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PNEUMATIC POWER DOOR OPERATING INSTALLATION

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4 Sheets-Sheet 1

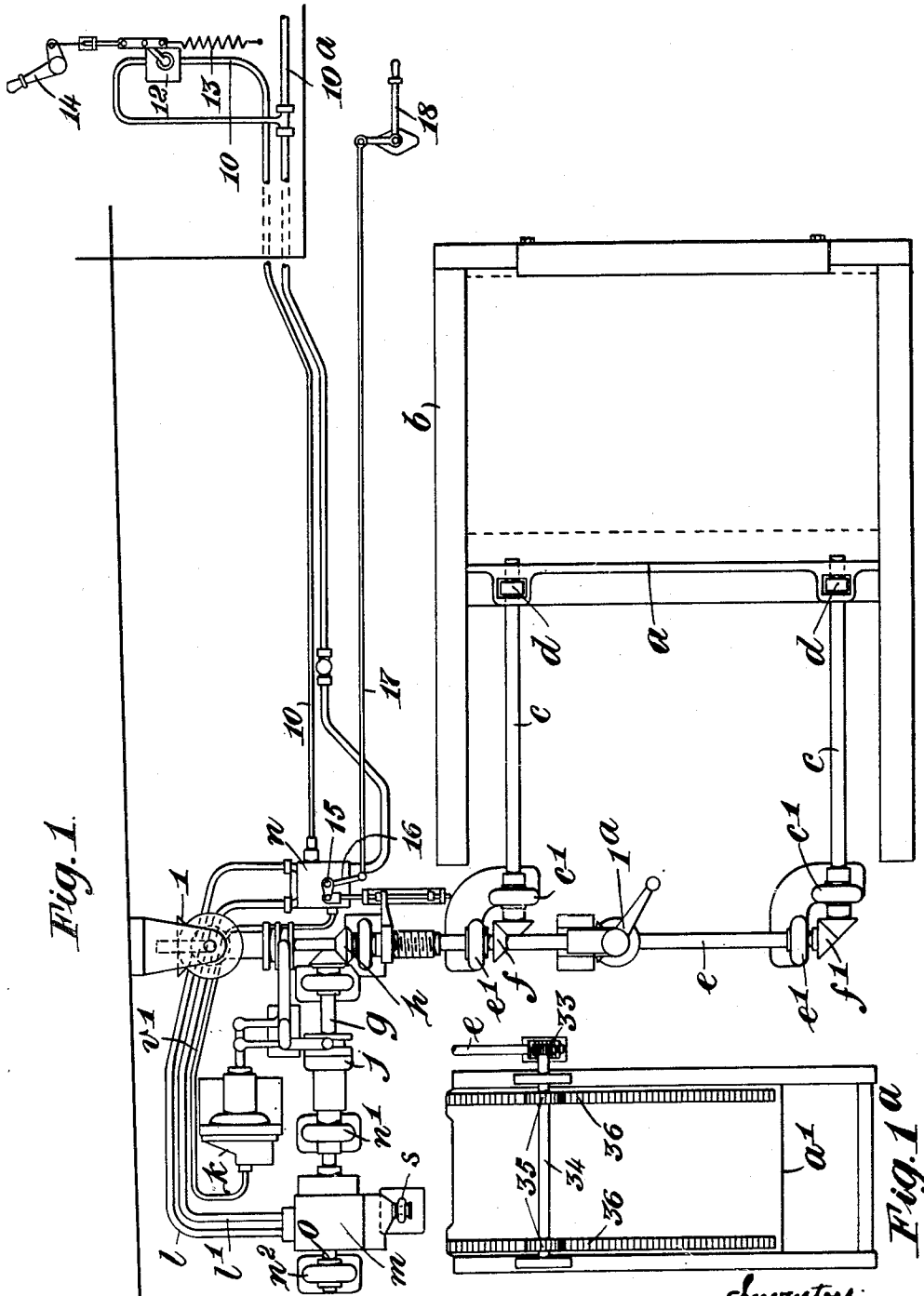


Fig. 1.

