

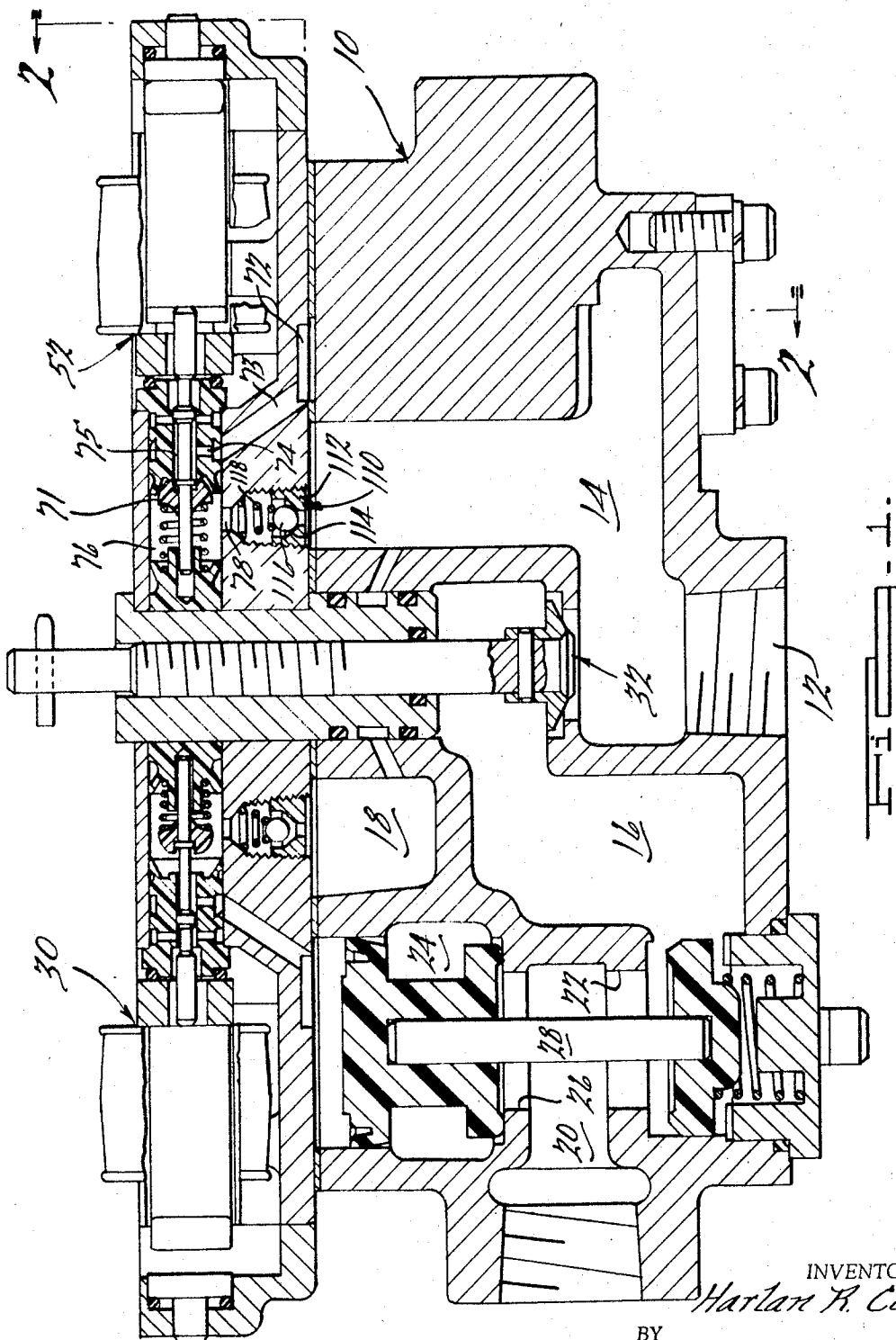
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UNLOADER CONTROL VALVE UNIT WITH MEANS FOR
MAINTAINING CONSTANT JAW PRESSURE

