

May 15, 1951

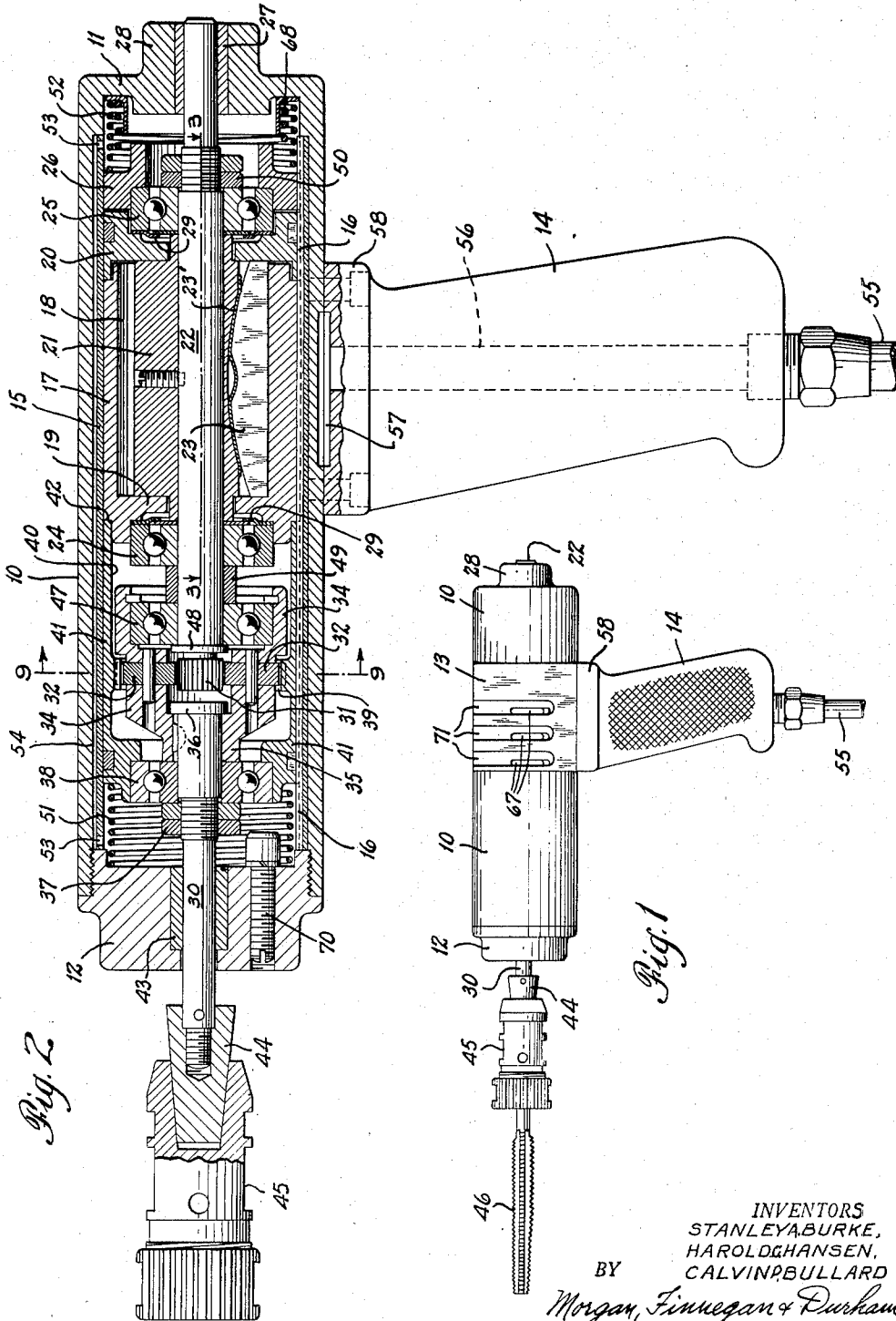
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2,552,840

