Sept. 17, 1963 P. ROSENBERG 3,104,351

ROTARY FILE WITH PHOTOELECTRIC SWITCH SELECTOR

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Fig. 1.

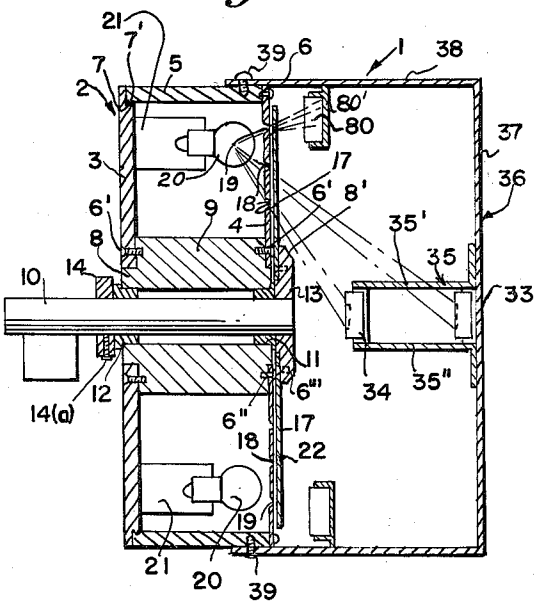


Fig. 3.

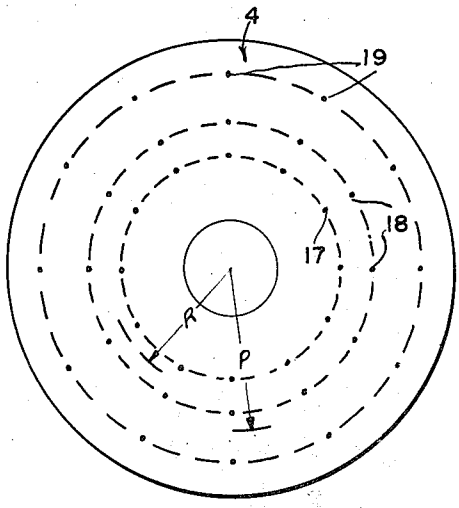


Fig. 2.

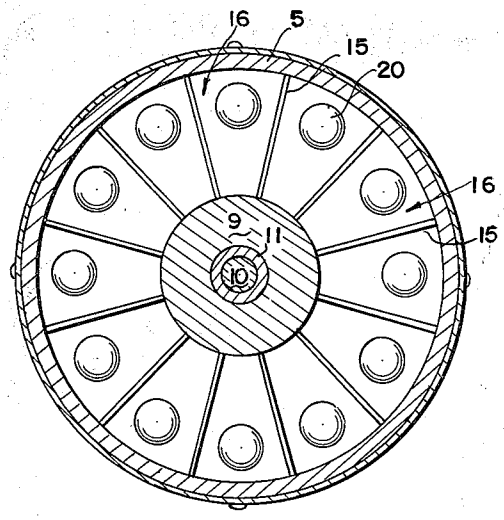
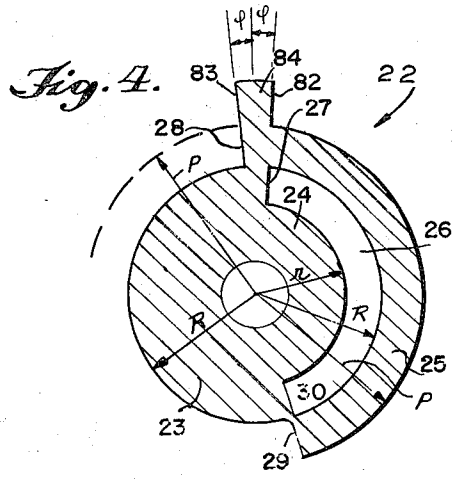


Fig. 4.



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Fig. 8.

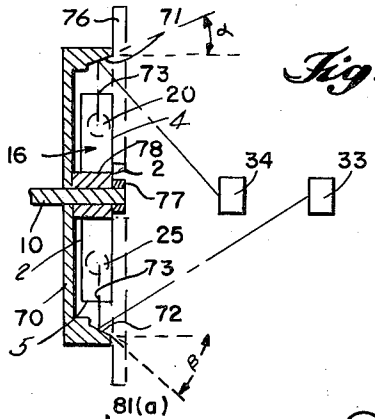
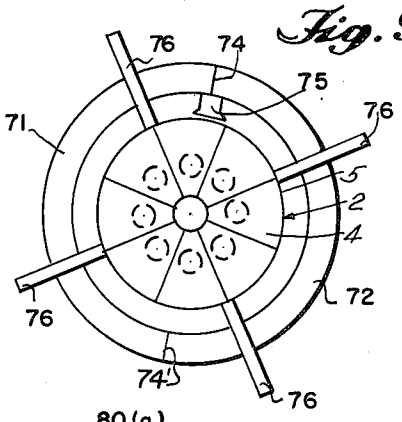


Fig. 9.



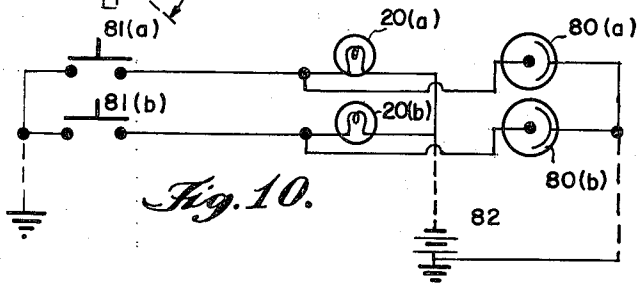
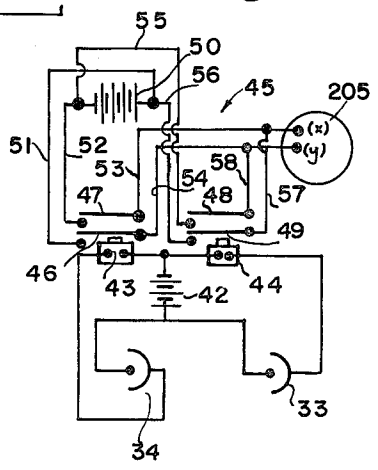


Fig. 10.

Fig. 14.



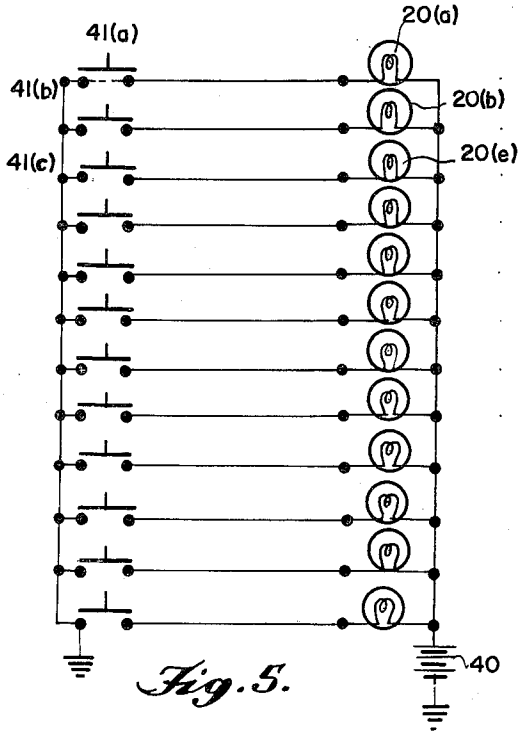


Fig. 5.

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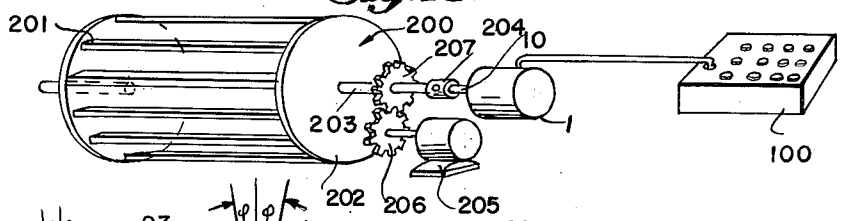
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ROTARY FILE WITH PHOTOELECTRIC SWITCH SELECTOR

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Fig. 15.



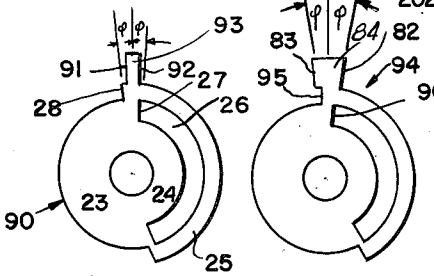


Fig. 11

Fig. 12.

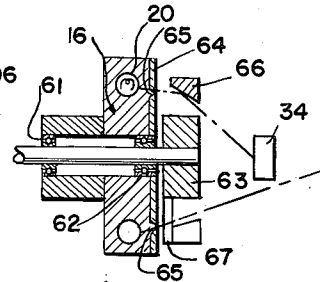


Fig. 6.

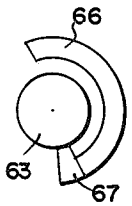
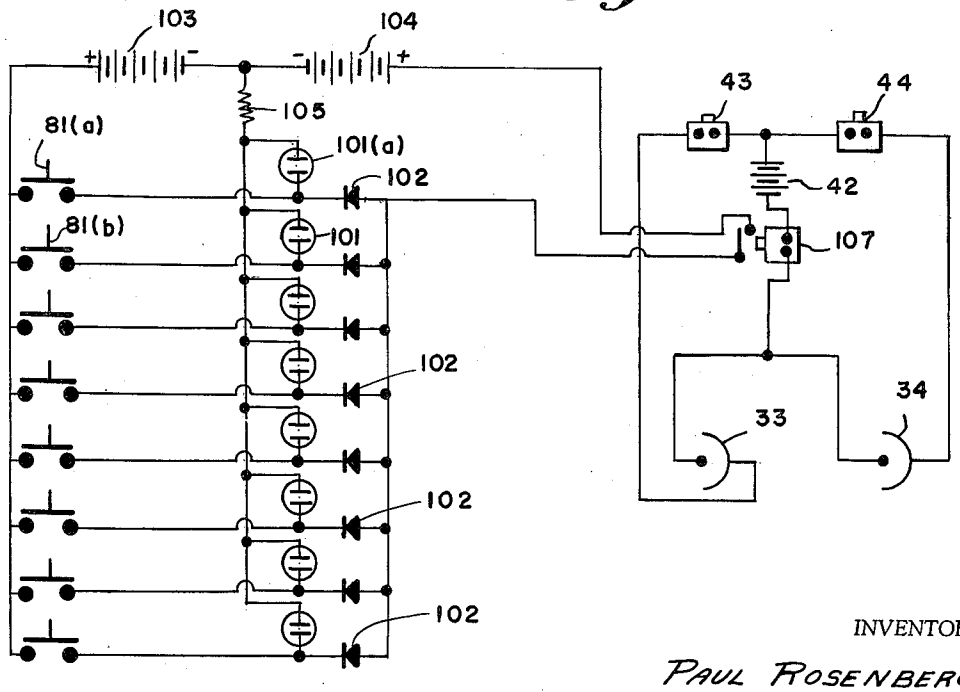


Fig. 7.

