

Aug. 27, 1968

M. D. CLARK

3,398,802

FLUID OPERATED DRILL

Filed Oct. 31, 1966

3 Sheets-Sheet 1

Fig. 1

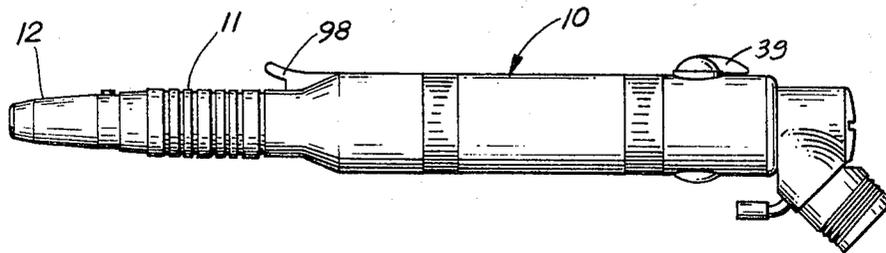
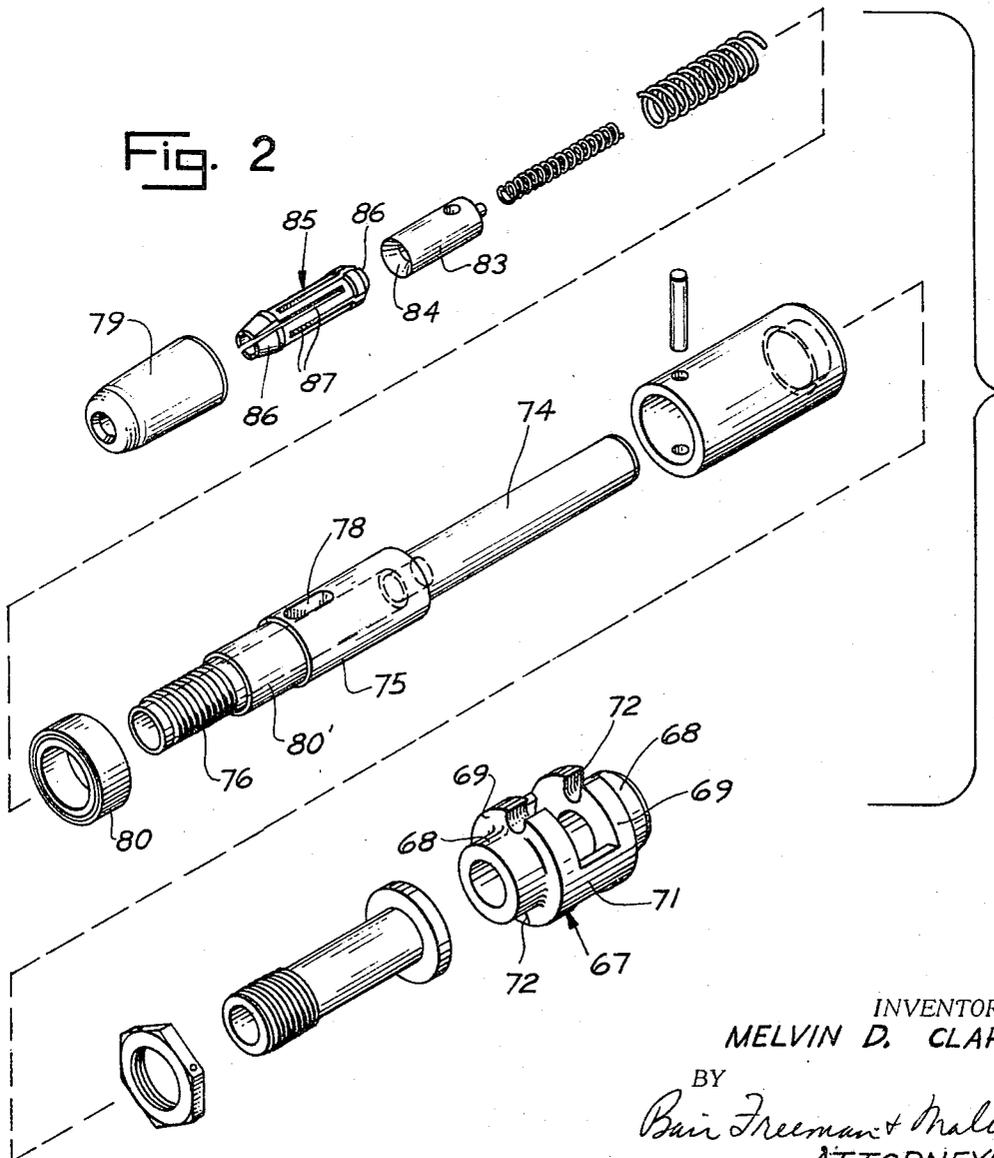


