputs to the mixer circuit prevent any possibility of trouble due to modulation of the carrier by local oscillator signal.

A brief summary of characteristics follows:

Electrical Characteristics

Frequency range, 540 kc to 2000 kc.

Frequency deviation ranges, ±20 cycles and ±100 cycles.

Stability of indication, ±5 parts per million.

R.F. input, approx. 1 volt across 70 ohm line termination.

Power supply, 105-125V, 50-60 cycles.

Power consumption, circuit power, 95 watts max. Oven heater power (intermittent) 70 watts max.

Mounting—std. 19" relay rack.

Dimensions — height, 15¾"; length, 19"; depth, 12½".

Weight—approx. 95 lbs.

As has already been mentioned, the electron image is made visible on a retractable fluorescent screen. This screen can be seen from the observer's position through ports at the base of the microscope. A periscope is provided which also permits viewing the intermediate image from the observers' position. This greatly facilitates the initial adjustments of the specimen and the locating of points of interest on the subject, since the magnification of this image is only about 100 diameters. In order to make this adjustment possible, the stage supporting the specimen is movable, controlled by the operator from the observers' position.

The specimen mounting is quite different for the electron microscope than the ordinary light microscope. A conventional glass slide cannot be used as it would be completely opaque to electrons. Instead the specimen to be examined is mounted on a thin film of notrocellulose which is only about a millionth of a centimeter thick. This film is supported on a small disk of metallic mesh.

The successful operation of an electron microscope depends to a great extent upon the constancy of the voltage supplied to the microscope and of the current in the lens coil. Special voltage and current supplies were constructed for the RCA microscope, having a constancy of better than one hundredth of one percent. A very compact reliable 100-kv unit for use with the instrument was designed, using a radio-frequency resonant transformer to obtain the high voltage.

Although the electron microscope is quite new, and its possibilities relatively unexplored, it stands high among the important scientific achievements of this century. By making visible things which are far too small to be seen with the light microscope it opens up new worlds to the microscopist. Many things of such importance as viruses, structure of micro-organisms, etc., which could only be studied by indirect methods are now revealed. It also makes possible the study of colloids, sub-microscopic fibres, and many other objects too small to have been observed before which are of vital importance to many industries. Thus its use is not restricted to pure science but is fully as important, if not more so, in the realm of industrial research. Figures 3, 4 and 5 are examples of micrographs made with the new RCA Electron Microscope.

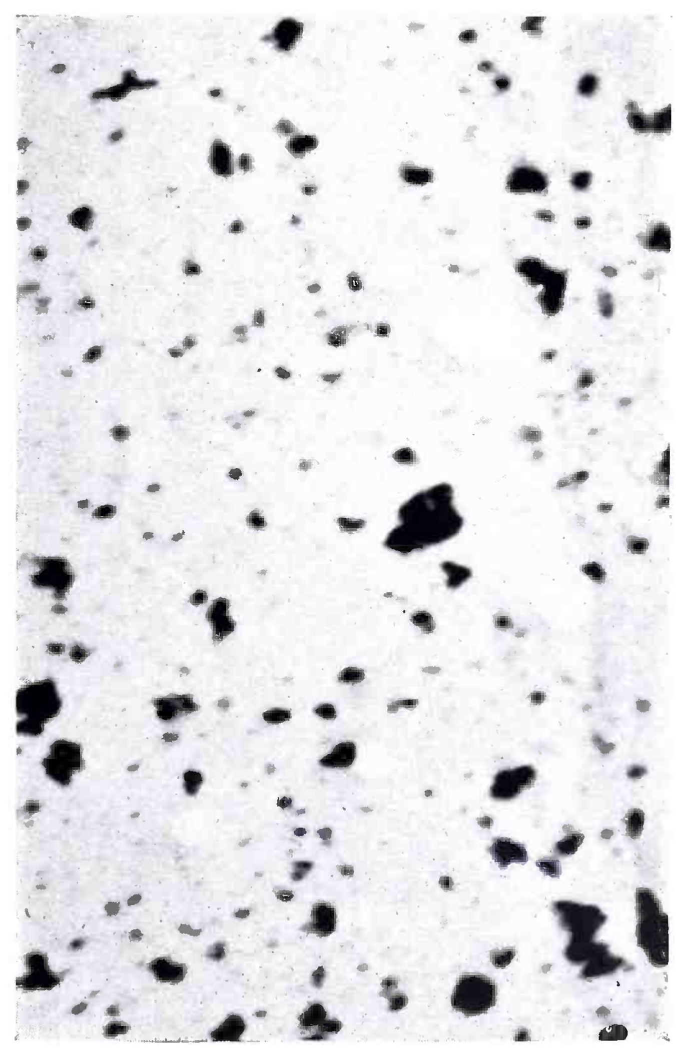
ERRATA

Page 23, Col. 1, March, 1940

$$C = \frac{K(N-2)(N)+1}{KN^2-1}$$

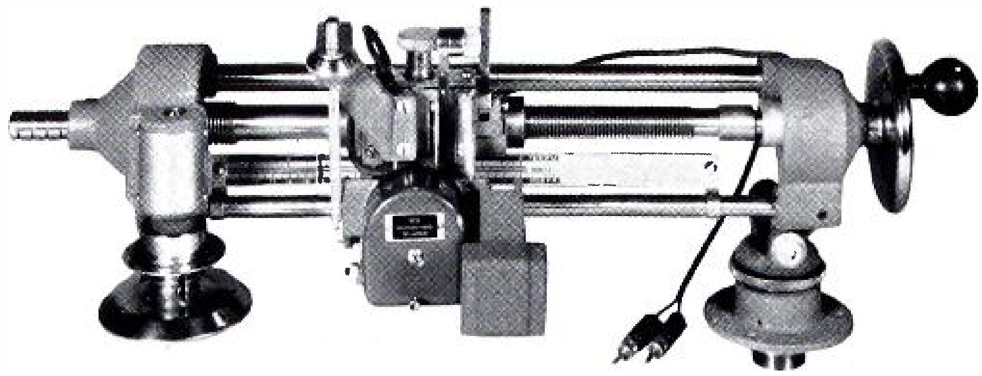
$$E = \frac{C+1}{N}$$

$$\text{Db. loss} = 20 \log \frac{2K-E}{\sqrt{K}\,(1-C)}$$



Colloidal Gold Magnification 25,000.

IMPROVED INSTANTANEOUS RECORDING ATTACHMENT



A NEW and improved instantaneous recording attachment has just been designed for use with RCA's 70-C Transcription Turntable. The new recorder is known as the RCA Type 72-C and offers many outstanding features. When used with a 70-C turntable, it provides a reasonably priced recording equipment with which fine recording can be made. The 72-C can be easily and quickly mounted on a 70-C turntable. No modifications are required, because the 70-C is furnished with the proper mounting holes already drilled. The 72-C may be used with RCA 70-A and 70-B turntables by modifying the platters.

The 72-C is equipped with a highly efficient cutting head which will make recordings with an essentially flat frequency response between 60 and 6000 cycles. The recordings made with the 72-C and 70-C combinations have extremely low noise level, are accurately timed, and free from "wows" and "flutter." The 72-C includes almost every known device for assisting the operator in producing highly satisfactory recording.

A spiralling hand wheel permits the recordist to leave a spacing between musical selections, etc. without breaking the continuity of the groove. A clutch prevents operating the spiralling wheel in the wrong direction.

A timing scale gives an accurate indication of the remaining recording time. The scale is marked for both 78 and 33-1/3 R. P. M. operation. An improved lowering device permits the operator to gently lower the cutter on to the record, thus avoiding stylii breakage or deep cuts from sudden dropping. The angle of the stylus can easily be adjusted at any time by means of a thumb screw which is conveniently located on top of the carriage assembly. The weight of the cutter pressure on the record (which regulates the depth of cut) is controlled by means of the spring tension adjusting nut, also mounted on the carriage assembly.

