This article describes the use of a scanning belt in both the camera and receiver. It is from a 1933 book called Radio Construction and Repairing, by James Moyer and John Wostrel.

CHAPTER XIX

THE TELEVISION RECEIVER

Transmission of Television Pictures.—A brief description of one method used at station W1XAV, Boston, Mass., in the transmission of television pictures is necessary for a clear

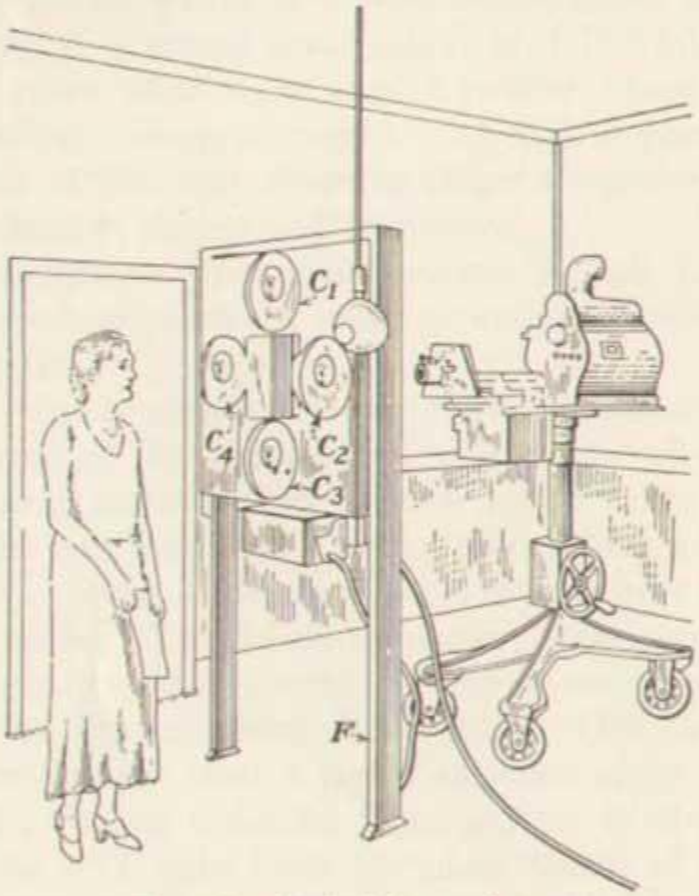

Fig. 169.—Television projector.

understanding of the apparatus required for a television receiver.

The source of light in the studio is a 3,200 candle-power electric arc. The rays of light are directed by a parabolic mirror toward a thin metal *scanning belt* 15 inches in diameter which is revolved horizontally by a synchronous motor

operating on 60-cycle alternating current. Around the edge of this belt there are 48 square holes equally spaced and arranged in a spiral; the first hole is close to the top edge of the belt and the last hole is placed the farthest away. When the scanning belt moves, rays from the arc light pass through one hole at a time and then through projection lenses like those used in moving picture machines. These lenses focus the light rays in spots on the figure or object to be transmitted by television. Thus the object or figure in front of the television transmitting apparatus is scanned by 2,304 spots of light every twentieth of a second or by 46,080 spots per second. These spots of light must be put together in the receiver to form the complete picture.

FIG. 170.—Photo-electric cell for television projector.

As shown in Fig. 169 the object is viewed by four photo-electric cells, C_1, C_2, C_3, and C_4, which are placed in a vertical frame F. The kind of photo-electric cell used in this apparatus has a 12-inch glass bulb evacuated of air but containing a small amount of the inert gas argon. The front of the photo-electric cell (Fig. 170) is transparent so that light can enter. The rear of the cell is covered with a coating of the alkali substance known as metallic potassium, which has the property of emitting electrons when it is struck by a light ray. Each photo-electric cell has two terminal wires, one being connected to the metallic coating on the inside of the cell and the other to a nickel electrode placed centrally in the bulb. The electrons emitted from the metallic coating pass to the positive central electrode; the quantity of electrons emitted increases as then amount of light entering the cell is increased. In other words, the photo-electric cell "views" the object (the person standing in front of the frame F), and produces a varying or pulsating current which is used in the transmission of the image of the object.