Fig. 1a

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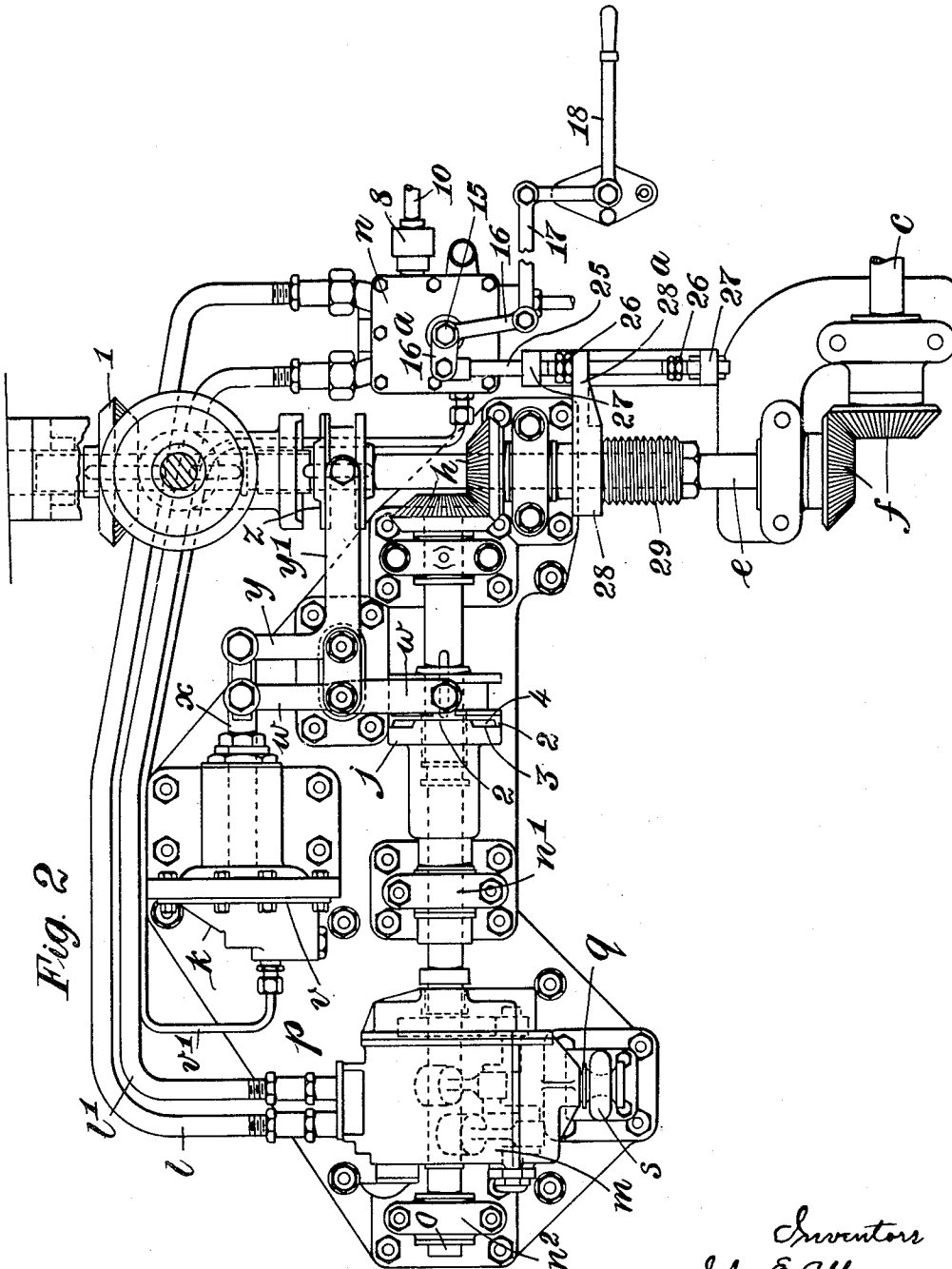
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PNEUMATIC POWER DOOR OPERATING INSTALLATION

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Fig. 3.

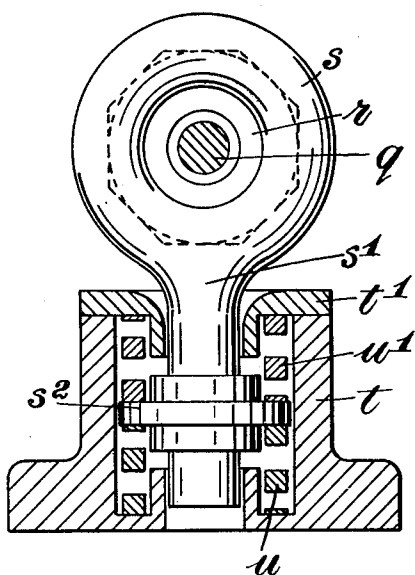


Fig. 4.

