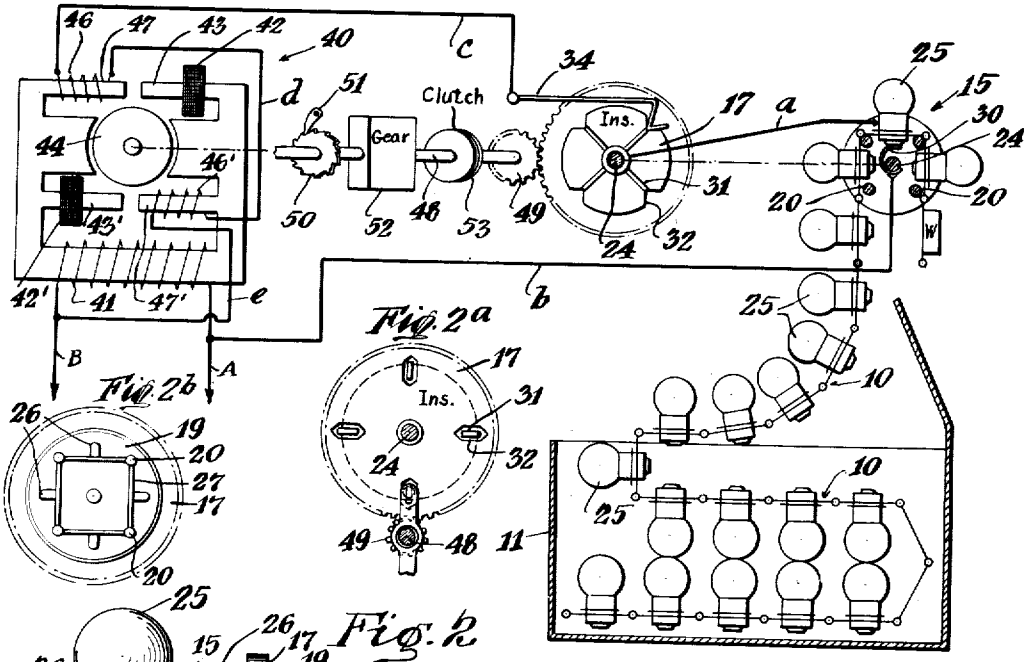
Oct. 7, 1941. J. R. MacKAY 2,258,575

LAMP CHANGING APPARATUS

Filed Feb. 15, 1938 2 Sheets-Sheet 1

Fig. 1



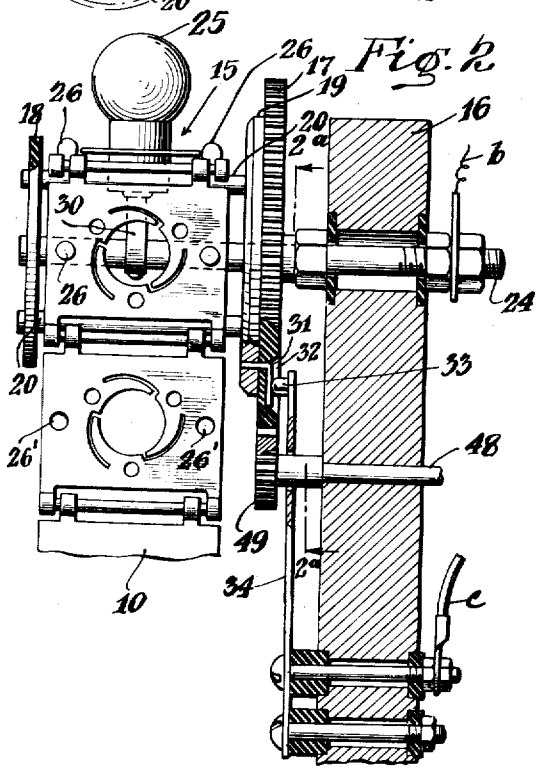
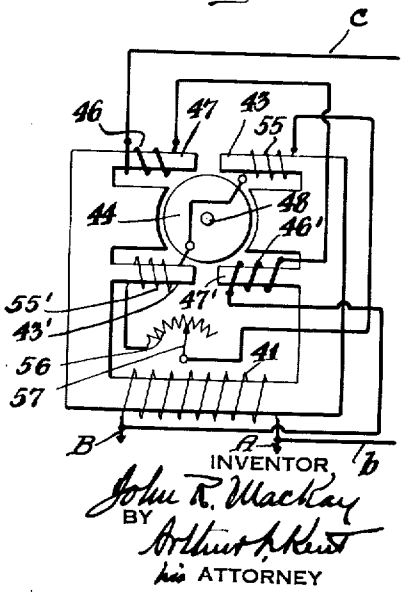