Fig. 13.



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ROTARY FILE WITH PHOTOELECTRIC SWITCH SELECTOR

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Filed Nov. 6, 1959, Ser. No. 851,333
22 Claims. (Cl. 318—467)

This invention relates broadly to selective switching systems and generally to a push-button controlled photoelectric switching system which is readily adapted to serve as an accurate position control means for a multi-position device such as a rotary file unit. In particular, the invention is directed to a novel photoelectric selective switching apparatus, a novel push-button arrangement for selectively controlling the switching apparatus and to the novel combination of photoelectric selective switching means and push-button control means for automatically positioning a multi-position device such as a rotating file unit.

The various aspects of the invention are presented hereinbelow, and their operation is explained, with reference to control of a rotary file unit, but it should be understood that although the push-button controlled photoelectric switching system has particular novelty and utility in this connection, the discussion is exemplary of but one use of such system. At the same time, however, the limitations and disadvantages of position control devices in common use today are pointed up when such devices are used to position rotary file drums. Therefore the advantages of the various aspects of the present invention will become clearly apparent from a discussion of the novel control means as used in conjunction with a rotary filing unit.

Filing units of the rotary type which are now in widespread use generally include a rotatably mounted drum or endless conveying means having a plurality of cradles pivotally supported around the circumference thereof. Card file trays are carried within the cradles and to examine a give card, the operator rotates the drum until the cradle carrying the tray in which the desired card is located is at a selected position. In some units movement of the conveying means to a given position, or to phrase it another way, selection of a cradle, in accomplished automatically. That is, the operator presses a push-button corresponding to a desired cradle whereupon the file rotates automatically and stops when the selected cradle reaches the correct position for the operator.

To provide for automatic operation, a variety of different types of selective control systems have been used, but all such systems have included either (*a*) sliding contact rotary switches or switch points or (*b*) non-sliding contacts such as micro-switches or contact points spring loaded or actuated by cams or cam-type mechanisms. These prior art control systems have suffered from the faults, difficulties and service troubles that inevitably beset sliding contact mechanism contact points and cam-operated switch mechanisms. In particular, there is poor accuracy of positioning the desired cradle in its operating position unless the selector switch is built with an impractically large diameter. Difficulty is encountered in the factory, as well as in the field, in adjusting the positions and tensions of the springs and contacts which must be included and accurately set. Of course, even after adjustment, the position of contacts and tensions on the springs can go out of adjustment easily. As wear of the mechanical elements, electrical contact points and electrical contact surfaces, as well as fouling thereof by dirt, corrosion, and oxidation are common problems. Aside

from other limitations of prior art systems, they are inherently expensive to fabricate.

In order to selectively control the positioning systems of the prior art, push-buttons of the latching type have been used. In many instances, the latching push-buttons have been mechanically interconnected so that only one push-button remains depressed with its switch closed at any one time. Latching push-buttons are more space consuming and require more mechanical parts than momentary push-buttons, and as a result some systems have incorporated momentary push-buttons for control. However, wherever momentary push-buttons were provided, the system required a relay associated with each button. Furthermore these relays would have to be interconnected with each other electrically or mechanically so that only one relay could be closed at the same time. Due to the expense of such an arrangement, momentary push-button control has not been generally commercially available.

From the foregoing discussion of development in the art of automatically controlled multi-position file units, it should be apparent that there are numerous shortcomings in the control systems of the prior art. As pointed out above, automatic control of filing units is an embodiment of the present invention but at the same time such control, and systems used therefor, serve as an exemplary basis for a discussion of the status of the present invention as an important step forward in the art relating to automatic selective control of multiposition devices.

This present invention has for a primary object the elimination of all of the disadvantages which have beset the prior art control systems. In particular, it is an object of the present invention to provide a selective switching means which eliminates the need for cams, and/or electrical switch contact points and surfaces and/or sliding contacts and/or springs and/or the critical adjustment thereof. Further objects of the invention are (*a*) to provide a selective switching means which is small in size and yet yields high accuracy (*b*) to provide a selective switching means wherein the mechanical rotating parts are reduced to a minimum number, (*c*) to provide a selective switching means which is not easily thrown out of adjustment, (*d*) to provide a selective switching means which can be operated with low torque, (*e*) to provide a selective switching mechanism which is durable and trouble-free in operation and (*f*) to provide a selective switching mechanism which is easily and economically manufactured and assembled.

In addition to providing an improved switching means for positioning, it is a still further object of this invention to provide an improved push-button arrangement for controlling the switching means which push-button arrangement eliminates the need for latching push-buttons and allows, economically, as well as advantageously, for the use of push-buttons of the "momentary" type, i.e. push-buttons which close their switch momentarily when the button is depressed and spring back to their open position as soon as the operator's finger is removed. Momentary push-buttons require less pressure and effort by the operator. When momentary push-buttons are incorporated in accordance with the teachings of this invention, it is not necessary to provide a relay associated with each push-button. Moreover, there is simplicity of mechanical and electrical construction, lower cost, less likelihood of failure to depress the button a sufficient distance to activate the contact, and furthermore, less space required for the push-button assembly so that the push-button assembly may be made semi-portable.

Still another object of this invention is to provide a momentary push-button controlled memory device which does not require relays, and in which memory is erased

by means of an opaque object which is not mechanically or electrically connected with the circuitry of the system.

Aside from the general objects of the invention set forth above, a more specific and particular object of this invention is to provide an automatic positioning device incorporating two basic components; namely, (*a*) photoelectric sensing means for causing a rotatable device to locate at a predetermined position, and (*b*) push-button switching means for causing energization of the photoelectric sensing means. Further, particular objects of the invention are to provide a push-button actuated photoelectric selective switching means with a rotating file unit which has a plurality of file tray cradles disposed on a rotatably mounted frame, and to provide such a switching means which causes the unit to locate at the selected position via the shortest angular route of travel. Still other particular objects of the invention are to provide a momentary push-button arrangement which may be conveniently used to control photoelectric selective sensing means.

When the positioning device provided by this invention is used with a rotating file unit of the above-described type, as presented in the exemplary description of operation hereinafter, the selector switch controls operation of a drive motor. The motor is connected through suitable gearing to the rotatably mounted frame of a multi-position device such as a file unit and the motor angularly positions the frame such that a cradle on the frame reaches a desired and selected level upon depression of a predetermined push-button. Of course, any similar multi-position unit may be used in a similar manner to the rotary file.

The photoelectric sensing means which selectively controls the motor as provided by this invention, basically comprises radiant energy emitters, radiant energy receivers and means for controlling the transfer of radiant energy from the emitters to the receivers. According to the exemplary embodiments incorporated herein, the radiant energy emitters are disposed in separate chambers with a cylindrical housing; one wall of the housing having apertures therein, at least one of which provides an opening into each chamber. The cylindrical housing, and in certain embodiments of the invention the closure members, have a bore through their center in which a shaft, suitably coupled at one end to the drive motor and/or a rotating file unit, is rotatably mounted. In axial alignment with, but spaced from the opposite end of the shaft, and from each other, are two radiant energy receivers that change in an electrical characteristic when radiant energy is incident upon them. Mounted rigidly to the shaft is a radiant energy control member that may be any one of several basic types, however all of the energy control members, without regard to type, carry a blocking member hereinafter referred to as a vane. The vane is an opaque member which serves to block energy emerging through an aperture from reaching a receiver. Relays are associated with each receiver and these relays have contacts to which are coupled leads from the motor circuit whereby energization of one receiver and its relay results in operation of the motor in one direction, whereas energization of the other receiver and its relays causes operation of the motor in the opposite direction.

In accordance with the invention, depression of a particular push-button causes a particular emitter to be energized and energy to be incident upon a particular receiver, whereupon the motor rotates to a predetermined position. Since the energy control members are specially designed, the receiver upon which the energy is incident would be that one which causes rotation of the motor in the shortest path of travel from the original position to the predetermined position selected by the operator in depressing the particular push-button. When a vane passes in front of, or blocks sufficient energy from the energized emitter, the receiver is de-energized and the motor stopped. If the vane were originally in front of the emitter energized, no movement would occur, and this of course is desirable.

In the above method of operation of the invention, latching push-buttons could be used. However, latching push-buttons may be eliminated by either of the following methods provided by this invention, namely, system A and system B.

With system A, for each emitter an additional receiver is used which short circuits the push-button once energized and thereby allows for release of the push-button and continued energization of the associated emitter until such time as means on the vane blocks energy incident upon the additional receiver. With system B, additional means is incorporated in the circuit of the motor actuating receivers, which means is operatively linked to the push-button circuitry whereby an emitter is maintained energized after release of a push-button and until energy to those receivers is blocked by the vane member.

The operation of the various systems and components of the invention and detailed construction thereof will become apparent, together with objects and advantages of the invention other than those specifically set forth above, to one of ordinary skill in the art when consideration is given to the following detailed description of exemplary embodiments of the invention presented in the annexed drawings.

In the drawings:

FIGURE 1 is a side sectional view of one form of the sensing device provided by this invention.

FIGURE 2 presents schematically a front sectional view of the interior of the housing incorporated in the embodiment of FIGURE 1.

FIGURE 3 is a plan view of a face of the housing presented in FIGURES 1 and 2.

FIGURE 4 is a plan view of an energy control member utilized in the FIGURE 1 embodiment and constructed in accordance with the teachings of this invention.

FIGURE 5 is a schematic circuit diagram of an electrical system which may be used with the sensing means provided by this invention.

FIGURE 6 is a schematic view of a modification of the sensing device presented in FIGURE 1.

FIGURE 7 is a plan view of an energy control member utilized with the embodiment of this invention presented in FIGURE 6.

FIGURE 8 is a side sectional view of a sensing device constructed according to another embodiment of this invention.

FIGURE 9 is a schematic front view, partially in section, of the housing of the sensing device presented in FIGURE 8.

FIGURE 10 is a schematic circuit diagram presenting an embodiment of this invention which provides for utilizing push-buttons of the momentary type to control the systems of the invention.

FIGURE 11 is a plan view of an energy control member constructed for use in the FIGURE 1 device when the circuit of FIGURE 10 is used for control.

FIGURE 12 is a plan view of another radiant energy control member for use in the FIGURE 1 device when the circuit of FIGURE 10 is used for control.

FIGURE 13 is a schematic circuit diagram of another embodiment of this invention which may be used for controlling the systems provided hereby, and which incorporates push-buttons of the momentary type.

FIGURE 14 is a schematic circuit diagram of a motor control system used with the circuits of FIGURES 5, 10 and 13.

FIGURE 15 is a perspective view presenting the overall system provided by this invention for controlling a multi-position device such as a rotary filing unit.

The various exemplary embodiments of the invention which are presented in the drawings will initially be discussed separately for purposes of clarity, however it should be understood that elements of the various embodiments overlap and there is a single theory of operation underlying each embodiment of the photoelectric sensing means.

