March 11, 1941. A. F. REHNBERG 2,234,452

DRILLING UNIT

Filed Aug. 17, 1938 2 Sheets-Sheet 1

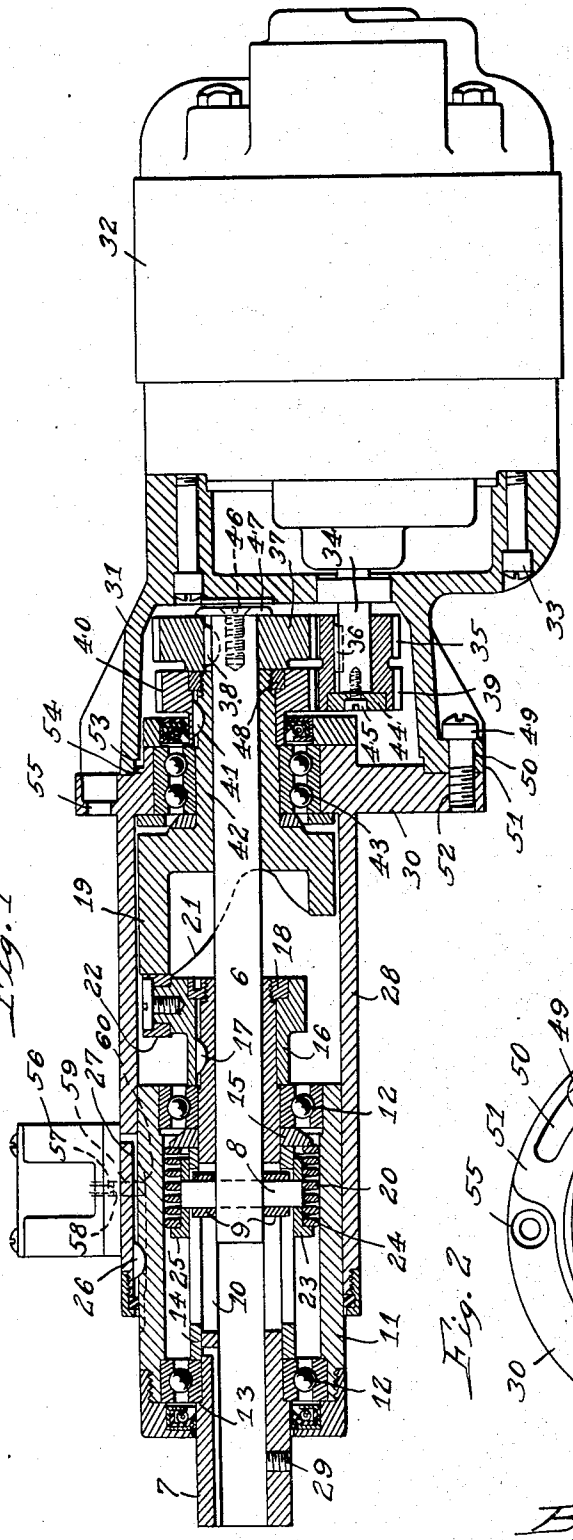

Fig. 1

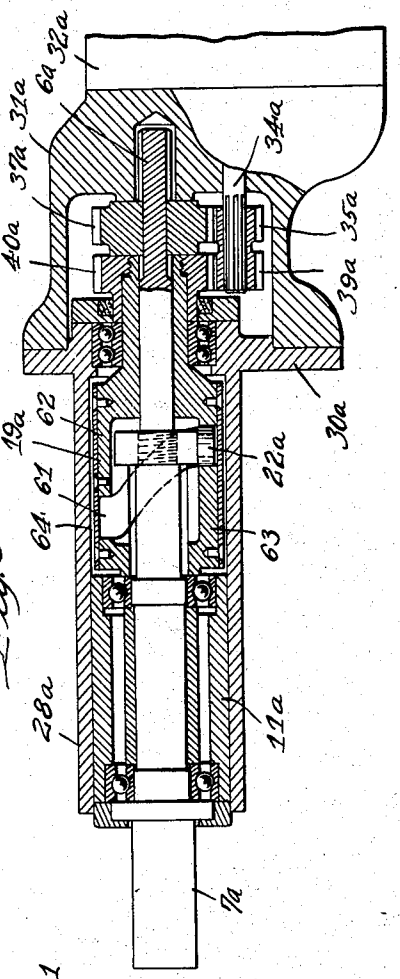

