A NEW DEVELOPMENT IN CARBON ARC LIGHTING*

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Summary-*A new motion picture arc lamp designed for use as a general lighting unit is described, in which the new 8-mm., copper-coated, cored carbons are used. Two special mechanisms feed the two carbons of the unit independently of each other, the rate of feed of each being controlled by the voltage drop in each arc. Each control circuit includes a voltage coil and a current coil, acting in magnetic opposition, which arrangement avoids variations of light intensity, flickering, and blinking. The lamps operate under a voltage of 115, drawing a current of 40 amperes, d-c.*

During the past five years the development of carbon arc lighting equipment for use in motion picture production was retarded by several factors. The introduction of panchromatic film, and its almost universal acceptance as negative raw stock, provided a photographic medium that was well adapted to photographing with incandescent filament lamps. The introduction of sound recording in connection with motion picture photography prohibited the use of any type of lighting equipment that was not quiet in operation. However, all through this period 150-ampere Sun arcs and Rotary Spots have been used to a large extent in combination with incandescent lighting.

By making mechanical improvements in the mechanism of Sun Arcs and Rotary Spots, quietness of operation was obtained which overcame the objections of the sound technicians. The old type of broadside lighting units, used extensively in the days of silent pictures, has been practically abandoned in modern picture production, because its design inherently prevented silent operation.

Early this spring, one of the leading producers of colored motion pictures requested Mole-Richardson, Inc., to investigate the possibility of developing a motion picture arc lamp for use as a general lighting unit. This firm was developing a new process of color photography, and it seemed that arc illumination would provide the most satisfactory means of lighting the sets to be photographed.

The specifications were as follows:

(1) The lamp should produce an illumination level of 200 foot-candies, as measured at fifteen feet with a standard Weston photometer.

(2) It must have a comparatively flat distribution curve over a projection angle of sixty degrees or more, and the field of illumination should be devoid of any hot spots, i. e., areas of illumination that are photographically objectionable.

(3) The feeding mechanism of the lamp should be so designed as to provide a reasonably uniform level of light intensity during its period of operation, and the spectrum of the light emitted should not show any alteration of its characteristics during the period of operation.

(4) It should be silent in operation, so that it may be satisfactorily operated in conjunction

with modern sound recording apparatus.

(5) It should take such a form, and be so mounted, that it will be convenient for placement, and be of such weight as to be easily handled on the set.

(6) It should be economical in operation with regard to attendance, the consumption of current, and carbon electrodes.

First experiments were made with half-inch white flame carbons, which had previously been used in practically all arc broadside lighting units. By improving the reflecting surfaces, it was found possible to boost the light flux of the old type of broadside units from 60 foot-candles, measured at fifteen feet with a standard Weston photometer, to about 90 foot-candles.

We quickly realized, however, that even though we overhauled and installed new reflectors in our old side arcs, it would be impracticable to attain the 200 foot-candle requirement desired by our client.

We communicated with the National Carbon Company to ascertain what new developments had been brought forth in arc carbons, which would be suitable for use in equipment of the broadside type, and as a result obtained samples of several types of carbons that were thought to fulfill the requirements. After numerous experiments, we decided that probably the 8mm., special, copper-coated, cored carbons that were recommended would best suit the purpose.

An old type broadside unit was adapted to operate with the carbons and was supplied with chromium-plated metal reflectors. With the 8-mm. carbons in both the upper and the lower carbon holders a marked improvement in light intensity was attained. Utilizing practically the same current, 40 amperes, the light intensity was raised from 90 foot-candles, measured at fifteen feet, to 120 foot-candles.

An inherent fault of the old type of broadside arc lighting unit was its inability to maintain a uniform level of illumination. When first energized, the old type lamps would consume from 40 to 45 amperes, and produced their maximum lighting intensity; by the time the feed mechanism came into operation, the current in most cases dropped to approximately 32 amperes, and the lighting level dropped about 40 per cent. The specifications set forth demanded a much more accurate control of the lighting intensity.