In FIGURE 15, a rotary file system constructed in accordance with the teachings of this invention is presented. The system includes a photoelectric sensing means **1**, a push-button control means **100** and a multi-position rotary file unit **200**. The file unit is of the type having a plurality of cradles **201** pivotally supported about the periphery of a rotatably mounted drum or frame **202**. A shaft **203** of the file unit **200** upon which drum **202** is mounted, or to which drum **202** is suitably geared, is coupled to a shaft **10** of the sensing means **1**. Any suitable coupling member such as a collar **204** may be used for the coupling. Although the manner of coupling between the shaft **10** and the drum **202** may vary, the coupling must be such, in the embodiments shown, that one revolution of shaft **10** corresponds to one revolution of the drum **202** for reasons which will become apparent hereinafter. As shown in FIGURE 15, a motor **205** is used to drive a gear **206** coupled to the motor shaft. Gear **206** meshes with gear **207** fixed to drum shaft **203**, and as a result the filing unit **200** and sensing means **1** are driven by the motor. Of course, the gear ratio between gears **206** and **207** may be adjusted to control operating speed.

It should be understood that although this description centers about a rotatable drum, any endless conveying means can be positioned in accordance with the teachings of this invention.

FIGURE 15 presents an overall system provided by this invention. The operation of the system is considered after an explanation has been made of the various components individually.

In FIGURE 1 the preferred embodiment of the photoelectric sensing means **1** is shown, and it will be noted that in this embodiment the photoelectric sensing means comprises a housing **2** consisting of two circular plates **3** and **4** joined by a circular ring member **5**. Plate **4** is fixed to member **5** by way of screws **6** whereas plate **3** is fixed to ring member **5** by way of cooperating screw threads **7** and **7'** carried by the plate **3** and ring members **5**, respectively. The plates **3** and **4** have central bores which carry the projecting cylindrical portions **8** and **8'** of cylindrical bearing block **9**. The bearing block **9** is attached to the plates **3** and **4** by any suitable means, such as by screws **6'** and part of the bearing block **9** serves to maintain plates **3** and **4** in spaced relation. Within the bearing block **9** are press-fitted two bearing plugs **11** and **12** having bores centrally disposed therein through which the shaft **10** passes. A hub **13** is fixed to the end of the shaft adjacent the plate **4** by any suitable means, such as by screws **6''**, and a collar **14** is fixed on the shaft **10** adjacent bearing plug **12** by means of a set screw **14**(*a*). The shaft **10** is thus journalled for roation centrally of the housing **2** formed by plates **3** and **4** and the circular ring member **5**. As best shown in FIGURE 2, a plurality of dividers **15** are radially disposed between bearing block **9** and circular ring **5** such that the housing is divided into a plurality of compartments generally designated by numeral **16**. The dividers can be fastened either to plate **3**, plate **4**, bearing block **9** or ring member **5** or to more than one of these parts. Preferably, however, the dividers or partitions **15** are fastened to the back plate **3** or to the bearing block **9** by any suitable means such as by welding. Plate **4** may be visualized as a cover for the housing **2** or for the compartments **16**, and plate **3** and ring member **5** according to such visualization serve as the bottom and end walls of each compartment **16**, dividers **15** serving as the side walls of each compartment.

Plate **4** as best shown in FIGURE 3, has a plurality of apertures **17**, **18** and **19** radially disposed in concentric circles. One aperture **17**, one aperture **18**, and one aperture **19** are located along a given radius and associated with a given compartment **16** whereby the compartment **16** is a "light-tight" box except for the apertures **17**, **18** and **19** associated therewith. Particular attention will be directed to the apertures **17** and **18** and not aperture **19** initially as aperture **19** has a special function regarding the momentary contact push-button arrangement provided by this invention which will be considered after consideration has been given to the photoelectric sensing means.

Within each compartment **16**, as shown in FIGURES 1 and 2, there is located a radiant energy emitter **20** which in the form shown comprises a small light bulb. Each light bulb is disposed in a socket **21** through which electrical connection is established for energizing the bulb. The lamps and sockets may be of any type commonly in use today and an electrical connection between the socket and the bulb may be accomplished in any convenient way.

Each compartment **16** serves as a source of at least two distinct rays of energy, one which emerges through an aperture **17** therein and another which emerges through an aperture **18** therein. The number of radiant energy sources and compartments **16** provided correspond, in accordance with the teachings of the invention, to the number of stations of the multi-position device to be controlled. For example, the housing **2** shown in FIGURE 2 is designed for use with a rotary file unit having 12 cradles or stations, and thus there are 12 compartments or 12 sources of radiant energy. These compartments as shown are equally spaced because the rotary file unit **200**, referred to above and controlled as explained herein, has equally spaced cradles. However, it should be understood that if the multi-position device has unequally spaced stations, then the sources of radiant energy, the compartments and the apertures may be located in angle to correspond to the uneven spacing of the stations.

It should also be understood that it is not necessary that the radiant energy emitters **20** be located very accurately in their correct angular position within the housing. It is sufficient to locate the emitters approximately. The accuracy with which the stations are positioned is dependent almost entirely upon the accuracy of location of the apertures in the plate **4** as will become apparent. The fact that the emitters do not have to be located accurately is one of the important features of the subject invention because this reduces the cost of manufacture and the difficulty of adjustment.

Having thus set forth the preferred and exemplary design of the housing **2** and components thereof, attention may now be directed to the other components of the sensing means, namely the energy control member and the radiant energy receivers.

The energy control member comprises, in the preferred embodiment presented in FIGURE 1, a vane **22** attached to the hub **11** by means of screw **6'''**. The hub **11** is fixed to the shaft **10** at the end of the shaft adjacent plate **6**. This vane member **22** is shown in detail in FIGURE 4 wherein it will be noted that it is provided with three sections; one substantially semi-circular opaque section of radius R designated by numeral **23**, another smaller substantially semi-circular opaque section of radius *r* which is diametrically opposed to the section of radius R and which is designated by numeral **24** and an opaque planar ring section with an internal radius equal to R designated by numeral **25**. The planar ring section **25** substantially surrounds the smaller semi-circular section **24** whereby a substantially semi-circular open (or transparent) ring section **26** is formed by the space between section **24** and section **25**.

The energy control member **22** can be made of any

convenient material such as metal, plastic, or any other moderately rigid or stiff material which will not transmit light (or any other radiant energy that may be used in the system). The vane 22 may be also fabricated by using a transparent disk, such as plastic or glass, upon which opaque areas are painted, printed, pasted, or otherwise applied to form the sections 23, 24, 25 and 26. Of course, the method of fabrication of the energy control means is not part of this invention, and therefore the means of fabricating the member should be considered as exemplary.

As is apparent from FIGURE 1, the energy control member 22 is disposed in parallel relation to the outer surface of plate 4, and since the energy control member is mounted on hub 11, it is rotatable with respect to the plate 4. The relationship between apertures 17 and 18 and the energy control member can be best understood by referring to FIGURES 3 and 4 whereupon it will be noted that apertures 17 are aligned with open section 26 and opaque section 23 of the energy control member whereas apertures 18 are aligned with opaque section 25 and the open area surrounding opaque section 23. It should be obvious that if the energy control member is made of transparent material with sections painted thereon as suggested above, the same alignment will result. The aligned relationship may be more apparent from the circles shown in broken lines in FIGURE 3, which circles have diameters P and R respectively corresponding to the radii labeled with the same letters in FIGURE 4. Because of this alignment of vane sectors and apertures the opaque sector 23 and the open or clear or transparent sector 26 rotate in front of the apertures 17 and the opaque sector 25 and the open sector disposed radially outwardly of the opaque sector 23 rotate in front of the apertures 18. Thus the vane or energy control member blocks off the radiant energy either from the aperture 17 or from the aperture 18 associated with any compartment 16 having an energized source thereon.

In order to appreciate the significance of the control exercised by the energy control member, it is first necessary to understand the energy receiving means provided in accordance with the systems of this invention. By again referring to FIGURE 1 it will be noted that two radiant energy receivers 33 and 34 are disposed in alignment with the longitudinal axis of shaft 10 and spaced from the end of that shaft carrying hub 11. These radiant energy receivers 33 and 34 are carried in a bracket 35 which is affixed to a hollow cylindrical covering 36 having one end 37 closed. The other end of the cover is open and the cylindrical wall 38 of the cover overlaps and engages circular ring 5 and is affixed thereto by screws 39. The cover 36 has a slightly greater diameter than the housing, or than circular ring 5 as is apparent but fits in relatively tight engagement therewith. The hollow cylindrical cover 36 when secured to ring member 5 serves to define a moderately light-tight assembly for preventing ambient illumination from reaching the radiant energy receivers 33 and 34.

The radiant energy receivers as shown are two photocells, 33 and 34, mounted in axial alignment with each other and with the shaft 10 but spaced from plate 4 as well as from each other. Of course the sensitive elements of the photocells face the radiant energy emitters 20 and the apertured plate 4. These photocells may be any one of the following types: (*a*) photo-conductive cells, such as lead sulfide or cadmium sulfide, that have the property of changing electrical resistance when illuminated by light or by other radiant energy; (*b*) photoelectric cells or photomultipliers, which emit photoelectrons when illuminated by light or other radiant energy, thereby permitting the passage of an electric current through the cells; (*c*) self-generating photocells which generate an electromotive force or a voltage when illuminated by light or other radiant energy; (*d*) phototransistors or similar solid state devices that detect light; and (*e*) any other cell, element or device that detects, or is sensitive to, light or other radiation.

At this point it should be understood that although the photoelectric sensing system is being described as operating by visible light, this invention includes the use of other forms of radiation including ultraviolet light and infrared light which can easily be used in place of the visible light. For example, the bulbs 8 can be considered as, or can be replaced by, infrared sources, and the photocells can be chosen to be sensitive to infrared. Alternatively, ultraviolet sources, such as small discharge bulbs or discharge tubes, can be used instead of the lamp 20, in conjunction with photocells sensitive to ultraviolet. Actually, when ordinary filament lamp bulbs are used, the radiation emitted is a combination of visible light and infrared, and many photocells that may be used in practice in the invention will be sensitive to both ultraviolet, infrared and visible light. Thus a combination of radiations can also be used. The examples specifically referred to in this paragraph are not intended as being of a limiting nature but instead are included to show the versatility of the invention.

The exact bracketing means for supporting the radiant energy receivers may be of various types but it is important that the bracketing means does not interfere with radiant energy directed toward the receivers. In the preferred construction, the legs or straps 35′ and 35″ of the bracket lie in an angular relation to one another and between two radii on which apertures 17 and 18 are located on plate 4, such that they do not interfere with light passing to the receivers.

