Jan. 2, 1923.

R. HOFSTETTER.

SYSTEM OF AIR CONTROL.

FILED MAR. 1, 1919.

1,441,088.

2 SHEETS—SHEET 1.

Fig. 1.

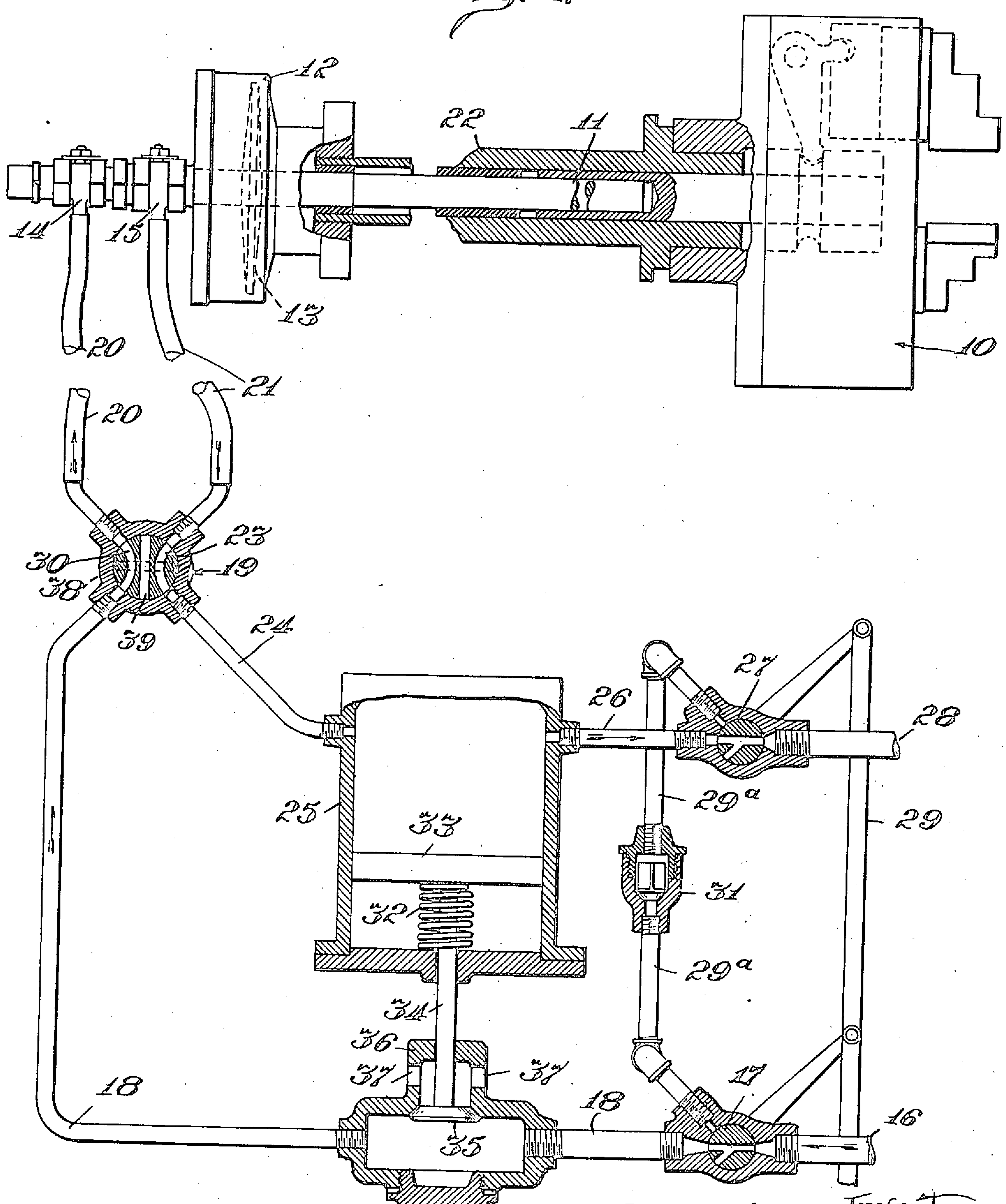

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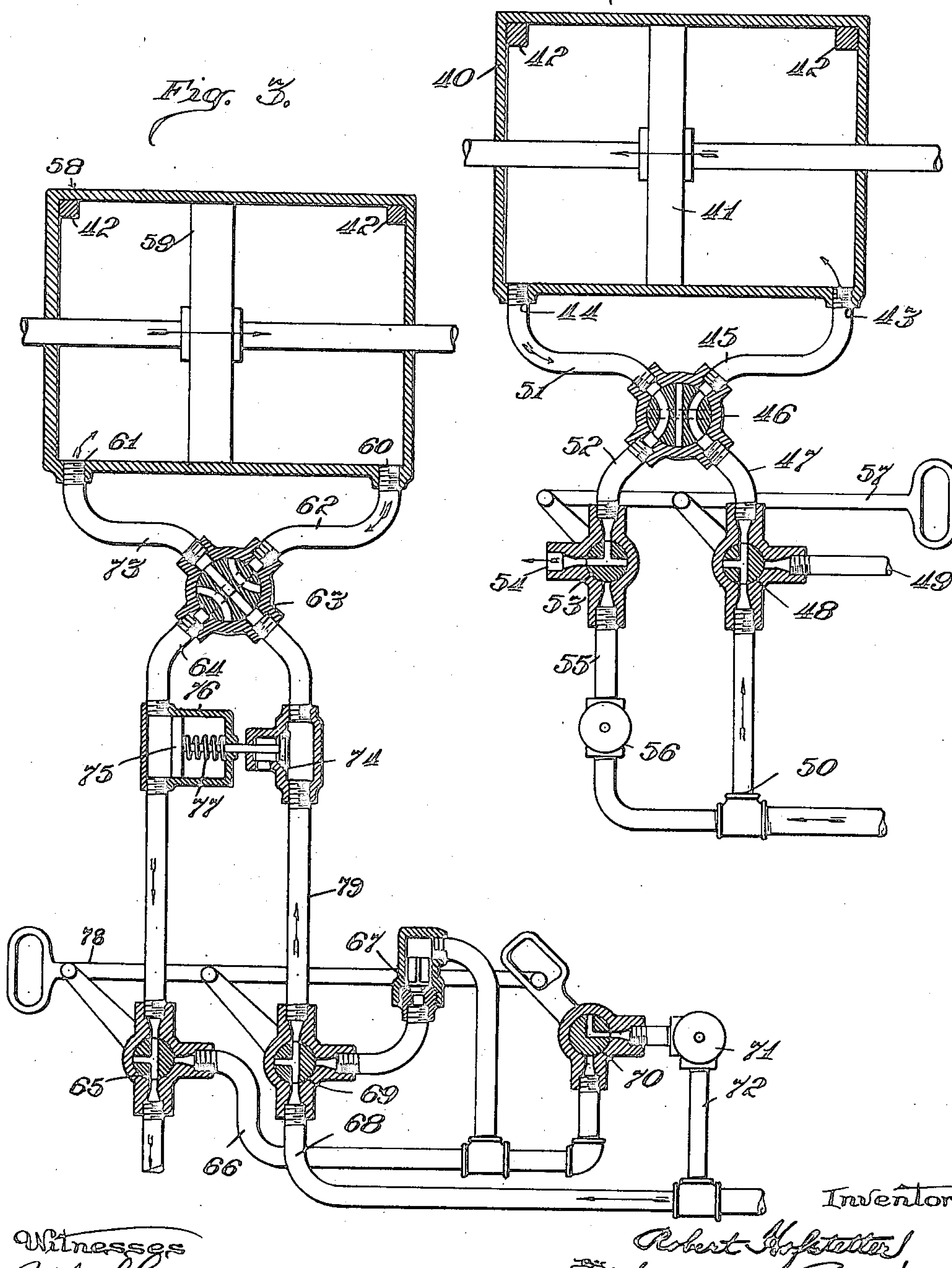
Fig. 2.



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UNITED STATES PATENT OFFICE.

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SYSTEM OF AIR CONTROL.

Application filed March 1, 1919. Serial No. 279,993.

