

Aug. 14, 1951

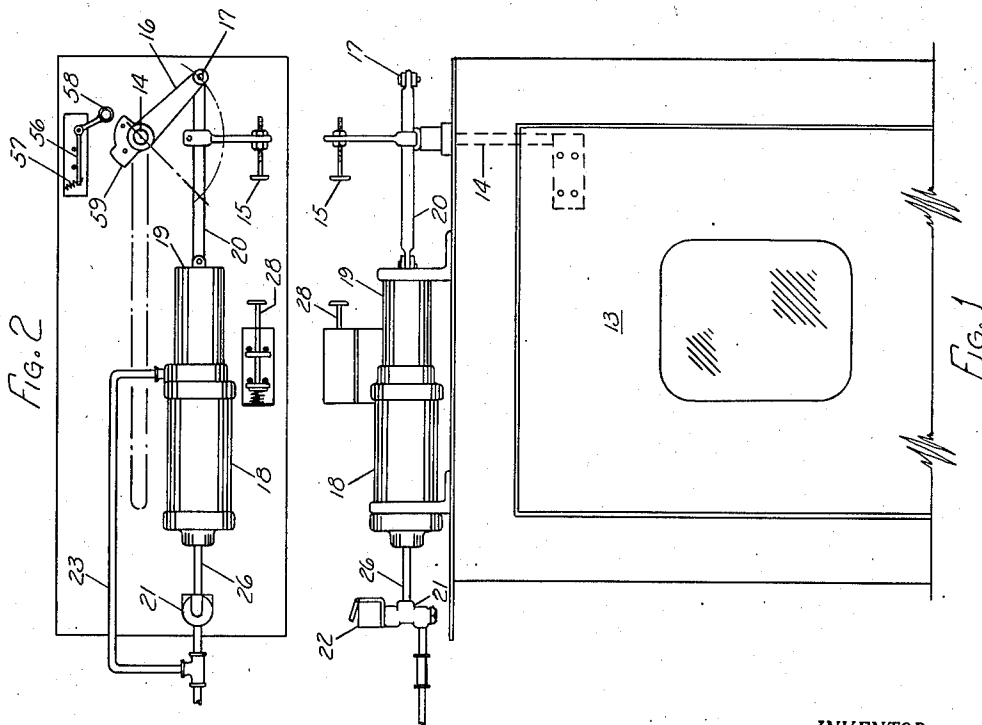
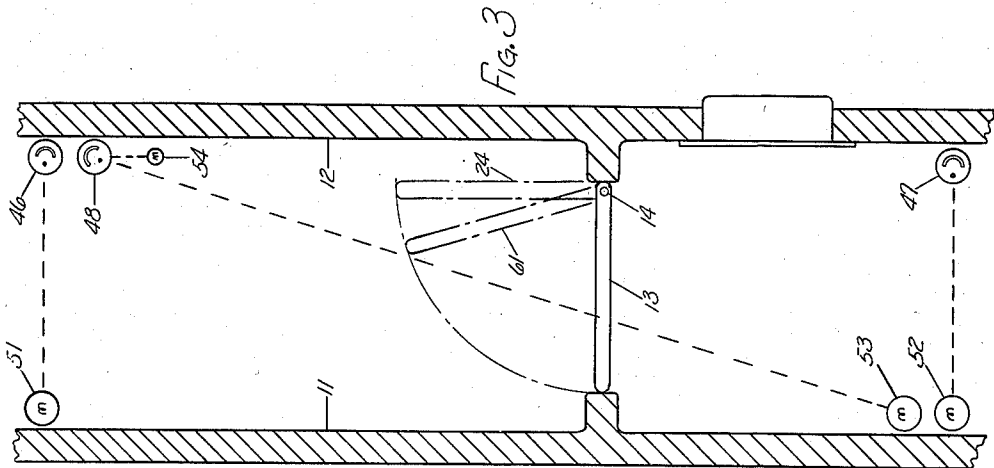
M. E. KARP

2,564,067

DOOR OPERATION AND CONTROL

Filed July 24, 1948

2 Sheets-Sheet 1



INVENTOR.

