

June 4, 1935.

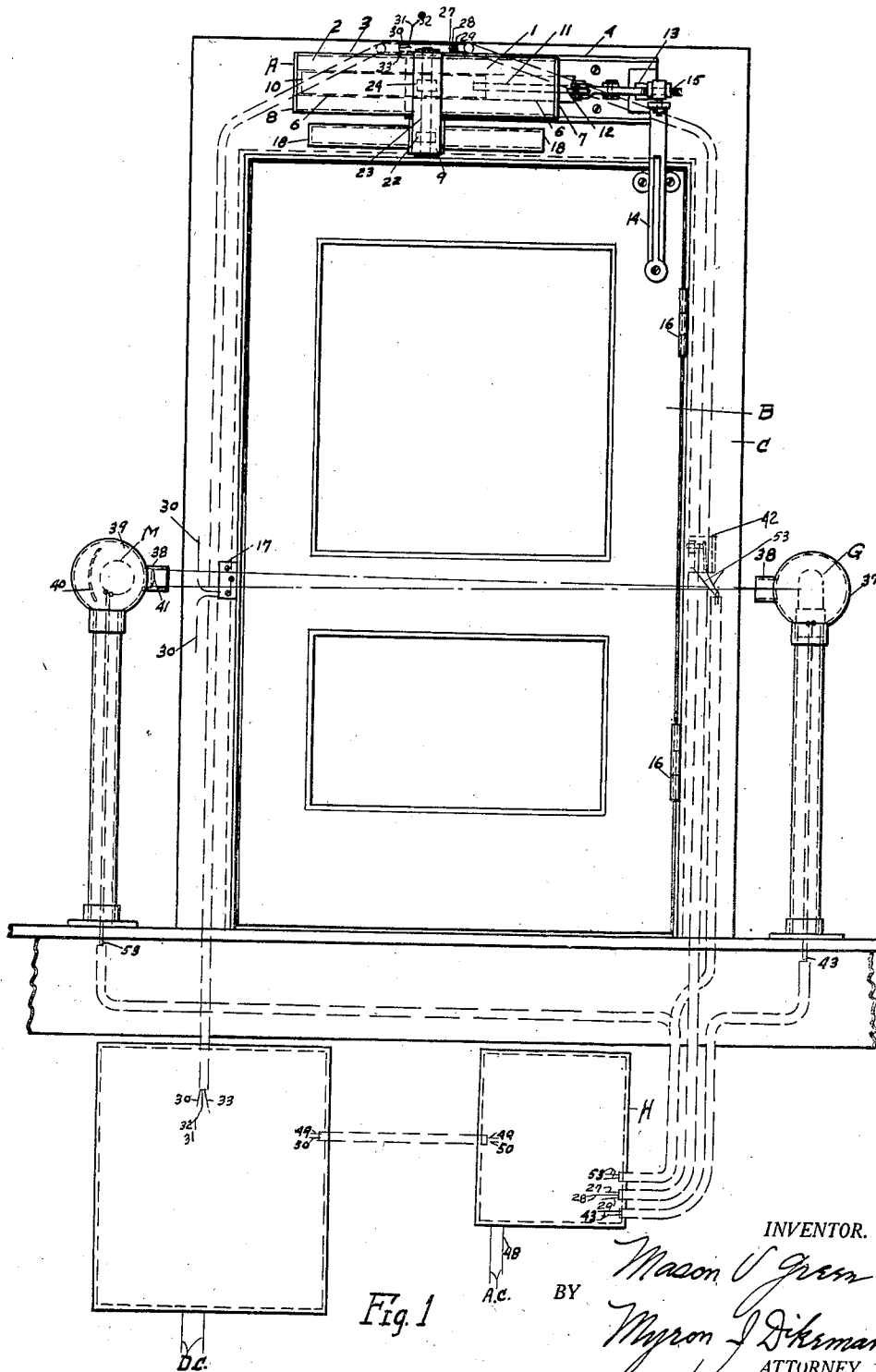
M. V. GREEN

2,003,533

ELECTRIC DOOR OPENING DEVICE

Filed March 7, 1932

5 Sheets-Sheet 1



June 4, 1935.

M. V. GREEN

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ELECTRIC DOOR OPENING DEVICE

