AUTOMATIC DOOR SYSTEM

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The present invention relates to security vaults and has particular reference to means for effecting the automatic locking and opening of an access door thereof. More specifically, the invention relates to novel means for opening and closing a bank vault door and the like by automotive power means, the invention including means for the automatic and timed actuation of pressure and boltwork elements to seat and firmly lock the door on closing.

The subject matter of the present invention is closely related to that defined in my copending application for patent Serial No. 450,619 filed August 18, 1954 and entitled Mechanized Vault Door. The invention there defined, related primarily to a combination door construction in which pressure and boltwork elements may be employed, the entire system including means for automatically actuating the boltwork and pressure elements to lock and unlock and seat and unseat the door in a predetermined sequence, the various elements of the invention being interconnected and operable through common hydraulic and electric circuits. The present invention, on the other hand, is an improvement of that system and construction; additionally, as will be defined hereinafter, novel means are provided for effecting automatic mechanical movement of the door from closed to open position and return. The various means for effecting movement of the door are synchronized with the operation of the boltwork and pressure systems which have been mentioned. As a further improvement, mechanical means are provided to overcome inertia whereby a door when once fully opened may be initially shoved exteriorly and sequentially moved hydraulically from open to closed position. Other novel features include unique means for giving impetus to the pressure elements prior to automatic actuation thereof.

It is an object of this invention to make a vault door system which is fully automatic to unlock and open or to close and lock a vault door.

It is another object of this invention to create a vault door system in which means for effecting locking, unlocking, closing and opening are disposed substantially integrally with the door.

As a further object of the invention, there is provided a vault door system in which the operating means of the system are synchronously related to effect accurate movement of the door from opened to closed position or the fractional point therebetween.

Yet another objective of invention is to provide in combination electric and hydraulic circuits for a vault door system wherein the vault door may be operated through locking, unlocking, closing and opening phases completely automatically upon actuation of power systems therefor, and wherein the entire system may be held in suspended animation as when any motion in the system meets interference.

Still a further object of the invention is to provide a closed circuit hydraulic system for locking and unlocking, closing and opening a vault door in which the elements of the entire system are inter-connected and interdependent.

As a further objective herein, it is intended that mechanical and hydraulic means may be used independently of one another to effect opening and closing in a vault door system, the elements for effecting manual automatic hydraulic movement thereof being inter-connected yet independently operable of one another.

Other objects of the invention will be apparent from reference to the accompanying drawings and ensuing description wherein like numerals relate to similar elements of the invention.

In the drawings:

Fig. 1 is a view in vertical elevation of the door, the face thereof being broken away to expose the major elements of the system;

Fig. 2 is a view in perspective of the invention wherein the vault door is open and the foot bridge lowered;

Fig. 3 is a vertical sectional view of the invention taken along the lines 3—3 of Fig. 2;

Fig. 4 illustrates schematically the electrical and hydraulic circuits as employed in the system;

Fig. 5 illustrates the electric circuit employed in a phase of operation; and

Fig. 6 illustrates the electric circuit employed during an advanced phase of operation of the system.

The system, it will be noted from reference to Fig. 1, consists in a vault door assembly 10 hinged as at 12 to a vestibule frame with the crane hinge assembly and principal operating parts of the device being encased in a hinged cover member 14. The cam assembly 16 comprises fixed anchor members 18 and a rotatable pressure element bearing member or plate cam 18. A corresponding bearing member plate cam 22, axially aligned with cam 18, is fixed to the frame on the free side of the door. Cams 18 and 22 respectively define cam grooves to receive and bear the eccentric elements 24 of the pressure system hereinafter defined, said eccentric elements being integrated with the pressure system spindle 26 to which is journaled hand arbor 28. Spindle 26 is geared in mesh with the reciprocable rack assembly 50. A reciprocable rack 54 is adapted to engage the geared portion of the spindle 26 of the pressure system as at 52. At the lower left hand portion of the door, there is secured means for absorbing shock during termination of outward movement of the door and for overcoming inertia in opening the door. The details of this assembly 30 will be pointed out hereinafter.