The rays of light which are directed from the light source toward the object are reflected from that object to the photo-

electric cells C_1, C_2, C_3 and C_4. The amount of light reflected from the surface of the object depends somewhat on the color, smoothness, and other characteristics of the surface. Thus in the scanning of a face, the hair, eyebrows, and lips, being relatively dark, reflect less light than parts of the cheek or nose. When a spot of light strikes the object, the reflected rays of greater or less intensity pass into the photo-electric cells and release electrons in them in amounts varying according to the light intensity.

The weak current from the photo-electric cells goes to a vacuum-tube amplifier and then to a modulator (p. 435) of six stages of high power. In a typical television transmitting station the carrier wave (p. 432) has a wave length of 141 meters, or a frequency of 2,120,000 cycles. The carrier wave is amplified and the output goes to a 50-watt vacuum-tube transmitter where it is modulated by the light from the picture. Finally the modulated wave is amplified by two 1,000-kilowatt tubes.

Television Receiving Equipment.—Receiving equipment of one type[1] which is available commercially consists, as shown diagrammatically in Fig. 171, of a television receiver R, a synchronizing amplifier A (Fig. 172), a power supply unit P (Fig. 171), and the device for showing the picture. A lens about 6 inches square is set in the front panel of the cabinet of the receiving equipment. The control apparatus includes an on-and-off switch S, a tuning dial D, and a volume control V which affects the *quality* of the picture. After the switch S is moved, the dial D is turned until a picture is seen plainly through the lens.

The *device* for showing the picture consists of a *scanning belt* B (Fig. 173) supported on a frame driven horizontally by a motor M, a neon lamp, and a lens (not shown in the figure). The scanning belt is, in general, of the same type as the one already described, having 48 square holes H each 0.020 inch on a side, and spaced equally in the form of a spiral. The motor M is of the synchronous type, rated at $\frac{1}{15}$ horsepower. The synchronous type is necessary because both the trans-

[1] Shortwave and Television Laboratory, Boston, Mass.