Now having discussed the disposition of the radiant energy receivers attention can again be directed to the function of the energy control member. Energy emitted from a source 20 may pass into the space between energy control member 22 and cover 36 through (*a*) an aperture 17 in plate 4 and transparent or open section 26 of the energy control member, or (*b*) through an aperture 18 in plate 4 and transparent or open sector 22 over opaque sector 23 of the energy control member. Because of the construction of the vane, rays from a particular emitter may not travel through both apertures 17 and 18 and passed the vane at the same time. As represented by the dotted lines in FIGURE 1, rays which emerge through aperture 17 make a greater angle with the normal to plate 4 than rays which emerge through aperture 18. This is, of course, due to the fact that aperture 17 is displaced further from the longitudinal axis of the emitter 20 than is the aperture 18. This difference in angle of emergence of the rays with respect to the plate 4 determines which of the two receivers, 33 or 34, the emergent ray will be incident upon. If the rays emerge from aperture 17 they will be incident upon receiver 34, whereas if they emerge from aperture 18 they will be incident upon receiver 33.

The radiant energy receivers 33 and 34 control operation of a drive means (motor 205 of FIGURE 15), which serves to position the multistation device as well as shaft 10 of the photoelectric sensing means. In FIGURES 5 and 14 the basic electrical circuitry, which is associated with the photoelectric sensing means presented in FIGURE 1, is shown. Each radiant energy emitter 20 is connected to the one side of a battery 40 and to one side of a switch 41. The other side of the switch 41 is connected to electrical ground or the other side of the battery 40. When a switch 41 is closed as shown by the dotted lines position of switch 41(*a*) the radiant energy emitter associated therewith, in this instance emitter 20(*a*), is energized and radiant energy travels to one of the two radiant energy receivers, or as shown photocells, 33 or 34. Each receiver is connected in series with a battery 42, and a relay. Cell 34 and relay 43 are in series with battery 42. Cell 33 and relay 44 are also in series with battery 42. As will be explained in more detail hereinafter, relay 43 causes energization of motor 205, the

drive means for the exemplary embodiment shown, in one direction and relay 44 causes energization of motor 205 in the opposite direction. Thus, when a switch 41 is closed and the source 20 associated therewith is energized, light falls upon one of the two receivers, 33 or 34, and motor 205 is caused to operate in one direction. The directional operation of the motor may be controlled by any suitable circuitry, but for exemplary purposes a circuit such as that generally indicated by the numeral 45 may be provided. The circuit includes blades 46 and 47 of relay 43, blades 48 and 49 of relay 44, a battery 50 and leads 51—58. Relay 43 is energized as a result of radiant energy being incident on cell 34, since such energy causes conduction by the cell. When relay 43 is so energized, blades 46 and 47 move into contact with the contact points of leads 51 and 52 and a circuit is established from the positive side of battery 50 through lead 51, blade 46 and lead 54 to terminal *y* of motor 205 and from terminal *x* of the motor through lead 53, blade 47 and lead 52 to the negative side of the battery. Motor 205, being a D.C. motor, would rotate its shaft in one direction. Now, if instead of relay 43 being energized, relay 44 was energized, as a result of radiation being incident on cell 33, then terminal *y* of motor 205 would be connected to the negative side of the battery through lead 58, blade 48 and lead 55 and terminal *x* would be connected to the positive side of battery 50 through lead 57, blade 49 and lead 56. Reversing the polarity of voltage applied to motor 205 would cause it to rotate its shaft in the opposite direction. It should be understood that phase reversal as well as polarity reversal or any similar direction control may be applied to the particular type of drive motor selected, and that the discussion in this paragraph is not intended to be limiting to a particular type of motor or direction control.

Since it is apparent from the foregoing discussion that the radiant energy receivers control operation of the drive motor and that the radiant energy incident upon a receiver is controlled by the vane member, the cooperation between the various components of the system to position a device such as a rotary file unit can now be considered. Assume that it is desired to position a given cradle of the rotating file unit shown in FIGURE 15 at the operating level, and assume that radiant energy emitter 20(*a*) is associated with that cradle position-wise in the system.

When the bulb 20(*a*) corresponding to the desired cradle is lit by closing switch 41(*a*) light from that bulb will fall either upon photocell 33 or upon photocell 34, depending upon the position of the vane at the time. If photocell 33 is activated, it conducts current from the potential source 42 through the relay 44 which starts the motor 205 in the direction of shortest travel to the desired cradle. If photocell 34 is illuminated it activates the relay 43 to drive the motor in the opposite direction. In this way the vane 22 "selects" or determines the direction of shortest travel to the desired tray.

The vane 22 rotates until either the edge 27 of the clear sector 26 or the edge 28 of the clear sector over opaque sector 23, depending upon the direction of travel, passes in front of the unblocked aperture 17 or 18 that is illuminated by the bulb 20(*a*). When this happens, the light is abruptly cut off from the illuminated photocell (either 33 or 34), the motor relay 43 or 44 is deactivated and opened, and the motor and file unit stop with the desired cradle in its selected position. When the motor relay 43 or 44 is deactivated and opened, a brake can automatically be applied to stop the file unit rapidly if required.

It will be noted in the drawing that the cut off edges 27 and 28 do not lie on the same radial line. This is to allow for the fact that the rotary file or other multi-position device coasts by momentum through a small but finite angle before the brake and general friction succeed in bringing the entire mechanism to a complete stop. The angle ϕ shown in FIGURE 4 is this angle

through which the mechanism coasts before stopping. If the multi-position device has an odd number of stations, each of the vane sectors subtends an angle of 180° minus the angle ϕ. If the multi-position device has an even number of stations (as illustrated in drawings), one open sector subtends an angle equal to

$$180° - \phi - \frac{360}{2N}$$

and the other sector subtends an angle equal to

$$180° - \phi + \frac{360}{2N}$$

where N is the number of stations in the device to be positioned. If desired, the energy control member or vane 22 can be made so that the angle between the edges 27 and 28 is adjustable. This adjustment can make up for the fact that the coasting angle may differ with (*a*) the load that is placed on the motor and bearings, (*b*) the variations in braking action and (*c*) the variation in friction as the machinery ages. The adjustment of the angle can be made simply by providing a smaller vane, or small piece, attached to the vane 22 by means of a set or thumb screw. Alternatively, the vane 22 can be made in two sections angularly adjustable with respect to each other and fastened in any desired relation to each other by a set or thumb screw. If the vane is made from a transparent disk of glass or plastic with imprinted or otherwise applied opaque sectors, as suggested previously in this description, the adjustment of the angle size can be made simply by erasing or painting a new opaque edge, or by removing or repasting pieces of opaque paper, or by removing and readhering opaque pressure-sensitive tape such as masking tape or the like. The ease with which adjustments and changes can be made on the vane is one of the subsidiary features of this invention.

It should be noted that the location of the two cut-off edges 27 and 28 are the only critical parts of the vane 22, and the only boundaries of the vane sectors that must be fabricated or adjusted with any precision. The other boundaries of the vane need not be precisely located. It is sufficient that these boundaries simply define necessary sectors of the energy control members. The edges 29 and 30 are *not* critical and need *not* be located accurately since the edges 29 and 30 do not cut off the beam of energy.

The accuracy with which the photoelectric sensing means provided by this invention stops the multi-position device at the proper station each time a station is selected is determined almost entirely by the angular accuracy with which the apertures 17 and 18 are located on the plate 4. The distance that each aperture lies radially outward from the center of the plate 4 is not critical. The angular location of each aperture is critical, because the accuracy of angular location of the aperture determines the accuracy with which the photoelectric sensing means will stop the multi-position device, in the illustrative embodiment, with the desired cradle in its proper position. By varying the size of the apertures 17 and 18 and by varying the diameter of the concentric circles on which the apertures lie the stopping precision may be adjusted. The smaller the apertures the more precise the stopping. Actually when the vane has blocked off only some fraction of the light issuing from the aperture, before *all* the light from that aperture is cut off, the current passing through the photocell will drop to a value low enough to open the associated relay even though this current is not entirely zero. The effect of this is to make the apertures 17 and 18 effectively narrower than they are, with the result that the device being positioned will stop very accurately.

The apertures 17 and 18 although shown as round need not necessarily be so shaped. Other shapes of apertures can be used to simplify fabrication and manufacture, or to increase the quantity of light emerging from

the aperture without sacrificing the accuracy of the device. For example, the aperture can be made in the shape of an arcuate sector with its center at the center of the plate 4 (i.e., a pie-shaped aperture with the point of the pie-cut off). Alternatively, the apertures 17 and 18 can be square in shape; or rectangular in shape. In the case of the rectangular slotted apertures, it is best to have the longest dimension of the rectangle parallel to a radius of the plate 4, so that the angular accuracy remains high. More light comes through a rectangular aperture than is the case with a circular aperture of the same width, and therefore, elongating the shape of the apertures radially enables more light to be emitted without sacrificing angular accuracy. If the plate 4 is of appreciable thickness, it is desirable, although not absolutely necessary, to countersink the apertures on the interior of housing 2 so as to allow more light to come through the apertures without sacrificing angular accuracy. In the case of rectangular apertures, this "countersinking" is the equivalent of bevelling the edges of the aperture.

The use of apertures that are elongated radially, and the use of countersunk or bevelled apertures, becomes most desirable when glow lamps (e.g. neon lamps) are used instead of incandescent filament lamps as sources of radiant energy, because glow lamps provide less intense illumination that filament lamps. The elongated apertures and the countersinking and bevelling also help to make it possible to use photocells that are less sensitive and hence less costly for the receivers of radiant energy.

The proper positioning of the vane 22 with respect to the stations of the multiposition device controlled can be set and adjusted by adjusting the hub 13 on shaft 10 and thus it is preferable to attach the hub to the shaft by means of a set screw. Alternatively, this positioning can be accomplished externally to the photoelectric sensing means in the mechanical coupling or gearing that connects the shaft 10 to the rest of the mechanical system. Another alternative way of accomplishing this positioning is to properly phase the entire stationary assembly of the photo electric sensing means when the same is mounted in position in or on the device to be controlled. Indeed, this last mentioned method of phasing is the easiest and most practical method of adjusting the phase not only during factory adjustment, but also in field adjustments. This adjustment can be provided to enable the operator to select the exact location at which the cradles of a filing unit, for example, will stop. To do this, it is necessary only to mount the photoelectric sensing means as a whole so that it can be rotated (by hand or by screw arrangement) through a small arc.

One of the features of the photoelectric sensing means and of the various designs described herein and in the accompanying drawings, is the simplicity with which the beams of light are collimated and defined. It is sufficient to collimate the beams by the single aperture 17 or 18, the spread of the beam being defined by the size of the filament in the radiant energy source 20 (or by the area of the gaseous discharge if glow lamps are used). In order that the beam of light issuing from an aperture be defined by the size of the filament alone, it is highly desirable that the inside of the entire housing 2 be painted a dull black to prevent reflections and to effectively absorb all the light emitted by the radiant energy source, except of course, the light that emerges from the apertures 17 or 18. This minimizes the chance of stray light being reflected through the aperture 17 in such direction as to reach the photocell 33 and likewise minimizes the chance of stray light being reflected through the aperture 18 in a direction to impinge upon the photocell 34.

