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CONTROL DEVICE FOR AIR MOTOR

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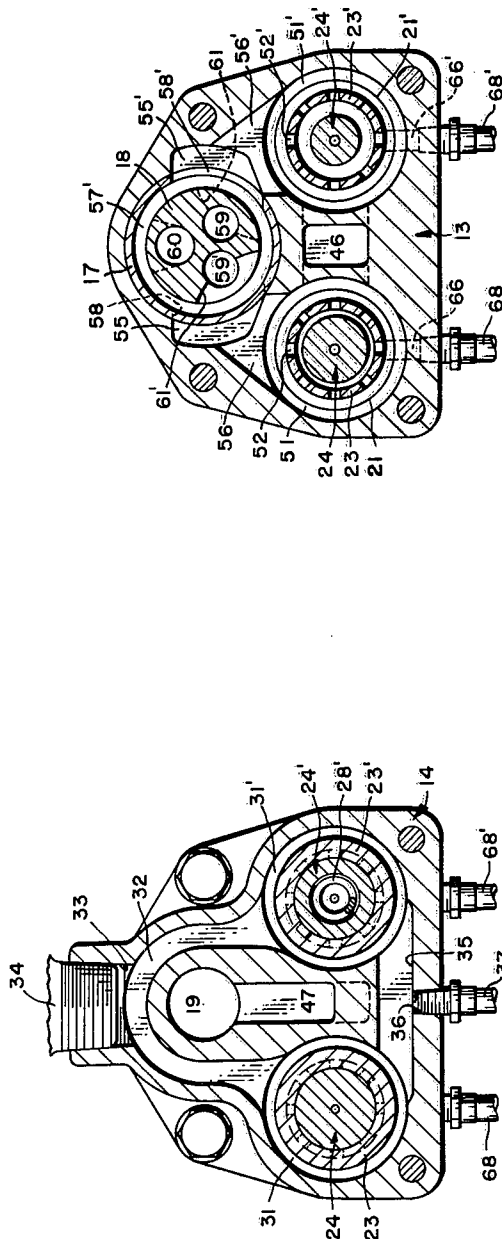


FIG. 5

FIG. 4

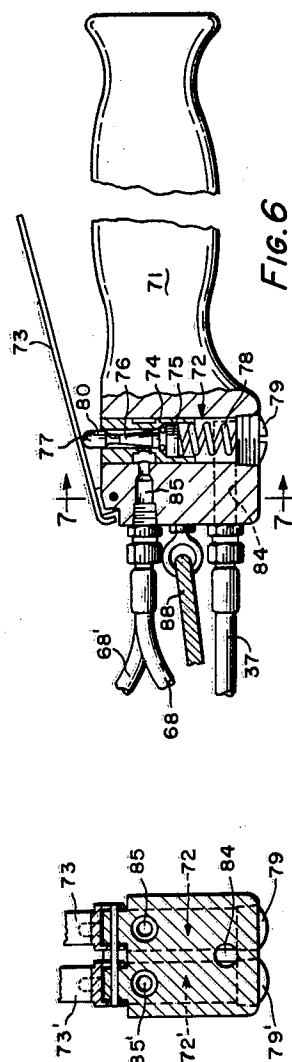


FIG. 6

FIG. 7

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CONTROL DEVICE FOR AIR MOTOR

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This invention relates to a control device for an air motor; and more particularly to a pendent control device for controlling an overhead air motor operated hoist.

In a control for a hoist motor, it is desirable to have a sensitive control for varying the speed of the motor and for maintaining selected constant speeds within a variable range of speeds.

An object of this invention is to provide an air operated control device including a rectilinearly movable member adapted to be variably positioned, and to be maintained in a selected position. Another object is to provide a device of this type in which the rectilinearly movable member is a spool-type throttle valve for an air motor.

A further object of this invention is to provide a control device for an air motor including two spool-type throttle valves which may be selectively positioned, by means of regulating valves in a pendent assembly, to control the speed of the motor. A still further object is to provide an improved sealing means between the spool valve and associated valve liners.

