THE CAMERA

The Prizma Process of Color Cinematography

IN the numerous past efforts to produce motion pictures in natural colors the two-color or three-color methods have been largely practised, but a color process has recently come before the public which may claim to be different, by virtue of the fact that the pictures are photographed through a series of four color filters, each of which is of a different hue.

This "four-color process," if one may use the term, is known as the Prizma process, and received its first public showing before an interesting gathering at the American Museum of Natural History on the evening of February 8, 1917.

As it is well known that all colors may be formed by admixture in proper proportions, of the fundamentals red, green and blue-violet, it might seem that a process which utilizes four taking-filters of different colors would be unduly complicated, but upon investigation, it becomes apparent that the theory of the Prizma process is not difficult of explanation, and the method, as practised, is sufficiently free from complication to be considered commercially feasible.

The underlying principle of the Prizma system of color cinematography, or, of most any other four-color additive method is—to eliminate the inherent inaccuracies of a two-color processes by combining two two-color processes, or, in other words, to record the negative color sensation records through a series of four color filters comprised of two sets of complementary colors. In this way any color which is not well reproduced by one of the two-color filter combinations will be satisfactorily rendered by the other two-color component. The desirability of such procedure was first recognized by Leiber,* who suggested the use of a double-width film bearing alternating sets of sensation images of complementary colors (or color values). Leiber suggests no specific mechanism in his patent by which such photographic color records might be produced and projected, but the system known as Prizma was suggested by Messrs. M. J. Wohl and Max Mayer (U. S. Patent No. 1,122,-455).

The Prizma system had been developed into a commercially practicable process by Messrs. William Van Doren Kelley and Charles Raleigh, who have secured a British patent on the method (Eng. Pat. No. 22,921) (1914), and are responsible for the technique of the process as it now stands. Wohl and Mayer subsequently divided their original patent and secured another based on its fundamentals (U. S. Pat. No. 1,211,904), which they assigned to Prizma, Inc., and which is the basis of the four-color successive method of color cinematography.

*Eng. Pat. 21,623 (1912).

