March 26, 1940. C. F. WALLACE ET AL 2,195,374

SIGNAL DEVICE

Filed Oct. 6, 1936 4 Sheets-Sheet 1

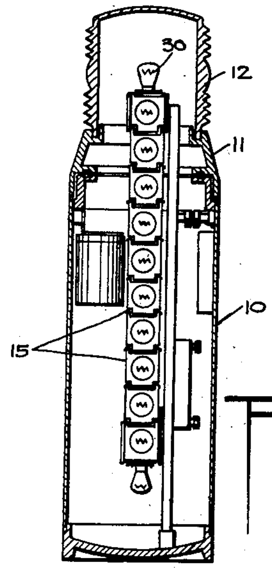


Fig. 1

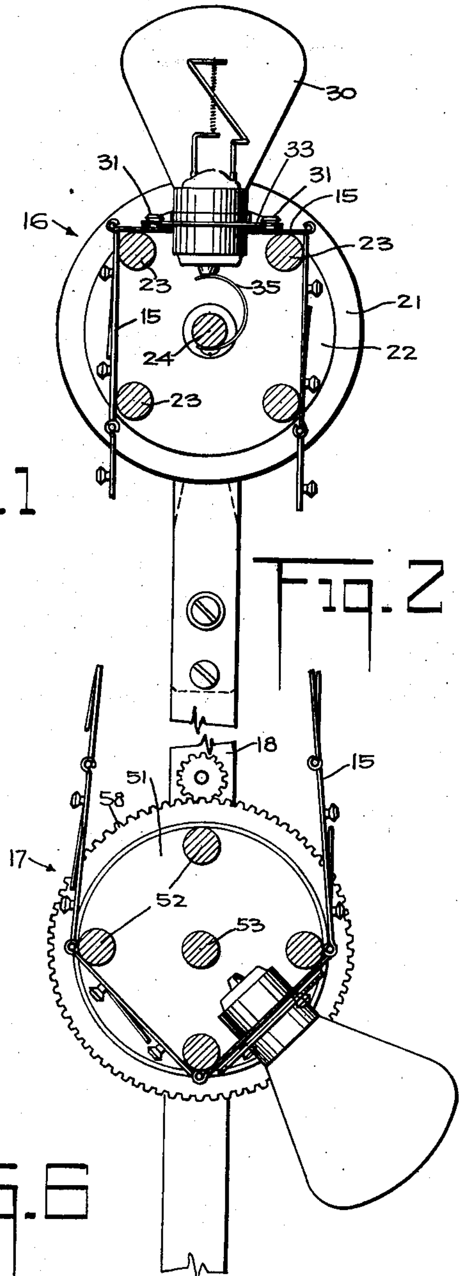


Fig. 2

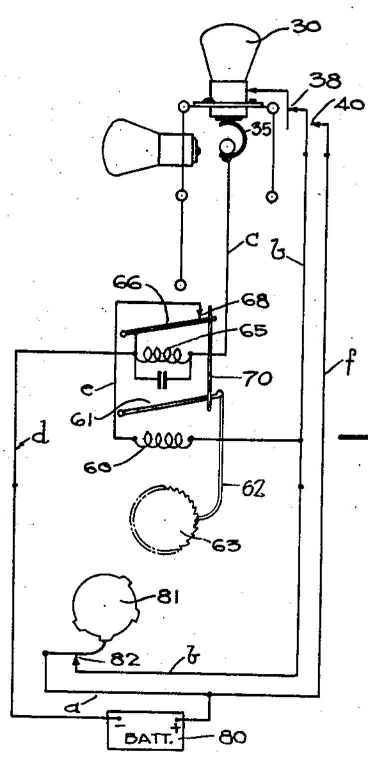


Fig. 6

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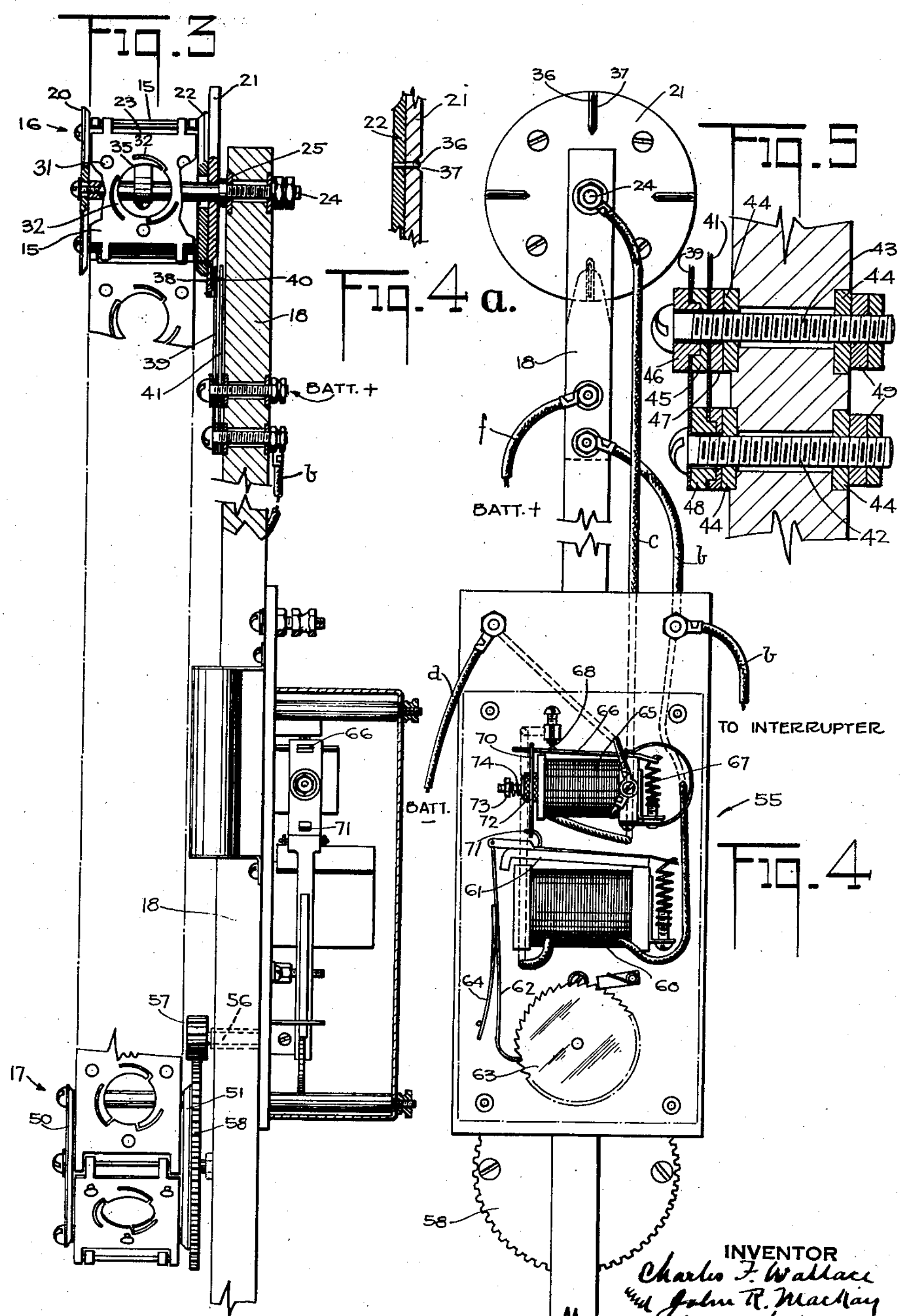
SIGNAL DEVICE