A hand arbor assembly 40 for shifting the boltwork of the vault door is disposed substantially midway between the top and bottom of the door. The assembly consists of a rotatable shaft 42 keyed to a pinion member to which is attached the hand arbor 44. The arbor handle 44 is engaged as at 46 by a collar which is universally attached for transmitting automatic hydraulic or pneumatic actuate motion to the hand arbor. Both the manual throw bolt assembly 40 and the manual pressure system assembly 28 are retained for facile operation in the event of power failure in the automatic system. It is to be noted that equivalent means such as rack and pinion may be employed to attain like results. When the necessity for manual operation arises, pressure is released from the hydraulic system and manual operation may be effected without the necessity of overcoming adverse hydraulic operating pressures.

The door swinging system is shown at 60 wherein it will be noted that a reciprocating rotary power hydro-motor 62 carries a torque motive member 64 to which is keyed a sprocket pinion member 66. Hydromotor 62 consists of a cylinder in which there is a shaft-vane assembly operable by force of the hydraulic or pneumatic medium...
against the vane. Typical of this type of unit is the hydromotor produced by The Bonnot Company, Canton, Ohio. The entire assembly 60 is securely mounted on the face of the door, beneath the cover 14 with the exception of the fixed sprocket pinion member 66' which engages the fixed shaft of the hinge assembly 12 at the lower portion of the door. In operation, this inter-connected door hinge system is adapted to operate upon the planetary gear principle whereby the connecting flexible chain 68 constituting power transmission element is adapted to rock about the fixed fulcrum 66', power being imparted to the internal sprocket pinion 66 as through the hydro-motor 62. Torque motion through pinion 66 upon chain 68 is translated into orbital movement of the chain and door about the hinge locating pin 64.

For purposes of effecting automatic hydraulic or pneumatic movement to the respective boltwork and pressure system, hydraulic assemblies 70 and 70', are attached to the door, the former being mounted so that movement may be effected to the arbor system 40, the latter, namely hydraulic system 70, being fixed for reciprocation movement of piston extension 54 which engages the rack system 50. In these hydraulic systems there are respectively hydraulic pressure lines 72', 74' and 72, 74 respectively, each being adapted to reciprocate its corresponding piston member. Valve assemblies 70x and 70x' respectively serve the systems 70 and 70' being four-way valves defined in detail hereinafter, whereas, valve assembly 90x serves the piston assembly 30 and the door swinging assembly 60. A clear understanding of the overall system can be obtained by referring to Fig. 4. Throughout the entire system, the respective hydraulic conduits are inter-connected and independent as is the electric circuit which is involved in the activation and deactivation of the hydraulic system.

In Figs. 2 and 3, there is shown a foot bridge assembly 100 consisting of an inclined plate 102 attached to and integral with a horizontal platform at its hinge end. Fixed to the inner surface of the platform is a torque bar 106 adapted to engage a rectangular orifice 104 within cranks 105 which are disposed at each lateral extremity of the platform. The torque bar being substantially rectangular throughout its length is preferably cylindrically shaped toward its ends for riding in a fixed bearing. The crank 105 is linked as at 110 through connector 112 and piston rod 114 to hydraulic piston assembly 116. Suitable conduits connect hydraulic assembly 116 to the solenoid valve assembly 110x which is shown in Fig. 1 of the drawings as at the top of the hydraulic system. See also Fig. 4 herein. Conduits leading from valve 110x to the hydraulic bridge piston assembly pass through protective channel 122 which is flexible to adapt it to arcuate movement of the door with respect to the frame, it will be noted that a counter-weight assembly 118 may be mounted within the vestibule of the vault to accommodate the crank assembly on the left side of the foot bridge.

The closed electrical circuit employed in the present invention is shown in Figs. 5 and 6. Solenoid valve assemblies 70x, 80x, 90x and 110x are superposed schematically and connected to the electrical circuit as shown; likewise, the motor 82 and pump 84 are illustrated. With the exception of valve 100x, the other valves are four-way valves each of which is a combination of two three-way valves arranged to incorporate a common inlet and exhaust pipe connections, the two solenoids of each valve being alternately energized in operation. When the valves are not energized, inlet pressure is blocked and cylinder ports are open to the exhaust line. In circuit 200, there is an electrical potential of 24 volts which may be advanced to conductor 221 through the use of the transformer 202. Within the circuit there is a latching relay 204 consisting of a series of upper contacts 206 and lower contacts 208 respectively operable upon energization of coils 210 and 212. A pump motor relay 214 is in connection with the latching relay and with the pump motor 82 shown.