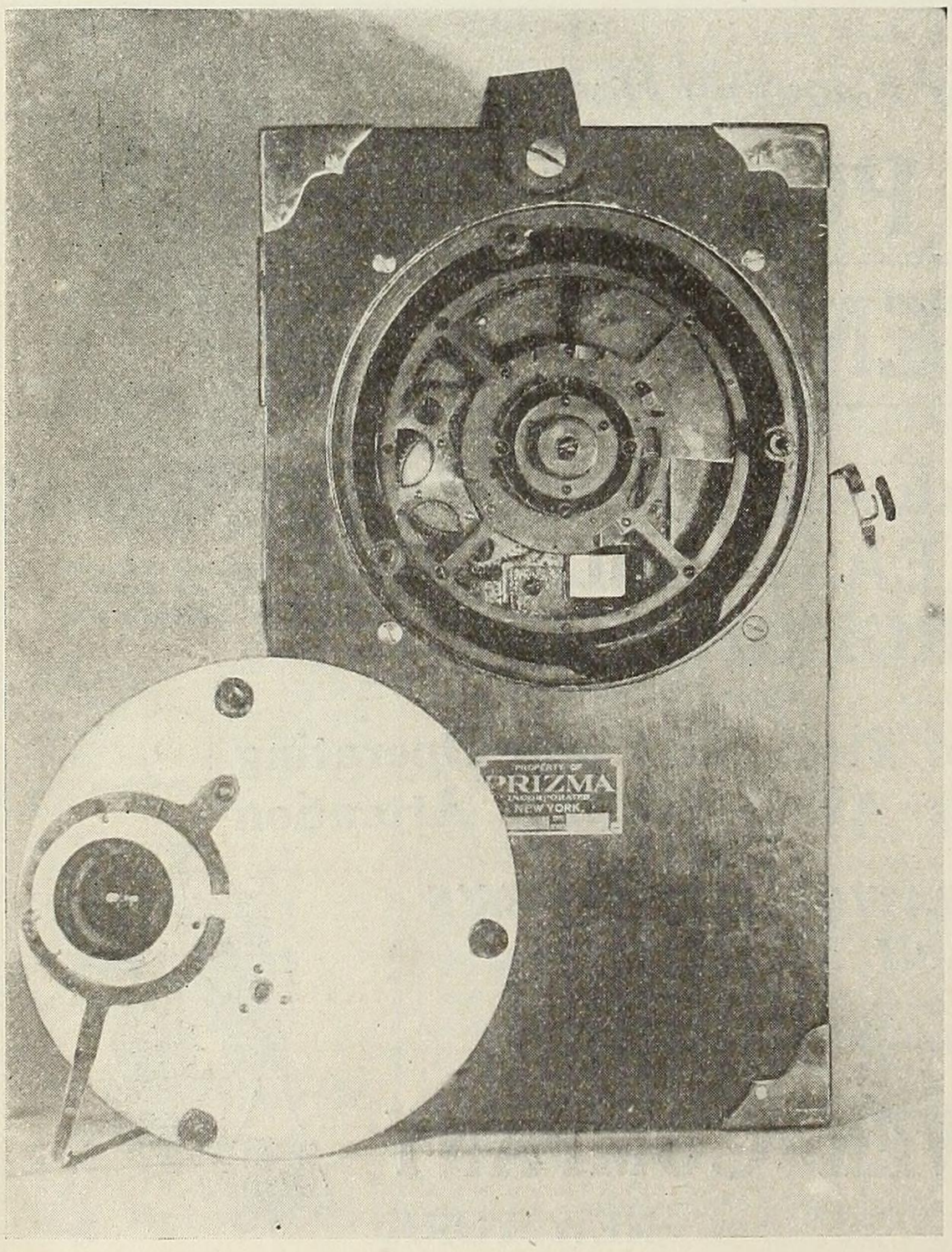

Fig. 1

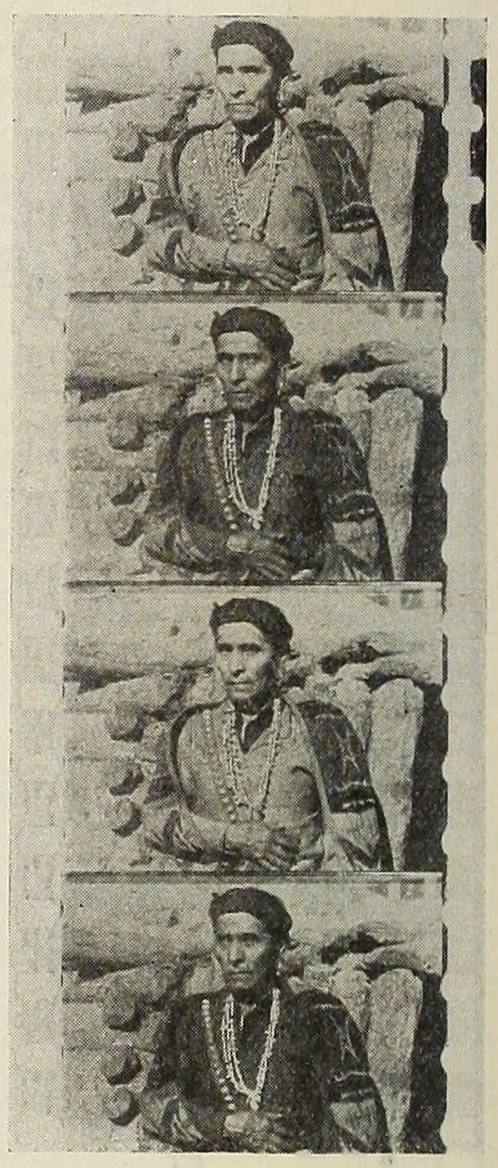

Fig. 2

We have had the opportunity of thoroughly examining the Prizma color camera and projecting apparatus and are, therefore, enabled to set forth authentic details concerning the processes by which Prizma color films are photographed and exhibited. In photographing the negative color-sensation records by the Prizma system a camera employing a Geneva and sprocket intermittent is used. We have previously set forth the advantages of the Geneva intermittent for use in this class of work** and we have learned that this movement has been utilized by the pioneers of Prizma for several years past, which closely coincides with the extent of our own experience in the use of such movements for color cameras. The Prizma camera exposes 16 images for each complete crank revolution and the negative records are produced at the rate of from 26 to 32 images per second.

