

• If you've been digging into television circuits with the idea of building your own TV transmitter, here's practical information on the construction of a camera, together with the essential amplifiers, sync and blanking circuits. It uses the same line and frame repetition frequencies as in commercial television, so puts out a signal that can be reproduced by an ordinary TV receiver. The camera tube is the modern version of the 2-inch iconoscope brought out some years ago for amateur use.

An Amateur Television Camera

BY JOHN W. KELLER, JR.,* W3NDB

THE usual drawbacks to the building and operation of a television camera are the expense of the pick-up tube, the complicated and complex magnetic deflection and focusing circuits, and the need for keystone and shading correction in the case of an iconoscope tube. These drawbacks can be eliminated in the construction of an amateur television camera by the use of the RCA type 5527 iconoscope tube.

The 5527 is a two-inch iconoscope with a definition capability of 250 lines. It uses electrostatic deflection and electrostatic focus, and the need for keystone and shading correction is eliminated by a type of mosaic construction that permits the use of a straight-sided tube. An inexpensive short focal-length lens can be used.

While some may feel that the 250-line definition is not sufficient, let me point out that the pictures are excellent and that only by using a monitor receiver with a picture tube of the 16-inch size or larger does the line structure become noticeable. Although the pictures are not interlaced, they can be received on a conventional television receiver which will lock in on the blanking pulses.

The amateur camera system described here consists of the following units: camera chassis, synchronizing and blanking chassis, and power-supply chassis.

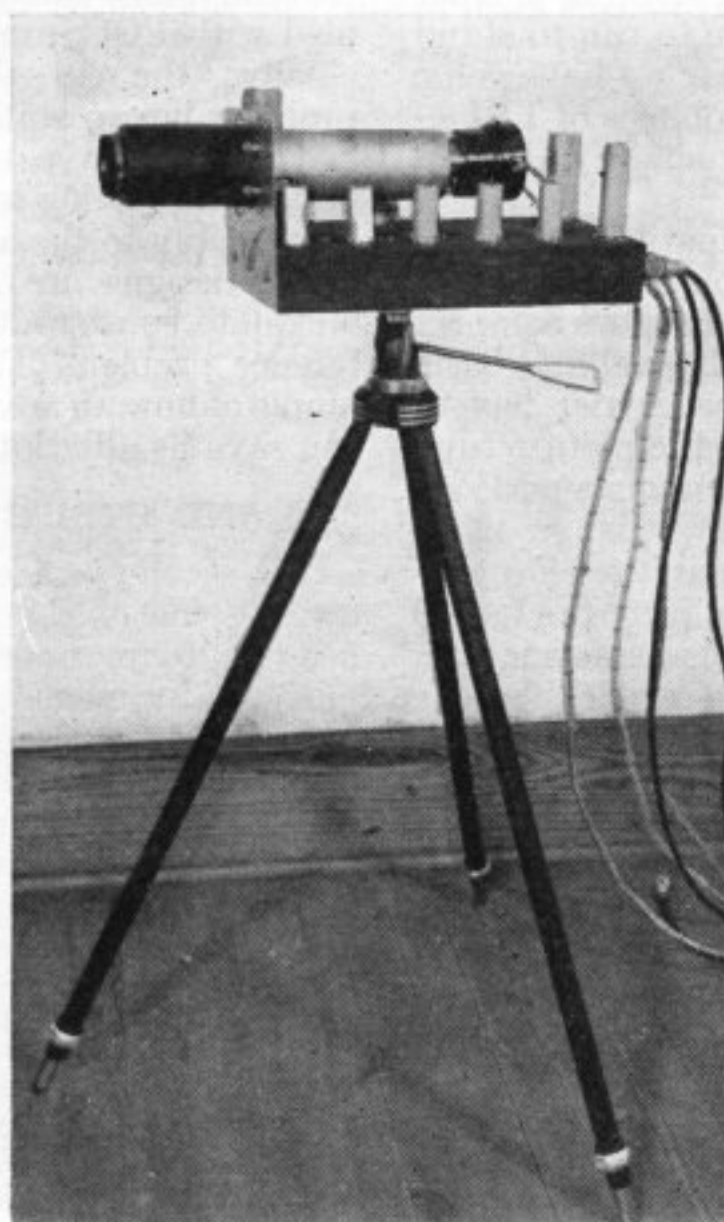
The Camera Unit

As the heart of any television system is the camera, special care should be given to its construction. The camera chassis shown in the photographs contains the iconoscope tube and its lens system, the video pre-amplifier stages, and the high-frequency peaker stage. The video amplifier

stages and the high-frequency peaker stage, Fig. 1, use Type 6AG5 tubes. No noticeable increase of gain or signal-to-noise ratio was realized by using 6AK5s in place of 6AG5s. Since the signal output from the iconoscope tube is very low, it is necessary to use four video preamplifier stages to increase the level to a value sufficient to feed through coax cable to the video line amplifier, which is located on the synchronizing and blanking chassis.

The output capacity of the iconoscope is shunted across the input of the video preamplifier, so it is necessary to compensate the preamplifier for the loss of high frequencies. This is accomplished by operating the video high-frequency peaker stage and the third video preamplifier stage in series. The 100- μ fd. capacitor from the

The camera unit mounted on a tripod ready for use. This chassis-mounted unit contains the 5527 "amateur" iconoscope, lens, and video preamplifier.

