

April 17, 1945.

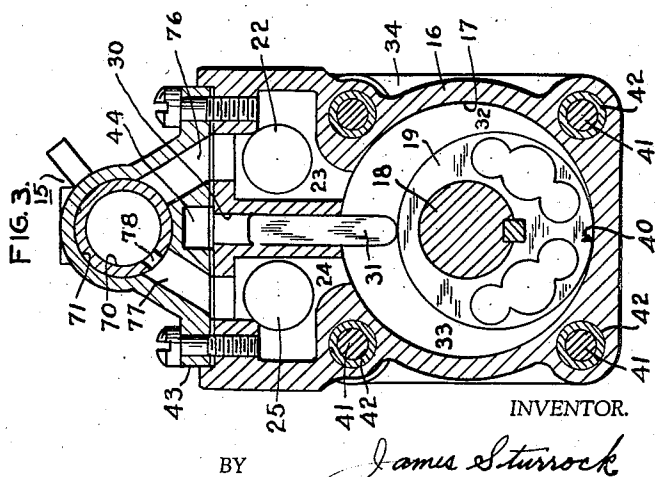
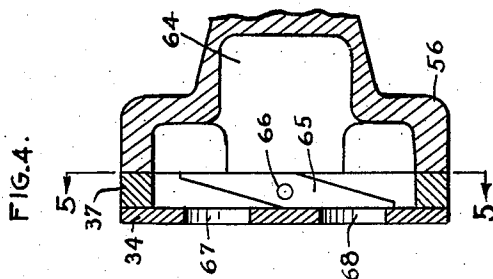
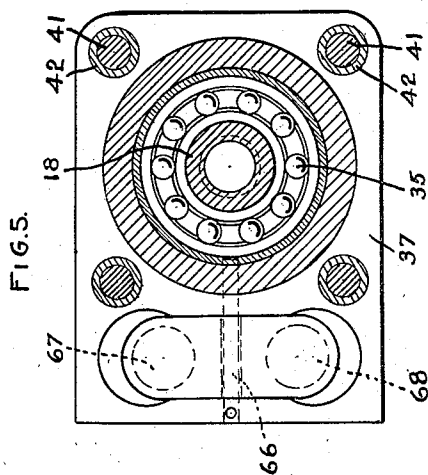
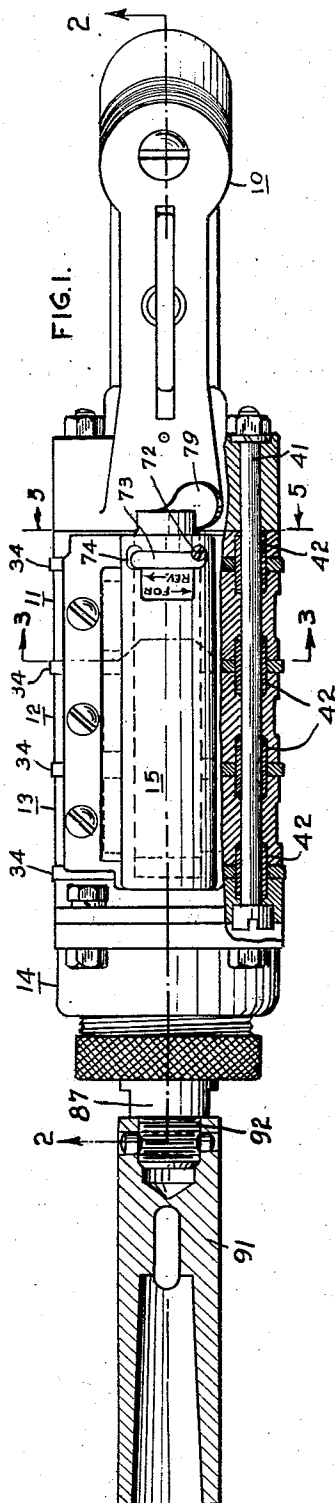
J. STURROCK

2,373,669

FLUID POWER MOTOR

Filed March 18, 1942

3 Sheets-Sheet 1



INVENTOR.