The negative color-sensation records are successively recorded upon the film strip in sets of four images—one taken through a red-orange filter, one through a bluish-green filter, one through a yellow filter and one through a blue filter. These are "wide banded" filters and their transmissions overlap one another to a considerable extent.

According to Messrs. Kelly and Raleigh's English patent, the spectral transmissions of suitable taking filters for the process are:

Red filter	W. L. 715 to W. L. 590
Yellow filter	W. L. 650 to W. L. 550
Green filter	W. L. 570 to W. L. 470
Blue filter	W. L. 550 to W. L. 450

While these are not the exact transmissions of the Prizma taking-filters, we are advised by the technical staff of the company that the figures here given are very close to the actual measurements of the taking-filters in use. Upon consideration it appears that the positives, made from sensation negatives secured through such "wide banded" filters, would appear much diluted with white when projected, and that saturated colors would be lacking in the screen results.

This is, as a matter of fact, the impression one gets when view-

** "Color Cinematography." "M. P. News," November 18, 1916—Page 3202.

ing an exhibition of Prizma color pictures, but the use of taking-filters whose transmission bands overlap considerably is a necessity in a four-color successive process, for if we used "narrow banded" taking filters which isolate the fundamental color sensations it will be appreciated that each separate color would only be emphasized as every fourth image was before the exposing aperture of the projector, and the result would be a severe pulsating effect in the case of vivid colors such as red or green.

