

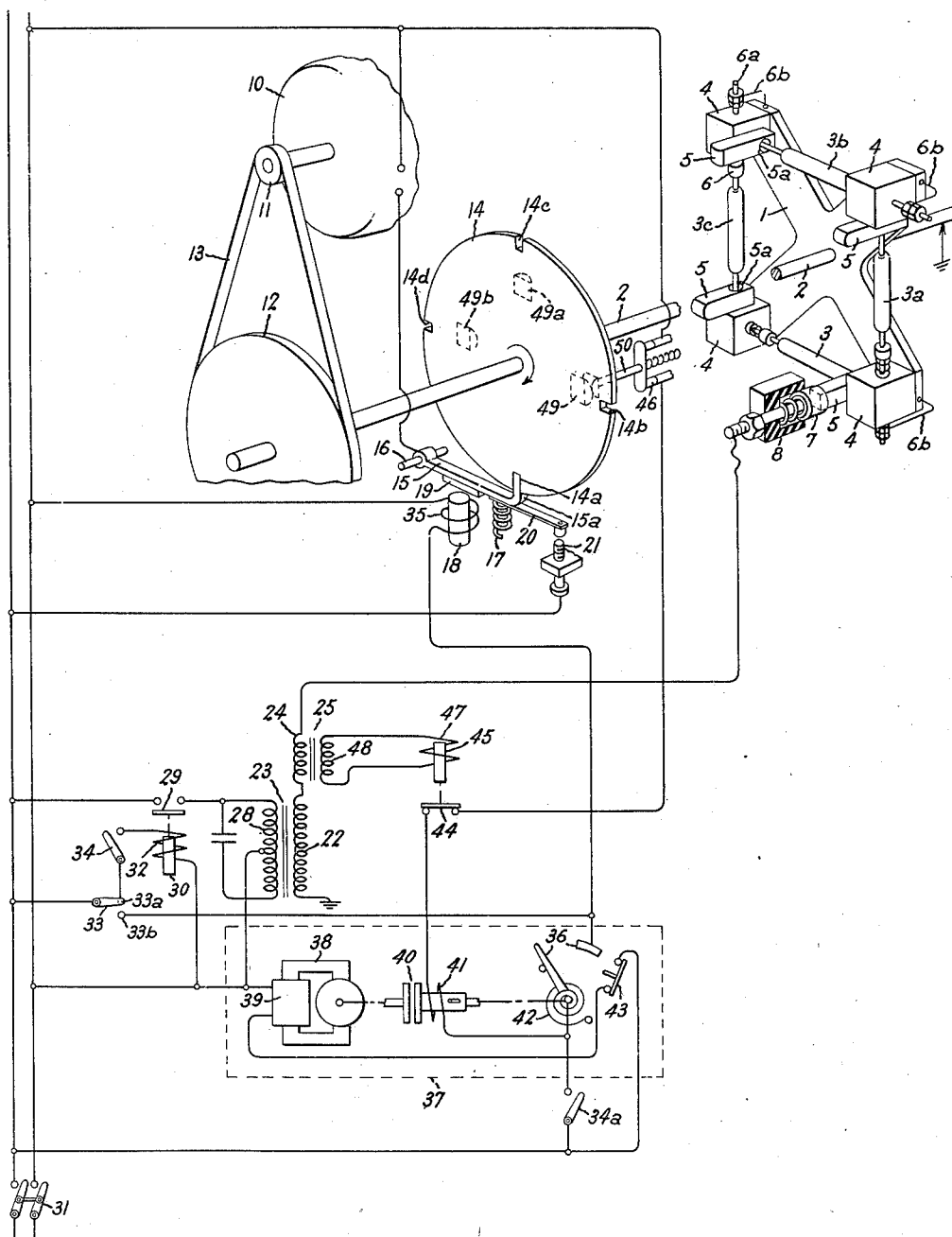
March 29, 1949.

J. P. FOULDS

2,465,795

LAMP CHANGER

Filed Oct. 1, 1946



Inventor:
John P. Foulds,

by *Charles H. Mott*
His Attorney.

