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PNEUMATIC MOTOR

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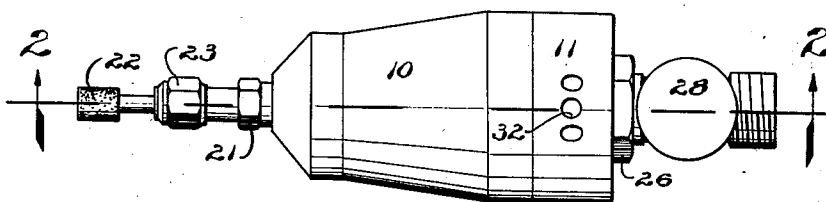
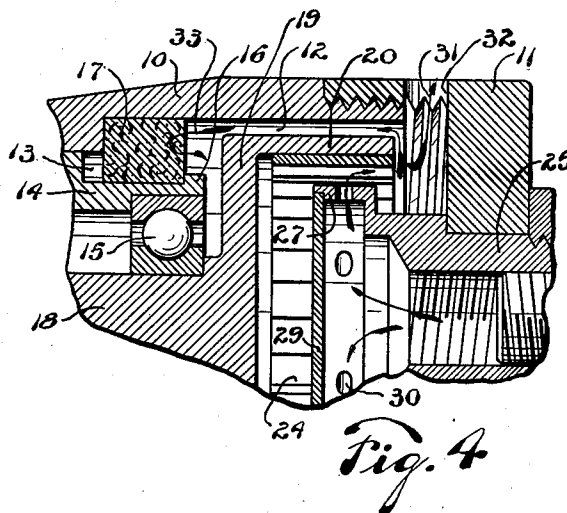
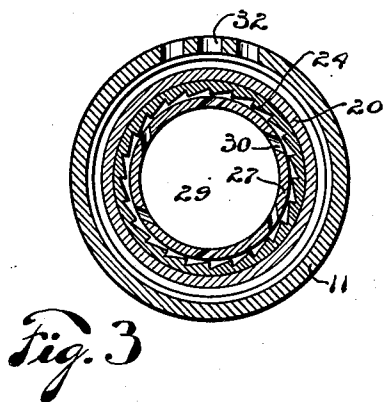
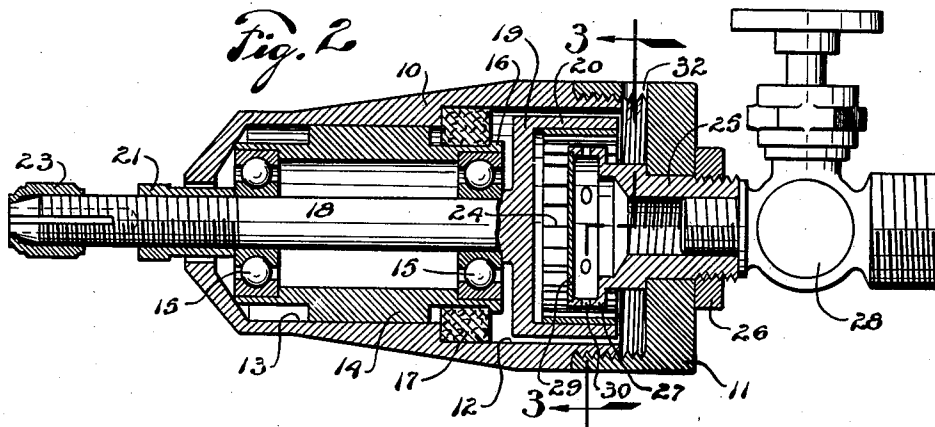


Fig. 1

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## UNITED STATES PATENT OFFICE

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## PNEUMATIC MOTOR

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8 Claims. (Cl. 253-2)

The object of my invention is to provide a pneumatic motor of simple, durable and inexpensive construction.

A further object of my invention is to provide a pneumatic motor capable of exceptionally high speed operation. My improved motor is adapted to drive a small internal grinding wheel at a peripheral speed sufficient to give an efficient grinding operation. It is well known in the grinding art that a surface or peripheral speed of between six and eight thousand feet per minute is necessary in order to produce an efficient grinding action. Consequently, when it is desired to finish the bore of small cylinders of from one-quarter or five-sixteenths of an inch in diameter, a very high speed of rotation is necessary to obtain the necessary six to eight thousand feet per minute peripheral speed.