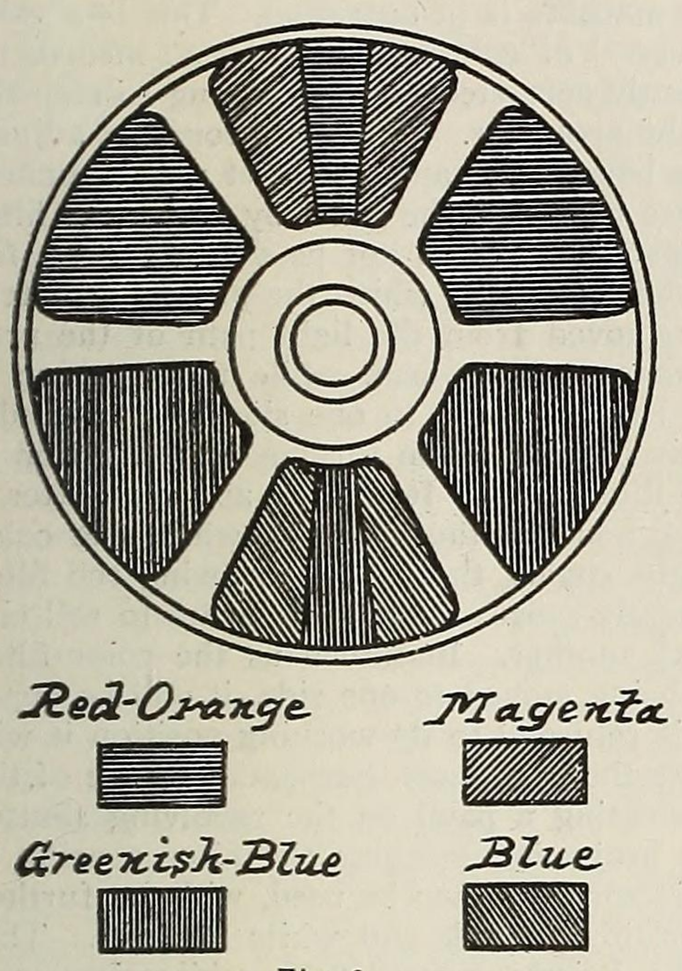

Fig. 3

In the Prizma color camera the color-filters are carried in a rotary filter-frame of aluminum which is mounted between the lens and the exposure plane of the instrument. It will, of course, be appreciated that the filter-disc only makes one complete revolution for every four pictures exposed. The exact arrangement is shown in Fig. 1, which also shows that the shutter allows an exposure interval three times as long as that required for the substitution of successive images before the aperture. This long period of exposure, in proportion to the period of movement is one of the important advantages incident to the use of the Geneva type intermittent, but is not the only point in favor of such mechanisms, for, according to our observations, the Geneva and sprocket intermittent is the only movement in extensive use at present which is capable of steady results when worked at the rate of 25 or more exposures per second.

Another feature of interest on the Prizma camera is a device which imprints a dot on the margin of the film strip at the side of every fourth image. This is accomplished by means of a curved slot (shown in Fig. 1) near the center of the filter-disc, which is so located as to allow light which enters the lens panel, through a small opening to pass through another small hole in the aperture plate and impress an identifying spot beside each red-sensation negative image just before it is photographed. Such identifying marks are of considerable importance when preparing films bearing successively recorded color-sensation images, as they constitute a necessary guide to the projecting machine operator in threading the projector so that any given color sensation image on the positive film strip may be in synchronism with its corresponding element in the projecting filter-disc.

These dots impressed on the margin of the negative strip when the camera is operated are, therefore, utilized when printing in such manner as to insure that a black mark appears opposite each red sensation image on the resultant positives. A series, or cycle, of four images of a Prizma positive film is shown in Fig. 2, which, in addition to showing that every fourth image is accompanied by its identifying mark, also serves to illustrate the differences in gradation, or color value, in the successive pictures, secured through the four filters. Although the reproduction cannot faithfully show all of the finest gradations of the positive images, it will be observed that each one varies somewhat from the others in its portrayal of the luminosity values of the spbject photographed. A close inspection of Fig. 2 will reveal that a set of four color-images in the Prizma camera is apparently divided into two distinctive parts, each pair showing plainly the absorbing effect of color filters which record those hues lying in the red and yellow, and the blue and green regions of the spectrum.

Since the components of a Prizma color cycle apparently fall into two distinct divisions, as regards color selection, it is found possible to project the positives at but twice the rate of black and white subjects, instead of at four times the ordinary projecting rate as might be thought necessary.

Prizma film subjects are, accordingly, projected at a rate of 32 pictures per second, and the successive color-sensation images are served by a projecting filter which makes one complete revolution for each two images projected, and which may be broadly stated to contain two color divisions. In the additive methods of color cinematography the preparation and adjustment of the projecting filters is a factor in securing correct color rendition, so it will prove interesting to ascertain how four different color records may be satisfactorily reproduced with a projecting filter having essentially two color elements.

The Prizma projecting filter is illustrated in Fig. 3, which shows that the filter-disc is divided into two distinctive sections—one being red-orange in color and the other blue-green. The projecting discs used by the Prizma concern are of substantial construction; they are made of sheet brass, while the color filters consist of suitably dyed gelatine films cemented in glass. While the filter disc is fundamentally divided into two sections there are six radial extensions to the filter-frame which of course separates the disc into six sections.

This two-color projecting filter is adapted to the requirements of the four-color recording scheme in the following manner: Two small segments of a Magneta color are adjusted over the center division of the red-orange half of the projecting filter, while two blue segments are adjusted over the center division of the blue-green half of the filter-disc. These small auxiliary filter elements do not replace any portion of the red-orange and blue-green filter elements, but are adjusted over them in the manner shown by Fig. 3. All of the filter media is spectroscopically adjusted, and the result of rotating a properly balanced Prizma projecting filter in the path of the projector rays is a sensation white of good quality.