A still further object of this invention is to provide a control device for an air motor which is simple in construction, involving minimum parts, and providing ease of maintenance.

The novel features of the invention, as well as additional objects and advantages thereof, will be understood more fully from the following description when read in connection with the accompanying drawings in which:

FIG. 1 is a sectional view of the portion of a control device attached to a motor, a portion of the motor being shown;

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1 looking in the direction of the appended arrows;

FIG. 3 is a fragmentary sectional view of a sealing ring for a spool valve;

FIG. 4 is a sectional view taken along the line 4—4 of FIGS. 1 and 2, looking in the direction of the appended arrows;

FIG. 5 is a sectional view taken along the line 5—5 of FIGS. 1 and 2, looking in the direction of the appended arrows;

FIG. 6 is an elevation view, partially in section of the pendent portion of a control device; and

FIG. 7 is a sectional view taken along the line 7—7 of FIG. 6, looking in the direction of the appended arrow.

In general terms, the invention is concerned with a control device, including a pendent portion, for a pneumatically operated motor. The control includes a pair of throttle valves mounted in a housing attached to the motor, spring biased to an exhaust position; each valve being movable between the exhaust position, in which certain motor ports are communicated with exhaust, and a supply position, in which certain motor ports are communicated with a supply of compressed air. The throttle valves are controlled by a pair of regulating valves mounted in a pendent housing, suspended below the throttle valve housing, and connected thereto by means of flexible air conduits. The regulating valves are controlled by levers such that the operator may grip the pendent housing and operate either of the levers with his thumb. Each regulating valve, when depressed, will direct pressurized air to one end of a corresponding throttle valve at a rate controlled by the operator. The corresponding throttle valve is then moved away from the exhaust position; and, through an arrangement of bleed ports bypassing the throttle valve and com-

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municating the opposite ends of the valve with atmosphere, the forces acting on the two ends of the throttle valve are maintained in equilibrium through the range of the movement of the throttle valve. The speed of the motor is determined by the amount of movement of the throttle valve from the exhaust position.

Referring now to the drawings, the device is embodied in a control for a radial piston air motor; however, it will be apparent that the device may be used as well for controlling other types of air motors or air actuated devices. In FIG. 1, there is shown a main valve housing which is secured on a housing 12 for a radial piston air motor, shown in part. The main valve housing consists of a valve chest 13 and a valve chest cap 14. The valve chest 13 is provided with a bore 15 axially aligned with a corresponding bore 16 in the motor housing 12. A valve bushing 17 is disposed within the bores 15 and 16 and journals a motor distributor valve 18 which is rotationally fixed to the motor crankshaft (not shown).

The chest cap 14 is provided with a bore 19 communicating with the chest bore 15, at its inner end, and being threaded at its outer end for the purpose of securing therein a muffler, for example. The bore 19 is the main exhaust opening for the motor, as will be seen.

The chest and chest cap are further provided with aligned parallel bores 21, 21' and 22, 22', respectively, which define generally cylindrical chambers. These bores are provided for the motor throttle valve assemblies and, since these assemblies are identical, only one assembly will be described in detail and the corresponding parts of the other assembly will be identified by the same reference numerals with a prime.

Referring to the bores 21 and 22, a valve liner or sleeve 23 is disposed within the chamber defined by these bores and coextensive therewith. A main throttle valve 24, in the form of a spool valve, is disposed within the valve liner for rectilinear movement in sealing engagement with the walls of the liner. The throttle valve is defined by a head portion 25, generally disposed in the chest cap portion of the housing; a head portion 26, generally disposed in the chest portion of the housing; and a connecting reduced diameter neck portion 27, defining an annular chamber between the valve 24 and the sleeve 23. The neck portion defines a conical or tapered surface merging with the head 25. The valve 24 is normally biased to its exhaust position, toward the chest end of the valve chamber, by means of a compression spring 28 disposed between the chest cap and a recess in the head 25 of the valve.

