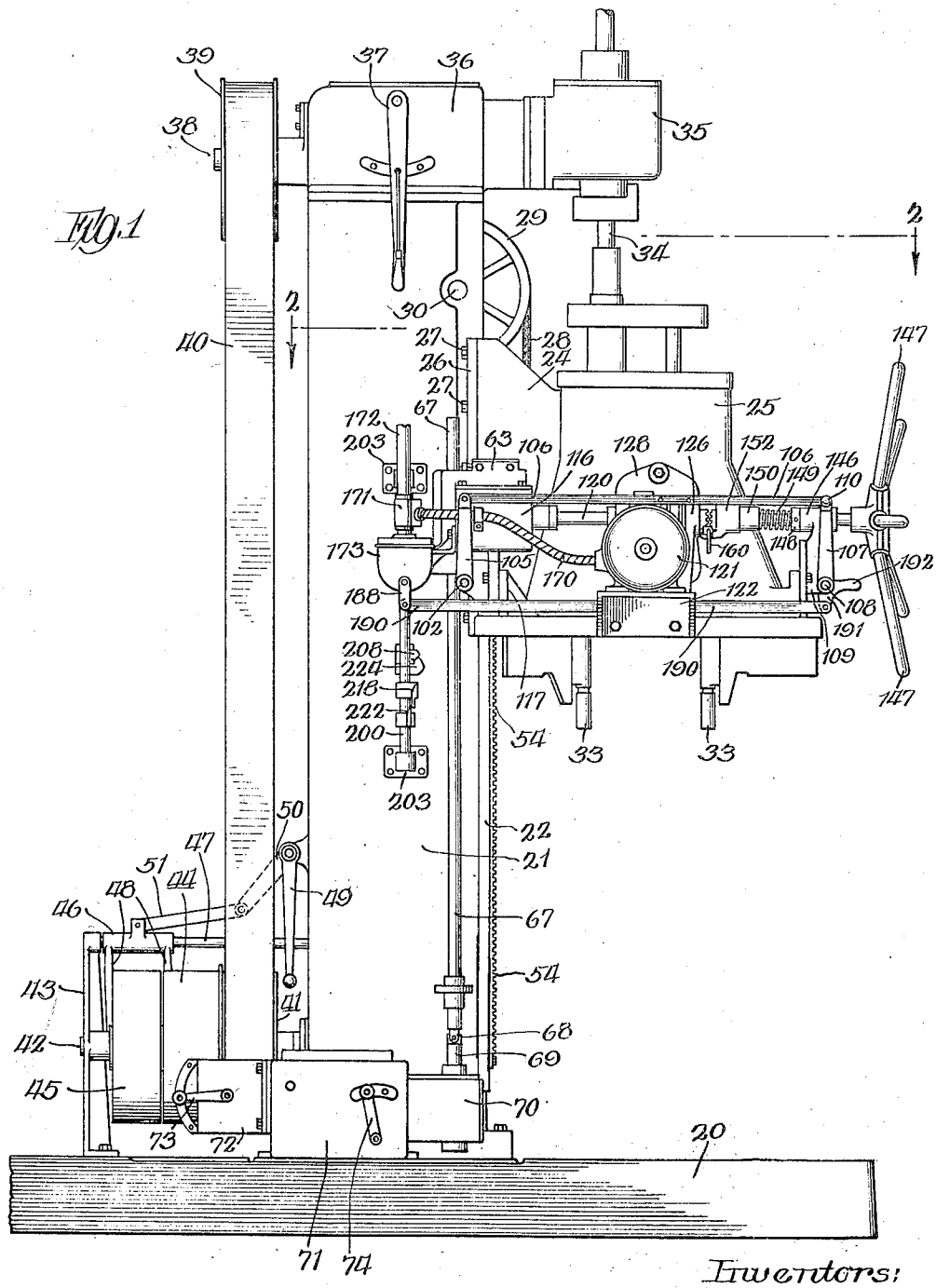
April 10, 1928. 1,665,411

R. M. GALLOWAY ET AL

DRILLING MACHINE

Filed Sept. 7. 1923 8 Sheets-Sheet 1

Fig. 1



Inventors:
Robert M. Galloway
Paul C. Burton
by Rector, Hibben, Davis & Macauley Atty's.

April 10, 1928. 1,665,411

R. M. GALLOWAY ET AL

DRILLING MACHINE

Filed Sept. 7, 1923 8 Sheets-Sheet 2

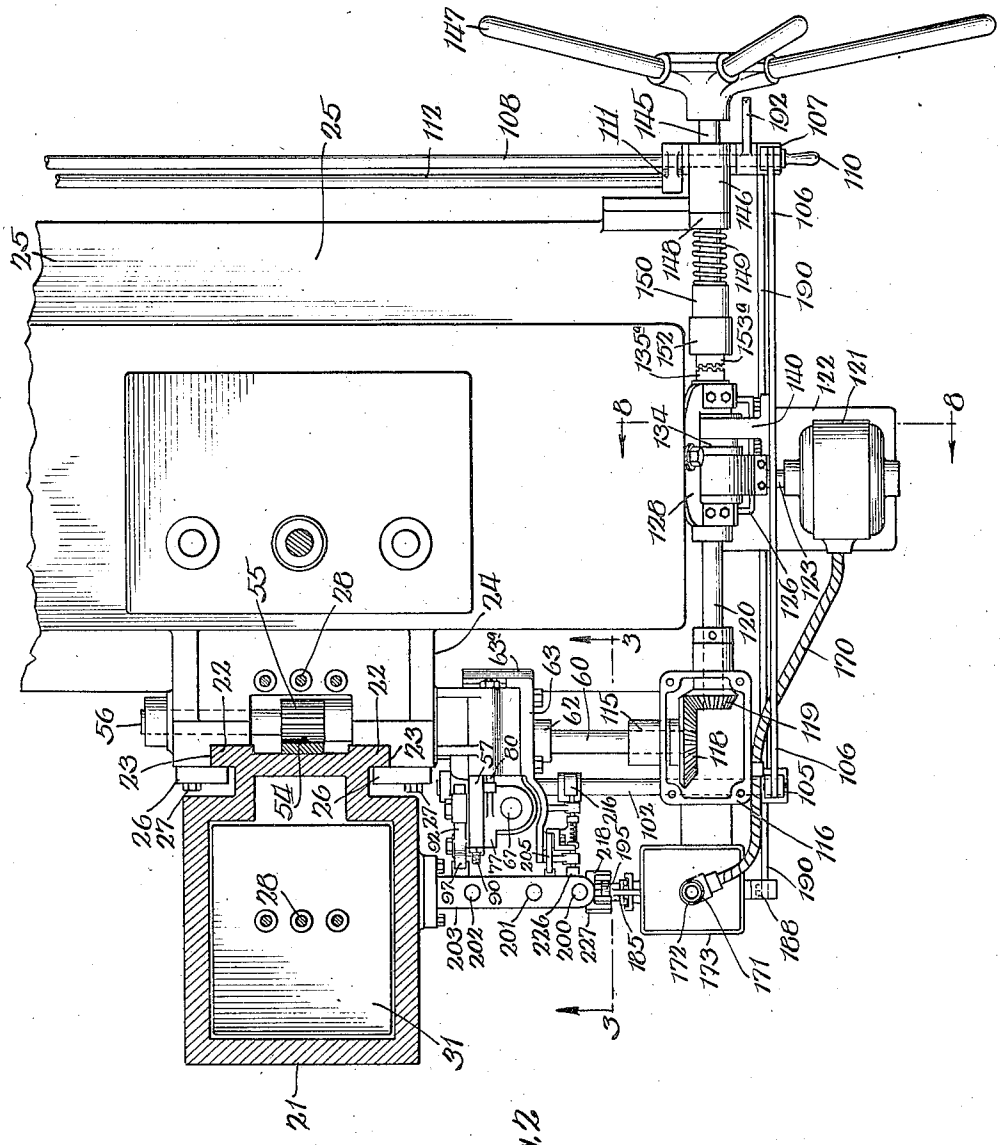


Fig. 2

Inventors:
Robert M. Galloway
Paul C. Burton
by Rector, Hibben, Davis & Macauley
Attys.