UNITED STATES PATENT OFFICE

2,465,795

LAMP CHANGER

John P. Foulds, Revere, Mass., assignor to General Electric Company, a corporation of New York

Application October 1, 1946, Serial No. 700,565

9 Claims. (Cl. 315—88)

1

My invention relates to lamp changing apparatus of the type wherein a plurality of lamps are moved successively into a desired operating position to replace a lamp which has failed. The invention is especially applicable to apparatus for use in conjunction with lamps of the type in which the starting time is subject to variation, such as gaseous discharge lamps and the like.

In lamp changing apparatus heretofore known operation of a lamp indexing mechanism is ordinarily initiated in response to failure of current in the lamp circuit. Cessation of indexing operation occurs only upon a resumption of lamp current. Thus if the lamp current is not re-established immediately upon positioning of the next successive lamp in the operating position, the indexing mechanism continues in operation and carries the replacement lamp beyond the operating position. Such apparatus is not suitable for use in conjunction with lamps wherein the starting time is subject to variation. For example, where a slight delay in lamp starting operation is ordinarily experienced, such an indexing mechanism would be forced to remain in continuous operation without ever affording an opportunity for resumption of lamp energization.

Accordingly it is a general object of my invention to provide a new and novel lamp changing apparatus suitable for use in conjunction with lamps in which the lamp starting time is subject to variation, such as gaseous discharge lamps or the like.

It is a more specific object of my invention to provide new and novel lamp changing apparatus in which the indexing mechanism is disabled for a predetermined interval following arrival of each lamp in the operating position to afford an opportunity for delayed lamp starting.

It is a still further object of my invention to provide lamp changing apparatus which includes means for accurately positioning the operative lamp with respect to a fixed point.

Briefly, in carrying out my invention I provide a lamp indexing mechanism including detent means arranged accurately to define a plurality of positions of the mechanism. Time element means are provided for initiating operation of the indexing mechanism only after a predetermined interval following failure of lamp current. The time element means, however, is de-energized and reset immediately upon initiation of the indexing movement. The lamp changing mechanism is self-indexing in that after initia-

2

tion of indexing movement the mechanism is maintained in operation independently of the time element means and is self-de-energizing upon arrival at the next detent position. Thus, upon arrival of the replacement lamp a new delay interval is available before resumption of indexing operation in the event the new lamp does not start within the interval. Moreover, the detent type indexing mechanism ensures that the lamp in operating position is always accurately positioned in space. Such accurate positioning is particularly desirable, and indeed necessary, in many types of light projectors including a reflector. In such projectors the reflector geometry is usually such that for proper operation the lamp must be positioned precisely with respect to the reflector.

A more complete understanding of my invention and a further appreciation of the various objects and advantages thereof may be had by referring now to the following detailed specification, taken in conjunction with the accompanying drawing, the single figure of which is a schematic circuit diagram of a lamp changing apparatus embodying my invention, the indexing mechanism being shown in exploded-perspective view.

Referring now to the drawing, the lamp changing apparatus therein shown comprises a rotatable lamp carrier 1 mounted upon an indexing shaft 2 and movable to position a plurality of lamps 3, 3a, 3b, and 3c successively in a predetermined desired operating position. In the illustrative embodiment of the invention the lamp carrier 1 is formed as a spider of electric conducting material having mounted at the extremity of each radially extending arm a mounting block 4 of suitable insulating material, such as a molded plastic insulating material or the like. Each mounting block 4 carries an axially protruding contact arm 5 of electric conducting material, and provides means for mounting between it and each adjacent block 4 one of the lamps 3, 3a, 3b, and 3c. The lamps shown are of the gaseous discharge type and each comprises an elongated vitreous envelope having conducting terminals at opposite ends thereof. For mounting the lamps each contact block 5 is provided with a recess 5a, and each mounting block 4 is provided with a contact cup 6 carried at the end of a spring-pressed pin 6a. As illustrated, one terminal of each lamp is inserted in a recess 5a and the opposite terminal is fitted into the spring-pressed conducting cup 6 on the adjacent mounting block 4. Each pin 6a is electrically

connected to the conductive carrier 1 by a lead wire 6b.

