Oct. 6, 1942. C. F. WALLACE ET AL 2,297,930

VIBRATORY ARMATURE ELECTROMAGNETIC MOTOR

Original Filed Oct. 6, 1936

Fig. 1

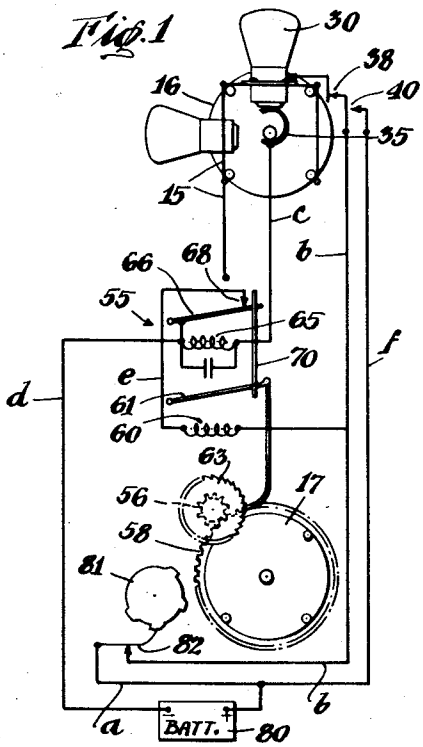


Fig. 4

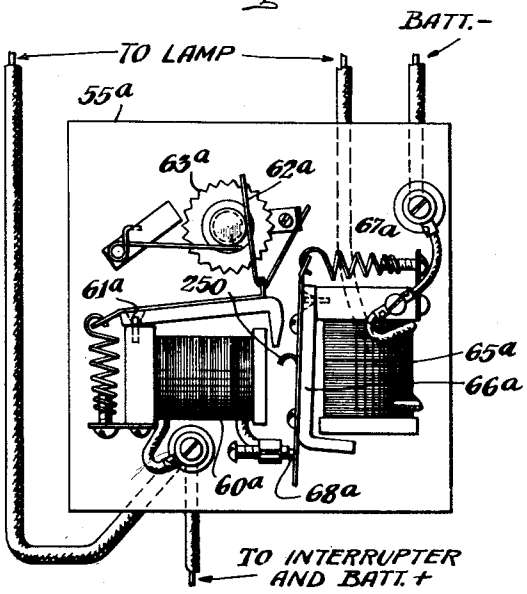


Fig. 2

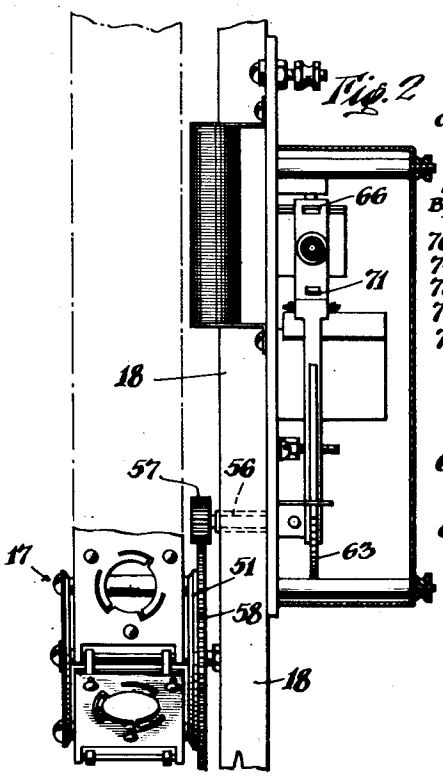
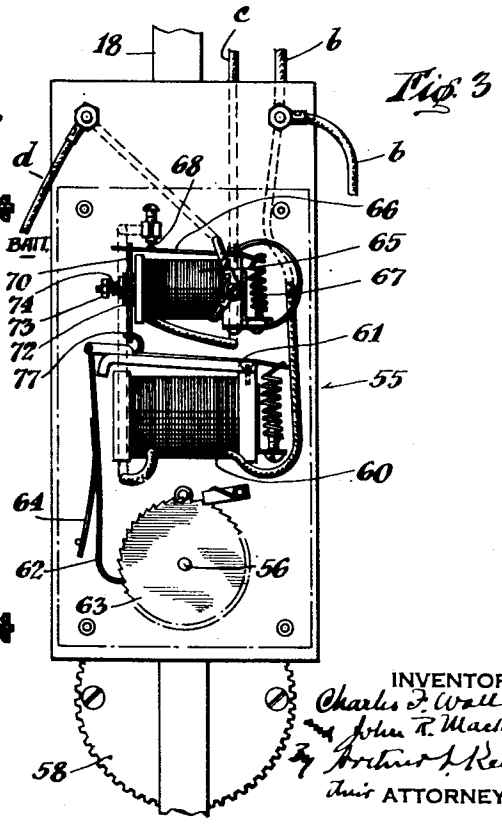


