the CBS Colortron

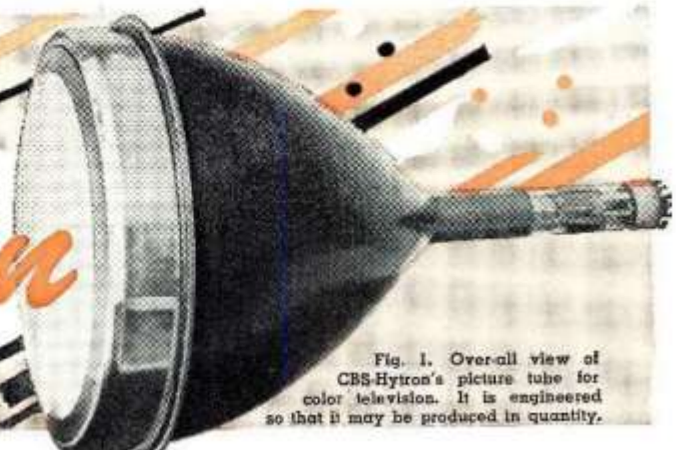

Fig. 1. Over-all view of CBS-Hytron's picture tube for color television. It is engineered so that it may be produced in quantity.

By
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CBS-Hytron

A new color tube—although its operation is basically identical to the RCA tube, its mechanical construction is so different that production problems are eliminated and restrictions on potential tube sizes are removed.

IT has long been recognized that one of the principal obstacles to low-cost, mass-produced color television has been the means by which the colored picture was reproduced. In recent years, most of the effort in this field has been directed toward perfecting a cathode-ray tube, capable of creating colored pictures in much the same manner as those used in black and white television. The problems involved in the successful accomplishment of this objective are prodigious. However, there has been tremendous progress in the direction of solving many of them.

Until recently, the only successful color tubes which had been demonstrated were exceedingly difficult to manufacture and almost as difficult to adjust and maintain in operation. With the announcement by *CBS-Hytron* of its new *CBS*-Colortron, the last barrier to mass production color television appears to have been removed. This new tube makes use of principles already demonstrated as being sound in earlier color tube designs and goes beyond that point to achieve a simplicity of design closely approaching that of black and white tubes.

Before discussing the improved features of the *CBS*-Colortron, a review of the earlier type of color tube may be helpful. One of the most successful of these earlier color tubes makes use of the principle of parallax to achieve the necessary separation of the three primary colors within the same tube structure. Three electron guns, located in the neck of the tube, are modulated by three individual signals. The beams from these three guns are aimed so as to come together, or converge, upon a mask containing a multiplicity of small holes. As the three beams pass through the holes in the mask, they become divergent again and arrive at the screen as three individual beams. The screen is printed with three types of phosphor, capable of producing the three primary colors—red, green, and blue. The individual phosphors are printed as very small dots on the screen and are arranged in groups of three so as to form little triangles, or triads, each containing a red, a green, and a blue dot. As the three individual beams strike the screen, they are caused to fall exactly over the center of one of the three color dots. Thus, the beam from the red signal gun passes through the mask and travels on to strike the red dot on the screen. The beam from the green signal gun passes through the same hole to continue on and strike the green dot. The blue dot is excited in like manner. This principle of separation by parallax is shown in Fig. 3A.

As stated earlier, tubes utilizing this principle have been demonstrated before. Their chief drawback has been their inherent complexity of construction and their dependence upon highly skilled artisans during their assembly. It has been because of these factors that the first estimates of color television set costs have been so high. It was inevitable that lower cost and more reliable designs would be sought. The *CBS*-Colortron is the result of such an effort.

The color television picture tube differs from its counterpart in black and white in three essential respects. It is these basic differences which will ultimately determine the cost differential between a color television picture tube and a black and white tube. The first of these differences is in the gun structure. The color picture tube in its present practical form requires three electron guns as compared to only one in the black and white tube. While it may conceivably become possible to design color tubes in the future, having only one gun, at present the three gun design seems to be the only practical design for a compatible color system.

The second essential difference consists of the mask which permits the three beams to be separated at the screen for proper color registration. There is no way of eliminating this added element in the parallax type of color tube. However, its method of fabrication and assembly leaves much latitude for improvement and consequent cost reduction.

The last essential difference consists of the special tri-phosphor screen, used in color television tubes, as compared with the simple screen used in black and white television. There appears to be no possibility of eliminating this essentially complex part of the color tube. However, once again the method of producing the screen leaves considerable area for improvement.

