This invention relates to an air operated control device; and more particularly to an air motor control device for hoists and the like.

In the operation of a pneumatic hoist, it is desirable to have a sensitive control for the hoist motor for varying the motor speed and for maintaining the motor speed, thereby controlling the lifting speed of the hoist.

An object of this invention is to provide an air operated control device including a rectilinearly movable member adapted to be variably positioned and maintained in a selected position.

Another object of this invention is to provide such a control device for controlling the supply of air to an air motor.

In the control of hoists, it is further desirable to provide a brake for the hoist which is controlled simultaneously with the hoist motor. Accordingly it is a further object of the invention to provide a control mechanism for a pneumatic hoist for controlling a hoist motor and a hoist brake simultaneously.

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 side view, partially in section, of a pneumatic hoist and a portion of the hoist control mechanism.

FIG. 2 is a sectional view of the control head for the hoist, taken along the line 2—2 of FIG. 1, looking in the direction of the appended arrows.

FIG. 3 is a view, taken along the line 3—3 of FIG. 1, looking in the direction of the appended arrows, showing the brake mechanism.

FIG. 4 is a side view, partially in section, of a pendent control handle associated with the control head shown in FIGS. 1 and 2.

FIG. 5 is a sectional view taken along the line 5—5 of FIG. 4.

Referring now to the drawings, the present invention is embodied in a control for a pneumatic hoist. As best shown in FIG. 1, the hoist includes a generally cylindrical housing 11 having a swivel hook 13, mounted at the top thereof, for suspending the hoist from a suitable support. Enclosed within the housing 11, at the left end thereof as viewed in FIG. 1, is a reversible rotary vane motor including a motor cylinder 15, an end plate 17, a rotor 19, and a plurality of sliding vanes 21 mounted in suitable slots in the rotor. A drive shaft 23 (not shown in FIG. 1) is directly driven by the rotor 19 and extends through the housing 11, to the opposite end thereof, for connection to a brake mechanism to be described, enclosed in end cap 25. A chain sprocket is mounted coaxially of the drive shaft 23, at the central portion of the housing 11, and is driven from the drive shaft 23 through reduction gearing contained within the housing 11. This mechanism, not shown, is conventional. A chain 27 is driven by the above mentioned sprocket and raises and lowers a load by means of a load hook 29.

A control head 31, mounted on the motor end of the housing 11 includes throttle valves for controlling the flow of air to the motor and includes mechanism for actuating the throttle valves and for actuating the brake mechanism. A pendent control handle 33, shown in FIGS. 4 and 5, is connected to the control head by means of three air hoses; and is supported from the head by means of a cable 35.

The control head 31, as best shown in FIGS. 1 and 2, includes a lower control chamber 41, an exhaust chamber 43 opening toward the motor housing and partially defined thereby, and spaced vertical bores 45 and 47 which extend from the top of the head 31 to the control chamber 41. The bores are sealed at the tops by suitable plugs. A header passage 49 communicates the two bores 45 and 47, adjacent their upper ends, and also communicates with a swivel coupling 51 mounted at the top of the control head for connection to a conduit for supplying pressurized air to the hoist.

Sleeves 55 and 57 are fitted within the respective bores 45 and 47 for cooperation with spool valves 59 and 61, hereafter referred to as throttle valves. The head 31 and the sleeves are provided with two intake ports 63 and 65 communicating respectively between the bores 45 and 47 and two motor intake ports in the end plate 17 of the motor. The head and sleeves are also provided with two exhaust ports 67 and 69 communicating respectively between bores 45 and 47 and the exhaust chamber 43.

Each of the throttle valves 59 and 61 consists of a cylindrical body 71, dimensioned for a sliding fit within its respective sleeve, an upwardly extending reduced diameter stem 73 supporting a head 75, and a downwardly extending boss 77. The head 75 is provided with an O-ring 79 for sealing with the sleeve and includes a tapered portion merging with the stem 73.

In the normal or closed positions of the spool valves, the valves are positioned so that the O-rings seal within the sleeves, at the upper ends thereof, to prevent communication between the upper ends of the valve bores and the annular chambers surrounding the valve stems.

