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[54] **REVERSIBLE DRIVE TOOL**

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[52] **U.S. Cl.** **173/4**, 91/61, 92/2, 92/61, 173/159

[51] **Int. Cl.** **B23q 5/22**, F15b 13/06, F01b 21/04

[58] **Field of Search** 92/61, 2, 52; 91/61, 91/167, 170, 401; 173/108, 153, 155, 159, 4

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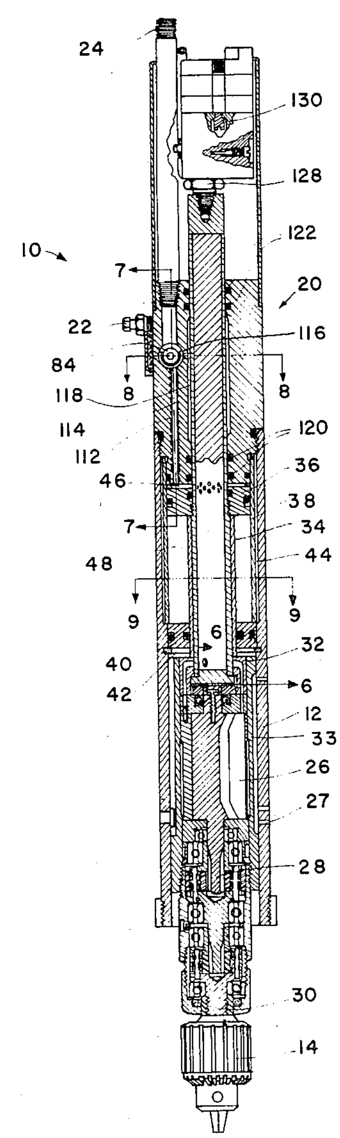
[57] **ABSTRACT**

A pneumatically driven tool for rotating a tool bit while advancing the bit into a work piece. The direction of rotation of the tool bit is reversed and the bit retracted from the work piece when a predetermined torque level is reached. The tool consists of a housing, an air motor within the housing for rotating the tool bit, a piston assembly connected to the air motor and slidable in the housing for advancing the tool bit into and out of the work piece, a control valve assembly for regulating air flow to the air motor and the piston, and a longitudinally divided tube supplying the air connections between the air control valve and the air motor.