Fig. 3

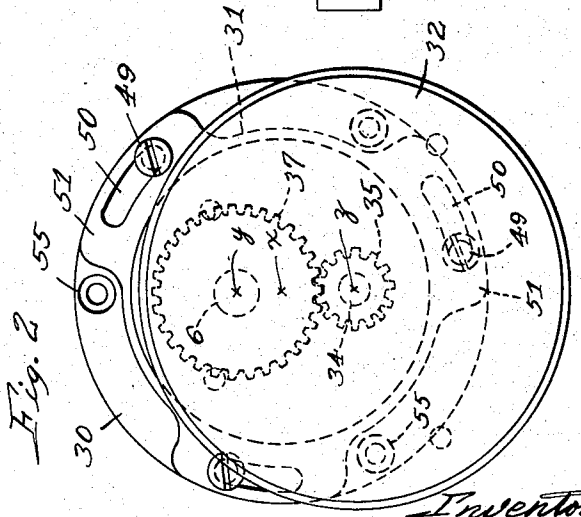

Fig. 2

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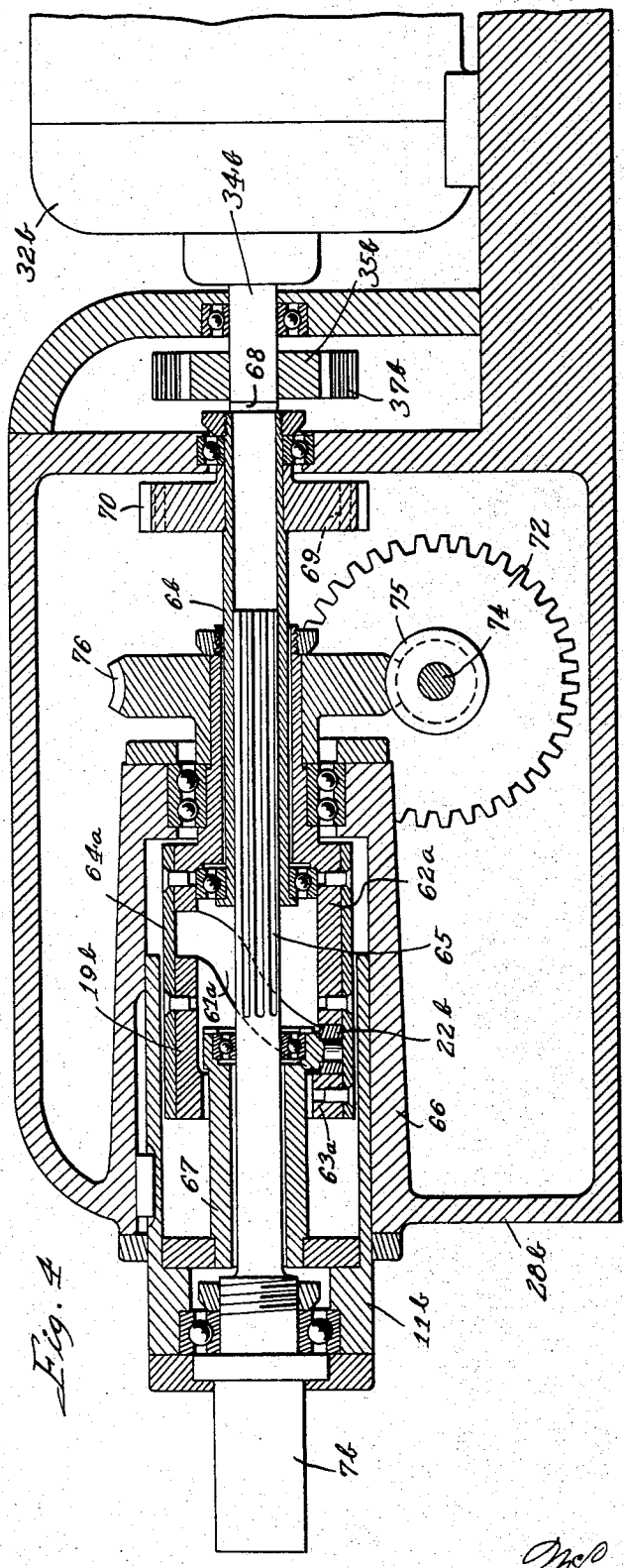