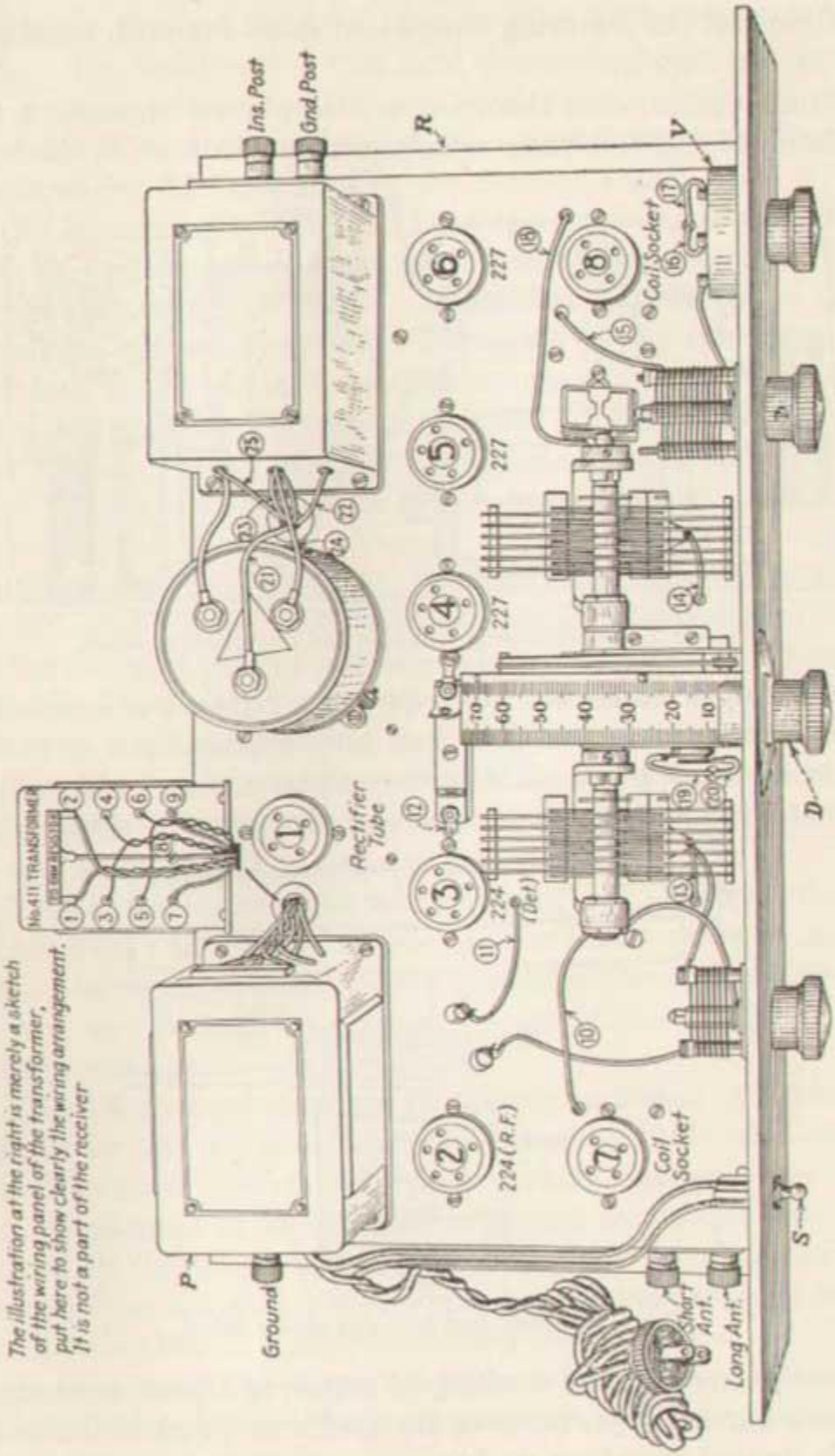

FIG. 171.—Television receiving equipment.

mitting and the receiving equipment must run with exactness at the same speed.

In the operation of this receiver, the picture appears on the "plate" of the *neon lamp* which corresponds here to the loud

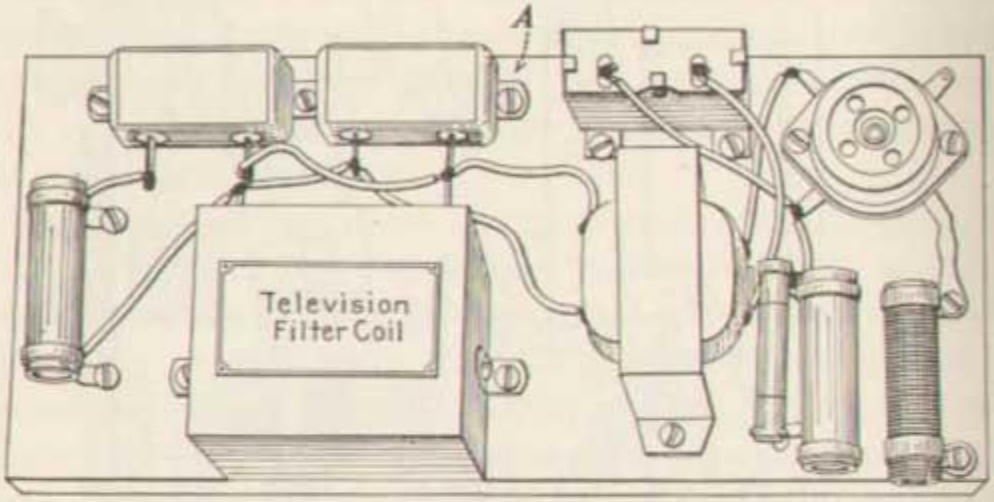

FIG. 172.—Synchronizing amplifier for television receiver.

speaker of a radio set for receiving "broadcast" signals. This neon lamp is a sealed glass bulb containing a quantity of the inert gas neon. The bulb contains a nickel *plate* which is connected to the negative side of the circuit including the

