

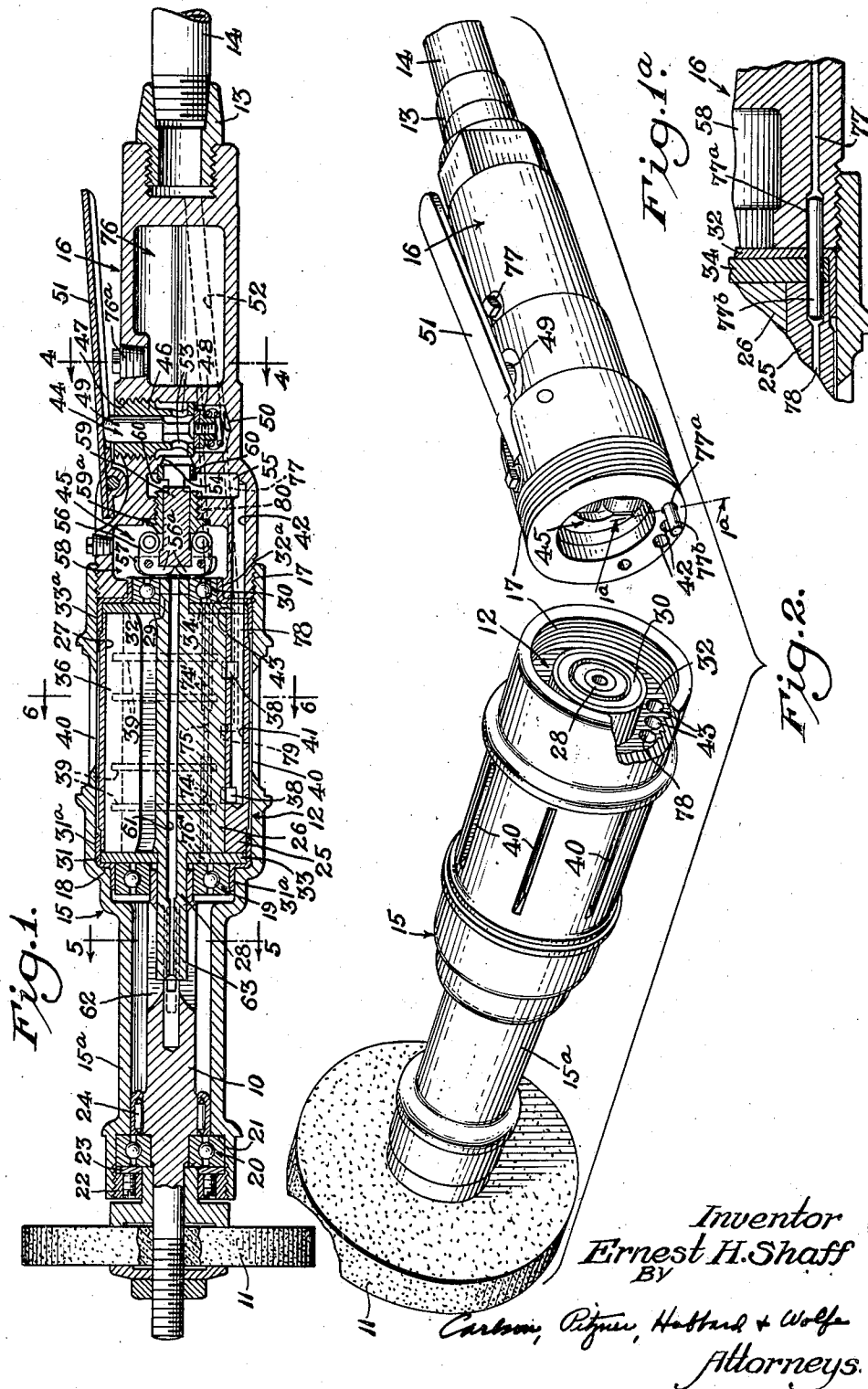
March 22, 1949.

E. H. SHAFF
LUBRICATION OF ROTARY EXPANSIBLE
CHAMBER SLIDING VANE TOOL MOTORS

2,464,997

Filed Jan. 8, 1944

3 Sheets-Sheet 1



Inventor
Ernest H. Shaff
BY

Carlson, Pitman, Hubbard & Wolfe
Attorneys.