AUTOMATICALLY REVERSIBLE AIR-DRIVEN TAPPING UNIT

Filed May 7, 1948

3 Sheets-Sheet 1



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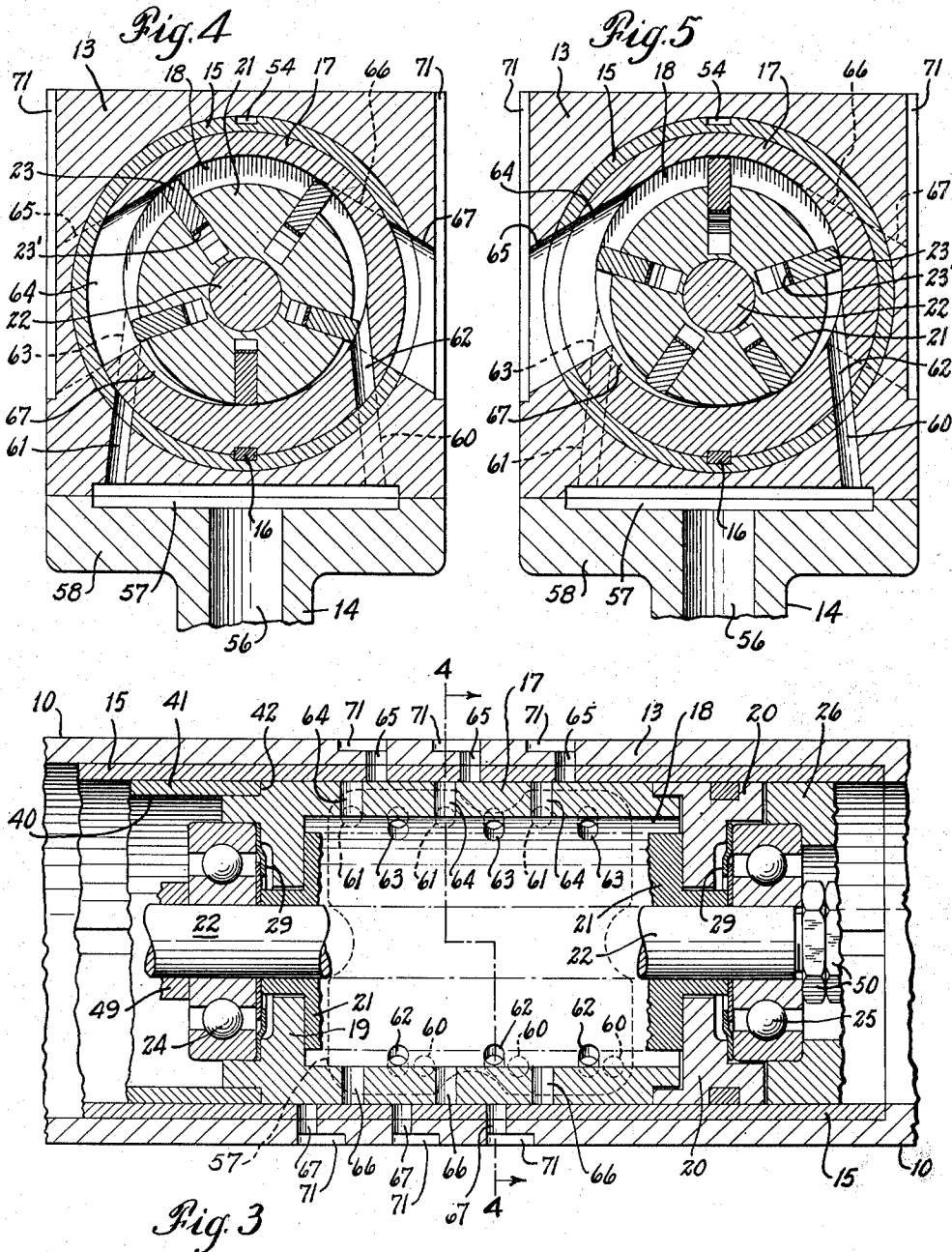
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AUTOMATICALLY REVERSIBLE AIR-DRIVEN TAPPING UNIT