Fig. 3



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Filed Feb. 15, 1938 2 Sheets-Sheet 2

Fig. 4

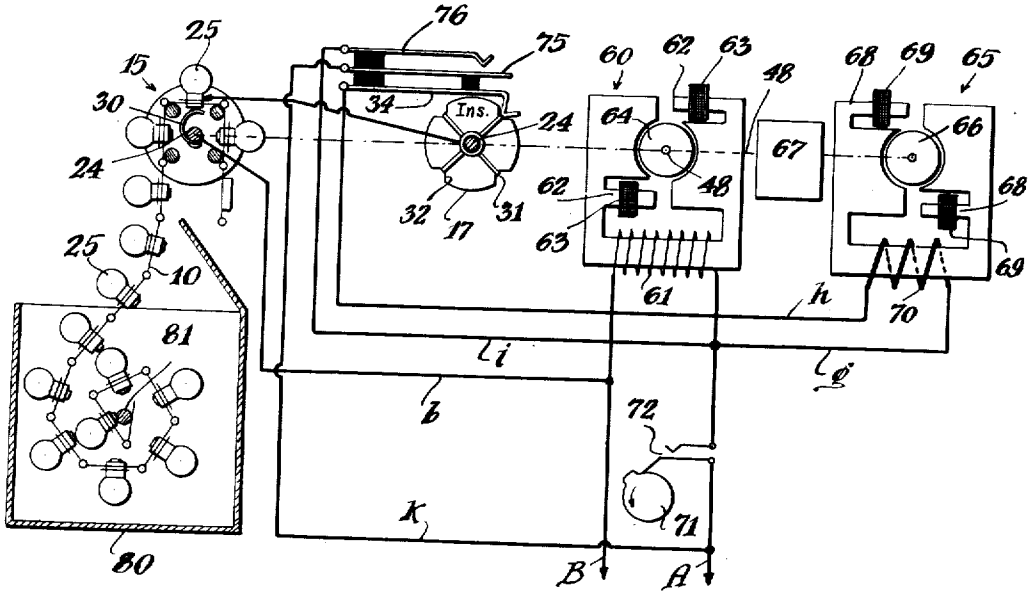
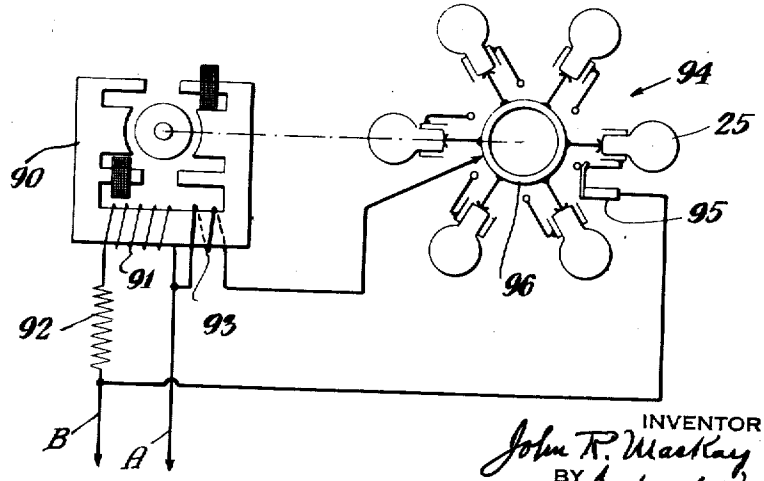