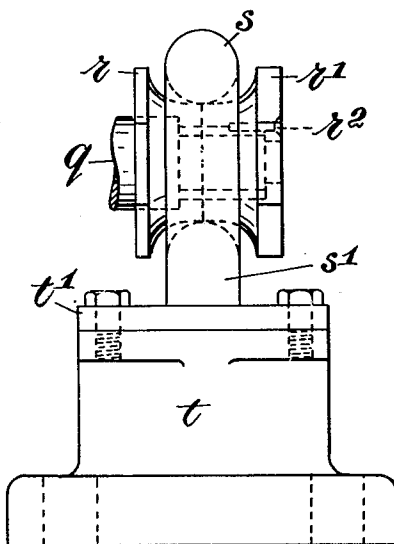
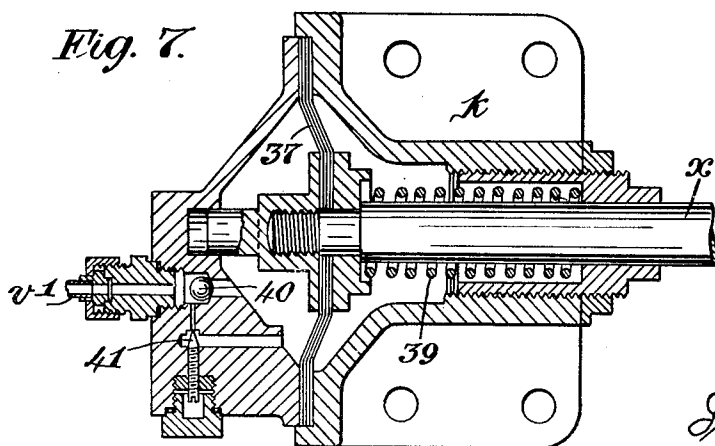


Fig. 7.



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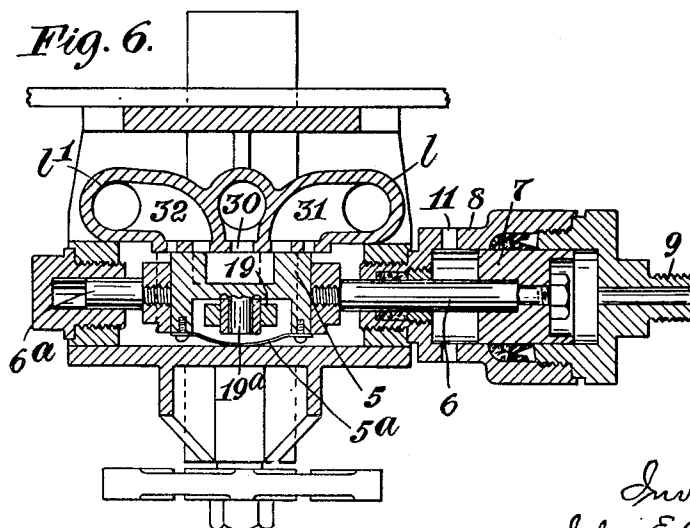
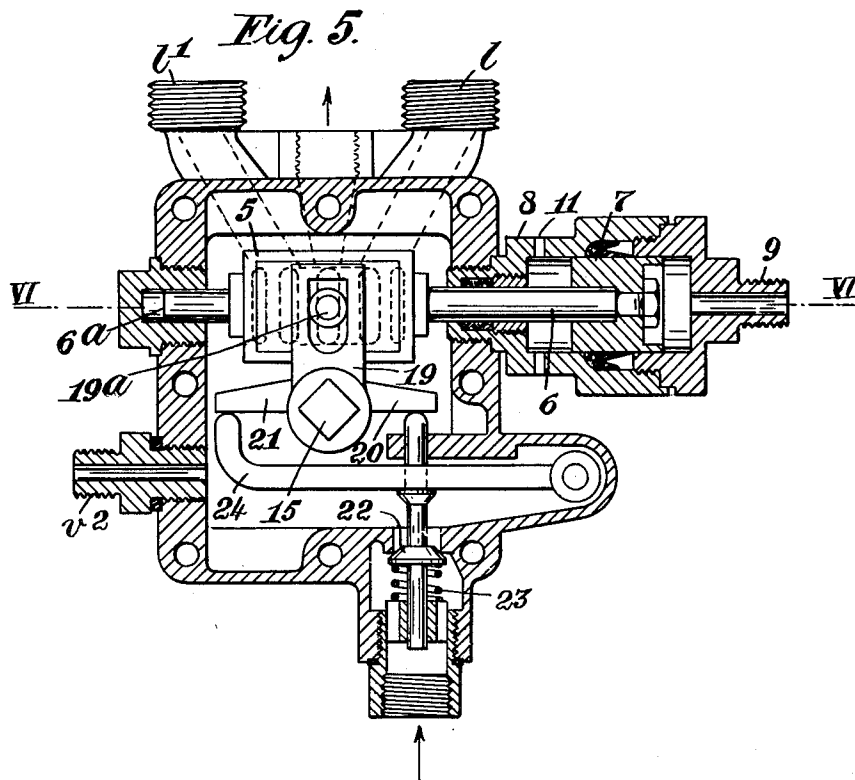
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UNITED STATES PATENT OFFICE

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PNEUMATIC POWER DOOR-OPERATING INSTALLATION

Application filed May 4, 1931. Serial No. 535,056.

This invention comprises improvements in pneumatic power door-operating installations and is particularly applicable for operating bulkhead and like safety doors on ships.

One object of the invention is to adapt a compressed air motor and its associate mechanism for the discharge of the heavy duties involved in overcoming inertia of the load and door-tightness at the commencement of an operation and especially at the commencement of an opening operation. In many installations the doors when closing are tightened against their seatings by means of wedging devices, and this tightness must be overcome by the motor when starting an opening operation. When hydraulic door-operating rams are employed, there is little difficulty in obtaining the requisite power but hydraulic equipment is expensive to instal and maintain. On ships propelled by power derived from internal combustion engines, and particularly Diesel engines, a compressed air supply installed for engine service is available also for compressed air auxiliary motors. The problem is to adapt compressed air motors for door service in an economical manner and to enable the relatively heavy duties to be performed by motors of a reasonably small rating.

Another object of the invention is to provide a power unit comprising a compressed air motor control and transmission mechanism, which unit can be applied as a unit for service with either a vertically movable door or a horizontally movable door.

Yet another object is to provide auxiliary devices for reducing shock and assisting the motor to assume its load, particularly when a tightly closed door is to be raised vertically to open it.

Further objects are to improve the fluid pressure controls and distributor valve devices so that prompt and efficient operation of the motor may be relied upon in all circumstances and with any disposition of the motor and its associate mechanism, and to provide timed automatic clutch controls to ensure that power operation shall not be hindered by hand-operated gearing and that

the latter gearing shall always be available if the power gearing should fail.

In the accompanying drawings:—

Figure 1 is a general arrangement view showing the application of a door installation embodying the present improvements to a horizontally moving door.

Figure 1a shows how the apparatus can be applied for operating a vertically movable door.

Figure 2 is an elevation, to a larger scale, of the motor, clutch, transmission mechanism and controls mounted as a unit assemblage on a base plate.

Figure 3 is a sectional elevation of a shock absorbing spring device employed in connection with the mounting of the motor.

Figure 4 is a side view of the device illustrated in Figure 3.

Figure 5 is a sectional elevation of a distributor valve device for controlling the motor.

Figure 6 is a horizontal section on the line VI—VI of Figure 5.

Figure 7 is a vertical section to a larger scale of the clutch-operating means of Figures 1 and 2.

Referring to Figure 1, *a* is a door slidable horizontally in a guide frame *b*, the movement of the door in this particular example being effected through the medium of screw shafts *c* working in nuts *d* on the door. The screw shafts *c* running in bearings *c'* are driven by a driving shaft *e* through the medium of bevel gears *f f'*. The shaft *e*, supported in bearings *e'* is driven from a motor shaft *g* through the medium of bevel gearing *h*. The motor shaft *g* is divided and the two parts can be coupled together by a clutch *j* operated by clutch mechanism *k* hereinafter described in detail. The compressed air motor *m* is served by two pipes *l l'* either of which can be connected with pressure whilst the other is put to exhaust, in order to drive the motor in one direction or the other as may be required for opening or closing the door *a*. The distribution of pressure and exhaust to the pipes *l l'* is controlled by a valve *n* also hereinafter described in detail.

The motor *m* is advantageously of the multi-cylinder type such as is used in pneumatic tools, the pistons of the cylinders being operative upon a crankshaft geared with the shaft *g*. As will be seen from Figure 2, the motor *m* is supported on the base plate *p* by bearings *n*, *n*², the shaft *g* running in the bearing *n*¹ and a tail or extension of that shaft, or a stub *o* on the motor casing, being supported by the aligned bearing *n*². The support of the motor is thus a pivotal one permitting the motor to oscillate about the axis of its shaft, oscillation being opposed and limited by a spring buffer device now to be described. As will be seen from Figure 2, the casing of the motor *m* at one side is provided with a trunnion or stub *q* which is screw-threaded to receive a collar device *r* *r*¹ illustrated in detail in Figures 3 and 4. The collar part *r* is in the form of a socketed nut screwed on to the stub *q* as far as is permitted by a shoulder on such stub. This nut has a hollow rounded bearing surface which is inserted into an eye *s*. The collar part *r*¹ which also has the form of a nut and is likewise formed with a similar hollow rounded bearing surface, is then screwed on to the stub *q* until it abuts against the nut part *r*, whereupon it is locked against unscrewing by a grub screw *r*². The two hollow rounded surfaces then provide a suitable bearing surface which has limited universal bearing in the ring of the eye *s*, the said ring being circular in cross section to permit of such universal bearing. The stem *s*¹ of the eye, which is formed or provided with a robust collar *s*², is inserted into a spring casing *t*, the collar *s*² being abutted against a strong compression spring *u* on the bottom of the casing, a similar spring *u*¹ being inserted to rest upon the collar *s*², and a cover *t*¹ being fitted on the casing to retain the spring *u*¹. Movement of the stem *s*¹ of the eye *s* either inwardly or outwardly of the casing *t*, is thus resisted by one or the other of the springs *u* *u*¹. It will now be seen that if the motor *m* runs light in one direction or the other, the casing of the motor will tend to turn about the axis of the shaft *g* but it will be prevented from turning due to the anchoring effect of the eye *s* on the stub *q*, but as the reaction is small during light running the consequent compression of the spring *u* or *u*¹, according to the direction of running, will be slight. If a heavy load be now clutched on to the motor, the corresponding reaction will cause the stub *q*, acting through the bearing collar *r* *r*¹, to operate the eye *s* and its stem *s*¹ inwardly or outwardly of the casing with considerable power and the spring *u* or *u*¹ will be correspondingly compressed. This not only absorbs shock which otherwise would be imparted to the mounting of the motor, but the power absorbed by the spring in compression, becomes available immediately after-

wards for assisting the motor to overcome its heavy load.

The control mechanism *k* of the clutch *j* Figure 1, comprises a pneumatic motive power device *v* Figure 2. The device *v* may comprise a diaphragm or piston connected with the rod *x*, the latter being pivotally connected with the lever *w* and spring-operated in the direction for normally holding the clutch *j* open. Compressed air is admitted slowly to the diaphragm chamber through a pipe *v*¹ past a valve such as a needle valve, so that pressure on the diaphragm gradually increases until it is sufficient for moving the diaphragm against the spring action, whereupon a two-armed lever *w* is rocked to close the clutch *j*. When the pipe *v*¹ is exhausted, a self-seating valve in the diaphragm chamber blows open and instantly exhausts the chamber so that the spring immediately opens the clutch. The details of this device will be hereinafter described with reference to Figure 7. A right-angled lever *y* *y*¹ has one arm *y* linked with the lever *w* and the rod *x*, the other arm *y*¹ which is longer than the arm *y* being operatively engaged with the clutch *z* of a hand gear. It will be seen that the parts are adjusted so that the clutch *z* is open when the clutch *j* is closed and vice versa. Normally, the clutch *j* is open, as aforesaid, and the clutch *z* is closed so that when pneumatic power is not active, the door can be opened or closed by manual power applied to the shaft *e* through the bevel gearing 1. In Figure 2, the clutch *z* is open and the clutch *j* is closed. When compressed air is admitted to the motor *m* as hereinafter described, such air is simultaneously admitted through the pipe *v*¹ to the power device *v*. The result is that the motor *m* starts and acquires speed, the rod *x* being then forced outwardly with the delay action above described. In the first portion of its movement the rod *x* through the angle lever *y* *y*¹ opens the clutch *z* and disconnects the hand gear and then, through the lever *w* closes the clutch *j*, the precedence of the opening of the clutch *z* being ensured by the greater length of the arm *y*¹. In the example illustrated, the teeth or projections 2 on one clutch part subtend a smaller angle than the gaps 3 between the teeth or projections of the other clutch part. The effect of this is that, upon closure of the clutch *j*, a tooth of one part will move through a circular clearance 4, seen in Figure 2, before striking against a tooth of the other part. As the motor *m* has already acquired speed and power, the forceful impact in the clutch is effective for overcoming the inertia and frictional resistance of the door *a* in its guides and the door is started on its opening or closing travel. With the teeth shaped as shown, and in the event of particularly heavy resistance by the door, the

movable clutch part can override the other part and come in again so that a series of impacts can occur to ensure the opening of the door. However, a friction clutch may be employed, if desired.

The valve *n* for controlling admission and distribution of compressed air to the pipes *l* and *v* is illustrated in detail in Figures 5 and 6, wherein the D-slide 5 is shown guided by rod parts 6, 6^a sliding in guides in the casing or chest. The rod 6 is fitted with a piston 7 which is movable in a small cylinder 8 attached to the chest. The outer end of the cylinder 8 is fitted with a spigot 9 for the connection of a pressure pipe 10 (Figure 1) leading to a distant control, the inner end being formed with vent holes 11 to prevent the setting up of pressure behind the piston 7. The distant control is seen in Figure 1 and comprises a cock 12 for admitting compressed air from a main supply 10^a to the pipe 10 or for exhausting it, the said cock being normally held closed against the main supply by a spring 13 and operated for admission by a lever 14 on the ship's bridge through a flexible connection. When compressed air is admitted to the pipe 10 from the main 10^a the piston 7, Figures 5 and 6, is forced inwardly of its cylinder and moves the slide valve 5 leftwardly in Figure 5 to what is called the door-closing position. The slide valve 5 may be operated by hand power in either direction. Referring to Figures 1, 2 and 5, it will be seen that a spindle 15 in the valve chest can be rocked in either direction by swinging the lever 16 which is connected by a link 17 with a hand lever 18. Within the chest, the spindle is fitted with a fork or slotted arm 19, Figures 5 and 6, which engages a projection 19^a on the valve 5 and, when turned, moves the valve 5 in one direction or the other along its slideway. The spindle 15, moreover, is fitted with see-saw arms 20, 21. When the spindle 15 is turned clockwise in Figure 5 to move the valve 5 rightwardly, the arm 20 presses down upon the stem of a main air supply valve 22 and opens the latter against the effort of a spring 23 and the pressure of the air supply. Compressed air then fills the chest of the slide valve 5. When the spindle is turned anti-clockwise, the arm 21 engages the upturned end of a long lever arm 24 and depresses the latter. The arm 24, being engaged with a collar on the stem of the valve 22, thereupon depresses such valve. Consequently, any movement of the slide valve 5, either to the right or left of the middle or neutral position, results in an admission of compressed air to the chest. The hub of the lever arm 16 is formed or fitted with a short arm 16^a, Figure 2 which normally has an approximately horizontal position. From the short arm 16^a a tappet rod 25 is pivotally suspended, this rod being fitted with adjustable tappet nuts 26 and vertically slid-

able in guides 27. A nut 28 works on a screw 29 on the shaft *e*, the said nut having a forked tappet arm 28^a engaging the rod 25. When the shaft *e* is revolved to close the door *a*, the nut 28 travels upwardly on the screw 29 and as the door reaches the closed position, the tappet arm 28^a strikes against the upper tappet nut 26, thereby lifting the rod 25 and turning the arm 16^a and spindle 15 clockwise. The movement thus imparted is just sufficient for restoring the slide valve 5 from its leftward or door-closing position to the middle or neutral position. Similarly, during a door opening operation the revolutions of the shaft *e* will cause the nut 28 to descend and as the door reaches the open position the tappet arm 28^a strikes against the lower tappet nut 26 and pulls down the rod 25. This turns the spindle counter clockwise and shifts the valve 5 from its rightward or door-opening position to the middle or neutral position.

As will be seen from Figures 5 and 6, the D-slide valve 5 works over three ports, namely, an exhaust port 30, a distribution port 31 for the pipe *l* and a distribution port 32 for the pipe *v*. The slot-openings of the ports 31, 32 in the slideway are duplicated, as seen clearly in Figure 6, for a purpose to be described. The D-slide, in the middle or neutral position in which it is shown, uncovers with its cavity the inner slots of the ports 31, 32 and puts these in communication with the exhaust 30. The blank or solid end portions of the D-slide underlap and do not quite cover the outer slots of the ports 31, 32 in this middle or neutral position as will be seen from Figure 6. Consequently, the two pipes *l* and *v*, and therefore the two sides of the motor *m*, are normally put to exhaust and the interior of the valve chest also is put to exhaust by the underlap aforesaid. If the valve 5 be moved leftwardly in Figure 6 to door-closing position, the cavity of the D-slide will uncover both slot openings of the port 32 and put them both into communication with the exhaust 30. The blank or solid part of the D-slide at the right-hand end will move away from the outer slot opening of the port 31 and will cover the inner slot opening of such port 31, whereupon the uncovered outer slot opening will admit compressed air from the interior of the chest into the pipe *l*. The porting arrangements above described, while affording adequate admission area for compressed air by the uncovering of one slot opening to the interior of the chest, afford a very ample area and passage for exhaust when the cavity of the D-slide uncovers the twin slot openings and by this means back pressure is avoided and the motor is enabled to discharge its high duties freely and efficiently. When the valve is moved in either direction a supply of air passes immediately through the connection *v*² and the pipe *v*

to the diaphragm chamber and an immediate exhaust of air is permitted through this connection when the valve is moved to the middle position. A coach spring 5^a acting against the cover is employed as shown for keeping the valve against the valve face.

Reference to Figure 2 will show that a complete pneumatic power unit, including transmission gearing, clutch controls and automatic valve tappet mechanism is mounted upon the base plate *p*. If this unit is to be applied for operating a horizontally movable door, this can be done by gearing the shaft *e* with worm or other shafts *c* through bevel gears *f*, as already described with reference to Figure 1. If the unit is to be applied for operating a vertically movable door *a'*, Figure 1^a, the shaft *e* may be extended downwards, or coupled with a downwardly extending shaft. A worm on this shaft may drive a worm wheel 33 on a cross shaft 34 fitted with a pinion or pinions 35 meshing with a rack or racks 36 on the door. Thus, when any given door is to be operated, a self-contained power unit is provided which is mounted in convenient relation to the door and geared with the latter, thereby avoiding the trouble, labour and expense involved in designing, making and fitting various mountings for supporting various parts in selected individual positions.

Referring now to Figure 7 it will be remembered that the device *k* operating the clutch *j* is connected by a pipe *v'* with the casing of the valve *n*. The device *k* comprises a flexible diaphragm 37 connected with a spring-operated rod *x*, the latter being connected through the lever *w* with the movable member of the clutch *j*. Normally the spring 39 forces the rod *x* inwards and holds the clutch disengaged. The chamber above the diaphragm 37 is supplied with compressed air through the pipe *v'* whenever the valve 22 (Figure 5) is opened to admit such air to the slide valve casing. Compressed air in the pipe *v'* presses the ball valve 40 on its seat but can pass slowly through the small passage regulated by the adjustable needle valve 41 into the diaphragm chamber. Therefore, whenever the slide valve 5 is shifted from neutral to open the supply valve 22 and to initiate a door-opening or door-closing operation, the motor *m* will be started but the clutch *j* will remain open until pressure has accumulated in the diaphragm chamber. When that pressure is sufficient to overcome the resistance of the spring 39, the diaphragm 37 and rod 38 are forced outwards thereby engaging the clutch *j* for transmitting the drive to the shaft *g*. By the time this has occurred the motor *m* has acquired sufficient speed to take up its load. When the slide valve 5 is restored to neutral position and the valve 22 closes, pressure no longer acts on the ball valve 40 which is immediately

blown off its seat to exhaust the diaphragm chamber and permit the spring 39 to open the clutch.

In operation, of the cock 12 is opened by the distant or bridge control, main air supply is admitted to all pipes 10 and all pistons 7 and D-slides 5 are formed leftwardly to door-closing position. In this position, compressed air (which is admitted to the slide valve chests by the opening of the valves 22 in the manner described) is admitted to the pipes *l* of the several motors *m* which are thereupon started and speeded up without load, the exhaust taking place through the pipes *l'* and ports 32 as described. Pressure admitted from the valve chests to the motive power devices *k* then becomes operative for opening the hand gear clutches *z* and for immediately afterwards closing the motor clutches *j*, whereupon the motors *m* effect door-closing in the manner described. If a person desires temporarily to open a door, as for example to effect an escape from a flooded compartment, that person operates a hand lever 18 in the direction for moving the D-slide to the rightward position, so that that *l'* becomes a pressure pipe and *l* becomes exhaust. The motor then speeds up in the reverse direction and assumes its load for door-opening when the clutch operation takes place as aforesaid. Immediately the person releases the hand lever 18, the pressure on the piston 7 will reverse the D-slide and restore it to the door-closing position. It will be understood, of course, that when the distant control lever 14 is pulled over to open the cock 12 for admission of pressure fluid to the pipes 10, it is retained in the pulled-over position and the spring 13 only becomes operative for re-closing the cock 12 when the handle 14 is released from its retaining means. When the door is to be opened or closed by hand operation, a hand gear on the deck above may be operated to drive the bevel gearing 1, or a hand gear 1^a, Figure 1, at the door may be operated.

We claim:—

1. Pneumatic power door-operating apparatus comprising a reversible compressed air motor, bearings pivotally supporting said motor on a pivot axis coinciding with the driving shaft axis, double-action, elastic buffering means connected with said motor for resisting pivotal movement in either direction, transmission gearing including a slippable clutch, fluid pressure control means operatively connected with said clutch, and a reversible valve for controlling motor operation.

2. Pneumatic power door-operating apparatus comprising a reversible compressed air motor, pivotal supports for said motor having a pivot axis coinciding with the driving shaft axis of said motor, elastic means operative on said motor for resisting pivotal

movement in either direction, transmission gearing, a clutch between said gearing and said motor, fluid pressure control means operatively connected with said clutch, and

5 valve means operative for simultaneously controlling operation of said motor and operation of said fluid pressure clutch control means substantially as set forth.

3. Pneumatic power door-operating apparatus comprising a reversible compressed air motor, pivotal supports for said motor having a pivot axis coinciding with the driving shaft axis of said motor, elastic means operative on said motor for resisting pivotal

15 movement in either direction, transmission gearing, a normally open clutch between said gearing and said motor, a hand gear, a normally closed clutch between said hand gear and said transmission gearing, fluid

20 pressure control means operatively connected with said clutches and adapted for closing the one clutch and opening the other in sequence, and valve means operative for simultaneously controlling operation of said motor and operation of said fluid pressure clutch control means substantially as set forth.

4. A pneumatic power unit for door operation comprising in assemblage on a common base plate a pivotally mounted reversible motor, double-action buffering means connected with said motor for resisting pivotal movement in either direction, a transmission gearing, a slippable clutch, and fluid pressure clutch control mechanism substantially as set

35 forth.

5. A pneumatic power unit for door operation comprising in assemblage on a common base plate a pivotally mounted motor with resilient anchoring against pivotal motion, a

40 transmission gearing, a slippable clutch, fluid pressure clutch control mechanism, and screw feed tappet mechanism adapted for operating the valve gear of said motor substantially as set forth.

45 6. A pneumatic power unit for door operation comprising in assemblage on a common base plate, a pivotally mounted motor with resilient anchoring against pivotal motion, a transmission gearing, clutch means, fluid

50 pressure clutch control mechanism including levers of different ratios adapted for effecting clutch operations in sequence, and tappet mechanism adapted for operating the valve gear of said motor at the limits of door-opening and closing substantially as set forth.

7. Pneumatic power operating apparatus comprising a reversible compressed air motor, resilient means resistant to working reactions of said motor, transmission gearing, a normally open clutch for connecting

60 said gearing with said motor, fluid pressure control means operatively connected with said clutch, a slide valve control for said motor, a self-closing compressed air supply

65 valve, tappet means operative directly be-

tween said slide valve and said supply valve for opening the latter when the slide valve is moved in one direction, and a lever mechanism under the influence of the tappet means and operative upon the supply valve to open it when the slide valve is moved in the other direction substantially as set forth. 70

8. Pneumatic power door operating apparatus comprising a reversible compressed air motor, resilient means resistant to working re-actions of said motor, transmission gearing, a normally open clutch for connecting said gearing with said motor, fluid pressure control means operatively connected with said clutch, a slide valve control for said motor comprising a D-slide valve slidable in a casing formed with an exhaust port and twin distribution ports located on either side of said exhaust port and communicable with the pressure and exhaust pipes of the motor, a supply valve, tappet means operative directly between said slide valve and said supply valve for opening the latter when the slide valve is moved in one direction, and a lever mechanism under the influence of the tappet means and operative upon the supply valve to open it when the slide valve is moved in the other direction. 80 85 90

9. Pneumatic power door operating apparatus comprising a reversible compressed air motor, resilient means resistant to working reactions of said motor, transmission gearing, a normally open clutch for connecting said gearing with said motor, a diaphragm chamber, a diaphragm mounted in said chamber, a spring operative on said diaphragm, means for the gradual admission of fluid to said chamber to act on the diaphragm against the action of the spring, means connecting said diaphragm to the clutch, a slide valve control for said motor, a self-closing compressed air supply valve, tappet means operative directly between said slide valve and said supply valve for opening the latter when the slide valve is moved in one direction, and a lever mechanism under the influence of the tappet means and operative upon the supply valve to open it when the slide valve is moved in the other direction substantially as set forth. 100 105 110 115

10. A fluid pressure motive power unit for door operation comprising a pivotally mounted reversible motor double-action buffering means connected with said motor for resisting pivotal movement in either direction, transmission gearing, a clutch, and delay action fluid pressure operating means for said clutch, substantially as set forth. 120

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