A Receiver for the New Amateur Television System

A 112-Mc. Band Superhet With Three-Inch Kinescope

BY J. B. SHERMAN*

THIS article describes a picture receiver for use in the amateur television system.[1] The receiver is of the superheterodyne type, and is intended to cover the 112–116-megacycle amateur television band. A three-inch Kinescope is used, either the type 3AP1/906-P1 (green screen) or 3AP4/906-P4 (white screen) being suitable.

The complete circuit diagram is shown in Fig. 1, and the chassis layout is shown in Fig. 2. A 956 acorn-type pentode is used as first detector with a 6J5 as oscillator. There is no r.f. stage. There are two i.f. stages using 6AC7/1852's. The second detector is one-half of a 6H6, followed by one 6AC7/1852 video stage. The other half of the 6H6 is used as a detector for synchronizing purposes only. This diode feeds a 6SC7 double triode, the first half of which is used as amplifier and the second half as sync separator. Multivibrators containing one 6SC7 each are the scanning oscillators. Each feeds one-half of a 6F8G double triode which delivers the vertical and horizontal saw-tooth deflecting voltages to the Kinescope deflecting plates.

The Kinescope is operated at 1500 volts second-anode potential, obtained inexpensively from a small receiver power transformer with two 5U4G's in a voltage-doubling circuit. This power supply also furnishes 750 volts for the 6F8G deflecting output circuit. The remainder of the tubes are operated from a low-voltage 5Y3G supply.

Circuit Features

The Aladdin i.f. transformers used in this outfit are designed to tune to 13.25 Mc. This means a difference in choice of 26.5 Mc. in oscillator frequency, depending on whether it is selected above or below the signal frequency. For the sake of improved oscillator performance the oscillator frequency is placed 13.5 Mc. below the signal frequency, so that its tuning range is 97.5 to 101.5 Mc.

These i.f transformers are well-suited to the requirements of the receiver. When they are peaked at 13.25 Mc., without loading, the overall response from antenna to Kinescope shows a characteristic which is down 50% at both sides of a 1-Mc. band. It will be recalled that the video band delivered by the modulator [1] is approximately 200 kc. wide, making the double-sideband transmission about 400 kc. This band is handled in the receiver with no appreciable loss.

A cathode-bias control on the first i.f. tube provides gain control.

It will be recalled that the synchronizing signals exceed the maximum video level by approximately 25%, and must be extracted from the composite signal by amplitude selection. This is

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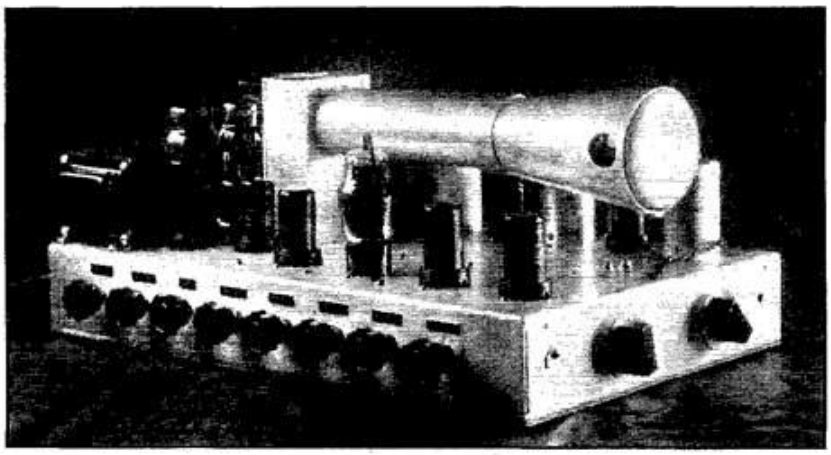
[1] "A New Electronic Television Transmitting System for the Amateur," by J. B. Sherman, *QST*, May, 1940.



Designed for amateur television reception on the 112-Mc. band, this unit complements the camera-modulator described in May *QST*.

