

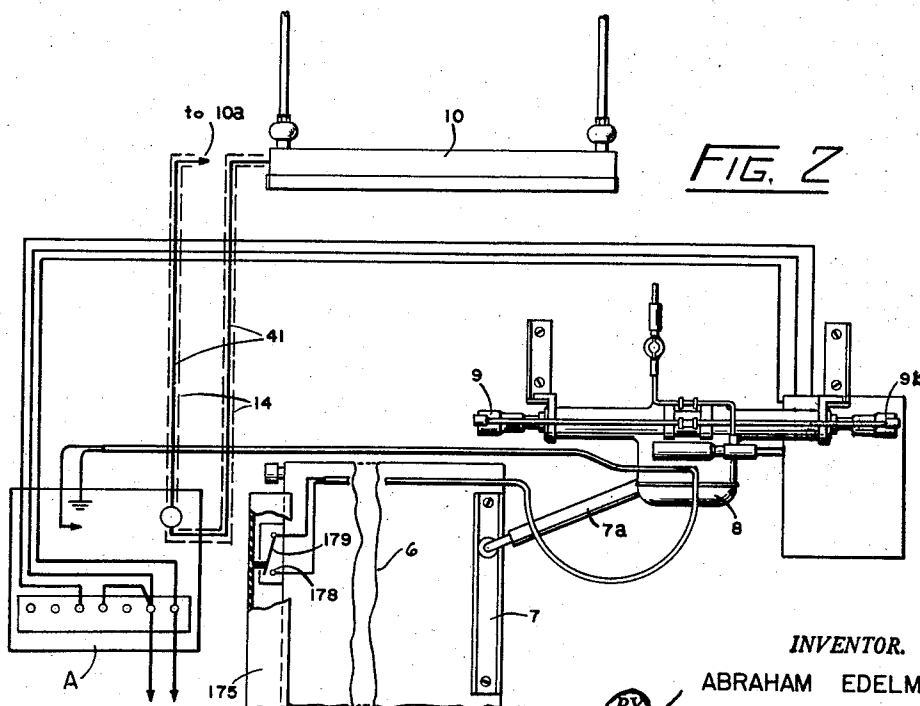
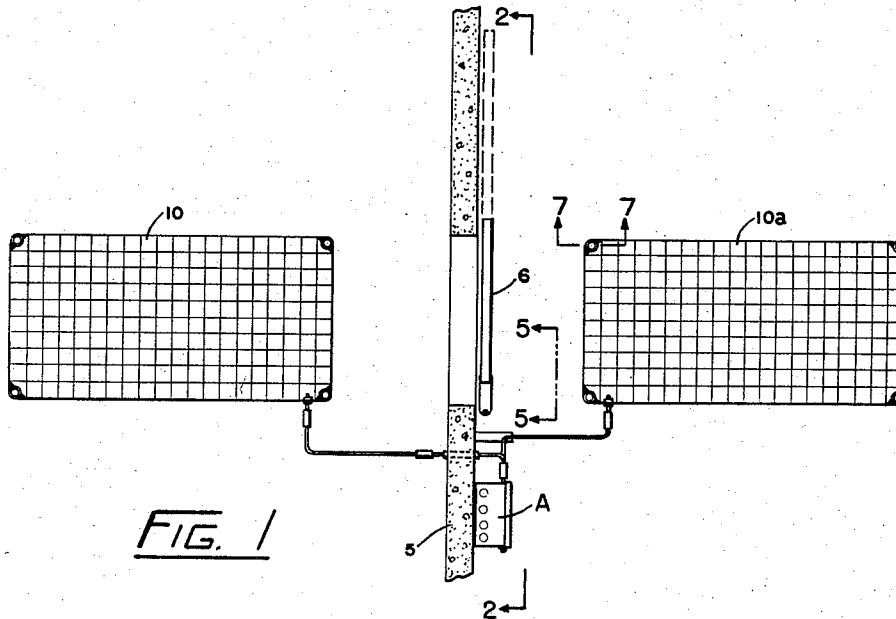
July 21, 1959