BY

James Sturrock

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3 Sheets-Sheet 2

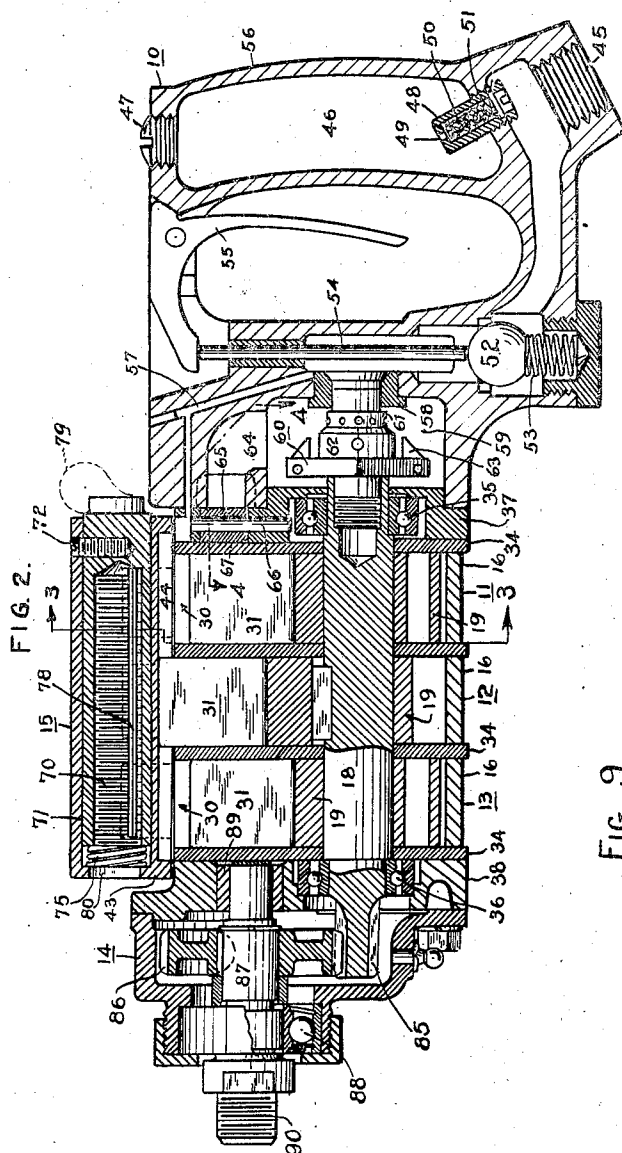
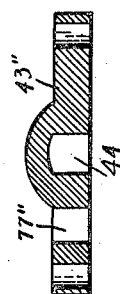


FIG. 9.



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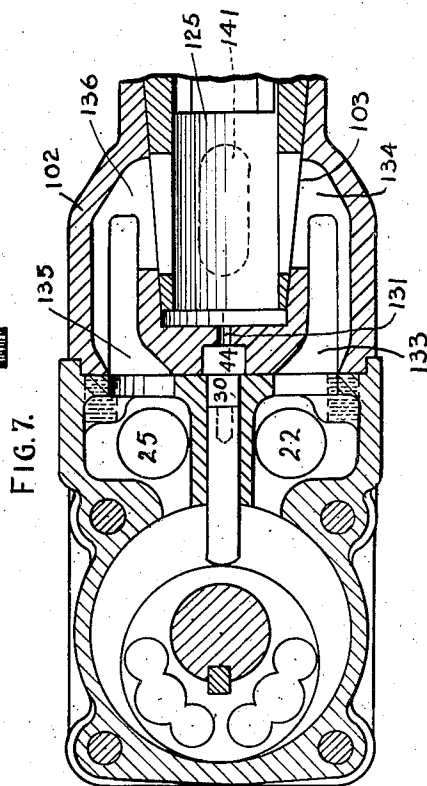
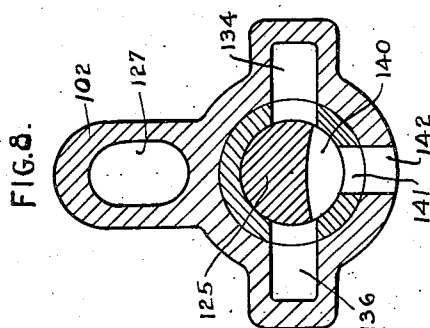
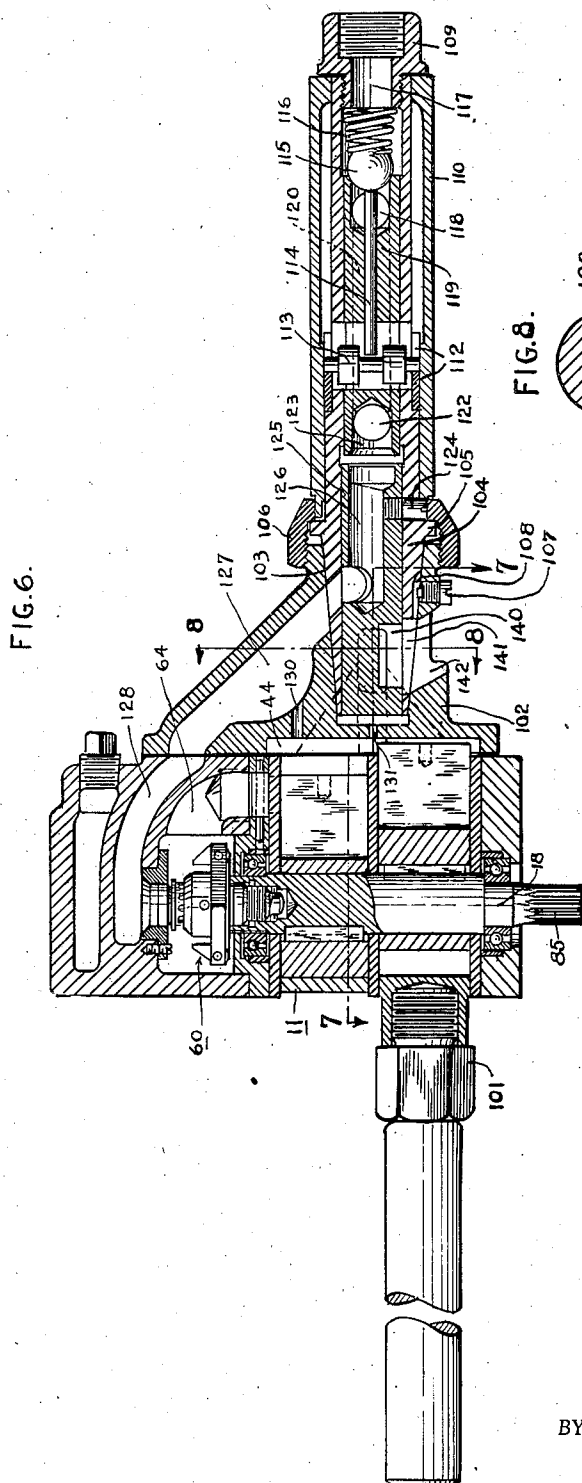
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FLUID POWER MOTOR

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3 Sheets-Sheet 3



INVENTOR.

BY

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UNITED STATES PATENT OFFICE

2,373,669

FLUID POWER MOTOR

James Sturrock, Cleveland Heights, Ohio, assign-
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of Ohio

Application March 18, 1942, Serial No. 435,884

5 Claims. (Cl. 121—34)

This invention relates to improvements in rotary fluid motors. Some similar embodiments are shown in my co-pending patent application Serial No. 435,883 of identical filing date, but now abandoned. This present application refers more to the reversing valve and mechanism and the air passages to and from the valve and through the motor, the handles and attendant parts.

My invention will be herein described as pertaining to rotary pneumatic tools but it should be understood that any reference to compressed air as a motive media includes any other form of fluid power applicable to my invention when broadly interpreted.

There are two general types of pneumatic rotary motors used to power portable tools on the market today. One has a concentric rotor with a plurality of vane slots cut in it, mounted eccentrically in a cylindrical bore, with vanes reciprocating in the slots to maintain contact with the cylinder walls under centrifugal or other forces. This type I will call the vane-type. The other type I will call the abutment-type. It has been marketed and developed practically exclusively by the assignee of this application under their issued patents. This type consists of an eccentric rotor mounted on a shaft which is concentric with a bored cylinder and an abutment mounted for reciprocating motion in a slot in the part containing the bored cylinder to contact with the eccentric rotor. Usually, though not necessarily, there is an inlet and exhaust port entering the bored cylinder one on either side of the abutment slot adjacent thereto.