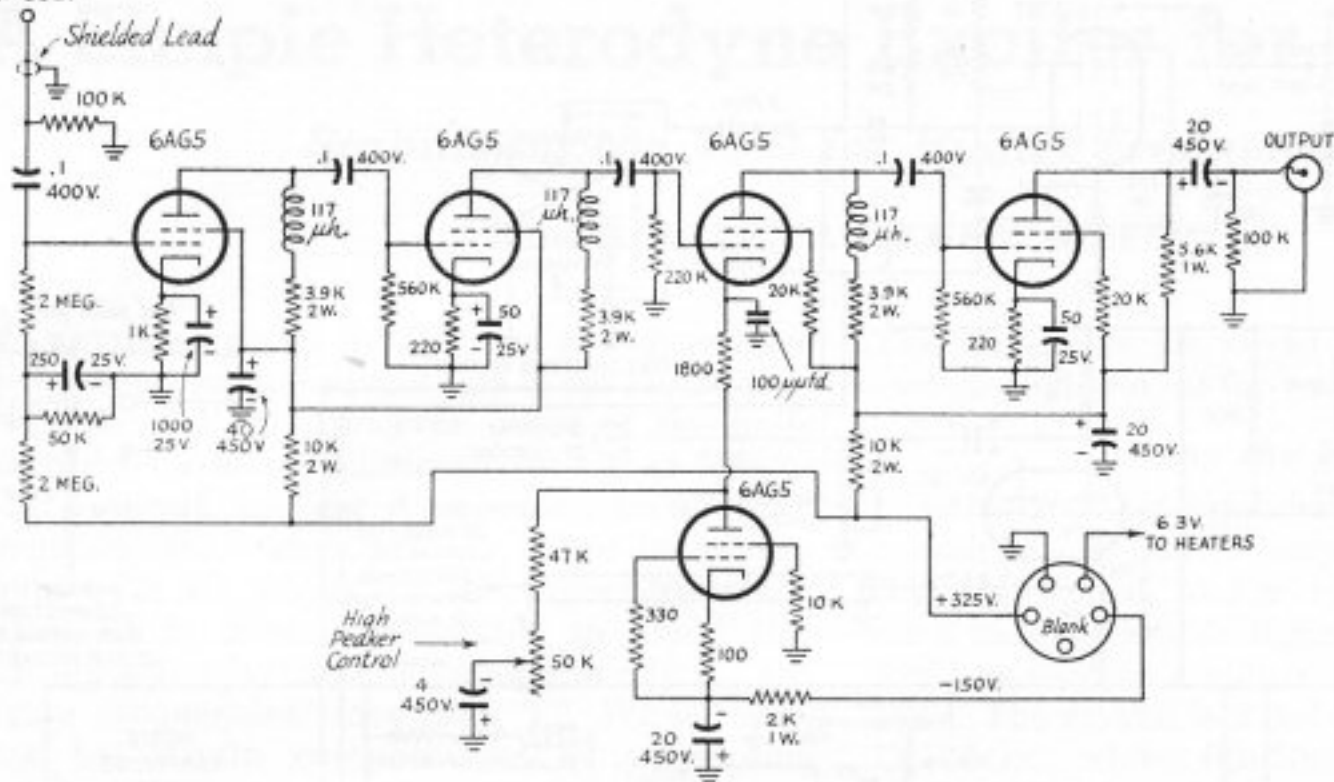


cathode of the third video amplifier stage by-passes the high frequencies, causing the stage to have more gain for the high than for the low frequencies. This type of high-peaker stage is very stable and quite free from microphonics. The amount of high-frequency compensation is set by adjusting the 50,000-ohm potentiometer in the plate circuit of the 6AG5 high-peaker stage. This adjustment is best made by adjusting the control to eliminate a black streak following a black bar on a white background. The control should be set so that the streak is just eliminated, and not moved far enough to cause over-compensation.

As the cathode of the 5527 iconoscope tube is operated at a high negative voltage above ground, it is necessary to use a separate filament transformer for this tube. This transformer is located on the synchronizing and blanking chassis to reduce the possibility of

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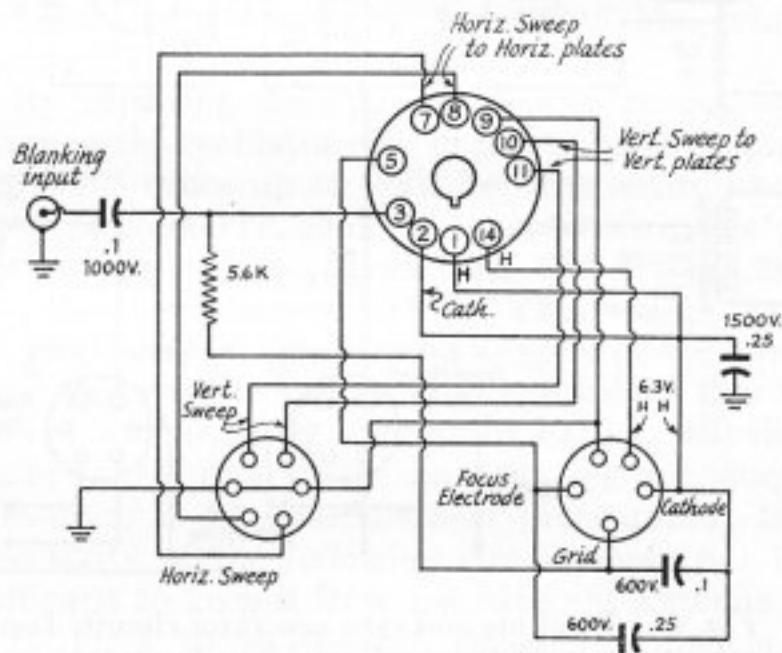
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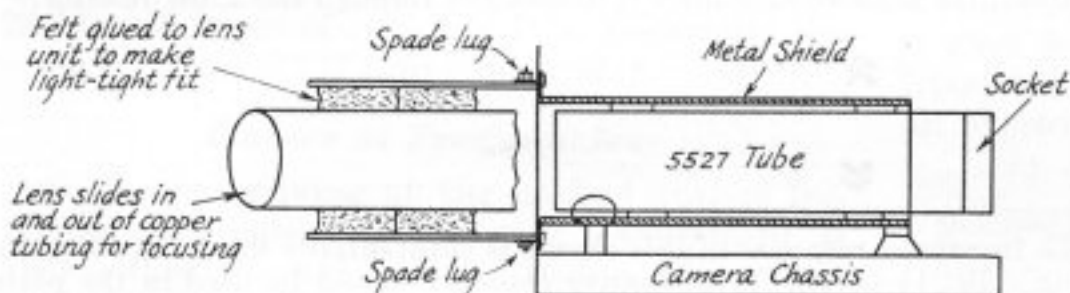
Fig. 1 — Camera preamplifier circuit. Resistors are 1/2 watt unless otherwise indicated. Capacitance values in μ f. except as indicated. Socket is for incoming power.