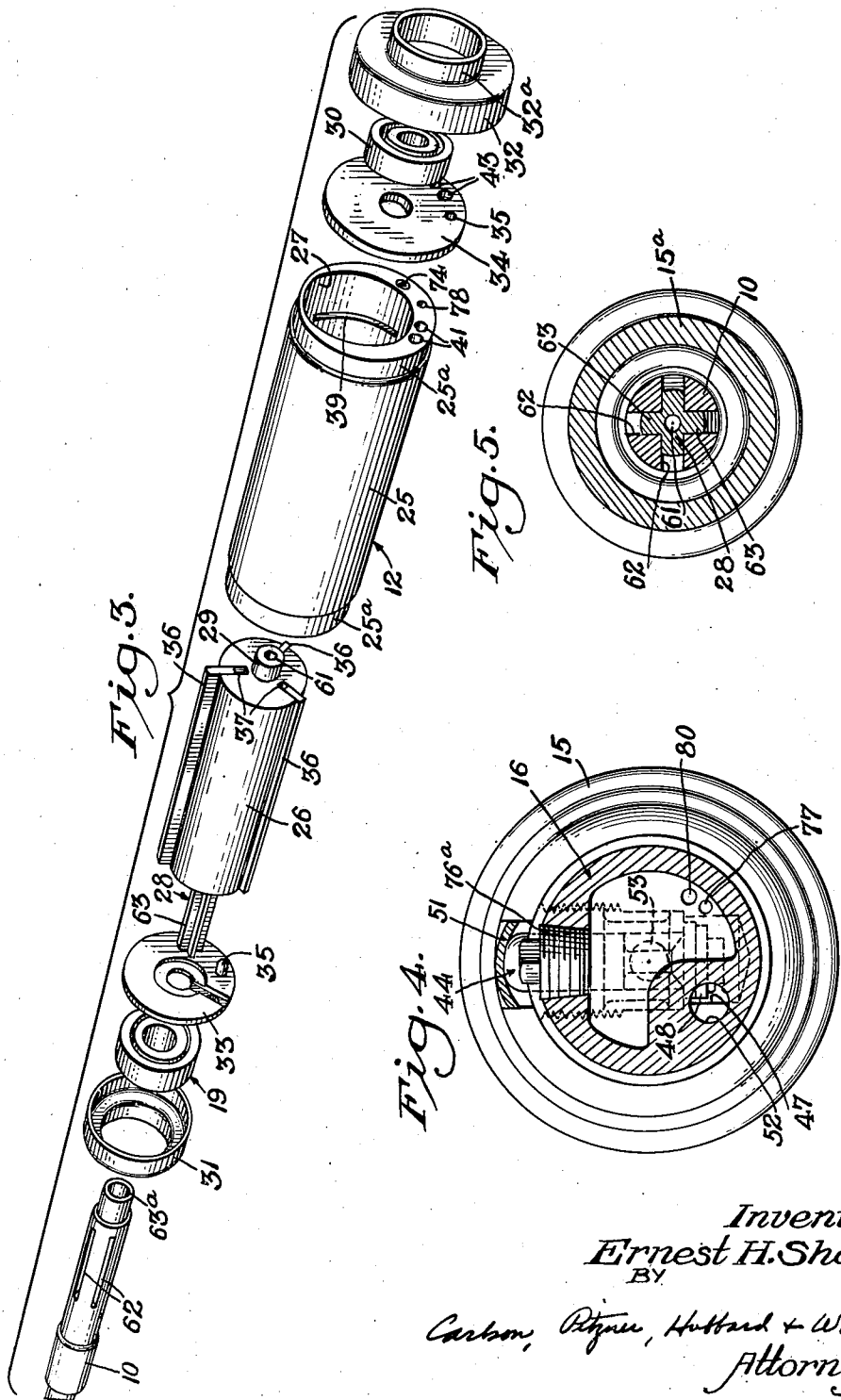
March 22, 1949.