Those who have witnessed an exhibition of Prizma color pictures must have been astounded at the ease with which the projecting machine operator could withdraw the color filters from the path of the light rays and replace them again (while the machine is in operation) in exact synchronism with the proper image on the rapidly moving film. The device by which the projecting filters are actuated and controlled when projecting Prizma color films is, to our mind, the most ingenious mechanical feature of the entire process, and an idea of this projecting attachment will be gained by a study of Fig. 4.

In Fig. 4 the Prizma color attachment is shown in conjunction with a Simplex projector. The complete attachment is assembled on a metal support, which is secured to the projector mechanism by the bolts that hold the upper film-magazine in place. As Fig. 4 shows, the filter disc is connected, by gearing and a small shaft, to the spindle upon which the revolving shutter of the projector is mounted. The gearing is, of course, so apportioned as to reduce

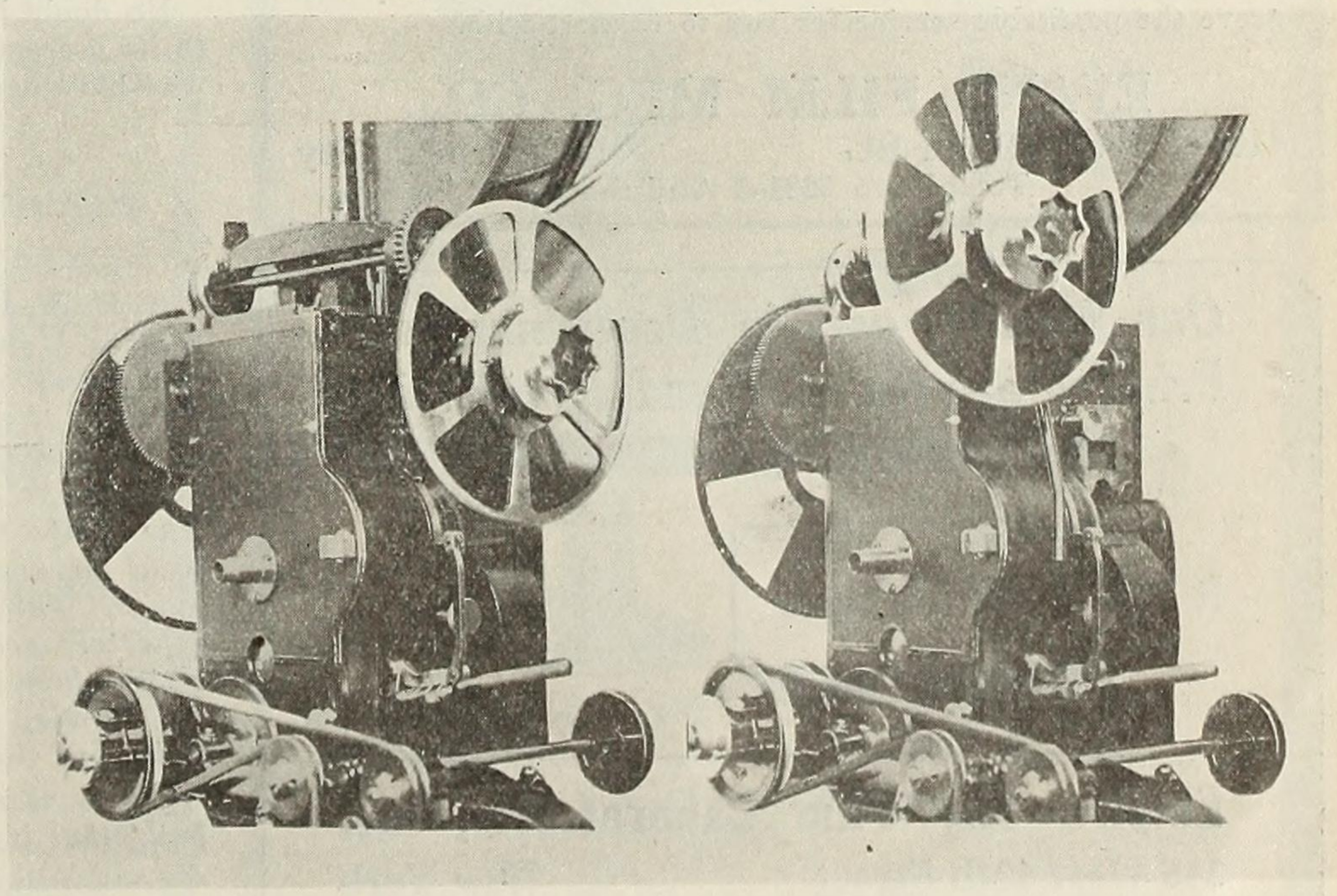
Fig. 4

the speed at which the color filter rotates to one-half the speed at which the shutter of the projecting machine operates. At the back of the filter-disc a knob will be noticed, and by turning this knob the adjustment of the projecting filter may be altered to any conceivable extent while the machine is in operation. This is a valuable feature since the reversal of colors (caused by an incorrectly joined film) may be instantly corrected without having to stop the exhibition and rethread the projector. This synchronizing adjustment is operated by three bevel gears and a ratchet which connect the knob and the filter-disc to one of the gears by which the filter is driven. The exact construction need not be detailed here, for we have now to explain the manner in which the projecting filters may be instantaneously removed from the light path of the projector and replaced in exact synchronism, while the machine is running. The filters are simply swung to one side by the handle shown in Fig. 4, and their position when thrown out of action is shown by the right-hand illustration. It will be apparent after a study of Fig. 4 that since none of the gears by which the color filter is driven run at right angles, the act of throwing the filter attachment to one side merely causes the driving gears to roll circumferentially around one another. Inasmuch as the color filter continues to rotate after being moved to one side, it will be apparent that when the filter is returned to its working position it will still be in synchronism with the proper color sensation image of the film being shown. By releasing a pawl on the revolving shutter shaft at the front of the projecting machine the filter gearing is disconnected and the projector may then be used, with no further changes, for projecting ordinary black and white pictures. This feature clearly entitles the Prizma system to consideration as a commercially practicable process.

