

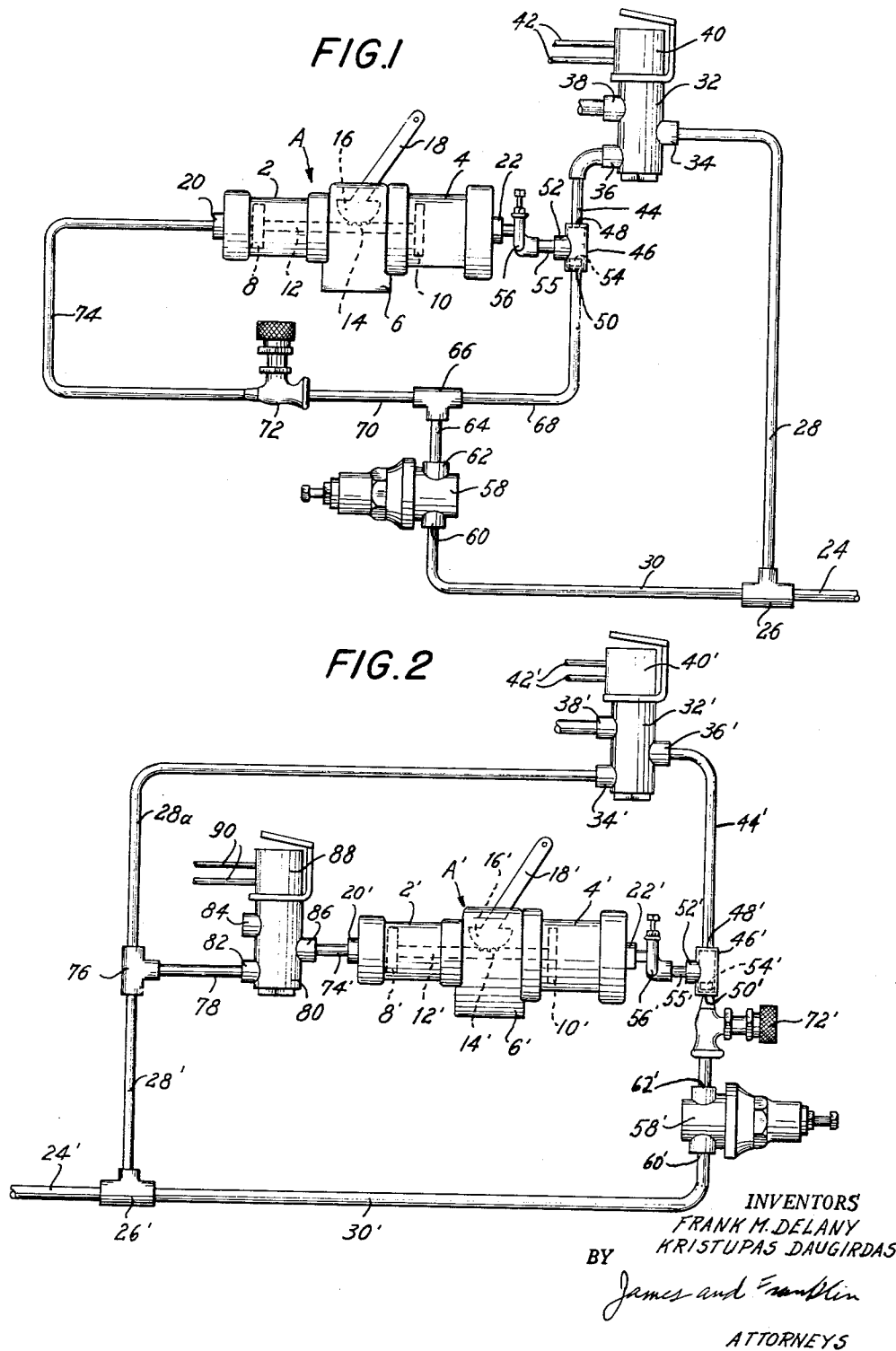
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PUSH DOOR MECHANISM

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PUSH DOOR MECHANISM

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The present invention relates to fluid pressure actuated apparatus for controlling the operation of doors normally held in closed position and adapted to be moved to open position when desired. The invention is particularly applicable for use with doors which are to be locked in closed position, manually pushed to open position, and automatically returned to closed position when manual pushing force is released. Such doors, generally termed "push doors," are in widespread use on public conveyances such as buses.