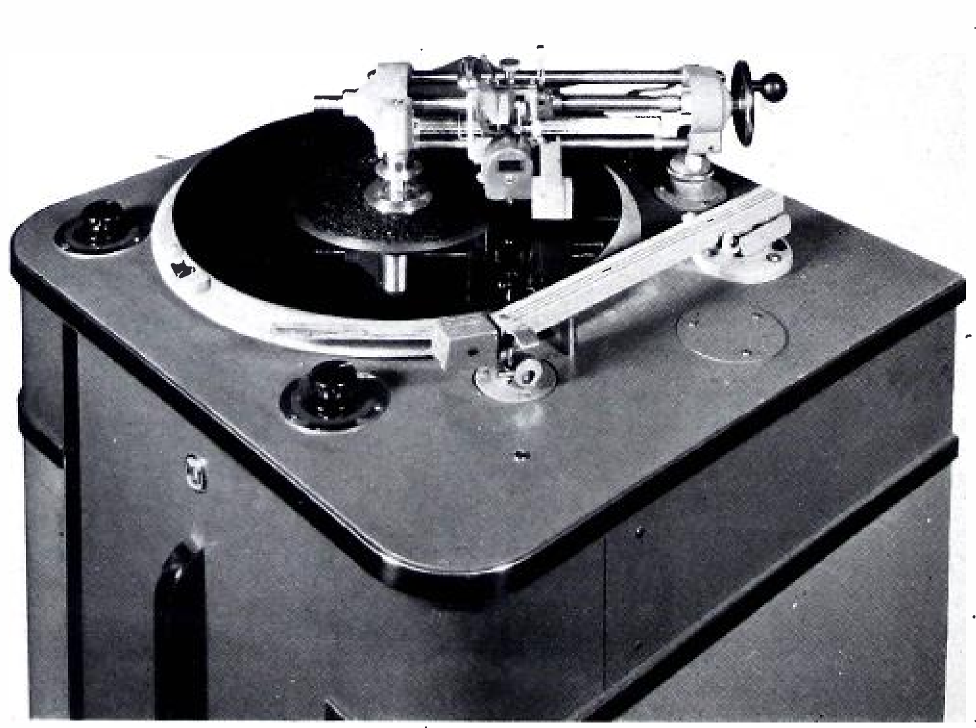
The frame of the 72-C has been made light, and high grade gears reduce the driving friction to a minimum. As a result, the load and wear on the turntable is negligible. A three-pin drive is used and prevents slippage or knocks, which were sometimes noticed on former drives when the turntable and recorder were not accurately aligned.

A lip has been turned on the driving spindle to catch the threads and prevent their climbing into the gears or bearings. A thumb nut on the mounting bearing above the base casting permits the 72-C to be easily aligned horizontally, so the depth of cut will be constant across the entire record. The 72-C is equipped with a stabilizer, which prevents "flutter" or vertical modulation in the recordings.

The feed screw cuts 112 lines per inch, and a multiple tooth driving nut is used. Precision machining assures uniform lines with a minimum amount of grouping.

The 72-C is furnished complete with standard cutter head (15 ohms impedance.) mounting base and rest post. If desired, the RCA MI-4887 High Fidelity Cutter head may be used, in which case the frequency response will be uniform from 50 to 10,000 cycles.

(Continued on Page 33)



The 72-C mounted on the RCA 70 C Turntable.

RCA SPECIAL UNITS REQUIRE SEPARATE PLANT

Indianapolis Division Manufactures Many Speech Input Items

By C. N. REIFSTECK
Chief Engineer, Indianapolis Plant, RCA Mfg. Co., Inc.

IN order to take care of the increasing demand for sound equipment, the RCA Manufacturing Company inaugurated the Indianapolis division in October, 1936, for the exclusive manufacture of sound reproducing equipment of all types, including studio and associated audio equipment for transmitter work. Since the inauguration of this plant, two additional activities have been added in the past two years. These are the manufacture of certain types of radio tubes, and the pressing of phonograph records.

This plant represents a total of 260,000 square feet of manufacturing floor space, and employs approximately 1400 people. Approximately 100,000 square feet are devoted exclusively to sound equipment manufacture.

Self-Contained Unit

This organization is a self-contained manufacturing unit, in that the design engineers and their laboratories, along with the manufacturing, accounting, billing, warehousing and shipping departments are all under the supervision of the Vice President in charge of this plant.

For broadcast station use, we manufacture transcription turntables, loudspeakers, all types of amplifiers, and their associated power supplies, and assemble and test complete custom-built equipment for special station needs.

Because of the precision type of manufacture required for such items, as transcription turntables, recorders and high quality monitor speaker units, a well-equipped and modern machine shop was set up. In this shop are employed a group of skilled mechanics who have been trained for this particular type of work. All mechanical parts are handled in this machine shop so that the quality of the product can be controlled. The Inspection Department on mechanical parts is equipped with the latest means and methods for making accurate checks, and the personnel has been selected and carefully trained for this type of manufacture.

The tests on transcription turntables are conducted in a sound proof room and all records of test by serial number are kept on file for a period of three years.

The tests made on each turntable are as follows:

1. "Wow" or speed constancy at 78 and 33-1/3 R.P.M.

2. Needle point pressure and horizontal friction of the tone arm.

3. Frequency response from 50-10,000 cycles with each setting of the Compensators.

4. Output noise level.

5. Final listening test.

The speed constancy of "Wow" measurement is made on a special unit developed for this purpose. This device will read accurately to one-tenth of one percent speed variation. Needle point and horizontal pressure tests are important to minimize record wear and to insure the best reproduction from the record. The final listening test is made to insure quiet operation of the machine for studio use.

Loudspeakers

Loudspeakers used for monitoring use must be of uniform frequency response within narrow limits from 60 to 10,000 cycles. Special processes of manufacture have been developed to insure maintaining a uniform production. A frequency response curve on each completed speaker and spare cone is made and filed by serial number. This data is kept for reference for five years.

The Sound Pressure Measuring room has been specially constructed to eliminate extraneous noises and to reduce the standing waves to a minimum in order that the room have but little effect on the measurements. To insure accuracy of the measurements the sound pressure equipment is checked at regular intervals and the microphone is periodically calibrated against a standard unit. Sample units from each production run of the various speakers are placed on an accelerated life test to make certain that the product is sturdy.

Amplifiers used in broadcast service must be constructed from parts, tested for long service and the frequency response and distortion must be kept within standards.

Life Tests

It is recognized in the design that component parts must be used only after sufficient life tests have been made to insure long uninterrupted life under continuous operating conditions and in many cases under circumstances which may be considered adverse.

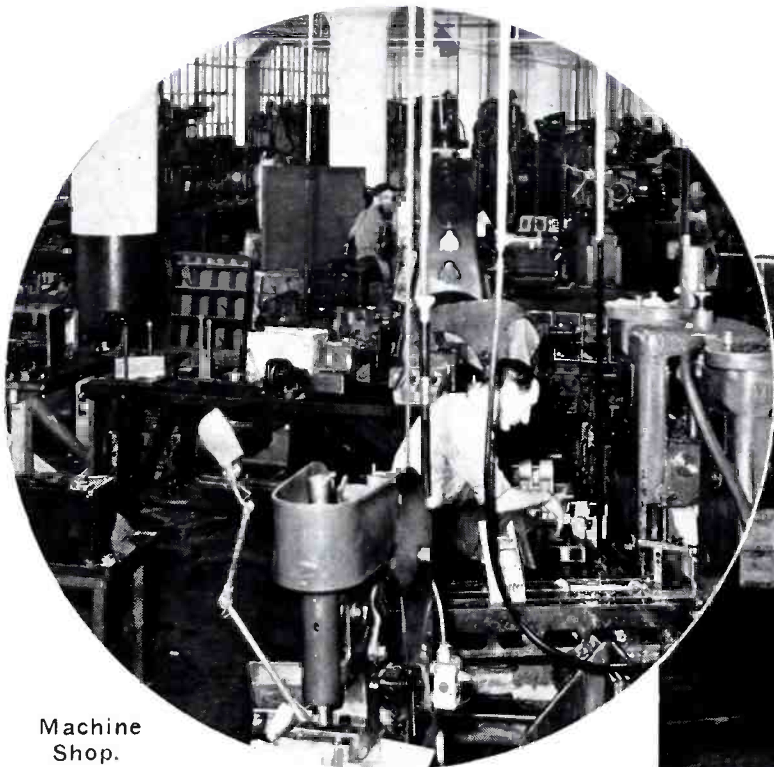
In the manufacture uniformity of product is maintained by supplying the assembly department a complete final approved model in all details including styling. Assemblies are made on what is known as the bench method, whereby a group of amplifier units are lined up on a bench and the operations performed in accordance with a pre-determined sequence to correspond exactly with the model. A typical set up of this method of assembly is shown in the accompanying photographs.

