Feb. 3, 1942. W. A. JOHNS 2,271,824

PNEUMATIC CONTROL DEVICE

Filed May 21, 1941 2 Sheets-Sheet 1

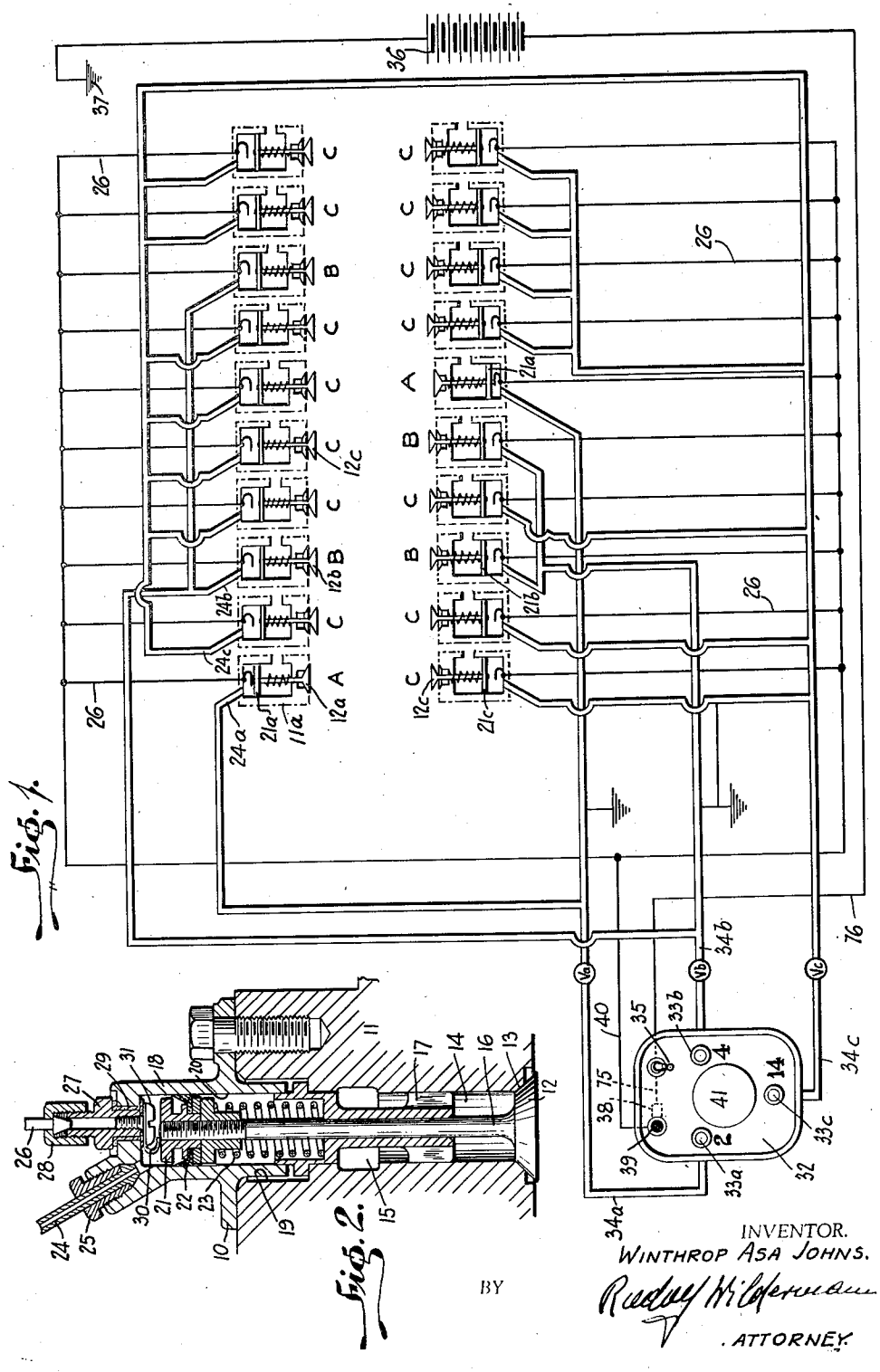


Fig. 1.

Fig. 2.