In the drawing the lamp 3 is shown in the operating position. This position is defined by a fixed contact terminal 7 positioned for engagement with the contact block 5 in which the operative lamp is seated. The fixed contact terminal 7 is slidably mounted in an insulating cup 8 and spring biased into engagement with the end of the cooperating contact block 5. For facilitating sliding engagement of the contact block 5 and the fixed contact 7, the ends of all these contacts are made generally spherical.

The indexing shaft 2 is driven by an electric motor 10 connected to the shaft in any desired manner. In the illustrative embodiment of the invention the motor is belted to the shaft 2 by a pair of pulleys 11, 12 and a belt 13.

The indexing shaft also carries a detent wheel 14 notched around its periphery at 14a, 14b, 14c and 14d. These four notches are in positions corresponding to the four lamp operating positions of the lamp carrier 1. A latching detent 15a on a pivoted detent lever 15 cooperates with the notches to define the various lamp operating or detent positions of the lamp carrier 1. The lever 15 is mounted upon a fixed pivot 16 and biased, as by a compression spring 17, into latching engagement with the detent wheel 14.

An electro-magnetic latch relay 18 is provided for releasing the detent 15a from latching engagement with the detent wheel 14. For this purpose the lever 15 carries a relay armature 19 of magnetizable material. The lever 15 carries also an electric spring contact 20 operable in conjunction with a stationary contact 21 to control an electric circuit which will be more fully described hereinafter. For the present it should be noted that when the latching detent 15a is in engagement with one of the notches in the index wheel 14 the contacts 20 and 21 are separated. Energization of the relay 18 both withdraws the detent 15a from the notch in the wheel 14 and also closes the contacts 20 and 21. Subsequent de-energization of the relay 18 prior to completion of a single indexing movement allows the detent 15a to ride upon the periphery of the index wheel 14. Such partial return movement of the lever 15 and the contact 20 is insufficient to separate the contacts 20 and 21.

The lamp circuit comprises a secondary winding 22 of a lamp transformer 23 to which the lamp in operating position is connected in series circuit relation with a primary winding 24 of a current transformer 25. One terminal of the transformer winding 22 is grounded, so that the lamp circuit may be followed from the ungrounded terminal of the winding 22 through the current transformer winding 24, the stationary contact terminal 7, the contact block 5, the lamp 3, the connected pin 6a and lead 6b, the spider 1, and the index shaft 2 to ground. The lamp transformer 22 is provided also with a primary winding 28 connected to a suitable source of alternating current supply through a switch contact 29 of a line contactor 30 and a disconnect switch 31. The line contactor 30 is provided with an energizing winding 32 arranged to be connected to the supply source through a selector switch 33 and a manually operable control switch 34. The selector switch 33 is a two-position switch, and when in engagement with the stationary contact 33a as shown in the drawing, it is set for automatic lamp changing operation. The switch 33 may also be moved into engagement with a sta-

tionary contact 33b for manual reset operation, as will be more fully explained hereinafter.

The latching relay 18 is provided with an energizing winding 35 connected across the supply source through a manually operable control switch 34a and a pair of normally open control contacts 36 of a time delay relay 37. The time delay relay 37 comprises a synchronous motor 38 having an energizing winding 39, and a normally disengaged magnetic clutch 40 having an energizing winding 41. The time delay contacts 36 are biased to a normally disengaged position by a spiral spring 42, and are arranged to be connected to the driving motor 38 by the clutch 40 for timed closing operation. The motor energizing winding 39 is connected to the alternating current supply source through the disconnect switch 31 and a normally closed limit switch 43. The switch 43 is arranged to be opened by the timing motor 38 itself in the event the clutch 40 is not disengaged before the movable timing contact reaches the limit of its travel. The timing relay clutch coil 41 is arranged to be connected to the supply source through the control switch 34a, a normally closed contact 44 of a current relay 45, and the contacts of a normally open cam switch 46 associated with the index wheel 14. The current relay 45 is provided with an energizing winding 47 connected directly across a secondary winding 48 of the current transformer 25 in the lamp circuit, so that whenever lamp current flows the relay 45 is energized and holds its contact 44 open. Preferably, though not necessarily, the motor 38 is a synchronous motor of the self-starting type having its output shaft connected to the motor armature through a gear reduction unit having a high gear ratio.