Before an amplifier is tested it is given a complete visual inspection. This consists of checking each component part for proper

(Continued on Page 30)

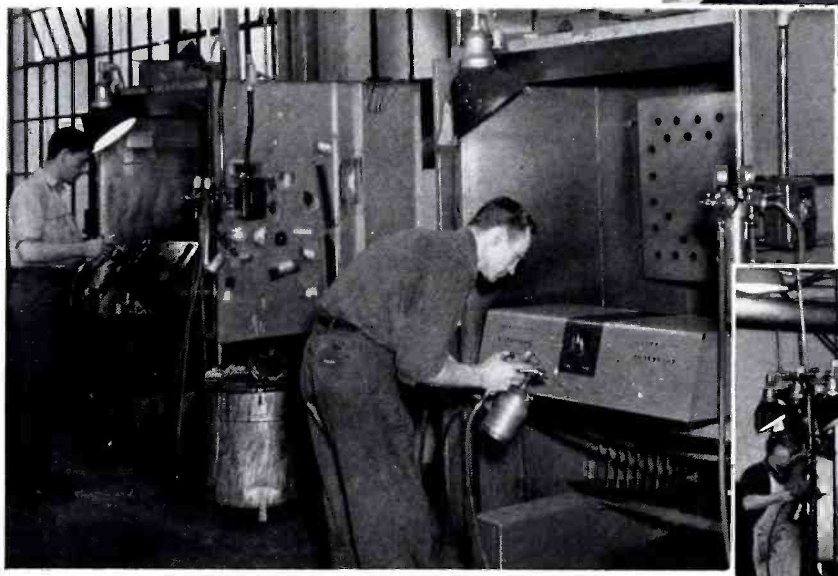
MEN AT WORK

Producing RCA Broadcasting Equipment At Our Indianapolis Plant

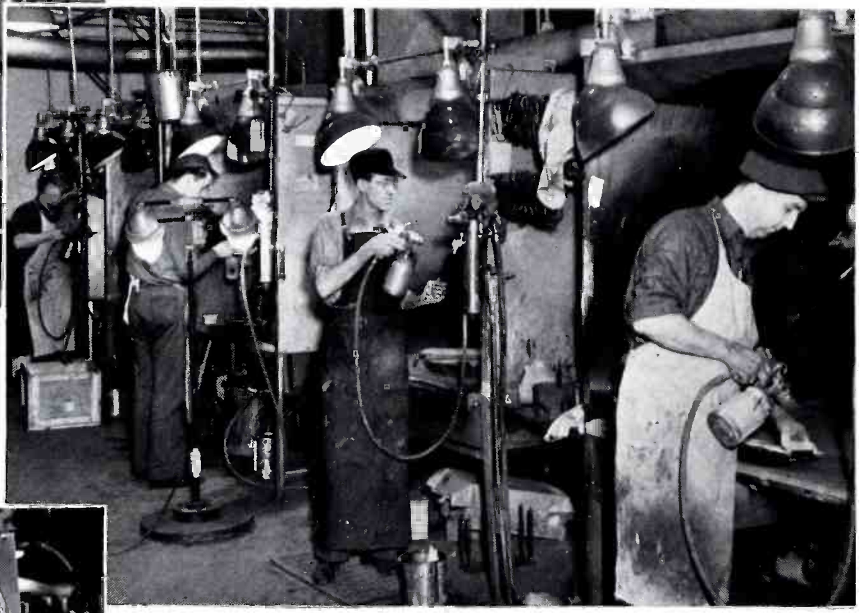


Machine Shop.

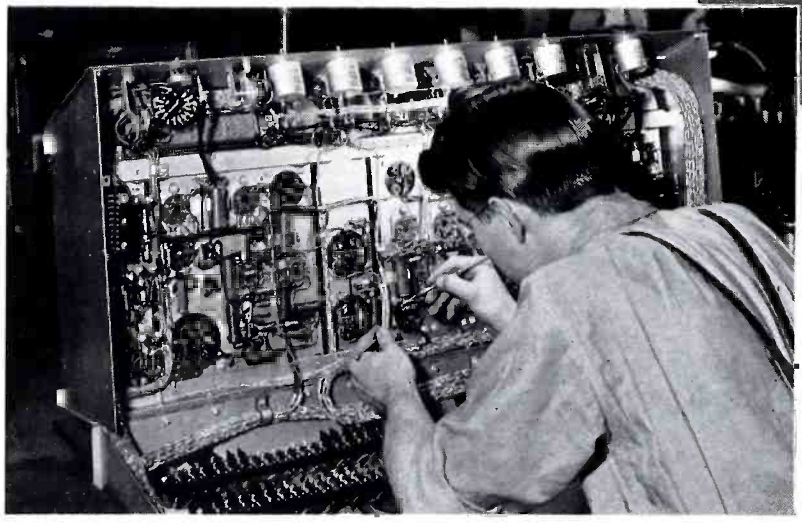
Machine Shop.



Finishing broadcast speech input apparatus.



Paint Booths.



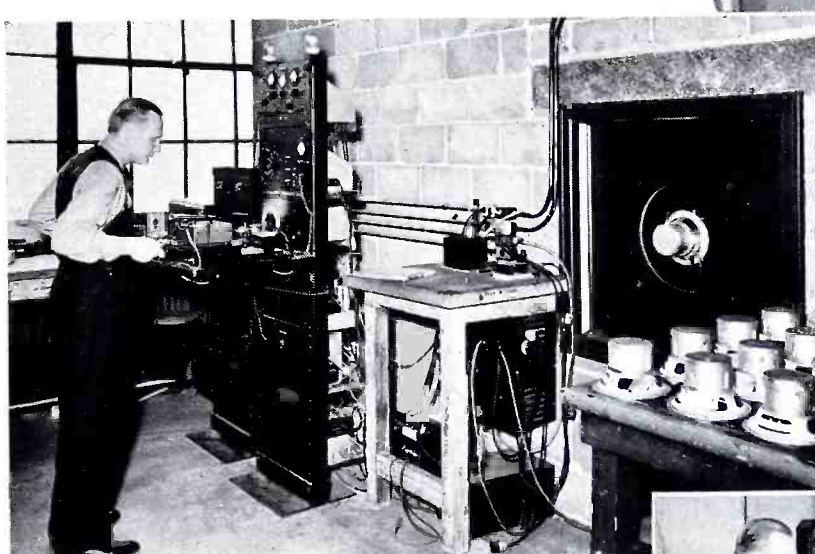
Inspecting 76-B1 Consolette.

FROM THE FIRST WIRE TO THE FINISHED PRODUCT

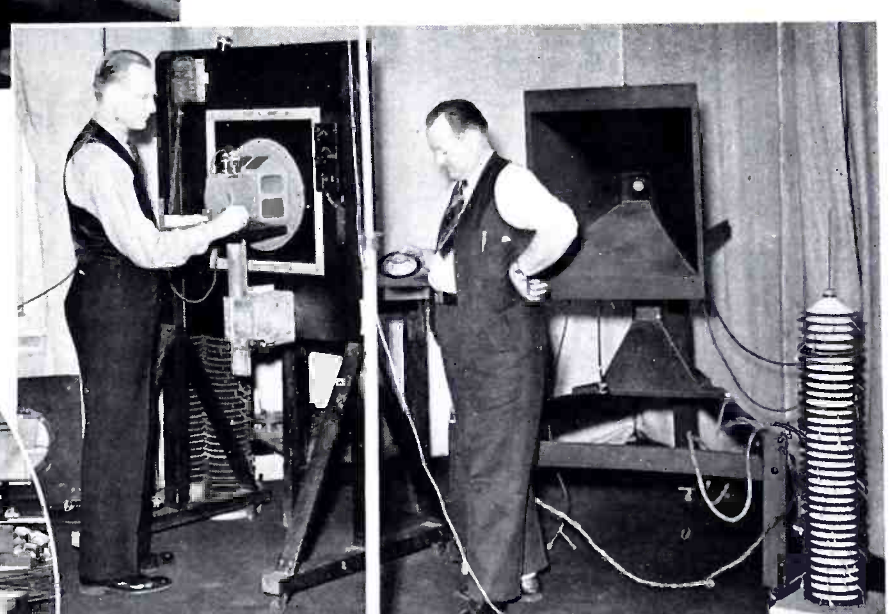
Ready for Shipment at Indianapolis

Assembling 76 B1 Consolettes.