Knowing the limitations of the old style carbon control mechanism of the various lamps that had been previously designed, it was decided to experiment with a lamp in which each pair of carbon electrodes would be separately controlled. An experimental model was built, and after a number of modifications a mechanism was developed that reduced the fluctuations in light intensity during the feeding cycle of the lamp to within 10 per cent.

In previously designed broadside lamps it had been attempted to control the feeding of the carbon by means of a single current coil in series with the arcs, and by utilizing various means for equalizing the feeding of the upper carbons toward the lower carbons. As far as we have been able to observe, mechanisms operated on such a principle fail to provide good operating conditions, due to the fact that the tolerances in the diameters of the carbon electrodes must of necessity be rather large; and if it happens that a carbon with a minus tolerance be placed in one side of the twin arc mechanism, and a carbon with a plus tolerance be placed in the other side, the carbon having the small diameter will inevitably feed more rapidly than that having a larger diameter. It is most difficult to devise a mechanism operating with a single control coil that would overcome the difficulty without greatly complicating the structural characteristics of the feeding device.

The mechanism developed for the M-R Type 29 twin arc broadside controls each pair of carbon electrodes, independently maintaining the voltage drop across each pair of electrodes at 35 to 40 volts, and the feed of each pair of electrodes is independent of the other and controlled by the voltage drop in the arc that the mechanism controls.

Fig. I is a schematic diagram showing the method by which this is accomplished. Each carbon arc has its lower carbon electrode in a fixed position. The upper carbon electrode is movable; and when no current flows, the lamp is in contact with the lower carbon. When the lamp is connected to the line, the circuit is closed with only the ballast resistance to impede the flow of current.

The current coils of each mechanism are in series with each other and with the two arcs. The current from the positive side of the line passes through the ballast resistance, 1, into the base of the lamp, through the switch to the control coil of mechanism No. 1, and on to the upper carbon; thence to the lower carbon, into the current coil of mechanism No. 2 through the coil to the other upper carbon, then to the lower carbon, and back to the line through the ballast resistance, 2. The energizing of the circuit actuates the solenoid armatures, which, through their connecting linkages, elevate the upper carbons in each are system, striking both arcs.

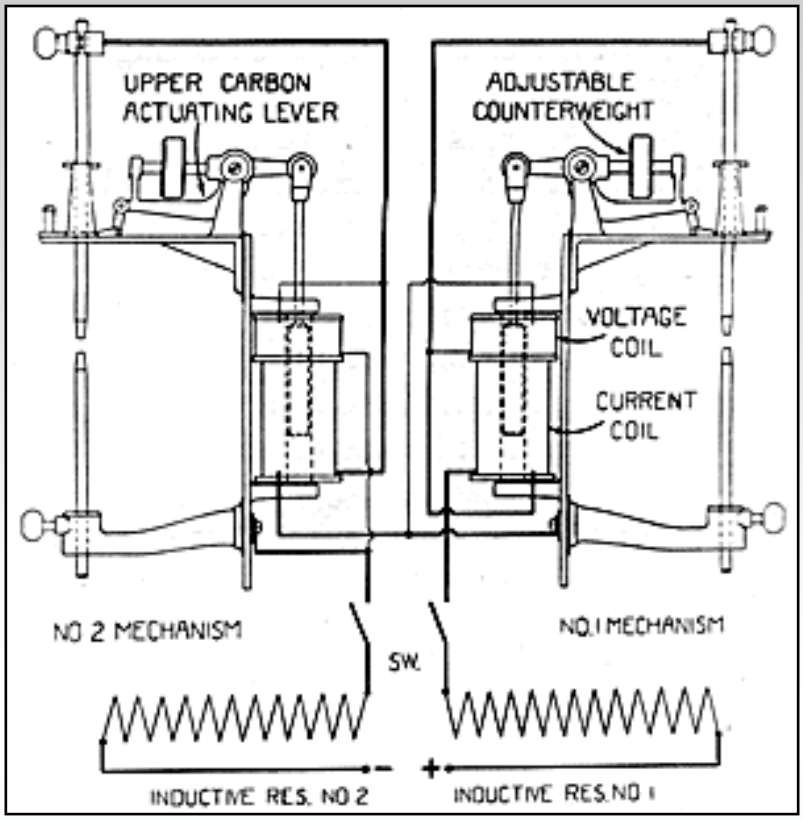

Fig 1. Schematic diagram of arc regulating mechanism.

