DRILL WITH AUTOMATIC FEED AND QUICK RETRACTION

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ABSTRACT OF THE DISCLOSURE

The application discloses portable power drills with various types of fixtures and clamping devices can be used in conjunction with the drill and work to secure the two together for a given drilling operation, the drill embodying a drill spindle, a power gear train for rotatively driving the spindle, and a feed gear train for advancing and retracting the spindle, together with automatic means for controlling the feed and retraction of the spindle and an automatic means for stopping the motor.

The invention relates generally to drills and particularly to portable and hand-held drills, such as finger drills and the like, and more particularly to mechanisms for advancing and retracting a drill spindle.

An object of the invention is to provide a new and improved feed mechanism for a drill spindle or the like embodying novel gear means for rotating, advancing, and retracting the spindle. In this connection it is an object to provide such means which rapidly retracts the spindle while continuing to rotate it in the normal drilling direction with the consequent advantages of this type of mechanism over a known type which reverses the rotation of the spindle upon retraction and has a high incidence of drill breakage.

Another object is to provide automatic means for reversing the axial movement of the drill spindle after it has advanced a predetermined distance, thereby enabling the drilling of blind holes without exceeding the required depth of the hole.

Another object is to provide novel means for controlling the feed and retraction of the drill spindle including means for preadjusting the length of the feed stroke and the relative position thereof with respect to the housing.

Still another object is to provide drill mechanisms of the type indicated which can utilize hollow spindles so that drilling lubricant can be circulated therethrough and through the drill to the work face.

These and other objects will be apparent from the drawings and the following description. Referred to the drawings:

FIG. 1 is an isometric view of a portion of a drill embodying the invention;

FIG. 2 is a central longitudinal vertical sectional view on line 2—2 of FIG. 1, but on a larger scale;

FIG. 3 is a sectional plan view on line 3—3 of FIG. 2;

FIG. 4 is an enlarged detail view of a portion of the apparatus of FIG. 2 in the same plane as that figure;

FIG. 5 is a fragmentary sectional view on line 5—5 of FIG. 4;

FIG. 6 is a fragmentary cross sectional view on line 6—6 of FIG. 2;

FIG. 7 is a longitudinal sectional view of a modification showing an automatic feed and retraction means;

FIG. 8 is a fragmentary sectional view on line 8—8 of FIG. 7;

FIG. 9 is a sectional view on line 9—9 of FIG. 8;

FIG. 10 is a fragmentary sectional view in the same plane as FIG. 7, showing a portion of the apparatus;

FIG. 11 is a fragmentary sectional view on line 11—11 of FIG. 10.

More particularly describing the invention, referring first to FIGS. 1—6, numeral 11 generally designates a finger drill, and this includes a suitable motor 12 and a housing 14 in which the drill spindle is mounted and which contains the mechanism 34 for driving a feed-threaded retraction spindle. The housing has a main body 15 with an enlarged tubular end 16 having an internally threaded bore 17 in which the motor 12 is mounted as shown. Forwards of this the housing body extends generally axially (much like a straight finger) but somewhat offset from the axis of the tubular end 16. The housing body is open-topped but covered by a plate 18 removably held by screws 19. A spindle 20 extends through the housing from top to bottom and is adapted to mount a drill or drill bit 22, shown attached to the lower end of the spindle in FIG. 2 by an adapter 23.

Between the motor and the spindle we provide means for advancing and retracting the spindle axially and means for simultaneously rotatively driving it. In general the means includes two sets of gears or two gear trains which will be termed a drive gear train 25 and a feed gear train 26. The drive gear train has a combination or special gear 27 (which may be made in two pieces suitably interlocked if desired) at the motor end that is mounted for rotation about a screw 28 with needle bearings 30 between the parts. The screw serves to secure a plug 31 in a bore 32 and counterbore 33 in the housing body and includes a threaded inner end section 34 received in an internally threaded bore 35 in the housing body. Gear 27 has a beveled gear face 38 for engagement with a beveled gear 40 on the end of the motor shaft 41 of the motor and consequently is driven thereby whenever the motor is operating. At the other end of the drive gear train is a drive gear 43 mounted in a bearing 44 secured in a bore 45 and counterbore 46 of the housing body. Gear 43 has a bore 47 therethrough of sufficient diameter to freely receive and pass the spindle so that the same may be moved axially therethrough in advancing and retracting the spindle. The driving connection between the drive gear and the spindle is shown as comprising two splines 50 (FIG. 6) integral with gear 43 and extending into longitudinal grooves or keyways 51 in the periphery of the spindle, the parts fitting just loose enough to permit of relative axial movement.