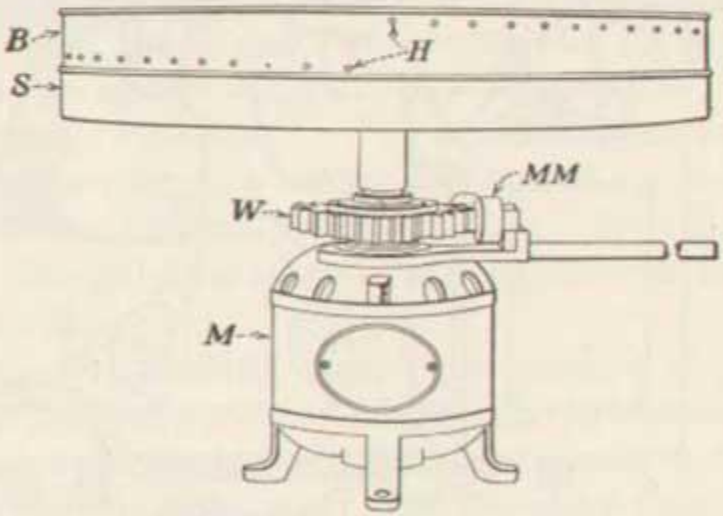

FIG. 173.—Scanning belt and motor drive.

photo-electric cell, and a wire *grid* requiring a positive charge. When a current flows between the grid and the plate the neon gas is ionized, breaking up into charged particles (atoms and electrons). The collision or bombardment of these particles

causes the plate of the neon lamp to glow with an orange-red light. The brilliancy of this light decreases if the voltage on the grid and the plate of the neon lamp is reduced, and increases if the voltage is increased. This change in voltage is produced by the variations in the received signal.

The neon lamp is placed behind the scanning belt *B* (Fig. 173) so that a spot of light is thrown through each hole in succession as the belt turns. The illusion of 48 lines of light travelling downward in rapid succession is produced because each hole in the belt is dropped a distance equal to its diameter below the position of the preceding hole during one revolution, and because of the high speed of the scanning belt. Each spot of light is on the plate of the neon lamp for one forty-thousandth of a second. Owing to the retentivity of vision; that is, the phenomenon that the image of an object is retained by the eye for some time, the 2,304 spots of light are retained on the retina of the eye and form a complete picture. Because this happens 20 times a second the eye is unable to distinguish the individual pictures and sees them in motion as a moving picture of the object. The received image on the plate of the neon lamp is about 1 inch square and is magnified by the lens to appear on a surface 4 inches square.

The picture is brought into "frame" by a control device which varies the motor speed. If the receiver is not on the same alternating-current power system as the transmitter the picture can be kept in view by means of this synchronizing adjustment.

There is no fixed standard for the transmission of television signals as may be seen from the following table of stations. The television receiving equipment which has been described can be adapted to any particular system by using a scanning belt with the proper number of holes, and by changing the speed of the motor. A motor speed control is provided which gives either 900 or 1,200 revolutions per minute.

In most cases the television equipment can be connected to an existing antenna without interference with the reception of a broadcast program.

LIST OF ACTIVE TELEVISION STATIONS

Call letters	Location	Power, watts	Lines	Pictures per second	Frequency, kilocycles per second
W1XAV	Boston	500	48 and 60	15 and 20	2,120
W9XR	Chicago	500	24	15	2,850 to 2,950
W3XK	Washington	1,500	48	15	2,050 and 2,900
W2XCR	Jersey City	1,500	48	15	2,800
W2XBU	Beacon, N. Y.	100	24	15	2,000 to 2,100
W2XR	Long Island City	500	48	15	2,160
W2XCW	Schenectady	20,000	48	20	2,150
W8XAV	East Pittsburgh	.....	60 and 72	20	2,050
W2XBS	New York City	250	60 and 72	20	2,100
W9XAO	Chicago	1,000	45	15	2,000 to 2,100
W9XAP	Chicago	1,000	45	15	2,750 to 2,850