Fig. 3



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VIBRATORY ARMATURE ELECTRO-MAGNETIC MOTOR

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5 Claims. (Cl. 172—126)

This invention relates to vibratory armature electromagnetic motors especially intended for use in apparatus for automatically replacing filament lamps which have failed or other electrical devices or units which indicate an improper operative condition by a reduction or cessation of the electric current normally consumed thereby.

In signal device lamp-changing apparatus heretofore in use, so far as we are aware, the lamp carrier has been moved either by a stepping magnet connected in parallel with the positioned lamp and controlled by a relay in series with the lamp, or by weight or spring-driven motor means controlled by such a stepping magnet, or by a weight or spring-driven motor means controlled merely by a tripping device operated by a relay in series with the lamp. The stepping magnet requires an intermittent current and this arrangement can, therefore, be used only with a flashing light, and in addition, as the rapidity of lamp change depends on the periodicity of current impulse, when this device is used with a slowly flashing light the period of change during which no lamp is flashing may be sufficient to cause trouble. The use of a spring or weight drive for the lamp carrier is objectionable for the reason that only a limited number of revolutions of the driven member can take place, so that, unless made unsuitably large, such a driving means has not sufficient rotational reserve to assure the breakdown by continued operation and repeated wiping of any high-resistance film which may form on the positioning or indexing contacts of the lamp carrier, and, furthermore, jarring such as may happen in heavy weither to a signal apparatus mounted on a buoy may cause the trip controlling the driving means to be released, and such devices require manual rewinding with the risk of inattention.

The present invention aims especially to provide a driving motor for lamp-changing apparatus which is adapted for both steady light and flashing light signal devices and which when used with flashing light devices operates independently of the periodicity of the impulses of the signal current, which moves the lamp carrier rapidly until a new lamp is positioned and connected in the lighting circuit and then stops with the new lamp accurately positioned, the motor having no tendency to coast or over-shoot, which consumes comparatively little current, and which will continue in operation to break down by repeated wiping any high resistance film from the indexing or lamp-positioning contacts.

To these ends, a motor according to the invention comprises a driving magnet having a vibratory armature, a quick-acting relay, or control, magnet, and a current-interrupting switch which is controlled both by the motor armature and by the relay magnet, the switch being operated by the driving magnet armature to maintain the motor in operation so long as current is supplied and the relay magnet is not energized, and the relay magnet, when energized, opening the switch to prevent operation of the motor and holding the switch open so long as it is energized.

The accompanying drawing shows illustrative embodiments of the invention. In said drawing—

Fig. 1 is a diagrammatic view and wiring diagram of a lamp-changing apparatus having a motor according to the invention;

Fig. 2 is a side view of the motor illustrated diagrammatically in Fig. 1;

Fig. 3 is a face view of the motor; and

Fig. 4 is a face view of a modified form of the motor.