April 10, 1928. 1,665,411

R. M. GALLOWAY ET AL

DRILLING MACHINE

Filed Sept. 7, 1923 8 Sheets-Sheet 3

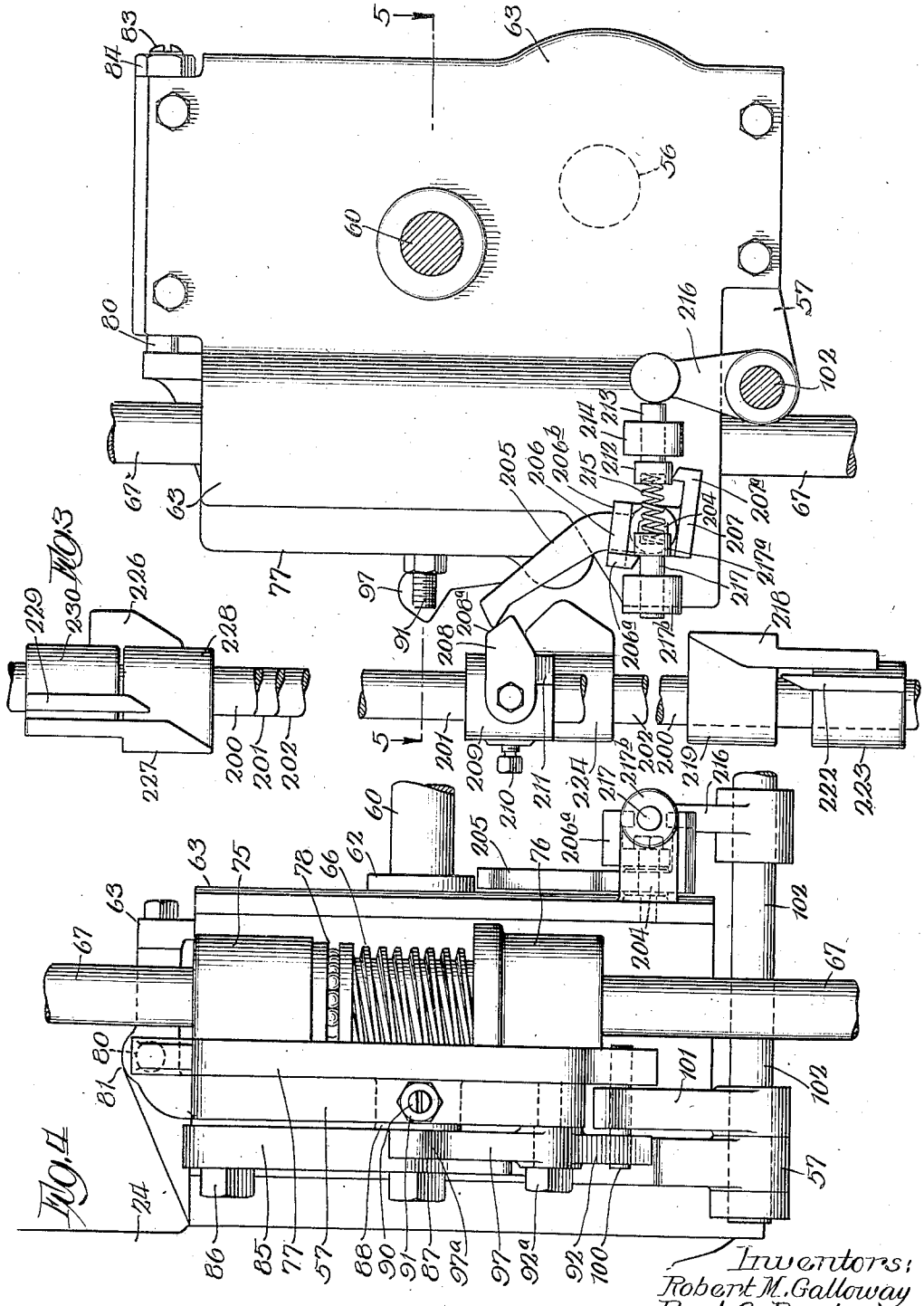


FIG. 4

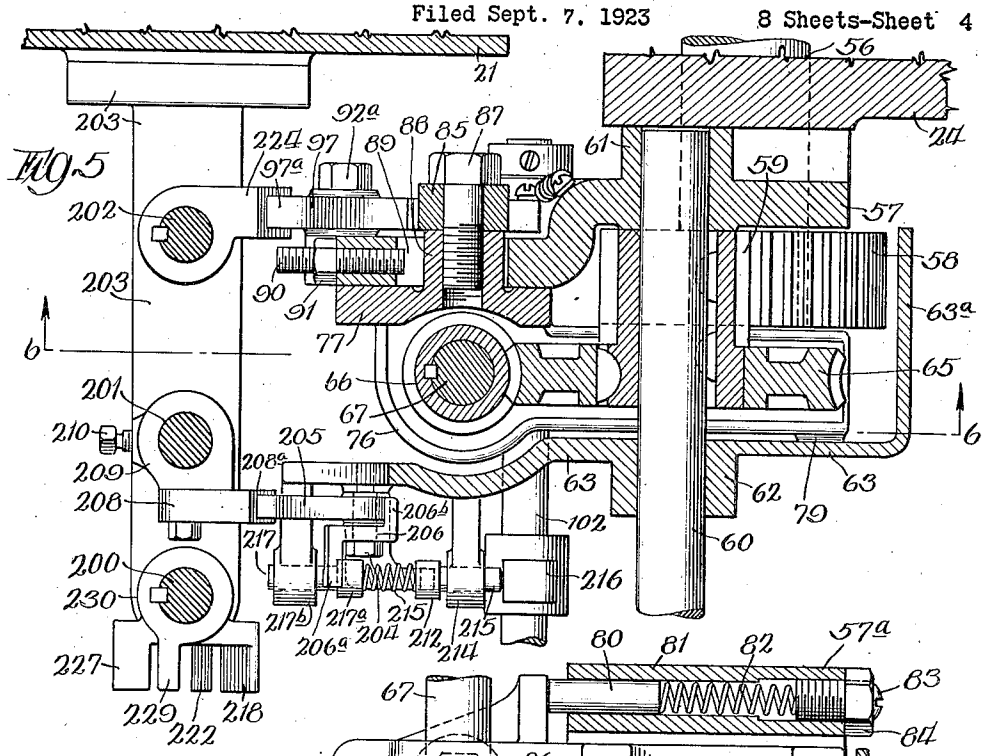
Inventors:
Robert M. Galloway
Paul C. Burton
by Rector, Hibben, Davis & Macauley Atty's.

April 10, 1928. 1,665,411

R. M. GALLOWAY ET AL

DRILLING MACHINE

Filed Sept. 7, 1923 8 Sheets-Sheet 4



Inventors:
Robert M. Galloway
Paul C. Burton
by Rector, Hibben, Davis and Macauley Attys.

April 10, 1928. 1,665,411

R. M. GALLOWAY ET AL

DRILLING MACHINE

Filed Sept. 7, 1923 8 Sheets-Sheet 5

Fig. 9

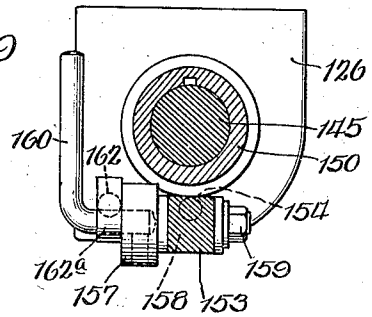


Fig. 8

Inventors:
Robert M. Galloway
Paul C. Burton
By Rector, Hibben, Davis & Macauley
Atty's.