It should be noted, however, that other means can be used in the invention to collimate and define the light emerging from the apertures. For example, one or more screens with collimating apertures of suitable size and shape can be placed between the emitters 20 and the apertures 17 and 18 so as to more sharply collimate the light beam and prevent stray light from reaching the wrong receiver. Light screens and suitable collimating apertures can also be located between the vane 22 and the photocells 33 and 34. Lenses can also be used to collimate and define the light beams more precisely if the application of the photoelectric sensing means so requires, and if the additional cost entailed by the lenses is warranted. Simple lenses or lens systems can be installed for this purpose either between each bulb 20 and its apertures 17 and 18, or between the vane 22 and the photocells 33 and 34, or in both places. These lenses can be spherical, cylindrical, or astigmatic, and can be used in combination either with or without the extra screens and collimating apertures discussed above. One of the effects of using a simple lens system is to concentrate more of the light emitted by the bulb upon the photocell, thereby enabling smaller apertures to be used with consequent increase in positional accuracy. Another advantage of using simple lens systems to collect and concentrate the light from the bulbs upon the photocells is that weaker light sources can be used; for example this will enable a week glow lamp to be used in place of the filament lamp, or a filament lamp can be operated at a voltage considerably below its rated voltage to increase its life. Still another advantage of using simple lens systems to collect and concentrate the light from the radiating sources upon the radiant energy receivers is that less sensitive (and hence less expensive) radiation receivers (e.g. photocells) can be used.

Another method of collecting and concentrating more light from the light source 20 is to use a spherical, parabolic, or other curved, polished reflector back of the bulb 20. Alternatively, the bulb 20 can be of a type which is silvered on its back half.

Still another interesting way of collecting and concentrating more light on the photocells is to use one large simple convex lens, either glass or plastic, mounted in a stationary position between the hub 13 and the photocell 34, with the axis of the lens colinear with the axis of the shaft 10, and with the outside diameter of the lens equal to or larger than the diameter of the circle on which the apertures 18 are located. Another lens could be similarly mounted between the photocells 33 and 34, either in place of, or in addition to, the aforementioned lens. Each one of these lenses would refract and partially focus the light emerging from any one of the apertures 17 and 18.

Yet another way of focusing and concentrating the light from the bulb 20 is to use, for the bulb 20, one of the commercially available miniature filament lamps made for pocket size "pen" flashlights. The front end of the glass envelope of this type of bulb consists of a built-in positive lens which acts as a miniature condensing lens to concentrate the light from the filament in the forward direction. This miniature light bulb would be mounted so that it pointed toward the apertures 17 and 18.

Aside from the suggested modifications of the preferred embodiment of the invention shown in FIGURE 1, which have been set forth above, modifications may be made in the circuitry of FIGURE 5. This figure illustrates the use of a battery 40 for furnishing the power to illuminate the radiant energy emitters or bulbs 20. A more practical source of power is a transformer whose primary operates on conveniently available 110 volt A.C., and whose secondary puts out a low voltage to operate the bulb filaments. Of course, the secondary would be connected in place of the battery in the circuit and a common ground can be used. This has the advantage that only one wire is needed to go from each switch 41 to its corresponding bulb, thereby, reducing the number of wires to a minimum.

Also, the potential for the receivers 33 and 34 and relays 43 and 44 need not be derived from a battery

as shown, but may be derived from an A.C. rectifying circuit of conventional design.

Although the photoelectric sensitive means embodiment of the invention presented in FIGURE 1 is preferred, the embodiment of the photoelectric sensing means presented more or less schematically in FIGURE 6 is also an important aspect of the present invention.

The essential components of the photoelectric sensing means of FIGURE 6 are the same as those of that shown in FIGURE 1. A plurality of radiant energy emitters **20** (e.g. filament lamp or glow lamp) corresponding to each station in the multiposition device to be controlled are provided and arranged in a circle. Each emitter is in a light-tight compartment **16**. The shaft **10** is shown turning in bearings **61** and **62** and this shaft is connected mechanically to the device to be controlled such as the rotary file unit **200** shown in FIGURE 15. One rotation of the drum of the file corresponds to one rotation of the shaft **10**. A hub **63** is attached to the shaft **10** by any suitable means such as by a weld or a set screw. Photoelectric cells or radiant energy receivers **33** and **34** lie on the axis of the shaft **10** and are spaced from the end thereof carrying hub **63**. The receivers may be mounted and supported in the same fashion as in the FIGURE 1 construction. An electrical hook-up or circuit identical with that of FIGURE 5 may be used with the sensing means of FIGURE 6, or in fact, as will become apparent hereinafter, other preferred circuitry which is provided by this invention may be used.

The sensing means of FIGURE 6 has the following features which differ from the FIGURE 1 construction: (1) there is only one circle of apertures **65** in the plate **64** instead of two circles of apertures **17** and **18** in the plate **4**, that is, each compartment **16** has only one aperture instead of two apertures; (2) the hub **63** carries a reflector **66** which as best shown in FIGURE 7, subtends an angle of approximately 180°. (The exact angle subtended by this reflector is the same as the angle subtended by the corresponding sector **25** of the energy control member **22** of FIGURE 4, the equation for which is given in connection with the description thereof.)

The reflector **66** is connected mechanically by a blocking vane **67** to the hub **63**. The blocking vane **67** subtends an angle 2ϕ where ϕ is the same angle as the angle ϕ discussed in the consideration of FIGURE 4. The angle ϕ in the instant embodiment is important for the same reason as is the case with the FIGURE 4 construction, namely to compensate for mechanical lag. The reflector **66** can be made of any material with a polished, shiny, or optically reflecting surface, such as polished metal, shiny plated metal, silvered glass, silvered plastic, or the like. The reflecting surface is cut at an angle such that the light beam emerging from an aperture **65** is reflected to the photocell **34** if the reflector **66** lies in position to intercept the light beam. Preferably, the reflecting surface is a portion of a conical surface, so that the light beam is reflected to the photocell **34** almost as though it were reflected by a plain mirror. Actually this conical surface will have a slight focusing action on the beam so that the beam will be slightly converged in one direction as though reflected by a cylindrical mirror. Alternatively, the reflector **66** can be cut so that its reflecting surface is spherical instead of conical, with the result that the reflected beam will be focused in both directions before impinging upon the photocell **34**. This focusing action has the same advantages of light collection and concentration as are discussed in the description of the FIGURE 1 construction with regard to modifications incorporating lenses.

Although the structure of FIGURE 6 is shown in schematic form, it is apparent that a housing such as that designated by the numeral **2** in FIGURE 1 may be used in conjunction with a cover such as **36**. FIGURE 6, therefore, merely presents schematically a modification of the FIGURE 1 construction. Likewise, the operation of the FIGURE 6 photoelectric sensing means is very similar to

that of the FIGURE 1 sensing means. When the circuit of FIGURE 5 is used with the FIGURE 6 embodiment of this invention and a switch **41** is closed, the bulb **20** corresponding to the closed switch and therefore the selected station of the multiposition device is energized. The light beam emerging from the corresponding aperture **65** may, depending upon the position of the hub **63** and the reflector **66** at that time, either reach the photocell **33** directly (if the reflector is not in front of that aperture), or be reflected to the photocell **34** by the reflector **66** (if the reflector is in front of that aperture). The photocell-receiver which is illuminated will become conducting and will pass current through its corresponding relay **43** or **44** which will start the motor **205** in the direction of shortest travel to the desired cradle. The photocell will continue to be illuminated, and the motor will continue to turn in the direction of shortest travel, until the light beam is cut off by the blocking vane **67**; whereupon the photocell becomes non-conducting, the relay opens, and the motor stops. The angular width of the blocking vane **67** is 2ϕ, thus allowing the mechanism to coast through the angle ϕ before it stops completely.

The advantage of the FIGURE 6 construction over that of FIGURE 1 is that the FIGURE 6 construction requires only one set of apertures **65** instead of two sets of apertures **17** and **18**. The disadvantage of the FIGURE 6 construction as compared to the FIGURE 1 construction is that the reflector and reflecting surface **66** are more difficult and costly to construct than the relatively simple vane **22**.

It should be noted that the FIGURE 6 construction can use either filament lamps or glow lamps as radiant energy emitters. The discussions of extra collimating apertures, collimating and collecting lenses, reinforcing reflectors, etc. in the description of the FIGURE 1 construction apply equally well to the FIGURE 6 construction, as do the discussions of the shapes and accuracy of location of the apertures and edges of the vane.

It should also be noted that the structural components of the FIGURE 6 construction have not been shown in detail because they correspond to the structural elements of FIGURE 1. For example, the compartments **16** would be part of a housing such as that designated by the numeral **2** of FIGURE 1, the receivers would be supported in a bracket such as that designated by numeral **34**, and a cover such as **36** would be included. In other words, in accordance with the teachings of FIGURE 6, a plate **64** having a single set of apertures may be substituted for plate **4** of FIGURE 1, and hub **63** carrying blocking vane **67** and reflector **66** could be substituted for hub **11** and vane **22**. Of course, it may be necessary to provide a collar on shaft **10** between plug bearing **11** and hub **63** in order to provide for proper spacing of vane hub **63** from plate **64** and in order to fix shaft **10** for proper non-sliding rotation.

Still another photoelectric sensing means embodiment of the present invention is presented in FIGURE 8. This embodiment is similar to the FIGURE 1 and FIGURE 6 constructions in that a plurality of radiant energy emitters **20** are provided in a plurality of circularly disposed compartments **16**, of a housing **2** in which a shaft **10** is centrally journalled for rotation. Also, two photocells **33** and **34** or radiant energy receivers are disposed along the axis of and spaced from the shaft and the housing. These cells are supported and housed in the same way as in the FIGURE 1 construction. The circuitry associated with the FIGURE 8 construction may be the same as that associated with the sensing means of FIGURE 1.

The FIGURE 8 construction differs from that of FIGURES 1 and 6 in the following respects: (1) the hub **70**, which is carried by, and coupled to the shaft **10** by any of the suitable coupling means heretofore suggested does not lie between sources **25** and the receivers **33** and **34**, but instead lies on the side of the sources

remote from the receivers; (2) the hub 70 carries two reflectors 71 and 72 which travel circumferentially outside the cylindrical housing 2 (instead of between the housing 2 and the receivers 33 and 34 as in the other constructions); (3) there is only one aperture 73 for each emitter 25; (4) these apertures 73 lie on the outside cylindrical surface of the housing 2, that is, these apertures are provided in the ring member 5 of the housing of FIGURE 1, and the plate 4 is imperforate.

Each of the two reflectors 71 and 72 subtends an angle of approximately 180°, the exact angle being the same as the angle subtended by the corresponding sectors of the vane 22, namely sectors 23 and 25 of FIGURE 4. The two reflectors 71 and 72 meet each other at the two joints 74 and 74' as shown in FIGURE 9. At one of these two joints, namely joint 74, the hub 70 carries a cut-off vane 75 which cuts off the beams of light emerging from the apertures 73 in much the same way as does the vane 67 in the FIGURE 6 construction. The angle subtended by the vane 75 is 2ϕ for the same reason that the vane 67 of FIGURE 6 subtends the angle 2ϕ, where ϕ is the angle through which the mechanism coasts after the motor is turned off and any braking incorporated is applied. Although no particular attention has been directed to the portion of vane 22 of FIGURE 4 between edges 27 and 28, it should be understood that that portion is a cut-off vane which also subtends an angle of 2ϕ just as is the case with vane 75 of FIGURE 9.