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5 Sheets-Sheet 2

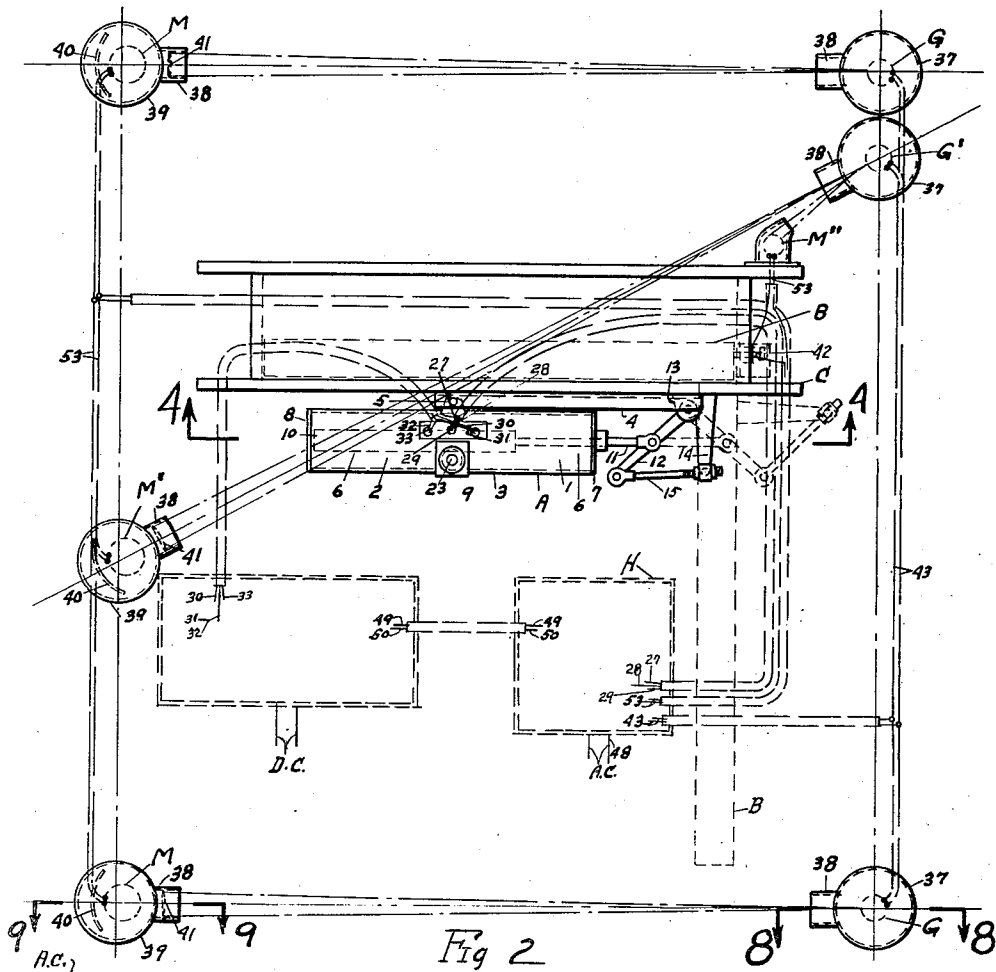


Fig. 2

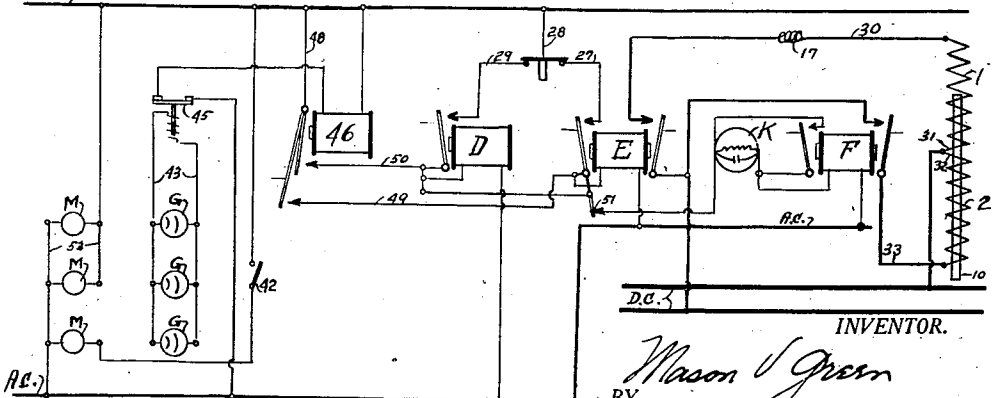


Fig. 16

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**June 4, 1935.**

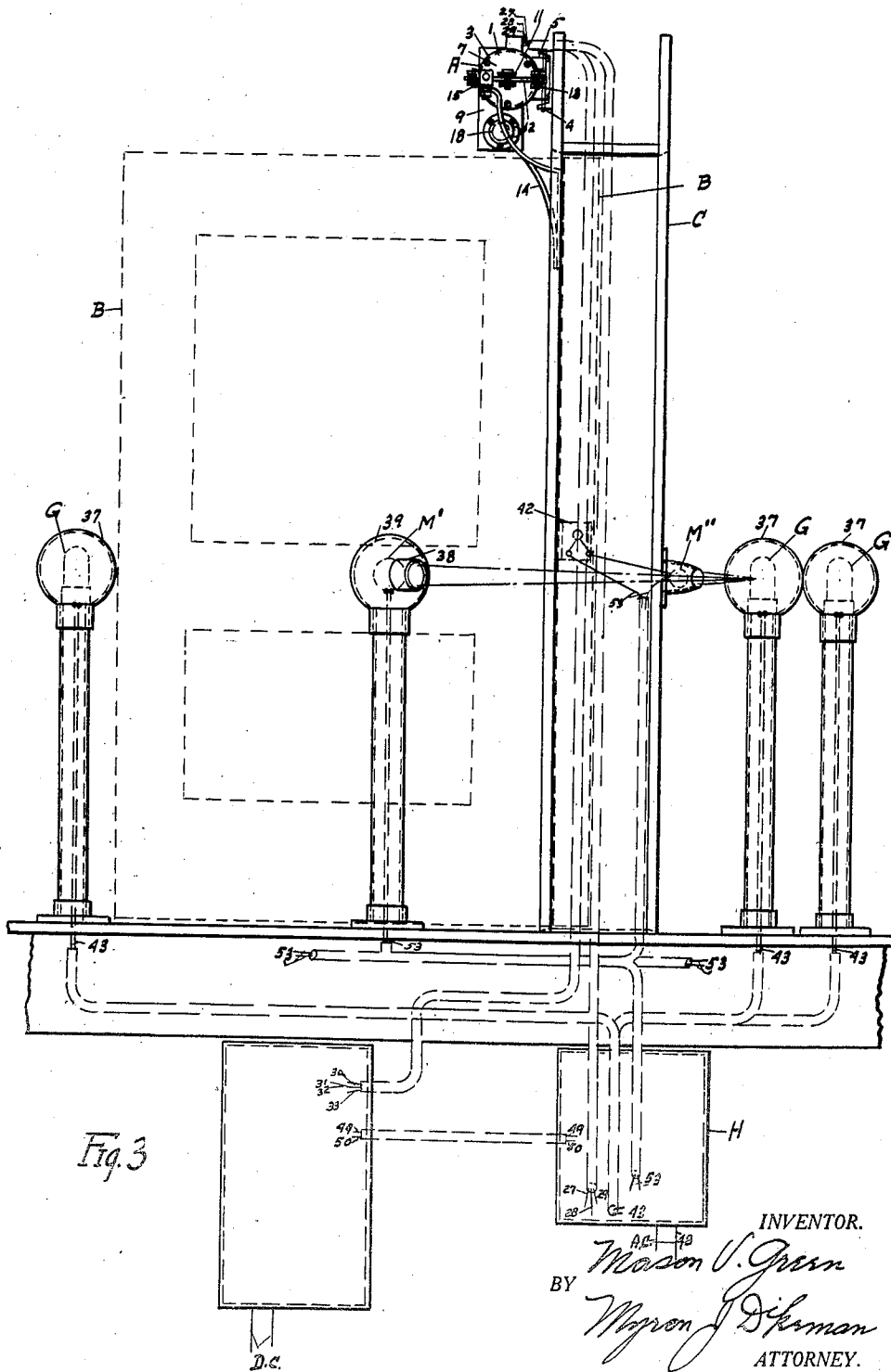
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# ELECTRIC DOOR OPENING DEVICE