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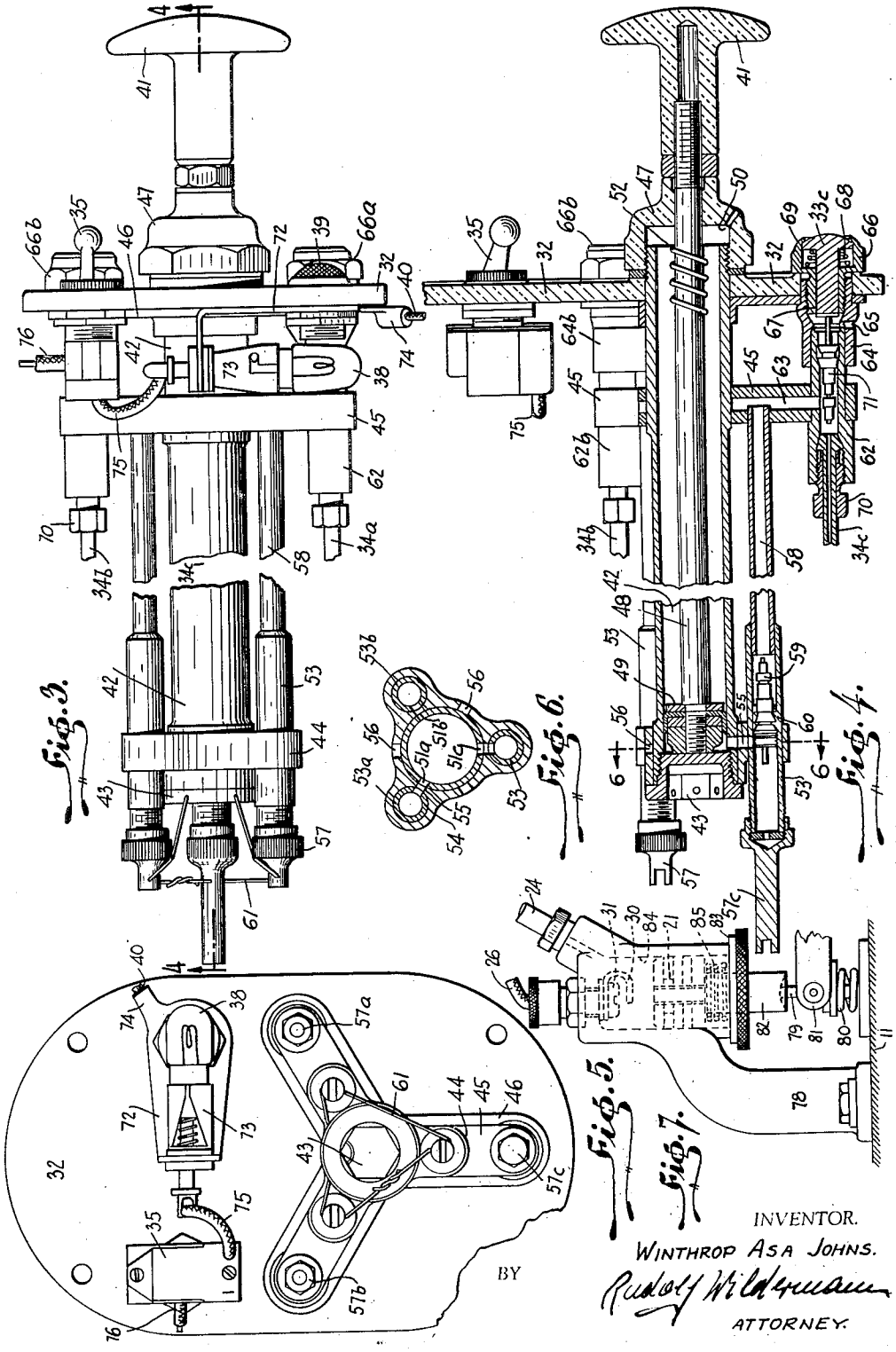


Fig. 3.

Fig. 6.

Fig. 4.

Fig. 5.

Fig. 7.

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PNEUMATIC CONTROL DEVICE

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11 Claims. (Cl. 123—182)

This invention concerns a pneumatic control device, more particularly a device intended for remote control. While a device of this invention might find use in connection with the variety of appliances where a simple remote control is desired, it has been developed to suit a particular need encountered in connection with multi-cylinder engines, particularly on airplanes; i. e. it is to serve for decompression control of some or all of the cylinders of such an engine.

In connection with the large, mobile engines which find extensive use these days it is desirable that they be controllable by a single operator; on the other hand it may be cumbersome to incorporate in the respective vehicle all equipment available for such single control. Thus, for instance, a large starter would be in order in connection with high-powered airplane engines, where a considerable torque is required initially to turn the engine over against a compression of the various cylinders, and that initial torque must be followed by further application of energy in order to start the engine, i. e. to initiate operation of the engine to the extent, that it turns over by itself.

Since it is not feasible to provide in an airplane starting equipment of the size, power and weight necessary to overcome such reaction, various devices have been developed to control decompression valves on some or all of the engine cylinders, having at any time of the starting period only those of the cylinders under normal compression, which are to be actuated forthwith, or already function normally.

In the past controls used for this purpose have been purely mechanical, or in some instances hydraulic, and electrical relay controls have also been considered. A purely mechanical remote control system lacks flexibility, may be complex and in order to be durable and dependable, it must have a weight undesirable in connection with airplanes.

An electrical control may have flexibility, but it requires a rather complicated relay system, and it involves heavy current consumption, even though only temporarily. Hydraulic controls require a supply of a special control liquid, and a closed return or circulatory system. Such disadvantages are to be overcome in the instant invention by a pneumatic control.

Taking under contemplation the advantages offered by a pneumatic system, and more particularly by an arrangement in accordance with this invention, we must, on the other hand, consider the question, whether an elusive gas offers a safe, dependable and readily retainable medium for such control purposes. Exhaustive tests, which have been conducted in this respect, have shown that a pneumatic control system is not only feasible but quite practical, provided it does not have to remain under pressure except for comparatively short periods of time.

It is therefore another object of this invention to adapt the intended decompression control, so that it may be made pneumatic.

It is another object of this invention to provide for simple signal means which advise the user or operator of the device concerning the functioning thereof.

Generally speaking this invention is to provide simple, reliable and compact means for decompression control and an easy method of such control.

Other objects of this invention will be learned from the following detailed description of specific embodiments of the instant invention, which is, however, rendered for purposes of illustration of the invention only, and not in limitation thereof.

In the drawings:

Fig. 1 is a schematic lay-out showing a control panel connected for the control of a plurality of decompression valves.

Fig. 2 is a cross-sectioned side view of an embodiment of a pneumatic decompression valve mounted upon a cylinder head.

Fig. 3 shows a top view of the pneumatic control means and panel.

Fig. 4 shows a corresponding cross-sectioned side view taken at a level and in the direction indicated in Fig. 3 by dot-dash lines, arrows and the numeral 4.

Fig. 5 is a corresponding rear view.

Fig. 6 is a corresponding cross-sectioned detail front view taken at a level and in the direction pointed out in Fig. 4 by dot-dash lines, arrows and the numeral 6.

Fig. 7 is a side view of another embodiment of a pneumatic actuator which is superimposed upon an exhaust valve of an engine.

Similar numerals refer to similar parts throughout the various views:

An actuator serving the instant purposes comprises an operative member, such as an expansive chamber, a plunger or piston, which is reciprocated by variations of the pressure of a fluid.

Such reciprocation may be transmitted to an element to be controlled thereby, by either placing a self-contained pneumatic actuator in operative relationship with such an element, or by

incorporating it in such element. In connection with the decompression of cylinders on an engine the control may either apply to a decompression valve separately and distinctly provided on some or all of the cylinders, or it may be applied to other valves on engine cylinders, which are suitable for such purpose, such as exhaust valves, and it is of course understood by those versed in this art that one pneumatic valve may control a plurality of engine valves at the same time, if so desired.

A pneumatic actuator self-containingly superimposed upon an engine exhaust valve is indicated in Fig. 7. Fig. 2 shows a similar pneumatic arrangement incorporated in a decompression valve 10 mounted upon a cylinder head 11. The parts proper which directly serve for pneumatic control, are similar to each other in these two embodiments, but they are shown at rest in Fig. 2 and are shown to be pressure actuated in Fig. 7.

Fig. 2 shows the conical valve head 12 to close upon the correspondingly shaped entrance or seat 13 of the valve bore 14 upon the inside of a cylinder 11. The valve bore 14 extends through the outlet chamber 15 which communicates with the atmosphere to the rear.

The valve stem 16 is slidably guided by a bushing 17 mounted in bore 14 of the cylinder 11 and is provided with suitable clearances in order to permit communication from the inside of the cylinder to the outlet 15, when the valve is open, i. e. when the valve stem is depressed and valve head 12 is lifted off the entrance or seat 13.

Cover flange 18 is mounted upon cylinder head 11, so that it registers with the valve ports proper and is shown to extend in a counterbore 19 of valve bore 14 into overlapping engagement, by way of a cylindrical recess 20, with bushing 17. The pneumatic piston 21 slidably seals, by way of leathers or packing 22, upon the inside of the cylindrical recess 20, is mounted upon the threaded upper end of valve stem 16, and reacts upon bushing 17 by way of compression spring 23.

Pneumatic tubing 24 serves as a connection for remote control and opens onto recess 20 at the top thereof, and the upset end of said tubing is sealingly engaged upon cover flange 18 by a gland 25.

The headed end of electric conductor wire 26 is drawn into electrical connection with a bushing 27 by a gland 28. An insulating sleeve and washers 29 accommodate the bushing 27 upon cover flange 18 and screw 31 serves to secure bushing 27 upon flange 18. One end of an electric contact spring 30 clampedly underlies the head of screw 31, thus being electrically connected to wire 26, and has a looped back end, which contacts with the top side of piston 21 in the position shown in the drawings, so that it is grounded. But spring 30 disengages from piston 21, so that electrical contact is interrupted, when the valve is depressed and valve head 12 is downwardly lifted off the entrance or seat 13.

Such opening of the valve against the reaction of the compression spring 23 is effected by the pressure of a fluid, e. g. air, entering through tubing 24 and filling cylindrical recess 20 above piston 21, the piston together with the valve proper being depressed thereby. Upon release of the pressure of the fluid the valve proper will be returned by the pressure of spring 23 to the closed position shown in Fig. 2.

Decompression units of the type just described may be assigned to each one of the cylinders of a multiple cylinder engine and are thus schematically indicated in connection with the 20 cylinders, A, B and C of an engine exemplarily serving as a basis for the lay-out of Fig. 1.

For purposes of turning over an engine, or for the purpose of starting the same, or for other objects, it is usually desirable to provide for decompression of all cylinders and of all cylinders minus one or more pairs of the cylinders. When all cylinders are decompressed, mechanical friction has to be overcome only, when the engine is turned over. Thereupon it may be desirable to terminate the decompression of one pair of cylinders, so that the normal combustion cycle may be initiated in those two cylinders; then two more pairs of cylinders may be added to the one pair first closed to allow normal compression, and then the decompression is to be discontinued for all of the cylinders, such successive steps of decompression control being timed according to the discretion of the operator.

For the control, which has been stated as an example, the operator may have in front of him a control panel 32, which provides three control buttons 33 distinguished from each other by the panel markings 2, 4 and 14. To each of these buttons 33 belongs a pipe system 34 which is divided into branches to terminate by way of the tubings 24 at groups of two, four or fourteen of the cylinders, which are respectively identified as cylinders A, B and C. Where parts are hereinafter to be identified with one or the other of those groups, the respective numerals or letters will be supplemental by the suffix *a*, *b* or *c*, corresponding to the respective group of cylinders A, B or C. Thus pipe system 34*a* connects to the pair of cylinders A—the cylinders grouped together should fire at positions relatively angularly displaced for about 180° on the crankshaft—system 34*b* to the four cylinders B, and system 34*c* to the 14 cylinders C. When all pipe systems contain air at a pressure sufficient to depress the respective pistons 21, all decompression valves will be open. A valve V may be provided on each of the system, in order to allow the air pressure to be shut off from any one of these systems, in case of an emergency, for purposes of testing etc.

When the operator depresses any one of the buttons 33, the respective pipe system 34*a*, 34*b* or 34*c* is opened to the atmosphere, i. e. it is bled. When any pipe system is thus bled, pressure is removed from the pistons 21 of the respective cylinders A, B or C, so that the respective decompression valves are closed. Since in Fig. 4 only the decompression valves of cylinders A are closed, it must be presumed, that the respective pipe system has been bled, whereas the other pipe systems are under air pressure. Thus it is understood, that if so desired, the operator may close 2, 4, 6, 14, 16, 18, or all of the decompression valves normally, e. g. for purposes of starting, however, the operator will preferably actuate button 33*a*, 33*b*, and 33*c*, so that first the decompression valves of one pair, then the decompression valves of two more pairs of cylinders, and finally the decompression valves of all cylinders are closed.

A switch 35 on control panel 32 is connected by

wire 76 with a supply of electrical current, e. g. battery 36, such battery being connected to ground at 37. A short lead 75 connects the other terminal of switch 35 to a signal bulb 38 behind a bull's eye 39 on panel 32, so that, when switch 35 is turned on, the signal bulb 38 will light, provided it is connected to ground. But such return connection 40 extending from bulb lamp 38 is shown to be branched into a multiplicity of parallel connections 26, each of which connects to one of the electrical contact springs 30 which are insulatedly mounted in recesses 20 of the decompression valve and which are connected to ground only in case the respective decompression valve is closed. With switch 35 closed, signal light 38 will therefore be burning at all times, except when all the decompression valves are open, i. e. all cylinders are decompressed.

On the control panel 32 are combined, in a self-contained and compact manner, the signalling means 38, 39, electric control means 35, the pneumatic control means 33*a* and 33*b* and 33*c*, as well as the means for setting up the desired fluid pressure, as signified on the front of the panel by the pump handle 41.

The tubular pump casing 42, Fig. 4, is closed at one end by the hexagonally countersunk plug 43. Circumferentially it spacedly accommodates the three three-legged web brackets 44, 45 and 46, which correspond in their angular disposition on the pump casing to the manner in which the three pneumatic control buttons 33 are spaced on top of the panel 32 around pump handle 41. The top one of the three brackets, which will hereinafter be distinguished as separator bracket 44, distributor bracket 45 and flange bracket 46, i. e. of bracket 46 abuts upon the back of control panel 32. In reaction upon this flange 46 the tubular casing 42 is clamped onto the front of the control panel 32 by a cap 47, which threadedly engages the other, front end of the tubular pump casing 42.

Cap 47 has a concentric bore, which reciprocatably accommodates the pump rod 48. At one end pump rod 48 is fastened upon handle 41. At the other end it carries the piston 49, which is of the customary construction, i. e. it passes during the return stroke air admitted to the pump casing 42 by the vent hole 50 in cap 47 during the compression stroke; and during the compression stroke the air thus passed is pushed out from the tubular pump casing 42 through the three openings 51, which are evenly spaced around the casing in a circle (see Fig. 6). A compression spring 52 floats on rod 48 and prevents the piston from striking too hard against cap 47 during the return stroke.

The check valve tubes 53 are mounted parallel with each other in the three legs of the separator bracket; they have openings 54 which, registering with holes 55, open into the bore of the separator bracket 44. These holes 54 and 55 may for instance be drilled by way of clearance holes 56 on the respective opposite side of bracket 44, before the pump casing 42 is inserted therein. When bracket 44 is assembled upon pump casing 42, openings 51, 54 and 55 are, in three sets, aligned with each other upon the three sides of the casing. Through these registering holes air compressed in pump casing 42 by piston 49 evacuates into the three check valve tubes, so that there is an unrestricted communication of air between the compression portion of the tubular pump casing 42 and the rear portions of tubes 53, the latter being sealed at the ends by caps 57.

These portions of tubes 53 are separated from the respective front ends and the connecting tube 58 extending from such front end into the distributor bracket 55, by check valves 59 mounted upon inserts 60 in each of the tubes 53. These check valves may for instance be of the type of air valves commercially used on tires and the like, and allow a flow of the air compressed by piston 49 to distributor bracket 45, but do not permit a flow of air in tube 53 in the opposite direction. For the purpose of servicing the check valves 59 the back of one or more of the caps 57 may be extended and shaped to serve as a key, as indicated in connection with the cap 57*c*. Caps 57 may be interlocked with a plug 43 by a wire 61 in the sealed position, as it is shown in Figs. 3 and 4.

In a manner corresponding to that explained in connection with the separator bracket 44, but spaced further out from the center, three parallel tubes 62 are mounted upon the three legs of the distributor bracket 55. Radial drill holes 63, which in an assembled device, are closed at their inner ends by the pump casing 42, connect these three parallel tubes 62 with the three connecting tubes 58. At the front end the tubes 62 seal upon bushing 64, which have an inwardly threaded shoulder extending through flange bracket 46 into panel 32, and are each provided with a lateral vent 65.

Parts 42, 44, 45, 46, 53, 58, 60, 62 and 64 may be mounted and sealed upon each other as an initial step of assembly, e. g. by brazing, thus yielding a rigid, light skeleton frame.