Referring to the drawing, Fig. 1 shows diagrammatically a lamp-changing mechanism which is fully illustrated and described in Patent No. 2,195,374, granted on our application Serial No. 104,182, filed October 6, 1936, of which this application is a division. This lamp-changing mechanism, shown by way of example, comprises an endless lamp-carrying belt formed of a plurality of flat plates 15 pivotally connected at their edges, the belt being mounted on two rotary supports 16 and 17 mounted on a vertical support 18. Each of the carrier plates carries a filament lamp 30, and as the belt moves and turns about the support 16 the lamps are successively positioned with their filaments at the desired point, a new lamp being positioned at each successive quarter revolution of the support when its carrier plate 15 is horizontal and the lamp extends vertically upward. The contact terminal at the end of the base of the positioned lamp engages a flexible contact strip or brush 35, and connection is made to the side terminal of the positioned lamp when and only when the lamp is in operative position by means which includes a contact 38 and which is fully illustrated and described in said Patent No. 2,195,374, whereby when a lamp is moved out of position and until another lamp is moved into position the lamp contact 38 is moved to open the lamp circuit and to make connection with a contact 40.

The lower support 17 serves as the drive wheel for the carrier belt and is driven by a driving mo-

tor 55, the drive shaft 56 of which carries the pinion 57 which drives a gear 58 attached to the support 17.

Referring now to Figs. 1, 2 and 3, the driving motor 55 is a vibratory motor comprising an electromagnet 60 having a vibratory armature 61 by which the drive shaft 56 is rotated through a pawl arm 62 acting on a ratchet wheel 63 fastened on shaft 56, the pawl end of the arm 62 being pressed against the ratchet wheel by a spring 64.

A current-interrupting switch operated by the armature 61 causes the driving magnet to alternately attract and release the armature so as to maintain the armature in operation so long as the magnet is connected in circuit to a source of current. This switch, in accordance with the invention, is also controlled by the armature of a quick-acting relay magnet 65 connected in the lamp circuit in series with the positioned lamp, this relay acting to operate said switch to prevent operation of the driving motor so long as the positioned lamp is operative and to permit the driving motor to operate when there is no flow of current through the lamp circuit because of failure of the positioned lamp, the driving magnet being slower acting than the relay. One switch operated by both the driving magnet and the relay magnet thus serves for maintaining the driving magnet armature in operation so long as current is supplied and the relay magnet is not energized, and for preventing operation of the driving magnet when the relay magnet is energized, that is, when an operative lamp is in operating position.

The relay, or control, magnet 65 is, as shown, mounted adjacent to the motor magnet 60, and its armature 66 when retracted by its spring 67 closes the circuit to magnet 60 through a stationary contact 68, and when the relay magnet is energized by flow of current through the lamp circuit and its armature attracted, the circuit to the driving magnet 60 is broken at the contact 68 and operation of the slower-acting driving magnet is prevented. This switch, formed by the relay armature 66 and the stationary contact 68, is operated by the driving magnet armature 61 through a connecting plate 70 which extends between the two armatures. A finger 71 on armature 61 extends through an opening in the lower end of the plate 70 the dimension of which in the direction of the length of the plate is greater than the thickness of the finger; and the end of the relay armature 66 extends through a similar opening near the other end of the plate 70 the dimension of which lengthwise of the plate is greater than the thickness of the end of the armature in the same direction. The plate 70 extends between two friction washers 72 of felt or other suitable material the pressure of which on the plate may be adjusted by means of a nut 73 on a stud extending from the end of the relay magnet core and acting through a coiled spring 74 bearing against the outer washer. The relay armature will thus be free to move up and down in its slot in the connecting plate or strip 70 to make and break contact with stationary contact 68 when the driving magnet is not energized, and when current flows to the driving magnet when the switch 68 is closed, the connecting strip 70 will be drawn downward to open switch 68 as the driving armature approaches the end of its movement toward its magnet pole, thus breaking the motor circuit. The driving magnet being thus deenergized, its armature is retracted by its spring, and, as it approaches the end of its movement away from the magnet pole, it permits the relay armature to close its contact 68 again.

As shown in Fig. 1, current for both the lamp and the driving motor is supplied from a battery 30, and the battery current is converted into an intermittent current by means of suitable current-interrupting mechanism comprising a program wheel 81 which may be driven by a suitable electric motor supplied with current from the battery 30 or other source and an interrupter 82 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.