Between the drive gear and the combination gear are a plurality of Idler gears designated 53, 54 and 55. Gears 53 and 54 are mounted on pins 56 and 57 respectively which are mounted in the housing as best seen in FIG. 2. Gear 55 is mounted on a hollow shaft 60 that is mounted in a bore 61 provided in the bottom wall 62 of the housing body. In each case bearings 63 are provided for the gears. With this construction it will be apparent that the spindle is rotatively driven in one direction at all times that the motor is operating.

Turning now to the feed gear train, at the outer end of the housing we provide a feed gear in the nature of a feed nut 70 which is mounted in a bore 71 provided in a bore 72 in the cover plate 18 of the housing. The axe plane of the feed nut 70 is within a counterbore 73 in the drive gear 43, the feed gear having an extension 74 which rotatively fits in said counterbore. The feed gear has an internally threaded bore 76 to accommodate the spindle which is provided with corresponding external screw threads 77. Thus relative rotation between the feed gear and the spindle will cause axial movement of the spindle.

At the motor end of the feed gear train is a coupling
gear 80 which normally engages through end teeth 81 with similar end teeth 82 on the adjacent end of gear 55 and which engages in a spiral in gear 55 and the feed gear are two idler gears designated 83 and 84 which are mounted on the aforementioned pins 56 and 57, respectively. The over-all ratio of the feed gear train is slightly different from that of the drive gear train so that when both gear trains are driven, as when the parts are in Fig. 2, the speed of rotation of the feed gear will be sufficiently greater than that of the drive gear to effect a gradual advance of the spindle.

In order to provide for rapid and positive retraction of the spindle, while continuing to drive the spindle rotatively in the original or given direction, we mount the coupling gear 80 on an axially movable shaft 86 which has a reduced inner end section 87 that is slidably received in the hollow shaft 60. Above this is a flange 88 and above this a main cylindrical section 89 which is interrupted by a groove 90 for a retainer ring 91 to hold the gear in place. The upper end of the shaft is provided with an operating lever 94 and when this is in the position of Fig. 2, the shaft is locked in the inner position so that the coupling gear is in driven relation with the combination gear, the parts being releasably held in this position by means of a pin 95 in the housing bored 96 for a coupling 97 (Fig. 3) in the depending hub 98 of the lever fits within a cylindrical cavity 98 in the mold. A compression spring 100 in the space 101 yieldsly urges the lever and shaft upwardly. When the lever is turned to release the shaft and permit it to move upwardly under the influence of the spring to the position shown in Fig. 4, an upper radially grooved annular end face 103 of the coupling gear engages a coupling brake ring 104 having a serrated end face 106 adapted to mate with face 103 thereby stopping its rotation and operation of the feed gear train. Consequently, since the spindle would be threaded oppositely with respect to the direction of its rotation, and it is still being rotated in the original direction, it rapidly retracts through the now stationary feed gear 70.

During retraction of the spindle, if an abutment on the spindle, such as the adapter 23 (Fig. 2), strikes the housing, slippage can occur between the coupling gear and the brake ring as spring 100 yields so that the feed gear can then rotate with the spindle and the spindle will not be subjected to any further retraction force. It is to be understood that various types of fixtures and clamping devices can be used in conjunction with the drill and the work to secure the two together for a given drilling operation.