Within the chest cap, an annular chamber 31 is defined by an annular groove in the bore 22 and an annular groove in the sleeve 23. As best shown in FIG. 4, the annular chambers 31 and 31' are connected to each other by a U-shaped passageway 32 which communicates, at the top of the chest cap 14, with a threaded opening 33. A swivel coupling 34 is threaded into the opening 33 and is provided for connection with a source of compressed air through a suitable conduit. It will be seen then that the annular chambers 31 and 31' are air supply chambers for the valves 24 and 24' respectively. The chambers 31 are further connected by a passage 35' and the lower wall of the cap is provided with a threaded opening 36, communicating with the passage 35. A fitting for a flexible air hose 37 is threaded into the opening 36 for supplying pressurized air to the pendent portion of the control device as will be seen.

Radially spaced ports 41, in the sleeve 23, communicate the chamber 31 with the interior of the sleeve. In the normal or exhaust position of the valve (illustrated by the valve 24'), the radial ports 41 are covered by the head 25. Since the chamber 31 is supplied with compressed air, ring seals 42 are provided in the head 25 and disposed

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at opposite sides of the radial ports 41 to prevent leakage of the pressurized air from the chamber 31 when the valve is in this position.

An annular chamber 45, disposed at the opposite end of the valve assembly, is defined by an annular groove in the chest bore 21 and an annular groove in the sleeve 23. The chambers 45 and 45' communicate with a central passage 46 in the valve chest 13, as best shown in FIGS. 2 and 5; and the passage 46 communicates with a passage 47 in the chest cap 14 which in turn communicates with the exhaust opening 19 in the chest cap. The sleeve 23 is provided with radial ports 48 which communicate the chamber 45 with the interior of the sleeve. It will be seen then that the annular chambers 45 and 45' are the exhaust chambers for the valves 24 and 24' respectively.

An intermediate annular chamber 51 is defined by an annular groove in the chest bore 21 and an annular groove in the sleeve 23. Radial ports 52 in the sleeve communicate the chamber 51 with the interior of the sleeve. In the exhaust position of the valve (illustrated by the valve 24'), the chambers 45 and 51 are communicated through their associated radial ports and through the annular chamber defined by the neck portion 27 of the valve 24. The chambers 51 and 51' are the motor chambers for the valves 24 and 24' respectively; and communicate with the motor distributor valve 18.

As best shown in FIGS. 1 and 5, the distributor valve bore 15, in the valve chest, is provided with enlarged recesses 55 and 55' and these are communicated respectively with the annular chambers 51 and 51' by passages 56 and 56' respectively. The recesses 55 and 55' are axially elongated in order to span axially spaced, inwardly facing annular grooves 57 and 57' in the distributor valve bushing 17. A port 58 communicates the groove 57 with the recess 55; and a corresponding port 58' communicates the groove 57' with the recess 55'. Accordingly, the annular grooves 57 and 57' are, at all times, communicated with valves 24 and 24' respectively.

The distributor valve 18, which is only partially shown in FIG. 1, is provided with three axial passages 59, 59' and 60. The passage 59 is plugged at its forward end and is in constant communication with the annular groove 57 by means of a milled slot 61; and the passage 59', similarly, is in constant communication with the annular groove 57' through a milled slot 61'. The passages 59 and 59' communicate with individual passages 62 to the several cylinders of the radial piston motor, selectively as the distributor valve rotates; and these passages 59 are alternately employed to direct compressed air to the motor cylinders and to exhaust air from the cylinders, depending upon the desired direction of motor rotation. The passage 60 is a primary exhaust passage which also communicates with the motor cylinder passages 62; and is open at the end of the distributor valve to communicate with the exhaust bore 19 in the valve chest cap. Accordingly, in operation, pressurized air is directed to the motor cylinders through one of the valves 24 and one of the passages 59; and air is exhausted from the motor cylinders through the other valve 24 and the other passage 59 and also through the primary exhaust passage 60. It will be apparent that the motor passages 56 and 56', communicating with the valves 24 and 24' respectively, could be connected to opposite sides of a rotary vane motor and that, therefore, the presently described control device could be used as well with a reversible rotary vane air motor.