3,463,186

Filed May 18, 1967

2 Sheets-Sheet 1



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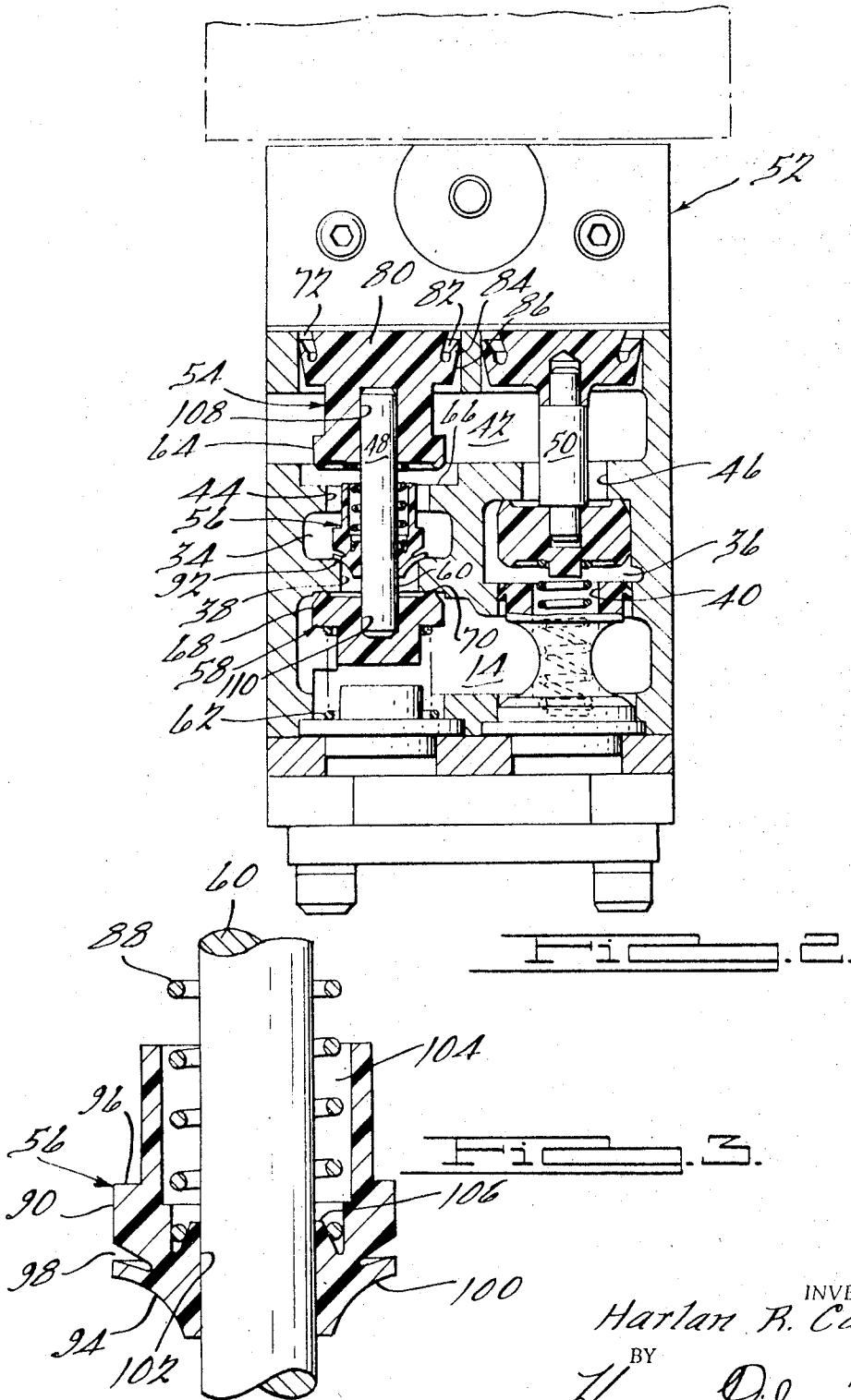


Fig. 2.

Fig. 3.

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UNLOADER CONTROL VALVE UNIT WITH MEANS FOR MAINTAINING CONSTANT JAW PRESSURE

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10 Claims

ABSTRACT OF THE DISCLOSURE

There is herein disclosed a control valve unit for controlling operation of an air operated swinging arm type press unloader and of an air operated jaw carried thereby. The valve unit includes valve means for maintaining constant air pressure at the jaw during gripping and movement of a workpiece.