A. EDELMAN
DOOR OPERATING MECHANISM

2,895,728

Filed Jan. 30, 1953

5 Sheets-Sheet 1



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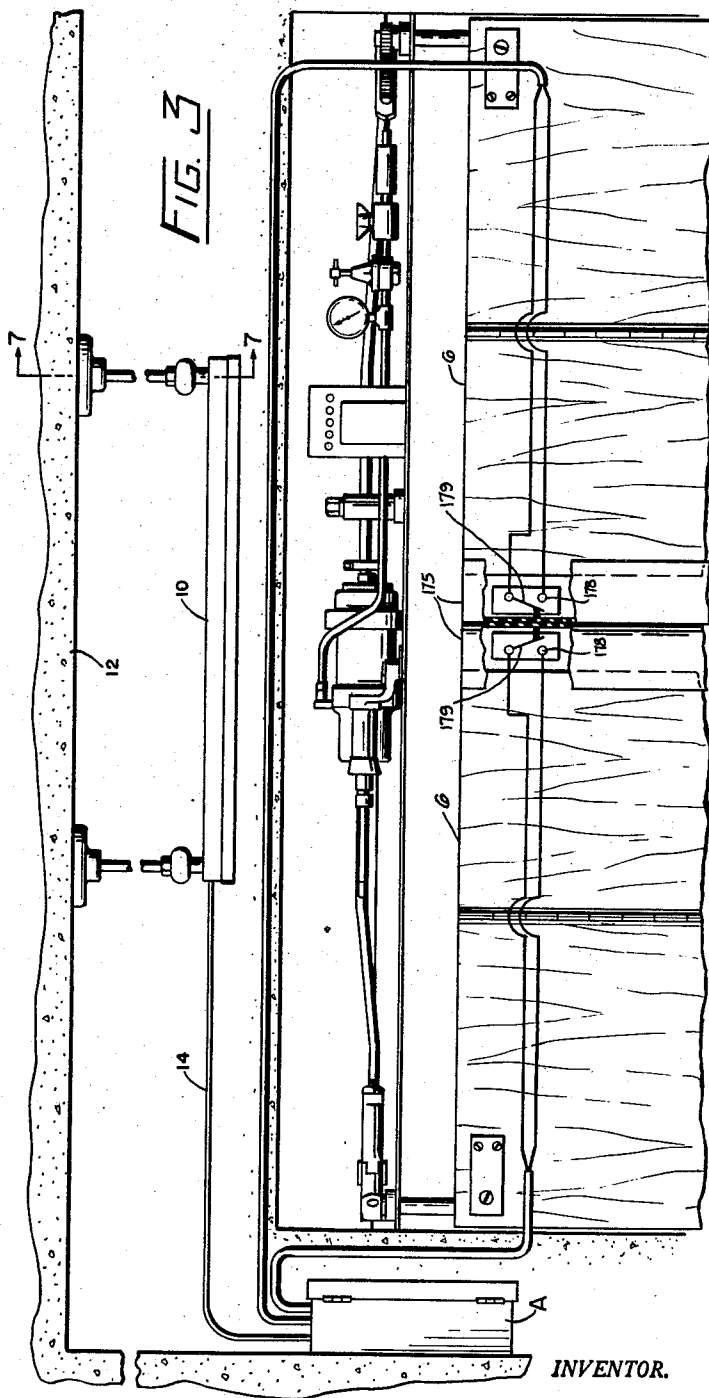
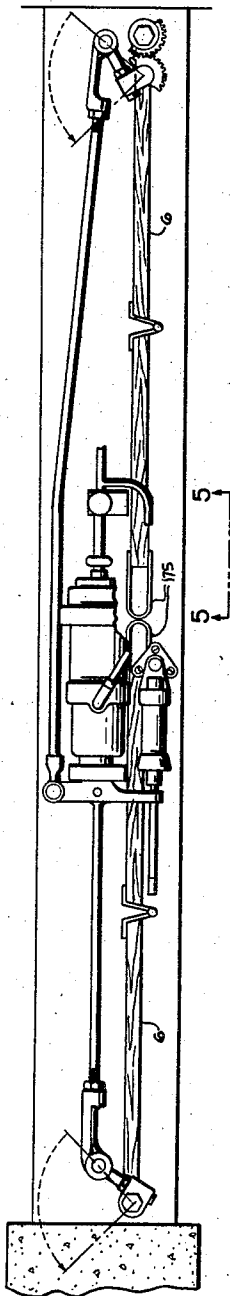
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5 Sheets-Sheet 2



