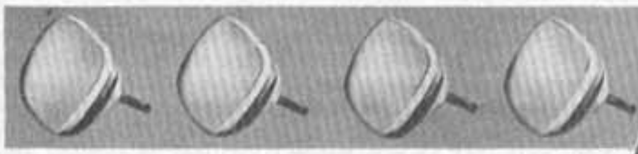
A New Single-Gun Color Tube



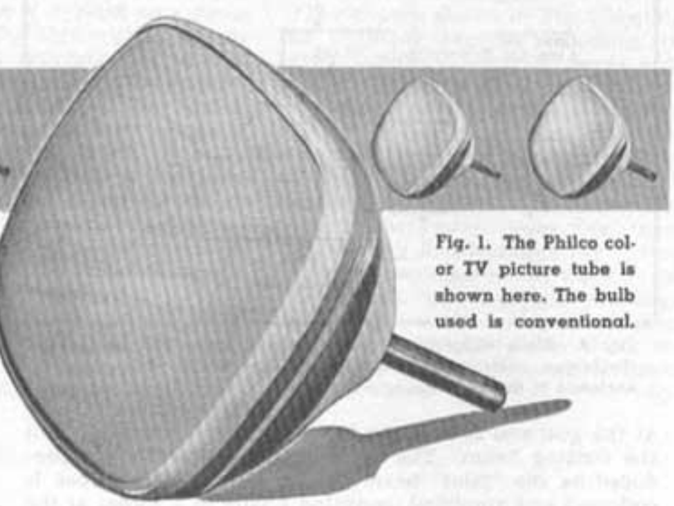


Fig. 1. The Philco color TV picture tube is shown here. The bulb used is conventional.

This is the tube that Philco has kept under wraps for over two years. It produces excellent color pictures, but receiver circuitry is not yet final.

FINALLY, after more than two years of secret development, the *Philco Corporation* has divulged the principles of operation and the extent of development already accomplished on its "Apple" color TV system. At the same time, the company released information on the single-gun color tube it developed to go with this color TV system. The word "Apple" has been used by *Philco* as a code name for this system, which has been one of the best kept secrets in the electronics industry.

Basically, the tube uses a single electron gun to excite the vertical color phosphor stripes on the face plate. Instead of directing the beam to a particular color stripe in a regular switching and deflecting sequence, as the *Lawrence* single-gun tube does, the "Apple" tube allows the beam to sweep across the face of the tube as in monochrome practice but the modulating information to the beam is switched according to the position of the beam. In other words, as the beam passes over a red stripe the red signal is passed to the gun. The same holds true for blue and green. Such a principle requires an indexing system to provide information concerning the whereabouts of the writing beam and a modulating system to provide the required beam modulation.

The "Apple" color picture tube, shown in Fig. 1, may be generally described as an all-glass 21" rectangular picture tube providing 260 square inches of useful screen area, having a diagonal deflection angle of 74°, and using magnetic focusing and deflection. The color television display system described here requires a picture tube that must satisfy certain specific and unusual requirements. These are:

1. Small spot size
2. Two electron beams that "track" each other and have a minimum of "crosstalk"
3. A screen consisting of a repeating pattern of vertical red, blue, and green luminescing phosphors arranged in lines in a precisely described fashion on the face of the tube
4. A secondary emission index-producing structure as an integral part of the screen

The two fundamental parts of the "Apple" system are "sequential writing" and "electrical index." The expression "sequential writing" means that the beam passes successively over triplets of fine vertical red, green, and blue stripes, as shown in Fig. 2. A particular color is produced by modulating the beam during the time it is passing over each triplet according to the proportions of primaries in the desired color.

The expression "electrical index" refers to a signal derived from the anode of the "Apple" tube itself that continuously gives information on the location of the beam. The beam current responds to two types of instructions: the color video signal from the transmitter and the index signal.