Fig. 4

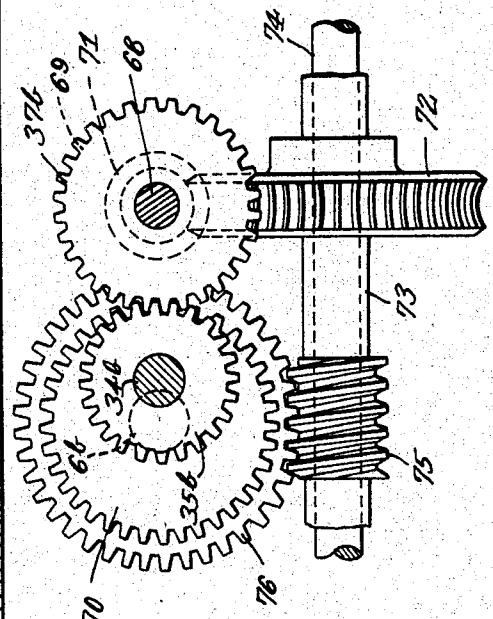

Fig. 5

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UNITED STATES PATENT OFFICE

2,234,452

DRILLING UNIT

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Application August 17, 1938, Serial No. 225,405

11 Claims. (Cl. 77—6)

This invention relates to a new and improved drilling unit.

The principal object of my invention is to provide a simple, compact and economical form of drilling unit embodying means for imparting reciprocatory movement to the drill spindle in a predetermined timed relation to the drive thereof, whereby to insure high all-around efficiency.

A salient feature of the drilling unit of my invention is the concentric arrangement with the drill spindle of the cam means or cam and spring means for imparting the feed and return movements to the spindle, whereby to secure not only compactness, but also freedom from vibration and at the same time make for easier operation by having the thrust transmitted as closely as possible to the axis of the drill spindle.

Still another important feature of the invention is the provision of a drilling unit of the kind mentioned having pick-off gears which may be changed readily to suit different requirements when a different cam means is substituted for a new set-up of the unit, and also having the head equipped with a rotatably adjustable face plate arranged to turn about a center in eccentric relation to the axes of the drill spindle and the drive or armature shaft so that these axes may be adjusted closer together or farther apart accordingly as the particular pick-off gears used may necessitate.

The invention is illustrated in the accompanying drawings, in which—

Fig. 1 is a longitudinal section through a drilling unit made in accordance with my invention;

Fig. 2 is an end view of Fig. 1, looking at the motor end;

Fig. 3 is a fragmentary sectional view similar to a portion of Fig. 1, but showing a modified construction;

Fig. 4 is a longitudinal section through still another drilling unit of further modified construction with a portion of the motor end broken off, and

Fig. 5 is an isolated view of the gearing for the unit shown in Fig. 4.

Similar reference numerals are applied to corresponding parts throughout the views.

Referring first to Figs. 1 and 2, disclosing that form of unit at present preferred, 6 is the driven spindle and 7 is the hollow drill spindle disposed in telescoping relation with the outer end thereof, and having drive transmitted thereto by the cross-pin 8 which carries rollers 9 working in the longitudinal slots 10 in the drill spindle. A sleeve 11 carries ball bearings 12 in the opposite ends thereof for anti-friction support of the drill spindle 7, one of these bearings having abutment with an annular shoulder 13 near the outer end of the spindle 7, and a spacing sleeve 14 being interposed between the outer bearing and the inner bearing along with a ring 15 which is held in place between the inner end of the sleeve 14 and the inner bearing 12. A collar 16 keyed on the inner end of the drill spindle 7, as at 17, and secured against endwise displacement from the spindle by means of a nut 18 threaded on the inner end of the spindle has abutment with the inner bearing 12 to keep the parts of the drill spindle assembly in assembled relation. Feed movement is imparted to the drill spindle 7 by a hollow cylindrical cam 19, and the spindle is adapted to be returned by a coiled compression spring 20, both of these being disposed in concentric relation with the spindles 6 and 7, as shown. Movement is imparted in both directions through the medium of the bearing sleeve 11, the cam 19 being arranged to transmit positive end thrust to the sleeve 11 through the inner bearing 12 by rolling contact of its profiled periphery 21 with the follower roller 22 mounted on the collar 16, and the spring 20 being arranged to transmit yielding end thrust to the sleeve 11 in the opposite direction by abutment with the ring 15 which engages the inner bearing 12 on the opposite side from the collar 16. A collar 23 surrounding the spacing sleeve 14 has diametrically opposed holes 24 therein receiving the ends of the cross-pin 8, and the annular flange 25 on this collar provides an abutment for the outer end of the spring 20. A key 26 on the sleeve 11 sliding in a keyway 27 inside the tubular housing 28 serves to hold the sleeve against turning while permitting reciprocatory movement with the drill spindle. The latter is shown with the sleeve 11 at the outer limit of its movement with the roller 22 disposed at the peak of the profiled cam surface 21 and with the spring 20 fully compressed and ready to return the sleeve 11 to retracted position so as to withdraw the drill from the work with the drill spindle 7. A set screw is shown at 29 for clamping a drill in place in the spindle 7.