The valves 24 and 24' are moved from their exhaust positions by the introduction of pressurized air to chambers 65 and 65', respectively, defined between the ends of the chest bores 21 and the valve heads 26. Air is directed to these chambers through ports 66 and 66', respectively which open from the bottom of the valve chest 13 and are threaded to receive fittings of flexible air hoses 68 and 68' respectively.

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Air is directed to the chambers 65 and 65' through a pendent control handle 71, best shown in FIGS. 6 and 7. This handle is an elongated member, adapted to be gripped by a hoist operator, and includes a pair of poppet type, regulating valve assemblies 72 and 72' actuated by pivoted levers 73 and 73', respectively disposed for convenient manipulation by the hoist operator's thumb.

The valve assemblies are identical and are disposed in parallel transverse bores, adjacent one end of the handle 71. Each valve assembly includes a sleeve 74, received in the upper end of the bore, and an associated valve closure member. The sleeve is provided with a stepped bore, larger at the lower end thereof, defining a shoulder which serves as the valve seat. The valve closure member includes a head 75, received within the larger sleeve bore and seating on the above mentioned shoulder, and a reduced diameter stem 76, which extends upwardly through the smaller sleeve bore and out of the sleeve. The head 75 is provided with flats or longitudinal grooves on its periphery to permit flow of air between the head and the larger sleeve bore when the valve is open. The stem 76 is tapered, from the head to an intermediate point, to provide a varying cross section; and terminates in a knob 77 dimensioned to fit the smaller sleeve bore in air sealing relationship. The knob projects from the sleeve to be engaged by the respective pivoted lever 73. The valve closure member is biased to seated or closed position by a coil spring 78 disposed between the valve member and a closure plug 79 for the lower end of the valve bore. The knob 77 is provided with a partial groove 80, defining a bleed passage which communicates the small sleeve bore with atmosphere when the valve closure member is seated. When the valve member is unseated, the groove 80 moves within the small sleeve bore to close this bleed passage.

A longitudinal passage 84 extends from the end of the pendent handle and communicates with the lower ends of both valves bores. This passage is threaded to receive a fitting of the air hose 37, the other end of which is connected with the chest cap passage 36 and communicates with the passage 35. Pressurized air, then, is directed from the passage 35 to the lower ends of the bores for the pendent handle valve assemblies 72 and 72'.

Longitudinal passages 85 and 85' are provided in the pendent handle 71, extending from the end of the handle to each of the valve bores respectively. The sleeves 74 are provided with ports for communicating these passages with the small bores of the sleeves. The hoses 68 and 68', which communicate with throttle valve chambers 65 and 65', respectively, are provided with fittings which are threaded into the passages 85 and 85', respectively. The pendent handle 71 may be supported by a cable 88, suitably connected to the throttle valve housing 11, to remove strain from the hoses 37, 68 and 68'.

It will now be seen that when the valve 72, for example, is opened by depressing lever 73, live air is directed from the hose 37 through the hose 68 to the chamber 66 of throttle valve 24. The valve must be depressed sufficiently so that the tapered portion of the stem 76 extends out of the smaller bore of the valve sleeve. The flow of air is determined by the annular area between the tapered stem and the smaller sleeve bore and, therefore, is controlled by the relative position of the valve closure member within the sleeve. When the valve closure member is so depressed, the knob 77 prevents escape of air from the upper end of the valve assembly. When the closure member is seated, however, the groove 80 provided in the knob 77 provides a bleed for the hose 68. Through this bleed 80, the chamber 65 is bled to atmosphere through the hose 68.