In the past doors of public conveyances such as buses have generally been completely power actuated between closed and open positions. More recently, however, a marked trend toward the use of push doors has developed, to a considerable extent because of the maintenance difficulties experienced with the completely power actuated systems, and especially with their control elements (e.g. treadles), and also because of a desire to minimize the work load on the operator of the vehicle, who often had to manually control the opening and closing of the doors.

Even when a push door is used, however, it still must be under the control of the operator of the vehicle to at least some extent. Obviously, while the vehicle is in motion some means must be provided for reliably locking the door in closed position. The door must not open when the vehicle makes a sharp turn, or when a person or group of persons might lean or be thrown against the door. Even when the vehicle is standing still there are occasions when the operator may not wish a particular door to be opened. And when opening of the door is permitted, it should be openable with but a minimum amount of pressure applied thereto, such pressure as might be exerted by a woman with her arms full of bundles.

The locking of push doors in closed position can, of course, be accomplished by means of mechanical latches of various types. An example of such a mechanism is shown in Newkirk Patent 2,419,964, entitled "Spring Return Push Door With Door Lock," assigned to the assignee of this patent. Such mechanical linkages are quite effective, but they involve the use of apparatus different from that previously employed in connection with completely power actuated doors, and thus involve the redesign, to an appreciable degree, of a portion of the body of the vehicles in which they are used. Moreover, there are today many thousands of vehicles with power actuated doors where conversion is desired to push door operation, and the use of push door control systems such as are shown in the aforementioned Newkirk patent require removal and scrapping of the already existing door operating equipment and the substitution therefor of new and different equipment. This is obviously a source of considerable expense, and represents appreciable economic waste.

The present invention has as its primary object the devising of system of push door control which does not rely upon mechanical linkages for locking the door in closed position (although such linkages might be employed as an additional safety feature if desired) but which instead relies upon the application of fluid pressure to forcefully lock the door in closed position when that is desired, and, when the door is to be opened, to retain the door in closed position with a reduced force

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which can readily be overcome by a person desiring to pass through the door opening. The use of fluid pressure for these purposes has another and very important advantage—it permits the modification of existing power actuated door systems to push door systems with a minimum of expense and without having to materially change existing installations.

Existing installations which positively move the door between open and closed positions quite generally employ fluid pressure motors of the differential type. In such motors the same pressure is exerted on opposite sides of a piston, those two sides having different effective areas. Hence a differential force is developed in a direction from the large side of the piston toward the small side thereof. The removal and application of pressure from one of the piston sides, while the same pressure remains constantly applied to the other side of the piston, is relied upon to cause the pistons to move, thereby moving the door.

In accordance with the present invention, this differential type motor is used in conjunction with a plurality of different pressures selectively applied to appropriate sides of the piston, thereby selectively energizing the fluid pressure motor so as to develop (a) a very large force on the piston in one direction, forcibly retaining it in what may be considered its normal position corresponding to the closed position of the door, thus locking the door closed, or (b) a greatly reduced force holding the piston in its normal position, but against which force the piston may be moved upon the application of minimal force to the door, thus permitting the door to be opened. The pressures active on the piston serve to return the door to closed position after the opening force exerted thereon has been released, thus eliminating the necessity for a mechanical door spring. The operator of the vehicle, by controlling the application of these pressures through a simple valve, can therefore lock the door or condition it to be pushed open. The system is such that it can readily be modified to provide for power opening of the door with an appropriately small force when that is desired.

To the accomplishment of the above, and to such other objects as hereinafter appear, the present invention relates to the door control system as defined in the appended claims and as described in this specification, taken together with the accompanying drawings, in which:

FIG. 1 is a schematic representation of one embodiment of the present invention which provides only for push door operation; and

FIG. 2 is a schematic representation of an alternative embodiment of the invention which provides for power actuation of the door to open position in addition to permitting push door operation.