The housing 28 which encloses the drill spindle and associated mechanism just described projects from a face plate 30 mounted on the head 31 of the drilling unit. This head is hollow and serves to enclose the intermediate gears between the electric drive motor 32 and the spindle and cam mechanism previously described, while

also supporting the motor 32, which, as shown, is secured to the head 31 by screws 33. The motor 32 drives the drill spindle 7 by means of the intermediate spindle 6, the drive being transmitted from the armature shaft 34 of the motor to a gear 35 keyed, as at 36, to the armature shaft and meshing with a gear 37 keyed at 38 to the inner end of the driven spindle 6. The gear 35 is integral with another gear 39 which meshes with a gear 40 keyed, as at 41, on the reduced cylindrical hub 42 of the cam 19. The hub 42 is supported in a double ball bearing 43 in the face plate 30. A washer 44 and screw 45 serve to retain the cluster gear 35—39 on the armature shaft 34. A screw 46 and washer 47 secure the gear 37 on the inner end of the shaft 6, and a nut 48 threaded on the inner end of the hub 42 of the cam 19 serves to secure the gear 40 in place. Now, it will be noticed that the gear 39 is slightly larger than its companion gear 35, and the gear 40 driven off the gear 39 is proportionately slightly smaller than the gear 37 driven off the gear 35, the differential being such that as the drill spindle 7 is driven by gears 35 and 37, the cam 19 driven at a slightly higher speed than the drill spindle 7 by gears 39 and 40 will be advanced rotatively in relation to the drill spindle 7 to cause the drill spindle to be positively fed toward the work to enter the drill to a predetermined depth by the cam 19 and follower roller 22. When the high point of the cam 19 passes the follower roller 22, the spring 20 yieldingly, but nevertheless with considerable force, withdraws the drill from the work by movement of the spindle 7 to retracted position, as permitted by the rotative advancement of the cam 19 in relation to the driving of the drill spindle.

The gear cluster 35—39 may be removed along with the related gears 37 and 40 when a cam having different characteristics from the cam 19 is to be used in a new set-up of the unit. I have so constructed the face plate 30 that it may be adjusted rotatably to change the spacing of the driven spindle 6 in relation to the armature shaft 34 as required when different sized gears are used. In Fig. 2, x designates the center about which the face plate 30 is adjustable relative to the head 31, and y and z designate the centers for the spindle 6 and armature shaft 34, respectively. Manifestly, by rotating the face plate 30 I am thereby enabled to adjust the spindle center y closer to or farther away from the armature shaft center z. In Fig. 2, the centers y and z are shown adjusted as far apart as possible. The means for detachably securing the face plate 30 in different positions of rotary adjustment relative to the head 31 comprises screws 49 entered through arcuate slots 50 in lugs 51 on the head 31 and threaded in holes 52 in the face plate 30. The slots 50 are struck on arcs from the center x of the face plate 30. A counterbore 53 is provided in the head 31 to receive a cylindrical portion 54 on the face plate 30 to accurately center the face plate with respect to the head 31 for the rotary adjustment. Holes 55 are provided in the face plate 30 through which bolts or screws may be entered for fastening the drilling unit onto a fixture.