Actual-size unretouched photograph of received 120-line picture, transmitted on a 114-Mc. carrier modulated by the unit described in May *QST*. Due allowance should be made for definition lost in photographing and printing processes.

accomplished in a triode-type separator. The composite signal is supplied with the sync signals, having positive polarity, to the second triode of a 6SC7 (V_2) with grid-leak bias. When the plate voltage is reduced sufficiently the video portion is clipped and only the sync impulses remain. The separator operation is improved by operating its grid with positive bias in addition to the grid-leak bias. Should it be desired to change the clipping level, R_{21} and R_{65} may be varied. The sync impulses appear in the separator output with negative polarity, which is correct for direct application to the scanning oscillators.

A form of multivibrator is used for the saw-tooth-wave generator. Referring to Fig. 1 and selecting the vertical oscillator as example, it is seen that the saw-tooth voltage is developed across C_{28} by charging this condenser through R_{26}. By causing triode V_2 to develop low-plate resistance, C_{28} is discharged. This is accomplished by feeding back voltage from the plate of V_2 to the grid of V_1, the amplified voltage at the grid of V_2 having the form of a large positive impulse which periodically causes V_2 to be conducting for a short time and thus discharge C_{28}, after which the saw-tooth cycle repeats.

The horizontal and vertical oscillators are similar except for constants, the frequencies being respectively 3600 and 30 cps. The vertical size control consists of the potentiometer R_{28} across the oscillator output, which is perfectly satisfactory for the low frequency and makes the frequency independent of the size control; however, this type of control results in loss of high-frequency components when applied to the horizontal. The horizontal size is therefore controlled by varying the supply voltage with R_{36}. This voltage control makes the frequency vary somewhat with size, but offers no difficulty in adjustment since the picture is normally of fixed size.

A filter with large time constant (R_{30}–C_{26}) is inserted in the vertical oscillator plate supply in order to minimize the effect of line voltage fluctuations. This is not necessary in the horizontal circuit because the constants are such that little fluctuation is transmitted.

The multivibrators offer the advantages of employing inexpensive tubes and parts; of synchronizing reliably with impulses of the order of only tenths of a volt; and of synchronizing directly with impulses of negative polarity, which is the polarity furnished by the type of sync separator used in this receiver.

A technical article on television reception is no novelty in *QST*. There have been over a dozen on the subject during the past several years, as shown by the bibliography elsewhere in this issue. But this particular article is novel because it is the first to describe a television receiver for purely amateur communication using our own standards on our own 112-Mc. band, in contrast to the others which described receivers restricted to use with transmissions from b.c. stations using commercial standards on the lower-frequency television band. The general principles remain the same, of course, and the reader is referred to the other articles listed in the aforementioned bibliography for a liberal education on the fundamentals.