April 10, 1928. 1,665,411

R. M. GALLOWAY ET AL

DRILLING MACHINE

Filed Sept. 7, 1923 8 Sheets-Sheet 6

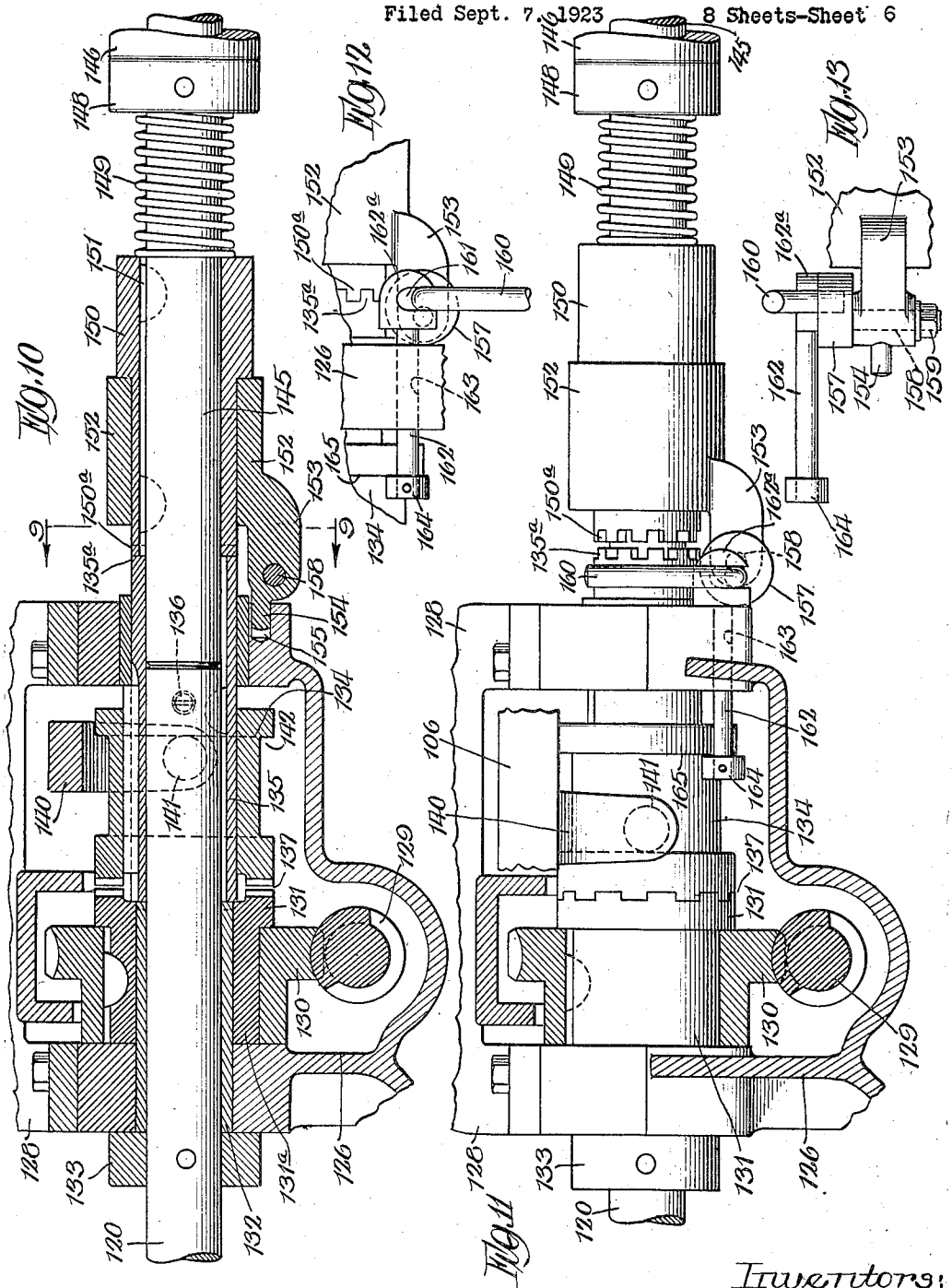


Fig. 10

Fig. 11

Fig. 12

Fig. 13

Inventors:
Robert M. Galloway
Paul C. Burton
by Rector, Hibben, Davis & Macauley
Atty's.

April 10, 1928. 1,665,411

R. M. GALLOWAY ET AL

DRILLING MACHINE

Filed Sept. 7. 1923 8 Sheets-Sheet 7

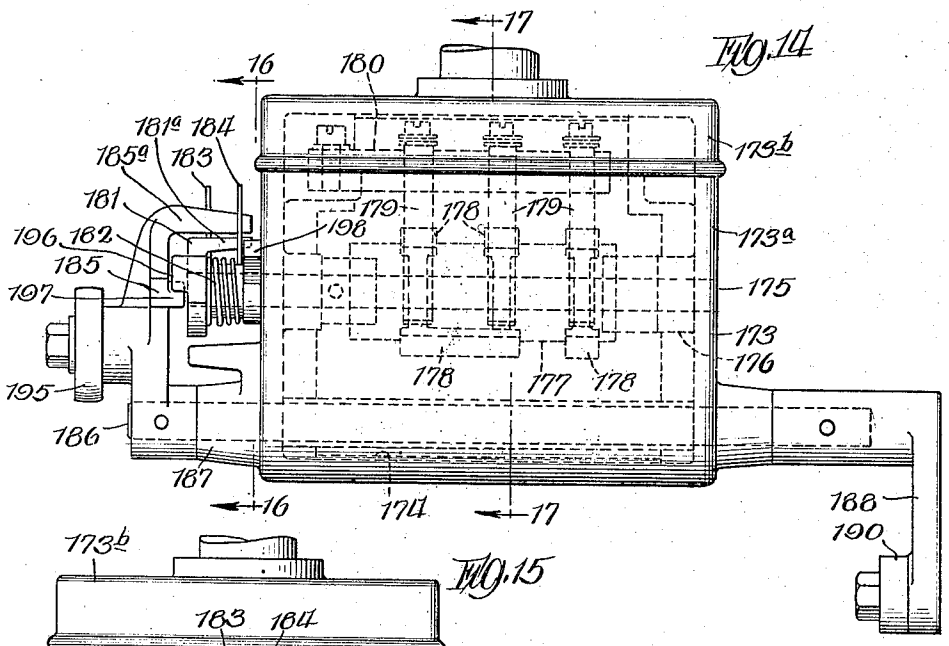


FIG. 14

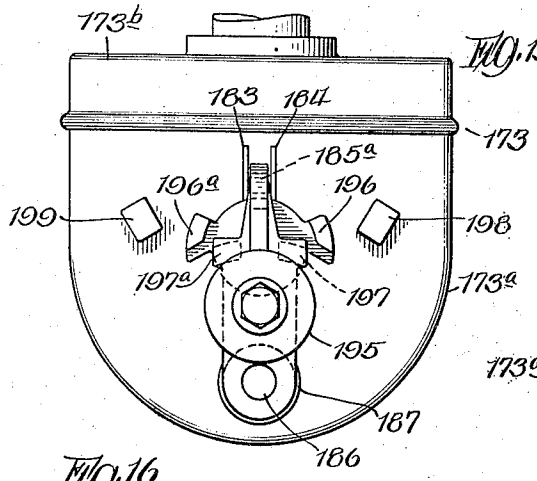


FIG. 15

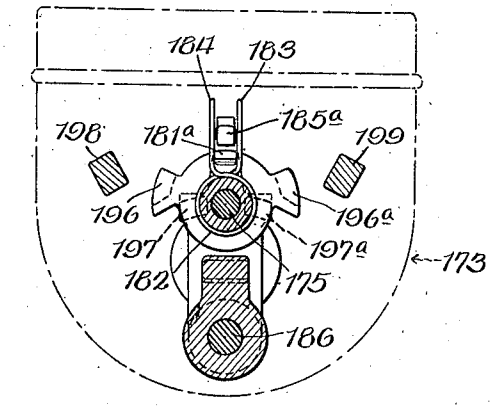


FIG. 16

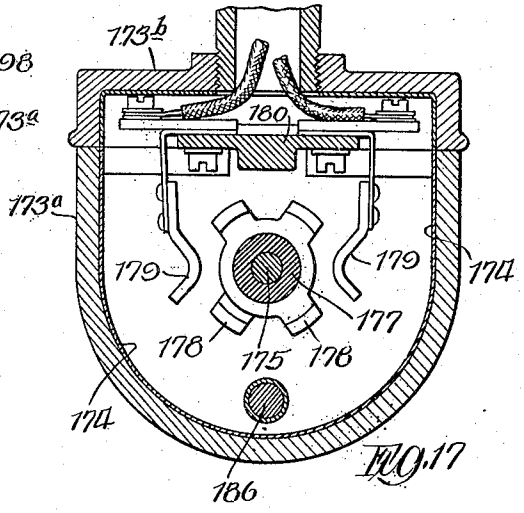


FIG. 17

Inventors:
Robert M. Galloway
Paul C. Burton
By Rector, Hibben, Davis & Macauley
Atty's

April 10, 1928. 1,665,411

R. M. GALLOWAY ET AL

DRILLING MACHINE

Filed Sept. 7. 1923 8 Sheets-Sheet 8

Fig. 18.

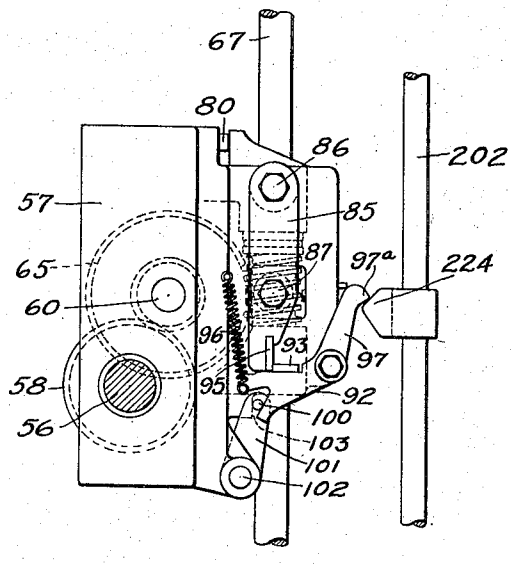
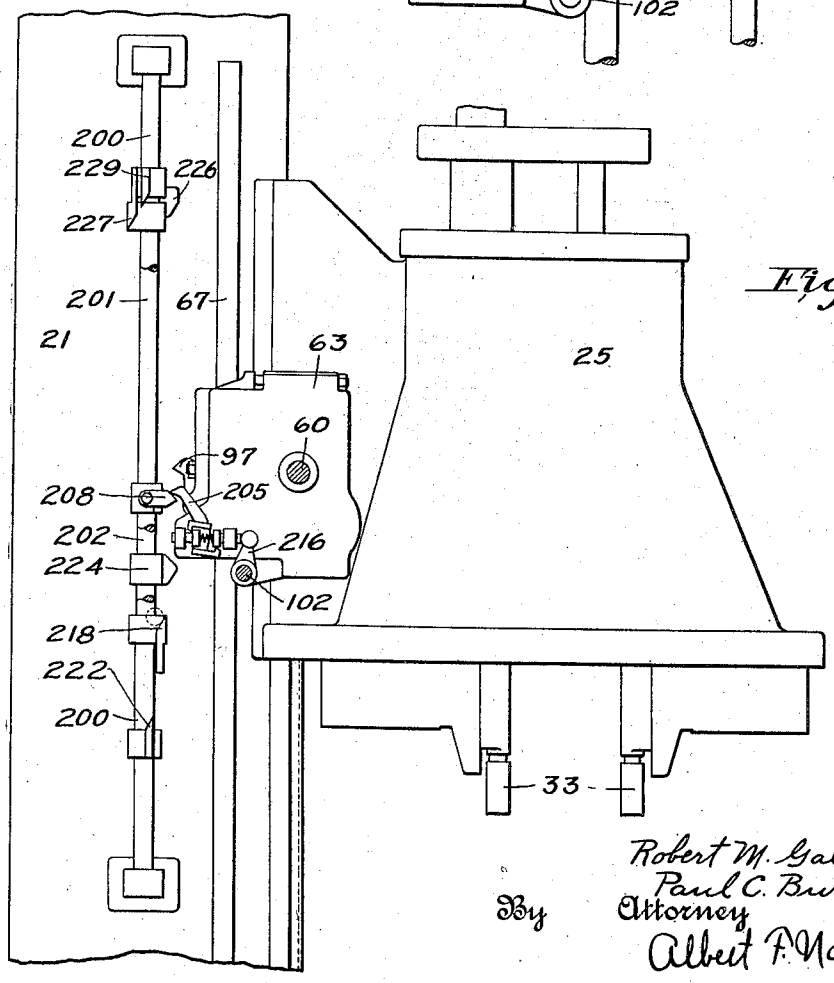


Fig. 19.