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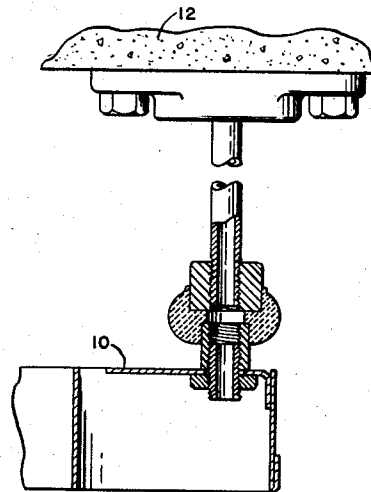
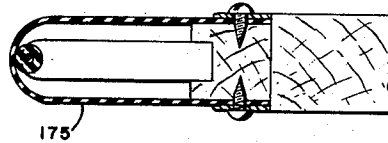
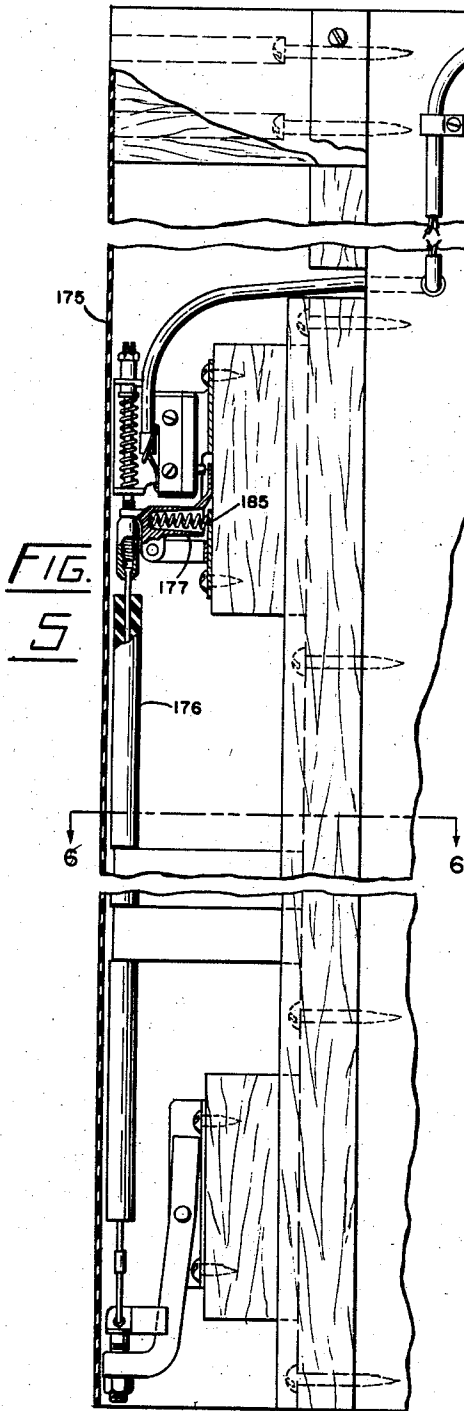
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5 Sheets-Sheet 3