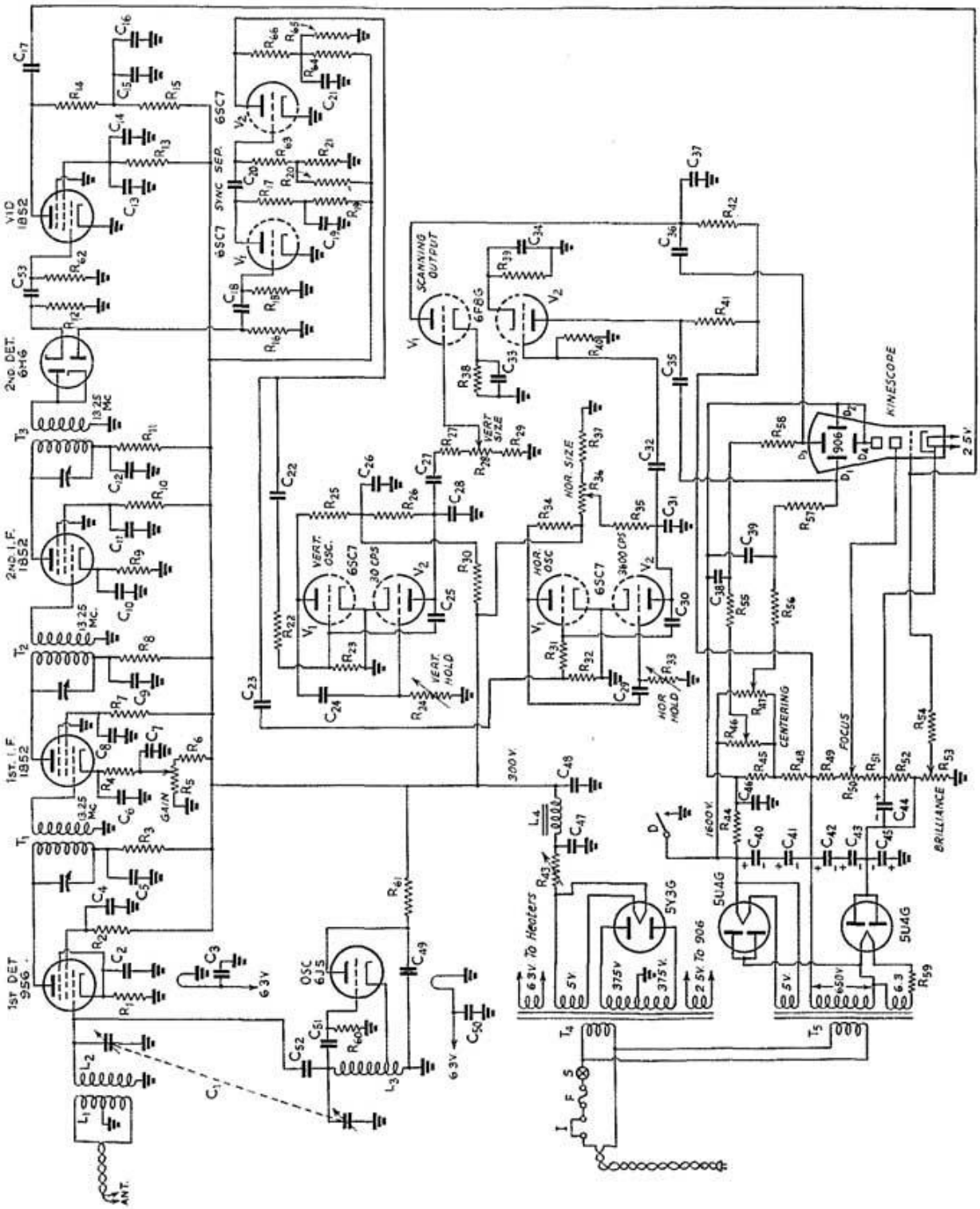

1ST DET 956
OSC 6J5
1ST. I.F. 1852
2ND. I.F. 1852
2ND. DET. 6H6
VID 1852
6SC7 SYNC SEP.
SCANNING OUTPUT
6F8G
VERT. OSC.
HOR. OSC
KINESCOPE
906
5U4G
5Y3G
To Heaters
To 906
ANT.
GAIN
VERT. HOLD
VERT. SIZE
HOR. SIZE
HOR. HOLD
CENTERING
FOCUS
BRILLIANCE
300 V
160 V
25 V

Fig. 1 — Circuit of the amateur television receiver.