We may also provide for automatic control of the feed and retraction of the spindle and one means for accomplishing this is shown in the form of the invention illustrated in Figs. 7–11 wherein a finger drill with automatic control means is shown. Referring to these figures, numeral 120 designates an air-driven motor and numeral 121, the housing for the apparatus of the invention. The motor has a threaded cylindrical end 122 which is mounted in a threaded counterbore 123 at the tubular end 124 of the housing. The motor is shown provided with a bevel gear 125 on the motor shaft 126 and this serves to drive a drive gear train 128 which is generally similar to the one previously described, and, under certain circumstances, a feed gear train 130 which is also generally similar to the one previously described. In view of the similarities, the latter the construction will not be described in minute detail. However, referring to the parts, they include the exteriorly threaded spindle 132 with the longitudinal grooves 133 that are received for axial movement through a drive gear 134 that is driven whenever the motor is operating through the rotation of the idler gears 135 and 137, the latter meshing with a combined gear 138 comprising a spur gear 140 and a bevel gear 141 which are locked together for rotation as a unit. Gear 138 is driven by the bevel gear 125 of the motor. The drive gear 134 has two integral splines (not shown) similar to the drive gear of the previously described form of the invention, which are received for slideable movement in the grooves 133 of the spindle.

The feed gear train includes the interiorly threaded feed gear 142 which receives the spindle, the idler gears 143 and 144 and a coupling gear 145 which normally is held engaged with gear 137 when the tool is operating and the drilling operation is being performed. However, in this form of the invention, the coupling gear 145 is mounted on an axially movable shaft 150 that is moved toward gear 137 and held in engagement therewith by fluid pressure, air being the desired fluid. To accomplish this, one end of the shaft has a head or piston 152 provided with a peripheral sealing ring 153, the piston fitting in a cylindrical bore 154 in the housing which is closed by a plug 155.

The gear 145 shifts axially with the shaft, being mounted on a bearing 157 that is restrained at one end by a ring 158 on the shaft and yieldably held thereagainst by compression spring 160.

Mating serrated faces 161 are formed on the gears 137 and 145 to establish a driving connection between the parts when they are held in engagement by means of air pressure in the cylinder 154. When the air pressure is relieved, spring 160 moves the shaft in a direction to disengage gears 137 and 145 and cause gear 145 to engage the receiving sleeve 162, the parts being provided with mating annular end faces 163 which comprise a radially serrated surface on one member and radially grooved surface on the other.

For the purpose of controlling the device automatically, stop means are provided on the spindle and, for convenience, such means has been shown as a pair of nuts 170 on one side of the housing and a pair 171 on the other side thereof. These can be adjusted and set to limit and position the stroke of the spindle, and they are designed to work in conjunction with a valve system designated generally by numeral 172 that controls the supply of air to the cylinder 154. In the housing we provide a bore 174 which receives a cylindrical valve 175 movable axially therein. The valve has enlarged end portions 176 and 177 and radially reduced intermediate sections 178 and 179 separated by three flanges 180 between which are seal rings 181. Another flange 182 adjacent section 176 defines a groove therewith to receive a seal ring 183. The annular space between the seal rings 181 and 183 serves to connect cylinder 154 through a suitable port and passage labeled "CYL." (Fig. 9) and other passage means in the housing either to air under pressure through a port and passage labeled "PRES." and other means not shown or to connect the cylinder to atmosphere or exhaust through a port and passage labeled "EXH." and other associated means not shown.

In the operation, assuming the parts are in the position of Figs. 7 and 9, air is supplied to cylinder 154 so that the feed gear train is driven and the spindle is being advanced. After the spindle has advanced the predetermined amount, stop nuts 170 on the spindle will engage an arm 186 on the end of the valve 175 and the further advancement of the spindle will move the valve the limit of its travel. This relieves the pressure on the piston 152 connecting it to exhaust and allows spring 160 to disengage coupling gear 145 from gear 137 and move it into engagement with coupling ring 162, thereby stopping the feed gear train and causing rapid retraction of the spindle. Upon retraction, when stop nuts 171 on the spindle engage an arm 185 at the other end of the valve, the valve will be returned to normal feed position.

One advantage of the construction is that the spindle can be made with a fluid passage therethrough to deliver a suitable fluid to the drill, it being only necessary to provide a rotary fitting in the end of the spindle for the attachment of a supply hose.

By way of example of a modification coming within the scope of the invention, we contemplate that the drive and feed gears might be interchanged in the two gear
trains, that is, the feed gear might be driven at all times and the drive gear coupled and uncoupled from the motor. It would then be necessary to have the spindle threaded in the same direction as the direction of rotation thereof when driven by the drive gear so that when the latter is stopped, the spindle will retract. Also, in this case, the drive gear will have to be driven slightly faster than the feed gear to effect the advance of the spindle.

