A Universal Test Unit for the Study of Television Images

Sweep Circuits, Video Amplifier and an Image Generating Tube Combined in a Unique Set-Up

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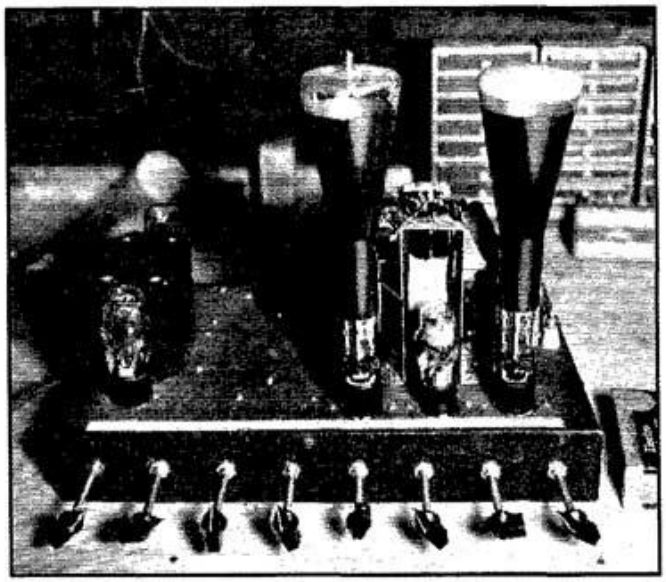
At this stage the reader of this series of articles will have a general idea of modern television technique together with enough circuit data to permit him to build a complete receiver. The circuit material has been made intentionally very general in nature in order to facilitate the description of the functioning of the various components. We could, at this stage, proceed with a detailed constructional type of article describing a complete receiver. Since regular scheduled transmissions are still (at the time of writing) unavailable and since the sincere experimenter will demand a still more detailed understanding of practical circuit and adjustment procedure, we have decided to devote this article instead to the description of what can be considered a universal experimental set-up, built around inexpensive equipment and suited for use either as portion of a receiver, as a "test set" capable of producing a complete picture signal for the adjustment of receiving apparatus, or as the basis of an experimental transmitter.

This experimental equipment is built around a most fascinating device, recently perfected for television work, which is actually a test picture generator tube. The device, under the name "Monoscope," was described by Mr. C. E. Burnett of RCA at a recent convention of the Institute of Radio Engineers. The original tube was a very beautiful affair designed for use in the testing of commercial studio and transmitter equipment and was rather out of the reach of the amateur. The very great usefulness of this device, however, has led other manufacturers to undertake development work aimed at the production of a small and inexpensive unit. Two such tubes under development are the "Monotron" of National Union and the "Phasmajector" of the Allen B. DuMont Laboratories.

These test picture generator tubes consist essentially of an electron gun similar to that used in conventional cathode-ray tubes. This gun focuses a beam of electrons upon an aluminum disk mounted in the position ordinarily occupied by the fluorescent screen of a cathode-ray tube. The picture to be reproduced is printed on this disk. The electron beam is deflected with normal sweep circuits and as the beam crosses the picture, variations in secondary emission from the picture disk result. The secondary electrons emitted are either gathered on a conductive coating inside the tube or on a special collector element, and the video output voltage is obtained either from the picture plate or from the collector.



THE COMPLETE PICTURE GENERATING EQUIPMENT TOGETHER WITH A VIEWING TUBE: AN EXPERIMENTAL SET-UP OF THE EQUIPMENT DESCRIBED

Power supplies for the video amplifier, the sweeps and generating and viewing cathode ray tubes are at the left. The video amplifier (with one tube upside down to shorten wiring) is between the C.R. tubes. Sweep circuit gear is at the right rear. The plentiful controls are, of course, to facilitate experiment.

The output of the device is surprisingly high and the gain of an amplifier used to bring the signal up to a sufficient level to operate the control grid of the C.R. tube need not be greater than 25.