Filed Oct. 6, 1936 4 Sheets-Sheet 2

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SIGNAL DEVICE

Filed Oct. 6, 1936 4 Sheets-Sheet 3

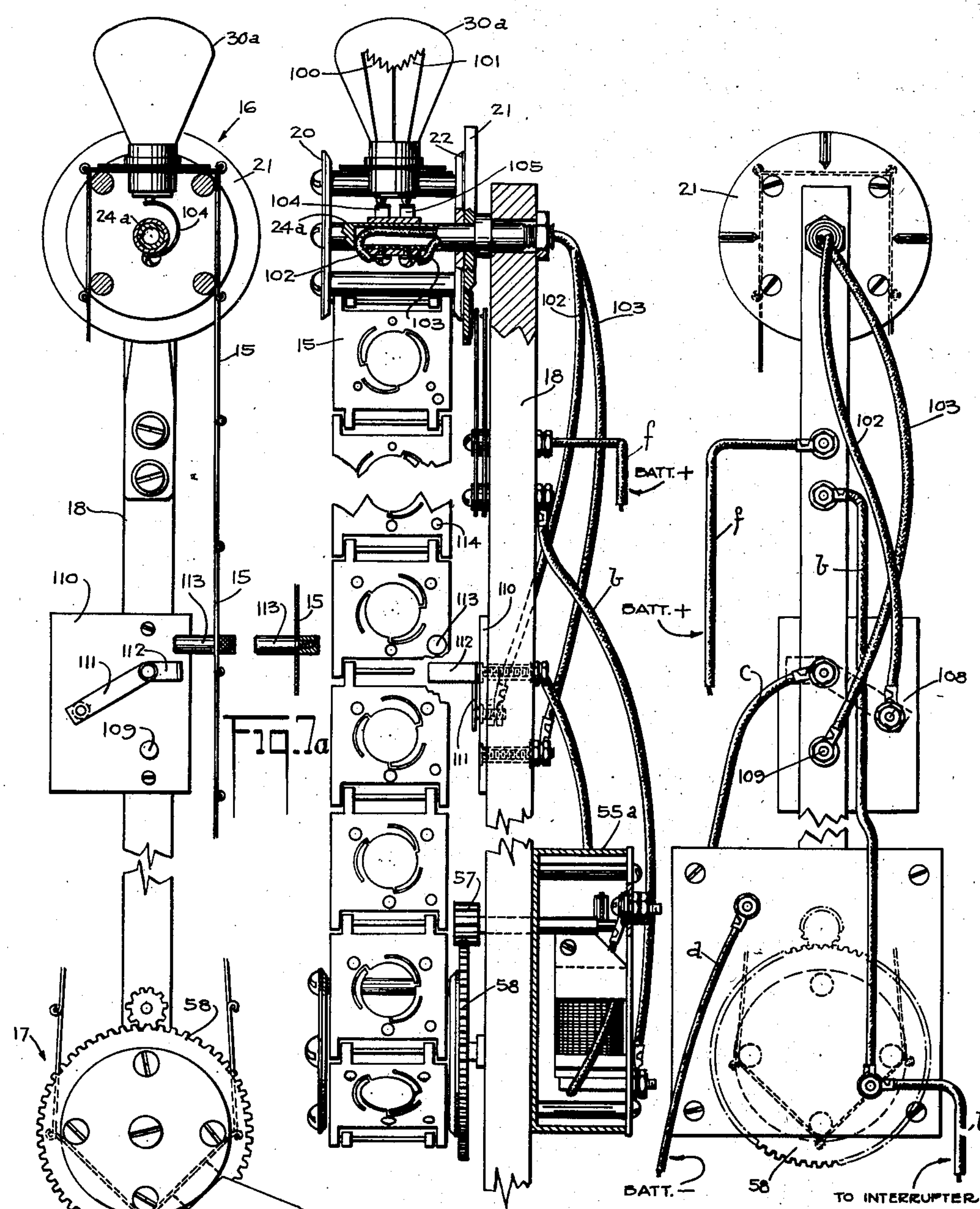


Fig. 7a

Fig. 7

Fig. 8

Fig. 9

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SIGNAL DEVICE

Filed Oct. 6, 1936 4 Sheets-Sheet 4

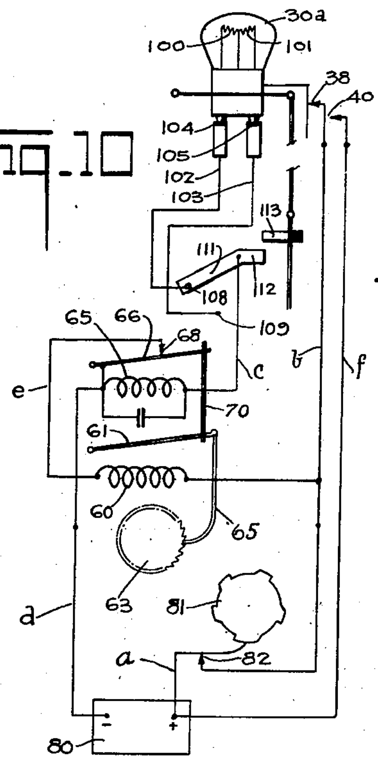


Fig. 10

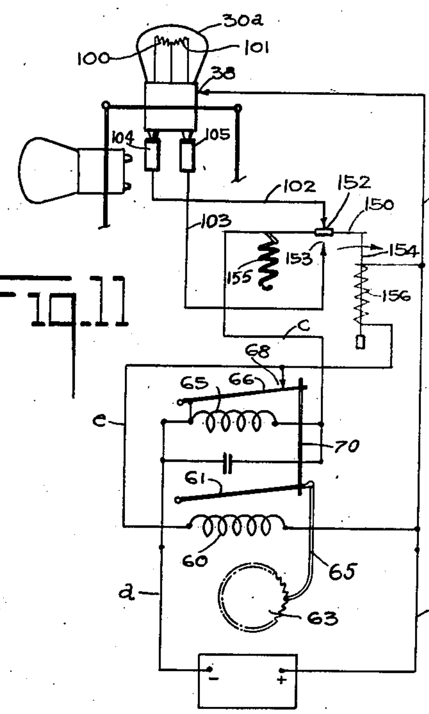


Fig. 11

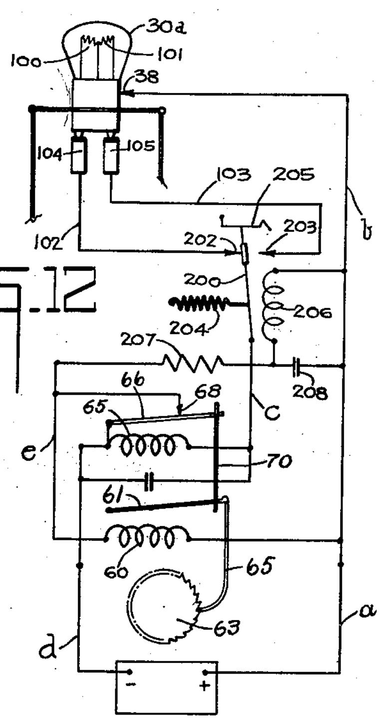


Fig. 12

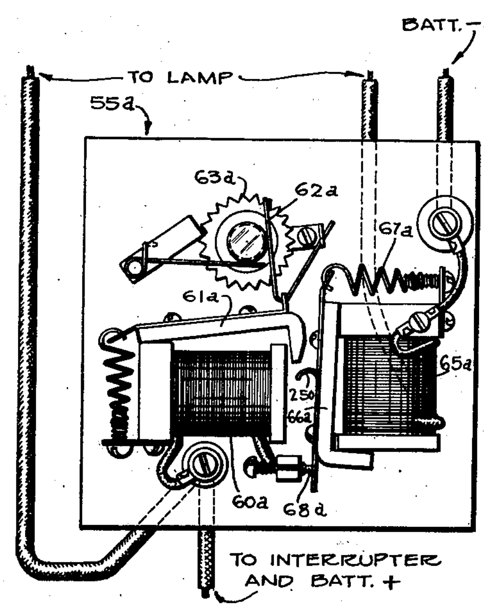


Fig. 13

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# UNITED STATES PATENT OFFICE

2,195,374

## SIGNAL DEVICE

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Application October 6, 1936, Serial No. 104,182

17 Claims. (Cl. 177—329)

This invention relates to apparatus for automatically replacing a lamp which has failed, or other electrical device or unit which indicates an improper operative condition by a reduction or cessation of the electric current normally consumed by it. The invention has been made especially with the idea of providing an improved lamp changing apparatus for signal devices which are required to operate for long periods of time without attention. More particularly, the invention aims to provide a lamp changing apparatus which may be made to have a large reserve lamp capacity, and especially to have such capacity without involving any interference by unused or failed lamps with the beam of light from the positioned lamp in a signal light of the 360° Fresnel type and without requiring the use of an uneconomically large lens; which is suitable for either fixed light or flashing light signal devices; which will rapidly move the new lamp into place and accurately position it; and which is adapted to the use of multi-filament lamps, the shift from one set of filaments of the series of lamps to another set being effected automatically.

The reserve lamp capacity of lamp changing apparatus as heretofore made has been limited by the use of some form of carrier wheel or table on which the lamp sockets are arranged. This is especially true for signal lights of the 360° Fresnel type. If too many lamps are mounted on a carrier wheel, it is necessary to use an uneconomically large lens, and in addition, unused and failed lamps adjacent to the positioned lamp will project into parts of the beam of light radiated from the positioned lamp. In order to avoid these difficulties, it has been found desirable with a Fresnel lens to space the lamps on a carrier wheel 90° apart. This limits the number of reserve lamps to three.