Having reference first to the embodiment of FIG. 1, the system of the present invention involves the use of a differential type fluid pressure motor generally designated A, one typical embodiment of which is illustrated in the drawings. That embodiment comprises a small cylinder section 2 and a large cylinder section 4 mounted on central body 6 and provided with pistons 8 and 10 respectively. The pistons 8 and 10 are connected by piston rod 12, the intermediate portion 14 of which passes through the central body 6 and has a rack formed thereon which meshes with gear 16 to which operating arm 18 is connected, that arm 18 being operatively connected to a door or the like in any conventional manner. Inlets 20 and 22 are provided at the ends of the small and large cylinder sections 2 and 4 respectively through which fluid under pressure can enter those cylinders and act against the pistons 8 and 10 respectively. The effective area of the piston 10 against which the pressure fluid is

active, it will be seen, is appreciably greater than the effective area of the piston 8. The cylinder 2 and its piston 8 will hereafter be termed the "small side" of the motor A, and the cylinder 4 and piston 10 will hereinafter be termed the "large side" thereof.

The pipe 24 connects the system to a source of fluid under relatively high pressure. As here specifically disclosed that fluid may comprise air under pressure of approximately 85-90 p.s.i. The pipe 24 leads to a T-fitting 26 from which pipes 28 and 30 extend. The pipe 28 leads to a control valve 32 having an inlet port 34, an outlet port 36, and a venting port 38. In one operative position of the valve 32 the ports 34 and 36 are connected, and in the other operative position thereof the ports 36 and 38 are connected and the port 34 is blocked off. The control valve 32 may be actuated to its respective operative positions by means of a solenoid 40 to which electrical leads 42 extend from a remote control switch (not shown) which may be located at the operator's station. The port 36 is connected by pipe 44 to a shuttle valve 46 having inlet ports 48 and 50 and an outlet port 52. The shuttle 54 is located in the valve 46 between the ports 48 and 50 and is movable between a lower position in which ports 48 and 52 are connected and an upper position in which ports 50 and 52 are connected. The outlet port 52 is connected by pipe 55 and speed fitting 56 to the inlet port 22 on the large side of the differential motor A.

The pipe 30 leads to an adjustable pressure regulator 58 having an inlet port 60 and an outlet port 62, the pressure regulator 58 being effective to reduce the pressure at its outlet port 62 to some desired value, such as 25 p.s.i. The port 62 is connected by pipe 64 to T-fitting 56, from which pipes 68 and 70 extend. Pipe 68 leads to the port 50 of the shuttle valve 46. Pipe 70 leads to relief valve 72, which is in turn connected, by pipe 74, to the inlet port 20 of the small side of the differential motor A.

The control valve 32 is adapted to be controlled in any appropriate manner so as to condition the system for locking the door to which the arm 18 is connected or for permitting it to be manually pushed open. As here disclosed energization of the electromagnet 40 can be controlled by the operator of the vehicle by means of a switch (not shown) connected to the leads 42. When the doors are to be locked in closed position the electromagnet 40 is so energized as to cause the control valve 32 to connect its ports 34 and 36. Thus high pressure will be applied to the upper end of the shuttle 54 while low pressure emanating from the pressure regulator 58 is applied to the lower end thereof. The shuttle 54 will move to its lower position, as illustrated, and high pressure will be applied to the large side of the motor A. At the same time low pressure emanating from the pressure regulator 58 will be applied to the small side of the motor A. The difference in size between the pistons 10 and 8, coupled with the fact that a higher pressure is applied to the large piston 10 than to the small piston 8, will result in a very large force maintaining the piston assembly 8, 10, 12, in its illustrated position all the way to the left, as viewed in FIG. 1, that position corresponding to the closed position of the door connected to the arm 18. Hence the door will be retained in its closed position with a force, perhaps on the order of 1700 in./lbs. of torque on the door shaft, sufficiently large as to resist any forces which might be expected to be applied to the doors. The doors are therefore effectively locked closed.