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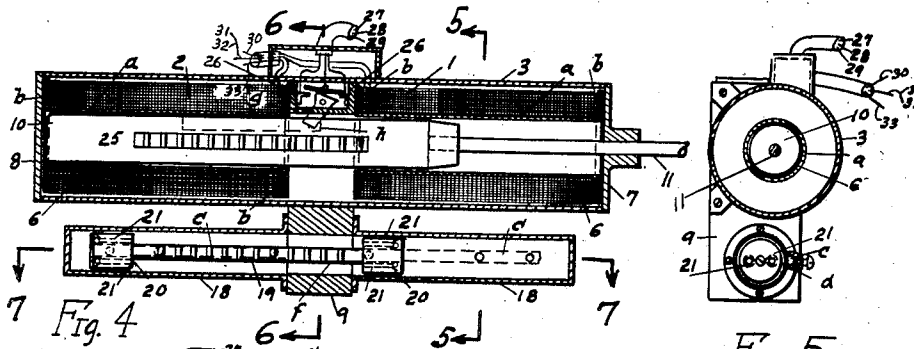
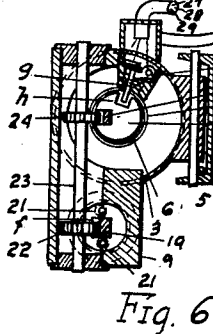
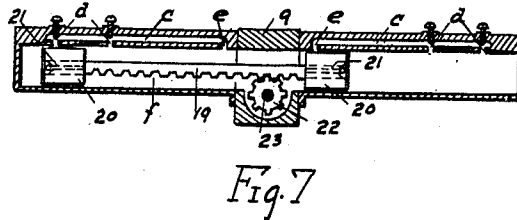
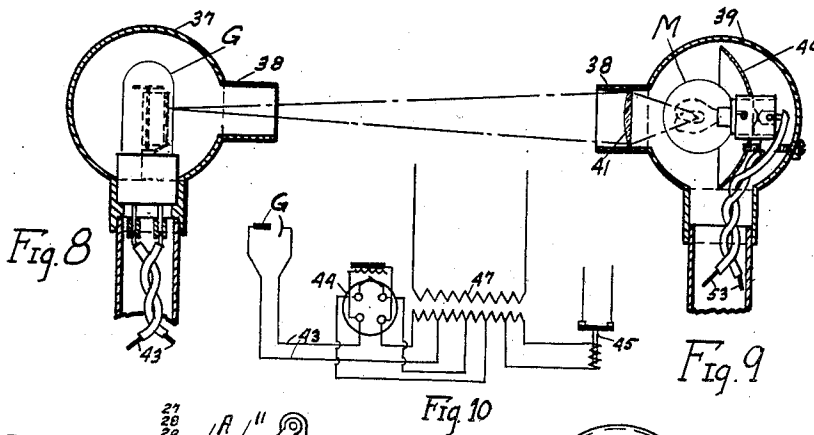
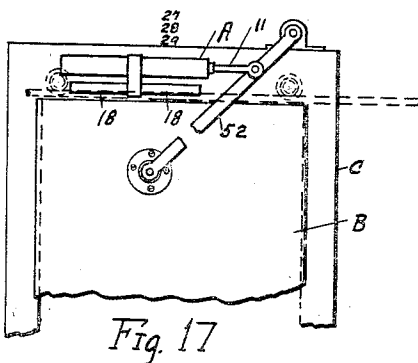
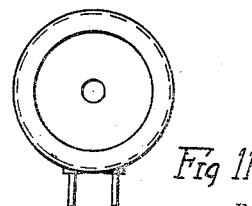
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ELECTRIC DOOR OPENING DEVICE