Filed Jan. 8, 1944

E. H. SHAFF
LUBRICATION OF ROTARY EXPANSIBLE
CHAMBER SLIDING VANE TOOL MOTORS

2,464,997

3 Sheets-Sheet 2



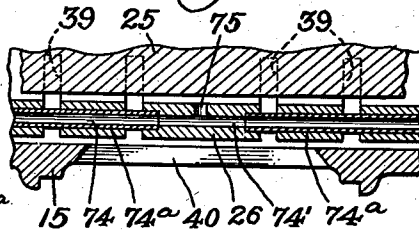
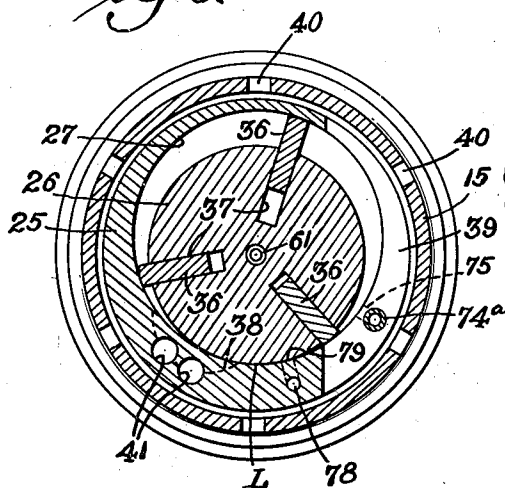
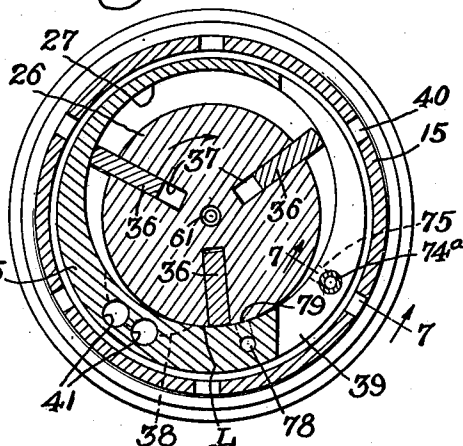
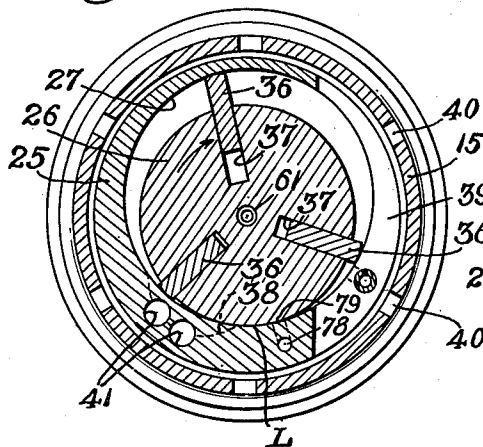
Inventor
Ernest H. Shaff
BY

Carson, Pitman, Hubbard & Wolfe
Attorneys.

Filed Jan. 8, 1944

CHILDERN BEARING FINE TOOTH MOTORS

3 Sheets-Sheet 3



Carlson, Pitzer, Hubbard & Wolfe
Attorneys.

UNITED STATES PATENT OFFICE

2,464,997

LUBRICATION OF ROTARY EXPANSIBLE
CHAMBER SLIDING VANE TOOL MO-
TORSErnest H. Shaff, Spring Lake, Mich., assignor to
Keller Tool Company, a corporation of Michi-
gan

Application January 8, 1944, Serial No. 517,526

6 Claims. (Cl. 121—34)

1

The present invention pertains to improve-
ments in portable pneumatic tools, and more par-
ticularly to such tools embodying rotary type
pneumatic motors.

One object of the present invention is to pro-
vide a novel and improved lubricating arrange-
ment for the cylinder walls of the motor of such
a device, which arrangement is of such character
as to insure adequate and effective lubrication
during operation of the motor without danger
of loss of the lubricant when the tool is idle.

More particularly, it is an object to provide a
lubricating arrangement for the cylinder walls
of the motor of such a device in which high fre-
quency pressure impulses in a restricted passage
leading from a lubricant chamber to the motor
cylinder are set up intermittently during opera-
tion of the tool and utilized to effectuate the
transfer of lubricant from the supply chamber
to the cylinder.

Still another object is to provide such a tool
embodying a novel and improved lubricating ar-
rangement for the bearings of a tool spindle
splined to the motor rotor.

Further objects and advantages of the inven-
tion will become apparent as the following de-
scription proceeds, taken in connection with the
accompanying drawings, in which:

Figure 1 is a longitudinal sectional view
through a tool embodying the present invention.

Fig. 1^a is a fragmentary sectional view on line
1^a—1^a of Fig. 2 showing a detail of construction.

Fig. 2 is an exploded perspective view of the
tool of Fig. 1.

Fig. 3 is an exploded perspective view of the
motor assembly for the tool.

Figs. 4 and 5 are enlarged transverse sectional
views taken substantially along the lines 4—4
and 5—5, respectively, in Fig. 1.

Fig. 6 is a transverse sectional view through the
motor taken substantially along the line 6—6 in
Fig. 1.

Figs. 6^a and 6^b are stop motion sectional views
similar to Fig. 6.

Fig. 7 is a fragmentary detail sectional view
taken substantially along the line 7—7 in Fig. 6.

While the invention is susceptible of various
modifications and alternative constructions, I
have shown in the drawings and will herein
describe in detail the preferred embodiment, but
it is to be understood that I do not thereby intend
to limit the invention to the specific form dis-
closed, but intend to cover all modifications and
alternative constructions falling within the spirit
and scope of the invention as expressed in the
appended claims.

2

Referring more particularly to the exemplary
embodiment of the invention illustrated in the
drawings, the tool there shown comprises a tool
spindle 10 carrying a grinding wheel 11 driven
by a rotary type pneumatic motor designated
generally as 12. Compressed air for operating
the motor is supplied through a nipple 13 at the
rear end of the tool, the nipple serving for at-
tachment of a flexible supply hose 14 to any suit-
able source (not shown).

To house the motor 12 and spindle 10, a
generally cylindrical casing or housing 15 is em-
ployed. A handle 16 is threaded in one end of the
casing (see Fig. 2) as indicated at 17 and clamps
the motor within the casing against a shoulder
18 in the latter (Fig. 1). The opposite end por-
tion 15^a of the casing 15 is of reduced diameter
and constitutes a tubular spindle housing. At
opposite ends of this spindle housing are ball
bearings 19 and 20 for supporting the spindle 10,
the latter bearings also serving to support one
end of the rotor of the motor. The outer race of
the ball bearing 20 is clamped against a shoulder
21 by a locking ring 22 threaded in the end of the
casing and having a packing 23 disposed between
it and the bearing races. A needle bearing 24
within the housing also aids in supporting the
spindle.

In the illustrative embodiment, the motor com-
prises a cylindrical body or cylinder 25 and a
rotor 26; the cylinder having an axially extend-
ing cylindrical bore 27 therein (see Figs. 1 and 3)
which constitutes the cylinder chamber and which
is eccentric with respect to the axis of the
cylindrical body. The periphery of the rotor is
cylindrical and is dimensioned for substantially a
line contact L with the inner wall of the cylinder
bore or chamber (see Fig. 6) when the rotor is
disposed concentrically with the body of the
cylinder. The ends of the rotor have reduced
diameter axial projections 28, 29 thereon, one
being received within a ball bearing 30 and the
other being splined within the telescoping inner
end of the tool spindle 10 and thus supported by
the bearing 19. Retainer rings 31 and 32 hold
end plates 33 and 34 in position at opposite ends
of the cylinder and also support the bearings 19
and 30 which in turn support the rotor projec-
tions 28 and 29. Dowels 35 serve to locate the end
plates.

The motor rotor 26 is provided with a plurality
of blades 36 (here shown as three in number)
equidistantly spaced about the axis of the rotor
and movable radially of the latter under the com-
pulsion of centrifugal force (see Figs. 3 and 6).
These blades 36 are received in slots 37 which

extend longitudinally of the rotor and the outer edges of the blades wipe in sealing contact with the inner wall of the cylinder. To revolve the rotor, compressed air is admitted to the cylinder through inlet ports 38 located on one side of the line of contact L of the rotor with the cylinder and permitted to escape through exhaust ports 39 located on the opposite side of such line of contact. In the present instance the exhaust ports 39 are formed as a plurality of longitudinally spaced circumferentially elongated slots in the cylinder, and the surrounding casing 15 is longitudinally slotted as indicated at 40 (Fig. 2) so that the exhausting air is free to escape to atmosphere. The intake ports 38 are, on the other hand, supplied with compressed air through a pair of passages 41 drilled in the cylinder and leading from the right-hand end thereof (as viewed in Fig. 1). Such passages communicate with a corresponding pair of supply passages 42 formed in the handle 16 and registering with holes 43 in the end plate 34 which in turn register with the ends of passages 41.

The admission of compressed air to the supply passages 42 is controlled by a manually operable valve 44 and a governor 45 (Fig. 1). The valve 44 comprises a bushing 46 threaded in a transverse bore 47 in the handle 16 and having a valve element 48 carried by a valve stem 49 slidable in it. A compression spring 50 interposed between the bottom of the bore and the valve element normally urges the latter into closed position against the valve seat constituted by the inner end of the bushing. A hand lever 51 pivoted on the handle 16 and overlying the end of the valve stem 49 serves to thrust the latter inward for moving the valve element away from its seat to open position. Compressed air is led through a passage 52 from the nipple 13 to the lower end of the valve bore 47 and when the valve element 48 is open, passes upward about it and around the reduced portion of the valve stem 49, finally emerging through openings 53 in the bushing 46. The compressed air leaving these openings 53 passes through a short bore 54 into a chamber 55 from which the passages 42 lead.

Entry of the compressed air into the chamber 55 is regulated by the governor 45 in order to maintain the speed of the motor substantially constant at a value determined by the setting of the governor. As shown, the governor 45 comprises a pair of flyballs 56 pivoted on a head 57 secured to the rotor extension 29 and located within a governor chamber 58 in the handle 16. These flyballs 56 have fingers 56^a bearing against the end of a stem 59 which is slidable axially in a bushing 59^a threaded in the portion of the handle separating the chambers 55 and 58 and slotted to form ports 60 controlled by the stem 59. The flyballs act in opposition to the pressure of the air acting on the end of the valve stem exposed in the chamber 55, and tend to close the ports as the speed increases to throttle the flow of air from the bore 54 into the chamber 55 variably, depending upon the axial displacement of the stem.

Provision is made for lubricating the spindle bearings 19, 20 with lubricant, such as light grease, from a reserve supply formed by the governor chamber 58. For that purpose an axial passage 61 is provided in the rotor 26 extending from end to end therethrough and communicating at its right-hand end with the interior of the governor chamber 58. The latter is re-

tained under substantial pressure by compressed air leaking along the stem 59 so that lubricant is forced from the governor chamber 58 through the passage 61 to the outer end of the latter in the rotor projection 28, the spindle housing being vented to facilitate such flow as hereinafter described. The spline coupling between the tool spindle 10 and rotor projection 28 is such as to permit lubricant to emerge from the latter into the spindle housing 15^a through which it passes to the several bearings 19, 20 and 24. For that purpose, the rear end of the spindle is made in the form of a sleeve having a plurality (herein four) of longitudinal slots 62 (Fig. 5) which are of somewhat greater length than complementary spline teeth 63 on the rotor projection 28 (Figs. 1 and 5). Since the slots thus extend somewhat beyond the end of the rotor projection, lubricant is free to flow from the open end of the passage 61 out through the unobstructed portions of these slots 62 into the spindle housing 15^a. The ball bearing 30 at the other or right-hand end of the rotor 26 (Fig. 1) is lubricated directly from the governor chamber 58, being mounted in one wall of the latter.

Venting of the spindle housing 15^a is accomplished through a passage 74 drilled in the cylinder 25 (Figs. 1 and 7) leading to a lubricant port 75 which opens into the exhaust zone or portion of the cylinder alongside the exhaust ports 39. Tubes 74^a pressed in the passage 74 bridge the exhaust ports or slots. At its end adjacent the spindle the passage 74 registers with a hole 76¹ in the end member 33, the latter having a radially extending relief or slot in its face adjacent the bearing 19. Since the spindle housing is thus vented through bearing 19, lubricant is carried to it and on to the port 75 where the rotor blades pick it up to wipe it around the cylinder walls.

