Feb. 15, 1944. J. R. MacKAY 2,342,085

SIGNAL DEVICE

Filed Dec. 3, 1941

Fig. 1

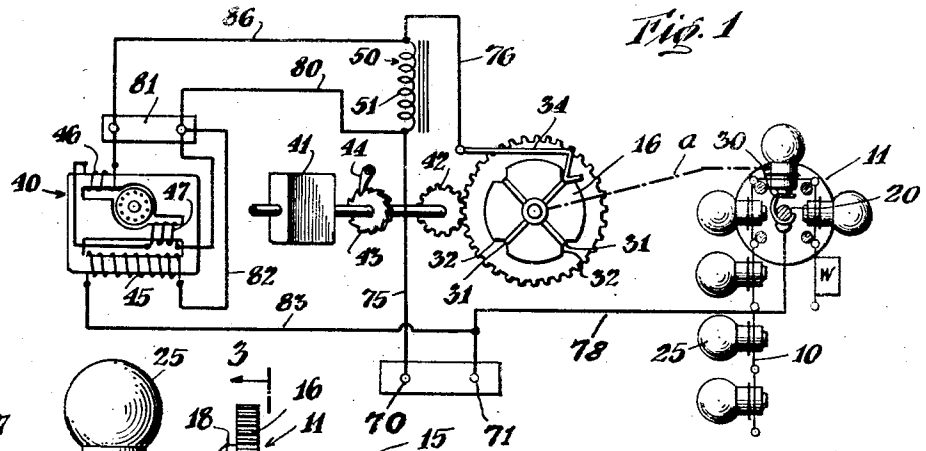


Fig. 2

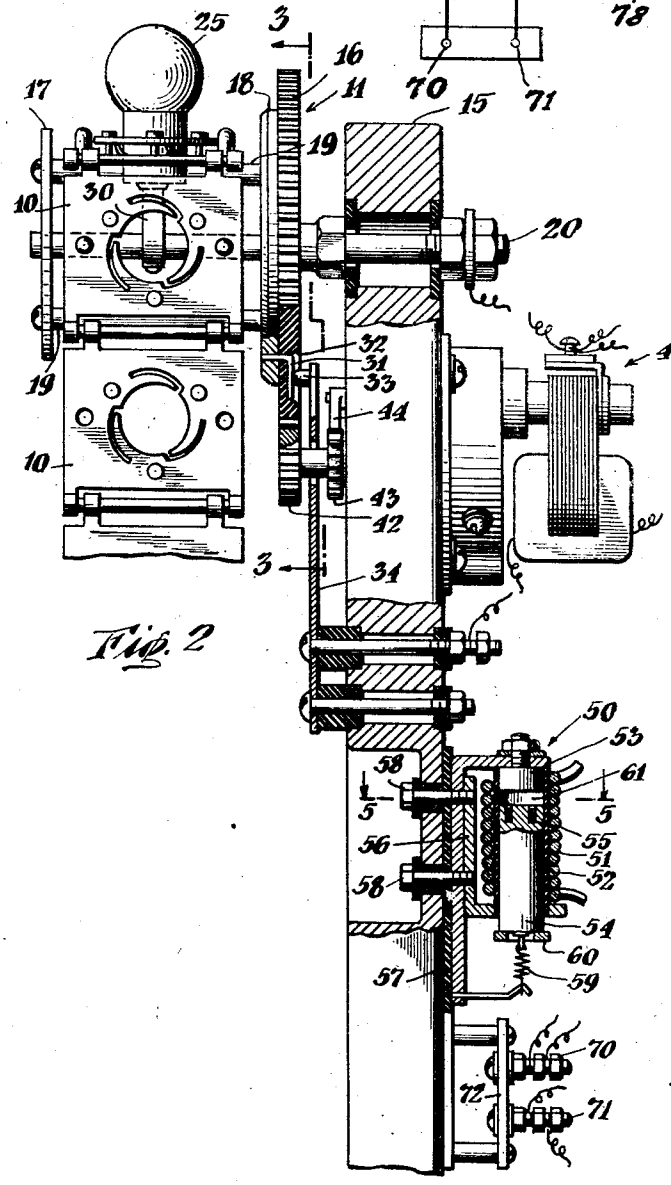


Fig. 3

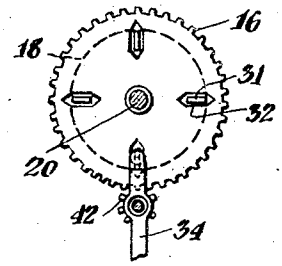


Fig. 4

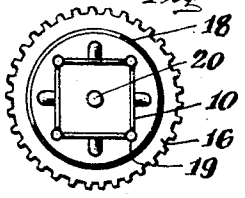
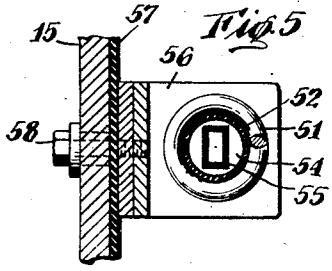