I will illustrate my invention with an embodiment of the abutment type but it is not limited to that type but many of its features are applicable to all types of fluid motors.

Throughout the many years, during which pneumatic tools have been designed and marketed, manufacturers have been conscious of a limitation which they have not been able to rectify, i. e., that a directionally reversible tool has not had as much power as if parts of the same size and displacement had been used in a uni-directional tool. Frequently the power of a reversible tool is much less in one direction than in the other and the tool is designed to favor the direction most used. This is especially customary and noticeable with internal vane tools.

50% loss of power is not unusual in the reverse direction under these conditions.

30% loss of power is not unusual when the power is the same in both directions as compared

with a uni-directional tool of similar displacement and identical rotors.

Accordingly, I have had as objects of my invention:

(1) To produce a reversible tool having the same power as a uni-directional tool of the same displacement.

(2) To produce a tool having greater efficiency and the same power when operated in either direction and simpler means to determine or change the direction of rotation.

(3) To produce a more powerful and efficient reversible tool in proportion to its weight.

(4) To produce a simpler speed direction control.

(5) To control the direction of rotation by manual selection of the exhaust ports only, as compared with a method that manually switches both the inlet and exhaust ports.

(6) To switch by a fluid operated means the inlet port at a point remote from the manual selector of the exhaust port.

(7) To improve the efficiency of the tool by materially shortening and straightening the air passages.

(8) To muffle the tool.

Further objects and novel features will be noted, and apparent from the drawings, claims and specifications which follow wherein identically or similarly numbered parts are identical or substantially equivalent and

Fig. 1 is a longitudinal view in elevation of an embodiment of my invention, partially broken away.

Fig. 2 is a sectional view cut substantially on line 2—2 of Fig. 1.

Fig. 3 is a sectional view cut substantially on line 3—3 of Figs. 1 and 2.

Fig. 4 is a sectional view cut substantially on line 4—4 of Fig. 2.

Fig. 5 is a sectional view cut substantially on line 5—5 of Figs. 1 and 4.

Fig. 6 is a sectional view similar to Fig. 3 showing a modified form of my invention.

Fig. 7 is a sectional view of cut substantially on line 7—7 of Fig. 6.

Fig. 8 is a sectional view cut substantially on line 8—8 of Fig. 6.

Fig. 9 is a sectional view of modified part.

Although the embodiment of my invention shown in Fig. 1 and Fig. 2 illustrates a pneumatic rotary tool suitable for drills, reamers, taps, nut setters, many features of my invention are applicable to other uses and types of tools. Generally speaking, this embodiment is composed of a

spade casting handle assembly 10, with suitable air passages, and a remotely controlled valve called by me a duplex valve, and hereinafter described, three similar motor cell units 11, 12 and 13, a speed reducing unit 14, and an exhaust selector control valve 15.

Fig. 3 shows in section a cylinder casting 16 having a bore 17. Concentric with the bore is a shaft 18 upon which is keyed an eccentric rotor 19, the rotor being free for limited sliding movement on the shaft. Air may enter through a longitudinal passage or port 22 and into bore 17 through passage 23 and may leave the bore 17 through passage 24 and longitudinal passage or port 25 or vice versa according to the positioning of a control valve 15 hereafter described in detail. The switching of the inlet and exhaust ports is effective to reverse the direction of rotation of the rotor. Special notice should be taken of the symmetry of the optional air passages used either for exhaust or intake according to the rotational direction desired described here and hereafter.

A vertical slot 30 is cut through a casting 16, with a milling cutter, intermediately ports 22 and 25 (see Fig. 3).

An abutment 31 is mounted in slot 30 for reciprocating motion to maintain contact between one end of abutment 31 and the peripheral surface of the eccentric rotor 19 and to maintain separation between the chambers 32 and 33, one of which is a pressure chamber and the other an exhaust chamber.

As shown in Fig. 2 on each side of each cylinder casting 16 is a separator plate 34, forming a thrust bearing plate to take the end thrust of the rotors 19, which bears chiefly to the left as shown in Fig. 2, mainly because of air pressures. These plates are perforated to pass the shaft 18 and to continue longitudinally ports 22 and 25. The separator plates 34 divide the bores 17, which would otherwise be joined, into separate motor cell units, such as 11, 12 and 13.

Ball bearings 35 and 36 for shaft 18 are mounted in end plates 37 and 38 respectively, although it is in the scope of this invention to mount shaft bearings in any suitable position and/or the making of one or more separator plates integral with bearing mounting plates.

The cylinder castings 16 and the contacting surfaces of the separator plates 34 and the end plates 37 and 38 are surface ground; and the cylinder casting 16, the rotor 19 and the vane 31 are of such close longitudinal lengths that a running fit is effected with the separate plates while maintaining a substantial air seal therebetween.

Since such an air motor is not self-starting except when the inlet passage 23 or 24 is between the near contacting surface of the rotor 19 called the land 40 and the abutment 31, the motor units are not usually used singly although such a construction is included in the scope of my invention but usually in multiples operating in parallel but with the rotors indexed on the shaft 180° with two motor cells and 120° with three motor cell units, etc. This relationship between the rotors is hereinafter called "opposite."

One or more motor cell units are clamped together with a plurality of the bolts 41, usually four in number, and keyed with dowel bushings 42 which usually pass through the separator plates and the adjacent parts. This design produces a stacked or laminated construction which is rigid and easily aligned, holding the parts in

parallel alignment. All cylinder castings, rotors, abutments, separator plates being identical and symmetrical, thus are interchangeable and reversible. Their identity facilitates standardization both for the manufacturer and the customer's parts and repair department. The slot 30 is an easy milling operation. Parts may wear more on one surface than the other because of the air inlet being to one end and on one side of the tool so that reversing such parts as the separator plates as well as interchanging them gives two wearing surfaces and accordingly prolongs their useful life.

If the tool is used principally in one direction, and only occasionally in reverse, the tool may be reassembled with all parts reversed so that the worn surfaces such as in the slot 30 will be reversed, saving the necessity of replacing the parts thereby securing dual life. This reversing can take place without decreasing the power of the tool because of the symmetry of the air passages and the parts.

In the manufacture of such tools one handicap is the necessity of keeping a wide variety of tools in production even though the volume in some instances is not high. This construction has the great advantage of flexibility of production. Tools of various horsepowers may be made from practically identical parts by increasing the length of the individual units, which change need not involve extensive change in dies or fixtures and an individual production run may be increased by machining a variety of motor cell parts of various lengths at the same time without changing the machine setup materially. Also identical parts are usable for either or both directions of rotation.

The slot 30 is covered by a cap 43 which embraces the length of the motor cell units such as 11, 12 and 13 and not only aids to align them but also to space the width of slot 30 supporting it from collapse by external forces.

Cap 43 can be made without a reversing valve as shown by 43' in Fig. 9 with an exhaust port 45 continued through or adjacent to the cap. Then further standardization of parts may be accomplished because by reversing this cap on the cylinder casing 16 Fig. 3 the direction of rotation will be reversed so that practically the same parts may be used for reversible tools and uni-directional tools having either left or right hand rotation particularly because the power of the tool is the same in either or both directions in contra-distinction to all tools now on the market.

Spade handle units

Fig. 2 shows the threaded opening 45 through which the live air enters. Chamber 46 is an oil reservoir fillable through plug 47. Hollow plug 48 having an orifice 49 and felt wick 50 held in place by a pin 51 is screwed into the oil chamber 46. Changes in air pressure cause the oil to seep through felt 50 to lubricate air passing through opening 45. Ball valve 52 normally held closed by a compression spring 53 is opened by a plunger rod 54 which is actuated by a bell crank 55 which is positioned to be gripped simultaneously with the spade handle grip 56. The live air under pressure is carried through passages 57 to a groove 44 in cap 43 to press vanes 31 against their respective rotors 19. The main flow of the live air is, however, through the bushing 58 to the governor chamber 59. A governor 60 of a well-known type in the industry is mounted in the end of shaft 18 and includes a perfo-

rated tube 61 which has a snug running fit in bushing 58 and a sleeve 62 which opens and closes the perforations of tube 61 responsive to centrifugal forces acting on weights 63. The sleeve 62 is normally held in a position which leaves the perforations in tube 61 unobstructed by an adjustable compression spring, not shown, positioned axially in the governor.

From the governor chamber 59 the air passes directly through passageway 64 to and through either (but not both) ports 67 and 68 which lead to ports 22 or 25 respectively (see Fig. 4).

A remotely controlled duplex valve 65 (see Figs. 4 and 5) is pivotally mounted on pin 66 and is selectively operable to close or to open, as the case may be, either one of the two ports 67 or 68. This valve, its design, use and functional location is an important part of my invention without which many of my novel results would be unattainable. It controls the selection of which port the air may enter (22 or 25) responsive to the air or fluid power currents passing through either ports 67 or 68 as selected by manual means to select the exhaust port as hereafter described.

Since the air in the passage 64 is always under greater pressure than in the exhaust port (either 22 or 25 as elected) the surge of air to the unrestricted exhaust port moves duplex valve 65 to open the other port (either 25 or 22 as elected) which said other open port becomes the inlet port to the motor, thereby making valve 65 responsive solely to the election of the exhaust port by the selector control 15 and operated by the air flow.

The air then passes directly through other port 22 or 25, whichever is used as an inlet, to the rotor chambers 32 or 33 (Fig. 3) respectively to revolve the rotor or rotors 19 and then to the port 25 or 22 whichever is used as an exhaust port to the manual exhaust selector control 15.

Exhaust selector control

In the abutment slot cap 43 previously described in part is a tubular member 70 closed at one end, journaled in a bore 71 and held therein for limited turning movement by a set screw 72 which operates in a radial slot 73 with enlarged ends 74. Compression spring 75 tends to press screw 72 into enlarged slot ends 74 to hold it in either one of its extreme positions. Air passageways 76 and 77 run from ports 22 and 25 respectively to bore 71. Slots or slot 78 in tube 70 allow exhaust air to pass from either passageway 76 or 77 but not both. Manual lever 79 is attached to the closed end of tubular member 70 and cap 43 is marked adjacent to the slot 73 to indicate forward or reverse (see Fig. 1) or left or right hand or other suitable indication of direction of rotation. When passageways 76 and port 22 are open for exhaust purposes, the duplex valve 65 responsively to the fluid flow closes port 22 and opens port 25 for inlet purposes, and when passageways 77 and port 25 are opened for exhaust purposes the valve 65 automatically seals port 25 and opens port 22 for inlet purposes. The air exhausts from tube 70 through its open end 80. The rotation of rotor 19 is always in a direction passing first the exhaust port, the abutment 31 and then the inlet port.

Since all ports 22 and 25 longitudinally interconnect all motor cells 11, 12 and 13, and only one cell is exhausting its maximum volume of air at one time, the air from one cell may exhaust through that section of slot 78 over one or both of the other cells. This is purposely encouraged

by making 78 a practically continuous slot over all three cells and so narrow that the pulsations of air from each cylinder will tend to equalize in the chamber formed by the longitudinal ports 22 or 25 and will exhaust into tubular member 70 in paths of varying lengths, thereby eliminating much of the pulsation of the exhaust air before it emerges from the open end 80, thereby muffling the exhaust. I further muffle the exhaust by threadably tapping the interior bore of tube 70 to deflect the air blown from the long narrow slot 78 at right angles to the tapped or threaded surface of 70. This materially will muffle the tool by toning down the screech so common and objectionable in pneumatic tools. Thus I have by novel design combined a simple reversing valve with a muffler without adding any parts which would not be essential to the valve itself.

Speed reducing unit

Shaft 18 passes through ball bearing 36 mounted in end plate 38 and terminates in an integral overhanging pinion 85 which meshes with a gear 86 mounted on a work spindle 87. Ball bearing 88 and bearing 89 journal the work spindle in a gear box housing 90 conventionally lubricated. The amount of speed reduction depends on the requirements of the work but since a pneumatic motor of this type must run much faster than the work spindle for many types of work it would be most inefficient to reduce the motor speed to a point where the gears might be eliminated. If the tool is to be used only in one direction the work spindle is terminated with a threaded end 92. If it is to be used in two directions it is conventionally terminated with a female Morse Taper 91. The number of gears in the train would, of course, vary with the speed requirements of the work spindle.