When the valves are shifted, through the control mechanism to be described, one valve is raised and one valve is lowered, as best shown in FIG. 2. Referring to FIG. 2, the valve throttle 61 is raised so that its head 75 is disengaged from the sleeve 57 to provide communication between the upper end of bore 47 and intake ports 65, to direct live air to drive the motor in one direction. The valve body 71 closes exhaust port 69 to prevent escape of live air. The tapered portion of valve head 75 is provided so that the annular opening between the head 75 and the upper end of the sleeve 57 may be varied depending upon the position of the valve with respect to the sleeve.

In this manner, air flow to the motor is controlled or throttled; and therefore the speed of the motor is controlled.

The throttle valve 59 is moved downward within its sleeve 55, its body 71 uncovering exhaust port 67 so that this port is communicated with intake port 63. Intake port 63 is now open to the driven side of the vane motor, and air compressed by the driven side of the motor is exhausted through the ports 63 and 67 into the exhaust chamber 43.

Primary exhaust air from the motor passes through ports 81, in the motor cylinder 15, into annular chamber 83 surrounding the motor cylinder; then through groove 85, in the motor cylinder, and a port 87, in the motor end plate 17, into exhaust chamber 43. A threaded opening 89, communicating exhaust chamber 43 with the opposite side of the control head 31, is provided for mounting a muffer 91 through which all of the motor exhaust air passes.

The mechanism for actuating the throttle valves and the brake mechanism includes a control shaft 95 rotatably mounted in, and extending through, the lower portion of the housing 11. This shaft extends into the control chamber 41, of the head 31, and has fixed thereto a rocker arm 97 having an integral segmental gear 99. The rocker arm is positioned to be engaged by the downwardly extending bosses 77, of the throttle valves 59 and 61, and
controls the positions of the throttle valves within their respective sleeves.

The brake mechanism for the hoist, best shown in FIGS. 12 and 13, includes a drum 101 non-rotatably secured to the end of drive shaft 23. A pair of brake shoes 103, which include suitable brake linings, is pivotally attached to the housing 11 for engagement with the drum 101. The brake shoes include depending portions 105 which coact with a bolt and spring assembly 107 to bias the shoe into engagement with the drum for braking action. The depending portions 105 also coact with a cam block 109, which is non-rotatably fixed to the end of the control shaft 95. The position of the cam block is fixed, so that when the rocker arm is positioned horizontally, and the throttle valves are in their closed positions, the cam block is positioned neutrally so that the brake shoes engage the brake drum. When the rocker arm is rotated to drive the hoist motor in one direction or the other, the cam block is rotated to disengage the brake shoes from the brake drum.

In the illustrative embodiment of the invention, the control device for actuating the above described control mechanism includes two identical actuators 111 and 113 mounted on the control head 31, each including a pneumatic cylinder with a piston therein operatively associated with the rocker arm 97, and the associated pendent control 33, including regulating valves.

Actuator 111 includes a cylindrical body 115 having a threaded extension 117 and a threaded connection with the control head 31, and an end cap 119. The body is provided with a large cylinder bore, closed by the end cap 119, and a small bore passing through the threaded extension 117. A piston 121 is mounted within the cylinder bore and is fixed to a rod 123, which extends through the small bore in the threaded extension 117 and transversely through the control head 31 to the opposite actuator 113. The piston, provided with a resilient seal ring 125 for sealing engagement with the cylinder walls, defines within the cylinder bore an outer chamber 127, between the piston and the end cap 119, and an inner chamber 129. A coil spring 131, disposed in the inner chamber, biases the piston into the outer chamber. The end cap 119 is provided with a threaded opening, into which is threaded a fitting 133 for an air hose 135 for directing air to the outer chamber 127. The piston is provided with an axial bleed orifice 137 communicating the inner and outer chamber 127 and 129. The body 115 is provided with a bleed orifice 139, at its inner end, for communicating the inner chamber with atmosphere.

The actuator 113 is identical in structure, including a cylindrical body 145, having a threaded extension 147 and end cap 149. Its piston 151 is also fixed to the rod 123 and includes a seal ring 155, defining an outer chamber 157 and an inner chamber 159. A coil spring 161 is disposed in the inner chamber. The end cap 149 includes an opening for a fitting 163 for an air hose 165. The piston is provided with a bleed orifice 167 and the cylinder body is provided with a bleed orifice 169.