Background and prior art

This invention comprises an improvement in a control valve unit of the type disclosed in U.S. Patent application Ser. No. 547,026 filed May 2, 1966. This kind of control valve unit is particularly adapted for use with press unloading devices of the type described in U.S. 2,609,776, for example. Such devices comprise a swinging arm which carries an air actuable jaw device between a lowered position adjacent a press cavity and a raised position located upwardly and outwardly from the press. The swinging arm is moved from the lowered position to the raised position by a single acting air operable power cylinder to which high pressure air is selectively directed. The swinging arm is lowered at a controlled rate as the high pressure air is exhausted from the cylinder. The jaw carried by the swinging arm is positively closed and opened, to grip and release a workpiece, by means of a double acting air operable power cylinder to and from which high pressure air is selectively directed and exhausted to obtain the opening and closing movements of the jaw. Ordinarily, with the swinging arm initially in the lowered position, the operational sequence is: (1) extend and close jaw to grip workpiece, (2) swing arm upwardly and carry workpiece from press, (3) open jaw to release workpiece, and (4) return arm to lowered position.

In the control valve unit described in Ser. No. 574,026, a single high pressure air line connects a source of high pressure air to a common inlet chamber in a valve housing containing an inlet and exhaust valve assembly for the single acting arm cylinder, an arm cylinder speed control valve, and a pair of inlet and exhaust valve assemblies for the double acting jaw cylinder. These valve assemblies are sequentially operated to control flow of high pressure air from the common inlet chamber to the arm cylinder and the jaw cylinder to effect the afore-described operational sequence.

Summary of invention

It has been discovered that a substantial pressure drop may occur in the common air inlet when the valve con-

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trolling flow to the arm cylinder is opened to cause upward movement of the arm. The pressure drop can be sufficient to adversely affect the gripping condition of the jaw by reducing the pressure in the jaw cylinder through the valve controlling flow to the jaw cylinder. This invention relates to the provision of means for maintaining a constant jaw gripping pressure during transfer of the jaw and workpiece by swinging movement of the arm. Constant pressure is maintained by providing check valve means to close the inlet passage to the jaw cylinder from the common inlet chamber as soon as the desired gripping pressure is obtained in the jaw cylinder and to maintain the check valve in the closed position until the jaw is positively moved to the open position during the pre-selected jaw opening portion of the operational sequence. After considerable experimentation and study, I have discovered a particularly satisfactory check valve design and manner of associating the check valve with a valve unit of the type disclosed in Ser. No. 547,026. In the presently preferred arrangement, I have mounted a spring loaded check valve of plastic material on a valve pin connecting spaced inlet and exhaust valves in a manner such that the check valve is operable without interference with the inlet and exhaust valves and provides a positive seal between the jaw cylinder and the inlet chamber upon attainment of a predetermined pressure condition and maintains the pressure condition regardless of changes in inlet chamber pressure.

Brief description of drawings

FIGURE 1 is a side elevational view, in section, of a valve unit incorporating the inventive features.

FIG. 2 is a sectional view taken along the line 2—2 in FIG. 1.

FIG. 3 is an enlarged detail view, in section, of a part of the apparatus shown in FIG. 2.

Detailed disclosure

Referring now to the drawings, in general, the valve unit comprises a valve housing 10 providing a common high pressure air inlet passage 12 by which a source of high pressure air is connected to interconnected high pressure inlet chamber means 14, 16, 18. An arm cylinder connecting chamber 20 is connected to the inlet chamber 16 through a valved inlet passage 22 and to an exhaust chamber 24 through a valved passage 26. An arm cylinder control valve assembly 28 is operable by control means in the form of a solenoid operated pilot valve assembly 30. The rate of flow from inlet chamber 14 to inlet chamber 16 is controllable by an adjustable flow control valve unit 32. Jaw cylinder connecting chambers 34, 36, FIG. 2, are connected to the inlet chamber 14 through valved inlet passage 38, 40 and to an exhaust chamber 42 through valved exhaust passages 44, 46. Jaw cylinder control valve assemblies 48, 50 are operable by control means in the form of a solenoid operated pilot valve assembly 52, FIG. 1. The general operation of these valve assemblies will be understood by those skilled in the art to which this invention relates and are described in further detail in prior application Ser. No. 547,026 and hereinafter only to the extent required for an understanding of the present invention. Suffice it to say that the jaw valve assemblies control flow of high pressure

air to and exhaust air from opposite ends of the jaw cylinder and are alternately actuated between inlet and exhaust positions while the arm valve assembly controls flow of high pressure air to and exhaust air from one side of the arm cylinder.

The jaw control valve assemblies 48, 50 are mounted in generally parallel side-by-side relationship at one end of the valve unit. Valve assembly 48 comprises an annular pilot-exhaust valve member 54, check valve means in the form of an annular intermediate check valve member 56, and an annular inlet valve member 58 mounted on and connected by a straight valve connecting pin 60. The valve assembly 48 is reciprocally movable axially between an exhaust position (shown in FIG. 2) and an inlet position (not shown) relative to one end of the jaw cylinder. A valve spring 62 biases the valve assembly to the exhaust position whereat cylinder connecting chamber 34 is connected to exhaust chamber 42 through passage 44. In the exhaust position, an exhaust valve head portion 64 of the exhaust-pilot valve member is located in an open position spaced from a valve seat 66 surrounding exhaust passage 44 and an inlet valve head portion 68 of the inlet valve member 58 is located in a closed position on a valve seat 70 surrounding inlet passage 38. A pilot valve 71, FIG. 1, is selectively operable to connect a pressure chamber 72 to the inlet chamber 14 through passages 73, 74, 75, a pilot valve chamber 76, and a passage 78 whereby high pressure air moves the valve assembly 48, FIG. 2, to the inlet position whereat cylinder connecting chamber 34 is connected to inlet chamber 14 through passage 38. In the inlet position, the exhaust valve head portion 64 is located in a closed position on valve seat 66 and the inlet valve head portion 68 is located in an open position spaced from valve seat 70. The pilot end portion 80 of the pilot-exhaust valve head member 54 is slidably mounted in pilot valve controlled pressure chamber 72 and is slidably guided therein for axial movement between the inlet position and an exhaust position. An undercut 82 in the pilot end portion 80 provides a sealing lip 84 having a tapered outer peripheral surface 86 sealably engageable with the wall of chamber 72.

Intermediate check valve member 56, FIGS. 2 and 3, is slidably mounted on pin 60 for axial reciprocable movement between an open and closed position relative to inlet passage 38. A compression spring 88 is mounted circumjacent pin 60 between the pilot-exhaust valve member 54 and the check valve member 56. The check valve member is a one-piece element made from a plastic material having low water absorption, a low coefficient of friction, high wear resistance, good machining characteristics, and an amount of flexibility in thin wall sections enabling the formation of integral sealing lips. Fluorocarbon polymer plastic materials such as tetrafluoroethylene polymer and fluorinated ethylenepropylene polymer appear to be particularly well suited for this purpose. Teflon material as manufactured by the E. I. duPont Company has proved satisfactory. An annular valve head portion 90 engages a conical valve seat 92 surrounding the inlet passage in the closed position and is spaced from the valve seat in the open position. Valve head portion 90 has a generally conical but somewhat concave valve face 94 at one end and an oppositely facing annular pressure surface 96 at the other end. An undercut 98 is provided in the outer periphery of the check valve head portion adjacent the generally conical valve face 94 to provide a flexible sealing lip 100 movable into sealing engagement with the valve seat by high pressure air. A central bore provides an integral annular guide surface 102 cooperable with pin 60 adjacent the valve head portion and an enlarged spring well 104 terminated by an undercut flexible sealing lip 106 on which the spring 88 is seated. The lip 106 is movable into sealing engagement with the adjoining pin surface by high pressure air acting in well 104.

When high pressure air is directed to the pressure chamber 72, the pilot portion of the pilot-exhaust valve mem-

ber acts as a piston and is moved toward the inlet position. Sealing lip 84 is acted upon by the high pressure air to establish a seal between the pilot portion and the pressure chamber. One end of pin 60 is mounted in abutting engagement in a corresponding bore 108 of the pilot-exhaust valve member and the other end is abuttingly mounted in a corresponding bore 110 in the inlet valve member whereby these separate parts act as a unit and are moved simultaneously. Valve head portion 68 of the inlet valve member is moved away from valve seat 70 against spring 62 until valve head portion 64 of the pilot-exhaust valve member engages valve seat 66. High pressure air in the inlet chamber 14 enters inlet passage 38 and, acting on surface 94, moves check valve member 56 away from valve seat 92 against the bias of spring 88. The high pressure air enters the connecting chamber 34 and goes to the jaw cylinder to actuate the jaw to the closed gripping position. When the jaw is closed and equilibrium pressure conditions are established in the jaw cylinder, the connecting passage (not shown), and chambers 14, 34, check valve member 56 will be moved onto the valve seat 92 by spring 88 to close the inlet passage 38 and maintain the desired high pressure condition in the jaw cylinder regardless of any subsequent pressure drop in the inlet chamber 14.