According to the present invention, the lamp carrier is a flexible belt mounted to turn about a relatively small rotary belt support, and the lamps mounted on the carrier belt are spaced apart sufficiently so that when one lamp is in operative position, adjacent lamps on each side thereof will be entirely outside of the path or zone of light radiated from the positioned lamp. The carrier belt may be of any desired length for supporting any number of lamps within the space limits of the apparatus, and is most desirably an endless belt extending between the lamp positioning belt-supporting wheel and a supporting and driving rotary member or wheel. Even with this simple arrangement of the carrier belt, a comparatively large number of lamps may be carried in a comparatively small space.

In a battery operated signal device provided with lamp changing mechanism it is often desirable to operate the lamps with a higher voltage than that for which the filament of the lamp is intended. In this way improved operation of the signal is obtained with a reduction in operating cost, as is shown by the fact that by over-voltaging the commercial tungsten filament lamp 25%, a 100% increase in candle power may be obtained with less than 40% increase in wattage and with only about 90% decrease in the life of the lamp. The same increase in efficiency could be obtained by using a lamp designed to operate at an increased filament temperature, but such lamps are not at the present time generally available. So far as we are aware, little practical use has been made in the signal field of over-voltaging filament lamps to obtain greatly increased light radiation with a relatively slight increase in power consumption, as previous lamp changing mechanisms have lacked sufficient reserve capacity to compensate for the reduced life of the lamps in operating in this manner. Because of the greatly increased reserve lamp capacity made possible by the present invention, and in addition, because of the use of multi-filament lamps made possible by the present invention, full advantage may be taken of this over-voltaging method of operation.