Fig. 2



INVENTOR.
MELVIN D. CLARK

BY
Bair Freeman & Malinac
ATTORNEYS

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M. D. CLARK

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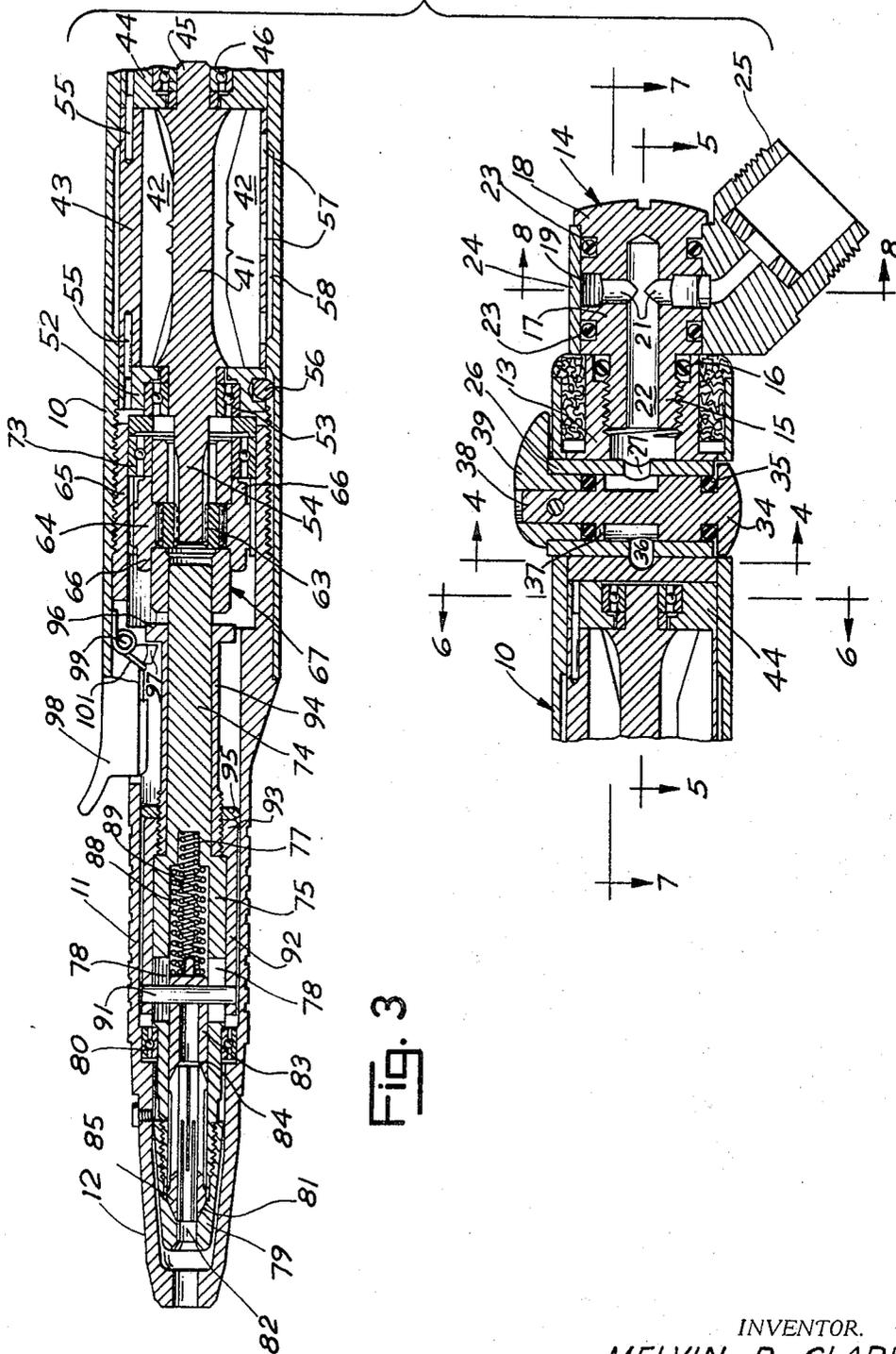