To all whom it may concern:

Be it known that I, ROBERT HOFSTETTER, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improved Systems of Air Control, of which the following is a description, reference being had to the accompanying drawings, which form a part of my specification.

My invention relates to systems for controlling air, or other fluid mediums, employed in the operation of mechanisms; the invention relating more especially to air controlled devices, such as lathe chucks and the like.

The object of my invention is to provide means whereby the consumption of air, or other fluid medium, employed in the operation of mechanisms or devices, will be greatly lessened, with the result that a great saving is obtained and the expense of operation, thereby materially reduced; the invention consisting of a system contemplating suitable valve mechanisms whereby the power-imparting medium, during one stroke of the operating cycle of the devices—namely the releasing or return stroke—will be employed at a greatly lower pressure than the pressure employed during the other or forward and operating stroke of the operating cycle; namely, either employing the expansion of low pressure secondary air to return the piston; or employing low pressure live air, or employing the expansion of low pressure secondary air and low pressure live air; with the result that the cost of operation of air-controlled devices or mechanisms, as at present employed, will be materially lessened.

My invention will be more fully understood and its advantages comprehended from the accompanying drawings, wherein:—

Figure 1 is a partial side and sectional, as well as a more or less diagrammatic view of means adapted to carry out my improved system shown applied to an air-operated lathe chuck.

Figure 2 is a diagrammatic view of means for utilizing a modification of my invention.

Figure 3 is a similar view of means for carrying out another modification of my improved system.

My improved system, in its more specific adaptation, contemplates the introduction into the air—or other fluid medium—conveying lines, of multi-ported reducing, releasing and check valves, and in certain instances a reversing valve, in connection with air operated-lathe chucks, stationary chucks, expanding lathe mandrels, vices, countershafts, arbor presses and the like; and the invention may have expression in different mechanical forms, as is evidenced by the drawings accompanying this specification, without, however, departing from the spirit of my invention as expressed in the claims hereto appended.

In the particular exemplification of the invention, as illustrated in Figure 1, it is shown applied to an air-operated chuck shown at 10 wherein the jaws are controlled by an air-operated spindle 11 slidably arranged in a suitable sleeve or shell; the end of the spindle 11 being disposed in the air cylinder 12 and provided with a suitable piston as shown at 13. The air or other fluid-operating medium, is conveyed by suitable valved lines and mechanisms to the couplings or inlets 14 and 15; the one being usually adapted to admit the air, by means of a passage through the piston and spindle and radial ports in the latter, so as to be effective on the forward side of the cylinder 12 and thereby drive the piston 13 backwardly, causing the jaws of the chuck to come into gripping relation with the material operated on; while the other coupling communicates directly with the near or rear side of the cylinder and therefore rearward of the piston, so that the latter will be forced forward into chuck-releasing position.

As the construction of the chuck, cylinder, and connections between the chuck and piston, as well as the construction of the air-inlets or couplings secured to the cylinder, form no part of my present invention, a detailed description and illustration of said mechanisms need not be given.

The more or less diagrammatic illustra-

tion of my improved system for the reduction of air consumption, contemplates a suitable source of compressed air supply which is conveyed into the system through pipe 16; the admission of the air being controlled by a three-way valve, as at 17. The valve 17 connects with a pipe or line 18 which connects with a multi-way reversing valve as at 19, whereby the course of the air in its passage tc and from cylinder 12 is controlled; the valve being operable in any suitable manner, while the casing or shell thereof has communication with the couplings or inlets 14 and 15 by means of pipes or conduits 20 and 21, respectively. With the three-way valve 17 positioned as shown in Figure 1, live air under high pressure is allowed to pass into line 18 and through the multi-ported reversing valve 19, which is shown positioned to establish communication with conduit 20. With this situation, the air is conducted by suitable passages through the cylinder, piston and spindle into the sleeve 11 and therefore forward of the piston 13 in cylinder 12, causing the piston to move backwardly or to the left in Figure 1, and thereby closing the chuck; while the space in the cylinder 12, rearward of the piston 13,—that is on the left hand side of the piston as illustrated in Figure 1,—is open to the atmosphere and any air in the space permitted to exhaust from the cylinder or escape into the atmosphere by means of coupling 15, conduit 21 and thence through port 23 of valve 19, into pipe 24. Pipe 24 is shown leading to a cylinder or chamber 25, which is also provided with a pipe 26 provided with a three-way valve 27 similar in construction and position to three-way valve 17. The three-way valve 27 is shown positioned so as to establish communication between pipe 26 and exhaust pipe 28, which is open to the atmosphere.