It has been in the latter two areas that the greatest significant advances have been made in the *CBS*-Colortron. Earlier designs made use of a flat, prestretched mask, firmly bolted to a heavy spacer frame, which was in turn clamped to the glass plate containing the phosphor dots. This assembly was not only difficult to maintain in proper registration during its assembly, but created equally difficult problems in evacuating and outgassing the completed tube. Because of the large mass contained in this structure, the time required to raise and lower the temperature of the entire tube during the evacuation process was considerably longer than for black and white tubes. This, of course, added to the ultimate cost of such a tube. In addition, the losses due to non-linear expansion and contraction in this subassembly ran very high, adding even further to the cost.

Other factors contributing to the high cost in the earlier flat mask type of color tube were such items as an internal decorative mask and the use of an additional glass panel used to seal the open end of the tube and serving as a window through which to view the phosphor screen mounted inside the tube. Both of these items are eliminated in the *CBS*-Colortron.

In order to achieve a significant reduction in the cost of preparing the phosphor screen, a new method of printing the dots had to be developed. The method used in the earlier color tubes was a silk screen process. This is a sort of stenciling operation where a silk screen, containing a pattern of holes, is laid over a flat glass plate and the phosphors are forced through it onto the glass by a wiping or squeegeeing motion. The process is essentially a hand operation, requiring a high degree of skill and experience. Since it must be repeated three times on each screen, the possibility of error multiplies rapidly.

A method of depositing the phosphor dots through the use of photographic techniques has been perfected which results in a great improvement in accuracy and which is capable of being performed by automatic equipment, thus effecting a substantial reduction in cost. This photographic technique has certain other advantages that may exceed those of direct cost. Through the use of this technique, it has been possible to eliminate the use of a separate piece of flat glass for supporting the phosphors. They can now be deposited directly onto the faceplate as in the black and white tube. By eliminating the extra glass surfaces of the older flatplate color tube, contrast is improved in the picture because there is less light dispersion and fewer halations caused by room lights, windows, etc. Still another advantage accrues from the placing of the phosphors on the inside of the faceplate. This inside surface is, of necessity, a curved surface so as to be able to serve as an arch and support the weight of the atmosphere pressing in upon the faceplate which would otherwise cause it to collapse.

Fig. 2. The CBS-Colortron (top) in "exploded" form to show component parts as compared to the separate components which go to make up another type color tube.

The use of a curved phosphor screen permits the use of a matching, curved mask. This combination of a curved mask and a curved faceplate distinguishes this type of tube from the earlier flat mask and flat phosphor plate tube.

One of the most difficult problems for the circuit designer using the flat mask type of color tube is that of obtaining proper convergence over the entire screen area. Fig. 3B shows diagrammatically why this problem exists.

It can be seen that in the case of a flat mask tube, if the beams are brought to convergence at the center of the screen, they will not be properly converged out near the edges of the picture. This is because the beams describe an arc as they swing back and forth across the mask, and the mask, being flat, fails to coincide with the plane of their point of convergence except at one point. Dynamic means of correcting this condition are required within the color receiver. A parabolic voltage waveform is required to modulate the convergence lens in order to shift the plane of the convergence point back onto the mask near its edges.

It is apparent from Fig. 3B that if the mask were a section of a sphere, the need for this dynamic convergence would be virtually eliminated. Actually, in a practical tube design, the mask and faceplate curvatures do not coincide exactly with the plane of the convergence point of the three beams. However, the correction obtained with even a moderate amount of curvature is considerable, and in the case of the *CBS*-Colortron, it is on the order of six to one over the flat mask type of tube. This means that the requirements placed upon the circuit designer are greatly lessened and the problems of the service technician in maintaining