FIG. 3

INVENTOR.
MELVIN D. CLARK
BY
Bair Freeman + Malinac
ATTORNEYS

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M. D. CLARK

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Fig. 4

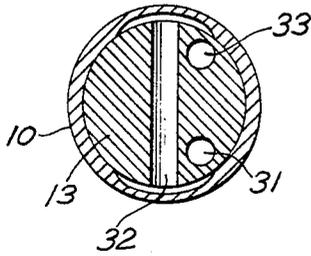


Fig. 5

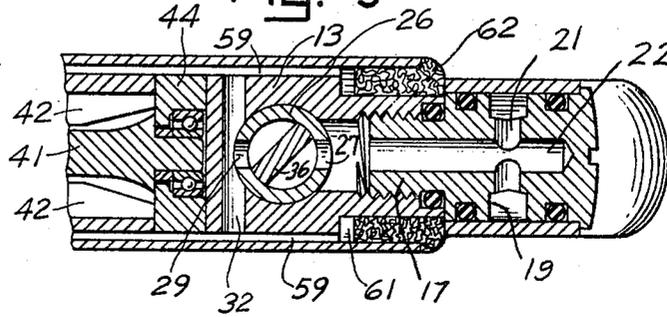


Fig. 6

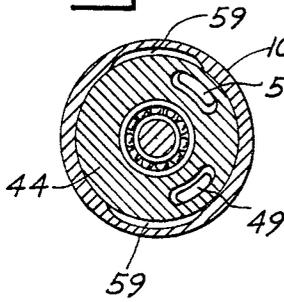


Fig. 7

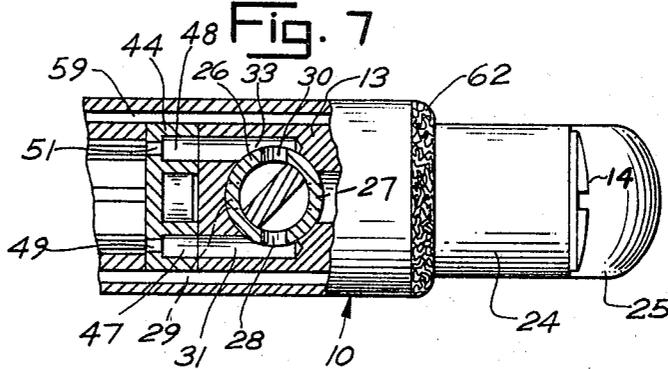
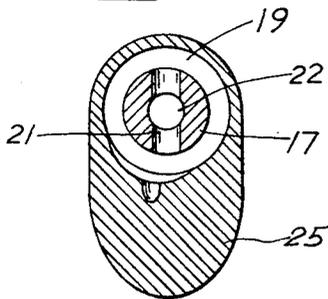


Fig. 8



INVENTOR.
MELVIN D. CLARK

BY

Bair, Freeman & Malinara
ATTORNEYS

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3,398,802

FLUID OPERATED DRILL

Melvin D. Clark, Bryan, Ohio, assignor to The Aro Corporation, Bryan, Ohio, a corporation of Delaware
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 10 Claims. (Cl. 173-169)

This invention relates to fluid operated drills and more specifically to improvements in relatively small drills to be held in the hand in the manner of a pencil for use in dental and similar work.

