A New Iconoscope for Amateur Television Cameras

An Economical 2-Inch Electrostatic-Deflection Type Tube

BY JAMES J. LAMB,* W1AL

THE heart of the experimental camera-modulator unit described in the May issue of *QST* is a developmental Iconoscope tube designed especially for use in amateur television transmitters. Although much smaller than the standard commercial types, the amateur model is a true Iconoscope operating on the storage principle and, despite a small-size mosaic, it is suitable for generating a clear picture of at least 120 lines for transmission in the 112-116-Mc. amateur band, or in a higher-frequency band available for amateur television transmission. In addition, the tube is also admirably adapted to use in experimental demonstration systems for teaching television principles and in simple television systems using wire-line transmission to points remote from the scene of action.

In addition to its low-cost design features, the new "Ike" permits further economies in practical application in that it requires much less elaborate auxiliary equipment than its commercial predecessors. Since the tube operates on a second anode voltage of only 600 volts, the cost of the high-voltage supply is small. Because electrostatic rather than magnetic deflection is used, a separate deflecting yoke is not required. The mosaic is perpendicular to the axis of the electron gun so that keystoning circuits are unnecessary. Since the mosaic is less than 2 inches in diameter, a relatively inexpensive short focal-length lens satisfies the requirements for good picture pickup.

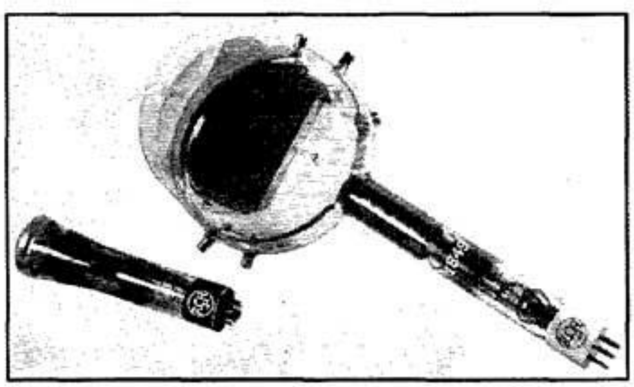
A convenient feature of the design of the Iconoscope is that its electrostatic deflection system is similar to that of the 902 miniature cathode-ray tube so that the latter can be readily used in conjunction as a monitor and electronic view-finder. The same anode and filament supply may be used for both tubes and the corresponding deflection plates may be operated effectively in parallel from the same sweep generators, vertical and horizontal. In addition to being something of an innovation in television practice, this feature is also a great convenience.

The picture viewed on the 902 monitor screen is the same, in both size and shape, as the image focused on the mosaic of the Iconoscope. However, this does not mean that the picture is restricted to this size in reproduction on the receiving Kinescope. At the other end of the transmission circuit, whether it be wire or radio, the picture may be "blown up" on the screen of a 3-inch cathode-ray tube, or to even greater dimensions with a larger tube.

How It Operates

The principal parts of the Iconoscope are the mosaic, signal electrode, collector, and electron gun with horizontal and vertical electrostatic deflection plates. The position of these parts in the developmental amateur Iconoscope is illustrated in the functional diagram of Fig. 1. The mosaic consists of a large number of small photosensitive particles deposited on one face of a transparent sheet of insulation. The particles are spaced a very small distance apart on the sheet

* Research Engineer, A.R.R.L.



The developmental amateur Iconoscope (left) as it appears alongside the standard commercial type (right) used in television broadcasting. Both tubes are produced by RCA Mfg. Co., Inc., Harrison, N. J.

so as to be insulated from each other. On the opposite face of the insulating sheet is a transparent conductive film, the signal electrode. This electrode is in contact with a band of conductive material on the inner surface of the bulb. Another band of conductive material is mounted on the external surface of the bulb, directly over the internal band. The capacitance between the two bands, in series with the capacitance between the signal electrode and mosaic, provides coupling between the mosaic and the signal-electrode terminal.