The operation of the drilling unit should be clear from the foregoing description; the relative rotation between the cam 19 and driven spindle 6 and drill spindle 7 cause endwise movement to be imparted to the drill spindle by the follower roller 22 which rides on the periphery 21 of the cam, and, while I have described the cam 19 as driven at a slightly greater speed than the driven spindle 6, it should be clear that if the cam is properly profiled, the cam may be driven at a slightly lower speed than the spindle to obtain the same results as herein disclosed. I wish at this point to emphasize the advantage of having the feed cam 19 and return spring 20 disposed in concentric relation with the drill spindle 7; this permits the compact construction disclosed and makes for easier and smoother operation, because there is no tendency for the parts to bind in their relative reciprocatory movement, due to the fact that the end thrust is transmitted as closely as possible to the axis of the drill spindle. The close relationship of the follower roller 22 to the drill spindle axis also minimizes danger of vibration, although I may, if so desired, provide counterbalancing means for the follower roller on the collar 16. The cam 19 may likewise be counterbalanced to eliminate vibration. However, counterbalancing is not necessary unless fairly high speeds are attained. In passing, attention is called to the limit switch 56, the plunger 57 of which is operable by a follower 58 guided in a hole 59 in the housing 28 and projecting into a longitudinal groove 60 in the sleeve 11. This switch is placed in circuit with manually operable start and stop switches (not shown) and serves to open the circuit for the motor 32 automatically upon return of the sleeve 11 with the drill spindle to fully retracted position. The arrangement is such that the operator merely depresses the starting button to initiate the circuit for the motor 32, and the switch 56 thereafter acts as a relay to maintain the motor circuit intact throughout the cycle of feed and return movements of the drill spindle, unless the operator for some reason finds it necessary to press the stop button before the cycle has been completed, in which event the motor 32 is stopped immediately and will not resume operation until the operator presses the start button again.

Fig. 3 illustrates a modified form in which the drill spindle 7a carries a follower roller 22a working in a continuous slot 61 between the sections 62 and 63 of a cam 19a. The two sections of the cam are secured together by a sleeve 64 suitably secured to the periphery of the sections, as shown. In this unit, the drill spindle is the only spindle required, the same being supported in a sleeve 11a slidable in the housing 28a and having a splined inner end 6a making a sliding driving connection with a gear 37a driven by a gear 35a fixed on the armature shaft 34a of the motor 32a. The cam 19a is driven by a gear 40a meshed with a gear 39a formed in a cluster with the gear 35a, the ratio between the gears 35a and 37a being slightly different from the ratio between gears 39a and 40a to provide the necessary differential between the speed of rotation of the drill spindle 7a and the cam 19a. The face plate 30a in this form may be adjustable rotatably on the head 31a similarly as in the other form to change the spaced relationship between the drive or armature shaft 34a and the spindle 7a. The operation of this form of unit will be substantially the same as the one previously described, with the exception that the return movements of the spindle are positive, the same as the feed movements.

The unit shown in Figs. 4 and 5 has a drill spindle 7b splined, as at 65, for a sliding driving connection with a driven spindle 6b. In this

case, the sleeve 11b slides in a bearing 66 in a larger housing 28b. The follower roller 22b is not revolved with the drill spindle, but is carried on a support 67 which merely reciprocates with the sleeve 11b. In view of the fact that the follower does not revolve, the cam 19b must be driven at a very low speed, which, of course, must still bear a predetermined relationship to the speed of the drill spindle 7b in order that the latter will be given feed and return movements similarly as in the units above described. The cam 19b is shown as made up of two sections 62a and 63a joined together by a sleeve 64a providing therebetween an endless track or slot 61a for the follower roller 22b. The drill spindle 7b is driven as follows: The motor 32b has its armature shaft 34b driving a gear 35b meshed with a gear 37b carried on a counter-shaft 68 parallel with the armature shaft 34b. Another gear 69 on the counter-shaft 68 meshes with a gear 70 on the driven spindle 6b, which, as previously pointed out, drives the splined end 65 of the drill spindle 7b. The cam 19b is driven as follows: A worm 71 on the counter-shaft 68 meshes with a worm wheel 72 on the sleeve 73 rotatably supported on a cross-shaft 74. This constitutes one step of reduction, and a further step of reduction is secured by a second worm 75 turning with the worm wheel 72 and meshing with a worm gear 76 suitably fixed to and turning with one section 62a of the cam 19b. The operation of a unit constructed along these lines is substantially the same as the operation of the other units, except, as previously pointed out, in regard to the rotation of the cam 19b alone, instead of the cam and follower both rotating. Then, too, the present construction is designed with a view to permitting an easier change in the gear ratio between the driving shaft and the drill spindle and its operating cam, the present design permitting easy change of the pick-off gears 35b and 37b.

It is believed the foregoing description conveys a good understanding of the objects and advantages of my invention. The appended claims have been drawn with a view to covering all legitimate modifications and adaptations.

