

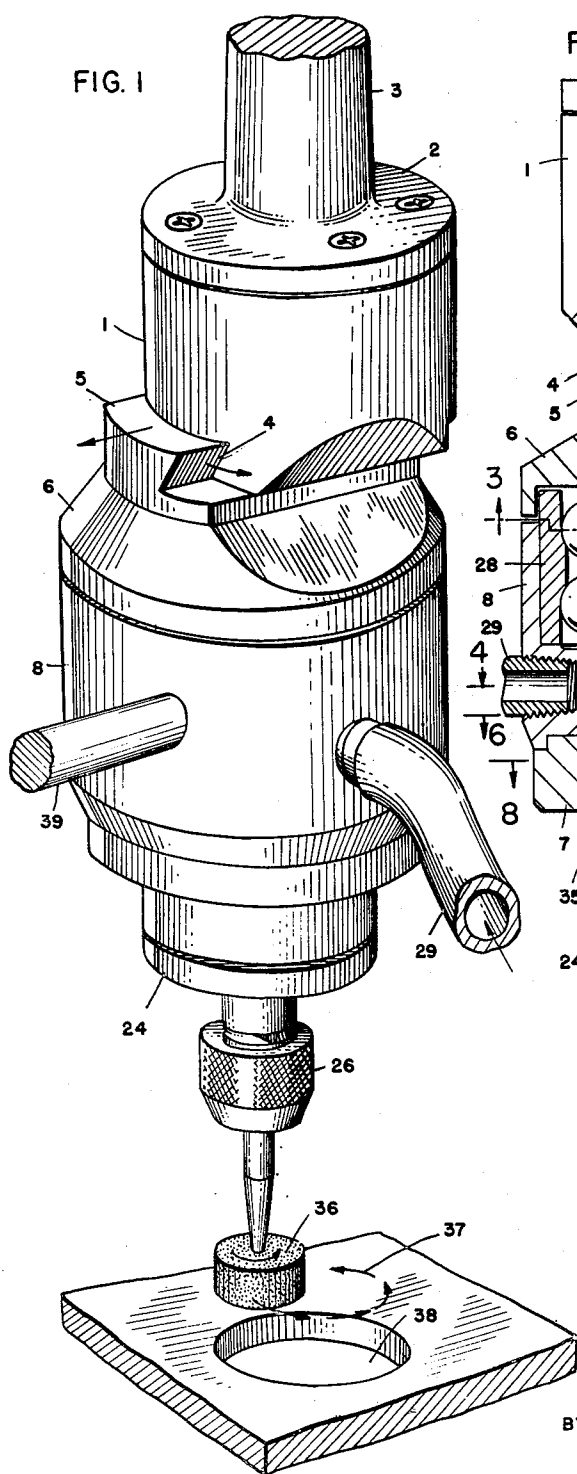
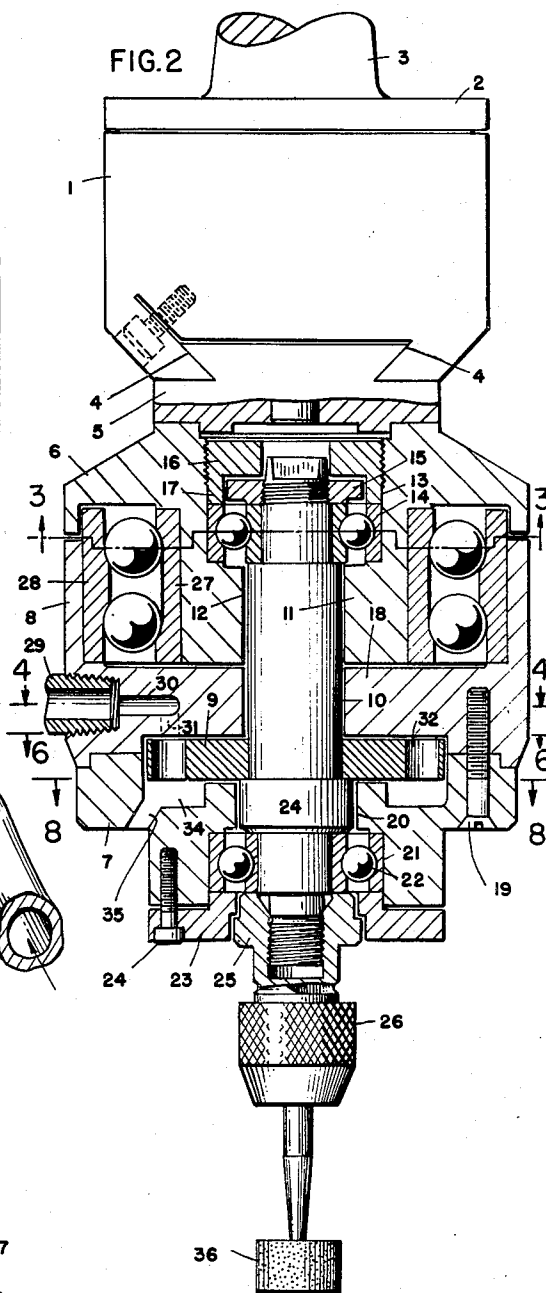
Sept. 2, 1952