Fig. 2 — Socket connections on camera chassis for iconoscope. Six-prong socket at left is for incoming sweep voltages, 5-prong socket at right for iconoscope power supply. The blanking input connector is a coax fitting.



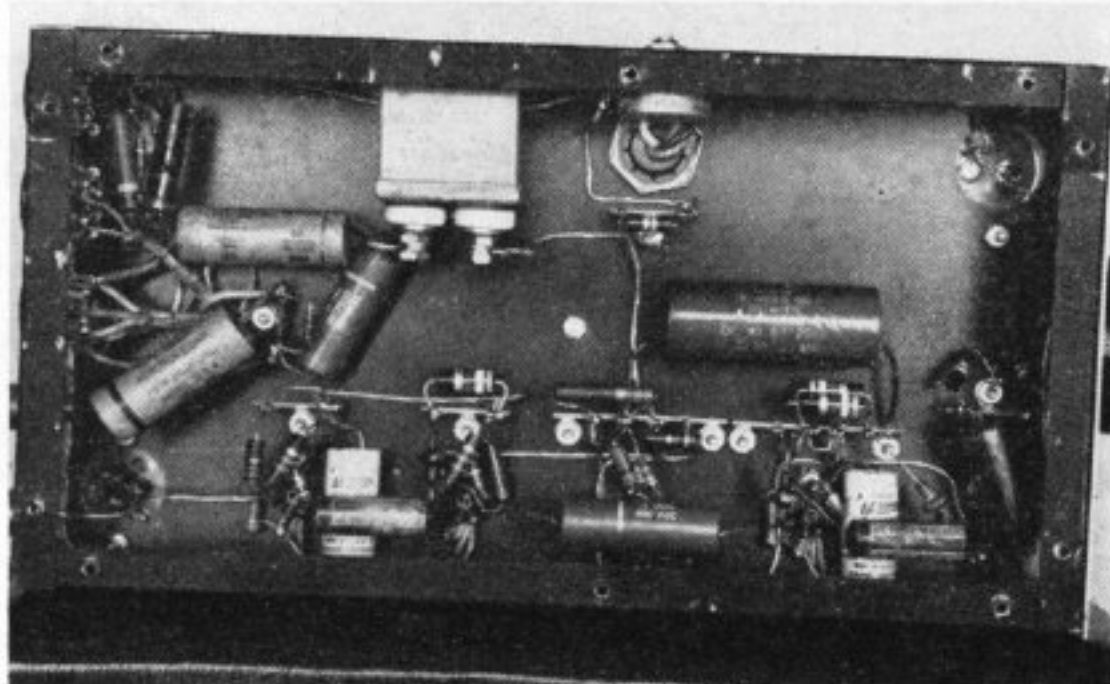
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Fig. 3 — Detail of the iconoscope and lens mounting.



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Bottom of the camera-unit chassis. The principal constructional point to watch out for is to keep stray capacities low in the "hot" video circuits to prevent loss of high-frequency response.