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3 Sheets-Sheet 3

Fig. 6

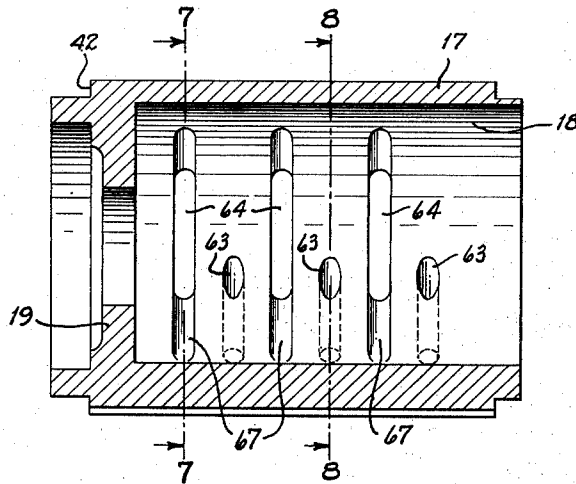


Fig. 7

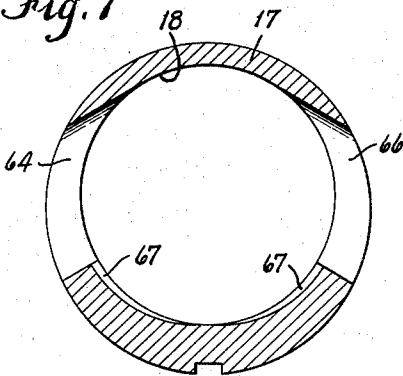


Fig. 8

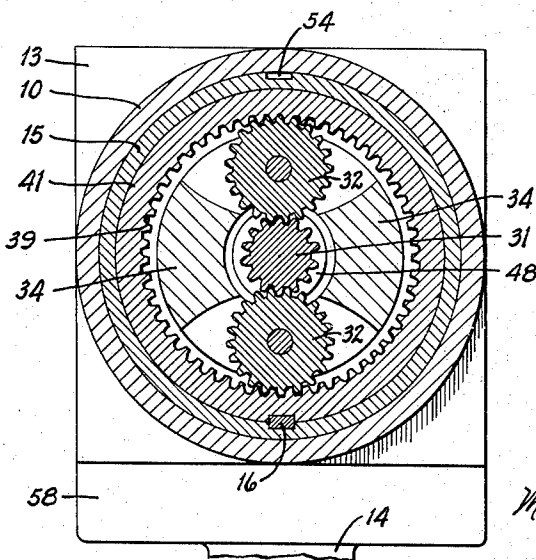
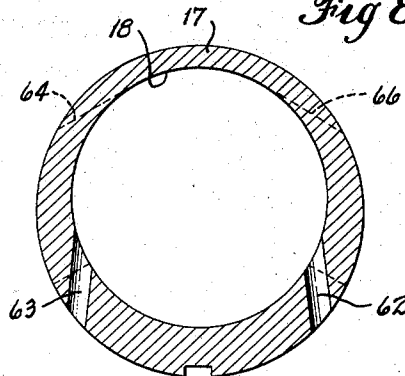


Fig. 9

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2,552,840

AUTOMATICALLY REVERSIBLE AIR-DRIVEN
TAPPING UNITStanley A. Burke and Harold C. Hansen, West-
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Application May 7, 1948, Serial No. 25,546

11 Claims. (Cl. 121—34)

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The invention relates to an air driven mechanical device for driving a tool such as one used for tapping, drilling, reaming or threading. More particularly, it relates to an air driven device which is reversible in rotation in accordance with the work conditions as they develop in the course of an operation.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the instrumentalities and combinations pointed out in the appended claims.

The invention consists in the novel parts, constructions, arrangements, combinations and improvements herein shown and described.

The accompanying drawings, referred to herein and constituting a part hereof, illustrate one embodiment of the invention, and together with the description, serve to explain the principles of the invention.