The index signal is obtained from the tube by means of the structure shown in the insert in Fig. 2. A line, called the index stripe, of a material having high secondary emission compared to the aluminized background of the tube face, is placed behind every red line. A second beam, the "pilot" beam, parallel to the writing beam, is produced

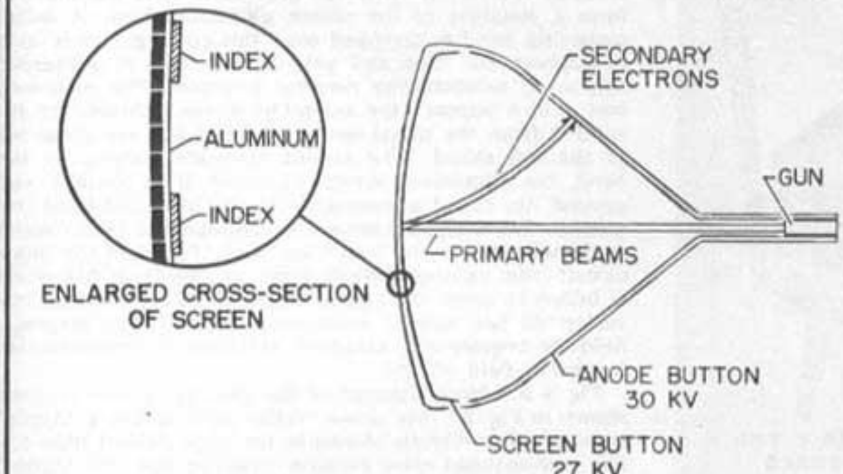
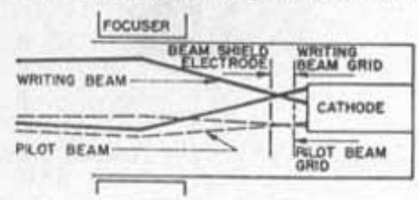


Fig. 2. Top cross-sectional view of the "Apple" color TV tube showing the path of the electron beam from the gun, and the path of the secondary electrons which are knocked off the screen and collected.

Fig. 3. Method of producing two electron beams in a single electron gun. Note the co-planar grids, one for each beam. Both beams, one for writing the picture on the screen and the other for indexing, must track perfectly if the system is to work.