Fig. 6 shows an application of my invention to a common form of pneumatic drill known as a side handle tool. This shows a tool composed of two motor cell units 11 and 12 identical to those originally described except for the addition of a dead side handle and boss 101 and including a shaft 18 with a pinion 85 which may be meshed with any suitable gears in any suitable gear box such as speed reducing unit 14 previously described.

In place of the abutment slot cap 43 there is substituted a larger casting 102 which covers the abutment slots 30 and contains a recessed groove 44. Into a tapered hole 103 in casting 102 is a live handle tube 104 with a flange 105 which is held longitudinally by a nut 106 and rotationally by a dog point screw 107 in a keyway 108.

Screwed into the extended end of the live handle tube 104 is a threaded socket 109 which holds longitudinally a control tube 110. A double V-shapel cam 112 is attached to the control tube 110 which is effective when turned with the control tube 110 in either direction from the position shown to move a follower 113 to the right as shown in Fig. 6 which pushes a rod 114 against a ball 115 of a ball valve, opening said valve by compressing spring 116 which normally keeps the valve closed. The double V-shaped cam is arranged for slight lost motion in the position shown and curved at either end of its movement to hold the ball valve open in either position without effort.

With the ball valve 115 open air enters through the axial bore 117 passing by the ball 115 and through a transverse hole 118 in an intermediate

piece 119 pressed into tube 104, which is round and tubular on both ends but flattened on opposite sides through its intermediate body allowing the air to bypass the mechanism operating the ball valve on each side thereof through two like passageways 120 indicated by broken lines and extending within tube 104 from the transverse hole 118 to hole 122 where the air re-enters the axial bore at 123.

A screw 124 in a notch in the left end of the control tube 110 passes through a 90 degree cut in the live handle tube 104 and is threaded into a valve 125 which thereby turns in unison with the control tube 110. Valve 125 contains an inlet passage 126 which is always open for the passage of incoming air regardless of the movement of valve 125 and carries the air to passage 127 in casting 102 and then to the governor 60 through passage 128.

Passage 130 takes live air pressure from passage 127 to groove 44 to keep the vanes in contact with the rotor periphery. Air pressure is also communicated from groove 44 to the back of valve 126 by passage 131 (Fig. 7), to balance the air pressure on valve 126 to make it easier to turn.

The air then passes through the governor 60 past the duplex reversing valve 65 into either ports 22 and 23 or 24 and 25 into the rotor chamber and out through either ports 24 and 25 or 22 and 23, identically as previously described relative to the first described embodiment.

Exhaust air leaves either passage 22 by passages 133 and 134 or passage 25 by passages 135 and 136 (see Figs. 7 and 8).

Cut into the left hand end of valve 125 is a port 140 to exhaust either passage 134 or 136, into the atmosphere through passage 141 in the live handle tube 104 and passage 142 in the vane cap casting 102.

In the position of the parts shown in Figs. 6 and 8 air could pass between passages 134 and 136 through port 140 but at this time the inlet ball valve 115 is closed and by the time the control tube 110 is revolved sufficiently to take up the lost motion in the cam 112 and to push back the ball 115 either valve 136 or 134 is completely closed for exhaust purposes.

The operation of this modified tool is so similar to the first embodiment that a detailed description is considered unnecessary.

One important virtue of my invention shown in the side handle embodiment is the shortening and straightening of the air passages and as a result considerable increase in power and efficiency as compared to present side handle tools.

Side handle tools now on the market take the air through the live or control handle to the governor chamber and then back to the side control handle then by double optional passageways to the motor chamber and then by double optional passages back to the control handle and then to the exhaust. This is because in order to govern the air it must first pass through the governor and then return to the control handle to select which side of the motor should become the inlet, then the exhaust must likewise be returned to the control so one port can be closed.

In practice this multiplicity of passageways with their attendant turns, etc., must either be laboriously drilled at odd angles, with intercepting holes or cast. In the latter case the cast holes are sufficiently rough to materially impede the air flow. Usually with so many passages, space

and structural limitations do not permit them to be of sufficient size to efficiently pass the air flow freely.

The comparative simplicity of the air passages in both the embodiments described materially increases the efficiency and power of the tool as compared to tools of like weight and displacement now accepted as standard on the market.