MARTIN E. KARP

BY

BY
Martin J. Finnegan
ATTORNEY

ATTORNEY

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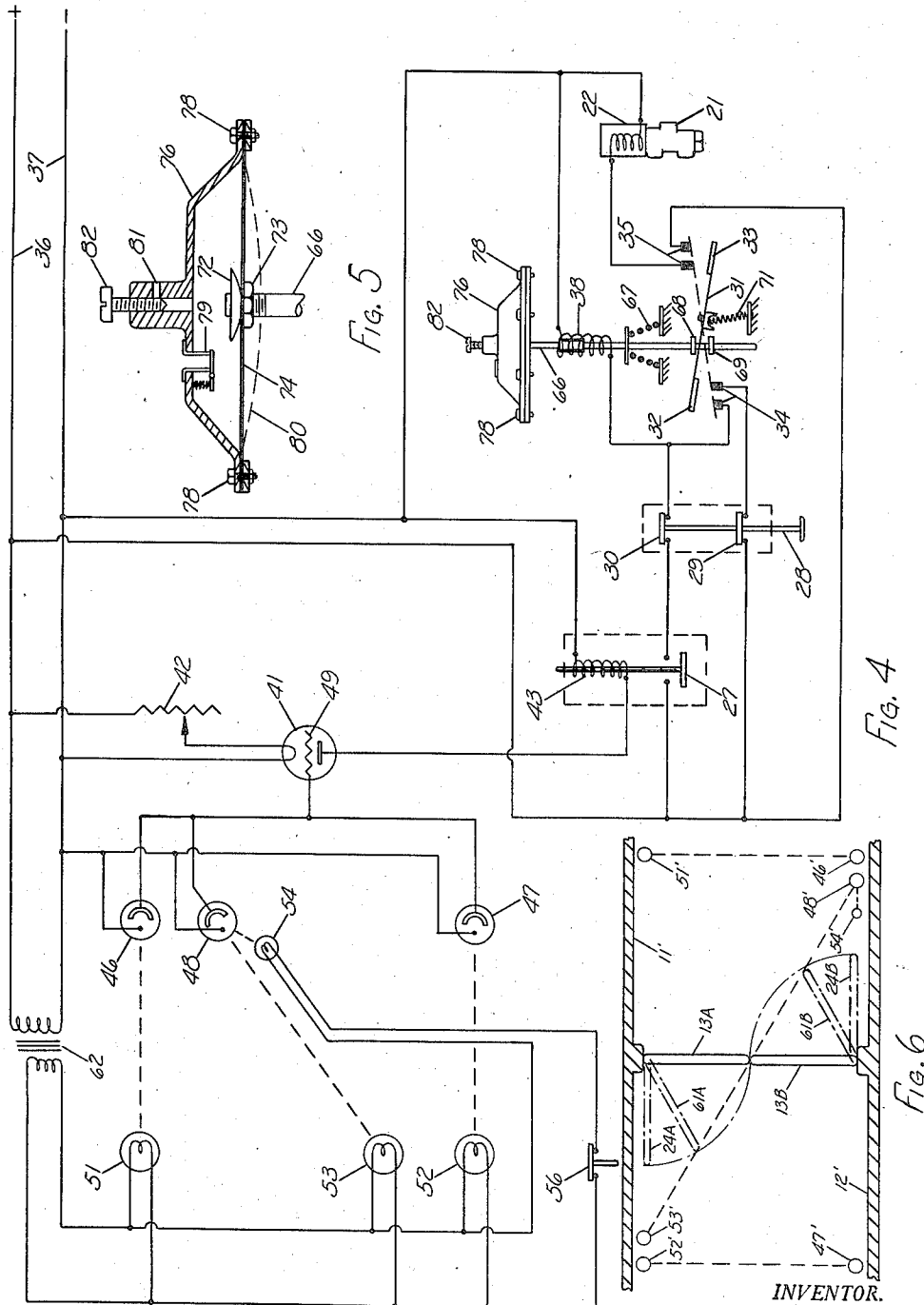
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INVENTOR.
MARTIN E. KARP
BY
Martin J. Finnegan
ATTORNEY

UNITED STATES PATENT OFFICE

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DOOR OPERATION AND CONTROL

Martin E. Karp, Kew Gardens, N. Y., assignor, by
mesne assignments, to National Pneumatic Co.,
Inc., Boston, Mass., a corporation of Delaware

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3 Claims. (Cl. 268—1)

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This invention relates to doors, and particularly to a system for automatically opening and closing one or more doors located in a passageway along which considerable traffic passes, the motion of the traffic being in two opposite directions.

An object of the invention is to provide, in a system including a motor, or motors, for applying the door opening and closing power, successively, novel automatic means for initiating and governing the energization of such motor or motors.