R_1 — 3000 ohms, ½ w.
R_2, R_{25}, R_{34}, R_{44} — 0.2 meg., ½ w.
R_3, R_{12}, R_{65} — 10,000 ohms, ½ w.
R_4, R_9 — 160 ohms, ½ w.
R_5 — 3000-ohm pot.
R_6, R_{19}, R_{37}, R_{49} — 0.1 meg., ½ w.
R_7, R_{10} — 60,000 ohms, ½ w.
R_8, R_{11} — 4000 ohms, ½ w.
R_{13} — 75,000 ohms, 1 w.
R_{14}, R_{15} — 10,000 ohms, 2 w.
R_{16}, R_{17}, R_{30}, R_{66} — 20,000 ohms, ½ w.
R_{18}, R_{63} — 10 megs., ½ w.
R_{20}, R_{26}, R_{35} — 1 meg., ½ w.
R_{21}, R_{27}, R_{42}, R_{51}, R_{55}, R_{56}, R_{62}, R_{64} — 0.5 meg., ½ w.
R_{22}, R_{45} — 0.25 meg., ½ w.
R_{23} — 50,000 ohms, ½ w.
R_{24}, R_{28}, R_{33}, R_{46}, R_{47} — 1-meg. pot.
R_{29}, R_{40}, R_{48} — 2 megs., ½ w.
R_{31} — 2000 ohms, ½ w.
R_{32} — 1000 ohms, ½ w.
R_{36}, R_{50} — 0.25-meg. pot.
R_{38} — 12,500 ohms, ½ w.
R_{39} — 6000 ohms, ½ w.
R_{41} — 0.25 meg., 1 w.
R_{43} — 750 ohms, 10 w., slider type.
R_{52} — 75,000 ohms, ½ w.
R_{53} — 20,000-ohm pot.
R_{54} — 5 megs., ½ w.
R_{57} — 3 megs., ½ w.
R_{58} — 5 megs., ½ w.
R_{59} — 0.43 ohm, 5 w. (1-ohm slider-type adjusted to give 5 volts at 5U4G socket).
R_{60} — 30,000 ohms, ½ w.
R_{61} — 15,000 ohms, 2 w.
C_1 — 2-plate per section, dual midget. Cardwell dual No. ER10AD with one rotor plate removed from each section. (See text.)
C_2, C_3, C_5, C_6, C_8, C_9, C_{10}, C_{11}, C_{12}, C_{13}, C_{15} — 0.002 μfd., 400 v., mica.
C_4, C_{29}, C_{49}, C_{50} — 500 μμfd., 400 v., mica.
C_7, C_{34} — 5 μfd., 25 v., electrolytic.
C_{14}, C_{16}, C_{22}, C_{40}, C_{41}, C_{44}, C_{45} — 4 μfd., 450 v., electrolytic.
C_{17} — 0.05 μfd., 600 v., paper.
C_{18}, C_{38}, C_{39} — 0.1 μfd., 200 v., paper.
C_{19} — 8 μfd., 450 v., electrolytic.
C_{20}, C_{27}, C_{28} — 0.25 μfd., 600 v., paper.
C_{21} — 8 μfd., 150 v., electrolytic.
C_{22} — 0.01 μfd., 200 v., paper.
C_{23} — 0.003 μfd., 200 v., paper.
C_{24} — 0.02 μfd., 600 v., paper.
C_{25} — 0.006 μfd., 600 v., paper.
C_{26}, C_{42}, C_{43}, C_{47}, C_{48} — 20 μfd., 450 v., electrolytic.
C_{30} — 100 μμfd., 400 v., mica.
C_{31} — 0.001 μfd., 400 v., mica.
C_{32} — 0.01 μfd., 600 v., paper.
C_{33} — 40 μfd., 25 v., electrolytic.
C_{35} — 0.005 μfd., 1600 v., paper.
C_{36}, C_{46} — 0.1 μfd., 1600 v., paper.
C_{37} — 0.01 μfd., 1000 v., paper.
C_{51} — 10 μμfd., 200 v., mica.
C_{52} — Approx. ½ μμfd.
C_{53} — 0.25 μfd., 200 v., paper.
L_1 — 2 turns No. 16 tinned copper, turns spaced wire diameter, ½ inch inside diameter.
L_2 — 7 turns No. 16 tinned copper, turns spaced wire diameter, ¼ inch i.d. (inside L_1).
L_3 — 8 turns No. 16 tinned copper, turns spaced wire diameter, 5/16 inch i.d., tapped at 1½ turns from ground end.
L_4 — 15-henry, 100-ma. choke.
T_1, T_2 — I.f. transformer (Aladdin type U100).
T_3 — I.f. transformer (Aladdin type U200).
T_4 — Power transformer (UTC Type R4).
T_5 — Power transformer (Thordarson Type T13R11).
I — Interlock. (See text.)
F — Fuse.
S — Switch.
D — Discharge switch. (See text.)

Each oscillator feeds one triode of the 6F8G deflection output stage. It will be noted that high plate loads are used, in order to minimize the current requirements. In order not to lose high-frequency components of the horizontal sawtooth with the high plate load, the circuit capacitance should be kept down by dressing the output load and coupling condenser away from the chassis.

All of the low-voltage power supply requirements are furnished by the 5Y3G supply operated from T_4. Two 5U4G's operating in a doubler circuit from T_5 furnish 1500 volts to the Kinescope and 750 volts to the scanning output stage.