In 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 break-down 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 weather to a signal apparatus mounted on a buoy may cause the trip to be released, and such devices require manual rewinding with the risk of inattention.

The carrier driving means of the present invention is adapted for both steady light and flashing light signal devices, and when used with flashing light devices operates independently of the duration and periodicity of the impulses of the signal current, moves the carrier rapidly until a new lamp is positioned and connected in the lighting circuit and then stops with the new lamp accurately positioned, consumes comparatively little current, and will continue in operation to break down by repeated wiping any high resistance film from the indexing, or lamp-positioning, contacts.

Other objects and features of the invention will be understood from the following description of illustrative embodiments of the invention shown in the accompanying drawings, in which:

Fig. 1 is a sectional view of a Fresnel type marine beacon provided with lamp changing apparatus of approved form in accordance with the invention;

Fig. 2 is a back view or view looking from the left of Fig. 1, partly broken away and with parts omitted;

Fig. 3 is a side view looking from the right in Fig. 2 with the parts shown in section.

Fig. 4 is a front view, looking from the right of Fig. 3, the cover of the box containing the driving motor being removed.

Fig. 4*a* is an enlarged detail sectional view of certain parts appearing in Fig. 4;

Fig. 5 is an enlarged detailed sectional view of the mounting means for two contact-carrying springs.

Fig. 6 is a schematic wiring diagram of the apparatus of Figs. 1 to 5.

Figs. 7, 8 and 9 are, respectively, back, side and front views of apparatus according to the invention designed for the use of multi-filament lamps.

Fig. 7*a* is a detail part-sectional view of certain parts appearing in Fig. 7;

Fig. 10 is the wiring diagram of the apparatus of Figs. 7, 8 and 9.

Fig. 11 is the wiring diagram of a multi-filament type lamp changer employing thermostatic means for changing from one set of filaments to another set.

Fig. 12 is the wiring diagram of a multi-filament lamp changer employing electromagnetic means for effecting change from one set of filaments to another set.

Fig. 13 shows in elevation a modified form of reciprocatory driving motor.

Referring to the drawings, and first to Figs. 1 to 6, the marine beacon shown in Fig. 1 comprises a housing 10 closed at its lower end and supporting at its upper open end a lens support casting 11 on which is mounted a Fresnel lens 12 closed at the top. Mounted within the housing and lens support is the lamp changing apparatus shown in Figs. 2 to 6.

The lamp changing mechanism comprises an endless lamp-carrying belt formed of a plurality of flat plates 15 pivotally connected at their edges. The carrier belt is mounted on two rotary supports, 16 and 17, mounted on a vertical support 18. The upper support 16 is formed of two spaced discs 20 and 21 of Bakelite or other insulating material, a metal disc 22 attached to the disc 21, and four rods 23 extending between the discs 20 and 22 and equally spaced from each other and equally spaced from the axis of rotation of the support. The discs 20 and 21 are rotatably mounted on a metal axle 24 extending from and insulated from the support 18, the threaded end of the axle rod extending through insulating washers 25 and being secured by a nut 26. The metal disc 22 has a central opening of such size that it does not make contact with the axle.

The carrier belt is supported on the rods 23 and these carrier supporting 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 a filament lamp 30, and as the carrier belt is moved and turns about the support 16 the lamps will be successively positioned with their filaments at the focal point of the lens 12 at each successive quarter rotation of the support, a lamp being so positioned in the apparatus shown when its plate 15 is horizontal and the lamp extends vertically upward therefrom.

As shown, and most desirably, the lamps are of the kind having a so-called prefocused base, and for such lamps each carrier plate has an opening to receive the end of the lamp base and three headed studs 31 arranged about the opening, and the plate is slotted from the opening to form three fingers 32 which are bent upward to serve as springs. The studs enter the slots in the focusing flange 33 of the lamp base and the spring fingers 32 press the flange against the stud heads and hold the lamp in position with relation to the plate. For lamps of other types other sockets will, of course, be provided.

The contact terminal at the end of the base of the positioned lamp engages a flexible contact strip or brush 35 on the axle 24. Connection to the side terminal of the lamp is made from the disc 22 through the supporting rods 23 and carrier plate 15. The disc 21 of insulating material has four indexing contacts 36 each formed by a short wire or other contact piece, most desirably of rare metal, set below the surface of the disc in a radial groove 37 in its outer face, the contact piece extending through the disc and being conductively connected to the metal disc 22, as shown best by Figs. 4 and 4*a*. These contacts 36 are equally spaced circumferentially of the disc. A contact 38 carried by a spring 39 bears against the disc 21 and is shaped and positioned so that when a lamp has been moved into position the contact 38 will enter one of the grooves 37 and engage the contact 36 therein to close the lamp circuit. As the disc 21 begins to turn when the carrier moves to position a new lamp, the contact 38 by its engagement with the side of the groove is immediately pushed away from the contact 36 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 36 to complete again the lamp circuit.

When the contact 38 is forced out of a groove 37, it or its spring 39 engages a contact 40 carried by a spring 41, thereby closing a circuit to the carrier driving motor hereinafter described. Thus, whenever a lamp is positioned in the lens 12, contact 38 will engage one of the contacts 36 to complete the circuit to the lamp, and during the lamp-changing movement of the carrier a motor circuit will be completed between contacts 38 and 40.

The contact-carrying springs 39 and 41 are mounted on the support 18 by means of bolts 42 and 43, the spring 39 being conductively connected to the bolt 42 and insulated from bolt 43, and spring 41 being conductively connected to bolt 43 and insulated from bolt 42, and both bolts being insulated from the support 18 by insulating washers 44. The spring 39 is held by the bolt 43 between a washer 45 and a bushing 46 both of insulating material, and the spring 41 is held by this bolt between the washer 45 and a threaded metal washer 47 through which it is conductively connected to the bolt; and the spring 41 is held by the bolt 42 between the washer 44 and an insulating bushing 48, while the spring 39 is held by the bolt 42 in electrical contact therewith between the head of the bolt and the bushing 48. The bolts are held fast in the support 18 by nuts 49. The bolts 42 and 43, in addition to holding the contact springs 39 and 41, serve as contact terminals for the springs to which conductors are connected as shown in Fig. 4.

