accessible bolts, and to mount the projector head again without in any way changing the focus or alignment of the picture upon the screen.

Performance—The performance of this reproducer set fulfills all requirements indicated by present-day standard of reproduction of sound recorded on film, and also anticipates any future developments that at present can be foreseen. The flutter content of the average machine, measured in production, is about 0.1 per cent; and with special adjustment the machine is capable of bettering this performance. The frequency characteristic conforms to the theoretical response for a scanning beam of the height employed. The introduction of calculated damping materials insures that the machine introduces no noise during the quiet passages of sound-track.

The reproducer set has been designed to have the appearance of a complete symmetrical machine. The inside is finished in white, to promote cleanliness and provide better visibility for threading the film. The materials used, the care in manufacture, and the finishes applied are all of the best, and it is confidently felt that the new reproducer set will give even longer service than its predecessors, many of the earliest of which are, as already mentioned, still in daily use.

RECENT DEVELOPMENTS IN HIGH-INTENSITY ARC SPOTLAMPS FOR MOTION PICTURE PRODUCTION*

E. C. RICHARDSON**

The high-intensity carbon arc affords certain advantages as a light-source for photography that are not possessed by other illuminants. Within the restricted area of its positive carbon is concentrated an intrinsic brilliancy greater than that afforded by any other artificial light-source. Fortunately, the distribution of radiant energy throughout the spectrum of a high-intensity carbon arc coördinates well with the spectral sensitivity of photographic emulsions and the transmission factors of camera lenses.

For the purpose of more effectively utilizing high-intensity arc sources in motion picture photography, two lamps have been recently developed. The *M-R* Type *90* lamp (Fig. 1) operates at 120 amperes. The *M-R* Type *170* lamp (Fig. 2) has a capacity of 150 amperes. The designs of these two lamps, which are in general quite similar, embody many new factors that greatly enhance their utility and add to the convenience of operating them. Fig. 3 shows the mechanism of the Type *90* high-intensity arc lamp, in which the following vital improvements have been incorporated: (*1*) increased rotational speed of positive carbon; (*2*) continuous non-intermittent feeding of both positive and negative electrodes; (*3*) rapid-action positive and negative manual adjustments.

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** Mole-Richardson, Inc., Hollywood, Calif.

When these new high-intensity arc lamps were being designed it was known that they would find extensive use in color motion picture photography. The requirements of illuminants for color cinematography are very rigid as to uniformity of spectral distribution and intensity. Considerable experimenting was done with

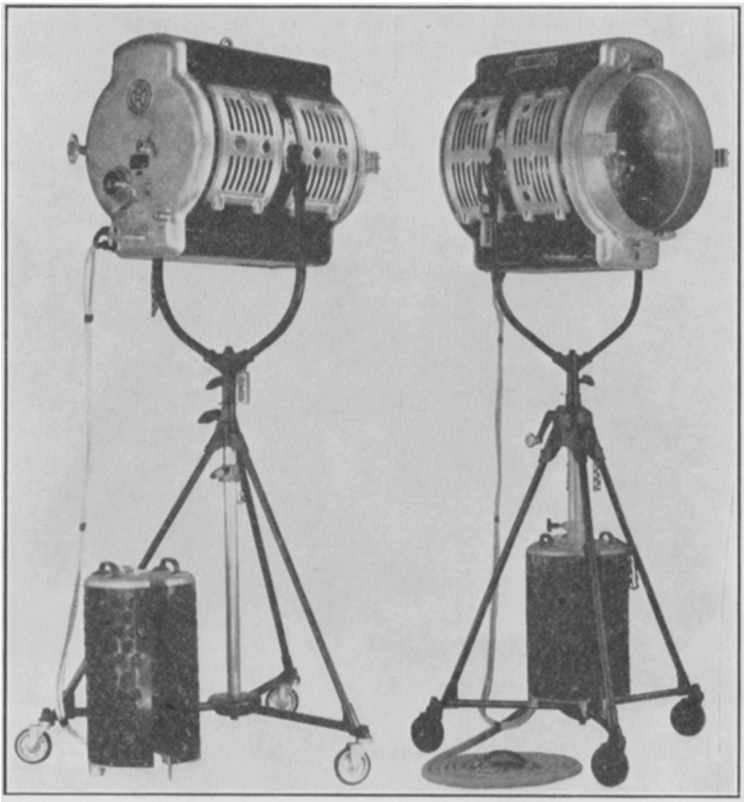

FIG. 1. (*Left*) *MR* Type *90* high-intensity arc spotlamp (rear view).