Fig. 5



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UNITED STATES PATENT OFFICE

2,258,575

LAMP CHANGING APPARATUS

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Application February 15, 1938, Serial No. 190,565

12 Claims. (Cl. 177—329)

This invention relates to apparatus for automatically replacing electric lamps which have failed. The invention has been made especially with the idea of providing an improved lamp-changing apparatus for fixed light or flashing light signal devices which are required to operate for long periods of time without attention.

More particularly, the invention aims to provide such a lamp-changing apparatus operated by alternating current motor means which is comparatively simple and inexpensive in construction and very reliable in operation, which has no relays or delicate electric contacts, which moves the new lamps into operative position rapidly and positions them accurately, and which effects the replacement operation smoothly, avoiding harmful jarring.

To these ends, in an apparatus according to the invention, the means for moving a plurality of lamps one after another into an operative position to replace units which have failed, comprises alternating current motor means which has a winding electrically associated with the lamp circuit in series with the positioned lamp whereby when a normally operating lamp is in operative position operation of the motor means to produce lamp-changing movement is prevented, and which when through failure of the positioned lamp the flow of current through said winding is stopped or sufficiently reduced does produce such movement.

Another object of the invention is to provide apparatus which may have a large reserve lamp capacity in a comparatively limited space. Other objects will appear from the following description.

A full understanding of the invention can best be given by a detailed description of apparatus embodying the invention or features thereof in the forms now considered best, and such a description will now be given in connection with the accompanying drawings illustrating such apparatus.

In said drawings:

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

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

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

Fig. 2*b* 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 18 removed and without the carrier belt thereon;

Fig. 3 is a diagrammatic view of a modified form of motor;

Fig. 4 is a view similar to Fig. 1 but showing a modified embodiment of features of the invention; and

Fig. 5 is a diagrammatic view of a further modified apparatus embodying features of the invention.

Referring to the drawings, and first to Figs. 1 to 2*b*, the lamp-changing apparatus shown comprises a lamp-carrying belt formed of a plurality of flat metal plates 10 pivotally connected at their edges. The carrier belt may be placed folded, as shown, in a suitable magazine 11, or the carrier belts may be supplied folded or otherwise suitably stored in such magazines. The end of the belt is placed about a rotary support 15 and may have a weight W on or attached to the end plate to exert a downward force to help hold the carrier belt in proper position on the rotary support. The rotary support, which as shown in Fig. 2 is mounted on a vertical support 16, is formed of two spaced discs 17 and 18 of Bakelite or other insulating material, a metal disc 19 attached to the disc 17, and four metal rods 20 extending between the discs 18 and 19 and equally spaced from the axis of rotation of the support and equally spaced from each other. The discs 17 and 18 are rotatably mounted on a metal axle 24 extending from and insulated from the support 16, and the metal disc 19 has a central opening of such size that it does not make contact with the axle.

The carrier belt is supported on the rods 20 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 an electric lamp 25, and as the carrier belt is advanced by rotation of the support 15, 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 15 serving to move one lamp out of position and the next lamp on the carrier belt into position. The rotary support is provided with pins 26 extending from plates 27 carried by the carrier supporting rods 20, these pins projecting sufficiently to enter corresponding perforations 26′ in the carrier plates to give good traction and insure accurate positioning of the carrier plate on the support.

Each carrier 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 carrier 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 **24**. Connection will thus be made to one contact terminal of the positioned lamp through the axle **24**, and connection to the other terminal of the positioned lamp is made from the disc **19** through the supporting rods **20** and the carrier plate.