Fig. 5



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2,342,085

UNITED STATES PATENT OFFICE

2,342,085

SIGNAL DEVICE

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Application December 3, 1941, Serial No. 421,451

6 Claims. (Cl. 240—37.1)

This invention relates to lamp changing apparatus for automatically replacing electric lamps which have failed. The invention relates more particularly to, and aims to provide, an improved motor means operative on failure of a positioned lamp for operating lamp mounting and positioning means to move the failed lamp out of position and a new lamp into position.

Motor means according to the invention comprises a shaded pole alternating current driving motor having a single set of shading coils, or a single shading coil, connected in a closed circuit and which normally causes the motor to rotate in one direction only, and said circuit being electrically associated with the lamp circuit by means for applying to said shading coils when normal current flows in the lamp circuit an E. M. F. of opposite phase from and of greater value than the E. M. F. normally induced in the shading coils by the field winding of the motor, whereby a counter-to-normal flow of current is set up through the shading coils, causing or tending to cause reverse rotation of the motor, and indexing means which prevents back movement.

Most desirably, the closed circuit of the shading coils includes an impedance of suitable value which is also connected in the lamp circuit in series with the positioned lamp. This impedance may be a non-inductive resistance, but it is now preferred to use a reactance, and I have made for this purpose of applying from the lamp circuit the required E. M. F. on the shading coils a special reactance device comprising a reactance coil and means providing a magnetic circuit associated with the reactance coil, including a movable core within the coil which, when normal current flows in the lamp circuit, is moved by magnetic action as in a solenoid to close an air gap in the magnetic circuit and thereby decrease the reluctance of the magnetic flux path and increase the reactance of the coil, and which, when current flow in the lamp circuit stops and the comparatively low voltage current induced in the shading coils by the field winding of the motor flows through the reactance coil, moves back to a position to open the air gap in the magnetic circuit, thereby increasing the reluctance of the flux path and decreasing the reactance of the reactance coil, the movable core then remaining in this position until current again flows in the lamp circuit. This variable reactance device thus provides the impedance required for applying to the shading coils, when normal current flows in the lamp circuit, the desired E. M. F. of greater value than that induced in the shading coils by the motor field winding, and, when there is no current flowing in the lamp circuit, provides a substantially lower impedance against the induced current then flowing in the shading coil circuit.

A full understanding of the invention can best be given by a detailed description of a lamp changing apparatus embodying the invention in the form now considered best, and such a description will now be given in connection with the accompanying drawing, in which:

Fig. 1 is a simplified diagrammatic view of a lamp changing apparatus according to the invention;

Fig. 2 is an enlarged detailed view partly in section showing parts of the apparatus of Fig. 1;

Fig. 3 is a detailed view taken on line 3—3 of Fig. 2 but on a smaller scale;

Fig. 4 is a view on the same smaller scale of the rotatable support for the lamp carrying belt looking from the left of Fig. 2 and showing the carrier with the disc 17 removed and without the carrier belt thereon; and

Fig. 5 is an enlarged detail view taken on line 5—5 of Fig. 2.

The motor means of the present invention may be used for operating any suitable lamp mounting means comprising a mounting device, or carrier, for a plurality of lamps which is movable for positioning the lamps successively, and means for connecting the positioned lamp in a lamp circuit, such, for example, as the mounting means of my application Serial No. 299,693, of which this application is a continuation-in-part or a mounting means such as shown in my Patent No. 2,258,575, which for simplicity is shown in this application.

Referring to the drawing, and first to the lamp mounting means, the lamps are mounted on a carrier belt formed of a plurality of flat metal plates 10 pivotally connected at their edges. The end of the belt is placed about a rotary support 11 and may carry a weight W which exerts a downward force to help hold the belt in proper position on the rotary support. The rotary support, which, as shown in Fig. 2, is mounted on a vertical support 15, is formed of two spaced discs 16 and 17 of Bakelite or other insulating material, a metal disc 18 attached to disc 16, and four metal rods 19 extending between the discs 17 and 18 and equally spaced about the axis of rotation. The discs 16 and 17 are rotatably mounted on a metal axle 20 extending from and insulated from the support 15, and the metal disc

18 has a central opening of such size that it does not contact with the axle.