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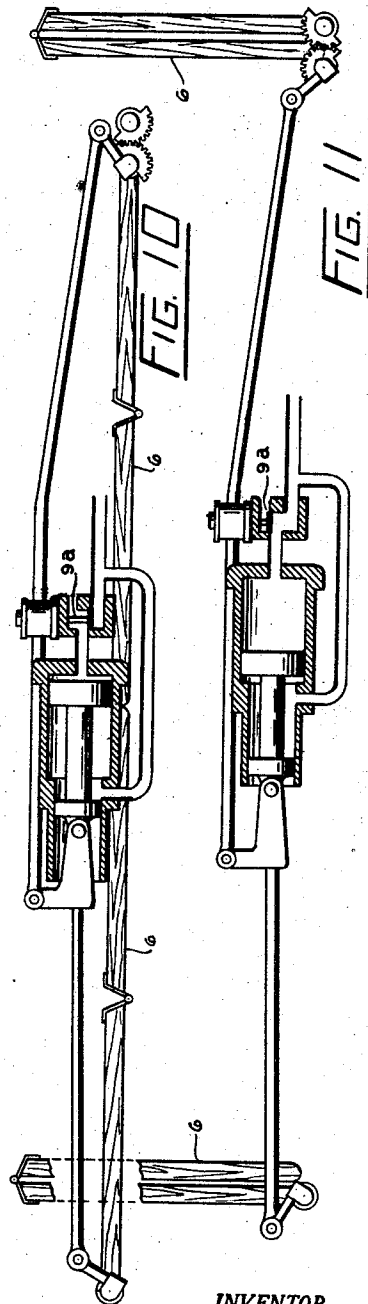
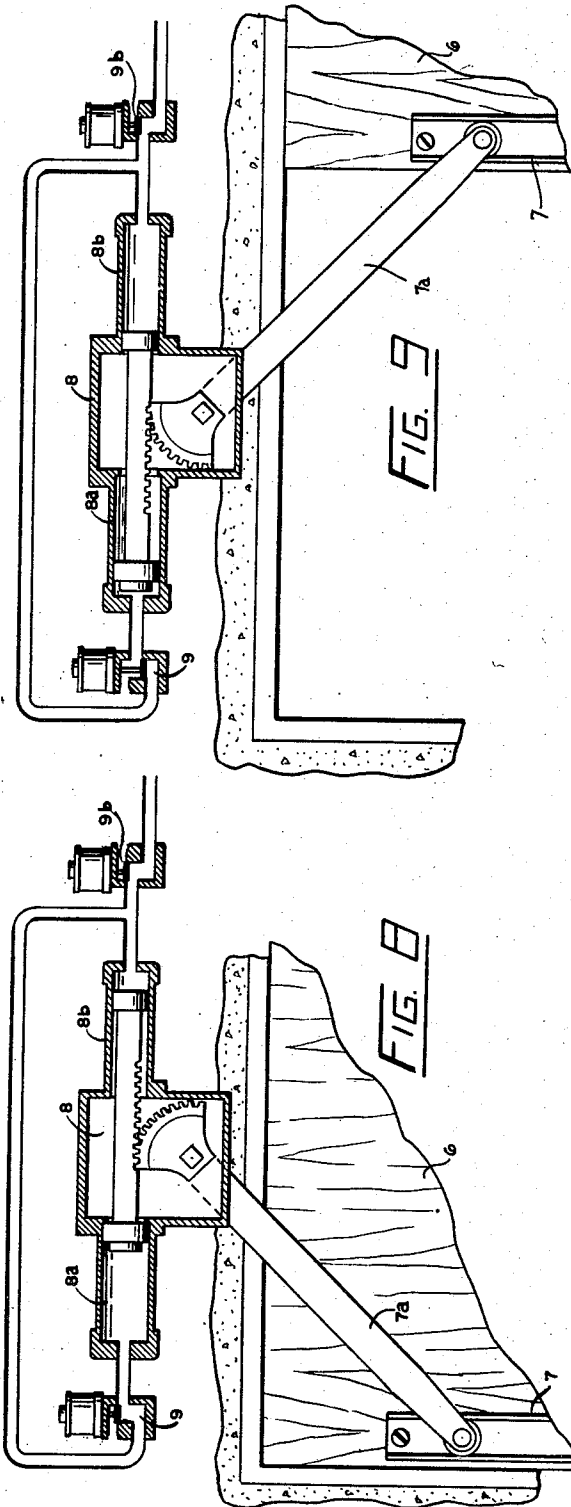
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5 Sheets-Sheet 4