The lower carrier support 17 is of similar construction to the upper support 16, being formed by two spaced discs 50 and 51 and four equally spaced supporting rods 52, and is mounted to turn on an axle 53 extending from the support 18. The discs 50 and 51 are desirably, although not necessarily, of insulating material. The support 17 serves as the drive wheel for the carrier belt, and is driven by a driving motor 55, the drive shaft 56 of which carries a pinion 57 which drives a gear 58 attached to the disc 51 of the support.

The circuit to the driving motor 55 is controlled when a lamp is in position by a quick acting relay connected in the lamp circuit in series with the lamp, this relay acting 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. This control by the quick acting relay is most desirably by opening the circuit to the driving motor, the driving motor being slower acting than the relay. The driving motor is, however, a motor which operates continuously so long as it is supplied with current, and it is desirable, therefore, that it should have a continuous current supply for effecting the movement of the lamp carrier and not be dependent on the intermittent current. In the construction shown, when the lamp carrier is first moved by the driving motor energized by the intermittent current when the lamp has failed, and the contact 38 is forced out of the groove in the disc 21, the closing of circuit between the springs 39 and 41 through contact 40 immediately establishes a circuit 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. In this lamp positioning movement of the carrier, when the indexing contact 38 enters any one of the grooves 37 of the disc 21 the supply of continuous current to the driving motor is interrupted and the motor then operates on the intermittent current to give the slight additional movement to the carrier required for positioning the lamp; and in the event that the lamp moved into position is a dead lamp, the motor will operate on the intermittent current until the indexing contact is forced out of the groove 37 and contact 40 is closed again for the supply of continuous current to the motor.

In the apparatus shown, the driving motor is a vibratory motor consisting of 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 magnet to alternately attract and release the armature 61 so as to maintain the armature in operation so long as the magnet is connected in circuit to a source of current. Most desirably and as shown, instead of providing for this purpose a separate switch in addition to the switch or contact device controlled by the quick acting relay for opening the circuit to the motor magnet while the current is flowing in the lamp circuit, one switch is operated by both magnets for serving both purposes. As shown in Figs. 3 and 4, the relay 65 connected in the lamp circuit in series with the lamp is mounted adjacent to the motor magnet 60, and its armature 66 when retracted by its spring 67 closes the circuit to the motor magnet through a stationary contact 68, and, when the relay is energized by flow of current through the lamp circuit and its armature attracted, the circuit to the motor magnet is broken at the contact 68 and operation of the slower-acting motor magnet is prevented.

This switch formed by the relay armature 66 and the stationary contact 68 is operated by the motor armature 61 through a connecting plate 70 which extends between the two armatures. A finger 71 on the 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 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 strip 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 so long as the motor magnet is not energized. When, however, current flows to the motor magnet when the switch 68 is closed, the connecting strip 70 will be drawn downward to open switch 68 as the motor armature approaches the end of its movement toward its magnet pole, thus breaking the motor circuit. The motor 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.

Current for both the lamp and the driving motor is supplied from a battery 80, 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 80 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.

The operation of the apparatus can best be described by reference to Fig. 6. 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, intermittent 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 to the cold filament of the lamp that the switch 66—68 is opened before there is sufficient flow of current through the motor magnet coil 60 to cause movement of its armature 61. On failure of the filament of the 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 motor 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 motor magnet, the ratchet wheel 63 is operated to cause movement of the carrier belt, thereby moving the disc 21 of the upper belt support and causing the contact 38 to be forced back out of the groove 37 in the disc 21 to open the lamp circuit at this point and to make connection with the 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, and conductor *b*, to motor 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 contact 38 will move into a notch 37 of the disc 21 to close the lamp circuit at this point, at the same time opening the circuit at contact 40 to stop the supply of continuous current to the driving motor. 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, the driving motor will again be operated by the intermittent current until the lamp carrier has moved sufficiently to cause the lamp circuit to be opened again at contact 38 and the continuous current circuit to the driving motor again established through the contact 40.

Apparatus such as so far described and as illustrated by Figs. 2 to 6 is adapted only for the use of lamps having one filament. Such an apparatus, because of the new belt carrier, may be made to have a comparatively large lamp capacity. The particular apparatus shown, for example, has a capacity of twenty-two lamps. The invention includes, however, means for using multi-filament lamps such as the ordinary 32—32 C. P. automobile headlight bulbs now in common use, although features of the invention are adaptable for using other multi-filament lamps and such lamps having more than two filaments. The length of service obtainable from an apparatus of given size fitted with multi-filament lamps will obviously be double that of the same apparatus fitted with single filament lamps, provided each filament of double filament lamps gives the same length of service as the filament of the single filament lamps. Obviously, the use of multi-filament lamps in accordance with the invention is not limited to lamp changing apparatus having the new belt carrier.

Referring now to Figs. 7 to 10, the apparatus shown by these figures is the same as that of Figs. 1 to 6 except for changes which adapt it to the use of multi-filament lamps and that the driving motor 55*a* is of the modified form shown in Fig. 13. The particular apparatus shown in these figures is for lamps having two filaments 100 and 101, two contact terminals, one for each filament at the end of the base of the lamp, and a common terminal for both filaments formed by the side wall of the base. The axle 24*a* on which the rotary belt support 18 is mounted in this apparatus is made hollow to accommodate insulated conductors 102 and 103 which lead from two brushes 104 and 105 mounted on the axle in position to engage the two end contact terminals of the positioned lamp. The brushes are insulated from the axle by being mounted on a sleeve 106 of insulated material, and as the carrier supporting rods of the rotary support 18 also are insulated from the axle, it is not necessary that the axle be insulated from the support 18.