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ELECTRIC DOOR OPENING DEVICE

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5 Sheets-Sheet 5

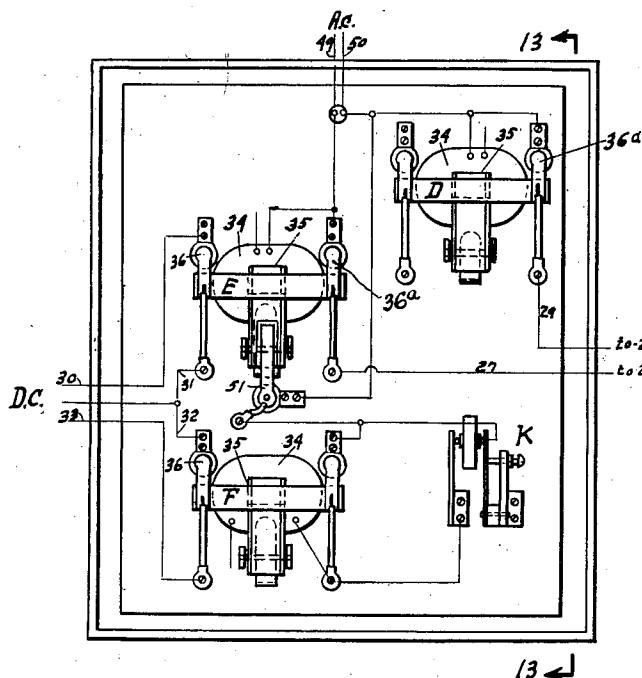


Fig. 12

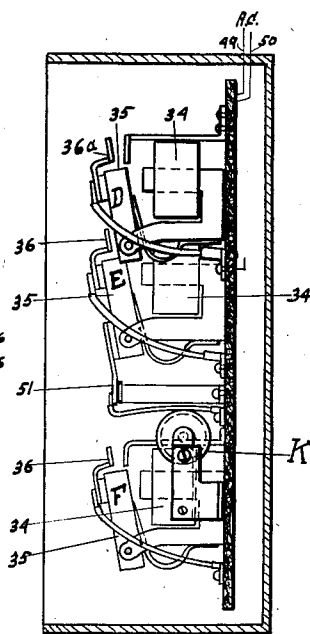


Fig. 13

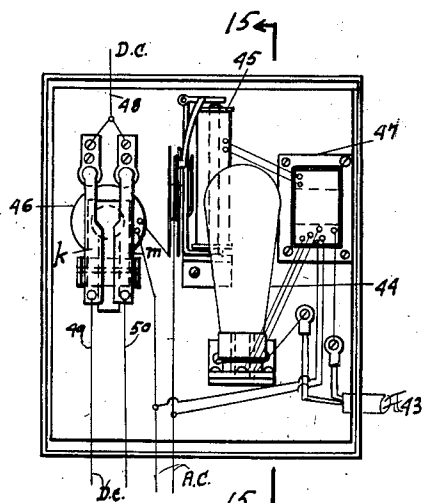


Fig. 14

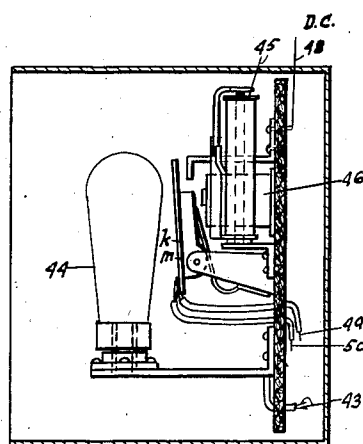


Fig. 15

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## UNITED STATES PATENT OFFICE

2,003,533

## ELECTRIC DOOR OPENING DEVICE

Mason V. Green, Lansing, Mich., assignor to  
Frank D. Hayes, Lansing, Mich., as trustee for  
F. D. Hayes Electric Company

Application March 7, 1932, Serial No. 597,100

4 Claims. (Cl. 268—65)

The object of my invention is to provide a door opening device that will operate automatically for opening and closing a door, either of the swinging or the sliding type, and without the aid of any manual means.

Another object is to produce an automatic door opener operated by an electric solenoid mechanism controlled by photo-electric cell and relay instruments, so adjusted that the approach of any person or object will automatically trip the sensitive relays and operate the mechanism for both opening and closing the door.

A further object is to produce an automatic door opener that is silent and noiseless, suitable for use in hospitals and like places, and that will also allow the door to be opened manually when the electric circuits are disconnected.

These several objects are attained in the preferred form by the construction and arrangement of parts more fully hereinafter set forth.

Similar parts on all drawings are marked by similar numerals or letters.

Fig. 1 is a front view of the door with the operating mechanism mounted thereon showing the general arrangement of the installed units.

Fig. 2 is a top view of the assembled door and operating mechanism showing the relative horizontal position of the photo-electric cells and lighting units with respect to the door opening.