No precision or accuracy is required in the construction of the joint 74 at which the reflectors 71 and 72 meet because the light beam is shut off by the vane 75 before the beam of rays is incident upon joint 74. Similarly, the joint 74' between the reflectors 71 and 72 requires little care and no precision in its construction, for exactly the same reason that the edges 29 and 30 of the vane 22 in FIGURE 4 require little care and no accuracy in their construction and location, that is because neither the joint nor edges are used to cut-off a beam of rays.

The mirrors 71 and 72 are conical surfaces of two cones of half vertex angles α and β respectively. The angle α is such that the light beam emerging radially from a compartment 16 in the housing 2 through an aperture 73 is reflected to the photocell 34. The angle β is such that the same light beam will be reflected to the photocell 33 if the reflector 72 is in front of the particular aperture through which the rays generated by an emitter 20 pass.

If the radiant energy emitters 20 are wired in accordance with FIGURE 5 and the radiant energy receivers are wired in accordance with FIGURE 14, then upon closing a switch 41 the associated bulb or emitter 20 is energized and one or the other of the photocells or receivers 33 or 34 is rendered conductive depending upon the positions of the reflectors 71 and 72 at that time. The particular cell upon which the beam is incident determines the direction of shortest travel, and starts the motor in this direction in exactly the same way as described with reference to FIGURES 4 and 5. The discussions of the methods of fabrication and effects and advantages of curving and shaping the reflectors of the FIGURE 6 construction apply equally well to the two reflectors 71 and 72. Of course, additional collimating screens and apertures, and additional lenses for collimation and light collection, can be used in the FIGURE 8 construction.

Also, it should be noted that, in the constructions of FIGURES 6 and 8 internally reflecting prisms can be used instead of the reflecting mirrors 66, 71 and 72.

Referring again more particularly to FIGURE 8, it will be noted that support arms 76 are provided to allow for mechanically supporting the housing 2 with its enclosed emitters 20. The supports 76 can be placed in any or all the planes defined by the partitions 15 without interfering with the light beams in their paths from the emitters 25 to the photocells 33 and 34.

The advantage of the FIGURE 8 construction as compared with that of FIGURES 1 and 6 is that it can be made shorter in the axial direction at the expense of a somewhat larger diameter. The disadvantage is that the FIGURE 8 construction requires the fabrication of two reflectors 71 and 72 as compared with only one reflector, or no reflectors at all.

No detailed consideration has been given to the structural features of FIGURE 8 for the same reason as applicable to FIGURE 6, however, it should be understood that the support members 76 may be joined to the housing 2 by any of the suitable coupling means heretofore suggested and that when these supporting members are included, the structure is similar to that of FIGURE 1. An essential difference in the construction is that the cells 33 and 34 should be supported on a casing which encloses the whole unit of FIGURE 8 so as to provide a relatively light-tight area. The support members 76 would, in such construction, be attached to the casing and the shaft 10 would project through a suitably formed aperture in one end of the case. The case may be made in two cup portions which threadedly engage one another, whereby the enclosing of the unit would be facilitated and also whereby the support members 76 may be conveniently attached to one portion of the casing prior to joining the two portions. A collar such as that designated by numeral 77 may be provided to hold shaft 10 in position in the bearing block 78. Various mechanical expedients may be used to perfect the specific details of construction, and the suggestions included herein in this regard are exemplary.

In connection with all of the photoelectric sensing embodiments discussed hereinabove, reference has been made to the circuits shown in FIGURE 5 to describe operation. In each instance, it was stated that a switch 41 must be *closed* to energize a particular emitter, and to those of ordinary skill in the art it should be obvious that the switch 41 must remain closed until the multiposition device to be controlled has reached the selected position. If at any time a switch 41 was opened, its associated emitter would be de-energized and as a result no beam would fall upon a receiver. This would cause the motor to stop. In order to use push-buttons and at the same time eliminate the necessity of having an operator continuously press the button, push-button switches of the latching or locking type could be incorporated. However, as pointed out in some detail at the beginning of this description, locking or latching push-buttons have many disadvantages and it is an object of this invention to provide a push-button arrangement for controlling the photoelectric sensing means, and thereby multiposition devices such as rotary file units, which allows for the use of "momentary" push-buttons. In accordance with the teachings of this invention, two systems are provided which allow for the use of such momentary contact push-buttons and these systems are designated hereinafter as system A and system B. The systems are discussed separately below for purposes of clarity.

In order to adapt the photoelectric sensing means of FIGURE 1 for use with system A and to eliminate the need for the latching push-buttons, an additional aperture 19 is placed in the plate 4, opposite each emitter 20. An additional photoelectric cell or radiant energy receiver 80 is mounted on a bracket 80' opposite each aperture 19, the bracket 80' being affixed to wall 38 of cover 36 similarly to bracket 35. The energy control member necessarily includes the edges 82 and 83 of an extended portion 84 which projects radially outward so as to pass in front of the apertures 19.

The circuit diagram for momentary contact push-button system A, applicable to all three photoelectric sensing embodiments is presented schematically in FIGURE 10. The emitters 20 of FIGURE 5 appear as emitters

20 in FIGURE 10. In addition however, push-buttons which are momentarily depressed and spring back to position upon release are shown and designated by the numeral 81. These push-buttons have been substituted for the latching type used in FIGURE 5. Moreover, radiant energy receivers 80 have been added and these receivers are connected in parallel relation to the push-button switches.

In this system, when a particular push-button, 81(*a*) for example, is depressed momentarily, its lamp 20(*a*) is energized and through its aperture 19 illuminates the corresponding photocell 80(*a*) that is connected in parallel with the depressed push-button. The illuminated photocell 80(*a*) becomes conducting when rays are incident thereupon and keeps current flowing through its associated emitter 20(*a*) from the source of current 82 after the push-button has been released. No other emitter than the one selected will be illuminated by this procedure. It should be noted that the circuit of FIGURE 10 is essentially the same as that of FIGURE 5. For this reason only two sets of units consisting of push-buttons 81, emitters 20 and receivers 80 have been presented, and dotted lines have been used to indicate that additional units are coupled to the system.

In accordance with the above example, the emitter 20(*a*) remains energized as long as its rays passing through its aperture 19 keep its photocell 80(*a*) conducting, even though the push-button, which has been released, no longer keeps the circuit closed. However, just before the multiposition device to be controlled reaches the desired position, the edge 82 or 83 of the vane section 84 (FIGURE 4) intercepts and cuts off the light beam emerging from the aperture 19 in front of the lamp 20(*a*) (FIGURE 1) whereupon the photocell 80(*a*) is no longer illuminated. This photocell therefore becomes non-conducting, and opens the circuit that was feeding current to the emitter 20(*a*), and thus emitter 20(*a*) is turned off automatically when the mechanism reaches the desired position.

If a push-button is pressed when the associated emitter is obscured by the vane section 84, the emitter will light up momentarily while the push-button is depressed; but the vane of the photoelectric sensing means and therefore the multi-position device controlled thereby will not move because the position of the vane section 84 prevents any light from reaching the photocells 33 and 34. This is as it should be, because the operator, by pressing the particular push-button has called for the very station presently in the desired position. The lamp will go out as soon as the push-button is released because the corresponding photocell 80 is obscured by the vane and therefore cannot keep its emitter energized. The photoelectric sensing means is therefore ready to receive a new command to proceed to any other desired station as soon as any other push-button is depressed.

The momentary contact push-button system A can, of course, be applied also when glow lamps (e.g. neon lamps) are used instead of filament lamps. Glow lamps have the advantage that they require less current than the filament lamps, with the result that the photocells are required to pass less current. Also photocells passing small amounts of current are more readily available and less costly to manufacture or procure. On the other hand, glow lamps in general emit less light than incandescent lamps of the same physical size, with the result that the photocells must be more sensitive for operation with glow lamps than with filament lamps.

Amplifiers, amplifying circuits, amplifying relays and other amplifying devices can be used with any or all the photocells (or other radiation sensitive devices) that have been described and discussed in this specification. (This applies to the various photoelectric sensing means when used with and without momentary contact push-button systems A or B.) These amplifying circuits and devices can be any one of the standard circuits and devices commonly known and utilized to increase the sensitivity and/or decrease the response time of the photocells or other radiant energy receivers. Amplification will be useful in applications of the photoelectric sensing means where extremely high accuracy is required for positioning the mechanism. In such cases, the high accuracy can be obtained by very small apertures which cut down the illumination of the photocells to the point where amplification is necessary to secure reliable and fast response. However, for almost all practical applications such as the application of the photoelectric sensing means to control a rotary file unit, amplification and amplifiers are not necessary, and the simple circuits shown in FIGURES 5, 10, 13 and 14 are sufficient. This simplicity of circuit design is one of the features of the invention described herein. Nevertheless, this invention includes the use of amplifiers, amplifying circuits, and amplifying devices when necessary.

If reference is now again made to the vane sector 84 shown in FIGURE 4, it will be seen that the edge 83 lies on the same radial line as the edge 28. Likewise the edge 82 lies on the same radial line as the edge 27. Consequently the energy control member or vane obscures the apertures 19 at the same instant that the vane obscures the other apertures 17 or 18 (as the case may be), since apertures 19 lie on the same radius as associated apertures 17 and 18. In other words, the illuminated photocell 80 has its light cut off at the same instant that the illuminated photocell 33 or 34 has its light cut off. This imposes the restriction that the angular positions of the apertures 19 must be exactly the same as the angular positions of the apertures 17 and 18, and that the apertures 19 be placed angularly with the same accuracy required for the apertures 17 and 18.

The aforementioned accuracy requirement for the angular location of the apertures 19 can be eliminated by utilizing an energy control member as shown in FIGURE 11. This energy control member 90 is the same as the member 22 (FIGURE 4) except that the edge 83 has been modified into an edge 91 which lies at an angle less than ϕ; and the edge 82 has been modified into an edge 92 which lies at an angle less than ϕ. In other words, the vane sector 84 (FIGURE 4) has been narrowed to become the vane piece 93 (FIGURE 11). The positions at which the energy control member 90 stops are now determined by the edges 27 and 28 as was the case for the energy control member 22 when used in a FIGURE 1 construction with a latching push-button system. The motor 205 is stopped when the illuminated cell 33 or 34 is cut off by the edge 27 or 28. A short time later, while the mechanism is coasting to its stationary position corresponding to the middle of the vane section 93, the illuminated cell 80 is cut off by the edge 91 or 92. This eliminates the necessity for the accurate angular location of the apertures 19 and also eliminates the necessity for accurate location or setting of the edges 91 and 92.

The energy control member 94 shown in FIGURE 12 is still another and more advantageous design for the FIGURE 1 construction where used with momentary contact push-button system A. The edges 82 and 83 of the vane sector 84 (FIGURE 4) remain at the angle ϕ. However, the edge 28 of FIGURE 4 is modified to form an edge 95 at an angle less than ϕ as shown in FIGURE 12, the edge 27 modified to form an edge 96 also at an angle less than ϕ. The angular amount of these displacements is not critical and need not be done with any accuracy; i.e. the angular locations of the edges 95 and 96 need not be made with any accuracy, provided only that they are located at angles comfortably less than ϕ.