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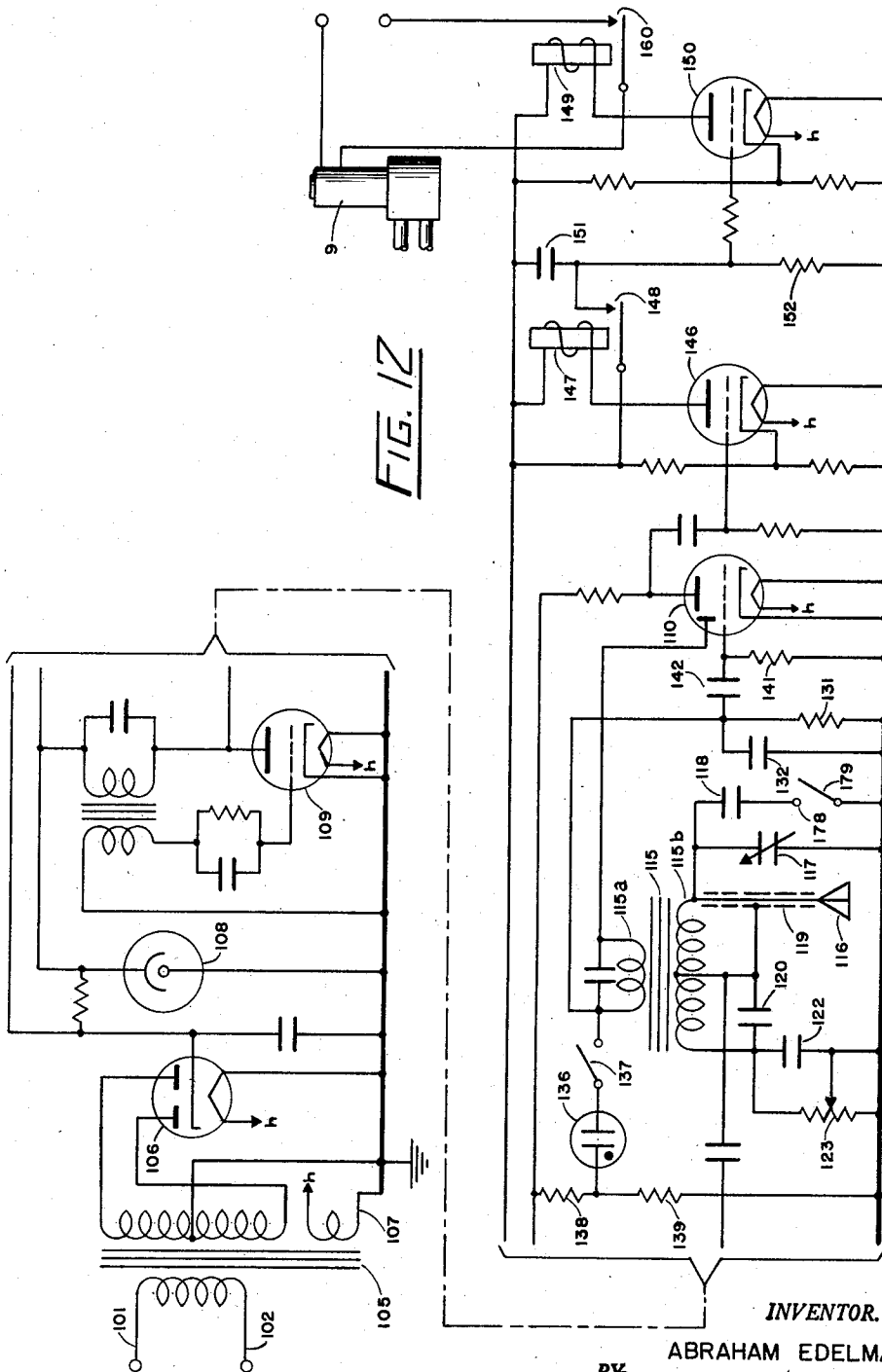
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DOOR OPERATING MECHANISM

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5 Sheets-Sheet 5



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DOOR OPERATING MECHANISM

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5 Claims. (Cl. 268—47)

This invention relates to door operating mechanisms, and particularly to the opening and closing of doors by power; the application of the power being under the control of electrical connections responsive automatically to changes in the rate of high-frequency energy flow at a control point in the vicinity of the door or doors to be operated.

In multi-department factories, warehouses, and the like, where departments are separated by doors, and in garages, office buildings and stores, it is often desirable to have the door open automatically when a person or object approaches and close automatically after the person or object has passed through the doorway. An arrangement of this kind is particularly useful in any location where doors must frequently be opened by persons whose hands may not be free to operate such doors.

Electrical control devices, as heretofore known, have commonly required the erection of stanchions (as in photoelectric systems) or metallic guide-rails (as in electrostatic capacitance systems) which operate to set off an initiating impulse for operation of the doors only after entry of a person (or vehicle), into the space directly between said stanchions or guide-rails. The system herein disclosed differs from these prior systems in that the operation is initiated solely by the approach of a person (or vehicle) and without resort to stanchions, guide-rails, or other auxiliary structures tending to obstruct the approach path.

An object of the invention, therefore, is to provide a system of control of door operation wherein the approach of a person, or object, sets off an electrical initiating impulse in a single control element which may be suspended from the ceiling directly above the area of approach to the door to be operated, and which is adapted to be electrically affected by such approaching person, or object.

A second object of the invention is to provide, in a system of the character indicated, an electronic control circuit whose electrical characteristics vary sharply in response to a relatively slight change the electromagnetic field emanating from the single control element.

A third object is to provide, in a system having such a control circuit, means for sharply varying the electrical characteristics of such circuit in response to the approach of a person, or object, and with such rapidity as to cause the operation of the door to occur well in advance of actual arrival of the person, or object, at the doorway itself.

These and other objects and features of the invention will be better understood upon reference to the following description of one embodiment of said invention, and to the accompanying drawing illustrative thereof; other embodiments being, of course, possible, and all such are embraced herein.

In the drawing:

2

Fig. 1 is a plan view of the invention as applied to a horizontally shiftable door controlling traffic between two areas separated by a dividing wall;

Fig. 2 is an elevation view of the apparatus of Fig. 1; along the line 2—2 of Fig. 1.