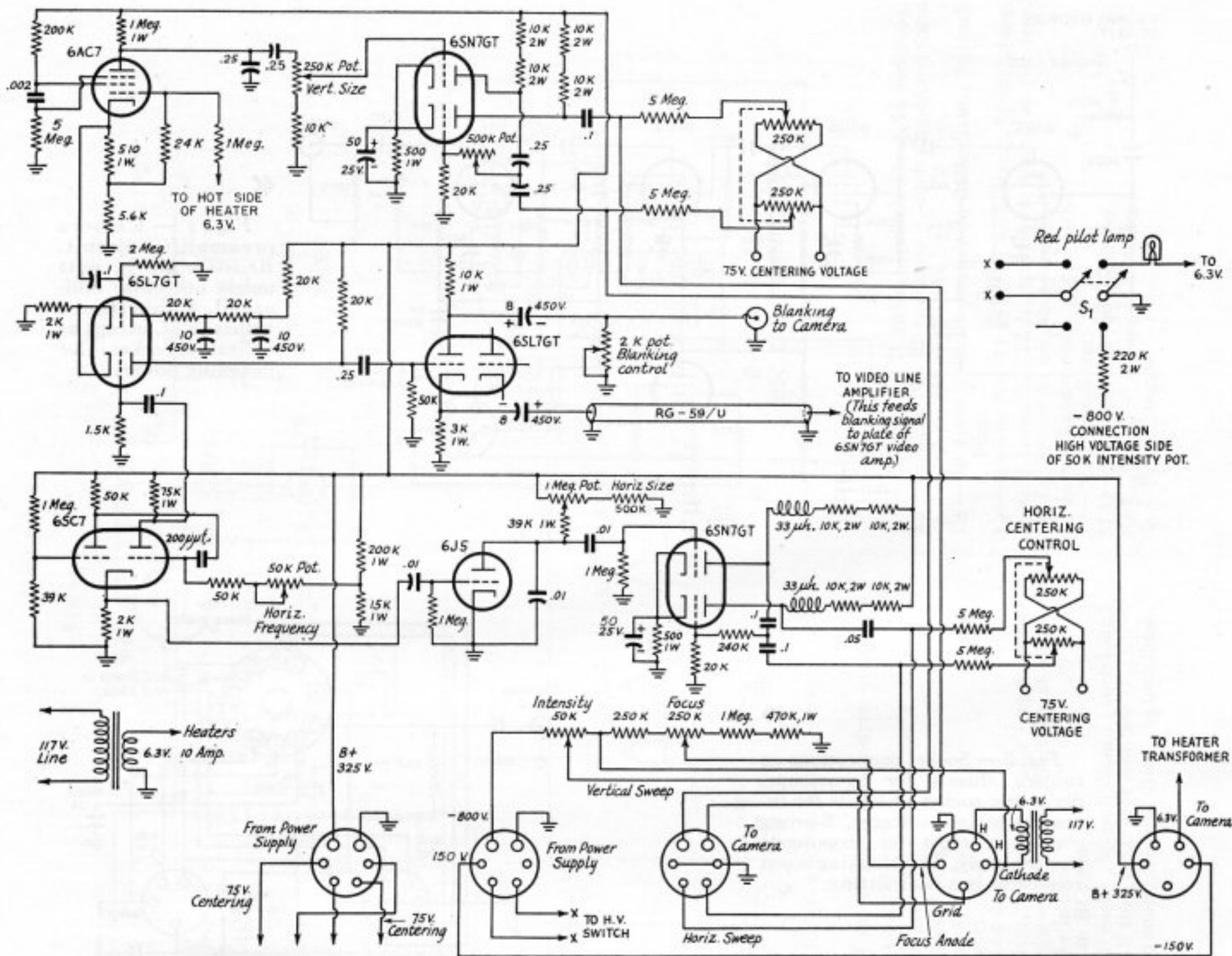


Fig. 4 — Blanking and sync generator circuit. Top section, vertical oscillator and sweep amplifier; middle section, blanking mixer, clipper and amplifier; lower section, horizontal oscillator, shaper, and amplifier. Fixed resistors $\frac{1}{2}$ watt, capacitance values in $\mu\text{f.}$, unless otherwise indicated. The inset diagram at the upper right is the high-voltage switching arrangement; when in the off position, the high-voltage filter is discharged through the 220K resistor.

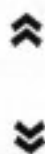
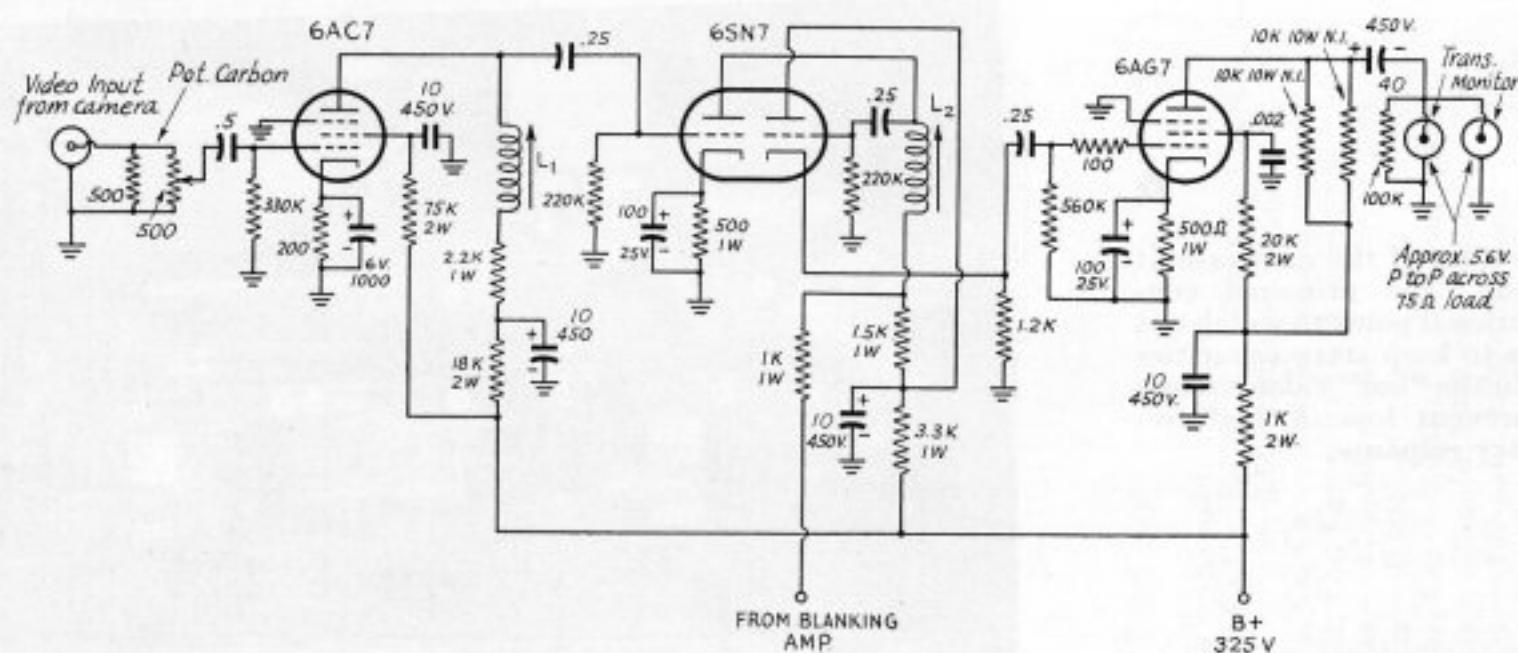


Fig. 5 — Video line amplifier diagram. The frequency response of this circuit is substantially flat from 60 cycles to 2.5 Mc. L_1 and L_2 are adjustable peaking coils, 44–68 $\mu\text{h.}$ Noninductive resistors should be used in the plate circuit of the 6AG7. A later modification, which improves the shape of the vertical blanking pulse, is to substitute a 10- $\mu\text{f.}$ 25-volt electrolytic condenser for the 0.25- $\mu\text{f.}$ condenser between the 6SN7 cathode and 6AG7 grid. It should be mounted well away from the chassis to prevent loss of high-frequency video.



its magnetic field affecting the iconoscope tube.