The various circuits are shown as at 221 through 237 inclusive, whereby the circuits are adapted to control solenoids of this nature, that an automatically operable time switch should be employed, such switches being automatically closed during predetermined periods of operation and open during periods of non-use. Additionally or in lieu of such a time switch, there is provided upon the door itself a key switch 300. In the circuit whereby the entire system may be de-energized or energized by the keeper of the vault having the key. Switches 302 and 304, associated with switch 300, are respectively operable for opening and closing the vault door, that is, for commencing the phases of operation during opening and closing, the former being used in opening and the latter being used in closing; both being normally open and of push-button type. Other switches in the system include switch 311 which is normally closed; switch 312 normally open, switch 313 normally open; switch 315 normally closed, switch 316 normally open; switch 317 normally open, switch 318 normally closed. Switching 202x is operable in unison to effect closing of the motor relay to energize the motor 82.

To open the door as in Fig. 5, the keeper closes key switch 300 whereby to energize the system; thereafter depressing switch 302, coil 210 is energized to close the upper contacts of the latching relay 204, the foot bridge 100 being raised, switch 318 which is out of contact therewith is normally closed as in this instance. Thus, the circuit is closed to energize the motor relay 214 thereby actuating the pump motor 82. Simultaneously, a solenoid of the boltwork valve is actuated to release pressure into hydraulic system 70' as through the line 74 thereof thus opening normally closed switch 311, which said switch is engaged by the piston of the hydraulic system when retracted. The hydraulic piston 76 of the boltwork assembly now moves to engage micro-switch 312 and in so doing imparts rotation to the arbor 40 thereby to retract the locking bolts of the vault door. The piston of the hydraulic system 70 being now fully extended, micro-switch 312 is energized and closed. Micro-switches 313 and 315 which are associated with the pressure element hydraulic assembly 70 are likewise closed as are micro-switches 317 and 318 which are associated with the foot bridge assembly. With the closing of switch 312, a solenoid of the pressure system four-way valve 80x is actuated and pressure introduced into the hydraulic system of the pressure system 70. In this instance, the piston of the pressure system is actuated as by hydraulic fluid entering through conduit 74' thus driveth the piston outwardly, thereby to move rack assembly 209 downwardly and to turn the pressure system spool 26 in a clockwise direction, thereby to disengage the eccentric 24 of the system from cam groove 22. As the pressure system rack moves to its full downward position, switch 313 is permitted to revert to its normally open position and switch 315 is depressed to open the circuit. Simultaneously a solenoid of the door latching relay valve 90x is actuated to motivate the hydraulic-motor into its opening cycle.

The door now begins its outward swing by virtue of rotation of pinion 66 to move the chain 68 about fulcrum 66'; clockwise turning the door outwardly in its normal swing. Upon reaching the full open position, the piston associated with the hydraulic assembly 30 abuts a fixed shock absorber and is retracted within the cylinder whereby switch 316 which has been detained is disengaged and closed to energize the foot bridge solenoid valve 110x.

In this connection, micro-switch 317, which has been closed heretofore, is now disengaged and opened. The foot bridge is gradually lowered into position, the platform thereof engaging normally closed micro-switch 318 thereby to open said switch and de-energize the upper contact portion of latching relay 204 thus cutting the pump motor and rendering the system inert.
Referring now to Fig. 6, we observe commencement of closing of the vault door and raising of the foot bridge. The phase here shown, that is, in Fig. 6, simulates closing as by depressing switch 304 hereby to energize the lowermost coil 212 of the latching relay and in this manner effecting contact between the lower contacts 208 of the latching relay to reverse the process hereinbefore described. It will be noted that the pump motor 80 is thus actuated and pressure once again applied to the hydraulic system. The respective pistons of the boltwork and pressure systems being retracted and extended respectively, micro-switch 312 is now closed and micro-switch 315 which is normally closed is now opened. Motor relay switches 320 are closed as are switches 311, 312 and 316. Thus, the second and reverse action solenoid of the four-way foot bridge valve 110x permits hydraulic pressure to now raise the piston of the foot bridge hydraulic system, whereupon the foot bridge is gradually rotated upwardly to its uppermost position and micro-switch 317 which is normally open is now engaged to close. Simultaneously, inertia platen system 30 is hereupon extended. The closing of switch 317 opens valve 90x which permits hydraulic pressure to be introduced into hydro-motor and the swing is actuated by the rotation of the sprocket within its planetary chain in a counterclockwise direction and the door commences closing. As the pressure system 30 reaches the full extent of its outward movement, micro-switch 316 is engaged and thus opened.