11 Claims, 9 Drawing Figures



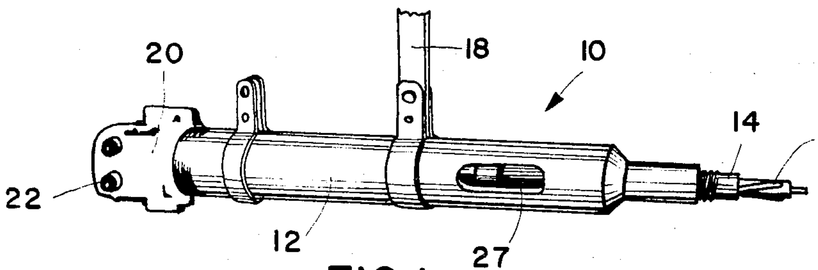


FIG. 1

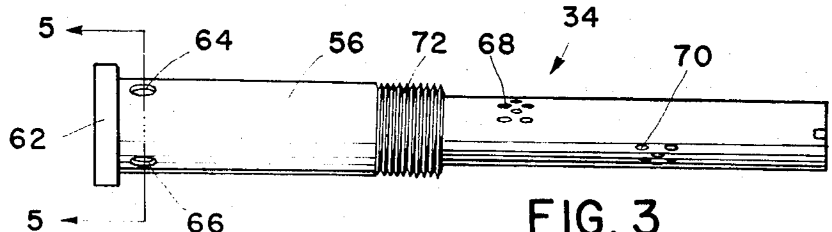


FIG. 3

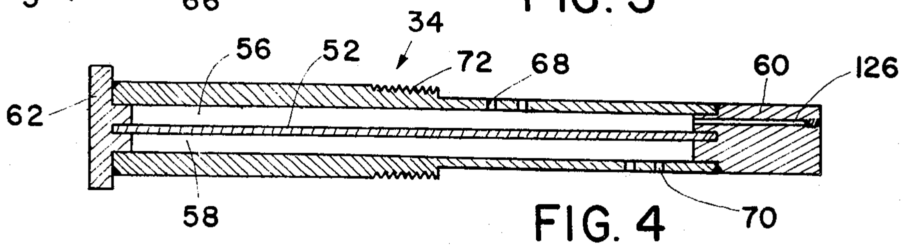


FIG. 4

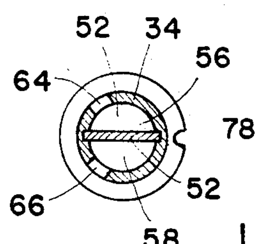


FIG. 5

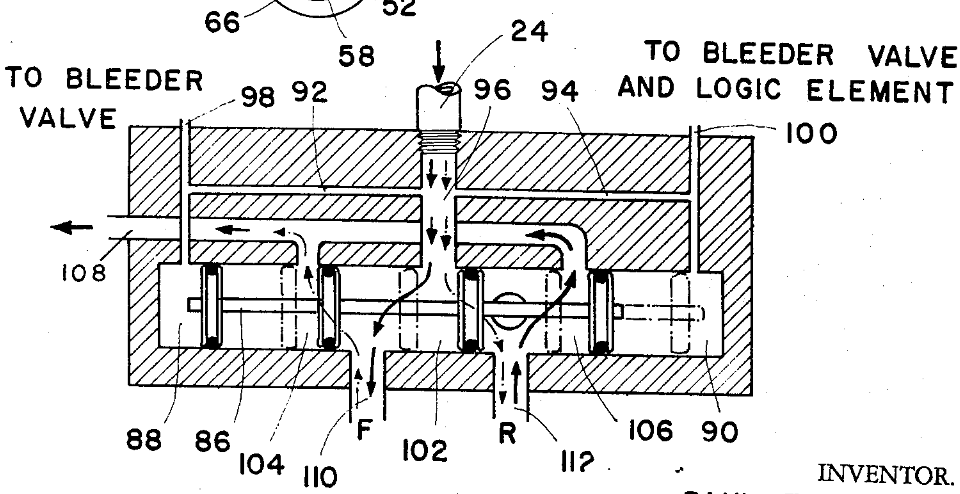


FIG. 7

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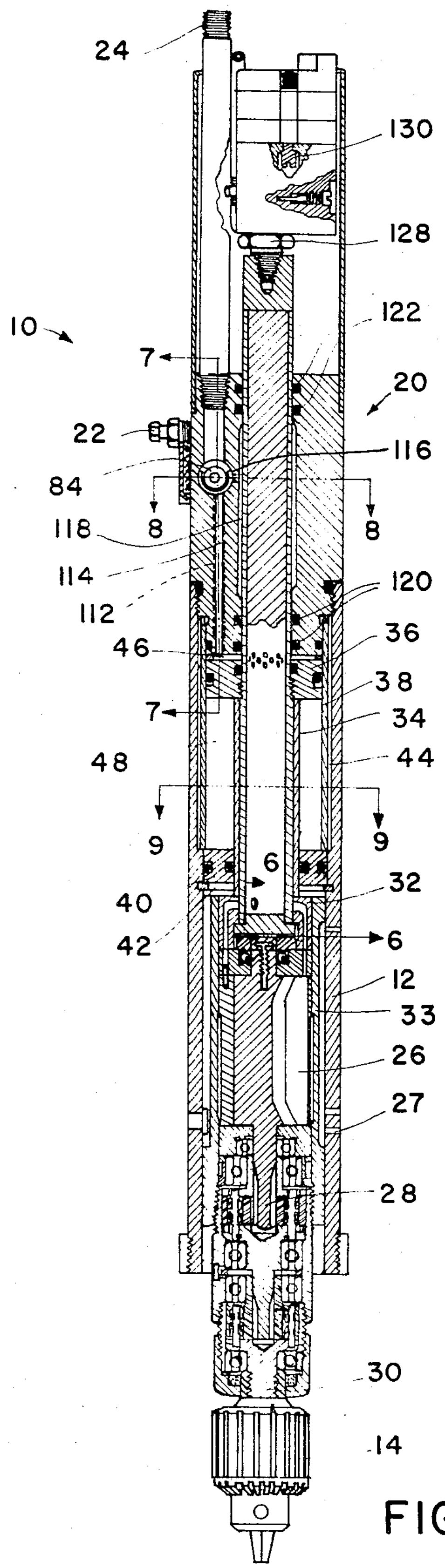