When the pressure chamber 34 is exhausted by actuating the pilot valve 52 to the exhaust position, the spring 62 moves inlet valve member 58 to the closed position and moves pilot-exhaust valve member 54 to the open position permitting the jaw closing high pressure air in the jaw cylinder to be exhausted through connecting chamber 34, passage 44, and exhaust chamber 42.

In order to further seal the jaw closing air in the jaw cylinder, I have found it to be highly desirable to insure that a pressure drop in the inlet chamber 14 does not reduce the pressure in pressure chamber 72 so as to cause the valve assembly 48 to be inadvertently moved to the exhaust position. To this end, a check valve assembly 110, FIG. 1, has been placed in the inlet passage 78 connecting the inlet chamber 14 to the high pressure chamber 72 through pilot valve 52. Experimentation has shown that a check valve of particular construction provides a most satisfactory seal. The check valve assembly comprises a stainless steel plug 112 threaded into inlet passage 78 and providing a conical valve seat 114. A molded neoprene ball valve 116 is ground to a specified diameter and biased onto the valve seat by a compression spring 118. When the pilot valve 71 is moved to an open position, shown by pilot valve assembly 30, relative to passage 75, high pressure air in the inlet chamber 14 forces the ball valve 116 off of seat 114 to allow flow of high pressure air to the pressure chamber 72 through chamber 76 and passages 73, 74, 75. When equilibrium conditions are established, the spring 118 will close the ball valve and thereafter maintain high pressure conditions in the pilot valve and pressure chambers 72, 76 until the pivot valve 71 is moved to the exhaust position in closed relationship to passage 75. In the exhaust position, chamber 72 is connected to an exhaust passage in the pilot valve through passages 72, 74, 75 by movement of the pilot valve spindle of pilot valve 52 to the position shown in FIGURE 1 whereat passage 75 is closed at one end by valve 71 and connected at the other end to the exhaust passage.

Thus, the gripping pressure in the jaw cylinder is maintained regardless of pressure changes at the source or in other parts of the system. For example, after valve assembly 48 is moved to the inlet position, arm controlling valve assembly 28 is similarly moved to its inlet position, shown in FIG. 1, whereat high pressure inlet chamber 16 is connected to the connecting chamber 20 through passage 22 and a substantial momentary pressure drop may occur in the inlet chambers. Check valves 56 and 110 isolate the jaw controlling portion of the control system so as to maintain constant gripping pressure.

The pilot valve assemblies 30, 52 may be of identical construction for purposes of standardization.

I claim:

1. A control valve unit for controlling flow of high pressure air or the like to and from a plurality of sequentially activated air operated devices comprising:
 - a plurality of inlet-exhaust chambers through which high pressure air is delivered to and exhausted from the devices, there being one inlet and exhaust chamber for each such device;
 - an inlet flow passage connected to each such chamber;
 - common inlet chamber means connected to each inlet flow passage;
 - an inlet valve associated with each inlet flow passage and being selectively sequentially operable between open and closed positions relative thereto to control flow from the common inlet chamber means through the flow passage to the associated device;
 - control means to sequentially operate the inlet valves to first open the inlet valve of one of the inlet passages and connect the common inlet chamber means to one of the devices to establish the high pressure condition in the common inlet chamber means in the one device to thereby actuate the one device and subsequently to open the inlet valve of another of the inlet passages and connect the common inlet chamber means to another one of the devices to establish the high pressure condition in the common inlet chamber means in the other device to thereby actuate the other device while maintaining the inlet valve of the one of the inlet passages open and the one device actuated;
 - and check valve means associated with the inlet flow passage having the first-to-be-operated one of the inlet valves and being operable to an open position permitting flow from the common inlet chamber means to the inlet-exhaust chamber when the inlet valve is in the open position and the pressure in the common inlet chamber means exceeds the pressure in the inlet-exhaust chamber, and being operable to a closed position preventing flow from the inlet-exhaust chamber to the common inlet chamber means when the inlet valve is in the open position and the pressure in the common inlet chamber means is less than the pressure in the inlet-exhaust chamber.
2. The invention as defined in claim 1 and having:
 - an exhaust passage connecting said inlet-exhaust chamber to exhaust;
 - an exhaust valve associated with the exhaust passage and being operable between open and closed positions relative thereto to control flow from the device to exhaust through the inlet-exhaust chamber, the exhaust valve being operable to the open position and closed position simultaneously with operation of the inlet valve to the closed position and open position, respectively;
 - a valve stem connecting said exhaust valve to said inlet valve and extending through said inlet-exhaust chamber; and
 - said check valve means comprising a valve head slidably mounted on said valve stem in said inlet-exhaust chamber, a valve seat formed about said inlet passage and abuttingly receiving said valve head in the closed position, and spring means biasing said valve head to the closed position.
3. The invention as defined in claim 2 and wherein:
 - said valve head being a one-piece sleeve-like member of plastic material having inner and outer peripheral surfaces,
 - a head portion formed at one end of said sleeve-like member,
 - a first sealing abutment lip formed along the outer peripheral surface of said head portion and being sealingly engageable with said valve seat,