Making "wow" tests on 70-C turntable.



Loudspeaker test. Individual curves are made on each broadcast type speaker mechanism.



Loudspeaker test.

Shipping Dept.

INDIANAPOLIS PLANT

(Continued from Page 27)

location and each individual soldered joint. To inspect the soldered joints a dentist's pick and dentist's mirror are used so there is no possibility of overlooking a connection. This procedure is followed on every amplifier from the smallest unit to the complete custom built equipment.

On each amplifier a complete set of electrical data is taken and this record is kept on file for a period of three years. On individual amplifiers, check tests include frequency response from 30 to 10,000 cyles, distortion at 5 points, all tube voltages and any other special tests relating to the particular unit.

Consolette Check

In checking a 76-B1 Consolette, a set up is made of all the auxiliary equipment duplicating the actual operating conditions of this unit in a studio. For example dummy lamps are set up for studio on-off lights, monitoring speakers and talk back microphones are connected, microphone lines, studio lines and house lines are simulated. All this wiring and set-up is required to check the actual performance of the consolette with respect to key clicks, cross talk, hum, noise, feed back, relay thump, etc. Tests are now run on each channel for gain, input signal, output signal, distortion, frequency response, hum level, noise level, cross talk, key clicks, relay operation and feed back. The complete check of frequency response from input to output properly loaded is made from 30 to 10,000 cycles. The hum level of each channel is checked at full gain and normal operating levels. Gain measurements are made at full gain. The distortion of each channel is checked at 100, 400, 1000, 2500, 5000 cycles on an RCA 68-B low distortion oscillator and RCA 69-B Distortion Meter. After this is complete, all controls, switches, push buttons, etc., are again operated to make sure all adjustments are correct. This unit is now ready for touch up by the paint department and then is given a final visual inspection before packing for shipment.

FLASH-ARC CURRENTS

(Continued from Page 16)

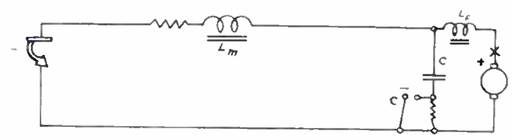


Fig. 3.

denser is maintained at full voltage because of the negligible regulation in the rectifier and the very small inductance of the filter reactor). The rectifier continues to supply the power until the breaker has cleared. At this instant, load current drops rapidly toward zero, but the filter condenser now starts to discharge in an oscillatory manner through the load. The period of this discharge is fixed by the *LC* constant of the circuit. The amplitude of the load current at its first quarter cycle maximum will be:

$$^{m}i_B = E_b \sqrt{\frac{C}{L}} \text{ approximately.}$$

The load current supplied by the rectifier prior to opening of the breaker is given by:

$$i_t = \frac{E_b}{R}\left(1 - \epsilon^{\frac{-Rt}{L}}\right)$$

In this case,

$E_b = 12000$ volts

$R = 29$ ohms

$L_m = 13.5$ henries

$L_f = 0.15$ henries

$C = 90 \times 10^{-6}$ farads.

Load current at time of breaker tripping:

$t = 0.0833$

$$i_t = \frac{E_b}{R}\left(1 - \epsilon^{\frac{-Rt}{L}}\right)$$

$$= \frac{12000}{29}\left(1 - \epsilon^{\frac{-21 \times .0833}{13.5}}\right)$$

$$= 414\ (1 - \epsilon^{-0.13})$$

$$= 414\ (1 - 0.8781)$$

$$= 414 \times 0.1219 = 50.5 \text{ amp.}$$

Maximum load current at the peak of the first quarter cycle of transient oscillation after breaker clears:

$$^{m}i_s = E_b \sqrt{\frac{C}{L}}$$

$$= 12000 \sqrt{\frac{90 \times 10^{-6}}{13.5}}$$

$$= 12000 \sqrt{6.66 \times 10^{-6}}$$

$$= 12 \times 2.58 = 31 \text{ amp.}$$

Resonant frequency of the discharge loop:

$$f_r = \frac{5.033}{\sqrt{LC \times 10^{-9}}}$$

$$= \frac{5.033}{\sqrt{13.5 \times 90 \times 10^{-3}}}$$

$$= \frac{5.033}{\sqrt{1.214}} = \frac{5.033}{1.11}$$

$$= 4.57 \text{cycles.}$$

time to reach ¼ cycle maximum:

$$t_m = \frac{1}{4.57} \cdot \frac{1}{4} = \frac{1}{18.26}$$

$$= 0.055 \text{ sec.}$$

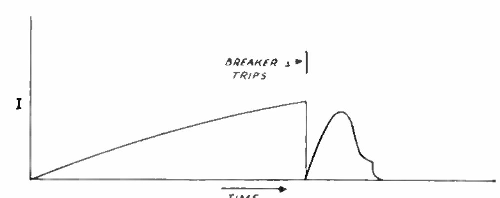


Fig. 4.

When the breaker trips, a high resistance of 10000 ohms consisting of a starting surge suppressor is inserted in series with the condenser. This insertion occurs in approximately 0.1 sec., to that before the oscillating discharge wave has reached the half-cycle point the insertion will have taken place and dropped the current to a very low value, extinguishing the arc.

The current wave during a P.A. arc-over will thus have a characteristic approximately as shown in Fig. 4.

By means of the foregoing analysis an approximate prediction of arc-over conditions is obtained, and we find that the surge limiting resistors used in the P. A. are subjected to very little stress as compared to those used in the modulator.

FEED THE LINE WITH QUALITY

New RCA Remote Amplifier is Light and Compact

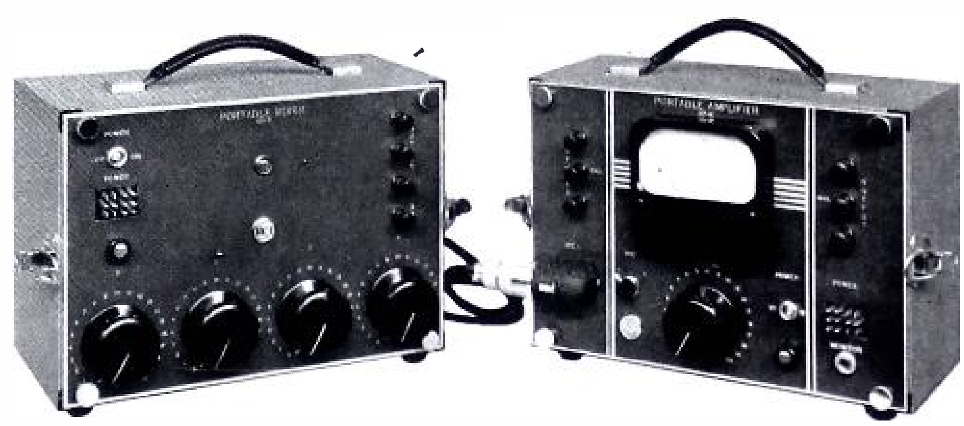
THE latest addition to RCA's line of remote pickup amplifiers are the new OP-6 and OP-7 Equipments. The OP-6 has been designed to provide the broadcaster with a superior quality amplifier which contains all the essentials necessary for making a high quality but economical pickup with one or two high quality microphones. The amplifier is available with or without a volume indicator meter which permits a substantial saving in cost for those cases where a meter is not required. The OP-6 is provided with a panel cutout so that a meter may be added at any time. A cover plate with "ON" lamp covers the cutout when the meter is not used.