A. NILSEN ET AL
PRECISION HOLE GRINDER

2,608,807

Filed Nov. 17, 1949

2 SHEETS—SHEET 1



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2 SHEETS—SHEET 2

FIG. 3

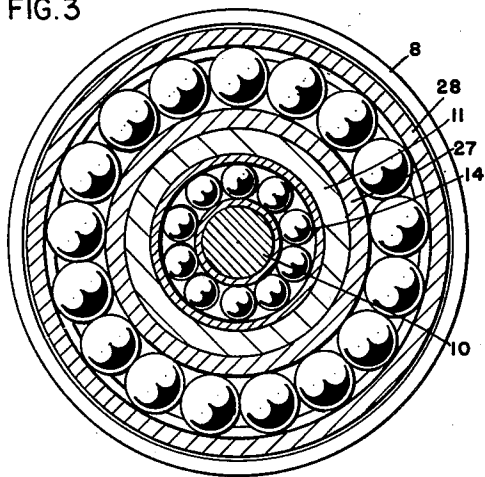


FIG. 6

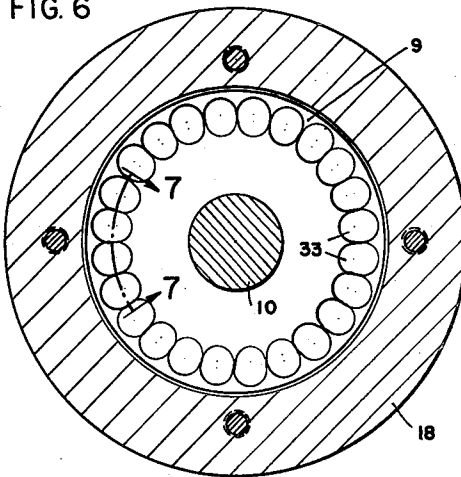


FIG. 4

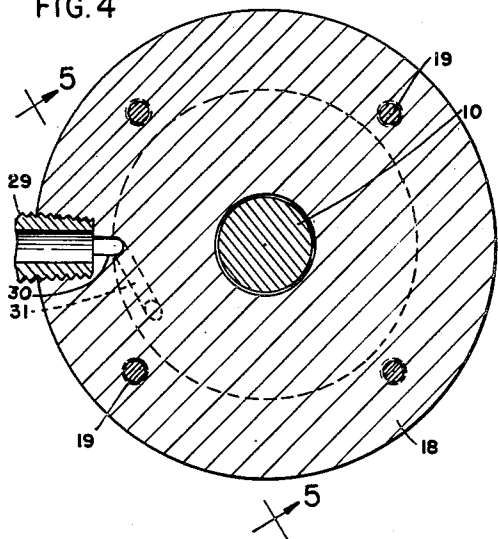


FIG. 7

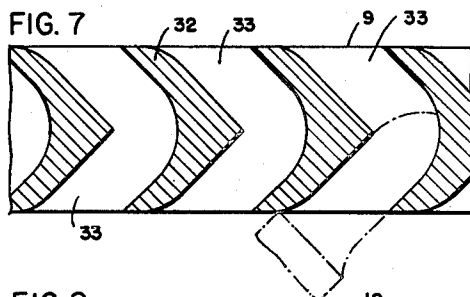


FIG. 8

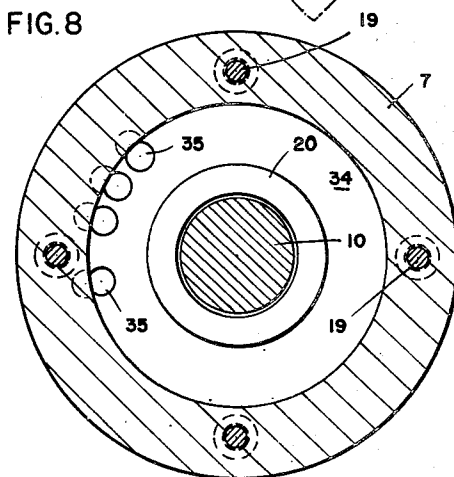
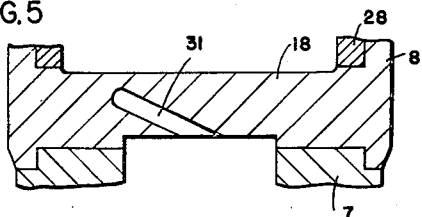


FIG. 5



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PRECISION HOLE GRINDER

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5 Claims. (Cl. 51-245)

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This invention relates to high speed hole grinders and particularly to the construction of a motor unit therefor, whereby the device as a whole may be mounted on a spindle for use on jig borers, vertical and horizontal milling machines, boring mills, lathes, surface grinders, internal grinders, drill presses, shapers, etc., for precision grinding operations requiring a gyratory action of the grinding wheel.

The main objects of this invention are to provide an improved high speed, motor driven tool for use in precision hole grinding; to provide such a device that may be mounted as a self-contained unit on a boring and facing head having transverse slideways for lateral or eccentric adjustment of the tool relative to the mounting head axis; to provide an improved construction for such a grinding unit; to provide a high speed