The conductors 102 and 103 lead to a switch by which either of the brushes 104 and 105 may be connected in the lamp circuit. The switch comprises two contacts 108 and 109 mounted on a plate 110 of insulating material fixed to the support 18 and a pivoted switch arm 111 also mounted on plate 110 and adapted to make circuit closing contact with the contacts 108 and 109. The switch arm is most desirably a swing arm carrying a contact part formed to snap into depressions in the contacts 108 and 109 so as to hold the arm against undesired movement away from either of the contacts with which it is engaged while permitting it to be moved at will from either contact to the other. When the switch arm engages contact 108, the lamp circuit will include the brush 104 and the filament 100 of each successively positioned lamp, and when the switch arm engages the other contact 109, the lamp circuit will include the brush 105 and the other filament 101 of any positioned lamp. For shifting the switch arm from contact 108 to contact 109, the arm has an operating arm or projection 112 which, when the switch arm is in engagement with contact 108 as shown in Fig. 7, extends into the path of upward movement of a pin 113 carried by one of the carrier plates 15 so as to be moved thereby to throw the switch arm away from the contact 108 and into engagement with the contact 109. The part of the pin 113 which engages the arm 112 is of insulating material, and in order that it may be attached to any one of the carrier plates the pin is made as shown in Fig. 7*a* and each carrier plate has a hole 114 into which the reduced threaded end of the pin may be placed and then secured by its cap or nut.

Assuming that the carrier has been supplied with a full complement of new lamps and that the switch arm 111 is in the position to engage contact 108 as shown by full lines in Fig. 7, the switch actuating pin 113 is attached to one of the carrier plates on the upwardly moving side of the carrier to be located just above the arm 112. The switch arm will then remain in engagement with the contact 108 while the carrier makes one full revolution to position all of the lamps successively with the brush 104 in the lamp carrier. This movement of the carrier will bring the actuating pin 113 to a position just beneath the arm 112. Then during the next movement of the carrier, whereby the first lamp of the series is again moved into operating position, the actuating pin will strike the arm 112 and move it upward, throwing the switch arm 111 away from the contact 108 and into engagement with the contact 109 as indicated by dotted lines in Fig. 7 so that when the first lamp of the series is moved into operating position for the second time the lamp circuit will be completed through the brush 105 and the second filament of the lamp. The switch will then remain in this position as the lamps are again successively positioned for lighting from the second set of filaments.

Referring to Fig. 10 which shows the wiring diagram for the apparatus of Figs. 7 to 9, current flows through the lamp filament 100 when the switch 111 is in its first position as shown in this figure and in Figs. 7, 8 and 9 as follows:

From the positive side of the battery 80 through conductor *a*, interrupter switch 82, conductor *b*, and by contact 38 to the side terminal of the lamp and then through filament 100 to brush 104 and by conductor 102 to switch contact 108 and then from the switch through conductor *c*, relay magnet coil 65, and conductor *d*, back to the negative side of the battery. That is the lamp circuit so long as the switch remains in its first position as shown, the circuit flowing at each current impulse through the filament 100 of the lamp which is in operating position, and upon failure of the filament 100 of the positioned lamp, the lamp carrier being shifted as described in connection with Fig. 6 to bring the next lamp into operative position. Then when the first filaments 100 of the series of lamps have been used, the actuating pin 113 on the next lamp changing movement of the carrier strikes the arm 112 and throws the switch away from the contact 108 and into engagement with contact 109, and thereafter circuit is closed at each current impulse to the second filament 101 of the successively positioned lamps, the circuit being as before, except that brush 105 and conductor 103 and contact 109 are included in the circuit in place of the brush 104 and conductor 102 and contact 108.

In Fig. 11 there is illustrated diagrammatically a two-filament lamp changing apparatus similar to the apparatus of Figs. 7 to 10 in the arrangement of the lamp carrier and the means for moving the carrier for positioning the lamps successively, but having a thermostatic means for effecting change over from one set of lamp filaments to the other. For the sake of simplicity, the apparatus is illustrated as a steady light apparatus, the current interrupter of the apparatus of Figs. 1 to 10 for producing a flashing light being omitted. Obviously, however, the apparatus of this Fig. 11 might be combined with a current interrupter for producing a flashing light, and the apparatus of Figs. 1 to 10 might equally be used without a current interrupter.

The change from one set of lamp filaments to the other in the apparatus of Fig. 11 is effected by means of a switch lever 150 carrying a contact which moves between two fixed contacts 152 and 153. When the switch is in its first position as shown in Fig. 11, the lamp circuit is through contact 152, conductor 102 and brush 104 to the lamp filament 100 of the positioned lamp. The switch lever 150 is held in this position by means of a bi-metallic strip 154 mounted with one end secured and with its free end extending when the strip is not heated to engage the end of the switch lever 150 and hold it, against the tension of a spring 155, in position with its contact engaging the fixed contact 152. When the strip 154 is heated sufficiently, its free end moves in the direction of the arrow far enough to release the switch lever which is then moved by spring 155 away from the contact 152 and into engagement with contact 153.

A resistance wire coil 156 is positioned to heat the bi-metallic strip 154 and connected across the battery in parallel with the motor magnet coil 60, so that the flow of current through this heating coil is controlled the same as the flow of current through the motor magnet coil by the armature of the relay magnet 65. So long as current can flow through the lamp circuit, therefore, the heating coil does not become heated, and it is so proportioned that the time required for heating the bi-metallic strip sufficiently to cause it to move its free end from under the end of the switch lever 150 is greater than the time normally required for moving a lamp having a burned out filament out of the operative position and bringing a new lamp into operative position. If, for example, it takes ten seconds for the lamp changing mechanism to remove a lamp and position another, the thermostatic device should be designed to release the switch lever after the heating coil has had the current flowing through it for a period greater than ten seconds.

In the normal operation of the apparatus of Fig. 11, therefore, when a filament of a positioned lamp burns out and current flows to the motor magnet coil 60 for moving the carrier belt to position a new lamp and at the same time flows through heating coil 156, the duration of current flow through the heating coil is too short to deflect the bi-metallic element sufficiently to release the switch lever 150. When, however, all of the first set of filaments of the lamps have burned out and the carrier is moved after failure of the last lamp in series, the lamp circuit will not be re-established by the next lamp that is moved into position and the movement of the carrier will be continued, and because of the longer flow of current through the heating coil, the bi-metallic strip will be heated sufficiently to cause it to release the switch lever 150 and permit it under the pull of the spring 155 to move into engagement with the contact 153. Connection is then established from the conductor *c* to the brush 105, so that when the next lamp is positioned circuit will be completed through its second filament 101. The operation of the apparatus will then continue, the second filament of the lamps being used as the lamps are again successively positioned.