FIG. 2

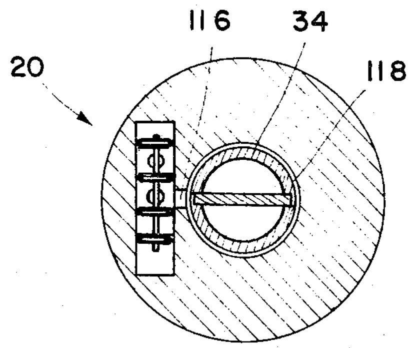

FIG. 8

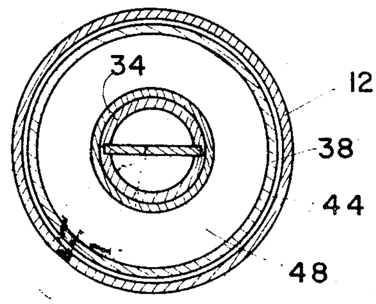

FIG. 9

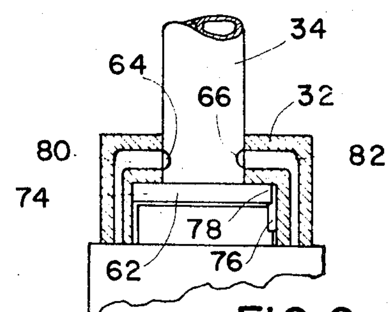

FIG. 6

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REVERSIBLE DRIVE TOOL

The present invention relates to pneumatic tools such as tube expanders, tappers, drills, nut runners, and the like, in which the tool bit is rotated and simultaneously advanced into the work piece. Currently available tools of this type usually may require manual controls for retracting the tool bit from the work piece. Reliance on manual control, however, is undesirable as this produces inconsistent results and increases the possibility of damage to either the tool or the work piece by permitting excessive torque to be applied. Present machines usually may employ non-reversing air motors to drive the tool bit and thus are not suitable for use in driving taps where reversal of rotation is essential for removal of the tap from the work piece.

It is the primary object of the present invention to provide a pneumatically driven tool which is automatically reversible with an extremely simple and reliable control.

A further object of the invention is the provision of a pneumatically powered tool in which the tool bit is advanced into the work piece while being rotated in a first direction and subsequently retracted from the work piece while rotating in the opposite direction.

Yet another object of the invention is the provision of a pneumatically powered tool of the type described above in which the reversal of rotation and the retraction of the tool bit from the work piece are accomplished automatically upon a predetermined torque load being applied to the tool bit.

Still another object of the invention is the provision of a reversible pneumatic drive tool which is of precision construction and capable of providing reliable operation over a substantial period of use.