When the operator of the vehicle wishes to permit passengers to leave the vehicle, he will so manipulate his switch as to energize the solenoid 40 to move the control valve 32 to its second position, in which the ports 36 and 38 are connected and port 34 is blocked off. Atmospheric pressure will now be active on the upper end of the shuttle 54, while low pressure (e.g. 25 p.s.i.)

is applied to the lower end thereof. The shuttle 54 will rise, blocking off shuttle valve port 48 and connecting ports 50 and 52. The low pressure of 25 p.s.i. will then be applied to the large side of the motor A, while the same low pressure remains active on the small side of the motor A. The piston assembly 8, 10, 12 will still be urged to its position all the way to the left, corresponding to the closed position of the door, but with a greatly reduced force which is dependent upon the difference in size between the pistons 8 and 10 and the magnitude of the smaller pressure applied to both pistons 8 and 10. This reduced force will serve to retain the door connected to the arm 18 in closed position, but will permit it to be pushed open by the application of a suitably small force. When it is pushed open the piston assembly 8, 10, 12 will move to the right, and when the door is subsequently released the pressure differential active on such piston assembly will cause that assembly to move back toward the left, thus closing the door. Because the force involved is not too great the door will close at a reasonable rate such that it cannot cause any injury or damage to people or things in its path. The speed of closing can be further controlled by appropriate setting of the speed fitting 56. A spring can be employed to assist in door closing and to aid in resisting door opening, but this is entirely optional.

The push door control system of FIG. 1, it will be seen, involves the use of the self-same differential motor A which has formerly been used in conventional systems where the doors are power-moved to open position, even when that motor A has already been installed in a vehicle. All that need be added to an existing system is the shuttle valve 46, the pressure regulator 58, the speed fitting 56 and the relief valve 72, together with appropriate piping. The same solenoid-actuated control valve 32, 40 which was formerly used to control the operation of the power opening system can also be used with the push door system of the present invention.

The embodiment of FIG. 2 is essentially similar to that of FIG. 1, except that it also provides for power movement of the door to open position when desired. Parts in the embodiment of FIG. 2 which are similar to those in the embodiment of FIG. 1 have the same reference numerals applied thereto, differentiated, however, by being primed.

In the embodiment of FIG. 2 the pipe 28' leads to T-fitting 76 from which pipes 78 and 28a extend. The pipe 28a extends to inlet port 34' of the control valve 32' which is adapted to be controlled by the driver of the vehicle. A second control valve 80 is provided, having ports 82, 84 and 86, and it is adapted to be controlled by solenoid 88 to which electrical leads 90 are connected. The control valve 80 in one operative position connects the ports 82 and 86, and in its other position connects the ports 84 and 86 and blocks off the port 82. The port 84 vents to atmosphere, the pipe 78 connects to the port 82, and the port 86 is connected by pipe 74' to the inlet port 20' at the small side of the differential motor A'.

When the door connected to the arm 18' of the motor A' in FIG. 2 is to be locked closed, the control valve 32' is actuated to connect the ports 34' and 36'. Hence high pressure will be applied to the port 48' of the shuttle valve 46', the shuttle 54' will be moved to its lower position, and that high pressure will be applied to the large side of the motor A'. The solenoid 88 for the valve 80 is adapted to be connected to a passenger-operated switch (not shown) such as a treadle or, preferably, a switch incorporated into the handle of the door to be pushed and adapted to be closed only when pushing pressure is applied to that handle. An electrical interlock is preferably provided between the switch controlled by the operator of the vehicle and the passenger-operated switch, so that the latter cannot be effective until the vehicle operator has unlocked the door. The normal condition of the valve 80 is to connect the ports 86 and 84, so that at-

atmospheric pressure is applied to the small side of the motor A'. The magnitude of the high pressure (e.g. 85-90 p.s.i.) on the large side of the motor A' will develop sufficient force to retain the door in its closed position with locking force. It will be noted that even if the valve 80 should be energized to connect the ports 82 and 86, thus applying the same high pressure to the piston 8' at the small side of the motor A' as is being applied to the large side of the motor A', the door will still be retained closed, although with a reduced force.

When the operator wishes to condition the door to be opened, either by pushing or by a power-assist, he will energize the solenoid 40' so that the control valve 32' will connect the ports 36' and 38' and block off the port 34'. As a result the shuttle 54' in the valve 46' will move upwardly, and the low pressure (e.g. 25 p.s.i.) emanating from the pressure regulator 58' will be active on the large side of the motor A'. Atmospheric pressure will still be applied to the small side of the motor A'. Thus the force urging the piston assembly 8', 10', 12' to the left as viewed in FIG. 2 will be greatly reduced, and consequently the door, although still urged to closed position, can be pushed open manually by the application of a suitably small force.

