Kodak engineers adapt lenticulated-film, additive-color system for fast processing of kinescopes required in re-broadcasting of time-delayed color television programs.

Simplified Method of COLOR Kinescope Recording

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GROWTH of color TV has created a demand for "quick kines" in color. These are motion-picture records of live TV shows, and they are made at the network facility where the program originates, by photographing TV pictures presented on special picture tubes known as recording kinescopes. The exposed film must be processed and ready for projection in less than three hours after exposure, because it is used for time-zone-delayed rebroadcasting to enable audiences in the eastern and western parts of the country to view the show at the same time of day.

Color pictures presented on special high-intensity television screens can be photographed on a typical color film, such as Eastman Color Negative Film, Type 5248. The difficulty comes in processing this film in time for the re-broadcast, because color development is a complex and time-consuming procedure.

No Color on Film

A new method of color-kinescope recording has been demonstrated at the Eastman Kodak Company research laboratories. This method utilizes 35-mm *black-and-white* film which can be processed simply and quickly to meet the demands of time-zone-delay. Three color-separation images are recorded on the film in black and white. One of these images represents the tonal gradations of the red parts of the subject, the second represents the green parts, and the third image represents blue.

In certain other additive color processes, three such images are recorded in the form of three individual picture frames. An outstanding feature of the newly proposed method of color-kinescope recording is that all three color-separation images are interlaced on a single 35-mm motion-picture frame. This in accomplished by means of very small plastic cylindrical lenses, called lenticules, which are embossed directly into the surface of the film base.

Similar lenticules were employed in the old Kodacolor additive color process for amateur motion pictures, and a similar film for theatre release prints is also available. Although very good color can be obtained by the lenticular additive color process, the big stumbling block encountered in practice is the severe loss of light which occurs during projection because a banded red, green, and blue filter must be placed in the optical system to impart color to the projected picture. The subtractive color processes give a much brighter picture.

Filters Not Needed

However, the color-TV system is additive, and therefore it is possible to employ an additive film process *without filters* both in kinescope recording and in subsquently televising the film records. The color TV camera employs beam-splitters and filters to derive red-, green-, and blue-separation pictures of the subject. The corresponding three electrical video signals generated by the TV camera can be used to control three separate kinescopes, and color-separation images will then appear on the kinescope screens. For kinescope recording purposes, it is not necessary that these screens be, respectively, red, green, and blue. In fact, the best phosphor for all three is one that gives off blue and ultraviolet radiation. If photographs are made of the pictures ap-