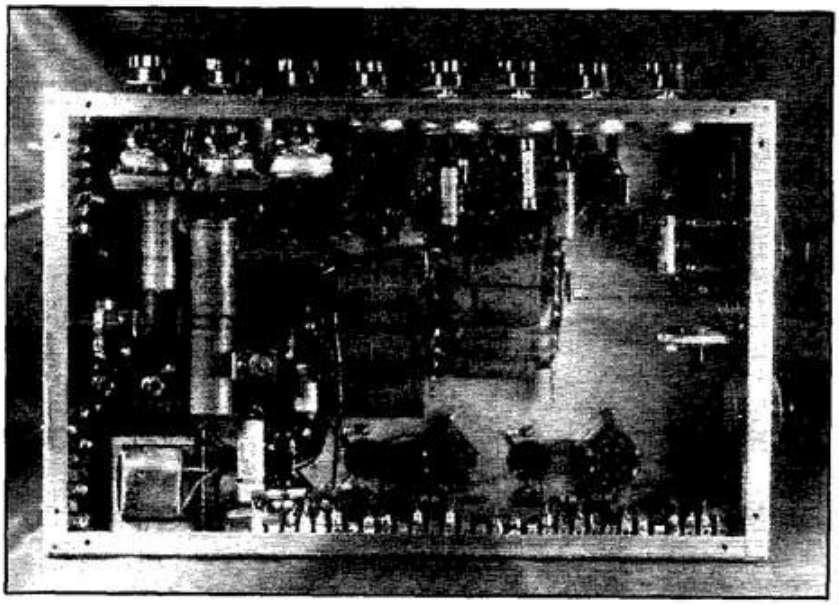
When the receiver is turned on, it is desirable to prevent the appearance of a stationary spot which may damage the Kinescope screen before the scanning starts. A simple circuit arrangement, not conveniently applicable in the camera unit but readily applied in the receiver, accomplishes this regardless of the setting of the brilliance control. It has been pointed out that the 6F8G scanning output tube receives its plate voltage from the Kinescope supply. This supply is connected to ground through the brilliance control R_{53}; hence the total d.c. cathode current of the 6F8G must flow through R_{53}. In the absence of this current there is no voltage drop in R_{53}. The Kinescope cathode is connected to a point approximately 75 volts above the negative end of the high-voltage supply; hence, if no current flows in R_{53}, the Kinescope grid will be 75 volts below its cathode and the Kinescope will be completely cut off. The voltage drop which appears across R_{53} due to the 6F8G cathode current opposes the voltage across R_{52}. Thus, until the scanning output tube has become heated, the Kinescope is cut off.

Layout and Testing

Fig. 2 shows the layout of parts on the chassis. The Kinescope is housed in a shield of aluminum and further shielding is obtained by three layers of thin sheet iron rolled around the Kinescope, inside the aluminum shield. The iron, of course, must not be magnetized. The Kinescope socket is mounted in an enclosure which supports the shielding and completely houses the connections to the Kinescope. The deflection coupling condensers are also placed in this housing.

As shown in the photographs of the receiver, all of the controls except tuning and gain are placed on the side of the chassis. The centering and focus controls are mounted away from the chassis on a bakelite plate, and the shafts extended with insulating couplings. The bottom cover of the chassis carries pin-jack interlocks which break the a.c. supply when the bottom is removed, and a mechanically-operated discharge switch shorts the high-voltage supply at the same time.

The 956 socket is mounted on the underside of



Bottom view of the receiver chassis with base plate removed. Note the interlock jacks at lower left, and the filter-discharge switch to right of the interlock jack strip.

the chassis between the tuning condenser and the first i.f. transformer, so that short leads are had to both. The tuning condenser is a Cardwell dual No. ER-10-AD with one rotor plate removed from each section. By bending the remaining plate slightly away from the stator, the 112-116-Mc. band is made to occupy most of the tuning range.