Of the drawings:

Fig. 1 is a side elevation of a device embodying the invention and showing attached thereto a conventional tapping tool;

Fig. 2 is a longitudinal central section through the main body of the device but with certain portions in elevation;

Fig. 3 is a fragmentary horizontal section, somewhat enlarged, taken on the line 3—3 of Fig. 2 but omitting the air driven rotor to more clearly show certain valve arrangements;

Fig. 4 is a transverse section taken along the line 4—4 of Fig. 3;

Fig. 5 is a view similar to Fig. 4 but showing the relation of the parts to each other after their positions have been shifted from those shown in Fig. 4;

Fig. 6 is a longitudinal central section in the same plane as Fig. 2 and showing the rotor housing only;

Fig. 7 is a transverse section taken along the line 7—7 of Fig. 6;

Fig. 8 is a transverse section taken along the line 8—8 of Fig. 6;

Fig. 9 is a transverse section taken along the line 9—9 of Fig. 2.

The present invention has for its object the provision of a novel and improved tool for use in drilling, cutting and other operations where a reversible drive is useful, the direction of rotation of the motor depending on whether the cutting means is being moved into or out of the work. A further object is the provision of

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a motor driven reversible tool in which the direction of rotation of the motor and of the cutting means driven thereby is automatically controlled by the axial direction of the thrust imposed on the motor or cutting tool. Still another object is the provision of a novel and improved motor driven tool in which power is applied to the motor only so long as normal axial thrust is applied thereto, whereby the motor automatically stops when the cutting tool is disengaged from the work or when the cutting tool is overloaded. A further object of the invention is the provision of such a tool which is extremely rapid in operation, is capable of rapid reversal without the manipulation of any additional control means by the operator, and may be manually moved toward and from the work or mechanically mounted for such movement. The invention further provides a compressed air-powered tool which attains the objects set forth, is compact, may be operated continuously and requires but little service for its continued efficient operation.

In general, the invention comprises a tool including a motor which is preferably driven by compressed air and drives a rotary cutter, such as a tap, die or drill in either direction of rotation, the direction of rotation being controlled by means, such as, air supply valves, these means or additional means also serving to control the supply of power to the motor so that the motor may be operated or not depending on the conditions. The direction of rotation of the motor is primarily and normally controlled by the thrust imposed on the tool during its operation, although this direction of rotation may be changed at will, if desired, so as to allow the tool to rotate continuously in either direction so long as power is supplied thereto, for instance, under control of a separate manually controlled air valve. The tool and its power controlling means, such as the valves are preferably constructed so that rotation of the motor is automatically stopped on overloads, such as might occur when a tap has fully threaded a blind hole.

Referring now to the drawings, the main body of the device comprises a cylinder 10 which is closed at the rear end by a wall 11 and at the front end by a threaded plug 12. Somewhat nearer the rear end, a portion of the periphery of cylinder 10 is enlarged into the form of a rectangular block 13 on one face of which may be secured the handle or grip member 14, and in which the various valve ports, to be described

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later, are formed. The bore of cylinder 10 is provided with a tightly fitted liner 15 in the bore of which are slidably mounted various operating parts of the device. To prevent rotation of the slidable members and maintain their longitudinal alignment a spline 16 is provided along the entire length of the bore in liner 15 with cooperating keyways provided in each of the sliding members.

The power means for driving the cutting tool attached to the device, as a tap, drill, etc., is a reversible, compressed air motor of the vane type and as embodied consists of a rotor housing 17 which is slidably mounted within the rear half of liner 15 (right in Fig. 2) and held against rotation by spline 16. An eccentric bore 18 in housing 17 extends from the rear end (right in Fig. 2) of the housing to near the front end where it terminates at an end wall 19. The rear end of eccentric bore 18 is closed by a disc 20 which is slidably mounted within liner 15 but keyed thereto to prevent rotation by spline 16.