The above and other objects of the invention which will become apparent in the following detailed description are achieved by providing a reversible drive tool which consists, essentially, of a housing, a reversible air motor within the housing for rotating the tool bit, a piston assembly connected to the air motor and slidable in the housing for advancing and retracting the tool bit toward and away from the work piece, a valve assembly for regulating air flow to the piston and the air motor, a sensing device for detecting an increase in air pressure to the air motor, indicating a predetermined torque level has been reached, the sensing device causing the valve assembly to reverse the flow of air to the piston and the air motor, and a longitudinally divided tube assembly moving with the piston and providing forward and reverse air flow connections between the valve assembly and the air motor.

For a more complete understanding of the invention and the objects and advantages thereof reference should be had to the following detailed description and the accompanying drawing where there is shown a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a side elevational view of the pneumatically powered tool of the present invention;

FIG. 2 is a longitudinal sectional view of the tool of FIG. 1;

FIG. 3 is a side elevational view of the longitudinally divided tube employed in the assembly of FIGS. 1 and 2;

FIG. 4 is a longitudinal sectional view of the divided tube of FIG. 3;

FIG. 5 is a transverse sectional view taken along the line 5—5 of FIG. 3;

FIG. 6 is a fragmentary sectional view taken along the line 6—6 of FIG. 2;

FIG. 7 is a fragmentary sectional view taken along the lines 7—7 of FIG. 2 and showing the valve assembly arrangement; and

FIGS. 8 and 9 are transverse sectional views taken along the lines 8—8 and 9—9, respectively, of FIG. 2.

Referring first to FIGS. 1 and 2 the general arrangement of the reversible drive tool of the present invention will now be described. The tool, designated generally by the reference numeral **10**, has a generally cylindrical housing **12**. A suitable chuck **14** receives the tool bit **16**, in this case a tube expanding mandrel. A handle **18** is provided to allow the tool operator to position the tool. A valve assembly **20** is also provided and includes control valves **22** for regulating the operation of the tool.

Contained within the housing **12** is an air motor **26** which, through suitable gearing **28**, rotates a spindle **30** which mounts the chuck **14**. The motor **26** is a conventional reversible air motor and has separate air inlet ports for forward and reverse operation. The primary exhaust of the motor is through suitable ports in the motor casing and through an opening **27** in the tool casing **12**. The inlet ports also serve as secondary air exhaust ports, the reverse inlet port serving as a secondary exhaust port during forward rotation and vice versa. The air motor **26** and gearing **28** are slidably received within the housing **12**. A collar **32** connects the air motor casing **33** to a tube **34**. As will be described in more detail below, the collar **32** and tube **34** serve to supply air to the air motor **26**. The rod **34** carries a piston **36** which is slidably received in a sleeve **38**, The sleeve **38** is held between a retaining ring **40** and the valve assembly **20**. A snap ring **42** received in an annular groove on the internal wall of the housing **12** holds the retaining ring **40** in place. It will be noted that there is an annular passage **44** provided between the sleeve **38** and the housing **12**. This annular passage **44** is separated from the chamber **46** above the top surface of the piston **36** but communicates with the chamber **48** below the piston **36**. It will be seen that when air pressure is applied in the chamber **46** the piston **36** moves downwardly moving the tube **34**, air motor **26**, gearing **28**, and spindle **14** downwardly. Likewise, when air pressure is applied to the chamber **48** the piston **36** is moved upwardly moving the tube **34**, air motor **26**, gear motor **28**, and chuck **14** upwardly. The arrangement whereby air is supplied to either of the chambers **46** or **48** will be described in greater detail below.

The invention contemplates that the air motor **26** will be a reversible type air motor. Such a motor has separate forward and reverse air inlet ports and requires separate air supply means for the forward and reverse air inlet ports. A longitudinally divided tube **34** of the type described in my copending application Ser. No. 129,679, filed Mar. 31, 1971, now U.S. Pat. No. 3,692,060, may be used to provide the necessary separate air supply passages for the reversible motor **26**. As will be seen from FIGS. 3 - 5, the tube **34** consists of a tubing length **50** which is divided along its entire length by a plate **52**. The plate **52** divides the interior of the tube length **50** into two separate semi-cylindrical passages **56** and **58**. The tube **50** is sealed at its first end by an upper end cap **60** and at its lower end by a lower cap 62. Adjacent the lower end cap 62 there are provided openings 64 and 66 which communicate, respectively, with the passages 56 and 58. Series of additional holes 68 and 70 also communicate with the passages 56 and 58, respectively. It will be noted that both series 68 and 70 are located on the upper end of the tube, above the threaded portion 72 by which the tube is connected to the piston 36. Also, the holes 68 and 70 are separated longitudinally from one another. The purpose of this separation will be described in greater detail below but serves to provide separate inlet regions for the two passages 56 and 58 of the tube 34. While the longitudinally divided tube illustrated is preferred, it will be understood that any tube arrangement which provides two separate air passages may be employed. As can be seen most clearly from FIG. 6, the collar 32 which is received on the lower end of the tube 34 engages the flange portion 74 of the tube end 62. This collar 32 has two separate ports 80 and 82 which are in communication, respectively, with the openings 64 and 66 of the tube 34 and hence with the chambers 56 and 58, respectively. The ports 80 and 82 of the sleeve 32 are aligned with the forward and reverse inlet ports, respectively, of the air motor 26.

Attention is now directed to the valve assembly portion 20 of FIG. 2 and FIGS. 7 and 8. The valve assembly incorporates a spool valve which has a valve bore 84 and a valve spool slidably received in the bore and having a number of spool sections dividing the bore into five chambers 88, 90, 102, 104, and 106. The valve is of conventional construction and is a four-way valve employing O-rings to form air tight seals between adjacent ones of the valve chambers. The two end chambers 88 and 90 are each connected by ports 92 and 94, respectively, to the inlet port 96 which is connected to the inlet nipple 24. Each of the two end chambers 88 and 90 is also connected by ports 98 and 100, respectively, to a bleeder valve. As long as both bleeder valves are closed equal pressure will be present in each of the end chambers 88 and 90 and the valve will remain in a fixed position. If either of the bleeder valves is opened, pressure in the corresponding one of the end chambers will be reduced while pressure in the opposite end chamber remains constant. The valve spool then moves in the direction of the chamber at lower pressure.

The central chamber 102 of the valve assembly is in communication with the inlet port 96 and, when the valve is in the first position it is also in communication with a port 110 which communicates with a passage 114 extending to the chamber 46 on the upper surface of the piston 36. When the valve is in this position one of the two intermediate chambers 106 is in communication with the exhaust port 108 and with ports 112 and 116. The port 116 leads to an annular passage 118 surrounding the upper portion of the tube 34 while the port 112 communicates with the annular passage 44 and to the chamber 48 on the lower side of the piston 36. When the valve shifts to its opposite position, the inlet port 96 communicates with the outlet port 112 while the outlet port 110 communicates with the exhaust port 108.