Fig. 12 shows diagrammatically an apparatus similar to that of Fig. 11, except that in place of the thermostatic means of Fig. 11 an electromagnetic means is provided for changing from one set of lamp filaments to the other. The change-over in this apparatus is effected by means of a switch lever 200 movable between fixed contacts 202 and 203. When the switch lever is in its first position in which it engages the contact 202, as shown in Fig. 12, the lamp circuit is closed through conductor 102 and brush 104 to the filament 100 of the positioned lamp, and when the switch is in engagement with contact 203, the lamp circuit is closed through the conductor 103 and brush 105 to the other filament 101 of the positioned lamp. A spring 204 tends to hold the switch in engagement with the contact 202, and when the switch has been moved into engagement with contact 203 it is held in such engagement by a latch 205.

The switch lever is moved from contact 202 to contact 203 by means of a magnet 206 of which the coil is connected across the battery terminals in parallel with the motor magnet coil 60. This magnet 206 is a slow acting magnet which will not be energized to shift the switch lever during the normal period required for operation of the lamp changing mechanism to remove a failed lamp and position a new one. In the construction shown, in order to get the required delay in operation of this magnet, a resistance 207 is connected in series with the magnet coil and a condenser 208 is shunted across the coil. When the normal lamp changing operation takes about ten seconds, the values of resistance and capacity are desirably so proportioned that there will be a delay of substantially more than ten seconds before sufficient voltage will build up across the windings of the coil 206 to cause the magnet to shift the switch lever.

When the switch lever is in its first position, as shown in Fig. 12, for causing the lighting current to flow through the filament 100 of the positioned lamps, in normal lamp changing operations the current limiting resistance 207 will prevent the condenser 208 from being charged sufficiently to permit sufficient current to flow through the coil 206 to cause shifting of the switch lever, but after the last of the first set of lamp filaments have failed the lamp changing motor will continue in operation and the condenser will become fully charged and the voltage across the windings of the coil 206 will build up to a value sufficient to shift the switch lever against the pull of spring 204 into engagement with the contact 203, in which position it will be held by the latch 205. Then when the next lamp is moved into operative position, the lamp circuit will be completed through its unused filament 101 and the operation of the lamp changing motor will be stopped, and the apparatus will continue as before, the filaments 101 of the successively positioned lamps being used.

The modified form of reciprocatory driving motor shown in Fig. 13 differs from that of Figs. 3 and 4 principally in the means whereby the armature of the quick-acting relay, which serves to cut off flow of current to the motor magnet when current flows through the lamp circuit, is operated by the motor magnet armature to make and break circuit for maintaining the motor in operation. Instead of having a lost motion connection between the armatures of the motor magnet and of the quick-acting relay by means of a connecting member movable against restraining friction as in the motor of Figs. 3 and 4 and as indicated in the wiring diagrams, the motor 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 motor 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 motor 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 motor 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 motor 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. 3 and 4, 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 motor magnet at contact 68*a* before there has been any flow of current through the winding of the motor magnet 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 relay magnet will not open the motor magnet circuit 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 constructions, arrangements and combinations of parts shown, but that it includes changes and modifications thereof within the claims, and that features of the invention as claimed may be used independently of and apart from other features with which they are combined in the illustrated apparatus.

With regard to the driving motor, while the vibratory motors described embody features of the invention and are especially adapted for use in lamp changing apparatus embodying other features of the invention, it is obvious that the apparatus does not require the use of this particular kind of vibratory motor or of a vibratory motor of any kind, but that motors of other types might be used.

What is claimed is:

1. A signal device, comprising a carrier belt for a plurality of lamps movable for positioning the lamps successively having lamp sockets for mounting the lamps thereon spaced longitudinally thereof and extending outwardly at right angles thereto, means for connecting the positioned lamp in an electric circuit, and means operative on failure of the positioned lamp to move the carrier belt to position a succeeding lamp.

2. In a signal device, the combination with a Fresnel lens, of a rotary support, a carrier belt

mounted on and turned about said support, a plurality of lamps mounted on the carrier belt spaced longitudinally thereof and extending at right angles thereto, said support being so positioned with relation to the lens that by rotation of the support and movement of the carrier belt the lamps may successively be positioned to extend radially of the axis of the support with their filaments at the focal point of the lens, means for connecting the positioned lamp in the lamp circuit, and means operative on failure of the positioned lamp to move the carrier belt to position a succeeding lamp.

3. A signal device, comprising a carrier belt for a plurality of lamps movable for positioning the lamps successively formed by a plurality of plates pivotally connected edge to edge and each having a lamp socket, a rotary support about which the carrier belt turns, means for connecting the positioned lamp in the lamp circuit, and means operative on failure of the positioned lamp to move the carrier belt to position a succeeding lamp.

4. A signal device, comprising a carrier belt having a plurality of lamp sockets for mounting a plurality of lamps thereon spaced longitudinally thereof, the belt being movable for positioning the lamps successively and being formed by a plurality of plates pivotally connected edge to edge, a rotary support about which the carrier belt turns, means for connecting the positioned lamp in the lamp circuit, and means operative on failure of the positioned lamp to move the carrier belt to position a succeeding lamp.

5. A signal device, comprising a carrier belt for a plurality of lamps movable for positioning the lamps successively, said belt being formed by a plurality of plates pivotally connected edge to edge and each having a lamp socket, a rotary belt support about which the carrier belt turns so positioned that the positioned lamp extends radially of the support axis, lamp circuit contact terminals one of which is in position to be engaged by the end terminal of the positioned lamp and the other of which is in position to be engaged by a contact carried by said belt support when a lamp is in position, the belt support having one such contact for each peripheral portion thereof on which one of the plates of the carrier belt can rest, and said contacts being conductively connected with the side terminals of lamps carried by the belt plates resting on the support, and means operative on failure of the positioned lamp to move the carrier belt to position a succeeding lamp.

