THE MONOSCOPE[1]

By

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Introduction

"MONOSCOPE" is the name which has been given to a developmental type of tube designed to produce a video signal of a test picture or pattern enclosed in the tube. Since the picture must be enclosed in the tube, the Monoscope is not suitable for developing a video signal which represents action. However, a signal of excellent fidelity can be obtained for a "still" picture which contains half-tones or consists only of lines.

Two general types of tubes which can be used for this purpose are: first, the type which utilizes the primary current of the scanning beam to produce the video signal, and second, the type which makes use of the secondary-emission current obtained when a suitable material is scanned with an electron beam.

Briefly, the first type of tube has a signal plate of some desired configuration cut from a conducting surface. When the plate is scanned, a signal current is obtained each time the beam strikes the plate. As a result, this video signal will produce a picture of the plate when applied to a suitable reproducer.

The second class of tube can be made in a number of workable combinations.* In general, two materials having different secondary-emission ratios are used to make the signal plate. As this plate is scanned, one magnitude of secondary-emission current is obtained from one material and another magnitude is obtained from the second. The difference in the magnitudes of these secondary-emission currents determines the amount of video current. Therefore, if two materials which have a numerical difference in secondary-emission ratios greater than one are used, it is possible to develop more video current than would be possible if only the primary current of the beam were utilized. Because of the attractiveness of this arrangement, a number of combinations of two materials having different secondary-emission ratios was investigated. A technique of preparing signal plates was developed which permits the accurate reproduction of all types of subject matter. The structure of a tube employing this principle will now be described.

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* British Patent No. 465715.

[1] This paper was delivered at the Fall Meeting of the Institute of Radio Engineers, Rochester, N. Y., Nov. 8, 1937.

MONOSCOPE STRUCTURE

The photograph of Figure 1 shows the Monoscope. The tube consists of an electron gun, a signal plate, and a collector enclosed in a highly evacuated envelope. The electron beam is scanned over the signal plate by an electromagnetic deflection system.

The electron gun which supplies the scanning beam must be of high quality if the best video signal is to be obtained. The electron beam should be very small when it strikes the signal plate if good resolution is desired. The beam current should be reasonably high because the video current varies directly with beam current. However, the size of the beam should not be sacrificed to obtain high beam currents. The electron gun developed for Iconoscopes, provides a

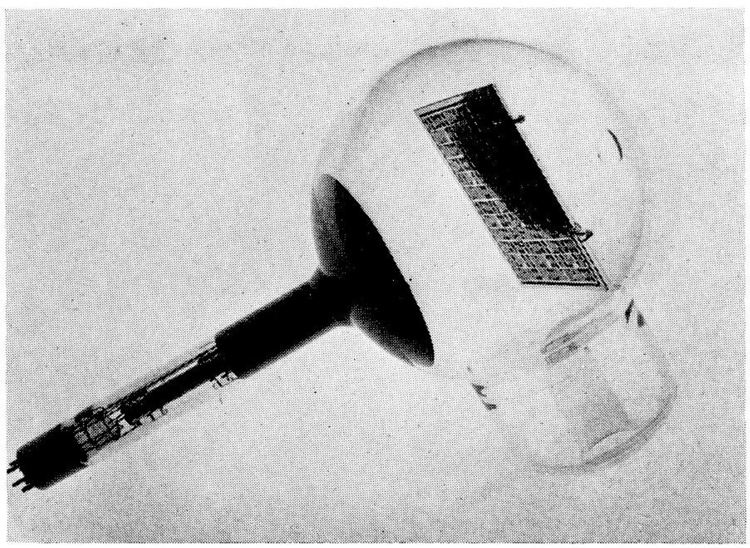

Fig. 1—Photograph of Monoscope.

small beam with adequate current, and therefore, was readily adapted to the Monoscope. The final anode of this gun operates at 1000 volts, and a very small beam can be obtained for currents of several microamperes. The use of this gun proves to be an advantage in test work when it is desired to use a Monoscope in an Iconoscope camera.

The signal plate is made from aluminum foil and carbon. The surface of the aluminum has a natural coating of aluminum oxide which has a reasonably high secondary-emission ratio while the carbon has a relatively low ratio. It was found that aluminum foil developed for advertising and packing purposes as well as special inks developed for printing on metal foils were satisfactory materials for signal plates. As a result the advantages and flexibility of commercial printing processes can be utilized. The desired picture or pattern is printed on aluminum foil with a black-foil ink. The only other processing necessary before sealing the signal plate in the tube is to fire it in hydrogen. This process removes the volatile matter from the ink and thus leaves it practically pure carbon.