The disc **17** 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 piece extending through the disc **17** and being conductively connected to the metal disc **19**, as shown in Figs. 2 and 2*a*. 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 **17** 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 a new lamp, the contact **33** by its engagement with the side of the groove is immediately pushed away from contact **31** and out of the groove, and then rides on the face of the 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 **17** 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*.

The carrier support **15** is turned for removing a burned out or defective lamp and bringing a new lamp into operative position by an alternating current motor **40**. This driving motor as shown is an induction motor of the shaded pole type having a shunt field winding **41** connected across the feed line A—B, and having ring type shading coils **42** and **42'** on split portions **43** and **43'** of the motor poles which with the field winding normally set up a rotating magnetic field to rotate the motor armature **44** in the direction to give the desired lamp-changing movement to the rotary support **15**. The motor has also wound shading coils **46** and **46'** on portions **47** and **47'** of the motor poles facing the portions **43** and **43'** respectively. These auxiliary shading coils **46** and **46'** are connected in series with each other and with the positioned lamp, the lamp circuit being from side A of the feed line by conductor *b* to the axle **24**, thence through the positioned lamp to the contact spring **34** and thence by conductor *c*, coil **46**, conductor *d*, coil **46'** and conductor *e* to the side B of the feed line. With a properly functioning lamp in correct operating position, therefore, the auxiliary windings **46** and **46'** will be normally energized from the feed line.

These auxiliary windings are so connected or phased to the current source that when so energized they exert a shading effect which tends to create a rotating field opposite to that produced by the shading coils **42** and **42'** sufficiently powerful to prevent the motor from rotating and turning the lamp support **15**. Therefore, when a lamp is properly positioned and functioning in the normal manner, the armature of the driving motor remains stationary, but when the positioned lamp burns out or the current through it becomes from any cause sufficiently less than normal so that the flow of current through the auxiliary coils **46** and **46'** is stopped or sufficiently reduced, the neutralizing effect of the auxiliary shading coils is removed and the motor operates to turn the support **15** until a new lamp has been moved into operating position, whereupon the normal current through the lamp circuit again energizes the auxiliary coils **46** and **46'** and stops the motor. Due to the damping or braking action in the motor when the auxiliary coils are normally energized, the motor is stopped quickly and there is no tendency for the lamp-changing mechanism to overrun. In the event that the lamp moved into position is a dead lamp, the motor will continue to operate until a working lamp has been positioned. As the lamp circuit is opened between contacts **31** and **33** at the beginning of the lamp-changing movement of the carrier **15** and closed again only when the disc **17** has made a full quarter turn to permit the contact **33** to engage the next contact **31**, there can be no motor stopping flow of current through the auxiliary shading coils until the new lamp has been moved all the way to its operative position.

Any suitable driving mechanism may be provided between the motor shaft **48** and the carrier support **15**. As shown, the carrier support is driven by a pinion **49** on the motor shaft which engages gear teeth formed on the periphery of the disc **17** of the carrier support. In order to prevent reverse movement of the motor, a ratchet wheel **50** is provided on the motor shaft, engaged by a pawl **51**. If for any reason, such as the use of a lamp of increased wattage, the flow of current through the lamp circuit should be so large that the effect of the auxiliary windings would tend to cause the motor to rotate backwards, the pawl and ratchet detent will prevent any backward rotation. The use of a detent for this purpose avoids recourse to a shunt across the auxiliary windings. Reduction gears shown diagrammatically at **52** are interposed in the motor shaft, and a clutch **53** is desirably provided to permit the carrier support to be turned manually in either direction when desired without turning the motor armature.

In the motor shown in Fig. 3, the pole portions **43** and **43'**, instead of being provided with ring type shading coils as in Fig. 1, are provided with wound shading coils **55** and **55'** which are connected in series in a closed circuit in which a variable resistance **56** is interposed. The resistance arm **57** is set in accordance with the size of the lamps that are to be operated so that the motor armature **44** will not turn until the lamp burns out or the current through it decreases to a predetermined minimum.