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The important feature of the whole development from the amateur point of view is that we are to have available an inexpensive method of producing a television signal which is certain to be of enormous benefit in facilitating experimental work. No longer need we wait for commercial transmitters nor, for that matter, need we give up hope of participating in television experiment just because we live beyond the range of the transmitters now operating. Even when we do have a commercial signal available, the new picture tube will make available a test picture of fixed and known quality with which accurate comparative work may be done. It is fortunate also that the necessary associated apparatus is relatively simple. And it is still more fortunate that the equipment built to operate the new tube is all entirely suitable for use in an experimental receiver.

In Fig. 1 is the complete circuit of a picture generating unit. It includes two sweep units, of the type described in the last article of this series, together with a two-stage video amplifier. Also, there is the necessary wiring for the picture tube itself. This unit, with a conventional three-inch cathode ray tube in place of the Monotron, becomes a television receiver by the addition of an r.f. section and a synchronizing pulse separation unit. On the other hand, it becomes a demonstration unit to allow the visual examination of the picture in the Monotron tube by connecting a three-inch cathode-ray tube to the 1000-volt supply, providing a separate voltage divider for focusing, then connecting the control grid of the cathode-ray tube to the output of the video amplifier. The output of the sweep circuits is connected, of course, both to the deflecting plate in the Monotron and in the cathode-ray tube.

Examination of the circuit will show that the sweep unit and the video amplifier correspond very closely to the circuits given in previous articles. Also, the arrangement of the Monotron portion follows exactly conventional cathode-ray tube practice. The only unconventional feature is in the arrangement used to extract from the sweep circuit suitable pulses for synchronizing and blanking. These pulses are obtained from the plate of the second tube in each sweep unit. In order to avoid interlocking between the two oscillators and to insure proper mixing of the two synchronizing pulses, the pulses are passed through a double diode before being mixed. They are then fed directly to the control grid of the Monotron in order to prevent the generation of any video voltage during the return traces of both sweeps. If this were not done, the video voltages would cause irregularities in the amplitudes of the synchronizing pulses. In order to get these pulses in the output of the complete unit, a small portion of the available pulse voltage is picked off a voltage divider and injected into the grid of the first