grinding unit having an improved mounting arrangement for the driven shaft or spindle; to provide an improved motor unit housing that is freely rotatable independently of both the motor shaft and the mounting head; and to provide a motor driven grinding tool unit having an improved suspension arrangement for independently rotatable motor and housing components.

A specific embodiment of this invention is shown in the accompanying drawings in which:

Figure 1 is a perspective view showing the improved grinding tool and illustrating its mode of operation.

Fig. 2 is a vertical sectional view of the same, showing its internal construction.

Fig. 3 is a sectional view of the same, taken on line 3-3 of Fig. 2, showing the bearing relationship for independent mounting of the motor shaft and the rotating portion of the unit housing.

Fig. 4 is a sectional view, taken on line 4-4 of Fig. 2, showing the air inlet for an air wheel or rotor to drive the motor shaft.

Fig. 5 is a sectional view, taken on line 5-5 of Fig. 4, showing the disposition of the air wheel nozzle.

Fig. 6 is a sectional view, taken on line 6-6 of Fig. 2, showing one face of the air turbine rotor which drives the motor shaft.

Fig. 7 is a fragmentary sectional view, taken on line 7-7 of Fig. 6, showing the shape and arrangement of the air turbine rotor blades, and

Fig. 8 is a sectional view, taken on line 8-8 of Fig. 2, showing the arrangement and location of the air outlets on the discharge side of the turbine rotor.