Fig. 3 is an elevation view of the invention as applied to a door assembly consisting of two sets of foldable panels;

Fig. 4 is a plan view of the apparatus of Fig. 3;

Fig. 5 is an enlarged sectional view along line 5—5 of Fig. 1, or of Fig. 4;

Fig. 6 is a transverse sectional view along line 6—6 of Fig. 5;

Fig. 7 is a vertical sectional view along line 7—7 of Fig. 1 and Fig. 3;

Figs. 8 and 9 are schematic views of the door operating mechanism of Figs. 1 and 2, in the two extreme positions;

Figs. 10 and 11 are schematic views of the door operating mechanism of Figs. 3 and 4, in the two extreme positions; and

Fig. 12 is a diagram of electrical connections.

The arrangement is shown as applied to door operation, but it is, of course, apparent to those skilled in the art that the system is adapted for controlling and operating any form of passage-controlling device. There is shown in Figs. 1 and 2 a building wall 5, having an opening controlled by the horizontal motion of a door 6. Supported over the door is a pneumatic motor 8 which is connected to the door channel 7 (Fig. 2) by pivotally connected lever 7a. A valve 9 (see Figs. 8 and 9) is electromagnetically actuated to direct compressed air into and out of the motor 8, in alternate stages. When current flows to the windings of the solenoid structure located directly above the valve stem and operatively connected thereto, the valve 9 exhausts the air from the cylinder 8a of motor 8, causing the door to open. When the current flow ceases, the valve 9 moves to allow compressed air to re-enter the cylinder 8a of motor 8, and cause the door to re-close. Valve 9a of the alternate form of door operating motor, as shown in Figs. 10 and 11, functions in a similar manner. Valve 9b of the motor of Figs. 8, 9, on the other hand, is to be considered as remaining "open" constantly, so that line pressure acts constantly on one side of the piston. This manner of operating doors and the interconnection of the parts are so very well known in so many forms that further illustration of details thereof is believed to be unnecessary. It may also be noted at this point, as will be apparent to those skilled in the art, that although a pneumatic motor is disclosed, any other form of power device may be similarly controlled.

Grid-like, interlaced electrically conductive antenna assemblies 10 and 10a are suspended from a ceiling 12 and are thereby insulated except for wires 41 which bring alternating current from a box A of electrical equipment. These wires may be electrically shielded as shown by shield 14. The resulting alternating potential establishes an alternating electric field between each antenna assembly and the surrounding space. A change in the electrical qualities of this surrounding space (as by the entry of a person or object) will influence the impedance of the antenna in relation thereto, and hence will influence the magnitude of the alternating current passing to the antenna through wire 41. The circuit contained within box A is so set up as to be sensitive to such a change, and is capable of energizing the electro-magnetic portion of the door controlling valve 9, as a result of such change. Shown in Fig. 12 is one form of circuit for this device, which may now be described.

The circuit, as shown in Fig. 12, consists of the following circuit groups:

Power supply
Oscillator
Bridge circuit
Detector circuit
Amplifier
Timing circuit
Output circuit

The functions and design of operation of each of these groups are as follows:

Power supply.—This group is fed through leads 101, 102, from a standard alternating current source. The alternating current is converted by a transformer 105 and the rectifier tube 106 into direct current of sufficiently high voltage to serve as the basic power supply for the entire control circuit. A small auxiliary winding 107 in the transformer furnishes low voltage alternating current for all of the vacuum tube heaters by way of common tie "h" and ground. An auxiliary circuit in the power supply unit utilizes a voltage regulator tube 108 to furnish accurately held voltage for an oscillator tube 109 and the first stage 110 of an amplifier circuit.

Oscillator.—The oscillator 109 is a Colpitts type circuit, producing a constant high frequency signal which feeds the bridge circuit.

Bridge circuit.—The bridge circuit consists of four legs and is fed by the output of the oscillator. Two of the legs are formed by the center-tapped antenna coil, 115b. A third leg is formed by various antenna capacitances to ground, including the antenna capacitance 116, the variable balancing capacitor 117, and fixed capacitor 118 in series with a switch 178—179 to ground.