In the manufacture of fuel pumps for Diesel type engines my motor is especially useful. The problem of finishing the small pump cylinder bores to the accurate dimensions required can only be done satisfactorily by grinding. My improved pneumatic motor is designed to grind such openings at an efficient grinding speed. The motor shown in the attached drawing has a normal operating speed of one hundred thousand revolutions per minute using a  $\frac{1}{8}$  inch diameter wheel and operating under 100 pounds of air pressure. A smaller sized motor is being made which operates at 175,000 revolutions per minute under the same air pressure. These high speeds are believed to be the result of improvements which form the subject matter of this application.

A further object of my invention is to provide a pneumatic motor of the class described in which the bearings are lubricated in an improved manner.

Still a further object of my invention is to provide a motor of the class described which will have an improved rotor construction and which will utilize the air supplied to operate same in a more efficient manner than heretofore has been accomplished.

With these and other objects in view, my invention consists in the arrangement, construction and combination of the various parts of my improved device, as described in this specification, claimed in my claims and illustrated in the accompanying drawing in which:

Figure 1 is a full-sized plan view of my improved motor construction.

Figure 2 is an enlarged sectional view, taken on the line 2-2 of Figure 1.

Figure 3 is a sectional view, taken on the line 3-3 of Figure 2, and

Figure 4 is a still further enlarged sectional view of the rotor portion of the motor illustrating

the path taken by the air in flowing through the motor.

Referring to the accompanying drawing I have used the reference numeral 10 to indicate a cylindrical housing, one end of which is threaded to receive a cap 11. That portion of the housing 10 adjacent to the cap 11 is formed with a relatively large bore 12 therein, while the bore 13 in the other or front end of the housing 10 is of smaller diameter. A bearing sleeve 14 is adapted to be pressed in the bore 13 and a pair of single row ball bearing assemblies 15 are pressed in the respective ends of the sleeve 14. An annular bead 16 extends outwardly from the inner end of the sleeve 14 and a felt ring 17 of rectangular cross-section is disposed in the bore 12 between the bead 16 and the shoulder formed between the bores 12 and 13. The ring 17 is adapted to be saturated with oil when assembled and to form a wick for lubricating the bearings, as will later be described.

The rotor of my improved motor comprises a shaft 18 which is mounted upon the bearings 15. The end of the shaft which terminates within the bore 12 is formed integrally with a disc 19, periphery of which is formed integrally with a driving cylinder 20. The cylinder 20 is housed within the bore 12 and is of a diameter sufficiently smaller than the bore 12 that an air passageway therebetween is provided. It will be noted that the shaft 18 projects through the front end of the housing 10 and that the projecting end of the shaft is threaded to receive a nut 21 which may be threaded down to thus prevent end movement of the shaft relative to the bearings 15. A further function of the nut 21 is to impress an axial load on the bearing assemblies just sufficient to take the end play out of the bearings. This is essential for high speed operation of all ball bearings.

The projecting end of the shaft 18 is bored to receive the shank of the grinding wheel 22 and is slotted longitudinally so that when a collet 23 is screwed down over the end of the shaft the shaft will grip the grinding wheel shank as in a conventional chuck.

It will be noted from Figure 3 that the bore of the cylinder 20 is formed of an annulus of saw-teeth 24, one edge of each tooth extending radially, and the other edge extending diagonally so as to connect the top of one tooth with the base of the adjacent tooth. These saw teeth extend substantially the full length of the cylinder 20. The cap member 11 is provided with a central opening therethrough, and fitting 25 is secured by means of a nut 26. The fitting 25 is provided with a distributing head 27 which is disposed within the cylinder 20 and a needle valve 28 is screwed into an opening in the other end of the fitting. The inner end of the head

27 is closed with a conventional expansion plug 29. Referring to Figures 2 and 3 it will be noted that six openings 30 are provided in the periphery of the head 27, these openings being equally placed therearound. The axis of each opening extends in a diagonal direction relative to the radial sides of the teeth so that air which is forced from the head through the openings 30 will be directed at an angle against the radial sides of the teeth 24.

The operation of my improved motor is as follows:

Air under pressure is admitted to the distributing head 27 by means of the needle valve 28 and is directed against the teeth 24 through the six openings 30. This causes the cylinder 22 to revolve. Inasmuch as repeated tests have shown this motor to be two to three times as efficient as similar motors having radially extending driving teeth, it is believed that the air after striking one tooth is forced against the periphery of the head and rebounds against a second tooth of the rotor. This operation is believed to be repeated until the air finally escapes from between the head and the rotor.