FIG. 2. (*Right*) *MR* Type *170* high-intensity arc spotlamp (front view).

various rotational speeds of positive electrode. It was found that at approximately 14 rpm. an optimal condition was established and that the crater was very symmetrical. It was noted that at that speed crater rims that had been chipped, either by careless striking or other causes, were quickly restored to symmetry.

The maintenance of a properly shaped, symmetrical crater is one of the most important requirements for stability of the arc. In the arcs under discussion, the angle between the positive and the negative electrodes is 127 degrees. It has been found that at that angle practically any carbon suitable for use under high-intensity conditions performs reasonably well. The 127-degree angle results in better performance than the much flatter angle generally used in the design of searchlights and Sun-arc lamp mechanisms. The objection to this angle is that in striking the negative to the positive, the contact between the two electrodes comes at the rim of the positive crater, which tends to cause chipping. That was one of the reasons why the lamp was designed to be struck manually rather than automatically. The other reason was that automatic striking would have increased the cost of the mechanism to a very considerable extent.

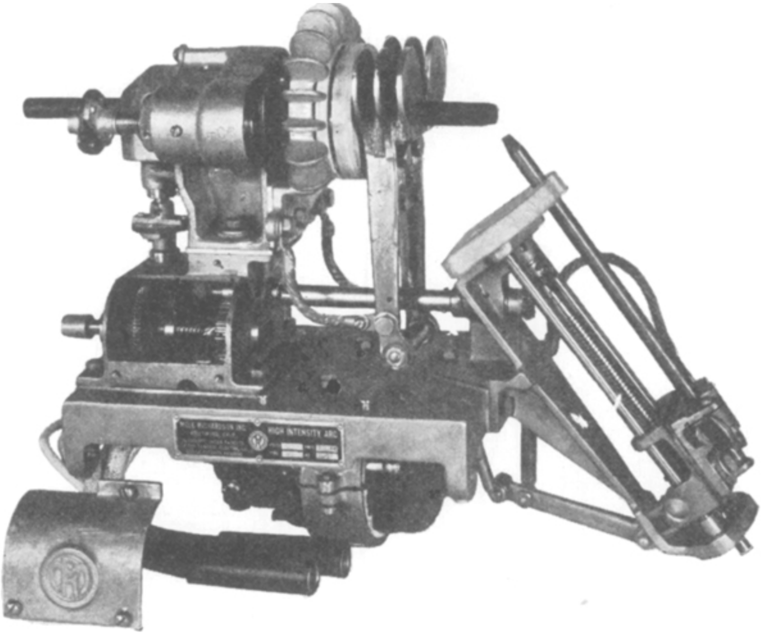

FIG. 3. Mechanism of *MR* Type *90* high-intensity arc spotlamp.

The feeding arrangements of these new high-intensity arc mechanisms differ from other designs in combining continuous, non-intermittent feeding of the positive and negative electrodes with rapid positive electrode rotation. So far as the writer is aware, all high-intensity arc mechanisms used in motion picture photography, having rotational speeds sufficiently rapid to maintain good crater conditions, have had feeding arrangements of the "stop and go" type. Only by uniform, non-intermittent feeding and positive electrode rotation faster than 10 rpm. can the constant stability of performance be attained in high-intensity arcs used for illumination in color photography. The mechanics of the feeding arrangements in these lamps permitted a rapid hand control: one revolution of the negative hand-feeding crank advances the negative electrode 0.1 inch. A similar movement of the positive hand control moves the positive electrode 0.08 inch.

Quietness of operation is, of course, essential in all motion picture equipment designed for use in conjunction with sound-recording apparatus. The motors of these new high-intensity arc lamps have grease-packed reduction gears, and no shafts or parts other than the motor reduction gearing have rotational speeds greater than 46 rpm. All shafts and rotating members, other than those rotating at the slowest speeds, are mounted upon either oil-less or ball-bearings. Again and again, in recent productions, these lamps have been operated satisfactorily within six or eight feet of the microphones. Provision has been made for com-