In the form shown in the drawings the invention is embodied in a construction having a com-

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pressed-air driven turbine type of motor intended for operation under approximately 100 pounds per square inch air pressure at a speed of 50,000 R. P. M. The turbine rotor is mounted directly on the motor shaft or unit spindle, which projects from the unit housing at one end, and the assembly is suitably supported within the housing for operation independently of the housing position or motion. The unit as a whole is adapted to be mounted by one end on a tool head having a radially adjustable slide, such as the Chandler boring and facing head described in United States Patent No. 2,356,651, issued August 22, 1944, to G. A. Chandler, whereby the axis of the unit may be shifted radially with respect to the axis of the tool head to provide a gyrating motion for the grinding wheel upon rotation of the tool head by any suitable machine.

As shown the tool head comprises a cylindrical body 1 mounted axially on the flange 2 of a shank 3 which in turn is adapted to be received and held in a suitable chuck, not shown, carried by the rotary spindle of the principal machine. The body 1 is provided with suitable dove-tail slideways 4 on its outer or lower end and an adjustable slide 5 is mounted in the slideways for transverse or radial movement with respect to the tool head axis. Suitable means, not shown, are provided within the body 1 to effect micrometric adjustment of the slide 5 and to hold the slide in whatever position it might be set; and such means are preferably adapted for operation while the body 1 is in rotation as described in the beforementioned Chandler patent. The present invention, however, does not concern the form or operation of the tool head and that unit, therefore, need not be further discussed.

The present invention is of an independent motor unit, adapted to be mounted by one end on a rotating head, characterized by a unit housing which is independently rotatable relative to both the mounting means and the motor shaft; and in the form shown in the drawings the improved motor unit comprises a pair of annular end bells or end members 6 and 7 and a cylindrical housing 8 disposed between the end bells, the end bells or end caps and the housing assembly enclosing a rotor 9 mounted fast on a shaft 10 which in turn is journaled within and extends axially through the housing 8.

The end bell or cap member 6 at the upper end of the motor unit is adapted to be suitably mounted, rigidly, on the adjustable slide 5 of the tool head assembly in such a manner that the shaft 10 extends axially relative to the axis of

the tool head assembly. The end bell 6 is also provided with a central, axially extending, hub 11 having a central bore 12 adapted to receive the shaft 10 freely and having an enlarged or counterbored portion 13 at its upper end within which an upper bearing 14 for the shaft 10 is mounted. The bearing 14 is a radial bearing having inner and outer races and is designed so that its outer race has a close fit within the counterbore 13. The inner race of the bearing 14 is adapted to be clamped fast to the upper end of the shaft 10 by means of a clamping nut 15 threaded onto the shaft, the shaft having a reduced end portion to receive the bearing race and to provide a shoulder against which the race seats. The counterbored portion 13 is also internally threaded at its upper end to receive an externally threaded plug or closure 16, which has an axially extending collar 17 adapted to surround the nut 15 and bear against the outer race of the bearing 14 to hold it fixedly and firmly in place within the end bell body. Thus, it will be seen that, in the vertical position shown, the shaft 10 is hung from, and mainly supported by, the bearing 14 and the upper cap member or end bell 6; the bearing 14 being designed to carry a thrust load in either axial direction.

The housing 8 is a hollow cylindrical shell, of substantially the same diameter as the top cap or bell member 6, having a transverse partition 18 at its lower end. The side wall of the housing is outwardly spaced from and encloses the hub 11 of the end bell 6, and also encloses a double-row preloaded ball bearing, interposed between the housing and the collar 17, by means of which the housing 8 is supported from the upper end bell as will be hereafter described. The lower end bell 7 is a cup-shaped member adapted to be fitted on and secured to the partition 18, at the lower end of the housing 8, as by means of screws 19; and is provided with a central opening 20 through which the shaft 10 extends. As shown, the interior of the cup-shaped end bell 7 is formed to enclose the rotor 9 by which the shaft 10 is driven. The lower end of the end bell 7 is counterbored as at 21 to receive a radial bearing 22 on which the lower end of the shaft 10 is mounted; the outer race of the bearing 22 being clamped in place by a cap plate 23 suitably fastened to the lower end of the end bell 7 as by screws 24. The inner race of the bearing 22 is clamped against a shoulder 24 suitably formed on the shaft 10 by a cylindrical enlargement thereof, by means of the mounting nut 25 of the chuck 26, the nut 25 being threaded onto the lower end of the shaft 10 in accordance with the usual practice.