By referring again to the indexing mechanism, it will be observed that the index mechanism driving motor 10 is arranged to be connected to the supply source through the normally open contacts 20 and 21 of the latch relay 18. It should also be particularly noted that at three detent positions of the index wheel 14 there are provided on the wheel 14 cams 49, 49a and 49b arranged for engagement with a cam follower 50 of the normally open cam switch 46. In these three latched positions of the index wheel 14 the cam switch 46 is thus held in its closed position. In the fourth latched position of the index wheel no cam is provided, so that in this position the cam switch 46 remains open for a purpose which will be more fully described hereinafter. The location of the cams 49, 49a and 49b on the wheel 14 depends of course upon the location of the cam switch 46 around the periphery of the wheel. In the form of the invention shown in the drawing the cams 49, 49a and 49b are adjacent the notches 14b, 14c and 14d, respectively. The cam switch 46 is so positioned that, with clockwise rotation assumed, the first cam 49 actuates the switch 46 when the notch 14a is engaged by the detent 15a.

With the foregoing understanding of the various elements of my new and novel lamp changing apparatus the operation of the apparatus as a whole will be readily understood from the following brief description.

Let it be assumed that the indexing motor 10 rotates the index shaft 2 in a clockwise direction as viewed in the drawing. Let it also be assumed that the disconnect switch 31 and control switches 34 and 34a are closed. The line contactor 30 will now be energized and picked up, so that power is supplied to the primary winding 28

of the lamp transformer 23. Assuming then that the lamp 3, which is shown in the operating position, is not defective, current is flowing through the lamp circuit. With current in the lamp circuit the current relay 45 is energized and the contact 44 opened. Because of the disengagement of the contact 44 the time delay relay clutch coil 41 is de-energized and the clutch 40 disengaged. The timing motor 39 however is running by reason of the connection of its energizing winding 39 to the power source through the limit switch 43. With the latch detent 15a engaging notch 14a of the index wheel 14, as shown, the latch relay contacts 20 and 21 are open and the indexing motor 10 therefore de-energized.

Let it now be supposed that the lamp 3 in the operating position burns out or otherwise becomes defective, so that current through the lamp circuit is interrupted. When the lamp current is interrupted the current relay 45 is de-energized and dropped out to close its contact 44. As soon as the contact 44 is closed an energizing circuit is established for the clutch coil 41 of the timing relay 37. This energizing circuit includes the contacts of the cam switch 46, which contacts are now closed by reason of engagement of the cam 49 with the cam follower 50. Accordingly therefore, immediately upon cessation of lamp current the timing relay motor 38 is connected to drive the timing contacts 36 toward closed position. After the time interval required to effect such closure of the contacts 36, for example 20 seconds, these contacts complete an energizing circuit for the actuating winding 35 of the latch relay 18.

Under energization of the latch relay 18 the detent 15a is disengaged from the notch 14a of the index wheel 14 and the contacts 20 and 21 are closed to energize the indexing motor 10. The motor 10 then drives the index shaft 2 and the connected lamp carrier 1 and index wheel 14 in a clockwise direction. After the index wheel 14 has moved a short distance the notch 14a is out of position for engagement with the latching detent 15a and displacement of the cam 49 allows the cam switch 46 to open its contacts. When the contacts of the switch 46 are opened the energizing circuit for the timing relay clutch coil 41 is disabled and the clutch coil 41 is de-energized. Ordinarily such de-energization of the clutch coil occurs before the timing contacts 36 reach the limit of their travel. Immediately upon de-energization of the clutch coil the clutch 40 is disengaged and the spring 42 resets the timing contacts 36 to their normally open position shown in the drawing. Separation of the contacts 36 interrupts the energizing circuit for the actuating winding 35 of the latch relay 18. The latch relay 18 therefore drops out and allows the latching detent 15a to ride upon the periphery of the index wheel 14. Such partial return movement of the lever 15, however, is insufficient to separate the latch relay contacts 20 and 21, so that the energizing circuit for the indexing motor 10 is held closed.