In the embodiment of the invention herein-after described, and illustrated in the accompanying drawings, the novel automatic means takes the form of a motor controlling relay electrically energized by the action of one or another of a plurality of electronic circuits, wired in parallel relationship, and each including a photo-sensitive initiator; the photo-sensitive initiators being, in turn, responsive to light beams individual thereto, one of which light beams has an intermittently applicable light source while the other light beams have constantly applicable light sources. However, it is to be understood that the illustrated and described embodiment of the invention is merely one of many arrangements which may be resorted to for practicing the teachings of the invention; also that component phases of the invention may be inter-combined in a variety of relationships, or used independently of other components, within the spirit of the invention as disclosed; the appended claims being subject to this understanding.

A further feature of the invention is the control of one of the above-described photo-sensitive initiators by a pair of light beams, one of which beams is the intermittently operable beam above referred to, and the other of which beams is constantly operable, and so located as to be subject to interruption so long as the control zone remains occupied; but which interruptions are alternately effective and ineffective, depending upon (a) the concurrent condition of said intermittently operable beam and (b) the particular stage of the door operating cycle at which such interruptions occur.

More specifically, a further object of the invention is to provide, in a photo-sensitive door control system of the character indicated, novel electrical combinations, as well as a novel method of physically inter-relating the several photo-sensitive elements and their respective light sources, with respect to the passageway and its

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door or doors, which novel electrical combinations and physical relationships make possible a more satisfactory response of the doors to the varying operational requirements dictated by the different traffic situations encountered from one minute to another. Merely by way of enumerating a few of the possibilities of the system, it may be noted that the following *modi operandi* are inherent therein:

a. The approach of a person (or vehicle) to the control zone, that is, to either of the two outer boundaries thereof, causes one of the parallel electronic circuits to become effective to actuate the motor controlling relay, whereupon the door opens automatically.

b. As the door, in opening, passes a pre-determined intermediate point, one of the two light sources theretofore operating to illuminate a selected photo-sensitive initiator is automatically extinguished; but as said selected initiator remains illuminated by the light from the second light source applicable thereto, this temporary cancellation of one light source does not interfere with the completion of the door opening movement, or with the automatic return of the door in timed relationship to its opening. On the other hand,

c. If a person (or vehicle) happens to interrupt the beam from said second light source during the closing movement of the door, and prior to the door's reaching the predetermined point referred to in sequence b, the motor controlling relay is again actuated—this time by one of the parallel electronic circuits other than the one referred to in sequence a—and the motor re-opens the door. But

d. If a person (or vehicle) happens to interrupt the beam referred to in sequence c, or any of the other beams, before the start of the door closing movement, that is, while the door is still in its opening movement, or "marking time" in the open position—there is no re-actuation of the door controlling relay, hence the door is free to start to close at the termination of the "marking time" period (the duration of the latter being adjustably pre-set as desired). This novel feature (of rendering the door controlling relay immune from re-actuation during the opening and "marking time" stages) is made possible by the novel electrical combinations above referred to, and without the need of short-circuiting or otherwise disassociating the photo-sensitive initiators, even momentarily.

e. An interruption of the beam referred to in sequence c while the door is in its final stage of

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closing—that is, after passing the predetermined point referred to in sequence *b*—will not re-actuate the door controlling relay (hence the door will not re-open) because on passing said predetermined point the first-named light source is automatically restored, and immediately becomes applicable to illuminate its associated photo-sensitive initiator, thus rendering any subsequent interruption of the second light source inconsequential for the remainder of the door closing period.

Referring now to the drawings:

Fig. 1 is an elevation view of a door and door operating motor equipped with control elements suitable for practicing the disclosed invention;

Fig. 2 is a plan view of the parts shown in Fig. 1;

Fig. 3 is a plan view of a passageway equipped with a door operable by a motor such as that shown in Figs. 1 and 2; the locations of the light sources and light-sensitive elements of the system being also indicated;

Fig. 4 is a circuit diagram showing the electrical relationships between the component parts of the system; and Fig. 5 is an enlarged view, in section, of the upper portion of the time delay mechanism shown schematically in Fig. 4. Fig. 6 shows control of a pair of doors.

Referring first to Figs. 1, 2 and 3, a passageway having bounding walls 11, 12 (Fig. 3) is traversed by a door 13 hinged, as at 14, to swing open and closed upon application of turning effort to a lever 16 (Fig. 2) secured to the upper end of the door hinge-shaft 14. Lever 16 is in turn hinged, as at 17, to a link 20 forming an operating connection with a piston assembly movable within the cylinder assembly 18, 19 (Figs. 1 and 2) constituting a fluid motor for power operation of the door 13. Link 20 carries a striker 15, for a purpose to be explained hereinafter.