What is claimed is:

1. An automatic feed and quick retraction drill assembly, comprising a housing, an externally screw-threaded spindle adapted to mount a drill bit, a spindle drive train in the housing adapted to be motor-driven and including a drive gear receiving said spindle and keyed thereto, said spindle being axially movable through said drive gear, a spindle feed train in the housing including an internally threaded feed gear threadedly receiving said spindle, an axially shiftable coupling gear forming part of said feed train for establishing a driving connection between said drive and feed trains and movable to disengage said connection, a stationary brake ring for restraining said feed train engageable by said coupling gear when the same is not coupled to said drive train, and means for shifting said coupling member including a fluid motor of the piston-cylinder type for moving said coupling member in an direction and spring means for returning the same.

2. The automatic feed and quick retraction drill assembly set forth in claim 1 in which said fluid motor is connected into a fluid system including a valve controlling flow of fluid to said fluid motor and in which adjustably positionable means is provided on said spindle operably associated with said valve.

3. An automatic feed and quick retraction drill assembly, comprising a housing, a spindle having external screw threads and adapted to mount a drill bit, a first gear train in the housing including a drive gear receiving said spindle and keyed thereto, said spindle being axially movable through said drive gear, said first gear train being adapted to be driven by a motor, a second gear train in the housing including an internally threaded feed gear threadedly receiving said spindle, said second gear train including an axially shiftable coupling gear movable into and out of driven relation with said first gear train, a brake member for restraining said coupling gear against rotation when engaged by the coupling gear when the same is not in driven relation with said first gear train and thereby cause retraction of the spindle, shift means engageable with said coupling gear for moving the same between said first gear train and said brake means, and spring means effectively interposed between the housing and said coupling gear yieldably urging said coupling gear into engagement with said brake means enabling said second gear train to rotate with the spindle against the restraining effect of said brake means when said spindle is prevented from retracting.

4. The automatic feed and quick retraction drill assembly set forth in claim 3 in which said spindle is provided with a stop limiting retraction of the spindle.

5. The automatic feed and quick retraction drill assembly set forth in claim 3 in which said coupling gear is mounted on an axially movable shaft having an actuating lever and means for releasably locking it in a position such that said coupling gear is in operative engagement with said first drive train, and in which spring means between lever and housing associated with said shaft urges the same in a direction to disengage said coupling gear from said drive element and urges it to engage the brake means.

6. An automatic feed and quick retraction drill assembly, comprising a housing having an aperture therethrough, an externally screw-threaded spindle extending through said aperture adapted to mount a drill bit, a first gear train mounted in said housing including a drive gear receiving said spindle and keyed thereto, said spindle being axially movable through said drive gear, said first gear train being adapted to be driven by a motor, a second gear train including an internally threaded feed gear threadedly receiving said spindle, said second train including a coupling gear, an axially movable shaft carrying said coupling gear, a brake ring in said housing beyond one end of said coupling gear, said shaft being shiftable axially selectively to cause said coupling gear operatively to engage said first drive train or to engage said brake ring, interengaging means on said housing and said shaft for releasably locking said shaft in position with said coupling gear in engagement with said first drive train, and spring means interposed between said housing and said shaft yieldably urging said shaft in a direction to cause said coupling gear to engage said brake ring.

7. In a finger drill, an elongated housing having a transverse opening at one end, an externally threaded drill spindle extending through said opening, an internally threaded feed gear in the housing receiving said spindle, a drive gear in the housing receiving said spindle and keyed thereto, said spindle being movable axially through the drive gear, a motor mounted at the other end of the housing, a drive gear train driven by said motor and extending between the motor and spindle and including said drive gear, a feed gear brake member, means for selectively coupling said feed gear to said drive gear train or said brake member including a shiftable coupling element, a stop member provided on said spindle, and means responsive to engagement by said stop member for shifting said coupling element.

References Cited

UNITED STATES PATENTS

434,576 8/1890 Wyman ............ 77—34.7
2,791,922 5/1927 Robinson ............ 77—34.4
3,124,817 3/1964 Mosier ............ 77—34.7 XR
3,421,392 1/1969 Bangerter et al. ............ 77—7
3,429,206 2/1969 Quackenbush ............ 77—34.7

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