It will now be seen that the end bell 7 and the housing 8 are so assembled as to act as a unit and that the bearing 22 serves mainly to keep the shaft 10 centered on the housing axis; although it will be understood that some vertical or axial support for the shaft 10 is also provided by the bearing 22 which is adapted to carry a thrust load.

As before mentioned, the housing and the lower end bell assembly of the motor unit is supported from the upper end bell 6 by a preloaded bearing which is disposed between the housing side wall and the central hub 11 of the upper end bell. This bearing is of a type adapted to support an axial thrust load in either direction as well as a radial load; and in the form shown, the bearing is a double row ball construction in which the inner race 27 is mounted fast on the

outside of the hub 11 by a tight drive fit, and wherein the outer race 28 is mounted in the housing 8 by a drive fit within its axially extending side walls. This bearing is preloaded to obviate axial or radial play beyond that only necessary to permit rotation, and, since the inner race is fast to the end bell and the outer race is fast to the housing shell, it will be seen that the housing shell and lower end bell assembly is hung from and carried by the upper end bell 6 in such a manner that the motor unit as a whole is held together as an operable assembly while, at the same time, the housing and lower end bell assembly is independently rotatable with respect to the upper end bell or cap member 6, which in turn is mounted fast to the slide 5 and the tool head.

With this manner of assembly, the motor shaft 10 is rigidly supported in exact axial alignment with the motor unit and is, therefore, freely rotatable at extremely high speed for precision operation without any possibility of whip or lateral throw. Also, the housing assembly is freely rotatable independently of the shaft 10, and the upper end bell 6 by which the motor unit is mounted to the tool head; and regardless of any movement that might be imparted to the motor unit by the tool head.

Also, since the housing assembly and the motor shaft are both hung from and directly supported by the upper end bell, the axial relation of the shaft and housing is maintained constant so that the clearance or spacing of the rotor 9, between the partition 18 and the lower end bell 7, will remain fixed under all conditions of operation.

In the form shown, the rotor 9 by which the shaft 10 is driven, is in the form of an air turbine wheel having a plurality of peripheral blades or buckets against which a stream of air, under pressure, may be directed to impart rotation. Air is supplied to the motor housing by means of a flexible connection 29 which extends into the side wall of the housing in the plane of the partition portion 18; the connection 29 communicating with a passage 30 in the partition 18 which leads to a downwardly inclined passage 31 disposed tangentially with respect to the face of the rotor 9 and which terminates at the bottom face of the partition 18 just above the annular row of blades or buckets 32.

The passage 31, which serves as the air nozzle for delivery of the air under pressure to the turbine wheel 9, is inclined relative to the upper face of the turbine wheel at an angle of substantially 21 degrees; and since the turbine wheel 9 is independently rotatable with respect to the housing of the motor unit, the air driven against the turbine blades 32 will cause the turbine wheel 9 to rotate and thereby drive the shaft 10.

As shown in Figs. 6 and 7, the turbine blades or buckets 32 are formed around the outer margin of the rotor 9 and just inside the periphery thereof, so that the air passages between the blades 32 extend from face to face of the rotor 9 and are open at their ends only. Thus, the air passing through or between the turbine blades cannot escape in a sidewise or radial direction and the maximum pressure effect of the air stream is exerted against the turbine blades. These openings 33, through the rotor or turbine 9, are formed in the rotor by drilling angularly spaced holes into each face of the rotor at an angle of 45 degrees with respect to the face of the rotor and from opposite directions so that the passage 33 will be V-shaped with an included

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angle of 90 degrees. In order to provide a smooth rounded contour for the wall of the passage, on the side thereof toward the direction of rotation of the rotor 9, the passages are drilled by means of a drill having a rounded tip as indicated by the dotted outline in Fig. 7.