The push button housings 66 have sleeve extensions 67, which engage in the threaded shoulders of bushings 64 and, together with cap 47, they thus strap the flange bracket 46, i. e. the said skeleton frame, onto the panel 32. Push button housings 66 are bored and countersunk to accommodate the push buttons 33. Those buttons are pressed by springs 68 against rims 69 provided by spinning in the outer end of push button housings 66, so that the buttons are exposed on the panel for manipulation.

Each of the three pipe systems 34 connects with a chamber 58, 63, and is shown to be sealed for such purpose by gland 70 into the rear end of tube 62. Where these latter tubes extend at their front ends into bushings 64, they accommodate poppet valves 71 of the known type which normally outwardly close the chambers extending from valves 59 through tube 58 and holes 63 to the respective pipe system 34, thus holding whatever pressure of air has been pumped into such chamber and system. But the release plunger of each poppet valve 71 is shown to connect to a push button 33. Upon the depression of a push button 33 air is thus released from a chamber and system, escaping through vent 65 to the atmosphere, so that the respective chamber and system are bled.

Switch 35 and bull's eye 39 are clamped onto the panel. The threaded sleeve and nut, by which the bull's eye 39 is thus clamped, also straps bracket 72 onto the back of the panel, which bracket provides on one end a shoe 74 connecting by wiring 40 to the contract springs 30 in the decompression valves. The other end of bracket 72 supports the bayonet socket 73 in a position in which an electric bulb or lamp 38 mounted therein shines through the bull's eye 39. Bracket 72 also connects to one, e. g. the bayonet terminal of bulb or lamp 38, whereas the other terminal of bulb 38 connects by wire

75 to one terminal at switch 35. The other terminal of switch 35 connects to battery 36 by conduit 76. While the mode of operation of the system and device just described have become evident from the foregoing description, the functions and operations accompanying the starting of an engine by a pneumatic device and system of the kind herein described shall now be reviewed as a whole.

Let us presume that a control panel 32 is mounted in front of an engineer, chauffeur or pilot for the control of a twenty-cylinder engine. The pilot first throws on the switch 35 and the current supply connected therewith will light the bulb 38, unless all cylinders should already be decompressed, i. e. all systems 34*a*, 34*b* and 34*c* are filled with air at a pressure sufficient to open all the decompression valves.

Normally that will not be the case and therefore the bulb 38 will light as soon as the switch 35 is turned on. Now the pilot starts pumping by reciprocating the handle 41, thus driving air past the check valves 59 into each one of the three systems 34*a*, 34*b* and 34*c*. He pumps, until the signal light 38 ceases to shine through bull's eye 39. That indicates that the circuit of bulb 38 has been broken, because the air compressed into all systems 34 has opened all decompression valves in cylinders A, B as well as C.

Now the engine may be turned over, and as soon as it turns over the pilot pushes button 33*a*, thus opening the valves 71*a* and bleeding the system 34*a*, so that the decompression valves of the pair of cylinders A will drop into their seat, and these two cylinders are ready for their normal combustion cycle. This stage of the performance is indicated in Fig. 1.

As soon as those two cylinders have started to function, the pilot pushes button 33*b*, thus bleeding the compressed air from the system 34*b*, so that the decompression valves of the cylinders B are closed, those cylinders being now ready to function normally. As soon as they do, the pilot may close the rest of the decompression valves by push button 33*c*, thus bleeding the system 34*c*, and all cylinders are now set for their normal combustion cycle.

That finishes the task assigned to the pneumatic decompression device in starting the engine, and the operator may turn off the lamp 38 by switch 35. The lamp 38 had been lit again since the first decompression valves had been closed.

In Fig. 7 a bracket 78 takes the place of the flange 18 of the modification shown in Fig. 2, and is mounted upon a cylinder head 11, alongside of the exhaust valve of a cylinder, which is indicated by stem 79, spring 80 and tappet 81. Bracket 78 superimposes upon the exhaust valve the pneumatic actuator part corresponding to parts 21—31 described above. A piston rod 82 slidably depends from the piston 21, through the bore of a cap 83 and depresses, when the piston is depressed, the valve stem 79 below, as shown. Rod 82 disengages from the valve stem in an elevated position, when piston 21 is not pneumatically actuated. Spring 85 is strong enough to suspend the piston 21 in such elevated position, when there is no fluid pressure behind the piston, and it reacts upon the cap 83, said cap at the same time closing the bottom end of cylindrical recess 84 of bracket 78, which serves as a piston cylinder.