Insofar as the reproduction of natural colors is concerned Prizma pictures are different from all other color projections which have been exhibited to date. The screen results by this process are characterized by extreme delicacy of color and subdued shades are most admirably rendered. By reason of the extensive spectral overlaps in the taking filters all details of the objects photographed are recorded, to some extent in all of the four respective sensation images of a Prizma series, and the screen results are, therefore, characterized by a wide range of photographic gradations. The blue-green element of the projecting filter appears to favor the blue rather than the green, and, as a result skies and water are well reproduced. We have not noticed anything approaching a true green in any of the subjects so far exhibited, although this is probably by reason of the fact that no prominent greens existed in the subjects photographed. Yellow is not in evidence in the current Prizma films, although a wide variety of warm tones are apparent ranging from chestnut-brown to a deep red-orange.

The process is adapted to use with a wide range of subjects, and is extremely proficient in reproducing scenery and landscapes, but colors in full saturation are hardly within the scope of this method.

No doubt it was a prodigious experimental task to bring Prizma to its present stage, and the process reflects great credit upon all who have had a hand in its practical development.

A. S. C.

Arrangement of Studio Lights

A. L. B., Detroit, Mich., propounds the following: *"I want to equip a Motion Picture Studio here in Detroit and would like to know your opinion on how best to put up lights. I am seriously thinking of using the* 1,000*-watt Blue Mazda Lamp, The Photolite, and would like to know at what height from the stage to hang these lamps, and how far from the back line to hang the first row. The lamps will be put on a crane to shift over both sets. I want to know your opinion on how and where to place the lamps. They are supposed to develop* 1,200 *C. P. each and with reflectors are supposed to increase the C. P. ten times, making sixteen lamps develop* 192,000 *C. P. Two arcs (for side lighting) will develop about* 2,000 *C. P. each. I think this must be enough light, but want to know your opinion.*

"Also, working with a 2-inch lens, how high should the sets be built, that is, for ordinary interiors of rooms?"

(A sketch, which we do not reproduce here, is included, showing two adjacent sets each 15 x 16 feet in size.)

In reply: