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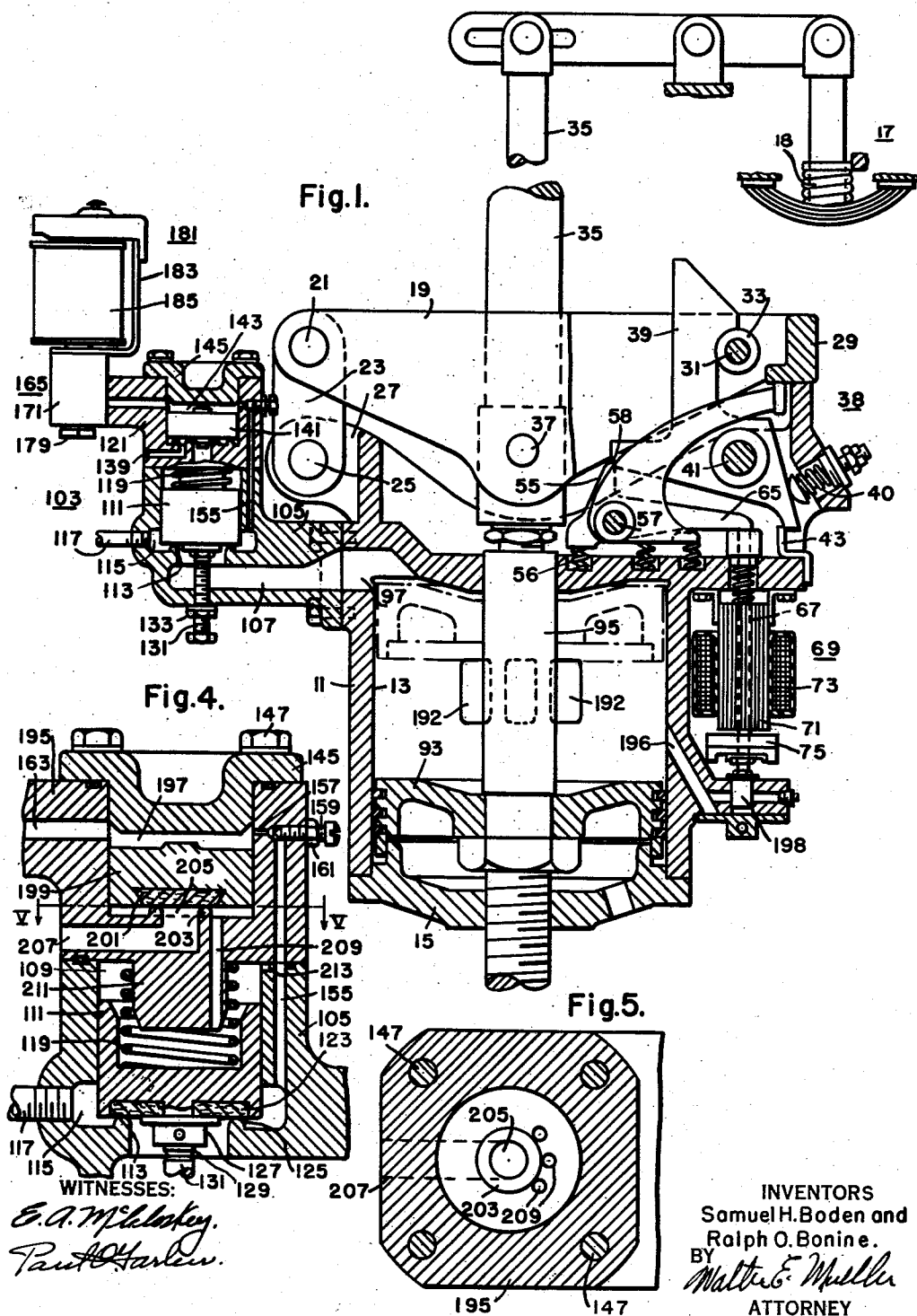
S. H. BODEN ET AL

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HIGH-SPEED INLET VALVE FOR FLUID OPERATED MECHANISM

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2 Sheets-Sheet 1



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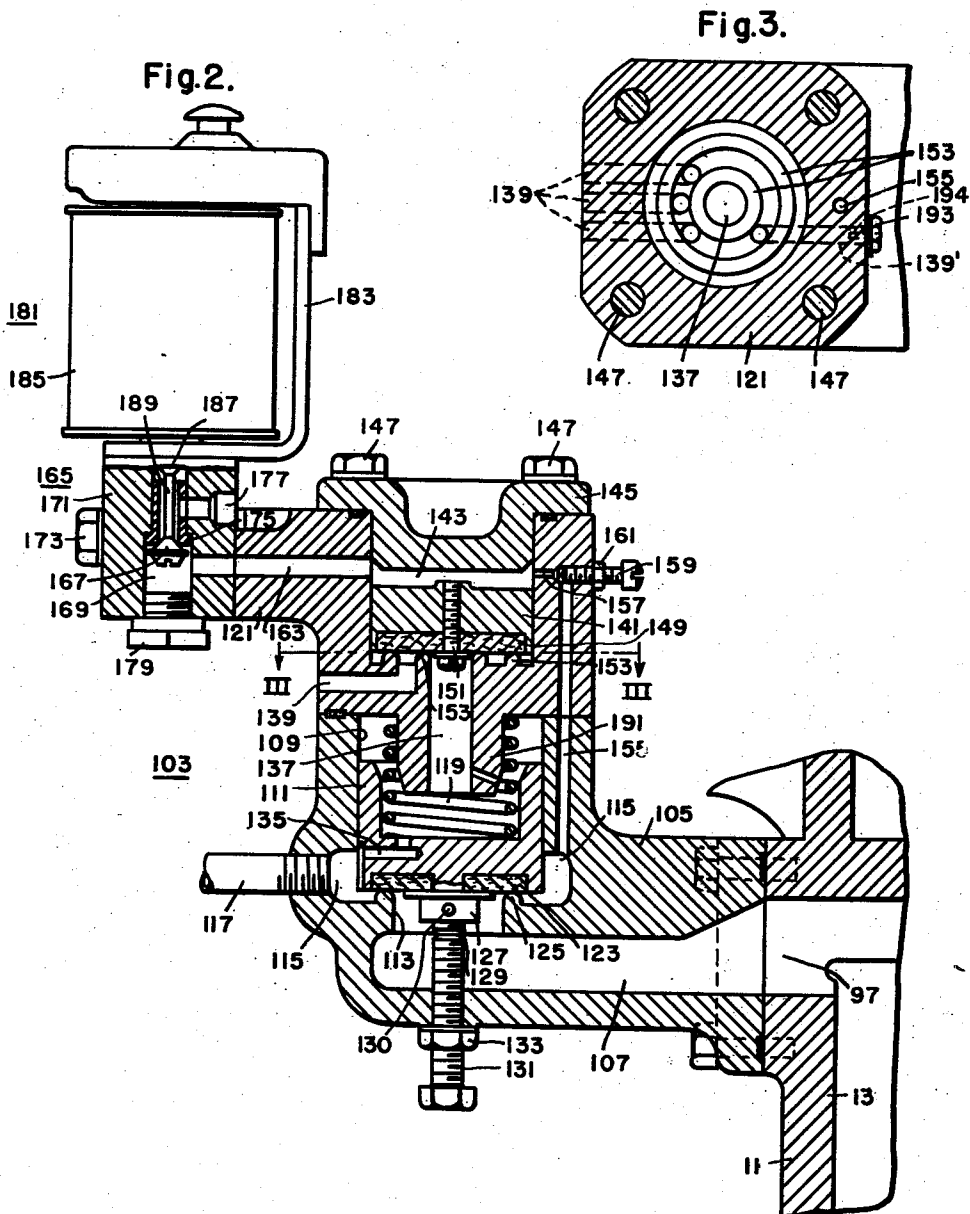
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HIGH-SPEED INLET VALVE FOR FLUID
OPERATED MECHANISM

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This invention relates to circuit breakers and more particularly to high-speed circuit breaker operating mechanisms of the pneumatic type.

In the high-speed operation of circuit breakers, it is important to provide quick automatic reclosing of the contacts immediately after interruption of a short circuit. Automatic reclosing time can be materially reduced by quickly reversing the opening movement of the breaker mechanism to reclose the breaker immediately after interruption of the circuit. This is particularly true if the reclosing movement is initiated before the breaker reaches full open position. In pneumatically operated mechanisms, high-speed reversal of the moving parts of a large circuit breaker requires an inlet valve which is capable of exceedingly high speed operation in order to quickly admit a charge of gas under pressure to the operating mechanism to reverse the movement of the breaker and quickly reclose the contacts.

An object of the invention is to provide a circuit breaker operating mechanism of the fluid pressure-operated type having an improved high-speed inlet valve mechanism.

Another object of the invention is to provide a circuit breaker operating mechanism of the fluid pressure-operated type having an improved inlet valve capable of high-speed operation for rapidly admitting a charge of compressed gas to said mechanism.

Another object of the invention is to provide a circuit breaker embodying an operating mechanism operable by fluid pressure to close the breaker having an improved high-speed inlet valve for quickly admitting a charge of gas under pressure to said mechanism to effect quick reversal of the opening movement of the breaker and quick reclosing of the breaker contacts.

Another object of the invention is to provide a circuit breaker embodying an operating mechanism of the pneumatic type having an improved high-speed inlet valve of simple and compact construction.

Another object of the invention is to provide a circuit breaker embodying a pneumatic operating mechanism for closing the breaker having an improved high-speed inlet valve provided with means for varying the speed of operation of the valve.

Another object of the invention is to provide a circuit breaker according to the preceding paragraphs wherein the inlet valve is substantially leakproof.

The novel features that are considered characteristic of the invention are set forth in par-

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ticular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof will best be understood from the following detailed description thereof when read in connection with the accompanying drawings.

In said drawings:

Figure 1 is an elevational view partly in section of a circuit breaker operating mechanism embodying the principles of the invention;

Figure 2 is an enlarged elevational sectional view of the inlet valve mechanism;

Figure 3 is a horizontal sectional view taken on line III—III of Figure 2, showing the multiple exhaust ports for the inlet valve; and

Figures 4 and 5 illustrate a modification of the inlet valve shown in Figure 2, Fig. 5 being a horizontal sectional view taken on line V—V of Fig. 4.

Referring to Fig. 1 of the drawings, the operating mechanism includes a main casting 11 which is formed to provide a main operating cylinder 13 closed at the upper end by an integral part of the casting. The lower end of the cylinder 13 is closed by means of a member 15. An operating lever 19 is pivotally mounted at an end on the casting 11 and consists of a pair of spaced parallel levers (only one being shown) pivotally mounted at one end on a pivot pin 21 in the upper end of a pair of parallel links 23 (only one being shown). The lower ends of the links 23 are pivotally supported on a pivot pin 25 mounted in ears 27 projecting upwardly from the main casting 11. The free ends of the operating levers 19 are rigidly connected by means of a cross member 29 and between them carry a short shaft 31 on which is mounted a latch roller 33 disposed between the two levers 19.

The circuit breaker, shown schematically at 17, is biased toward open circuit position by means of an accelerating spring 18 and is connected to the operating mechanism by means of an operating rod 35 which is, in turn, pivotally connected to the operating lever 19 by means of a pivot pin 37.

The breaker is releasably held in the closed position against the bias of the accelerating spring 18 by means of a latch mechanism indicated generally at 38. The latch mechanism comprises a main latch 39 of the slip-off type which engages the latch roller 33 to restrain the operating lever 19 in the closed position. The main latch is pivoted on a pivot pin 41 and is held in latching position by an auxiliary latch 55 pivoted on a pivot pin 57 and engaging a notch

53 in the main latch, the pivot pins 41 and 57 being suitably supported on the main casting 11. The latches 39 and 55 are biased to latching position by suitable spring means 40 and 55 respectively, the main latch 39 being biased against a stop 43 to prevent it from being moved beyond latching position.

The auxiliary latch 55 is provided with a projection 65 which extends directly above the upper end of a trip rod 67 of an electromagnetic trip device 69 which, in addition to the trip rod 67, comprises a magnet core 71, an energizing coil 73 and a movable armature 75.

Energization of the trip device 69 in response to overload currents effects upward movement of the armature 75 and the trip rod 67 which movement actuates the auxiliary latch 55 counterclockwise to effect release of the main latch 39. When this occurs, the accelerating spring 18 moves the operating lever 19 counterclockwise forcing the main latch 39 in unlatching direction and quickly moves the circuit breaker to the open position.

The breaker is actuated to the closed position by means of compressed gas admitted to the operating cylinder 13 above an operating piston 93 which is secured to a piston rod 95 having its upper end suitably secured to the breaker operating rod 35.

As the breaker approaches the closed position, the latch roller 33 (Figure 1) engages and wipes by the beveled portion of the main latch 39 moving the latch in unlatching direction until the breaker is in the fully closed position, whereupon the main latch under the influence of its biasing means resumes its latching position and the auxiliary latch 55 is moved to its latching position by its biasing means. In the closed position of the breaker, the piston 93 normally occupies a position near the lower end of the cylinder 13 and is moved to the upper end of the cylinder upon opening movement of the breaker.

Compressed gas is admitted to the upper end of the cylinder 13 above the piston 93 from a suitable source (not shown) of compressed gas through an inlet passage 97 controlled by an improved high-speed inlet valve mechanism indicated generally at 103 secured to the side of the main casting 11.

Referring to Figure 2, the high-speed inlet valve mechanism comprises a valve housing member 105 rigidly secured to the side of the main casting 11 adjacent the upper end thereof and has formed therein a passage 107 cooperating with the inlet passage 97 in the casting 11. Also formed in the housing member 105 is a cylinder or valve chamber 109 in which is disposed a piston-type, cup-shaped inlet valve 111 which normally closes a communication 113 communicating a high-pressure inlet chamber 115 with the passage 107. Compressed gas is supplied from a suitable storage tank (not shown) to the inlet chamber 115 by means of a conduit 117.

The inlet valve 111 is biased by means of a compression spring 119 to seated or closed position. The spring 119 is compressed between the inlet valve 111 and an upper valve housing 121 secured to the housing 105 and forming a closure for the upper end of the cylinder 109. The bottom of the inlet valve 111 is recessed to receive a valve facing 123 of tough resilient material which is seated on an annular valve seat 125 having its upper edge rounded substantially as shown. The valve facing 123 may be suit-

ably secured in the recessed lower face of the valve 111 as, for instance, by cementing and is also retained in place by a flanged collar 127 threadedly engaging a projection 129 integral with the valve 111 and locked in place by suitable means such as a pin or set screw 130. The lower end of the projection 129 cooperates with the upper end of an adjusting screw 131 threadedly mounted in the lower portion of the housing 105 and locked in adjusted position by means of a lock nut 133. Since the valve facing 123 is resilient the screw 131 is adjusted to permit a predetermined pressure of the facing 123 on the valve seat 125 before the projection 129 engages the screw 131 thus limiting the pressure of the valve facing on the valve seat. The adjusting screw 131 adjustably determines the closed position of the valve 111 and is adjustable to compensate for any wear on the valve facing 123.

The inlet valve 111 is of the balanced-pressure type and is provided with a small port 135 communicating the high-pressure chamber 115 with the cylinder 109 above the valve 111 so that the pressure in the cylinder 109 and the chamber 115 is normally the same. The valve 111 is actuated to the open position by suddenly exhausting the gas pressure from the cylinder 109 above the valve which permits the high-pressure gas in the chamber 115 below the valve 111 to snap it to its fully open position at extremely high speed. The pressure above the valve 111 is exhausted through a passage 137 extending axially through the lower portion of the housing 121 and through a plurality of exhaust ports 139 (see also Figure 3) under the control of an auxiliary piston-type valve 141 disposed in an auxiliary valve chamber or cylinder 143 formed in the upper valve housing 121. The upper end of the cylinder 143 is closed by means of a cap 145 secured to the housing 121 by four bolts 147 which extend through suitable openings in the housing 121 and threadedly engage the lower housing 105 thereby securing the upper housing 121 to the housing 105. Suitable gaskets are provided between the cap 145 and the housing 121, between the housing 121 and the housing 105, and between the latter housing and the main casting 11 to completely seal these joints.

The valve 141 is provided with a recess in its lower face in which is mounted a valve facing 149 similar to the valve facing 123 for the valve 111 and suitably secured thereon as by cementing and also by a screw 151. The valve facing 149 is seated against concentric, annular valve seats 153 having the seating portions thereof rounded off substantially as shown.

The valve 141 is also of the balanced-pressure type, and high-pressure gas is admitted to the cylinder 143 above the valve 141 to balance the pressure in the passage 137 below the valve 141 by means of a passage 155 in the housing members 105 and 121. This passage communicates the high-pressure chamber 115 to the cylinder 143 above the valve 141 and terminates in the cylinder 143 by a reduced portion 157. The rate of flow of compressed gas to the cylinder 143 is controlled by an adjustable valve member 159 threadedly engaging an opening in the housing 121 and having a tapered end extending into the junction of the passage 155 and the reduced terminal portion 157 thereof. The valve member 159 is locked in its adjusted position by means of a lock nut 161.

The valve 141 is normally maintained in closed position due to the area on top of the valve on

which the gas pressure acts in a downward direction, being much greater than the area of upward pressure below the valve, the latter being defined by the passage 137.

The valve 141 is actuated to open the passages 137—139 by quickly exhausting the pressure from the cylinder 143 above the valve which permits the high pressure in the passage 137 to quickly snap the valve 141 to its fully open position. The pressure in the cylinder 143 is exhausted through an exhaust passage 163 in the housing 121 under the control of an electromagnetically operated pilot valve indicated generally at 165. The pilot valve 165 comprises a valve member 167 disposed in a chamber 169 formed in a housing 171 secured by means of bolts 173 (only one being shown) to the housing 121. The valve member 167 is seated against a valve seat 175 and controls a passage communicating the chamber 169 to an exhaust port 177 formed in the housing 171. A plug 179 screwed into the lower end of the chamber 169 closes the chamber.

The valve 167 is adapted to be actuated to the open position by a low-energy electromagnet 181 comprising a magnetic yoke 183 rigidly mounted on the housing member 171, an energizing winding 185 and an armature 187 to which the valve 167 is connected by means of a rod 189, the armature being biased upwardly to close the valve by a spring (not shown).

The operation of the mechanism shown in Figures 1 and 2 is as follows assuming the breaker to be in the open position with the operating piston 93 occupying a position in the upper end of the cylinder 13. Compressed gas is admitted to the cylinder 13 above the piston 93 to close the breaker by energization of the electromagnet 181. This may be accomplished manually or automatically by means of a suitable control circuit, preferably of the type shown in Patent No. 2,408,199, issued September 24, 1946, to G. M. Cumming and R. C. Cunningham, and assigned to the assignee of the instant invention. When the electromagnet 181 is energized, it opens the pilot valve 165 by moving the valve member 167 downwardly thus opening the communication between the passage 163 and the exhaust port 177. When this occurs, the pressure in the cylinder 143 above the valve 141 is quickly exhausted to atmosphere, and the pressure in the cylinder 109 and the passage 137 snaps the valve 141 up against the cap 145, thus opening the communication between the passage 137 and the several exhaust passages 139. The pressure in the high-pressure chamber 115 thereupon snaps the main valve element 111 upwardly against a tubular extension 191 of the housing 121. This effects high-speed opening of the large communication 113 which admits a charge of closing gas through the passages 197—97 to the operating cylinder 13 above the operating piston 93 to move the piston downwardly and close the breaker in the manner previously described. The tubular extension 191 serves as a stop for the main inlet valve 111 and also serves to limit the volume of gas in the cylinder 109 which must be exhausted to effect opening of the valve 111.

As the breaker nears the closed position, the electromagnet 181 is automatically deenergized permitting a spring (not shown) to close the pilot valve 167 thus sealing off the exhaust passage 163—177. High-pressure gas is then admitted through to passage 155—157 to the cylinder 143 above the valve 141 which immediately moves the valve to closed position. As soon as the valve 141

is closed, high-pressure gas flowing through the passage 135 in the main inlet valve 111 quickly equalizes the pressure above and below the valve 111 and permits the spring 119 to quickly close the main inlet valve thus shutting off the communication 113.

In quick automatic reclosing operations of a circuit breaker of the type disclosed herein, the inlet valve electromagnet is usually energized automatically shortly after the trip device functions. The time for reclosing the breaker contacts following energization of the trip coil then depends largely on the speed with which the main inlet valve operates to admit compressed gas to the mechanism to reverse the movement of the mechanism to reclose the contacts. The herein disclosed invention has materially reduced the time required to automatically reclose the circuit breaker following the initiation of an opening operation.

When the circuit breaker is closed against a fault it is necessary to quickly dump the closing charge of high pressure gas from the operating cylinder 13 (Fig. 1) in order to permit high-speed reversal of the moving parts and opening of the breaker. This is accomplished by means of a pneumatically operated exhaust valve (not shown) which controls exhaust ports 192 (Fig. 1). Compressed gas is admitted to operate the exhaust valve through a passage 196 controlled by a pilot valve 198 and a pipe (not shown) but which communicates with the exhaust valve. The pilot valve is connected to and operated by the trip rod 67.

When the circuit breaker closes in against a fault the trip device 69 is energized to trip the breaker and, at the same time, opens the pilot valve 198 admitting gas under pressure from the cylinder 13 to actuate the exhaust valve (not shown) and open the exhaust ports 192.

The exhaust valve device is fully disclosed in Patent No. 2,403,082, issued July 2, 1946, to Allan W. Hill and James M. Cumming and assigned to the assignee of the present invention. Reference may be had to this patent for a more complete understanding of the exhaust valve device.

Provision is made for varying the speed of opening of the inlet valve device shown in Figures 1, 2 and 3 so that the same valve may be used in certain applications of the breaker when high-speed reclosing operations are not required. This feature includes the multiple exhaust passages 139 (Figure 3). By increasing the number of exhaust passages, the rate of dumping of gas pressure from the cylinder 109 and passage is increased thus increasing the speed of opening of the main inlet valve 111. Also by decreasing the number of exhaust passages the rate of dumping the gas pressure is decreased which results in slower opening of the main inlet valve.

As an example, in Figure 3 there are shown three passages 139 and one passage 139', the latter having a plug 193 thereon to close it off. If all four of the passages 139—139' were open, the main inlet valve would open at its maximum speed. But, if in a particular situation, it is desired to slow down the speed of opening of the main inlet valve 111, the plug 193 may be inserted to retard the dumping of pressure above the inlet valve 111, thus correspondingly retarding opening of the valve. As a further and finer adjustment of the opening speed of the valve 111, the plug 193 may have an axially disposed opening therethrough. By this adjustment, the point during an opening stroke at which the inlet valve

111 will function to cause reversal of the movement of the breaker to close the contacts may be precisely determined.

Another important feature of the invention is the provision of the outer concentric valve seat 153 for the valve 141. It is impossible to construct a piston-type valve with such close fit that gas pressure will not leak by the piston and escape to atmosphere. By the provision of the outer valve seat 153, any pressure leaking past the valve member 141 is effectually trapped in the annular area below the valve and outside the outer valve seat 153 thus making the entire valve device leakproof.

According to the modification of the invention shown in Figures 4 and 5, an upper valve housing 195 of somewhat different arrangement is secured to the lower valve housing 105 which is the same as that shown in Figure 1. The housing 195 is provided with a cylinder portion 197 in which is disposed a piston-type valve 199 having a valve facing or insert 201 of resilient material secured in a recess of the lower surface thereof. The insert 201 is seated on an annular valve seat 203 having a rounded seating surface. The valve seat 203 defines a large exhaust passage 205 which communicates with the atmosphere through a passage 207. The space below the valve 199 outside the annular valve seat 203 communicates with the space in the cylinder 109 above the valve 111 by means of a plurality of passages 209 extending longitudinally through the lower wall of the housing 195 and through a cylindrical extension 211 integral therewith. Also, the by-pass passage 135 through the valve 111 has been eliminated and a passage 213 provided by milling out a portion of the upper edge of the housing 105 communicating the passage 155 with the valve chamber 109 above the valve 111 so that pressure is supplied back of both of the valve elements through the passage 155.

The operation of the device shown in Figure 4 is the same as that of the device shown in Figure 1. When the valve 199 is opened, the gas pressure above the valve 111 is exhausted through the multiple passages 209 and the large passages 205 and 207 to atmosphere, thus permitting the pressure in the high-pressure chamber 115 to quickly open the main inlet valve 111.

One advantage of the device shown in Figure 4 is the elimination of one of the valve seats 153 of the Figure 1 device. This permits the use of a smaller insert 201, and the single annular valve seat provides for more evenly seating of the insert on the valve seat. At the same time, the single valve seat effectually prevents any gas pressure leaking past the piston valve 199 from escaping to atmosphere.

By removing the bolts 147, the cap 145 and the upper housing member 121 may be readily removed and the valve members 141 and 111 are then accessible and may be easily removed.