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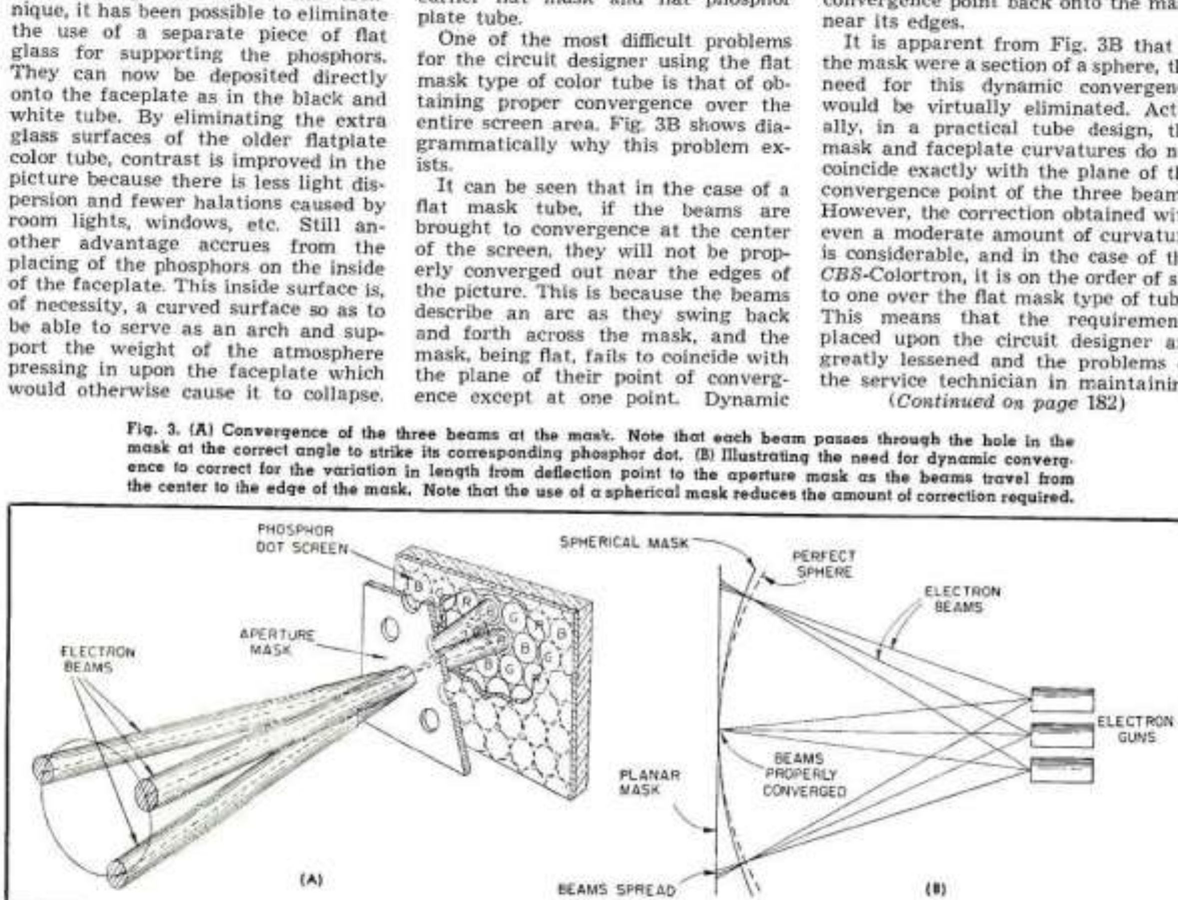
Fig. 3. (A) Convergence of the three beams at the mask. Note that each beam passes through the hole in the mask at the correct angle to strike its corresponding phosphor dot. (B) Illustrating the need for dynamic convergence to correct for the variation in length from deflection point to the aperture mask as the beams travel from the center to the edge of the mask. Note that the use of a spherical mask reduces the amount of correction required.



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sets in proper working order, once they have been in the field, are likewise reduced.

The aperture mask is stamped into an arched-shape and six spring clips are welded around the edges. The studs holding three of the spring clips have small v-shaped surfaces on their heads which are designed to fit over three mating domes, or hemispheres, on the inside of the faceplate beyond the picture area. These hemispheres, which are molded into the glass, precisely locate the mask in relation to the screen. The six springs are clipped over the inside lip of the metal flange which is used to attach the faceplate panel to the funnel. These clips provide a small amount of forward thrust to keep the mask pressing down on the mounting hemispheres. There is no other assembly operation to be performed except to bring the faceplate panel and the funnel together and weld their flanges around the edges. The simplicity of this method of assembly is apparent.

Considerable speculation exists as to what size and shape the color picture tube will take in its ultimate form. Up to this time, the only tubes that have been demonstrated have shown relatively small pictures by present day standards and they have been in round bulbs. This is largely because the older, flat mask type of tube becomes exceedingly difficult to design and manufacture as larger sizes are attempted. The problems already mentioned become intensified and do not appear to be a simple linear function. The problem of maintaining dynamic convergence over wider angles than those already attempted in the flat mask type of tube may be considered as almost insurmountable.

The curved mask and faceplate tube, on the other hand, already has a six to one advantage in connection with the convergence problem in the same size of bulb and with the same deflection angle. It, therefore, becomes quite apparent that this type of tube can be expected to be made in larger sizes, having deflection angles comparable to present day black and white tubes. Likewise, we can expect to see these larger size tubes in the rectangular bulb shapes. This will contribute to cabinet economies because of the more efficient use of the space within the cabinets.

In summary, the *CBS*-Colortron appears to be the first such color tube ideally designed for mass production on largely existing manufacturing facilities. It eliminates several components found in earlier models and achieves an improvement in contrast, as well as a simplification of circuit requirements, adjustment time, and a reduction in the amount of really serious field service problems that would be the result of drifting of convergence circuits. —30—