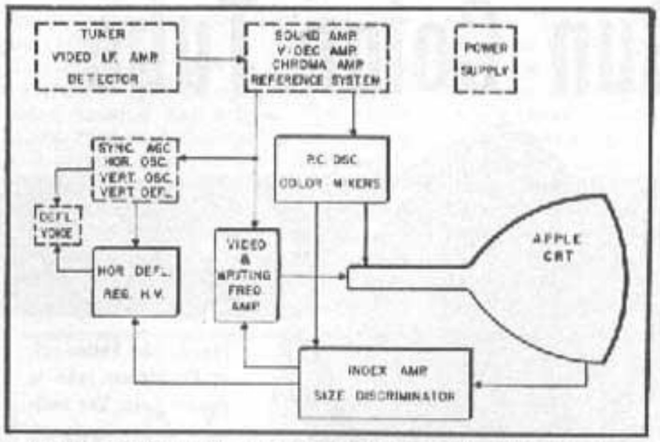


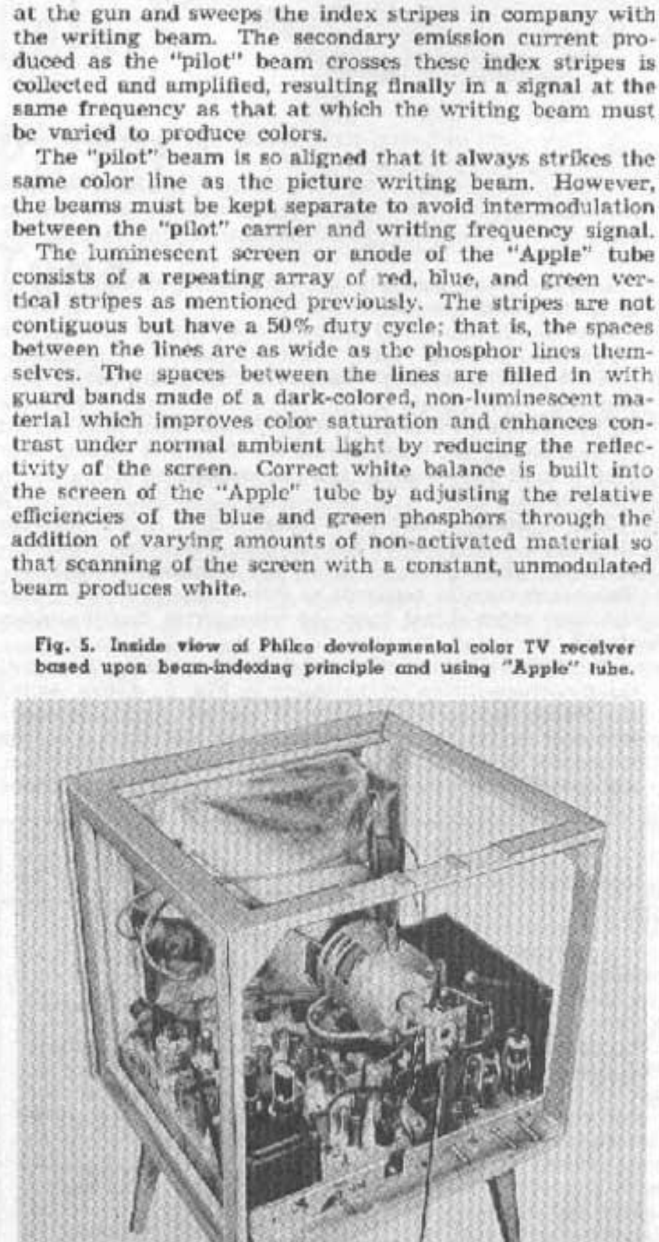
Fig. 4. Block diagram of developmental color TV set using single-gun color tube described in this article. The circuits enclosed in the solid boxes are peculiar to the "Apple" system.

at the gun and sweeps the index stripes in company with the writing beam. The secondary emission current produced as the "pilot" beam crosses these index stripes is collected and amplified, resulting finally in a signal at the same frequency as that at which the writing beam must be varied to produce colors.

The "pilot" beam is so aligned that it always strikes the same color line as the picture writing beam. However, the beams must be kept separate to avoid intermodulation between the "pilot" carrier and writing frequency signal.

The luminescent screen or anode of the "Apple" tube consists of a repeating array of red, blue, and green vertical stripes as mentioned previously. The stripes are not contiguous but have a 50% duty cycle; that is, the spaces between the lines are as wide as the phosphor lines themselves. The spaces between the lines are filled in with guard bands made of a dark-colored, non-luminescent material which improves color saturation and enhances contrast under normal ambient light by reducing the reflectivity of the screen. Correct white balance is built into the screen of the "Apple" tube by adjusting the relative efficiencies of the blue and green phosphors through the addition of varying amounts of non-activated material so that scanning of the screen with a constant, unmodulated beam produces white.

Fig. 5. Inside view of Philco developmental color TV receiver based upon beam-indexing principle and using "Apple" tube.



Among the important advantages of the "Apple" tube is its similarity to a black-and-white tube. In fact, in the absence of a chrominance signal, it cannot help making a good black-and-white picture. None of the writing beam in the "Apple" tube is intercepted nor deflected in such a way as to waste any high voltage power, and there is no problem of matching the characteristics of three guns to obtain good colorimetry.

The color saturation obtainable at any particular brightness level is obviously limited by the spot size at the beam current associated with that brightness. If the spot is too large to land on one primary color stripe at a time, then de-saturation of primary colors occurs. This consideration, plus that of reasonable structural resolution, made the development of an electron gun producing a spot substantially smaller than usual in a monochrome tube, a prime necessity for this beam-indexing tube.

A combination of a small, countersunk aperture and close cathode-to-grid spacing is primarily responsible for obtaining a greatly reduced spot size.