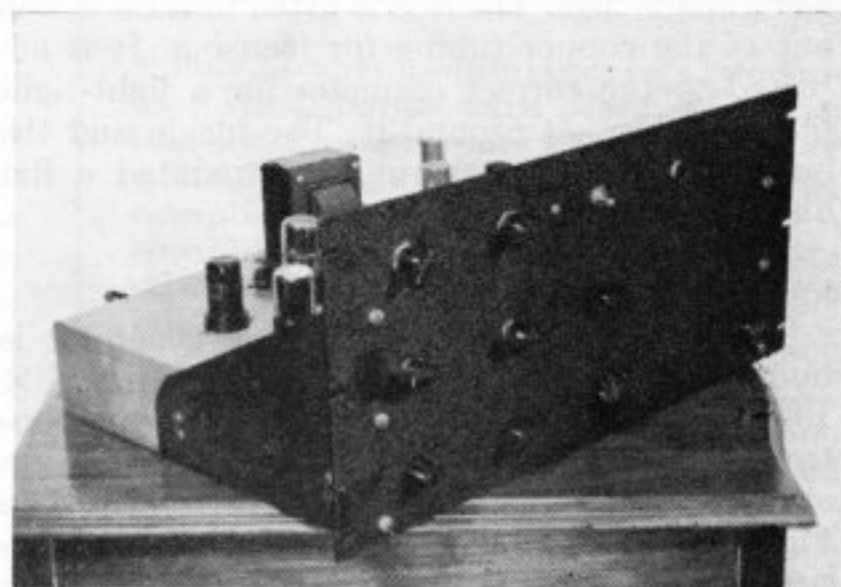
The camera is built on a $7 \times 13 \times 2$ -inch chassis with a bottom plate. The bottom plate is very necessary for shielding — without it, the wiring picks up a strong signal from the local broadcast station, thereby causing interference in the picture. Two five-prong sockets are used to connect the necessary voltages to the camera unit, and the sweep voltages are fed in through a six-prong socket. Regular coax cable connectors are used for the blanking signal input and the video output of the camera.

The interconnecting cables between the camera and the synchronizing and blanking chassis are made up as follows: For the 325-volt B+, the 150-volt negative voltage, and the heater supply, a cable of five wires is used; for the control voltages and heater voltage of the iconoscope tube, a five-wire cable; for the vertical and horizontal sweep voltages, a five-wire cable. The cable-socket connections are given in Figs. 1 and 2.

It may be wondered why shielded cable was not used for the sweep voltages; this was tried, but because of the capacitive effect of the shielded cable, the 15,750-cycle horizontal sawtooth voltage was distorted. This resulted in a nonlinear picture. As the sweep voltages are relatively high the unshielded cable worked well, and if the length is not excessive there is no need to worry about using shielded cable.

The first video amplifier stage is connected to the signal electrode of the 5527 iconoscope tube by a low-capacity shielded lead, made up by using a small-diameter lead shielded by braid having a rather large inside diameter.

The peaking coils used by the author were standard 117-microhenry units used in Motorola television sets. The new adjustable-type video peaking coils can be used if desired. These can be adjusted to the correct value needed for best



The sync and blanking generator. This unit also contains a video line amplifier. Controls are as follows: top row, left to right — intensity, focus, high-voltage switch; second row — vertical centering, horizontal centering, blanking; bottom row — vertical size, horizontal frequency, horizontal size. The control at the extreme lower right is the video gain control.

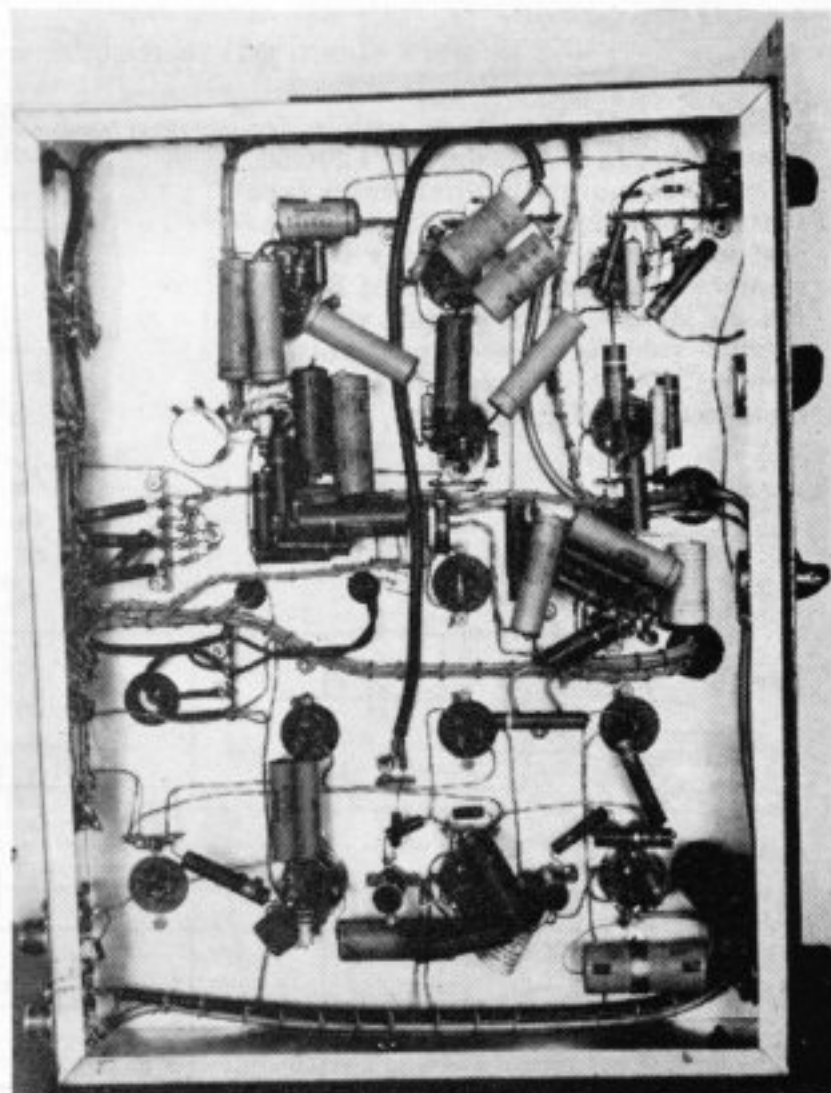
frequency response of the video amplifiers.