With the vane 94 just described, the photoelectric sensing means and thereby the multi-position device which it controls is stopped in its desired position only by the edges 82 and 83 and not by the edges 95 and 96. As soon as the edge 82 (or 83) passes in front of, and obscures, the aperture 19 corresponding to the desired station, the corre-

sponding photocell 80 becomes dark, whereupon the illuminated lamp 20 is turned off, the illuminated photocell 32 or 33 is the de-activated relays 43 and 44 open, and the motor 205 stops. In other words, instead of stopping the motor by intercepting the light that is falling upon the photocell 33 or 34, the motor has been stopped by turning off the lamp that was illuminating that photocell.

The advantages of the last described vane design of FIGURE 12 are: (1) only one set of apertures 19 must be accurately located in angle, instead of the two sets of apertures 17 and 18; (2) the apertures 17 and 18 can be made larger so as to make more light available to illuminate the photocells 33 and 34 (this permits photocells of less sensitivity to be used, or it permits the lamps to be operated at lower current and lower temperature, thereby increasing lamp life); and (3) the accuracy with which the multi-position device stops in its desired position is increased by the use of vane 94, because the apertures 19 are located on a circle of larger diameter than the circles of apertures 17 and 18.

As stated above, an additional embodiment of the present invention relates to another system allowing for use of momentary push-buttons to control the photoelectric sensing means provided by the invention. This additional system, system B, eliminates the necessity for additional photocells 80, additional apertures 19, and an extended vane portion as required by system A.

Momentary contact push-button system B uses glow lamps instead of incandescent filament lamps as radiant energy emitters in the photoelectric sensing means. By a glow lamp is meant an electric discharge lamp consisting of two electrodes inserted in a glass bulb containing one or more "rare" or inert gases. When a high enough voltage is applied across the electrodes, electrons and positively charged particles in the gas carry current between the electrodes, or, to phrase it another way, the tube fires and as a result light is produced in the glow lamp. Glow lamps such as those commercially available, are usually filled with neon or argon.

It is a known characteristic of glow lamps that they have a critical "breakdown" or "firing" or starting voltage below which the lamp may be considered an open circuit. When this starting voltage is reached, the discharge begins and light is emitted. However, after the discharge has once started and light is emitted, the discharge can be maintained and light will continue to be emitted at an appreciably lower voltage than the breakdown voltage. In other words glow lamps have an "extinction" potential below the "breakdown" or firing potential. For example, the commercially available lamp type T–2, which is a 1/25 watt neon lamp, requires a D.C. starting voltage of 73 volts, but can be maintained firing at a voltage as low as 55 volts. This property of glow lamps is used in the present embodiment of the invention.

FIGURE 13 shows the circuit diagram for the momentary contact push-button system B. Glow lamps 101 have been substituted for the lamps 20 in FIGURE 5. Each of the glow lamps 101 is connected as shown to one of a set of momentary contact push-buttons 81. Each glow lamp 101 is connected also to one of a series of diodes 102. The diodes can be of simple type with a low current rating because the current drawn by each glow lamp is low. (By diodes is here meant any device which allows current to pass in one direction only, such as for example a germanium or silicon diode or rectifier, or some other form of crystal diode or transistor diode, or solid state rectifier or for that matter a vacuum tube diode or rectifier.) In practice, the simplest and most inexpensive and rugged type of diode, such as a silicon or germanium crystal, will suffice.

Batteries 103 and 104 serve as two sources of D.C. voltage and current. These sources may be batteries as indicated in solid lines in FIGURE 13, or they may be part of a potentiometer network supplied with D.C. power, or they may be rectifier circuits supplied from an A.C. power line through rectifiers or a rectifier bridge. Source 103 furnishes the starting voltage of the glow lamp, and source 104 furnishes the maintaining voltage for the glow lamps, which maintaining voltage, as explained above is lower than the starting voltage. The current limiting resistor 105 is the resistance that is customarily put in series with a glow lamp to limit the current drawn by such lamp.

The operation of the circuit is as follows. When any one of the push-buttons, such as 81(*a*) is depressed momentarily, the corresponding glow lamp 101(*a*) receives its starting voltage from battery or source 103. Although all the glow lamps are in a sense connected in parallel with each other, none of them except 101(*a*) is "fired" because the polarity of the diodes 102 prevents the D.C. current of source 103 from passing through any of the glow lamps except 101(*a*). When glow lamp 101(*a*) is "fired" its rays are cast upon either photocell or receiver 33 or 34 and the illuminated cell causes its associated relay 43 or 44 to be energized whereupon motor 205 is started in the direction of shortest travel to the desired station. In other words, when photocell 33 or 34 is illuminated and becomes conducting, it closes the circuit through the source of potential 42 to either the relay 43 or 44, which starts the motor 205 in the proper direction. Like components in FIGURES 5, 13 and 14 are designated by like numerals and it should be understood that operation of the motor circuit is the same in FIGURES 5, 13 and 14, the difference lying in the fact that momentary push-buttons may be used, and glow lamps have been substituted for incandescent lamps. Of course, the circuitry for energizing the glow lamps of FIGURE 13 differs from that of FIGURE 5, and is an important aspect of the present invention.

The motor circuit of FIGURES 13 and 14 is not exactly the same because, in accordance with system B provided by this invention, a relay 107 has been placed in series with both photocells 33 and 34 and the source of potential 42. Due to the series connection, this relay is energized whenever one of the cells 33 or 34 is rendered conductive by the incidence of radiation thereon. When the relay 107 is energized and the contacts of relay 107 are closed, the maintaining voltage from source 104 is simultaneously applied to all of the glow lamps. However, only the glow lamp 101(*a*) which has already been started by the starting voltage from source 103 (applied through the momentary contact push-button 81(*a*)) maintains its glow discharge. All the other glow lamps remain dark because the maintaining voltage is not enough to start or "fire" them. The maintaining voltage is adjusted to a value between the firing and extinction potentials of the glow lamp used.

Any glow lamp which is energized by momentary depression of a push-button 81 remains energized until the vane of the photoelectric sensing means cuts off the light radiant upon photocell 33 or 34, whereupon the photocell ceases to conduct and relay 107 is de-energized. The contacts of relay 107 then open, the maintaining voltage from source 104 is interrupted, and the glow lamp which was energized is turned off. The photoelectric sensing means is then ready to receive another command to proceed to any other station by the momentary depression of one of the pushbuttons.

If pushbutton 81(*a*) of the above example should be depressed again while the controlled multi-position device is in the position corresponding to that push-button, the glow lamp 101(*a*) will be illuminated momentarily while the push-button remains depressed, but the vane and device being controlled will not move because the vane prevents any light from reaching either of the photocells 33 or 34. Since these photocells or receivers are not illuminated, the relay 107 is not actuated, its contacts remain open, the maintaining voltage cannot flow to any of the glow lamps, and the glow lamp 101(*a*)

therefore is de-energized as soon as the push-button 31(*a*) is released, which is as it should be because the multi-position device is already at the station that the operator selected.

Momentary push-button system B may be modified such that no diodes are required. In the electrical circuit of FIGURE 13 each diode can be replaced by a capacitor, and the source 104 of the maintaining voltage can be changed from D.C. to A.C. The capacitors then conduct the maintaining voltage originating from source 104 because this voltage is alternating, but the capacitors do not conduct any current from source 103 because this voltage is direct. Consequently the capacitors function in the circuit in a way analogous to the diodes, and the momentary contact push-button system B operates essentially as it did before, except that diodes are not required.

Although momentary push-button systems A and B have been specifically referred to with regard to control of the photoelectric sensing means of FIGURE 1, it should be understood that those systems function equally well with the embodiments of FIGURES 6 and 8. Of course, if system A is used, the energy control members of FIGURES 6 and 8 may be modified in accordance with the teachings of this invention just as the energy control member of FIGURE 1 was modified as explained with regard to FIGURES 11 and 12. That is, an extension should be made on the blocking member to block the energy emerging from the additional aperture provided in accordance with the teachings of system A.

Aside from utilization of the circuits of FIGURES 10 and 13 to control a motor drive mechanism as discussed above, it should be noted that these circuits may serve as memory devices. Referring more specifically to FIGURE 10, when any one of the momentary contact push-buttons 31 is depressed, the circuit "remembers" which push-button was depressed because the corresponding emitter 20 remains energized through its corresponding receiver 30. The circuit retains this memory until such time as a vane or other opaque object is interposed between the emitter 20 and the receiver 30, whereupon the interruption of the radiant energy going from the emitter 20 to the receiver 30 erases the memory. This system is capable of remembering the depression of more than one momentary contact push-button, because the second or third, etc. push-button can be depressed after the first has been depressed and before the first memory has been erased. The memory of each depressed push-button is retained by the system until such time as that particular memory is erased by the interruption of the radiant energy traveling between the particular emitter and its associated receiver.

Similarly, the circuit shown in FIGURE 13 can be considered a memory device which remembers which momentary push-button (or push-buttons) have been depressed. In the case of this system (FIGURE 13), however, the memory of all depressed push-buttons is erased simultaneously by the momentary interruption of the circuit that carries the current from battery 104. One difference between the memory system of FIGURE 13 and the memory system of FIGURE 10 is that erasure of the memory in FIGURE 13 is accomplished by opening an electrical switch momentarily, whereas erasure of the memory in FIGURE 10 is accomplished by the insertion or passage of an opaque vane or object in the space between a particular emitter and its corresponding receiver.

The memory aspects of FIGURES 10 and 13 may be utilized in a system where an operator wishes to call for a card, envelope, letter of other object to be placed or located in a given one of a number of locations or positions. In each one of these positions or locations, there can be located an emitter 20 and a corresponding receiver 30 as in the circuit diagram of FIGURE 10. Momentary contact push-buttons corresponding to each one of the aforementioned emitters and receivers would be placed in front of the operator. When the operator depresses a

particular push-button, a corresponding emitter 20 would be energized and this would signify to another operator that a card, envelope or letter was called for at that particular location. The emitter 20 would remain illuminated until it is satisfied by the card, letter or envelope being placed at that location between that particular emitter 20 and its receiver 30; whereupon, the demand for a card in that location having been satisfied, the memory of that demand would be automatically erased. That is, light traveling between an emitter and associated receiver would be interrupted and the emitter would be de-energized. It should be noted that the operator can call for cards or other objects to be placed at more than one location at the same time by depressing any number of push-buttons either simultaneously or sequentially. In this application the memory of one push-button and its associated emitter and receiver is independent of the memory of other push-buttons.

An alternative to the use of pushbuttons (latching and momentary) is the following:

The operator signals the desired station by dialing the number of the station on a dial similar to a telephone dial. (The station number may have more than one digit, for example 64, or 273 or 2409.) The dial actuates step-switches or rotary step-switches such as are commonly used to select circuits in telephone systems or similar systems, such as those manufactured and sold by Automatic Electric Company, of Chicago, Illinois. The step-switches (or step-switch) closes the circuit to the light emitter (bulb) corresponding to the desired station, thereby lighting the bulb as though the operator had depressed a corresponding push button.