In the modification shown in Fig. 4, two induction motors are provided which tend to turn the driving shaft **48** in opposite directions, one of these, the driving motor, turning the shaft when the lamp burns out and the other one stopping the driving motor and shaft when a new lamp arrives at its operating position, and so long as

the positioned lamp functions normally; also, the apparatus is a flashing light apparatus, a current interrupter being provided whereby an intermittent current is supplied to the lamp circuit and also to the field winding of the driving motor when a normally functioning lamp is in operating position.

The driving motor **60** is an induction motor having a field winding **61** and poles **62** with shading coils **63** to cause the armature **64** to turn the shaft **48**, and thereby the carrier support **15**, in the proper direction to move a lamp into operating position. The stopping motor **65**, which is also an induction motor, is most desirably smaller than the driving motor and has its armature **66** connected through a reduction gearing **67** to the driving shaft **48**. Its shading poles **68** are provided with shading coils **69** and its armature tends to turn in the opposite direction to that of the armature of motor **60**.

The field winding **70** of the stopping motor is connected in series in the lamp circuit, the connection being by conductor *g* from the side A of the feed line to one end of the field winding and from the other end of the field winding through conductor *h*, contact spring **34** and contact **31** of disc **17** to the positioned lamp, and from the lamp through conductor *b* to side B of the feed line, the disc **17** operating the contact spring **34** to open the lamp circuit at the start of a lamp-changing movement of the carrier support **15** and to close the lamp circuit again only when a new lamp has been moved into operative position.

The apparatus of Fig. 4 is a flashing light apparatus, the current supplied to the lamp circuit from the feed line A—B being converted into an intermittent current by means of suitable current-interrupting mechanism comprising, as shown, a program wheel **71** driven by any suitable means and an interrupter **72** operated by the program wheel to cause regular or irregular current impulses as determined by the arrangement of the teeth or cam projections of the program wheel, which as shown has one such projection for closing the circuit for a short interval once for each rotation of the wheel. The field winding of the driving motor **60** is also connected across the feed line beyond the current interrupter so that the same intermittent current will be supplied to the driving motor as is supplied to the lamp and to the stopping motor. This is necessary as otherwise the driving motor would operate during the intervals when no current was flowing in the lamp circuit, during which intervals the stopping motor would be inactive.

If, however, the driving motor were dependent on the intermittent current for its lamp-changing operation so that the rapidity of lamp change depended on the periodicity of current impulse, the movement of the lamp carrier would be comparatively slow and the period of change during which no lamp was flashing might be sufficient to cause trouble. Means are provided, therefore, whereby when, on failure of the positioned lamp, the carrier support is first moved by the driving motor energized by the intermittent current, the current interrupter is shunted to permit current to be supplied continuously to the driving motor from the feed line until a new lamp has been moved into operative position. For this purpose, a spring contact **75** is provided in position to be moved by the contact spring **34** when the latter is forced out of a groove **32** of the disc **17** at the beginning of the lamp changing movement. When so moved by the contact spring **34** the spring contact **75** engages a contact **76**, thereby shunting the interrupter and establishing a circuit through conductors *i* and *k* whereby current is continuously supplied to the driving motor so that it operates continuously until a new lamp has been positioned. If the lamp moved into position is a dead lamp, the motor will operate on the intermittent current until the contact **33** carried by the spring **34** is again forced out of the groove of the disc **17** and circuit again closed between contacts **75** and **76** for continuous supply of current to the motor.

It will be understood that with any of the illustrative forms of motors shown the current supplied to the lamp and to the motor coils may be an intermittent current for producing a flashing signal light, and in any such case means such as above described or other suitable means should desirably be provided for causing current to be supplied to the driving motor continuously during the lamp-changing operation of the motor. Also, the two-motor motor means of Fig. 4 may, obviously, be used in a steady, or fixed, light apparatus.