Fig. 3 is a side view of the door and inclosing door casing showing the relative vertical positions of the cells and operating mechanism.

Fig. 4 is a vertical sectional view through the solenoid taken on the line 4—4 of the Fig. 2, showing the interior arrangement of the operating of the solenoid mechanism and connected retarding cylinders.

Fig. 5 is a cross sectional view of the solenoid taken on the line 5—5 of the Fig. 4 showing the operating plungers of the solenoid unit and the liquid escape passage in the retarding cylinders.

Fig. 6 is also a cross sectional view of the solenoid section taken on the line 6—6 of Fig. 4, showing the gear connection between the two units.

Fig. 7 is a horizontal sectional view taken on the line 7—7 of the Fig. 4 showing the liquid escape passages and the regulating valves mounted therein.

Fig. 8 is a vertical sectional view through the casing head taken on the line 8—8 of the Fig. 2, showing one of the photo-electric cells mounted therein.

Fig. 9 is a vertical sectional view through the opposite casing head taken on the line 9—9 of

the Fig. 2, the electric light bulb of the source light unit with the reflector and lens mounted therewith.

Fig. 10 illustrates the electric wiring of the cell unit with a sensitive cell relay instrument with which the photo-electric cell is operated.

Fig. 11 shows an alternate form of photo-electric cell of another type, that may be substituted for the cell shown in Fig. 8 if desired.

Fig. 12 is a front view of the control contactor box showing the general arrangement of the circuit contactors mounted therein, and their circuit connections.

Fig. 13 is a vertical sectional view taken through the contactor box showing the relative position of the moving parts of the control contactors.

Fig. 14 is a front view of the sensitive photo-electric relay which operates with the cell, showing the general arrangement of the electrical units mounted therein.

Fig. 15 is a vertical sectional view through the sensitive relay box taken on the line 15—15 of Fig. 14 showing the relative position of the units mounted therein.

Fig. 16 shows the wiring diagram for the entire instrument set-up, showing the direct current circuit for the solenoid coils separated from the electric circuit through the electrical instruments which control and regulate it.

Fig. 17 illustrates the application of the door opening mechanism applied to a sliding door panel instead of the swinging door previously illustrated.

In general, my device comprises a double solenoid door operating mechanism suitable for mounting on the top door casing head, and is provided with exterior operating parts mechanically connected to the door panel, near the hinged edge thereof, the double solenoids being operative in both directions by separate electric currents applied thereto alternately, to the respective solenoid coils, said circuits being regulated and controlled automatically by means of connected photo-electric cells and cell relay instruments used in combination with a fixed light source. The light source being reflected upon the cells, and the sensitive relays connected thereto being operative for controlling the instrument electric circuit, when the light rays are broken. The cells with their respective light source are arranged in pairs, one pair located on each side of the swinging door panel, so that the light rays may be broken by a person passing or approaching the door from either side, thus operating the connected sensitive cell relay and door opening

mechanism automatically. The device is preferably divided into two separated electric circuits, preferably a direct current circuit for the solenoid door operating coils, and preferably an alternating current circuit for the lighting and operating instrument units which control the flow of current through the solenoid circuit. However, the type of electric current is not essential to the mechanical operation of the device. In the drawings I have shown the control instruments and the sensitive cell relay units below the door frame to indicate they are preferably to be installed within the basement, although they may be installed in any place.

I will now describe more fully the detailed construction of my device, referring to the drawings and the marks thereon.

The door operating unit A comprises right and left solenoid coils 1 and 2 fixedly mounted in the opposite ends of a rigid metal tubular housing 3, the coil ends being slightly separated at the center. The housing 3 is pivotally mounted on a rigid wall bracket 4 through a vertical pivot bearing 5 attached thereto near the center of the housing. The wall bracket 4 is provided with screw holes for fixedly mounting same on door casing head as shown in Fig. 1, thus providing a permanent but adjustable mounting for the coil unit A. The coils 1 and 2 are each provided with a hollow tubular by-pass core 6, preferably made of thin brass tubing *a* having fiber end collars *b* fixedly mounted thereon, the cores being positioned lengthwise through the centers of the coils with their axis coinciding with the axis of the cylindrical housing 3, forming a continuous cylindrical passage throughout both the solenoid sections, the coils 1 and 2 being retained within the housing 3 by the end collar plates 7 and 8 fixedly attached to the housing ends and the center gear housing 9. Within the double solenoid cores 6 is slidably mounted a cylindrical iron armature plunger 10, closely fitted to the core walls yet free to slide endwise therein, the plunger 10 being of a shorter length than the assembled coils and inclosing housing 3, is capable of reciprocating endwise therein under the magnetic attraction of the respective solenoid coils when the electric current is connected alternately therewith.

Fixedly attached to one end of the armature plunger 10 is an operating rod 11, positioned along the axis of the plunger, and is extended outside the casing 3 through a center bearing opening formed in the end collar 7. The operating rod 11 is pivotally attached to an operating bar 12, near the center thereof, said bar 12 being mounted at one end thereof to the face of the wall bracket 4 by a fixed pivot bearing 13, the bar being capable of a horizontal swinging movement through a plane parallel to the solenoid coil axis as the plunger 10 is moved through the armature cores, the irregular movement of the swinging bar 12 causes the housing 3 to adjust slightly on its supporting pivot 5. The outer end of the operating bar 12 is connected to the extended end of a door bracket 14 by an adjustable connecting rod 15 pivotally attached at both ends. The door bracket 14 is fixedly attached to the door B near the hinged door edge, and the connecting rod 15 adjusted to allow the door to be opened and closed as the armature plunger 10 is moved from one extreme end of the solenoid coils to the other. The door B is mounted within the casing C by the hinges 16, and where the occasion demands, an electric lock release 17 may be mounted within

the door edge and connected in the opening solenoid electric circuit.