When pressurized air is directed to one of the chambers 65, the corresponding throttle valve 24 is caused to move (to the right in FIG. 2) away from its normal or exhaust position (illustrated by the valve 24') and against the pres-

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sure of compression spring 28. According to the present invention, means are provided for establishing a balance of forces acting on the opposite ends of the valve 24 so that the valve may be maintained at selected position within its limit of travel in the valve chamber. In order to provide this balance of forces, means are provided for permitting escape of the pressurized air which is admitted to the chamber 65 from the regulating valve 72. This means including a bleed passage 91 which extends axially through the valve 24 communicating the chamber 65, at one end of the valve, with a chamber 92, at the opposite end of the valve in which is disposed the spring 28. A second bleed passage 93 is provided in the valve chest cap 14 to communicate the chamber 92 with the exterior of the housing, hence to atmosphere.

When the regulating valve 72 is opened to a selected degree, there will be a certain flow of air into the chamber 65 effecting an increase of pressure in this chamber to move the valve 24 against the spring 28. There will also be a flow of air through the bleed passage 91 into the chamber 92 effecting an increase in pressure in the chamber 92; and there will be a flow of air through the bleed passage 93 to atmosphere. It has been observed that the air in the chamber 92 will attain a pressure above that of ambient atmosphere, as determined by the flow of air through the bleed passage 91 and 93, and, it is believed, through a turbulence effect created in the chamber 92. As the valve 24 moves against the spring, the resisting force of this spring increases. The pressure within the chamber 92 produces a force, acting with the force of the spring, to oppose the force produced by the pressure in the chamber 65. After certain desired movement of the valve 24 is reached, these forces are brought into balance and the valve will remain stationary so long as the regulating valve 72 is maintained stationary.

The existence of a back pressure within the chamber 92 has been shown by operation of the device; and it has been further shown that the desired balance of forces occurs when the cross-sectional area of the bleed passage 93 is somewhat larger than the minimum cross-sectional area of the bleed passage 91.

When the regulating valve 72 is opened further, the flow of air to the chamber 65 is increased and the pressure increases, effecting further movement of the valve 24 against the spring 28 and increasing the resistant force of the spring. The increased air flow through the bleed passages results in a pressure increase in the chamber 92 also, and again the opposing forces will become equalized so that the valve 24 will maintain a static position.

When the throttle valve moves against the spring, the head 26 covers the radial ports 48 communicating with the exhaust chamber 45; and the head 25 is moved to uncover the radial ports 41 communicating with the supply chamber 31. This results in flow of air from the supply chamber 31, through the annular chamber defined by the neck portion 27 of the valve 24 and into the motor chamber 51 through the radial ports 52. Further movement of the valve 24 increases the flow of air from the supply chamber 31 to the motor chamber 51, the flow being partially determined by the tapered neck portion 27. In FIG. 2 the valve 24 is shown in the full open position providing maximum flow of air to the motor and hence maximum speed of the motor.

It will be seen from the foregoing that the flow of air to the motor is directly controlled by the throttle valves 24 which are, in turn, controlled by the regulating valves 72 in the pendent control handle 71.

A feature of the throttle valve structure is the provision of improved ring seals in the valve head 25, for sealing the supply chamber 31 when the valve is in the exhaust position. This structure is best shown in FIG. 3. The valve head 25 is provided with a pair of annular grooves 96, having a rectangular cross-section. An outer annular sealing ring 97, having a generally U-shaped cross-section, is disposed within groove 96, and is dimen-

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sioned to be closely confined by the walls of the groove and for a sealing fit with the wall of the sleeve 23. The sealing ring 97 is preferably made of a synthetic material having self-lubricating qualities, such as Teflon. An inner O-ring 98, constructed of rubber or other resilient material, is disposed within the groove and defines an expander ring which exerts an outward force holding the outer ring 97 against the sleeve wall.