Fig. 4 shows, also, a different sort of container or magazine **80** for the lamp carrier belt. As here shown, a support **81** is provided in this magazine around which the carrier belt with the lamps thereon may be wound.

In the modification shown by Fig. 5, the motor **90** is an induction motor having split poles and shading coils similar to the motor of Fig. 1 and a main field winding **91** connected to the feed line A—B with resistance **92** in series with it. An auxiliary field winding **93** opposing the winding **91** is provided and is connected in series in the lamp circuit. This auxiliary field winding consists most desirably of a few turns of heavier wire and is opposite in electromagnetic effect to the main field winding and so proportioned that its field will be sufficient to prevent rotation when a lamp of minimum wattage is in series with it. The purpose of the resistance **92** is to prevent excessive heating of the main field winding which would otherwise result from the increased current flow through the winding due to its decreased impedance caused by the closely placed auxiliary field winding.

The lamps **25** are mounted on a rotary carrier **94**. As the lamps are successively moved into operative position, the side contact of the positioned lamp is connected with a stationary contact **95** connected to one side of the supply circuit A—B, and the bottom contacts of all the lamps on the carrier are connected to a rotating contact ring **96** against which bears a brush connected to the auxiliary winding **93** from the other end of which there is a connection to the other side of the supply circuit.

The operation of this apparatus of Fig. 5 is similar to that of the others in that when normal current is passing through the positioned lamp the field produced by the auxiliary winding **93** prevents the field produced by the main winding **91** from causing rotation of the motor armature, but when the lamp circuit is opened or the current through the lamp and through coil **93** is too small, due either to burning out or deterioration of the lamp, the motor operates until the carrier has been turned to bring the next lamp to its operating position.

In the apparatus of Figs. 4 and 5, a ratchet wheel and pawl as shown in Fig. 1, or other suitable detent device, should, most desirably, be

provided for preventing backward rotation of the driving shaft, and suitable reducing gearing should also be provided between the driving motor and the lamp carrier, and a clutch may be provided as in Fig. 1, all of which parts for simplicity of illustration are omitted from Figs. 4 and 5.

It is usually advantageous to proportion or relate the motor elements to each other in such a way that the torque of the stopping motor is sufficient to overcome that of the driving motor in a two motor apparatus such as shown in Fig. 4 or, in the other apparatus illustrated, in such a way that the effect of the auxiliary windings in series with the positioned lamp is greater than required to stop the lamp-changing movement, by such a margin that the teeth of the ratchet which prevents backward driving of the lamp carrier are brought into contact with the stopping pawl.

The association of one of the motor windings with the lamp circuit in series with the positioned lamp will usually and most desirably be by a direct connection in the circuit as shown in the drawings rather than by an inductive connection. The winding will obviously be electrically associated with the lamp circuit in either case.

What is claimed is:

1. In a lamp changing apparatus, a plurality of lamps, and means including an alternating current motor for moving said lamps successively into current-consuming position, said motor having a coil in series with the positioned lamp for preventing the motor from operating when normal current is flowing through the positioned lamp by substantially neutralizing a rotation-producing component of the magnetic field of the motor.

2. In a lamp changing apparatus, a carrier for a plurality of lamps movable for positioning the lamp successively, a lamp circuit having terminals for connecting the positioned lamp in the circuit, an alternating current motor means for moving the carrier on failure of the positioned lamp to position another lamp, said motor means having a winding to create a forwardly rotating magnetic field and a winding in series with the positioned lamp to prevent rotation of said rotating magnetic field.

3. In a lamp changing apparatus, a lamp 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 including a rotary armature alternating current motor operative on failure of the positioned lamp to move said carrier to position another lamp, said motor having a coil connected in the lamp circuit in series with the positioned lamp which when normal current is flowing through the positioned lamp substantially neutralizes a rotation-producing component of the magnetic field of the motor and thereby prevents operation of the motor.