Above each current coil, and surrounding each armature, is a coil wound with fine wire and a large number of turns, connected across the arc controlled by it. These coils are wound counter to their respective current coils, and the instant the arc is struck a small current flows through each coil. Since they are shunted across the arcs, the energy introduced into them increases as the voltage drop of each arc increases, the magnetic flux of each voltage coil opposing that of its corresponding current coil. By properly proportioning the number of turns

in the current and voltage coils, and proportioning and spacing their respective armatures, it is possible by this method to control the opening of the arc and to maintain quite accurately a uniform voltage drop across the arcs. Ball-bearings were introduced at the fulcrum of the upper carbon actuating levers, so as to make the mechanism sensitive to the changes of voltage of the arc. Simple, plate-type carbon clutches have proved entirely adequate.

Since maximum efficiency with the carbon electrodes used was attained by using a 5/8-inch arc gap, it was necessary to take precautions to prevent magnetic "blowing" of the arcs. This was accomplished by connecting the current coils of each mechanism so that they formed a closed magnetic circuit, and by placing a steel magnetic baffle plate between the coils and the arc.

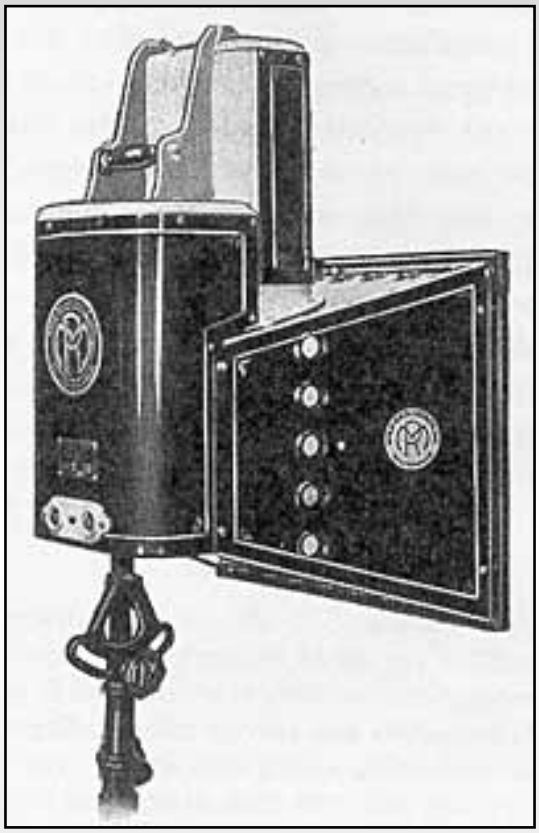

Fig. 2 Broadside Twin Arc Lamp M-R type 29

The entire mechanism is relatively simple, and may be economically manufactured, because, except for connections in the wiring, each unit of the mechanism is an exact duplicate of the other. To adjust each mechanism so that it will operate in harmony with its adjacent unit, it was desirable that a simple adjusting means be provided. This adjusting means is the movable counterweight mounted on the arc actuating lever. As the lamps leave the factory they are adjusted for operation on 115 volts, 40 amperes d-c-, voltage readings being taken across each arc and the counterweights adjusted for balanced operation.

Under practical and test conditions it has been found that with this mechanism flickering has been totally eliminated. Even though the line voltage be greatly disturbed, as it often is on motion picture stages when operating under heavy loads, the mechanism is so responsive that such disturbances are compensated without the "blinking" that was often experienced with the

old type twin arc lamps.