The heater leads for the 6AG5s should be run along the edge of the chassis to reduce the field around these leads. The 0.1- μ f. coupling capacitors should be placed well away from the chassis as should the peaking coils. The Type 5527 tube is mounted in a shielded housing to protect it from stray fields.

The lens system is shown in Fig. 3. The lens used was a surplus one originally made for the sniper scope unit. It is a Bausch & Lomb $f2.1$, focal length 3.5 inches. With this fast lens very good pictures can be obtained by using one or two No. 1 photoflood lamps to supply the necessary light.

A piece of $2\frac{7}{8}$ -inch copper tubing $4\frac{1}{8}$ inches long is mounted to the front of the camera by

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Top and bottom views of the sync, blanking, and video line amplifier chassis. The video line amplifier is along the left-hand edge of the chassis in the top view, and along the lower edge in the bottom view.



using spade lugs. The lens is fitted to slide in and out of the copper tubing for focusing. It is adjusted to the correct diameter for a light-tight fit by gluing felt around it. The inside and the outside of the copper tubing is painted a flat black to eliminate reflections.

Sync and Blanking Chassis

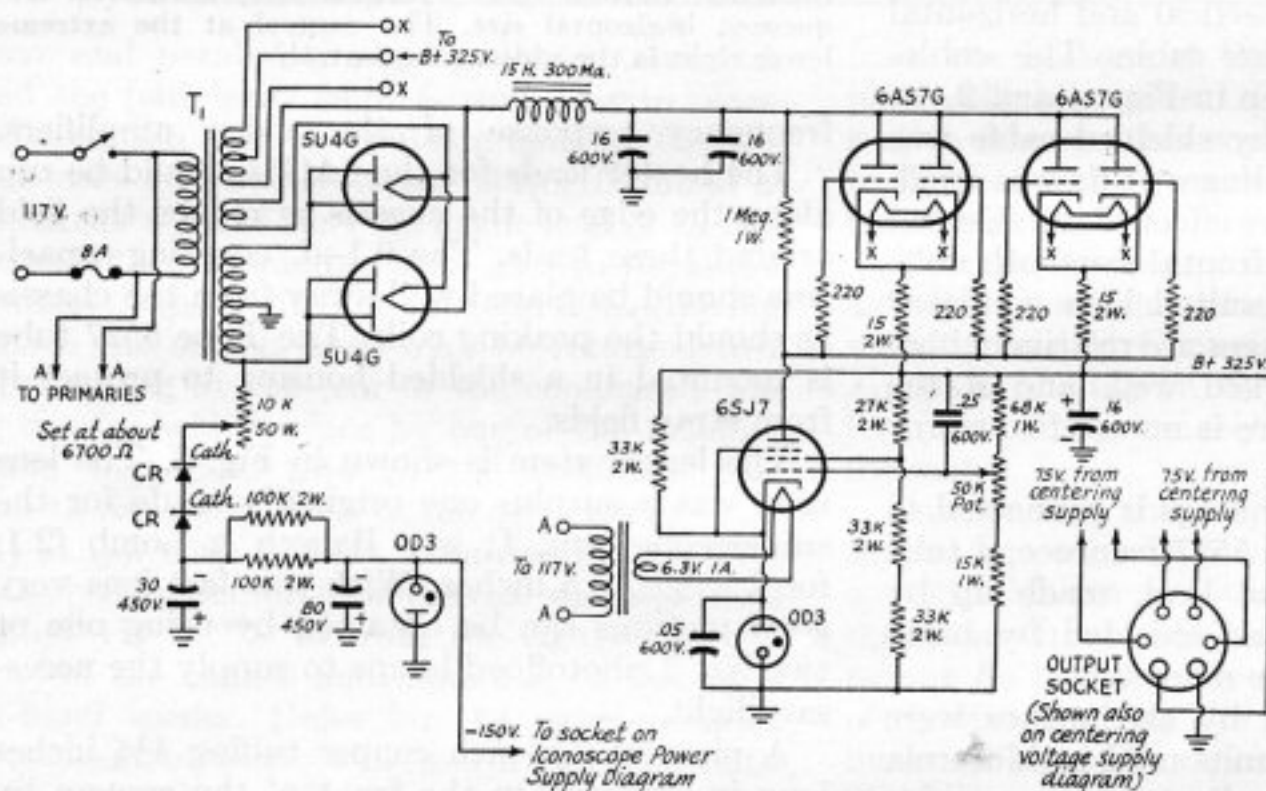
The synchronizing and blanking generator is built on a 13 × 17 × 3-inch chassis. An 8 3/4 × 19-inch panel is used to mount the necessary controls for the camera unit. The circuit of the synchronizing and blanking generator is shown in Fig. 4. In the unit built by the writer standard-size tubes were used, but miniature types may be used if desired. The photographs show several views of this unit.

The vertical synchronizing and sweep pulses

are generated by a Type 6AC7 tube. The grid of this tube is coupled to the 6.3-volt heater voltage, thus locking the vertical synchronizing and sweep voltage directly to the power-line frequency. A Type 6SN7 tube is used as an amplifier to provide sufficient sweep voltage for the iconoscope tube. The 0.5-megohm control located in the grid of the second section of the 6SN7 should be adjusted for equal output voltages to the deflection plates of the 5527 iconoscope.