The over-all operation of the control device according to the present invention will be apparent from the foregoing, and will be briefly summarized. The swivel coupling 34 is connected to a source of compressed air by means of a suitable conduit. When so connected, pressurized air is directed to the supply chambers 31 and 31' through the passages 33 and 32; and is directed to the regulating valve assemblies 72 and 72' through passages 35 and 36, the hose 37, and the passage 84. The valves 24 and 24' are maintained in the normal or exhaust positions by the springs 28 and 28' respectively; and the regulating valves 72 and 72' are maintained in the closed position by respective springs 78 and 78'.

When it is desired to drive the motor in one direction, the lever 73, for example, is depressed by the operator to open the regulating valve 72. This permits a certain flow of air through the regulating valve and hose 68 to the chamber 65 of the throttle valve 24. The throttle valve 24 then moves against the spring 28 to first seal off the exhaust chamber 45, then to communicate the supply chamber 31 with the motor chamber 51. Pressurized air then flows through the throttle valve into the chamber 51, then through passage 56, recess 55, port 58, and into the annular groove 57 of the distributor valve bushing 17. From the groove 57, air flows through the slot 61 and passage 59 of the distributor valve 18 to effect operation of the motor.

A portion of exhaust air from the motor passes through the distributor valve passage 59', slot 61', the bushing groove 57', port 58', recess 55', passage 56', and motor chamber 51' to the valve 24' which remains in the exhaust position. This exhaust air then flows through the valve 24' into the exhaust chamber 45', and passages 46, 47 and 19 to atmosphere. Another portion of the exhaust air from the motor passes through the distributor valve passage 60 directly into the exhaust passage 19 to atmosphere.

For reverse operation of the motor, the lever 73 is released and the lever 73' is depressed to open the valve 72'. The throttle valve 24' will then act to direct pressurized air to the motor and the valve 24 will function as the exhaust valve.

In order to provide for quick reversal of the motor when one of the levers 73 is released, the regulating valve 72 immediately closes and the bleed passage 80 in the knob 77 opens the hose 68 and the chamber 65 to atmosphere. Additionally, bleeding of the chamber 65 may occur through the bleed passage 91 and bleed opening 93 so that the valve 24 is quickly returned to the exhaust position by the spring 28.

What is claimed is:

1. An air operated control device comprising:

a housing defining a valve chamber; a spool valve disposed for rectilinear movement in said chamber, in air sealing relation with the walls thereof; said housing having control passages communicating with said valve chamber, for selective communication with each other by means of said spool valve; means urging said spool valve toward one end of said chamber;

conduit means communicating said one end of said chamber with a supply of pressurized air; a regulating valve in said conduit means for controlling the flow of air to said chamber;

means defining a first bleed passage communicating the ends of said chamber on either side of said spool valve; means defining a second bleed passage opening from the other end of said chamber;

and said spool valve being selectively moved and positioned within said chamber, to control the flow of air through said control passages through selective control of said regulating valve.

2. The invention set forth in claim 1 wherein said second bleed passage is larger than said first bleed passage.

3. The invention set forth in claim 1 wherein said first bleed passage is defined by a restricted passage through said spool valve.

4. An air operated control device comprising:

a valve chest defining a pair of valve chambers and an air control passage communicating with each of said chambers; a pair of main valves disposed in said chambers; each of said valves being movable rectilinearly, in its respective chamber, between a supply position and an exhaust position for its control passage; means urging each of said valves to its exhaust position at one end of said chamber;

a manually gripable housing; a regulating valve in said housing, for each of said main valves, communicating with said one end of said valve chamber; independently movable operating elements, for each of said regulating valves, accessible to the hand of an operator gripping said housing;

means responsive to variable opening of either of said regulating valves for causing its corresponding main valve to move to variable supply positions; said last named means including a restricted passage communicating the ends of said chamber on either side of said main valve, and including a restricted passage opening from the other end of said chamber.

5. The invention set forth in claim 4 wherein said restricted passage communicating the ends of said chamber is defined by a passage through said main valve.