As thus constructed the cavity formed by end wall 19, bore 18 and closure disc 20 provides the space within which the air motor rotor may be rotatably mounted. The rotor, as embodied, consists of a rotor hub 21 secured to a rotor shaft 22 and is provided with a plurality of radially extending vanes 23 which are slidably mounted in equally spaced radial slots along the length of hub 21. Vanes 23 may be urged outwardly by leaf springs 23¹ interposed between base of the vanes and the bottom of the vane slots in rotor hub 21. Rotor hub 21, by means of its shaft 22, is concentrically mounted with respect to rotor housing 17 and therefore is eccentric in relation to housing bore 18 within which the hub rotates. The diameter of hub 21 is such that it has a line contact with the bore 18 along its full length, leaving a crescent shaped chamber between the hub and the bore at all other points. The vanes 23 are adapted to project into this crescent shaped chamber and have a sliding contact at all times with the surface of bore 18 thus dividing the chamber into segments or pockets with increasing and decreasing volume as the hub rotates. Compressed air when admitted into one of these pockets between the vanes 23 at a point where the pocket is of minimum volume expands and by reaction against the forward vane rotates the rotor hub 21 and its shaft 22 until the forward vane reaches a point where the pocket is at its maximum volume when further travel of the vane opens the pocket to appropriate exhaust ports. The rotation thus produced presents successive pockets to the compressed air source and results in continuous rotation at a high rate of speed.

Rotor shaft 22 is rotatably mounted with respect to housing 17 by means of a ball bearing 24 carried in a recess in the forward end of housing 17 and a ball bearing 25 carried in a recess formed in a ring support 26 which is slidably mounted in the bore of liner 15 adjacent to closure disc 20 but held against rotation by spline 16. A rearward extension of rotor shaft 22 is further journaled in an anti-friction sealing bushing 27 fixed in a boss 28 formed on the rear end of main body cylinder 10. Both ball bearings 24, 25 are provided with sealing discs 29 on the side towards the rotor hub 21 to prevent the escape of compressed air from the air motor other than by escape ports purposely provided therefore.

In order to convert the relatively low torque high speed of rotor shaft 22 to a higher torque

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lower speed tool spindle 30, arranged along the same axis as the rotor shaft, a planetary gear reduction unit is provided therebetween. As embodied a small drive gear 31 is provided on the forward end of rotor shaft 22 and this meshes with two diametrically opposite pinions 32 journaled on pins carried by a rotatable pinion casing 34. The tool spindle 30 is keyed in a reduced hub portion 35 of pinion casing 34 and secured thereto by means of spindle head 36 and threaded jam nuts 37 carried by the spindle and clamping thru the inner race of ball bearing 38.

The non-rotatable member of the planetary gear unit consists of an internal gear 39 formed on a portion of the bore 40 of a sleeve 41. The pinion casing 34 is so positioned within the bore 40 that the pinions 32 mesh with internal gear 39 of sleeve 41. Since sleeve 41 is held against rotation by spline 16 of liner 15 any rotation of rotor drive gear 31 is transmitted at higher torque and lower speed to pinion casing 34 and the attached tool spindle 30. The internal gear sleeve 41 is slidably mounted within liner 15 and held in fixed relation to rotor housing 17 by having its inner end telescoped over a reduced portion of housing 17 and abutting a housing shoulder 42, and being fixed at its outer end on the outer race of ball bearing 38, as well as other means described hereafter.

The forward end of tool spindle 30 passes thru cylinder plug 12 where it may be journaled within an anti-friction sealing bushing 43 and at its end provided with a removable adapter plug 44 upon which any conventional tool chuck 45 and cutting tool, as tap 46, may be secured in driving connection.

Rotational mounting of the tool spindle 30 and attached pinion casing 34 is attained by ball bearing 38 carried in the forward end of internal gear sleeve 41, and ball bearing 47 which is fixed in a recess in the rearward end of pinion casing 34. The inner race of bearing 47 is clamped on the forward end of rotor shaft 22 between shaft shoulder 48 and spacer 49. This clamping action is derived from jam nuts 50 which are threaded on the rearward end of rotor shaft 22 and act thru all the parts directly mounted on the shaft between shaft-shoulder 48 and nuts 50.

From the description thus far and an inspection of the drawings (Fig. 2) it is clear that all parts carried by the rotor shaft 22 and tool spindle 30 as well as internal gear sleeve 41, rotor housing 17 and bore closure disc 20 are clamped together in longitudinally fixed relation to each other by nuts 37 and 50 so that any axial movement of the spindle 30 relative to the body 10 produces the same movement in all the mentioned parts as a unit. This unit, as thus described, slides in either axial direction within liner 15 but is normally maintained in a central, or neutral, position as shown in Fig. 2, by balanced spring action. As embodied coiled spring 51 is interposed at the forward end of the unit between body plug 12 and internal gear sleeve 41, and a spring 52 of equal strength interposed at the rear end of the unit between body end wall 11 and ring support 26. Elimination of the dash pot effect of unit movement is attained by providing air communication between the two spring chambers thru apertures 53 and a groove 54 formed in liner 15.

One object of the device is to provide a mechanism whereby the thrust given the device by the

operator to urge the tool into or out of the work may be utilized to control automatically, by valve means, the rotation in either direction or the non-rotation of the air motor, and hence the cutting tool. As embodied a flexible hose 55 is connected at one end to a source of compressed air (not shown) and at the other to the outer end of the device handle 14. Leading from the latter connection is an air passage 56 which communicates with a shallow cavity 57 formed equally by registering recesses in the handle base 58 and that face of cylinder block portion 13 to which the handle is firmly attached. The cavity 57 functions as a distributor head to two sets of inlet ports 60 and 61. Inlet ports 60 are associated with the forward drive action of the cutting tool (counter-clockwise as viewed from the front of the device or as viewed in Figs. 4 and 5) and inlet ports 61 are associated with the reverse drive action as for withdrawing the cutting tool out of the work (clockwise). Inlet ports 60, (forward drive) shown as three in number, lead upwardly from the right side of cavity 57 (as viewed in Figs. 4 and 5) and through both the block portion 13 and the body liner 15. Ports 60, when properly in register with three valve ports 62 formed in rotor housing 17 permit compressed air to enter the right side of eccentric bore 18 (Fig. 5) and, as previously explained, act upon vanes 23 of rotor 21 to cause rotation of the rotor in a counter-clockwise direction. Inlet ports 61 (reverse drive) lead upwardly from the left side of cavity 57 (Figs. 4 and 5) and thru block portion 13 and liner 15. When inlet ports 61 are in register with three valve ports 63 formed in housing 17 compressed air is admitted to eccentric bore 18 and causes rotor 21 to rotate clockwise. It is to be noted that the two sets of valve ports 62 and 63 in the slidable housing 17 are disposed directly opposite each other on opposite sides of the housing and the three ports in one set are equally spaced from each other. However, in the case of the two sets of inlet ports 60 and 61, ports 60 are not opposite ports 61 but nearer the rear (right in Fig. 3) of the device by a distance equal to at least four times the diameter of a port.

Thus when the device body 10 is shifted to the left (Figs. 2 and 3) relative to the housing 17 forward drive inlet ports 60 register with valve ports 62 and the rotor 21 rotates counter-clockwise as viewed in Fig. 5 and the expanded air in the rotor pockets is exhausted through three exhaust valve ports 64 in housing 17 which are then in register with exhaust ports 65 in liner 15 and body block portion 13. Both the exhaust ports 64 and exhaust valve ports 65 are on the opposite side of the device from inlet ports 60 and 62.

Clockwise (reverse) rotation of the rotor is produced when the main body 10 is shifted to the right (Figs. 2 and 3) relative to housing 17 until the head of an adjustable screw 70, which is threaded into body plug 12, strikes the forward end of the internal gear sleeve 41 of the slidable operating unit. The inlet or reverse ports 61 and valve ports 63 are thus brought into register and, on the opposite side of the device, three exhaust valve ports 66 in housing 17 are registered with three exhaust ports 67 formed in the main body 10 and liner 15 and the air motor is then drivable in reverse direction. Screw 70 may be turned to move it to the right (Fig. 2) so as to hold the slidable unit with the valves 63 in register thereby causing continuous rotation in a clockwise direction.