The horizontal synchronizing and sweep pulses are generated by a free-running multivibrator using a Type 6SC7 tube. The horizontal frequency can be set by a front-panel control. The 6J5 is used as a horizontal discharge tube, and the horizontal sawtooth is amplified by a 6SN7 to an amplitude sufficient to sweep the 5527 tube.

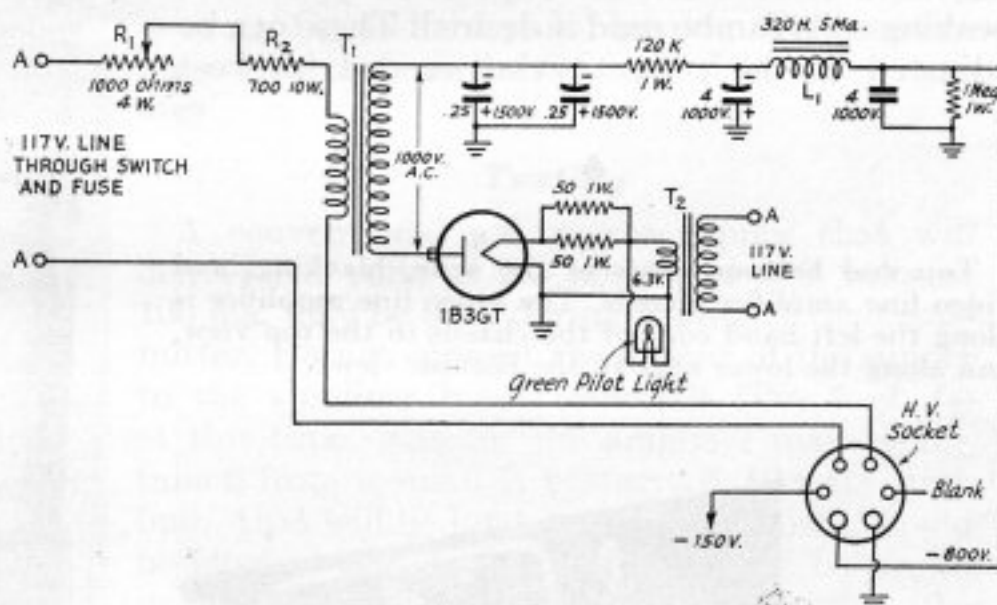
The straight-sided pulse that is developed in



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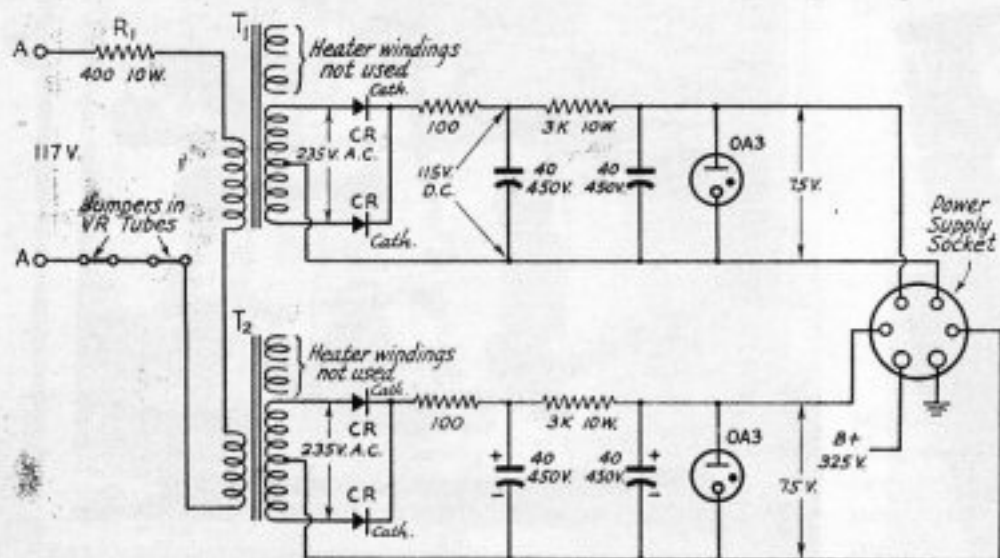
Fig. 6 — Regulated plate supply for sync and blanking tubes and video amplifiers. T_1 — 525 v. each side c.t., 300 ma.; 5 v. at 6 amp.; 6.3 v. at 6 amp. CR — Selenium rectifier, 65 ma.

Fig. 7 — High-voltage supply for iconoscope. L_1 — Thordarson T20C50. T_1 — Neon sign transformer (see text). Thordarson T22R40 or equivalent may be used, but it may be necessary to change the values of R_1 and R_2 . R_1 should be of proper value to permit varying the output voltage from -700 to -900 volts. T_2 — Filament transformer, 6.3 volts, 1 amp.



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Fig. 8 — Centering-voltage power supply diagram. T_1 and T_2 are replacement-type power transformers rated at 600 volts, center-tapped, at 40 ma. With different transformers, R_1 should be chosen to give the transformer secondary voltages indicated. CR — Selenium rectifier, 65 ma.





This power supply chassis contains the three supplies shown in Figs. 6, 7 and 8. *Right* — bottom view of the power supply chassis.

the cathode circuit of the 6AC7 vertical oscillator and the straight-sided pulse that is developed in the plate circuit of the 6SC7 horizontal oscillator are fed into a 6SL7, which mixes and clips them to develop square waves that are used for blanking. These blanking signals are amplified in one half of another 6SL7 where pulses of proper polarity to blank the 5527 iconoscope are taken from the plate. A like pulse but of opposite polarity is taken from the cathode of the same tube and used for blanking the video line amplifier. (A monitor television receiver also can be locked in on these pulses.)