In operation of the Iconoscope, an image of a scene is focused on the mosaic, and the beam of electrons provided by the gun is made to scan the image. As the beam moves over the image, there is generated across the load resistor a voltage whose magnitude at any instant depends on the image brightness at the point where the beam is at that instant. This voltage is used as the video signal for television transmission of the scene viewed by the Iconoscope. The process by which the Iconoscope generates this voltage can be described briefly as follows:

Consider first the action of the tube when the mosaic is scanned by the beam with no illumination on the mosaic. When the electron beam strikes a mosaic particle, the particle emits secondary electrons, the number of secondaries being several times the number of beam electrons striking the particle. Some of these secondaries return almost immediately to the particle; the rest escape and go either to the collector or to other parts of the mosaic. During the first part of the time of contact between the electron beam and mosaic particle, most of the secondaries emitted from the particle escape from it. Because the particle is insulated, its potential changes in the *positive* direction as long as the number of electrons escaping from it is greater than the number of electrons flowing to it. The number of electrons which escape depends on the potential of the particle, the number becoming less, of course, the more positive the particle becomes. Hence, if the beam is on the particle a sufficiently long time, the particle will be driven to a *positive* potential at which the number of electrons escaping is equal to the number of electrons arriving. In usual operation, the time required for the beam to pass over a particle is long enough for the particle to attain this positive potential. The value of this potential for typical operating conditions is a few volts positive with respect to the collector; this is the maximum positive potential attained by a photosensitive particle.

After the beam passes the particle, some of the secondary electrons emitted from the rest of the mosaic fall on the particle. The arrival of these electrons changes the particle potential in the *negative* direction to a new value. In a typical operating condition, this value is a few volts *negative* with respect to the collector. With no light on the particle, the particle stays at this negative potential until the next time the beam strikes, when the particle again releases electrons and rises to its maximum positive potential.

Consider now the action of the tube when the mosaic is scanned with part of it illuminated. *Both an illuminated particle and an unilluminated one, when struck by the beam, rise to the same maximum positive potential of a few volts with respect to the collector.* During the time between contacts with the beam, both the illuminated particle and the unilluminated particle receive electrons from the rest of the mosaic, and, therefore, charge in the *negative* direction during this time. The illuminated particle, however, at the same time emits electrons, the emission being caused by the light on this particle. The illuminated particle, therefore, does not fall to as negative a potential as the unilluminated one does. Hence, the next time the beam strikes, the illuminated particle does not have as far to rise to reach maximum positive potential. As a result, *less charge is released to the collector when the beam strikes the illuminated particle than when the*

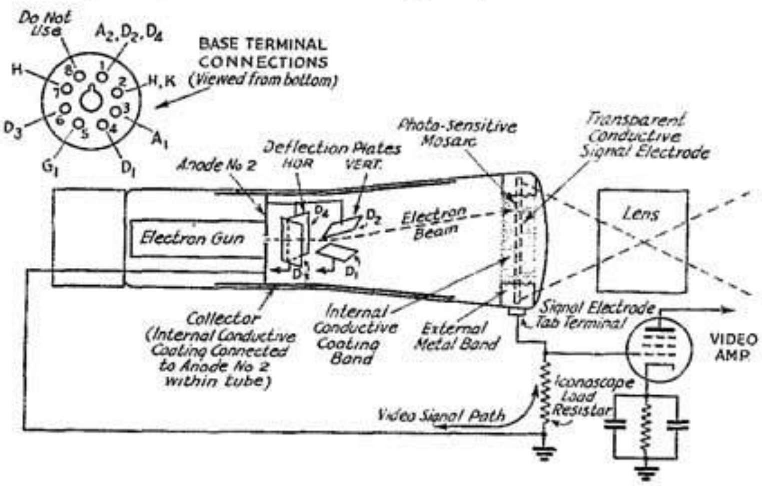


Fig. 1 — Functional diagram illustrating the operation of the amateur Iconoscope.

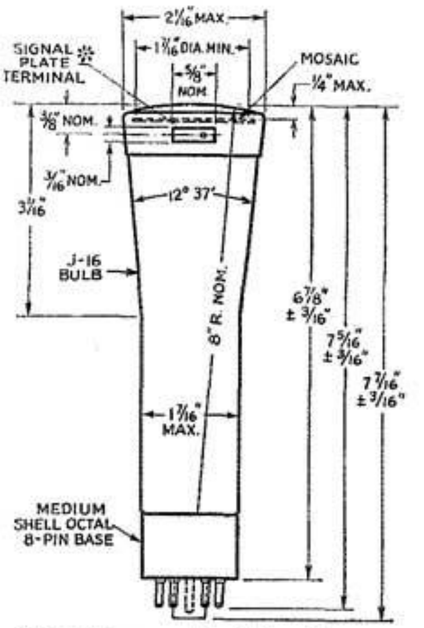


Fig. 2 — Dimension drawing of the Iconoscope.

beam strikes the unilluminated one. The difference in charge is approximately proportional to the difference in illumination.