As will be seen most clearly from FIG. 2, a pair of O-rings 120 are provided in the valve body surrounding the tube 34. These O-rings 120 are located so that when the tube 34 is in its upper most position the series of holes 68 which communicate with the passage 56 of the tube 34 are between the two O-rings 120 and hence not in communication with the air supply. However, when air pressure is applied through the passage 114 the piston 36 is forced downwardly bringing the series of openings 68 into the chamber 46 above the piston 36. As a result, air now enters the passage 56, flows through the passage, to the opening 64, and the port 80 of the sleeve 32 to the forward inlet port of the air motor 26. At the same time, the holes 70 of the tube 34 which communicate with the passage 58 are also in communication with the annular recess 118 and the passage 116. Since at this time the valve is in its normal position the passage 116 is connected to the port 112 and chamber 106 to the exhaust port 108. A discharge path for the secondary discharge of the air motor 26 is thus provided through the bore 82 of the collar 32, the opening 66, and the passage 58. The annular passage 118 also communicates by a port (not shown) with the annular passage 44 between the sleeve 38 and the cylinder wall 12. Thus, the chamber 48 below the piston 36 is also connected to the exhaust port 108. When the valve is in this position the piston 36 moves downwardly, advancing the tool toward the work piece. After a short initial movement sufficient to bring the holes 68 into the annular opening 46, air is also supplied to the air motor 26 causing the motor to rotate in its forward direction. When the valve shifts to its opposite position, in a manner to be described below, the air flow pattern is reversed, air pressure being applied to the chamber 48 below the piston forcing the piston upwardly. Air pressure is also supplied through the holes 70 to the passage 58 of the tube 34 and, hence, to the reverse air inlet of the air motor 26. The chamber 46 on the upper side of the piston and the passage 56 of the tube 34 are now connected to exhaust and thus the motor rotates in the reverse direction as the piston 36 moves upwardly, retracting the tool from the work piece. It will be noted that the holes 68 of the divided tube 34 will move upwardly out of the chamber 46 and past the lower one of the O-rings 120 before the piston has reached its fully retracted position. As a result, the secondary air return path of the air motor 26 is closed and the motor ceases to rotate a short time before the piston and motor are fully retracted.

In order to provide for the automatic reversal of the tool when a predetermined torque limit has been reached, there is provided a passage 126 in the upper end cap 60 of the tube 34 with this passage communicating with the forward air feed passage 56 of the tube. A fitting 128 connects the passage to a pneumatic logic assembly 130. Such a pneumatic logic assembly is a conventional device and may, for example be a Model 59011 "AND" logic element manufactured by The Aro Corporation of Bryan, Ohio 43506. The logic unit 130 is also connected through the port 100 to the second end chamber 90 to the spool valve assembly. The logic assembly 130 operates by sensing the increase in pressure in the chamber 56 of the tube 34 as the motor torque increases. When this pressure exceeds a predetermined value indicating that the upper torque limit has been reached the logic control 130 causes a release of pressure from the end chamber 90 of the valve assembly. The valve assembly thus shifts to the reverse position and, as described above, the motor is automatically reversed and retraction of the tool bit commences. It will be understood that suitable adjusting means, not shown, may be provided for regulating the operating pressure of the logic element **130** so that the torque limit can be varied, depending on the type of tool bit used, the operation being performed, and other relevant factors.

The two bleeder valves connected, respectvely, to the ports **98** and **100** of the control valve permit manual operation of the tool when desired. Thus, motor reversal and retraction can be accomplished manually by opening the bleeder valve connected to the port **100**.

While only the best known embodiment of the invention has been illustrated and described in detail herein the invention is not limited thereto or thereby. Reference should therefore be had to the appended claims in determining the true scope of the invention.

What is claimed is:

1. A reversible drive tool, comprising:

a generally cylindrical housing;

a reversible rotary air motor slidably received in the housing for rotating a tool bit, the air motor having separate forward and reverse inlet ports;

a tube attached to the air motor and extending substantially parallel to the axis of the housing, the tube having at least two separate passages communicating, respectively, with the forward and reverse inlet ports of the air motor;

a substantially cylindrical sleeve positioned within the housing and spaced from the inner wall of the housing to define an annular passage between the housing and the sleeve, an inner surface of said sleeve defining the walls of a chamber, said passage forming a part of the air flow path leading to a portion of said chamber within the sleeve;

a piston connected rigidly to the tube and having a substantially air-tight sliding relation to the walls of the chamber and dividing said chamber into two chamber portions;

means for directing air to either the portion of the chamber remote from the air motor and a first passage of the tube communicating with the forward inlet port of the air motor or the portion of the chamber nearer to the air motor and the other passage of the tube;

means in said tube to provide communication between the first passage of the tube and the portion of the chamber remote from the air motor; and

means to prevent air flow to said first passage of said tube when the piston is at its extreme remote position in the chamber.