The path followed by the air is shown by arrow 31 in Figure 4. The air after leaving the rotor collects in the space between the cap 11 and the large end of the cylinder 20. Three exhaust ports 32 are provided in the cap 11 through which the major portion of the air is discharged. However, these ports sufficiently restrict the flow of air from the housing that a small but definite percentage flows forwardly between the cylinder 20 and the housing 10, as shown by arrows 33. This portion of the air strikes against the felt ring 17. The air rebounds from the felt ring and flows downwardly along the forward side of the disc 19 and enters the space between the balls of the inner bearing assembly 15. The air then flows forwardly along the sleeve 14 and then through the outer bearing assembly 15. The air is discharged through an enlarged shaft opening in the forward end of the housing 10.

An extremely important feature in connection with this motor is that the felt ring when assembled is saturated with oil and the air being directed upon the ring picks up minute quantities of the oil and conducts same to the bearing assemblies. In the high speed operation of ball bearings great difficulty has been encountered in providing lubrication which will allow the bearings to operate at the high speed without burning up. If no lubrication is provided, chattering begins and the bearings soon fail. If, however, a relatively large amount of oil is provided, which in this case would be a single drop of oil, then the bearings will burn up, due to the great internal friction set up in the oil. It is essential for the successful operation of any bearing at speeds mentioned herein that only minute quantities of oil be deposited on the balls of the bearings. This can readily be demonstrated by applying a single drop of oil to a bearing of the size shown, while it is rotating at 100,000 revolutions per minute. As soon as the oil is applied the bearing will almost instantly turn blue with the excessive heat and of course fail. The applicant has provided a unique method of applying minute quantities of oil to the bearings by utilizing a small proportion of air required to operate the motor and directing this small portion of the air against an oil-fed wick and then directing the air to the bearing. As the outer surface of the ring 17 tends to dry out oil is

immediately replenished by capillary action from the rest of the ring.

Among the many advantages arising from the use of my improved motor, it may be well to mention that this motor has a rotor of an exceptionally low weight for the power developed. Furthermore, my improved rotor may be conveniently and economically machined to almost perfect dynamic balance.

Still further, due probably to the rebound air against a second tooth after it strikes one of the rotor teeth, much more efficient operation of the motor is obtainable than is possible with other air motors of this character.

Some changes may be made in the arrangement, construction and combination of the various parts of my improved motor without departing from the spirit of my invention, and it is my intention to cover by my claims such changes as may reasonably be included within the scope thereof.

I claim as my invention:

1. A device of the character described comprising, a housing, a shaft rotatably mounted upon bearings within said housing, a driving member secured to said shaft within said housing, said member having an annulus of teeth thereon, an air distributing member secured to said housing adjacent to said driving member, said distributing member having an opening therein which directs air under pressure against said teeth to rotate said shaft, an oil saturated wick disposed within said housing, said housing having an exhaust opening therein through which a portion of the air escapes after it is discharged from said distributing member, there being a continuous passageway within said housing from said distributing member past said wick and through said bearings to the outside of said housing, the remaining portion of the discharged air escaping through said passageway, for the purpose described.

2. A device of the character described comprising, a housing, a shaft rotatably mounted upon bearings in said housing, the inner end of said shaft terminating within said housing while the outer end thereof projects outwardly therefrom, a disc formed on the inner end of said shaft, the periphery of said disc having a cylinder projecting axially therefrom and within said housing, the bore of said cylinder comprising an annulus of saw teeth which extend axially along said bore, an oil saturated wick disposed within said housing, and an air-distributing head secured to said housing in position within said cylinder, said head having a diagonally extending opening in its periphery which directs the air from within at an angle against one side of each of said teeth, and said housing having an exhaust opening therein whereby a portion of the air escapes after it is discharged from said head, there being a continuous passageway within said housing from said distributing head past said wick and thru said bearings to the outside of said housing, the remaining portion of the discharged air being directed against said wick and then escaping from said housing along said passageway, for the purpose described.

3. A device of the character described comprising, a housing, a shaft rotatably mounted within said housing upon a pair of spaced bearing assemblies, one end of said shaft projecting outwardly from said housing, a cylinder secured to said shaft within said housing, the bore of said cylinder being formed of an annulus of saw

teeth which extend axially along said bore, an oil saturated wick disposed within said housing, and an air-distributing head secured to said housing within said cylinder, said head having a plurality of diagonally extending openings in its periphery which direct air from within said head outwardly at an angle to the radial against the radial sides of said saw teeth, said housing having an exhaust opening therein through which a portion of the air discharged from said head escapes from said housing, the remaining portion of the air from said head being directed against said wick and then escaping from said housing along a path through said bearings.