Inventors
Robert M. Galloway
Paul C. Burton
By Attorney
Albert F. Nathan

Patented Apr. 10, 1928. 1,665,411

UNITED STATES PATENT OFFICE.

ROBERT M. GALLOWAY AND PAUL C. BURTON, OF RICHMOND, INDIANA, ASSIGNORS TO THE NATIONAL AUTOMATIC TOOL COMPANY, OF RICHMOND, INDIANA, A CORPORATION OF INDIANA.

DRILLING MACHINE.

Application filed September 7, 1923. Serial No. 661,447.

This invention relates to drilling machines and its purpose is to provide improved means for increasing the efficiency and speed of operation of such machines, particularly when they are power driven. In the operation of drilling machines, it has heretofore been the common practice to move the drill head manually to and from the work to be drilled, the power feed mechanism being in operation only while the drills or other tools were passing through the work. Another method has been to permit the power feed mechanism to operate throughout the movement of the drill head. The first method involves considerable labor on the part of the operator and both methods necessarily result in a slow speed operation of the drill. The principal object of the present invention is to provide power driven means for automatically effecting a rapid movement of the drill head in moving the drills or other cutting tools to or from the work to be operated on, the power feed for advancing the drill head during the drilling operation being automatically thrown into operation after the drills have reached the work while the means for effecting the rapid movement of the drill head is thrown out of operation until the drills have passed through the work, when the head is again moved rapidly upward. Another object is to provide improved means for effecting the rapid traverse of the drill head toward its non-working movement without interfering with the usual manual operation thereof. Still another object is to provide improved mechanism for controlling the movements of the drill head and means for automatically controlling the operation of that mechanism. Other objects relate to various features of construction and arrangement which will appear more fully hereinafter.

The nature of the invention will be understood from the following specification taken with the accompanying drawings in which one embodiment is illustrated. In the drawings, Fig. 1 shows a side elevation of a multi-drilling machine embodying the improvements of the present invention; Fig. 2 shows a horizontal section on the line 2—2 of Fig. 1 looking in the direction of the arrows; Fig. 3 shows an enlarged section on the line 3—3 of Fig. 2, looking in the direction of the arrows; Fig. 4 shows a side elevation of the gear casing illustrated at the right of Fig. 3; Fig. 5 shows a detailed section on the line 5—5 of Fig. 3, looking in the direction of the arrows, illustrating the mechanism for throwing the power feed mechanism into and out of operation; Fig. 6 is a detailed sectional view taken on the line 6—6 of Fig. 5; Fig. 7 shows a side elevation of the mechanism for controlling the engagement of the worm and worm wheel illustrated in Figs. 5 and 6, showing the mechanism as viewed from the rear side of Fig. 6; Fig. 8 is a sectional view along the line 8—8 of Fig. 2; Fig. 9 is a detailed section taken on the line 9—9 of Fig. 10; Fig. 10 shows a section taken on the line 10—10 of Fig. 8; Fig. 11 is a view somewhat similar to Fig. 10 showing a part of the construction in side elevation and showing the opposite arrangement of the two clutch members illustrated in Fig. 10; Fig. 12 is a detailed view showing a side elevation of the mechanism for preventing the simultaneous operation of the clutch for controlling the rapid traverse mechanism and the clutch for permitting a manual operation of the drill head; Fig. 13 shows a bottom plan view of the mechanism illustrated in Fig. 12; Fig. 14 shows a side elevation of the electric switch for controlling the circuit of the rapid traverse motor; Fig. 15 shows an end elevation of the switch illustrated in Fig. 14; Fig. 16 shows a detailed section taken on the line 16—16 of Fig. 14; and Fig. 17 shows a vertical section taken on the line 17—17 of Fig. 14; Fig. 18 is a view of certain of the elements shown in Fig. 6 but looking in the opposite direction, showing particularly means for holding a feed-worm in engagement with a cooperating worm-wheel and trip mechanism for rendering said means ineffective. Fig. 19 is a side view of a portion of the machine frame and the tool-head translatably mounted thereon, showing the various dogs for throwing in and out of the rapid traverse and slow feeding means for the tool head and the dogs for actuating the motor control switch to start, stop and reverse the directions of rotation of the rapid traverse motor.

As illustrated in the drawings, the improved drilling machine comprises a supporting base 20, having mounted thereon a hollow vertical standard 21 adapted to

carry the principal parts of the drill mechanism. This standard is provided on one side with vertical guide flanges 22 which are adapted to engage the vertical guideways 23 formed on the lateral extension 24 of the drill head 25. The part 24 of the drill head has plates 26 secured thereto by bolts 27 to overlap the guide flanges 22, thus locating the drill head securely on the supporting standard and permitting the vertical movement thereof. The drill head is connected to a cable 28 which extends over a pulley 29 mounted in a slot in the upper part of the standard on a shaft 30, and a suitable counterweight 31 is connected to the other end of the cable within the hollow standard 21, thus minimizing the work which must be done to move the drill head along its vertical guideway.

The drill head 25 is provided with a plurality of drill spindles 33, only two of which are illustrated, and these drill spindles are actuated by suitable gears and pinions located within the drill head and driven from above through a vertical drive shaft 34. This shaft is driven by bevel gears located in the gear casing 35 which is mounted on the upper end of the standard 21 and these gears are in turn actuated by suitable drive mechanism located in the transmission casing 36, containing change speed gears which are operated by a lever 37. The transmission mechanism within the casing 36 is driven by a shaft 38 having fixed thereon a pulley 39 which in turn is actuated by a belt 40. This belt is driven by a pulley 41 fixed on the shaft 42 which is journalled in bearings carried by the standard 21 and the bracket 43 mounted on the base 20. Another pulley 44 is fixed on the shaft 42 adjacent to the pulley 41 and an idler pulley 45 is rotatably mounted on the shaft adjacent to the pulley 44. A driving belt actuated by a motor or line shaft is adapted to engage the pulleys 44 and 45 and to be passed from one to the other by means of the shifting fork 46 which is slidably mounted on the rod 47 extending between the bracket 43 and the standard 21. The fork 46 carries arms 48 adapted to extend on opposite sides of the drive belt and the sleeve is shifted on the rod 47 by means of a crank 49 which actuates a lever 50 connected by a link 51 to the fork. The foregoing features of construction are common in drilling machines and do not in themselves constitute a part of the present invention.

The drill head 25 is moved vertically on the standard 21 by means of a rack bar 54 mounted on the side of the standard between the guide flanges 22 and adapted to be engaged by a pinion 55 mounted on the horizontal shaft 56 which is journaled in bearings carried by the lateral extension 24 of the drill head. The shaft 56 extends through the wall of the part 24 of the head and through a plate 57 which is secured to the side of the head, as illustrated particularly in Figs. 5 and 6. The end of the shaft 56 has a gear 58 keyed thereon and this gear is driven by a pinion 59 secured on the shaft 60 which is journaled in a bearing 61 formed in the plate 57 and in another bearing 62 formed in the plate 63 which is rigidly connected to the plate 57 adjacent to the bottom thereof by means of a transverse plate 64. The plate 63 has a lateral extension 63^a at one edge thereof and the plate 57 has an extension 57^a extending from the top thereof over the gears located between the plates, so that the two plates and their projecting parts form a housing for the gearing mechanism by which the horizontal shaft 56 is driven. The hub of the pinion 59 has a worm wheel 65 secured thereon and this worm wheel is adapted to be driven by a worm 66 splined on the vertical shaft 67 which extends downwardly and is connected through a universal joint 68 with a shaft 69 extending upwardly from the gear casing 70. The shaft 69 is driven through gearing mechanism located in the housings 71 and 72 which contain change speed gears for varying the speed of the shaft 67 through the operation of hand levers 73 and 74. The change speed mechanism which actuates the vertical shaft 67 is driven by suitable gearing mechanism from the hub of the pulley 41, this pulley having a spiral gear fixed on its hub to mesh with another spiral gear mounted at right angles thereto and secured to a shaft extending into the casing 71 to drive the gearing mechanism located therein.