It is believed obvious that as the vault door continues its closing swing, substantially the reverse procedure of switching and hydraulic motion takes effect. Thus as hydraulic system switch 316 is opened, foot bridge switches 317 and 318 are closed to energize the branch circuit for the operation of the pressure element hydraulic system and sequentially the normally open micro-switch 313 is closed to prepare the boltwork hydraulic system for actuation; the second solenoid thereof being energized to permit the passage of pressure into said system. Following this, micro-switch 312 is opened as by retraction of the boltwork element to effect opening of micro-switch 311 whereupon the motor relay switches 320 are de-energized and the system returned to inoperativeness.

In construction, the angle of contact of the pressure system cams 22 is important. In this connection, the angle between the center axis of rotating spindle 26 and the center of the eccentric lug, which is off-set thereof, must be less than 90°. In closing, the off-set lug of the spindle 26 engages the cam groove and is given thereby an initial start or impetus upon closing to partially rotate the pressure system spindle 26, whereby rack assembly 50 is moved sufficiently from switch 315 to close same, thus restoring it to its normal position, whereupon the boltwork four-way valve closing solenoid switch 313 is engaged and closed to cause the boltwork piston to retract, thereby to extend the boltwork and lock the door in position within the frame.

To regulate the flow of the hydraulic fluid from the main pressure line to the reservoir there is provided a hand operated globe valve 100x, its specific function residing in control of speed of operation by regulating the amount of fluid which is bled from the main pressure line to the reservoir 86.

As a safety factor, a relief valve assembly 120x is employed in the system whereby upon build-up of excess pressure within the hydraulic system, the pressure will render the system in suspended animation until said pressure is released. This assembly includes a gauge as shown. Thus, if an individual were to attempt to stop movement of the door during any phase of operation from opening to closing or from closing to opening, application of a predetermined pressure as by holding or interference would render the system inert beyond the build-up of further pressures. A suitable gauge and relief valve are shown in Figs. 4 and 1 respectively.

It is believed apparent that the system could be equally as effective if operated on pneumatic principles.

Thus, the invention has been defined with specificity it is to be understood that various modifications may be made to the system without departing from the spirit of invention as defined in the appended claims. Since a conventional combination locking system is employed, with the elements herein, no attempt has been made to define or claim same.

1. In a vault door opening and closing system wherein the door is mounted for mechanical pivotal movement on a frame and in which door movement components are an integral portion of the door per se: a vault door and frame therefor, at least one fixed door pinion mounted upon the frame, a rotatable pinion mounted upon the door in spaced relation to said fixed pinion, flexible power transmission means connecting said rotatable pinion and said fixed pinion, rotatory drive means mounted upon the door actually engaging the rotatable pinion, the rotatable pinion upon actuation transmitting torque through said power transmission means about said fixed pinion, whereby said rotatable pinion, said power transmission means and said door may be accurately moved about said fixed pinion by orbital movement of said power transmission means about the rotatable pinion to effect opening and closing of the door.

2. In the system according to claim 1, including a pressure element to fully seat and unseat the door, automatic pressure element actuating means mounted on the door and interconnected with the opening and closing system including timing means to effect sequential actuation of the pressure element following closing and in preparation for opening.

3. The system according to claim 2 wherein the pressure element includes at least one rotatable eccentric mounted upon the door and at least one corresponding cam fixed to the frame, impetus means on the cam to augment operation of the eccentric sequentially preceding automatic actuation thereof during the closing cycle of the door.

4. The system according to claim 1 including impetus means carried by the door in engageable-disengageable relation to a fixed abutment, said impetus means being automatically actuable immediately precedent to operation of the closing of the door to overcome inertia thereof.

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