Lubrication of the cylinder wall to prevent scoring by the rotor blades is an especially acute problem in tools of the general type described and, in accordance with one aspect of the present invention, a novel arrangement is provided for furnishing lubricant for that purpose and may serve either as a supplement to or instead of the supply to the cylinder so far described. A reserve supply of lubricating oil for lubrication of the cylinder wall is contained in a chamber 76 within the handle 16 (Fig. 1) and having a filler opening closed by a plug 76^a. In brief, lubricant from this chamber 76 is conveyed to the cylinder by utilizing the motor rotor, when the latter is in operation, to apply intermittent high frequency impulses of pressure to an extremely restricted passage leading from the supply chamber to the cylinder.

In the particular construction illustrated (see Figs. 1, 4 and 6), lubricant is supplied from the chamber 76 through a small passage 77 in the handle 16 and then through a corresponding small passage 78 in the cylinder 25 which terminates in a lubricant port 79. This latter port 79 is located substantially midway between the line of contact L between the rotor and cylinder and the adjacent end of the exhaust slots 39. As the rotor 26 revolves, each successive blade 36 passes from the position of Fig. 6 to that of Fig. 6^a and at which latter position communication between the lubricant port 79 and exhaust slots 39 is cut off. Thereafter the blade and rotor compress the air trapped between the blade and the lubricant port, applying pressure to the latter. When the blade passes the lubricant port (Fig. 6^b), the

5

pressure impulse is interrupted by the reestablishment of its communication with the exhaust slots. Thus pressure is applied to the closed lubricant chamber 76 intermittently and at high frequency, there being three such applications and release of pressure for the lubricant port, one for each blade, during each revolution of the rotor. The rotor of the particular tool illustrated revolves at nearly 20,000 R. P. M. when running free and has a normal operating speed of about 12,000 R. P. M. when controlled by the governor 45 for normal operation. In other words, there are normally 36,000 pressure impulses per minute or 600 per second applied intermittently to the lubricant port 79.

To afford a suitably high degree of restriction in the passage 77, 78 between the lubricant reservoir 76 and port 79, the passage is slightly enlarged at 77^a (Fig. 1^a) and a pin 77^b of only slightly smaller diameter inserted in this enlargement. By way of example, the enlarged portion of the passage may be 0.0960 inch in diameter and the pin 0.0937 inch in diameter. As shown, such enlarged portion is located at the junction of the handle with the cylinder.

It has been found that when high frequency pressure impulses are applied to such a restricted passage in the manner described, that an effectual and continuous flow of lubricant takes place from the supply chamber to the lubricant port. At the latter it is picked up by the blades and wiped around the cylinder walls. On the other hand, when the tool is idle, the passage from the supply chamber is so highly restricted at 77^a, 77^b that no appreciable amount of the lubricant leaks into the cylinder. Theoretical analysis of the action of the device in inducing such flow of lubricant is difficult. Apparently, however, the successive sudden releases of pressure at the lubricant port cause corresponding minute increments of lubricant to be aspirated through it, and the next succeeding blade each time intercepts the increment of lubricant before it can be blown out of the exhaust slot and wipes it around the cylinder wall.

The intermittent pressure applied by the motor to the lubricant chamber 76 may also be utilized to inject lubricant into the motor cylinder through the port 75. For this purpose, the passage 74 (Fig. 7) is extended rearwardly from the port 75 as at 74' for connection with a passage 80 in the handle, leading to the chamber 76.

As previously noted, the lubricant port 75 opens into the inner cylinder wall on the exhaust side. When so arranged, the pulsations of pressure applied to the port 79 are transmitted through the passage 78, 77 to the lubricant in the supply chamber 76, thus forcing such lubricant out through the passage 80 to the other lubricant port 75 where it is picked up by successive ones of the blades 36 and wiped about the cylinder wall. The passage 80, like the passage 78, 77, must be highly restricted in order to prevent using an excess of lubricant.

I claim as my invention:

1. In a portable tool, the combination of a rotary pneumatic motor including a cylinder having a rotor eccentrically mounted therein, said rotor having a plurality of blades thereon and movable outwardly therefrom by centrifugal action in the rotation of the rotor, said cylinder having air inlet and exhaust ports disposed on opposite sides of the point of least displacement of the rotor from the cylinder, said cylinder also

6

having a lubricant port disposed between said point and said exhaust port and at a lesser distance from the latter than the spacing between successive blades, and means defining an air tight lubricant chamber communicating with said lubricant port through a highly restricted passage, each of said blades being operative in the rotation of the rotor to trap and deliver to said chamber through said lubricant port a small quantity of air serving to force the lubricant in the chamber reversely through the port following movement of the blade past the port.