In the claims, the term decompression valve is not restricted to valves which exclusively serve for decompression, but comprises any means which may be converted for that or for similar service or which is suited for analogous control.

Having thus described my invention in detail, yet I do not wish to be limited thereby, except as the state of the art and the appended claims may require, for it is obvious that various modifications and changes may be made in the form of the embodiment of my invention, without departing from the spirit and scope thereof.

What I claim is:

1. In combination with a multi-cylinder engine and with decompression valves on cylinders of said engine, a fluid actuated signalling device, control means for the fluid actuating said device, each operatively connected with one of said decompression valves, and a circuit for the fluid actuating said signalling device comprising all of said control means in parallel with each other.

2. In combination with a multi-cylinder engine and with decompression valves on cylinders of said engine, a fluid actuated signalling device, control means for the fluid actuating said device, each operatively connected with one of said decompression valves, actuated by closing of the respective valve and shutting off the flow of a fluid therethrough when the respective decompression valve is open, and a circuit for the fluid actuating said signalling device comprising all of said control means in parallel with each other.

3. In combination with a multi-cylinder engine and with decompression valves on cylinders of said engine, an electric signalling device, and electric switches each controlled by one of said valves and all connected to said signalling device.

4. The method of operating fluid pressure controlled decompression valves on a plurality of engine cylinders, comprising substantially simultaneously opening all the valves by admitting a pressure fluid thereto, closing part only of said valves by bleeding the pressure fluid admitted thereto, and then closing others of said valves by bleeding the pressure fluid admitted to these other valves.

5. Apparatus for decompressing a multi-cylinder engine comprising, in combination with decompression valves on cylinders of an engine, a plurality of similar pistons connected for simultaneous actuation by fluid pressure and operatively connected to said valves, and fluid pressure systems each including a separate group of said pistons and a pressure relief means, so that actuation of said pistons may be discontinued at will in a random rotation of the respective systems.

6. Apparatus for decompressing a multi-cylinder engine comprising, in combination with decompression valves on cylinders of an engine, a plurality of pistons operatively connected to said valves, a pneumatic system, a compressed gas supply connected by said system with said pistons for substantially simultaneous actuation of said pistons, check valves in said system preventing return flow from separate groups of said pistons to said supply thus dividing said system into portions, and control vents on said portions of said system for releasing the gas contained therein at will.

7. Apparatus for decompressing a multi-cylinder engine comprising, in combination with decompression valves on cylinders of an engine, a plurality of pistons operatively connected to said

valves, a pneumatic system, an air pump connected by said system with said pistons for substantially simultaneous actuation of pistons, check valves in said system preventing return flow from separate groups of said pistons to said air pump thus dividing said system into portions, and control vents on said portions of said system for releasing air contained therein to the atmosphere.

8. A pneumatic control apparatus comprising a cylindrical casing, a hand controlled piston for compressing air at one end of the casing, chambers clustered about said casing, check valves connecting said one end of the casing with each of said chambers, and control vents on said chambers permitting each of said chambers to be bled at will.

9. A pneumatic control apparatus comprising a panel, a cylindrical casing mounted at one end on and extending to the rear of said panel, a piston in said casing for compressing air at the other end of said casing, chambers extended alongside of said casing, check valves connecting said chambers with said other end of said casing, control vents on said chambers, a pump handle on said piston, and manipulating means for said vents, said handle and means projecting to the front of said panel.

10. A pneumatic control apparatus comprising a panel, a cylindrical casing mounted at one end on and extending to the rear of said panel, a piston in said casing for compressing air at the other end of said casing, chambers evenly spaced around said casing, check valves connecting said chambers with said other end of said casing, control vents on said chambers, a pump handle on said piston, and manipulating means for said vents, said handle projecting to the front of said panel and said means being spaced on said panel around said handle.

11. A pneumatic remote control apparatus for control of decompression valves on an engine comprising pneumatically actuated pistons for actuating the decompression valves, a control board, an air pump mounted on said board a plurality of air chambers extending from said board to said pistons and each comprising at least one of said pistons, check valves connecting each of said chambers with said pump, and control vents for bleeding said chambers mounted on said board.

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