Having described but three embodiments of my invention it is obvious that many other modifications are practical without departing from the spirit of my invention accordingly.

I claim:

1. In a rotary reversible motor powered by compressed air and having in combination a shaft, a motor cylinder block, walls in said block defining three openings parallel to said shaft, the shaft being mounted for rotation in one of said openings, the two other parallel openings having ports connecting them to the said one opening, a manually operated valve, means to normally hold said valve in either of two optional positions to optionally close one of said two openings to atmosphere, and air operated valve means acting sequentially to the operation of the manual valve to open the same passage to compressed air thereby electing the direction of rotation of said reversible motor.

2. In a rotary reversible motor powered by compressed air and composed of a plurality of oppositely indexed abutment type motor cells having walls defining a bore, the combination of two parallel passages through said motor interconnecting said cells, each passage having an opening into the walled bore of each motor cell, a manually operated sleeve valve to optionally close one of said passages to atmosphere, and air operated means acting sequentially to the operation of the manually operated sleeve valve to open the same passage to compressed air to elect the direction of rotation of said reversible motor.

3. In a rotary reversible motor powered by compressed air, the combination of a shaft, a plurality of cylinder blocks each having walls defining three openings parallel to said shaft, the shaft being disposed for optional rotation in one of said openings, the two other parallel openings being continuous through said plurality of blocks and having ports connecting them to the said one opening, a groove severing one wall of said block and opening into the said one opening and positioned between said ports, an abutment mounted for reciprocating movement in said groove, a plate to cover the grooves in all of said cylinder blocks, passages from the said two other openings into said plate, a manual valve operably mounted in said plate to optionally close all passages with openings on one side of said reciprocating abutments to atmosphere, and an air operated valve acting sequentially to the operation of the manually operated valve to open the same passages to compressed air to effect the rotation of the shaft in an optionally selected direction.

4. In a rotary reversible motor driven by motive fluid, the combination of a motor housing having a bore and a rotor mounted in said bore, said housing having a first fluid passage with a fluid entrance end and a fluid exit end and having a second fluid passage with a fluid entrance end and a fluid exit end, a first port interconnecting the bore with the first passage intermediate the entrance and exit ends thereof, a second port interconnecting the bore with the second passage intermediate the entrance and exit

ends thereof, said ports directing fluid to and from the bore to operate the rotor, manually operated valve means arranged to be selectively actuated to either one of two positions, and fluid operated valve means acting sequentially to the operation of the manually operated valve means and arranged to be actuated by the motive fluid to either one of two positions, said manually operated valve means in one of said positions opening the exit end of the first passage to atmosphere and closing the exit end of the second passage and said fluid operated valve means sequentially closing the entrance end of the first passage and opening the entrance end of the second passage to motive fluid, and said manually operated valve means in the other position closing the exit end of the first passage and opening the exit end of the second passage to atmosphere and said fluid actuated valve sequentially closing the entrance end of the second passage and opening the entrance end of the first passage to motive fluid.

5. In a rotary reversible motor driven by motive fluid, the combination of a motor housing having a bore end and a rotor mounted in said bore, said housing having a first fluid passage with a fluid entrance end and a fluid exit end and having a second fluid passage with a fluid entrance end and a fluid exit end, a first port intercon-

necting the bore with the first passage intermediate the entrance and exit ends thereof, a second port interconnecting the bore with the second passage intermediate the entrance and exit ends thereof, said ports directing fluid to and from the bore to operate the rotor, an abutment vane slidably mounted in the said housing and engaging to rotor between said first and said second ports, manually operated valve means arranged to be selectively actuated to either one of two positions, and fluid operated valve means acting sequentially to the operation of the manually operated valve means and arranged to be actuated by the motive fluid to either one of two positions, said manually operated valve means in one of said positions opening the exit end of the first passage to atmosphere and closing the exit end of the second passage and said fluid operated valve means sequentially closing the entrance end of the first passage and opening the entrance end of the second passage to motive fluid, and said manually operated valve means in the other position closing the exit end of the first passage and opening the exit end of the second passage to atmosphere and said fluid actuated valve sequentially closing the entrance end of the second passage and opening the entrance end of the first passage to motive fluid.

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