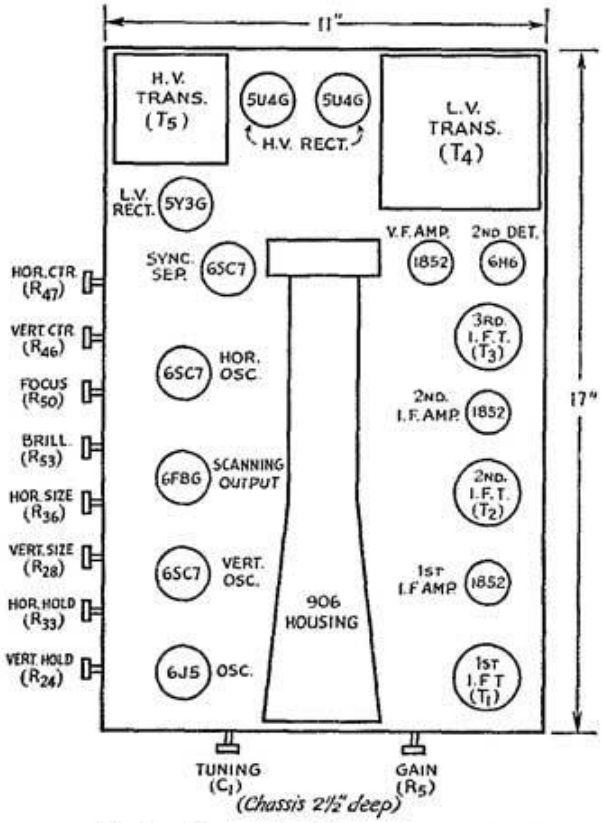


Fig. 2 — Chassis plan of the receiver as viewed from the top.

It is possible to test the performance of the video amplifier, synchronizing circuits, Kinescope, etc., of the receiver before the r.f. section of the transmitter has been built. For this purpose a simple connection may be made to the camera-modulator unit described in the May issue of *QST*.[1] First remove the 6H6 detector from its socket and by means of a tube-base type plug connect leads to pins Nos. 2, 4 and 5. Pin No. 2 will serve to connect the ground of the receiver to the ground of the camera unit. Pin No. 4 should be connected to the high side of the modulator output. Pin No. 5 should be connected to the grid of the sync amplifier No. 2. Since both grids of this tube are connected together, a clip may be readily attached to the top cap.

Synchronization should be quite positive with this arrangement. It is necessary to adjust the modulator output control to get a satisfactory picture; there should be enough signal available from the modulator to overload the video amplifier of the receiver considerably when modulator output control R_{24} is turned up.

This same procedure may be followed where the construction of a transmitter is not contemplated. Of course, in this case it is not necessary to construct the r.f. and i.f. portions of the receiver. Where distances greater than a few feet are to be covered, the video transmission line must be properly terminated.

A photograph of a picture on the Kinescope screen is shown. This picture was picked up initially by the Iconoscope equipment described

in May *QST*. The modulator output was connected to an r.f. signal generator operating at 114 Mc., and the picture-modulated carrier was fed to the antenna terminals of the receiver.

Bibliography of Articles On Television Reception (Commercial Standards)

"Radio Amateurs in the Television Picture," by J. J. Lamb, *QST*, Dec., 1937.

"Introduction to Modern Television," by M. P. Wilder, *QST*, Dec., 1937.

"Circuit Elements in Modern Television Reception," by M. P. Wilder, *QST*, Jan., 1938.

"Sweep Circuit Considerations in the Television Receiver," by M. P. Wilder, *QST*, Feb., 1938.

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"A Practical Television Receiver for the Amateur," by C. C. Shumard, *QST*, Dec., 1938.

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"Using Electro-Magnetic Deflection Cathode-Ray Tubes in the Television Receiver," by J. B. Sherman, *QST*, Feb., 1939.

"An Electrostatic-Deflection Kinescope Unit for the Television Receiver," by J. B. Sherman, *QST*, March, 1939.

"A Deflection and Video Chassis for Television Reception," by H. C. Lawrence, *QST*, Feb., 1940.

"A Design for Living — With Television," by P. Rosenblatt, *QST*, March, 1940. (High-voltage power supply with safety features.)

— *J. J. L.*

New Iconoscope

(*Continued from page 16*)

bers are according to the RMA system which is conventional for octal bases.

The tube is normally intended for operation in a horizontal position with the tab downward. Therefore, with deflection plates D_3 and D_4 used for horizontal deflection, the socket should be located so that Pins 3 and 6 are in a horizontal line with the base key up. It is suggested that the socket be mounted in a plate with holes for screws slotted circumferentially so that the socket may be rotated through approximately 20° to line up the scanning rectangle (raster) exactly.