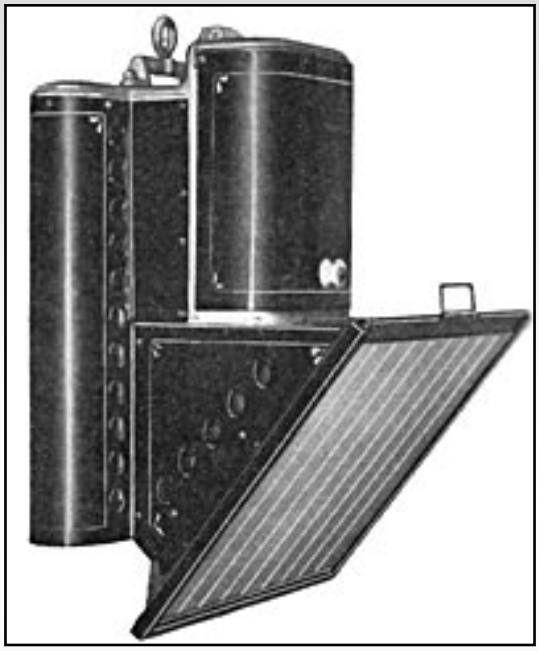

Fig 3. Twin Arc Scoop Lamp
M-R type 27

The mechanism has been built into two types of lamp heads: the M-R type 29 Twin Broadside Arc and the M-R type 27 Twin Arc Scoop. The Broadside Lamp, designed for floor use, is mounted on pedestal having two telescoping sections, and may be elevated from height of four feet one inch, to eight feet eight inches from the floor. The housing of the M-R type 29 has been constructed of duralumin sheet metal and aluminum castings (Fig. 2). The mechanism may be tilted from the vertical position thirty degrees forward or backward without disturbing the operating characteristics. Chromium plated reflectors, which have proved to be entirely satisfactory in this type of equipment, increase the light flux of the lamp in excess of the specification requirements.

The scoop is illustrated in Fig. 3. Its housing, in addition to carrying the mechanism, also carries the resistance units. To facilitate the dissipation of the added heat of the resistance, the head has been amply ventilated with louvers. The aperture of the lamp has been set at an angle to deflect the light downward, as the scoop is primarily designed for overhead use. To assist in carrying off the fumes from the arc coring, both types of lamps are provided with a chimney midway between the twin arcs. This ventilation contributes to the cleanliness of operation of the equipment, a large portion of the white condensate from the arcs passing off through the chimney.

Both types of lamps are intended to be used with glass diffusers. A Prismatic glass, sand-blasted on one side, has proved best for the purpose, its high lead content inhibiting the transmission of ultraviolet radiation. No complaints have been received from actors working under the lamps in regard to injury of their eyes.

While it is not anticipated that this new equipment will revolutionize motion picture stage lighting, there are many types of photography and many special effects for which this equipment is peculiarly adapted.

DISCUSSION

Mr. Joy: Any one who has seen Mr. Mole's lamp in operation realizes that he has made a very material contribution to the art of illuminating motion picture sets. The feeding of the carbons is uniform and regular, as the feeding solenoid of each are is controlled by the current and voltage of that arc, resulting in a steady light from the unit. Tests have shown that within an angle of 60 degrees in front of the lamp, the decrease in light from the center to the outside is only about 15 per cent. Such a small change over such a wide angle should be particularly advantageous in photographic and motion picture work.

Member: What is the bulk or weight of the equipment? To what extent does it add to or detract from the regular incandescent equipment?

Mr Mole: It would not add to the bulk or the number of units. Experience has shown that the number of units used on the set depends entirely on the set, regardless of whether arcs or incandescents are used. As many units are used as the size of the set demands, so that the entire set will be covered.

Mr. Cour: What is the comparison in wattage? Mr Mole: That is very difficult to answer. One cameraman on a 15 by 15 set would use 600 amperes and another would use 1200 amperes, so there is no way of determining the saving. More lumens per watt are radiated by an arc,than by incandescents, but whether a man is working on a low level or high level, we don't know.

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

Jounal of the SMPE January 1934, pp 51-57

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