4. A device of the character described comprising, a housing, a shaft rotatably mounted within said housing upon a pair of spaced ball bearing assemblies, one end of said shaft terminating within said housing and the other end projecting outwardly therefrom, the inner end of said shaft having a cylinder formed thereon, the bore of said cylinder comprising an annulus of saw teeth which extend axially along said bore, an oil saturated ring disposed within said housing between said cylinder and said bearings, and an air-distributing head secured to said housing within said cylinder, said head having a plurality of diagonally extending openings in its periphery which direct the air from within said head outwardly at an angle to the radial against the radial sides of said saw teeth, said housing having an exhaust opening therein through which a portion of the air discharged from said head escapes from said housing, the remaining portion of the discharged air being directed against said ring and then escaping from said housing along a path through said bearings.

5. A device of the character described comprising, a tubular housing, one end of which is provided with a bore materially larger than the bore in its other end, a bearing retaining sleeve secured in the smaller of said bores in said housing, said sleeve supporting the peripheries of a pair of ball bearing assemblies in the respective ends thereof, a shaft extending through said bearings and rotatably mounted thereby, the end of said shaft adjacent to said larger bore having a disc formed integrally therewith, the other end of said shaft projecting outwardly from said housing, said projecting end being screw threaded, a nut threaded upon said shaft which produces an axial load upon said bearings, a cylinder formed integrally with the periphery of said disc, said cylinder projecting axially in a direction opposite to said shaft, the bore of said cylinder comprising an annulus of saw teeth which extend axially along said bore, an outwardly projecting retaining member formed on the inner end of said bearing sleeve, a felt oil saturated ring disposed within the larger of said bores upon said bearing sleeve in position between said retaining member and the shoulder formed in said housing between said bores, and an air-distributing head disposed within said cylinder, said head having a plurality of diagonally extending openings in its periphery which directs air at an angle against the straight sides of said saw teeth, said housing having an exhaust opening therein through which a portion of the air discharged from said head may escape from said housing, the remaining portion of the air discharged from said head being directed along a path between said cylinder and said housing against said ring and then escaping from said housing along a path through said bearing assemblies.

6. A device of the character described comprising, a cylindrical housing, a sleeve fixed within the bore of said housing, said sleeve having a pair of ball bearing assemblies mounted in the respective ends thereof, a shaft rotatably mounted upon said bearing assemblies, one end of said shaft terminating within said housing and the other end projecting outwardly therefrom, the inner end of said shaft having a cylinder formed thereon, the bore of which cylinder has an annulus of saw teeth extending axially therealong, an oil saturated ring disposed within said housing between said cylinder and said bearings, an air distributing head secured to said housing within said cylinder, said head having a plurality of diagonally extending openings in its periphery which direct the air from within said head outwardly at an angle against the radial sides of said saw teeth, and said housing having exhaust openings therein through which a portion of the air discharged from said head escapes from said housing, the remaining portion of the air being directed against said ring and then escaping from said housing along a path through said sleeve and bearings, for the purpose described.

7. A device of the character described comprising a housing, spaced ball bearings mounted within said housing, a shaft mounted upon said bearings to rotate within said housing, a driving member secured to said shaft in said housing, said member having an annulus of teeth thereon, an air distributing member secured in said housing adjacent to said driving member, said distributing member having an opening therein which directs air under pressure against said teeth to rotate said shaft, an oil saturated wick disposed within said housing, said housing having two exhaust openings therein for the air leaving said teeth, the first of which communicates directly with the discharge side of said teeth and the second of which communicates with said discharge side only through said bearings, the parts being so arranged that air entering said device picks up oil from said wick and that portion which is discharged through said second mentioned exhaust opening deposits a portion of the oil carried thereby upon said bearings.

8. A device of the character described comprising, a housing, a pair of spaced bearings mounted in said housing, a shaft mounted upon said bearings to rotate within said housing, a driving member secured to said shaft within said housing, said member having an annulus of teeth thereon, an air distributing member mounted within said housing, said distributing member having a flat disc-shaped chamber therein and having a central opening therein through which air enters said chamber, said distributing member also having a plurality of discharge openings around its periphery which directs the air under pressure against said teeth, said housing having two exhaust openings therein through which air from said driving member is simultaneously discharged to the outside atmosphere, the first of said openings communicating directly with the discharge side of said teeth so that air may flow directly from said teeth to the outside, while the second communicates with the discharge side of said teeth only through said bearings, and an oil saturated member disposed within said housing, whereby the air which operates said motor picks up oil from said saturated member and deposits same upon said bearings before being discharged from said second-mentioned exhaust opening.