In order to release the chuck-jaws, the air—or other medium—must, of course, be admitted to the opposite or left hand side of the piston 13, as shown in Figure 1, while the pressure forward of the piston must be reduced.

It is the purpose of my improved system, as exemplified in Figure 1, to utilize the secondary air, namely the air previously employed in driving the piston into chuck-closing position, for moving the piston in the opposite or chuck-releasing position; so that expansion of the previously employed air—or other medium—will be further utilized before it is allowed to exhaust or escape. This is accomplished by proper operation of the three-way valves 17 and 27, which are operatively connected together by an operating rod 29 which is pivotally secured to the levers of the valves 17 and 27 so as to cause them to operate in unison. Proper operation of connecting rod 29, namely in a downward direction in Figure 1, will give valves 17 and 27 a quarter turn and bring the ports or passages of both into communication with a connecting line or pipe 29ª and with pipes 18 and 26, respectively. The high pressure air, forward of the piston 13—namely, to the right thereof in Figure 1,—will then be caused to flow out of cylinder 12 through coupling 14 having communication with that side of the cylinder 12, thence through conduit 20 to valve 19, through passage 30 of the valve into pipe 18, through valve 17 into line 29ª, which is shown provided with a suitable check-valve at 31, operable only in the direction of flow from valve 17 to valve 27. The high pressure air will cause check-valve 31 to move off its seat and permit the air to continue through pipe 29ª, into valve 27 and thence into line 26 and small cylinder or chamber 25 on through conduit 24—valve 19—conduit 21—coupling 15, into the space back of piston 12. It will be understood that the quarter turn given valves 17 and 27 will cut off communication with conduits 16 and 28, respectively. The admission of the air into small cylinder 25 at the upper end of the cylinder as shown in Figure 1 causing the pressure to become such that the pressure of spring 32 on the opposite side of the piston 33 is overcome, because of the area of piston 33 relative to the valve later described, and piston 33 forced to the lower end of the cylinder against the action of spring 32, which is thereby compressed. Piston 33 is connected by stem 34 with a valve 35 mounted in a casing 36 located in line 18.

As shown in the drawing, valve 35 will not only be maintained on its seat—when the pressure in cylinder 25 has not reached a predetermined degree,—by spring 32, but also by the air pressure in pipe 18 and casing 36. The equalizing of pressures in cylinder 25 and line 18, provided with valve 35, causes valve 35 to move off its seat and thus permit air in line 18 and casing 36 to escape into the atmosphere through ports 37 formed in casing 36 intermediate of the seat of valve 35 and the small cylinder 25. The unseating of valve 35 will permit the air remaining in cylinder 12 forward of piston 13 and in line 18 to escape into the atmosphere through ports 37; while the air in lines 21, 24 and 26 will be held back by check-valve 31. As soon as the pressure in line 18 decreases, the piston 13 in cylinder 12 will start forward into the position shown in dotted lines in Figure 1,—in which position the chuck is in releasing condition—because the air in lines 24 and 21 is now at a higher presure than that in lines 20 and 18; the latter having been reduced to atmospheric pressure.

The foregoing description sets forth one complete cycle of operation; namely in the mechanism disclosed, a closing and opening of the chuck.

In situations where it is desired to first drive piston 13 forward, or to the right in Figure 1, instead of in the manner previously described, this may be accomplished by giving reversing valve 19 a quarter turn so as to bring the straight port or passage 38 into communication with line 18 and conduit 21, thus permitting the live air or pressure-inducing medium entering by means of three-way valve 17 to flow into cylinder 12 at the left of piston 13. With this operation of valve 19, a second straight port or passage 39 is brought into position so as to establish communication between conduit 20 and line 24, when the operation and control of the air pressures by the various elements will be the same as previously described, except as to points of original introduction into cylinder 12.