The OP-6 is unusual in that it has a completely self-contained AC power supply in a small and light case and yet has a low hum and noise level equal to many elaborate studio installations. There are no external power supplies or transformers to bother with. The OP-6 may be instantly connected for battery operation without making any circuit modifications. A separate battery box is available and is furnished with a cable which when plugged into the OP-6 power receptacle makes all necessary connections for battery operation.

Light and Convenient

Prime requisites of satisfactory portable equipment are that it be light and convenient to use. The OP-6 weighs only 20½ lbs. complete with vu meter and power cord. Its case is small and is provided with a strong, comfortable, steel-reinforced leather carrying handle. The handle lies flat when not in use. In addition, a shoulder strap is furnished for carrying the unit when it is being transported, thus leaving the hands free for microphone, etc. The microphone input receptacle and line output terminals are located on the front panel where they are convenient for quick use. The volume control is equipped with an attractive and comfortable RCA knob designed to relieve gain-riding fatigue. The large size, illuminated, standardized vu meter which is recommended for use with the OP-6 permits better gain controlling and more accurate "peaking" with the studios, networks and line companies.

The performance of the OP-6 is outstanding. A high overall gain of 90 db permits the use of better quality microphones under adverse conditions. The frequency response is flat within ±1 db from 40 to 10,000 cycles. The hum and noise are —59 db below signal level at normal gain settings (70 db gain). The distortion is less than 1% RMS over the entire audio range of 40 to 10,000 cycles at the maximum rated output level of + 19 vu. When used at normal output level (+8 vu.), the distortion is only a fraction of one per cent. The excess output power capability permits better quality on peaks or when high output levels are required to override line noises.



Unique Circuit

A unique circuit using two feedback loops is employed. One is around the first stage and connected with the volume control to automatically maintain the maximum amount of feedback consistent with the gain required. The second feed back loop is fixed at 24 db and is connected around the second and third stages. The three stages utilize the same type tubes, namely, RCA-1620. These relatively low-priced metal tubes have been specially selected for low noise level and long life operation and are non-microphonic. Easily available receiving tubes (6J7) may be substituted in a emergency. The rectifier is an RCA-6X5. The use of only two types of tubes reduces the number of spares. The input transformers are tapped for use with either 30/50 or 250 ohm microphones and the output load impedance is 600 ohms. A 2 db pad is used in the output to isolate the meter and amplifier from varying line impedances. Two inputs are provided and either may be selected by means of a turn key which is mounted on the front panel. One input uses a standard sized Cannon three contact receptacle and the other shielded binding posts. Output terminals are insulated binding posts on the front panel and are convenient for connecting to lines. A monitoring phone jack is connected across the secondary of the output transformers through bridging resistors. The power toggle switch operates with either AC or batteries. A standard glass catridge fuse is used in the leads to the AC power transformers and is inclosed in an insulated socket which is serviceable from the front.

(Continued on Page 33)

CALCULATION OF T.I.F. FOR TRANSMITTER LOADS

By J. C. WALTER

Continued from Previous Issue.

Calculation of T. I. F. and I. T. Product

After computing harmonic currents and voltages, an empirical weighting factor is applied to obtain current T. I. F. and voltage T. I. F. This weighting factor varies with frequency in accordance with an average curve of aural sensitivity. Weighting factors for odd harmonics are given in the following table:

T.I.F. WEIGHTING FACTOR

f	Wtg.	f	Wtg.
60	8.8	1380	6100.
300	440	1500	4500.
420	1100.	1740	3000.
660	2540.	1860	2600.
780	3870.	2100	2000.
1020	11700.	2220	1800.
1140	16100.		

Computation Sheet for Estimate of Harmonic Currents and Voltages in A-C Supply

Data required for estimate of wave shape:

Supply system phase to phase voltage, $V\phi\phi$ =

System phase to phase voltage, Z_{ns} =

Number of rectifier phases =

Three-phase rating of rectifier transformer, KVA =

Percent leakage reactance of rectifier transformer, %X =

Actual power input to rectifier for which estimate is desired, A = KVA.

Calculation:

Leakage impedance of rectifier transformer:

$$Z_{Tn} = \frac{\%X}{100} \times \frac{\overline{V\phi\phi}^2}{1000\,(\text{KVA})} \times n$$

Fundamental current (a-c):

$$I\phi = \frac{1000A}{\sqrt{3}V\phi\phi} = 577.\frac{A}{V\phi\phi}$$

Rectifier Internal Resistance:

$$R_0 = \frac{V\phi\phi}{3\sqrt{3}I\phi} = 0.192\frac{V\phi\phi}{I\phi}$$

Tabulation:

f	I_n amp.	I_n % Fund	TIF Wtg / 100	TIF Wtg. x 100 / % Fund	V_n (ø N) volts	V_n (øN) % Fund	TIF Wtg. / 100	TIF Wtg.x 100 / % Fund
		100				100		
Current TIF RMS				=	Voltage TIF RMS			=

Harmonic Current and Voltage:

$$\bar{Z}_n = \bar{Z}_{sn} + \bar{Z}_{Tn}$$

$$I_n = \frac{K(V\phi\phi)}{3\sqrt{3}n\sqrt{R_0^2 + Z_n^2}}$$

$[K = 1.0 \text{ for 6-phase}]$

$$Vn(_{\phi N}) = I_n Z_{sn}$$

Conclusions

Wave shape distortion will generally be minimized if the rectifier is supplied from a power source of relatively large KVA capacity over a short high voltage circuit. The possibility of adverse effects from this distortion will be minimized where this circuit is a direct feed to the rectifier and is not involved in exposures with telephone circuits.

The distortion of the supply circuit voltage wave shape will generally be less when the rectifier is supplied from a cable network rather than from overhead wires.

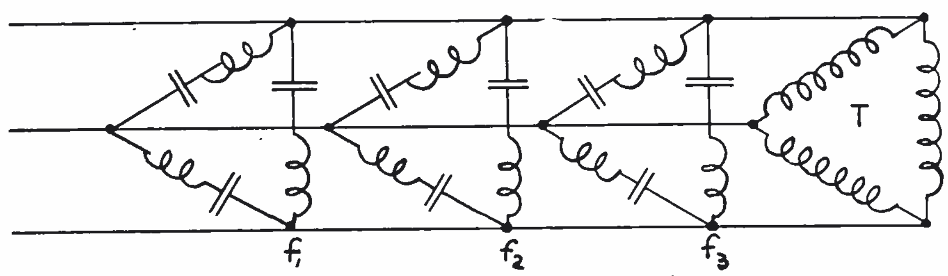
The distortion of voltage wave shape on distribution circuits supplied from the same transmission system as a rectifier may be an important factor. This is especially true where the distribution circuits occupy poles jointly with telephone circuits. As an approximation, the voltage T. I. F. on the distribution system may be assumed equal to the voltage T. I. F. on the transmission system at the point where the distribution system is supplied. The voltage T. I. F. at any point on the transmission system may be estimated by the empirical methods previously discussed.

Corrective Measures

The logical point to apply corrective apparatus is at the source of distortion and in general it is found most economical to insert harmonic filters in the line side of the rectifier transformers. In non-radio applications it is sometimes feasible to use series inductance and shunt capacitors arranged as a half-section low-pass filter in each line. In cases where the system is inductive, shunt capacitors alone may prove sufficient. In radio applications, however, such arrangements are not indicated, since it is essential to hold regulation to a minimum. The most practical solution in such cases appears to be a bank of delta-connected series resonant branches, one branch for each important harmonic. Usually four branches will be found sufficient, resonated at the 13th, 17th, 19th, and 23rd harmonics respectively. These are the important harmonics, due to the very large weighting factors involved in this region. A typical arrangement is shown diagrammatically:

similar equations hold for L_2C_2, L_3C_3, L_4C_4.
Primed value of X^t is at f_1, double primed value at f_2 etc.
r = total resistance of shunt arm.

In the case of direct power feed, the most effective location for the



Schematic: Delta-connected shunts.