Drills of the general type to which the invention relates have heretofore been known and used but have all been subject to one or more objections. It is a general object of the present invention to provide an improved fluid operated drill which overcomes the several objections to drills of this general type as heretofore known.

A specific object is to provide a drill which can be handled easily and freely without bind or stiffness due to the effect of fluid pressure on the fluid pressure supply connections to the drill. Another object is to provide a drill which is driven by a positive displacement relatively high torque fluid motor and in which the motor can be reversed.

A further object is to provide an improved reversing and control valve for the motor which is operable not only to reverse the direction of rotation of the motor but also accurately to control the speed thereof.

Still another object is to provide an improved drill in which the fluid motor is connected to the tool holding means through a simple but highly efficient gear reduction.

Yet another object is to provide an improved double-ended collet for a drill which will securely grip the shank of a tool or the shaft of a contra-angle uniformly and securely and which is positively and easily released through manipulation of a lever on the outside of the drill housing.

The above and other objects and features of the invention will be more readily apparent from the following description when read in connection with the accompanying drawings, in which:

FIG. 1 is a side elevation of a complete drill embodying the invention in substantially full size;

FIG. 2 is a disassembled perspective view of a portion of the interior mechanism of the drill;

FIG. 3 is an enlarged axial section through the drill; and

FIGS. 4-8 inclusive are sections, respectively, the lines 4-4 to 8-8 of FIG. 3.

As shown in FIG. 1, the drill of the present invention comprises a tubular housing indicated generally at 10, which is of a size both as to length and diameter to be held comfortably in one hand in much the manner of a pencil. As shown, the housing is of uniform relatively large diameter throughout the major portion of its length and tapers to a smaller diameter portion 11 which terminates in a tapered tip 12. The tip 12 has a central opening at its end, as shown in FIG. 3, to receive the shank of a drill or a shaft of a contra-angle or similar tool.

At its opposite larger end, the housing is connected to a supply connection for operating fluid such as compressed air. As best seen in FIG. 3, a head 13 is secured in the large end of the housing and is provided with a straight internally threaded hub portion. A core indicated generally at 14 is formed with an externally threaded hub portion 15 which is threaded into the head 13 to secure

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the core to the housing. The core is sealed to the housing by an annular seal such as an O ring 16 fitting into an internal recess in the end of the hub portion of head 13 and sealing against a smooth cylindrical surface on the core 14 beyond the threaded hub 15 thereof. Externally of the housing the core 14 comprises a main body 17 having a cylindrical outer surface and terminating in a head 18 of larger diameter than the body portion 17. The body portion 17 is formed centrally of its length with an annular groove 19 connected through radially extending ports 21 with a central bore 22 which extends through the hub portion 17 but which is blocked at the head 18. The body portion 17 is also formed with a pair of external grooves at opposite sides of the annular recess 19 to receive sealing means such as O rings 23.

A collar 24 is rotably supported on the body portion 17 of the core 14 and is retained in place thereon by the enlarged head 18. At one side the collar is formed with a hose connection 25 extending outwardly therefrom at an acute angle, shown as approximately 45 degrees. A flexible hose for conveying compressed air to the drill may be connected to the connection 25 and may lead to any suitable source of compressed air or similar fluid.