The carrier belt is supported on the rods 19 and these rods are spaced according to the length of the carrier plates so that the carrier belt will turn about the support with its plates successively bridging the space between adjacent supporting rods. Each of the carrier plates carries one of the electric lamps 25, and, as the carrier belt is advanced by rotation of the support 11, the lamps will be successively moved to operative position, which in the apparatus shown is the uppermost position in Figs. 1 and 2, a quarter rotation of the support serving to move one lamp out of position and the next lamp on the carrier belt into position. Each carrier belt plate is provided with a lamp socket such that the side of the lamp base will be electrically connected with the carrier plate. The lamps shown are of the kind having a prefocused base and are mounted on the carrier plates so that the base extends through the plate. Whatever type of lamp is used, the sockets on the plates will be such that the contact terminal at the end of the base of the positioned lamp will engage a flexible contact strip or brush 30 on the axle 20. Connection is thus made to one contact terminal of the positioned lamp through the axle 20, and connection of the other terminal of the positioned lamp is made from the disc 18 through the supporting rods 19 and the carrier plate.

The disc 16 of insulating material has four indexing contacts 31, most desirably of rare metal, set below the surface of the disc in radial grooves 32 in its outer face, the contact pieces extending through the disc 16 and being conductively connected to the meal disc 18, as shown in Figs. 2 and 3. The contacts 31 and grooves 32 are equally spaced circumferentially of the disc. A contact 33 carried by a spring 34 bears against the disc 16 and is shaped and positioned so that when a lamp has been moved into operative position the contact 33 will enter one of the grooves 32 and engage the contact 31 therein to close the lamp circuit. As the disc begins to turn when the carrier is moved to position the new lamp, the contact 33 by its engagement with the side of the groove is immediately pushed away from the contact 31 and out of the groove and then rides on the face of the insulating disc until another lamp has been moved into position, whereupon it makes engagement with the next contact 31 to complete again the lamp circuit.

In Fig. 1, for convenience in diagrammatic illustration, the disc 16 is shown as having peripheral notches in which the contacts 31 are located, and the contacts are shown as connected to a ring from which connection to the positioned lamp is indicated by line *a*.

It will be understood that the carrier support 11 is intended to be mounted in association with a Fresnel lens or other optical system so that the positioned lamp will be properly located within the lens or other optical system.

The motor means for turning the carrier support for removing a burned out or defective lamp and bringing a new lamp into operative position comprises a rotary armature alternating current motor 40 of the shaded pole type. Any suitable driving mechanism may be provided between the motor shaft and the carrier support 11. As shown, the motor is mounted on the support 15 and drives the carrier support 11 through a reduction gear unit 41 and pinion 42 which meshes with gear teeth formed on the periphery of the disc 16. In order to prevent reverse movement of the motor and carrier support, a ratchet wheel 43 is provided on the connecting shaft engaged by a pawl 44. In addition to serving as a detent to prevent backward movement, pawl 44 also serves, in conjunction with the tendency of the motor to rotate the carrier backward when a live lamp is in position, as hereinafter explained, as an indexing means for determining the exact position of the positioned lamp and for maintaining the lamp accurately in position.

The motor 40 has the usual field winding 45 and two shading coils 46 and 47 which when short circuited cause rotation of the motor in the direction to move the lamp carrier support clockwise as viewed in Fig. 1. These shading coils are connected in a closed circuit which includes an impedance 50 which is also connected in the lamp circuit in series with the positioned lamp. Rather than a non-inductive resistance, as indicated in Fig. 1, most desirably a reactance, as indicated in Fig. 1, and the impedance is of such value that when normal current is flowing through the lamp circuit there is applied to the shading coils an E. M. F. of greater value than the E. M. F. normally induced in the shading coils by the field winding of the motor, and the connections are such that this applied E. M. F. is of opposite phase from the E. M. F. induced in the coils by the field winding. This applied E. M. F. will therefore cause the motor to rotate in a reverse direction or backward, or to tend to rotate backward against the restraint of the detent means. When, however, no current is flowing in the lamp circuit, the presence of the impedance 50 in the shading coil circuit does not prevent normal forward rotation of the motor. By thus applying to the shading coils when normal current flows in the lamp circuit an E. M. F. of opposite phase from and of greater value than the E. M. F. normally induced in the shading coils by the field winding, the necessity of providing a motor of this kind with additional and oppositely placed shading coils to effect reverse rotation, as shown in said Patent No. 2,258,575, is avoided.