All quantities referred to distribution voltage.

$$2\pi f_1 L_1 10^{-3} = \frac{10^6}{2\pi f_1 C_1}$$

$$2\pi f_2 L_2 10^{-3} = \frac{10^6}{2\pi f_2 C_2}$$

$$2\pi f_3 L_3 10^{-3} = \frac{10^6}{2\pi f_3 C_3}$$

$$2\pi f_4 . L_4 . 10^{-3} = \frac{10^6}{2\pi f_4 C_4}$$

$$Q_1 = \frac{2\pi f_1 L_1 10^{-3}}{r_1}$$

$$Q_n = \frac{2\pi f_n L_n 10^{-3}}{r_n}$$

B_1 = effectiveness desired $= \frac{V_n}{V^1_n}$ at frequency f_1

B_2 = effectiveness desired $= \frac{V_n}{V^1}$ at frequency f_2

When shunts are connected delta:

$$L_1 = \frac{3X^1 t Q_1 10^3}{B_1(2\pi f_1)} \quad \text{MH}$$

$$C_1 = \frac{10^9}{(2\pi f_1)^2 L_1} \quad \text{MFD}$$

filter is on the line side and immediately adjacent to the rectifier transformer. Frequently in radio station applications two voltage transformations are made between the supply feeder and the rectifier. In situations of this character the most effective location for the filter appears to be between the two transformer banks. If a regulator is used, the filter should be on the line side of the regulator.

RECORDING ATTACHMENT

(Continued from Page 26)

Other attachments are an outside-in feed screw and timing scale, and an automatic frequency compensator which partially overcomes reproducing needle loss by increasing amplitude of the higher frequencies as the recording cutter approaches the center of the record.

REMOTE AMPLIFIER

(Continued from Page 31)

The cabinet is sturdily constructed of rust-proofed steel with welded corners and with long wearing gray wrinkle finish.

The cabinet is equipped with rubber feet to prevent scratching any surface on which it may be placed. The lid is securely held in place by two strong, loop-type, pull-down fasteners. When in place, the lid covers all controls, meters and receptacles, thereby preventing injury from bumps, dust, etc. A schematic circuit diagram of the amplifier is fastened in the lid.

A Jones power input receptacle is mounted on the front panel and is used for both AC and battery operation. The AC cord is furnished with the OP-6 and the battery cord is supplied with the battery box. Both cords are provided with Jones plugs and the contacts are arranged to automatically connect the amplifier circuit for the proper source of power, thereby preventing any possibility of accidental damage. The AC cord furnished with the O-P-6 is 8 ft. in length, covered with high quality rubber and equipped with a non-breakable rubber AC plug. The power cord is stored in the lid when not in use.

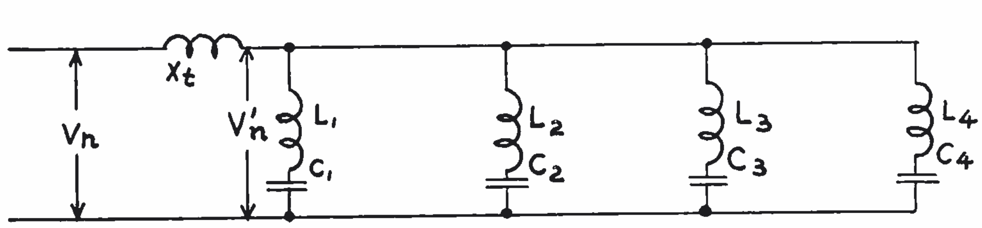
The possibility of separate purchases of basic amplifier unit, vu meter, battery box and separate four-position mixer (Type OP-7) provides a maximum of flexibility in obtaining remote equipment which can always be made to meet any pickup requirement at a minimum of cost.

Type OP-7 Remote Preamplifier-Mixer

The RCA Type OP-7 Remote Preamplifier-Mixer is a four position high level mixer for AC or battery operation and contains a built-in AC power supply. Use of the OP-7 permits mixing four high quality microphone channels without the increase of noise level which results from the use of low-level mixers. It matches the appearance of the OP-6 Remote Amplifier with which it has been designed to operate, however, it may be used with any amplifier having adequate gain.

Each mixing channel has a one stage preamplifier — utilizing an RCA-1620 low noise level tube. The rectifier employs one RCA 6X5. Specially shielded RCA audio and power transformers are used. As a result, the hum level

(Continued on Page 34)



Phase-neutral equivalent circuit

REMOTE AMPLIFIER

(Continued from Page 33)

is 60 db below normal output. The frequency response is flat within ±1 db from 40 to 10,000 cycles. The distortion is less than 0.5% RMS when measured at any frequency from 40 to 7,000 cycles at normal output. It does not exceed 1% RMS at the maximum output level of —30 vu. Although equipped with high grade carbon volume controls which have been proved to give long satisfactory performance in actual field use, sufficient mounting space is left for installing standard step-by-step type mixers.

Tapped input transformers are provided for use with 30/50 and 250 ohm microphones. Four standard Cannon 3-connector receptacles are mounted on the back of the case. The output load impedance is 250 ohms and is terminated in a Cannon receptacle on the back of the case and on binding posts. An interconnection cable is furnished for use with the OP-6 and is equipped with Cannon plugs. Should the interconnecting cable become lost or damaged, emergency connections by means of wires may easily be made between the binding posts on each unit. When not in use, the interconnecting cable and AC power cords are stored in the lid.

The OP-7 is mechanically similar to the OP-6 described above. It weighs only 22 lbs. including cables. A shoulder strap is included and a weather proof fabric cover is available on separate order. The fabric cover completely encloses the case, thus protecting the rear microphone receptacles. The OP-6 battery box is furnished with two power cords permitting simultaneous operation of both the OP-6 and OP-7 from the same set of batteries.

TWO NEW 1-G's

(Continued from Page 14)

sag. The usual procedure of adjusting for sag in a level transmission line by simply tightening each end of the wire and having the sag conveniently and automatically even up between each span, was out of the question in view of the steep incline on which the line was built. It was found that the bottom span invariably received more than its quota, making it necessary to adjust each span individually.

Exceptionally comfortable and spacious living quarters are provided for in the transmitter building, including twin beds for two operators, running water facilities and showers, modernly equipped kitchen, and sitting room. As can be seen from the accompanying photograph of the transmitter and speech input equipment, everything has been symmetrically and conveniently laid out.

Although the picking of a suitable site for the Timmins transmitter did not present the same difficulties that were encountered at Kirkland Lake, considerable trouble was experienced before a suitable location was decided upon and approved by the Department of Transport. Unlike Kirkland Lake, there is a comparatively large amount of cleared farmland in the immediate vicinity of the city, 50% of it surrounding Lake Porcupine. At first it appeared as though all that would be necessary would be to take our choice. However, our hopes in this regard were soon shattered when it was pointed out to us by the Department of Transport that in view of the vertical radiator we intended using, which constituted a flying hazard, we would not be allowed to locate on or near the shores of Porcupine Lake, the lake being a very active air base. This development of affairs confined our search to a very small area of suitable farmland west of the city, where power, roads and telephone lines were available. In view of the presence of these facilities, however, and the fact that every foot of this land had been cleared of bush by hard-working pioneers at a very high initial cost, the price of property in this sector made it almost economically out of the question to purchase it for the sole purpose of building a radio station on it. We managed to get around this obstacle, however, by agreeing to bury all ground radials deep enough so that the ground could still be used for agricultural purposes.

The transmitter installation at CKGB, Timmins, is very much the same as Kirkland Lake in that the antenna is of the same manufacture and an RCA 1-G transmitter is employed. CKGB was originally intended to operate on 960 kilocycles and has a one-sixth wave antenna 176 ft. in height and 120 ground radials each 423 ft. long buried 17 inches under the surface. These radials were put in with the help of a special cable plough loaned to us by John E. Lingo, Inc.

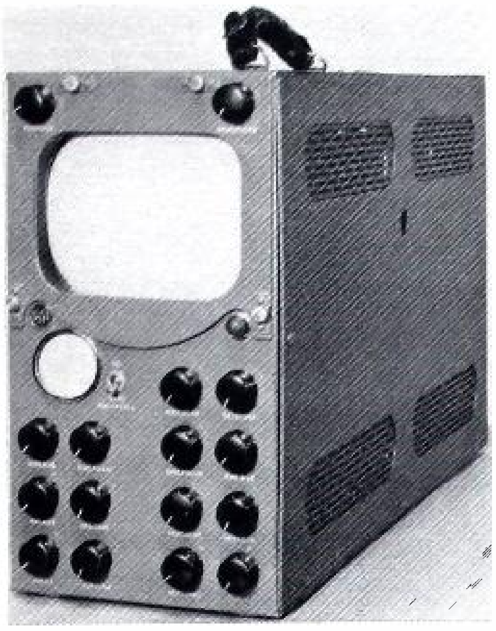
At the present time, CKGB is operating on a frequency of 1440 kilocycles awaiting the outcome of the continent-wide frequency reassignments, at which time it is expected that 960 kilocycles will be avaliable for permanent use.