With this construction the collar 24 can rotate freely on the body portion 17 of the core 14 and, due to the angle of the hose connection 25, the tool can be turned and manipulated freely by hand without creating any bind due to the effect of air pressure on the connections. Air from the supply connection is supplied to the air operated motor as described hereinafter through a combined reversing and speed control valve as best shown in FIGS. 3, 5 and 7. The valve comprises a tubular sleeve 26 which extends diametrically of the housing through aligned openings in the housing outer wall and in the head 13. The sleeve is formed centrally of its length with four uniformly spaced peripheral ports 27, 28, 29 and 30. The sleeve is so oriented that the port 27 communicates with the passage 22 in the core 14, the port 28 communicates with a supply passage 31 formed in the head 13, the port 29 communicates with a cross bore 32 in the inner end of the head 13, and the port 30 communicates with a supply passage 33 formed in the head 13.

The valve is completed by a core 34 which is rotatable therein. As best seen in FIG. 3, the core has an enlarged head at its lower end fitting into the opening in the housing and seating against the adjacent end of the sleeve. Above the head the core is formed with a peripheral groove to receive an O ring 35 to seal the core in the sleeve. In its central portion the core is cut away at its opposite sides to leave a flat diametrically extending strip 36 registering axially with the ports 27-30. Above the flat portion 36, a flange 37 is provided which is circular in outline to engage the interior of the sleeve 26. The core terminates in a stem 38 extending upwardly beyond the end of the sleeve 26.

The valve is completed and is operated by a handle 39 having an annular cylindrical hub which fits over the stem 38 and which is pinned or otherwise secured thereto. When the handle is assembled on the stem, the end of its hub will be spaced from the flange 37 to provide an annular recess to receive a seal such as the illustrated O ring. The handle includes an elongated finger piece overlying the outside of the housing and which can easily be engaged by a finger or a thumb of an operator to turn the handle thereby to turn the valve core.

When the valve core is turned to the position shown in FIG. 5, the ports 27 and 28 will be connected and the ports 29 and 30 will also be connected. Thus compressed air supplied through the passage 22 will flow through port 27, port 28 and passage 31 to one of the motor ports of the exhaust air from the motor will return through passage 33 and through ports 30 and 29 to the cross passage 32 to be exhausted to atmosphere as described more fully hereinafter. When the valve is turned through 90 degrees, the ports 27 and 30 will be connected and similarly the ports 28 and 29 will be connected to cause the motor to operate in the reverse direction. By turning the valve core to intermediate positions such that the bar portion 36 thereof partially blocks diametrically opposite ports, the speed of operation of the air motor can be accurately controlled. According to the present invention, the drill is adapted to be driven by a vane type reversible positive displacement motor the rotor and housing of which may be of substantially conventional construction. As shown the motor comprises a rotor 41 which is mounted for rotation coaxially with the housing 10. The rotor as is understood in the art is formed with a series of radially extending slots in which vanes 42 are radially slidable. The outer edges of the vanes 42 slide against the interior of a casing 43 mounted in the drill housing and whose axis is displaced from the axis of the rotor 41. As seen in FIG. 3 the casing 43 is thicker at the top than at the bottom so that the casing axis is displaced below the axis of the rotor 41.

The rotor is supported at one end in a combined bearing and end plate 44 which is seated against the inner end of the head 13. The end of the rotor adjacent to the end plate 44 is formed with a stub shaft 45 which is rotatably journaled in a ball bearing 46 carried by the end plate 44 in a central recess therein. The end plate 44 is also formed with fluid passages 47 and 48 registering respectively with the passages 31 and 33 in the head 13. The passages 47 and 48 terminate at the face of the end plate adjacent to the rotor in ports 49 and 51. These ports are positioned in the upper quadrants of the ring as viewed in FIG. 3 and appear in the upper and lower right-hand quadrants as seen in the section FIG. 6. Therefore, air under pressure entering the fluid motor through either of the ports will flow into the spaces defined by the vanes in an area where the spaces are small so that the air pressure will act on the vanes to turn the rotor in one direction or the other. The other port through which fluid is not admitted serves as an exhaust port to exhaust fluid from the vane spaces as their volume is decreasing due to rotation of the rotor.