Referring now to the means for controlling the engagement of the worm wheel 65 and the worm 66 which affect the power feed of the drill head during the drilling operation, it will be observed that the worm 66 is located between bearings 75 and 76 formed on a bracket 77 which has an upper arm 77^a and a lower arm 77^b adapted to extend between the plates 57 and 63. A ball thrust bearing 78 is mounted between the worm 66 and the upper bearing 75 and the shaft is free to rotate in both of the bearings. The arms 77^a and 77^b of the bracket have lugs 79 extending laterally therefrom to engage the plate 63 and prevent lateral turning of the bracket during rotation of the shaft 67. The bracket 77 normally tends to move outwardly away from the shaft 60 to effect a disengagement of the worm 66 with the worm wheel 65 due to the action of a plunger 80 which is mounted in a sleeve 81 carried by the lateral extension 57^a of the plate 57 and actuated by a coil spring 82 located in the sleeve. The tension of this spring may be adjusted by means of a screw plug 83 having a lock nut 84 mounted on the projecting end thereof. The movement of the bracket 77 and the worm 66 is controlled by a bar 85

which is pivoted at 86 on the plate 57 and pivotally connected at 87 to the lug 88 which projects laterally from the bracket 77 through a slot 89 which is formed in the plate 57, as shown particularly in Fig. 5. The slot 89 is elongated to permit movement of the worm 66 to and from the worm wheel 65 and the extent of this movement may be regulated by means of an adjusting screw 90 which extends through the wall of the slot 89 and is held in adjusted position by means of a lock nut 91. When the bar 85 is in its vertical position, as illustrated in Figs. 6 and 7, the worm is in engagement with the worm wheel, and the bar 85 is normally held in this position by means of a latch member 92 pivoted at 92a on the lower part of the plate 57. The latch member 92 carries a lug 93 which is adjustable thereon by means of a screw 94 and this lug normally engages a shoulder 95 formed on the lower end of the bar 85, the lug being held in this engaging position by the action of a coil spring 96 which is connected to the outer end of the latch member 92 and to the plate 57. The latch member 92 is formed integrally with a cam arm 97 having an extremity 97a which is adapted to be engaged by a stationary cam or dog during the downward travel of the drill head, as hereinafter described. The end of the latch member 92 is provided with a notch 99 loosely engaged by a pin 100 which is fixed in the outer end of a lever 101 mounted to rotate with a shaft 102 journaled in bearings carried by the plate 57 and the gear case 116, hereinafter described. The pin 100 which projects through the end of the lever 101 also engages a notch 103 formed in the lower part of the bracket 77, so that when the cam arm 97 is operated the latch member 92 moves downwardly to release the bar 85 and at the same time the latch member rotates the shaft 102 and thereby shifts the worm 66 out of engagement with the worm gear 65 through the engagement of the pin 100 with the notch in the bracket 77.

The shaft 102 extends horizontally toward the side of the machine, as viewed particularly in Figs. 1 and 2, and the end of the shaft has a lever 105 fixed thereon, this lever extending upwardly and being pivotally connected to a shift rod 106 which extends horizontally and has its other end pivotally connected to another lever 107. The lever 107 is fixed on a shaft 108 which is journaled in brackets 109 secured to the front side of the head 25. The lever 107 may be rocked about its pivot by means of a handle 110 secured at the point of pivotal connection of the lever with the shift rod 106 or the lever 107 may be operated by means of the crank arms 111 which are secured to the shaft 108 and which have a bar 112 connecting the upper ends thereof, as shown in Fig. 2.

The shaft 60 which serves as the intermediate shaft of the power feed mechanism, being driven for that purpose by the worm 66 and the worm wheel 65, also serves as the intermediate shaft of the rapid traverse mechanism when the drill head is being rapidly raised or lowered from and to the work being operated on. For this purpose the shaft 60 is extended horizontally from the plate 63 with the end thereof journalled in a bearing 115 carried by the casing 116 secured to the bracket 117 formed on the head 25. A bevel gear 118 is secured to the shaft 60 and this bevel gear is adapted to be driven by another bevel gear 119 secured to the end of the horizontal shaft 120 which extends from the casing 116 along the side of the drill head 25 as illustrated in Fig. 2. The shaft 120 is adapted to be driven by a small electric motor 121 which is mounted on a bracket 122 secured to the side of the head 25, as shown in Fig. 8. The motor shaft 123 is connected by a coupling sleeve 124 with a shaft 125 journalled in bearings formed in the walls of a casing 126 which is secured at its lower side to the bracket 122 while the upper part thereof is connected by a bracket 128 to the side of the drill head. A worm 129 is formed as an integral part of the shaft 125 and this worm meshes with a worm wheel 130 which is keyed on the hub 131a of a clutch member 131. The clutch member 131 is rotatably mounted on the bushing 132 which in turn is mounted on a shaft 120, a collar 133 being secured on the shaft 120 adjacent to the casing 126 to prevent longitudinal movement thereof. A driving engagement is adapted to be effected between the clutch member 131 and the shaft 120 by means of a longitudinally movable clutch member 134 which is splined on a sleeve 135 secured to the shaft 120 by a Woodruff key and a transverse pin 136. The clutch member 134 is moved longitudinally on the sleeve 135 to bring the clutch teeth 137 into and out of engagement with each other by means of a forked operating member 140, the opposite arms of which are provided with inwardly projecting lugs 141 adapted to engage the annular groove 142 formed in the clutch member 134. The clutch operating member 140 is rigidly secured to the shift rod 106 previously described so that when the power feed mechanism is thrown out of operation by the disengagement of the worm 66 and the worm wheel 65, the shift rod 106 operates simultaneously to move the member 140 and shift the clutch member 134 into engagement with the clutch member 131 which is driven by the rapid traverse motor 121.

The shaft 120 terminates within the sleeve 135 and the projecting end of this sleeve serves as a bearing for a pilot shaft 145 which has its other end journalled in a bearing 146 carried by the head 25. A hand

wheel 147 is secured to the end of the shaft 145 beyond the bearing 146 and at the end of this bearing opposite the hand wheel the shaft has a collar 148 fixed thereon to prevent longitudinal movement of the shaft. A coil spring 149 is mounted on the shaft 145 between the collar 148 and the clutch member 150 which is splined on the shaft by means of keys 151. This clutch member is provided at its opposite end with clutch teeth 150^a which are adapted to engage the clutch teeth 135^a formed on the sleeve 135 so that when these clutch teeth are in engagement with each other, the motion of the shaft 145 is adapted to be transmitted to the shaft 120. The clutch member 150 is reduced in diameter adjacent to the sleeve 135 and this reduced portion has a rotative engagement with a collar 152 carrying a pin 154 which engages a recess 155 in the housing 126 to prevent the rotation of the collar with the clutch member 150. The collar 152 serves as a support for a mechanism by which the clutch members 135 and 150 are prevented from engagement simultaneously with the engagement of the clutch members 131 and 134. This mechanism comprises a cam 157 carried by an eccentrically located shaft 158 which is journalled in the longitudinal extension 153 of the collar 152 and secured in place by a nut 159. The cam is operated by a handle 160 which is located diametrically opposite from the axis of the shaft 158 and the horizontal portion of the handle engages a slot 161 formed in the head 162^a of a rod 162 which is slidably mounted in an aperture 163 formed in the end of the casing 126. The opposite end of the rod 162 is engaged by a fixed collar or nut 164 which extends into the annular groove 142 of the clutch member 134, being adapted to co-act with the shoulder 165 at the end of the groove, as shown particularly in Fig. 12. When the handle 160 is rotated to place the cam 157 in the position illustrated in Fig. 12, the nut 164 engaging the shoulder 165 holds the clutch member 134 out of engagement with the clutch member 131 so that these clutch members can not engage at the time that the clutch member 150 engages the clutch member 135, the latter engagement being effected automatically by the action of the coil spring 149 mounted on the shaft 145. When the operator desires to effect the manual rotation of the shaft 120 through the shaft 145 and the hand wheel 147 the handle 160 of the cam 157 should be moved to the position shown in Fig. 12 to prevent the accidental simultaneous operation of the shaft 120 by the motor driven clutch member 131, and when the motor driven clutch member is to be operated, the handle 160 should be rotated through 180 degrees to the position illustrated in Fig. 11 where the cam 157 has forced the collar 152 toward the right with a resulting disengagement of the teeth of the clutch members 135 and 150 while at the same time shifting the rod 162 toward the left to permit the engagement of the clutch members 131 and 134.