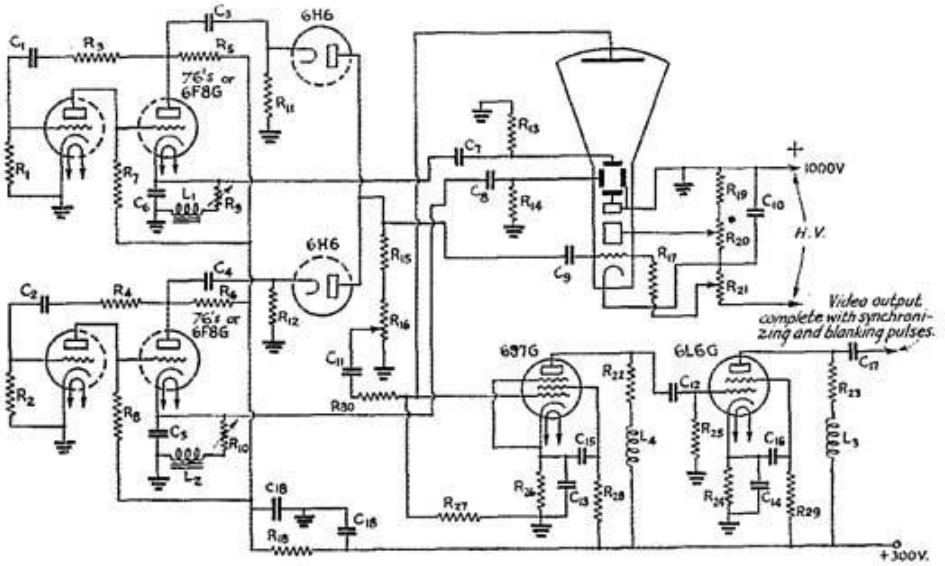

FIG. 1—THE COMPLETE CIRCUIT OF THE STANDARD PICTURE SIGNAL GENERATOR UNIT

R_1, R_2, R_{11}, R_{12}, R_{13}, R_{14}, R_{25}—1 megohm.
R_3, R_4—4000 ohms.
R_5, R_6—2000 ohms.
R_7, R_8—100,000 ohms.
R_9—50,000 ohms.
R_{10}—150,000 ohms.
R_{15}—200,000 ohms.
R_{16}, R_{21}—10,000 ohms.
R_{17}—.5 megohm.
R_{18}—1500 ohms.
R_{19}—150,000 ohms.
R_{20}—75,000 ohms.
R_{22}, R_{23}—2500 ohms.
R_{24}—220 ohms.
R_{26}—1500 ohms.
R_{27}—25,000 ohms.
R_{28}—250,000 ohms.
R_{29}—30,000 ohms.
R_{30}—250,000 ohms.
C_1, C_2—.002 μfd.
C_3, C_4—.01 μfd.
C_6—.2 μfd.
C_8—.001 μfd.
C_7, C_8, C_{12}, C_{17}—.5 μfd.
C_9, C_{10}—1 μfd.
C_{11}—.25 μfd.
C_{13}, C_{14}—50 μfd.
C_{15}, C_{16}, C_{18}—8 μfd.
L_1—100 henrys.
L_2—2000 henrys.
L_3, L_4—100 microhenrys.

video amplifier tube along with the signals from the Monotron. The output of the video amplifier thus contains the picture voltages plus the synchronizing and blanking pulses. In other words, the output of the unit corresponds very closely to that obtained from the final video amplifier in a receiver tuned to a normal television signal. In setting up the equipment it is as well to have a three-inch cathode-ray tube available. This tube is placed in the socket ordinarily occupied by the picture generating tube and the sweep circuits are then adjusted until the usual scanning lines cover the desired area. Some workers will find it worthwhile to add adjustable positioning controls to permit centering the pattern—the necessary circuits being available in many pamphlets and books dealing with cathode-ray tube technique. With this setup the voltages on the cathode-ray tube may also be adjusted to give the desired brilliance and focus. The operation of the blanking pulses can be checked by removing the diode tube, in which case the return traces will be visible on the screen. All of this suggests that the device, in addition to serving its prime purpose of a picture signal generator, is also an excellent cathode-ray oscilloscope. Additional condensers may be provided in the cathode circuit of the sweep units to give a wide variety of frequencies and the video amplifier may be used to provide amplification of the voltage whose waveform is to be studied. Should the experimenter already have a complete oscilloscope it will not be necessary to build the entire rig. One additional sweep unit may be added to that already in the oscilloscope and the only additional item will then be the video amplifier.

In our experimental work the unit shown in the photograph has been used for a variety of interesting jobs. In its complete form it allows, in the first place, a very excellent demonstration of the fundamental principles of transmission. Also, it immediately permits an examination of the capability of both the Monotron and the cathode-ray tube in resolving a television image. The pattern provided on the picture tube is sufficiently complex in its drawing so that it is possible to receive all the details present only if the equipment is excellently adjusted. Incorrect sweep amplitudes immediately become apparent as a distortion in the breadth or height of the image. Poor high-frequency response in the video amplifier is indicated by poor definition on the edges of lines—particularly when they are vertical. Phase shift is indicated by the edges being reversed in color or by the lines themselves being shifted slightly to the right—giving a ghost of the pattern displaced slightly from the original. Then, the ability of the screen, tube and coupling circuit to reproduce good tone values can be tested by observing whether or not any halftones in the original can be duplicated in the final picture.

The unit is essentially a device for facilitating the construction and adjustment of television receivers, but one needs little imagination to visualize it as a source of modulation for a ham television transmitter. Indeed, such equipment has already been used by some of us for preliminary experimental work with considerable success. This is not to say that the day of practical amateur television transmission is here. This gadget permits the transmission of a single picture only and we must await the development of inexpensive Iconoscopes before the reproduction and transmission of moving images becomes possible. It is important to realize, though, that the necessary technique is being given close study and that before very long we shall find amateur television transmission to be not much more complicated nor much more expensive than 'phone transmission is to-day.

In the meantime, we firmly suggest that the television enthusiasts should study and possibly duplicate a unit such as that described. Its operation will give him a very intimate picture of many of the details of television technique which are so difficult to assimilate in any other fashion and will provide him with units suitable for immediate application to experimental reception.