2. The reversible drive tool according to claim **1** wherein said means for directing air to the chamber and the passages of the tube comprises a valve assembly including a casing having a through bore in which the divided tube is slidably received, the bore having an enlarged annular portion, the portion of the tube extending into the enlarged portion having an opening communicating with the second passage of the tube, the enlarged portion forming a part of the air passage to the second passage of the tube.

3. The reversible drive tool according to claim **2** wherein the valve assembly includes a spool valve having a plurality of chambers and a pair of end chambers each connected to an air inlet and to a bleeder valve, and also has ports for connecting to atmosphere for secondary exhaust of the air motor.

4. The reversible drive tool according to claim **3** further including sensing means for detecting an increase in air pressure in the first passage of the divided tube, the sensing means producing an air pressure reduction in one of the end chambers of the spool valve upon a pressure increase in the first passage of the divided tube to cause the valve to shift reversing the motor and retracting the piston.

5. The reversible drive tool according to claim **1** wherein said means in said tube to provide communication between the first passage of the tube and the portion of the chamber remote from the air motor, comprises at least a first opening in the tube wall communicating with the first passage of the tube and positioned on the tube such that it communicates with the portion of the chamber remote from the air motor except when the piston is at its extreme position in the chamber and it is blocked thereby.

6. A pneumatically driven tool, comprising;

a generally cylindrical housing;

a valve assembly at the first end of the housing, the valve assembly including an inlet port for connection to a source of air pressure, an exhaust port, and first and second outlet ports, a valve for connecting either the first port to the inlet port and the second port to the exhaust port or vice versa, a through bore extending coaxially with the housing and having an enlarged annular portion intermediate the ends of the bore, the second outlet port communicating with the enlarged portion of the bore;

a tube slidably received in the bore of the valve assembly and extending toward the second end of the housing, the tube being divided longitudinally into first and second separate passages, openings being provided in the tube wall communicating with the first and second passages, respectively, the openings being longitudinally separated from one another whereby the first opening is located toward the second end of the housing and remote from the enlarged portion of the bore and the second opening is located within the enlarged portion of the bore and the second opening is located within the enlarged portion of the bore;

a piston connected to the tube at a point on the portion thereof extending toward the second end of the housing, the piston being slidably received in a chamber adjacent the valve assembly and the first outlet port of the valve assembly communicating with the portion of the chamber between the piston and the valve assembly; and

a rotary air motor connected to the end of the tube toward the second end of the housing, the motor being reversible and having separate forward and reverse air inlets, the first passage of the tube communicating with the forward air inlet of the motor and the second passage of the tube communicating with the reverse air inlet of the motor.

7. The pneumatically driven tool according to claim **6** wherein the opening communicating with the first passage of the tube is located so that said opening is positioned in the through bore of the valve assembly when the tube is in its fully retracted position and communicates with the piston chamber when the tube is advanced from its fully retracted position, sealing means being provided to prevent air flow from the piston chamber to the through bore.

8. The pneumatically driven tool according to claim **6** further including means to manually control the valve.

9. The pneumatically driven tool according to claim **6** further including a pressure actuated means connected to the first passage of the tube and operative, upon a pressure increase in the first passage above a predetermined value, to effect reversal of the valve whereby the air motor is reversed and retracted.

10. In a pneumatically driven tool having a rotary air motor, a housing, a piston slidably received in the housing for advancing and retracting the air motor out of and into the housing, and a control valve assembly controlling the operation of the motor and the piston, the improvement wherein

the air motor is a reversible air motor having separate air inlet ports for forward and reverse operation; and

a tube is connected to the motor and to the piston and extending in sliding relation into the valve assembly, the tube having two separate longitudinal passages communicating, respectively, with the forward and reverse air inlet ports of the motor and with separate outlet ports of the valve assembly.

11. The improvement according to claim **10** wherein the tube is comprised of a tubing length divided longitudinally by a wall.

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