The opposite end of the rotor is rotatably supported in a similar end plate 52 carrying a ball bearing 53. At that end the rotor is formed with a shaft extension 54 extending through and beyond the bearing 53 for connection to a gear reduction unit. The motor casing 43 and the end plates 44 and 52 are secured together against relative rotation by pins 55 as shown in FIG. 3. The end plate and casing assembly is further secured against rotation in the drill housing by any suitable means. As shown the end plate 52 is formed radial with a hole and a ball 56 fits into the hole and into an internal groove in the housing 10.

The primary exhaust of air from the motor is provided by ports 57 in the inner bottom portion of the motor casing 43, as shown in FIG. 3. The ports 57 open into an annular space 58 defined by an internal recess 58 in the motor housing 10. The annular chamber 58 communicates through passages 59 formed by elongated grooves in the interior of the drill housing 10 around the end plate 44 and head 13 with an annular chamber 61 defined at the large end of the drill housing between the interior thereof and the hub extension of the head 13. This annular cavity opens at the large end of the drill housing around the core 14 of the supply connection so that all

of the exhaust air from the motor will be discharged rearwardly from the housing. The annular space is preferably filled, or partially filled, with a sound muffling material as shown at 62 which may be fibrous material but which is preferably a ring of porous sintered metal. Due to the relatively large area of the recess 61 and the presence of the material 62, the air will be discharged at a relatively low velocity and any hissing or whistling thereof will be muffled by the material 62.

Since the air motor normally turns at relatively high speed, it is desirable to reduce the motor speed between the motor and the tool. For this purpose a planetary speed reduction gear set is provided, including a sun gear 63 secured to the motor shaft 54. The sun gear meshes with planet gears 64 which in turn mesh with ring gear teeth formed on the interior of a sleeve 65 forming a part of the drill housing. The planet gears as shown are formed with short stub shafts 66 extending from the opposite ends thereof and by means of which they are rotatably supported in a planet carrier indicated generally at 67. As best seen in FIG. 2, the planet carrier 67 comprises a pair of axially spaced and axially aligned tubular hubs 68 which are formed at their adjacent ends with outwardly projecting circular flanges 69. The flanges 69 are connected by spaced bars 71 which may be integral with the flanges as shown. At spaced points in their periphery whose number depends upon the number of planet gears employed, the flanges 69 are formed with radially extending notches 72 into which the stub shafts 66 may fit. Preferably, there are two sets of notches and two planet gears although this is not critical. With this carrier construction the gear set can be assembled very simply by inserting the sun gear 63 in the space between the flanges 69 and then sliding it on to the end of the shaft 54 to be rotatably connected thereto through splines, or the like. Thereafter, the planet gears 64 can simply be dropped into place with their stub shafts 66 fitting rotatably in the notches 72 and the assembly can then be slid into the sleeve 65. Alternatively, the assembly of sun gear and planet gears and carrier could be slid into the sleeve 65 with the planet gears meshing with both the ring gear teeth and the sun gear teeth and thereafter, the shaft 54 could be inserted into the sun gear. Preferably, a bearing shown as a ball bearing 73 is provided around one of the hubs 68 to support it rotatably in the sleeve 65 of the drill housing.

The other hub 68 is secured to the end of a composite shaft and collet casing which includes a relatively small shaft portion 74 extending into and secured to the hub 68 and an enlarged tubular portion 75. The tubular portion 75 terminates in an externally threaded tip 76 and is formed throughout its length with a bore of uniform diameter. As shown in FIG. 3, a smaller diameter recess 77 may be provided at the inner end of the bore. Additionally, the tubular portion 75 is formed with diametrically opposite axially elongated slots 78 therein, for a purpose to appear later.