If the passenger-actuated switch (treadle or door-switch) is appropriately manipulated the control valve 80 will connect the ports 82 and 86 so that the high pressure of 85-90 p.s.i. will be applied to the small side of the motor A' while the low pressure of 25 p.s.i. remains applied to the large side of the motor A'. The sizes of the pistons will be so related to the difference in the magnitude of these two pressures that a resultant force will be developed tending to move the piston assembly 8', 10', 12' to the right, thus opening the door or providing a power-assist for the opening of the door in the event that the door is also opened against mechanical spring pressure. The power-opening force will be rather small so that no injury or damage will result if the door, in opening, should strike a person or object.

When either the control valve 80 or the control valve 32' or both are returned to their initial position the pressure then active on the large side of the motor A' will power-move the door back to its closed position, the speed of door movement being controlled through setting of the speed fitting 56'.

Thus it will be appreciated that, through the use of a small amount of stock equipment (piping, relief valve, shuttle valve, pressure regulator and speed fitting) existing power opening systems for doors, and even those already installed in vehicles, may readily be converted to push door operation. The instant system is also valuable as an initial installation, since it provides, with a minimum of moving parts and without having to use springs or complicated mechanical structures subject to breakage, a readily controlled arrangement for reliably retaining a door in locked closed position and releasing it for power or manual movement to open position.

Although the present invention has been here specifically described in connection with its use with doors in public conveyance vehicles, which is at present its main field of use, it will be apparent that the invention is not limited thereto, but may without substantial modification be adapted for use in other environments. It will further be apparent that many variations may be made in the specific details of the system here disclosed, without departing from the spirit of the invention as defined in the following claims:

We claim:

1. In combination, a door adapted to be pushed from first to second position, a differential piston-cylinder assembly having a small side and a large side, an operative connection between said piston and said door, a plurality of fluid sources having fluid at different predetermined high and low pressures the relative magnitudes of which are defined hereinafter, and control means operatively

connected between said fluid sources and said differential assembly, said control means being effective to perform the following functions: (a) set up a locking condition by connecting fluid at high pressure to the large side of said assembly and connecting fluid at low pressure to the small side thereof, and (b) set up a pushing condition by connecting fluid at low pressure above atmospheric pressure to the large side of said assembly and fluid at low pressure to the small side thereof, the magnitude of said high pressure applied to the large side of said assembly in said locking condition being such, in conjunction with the difference in size between said large and small sides of said assembly and the magnitude of the low pressure then applied to the small side thereof, as to retain said door in its first position with a large locking force, the magnitude of the low pressure applied to the large side of said assembly in said pushing condition being such, in conjunction with the difference in size between said large and small sides of said assembly and the magnitude of the low pressure then applied to the small side thereof, as to retain said door in its first position with a reduced force which can be overcome by manually pushing on said door.

2. The combination of claim 1, in which said control means comprises a shuttle valve having an outlet connected to the large side of said assembly and having a pair of inlets connected to the fluids at high and low pressure respectively, said fluids being active on opposite sides of the shuttle portion of said valve, the connection between said shuttle portion and said high pressure fluid including a valve movable between a first position connecting said shuttle portion and said high pressure source and a second position venting said shuttle portion and blocking said high pressure source.

3. The combination of claim 1, in which the low pressure applied to the small side of said assembly in both said locking and pushing conditions is substantially the same as the low pressure applied to the large side thereof in said pushing condition.

4. The combination of claim 3, in which said control means comprises a shuttle valve having an outlet connected to the large side of said assembly and having a pair of inlets connected to the fluids at high and low pressure respectively, said fluids being active on opposite sides of the shuttle portion of said valve, the connection between said shuttle portion and said high pressure fluid including a valve movable between a first position connecting said shuttle portion and said high pressure source and a second position venting said shuttle portion and blocking said high pressure source.

5. The combination of claim 1, in which the low pressure applied to the small side of said assembly in both said locking and pushing conditions is substantially the same as the low pressure applied to the large side thereof in said pushing condition.

6. The combination of claim 5, in which said control means comprises a shuttle valve having an outlet connected to the large side of said assembly and having a pair of inlets connected to the fluids at high and low pressure respectively, said fluids being active on opposite sides of the shuttle portion of said valve, the connection between said shuttle portion and said high pressure fluid including a valve movable between a first position connecting said shuttle portion and said high pressure source and a second position venting said shuttle portion and blocking said high pressure source.