The saving of air—or other operating medium—accomplished by the foregoing described system, over the amount of air consumption required in devices as at present employed, is at least fifty per cent; due to the fact that secondary air is utilized for completing the cycle of operation; whereas the method of operation at present employed, necessitates the introduction of fresh air under pressure to both sides of the piston; while the air is then allowed to exhaust into the atmosphere.

In the exemplification of the invention, as disclosed in the more or less diagrammatic view shown in Figure 2, I show a cylinder 40 provided with a piston 41; while opposite ends of the cylinder are also shown provided with stops 42, 42, whereby the travel of the piston is limited so as not to cover the air-ports 43 and 44 shown at the ends of the cylinder. The port 43 is provided with a conduit 45 which preferably leads to a reversing valve 46, provided with multi-passages, whereby communication between the conduit 45 and a conduit 47 is established. Conduit 47 communicates with a three-way valve 48, which may establish communication with the atmosphere at 49 and also with an inlet conduit 50. The reversing valve 46 also communicates with a conduit 51 leading to port 44 at the opposite end of the cylinder; and the reversing valve 46 is also adapted to establish communication with a conduit 52 leading to a three-way valve 53 having communication with the atmosphere at 54 and with a conduit 55. Conduit 55 is provided with a pressure-reducing valve at 56; while the opposite end of conduit 55 connects with inlet conduit 50.

The two three-way valves 48 and 53 are intended to be operated by means of a lever 57 so as to operate in unison; the valves being so positioned that when valve 48 establishes communication between inlet conduit 50 and conduit 47 leading to reversing valve 46 and thereby admitting a high pressure charge, three-way valve 53 will be in position to establish communication between conduit 52 and the atmosphere port 54 so as to exhaust the pressure in lines 51 and 52, when reversing valve 46 is in the position shown in Figure 2. With this position of the valves, it is apparent that the air under pressure entering conduit 50, passing through three-way valve 48, conduit 47 and conduit 45 will be admitted through port 43 into the right hand end of cylinder 40 and induce the initial stroke of the operating cycle of the piston 41; while any air in the left hand end of cylinder 40 may exhaust through port 44, conduits 51 and 52 and valve 53 into the atmosphere through port 54. Under these conditions the piston 41 will be forced to the left end of cylinder 40 until it reaches the stop 42 at the left hand end of the cylinder. In order to drive piston 41 back to the right hand side of cylinder 40, namely into what may be termed the work-releasing position and therefore requiring a less air pressure, lever 57 is actuated so as to give three-way valves 48 and 53 a quarter turn, thereby bringing the passage-ways or ports of valve 48 into communication with conduit 47 and air port 49; while the passage-ways of valve 53 will have been moved so as to establish communication between conduits 52 and 55 and thereby shutting off the atmosphere communicating port 54. Conduit 55, being in communication with the inlet conduit 50, will be charged with live air but at a reduced pressure predetermined by means of a reducing valve 56, so that the operation of the three-way valve just described will permit the air, at a reduced pressure, in conduit 55 to pass through valve 53, conduits 52 and 51 and through port 44 into the left hand end of cylinder 40; while the air pressure in the right hand side of cylinder 40 will be permitted to exhaust through conduits 45, 47 and three-way valve 48 out into the atmosphere through port 49; with the result that the piston 41 will be driven back to the right hand side of the cylinder until it contacts with stop 42.

The reversing valve 46, like reversing valve 19 previously described, is provided with a number of passages or ports which will permit communication to be established between conduits 45 and 52 and between conduits 47 and 51. When the straight passages of reversing valve 46 are in communication with the conduits as just stated, the high pressure air passing through three-way valve 48 will be conveyed through conduit 47 into conduit 51 and through port 44 into the left hand side of cylinder 40; while the

reduced pressure upon proper operation of the three-way valves 48 and 53 will then pass through conduits 52 and 45 into the right hand side of the cylinder 40 through port 43.

Where no occasion arises for reversing the operation, that is to say, where no occasion arises for at one time admitting the high pressure on one side of the cylinder and a second time at the opposite end of the cylinder, the reversing valve 46 may be omitted and in that event conduits may be employed for directly conveying the air from three-way valve 48 into port 43 of the cylinder 40 and from three-way valve 53 into port 44 at the left hand end of cylinder 40.