Preferably each of the exhaust valve ports 64

and 66 may be provided with grooves 67 leading therefrom in diminishing area towards the line contact between rotor hub 21 and rotor housing 17. The grooves 67 prevent the trapping of any air in a rotor pocket before the pocket reaches the point of air inlet.

Provision is made in the device so that under certain conditions of operation, as for instance the tapping tool reaching the bottom of a blind hole or an overloading of the mechanism due to a broken tool, etc., the air motor is automatically stopped even before the operator can react to the conditions and bring the motor to a stop manually. As embodied a relatively strong compression spring 68 is nested within the rear spring 52 between ring support 26 and end wall 11 but it is shorter than spring 52 by a distance equivalent to that necessary to register intake ports 60 and valve ports 62. It is adapted to be engaged and compressed by the ring support 26 in the course of the rearward travel of the ring support and resists further relative movement of the operating unit unless additional thrust effort is applied to the device by the operator. This additional thrust effort occurs when, for any reason, the normal feeding of the tool into the work is arrested by adverse or other conditions and continuing push by the operator occurs. The spring 68 is then compressed and valve ports 62 move out of register with forward drive intake ports 60 thus stopping the air motor and allowing the operator time to take appropriate action to reverse the motor or investigate the reason for the stoppage.

Means are also provided in the device to enable it to be run continuously, as for instance in production drilling, still retaining the overload stopping feature but not the reversing feature. As embodied the adjustable screw 70 threaded into the body plug 12 may be screwed inwardly to force the slidable operating unit rearwardly (against balancing spring 52) until forward inlet ports 60 are in register with valve ports 62. The air motor, in this position, will then run continuously as long as compressed air is supplied thereto or until such conditions arise where the body 10 moves forward relative to the operating unit (as in overload), compressing spring 68 and shutting off air supply by de-registering intake ports 60 and valve ports 62 as previously described.

If desired, when using the device as adjusted for continuous running, a conventional trigger type air valve (not shown) may form part of the handle 14.

The device as a whole is so constructed that it may be used as an attachment for a machine tool as for instance a turret lathe. When used in this manner the side or top faces of body block portion 13 may serve as bolting surfaces for brackets or supports (not shown) forming part of the machine tool. Recessed passages 71, in communication with each of the two sets of exhaust ports 65 and 67 are formed in the two side faces of block portion 13 so that if these sides are used as bolting surfaces the exhaust air circuit is not blocked.

Operation

In a right hand thread tapping operation in a blind hole the device is operated as follows: outer end of tapping tool 46 is placed in the hole entrance and the operator presses the device towards the work (left in Figs. 1 and 2). The tool 46, not yet rotating, and the slidable operating

unit inside the device to which it is attached cannot yet move but the body 10 moves forward under the operator's pressure, causing the rear balance spring 52 to be compressed between the body end wall 11 and ring support 26 of the operating unit and registering forward intake ports 60 and valve ports 62. Compressed air, thus admitted to rotor housing bore 18, starts air motor and tool 46 rotating forwardly. Tool 46 begins and continues to cut threads in the hole, pulling itself into the work. The body 10 of the device is continuously urged forward by the operator during the tool feeding movement with just sufficient hand pressure to maintain the air intake ports in register.

When the tapping tool 46 reaches the bottom of the hole and the internal operating unit cannot move further forward the continued hand pressure of the operator moves the body 10 still further forward, compressing secondary spring 68 and moving intake ports 60, 62 and exhaust ports 64 and 64 out of register thus stopping rotation of air motor and tool 46 and notifying the operator that the threading action is completed.