While the invention has been disclosed in accordance with the provisions of patent statutes, it is to be understood that various changes in the structural details thereof may be made without departing from some of the essential features of the invention.

We claim as our invention:

1. In a fluid pressure operated mechanism, the combination of inlet valve means for controlling the flow of fluid under pressure comprising a valve housing having a normally high pressure inlet chamber and an outlet chamber, a first valve chamber and a second valve chamber in said

valve housing, a main inlet valve disposed in said first valve chamber, an auxiliary valve element disposed in said second valve chamber, spaced concentric annular valve seats in said second valve chamber cooperating with said auxiliary valve element, by-pass passages communicating said high-pressure chamber to said valve chambers above said main inlet valve and above said auxiliary valve element, a centrally disposed passage communicating said first valve chamber above said main inlet valve with said second valve chamber below said auxiliary valve and terminating within the inner one of said concentric annular valve seats, a plurality of exhaust ports communicating said second valve chamber below said auxiliary valve element to atmosphere, said exhaust ports terminating in said second valve chamber between said concentric annular valve seats, and an electromagnetically operated pilot valve operable to quickly dump the fluid pressure from said second valve chamber above said auxiliary valve to atmosphere thereby permitting fluid pressure in said first valve chamber above said main inlet valve to quickly move said auxiliary valve to open position to thereby dump the fluid pressure from said first valve chamber above said main inlet valve through said centrally disposed passage and said exhaust ports to atmosphere, and said fluid pressure in said high-pressure chamber then quickly moving said main inlet valve to open position.

2. In a fluid pressure operated mechanism, the combination of inlet valve means for controlling the flow of fluid under pressure comprising a valve housing having a high-pressure inlet chamber and an outlet chamber, an inlet port communicating said inlet and outlet chambers, first and second valve chambers in said housing disposed in axial alignment, an inlet valve in said first valve chamber controlling said inlet port, spring means biasing said inlet valve closed, an auxiliary valve in said second valve chamber, spaced annular valve seats cooperating with said auxiliary valve, by-pass passage means communicating said high-pressure chamber with said valve chambers above said inlet valve and said auxiliary valve, passage means communicating said first valve chamber above said inlet valve and said second valve chamber below said auxiliary valve within the inner valve seat, exhaust port means communicating said second chamber below said auxiliary valve to atmosphere, and a pilot valve operable to quickly dump the fluid pressure above auxiliary valve to atmosphere permitting fluid pressure in said first valve chamber above said inlet valve to quickly move said auxiliary valve to open said passage means and said exhaust ports to thereby dump the fluid pressure from said first valve chamber above said inlet valve to atmosphere, the fluid pressure in said high-pressure chamber quickly moving said inlet valve to open position.

3. In a fluid pressure operated mechanism, the combination of an inlet valve device for controlling the flow of fluid under pressure comprising a valve housing having a high-pressure chamber and an outlet chamber, a partition between said chambers having an inlet port therein, a main cylinder and a second cylinder in said housing, said cylinders being in axial alignment, an inlet valve in said main cylinder for controlling said inlet port, spring means biasing said inlet valve closed, a communication between said main cylinder and said second cylinder, exhaust

port means communicating said second cylinder to atmosphere, inner and outer annular valve seats in said second cylinder, an auxiliary valve in said second cylinder, said exhaust port means communicating said second cylinder below said auxiliary valve to atmosphere, by-pass passage means communicating said high-pressure chamber with said main cylinder and said second cylinder above said inlet valve and above said auxiliary valve, said auxiliary valve cooperating with said inner annular valve seat to seal off said communication between said cylinders and said exhaust port means, said auxiliary valve cooperating with said outer annular valve seat to prevent fluid pressure leaking past said auxiliary valve from escaping to atmosphere, and pilot valve means operable to dump the fluid pressure from said second cylinder to permit said auxiliary valve to open said communication between said cylinder and said exhaust port to thereby permit fluid pressure in said high-pressure chamber to open said inlet valve.