The fourth leg of the bridge is the antenna balance capacitor 122 and the adjustable antenna balance resistor 123. The bridge is balanced by adjusting the variable bridge balance capacitor 117 so that the total capacitance on this arm of the bridge matches the capacitor 122, and by adjusting the antenna balance resistor 123 to match the resistance of the antenna and its lead-ins to ground and similar resistive losses that may occur in the total bridge circuit. The capacitor units are inter-connected to maintain a fixed total capacitance across the terminals of the bridge circuit. It is possible to so adjust the parts as to produce almost a zero voltage across the tapped winding of the antenna coil, 115b. For better performance, however, it is desirable to slightly unbalance the bridge in a direction that will permit an increase in antenna capacitance to further unbalance the bridge in the same direction. The antenna lead-in wire is shielded by shield 119, connected to center-tap of antenna transformer primary 115b. The capacitance introduced into the circuit by this shield and its connection is balanced by a fixed capacitor 120 connected symmetrically across the adjacent half of primary winding 115b.

Detector circuit.—The detector circuit consists of the tuned secondary 115a of the antenna coil 115 feeding a diode section of the first amplifier 110, which is in series with a resistor 131 paralleled by a capacitor 132. The purpose of this circuit is to convert the A.-C. unbalance voltage of the bridge into a D.-C. signal which can then be amplified to operate relay circuits. The magnitude of the D.-C. voltage produced in this circuit is directly proportional to the unbalance voltage produced in the bridge. Measurement of this voltage is obtained by use of the neon lamp 136 which is mounted on the panel A. Neon lamp 136 is connected on one side to the load resistor 131, so that this side of the lamp achieves a potential negative to ground, in proportion to the magnitude of the unbalance voltage in secondary winding 115a. The lamp is connected on the other side to a high resistance voltage divider comprising resistors 138 and 139, bridged between ground and a voltage of, say, 150 volts, so that this side of the lamp may have a high fixed po-

tential, say, about 55 volts above ground for a neon lamp that ignites at 60 volts. Thus, if the bridge is in balance, the neon lamp has only 55 volts across itself, and does not ignite; but if the bridge is out of balance more than 5 volts, then the neon lamp ignites.

Amplifier.—The first amplifier stage is a triode section of the tube 110. The detector circuit is coupled to the grid of this tube through a resistor 141 and a capacitor 142. The circuit is designed so that only changes in unbalance voltage will be transferred to the grid of the amplifier tube. This amplifier steps up the small changes in unbalance voltage to the high level required.

The second amplifier stage is one-half of the tube 146. Its grid is connected to the output of the first amplifier stage and the same type of resistance-capacitor circuit is used as connects the detector to the first amplifier. The change in unbalance voltage which appears at the input to the second amplifier produces changes in current through the amplifier tube. Connected in series to this amplifier tube is the coil of a sensitive relay 147. The relay is adjusted so that when a change in current of the magnitude produced by a normal disturbance in the antenna field occurs, the relay will close its contacts 148. This relay controls the output relay 149 through a timing circuit, now to be described.

Timing circuit.—The timing circuit consists of a capacitor 151 and resistor 152 in series. One end of the resistor is grounded, the other end is connected to the capacitor and the capacitor is fed from the transformer secondary. The contacts of the relay 147 are connected directly across the capacitor. When the relay 147 operates, it short circuits the timing capacitor 151 in the timing circuit. When the relay 147 is de-energized, it permits the timing capacitor to recharge. The sequence of voltages produced by these actions control the output circuit, now to be described.

Output circuit.—The output relay 149 is operated from the plate side of tube 150. The grid of this tube is fed from the timing capacitor 151. When the timing capacitor is short-circuited by the relay 147, the tube 150 conducts sufficiently to operate the relay 149. As the timing capacitor 151 recharges after de-energization of relay 147, the relay 149 remains energized. When the timing capacitor 151 has charged to predetermined voltage, the relay 149 is de-energized. The time required for this change in voltage to occur is readily controllable by the value selected for the timing resistor 152.

Operation.—The approach of a person (or object) to the antenna 10 (or 10a) develops an increased negative voltage in resistor 131, and so drives grid potential of amplifier tube 110 negatively through coupling capacitor 142. This drives the next grid, of tube 146, positively, and so markedly increases the flow of plate current through relay coil 147, and energizes this relay, causing its contacts 148 to engage. Such contact engagement, in turn, causes energizing current to flow to the relay 149, to close switch 160 and thus energize the solenoid portion of the door-opening valve 9. The motor 8 thereupon functions to open the door. When the person (or object) leaves the sensitive area, the grid potential returns to normal status and the contacts of relay 147 reopen. Motor 8, after a brief time interval, then re-closes the doors. The timer circuit 151, 152 operates to delay the valve return action sufficiently to assure the person's passage through the door-way before re-closing the door.