The collet casing is completed by a tip 79 which is secured to the tubular shaft portion by being threaded thereon. The tip is formed in its interior with a conically tapered surface 81, facing inwardly of the collet casing, and is formed in its outer end with a bore 82 through which the shank of a tool or a shaft to be driven can be inserted.

The combined shaft and collet casing is rotatably supported in the drill housing by a bearing shown as a ball bearing 80 fitting into the housing and fitting over an intermediate diameter portion 80' of the combined shaft and collet casing between the larger portion 75 and the threaded tip 76 thereof.

A cam 83 is slidable in the bore in the collet casing and is formed at one end with a conically tapered recess 84, facing the conically tapered surface 81. The two conically tapered surfaces 81 and 84 are adapted to act against the ends of a double collet indicated generally at 85.

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As best seen in FIG. 2, the double collet 85 comprises a tubular member formed at its ends with conically tapered surfaces 86 which preferably taper at the same angles as the surfaces 81 and 84. The body of the sleeve is formed with a series of elongated slots 87 which extend alternately from opposite ends of the sleeves and which are longer than half the length of the sleeve so that they overlap. The sleeve is thus made radially flexible so that when its ends are pressed against the tapered surfaces 81 and 84, the sleeve diameter will be decreased uniformly throughout its length so that it will grip a tool shank, or similar shaft member, uniformly throughout its length and will hold it accurately in alignment.

The cam 83 is urged in the direction of the conical surface 81 to exert pressure on the sleeve 85 by means of a pair of springs 88 and 89. The spring 88 lies in the bore in the collet casing 75 and the spring 89 is of smaller diameter to lie within the spring 88 with its end extending into the recess 77. The pressure exerted by the springs on the cam causes the cam surface 84 of the cam to press against the tapered end 86 of the collet sleeve and simultaneously presses the opposite end of the collet sleeve against the surface 81. The springs are so designed as to produce the desired gripping pressure by the collet.

In order to release a tool or shaft gripped by the collet, means are provided according to the present invention to move the cam 83 positively away from the collet sleeve. By moving the cam it is insured that the pressure against the ends of the collet sleeve will be relieved so that the collet sleeve can expand to release the tool or shaft whereas, if only the spring pressure against the cam were relieved, there would be a possibility of the cam sticking and maintaining pressure on the sleeve.

In order to move the cam, a pin 91 is extended radially through a transverse bore in the cam with the ends of the pin projecting through the slot 78 in the tubular portion 75 of the collet casing. The ends of the pin 91 extend into openings in a sleeve 92 which is slidable axially on the portion 75 of the collet casing. At its opposite end the sleeve 92 is formed with an internally threaded flange 93 which is threaded on the end of a sleeve 94 which is slidably mounted on the shaft portion 74 of the combined shaft and collet casing. Preferably, a lock or jamb nut 95 is also threaded on the sleeve 94 to secure the sleeves 92 and 94 in a desired adjusted position. By adjusting the sleeve 92 and jamb nut 95 the tension of springs 88 and 89 can be adjusted within the limits of the elongated slots 78 of shaft 75.

At its opposite end, the sleeve 94 is formed with an outwardly extending radial flange 96 which is normally spaced from the hub 68 of the planet carrier 67. The flange 96 is adapted to be engaged and moved by a finger 97 on a manually operable lever 98 which is pivoted at 99 in the drill housing. A spring 101 acts on the finger lever 98 to urge it outward of the housing thereby urging the finger 97 in a clockwise direction and away from the flange 96. When it is desired to release a tool from the collet, the operator need merely press inwardly on the finger lever 98 thereby rocking the finger 97 counterclockwise and causing it to press against the flange 96 and shift the sleeves 92 and 94 to the right as seen in FIG. 3. Through connection of the sleeve 92 to the cam 83 by the pin 91, the cam 83 will also be moved to the right away from the collet sleeve thereby relieving pressure on the collet sleeve and releasing a tool or shaft which is gripped thereby.