With the construction just described, the air consumption necessary for completing a cycle of operation is somewhat greater than the air consumption necessary for completing the cycle of operation with the construction shown in Figure 1; because in the construction shown in Figure 2 live air at a low pressure is employed for returning the piston in the air-operated cylinder, namely during the non-operating or return stroke of the cycle of operation. The quantity of air—or other operating medium—necessary with the mechanism disclosed in Figure 2 for completing a cycle of operation, is, however, materially less than the consumption of air necessary in the method of operation at present employed in connection with air-operated or controlled devices, wherein live air, under equal pressure, is admitted at both ends of the air-cylinder for completing a cycle of operation.

In the modification of my improved system as disclosed in Figure 3, the mechanism is shown in a more or less diagrammatic manner and illustrates an air-cylinder 58 provided with a piston 59 adapted to travel lengthwise of the cylinder; the ends of the latter being preferably provided with stops as at 42, 42 whereby the travel of the piston is limited so as to leave air ports 60 and 61 uncovered at the ends of the cylinder. Air port 60 communicates with a conduit 62 preferably leading to a reversing valve 63 which is shown provided with multi-ports or passages. The valve 63 is positioned in Figure 3 so as to establish communication between conduit 62 and line 64. Line 64 is shown provided with a three-way valve 65; and the line, beyond the valve 65, is adapted to communicate with the atmosphere as shown. The three-way valve 65, as disclosed in Figure 3, shows conduit 64 open to the atmosphere and therefore would permit any air at the right hand end of cylinder 58 to exhaust into the atmosphere. The three-way valve 65 upon receiving a quarter turn is adapted to establish communication between line 64 and a line 66. Line 66 is shown branched and provided with a check-valve at 67 whereby communication may be established between line 66 and a line 79, namely at a point where line 68 is provided with a three-way valve 69. The three-way valve 69 in the figure is shown positioned so as to shut off communication between line 68 and the branch of line 66 provided with the check-valve 67. Line 66 is also provided with a two-way valve 70 arranged in advance of a reducing valve 71 which has communication with line 68 by means of a line 72. Line 68 is intended to connect with a suitable source of air supply and also communicates with the reversing valve 63 through the medium of line 79; reversing valve 63, in the position shown in Figure 3, establishes communication between lines 79—68 and a conduit 73 which leads to port 61 at the left hand end of cylinder 58. Line 79 is shown provided, at a point intermediate of reverse valve 63 and three-way valve 69, with a vale 74 controlled by means of a piston 75 arranged in a suitable casing or cylinder 76 which is disposed in line 64. The piston 75 is controlled by means of a suitable spring 77 and in turn maintains valve 74 on its seat so that the air passing through line 79 cannot escape into the atmosphere. Assuming that the high air pressure is permitted to flow into line 68, the air, with the positioning of the valves as shown in the figure, will flow through three-way valve 69 and be conveyed through reversing valve 63 into conduit 73 and thence into the left hand end of cylinder 58. With the valves as shown, the right hand end of cylinder 58 is open to atmosphere by means of conduit 62, line 64 and three-way valve 65, so that the high pressure air entering the left hand end of the cylinder will cause piston 59 to travel to the right in the position shown.

Reducing valve 71 is set so as to reduce the live compressed air to a predetermined degree of pressure commensurate with the nature of work or operation intended to be performed by the air controlled device on the return stroke thereof. In order to reverse the operation of the piston 59, it becomes necessary to operate three-way valves 65 and 69 and the two-way valve 70. The three valves mentioned are controlled by means of a suitable lever, as at 78, which enables the three valves to be operated in unison; causing the valves to be given a quarter turn to establish the desired connections. The two-way valve 70, however, has such connection with lever 78 that it will not be positioned until slightly after the three-way valves 65 and 69 have completed their operation; in other words, the three-way valves 65 and 69 are intended to be positioned so as to establish communication between line 64 and line 66 and between line