Now consider the action of the tube when an image is focused on the mosaic and scanned by the electron beam. As the beam moves over the mosaic, varying amounts of charge flow from the mosaic to the collector, the amount of charge flowing at any instant being a measure of the light on the particle where the beam is at that instant. In other words, a video signal current flows between the mosaic and collector. It can be seen that, since the beam current to the mosaic is constant, the video signal current must complete its circuit path through the load resistor, the capacitance between the external and internal bands and the capacitance between the signal electrode and mosaic, as shown in Fig. 1. The voltage developed across the load resistor by this signal current is the video signal output of the Iconoscope.

It also can be seen that when the beam moves from a dark portion of the image to a brighter portion, the electron current from the mosaic to the collector *decreases*. The output voltage, therefore, changes in the negative direction. Hence, the signal output of the Iconoscope is of negative polarity; that is, a highlight in the image is represented by a relatively negative value of signal voltage; a shadow in the image is represented by a positive value.

This peculiarity in polarity of output requires an *odd* number (1, 3, 5, etc.) of conventionally coupled video amplifying stages between the Iconoscope signal output and Kinescope (or monitor) grid to give the correct polarity for positive reproduction of the picture. For modulation with *negative* polarity (in accordance with usual American practice) an *even* number of conventionally coupled amplifying stages should be used — including the modulator when the output is taken from its plate circuit. It must be remembered that there is no reversal of polarity in a cathode-follower coupling stage (that is, one in which the cathode resistor is the output coupling load); therefore such stages are not to be counted in determining whether the total number is odd or even.

Tentative Characteristics and Ratings

Heater voltage (a.c. or d.c.)	6.3 volts
Heater current	0.6 ampere
Direct interelectrode capacitances:	
Control electrode G_1 to all other electrodes	7 μμfd.
Deflecting plate D_1 to all other electrodes	6 μμfd.
Deflecting plate D_3 to all other electrodes	5 μμfd.
Signal-electrode terminal to all other electrodes (with external shielding)	11 μμfd.
Signal electrode to signal-electrode terminal	50 μμfd.
Bulb	J-16
Base	Medium Shell Octal 8-Pin

Maximum Ratings and Typical Operating Conditions

(Voltages are specified with respect to cathode)

Anode No. 2 and collector voltage *	600 max. volts
Focusing electrode (Anode No. 1) voltage *	200 max. volts
Control electrode (Grid G_1) voltage	Never positive
Negative grid bias for current cut-off	Not more than 15% of Anode No. 2 voltage
D.c. resistance between grid and cathode	1 max. megohm
Peak voltage between anode No. 2 and any deflecting plate	350 max. volts
Typical Operation:	
Heater Voltage	6.3 volts
Anode No. 2 and collector voltage	600 volts
Anode No. 1 voltage	150 approx. volts
Grid voltage	Adjust for best picture
Horizontal deflecting voltage (D_3-D_4)†	200 volts
Vertical deflecting voltage (D_1-D_2)†	225 volts

* Design maximum for 117-volt line.

† Peak-to-peak value required for scanning full mosaic diameter.

Base Connections

The base connections (also shown in a bottom-view diagram) are as follows:

Pin 1 — Anode No. 2 and Deflection Plates (D_2, D_4)
Pin 2 — Cathode and Heater (K,H)
Pin 3 — Anode No. 1 (A_1)
Pin 4 — Free Vertical Deflection Plate (D_1)
Pin 5 — Grid (G_1)
Pin 6 — Free Horizontal Deflection Plate (D_3)
Pin 7 — Heater (H)
Pin 8 — No connection (actually connected within tube to Pin No. 1)

The tab on the metal band at the front of the tube is the signal plate connection. The pin num-

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