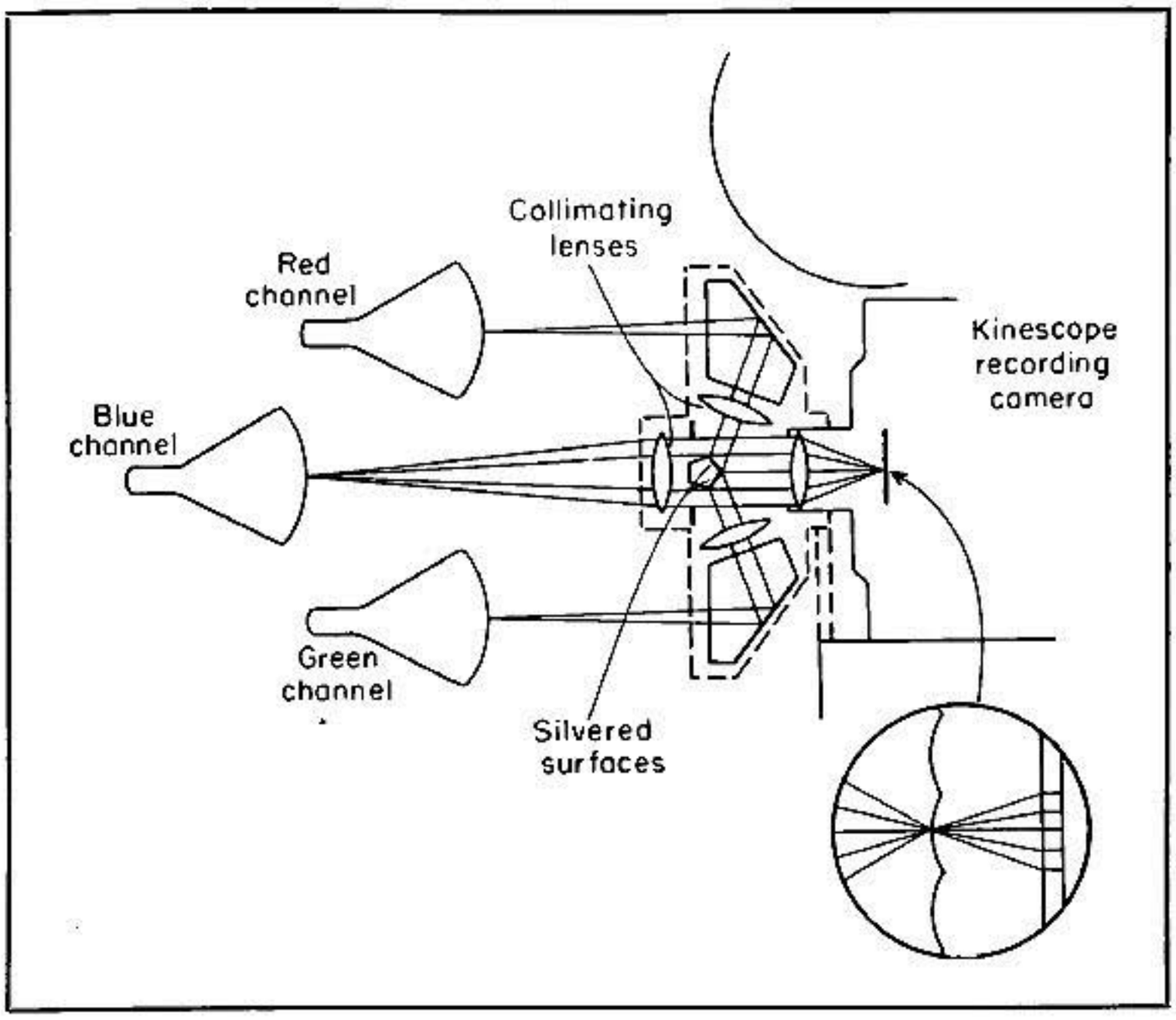

FIG. 1. Color-kinescope recording on blue-sensitive embossed film.

pearing on the three kinescope screens, then a set of three color-separation records will be obtained.

This is actually done in the embossed film method of color kinesope recording, but as pointed out earlier, all three separation images are combined, frame by frame, on a single strip of film. Figure 1 shows the arrangement of kinescopes, optical system, and recording camera. All of the kinescope screens are coated with P-16 phosphor, which emits blue and ultraviolet radiation.

A blue-sensitive embossed film records the images. The film is loaded into the camera with its base side toward the lens, so that light must travel through the embossed lenses before it can strike the light-sensitive emulsion layer. The lenticules on the film base are greatly enlarged in the diagram to show how they operate. Actually, they are very small cylindrical lenses, each 1/25-mm high, running all the way across the film, perpendicular to the edge.

The three color separations are recorded in different areas behind each lenticule by employing special apertures located in front of the camera lens. This lens images the three kinescope pictures in focus and in register on the film, and at the same time each one of the lenticules images the special apertures in focus on the very narrow area of the emulsion which lies directly behind that lenticule. Light from each individual kinescope passes through one of the apertures, and light from the other two kinescopes is excluded from that aperture.

Beam-Splitter Used

As illustrated in Fig. 1, light from the red-channel kinescope is directed to a silvered glass surface placed in front of the camera lens. This surface acts as the aperture for the red channel, and reflects the light into the camera lens. Light from the green channel is similarly reflected from an adjacent silvered surface. The useful light from the blue-channel kinescope is divided into two beams which pass above and below the two silvered surfaces.