6. A signal device, comprising a carrier belt having a plurality of lamp sockets for mounting a plurality of lamps thereon spaced longitudinally thereof, the belt being movable for positioning the lamps successively and being formed by a plurality of plates pivotally connected edge to edge, a rotary belt support about which the carrier belt turns so positioned that the positioned lamp extends radially of the support, lamp circuit contact terminals one of which is in position to be engaged by the end terminal of the positioned lamp and the other of which is in position to be engaged by a contact carried by said belt support when a lamp is in position, the belt support having one such contact for each peripheral portion thereof on which a lamp-carrying plate of the carrier belt can rest, and said contacts being conductively connected with the side terminals of lamps carried by the belt plates resting on the support, and means operative on failure of the positioned lamp to move the carrier belt to position a succeeding lamp.

7. A signal device, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a plurality of multi-filament lamps mounted on the carrier, means for connecting a single filament of the positioned lamp in a lamp circuit including a source of energy, means operative on failure of the circuit-connected filament of the positioned lamp to move the carrier to position a succeeding lamp, a selective switch for determining which filament of a positioned lamp is connected in the lamp circuit, and means for automatically operating said switch after a number of the lamps have been successively positioned with one of their filaments connected in the lamp circuit to include an alternative filament of the successively positioned lamps in the lamp circuit.

8. A signal device, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a plurality of multi-filament lamps mounted on the carrier, means for connecting a single filament of the positioned lamp in a lamp circuit including a source of energy, means operative on failure of the circuit-connected filament of the positioned lamp to move the carrier to position a succeeding lamp, a selective switch for transposing said circuit to include an alternative filament of the positioned lamps, and means on the carrier for controlling the operation of said switch.

9. A signal device, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a plurality of multi-filament lamps mounted on the carrier, means for connecting a single filament of the positioned lamp in a lamp circuit including a source of energy, lamp changing means operative on failure of the circuit-connected filament of the positioned lamp to move the carrier until a live lamp has been positioned, a selective switch for transposing said circuit to include an alternative filament of the positioned lamps, and delayed action means for causing operation of said switch only after the lamp changing means has operated for a time greater than that required for moving one new lamp into position.

10. A signal device, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a plurality of multi-filament lamps mounted on the carrier, means for connecting a single filament on the positioned lamp in a lamp circuit including a source of energy, lamp changing means operative on failure of the circuit-connected filament of the positioned lamp to move the carrier until a live lamp has been positioned, a selective switch for transposing said circuit to include an alternative filament of the positioned lamps, and thermoelectric means for operating said switch only after the lamp changing means has operated for a time greater than that required for moving one new lamp into position.

11. A signal device, comprising a carrier for a plurality of lamps movable for positioning the lamps successively, a plurality of multi-filament lamps mounted on the carrier, means for connecting a single filament of the positioned lamp in a lamp circuit including a source of energy, lamp changing means operative on failure of the circuit-connected filament of the positioned lamp to move the carrier until a live lamp has been positioned, a selective switch for transpos-

ing said circuit to include an alternative filament of the positioned lamps, and electromagnetic means for operating said switch only after the lamp changing means has operated for a time greater than that required for moving one new lamp into position.

12. In a signal device, in combination, 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 lamp changing means operative on failure of the positioned lamp to move the carrier to position another lamp, said lamp changing means including an electric driving motor adapted to operate so long as current is supplied thereto, circuit connections for supplying current to said motor, and means actuated by flow of current in the lamp circuit to prevent supply of current to said motor.

13. In a signal device, in combination, a lamp carrier for a plurality of lamps movable for positioning the lamps successively, a lamp circuit having terminals for connecting the positioned lamps in the circuit, and lamp changing means operative on failure of the positioned lamp to move the carrier to position another lamp, said lamp changing means including a vibratory-armature electromagnetic driving motor adapted to operate so long as current is supplied thereto, circuit connections for supplying current to said motor, and means actuated by flow of current in the lamp circuit to prevent supply of current to said motor.

14. In a flashing light signal device, in combination, 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, a source of intermittent current for supplying the lamp circuit, and means operative on failure of the positioned lamp to move the carrier to position a succeeding lamp, said means including an electromagnetic driving motor adapted to operate so long as current is supplied thereto in a shunt circuit across said source of intermittent current, means actuated by flow of current in the lamp circuit to prevent supply of current to said motor, and means operated by said motor to cause current to be supplied to said motor continuously until the lamp circuit is again completed through a positioned lamp.

15. In a flashing light signal device, in combination, 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, a source of current for supplying the lamp circuit, a current interrupter for intermittently interrupting the current in the lamp circuit, and means operative on failure of the positioned lamp to move the carrier to position a succeeding lamp, said means including an electromagnetic driving motor connected in parallel with the lamp across said source of current in series with said interrupter, means actuated by flow of current in the lamp circuit to prevent supply of current to said motor, and a switch operated by the lamp carrier to shunt said interrupter and to open the shunt when the circuit is again completed through a positioned lamp.

16. A flashing light signal device, comprising a lamp carrier for a plurality of lamps movable for positioning the lamps successively, a plurality of contacts set in recesses in a plate of insulating material movable with the carrier, a lamp circuit including a spring contact in position to engage one of said contacts movable with the carrier when a lamp is in position to close the circuit to the positioned lamp, a source of intermittent current for supplying the lamp circuit, and means operative on failure of the positioned lamp to move the carrier to position a succeeding lamp, said means including an electromagnetic driving motor in a shunt circuit across said source of intermittent current, means actuated by flow of current in the lamp circuit to prevent supply of current to said motor, and a contact positioned to be engaged by said spring contact when by movement of the carrier the spring contact is moved out of one of said contact recesses, whereby a circuit is closed to supply current continuously to said motor until the lamp circuit is again completed through a positioned lamp.

17. A signal device, comprising a lamp carrier for a plurality of lamps movable for positioning the lamps successively, a lamp circuit including means 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 electromagnetic driving motor having a vibratory armature and a current interrupting switch operated by the armature, said motor being adapted to operate so long as current is supplied thereto, circuit connections for supplying current to said motor, and a quick-acting relay in the lamp circuit in series with the lamp for operating said switch to cut off the supply of current to the motor when current flows in the lamp circuit.

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