6. An air operated control device comprising:

a valve housing having a control air passage for communication with a controlled mechanism; said housing having a bore, defining a cylinder, and a chamber for connection to a supply of pressurized air; axially spaced ports communicating said cylinder with said control air passage and with said air supply chamber, respectively; a piston slidable in said cylinder, defining a spool valve cooperating with said ports; means urging said piston to one end of said cylinder;

air conduit means communicating with said one end of said cylinder for directing pressurized air to one face of said piston; said piston having an axial bleed passage extending therethrough; said cylinder having a bleed passage, at the other end thereof, larger than said piston bleed passage;

a regulating valve in said air conduit means for controlling the flow of air into said cylinder; said spool valve controlling the flow of air through said control passage, responsive to the position of said spool valve in said cylinder; and the position of said spool valve being responsive to the variable opening of said regulating valve.

7. An air operated control device comprising:

a valve housing having two spaced bores defining cylinders, two control passages for communication with a controlled mechanism, a chamber for connection to a supply of pressurized air, and an exhaust passage; axially spaced ports opening into said cylinders for communicating each of said cylinders with a respective control passage, with said air supply chamber, and with said exhaust passage; a piston slidable in each cylinder, defining a spool valve cooperating with said ports to communicate said control passages selectively with the air supply chamber and with said exhaust passage;

means urging each piston toward one end of its cylinder; air conduit means connected to said housing for supplying pressurized air to each cylinder at said one end thereof; valve means in said conduits for individually regulating the flow of air to each cylinder; each of said pistons having an axial bleed passage extending therethrough; each of said cylinders having a bleed passage opening from the other end thereof;

each spool valve controlling the flow of air from the supply chamber to a control passage responsive to the axial position of said spool valve in said cylinder; and the position of said spool valve being responsive to the variable opening of said regulating valve.

8. An air operated control device comprising:

a housing having a supply chamber for compressed air, an exhaust chamber, and a pair of control passages for communication with a controlled mechanism; a pair of main valves slidably mounted in valve chambers in said housing;

a supply port for each of said valve chambers communicating with said supply chamber; an exhaust port for each of said valve chambers communicating with said exhaust chamber; a control port for each of said valve chambers, each communicating with said one of said control passages; each of said main valves being slidable between an exhaust position, in which its control port is communicated with its exhaust port, and variable supply positions, in which its control port is communicated with its supply port; means urging said main valves to their exhaust positions at one end of respective chambers;

conduit means communicating said one end of each valve chamber with said supply chamber; individual regulating valves for controlling the flow of air in said conduit means to respective valve chambers;

each of said main valves having a restricted passage communicating the valve chamber on either side of the valve; the other end of each valve chamber having a restricted passage opening therefrom;

said main valves being variably movable in said valve chambers for controlling the flow of air from said supply chamber to the control passages; and the movements of said main valves being responsive to the valve opening of respective regulating valves.

9. The invention set forth in claim 8 including a pendant housing gripable by an operator; said regulating valves being carried in said housing for convenient manipulation by an operator; and said conduit means including a flexible air hose, communicating said air supply chamber with said regulating valves, and a pair of flexible hoses communicating said regulating valves with respective main valve chambers.

References Cited in the file of this patent

UNITED STATES PATENTS

1,763,154	Holzwarth	June 10, 1930
1,923,205	Hoffman	Aug. 22, 1933
2,485,504	Morgan	Oct. 18, 1949
2,556,829	Teague	June 12, 1951
2,604,072	Beckett et al.	July 22, 1952
2,743,708	Lungerhausen	May 1, 1956
2,784,013	Groen	Mar. 5, 1957
2,977,971	Ruhl	Apr. 4, 1961
2,981,289	Martin	Apr. 25, 1961
2,998,026	Becker	Aug. 29, 1961
3,085,833	Schultz	Apr. 16, 1963

FOREIGN PATENTS

931,694	Germany	Aug. 16, 1955
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