The indexing motor 10 thus continues in operation until arrival of the index wheel 14 and the lamp carrier 1 at the next detent position. In this position of the wheel 14 the detent 15a drops into the notch 14b of the wheel. As soon as the detent 15a drops into this next indexing notch the latch relay contacts 20 and 21 are opened by movement of the detent lever 15, so that the circuit of the indexing motor 10 is interrupted. In this position of the indexing mechanism the cam

49a on the index wheel 14 engages the cam follower 50 to hold the contacts of the cam switch 46 closed. In this detent position also, the lamp 3a is in the lamp operating position.

If now lamp current is re-established immediately upon completion of the lamp circuit at the lamp terminal 7, the current relay 45 is again energized and disables the energizing circuit for the timing relay clutch coil 41. If however, lamp current is not immediately established, the timing relay clutch coil 41 is energized and the clutch re-engaged as soon as the index wheel 14 arrives at the new position and closes the cam switch 46. The timing contacts 36 are thus again set in operation to time an interval, for example 20 seconds, before energization of the latch relay 18. If the replacement lamp is a good lamp it will start within the time interval thus allowed, so that prior to engagement of the contact 36 the current relay 45 will be energized and the clutch winding 41 disabled. If such disabling of the clutch winding 41 takes place before closure of the timing contacts 36, the contacts 36 are simply reset by the biasing spring 42 and normal operation re-established. On the other hand if the replacement lamp 3a is a defective lamp, current is not re-established in the lamp circuit, the timing contacts 36 complete their timing movement, and another indexing operation is initiated.

It will now be evident that when the lamp 3c comes into the operating position the cam switch 46 associated with the index wheel 14 is left in the open position by reason of the omission of a co-operating cam on the index wheel in this position. In this position of the indexing mechanism, then, no automatic lamp changing operation is possible because the energizing circuit of the timing relay clutch coil 41 is disabled at the cam switch 46. The clutch coil remains de-energized even though the contact 44 of the current relay 45 is closed upon current failure. The reason for this arrangement is that the lamp 3c is the last in the series of lamps, so that presumably when the lamp 3c is in the operating position all the other lamps on the carrier 1 are defective. For proper operation, therefore, the lamp 3 should be regarded as the first lamp in the series and should be placed in the operating position initially whenever a new set of lamps is placed on the carrier.

It will of course be readily understood that, if it is desired that automatic indexing operation be continuous throughout the four lamp positions, a fourth switch cam may be added to the index wheel 14 without departing from the spirit and scope of my invention.

When, however, as shown in the drawing, a switch cam is omitted in one position of the index wheel 14, so that the cam switch 46 prevents automatic indexing from the last to the first carrier position, manual means are necessary to accomplish indexing between these positions. For this purpose the selector switch 33 is provided with the reset contact 33b. When the selector switch 33 is placed on the reset contact 33b the switch 33 simply shunts the timing contacts 36, thereby to energize the latch relay 18 and immediately to initiate a lamp changing operation. It should be noted that the reset selector switch 33 should be removed from the contact 33b before completion of a single indexing operation, for if the manual reset circuit is left closed indexing will continue so long as the circuit is closed.

Occasionally it may be desirable to effect manual lamp changing operation even though the

lamp in operating position is not defective. In such manual operation the lamp to be replaced is carrying current when indexing is initiated. Therefore, to prevent arcing at the lamp terminal 7, means are provided for interrupting the lamp circuit in manual indexing operation. Interruption of the lamp circuit is effected by the selector switch 33 when it moves off its contact 33a. As soon as the contact 33a is disengaged the actuating winding 32 of the line contactor 30 is de-energized and the line contact 29 opened. Power is thus removed from the primary winding 28 of the lamp transformer 23. It will, of course, be understood that no such interruption of the lamp circuit on the primary side is necessary during automatic indexing operation by reason of the fact that the lamp circuit is already necessarily interrupted on the secondary side before automatic indexing can be initiated.

While I have described only a preferred embodiment of my invention by way of illustration many modifications will occur to those skilled in the art, and I, therefore, wish to have it understood that I intend in the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a lamp changer, a lamp circuit having terminals defining a desired lamp operating position, a movable carrier for a plurality of lamps, indexing means arranged to move said carrier to position said lamps for operation successively, electromagnetic time delay means including a movable member actuatable in response to failure of current in said lamp circuit to time an interval following such current failure, and control means engaged by said movable member at the termination of said time interval and connected to initiate operation of said indexing means.