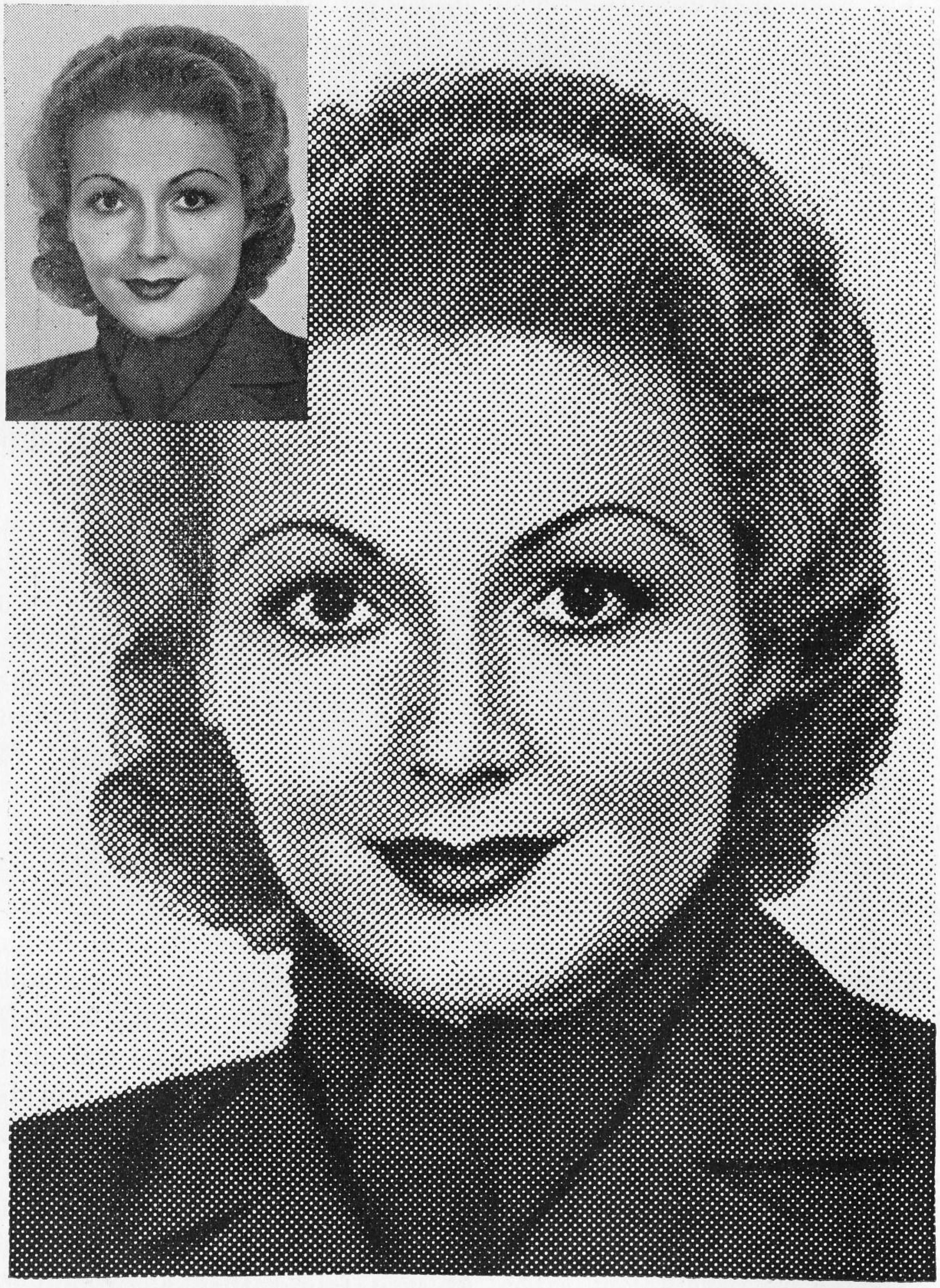

Fig. 2—Enlargement of photograph inset to show effect of screen in the half-tone process.

Subject matter for reproduction on a signal plate can be divided into two classes: black and white, and half-tones. Cartoons are a good example of the first, while snapshots, which contain tones between black and white, illustrate the half-tone group. Photo-engravings are made of the subject matter for printing the signal plates. The black-and-white material is treated as a line-cut, but the half-tone material must be broken into a number of dots of various sizes depending on the half-tone value. This is done when the photo-engraving is made by photographing the material through a suitable screen. A screen is used which will break the picture into more elements than are used in the television scanning system for which the tube is designed. As a result, this technique of obtaining half-tones does not limit the resolution of the television system and the half-tone effect is reproduced just as in a newspaper photograph. This is illustrated in Figure 2, which shows an enlargement of the inset photograph after the latter was photo-engraved. It will be noted that the enlarged picture is now made up of numerous dots of various sizes.