To avoid sudden or irregular movements of the door when moved by the solenoid mechanism, liquid retarding cylinders 18 are fixedly mounted beneath the solenoid housing 3 and rigidly attached to opposite sides of the center gear housing 9, the cylinders 18 being closed at their outer ends and are positioned in straight alignment with each other. Within the double retarding cylinders is a slidably mounted piston shaft 19, provided with a piston head 20 at each end thereof. The piston heads 20 are formed with valved ports 21 therethrough, designed to allow a free flow of liquid within the retarding cylinder chambers, from the center toward the piston outer ends, but close against any outer end piston pressure. The tubular retarding cylinders 18 are provided with side liquid escape channels *c* formed along the back cylinder casing walls, the channels opening into the respective cylinder chambers at each end thereof through various predetermined valve ports *d* and *e*, designed to regulate the speed of the liquid flow therethrough, and to retard the movement of the door operating mechanism as it reaches its extreme positions. The piston shaft 19 is formed with gear rack teeth *f* through the center portion thereof which meshes with a small pinion gear 22 fixedly mounted on a gear shaft 23. The shaft 23 is rotatably mounted within the connecting gear housing 9 and is extended to a position above and adjacent to the armature plunger 10 and carries fixedly mounted on the upper end a small pinion drive gear 24, which meshes with a gear rack 25 fixedly imbedded along the surface of the armature plunger, so that any longitudinal movement of the armature plunger 10 will rotate the shaft 23 and likewise displace the plunger pistons 20 within the retarding cylinders accordingly. A suitable liquid, such as oil of a proper density is placed within the retarding cylinder chambers, and its restrained flow therethrough by the valved ports and channels will regulate the speed of the connected solenoid plunger.

Within the top wall of the cylindrical solenoid housing 3 is mounted a small double electric limit switch 26, and which is a combination opening and closing switch installed within separate opening and closing electric circuits through the connected circuit wires 27, 28 and 29 which lead to different operating instruments. The projected switch lever *g* closes on one side in one of the circuits at the same time it opens the other, and is actuated by engaging the ends of a slotted recess *h* formed along the adjacent armature walls, the groove ends are positioned to engage the switch lever at the extreme ends of the plunger stroke for automatically stopping the plunger stroke, by breaking the electric current through the solenoid which is controlled by the connected contactor instruments D, E, and F.

The solenoid coils 1 and 2 are provided with pairs of terminal wires 30, 31, 32 and 33 which are connected into two separate direct current electric circuits, one circuit for each coil, and connected to the switch terminals of the operating opening and closing contactors E and F respectively, the contactors being operated and regulated by separate electric circuits through their magnetic coils under control of the connected photo-electric cell and relay mechanism G and H. A time delay switch K is mounted within the instrument circuit between the opening and closing contactors E and F to cause a

slight delay in operation of the door opening mechanism before it closes the door. Each of the contactors D, E and F is formed with an electric magnet 34 and a movable contactor switch arm 35 pivotally mounted above the magnet, each switch arm 35 of contactors E and F carrying mounted thereon switch terminals 36 one in each of the solenoid direct current circuits. Also a like terminal 36a is mounted on the similarly positioned switch arm 35 for the circuit holding contactor D. The contactor switch arms 35 are held disconnected from their respective magnets when inoperative, by connected spring members. The wiring diagram shown in Fig. 16 of the drawings shows the complete set-up and wiring of the various instruments in the two separated electric circuits. The solenoid coils are connected in a direct current circuit while the operating instruments controlling this circuit are connected and operated by a completely separate electric circuit.

Positioned on opposite sides of the door B are fixedly mounted sensitive photo-electric cells G, each being placed within a suitable casing head 37 which is herein illustrated as mounted on an ornamental newel post securely attached to the floor, although any fixed mounting of the casing heads may be used as desired. The casing heads 37 are provided with side light tubes 38, each positioned parallel with the door panel B. The photo-electric cells G may be of any suitable standard types, several of which are now on the market, and are preferably connected in a parallel circuit which leads to a sensitive relay instrument H, where in some types of tubes a voltage is connected therewith. Positioned directly opposite each of the cells G, along the opposite door edge, is a light source bulb M, also mounted within a casing head 39 mounted on top of a fixed newel post and provided with side light tubes 38, each facing the light tube 38 of its respective cell. The light source bulbs M are also preferably connected in parallel in any suitable electric lighting circuit by wires 53. Any type of electric bulb may be used that will produce a steady light ray. The light rays from each of the light source bulbs M are focused directly upon its respective cell G as is positioned opposite thereof, and must be accurately adjusted and balanced so that the same strength light falls on each cell, as the difference in light densities will cause the cells to function, and thereby trip the connected sensitive cell relay and start the door operating mechanism. It is desirable to provide the light source bulbs M with suitable reflectors 40 and lens 41, for more accurately focusing the rays directly on the cells. The photo-electric cells G are manufactured units now on the market, which transform light unit energy directly into electrical energy, and in some types without the use of applied voltage.