Television Receiver.—This instrument has two stages of tuned screen-grid radio-frequency amplification, a non-regenerative screen-grid detector, a three-stage audio-frequency amplifier with resistance coupling, and a power stage with one UX-245 tube. Resistance coupling is used in order to obtain the necessary frequency range, a television picture containing frequencies which vary from 10 to 40,000 cycles. With transformer or impedance coupling the limiting frequency is usually at about 8,000 cycles. This receiver will tune wave lengths from 15 to 550 meters for the reception of music, speech, television images, or code messages. It is designed to be operated from a 50- to 60-cycle, 110- to 115-volt alternating-current circuit. The television receiver is so designed that by changing the four *plug-in coils* shown in Fig. 174 it becomes a regenerative receiver covering a wave-length band of 15 to 550 meters. One of these plug-in coils is wound with No. 12 enameled wire; the other three having Nos. 14, 16 and 25 enameled wire. Each of these coils is on a bakelite form

1⅞ inches in diameter and 3⅝ inches high. A wave-length range of 16 to 225 meters is covered by the four coils shown. With a variable condenser of 0.00005-microfarad capacity these coils will cover the 10- to 80-meter band.

FIG. 174.—Plug-in coils for television receiver.

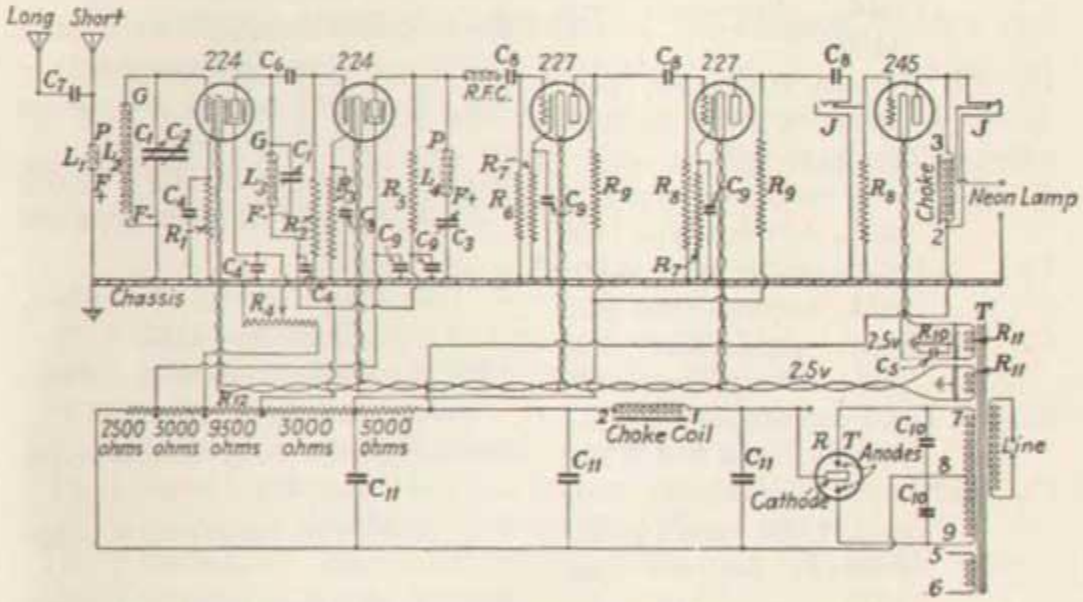

FIG. 175.—Circuit diagram for television receiver.

The circuit diagram is shown in Fig. 175, and the list of parts[1] is given in the following table. The symbols in this parts list are the same as those shown in the figure.

[1] The parts listed for this television equipment may be obtained at S. S. Kresge stores in the principal cities.