The electric motor 121 which drives the mechanism for effecting a rapid movement of the drill head is operated by an electric circuit comprising electric conductors leading thereto through the flexible conduit 170. The flexible conduit 170 leads from a junction box 171 having a connection with the conduit 172 in which the feed wires are located. The junction box 171 is connected through a short conduit with a switch casing 173 having mounted therein the switch mechanism for controlling the circuit of the motor. This switch is illustrated particularly in Figs. 14 to 17, inclusive. The casing 173 comprises a lower body portion 173^a having a detachable cover 173^b, both of which are lined with suitable insulating material 174. A shaft 175 is journalled in bearings 176 carried by the end walls of the casing and this shaft has fixed thereon a drum 177 of insulating material carrying contact rings 178 which are adapted to form connections between the contact fingers 179 mounted on the insulating bar 180 located in the upper part of the casing. The contact fingers are connected to the electric conductors leading into the casing from the junction box 171 and the free ends thereof are adapted to bear on the peripheral surface of the drum 177 so that when the drum is rotated the contact rings are brought into engagement with the contact fingers and the circuit of the motor is closed to effect the rotation of the motor in the desired direction or the circuit thereof is opened to discontinue its operation. The shaft 175 projects from the casing 173 and has fixed thereon a rocker 181. A coil spring 182 is mounted on the hub of this rocker with the extremities 183 and 184 thereof projecting upwardly on opposite sides of the lug 181^a which is formed on the rocker. The extremities of the spring also project on opposite sides of another lug 185^a which is formed on the upper end of a lever 185 by which the switch is operated. This lever is fixed on a shaft 186 which extends through the lower part of the casing 173, being journalled in bearings 187 carried by the end walls of the casing. The shaft 186 is operated by a crank arm 188 which is secured thereto at the end of the switch casing opposite the lever 185, and this crank arm is pivotally connected with a switch link 190 which extends along the side of the drill head 25 as illustrated in Fig. 1. The other end of this switch link is pivotally connected to a bell crank lever 191 which is pivoted on the end of the shaft 108 previously described. The lever 191 has a projecting handle 192 which may be engaged by the op-

erator to effect the manual operation of the switch mechanism but the switch is adapted to be operated, during the automatic operation of the machine, by means of trip dogs or cams arranged to be engaged by a roller 195 which is rotatably mounted on the lever 185 as shown in Fig. 14. When the lever 185 is moved toward the right as viewed in Fig. 15, either by the engagement of a dog with the roller 195 or by the manual operation of the switch link 190, the lug 185[a] engages the end 184 of the spring 182 and thereby carries with it the rocker 181 until the lug 196 on the rocker is engaged by the lug 197 on the lever. A further motion of the lever 185 in the same direction continues to carry the end 184 of the spring with it while the lug 197 slides under the lug 196, thereby winding up the spring, due to the fact that the end 183 of the spring is held by the lug 181[a] of the rocker and that the rotation of the rocker is prevented by the engagement of the lug 196 with the lug 197. When the lug 197 is moved through the required distance, the lug 196 passes between the lugs 197 and another similar lug 197[a] on the lever 185 and the spring 182 then turns the rocker and the shaft 175 with the result that the contact fingers 179 are connected by the rings 178. When this is accomplished the energy of the spring is exhausted and the contact rings remain in engagement with the fingers until the lever 185 is moved the required distance in the reverse direction. A further motion of the lever 185 in the same direction, after the circuit has been closed, is prevented by the engagement of the lug 185[a] with a stationary lug 198 formed on the end wall of the casing. A similar lug 199 limits the movement of the lever 185 in the reverse direction. To bring the contact rings 178 out of engagement with the fingers 179, the lever 185 is moved in the opposite direction, whereupon the lug 185[a] engages the end 183 of the spring and carries the rocker with it until the end of the lug 196 strikes on the under face of the lug 197 and stops the motion of the rocker while the lug 197 slides over the lug 196 until a point is reached where the rocker is free to return to its original position under the influence of the spring which is partially wound up while the lugs 196 and 197 are in sliding contact with each other. When the lever 185 is moved in the reverse direction, that is, toward the left from the neutral position illustrated in Fig. 15, the operation is reversed and the lugs 196[a] and 197[a] control the action of the spring in permitting a quick release of the rocker to move the contact rings into engagement with the fingers, thereby establishing a circuit through the motor in the reverse direction. By means of this construction the circuit of the motor is broken or closed almost instantaneously regardless of the angular velocity of the operating lever 185, which may be moved very slowly in some instances.

The switch for controlling the operation of the electric motor 121 and the levers for controlling the operation of the clutches by which the feed mechanism and the rapid traverse mechanism are operated, are controlled by means of trip dogs or cams which are mounted on the vertical trip rods 200, 201 and 202 extending parallel to each other adjacent to the standard 21 with their upper and lower extremities mounted in stationary brackets 203 carried by the standard. Assuming that the machine has been set in operation initially, with the drill head 25 in the upper part of its path of movement by manually operating the bell crank lever 191 to actuate the electric switch for closing the circuit of the motor 121, the head 25 moves downwardly until it is arrested by the operation of the mechanism illustrated particularly in Figs. 3 and 4. The plate 63 in which the shaft 60 is journalled carries a pin 204 having pivotally mounted thereon a trip lever 205 and a latch member 206. The lever carries at its lower end a transverse plate 207 provided with an upwardly extending pawl 207[a], while the latch member 206 is provided at one end with a downwardly extending pawl 206[a] and at the other end with a transverse lug 206[b] adapted to be engaged by the trip lever 205 when it is tilted toward the right, as viewed in Fig. 3. When the drill head 25 has reached a predetermined position in its downward movement, that is, a position which will locate the points of the drills in proximity to the surface of the object to be drilled, the end of the trip lever 205 engages a dog or cam 208 which is pivoted on a block 209 adjustably secured on the trip rod 201 by means of a set screw 210. The dog 208 is normally held in a horizontal position by the engagement of the under side thereof with a lug 211 projecting laterally from the block 209. The dog 208 has an upper inclined cam face 208[a] which contacts with the extremity of the trip lever 205 and as this lever is swung upwardly about its pivot, the pawl 207[a] releases the hand 212 of a plunger 213 slidably mounted in the block 214 projecting from the face of the plate 63. The head 212 is provided with a socket engaged by one end of a coil spring 215 and when the head of the plunger is released by the pawl 207[a], the plunger moves toward the right, as viewed in Fig. 3, thereby operating the lever 216 which is mounted on the shaft 102. The rotation of the shaft 102 turns the lever 101, and the pin 100 on the lever, engaging the notch 103, moves the bracket 77 inwardly until the feed worm 66 meshes with the worm wheel 65. At the same time, the movement of the pin 100 permits the arm 92 to be moved upwardly by

the coil spring 96 so that the latch plate 93 is brought into position engaging the plate 95, at the lower end of the member 85, as illustrated in Figs. 6 and 7, thereby holding the worm wheel in mesh with the worm while the head 25 is being fed downwardly during the working stroke. At the same time, the roller 195 on the switch operating lever 185 engages the dog 218 carried by the block 219 which is adjustably mounted on the trip rod 200, thereby moving the switch arm to its neutral position and opening the circuit of the rapid traverse motor 121. As these operations occur, the trip lever 205 continues to slide downwardly on the inclined face of the dog 208 with the result that the pawl 206^a is elevated by the engagement of the trip lever 205 with the lug 206^b, until it clears the head 217^a of the plunger 217 which is slidably mounted in a guideway 217^b carried by the plate 63 in alignment with the guideway 214. The head 217^a of this plunger is provided with a socket to receive one end of the coil spring 215 which extends between this plunger and the plunger 213 previously described, so that when the pawl 206^a releases the plunger 217, it is moved toward the left as viewed in Fig. 3, until the spring 215 is completely expanded. The drill head 25 then continues its relatively slow downward movement until a predetermined limit is reached, this limit being determined by the thickness of the work being operated upon. When this limit is reached, the roller 195 on the switch lever 185 engages a dog or cam 222 carried by the block 223, which is adjustably mounted on the trip rod 200, with the result that the switch lever is thrown over to set the rapid traverse motor 121 in operation in a direction adapted to effect the elevation of the drill head when the clutches 131 and 134 are engaged. At the same time, the trip lever 97, previously described, strikes the dog 224 which is adjustably mounted on the trip rod 202 and the point of the lever follows the inclined face of the trip dog with the result that the lever is moved upwardly and inwardly against the tension of the spring 96 until the member 85 is released by the latch plate 93. When the latch plate is disengaged from the member 85, the plunger 80 is moved outwardly by the coil spring 82 thereby causing an outward movement of the bracket 77 and a disengagement of the worm 66 with the worm wheel 65. The outward movement of the bracket 77 operates through the pin 100 to turn the lever 101 and the shaft 102, thus moving the lever 216 toward the left, as viewed in Fig. 3, until it reaches a position wherein the pawl 207^a snaps upwardly behind the head 212 of the plunger, this movement of the pawl being effected by the weight of the trip lever 205 by which it is carried. The turning of the shaft 102 also actuates the shift rod 106 with the result that the rapid traverse clutches 131 and 134 are engaged and the drill head 25 is moved rapidly in the upward direction. As the head moves upwardly, the lever 205 engages the under side of the trip dog 208 and swings it upwardly about its pivot. When the lever has passed, the dog 208 drops again to its normal position resting on the lug 211. As the head 25 approaches the upper limit of its travel, the outer end of the plunger 217 engages the inclined face of the dog 226 which is adjustably mounted on the trip rod 201, with the result that the spring 215 is compressed until the pawl 206^a is permitted to drop into position engaging the shoulder on the head 217^a of the plunger. The spring 215 is then fully compressed and both of the plungers 213 and 217 are held by the pawls 207^a and 206^a respectively, in readiness for a succeeding downward movement of the drill head. Immediately after this occurs, the roller 195 on the switch lever 185 engages the trip dog 227 carried by the block 228 which is adjustably mounted on the upper part of the trip rod 200 thus causing the switch to be thrown to its neutral position and arresting the operation of the rapid traverse motor 121. The momentum of the drill head and other moving parts will cause a limited upward movement of the roller 195 and the switch lever 185 after they are moved to neutral position, with the result that the roller engages the trip dog or cam 229 carried by the block 230, which is adjustably mounted on the trip rod 200 just above the block 228. The dog 229 throws the switch lever 185 into a position adapted to cause a forward rotation of the motor 121 with the result that the drill head 25 immediately begins a rapid return movement in the downward direction. As the drill head travels downwardly the lever 205 engages the trip dog 208 again, when the points of the drill are in proximity to the surface of the object to be drilled, causing the disengagement of the rapid traverse mechanism and the engagement of the power feed mechanism in the manner previously described, the operations previously described being repeated as before with a resulting upward and downward movement of the drill head controlled entirely by the automatic operation of the trip levers and the trip dogs or cams.