The rod 123 is provided with a number of teeth, intermediate its ends, defining a rack 124 for engagement with the gear 99 of the rocker arm 97. The rod is dimensioned to slide within the bores of the threaded extension 117 and 147 in substantial air sealing relation.

Air is directed to the actuators 111 and 113 through the pendent control handle 33, best shown in FIGS. 4 and 5. This handle is an elongated member, adapted to be gripped by a hoist operator, and includes a pair of poppet type, regulating valves 173 and 175 actuated by pivoted levers 177 and 179, respectively, disposed for control. Manipulation by the operator, through the valves, is communicated to the pistons of the actuator by the central connecting rod 181, received in the upper end of the bore, and associated valve member. The sleeve 181 is provided with a stepped bore, larger at the lower end thereof, defining a shoulder which serves as the valve seat. The valve member includes a head 183, received within the larger sleeve bore and seating on the above mentioned shoulder, and a reduced port which extends upward through the smaller sleeve bore and out of the sleeve 181. The head 183 is provided flats or longitudinal grooves on its periphery to permit flow of air between the head and the larger sleeve bore. The stem 185 is tapered, from the head to an intermediate point to provide a varying cross section, and terminates in a knob 187 dimensioned to fit the smaller sleeve bore in air sealing relationship. The knob projects from the sleeve to be engaged by a respective pivoted lever. The valve member is biased to seated or closed position by a coil spring 189 engaged between the valve member and a closure plug 191 for the lower end of the valve bore. The knob 187 is provided with a partial groove 188 defining a bleed passage which communicates the small sleeve bore with atmosphere when the valve member is seated. When the valve member is unseated, the groove 188 moves within the small sleeve bore to close this bleed passage.

A longitudinal passage 193 extends from the end of the pendent handle 33 and communicates with the lower ends of both valve bores. A fitting 195 for an air hose 197 is threaded into this passage. The other end of the hose 197 is provided with a fitting 199 which is threaded into a passage 201, in the control head 31, which communicates with the upper end of the throttle valve bore 47 and with the inlet header passageway 49. Air is then, directed from the throttle valve bore 47 to the lower ends of the bores for the pendent handle valves 173 and 175.

Longitudinal passages 203 and 205 are provided in the pendent handle 33, extending from the ends of the handle to each of the valve bores respectively. The sleeves 181 are provided with ports for communicating these passages with the small bores of the sleeves. The hoses 135 and 165, which are connected to actuators 111 and 113, respectively are provided with fittings which are threaded into the passages 203 and 205, respectively.

It will now become apparent that when the valve 175, for example, is opened, by depressing lever 179, live air is directed, from the hose 197, through the hose 165 to the outer chamber 157 of actuator 113. The valve must be depressed sufficiently so that the tapered portion of the stem 185 pierces the outer chamber 157 of the valve sleeve. The flow of air is determined by the angular area between the tapered stem and the smaller sleeve bore and, therefore, is controlled by the relative position of the valve member within the sleeve. When the valve member is so depressed, the knob 187 prevents escape of air from the upper end of the valve. When the valve member is seated, however, the groove 188 provided in the knob 187, provides a bleed for the hose 165. Through this bleed, the outer chamber 157 is bled to atmosphere through the hose 165 when the valve 175 is closed. It will be seen then that, when the hoist is not operated, both chambers of each of the actuators 111 and 113 are communicated with atmosphere.

The overall operation of the hoist control will now be described. The hoist is connected to a source of compressed air (live air) by connecting a suitable conduit to the swivel coupling 51. Live air is then directed to the upper ends of the throttle valve bores 45 and 47, and through the hose 197 to the pendent handle bores 173 and 175. The rocker arm 97 and the cam block 109, of the brake mechanism, are maintained in neutral positions through the biasing effect of the actuator springs 131 and 161 and the brake spring assembly 107. The throttle valve sleeves 59 and 61 are seated within their respective sleeves, to prevent compressed air with the intake ports 63 and 65, and are urged into engagement with the rocker arm 97 by the pressure of air acting on the valve heads.
To drive the hoist motor in one direction, lever 179, for example, is depressed by the operator to open regulating valve 175, as desired. The flow of live air from the hose 197 is now controlled through the valve 175, and is directed through hose 165 to the outer chamber 157 of actuator 113. This creates a certain air pressure in the chamber 157 which causes a shifting of the piston 151 to the left, as viewed in FIG. 2. The rod 123 and the piston 121 are correspondingly shifted to the left, and the rack 124, through engagement with the gear 99, rocks the rocker arm 97 counter-clockwise. The rocker arm 97 moves the throttle valve 61 upward and permits downward movement of the throttle valve 59 which movement is effected by the air pressure acting on the valve head. Intake port 65 is now communicated with live air and directs live air to one side of the vane motor, the flow of air and speed of the motor being determined by the amount of movement of the valve 61. The intake port 63 and the exhaust port 67 are communicated by the throttle valve 59 so that air compressed by the driven side of the motor is exhausted.