List of Parts for Television Receiver

	1	Metal panel, 8 by 21 inches
	1	Aluminum chassis
	2	Sets of plug-in coils (each set consisting of coils L_1-L_2, L_3-L_4, L_5-L_6, and L_7-L_8
	1	Special television coil
	1	Drum dial (type 1285) with light
C_1	2	Variable condensers, Hammarlund MLW type 150
C_2	1	Variable condenser, midget type J-13, and knob
C_3	1	Variable condenser, midget type J-23, and knob
	1	Toggle switch type 609
C_4	3	Fixed condensers, 0.02 mfd., Averovox type 1450
C_5	1	By-pass condenser, non-inductive 2.0 mfd., Aerovox type 261
C_6	1	Fixed condenser, 0.00015 mfd., Aerovox type 1450
C_7	1	Fixed condenser 0.00005 mfd., Aerovox type 1450
C_8	4	Fixed condensers 0.25 mfd., Aerovox type 260
C_9	4	Fixed condensers 1.0 mfd., Aerovox type 261 XX
C_{10}	2	Buffer condensers 0.02 mfd. 1,000 volts (direct-current), Aerovox type 1070
C_{11}	1	Electrolytic condenser, 3 sections, Aerovox type E5-888
R_1	1	Resistance 400 ohms Aerovox No. 992
R_2	1	Resistance (metallized), with pigtails, 1 watt, 5 megohms
R_3	2	Resistances (metallized) with pigtails, 1 watt, 50,000 ohms
R_4	1	Potentiometer, 50,000 ohms, Electrad
R_5	1	Resistance (metallized) with pigtails, 1 watt, 100,000 ohms
R_6	1	Resistance (metallized) with pigtails, 1 watt, 0.5 megohm
R_7	2	Wire grid resistances, 4,000 ohms (Electrad)
R_8	2	Resistances (metallized) with pigtails, 1 watt, 0.25 megohm
R_9	1	Resistance (metallized) without pigtails, 1 watt, 50,000 ohms
R_{10}	1	Resistance, 2 watt, 1500 ohms, (International)
R_{11}	2	Center-tapped resistances 20 ohms, type 354
R_{12}	1	Voltage divider, 25,000 ohms, Aerovox type 996 SW
J	2	Phone jacks, 3 contact, Frost type 1165
RFC	1	Radio-frequency choke coil, Baird type 100
Choke	1	Choke coil, double type, No. 431
T	1	Power transformer, type 411
RT	1	Rectifier tube, Raytheon BH
	4	Tube sockets, type 216
	4	Tube sockets, type 217
	2	Vacuum tubes, type 224
	2	Vacuum tubes, type 227
	1	Vacuum tube, type 245
	1	Fixed rheostat, type 201A
	1	Grid leak mounting, Aerovox type 1049
	1	Phone plug, type 309

LIST OF PARTS FOR TELEVISION RECEIVER.—(*Continued*)

RT	1 Loud speaker, Magnavox No. 410	1 Bakelite strip, 8½ by 1¾ by ⅛ inches, type 1001
	2 Antenna binding posts (Eby)	1 Assembly package, type 1000
	1 Ground binding post (Eby)	1 Spool of solder (rosin core)
	5 Binding posts, plain (Eby)	50 feet of flexible hook-up wire, rubber-covered

L_1-L_2 is the plug-in coil in No. 7 socket and L_3-L_4 is the coil in No. 8 socket.

A top view of the layout of the apparatus and the wiring is shown in Fig. 171, and a bottom view in Fig. 176.

Synchronizing Amplifier.—This unit consists of one stage of power audio-frequency amplification. It takes the 720-cycle note from the neon lamp circuit, and amplifies it enough to operate the small synchronous motor on top of the large motor. This small motor consists of the magnet holder and the synchronizing tooth wheel with the magnets. The layout of the apparatus of the *synchronizing amplifier* for the television unit is shown in Fig. 172. The wiring diagram and the wiring connections are given in Fig. 177.