4. In a fluid pressure operating mechanism, the combination of inlet valve means for controlling the flow of fluid under pressure comprising a valve housing having a normally high pressure inlet chamber and an outlet chamber, a first valve chamber and a second valve chamber disposed in axial alignment in said valve housing, a main inlet valve disposed in said first valve chamber, a normally closed auxiliary valve element disposed in said second valve chamber, passage means communicating said first valve chamber above said main inlet valve with said second valve chamber below said normally closed auxiliary valve element, exhaust port means communicating said second valve chamber below said normally closed auxiliary valve element to atmosphere, valve seat means in said second valve chamber cooperating with said auxiliary valve element to normally close both said passage means and said exhaust port means, by-pass passage means communicating said high-pressure chamber to said first and second valve chambers above said main inlet valve and above said auxiliary valve element, and an electromagnetically operated pilot valve operable to quickly dump the fluid pressure from said second valve chamber above said auxiliary valve element to atmosphere thereby permitting the fluid pressure in said first valve chamber above said main inlet valve to quickly move said auxiliary valve element to open position to dump the fluid pressure from said first valve chamber above said main inlet valve to atmosphere whereby said fluid pressure in said high-pressure chamber effects high-speed opening of said main inlet valve to open position.

5. In a fluid pressure operating mechanism, the combination of an inlet valve device for controlling the flow of fluid under pressure comprising a valve housing having an inlet valve chamber and an auxiliary valve chamber therein, an inlet valve in said inlet valve chamber for controlling the flow of fluid under pressure, a normally closed auxiliary valve in said auxiliary valve chamber, concentric annular valve seats in said auxiliary valve chamber cooperating with said auxiliary valve, means providing balanced pressure on both sides of each of said valves, both of said valves being operable to open position upon unbalancing of the pressure on one side thereof, passage means respectively communicating said inlet valve chamber above said inlet valve with said auxiliary valve chamber below said normally closed auxiliary valve and

communicating said auxiliary valve chamber below said normally closed auxiliary valve to atmosphere, said auxiliary valve in the closed position cooperating with said concentric valve seats to close off both of said passage means, and pilot valve means operable to dump the fluid pressure from said auxiliary valve chamber above said auxiliary valve to permit said auxiliary valve to open said passage means to dump the fluid pressure from said inlet valve chamber above said inlet valve thereby permitting high-speed opening of said inlet valve.

6. In a fluid pressure operated mechanism, the combination of an inlet valve device for controlling the flow of fluid under pressure comprising a valve housing two axially aligned valve chambers, an inlet valve in one of said chambers operable to control the flow of fluid under pressure, passage means within said housing normally providing balanced pressure on both sides of said inlet valve, said inlet valve being operable to open position upon unbalancing of said pressure, a second valve in the other of said chambers operable to effect unbalancing of the pressure on one side of said inlet valve to effect opening of said inlet valve, inner and outer concentric valve seats cooperating with said second valve, a relatively large passage communicating said valve chambers within said inner concentric valve seat, a plurality of relatively small exhaust ports communicating the space between said concentric valve seats to atmosphere, a passage means within said housing normally providing balanced pressure on both sides of said second valve, said second valve being operable to open said relatively large passage and said exhaust ports upon unbalancing of said pressure on one side of said second valve, and an electromagnetically operated pilot valve operable to effect unbalancing of the pressure on one side of said second valve to effect opening of said relatively large passage and said exhaust ports.

7. In a fluid pressure operated mechanism, the combination of an inlet valve device for controlling the flow of fluid under pressure comprising a valve housing having two valve chambers disposed in axial alignment, an inlet valve in one of said chambers operable to control the flow of fluid under pressure, passage means disposed in said housing normally providing balanced pressure on both sides of said inlet valve, said inlet valve being moved to open position upon unbalancing of said pressure, a second valve in the other of said chambers operable to effect unbalancing of the pressure on one side of said inlet valve to effect opening of said inlet valve, spaced inner and outer concentric valve seats cooperating with said second valve, a relatively large passage communicating said valve chambers within said inner concentric valve seat, a plurality of relatively small exhaust ports communicating the space between said inner and outer concentric valve seats to atmosphere, said second valve normally closing said relatively large passage and said exhaust ports, passage means normally providing balanced pressure on both sides of said second valve, said second valve being operable upon unbalancing of the pressure on one side thereof, a pilot valve operable to effect unbalancing of the pressure on one side of said second valve to effect opening of said second valve to open said relatively large passage and said exhaust ports, and adjusting means for varying the opening speed of said second valve to thereby vary the rate of unbalancing the pressure on said

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one side of said inlet valve and the speed of opening movement of said inlet valve.

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