The transmission line at CKGB is of the same four-wire open type as that used at Kirkland Lake, and is approximately 400 ft. long. The transmitter speech input systems at both CKGB and CJKL consist basically of RCA 96-A limiting amplifiers along with the regularly associated mixing and termination apparatus, usually found at a transmitter house. Monitor equipment includes RCA 66-A modulation meters, with General Radio Frequency monitors and Deviation Meters.

A new ultra-modern building is under construction in the heart of the city at Timmins which will house a complete new set of studios for CKGB. These studios will be of the very latest in architectural design and will be equipped with the last word in studio speech equipment. At the time of writing, CKGB's new home is rapidly nearing completion and it is expected that occupation will take place in early summer. After completion, a description of these studios will probably be published in Broadcast News.

TELEVISION EQUIPMENT

(Continued from Page 13)



Camera Control Unit.

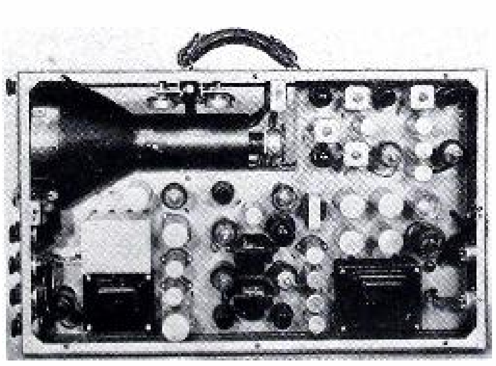
spot welded in position to increase the over-all rigidity. On one side of the chassis, all circuit components such as resistors and capacitors are located; on the other side are the tubes and transformers. The method of construction makes servicing surprisingly easy in view of the compactness of the apparatus.

In a normal field set-up, the Synchronizing Generator, Master Control and Camera Control units are grouped closely together in a location central to the camera pick-up points where the cameras and their respective auxiliaries are located. Thus, from this central location, the pictures from every camera can be observed prior to selection by the Master Control for feeding the transmitter.

The location of the transmitter depends to a large extent upon the physical nature of the terrain, surrounding buildings, etc. In locations where considerable antenna height is necessary in order to obtain line of sight transmission to the receiving antenna, it is not always practical to run a long transmission line from the transmitter to its directive antenna. The operating frequency of the relay carrier is in the neighborhood of 300 megacycles, and most types of transmission line available at present have rather high losses at this frequency, hence, it is desirable to keep the line length as low as possible. An alternative is suggested, then, by the fact that almost any coaxial cable is capable of carrying video signals over comparatively long runs without introducing excessive losses. For these reasons, it is often the case that the transmitter is installed in a position that allows the shortest possible run to the antenna, even though a long video cable connection to the Master or Camera Control is necessary.

Master Control Unit.

(To Be Continued)



Internal side view of Camera Control Unit showing method of construction.

AR-77

(Continued from Page 23)

Symmetry of plan has been achieved in the design of the cabinet and a durable wrinkle finish of umber gray has been placed on the surfaces which receive the greatest wear. The lighter, smooth, umber gray finish between the polished metal trim completes the color scheme.

The chassis can be installed on a standard 19-inch rack by attaching a special front panel and mounting supports that are available for this purpose.

The rack mounting panels for both the chassis and the loudspeaker have a smooth black finish or choice of color may be specified on special order.

The factor of "eye appeal" is of importance when the constant view by the operator is considered. The effects of size, shape and color have been given careful attention in the design of the AR-77.

VOLUME INDICATOR

(Continued from Page 7)

Conclusion

The cooperative investigation, development and standardization of the standard volume indicator, reference level and the term "vu" was primarily for broadcast program service, however, it is hoped that these standards will find usage and adoption in other allied fields in the communications industry.

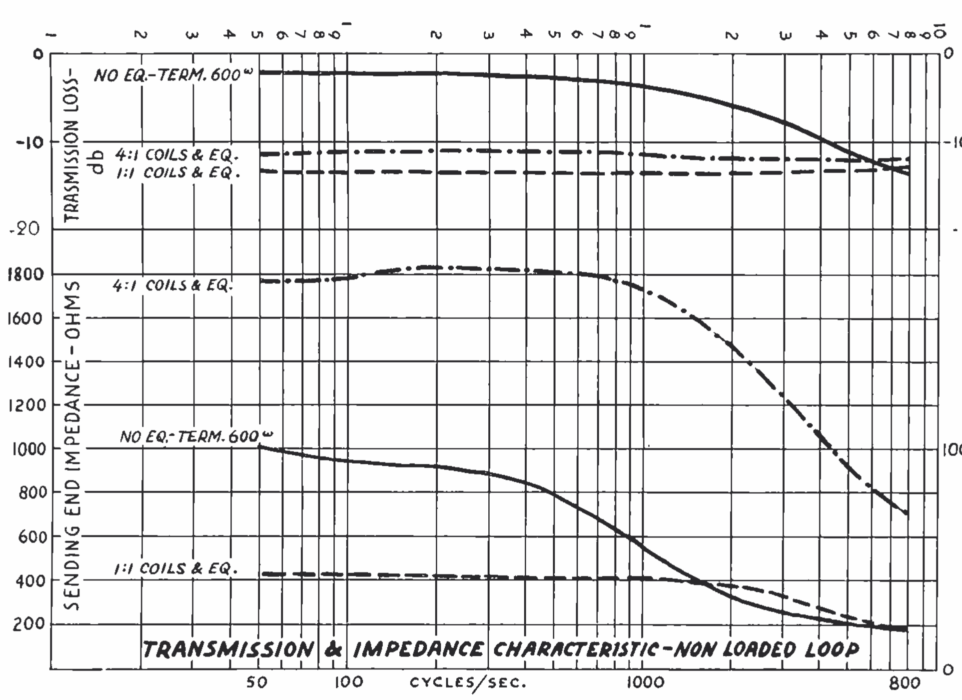


Fig. 6.

NEW RCA 64-B SPEAKER

Gives Wide Angle Sound Distribution

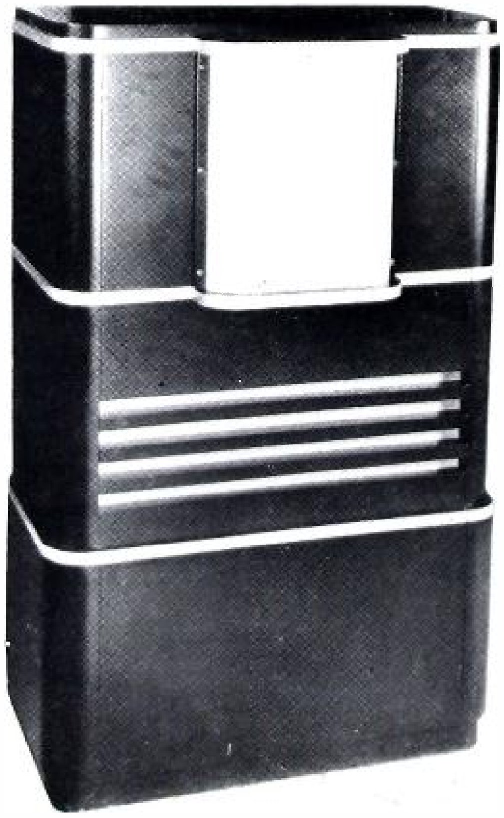
A REDESIGN of the well-known RCA 64-AX monitoring Loudspeaker has just been announced. It is known as the RCA 64-B Monitoring Loudspeaker and differs from the 64-AX in that improved cabinet styling and a new permanent magnet mechanism have been employed.