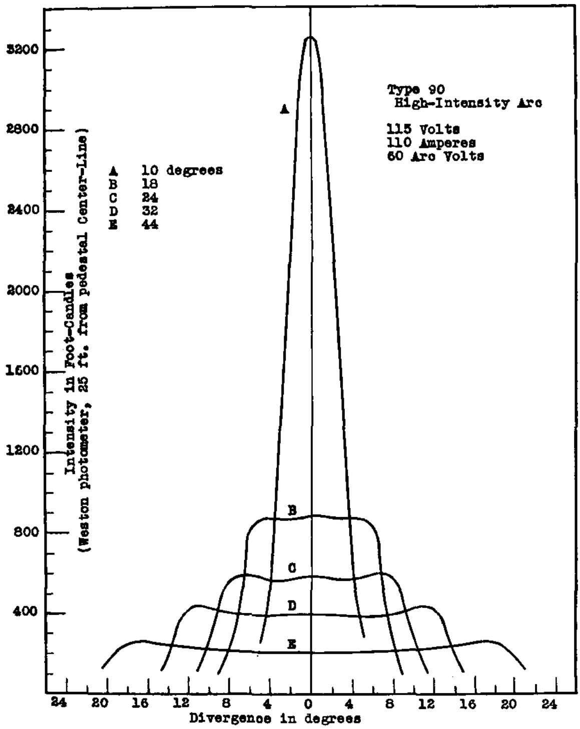

FIG. 4. Typical distribution curves of Type *90* high-intensity arc.

pletely stopping the driving motor in the few situations that arise when the microphone has to be placed within six feet of the lamp.

Aside from improvements in the mechanism, probably the most outstanding other improvement in these new equipments is the application of "Morinc" flat corrugated lenses as a means of collecting and projecting the light of the arc. The carbons used in the Type *90* are a 13.6-mm. positive and a $^3/_8 \times$ 9-inch copper-coated negative. The Type *170* uses a 16-mm. positive carbon and a $^7/_{16}$-inch copper-coated negative carbon. It is characteristic of these high-intensity arc combinations that the most effective portion of their radiation falls within an angle of 60 degrees each side of the axis, and principally within a total angle of 80 degrees. Within 80 degrees the intensity is not less than 10 to 17 per cent of the intensity at the axis. Heretofore, in order to project the light from a high-intensity motion picture arc spotlamp effectively, the principal optical means em-

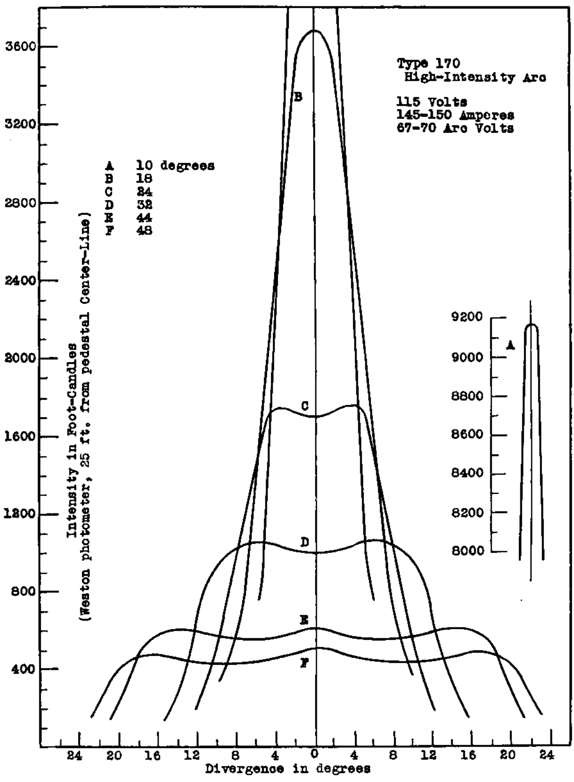

FIG. 5. Typical distribution curves of Type *170* high-intensity arc.

ployed have been parabolic reflectors and spherical lenses. The high temperature developed directly in front of the positive crater in arcs operating at currents greater than 100 amperes is such that lenses, for practical use, have been limited in diameter to 8 inches, and to focal lengths such that the arc would not be closer to the lens than 6 inches when the desired flooding angle was attained. Experience has demonstrated that if lenses greater than 8 inches in diameter were used, or if the arc were brought closer than 6 inches, the glass elements were subjected to pitting by the copper coating of the negative electrode and the hazard of breakage was greatly increased, regardless of the efforts of lens manufacturers to make use of the advantages of heat-resisting glass having low coefficients of expansion.