In order to provide for the final discharge of the air which drives the turbine wheel 9, the end bell 7 is provided with an annular channel 34 located directly below the annular row of turbine blades, and a plurality of discharge openings 35 are provided to lead from the channel 34 to the outer surface of the end bell 7. These discharge passages 35 are preferably located opposite the incoming air nozzle 31, and several are provided to assure rapid discharge of the air after it has passed through the turbine blades and to obviate the building up of back pressure in the channel 34.

With this type of power wheel or rotor for driving the motor unit shaft 10, the speed of the shaft will be governed to a large extent by the pressure of the air that is used to drive the rotor. In practice, the motor unit is designed to operate at a speed of fifty thousand revolutions per minute under an actuating air pressure of 100 pounds per square inch; a particular advantage of this form of drive being that such a high speed can be obtained with a relatively small air consumption.

In the operation of the device, for the precision grinding of holes or any other internal grinding operation, the tool head shank 3 is mounted in the chuck of a suitable rotating machine, such as a drill press, milling machine, boring machine or the like, whereby the grinding unit as a whole may be rotated. The grinding stone 36 is then mounted by its shank in the chuck 26 of the grinding unit, and the slide 5 is laterally off-set with respect to the axis of the shank 3 so that the periphery of the grinding stone will engage the rough surface of the hole or opening that is to be ground, which opening is, of course, centered on the axis of the shank 3. The tool head is then rotated so that the grinding unit is gyrated in a circle that will cause the periphery of the grinding stone to follow the periphery of the opening that is to be ground.

This is illustrated in Fig. 1 wherein the slide 5 is shown off-set laterally and wherein the arrows 37 indicate the gyratory path of the grinding stone for finishing the surface of an opening 38. Thus, while the grinding unit is gyrating so that the stone will follow the path indicated by the arrows 37, the grinding stone 38 will be driven at high speed by the motor unit shaft 10. As the grinding stone works on the surface of the opening 38, the slide 5 is gradually shifted in an outward direction to increase the size of the circle of gyration until the opening being ground has reached the precise diameter desired.

The mechanism for shifting the slide 5 while the tool head is rotating, is not herein shown or described since it forms no part of the present invention and a suitable mechanism for this purpose is disclosed in the before-mentioned United States Patent No. 2,356,651.

The housing assembly, comprising the body 8 and the lower end bell 7, provides the reaction means for the force which drives the rotor 9 and, since the housing is free to rotate relative to the primary supporting end bell 6, it is necessary to provide some suitable restraining means to prevent free turning of the housing, in the direction opposite the rotation of the rotor, which at the same time will permit the housing to gyrate

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about the axis of the shank 3. Such a restraining means may comprise a cable, or a coiled spring, connected between the unit housing and a fixed or stationary element, such as an upright portion of the machine on which the unit is mounted, or a rigid arm extending from the unit housing into slidable lateral engagement with a fixed abutment. As shown in Fig. 1 a rigid arm 39, projecting laterally from the housing 8, is indicated as a restraining means and it will be understood that this arm slidably engages a fixed portion of the machine, which carries and drives the tool head 1, so as to prevent rotation of the housing 8.

The main advantages of this invention reside in the simple and sturdy arrangement of the grinding unit components whereby the housing and the driven motor shaft are each rotatably and independently mounted on an end bell which in turn, serves as a primary support for the unit assembly, and in the bearing arrangement whereby the housing body of the unit is freely rotatable with respect to the end bell and the motor shaft and is yet supported and held in axially fixed relation with those parts.

Other advantages of this invention are to be found in the construction wherein the unit housing may be held against rotation, even though the unit is mounted on a rotating fixture, thus permitting a direct, non-rotating, connection between the housing and the power source; and in the construction of the unit assembly whereby a very high speed may be imparted to the motor shaft without any danger of whip or misalignment occurring in the grinding wheel spindle.