The 64-B Loudspeaker has been designed primarily for broadcast control room monitoring but its superior reproducing qualities make it ideally suited for offices, audition rooms, lobbies and wherever high quality is of prime importance. The functional cabinet construction blends harmoniously with almost every interior decorative design and is available with black, umber gray or walnut finishes.

RCA's double voice coil speaker mechanism and folded horn cabinet have been combined in the 64-B to reproduce what is probably the widest frequency response band ever obtained in such a small cabinet. All the frequencies between 60 and 10,000 cycles are faithfully reproduced with exceedingly low distortion through this coordinated design of speaker and cabinet. Cabinet resonance or boom is completely eliminated by means of the folded horn and because the back is closed, the cabinet may be placed against a wall without affecting the performance. Cabinet construction using heavy, seasoned wood with rigid reinforcing prevents annoying vibration buzz.

A unique feature of the 64-B is its wide angle of sound distribution. Diffusing vanes are located in front of the cone and effectively spread the high frequency radiation over a 100 degree arc at 10,000 cycles. Thus it is possible to enjoy high fidelity reproduction at all parts of the room and not just directly in front of the speaker.

The speaker mechanism is equipped with a permanent magnet field which requires no power supply and connecting leads. The highest quality magnet material plus correct pole piece design permits the use of a permanent magnet without loss of efficiency or power handling capability. The unusually high sensitivity of the 64-B Loudspeaker (20 bars at 4 feet for 1 watt input) provides much more acoustic volume with lower amplifier powers than is generally obtained in ordinary speaker design. The unit is rated at a power input of 10 watts at 300 cycles, constant tone.



The 64-B with the base.

A Hubbell Jr. twist lock receptacle is provided in the rear of the cabinet for the external audio connections. A matching plug is furnished.

The 64-B may be obtained finished in black, walnut, RCA umber-grey or RCA transmitter grey. The weight unpacked is 90 lbs and the overall dimensions are 33" high, 29" wide and 19" deep.

Matching base cabinets are available for installations requiring an amplifier associated with each speaker. This cabinet serves as a mounting base for the 64-B and as a housing for a speaker driving amplifier such as the RCA 82-B. The base cabinet weighs 27 lbs, and its dimensions are 13¾" high, 30½" wide and 20" deep.

THE RCA HAM GUIDE

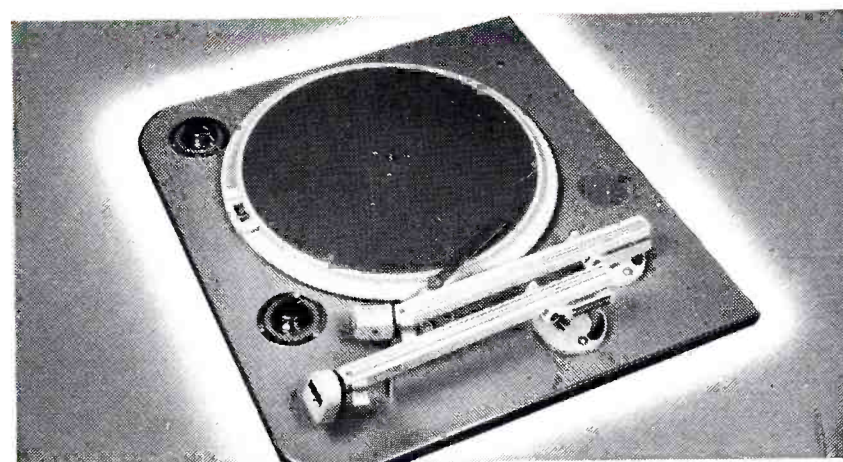
Forty-eight pages filled with timely technical information for radio amateurs on transmitter construction, transmitting-tube circuits and tube data. Easy-to-build rigs designed from "mike to tank"; latest in cathode modulation; "hot" plate modulated and c-w rigs; straight-forward single-stage circuits; up-to-the-minute data on tubes like the 802, 806, 807, 808, 809, 810, 811, 812, 828, etc. Richly illustrated, it is a radio transmitter book you will want in your shack. A boon to the new-comer; indispensable to the old-timer. Available through RCA Power Tube Distributors, or send 15c direct to the Commercial Engineering Section, RCA Manufacturing Co., Inc., Harrison, N. J. Ask for the new RCA Ham Guide.

RCA EQUIPMENT FOR HIGH FIDELITY

Recording and Reproduction of Transcribed Programs

OVER 1400 RCA 70 SERIES transcription turntables are now in use. Surely this is impressive evidence of the high regard broadcasters have for the performance of this equipment. Designed to meet every requirement of all types of transcribed programs, RCA equipment gives maximum dollar for dollar service.

• **RCA 70-C Turntable With Lateral Pickup!** Long wear Diamond Point Stylus. Frequency response 30 to over 9,000 cycles. Low distortion. High quality Lateral Reproducer, adjustable filters for properly reproducing all recordings. Accurate timing. Low noise level in reproduction, operates quietly. 33⅓ and 78 RPM—speed change mechanism in rim where it can be seen at all times and can be changed quickly. Quiet starting synchronous motor with gear speed reducer provides accurate timing. Large flywheel which always revolves at 78 RPM. Large front door provides complete accessibility. Finished rear of cabinet improves appearance.



• **Vertical Pickup Attachment Type 71-C.** Proper frequency response in reproducing present day vertically cut recordings is assured by a new compensator. The tone arm is similar in appearance and construction to the lateral tone arm of the 70-C. Pickup head is of the moving-coil type with a diamond point stylus.

• **Instantaneous Recorder Attachment Type 72-C.** Complete with fittings to adapt it for use on 70-C turntable. RCA "float stabilizer" prevents "flutter." High quality 6,000-cycle cutting head. Three pin drive prevents slippage and eliminates knocks. Spiraling handwheel permits separating selections without breaking continuity of groove. New lowering mechanism prevents damage to stylus. Accurate and convenient adjustments for stylus pressure and angle.

FOR FINER PERFORMANCE... GO RCA ALL THE WAY

Microphones
Speech Input Systems
Associated Equipment
Transmitters

Use RCA Radio Tubes in your station for reliable performance

RCA **Broadcast Equipment**

RCA Manufacturing Co., Inc., Camden, N. J. • A Service of the Radio Corporation of America

for highest-fidelity monitoring

NEW RCA 64-B SPEAKER

50 to 10,000 cycle response

Famous RCA 64-AX Loudspeaker restyled and redesigned with permanent magnet field which requires no power supply

DESIGNED with the exclusive RCA double voice coil mechanism and folded horn cabinet, the RCA 64-B Monitoring Loudspeaker reproduces what is probably the widest frequency band ever obtained in so small a cabinet. High frequency diffusing vanes in front of cone, spread high fidelity response over a wide angle.

Low Distortion With High Power

Coordinated design of speaker and cabinet reduces harmonic distortion to a new low. And the sturdy, reinforced cabinet is built to eliminate resonance and vibration.

More Acoustic Volume With Less Amplifier Power

The unusually high sensitivity of the RCA 64-B Loudspeaker provides much more acoustic volume with lower amplifier powers than is generally obtained in ordinary speaker design. The highest quality permanent magnet material together with correct pole design permits the use of a permanent magnet without loss of efficiency or power handling capability.

Double Voice Coil Reproduces High Frequencies Naturally

No separate or "tweeter" speakers are required—and the RCA 64-B delivers outstanding performance at a low cost.

The pleasing modern design of the RCA 64-B makes it desirable for use in studios, offices and lobbies. Available in black, umber-grey—or walnut, it blends in with any interior design. A matching base cabinet may be used in installations requiring an amplifier—such as the RCA 82-B—associated with each speaker.

$70 in black or grey. $75 in walnut.

FOR FINER PERFORMANCE... GO RCA ALL THE WAY

Microphones
Speech Input Systems
Associated Equipment
Transmitters

RCA Broadcast Equipment

RCA Manufacturing Co., Inc., Camden, N. J. • A Service of the Radio Corporation of America

New York: 1270 Sixth Ave. • Chicago: 589 E. Illinois St. • Atlanta: 530 Citizens & Southern Bank Bldg. • Dallas: Santa Fe Bldg. • San Francisco: 170 Ninth St. • Hollywood: 1016 N. Sycamore Ave.