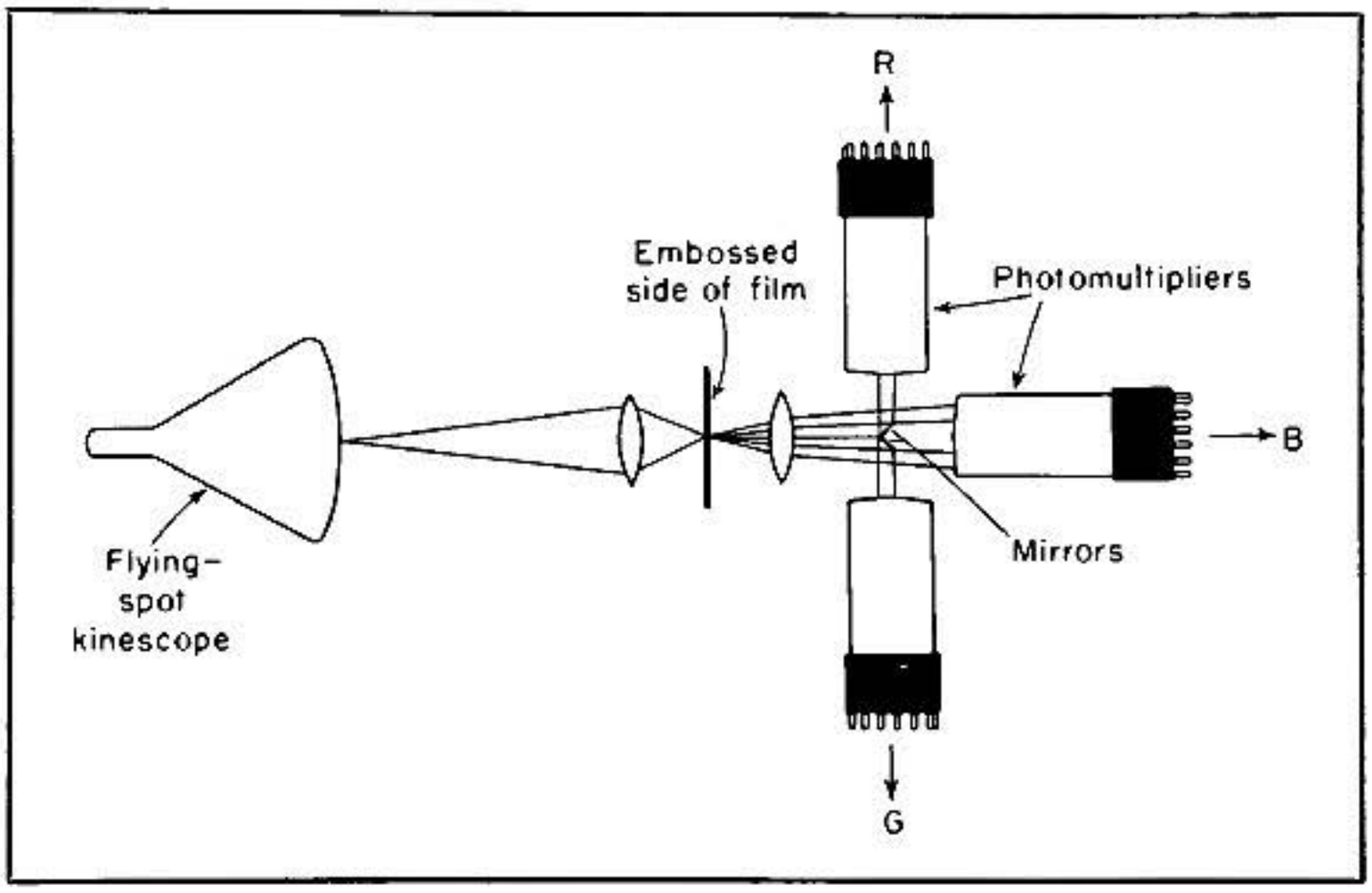

FIG. 3. Televising embossed film color records by means of a flying-spot scanner.

Figure 2 shows the effective apertures as seen from the lenticules. The insert at the bottom right side of Fig. 1 shows how each lenticule images these apertures onto the emulsion. From top to bottom, the four subdivisions of the emulsion area behind the lenticule receive images of the lower half of the blue-channel aperture, the green-channel aperture, the red-channel aperture, and the upper half of the blue-channel aperture.