The 24- and 36-inch parabolic mirrors, which have given the best performance, have both been limited to the $18^3/_4$-inch focus. The mechanical limitation has been imposed by the fact that there must be room for interposing a negative carbon of suitable length between the crater and the mirror surface when the lamp is adjusted for flooding. This prevents the positive crater from being placed nearer than $11^3/_4$ inches from the center of the mirror surface. Even though the lamp operators on the stages exercise the utmost care to protect their sun arcs from wind and sudden changes of temperature, there has always been a great deal of dissatisfaction regarding the breakage of parabolic mirrors in studio use. The "Morinc" lens, designed for these new high-intensity arc lamps affords ideal distribution of illumination for photographic purposes. Figs. 4 and 5 illustrate the distribution attained at various angles of divergence when the lamps are used for flooding, and show the wide range of divergence attainable. Variations from spot beams of 8 degrees to floods of 44 degrees are produced having smooth fields of photographically useful light. The edges of the various beams vignette and make it practicable to overlap fields of illumination, as is often necessary in motion picture set lighting, without creating high-intensity areas in the overlaps or distinct markings defining the circumference of the field.

In both lamps every effort has been made to facilitate operating them in their many applications in the studios. Each has a resistance grid, so designed that it may be removed from the pedestal, permitting the grid and lamp head to be taken as a complete operating unit to the overhead cat-walks and parallels.

The Type *90* lamp weighs 224 pounds and is tending to replace the 24-inch Sun arc, which as a rule weighs more than twice as much. The Type *170* lamp, which weighs 311 pounds, is, in most cases, replacing the 36-inch Sun arc, many of which weigh considerably more than 600 pounds each.

In recognition of the value of reflector arcs of the type generally classed as Sun arcs, it should be noted that for divergences of less than 15 degrees they show definite superiority, and it is not anticipated that projectors of the lens type will displace them for uses requiring such narrow beams.

Lamps of the types described have carried the major burden in all artificial lighting used in the Technicolor productions *Trail of the Lonesome Pine, Dancing Pirates, Garden of Allah, Ramona,* and *God's Country and the Woman.* Very considerable numbers of lamps are now in use at the Warner Brothers, Metro-Goldwyn-Mayer, Paramount, United Artists, and Columbia studios in Hollywood, and at London Films Denham Studio in England for both black-and-white and color photography.

DISCUSSION

MR. PALMER: Is the motor connected directly across the line, so that the speed does not vary with arc voltage?

MR. RICHARDSON: It is a shunt motor, connected across the arc. We experimented with placing the fields across, or ahead of, the resistance, but adopted the present arrangement because we have to separate the rheostat from the lamp head on account of the heat. The motor changes speed somewhat with the slight voltage fluctuations resulting from changes of arc length, so we have some degree of regulation.

The mechanism will work the positive carbon down to about $3^5/_8$ inches, when consumed to the limit. There have been many attempts to devise ways of saving carbons; but using such heavy currents as we do in the high-intensity lamps, perfect conductors are required to get the current to the tip of the positive carbon.

MR. MISENER: Are the motors sealed?

MR. RICHARDSON: They are entirely enclosed, and require very little servicing. In fact, I do not believe that, of 250 lamps we have in operation, more than 10 have ever required servicing. Eventually brushes will have to be replaced; but if the motor is used, say, two hours a day, the brush life should be quite long.

MR. CRABTREE: We read in the newspapers about the high temperatures existing in the Hollywood studios. What is being done in the way of air conditioning?

MR. RICHARDSON: That question has been asked a number of times. I have not heard of the terrific heat, except that the temperature does get rather high at the studios in the San Fernando Valley. The outdoor summer temperature there is occasionally 100 or over. As far as I know the stages are not refrigerated, although many of them pass the air through water sprays, which have some cooling effect.

MR. TASKER: Many stages are now equipped with blowers for changing the air during takes. There are three conditions under which the heat becomes uncomfortable: when one is working in a small closed room, particularly for photographic reasons; when the actors are wearing arctic or winter costumes on the stages; and when working with color.

MR. RICHARDSON: A large cold-storage company in Hollywood had an enormous ice storage building that had become obsolete due to the activities of the electric refrigerator manufacturers. They conceived the idea of turning it into a cold stage, and installed refrigerating equipment. When you see Columbia's *Lost Horizon* you will see the actors walking about with vapors coming from their nostrils—a very convincing arctic scene, because the temperature may be as low as 20 degrees, even on a summer's day.

THE SCHWARZKOPF METHOD OF IDENTIFYING CRIMINALS*

J. FRANK, JR.**

During the past two years experiments have been conducted that have resulted in a recognized contribution to the science of sight identification. This paper describes the background indicating the need for such a method, some of the ex-

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** International Projector Corp., New York, N. Y.