If, for any reason, the person or vehicle has not completed passage through the door-way within the time interval set up by the timing elements above described, there will be an automatic re-energization of the door motor valve 9 at that point in the door's closing movement when physical contact occurs between a tarrying person (or vehicle) and the yieldable rubber guard 175 of conventional construction, slidably mounted on the forward edge of the door (Figs. 2 and 5). Such physical

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contact transmits pressure to linkage 176, 177 and thereby causes engagement of circuit contacts 178, 179 in a circuit shown in Fig. 12.

The contacts connect capacitor 118 in parallel with the previously described antenna capacitor, and so has the same effect as an approach to the antenna. The resulting re-energization of valve 9 reverses the direction of fluid pressure application, causing a re-opening of the door. In due course thereafter, there is a de-energization of valve 9, whereupon fluid pressure operates upon the door motor to re-close the door, or at least to return the door to the point of re-striking the obstructing person or vehicle, if such obstruction is still present. The doors will continue the cycle of re-opening and partly closing until the obstruction is removed, whereupon they will close completely, and remain closed until some new element enters the area.

What I claim is:

1. In a door control system for a door equipped with power means for producing an opening and reclosing thereof and an electric current receiving element for directing operating energy to the power means, the combination, with said door and said current receiving element, of an antenna assembly suspended above the area of approach to said door, a substantially balanced bridge circuit having said antenna in one of its legs, a lead-in wire connecting the antenna assembly to other bridge legs, shielding means shielding said lead-in wire, said shielding means including balancing capacitance means connected between the bridge circuit and the shielding means for balancing the capacitance of the shielding means in reference to the balance of the bridge circuit, a source of high frequency current connected to said bridge circuit and active to impress upon said antenna assembly a high frequency potential to create an electric field adapted to encompass some part, at least, of a body approaching said door, and circuit means connecting said bridge circuit and said current receiving element responsive to a disturbance produced in said field by said approaching body to actuate said current receiving element and thereby to cause said power means to open the door, said circuit means for actuating the current receiving element including electronic timing means for causing said power means to reclose the door after a predetermined period of time measured from the commencement of operation of said actuating circuit means, and means included in said timing means for prolonging said measured period of time in response to a continued disturbance in the field due to a delay in the departure of said body from said door.

2. In a door control system for a door equipped with power means for producing an opening movement thereof and an electric current receiving element for directing operating energy thereto, the combination, with said door and current receiving element, of an antenna assembly suspended above the area of approach to said door, means to impress upon said antenna assembly an alternating electric potential of sufficiently high frequency to create an electric field adapted to encompass some part, at least, of a body approaching said door, means responsive to the disturbance produced in said field, by said approaching body, to actuate said current receiving element and thereby to cause said power means to open the door, said

actuating means including electronic timing means for causing said power means to reclose the door at a predetermined time measured from the commencement of operation of said actuating means, and means included in said timing means for prolonging said measured time, in response to a delay in the departure of said body from said door.

3. In a door control system for a door equipped with power means for producing an opening movement thereof and an electric receiving element for directing operating energy thereto, the combination, with said door and current receiving element, of an antenna assembly suspended above the area of approach to said door, means to impress upon said antenna assembly an alternating electric potential of sufficiently high frequency to create an electric field adapted to encompass some part, at least, of a body approaching said door, said means comprising a bridge circuit having four legs and including, as two legs of the bridge, a transformer having a center-tapped primary coil, capacitor and resistance units in the other two legs, one of which capacitor units includes said antenna assembly, said antenna being included in the bridge circuit by a lead-in wire, shielding means for the antenna assembly lead-in wire connected across one of the legs of the said tapped coil, a capacitance means connected across the other legs of said coil to balance the capacitance of the shielding means, means in said other two legs for adjusting the bridge circuit to a slight imbalance in a direction that will permit an increase in antenna capacity further to unbalance the bridge circuit in the same direction, means responsive to the disturbance produced in said field, by said approaching body, to actuate said current receiving element and thereby to cause said power means to open the door, said actuating means including electronic timing means for causing said power means to reclose the door at a predetermined time measured from the commencement of operation of said actuating means, and means included in said timing means for prolonging said measured time, in response to a continuing disturbance in the field due to a delay in the departure of said body from said door.

4. A door control system according to claim 3 and further comprising indicating means connected in circuit with said bridge transformer, said indicating means being actuated by a bridge unbalance above a predetermined value to indicate such unbalance.

5. A door control system according to claim 4 wherein said indicating means comprises a neon lamp connected to ignite in response to a bridge unbalance above said predetermined value.

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