In order to give the picture the correct polarity on the Kinescope, i.e., so that white corresponds to white in the original, it is necessary to make the signal plate in a definite manner, depending on the number of stages in the video amplifier. If the video amplifier has an odd number of stages (as is normal between Iconoscope and Kinescope) the picture on the signal plate of the Monoscope should have blacks and whites reversed, but should not have printed matter reversed. The reversal of blacks and whites is necessary because the aluminum oxide, although white in appearance, has a higher secondary-emission ratio than the carbon, and, therefore, produces a signal which corresponds to black.

The secondary-emission current from the signal plate is collected by a conductive coating on the bulb wall. This coating is operated at a potential positive with respect to the signal plate, which is operated at the same potential as the final anode of the electron gun.

Operation of the Monoscope

The electrical operation of the Monoscope is very similar to that of the Iconoscope except that a collecting voltage is required for the secondary-emission from the signal plate. However, no optical system is required because the test picture or pattern is enclosed in the tube. A typical connection is shown in Figure 3. For convenience, the second anode is operated at ground potential. The first stage of the video amplifier may be operated with self-bias or fixed bias. In the latter case the bias adds to the collecting voltage, but the value of the combined voltage is not critical for potentials above 20 or 30 volts.

The video amplifier must be of high quality to amplify faithfully the video signal. If the signal is to be used for test work, the frequency band of the amplifier should be broader than the circuits under test so that limiting conditions will not be confused.

Uses of the Monoscope

The Monoscope may be used for a variety of purposes. In commercial applications, frequently repeated announcements and advertisements could be taken from a Monoscope. Fixed backgrounds for studio work could be obtained—the final signal being a suitable combination of video signal from an Iconoscope for action and from a Monoscope for background.

However, the biggest field for the Monoscope is in television testing. The same video signal can be obtained from day to day, and the quality is not affected by such variables as poor optical focus, dark spot, and amplifier noise. The Monoscope, therefore, is an important device for checking performance of Kinescopes, receivers, and studio systems.

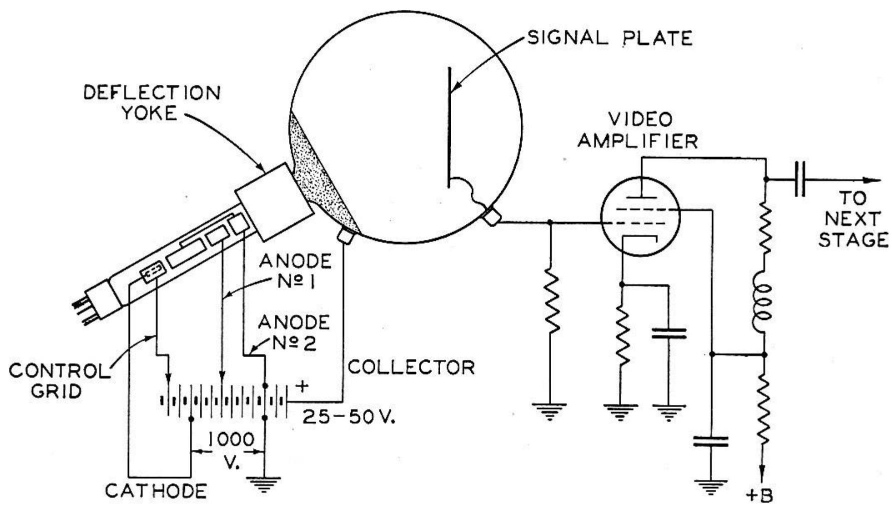

Fig. 3—Schematic diagram to show Monoscope connections.

1. *Kinescope Tests*

The television-tube manufacturer is concerned with how well his product will perform when reproducing video signals. Short-cut tests have been tried, but give poor correlation with the results obtained when an actual picture is reproduced. However, the quality of the latter is difficult to reduce to a quantitative basis unless the test picture or pattern has a specific character which can be accurately converted into a reliable video signal. The Monoscope is admirably suited for this purpose.