7. In the combination of claim 5, control means for (c) setting up a power-opening condition by connecting fluid at high pressure to the small side of said assembly while the large side thereof remains connected as in said pushing condition, the magnitudes of the pressures then applied to the large and small sides of said assembly being such, in conjunction with the difference in size between said sides, as to power-move said door to its second position.

8. In the combination of claim 5, control means for

(c) setting up a power-opening condition by connecting fluid at high pressure to the small side of said assembly while the large side thereof remains connected as in said pushing condition, the magnitudes of the pressures then applied to the large and small sides of said assembly being such, in conjunction with the difference in size between said sides, as to power-move said door to its second position, and in which said control means comprises a shuttle valve having an outlet connected to the large side of said assembly and having a pair of inlets connected to the fluids at high and low pressure respectively, said fluids being active on opposite sides of the shuttle portion of said valve, the connection between said shuttle portion and said high pressure fluid including a valve movable between a first position connecting said shuttle portion and said high pressure source and a second position venting said shuttle portion and blocking said high pressure source.

9. In combination, a door adapted to be pushed from first to second position, a differential piston-cylinder assembly having a small side and a large side, an operative connection between said piston and said door, first and second fluid sources having fluid at high and low pressures respectively, and control means operatively connected between said fluid sources and said assembly, said control means being effective to perform the following functions: (a) set up a locking condition by connecting said first source to the large side of said assembly and said second source to the low side thereof, and (b) set up a pushing condition by connecting said second source to both sides of said assembly, the difference in size between said large and small sides of said assembly and the magnitudes of the pressures of said sources being such as, in said locking condition to retain said door in its first position with a strong locking force and, in said pushing condition, to retain said door in its first position with a reduced force which can be overcome by manually pushing on said door.

10. The combination of claim 9, in which said control means comprises a shuttle valve having an outlet connected to the large side of said differential assembly and having a pair of outlets connected to said first and second fluid sources respectively, said fluid sources being operatively active on opposite sides of the shuttle portion of said valve, the connection between said shuttle portion and said first fluid source including a valve movable between a first position connecting said shuttle portion and said first fluid source and a second position venting said shuttle portion and blocking said first fluid source.

11. In combination, a door adapted to be pushed from first to second position, a differential piston-cylinder assembly having a small side and a large side, an operative connection between said piston and said door, first, second and third fluid sources having fluid at high, intermediate and lower pressures respectively, and control means operatively connected between said fluid sources

and said assembly, said control means being effective to perform the following functions: (a) set up a locking condition by connecting said first source to the large side of said assembly and said third source to the small side thereof, and (b) set up a pushing condition by connecting said second source to the large side of said assembly and said third source to the small side thereof, the difference in size between said large and small sides of said assembly and the magnitudes of the pressures of said fluid sources being such as, in said locking condition, to retain said door in its first position with a strong locking force and, in said pushing condition, to retain said door in its first position with a reduced force which can be overcome by manually pushing on said door.

12. The combination of claim 11, in which said control means comprises a shuttle valve having an outlet connected to the large side of said differential assembly and having a pair of outlets connected to said first and second fluid sources respectively, said fluid sources being operatively active on opposite sides of the shuttle portion of said valve, the connection between said shuttle portion and said first fluid source including a valve movable between a first position connecting said shuttle portion and said first fluid source and a second position venting said shuttle portion and blocking said first fluid source.

13. In the combination of claim 11, control means for (c) setting up a power-opening condition by connecting said first source to the small side of said assembly and said second source to the large side thereof, the difference in size between said large and small sides of said assembly and the magnitudes of the pressures of said first and second sources being such that the pressure differential over-balances the size differential, thereby to power-move said door to its second position.

14. The combination of claim 13, in which said control means comprises a shuttle valve having an outlet connected to the large side of said differential assembly and having a pair of outlets connected to said first and second fluid sources respectively, said fluid sources being operatively active on opposite sides of the shuttle portion of said valve, the connection between said shuttle portion and said first fluid source including a valve movable between a first position connecting said shuttle portion and said first fluid source and a second position venting said shuttle portion and blocking said first fluid source.

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