68 and the check-valve branch of line 66 before two-way valve 70 establishes communication between the line 66 and the reducing valve 71. Upon completing the operation of the valves 65, 69 and 70, as just described, the passage of air through line 68 to reversing valve 63 will be shut off by three-way valve 69; while communication to atmosphere through valve 65 is also shut off, causing the air to flow as follows: from the left hand side of piston 59 through 61, 73, 63, 74, 79, 69, 67, 66, 65, 75, 64, 62, 60 to the right hand side of the piston 59; this flow continuing until the pressure in lines 64 and 79 balance approximately. The check-valve 67 is adapted to open in line 79 when the latter is placed in communication with the branch of line 66. As soon as the pressures in lines 64 and 79 become about equal, the piston 75 (because of its greater area than the area of valve 74) will be forced against the action of spring 77 and therefore move valve 74 off of its seat and permit the remaining air in line 79 to discharge into the atmosphere, thus causing the air remaining in line 64 and connections (which air cannot escape on account of check-valve 67) to push the piston 59 toward the left.

As soon as the pressure in line 64 and connections drops to a certain value (due to the movement of piston 59 towards the left), reducing valve 71 opens and adds live air of a lower pressure than prevails in line 68, to the secondary air in lines 66, 64 and thus completes the return stroke of the piston.

The operation just described completes a cycle of operation of the air-controlled piston 59, which has again been brought back to original or normal position.

Where the operation heretofore described is to be reversed, namely where the high pressure is to be initially discharged into the right hand end of cylinder 58, this may be accomplished by a quarter turn of reversing valve 63 which will bring the curved passages or ports of the valve into such position as to establish communication between inlet line 68 and conduit 62; while the other curved passage or port of reversing valve 63 will have established communication between line 64 and conduit 73.

In the modification just described, the consumption of live air is somewhat greater than the consumption with the construction disclosed in Figure 1, but the saving, over the methods at present employed, is nevertheless very material.

I have shown and described various means adapted to carry out my improved system which, as is clearly evident from the foregoing description and the drawings, results in a great saving of air in the operation of air controlled devices; and while I believe the means diagrammatically illustrated and herein described as best adapted for practicing my invention, I do not wish to be understood as confining myself to any specific construction of mechanism.

What I wish to secure by Letters Patent is:—

1. A system of air control for air-operated devices, comprising a pair of air-conveying lines adapted to communicate with an air supply, means intermediate of the two lines whereby air from the initial inlet line may be transferred to the other line for the return or non-operating stroke of the air-controlled mechanism of the devices and communication with the source of air supply disconnected, and pressure controlled means intermediate of both lines and operable by pressure in the second line for establishing communication between the initial inlet line and the atmosphere when pressure in the second line reaches a predetermined degree.

2. A system of air control for air-operating devices, comprising an initial inlet line, a second line, means whereby the high pressure supplied to the initial inlet line may be shut off and whereby a portion of the air pressure from the initial inlet line may be conveyed through said second line to complete the cycle of operation of the devices and the pressure in the initial inlet line redced to atmospheric pressure, and automatic means for conveying a reduced charge of live air into said second line to supplement the charge of secondary air admitted from the initial inlet line.

3. A system of air control for air-operated devices, comprising a pair of lines, means whereby both of said lines are selectively adapted to be placed in communicatiton with a source of air-supply and also adapted to be placed in communication with the atmosphere, and means whereby communicatiton between the two lines and communication between one of the lines and the atmosphere may be simultaneously effected through a single actuation of a portion of said means.

4. A system of air control for air operated devices, comprising a pair of air lines, means whereby both of said lines are selectively adapted to be placed in communication with a source of air supply and also adapted to be placed in communication with the atmosphere, means whereby communication between the two lines and between one of the lines and the atmosphere may be simultaneously effected through a single actuation of a portion of said means, and means intermediate of both lines whereby the initial flow of air may be reversed.

5. A system of air control for air operated devices, comprising a pair of air lines, means whereby both of said lines are selec-

tively adapted to be placed in communication with a source of air supply and also adapted to be placed in communication with the atmosphere, means intermediate of both lines whereby the initial flow of air may be reversed, means whereby communication between the two lines and between one of the lines and the atmosphere may be simultaneously effected through a single actuation of a portion of said means, and means intermediate of the two lines, operable by the increase pressure in one of said lines, whereby the other line is opened to atmosphere.

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