In a flashing light signal apparatus such as shown by Fig. 1, in which the lamp is supplied with an intermittent current, means must be provided whereby when the driving motor starts on the failure of a lamp it will have a continuous current supply for effecting movement of the lamp carrier until circuit is again established through a positioned new operative lamp. For this purpose, means may be provided such as shown in said Patent No. 2,195,374, whereby, when on failure of the positioned lamp, the lamp carrier is first moved by the driving motor energized by the intermittent current, the circuit is immediately opened at contact 38 and closed at contact 40 to establish a shunt circuit around the interrupter 82 whereby current is continuously supplied to the driving motor so that its operation then continues until a live lamp is again positioned by the carrier, the carrier belt being moved comparatively rapidly but steadily, its movement being independent of the duration and periodicity of the current impulses of the intermittent signal current. When a new lamp is moved into position the circuit is opened at contact 40 and closed through contact 38 and the supply of current to the driving magnet becomes again subject to the control of the relay 65. In the event that the lamp moved into position is a dead lamp, the motor will operate on the intermittent current until by further movement of the lamp carrier the shunt circuit is again closed at 40 for supplying continuous current to the motor.

The operation of the apparatus as shown in Fig. 1 is as follows: Assuming that a high spot of the program wheel 81 has closed the interrupter switch 82 and that the positioned lamp 30 is in working condition, current will flow to the lamp as follows: From the positive side of the battery, through conductor *a*, interrupter switch 82, conductor *b*, and by contact 38 to the lamp, and from the lamp through brush 35, conductor *c*, relay magnet coil 65, and by conductor *d* back to the negative pole of the battery. At each closing of the lamp circuit by the interrupter 82, the armature 66 of relay 65 is operated so quickly by the momentary heavy rush of current through the cold filament of the lamp that the switch 66—68 is opened before there is sufficient flow of current through the driving magnet coil 60 to cause movement of its armature 61. On failure of the filament of a positioned lamp, however, current will flow at the next closing of the interrupter switch 82, from the positive side of the battery through conductor *a*, switch 82, and conductor *b*, to the driving magnet coil 60, and thence by conductor *e* to switch 66—68, which, because of the lamp having failed, will be closed,

and thence, through conductor *d*, back to the battery.

Immediately upon energization of the driving magnet, the ratchet wheel is operated to cause movement of the carrier belt whereby circuit is closed at contact **40**, thereby by-passing the current-interrupting switch **82** by establishing a circuit as follows for supplying current continuously to the motor magnet: from the positive side of the battery through conductor *f*, contact **40**, conductor *b* to driving magnet coil **60**, and thence by conductor *e*, switch **66—68** and conductor *d* back to the battery, the switch **66—68** being then operated by the motor armature **61** to maintain the armature in vibration. Movement of the carrier will then continue regardless of the operation of the interrupter **82** until a new lamp is brought into position, whereupon the circuit will be opened at contact **40** to stop the supply of continuous current to the driving magnet. If the newly positioned lamp is in working condition, operation of the driving motor will immediately cease and flashing of the lamp will start and continue until the new lamp fails. If the newly positioned lamp should not be a working current-consuming lamp or if good electrical connection to the newly positioned lamp is not established, the driving motor will again be operated by the intermittent current until the lamp carrier has moved sufficiently to cause the continuous current shunt circuit to the driving motor to be again established through the contact **40**. The driving motor will thus continue to operate until the proper working current is flowing through a positioned good lamp.