LIST OF PARTS FOR SYNCHRONIZING AMPLIFIER

T	1 Audio transformer, 6 to 1 ratio (Dongan)
F	1 Filter coil, television type, Baird No. 200
N	1 Neon lamp, 1-inch plate
C_1	2 Fixed condensers, 0.25 mfd., Aerovox type 260
C_2	1 Fixed condenser, 1.0 mfd., Aerovox type 200 S
R_1	1 Resistor, 4,000 ohms, Aerovox type 992
R_2	1 Resistance (metallized) with pigtails, 1 watt, 50,000 ohms
R_3	1 Resistance, 1,000 ohms, Aerovox type 992
R_4	1 Variable resistance, 2 ohms, 25 watts, Electrad type B.02
	1 Vacuum tube, type 245
	1 Tube socket, type 216
	1 Baseboard, 4 by 10 inches

Scanning Belt Unit.—The motor which turns the *scanning belt* (shown in detail in Fig. 178), and the motor controls, are shown in Fig. 173. The motor connections for this unit are given in Fig. 179. The symbols used in these figures are the same as those which appear in the parts list.

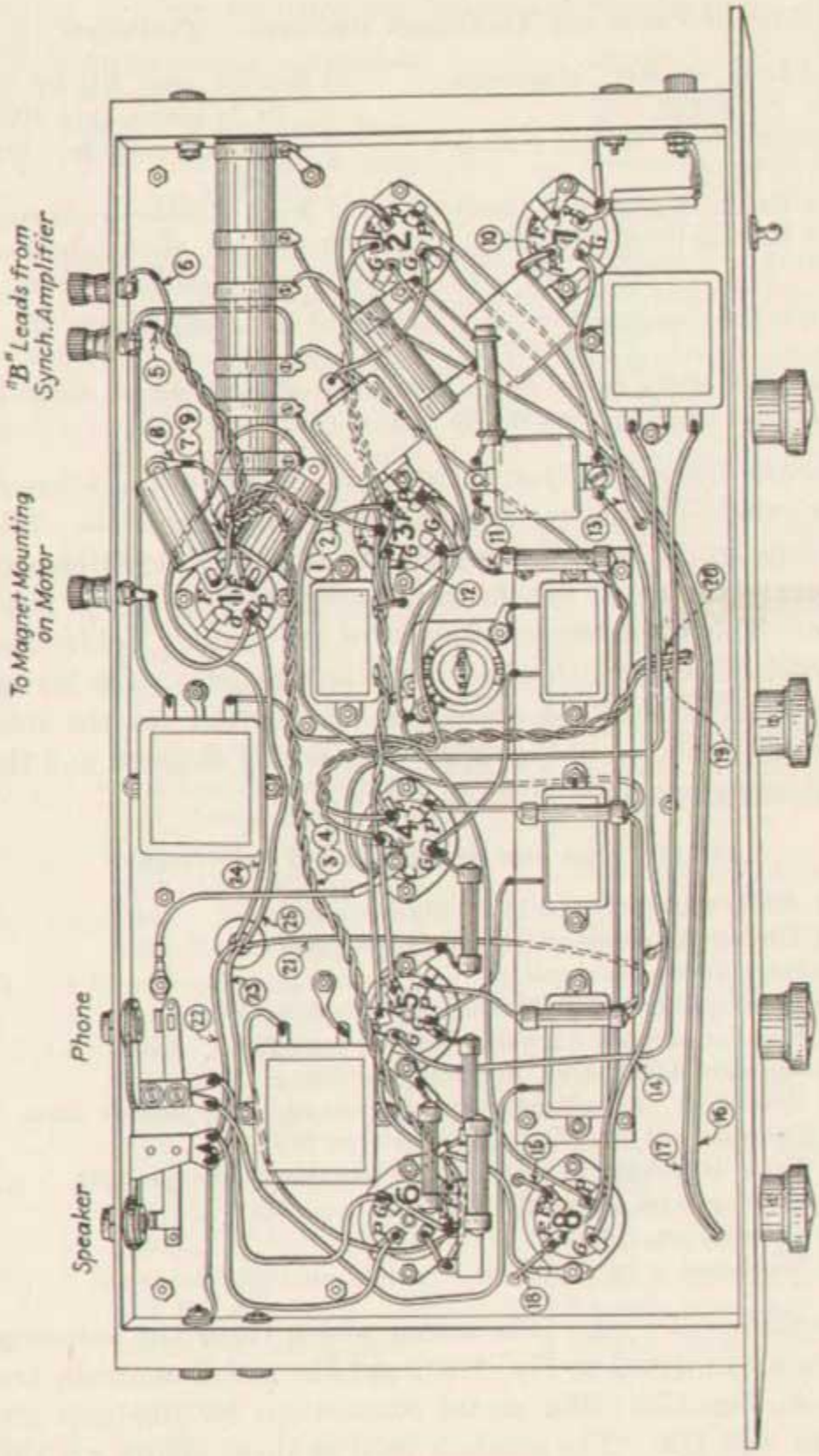

FIG. 176.—Bottom view of television receiver.