- a guide hub formed along the inner peripheral surface of said head portion, and
- a second sealing abutment lip formed at one end of said guide hub and being sealingly engageable with said valve stem.
4. The invention as defined in claim 3 and wherein:
 - a spring well being formed at the other end of said sleeve-like member,
 - said spring means comprising a compression spring mounted circumjacent said valve stem in said spring well, and
 - one end of said compression spring being seated on said second sealing abutment lip and exerting a sealing force thereon.
5. The invention as defined in claim 4 and having first and second sealing abutment lips formed by undercuts in said sleeve-like member providing pressure surfaces upon which high pressure air in said inlet-exhaust chamber is operative to exert sealing forces on the lips.
6. The invention as defined in claim 2 and wherein said control means comprises:
 - a pressure chamber for operating said inlet valve and said exhaust valve,
 - pilot valve means for selectively connecting said pressure chamber to the common inlet chamber means, and additional check valve means between said pressure chamber and said common inlet chamber means operable to an open position permitting flow from the common inlet chamber means to the pressure chamber when the pilot valve means is in the open position and the pressure in the common inlet chamber means exceeds the pressure in the pressure chamber, and being operable to a closed position preventing flow from the pressure chamber to the common inlet chamber means when the pilot valve is in the open position and the pressure in the pressure chamber exceeds the pressure in the common inlet chamber means.
7. The invention as defined in claim 6 and said additional check valve means comprising:
 - a conically shaped valve seat;
 - a ball valve engageable with said valve seat in the closed position; and
 - spring means biasing the ball valve to the closed position.
8. The invention as defined in claim 7 and the surface of said valve seat being formed of stainless steel; and the ball valve being of neoprene rubber.
9. A control system for operating at least two fluid operable devices comprising:
 - a common high pressure inlet chamber for receiving high pressure fluid to be delivered to said devices for actuation thereof,
 - a first fluid delivery passage connecting said chamber to one of said devices,
 - a second fluid delivery passage connecting said chamber to the other of said devices,
 - flow control means in each passage for selectively opening and closing each passage, and
 - check valve means in at least one of said fluid delivery passages operable to an open position upon actuation of said flow control means and permitting flow through said fluid passage in the open position and being operable by the pressure differential between the fluid operable device and the inlet chamber to the open position and remaining in the open position until pressure equalization between the fluid operable device and the inlet chamber and thereafter being operable to a closed position preventing reverse flow of high pressure air from the fluid operable device to the inlet chamber.
10. A fluid flow control valve system comprising:
 - a valve body,
 - an exhaust port in the valve body,
 - an inlet port in the valve body,

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a flow port in the valve body through which fluid is delivered and returned from a fluid operable device connected to said exhaust port and said inlet port, spaced valve heads in the valve body controllably associated with said exhaust port and said inlet port to alternately open and close the exhaust port and the inlet port relative to the flow port, 5
valve stem means connecting said spaced valve heads and causing simultaneous operation of each, and check valve means mounted on said valve stem 10
means between said valve heads and being slidable thereon between an open and closed position relative to said inlet port and closing said inlet port when said spaced valve heads are in the open position rela-

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tive to said inlet port and the pressure in said flow port is equal to or greater than the pressure in said inlet port.

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