Although but one specific embodiment of this invention is herein shown and described, it will be understood that details of the construction shown may be altered or omitted without departing from the spirit of this invention as defined in the following claims.

We claim:

1. A motor unit comprising an end bell adapted to be mounted rigidly on a rotatable support and having an integral outwardly projecting hub, said hub having a central axial bore; a hollow housing surrounding said hub and having its side wall spaced radially therefrom; a bearing having radially spaced inner and outer races, and capable of carrying an axial thrust in both axial directions, interposed between said hub and the side wall of said housing, the inner race of said bearing being mounted fast on said hub and the outer race being mounted fast on the wall of said housing and comprising the sole support therefor; a cap member mounted fast on the end of said housing axially opposite said end bell, said cap member having a central opening therethrough; a shaft extending axially through said housing and cap member and having one end journaled in the bore of said hub; a rotor enclosed by said housing and cap member and fast on said shaft; bearing means in said cap member spaced axially outward from said rotor for holding said shaft in axial alignment with the central bore of said hub, and means within said motor unit for driving said rotor, said housing being independently rotatable relative to said end bell and said shaft.

2. A motor unit comprising an end bell adapted to be mounted rigidly on a rotating support and having an integral outwardly projecting hub, said hub having a central axial bore; a hollow housing surrounding said hub and having its side wall spaced radially therefrom; a bearing

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having radially spaced inner and outer races, and capable of carrying an axial thrust in both axial directions, interposed between said hub and the side wall of said housing, the inner race of said bearing being mounted fast on said hub and the outer race being mounted fast on the wall of said housing; a cap member fast on the end of said housing axially opposite said end bell, said cap member having a central opening therethrough axially aligned with bore of said hub; a shaft extending axially through said housing and into the bore of said hub; a radial bearing mounted within said hub to journal said shaft radially, said bearing being secured to said shaft to support the same against axial motion; means enclosed by said housing and cap member for driving said shaft; and radial bearing means mounted in the opening of said cap member outwardly of the last-named means for holding said shaft in rigid axial alignment with the central bore of said hub.

3. A motor unit comprising an end member adapted to be mounted rigidly on a rotating support and having an integral axially extending central hub, said hub having a central axial passage, a rotatable shaft extending axially from said hub and having one end journaled in a radial bearing mounted in said passage and adapted to carry axial thrust for holding said shaft against axial movement, a cup-like housing having its side wall spaced from and surrounding said hub, a pre-loaded radial bearing disposed between said hub and said housing and having inner and outer races respectively secured to said hub and the housing side wall, said bearing being adapted to carry an axial thrust load and support said housing in an axial direction while permitting the same to rotate independently of said hub, bearing means mounted in said housing beyond the end of said hub for holding said shaft aligned with the axis of said hub, and means enclosed within said housing for driving said shaft.

4. In a device of the class described, the combination with a rotatable tool head of a motor unit extending axially therefrom and having an end member rigidly secured to said head for rotation therewith, a housing mounted on and extending axially from said end member, said housing being journaled on said end member for independent rotation relative thereto and on the axis thereof, a shaft extending axially through

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said housing, bearing means in said end member and the opposite end of said housing for rotatably supporting said shaft in rigid axial alignment therewith, a turbine rotor within said housing and fixed on said shaft, and a conduit connection on said housing and leading to said rotor for a source of fluid pressure supply.

5. In a device of the class described, a motor unit comprising an end member having means for mounting the same rigid on a rotatable tool head and having an axially extending hollow hub, a cylindrical housing having a side wall extending axially from said end member and surrounding said hub, said housing being rotatably mounted on the outer side of said hub on pre-loaded radial bearing means adapted to carry an axial thrust load, said bearing means having inner and outer races respectively secured on said hub and on the inside of said housing side wall, a rotatable shaft extending axially through said housing and into said hub, bearing means mounted in said hub and in said housing respectively for supporting said shaft, motor means within said housing for driving said shaft, and means on said housing leading to said motor means for fixed connection with a source of power therefor.

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