To extract the tapping tool from the work the body 10 is moved rearwardly away from the work. The tool and internal operating unit cannot yet follow this movement with the result that the body 10 shifts relative thereto until the head of adjustable screw 70 strikes internal gear sleeve 41, compressing forward balance spring 51 and bringing reverse intake ports 61 and valve ports 63 and exhaust ports 66 and 67 into register. Air, thus admitted to the reversing side of the air motor, reversely rotates tool 46 which screws itself out of the work, the operator, during this time, maintaining the necessary hand pressure rearwardly to maintain the air ports in register. As soon as the tool 46 is free from the hole, forward balance spring 51 restores the internal operating unit to its central position in the body 10, de-registering all air ports and stopping the rotation of the air motor.

In tapping a through hole the operation is the same as above described except that as the tool finishes its cutting work and starts riding forward at a higher speed through the finished hole the rear balance spring 52 urges the operating unit forward faster than the operator is urging the body 10 resulting in centralizing the two parts and thus de-registering air ports to stop rotation. Retraction of the tool from the work is the same as already described above.

Drilling operations follow the same procedure as tapping except that the infeed of the drill is maintained by the operator's pressure on the device which holds the forward intake ports in register. The infeed pressure thus partakes of the strength of rear balance spring 52. In drilling a blind hole the operator simply stops forward thrust of the device when the desired hole depth is reached and the body 10 and internal operating unit automatically centralizes and stops rotation. Rearward pull on body 10 by the operator either retracts the drill from the work direct if it is sufficiently free in the hole or sets the device in reverse rotation position and twists the drill out of the hole.

Alternatively, drilling may be accomplished with continued rotation by shifting the slidable unit 17 by means of adjustable screw 70. In this case rotation is controlled by the manually controlled valve, not shown, in the supply line 55.

It will be obvious from a study of the drawings that numerous other machining operations

may be performed by the described device by use of other cutting tools such as burnishers, end grinders, counterbores, chamfers, and mills, key-way cutters, etc.

The invention in its broader aspects is not limited to the specific mechanisms shown and described but departures may be made therefrom within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

What we claim is:

1. In an air driven motor tool, the combination of a reversible, rotary air motor, a casing in which the motor is slidably mounted, valve ports for supplying air to drive the motor in one direction and alternatively in the opposite direction and means controlled by the axial thrust imposed by the work on the motor for selectively controlling said valve ports whereby the direction of rotation of the motor is controlled by the direction of thrust on the motor.

2. An air driven motor tool as claimed in claim 1 in which the valve ports comprise air passages in the motor and casing normally out of register with each other and selectively brought into register by relative sliding movement of the motor and casing.

3. An air driven motor tool as claimed in claim 1 in which resilient means are provided for moving the motor to a normal position in the casing.

4. An air driven motor tool as claimed in claim 1 in which the motor is formed with a plurality of air inlet ports, and the casing is provided with a plurality of air ducts selectively registered with the ports by relative sliding movement of the motor and casing.

5. An air driven motor tool as claimed in claim 4 in which spring means at each end of the casing normally centralize the motor and the ports and ducts are so spaced as to shut off the air supplied to the motor in its centralized position.

6. An air driven motor tool as claimed in claim 5 in which the motor drives a tool holding spindle through planetary speed reduction gearing mounted at one end of the motor and within the casing.

7. An air driven motor tool as claimed in claim 6 in which the motor is a reversible eccentric vane air motor.

8. In a motor tool for reversible operation, the combination of a high speed reversible motor, a cutter-tool holder driven by the motor, selector means for reversibly supplying the motor with power to drive it alternatively in one direction or the other, a casing in which the motor is slidably mounted for axial movement by thrust imposed on the work, and means controlled by axial sliding movement of the motor in its casing for selectively controlling said selector means to cause operation of the motor in one direction or the other depending on axial displacement of the motor in its casing from its normal position.

9. A motor driven tool according to claim 8 in which spring means normally centralize the motor in the casing and the selector means interrupts the supply of power to the motor in that position.

10. A motor driven tool according to claim 9 in which means are provided for stopping the supply of power to the motor on overloads.

11. A motor driven tool according to claim 8

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in which means are provided for stopping the supply of power to the motor on overloads.

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