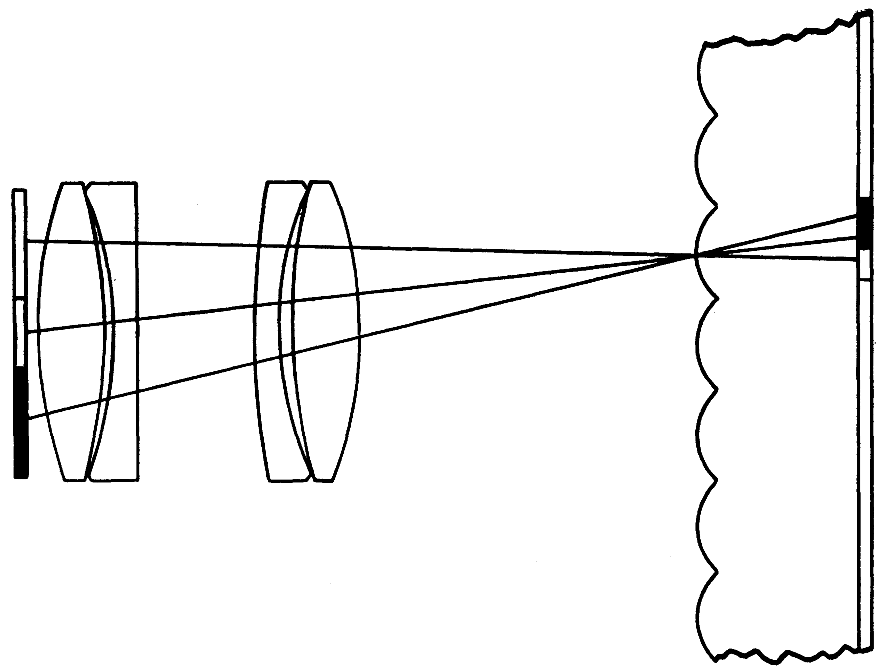
How New Color Movie Camera Works

Photography

By Edwin E. Slosson



IN MAKING THE NEW COLOR MOVIES, the tri-color filter, on the left, splits the light into red, green and blue bands which the lens focuses on the film. The ridges on the celluloid side act as little lenses, focusing the three bands as fine lines in the sensitive side. In projecting, the arrangement is the same; only the direction of the light rays is reversed

If you remember the play of colors that you get when light falls on an old-fashioned chandelier, or a cut-glass goblet or a corrugated glass screen, you will understand the principle of the new Kodacolor camera of the Eastman Kodak Company. Any angular piece of any transparent material will break up plain white light into its color components and sort these according to their respective wave lengths, much as your radio receiver sorts out the broadcasts of the various stations according to their wave lengths. A lens is simply a circular prism. It slopes down on all sides from the center, so various colors are thrown into rings like a rainbow instead of a straight spectrum band.

We commonly say that there are seven colors in the spectrum, but that is merely because seven was a sacred number and it used to be supposed that everything in the universe was created in sets of seven. But we can as well say that white light consists of a hundred or a thousand colors, for we can divide it into as many parts as we please, depending purely upon the power of our prisms.

But for practical purposes we do not need even so many as seven. Three colors suitably selected are sufficient to reproduce any color, shade or tint of all the infinite variety of nature. The three taken together give white. Absence of all three gives black. Other combinations give various colors.

Now the eye is a marvelous mechanism, but we must confess that it is rather slow and clumsy when we get down to a fine point. And it is because of the clumsiness of our born optical apparatus that the printer and the motion-picture producer are able to cheat us into thinking we see something that really isn't there. Looking at an illustration in a book or paper, we think we see smooth gradations of shade from dark to light. But if we look at it with a microscope we discover that we have been deceived and that there are no half-tones at all in this "half-tone picture." It is composed entirely of black-and-white dots.

So, too, there are no moving pictures in the "moving pictures." What we see is a swift succession of still pictures, slightly different, from which we falsely infer that we are seeing movement.

So, too, the film of the Kodacolor has no color. The image is delineated on it by more or less opaque places due to more or less dense deposits of black metallic silver, like any ordinary photographic film. But the Kodacolor differs from ordinary film in that the light coming from the original scene has been broken up into three primary colors by a filter screen in front of the lens and then these have been caught by minute lenses on the celluloid strip before reaching the sensitive surface of silver salts. The filter is striped in red, green and blue so the ray of light reflected from each point of the surface of the object photographed is sifted out or allowed to pass through this tri-color screen in accordance with the proportion of the particular color it carries.

Next the night, now split up into three bands of color, strikes the film, but from what we should call "the wrong side" for the sensitive coating is behind. The celluloid side in front has been embossed with a series of little cylindrical lenses, ridges as it were, running lengthwise of the ribbon of film. These catch the colored rays and focus them on the sensitive emulsion of the other side. So we finally have a film in which the original scene in front of the camera is represented in miniature by dots or lines side by side standing for its color components. It is a sort of a camera inside a camera, for each tiny cylindrical line on the front of the film has taken a picture of the three parallel vertical strips of the filter in front of the camera. These lenses or corrugations on the film are so narrow as to be undiscernible with the naked eye. There are 559 of them in an inch-wide strip of film, some seven times as minute as the dots that make up our newspaper pictures.

When the film is projected by the reverse of the procedure by which it was taken the picture on the screen really consists of red, blue and green points, but too small to be separable by the eye, so we see them as smooth and blended color. The machine, like the magician, moves quicker than the eye.