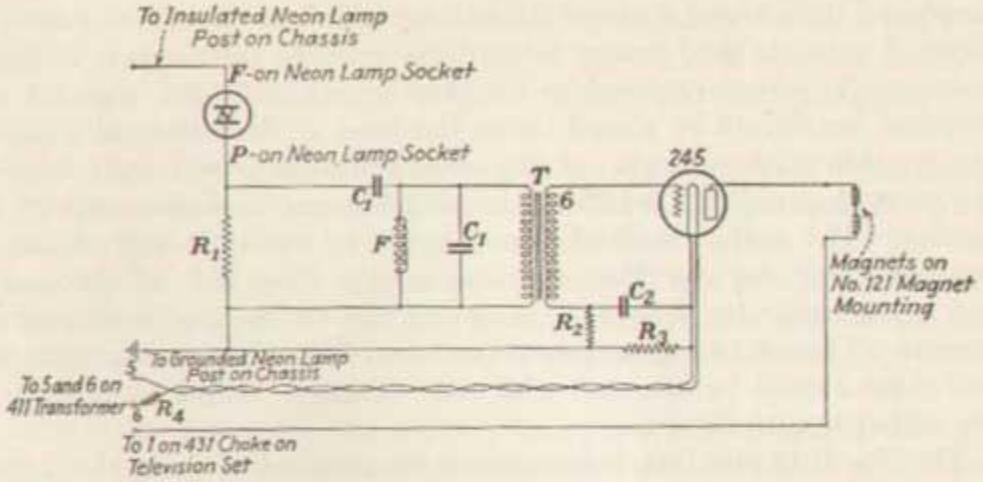

FIG. 177.—Wiring diagram of synchronizing amplifier.

LIST OF PARTS FOR SCANNING-BELT UNIT

M 1 Vertical motor, variable speed, 1/15 horsepower, Baldor type 120
C 1 Fixed condenser, oil impregnated, Aerovox type A-1409
R 1 Rheostat, power type, with knob, Centralab type GR-150
MM 1 Magnet holder, type 121
W 1 Synchronizing wheel, 48 teeth, type 122
S 1 Spider for scanning, type 123
B 1 Scanning belt, 48-hole, type 124
SW 1 Switch, alternating-current type
1 Magnifying lens, 3 inches square, type 125
1 Fixture cord and plug
1 Cabinet of suitable size

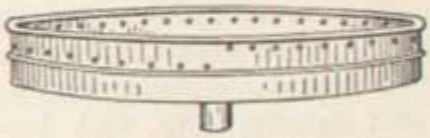

FIG. 178.—Details of scanning belt.

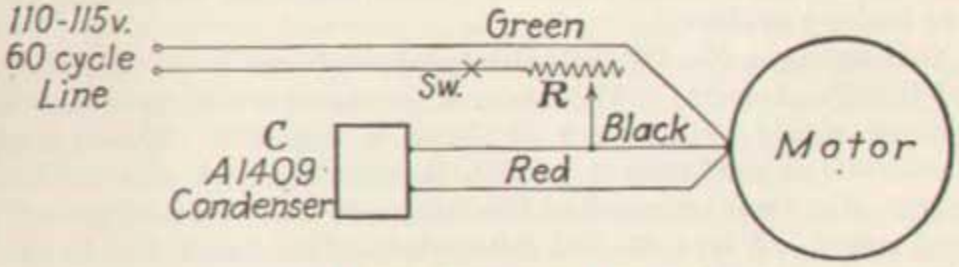

FIG. 179.—Diagram of motor connections.