The modified form of driving motor shown in Fig. 4 differs from that of Figs. 2 and 3 principally in the means whereby the armature of the quick-acting relay, which serves to cut off flow of current to the driving magnet when current flows through the lamp circuit, is operated by the driving magnet armature to make and break the circuit for maintaining the motor in operation. Instead of having a lost motion connection between the armatures of the driving magnet and of the quick-acting relay by means of a connecting member movable against restraining friction as in the motor of Figs. 2 and 3 and as indicated in the wiring diagram, the driving magnet **60***a* and the relay magnet **65***a* are mounted at right angles to each other, and the free end of the armature **61***a* of the driving magnet is shaped to act as a cam against an abutment or finger **250** on the armature and movable switch member **66***a*, to move this armature and switch member to carry its contact end away from the fixed contact **68***a* as the armature **61***a* makes its inward movement under the pull of the driving magnet, and to permit the armature and switch member **66***a* to return under the pull of its spring **67***a* to its circuit closing position engaging the contact **68***a* as the armature **61***a* makes its return movement. The inductance of the driving magnet and its mechanical inertia are made sufficiently high to obtain complete and relatively slow movements of the armature **61***a*, the inertia of the armature **61***a* being sufficient so that it makes the necessary full movements in each direction even though the driving magnet circuit is opened and closed by the switch **66***a*—**68***a* before the armature reaches the end of its movement in the respective directions.

As in the case of the motor of Figs. 2 and 3, the lighting current normally flows to the lamp through the winding of the relay **65***a*, causing its armature **66***a* to open the circuit to the driving magnet **60***a* at contact **68***a* before there has been any flow of current through the winding of the magnet **60***a* sufficient to cause any appreciable movement of its armature. When, however, the positioned lamp fails, or, if the motor is used otherwise than in apparatus such as shown, if for any reason current does not flow through the circuit in which the relay magnet is connected in series with sufficient force to energize the relay magnet, then the driving magnet circuit will no longer be opened by the relay magnet and the motor will operate to position a new lamp, or, when used otherwise than in apparatus such as shown, to re-establish a condition in which current flows through the circuit in which the relay magnet is connected in series with sufficient force to energize the relay magnet.

It is to be understood that the invention is not to be limited to the exact construction, arrangements and combinations of parts shown, but that it includes changes and modifications thereof within the claims. Obviously, the relatively quick action of the relay **65** or **65***a* is needed only on the inward movement of its armature toward the magnet. It does not need to be quick on release. The term "quick-acting" as applied to the relay is to be understood, therefore, as meaning that the inward movement of its armature is relatively quick, that is, quicker than the motor magnet armature.

What is claimed is:

1. A vibratory electromagnetic motor, comprising in combination a driving magnet and armature, a quick-acting control magnet and armature, and a current-interrupting switch operated by the control magnet armature to prevent operation of the motor when the control magnet is energized and operated by the driving magnet armature to maintain the motor in operation when the control magnet is not energized.

2. A vibratory electromagnetic motor, comprising in combination a driving magnet and armature, a quick-acting control magnet and armature, a current-interrupting switch operated by the control magnet armature to prevent operation of the motor when the control magnet is energized, and means whereby the driving magnet armature operates the control magnet armature to operate the switch to supply current to the driving magnet intermittently when the control magnet is not energized.

3. A vibratory electromagnetic motor, comprising in combination a driving magnet and armature, a quick-acting control magnet and armature, and a current-interrupting switch operated by the control magnet armature to prevent operation of the motor when the control magnet is energized, the armature of the driving magnet being connected to the armature of the control magnet by a member having a lost motion connection with each of said armatures and which is moved against a movement retarding friction, whereby the switch is operated to supply current to the driving magnet intermittently when the control magnet is not energized.

4. A vibratory electromagnetic motor, comprising in combination a driving magnet and armature, a quick-acting control magnet and armature, and a current-interrupting switch operated by the control magnet armature to prevent operation of the motor when the control magnet is energized, the armature of the driving mag-

net being connected to the armature of the control magnet by a member having a lost motion connection with each of said armatures, whereby the switch is operated to supply current to the driving magnet intermittently when the control magnet is not energized.

5. A vibratory electromagnetic motor, comprising in combination a driving magnet and armature, a quick-acting control magnet and armature, a current-interrupting switch operated by the control magnet armature to prevent operation of the motor when the control magnet is energized, the control magnet being mounted at substantially right angles to the driving magnet, and the driving motor armature and the control magnet armature having coacting cam faces by engagement of which when the control magnet is not energized the control magnet armature is moved to open the switch as the driving magnet armature makes its inward movement, the driving magnet armature being of relatively high inertia.

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