I claim:

1. In combination, a driven spindle adapted to drive a drill or other tool, means for supporting said spindle for rotation and reciprocation, means comprising a drive shaft having a direct driving connection with the spindle for rotating the spindle at a substantially constant speed, said direct driving connection consisting of a gear fixed on the shaft in direct mesh with a gear fixed on the spindle, and means for reciprocating said spindle in feed and return movements including a cylindrical end thrust cam in concentric relation with and closely surrounding the spindle, said cam having an internal endless cam slot provided therein intermediate the ends thereof, a follower turning with the spindle close to the axis thereof and projecting into said slot for positive actuation of the spindle in its reciprocatory movement during rotation, and means consisting of a gear fixed on the cam meshing directly with a gear fixed on the drive shaft for driving said cam at a substantially constant speed bearing a predetermined differential relationship to the speed of the spindle.

2. In combination, a casing, a drill spindle projecting therefrom and adapted to carry a drill, a bearing sleeve slidable in the casing and having anti-friction bearings therein supporting said spindle for rotation, means for rotating the spindle at a substantially constant speed, including a driven spindle in telescoping driving relation with the drill spindle, and means for reciprocating said drill spindle in feed and return movements, including a coiled compression spring inside said sleeve in concentric relation with said spindles and disposed on one side of one of said anti-friction sleeve bearings and having its one end supported against endwise movement by the driven spindle and its other end movable and arranged to transmit movement through the adjacent anti-friction sleeve bearing to the sleeve so as to move said drill spindle yieldingly in one direction, a cam follower carried on said drill spindle outside said sleeve and disposed within the casing on the opposite side of the aforesaid anti-friction sleeve bearing to transmit positive movement to said sleeve and drill spindle in the opposite direction, a cylindrical end thrust cam abutting said follower and disposed in concentric relation with the driven spindle within the casing, and means for driving said cam at a substantially constant speed bearing a predetermined differential relationship to the speed of the drill spindle.

3. In a drilling unit the combination of a hollow head adapted to be mounted on a support and adapted to support a drive motor on one side thereof and a drill spindle projecting from the other side thereof, a drive motor mounted on one side of said head, a tubular housing for a drill spindle mounted on and projecting from the other side of said head, a drill spindle in said housing extending lengthwise thereof into the head, bearing means in the outer end of said housing supporting the spindle for rotation and reciprocation, a hollow cylindrical cam surrounding said spindle in the inner end of said housing and having a reduced hollow cylindrical portion bearing on the inner end of said spindle and projecting into said head, bearing means in the inner end of said housing supporting the reduced portion of said cam for rotation and against endwise movement, said cam having an endless cam slot provided therein intermediate the ends thereof, a radially projecting follower on the spindle slidably engaging in said slot, the aforesaid motor comprising an armature shaft extending through said head in parallel relation to the inner end of said spindle, two different gears fixed on the end of said armature shaft in said head, and two other different gears in said head meshing with the last named gears, one being fixed on the inner end of the reduced portion of said cam and the other having a sliding driving connection with the inner end of the spindle.

4. In a drilling unit the combination of a hollow head adapted to be mounted on a support and adapted to support a drive motor on one side thereof and a drill spindle projecting from the other side thereof, a drive motor mounted on one side of said head, a tubular housing for a drill spindle mounted on and projecting from the other side of said head, a driven spindle and a drill spindle having a telescoping driving connection with one another and disposed in said housing with the drill spindle extending from the outer end of said housing and the driven spindle projecting from the inner end of said housing into said head, bearing means in the outer end of said housing supporting the drill spindle for rotation and reciprocation, a hollow cylindrical cam surrounding said driven spindle in the inner end of said housing and having a

reduced hollow cylindrical portion bearing on said spindle and projecting into the head, bearing means in the inner end of said housing supporting said cam by its reduced portion for rotation and against endwise movement, said cam having an endless cam track provided thereon, a radially projecting follower on the drill spindle slidably engaging said track, the aforesaid motor comprising an armature shaft extending into said head in parallel relation to the inner end of said driven spindle, two different gears fixed on the end of said armature shaft in said head, and two other different gears in said head meshing with the last named gears, one being fixed on the inner end of the reduced portion of said cam and the other being fixed on the inner end of the driven spindle.