A second requirement is that the two beams "track" each other. Since one beam is used to tell where the other beam is, the relative position of the beams must be known at all times. The two beams are formed close together by using a single cathode, and two separate, co-planer, control grids, each with its aperture close to the end of the grid, these ends being separated by .002 inch. The center-to-center separation of the two beams at the grid plane is only .029 inch. See Fig. 3. This setup assures good "tracking," since both beams are so close together that they will be acted upon in exactly the same amount by deflecting fields, etc.

The third special requirement of this beam-indexing tube arises from the need for preventing the control voltage of one beam from affecting the intensity or position of the other beam. This is satisfied by using a simple shield between the two beams in the region just above the grid apertures. This shield, shown in Fig. 3, effectively eliminates beam "crosstalk" as a limitation on the functioning of the system.

The final unique feature of the *Philco* beam-indexing color tube is the index structure which provides the required continuous monitoring signal. This signal is generated by the difference in secondary emission between an array of magnesium oxide stripes applied to the gun side of the aluminized screen and the bare aluminum between these stripes. There are two contact buttons on one side of the tube envelope (see Fig. 5), and one of these is connected to the screen aluminum coating, making it possible to maintain the screen potential at approximately 27 kilovolts. The second contact button connects to the bulb coating which is maintained at 30 kilovolts. The three kilovolt differential between screen and bulb coating results in the collection of the secondary electrons from the screen by the bulb coating.

To obtain the indexing signal, an external band of a conductive coating encircles the screen viewing area to form a coupling to the screen aluminum film. A metal mounting band is strapped over this coating and is used to support the tube and yoke-focuser cup in a manner similar to monochrome receiver practice. The mounting feet, which support the assembly in the cabinet, are insulated from the metal mounting band but are grounded to the foil shield. The circuit elements formed by the band, the aluminized screen to which it is coupled, and ground, are tuned to resonance at the index sideband frequency. Index signal take-off is accomplished by a coaxial lead connected to the mounting band. To shield the index circuit from external interference, an aluminum foil shield is folded to cover the rim of the CRT. The tube and circuitry do not appear sufficiently sensitive to magnetic fields to require any magnetic shielding or compensation for earth field effects.

Fig. 4 is a block diagram of the circuitry of the receiver shown in Fig. 5. This is one version of a complete "Apple" receiver. The circuits shown in the light dashed lines follow conventional color receiver practice and the "Apple" receiver imposes no special requirements here. The remainder of the receiver outlined in heavy solid lines is shown in four separate sections: the index amplifier, the "pilot" carrier oscillator and color mixers, the writing frequency amplifier, and the horizontal sweep and high voltage.

The horizontal sweep-high-voltage section is similar to monochrome practice. Some details include the use of a pair of 6CD6 tubes for horizontal drive, and a special high-perveance diode, the L-1379, as the damper. The 30 kilovolt supply is obtained by a voltage doubler using 1B3's.

To aid in maintaining horizontal sweep linearity with changes in line voltage, and to maintain a nearly constant picture height, it appears advantageous to derive the plate supply voltage for the horizontal and vertical oscillators from the regulated energy in the horizontal system.

Vertical dynamic focus only is used in this receiver; for this, a vertical frequency parabola is applied to a focus control tube. The high-voltage supply must have two regulated outputs in order to maintain optimum focus, horizontal sweep operation, and index. This has been accomplished by use of two all-glass gas regulators.

The mixer unit consists of two tubes whose triode sections accomplish nearly all the color signal processing required by the receiver. The functions of this section are to generate an unmodulated "pilot" frequency carrier, and to transfer the chrominance modulation to a second "pilot" frequency carrier. The latter signal is mixed with the amplified index information derived from the CRT to form a chrominance-modulated writing signal which includes the positional information of the index signal.

The chassis shown in Fig. 5 contains the complete receiver including the power supply. This receiver, as a developmental type, does not use an excess of dual-section tubes, yet its complement is only eight tubes more than a shadow-mask receiver containing the same non-display circuitry. In the foreseeable future this differential may be not more than five tubes. Against this disadvantage are the potential advantages of an electron optical system requiring only two alignment adjustments and a cathode-ray tube completely free from static and dynamic white balance, and magnetic field problems. —30—