Figs. 2 and 5 show the special variable reactance device referred to in the introductory part of this specification and which for reasons there pointed out is most desirably used. This variable reactance device comprises a reactance coil 51 having comparatively few turns of heavy insulated wire carried on a tube 52, which may be made of insulating material or may be a metal cylinder with a longitudinal slot to reduce eddy current losses, and within the tube is a two-part core formed by an upper fixed part 53 and a lower part 54 which is movable within the tube in the manner of a solenoid core, both parts being made of soft or laminated iron. The movable lower core member 54 has a shading coil 55 set into its upper end for holding purposes when the device is energized by alternating current. The device is carried by a bracket 56 formed of two angle plates of soft or laminated iron connected together and mounted on a panel of insulating material 57 by screws 58. The arm of one of these angle plates extends over and is secured to the fixed core member 53, and the arm of the other angle plate holds the lower end of the tube 52. The bracket thus forms a U-shaped magnetic return for the magnetic flux created by the coil 51. A spring 59 tends to draw the core member 54 down away from the member 53 and against a stop plate 60, as shown in Fig. 2, thus opening an air gap 61 between the two core mem-

bers. The tension of the spring 59 is sufficient to draw the core member 54 down to the position shown in Fig. 2 when only the normal shading coil current induced by the motor field flows through the reactance coil 51, but not sufficient to resist the upward pull on the core member 54 when normal lamp circuit current flows through coil 51, the core member 54 then being drawn upward by magnetic action to close the air gap 61.

As will be understood, the air gap 61, formed when the core member 54 is in its retracted position, increases the reluctance of the magnetic circuit formed by the U-shaped bracket 56 and the two core members 53 and 54, and the reactance of the coil 51 is then less than when the core member 54 is in its upper position abutting the core member 53. When the core member 54 is in its upper position abutting the core member 53, the magnetic circuit is improved and the reluctance of the flux path decreases, thus increasing the reactance of the coil.

The feed line from the source of alternating current is connected to binding posts 70 and 71 carried by a terminal panel 72 mounted on the support 15. The wiring connections are as shown in Fig. 1. Current from one side of the source connected to the binding post 70 flows in a circuit including wire 75, reactor coil 51, wire 76, and through spring contact arm 34, one of the contacts 31, and disc 18 to the positioned lamp, and from the lamp circuit is completed through axle 20 and wire 78 and binding post 71 to the other side of the current source. The field winding of the motor 40 is, as shown, energized from the same current source, the circuit extending from wire 75 by wire 80 to the motor binding post panel 81 and by wire 82 to one side of the field winding, the other side of the field winding being connected to the terminal post 71 by wire 83. The shading coils 46 and 47 of the motor are connected to binding posts on the panel 81 and connected in parallel across the reactance coil 51 by wires 86 and 80.

When a live lamp is moved into operative position, it is connected in the lamp circuit, and the lamp circuit current then flows through the reactance coil 51 and, the core member 54 being by such flow raised to close the air gap 61, produces a voltage drop across the coil, causing current to flow in the shading coil circuit under an E. M. F. which is greater than the E. M. F. normally induced in the shading coils by the motor field winding 45 and is opposite in phase. A rotating magnetic field is thus produced by the shading coils in such direction as immediately to stop the motor and cause it to start rotating backward, that is, in the reverse direction of rotation. This backward rotation is stopped by the indexing pawl 44 and the tendency of the motor to rotate backward then maintains the lamp in proper focal position at all times against any tendency of vibration or other cause to move the carrier and lamp out of position until the newly postioned lamp fails. On failure of the lamp, however, flow of lamp circuit current through the reactance coil 51 ceases, the core member 54 of the reactor is retracted, thereby re-establishing the air gap 61 and reducing the impedance of the coil, and current induced by the motor field winding then flows in the shading coil circuit, with the result that normal shading action takes place in the motor and the motor rotates in its normal forward direction, driving the lamp carrier forward, that is, in clockwise direction as viewed in Fig. 1. The motor continues to rotate, causing this forward movement of the lamp carrier, until a new lamp has been moved into focal position. Immediately on the positioning of the new lamp, there is a momentary heavy rush of current to the cold filament of the lamp, and the flow of this heavy current through the reactance coil 51 raises the core member 54 to close the air gap and increase the impedance of the coil, and the motor is immediately stopped and caused to rotate or tend to rotate in the reverse direction, which backward movement, however, is stopped by the indexing means; and thereafter, until the newly positioned lamp fails, the carrier and lamp are by the tendency of the motor to rotate backward maintained in accurate position, as before pointed out.