Thus, the picture information on each kinescope is recorded within a specific area of the emulsion, interlaced with the information recorded from the other two kinescopes. Stated in another way, the picture as a whole is divided into about 390 horizontal strips, corresponding to the number of lenticules contained in the height of one 35-mm motion-picture frame, and each of these strips is subdivided into its three color-separation components. Although the developed silver images are colorless, nevertheless they contain the information required by the television system to produce a color picture.

This information can be fed back into the television system by any of the means commonly used to televise motion-picture film. However, special optical systems have to be employed. Figure 3 shows an arrangement utilizing a flying-spot scanner. The scanning spot is focused on the emulsion side of the film, and light transmitted by the various black-and-white color-separation images then passes through the lenticules. They project this light in bands corresponding to the apertures used in recording. A lens and mirror assembly separates the bands of light and directs them to three different photomultiplier tubes which generate, in accordance with the information recorded on the film, the "red," "green", and "blue" video signals.

In a three-Vidicon system, embossed film can be televised by inserting a banded filter in front of the projection lens to form a colored picture in the field lens commonly employed in that system. The sensitivity and the signal-to-noise ratio of the Vidicon tubes are sufficient to overcome the loss of light by absorption in the filter.

In addition to its direct use for time-zone-delayed rebroadcasting, the embossed-film original can also be used in a reduction printer to make ordinary 16-mm color prints. These prints are convenient permanent records which can be projected with any 16-mm projector, and which can be televised at any station having regular 16-mm color-TV projection equipment.

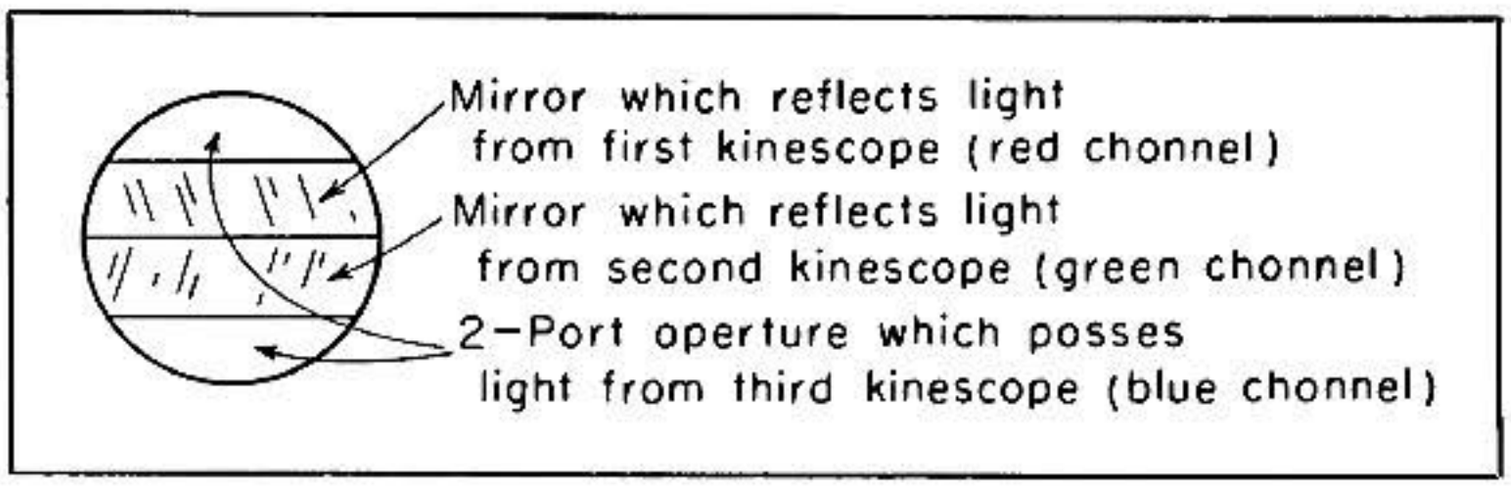

FIG. 2. Effective apertures of the three optical channels of Fig. 1 as seen from the lenticules.