It will be apparent from the foregoing description that after starting the machine in operation initially, by the manual operation of the handle 192 to effect the starting of the rapid traverse motor 121, the operation of the machine is entirely automatic. The rapid downward movement of the drill head continues until the drills or taps are in proximity to the surface of the object being worked on, whence the rapid traverse

clutches are disengaged and the rapid traverse motor stopped immediately after the engagement of the power feed worm and worm wheel. This clutch mechanism is so connected with the mechanism by which the worm is moved into engagement with the worm wheel that it is impossible for the rapid traverse to operate simultaneously with the operation of the power feed mechanism. The power feed mechanism operates while the drills or taps are passing downwardly through the work being operated on and when the predetermined limit of this movement is reached, the rapid traverse motor is started in the reverse direction, the drill head then moves up rapidly until it reaches the upper limit of its travel whereupon the direction of rotation of the rapid traverse motor is automatically reversed and the drill head moved downwardly again. The various trip dogs or cams by which these operations are controlled are adjustably mounted on the trip rods 200, 201 and 202 so that any particular step in the operation of the mechanism may be caused to occur at any desired time, thus permitting the drill head to be used on great varieties and sizes of work. The advantages of automatic operation are secured without dispensing with the mechanism for effecting the manual operation of the drill head, inasmuch as the shaft 120 may be operated by the hand wheel 147 through the intermediate shaft 145. The shaft 145 is adapted to be connected to the shaft 120 through the clutches 135 and 150 and the connections from the collar 152 to the clutch member 134, previously described, are such that the rapid traverse clutches 131 and 134 can not be engaged simultaneously with the engagement of the manual operation clutches 135 and 150. The circuit of the rapid traverse motor 121 and the rapid traverse clutches 131 and 134 may be manually operated by the handles 192 and 110 respectively, these handles effecting the operation of the rods 190 and 106 respectively, independently of the automatic trip dog mechanism. This manual control is of advantage in starting the operation of the drill and also in arresting and controlling its operation at will during the operation of the machine. It will be apparent that, in a drilling machine or other machine to which the invention may be applied, the advantages of manual control are obtained in combination with the provision of mechanism by which the working tool is capable of being moved rapidly during its non-working strokes, thus causing a great saving of time as compared with the previous practice of operating the drill head or other working part manually or causing it to be moved throughout its stroke by the operation of the power feed mechanism.

Although one embodiment of the invention has been shown and described for purposes of illustration, it will be understood that the invention may be constructed and applied in various other forms and ways without departing from the scope of the appended claims. The electric switch mechanism, herein shown and described, is not claimed but will be covered in a separate divisional application.

We claim:

1. A drilling machine combining a frame; a drill-head translatably mounted on the frame; a rack arranged lengthwise of said frame; a pinion rotatably journaled in said drill-head and meshing with said rack; an electric motor mounted on said head; an operative connection between said motor and said pinion whereby the former may rotate the latter to effect rapid traverse of the drill head; a motor controlling switch carried by said drill-head; manual means to actuate said switch to cause said motor rapidly to traverse said head; and automatic means controlled by the movement of said head to actuate said switch to discontinue the rotation of said motor and thereby the movement of said head.

2. A drilling machine combining a frame; a drill-head translatably mounted on the frame; a rack arranged lengthwise of said frame; a pinion rotatably journaled in said drill-head and meshing with said rack; an electric motor mounted on said head; an operative connection between said motor and said pinion whereby the former may rotate the latter to effect rapid traverse of the drill-head; a motor controlling switch carried by said drill-head; manual means to actuate said switch to cause said motor rapidly to traverse said head; automatic means controlled by the movement of said head to actuate said switch to discontinue the rotation of said motor and thereby the movement of said head; and means independent of said motor to give said drill-head a slow feeding movement.

3. A drilling machine combining a frame, a drill-head translatably mounted on the frame; a plurality of spindles rotatably journaled in said drill-head; a prime-mover; means actuated by said prime-mover to rotate said spindles; a bar extending lengthwise of said frame; a rotatable member journaled in said drill-head and engaging said bar; an electric motor mounted on said drill-head; a high speed operative connection between said motor and said rotatable member whereby rotation of the motor effects rapid traverse of said head; a slow speed drive between said prime-mover and said rotatable member to give to said drill-head slow feeding movements; and automatic means actuated by the movement of the drill-head to discontinue the rapid traverse and to start said slow feed mechanism.

4. A drilling machine combining a frame; a drill-head translatably mounted thereon; drill-spindles rotatably journaled in said drill-head; a prime mover; means actuated by said prime-mover to rotate said spindles; a rack arranged lengthwise of said frame; a pinion rotatably supported by said head and meshing with said rack; a reversible electric motor mounted on said head; a high speed driving connection between said motor and said pinion to effect rapid traverse of said drill-head; a slow speed driving connection between said prime-mover and said pinion to effect slow feeding movements of said head; a motor-controlling switch carried by said drill-head; switch-actuating means supported by said frame and adapted upon a predetermined movement of said drill-head under the action of said motor to actuate said switch to stop said motor; automatic means to render effective said slow speed drive; and means actuated by the movement of the head under said slow feeding means to actuate said switch to cause said motor to rotate in the reverse direction rapidly to retract the drill head.

5. In a machine of the class described, a movable head, means including an operating shaft for moving said head, a power driven feed shaft, means for operatively connecting said feed shaft and said operating shaft, a high speed power driven shaft, means for detachably forming an operative connection of said high speed shaft with said operating shaft, means controlled by the movement of the head for rotating the high speed power driven shaft in a forward and a reverse direction, and means for automatically effecting the alternate operative connection of said operating shaft with said feed shaft and said high speed shaft.

6. In a machine of the class described, a movable head, means including an operating shaft for moving said head, a power driven feed shaft, means for operatively connecting said feed shaft and said operating shaft, a high speed power driven shaft, means for operatively connecting said high speed shaft with said operating shaft, means for rotating said high speed power driven shaft in a forward and in a reverse direction, and means actuated by the movement of said head for automatically effecting the alternate operative connection of said operating shaft with said feed shaft and said high speed shaft, and for controlling the direction of rotation of the high speed power driven shaft.

7. In a machine of the class described, a movable head, means including an operating shaft for moving said head, a power driven feed shaft, means for operatively connecting said feed shaft and said operating shaft, a high speed power driven shaft rotatable in a forward and in a reverse direction, means for operatively connecting said high speed shaft with said operating shaft, means for automatically effecting the alternate operative connection of said operating shaft with said feed shaft and said high speed shaft, and means for automatically reversing the direction of rotation of said high speed shaft.

8. In a machine of the class described, a movable head, means including an operating shaft for moving said head, a power driven feed shaft, means for forming an operative connection between said feed shaft and said operating shaft, a power driven high speed shaft, means comprising a clutch for forming a driving connection between high speed shaft and said operating shaft, means for disconnecting said clutch and simultaneously forming a connection between said feed shaft and said operating shaft after a predetermined movement of said head, means for engaging said clutch and disconnecting said feed shaft and said operating shaft after a further predetermined movement of said head in the same direction, means for reversing the direction of rotation of said high speed shaft to effect a reverse movement of said head, and means operative after a predetermined reverse movement of said head for again reversing the direction of rotation of said high speed shaft.

9. In a machine of the class described, a movable head, means including an operating shaft for moving said head, a power driven feed shaft, means for forming an operative connection between said feed shaft and said operating shaft, a power driven high speed shaft, means comprising a clutch for forming a driving connection between high speed shaft and said operating shaft, means for disconnecting said clutch and simultaneously forming a connection between said feed shaft and said operating shaft after a predetermined movement of said head, means for engaging said clutch and disconnecting said feed shaft and said operating shaft after a predetermined movement of said head in the same direction, means for reversing the direction of rotation of said high speed shaft to effect a reverse movement of said head, means operative after a predetermined reverse movement of said head for again reversing the direction of rotation of said high speed shaft, and means for adjusting the periods of operation of said feed shaft and said high speed shaft.