If desired, an extra pair of cell and light source units G' and M' may be positioned diagonally through the door opening as illustrated in Fig. 2 of the drawings, and so focused that the light intensity is the same as in the other pairs of units, each preferably being connected in parallel with the corresponding units of the other pairs. The units G', M' will operate to prevent the door being closed when any person or object is standing in a position to break the rays of light. As the door is being closed in the ordinary manner, a cooperative light source M'' adjacent the cell G' is lighted by the closing of a mechanical switch 42 just prior to the cutting of the light rays by the door from the source

light M'', thus preventing the cell from tripping the connected relay mechanism which would function to re-open the door.

The photo-electric cells G which are connected in parallel, are connected to the sensitive cell-relay unit H by the circuit wires 43. This cell-relay is a light sensitive device for controlling an electric current which operates through the unit, in response to any substantial increase or decrease in the amount of light which falls on the connected photo-electric cell. The essential elements of the cell-relay is an amplifying unit 44, a sensitive relay unit 45, a sensitive relay contactor 46, and in cases where the amplifier requires a voltage, a small transformer 47 may be supplied. These units are herein illustrated in a single casing as a combined unit which is obtainable on the market in the assembled form. However, any other form or arrangement of the essential elements will do equally as well. The controlling element of this unit is the photo-electric cell G, and with the voltage of proper magnitude and polarity between the two units, the current it passes is proportional to the amount of light shining on the cell. The flow of current from the cells G when functioned by a change of light rays falling thereon, operates to connect the sensitive cell relay 45 which closes the circuit through the sensitive contactor 46. The contactor 46 is mounted within an electric circuit which flows through the magnet coils 34 of the controlling contactors D, E and F, and which are also mounted within the solenoid direct current circuit. The switch arm of the sensitive contactor 46, is separated into two sections k and m, completely insulated from each other, and this switch so connected within the circuits running to the different instrument as to function in two circuits as clearly indicated by the wiring diagram shown in Fig. 16 of the drawings. The circuit entering the relay contactor switch through the common terminal wire 48, with the terminal wires 49 and 50 of the separated circuits connected to the separated insulated sections k and m of the contactor switch arm. The circuit wire 49 is connected through the electro-magnetic coil 34 of the opening contactor E, also through the contactor switch terminals 36a to the opening solenoid switch 26, while the circuit wire 50 is connected through the electro-magnetic coil 34 of the circuit holding contactor D, and through the contactor switch terminals to the closing solenoid switch 26, and also this circuit is continued through a mechanical switch 51 formed on the back side of the opening contactor E, which closes when the switch arm 35 of the contactor E is released for opening said contactor switch, the circuit being continued through a time delay switch K of any desired type to the electro-magnetic coil 34 of the closing contactor F. The time delay switch K is illustrated as a thermal switch making an electrical connection by heat expansion of an interior element, although the type used is not material, the switch merely causing a slight delay in shifting the electric current circuit from the opening contactor E to the closing contactor F. The switch terminals 36 of both contactors E and F are connected into the direct current circuit leading to the solenoid coils 1 and 2 respectively of the door operating unit A. The electric door release 17 is connected into the solenoid opening circuit and is operative at the first flow of current therethrough.

When the device is completely installed and

adjusted, with the light rays from the source bulbs M carefully reflected and adjusted upon their corresponding photo-electric cells G, and the cell relay instrument adjusted thereto, the electric circuits all stand open and the device inoperative, but upon breaking of any line of rays of light from the source bulbs as may fall on any cell G the sensitive cell-relay 45 closes under action of the electric energy from the cell, and likewise closes the circuit through the sensitive contactor 46 which directs an operating electric circuit through the controlling contactors D, E and F as heretofore described, thus closing the circuit in the opening solenoid coil 1, and after a short pause caused by the time delay switch K, transfers the circuit to the closing solenoid coil 2, thus opening and closing the door B automatically. At any time during the closing operation, if any of the light rays reflected on any of the cells G be broken, the opening mechanism will immediately function to re-open the door, and without completing the closing operation.

The various instruments may be wound to operate under either direct current or for alternate current, as desired, although the direct current solenoid winding will operate more quietly than the other windings.

Fig. 17 shows the door mechanism applied to the sliding type of door, the door being moved back and forth by the vertically positioned operating bar 52, actuated by the connected operating rod 11. The operation is the same as heretofore described.

While I have illustrated my device with the preferred types of electrical instruments, it is apparent that various modifications in both instrument units and arrangement of set-up may be made without departing from the spirit of my invention, and that various types of sensitive cells, relay instrument, electro-magnetic contactors or time delay switches, may be used if desired to replace the units herein illustrated, and I claim as my invention the device as herein shown and any modification thereof that is substantially a substitution of parts or sections.

Having fully described my electric door opening device, what I claim as my invention and desire to secure by Letters Patent is:

I claim:

1. An electric device adapted for opening and closing a connected door panel and used in combination therewith, comprising right and left solenoid coils concentric about the same axis and mounted within a rigid frame by a pivoted hinge connector, said coils being connected within separate electric circuits, a single straight armature plunger slidably mounted through the double solenoid coils, lever mechanism connected to the solenoid frame and also attached to the armature plunger and actuated thereby in a manner for operating a connected door panel, an operating contactor having magnetic operating coils mounted within each of the solenoid circuits, light sensitive photo-electric cells with co-operative light sources mounted at different positions across the passage way leading through the door, said photo-electric cells being connected in parallel to a sensitive cell-relay instrument with a sensitive circuit contactor installed within a separate electric circuit leading through the magnetic coils of the operating contactors for operating same and the connected door opening solenoid as a person or object approaches the door.