While one embodiment of the invention has been shown and described in detail, it will be understood that this is for the purpose of illustration only and is not to be taken as a definition of the scope of the invention, reference being had for this purpose to the appended claims.

What is claimed is:

1. A fluid operated drill comprising an elongated housing, a collet in the housing adjacent to one end thereof to grip a tool, a fluid operated motor in the housing con-

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ected to the collet to rotate it, a fluid supply connection to the other end of the housing of smaller diameter than the housing to supply operating fluid to the motor, and the housing being formed with exhaust passage opening at said other end of the housing radially beyond the fluid supply connection.

2. The drill of claim 1 in which the exhaust passage terminates in an annular chamber at said other end of the housing and including an annular mass of porous material in the chamber to muffle the exhaust fluid.

3. The drill of claim 1 in which the fluid supply connection comprises a cylindrical core secured to the housing and having fluid passages therein terminating in peripheral openings intermediate its ends, a collar rotatable on the core, a hose connection on the collar extending outwardly at an acute angle to the collar axis, the collar having an internal fluid port therein registering with the peripheral openings in the core, and seals carried by the core and sealing against the collar at opposite sides of the openings and port.

4. The drill of claim 1 in which the motor is a reversible vane type positive displacement motor.

5. The drill of claim 4 including a valve between the fluid supply connection and the motor, the valve comprising a cylindrical sleeve having four ports therein spaced uniformly around its periphery, one of the ports communicating with the supply connection, another with the exhaust passage and the remaining two with spaced motor ports, a stem rotatable in the sleeve and formed with passages cooperating with said ports selectively to connect the first two named ports to said remaining two ports, and a handle on the outside of the housing connected to the stem to turn it, the stem being rotatable to positions in which it partially blocks the ports to control the speed of the motor.

6. The drill of claim 5 in which the sleeve extends diametrically through the housing adjacent to said other end thereof and the handle is directly connected to the stem.

7. The drill of claim 1 including reduction gearing in the housing connecting the motor to the collet and comprising a sun gear connected to the motor to be driven thereby, a planet carrier drivably connected to the collet formed by spaced aligned hubs having notched radial flanges at their adjacent ends connected by spaced bars, the sun gear lying axially between the flanges, planet gears meshing with the sun gear and having projecting shafts fitting rotatably in the notches, and a ring gear secured in the housing and meshing with the planet gears.

8. The drill of claim 1 in which the collet comprises a tubular casing terminating at its end in a conically tapered interior cam surface, a cam slidable in the casing and formed in its end with a conically tapered recess facing said conically tapered surface, a sleeve in the casing formed with conically tapered ends engageable with the conically tapered surface and the recess respectively and having overlapping slots in its sides extending alternately from its opposite ends, a spring urging the cam toward the conically tapered surface, and a manually operable member on the outside of the housing operatively connected to the cam to move it away from the conically tapered surface.

9. In a drill including an elongated tubular housing and a motor in the housing, and a collet in the housing adjacent to one end thereof and drivably connected to the motor, the improvement in the collet which comprises a tubular casing drivably connected to the motor and terminating at its outer end in an interior conically tapered surface, a cam slidable in the casing and formed in its end with a conically tapered recess facing said surface, a sleeve in the casing with conically tapered ends to engage the surface and recess respectively and having overlapping slots in its sides extending alternately from its opposite ends, a spring urging the cam toward the surface, and a manually operable lever on the outside of the housing

operably connected to the cam to move it away from said surface.

10. The construction of claim 9 in which the casing is defined in part by a tubular shaft which is connected to the motor and in which the cam is slidable and in which the manually operable lever engages a flange on a sleeve which is slidable on the shaft and is connected to the cam by a pin extending through elongated slots in the shaft.

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NILE C. BYERS, JR., *Primary Examiner.*