2. In a lamp changer, a lamp circuit having terminals defining a desired lamp operating position, a movable carrier for a plurality of lamps, indexing means arranged to move said carrier to position said lamps for operation successively, electromagnetic means responsive to failure of current in said lamp circuit, time element means including a movable member connected to be set in operation by said electromagnetic means to time an interval following such current failure, and control means engaged by said movable member at the termination of said interval and connected to initiate operation of said indexing means.

3. In a lamp changer, a lamp circuit having terminals defining a desired lamp operating position, a movable carrier for a plurality of lamps, indexing means arranged to move said carrier to position said lamps for operation successively, means responsive to failure of current through said lamp circuit, movable time element means actuated by said current responsive means to initiate operation of said indexing means, and means actuated by initial indexing movement of said indexing means and connected to reset said time element means and to maintain said indexing means in operation for one complete indexing movement.

4. In a lamp changer, a lamp circuit having terminals defining a desired lamp operating position, a movable carrier for a plurality of lamps, indexing means arranged to move said carrier to position said lamps for operation successively, said indexing means including driving means and detent means defining a plurality of lamp carrier

positions, means responsive to failure of current through said lamp circuit, movable time element means actuated by said current responsive means to release said detent means and to energize said driving means, and means actuated by initial movement of said indexing means and connected to reset said time element means and to hold said driving means energized until said carrier reaches its next successive detent position.

5. In a lamp changer, a lamp circuit having terminals defining a desired lamp operating position, a movable carrier for a plurality of lamps, indexing means arranged to move said carrier to position said lamps for operation successively, said indexing means including driving means and detent means defining a plurality of lamp carrier positions, means responsive to failure of current through said lamp circuit, movable time element means actuated by said current responsive means to release said detent means and to initiate operation of said driving means, means operable upon release of said detent means for retaining said driving means in operation independently of said time element means, and means actuated by initial movement of said indexing means and connected to reset said time element means.

6. In a lamp changer, a lamp circuit having terminals defining a desired lamp operating position, a movable carrier for a plurality of lamps, indexing means arranged to move said carrier to position said lamps for operation successively, said indexing means including electric driving means and detent means defining a plurality of lamp carrier positions, relay means responsive to failure of current through said lamp circuit, time element switching means actuated by said relay means to release said detent means and to complete an energizing circuit for said driving means, circuit holding means for said driving means controlled by said detent means, and switching means actuated by initial movement of said indexing means and connected to reset said time element means.

7. In a lamp changer, a lamp circuit having terminals defining a desired lamp operating position, a movable carrier for a plurality of lamps, indexing means arranged to move said carrier to position said lamps for operation successively, means responsive to failure of current through said lamp circuit and connected to initiate operation of said indexing means after a predetermined time interval following such current failure, manually operable means connected to initiate operation of said indexing means independently of said current responsive means, and switching means controlled by said manually operable means and connected to disable said lamp circuit during manual indexing operation.

8. In a lamp changer, a lamp circuit having terminals defining a desired lamp operating position, a movable lamp carrier for a plurality of lamps, indexing means arranged to move said carrier to position said lamps for operation successively, means responsive to an electrical condition in said lamp circuit and connected to initiate indexing operation in all except one lamp operating position of said carrier, and manually operable means connected to initiate said indexing operation when said carrier is in said one lamp operating position.

9. In a lamp changer, a lamp circuit having terminals defining a desired lamp operating position, a movable lamp carrier for a plurality of lamps, indexing means arranged to move said

carrier to position said lamps for operation successively, means responsive to an electrical condition in said lamp circuit and connected to initiate indexing operation in all except one lamp operating position of said carrier, and manually operable means connected to initiate said indexing operation when said carrier is in any of its lamp operating positions.

JOHN P. FOULDS. 10

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,054,013	Wallace -----	Sept. 8, 1936
2,097,250	Keith -----	Oct. 26, 1937
2,195,374	Wallace -----	Mar. 26, 1940