Simple tests insure the quality of the video signal used for rating the Kinescope. If the scanning on the Monoscope is reduced and that on the Kinescope is maintained at normal, an enlargement of the scanned portion of the signal plate will be seen on the Kinescope. This enlargement removes the possible limitation of Kinescope resolution. Also, the reduced scanning lowers the frequency band of the video signal so that the video amplifier does not limit the resolution. Under these scanning conditions, the focus of the electron gun in the Monoscope can be accurately set to give maximum resolution. The electron gun used in the Monoscope will give a resolution of 500 to 600 lines without difficulty; therefore, it more than fulfils the requirements of the present system of 441 lines. Figure 4 shows a test pattern which is often used for checking resolution. The lines used to form the half-tone circles in the center can be easily seen when the scanning is condensed.

After the focus of the Monoscope is set for maximum resolution, the resolution of the video amplifier can be checked. This is done by making the Monoscope scanning normal size and increasing the scanning on the Kinescope. The latter is necessary to remove the possible limitation of Kinescope resolution. If a test pattern similar to Figure 4 is used, the resolution of the amplifier is easily checked by noting the resolution of the "V" in the upright position. The resolutions of the Monoscope and video amplifier should be appreciably more than the resolution to which the Kinescope is to be rated. Under these conditions, the limits of the Kinescope resolution can be determined and reliable test data obtained.

Experience has shown that the resolution in all parts of the scanning pattern on a Kinescope may not be uniform. Figure 5 shows a test pattern which is suitable for checking all parts of the scanning pattern under similar conditions. Each section carries "V's" which correspond to resolutions of 150 to 450 lines. Also, tones between black and white are included to give a check on the modulation characteristic. With such a pattern as this, the Kinescope can be rated under different bias conditions with various amounts of video signal input. An illuminometer can be used to check the light output for a definite signal. Experience has shown that such elaboration is necessary to obtain reliable test information. Perhaps, as the art progresses, suitable short-cut tests can be devised.

2. *Receiver Tests*

A standard source of high-quality signal has numerous advantages in the development and production testing of receivers. Various resolution patterns serve as good "yardsticks" for measuring receiver characteristics if they can be converted into video signals of good fidelity. As has been pointed out, the Monoscope is particularly useful for this purpose. By adding standard synchronizing impulses to the Monoscope signal and modulating a small transmitter, a very useful test signal can be obtained for readily checking the receiver.

3. Television System Tests

When a television system is installed, numerous tests must be made to adjust the various circuits. The Monoscope materially aids such testing. For instance, any extraneous signals entering the grid circuit of the Iconoscope can be easily detected. Since the video signal from the Monoscope is directly proportional to the beam current, any variation in beam current is revealed as a modulation of

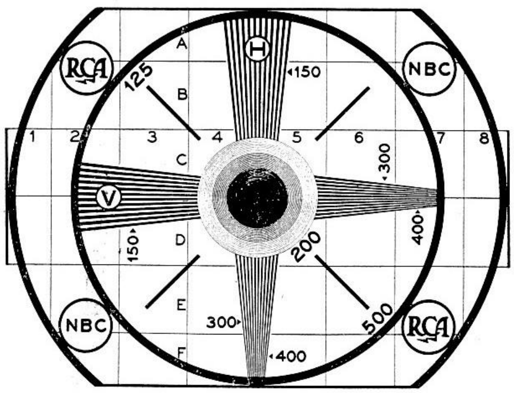

Fig. 4—Test pattern for checking resolution.

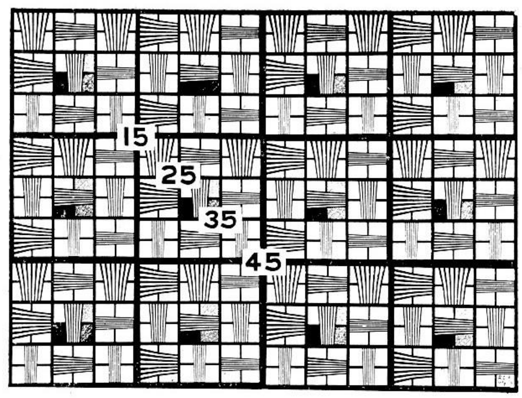

Fig. 5—Test pattern for checking all parts of scanning pattern.

the video signal. Therefore, any extraneous signal or hum in the circuits is revealed.

When the shading signals which are sometimes added to the Iconoscope video signal are removed, the video-amplifier can be checked for pick-up and frequency response by using a Monoscope video signal. Such tests help to separate confusing factors which often combine to give poor over-all operation.

Because there are not any half-tones in the video signals from a Monoscope except those that are created by the limitation of resolving power of the beam, the signal is rich in the higher-order harmonics which make up the corners of a square wave. This type of signal is exceptionally good for showing the transient response of video amplifiers.

The Monoscope is a type of tube which has proved very useful for testing of television devices and circuits. It is believed that the Monoscope will aid materially in advancing and perfecting the art of television.