10. In a machine of the class described, a movable head, operating means for said head, means comprising a feed shaft for driving said operating means, means comprising a high speed shaft for driving said operating means, a motor for driving said high speed shaft, means comprising a clutch for

connecting said motor with said high speed shaft, means for automatically opening said clutch and forming an operative connection between said feed shaft and said operating mechanism, and means for arresting the operation of said motor when said clutch is opened.

11. In a machine of the class described, a movable head, operating means for moving said head, a shaft for driving said operating means, a motor for driving said shaft, a clutch member rotatably mounted on said shaft and driven by said motor, a second clutch member slidably mounted on said shaft, a manually operated shaft mounted in alignment with said first named shaft, a third clutch member secured on said first named shaft, a fourth clutch member slidably and non-rotatably mounted on said manually operated shaft, and connections between said second and fourth named clutch members for insuring their alternate operation in engaging said first and third named clutch members respectively.

12. In a machine of the class described, a movable head, operating means for moving said head, a shaft for driving said operating means, a motor for driving said shaft, a clutch member rotatably mounted on said shaft and driven by said motor, a second clutch member slidably mounted on said shaft, a manually operated shaft mounted in alignment with said first named shaft, a third clutch member secured on said first named shaft, a fourth clutch member slidably and non-rotatably mounted on said manually operated shaft, means tending normally to move said fourth named clutch member into engagement with said third named clutch member, and means for preventing said engagement except when said second named clutch member is out of engagement with said first named clutch member.

13. In a machine of the class described, a movable head, operating means for moving said head, high speed mechanism mounted on said head for actuating said operating means, means for mechanically connecting said high speed mechanism with said operating means, a trip rod, a trip dog mounted said rod, and a trip lever movable with said head and actuated by the engagement thereof with said trip dog for effecting the disconnection of said high speed mechanism and said operating means.

14. In a machine of the class described, a movable head, operating means for said head, high speed mechanism for actuating said operating means, means for connecting said high speed mechanism with said operating means, a trip rod, a trip dog mounted on said rod, a trip lever movable with said head and actuated by the engagement thereof with said trip dog for effecting the disconnection of said high speed mechanism and said operating means, a motor for driving said high speed mechanism, a motor controlling switch movable with said head, a second trip rod, and a dog mounted on said second trip rod to effect the actuation of said switch after a predetermined movement of said head.

15. In a machine of the class described, a movable head, means comprising an operating shaft for moving said head, a feed shaft, clutch mechanism for forming a driving engagement between said feed shaft and said operating shaft, a high speed shaft, means including a clutch for forming an operative connection between said high speed shaft and said operating shaft, latch mechanism tending to maintain the connection of said feed shaft with said operating shaft, and means actuated by the movement of said head for releasing said latch mechanism, disconnecting said feed shaft and said operating shaft and engaging said clutch to effect the operation of said operating shaft by said high speed shaft.

16. In a machine of the class described, a movable head, operating means for moving said head, a shaft for driving said operating means, an electric motor supported on said head for driving said shaft, an electric circuit for said motor, a switch for controlling the operation of said motor circuit, an operating member controlled by the movement of said head for actuating said switch, and a dog engaging said operating member for opening the circuit of said motor after a predetermined movement of said head.

17. In a machine of the class described, a frame, a movable head, operating means for moving said head, a shaft for driving said operating means, an electric motor supported by said head for driving said shaft, an electric circuit for said motor, a switch carried by said head for controlling the operation of said motor circuit, an operating member for actuating said switch, a dog supported by said frame and engaging said operating member for opening the circuit of said motor after a predetermined movement of said head, and a second dog supported by said frame and adapted to engage said operating member after a further movement of said head for reversing said motor and thereby effecting a reverse movement of said head.

18. In a machine of the class described, a frame, a movable head, power feed mechanism for moving said head, rapid traverse mechanism for moving said head, an electric motor mounted on said head for driving said rapid traverse mechanism, an electric circuit for said motor, switch mechanism carried by said head and connected in said circuit and means actuated by the movement of said head for controlling the operation of said switch.

19. In a machine of the class described, a movable head, power feed mechanism for moving said head, rapid traverse mechanism carried by the head for effecting movement thereof, an electric motor mounted on the head for driving said rapid traverse mechanism, an electric circuit for said motor, switch mechanism connected in said circuit and means actuated by the movement of said head for controlling the operation of said switch, and separate means actuated by the movement of said head for controlling the operation of said power feed mechanism.

20. In a machine of the class described, a movable head, power feed mechanism, clutch mechanism for connecting said power feed mechanism to move said head, rapid traverse mechanism, clutch mechanism for connecting said rapid traverse mechanism to move said head, an electric motor mounted on the head for driving said rapid traverse mechanism, an electric circuit for said motor, a switch connected in said circuit, means actuated by the movement of said head for controlling the operation of said switch, and means actuated by the movement of said head for controlling the operation of each set of clutch mechanism.

21. In a drilling machine, the combination comprising a frame; a drill head slidably mounted on said frame; means comprising a rotatable member for moving the head along said frame; slow power means carried by said frame for rotating said rotatable member to give said head a feeding movement; a high speed rapid traverse motor mounted on said head; and a single clutch controlled by the movement of the head for connecting the motor to said rotatable member.

22. In a drilling machine, the combination comprising a frame; a drill head slidably mounted on said frame; means comprising a rotatable member for moving the head along said frame; a motor mounted on said head; a single clutch controlled by the movement of the head for connecting the motor to said rotatable member; and means for selectively operating said motor in a forward and in a reverse direction under the control of the moving head.

23. In a drilling machine, the combination comprising a frame; a drill head slidably mounted on said frame; means comprising a rotatable shaft for effecting movement of the head along the frame; a prime mover mounted on the head; a single clutch controlled by the movement of the head for connecting the prime mover to said rotatable member, said prime mover serving to effect a traverse movement of the head at a relatively rapid rate; and means for automatically controlling said prime mover in accordance with the movement of the head.

24. In a drilling machine, the combination comprising a frame; a drill head slidably mounted on said frame; means comprising a rotatable member for effecting movement of the head along the frame; a prime mover mounted on the head for operating said member to effect traverse operation of the head; means comprising a feed shaft mounted on the frame for operating the member to effect feeding movement of the head; and means for selectively operating said member by the prime mover and the feed shaft in accordance with the movement of the head.

25. In a machine tool, the combination comprising a tool head slidably mounted on the frame of the machine; mechanism comprising a rotatable member mounted on said head for effecting movement of the head on the frame; feed mechanism mounted on the frame for operating said member; high speed power mechanism mounted on the head for operating said member; and means controlled by the movement of the head for selectively connecting the feed mechanism and the high speed power mechanism to said member.

26. In a drilling machine, the combination with a frame; a tool head slidably mounted on said frame; means comprising a rotatable member for effecting movement of the head along the frame; a motor mounted on said head; means comprising a clutch mechanism for operatively connecting the motor to said member; a feed shaft mounted on the frame; a clutch mechanism for connecting the feed shaft to said member; and means for selectively operating said two clutch mechanisms in accordance with the movement of the head.

27. In a drilling machine, the combination with a frame; a tool head slidably mounted on said frame; means comprising a rotatable member for effecting movement of the head along the frame; a motor mounted on said head; means comprising a clutch mechanism for operatively connecting the motor to said member; a feed shaft mounted on the frame; a clutch mechanism for connecting the feed shaft to said member; and means for selectively operating the motor in a forward and in a reverse direction and for selectively operating the two clutch mechanisms in accordance with the movement of the head.

28. In a machine tool, a tool head slidably mounted on the frame of the machine; operating means for said head; means comprising a feed shaft for driving said operating means and mounted on the machine frame; means comprising a high speed shaft for driving said operating means, said high speed shaft being mounted on said head; a motor for driving said high speed shaft; means comprising a single clutch for connecting said motor with said high speed

shaft; means for automatically opening said clutch and forming an operative connection between said feed shaft and said operating mechanism; and means for opening the circuit of said motor when said clutch is opened.

29. In a machine tool, a tool head movable along the frame of the machine; operating means for said head; means comprising a feed shaft for driving said operating means; means comprising a high speed shaft for driving said operating means; a motor operable in a forward and in a reverse direction for driving said high speed shaft; means comprising a clutch for connecting said motor with said high speed shaft; means for automatically opening said clutch and forming an operative connection between said feed shaft and said operating mechanism; and means controlled in accordance with the movement of the head for opening the circuit of the motor when said clutch is opened.

30. In a machine tool, the combination comprising a tool head movable along the frame of the machine; operating means for said head; means comprising a feed shaft for driving said operating means; a clutch mechanism for connecting the feed shaft to said operating means; means comprising a high speed shaft for driving said operating means; a clutch mechanism for connecting the high speed shaft to said operating means; a motor for driving said high speed shaft; and means controlled in accordance with the movement of the tool head for selectively operating said two clutch means and for selectively operating the motor in a forward and in a reverse direction.

ROBERT M. GALLOWAY.
PAUL C. BURTON.