2. In a portable tool, the combination of a rotary pneumatic motor including a cylinder and having a cylindrical rotor eccentrically mounted therein and disposed in line contact with the inner wall of the cylinder, said cylinder having air inlet and exhaust ports disposed on opposite sides of the line of contact between said rotor and cylinder, said rotor having a plurality of blades thereon movable generally radially of the same, said cylinder also having a lubricant port therein disposed between said exhaust port and the line of contact between the rotor and cylinder, said lubricant port being at a lesser distance from the exhaust port than the spacing between successive blades about the rotor, means defining an air tight lubricant chamber communicating with said lubricant port through a passage, and a plug partially filling said passage to afford a high degree of restriction in the same.

3. In a portable tool, the combination of a rotary pneumatic motor including a cylinder and having a cylindrical rotor eccentrically mounted therein and disposed in line contact with the inner wall of the cylinder, said cylinder having air inlet and exhaust ports disposed on opposite sides of the line of contact between said rotor and cylinder, said rotor having a plurality of blades thereon movable generally radially of the same, said cylinder also having first and second lubricant ports therein, said first lubricant port being disposed between said exhaust port and the line of contact between the rotor and cylinder, and means defining a closed lubricant chamber communicating with said first lubricant port and also defining a second passage from said chamber to said second lubricant port, the latter port being located within said cylinder in a zone constantly in communication with said exhaust port.

4. A portable tool having a rotary pneumatic motor including a cylinder and a rotor, said rotor having an axial projection at one end thereof provided with longitudinally extending spline teeth, a tool spindle telescoped over said projection and having longitudinally extending slots therein receiving said teeth, said teeth being disposed to stop short of the inner ends of said slots to leave the inner portions of the latter open, a bearing supporting said spindle, and said rotor having an axially extending passage therein for supplying lubricant to said bearing, said passage terminating at the end of said projection, whereby lubricant emerging from the passage at the end of said projection is free to pass outward through said open inner portions of said slots into proximity with said bearing.

5. A portable tool having a rotary pneumatic motor including a cylinder and a rotor, an elongated body providing a motor casing with extensions at opposite ends of the motor defining, respectively, a lubricant chamber and a spindle housing, said rotor having an axial projection on the end thereof adjacent said spindle housing, a tool spindle in said spindle housing telescoped

over said projection and splined thereto, such spline connection including longitudinal slots in said spindle receiving teeth on said projection, bearings at opposite ends of said spindle housing supporting said spindle, the bearing at the inner end of said spindle housing receiving the end portion of the spindle telescoped over said projection and thereby also supporting the adjacent end of said rotor, said rotor having an axial passage therethrough leading from said lubricant chamber and terminating at a port in said projection, said teeth extending for only part of the length of said slots to permit the egress of lubricant from said port into the spindle housing at a point intermediate said bearings, and means for admitting air under pressure to said lubricant chamber to force lubricant from the latter through said passage and out of said port.

6. A portable tool having a rotary pneumatic motor including a rotor, said rotor having an axial projection at one end thereof, a tool spindle splined to said projection, bearings for said spindle and said one end of the rotor, means defining a lubricant chamber adjacent the other end of said rotor, and said rotor having an axial passage therein leading from said chamber and through said projection to a point adjacent said

bearings, said splined connection including a slot permitting the escape of lubricant from said passage.

ERNEST H. SHAFF.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
316,309	Telfer	Apr. 21, 1885
560,314	Fertig	May 19, 1896
611,700	Miner	Oct. 4, 1898
927,929	Bearinger et al.	July 13, 1909
1,122,109	Hansen	Dec. 22, 1914
1,385,880	Master	July 26, 1921
1,514,007	Moore et al.	Nov. 4, 1924
1,931,167	Price et al.	Oct. 17, 1933
1,933,000	Young	Oct. 31, 1933
2,099,280	Shaff	Nov. 16, 1937
2,246,910	Amstberg	June 24, 1941

FOREIGN PATENTS

Number	Country	Date
9,645	Great Britain	Apr. 25, 1902