In a flashing light apparatus, that is, apparatus supplied with intermittent current resulting from the introduction of a current interrupter in one side of the supply line, it is desirable to provide means whereby when, on failure of the positioned lamp, the carrier is first moved by the driving motor energized by the intermittent current, the current interrupter is temporarily shunted to permit current to be supplied continuously to the driving motor from the supply line until a new lamp has been moved into operative position, thereby avoiding the relatively slow lamp-changing operation that would result if the motor were dependent on the intermittent current. Means suitable for this purpose is shown and described in said Patent No. 2,258,575.

The association with the lamp circuit of the closed circuit including the shading coil or coils of the driving motor will usually and most desirably be by a direct connection as shown in the drawing rather than by an inductive connection. The closed shading coil circuit will obviously be electrically associated with the lamp circuit in either case.

What is claimed is:

1. Lamp changing apparatus, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a lamp circuit having terminals for connecting the positioned lamp in the circuit, and means for moving the carrier on failure of the positioned lamp to position another lamp, said means comprising an alternating current driving motor having a shading coil connected in a closed circuit and means responsive to current flow in the lamp circuit for applying to said shading coil when normal current flows in the lamp circuit an E. M. F. of opposite phase from and of greater value than the E. M. F. induced in the shading coil by the field of the motor, and indexing means preventing backward movement of the carrier.

2. Lamp changing apparatus, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a lamp circuit having terminals for connecting the positioned lamp in the circuit, and means for moving the carrier on failure of the positioned lamp to position another lamp, said means comprising an alternating current driving motor having a shading coil connected in a closed circuit which is electrically associated with the lamp circuit by means whereby when normal current flows in the lamp circuit an E. M. F. of opposite phase from and of greater value than the E. M. F. normally induced in the shading coil by the field of the motor is applied to the shading coil while normal voltage is applied to the lamp, and indexing means for preventing backward movement of the carrier.

3. Lamp changing apparatus, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a lamp circuit having terminals for connecting the positioned lamp in the circuit, and means for moving the carrier on failure of the positioned lamp to position another lamp, said means comprising an alternating current driving motor having a shading coil connected in a closed circuit which includes an impedance connected in the lamp circuit in series with the positioned lamp, the impedance being of such value that when normal current flows in the lamp circuit an E. M. F. of opposite phase from and of greater value than the E. M. F. normally induced in the shading coil by the field of the motor is applied to the shading coil but not of sufficient value to prevent normal voltage being applied to the lamp, and indexing means for preventing backward movement of the carrier.

4. Lamp changing apparatus, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a lamp circuit having terminals for connecting the positioned lamp in the circuit, and means for moving the carrier on failure of the positioned lamp to position another lamp, said means comprising an alternating current driving motor having a shading coil connected in a closed circuit which includes a reactance coil connected in the lamp circuit in series with the positioned lamp, whereby when normal current flows in the lamp circuit an E. M. F. of opposite phase from and of greater value than the E. M. F. normally induced in the shading coil by the field of the motor is applied to the shading coil, and indexing means for preventing backward movement of the carrier.

5. Lamp changing apparatus, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a lamp circuit having terminals for connecting the positioned lamp in the circuit, and means for moving the carrier on failure of the positioned lamp to position another lamp, said means comprising an alternating current driving motor having a shading coil connected in a closed circuit, a reactance coil connected in the shading coil circuit in series with the shading coil and also connected in the lamp circuit in series with the positioned lamp, means for increasing the reactance of the reactance coil when current flows in the lamp circuit, and indexing means for preventing backward movement of the carrier.

6. Lamp changing apparatus, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a lamp circuit having terminals for connecting the positioned lamp in the circuit, and means for moving the carrier on failure of the positioned lamp to position another lamp, and means comprising an alternating current driving motor having a shading coil connected in a closed circuit, a reactance coil connected in the shading coil circuit in series with the shading coil and also connected in the lamp circuit in series with the positioned lamp, means providing a magnetic circuit associated with the reactance coil including a core member movable within the coil and normally held yieldingly in position to leave an air gap in the magnetic circuit and movable by magnetic action to close said air gap when the lamp circuit current flows through the reactance coil, whereby the reactance of the reactance coil is increased when current flows in the lamp circuit, and indexing means for preventing backward movement of the carrier.

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