The close and lasting connection of the two famous American inventors, George Eastman and Thomas Edison, began nearly forty years ago, for it was in August, 1889, that Eastman sent to Edison the first samples of the flexible photographic film that solved the problem of the motion picture. As Edison has said: "In the year 1887 the idea occurred to me that it was possible to devise an instrument which should do for the eye what the phonograph does for the ear, and that by a combination of the two, all motion and sound could be recorded and reproduced simultaneously." And he expressed the belief that in the (*Turn to next page*)

How New Color Movies Work—*Continued*

coming years "grand opera can be given at the Metropolitan Opera House at New York without any material change from the original, and with artists and musicians long since dead."

Edison himself got the germ of his idea from a toy of his childhood, the Zoetrope, in which a rotating paper panorama gave a fleeting illusion of motion to those who peeked through the slits of the drum. Edison first tried to produce motion pictures by means of microscopic photographs arranged spirally on a circular glass plate like a phonograph disk record, but such a series was too small and short and he did not get far until the Eastman Kodak Company at Rochester had succeeded in sensitizing the gelatine coating of a strip of cellulose nitrate in unlimited length. With this film Edison equipped his peepshow kinetescope which promptly became popular. In 1895 he attempted to synchronise the film with the phonograph, but the problem of the combination of sight and sound was not solved sufficiently to satisfy the public until the present year, when several forms of "talky-movies" are competing for favor — and for theaters.

Motion pictures in natural colors was also one of the problems which Edison attempted in the last century, but which was not satisfactorily solved till the present. He tried hand-painted films in 1896. But nothing spectacular appeared in this field until 1910, when Charles Urban showed his kinemacolor at Brighton, England. This was a two-color process, red and green being taken and projected alternately by means of a rotating disk of tinted filters. Because an image on the retina persists for about a sixteenth of a second before it fades away, each color fused with the succeeding one, except when movement was too fast. But when a horse was running the legs showed alternately a glaring red and green which somewhat impaired the illusion. The most popular of the kinemacolor films was the ceremonies of the Durbar at Delhi, India, in 1912.

The Gaumont process was more scientific but also more complicated, for it employed three pictures taken in the three primary colors by three lenses on the same film and projected through three objectives. For still pictures taken on glass plates it has been found possible to get satisfactory color effects by the use of ruled lines or dots or scattered starch grains in two or three colors, but these are apt to show their pattern when enlarged to the size of the theater screen.

The more recent inventions, the Prizma, Technicolor and Kodachrome processes, also use two complementary colors, but on the opposite sides of the same double-coated strip. Each side represents the scene as photographed through a tinted filter of that color and the white light shining through the two colored films takes the hue and design of both and throws the combination on the screen. The two colors are so selected as to cover singly or in varying proportions all the tints and shades of the original scene as nearly as any two colors can. A red inclined to orange and a green inclined to blue are the couple generally chosen.

But all processes depending upon dyes are more or less defective. The ideal method would be to employ the principle of the prism which converts white light into a band of pure colors and can as readily recombine them. The advantage of this was first pointed out in 1869 by a Frenchman, Charles Cros, who said:

> "The synthesis by refraction gives one of the most elegant solutions of the problem. . . . Thus one will have the reproduction of a natural object, either direct in the eye or on a screen. This solution is remarkable in that the result does not depend on an artificially colored product. The colors are thus transformed under purely geometrical conditions and these conditions regenerate in turn the colors. The apparatus only renders in this way that which it receives."

Dozens of inventors have tried to apply the principle of the prism to color photography since it was first suggested nearly seventy years ago. Among the devices employed were shifting prisms, diffraction gratings or slits, micro-spectroscopes, pinhole screens, multiple lenses and corrugated filters or films.

The achievement of the Eastman Kodak Company is in finding a way of adapting the principle of the prism, discovered by Sir Isaac Newton, to the hand camera so that the amateur can make his own motion-pictures in the natural colors of the scene he snaps.

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America's Industrial Future

Engineering—Economics

DEXTER S. KIMBALL, in *Mechanical Engineering.*

The most significant phenomenon of recent times has been the rise of the United States to a dominating position industrially, financially, and consequently politically. Census figures indicate that our national wealth is approaching $400,000,000,000 and that our national income is approaching $90,000,000,000. These are amazing sums of money. No such wealth has ever been acquired by any people, and at no time or place in the history of the race has the level of existence been so high. Most remarkable of all is the short time in which this vast amount of wealth has been accumulated, and having in mind that these totals are increasing at a rapid rate it is interesting to speculate as to what the future holds for us.

Whence comes this great wealth? Of course, there are many factors that have influenced this result. Natural resources, an inventive people with highly developed manufacturing ability, a large native population with free internal trade, a willingness to produce upon the part of the workers, and a willingness to pay upon the part of the employers have all been important factors in making our civilization what it is. Many trades and callings have contributed their share in the result, and all of them are important. If I were asked, however, to name the three most important callings I should name Agriculture, Preventive Medicine, and Engineering, using the last term in its broadest sense to include the applications of science to the problem of productive industry. These fields of endeavor are more or less mutually interdependent. The Panama Canal, for instance, was made possible through engineering and preventive medicine. Great cities like New York are habitable largely through the same agencies, and the relation between agriculture and manufacturing needs no explanation.

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