2. An electric door operating device to be used

in combination with a connected movably mounted door panel, comprising right and left solenoid coils concentric about the same axis and fixedly mounted in opposite ends of a cylindrical casing, said casing being pivotally mounted within a rigid solenoid frame, each of the solenoid coils being connected within suitable separated electric circuits, a single straight armature plunger slidably mounted through both of said solenoids and capable of being reciprocated therein, a plunger rod fixedly attached to the armature plunger and having its outer end pivotally connected to an operating bar attached to the solenoid frame, means mounted on said operating bar for connecting same to a movably mounted door panel in a manner for opening and closing same as the armature plunger is actuated by the solenoid coils, electric opening and closing operating contactors having magnetic operating coils connected within the separate solenoid electric circuits, a series of light sensitive photo-electric cells, with co-operative light sources mounted at different positions on opposite sides and through the passage way leading through the doorway, said cells being connected in parallel with a sensitive cell-relay-contactor instrument connected within a separate electric circuit leading through the magnetic operating coils of the opening and closing electric contactors for regulating and operating the circuits through the solenoid coils as the light rays on the respective cells are broken, and a time delay instrument mounted within the circuit between the operating contactors for retarding the current as the circuits are alternated from one contactor to the other.

3. An electric device adapted for operating a movably mounted door panel and used in combination therewith, comprising right and left solenoid coils concentric about the same axis and rigidly mounted in opposite ends of a cylindrical casing, said casing being pivotally mounted within a frame suitable for attaching to a door casing head, each of said solenoid coils being connected within separate electric circuits, a single, straight armature plunger slidably mounted through both of the coils and capable of being reciprocated thereby, a plunger rod fixedly attached to the armature plunger and extended outside the coil casing and pivotally connected to an operating bar pivotally attached to the solenoid frame, means mounted on said bar for connecting same to a movably mounted door panel in a manner for opening and closing same as the armature plunger is actuated by the inclosing solenoid coils when an electric current is passed alternately through the solenoid casing capable of opening the electric circuit through the respective coil circuits as the armature plunger reaches its extreme end positions, said switch being actuated by the armature plunger movements, a retarding element mounted on the solenoid casing and mechanically connected to the armature plunger in a manner to retard the plunger movements as it nears the respective casing ends, electric opening and closing operating contactors having magnetic operating coils mounted within the respective solenoid circuits and used in combination with a common circuit holding contactor, a series of sensitive photo-electric cells, with corresponding co-operative light sources mounted in different positions on opposite sides and through the passageway leading through the door, said series of cells being connected in parallel with a sensi-

5 tive cell-relay-contactor instrument connected within a separate electric circuit leading through the magnetic operating coils of the electric circuit holding and the opening and closing operating contactors, said circuit having a time delay switch mounted between said opening and closing contactors, the light cells and co-operative light sources being adjusted to operate the solenoid door opening mechanism when sufficient light rays are broken to materially change the light density on any cell.

10 4. An electric device adapted for operating a movably mounted door panel and used in combination therewith, comprising right and left solenoid coils concentric about the same axis and fixedly mounted in opposite ends of a cylindrical casing, the casing being pivotally mounted within a rigid wall frame, each of said coils being connected within separated electric circuits, a single, straight armature plunger slidably mounted through the double coil sections, capable of being reciprocated therethrough as the electric current is alternated through the respective coil sections, a plunger rod fixedly attached to the plunger end and projected outside the solenoid casing, said plunger rod being pivotally connected to an operating bar pivotally attached to the solenoid frame, adjustable means mounted on said operating bar for connecting same to a movably mounted door panel, a double action limit switch fixedly mounted within the solenoid casing capable of being actuated by the armature plunger at the ends of the plunger strokes for opening the electric circuit through the respective coil electric circuits, liquid retarding chambers mounted

on the solenoid casing, valved plungers mounted within said retarding chambers, geared means mounted on said casing for mechanically connecting the armature plunger with the valved plungers of the retarding chambers, said liquid chambers being provided with a suitable liquid and with liquid side passages formed through the casing walls, said side passages being provided with suitable valved ports, electrical circuit holding and opening and closing controlling contactors having magnetic operating coils mounted within the separate solenoid electric circuits and controlled by the double action limit switch circuits mounted on the solenoid casing and actuated by the armature plunger, a series of light sensitive photo-electric cells, with co-operative light sources fixedly mounted in different positions on opposite sides and through the passageway leading through the door, said cells preferably being connected in parallel to a sensitive cell-relay-contactor instrument connected within a separate electric circuit leading through the magnetic operating coils of the circuit holding and operating opening and closing contactors, one of said circuits having a time delay switch mounted therein between the opening and closing contactors, the respective cells with co-operative light sources being so adjusted as to operate the connected cell-relay-contactor instrument and connected contactors also the solenoid door opening mechanism whenever any set of light rays leading to any photo-electric cell are sufficiently broken to materially change the light density on any cell.

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