Air flows from the outer chamber 157 of actuator 113, through the bleed orifice 167, to the inner chamber 159 at a rate determined by the pressure differential between the two chambers and the size of the bleed orifice. Air flows from the inner chamber 159 through the bleed orifice 169, at a rate determined by the differential pressure across the orifice and the size of the orifice. When the regulating valve 175 is opened a selected amount, the actuator piston 151 will seek an equilibrium position determined by the forces acting on the piston. The pressure in the outer chamber 157 asserts a force tending to move the piston to the left; and this is opposed by the force of the spring 161 and the pressure of air in the inner chamber 159 asserting a force tending to move the piston to the right. The air pressure in the inner chamber 159 is determined by the flow of air through the orifices 167 and 169, and, it is believed, through a turbulence effect created by the flow of air. It has been found that the piston will find an equilibrium position and will maintain this position indefinitely, so long as the regulating valve 175 is held in the selected position. The flow of air through the regulating valve 175, the orifice 167, and the orifice 169 is then constant. During this condition, the throttle valve 61 is maintained at a fixed position and the flow of air to the vane motor is constant, driving the motor at a constant speed.

When the regulating valve 175 is opened further, more air flows through the valve and the air pressure in the outer chamber 157 is reduced. The piston 151 is moved and positive force moves the piston 151 further to the left resulting in further opening of throttle valve 61 to increase flow of air to the motor. The piston movement further compresses spring 161 so that its opposing force is increased. It is believed that the opposing force asserted by the air in the inner chamber 159 also increases. The flow of air through the orifices 167 and 169 will again become constant, so long as the regulating valve is held in the new selected position; however, the flow of air is greater, hence velocity through the orifices is greater resulting in probable greater turbulence of air in the inner chamber 159.

In the above described manner, the piston 151 may be moved to any selected position, within the range of the parameters built into the control device, and the piston may be maintained in any such selected position. In the above described embodiment of this invention, the piston movement is directly translated, through mechanical linkage, to movement of the motor throttle valve, which is the function to be controlled. In a broader sense, it is the movement of the piston 151 which is controlled, and which movement may be employed to control any desired function. It has been found that the most effective control is obtained when the bleed orifice (169), which communicates the inner chamber with atmosphere, is larger than the bleed orifice (167) which communicates the inner and outer chambers.

During the operation, as above described, the actuator 111 has no effect except for possible negligible effect of its spring 131.

When the lever 179 is released, the valve 175 closes cutting off the supply of live air to the outer chamber 157; and this chamber and the hose 165 are bled to atmosphere through the bleed passage 188 of valve 175, as well as through the orifices 167 and 169. The bleed through the valve 175 is provided so that the actuator pistons and the rack 124 quickly return to the neutral position to stop the hoist motor and effect application of the hoist brake.

When it is desired to operate the hoist motor in a reverse direction, the lever 177 for the regulator valve 173 is depressed and this controls the actuator 111 in the manner described.

In order to prevent damage to the hoist by driving the hoist beyond the limitations defined by the length of the chain 27 a lever 211 is nonrotatably fixed to the control shaft 95. The lever is positioned to be engaged by stops, such as the stop 213 associated with the load hook 29. When the load hook is raised by the hoist motor, for example, the control shaft 95 and the lever 211 will be rocked from a neutral position; and this mechanism is so arranged that the stop 213 will engage the lever 211 returning it to neutral position to stop the hoist motor and engage the brake.

There has been described a novel control mechanism for controlling a hoist motor and particularly for simultaneously controlling the motor and the hoist brake. A particular feature of the control mechanism is the control device, comprising an actuator and an associated regulating valve, which provides for variable control of the motor and for maintaining the motor at a preselected constant speed.