5. A drilling unit as set forth in claim 3 wherein the housing includes a face plate on the inner end thereof rotatably adjustable on and detachable from said head, the rotatable adjustment being about a center in eccentric relation to the centers of the armature shaft and cam driven therefrom.

6. A drilling unit as set forth in claim 4 wherein the housing includes a face plate on the inner end thereof rotatably adjustable on and detachable from said head, the rotatable adjustment being about a center in eccentric relation to the centers of the armature shaft and cam driven therefrom.

7. In combination, a casing, a drill spindle projecting therefrom and adapted to carry a drill, a bearing sleeve slidable in the outer end of said casing and having anti-friction bearings therein supporting said spindle for rotation, an electric motor for driving the spindle at a substantially constant speed, comprising an armature shaft in parallel relation to the spindle, a gear on said armature shaft meshing directly with a gear on the spindle to drive the same, and means for reciprocating said spindle in feed and return movements including a hollow cylindrical cam surrounding said spindle and having a reduced hollow cylindrical portion supported in anti-friction bearings in the inner end of the casing, another gear on said armature shaft different from the first gear meshing with a gear on said reduced hollow cylindrical bearing portion, whereby said cam is driven in the same direction but in differential relation to the spindle, said cam having a cam track provided thereon, and a radially projecting follower on the spindle slidably engaging said track.

8. A drilling unit comprising, in combination, an electric motor having an armature shaft with two different gears fixed thereon, a drill driving spindle disposed in close parallel relation with the armature shaft having a gear splined thereon meshing with one of the armature shaft gears for a direct driving connection with the motor, another gear meshing with the other armature shaft gear in concentric relation with the drill spindle gear, and relatively rotatable cam and follower means, one relatively rotatable portion of which turns with the drill spindle and the other relatively rotatable portion of which turns with the last mentioned gear in differential relation with the first named portion.

9. A drilling unit comprising, in combination, an electric motor having an armature shaft with two different gears fixed thereon, a drill driving spindle disposed in close parallel relation with the armature shaft having a gear splined thereon meshing with one of the armature shaft gears for a direct driving connection with the motor, an elongated housing rigid with the housing of said electric motor, a bearing sleeve slidable in said housing supporting the drill spindle for rotation and reciprocation, another gear meshing with the other armature shaft gear in concentric relation with the drill spindle gear, a hollow cylindrical cam in concentric relation with the drill spindle driven by the last named gear in the same direction but in differential relation with the drill spindle, said cam having an endless cam track, and a follower turning with the drill spindle and engaging said track whereby the drill spindle is positively fed in one direction and positively returned in the continuous rotation of the spindle.

10. A drilling unit comprising, in combination, an electric motor having an armature shaft carrying two different gears, a pair of other gears rotatable relative to one another about a common center meshing with the first named gears, the last named pair of gears being of a diameter in relation to the first named gears to lie substantially wholly within the diameter of the motor, housing means rigid with the motor enclosing said gears and including a hollow cylindrical extension in coaxial relation with the second named pair of gears, a drill spindle projecting from said extension and adapted to carry a drill, a bearing sleeve slidable in the outer end of said extension and having anti-friction bearings therein supporting said spindle for rotation, said spindle having means connected with one of the second named pair of gears whereby the spindle is driven, a hollow cylindrical cam received in bearings provided therefor in the inner end of said housing extension and carrying the other of the second named pair of gears, and a cam follower engaging a track provided on the cam and turning with the spindle.

11. A drilling unit comprising, in combination, an electric motor having an armature shaft carrying two different gears, a pair of other gears rotatable relative to one another about a common center meshing with the first named gears, the last named pair of gears being of a diameter in relation to the first named gears to lie substantially wholly within the diameter of the motor, housing means rigid with the motor enclosing said gears and including a hollow cylindrical extension in coaxial relation with the second named pair of gears, a drill spindle projecting from said extension and adapted to carry a drill, a bearing sleeve slidable in the outer end of said extension and having anti-friction bearings therein supporting said spindle for rotation, said spindle having shaft means connected with one of the second named pair of gears for driving the spindle, a hollow cylindrical cam surrounding the last named shaft having a reduced hollow extension for positioning said last named shaft in concentric relation with the housing extension, said reduced hollow extension being fixed to the other of the second named pair of gears, bearing means supporting said reduced hollow extension in concentric relation with the housing extension, and a cam follower engaging a cam track on said cam and turning with the drill spindle.

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