4. In a lamp changing apparatus, 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 alternating current motor means for moving the carrier on failure of the positioned lamp to position another lamp, said motor means comprising two windings, one of said windings when no current is flowing in the other winding causing continuous rotation whereby the carrier is moved to move the failed lamp out of operative position and a new lamp into operative position, and the other winding being electrically associated with the lamp circuit in series with the positioned lamp and tending when normal current is flowing through a positioned lamp to cause rotation in the opposite direction and thereby preventing the motor means from operating to move the positioned lamp out of position.

5. In lamp changing apparatus, 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 alternating current motor means for moving the carrier on failure of the positioned lamp to position another lamp, said motor means comprising two windings, one of said windings when no current is flowing in the other winding causing continuous rotation whereby the carrier is moved to move the failed lamp out of operative position and a new lamp into operative position, and the other winding being connected in the lamp circuit in series with the positioned lamp and tending when normal current is flowing through a positioned lamp to cause rotation in the opposite direction and thereby preventing the motor means from operating to move the positioned lamp out of position; and means for preventing backward rotation of the motor.

6. In a lamp changing apparatus, 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 alternating current motor means for moving the carrier on failure of the positioned lamp to position another lamp, said motor means being a shaded pole alternating current motor having opposed shading coils, one of which is electrically associated with the lamp circuit in series with the positioned lamp, whereby the motor is prevented from operating when normal current is flowing through a positioned lamp.

7. In a lamp changing apparatus, a plurality of lamps, and means including an alternating current motor for moving said lamps successively into current-consuming position, said motor having opposed shading coils one of which is in series with the positioned lamp for preventing the motor from operating when normal current is flowing through the positioned lamp.

8. In a lamp changing apparatus, 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, alternating current motor means for moving the carrier on failure of the positioned lamp to position another lamp, said motor means being a shaded pole alternating current motor having opposed shading coils, one of which is connected in the lamp circuit in series with the positioned lamp, whereby the motor is prevented from operating when normal current is flowing through a positioned lamp, and detent means for preventing backward rotation of the motor.

9. In an apparatus of the character described, 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 operative on failure of the positioned lamp to move the carrier to position another lamp, said means including an induction motor having opposed field coils one of which is connected in the lamp

circuit in series with the positioned lamp, and tends when normal current is flowing through the positioned lamp to cause reverse rotation and thereby prevents the motor from operating.

10. In a lamp changing apparatus, a lamp 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 including a rotary armature alternating current motor operative on failure of the positioned lamp to move said carrier to position another lamp, said motor having wound shading coils connected in a closed circuit in series with an adjustably variable resistance, and having other wound shading coils opposed to the first said shading coils and electrically associated with the lamp circuit in series with the positioned lamp for preventing the motor from operating when normal current is flowing through the positioned lamp by substantially neutralizing a rotation-producing component of the magnetic field of the motor.

11. In an apparatus of the character described, 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 alternating current motor means for moving the carrier on failure of the positioned lamp to position another lamp, said motor means comprising two motors tending to produce rotation in opposite directions, one of which is the driving motor in a circuit independent of the lamp circuit and the other of which motors is a stopping motor and is electrically associated with the lamp circuit in series with the positioned lamp and tends when normal current is flowing through a positioned lamp to cause rotation in the opposite direction and thereby prevents the driving motor from operating to move the positioned lamp out of position.

12. In an apparatus of the character described, 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, alternating current motor means for moving the carrier on failure of the positioned lamp to position another lamp, said motor means comprising two induction motors tending to produce rotation in opposite directions, one of which is the driving motor in a circuit independent of the lamp circuit and the other of which motors is a stopping motor and is connected in the lamp circuit in series with the positioned lamp, whereby the driving motor is prevented from operating to move the lamp carrier when normal current is flowing through a positioned lamp, and detent means for preventing backward rotation of the driving motor.

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