What is claimed is:

1. An air operated control device comprising means defining an air chamber; a piston movable rectilinearly within said chamber in sealed relation with the walls thereof; means biasing said piston toward one end of said chamber; conduit means communicating with said one end of said chamber for connection with a source of pressurized air; manually operable valve means in said conduit for regulating the flow of air to said chamber; means defining a first continuously open bleed passage communicating the ends of said chamber on either side of said piston; means defining a second continuously open bleed passage opening from the other end of said chamber to atmosphere; and said piston defining a control member selectively movable in said chamber through selective control of said valve means.

2. The combination according to claim 1 wherein said second bleed passage is larger than said first bleed passage.

3. The combination according to claim 1 including a rod fixed to said piston and extending from said chamber, in sealing relation therewith; and means for operatively connecting said rod to an element to be actuated thereby.

4. An air operated control device comprising an air cylinder, a piston in said cylinder defining first and second chambers therein; said piston being movable rectilinearly within said cylinder; means biasing said piston into said first chamber; conduit means for supplying pressurized air to said first chamber; manually operable valve means in said conduit for regulating the flow of air to said first chamber; said piston having a continuously open bleed passage communicating said first and second chambers; said cylinder having a continuously open bleed passage communicating said second chamber with atmosphere; and said piston defining a control member selectively moved and positioned within said cylinder through selective control of said valve means.

5. The combination according to claim 4 including a rod fixed to said piston and extending from said cylinder; and means for operatively connecting said rod to an element to be actuated thereby.
6. An air operated control device comprising means defining a cylinder; a piston movable rectilinearly in said cylinder and defining a first chamber at one end thereof and a second chamber at the other end thereof; means urging said piston toward said one end of said cylinder; air supply conduit means connected to said one end of said cylinder for communication with said first chamber; manually operable valve means in said conduit for controlling the flow of air into said first chamber; means defining a first continuously open bleed passage communicating said first and second chambers; means defining a second continuously open bleed passage opening from said other end of said cylinder to communicate said second chamber with atmosphere; and means for operatively connecting said piston to an element to be actuated thereby.

7. The invention set forth in claim 6 wherein said first bleed passage is a passage extending through said piston.

8. The invention set forth in claim 6 wherein said second bleed passage is larger than said first bleed passage.

9. The invention set forth in claim 6 wherein said first and second bleed passages are related in size to produce a pressure in said second chamber which is lower than the pressure in said first chamber and which is higher than the pressure of the ambient atmosphere.

10. An air operated control device comprising a pair of air cylinders mounted in axial alignment in fixed relation to each other; a piston movable rectilinearly in each of said cylinders, and each defining first and second chambers in respective cylinders, a rod rigidly connecting said pistons, said rod passing through the inner end walls of said cylinders and passing through said second chambers of said cylinders; spring means disposed in each of said second chambers for urging respective pistons toward said first chambers, and for defining a neutral position for the assembly of said pistons and said rod; an air supply conduit means connected to each of said cylinders for communication with the respective first chambers; valve means in said conduits for selectively controlling the flow of air into each of said first chambers; each of said pistons having a bleed passage extending therethrough, communicating the first and second chambers of its respective cylinder; each of said cylinders having a bleed passage opening therefrom for communicating the respective second chambers with atmosphere; and means for operatively connecting said rod to an element to be actuated thereby.

References Cited by the Examiner

UNITED STATES PATENTS

1,449,736 3/23 Degen ----------- 91—49 X
1,667,559 4/28 McCaleb ----------- 91—52
2,359,802 10/44 Stephens.
2,445,585 7/48 Shaff ----------- 192—3
2,466,795 4/49 Crot.
2,677,417 5/54 Logan et al. ----------- 91—52
2,743,708 5/56 Lungerhausen ----------- 192—3
2,823,775 2/58 Zwayer ----------- 192—3
2,831,554 4/58 Reynolds ----------- 192—3
2,833,602 5/58 Bayer ----------- 92—162 X
2,884,905 5/59 Jensen ----------- 91—52
2,893,357 7/59 Clarke.
3,032,016 5/62 Smith.

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Disclaimer


Hereby enters this disclaimer to the terminal portion of the term of said patent subsequent to Oct. 26, 1981.

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