While the fluid motor 18, 19 may be of any desired construction, the arrangement suggested in Figs. 1 and 2 is convenient for the purposes of the present invention in that it requires only one shiftable valve (indicated at 21 in each of Figs. 1, 2 and 4) to control the alternate door opening and door closing strokes of the piston assembly within the motor.

This single valve control is possible by reason of the differential cross-sectional areas of the two joined cylinders 18 and 19, and the correspondingly differing areas of the two joined piston sections reciprocable in said cylinder assembly. A solenoid 22, when energized (by the novel circuit action hereinafter described) shifts the valve 21 to a position permitting discharge to the atmosphere of the pressure fluid within cylinder 18 to the left of the piston assembly; and as line pressure is constantly maintained in conduit 23 supplying the cylinder 18 to the right of the larger piston section, there is produced a movement of the piston assembly to the left, as viewed in Figs. 1 and 2, whereupon links 18 and 16 cause the door 13 to swing to the open position indicated by dash lines 24 in Fig. 3. Subsequent de-energization of solenoid 22 (by novel means hereinafter described) permits a biasing spring in the valve 21 to restore said valve to its normal setting, in which normal setting line pressure is re-applied to the left end of cylinder 18, by way of conduit 26, to over-balance the line pressure in the right-hand end of said cylinder, thereby causing link 18 to move to the right, back to the position indicated in Figs. 1 and 2, thus re-clos-

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ing the door 13. The novel means producing these alternate energizations and de-energizations of the solenoid 22 will now be described.

The elements controlling solenoid 22 include, as illustrated schematically in Fig. 4, an electronically actuated relay switch 27, a motor-operated switch 28 having bridging sections 29, 30 and a snap-action switch 31 having bridging sections 32, 33 engaging pairs of contacts 34, 35, respectively; the latter pair being directly in series with the winding of solenoid 22, in a circuit extending from current supply lines 36, 37, and the former pair of contacts being in series with the winding of the relay 38, to hold said relay energized following initial current flow thereto by way of the first named relay switch 27, and until interruption of current flow by reason of the opening of normally closed switch section 29.

The novel control elements further include an electronic amplifier 41 whose cathode energy is received from line 36, 37, being adjustable by use of a variable resistor 42, and whose anode circuit includes the winding 43 of the relay switch 27; also a plurality of photo-electric cells 46, 47, 48, all connected in parallel relationship across line 36, 37, in a circuit which includes the grid element 49 and the cathode of amplifier 41. Cells 46 and 47 are located at opposite ends of the passageway 11, 12, as shown in Fig. 3, and are in positions to receive light from lamps 51, 52, respectively. Cell 48 is adjacent cell 46, and can be illuminated by each of two lamps 53, 54, the former being adjacent lamp 52 and the latter only a short distance from the cell itself—in practice, it may be enclosed in the fixture housing the cell 48. A switch 56 (Figs. 2 and 4) is normally held closed by a spring 57 (Fig. 2) but includes a cam-roller 58 engageable by a cam 59 on lever 16, to open said switch and thus interrupt current flow to lamp 54 when the door is in the position indicated by dash line 61 in Fig. 3, or thereabouts. Lamps 51 to 54 are wired in parallel, in the secondary circuit of transformer 62. Their operating voltage is, of course, less than that of line 36, 37.

Switch 31 is shown as operable by a pair of collars 68, 69 on the plunger rod 66 of relay 38, the rod being urged upwardly by a compression spring 67, and downwardly by the magnetic effect produced while current flows through the winding of relay 38. As one or the other of collars 68, 69 engages the switch arm, and tilts it about its central pivot, over-center spring 71 completes the switch throw and assures firm, simultaneous making or breaking of both circuits controlled thereby, depending upon the direction of swing.

To delay the upward, or return movement of rod 66, following de-energization of the relay 38, for a pre-determined interval of adjustable length, so that there will be a pre-determined interval of delay in the opening of the circuit to the door valve magnet 22, there may be employed any known type of delay dash-pot, or the like, such as the delay mechanism indicated at 72—82 in Figs. 4 and 5. As shown, this delay mechanism includes an air receiving vessel 76 closed along its lower circular edge by a flexible diaphragm 74 secured to said edge by screws 78. Rod 66 carries elements 72, 73 for adjustably clamping the diaphragm 74 thereto. An air inlet valve 79 is urged to closed position by a compression spring, but is drawn open by suction as rod 66 moves diaphragm 74 down to the dash-line position shown at 80 in Fig. 5.