These step switches are preferably of the type that do not make contact until they reach their desired position, at which time they make contact with the desired contact point. Likewise when the step switch returns to its home position, it does not make contact with any contact points en route. This is desirable in the photoelectric switch selector because the lamps at the intermediate positions are not illuminated as the step switch moves to illuminate the desired pre-selected lamp.

This dial system has advantage when there are a large number of stations, for example, several hundred, in which case it is easier for the operator to dial the station number like a telephone number, instead of finding the desired button in a confusing bank of many buttons.

What is claimed is:

1. A system for automatically controlling a rotatable device having a finite number of selectable positions, said system comprising power means to move said device to said positions, a plurality of sources of radiant energy corresponding to said positions, radiant energy receiving means coupled to said power means for controlling said power means in response to radiant energy received thereby, said radiant energy receiving means including radiant energy receivers, radiant energy control means comprising a member having a plurality of sectors for directing radiant energy emerging from one of said sources upon one of said receivers at a time whereby said power means moves said device along the shortest angular route to the selected position, switching means for selectively energizing said sources, said switching means comprising push-button switches of the momentary type, and radiant energy receivers associated with said sources for maintaining said sources of energy energized after said push-button switches cease to cause energization of said sources.

2. A system for automatically controlling a rotatable device as defined in claim 1 wherein said switching means further includes means to maintain said sources energized after said push-button switches cease to cause energization of said sources.

3. An automatically controlled storage apparatus comprising a rotatable frame having a plurality of carrying means supported about the periphery thereof at spaced intervals and a shaft coupled thereto, power means cou-

pled to said shaft for rotating said frame to selectable positions to dispose each carrying means at a given location, a radiant energy sensing device for controlling said power means and connected to said shaft and including a plurality of sources of radiant energy corresponding to said carrying means, radiant energy receiving means comprising two radiant energy receivers, means coupled between said receivers and said power means for causing the latter to drive said frame in opposite directions corresponding to the receiver energized, means movable with said shaft for controlling the radiant energy passed from said sources to said receiving means, comprising a member having a plurality of sections for directing energy upon one of said two receivers; and switching means including push-button switches for selectively energizing said sources, whereby the radiant energy from the selected source directed to one of said receivers causes the power means to drive the frame to the selected position via the shortest angular course.

4. A control unit for selectively positioning a rotatable device having a finite number of selectable positions, said unit comprising rotatable shaft means adapted to be coupled to said rotatable device; power means for driving said rotatable device and said shaft means; a plurality of radiant energy sources disposed around said shaft means in a corresponding relation to said positions; switching means for selectively energizing said sources; radiant energy receiving means comprising two radiant energy receivers spaced from said sources; means coupled between said receivers and said power means for causing said power means to drive said shaft in opposite directions according to which receiver is energized; and radiant energy control means coupled to said shaft means for rotation therewith and disposed in the path of energy traveling from said sources to said receiving means and having an energy blocking sector positioned so that energy is cut off from said energy receiving means when a selected position is reached, said radiant energy control means having a plurality of sectors for directing energy emerging from one of said sources upon one or another of said two receivers whereby said shaft is driven to the selected position via the shortest angular route.

5. A control unit for selectively positioning a rotatable device having a finite number of selectable positions, said unit comprising rotatable shaft means adapted to be coupled to said rotatable device; power means for driving said rotatable device and said shaft means; a plurality of radiant energy sources disposed around said shaft means in a corresponding relation to said positions; switching means for selectively energizing said sources; radiant energy receiving means comprising two radiant energy receivers spaced from said sources; means coupled between said receivers and said power means for causing said power means to drive said shaft in opposite directions according to which receiver is energized; and radiant energy control means coupled to said shaft means for rotation therewith and disposed in the path of energy traveling from said sources to said receiving means and having an energy blocking sector positioned so that energy is cut off from said energy receiving means when a selected position is reached, said radiant energy control means having a plurality of sectors for directing energy emerging from one of said sources upon one or another of said two receivers whereby said shaft is driven to the selected position via the shortest angular route; each of said radiant energy sources comprising energizable radiant energy emitters having different breakdown and extinction potentials; said switching means comprising a push-button switch of the momentary type coupled to each of said emitters, means for generating a firing potential coupled to said switchs and to said emitters, means for generating a potential sufficient to maintain said emitters in an energized state, but insufficient to fire said emitters, and means coupled to said receiving means for connecting said emitters with the means for generating a maintaining potential when energy is incident upon said receiving means, whereby when a push-button is activated to connect an emitter to said means for generating a firing potential the emitter is energized and when energy from said emitters is incident upon said receiving means, said emitters are coupled to said means for generating a maintaining potential and remain energized after said push-button switch is deactivated.

6. A control unit for selectively positioning a rotatable device as defined in claim 5 wherein said radiant energy emitters are gaseous discharge tubes.

7. A control unit for selectively positioning a rotatable device having a finite number of selectable positions, said unit comprising rotatable shaft means adapted to be coupled to said rotatable device, power means for driving said rotatable device and said shaft means, a housing surrounding part of said shaft means, a plurality of energizable radiant energy emitters disposed in circumferentially spaced relation around said shaft means, said emitters being substantially isolated except for a least one aperture associated with each emitter corresponding to said positions, said apertures being disposed on a given face of said housing, switching means for selectively energizing said radiant energy sources, means including two primary radiant energy receivers spaced from said housing for controlling said power means in response to radiant energy incident upon said receivers, and a radiant energy control member coupled to said shaft means, said radiant energy control member being disposed in the path of energy traveling between an energized source and said receivers and having energy transmitting and blocking sectors such that energy is cut off from said primary receivers when a selected position is reached.

8. A control unit for selectively positioning a rotatable device as defined in claim 7 wherein said energy control member has a plurality of energy transmitting sectors for directing energy to one or the other of said receivers whereby said shaft means and said rotatable device are driven to a selected position via the shortest angular route.

9. A control unit for selectively positioning a rotatable device as defined in claim 7 wherein at least two spaced apertures on the same radii communicate with each emitter on a face of said housing at least substantially perpendicular to said shaft means, said apertures defining two concentric circles on said face of radii R and P respectively, and wherein said energy control member comprises a first substantially semi-circular section which does not transmit radiant energy, said first section having a radius between R and P, a second substantially semi-circular section of a radius less than R and P that also does not transmit radiant energy, and a third arcuate section having an internal radius greater than R and P that also does not transmit radiant energy, said third section surrounding said second section whereby an energy transmitting arcuate section is defined by the outer periphery of the second section and the inner periphery of the third section.

10. A control unit for selectively positioning a rotatable device as defined in claim 9 wherein said energy control member has a substantially triangularly shaped non-energy transmitting section adjacent said first, second and third sections, said triangular section having a vertex angle substantially corresponding to twice the inherent angular displacement of said shaft means which occurs when said power means is de-energized after driving said shaft means to a selected position.

11. A control unit for selectively positioning a rotatable device as defined in claim 7 wherein said energy control member has at least one reflecting surface for directing energy to one or the other of said receivers whereby said shaft means and said rotatable device are driven to a selected position via the shortest angular route.

12. A control unit for selectively positioning a rotatable device as defined in claim 11 wherein an aperture com-

municates with each emitter on a face of said housing at least substantially perpendicular to said shaft means, said apertures defining a circle on said face, and wherein said energy control member comprises a hub carried on said shaft means, a substantially semicircular reflector for directing energy upon one of said receivers, said reflector being linked to said hub by said energy blocking sector.

13. A control unit for selectively positioning a rotatable device as defined in claim 12 wherein said blocking sector subtends an arc substantially equal to at least twice the inherent angular displacement of said shaft means which occurs when said power means is de-energized after driving said shaft means.

14. A control unit for selectively positioning a rotatable device as defined in claim 7 wherein said housing is cylindrical, and said apertures communicate with each of said emitters on a given circle on the arcuate wall of said housing, and wherein said energy control member has at least two substantially semi-circular reflecting surfaces surrounding said cylindrical wall and disposed at different angles with respect thereto whereby energy emerging from an aperture is directed upon one or the other of said receivers.

15. A control unit for selectively positioning a rotatable device as defined in claim 7 wherein said combination further includes potential means for energizing said receivers, wherein another aperture in addition to said one is provided on said face to communicate with each of said emitters, wherein said energy control means includes a sector for blocking energy emerging from said additional aperture, and wherein said switching means comprises a plurality of push-button switches of the momentary type, one switch coupled to each of said emitters and the potential means for initially energizing said emitters, and a plurality of secondary radiant energy receivers disposed opposite each of said additional apertures whereby energy incident thereupon may be blocked therefrom by said energy control member, said secondary receivers being coupled to said emitters and said switches whereby said receivers cause said potential means to keep said emitters energized after said push-button switches are de-activated and while energy is incident upon said receivers.

16. A control unit for selectively positioning a rotatable device as defined in claim 15 wherein said sector of said energy control means for blocking energy from said secondary receivers is of a greater effective blocking area than said sector for cutting off energy from said primary receivers.

17. A control unit for selectively positioning a rotatable device as defined in claim 15 wherein said sector of said energy control means for blocking energy from said primary receivers is of a lesser effective blocking area than said sector for cutting off energy from said primary receivers.

18. A control unit for selectively positioning a rotatable device as defined in claim 7 wherein means for controlling said power means in response to radiant energy incident upon said receivers also includes means for applying an electrical potential to said receivers, and switching means coupled to the potential means and each of said receivers and activated thereby for selectively controlling the direction in which said power means drives said shaft means and said rotatable device.

19. A momentary push-button controlled circuit for maintaining energization of any one of a plurality of energizable radiant energy emitters having a separate breakdown and extinction potential and generating radiant energy incident upon radiant energy receiving means, said circuit comprising a first source of electrical potential of a value sufficient to cause breakdown and energization of said emitters, a second source of electrical potential of a value above the extinction potential but below the breakdown potential of said emitters, a plurality of activatable push-button switches of the momentary type coupled to said emitters and said first source of electrical potential so that activation of any one said switches causes a given emitter to become energized, and means coupled to said radiant energy receiving means for coupling said emitters with said second source of electrical potential whenever radiant energy is incident upon said radiant energy receiving means.

20. A momentary push-button controlled circuit as defined in claim 19 wherein said switches are each serially coupled to a different one of said emitters thereby forming a unit, and said units are coupled in parallel across said first source, and wherein a unitary means is coupled to said radiant energy receiving means for coupling said emitters with said second source and means are provided in the coupling between said unitary means and said emitters for only passing potential from said first source to an emitter coupled thereto by its associated switch.

21. A momentary push-button controlled circuit as defined in claim 20 wherein said means for only passing potential from said first source to an emitter coupled thereto by its associated switch comprises a diode.

22. A momentary push-button controlled circuit as defined in claim 20 wherein said first source is A.C. and wherein said means for only passing potential from said first source to an emitter coupled thereto by its associated switch comprises a capacitor.

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