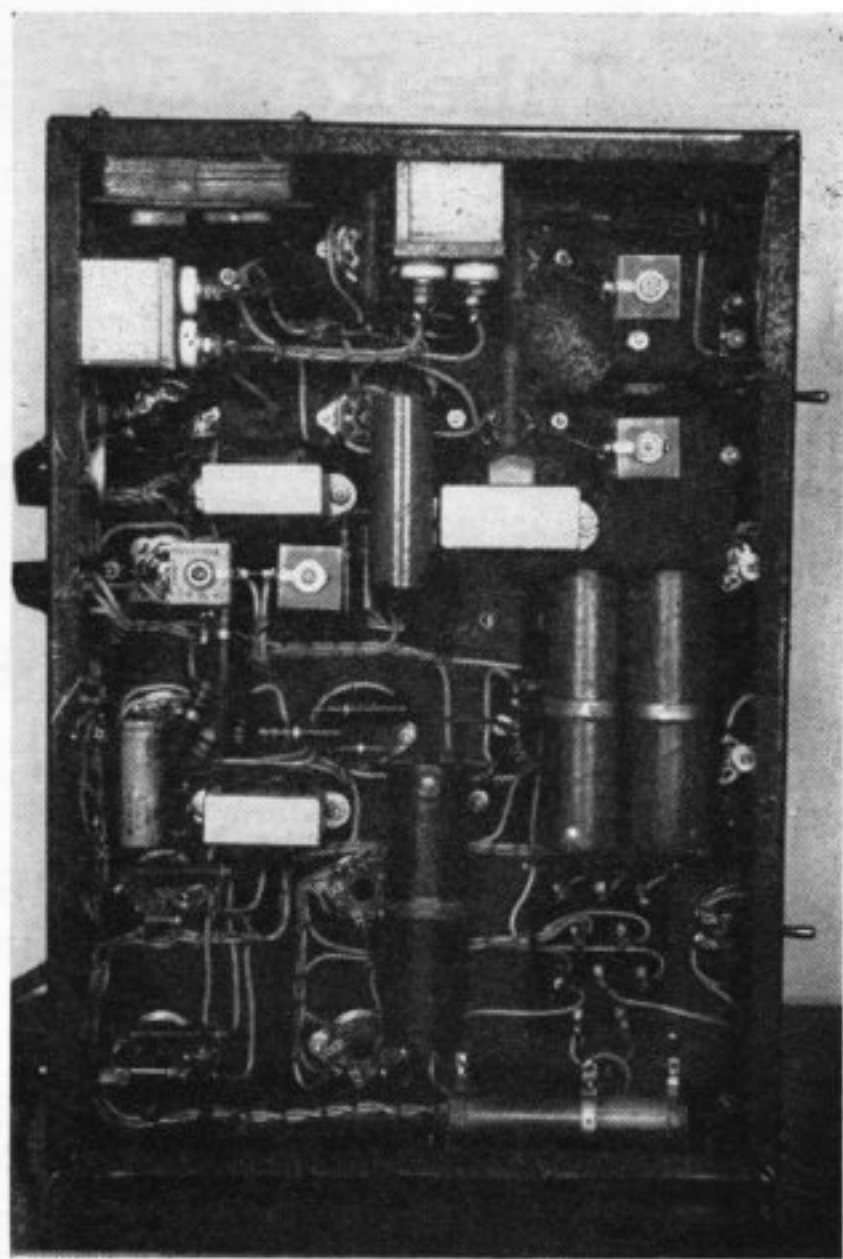
The video line amplifier, the circuit of which is given in Fig. 5, is built along the right edge of the chassis. As in the construction of the camera preamplifier, all leads should be kept as short as possible and the coupling capacitors should be dressed away from the chassis to prevent any loss of high frequencies. The blanking pulses are fed into the plate circuit of the second video amplifier stage. The 1000-ohm resistor in series with the blanking lead is used to prevent loss of video signal.

The filament transformer for the tubes in the synchronizing, blanking video line amplifier, as well as for the camera preamplifier stages, is located on this chassis.

Power Supplies

The power supplies for the operation of the camera unit are built on a 13 × 17 × 3-inch chassis. For the operation of the camera preamplifiers, video line amplifier, and necessary synchronizing and blanking stages, a 325-volt regulated supply is used. A 150-volt negative supply is used for the video high-peaker stage. Two 75-volt supplies are used to furnish centering voltages for the iconoscope tube. An 800-volt supply is also included on this chassis to provide the necessary negative high voltage for the iconoscope tube.

The 325-volt regulated supply uses two 5U4Gs for rectifiers, two Type 6AS7 tubes as series



regulator tubes, a 6SJ7 as control tube, and a VR-150 as reference tube. The 150-volt negative supply uses two selenium rectifiers in series to supply the necessary voltage. This voltage is regulated by a VR-150. The two 75-volt centering supplies each use two selenium rectifiers in a full-wave circuit, with the output voltages regulated by VR-75s.

In the author's unit a neon-sign transformer was used to supply the negative 800 volts necessary for the operation of the iconoscope tube, the voltage being rectified by a 1B3G. The use of this 60-cycle supply requires rather elaborate filtering. A radio-frequency type power supply would require a lot less filtering, and since the total drain is very small this type of supply should work very satisfactorily.

Acknowledgment

I would like to thank Mr. R. R. Barrett and Mr. M. M. Goodman, Tube Department, Radio Corporation of America, and the McGraw-Hill Publishing Company, Inc., for permission to use some of the circuits from the article, "Simplified Television for Industry," that appeared in *Electronics*, June, 1947. Thanks also are due to Ken Neidig, W3MXT, who took all photographs [including cover shot — Ed.] of the equipment.

OUR COVER

John Keller, author of the TV camera article presented in these pages, puts his equipment through its paces in the W3NDB shack. Other cameras, built by W4ATO and W4HER, are shown on page 63.