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The air thus drawn in can be expelled, as the rod 66 attempts to re-ascend, only through the adjustably restricted exhaust port 81, controlled by screw 82. Thus the period required for complete re-ascend of the rod 66 (even though spring 67 continuously urges the rod upwardly) can be regulated by adjustments 72, 73, and 82.

As hereinabove indicated, interruption of the light beam illuminating cell 46, or the light beam illuminating cell 47, will so disturb the potential balance in the circuit of grid 49 of amplifier 41 (and, incidentally, there may be one such amplifier for each cell, with their anodes wired in parallel with each other and in series with relay 43) as to cause current flow from power source 36 to relay 43 the flow path being through the amplifier 41.

a. As relay 43 is thus energized, switch 27 is caused to close, whereupon current flows to relay 38, the flow path including switches 27 and 30 in series. Rod 66 is pulled down by the magnetic action of relay 38 thereon, and the downward movement throws switch 31 to the dash-line position, bridging switches 34 and 35. Closure of switch 34 sets up a self-holding circuit for relay 38, by way of switch 29, and closure of switch 35 energizes valve magnet 22, whereupon fluid is exhausted through valve 21 and motor 18, 19 shifts rod 20 to the left, to swing door 13 open to the position marked 24 in Fig. 3.

b. As door 13, in opening, reaches the position marked 61 in Fig. 3, cam 59 will automatically swing switch 56 to the open position, thus extinguishing light 54 (see Fig. 4); but as photo-cell 48 remains illuminated by the light from source 53, this temporary cancellation of light source 54 does not interfere with the completion of the door opening movement, or with the automatic return of the door in timed relationship to its opening. Such automatic return occurs as a result of the following sequence of events: first, switches 29 and 30 open as striker 15 (Fig. 2) engages switch rod 28, just as the door approaches open position 24; secondly, this opening of switch 29 de-energizes relay 38 and allows spring 67 to return rod 66 to its upper position (at the delayed pace determined by the adjustments of unit 76); thirdly, return of rod 66 to its upper position throws switch arm 31 back to the full-line position, breaking the circuit to valve magnet 22 at the switch 35; fourthly, this de-energization of valve magnet 22 allows valve 21 to re-connect motor line 26 with the fluid supply, whereupon the motor pistons start moving to the right and cause door 13 to swing back toward the closed position. From this point on, the sequences and possibilities are as indicated in paragraphs c, d, and e of the earlier portion of this description.

Should it be desirable, suitable variable resistors may be included in the photo-cell circuits, to facilitate adjustment and equalization of potentials therein.

The system will, of course, operate similarly when applied to a passageway controlled by a pair

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of doors, such as doors 13A and 13B of Fig. 6, or to any other type of door or door combination; also with door motive power differing from that specifically illustrated in Figs. 1 and 2.

What I claim is:

1. In a door operating system, a door operating motor, a circuit controlling energization of said motor, a normally open motor-controlling switch in said circuit, means including a solenoid and a retardation device for causing closure and subsequent re-opening, respectively, of said switch, a circuit including said solenoid, said circuit including two switches in series relationship, the first series switch being normally open and the second normally closed, means including a second solenoid and energizing means therefor for closing said first series switch and thereby energizing said first-named solenoid to cause closure of said motor-controlling switch and motor-energizing circuit and consequent opening movement of the door by action of said door operating motor, a holding circuit for said first-named solenoid, means operated by said motor as the door reaches fully open position to open said holding circuit and simultaneously open said second series switch and thereby prevent the transmission to said first solenoid of any further energizing impulses during the interval between opening of said holding circuit by said motor operated means and re-opening of said motor-controlling switch by operation of said retardation device, thereby making it impossible to prolong said interval even though further energizing impulses should be applied to said second solenoid during such interval.

2. A door operating system as defined in claim 1, wherein said motor-operated means for opening said holding circuit includes a switch in said holding circuit, and a mechanical link between said holding circuit switch and said second series switch for causing their simultaneous operation by said motor-operated means.

3. A door operating system as defined in claim 1, wherein said door operating motor includes a cylinder and a piston movable in said cylinder in response to creation of a fluid pressure differential on opposite faces of said piston, means responsive to closure of said motor-controlling switch to create such a fluid pressure differential, in a direction opposite to that which normally prevails, and thereby cause said piston to move in a door-opening direction.

MARTIN E. KARP.

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