

May 6, 1924.

W. C. BUCKNAM

1,493,428

DRILLING MACHINE

Filed Nov. 5, 1920

4 Sheets-Sheet 1

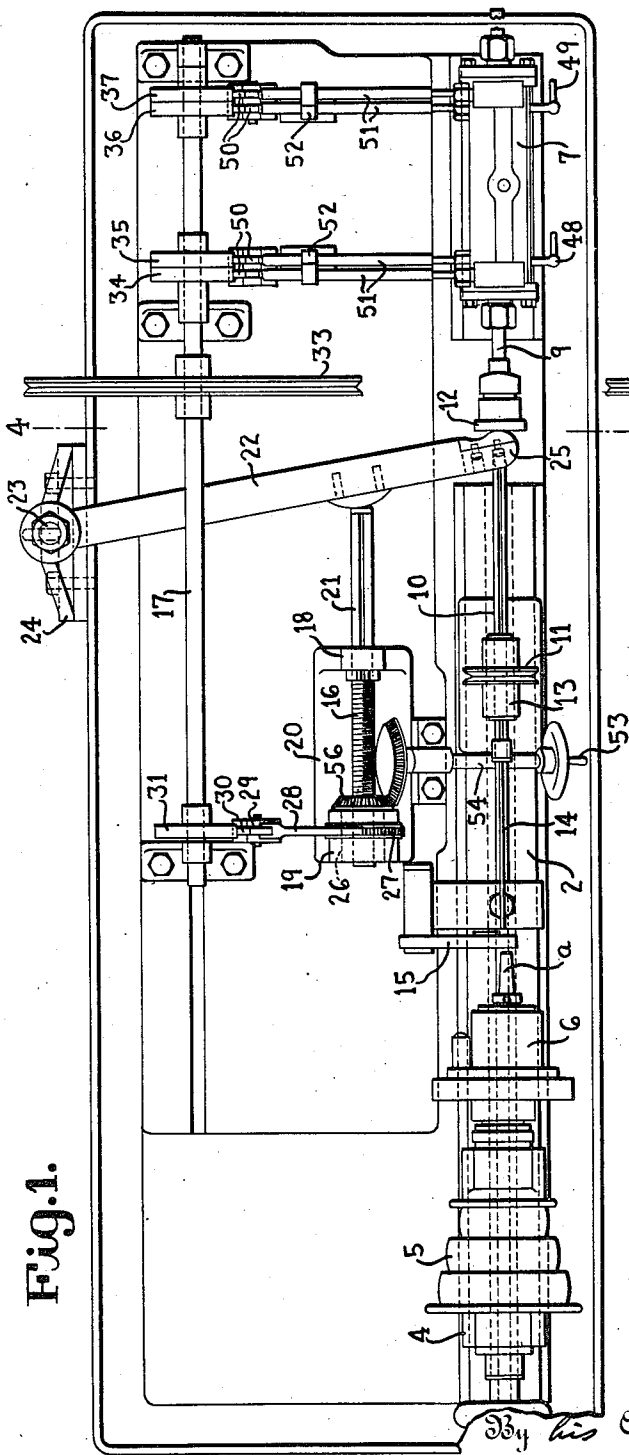


Fig. 1.

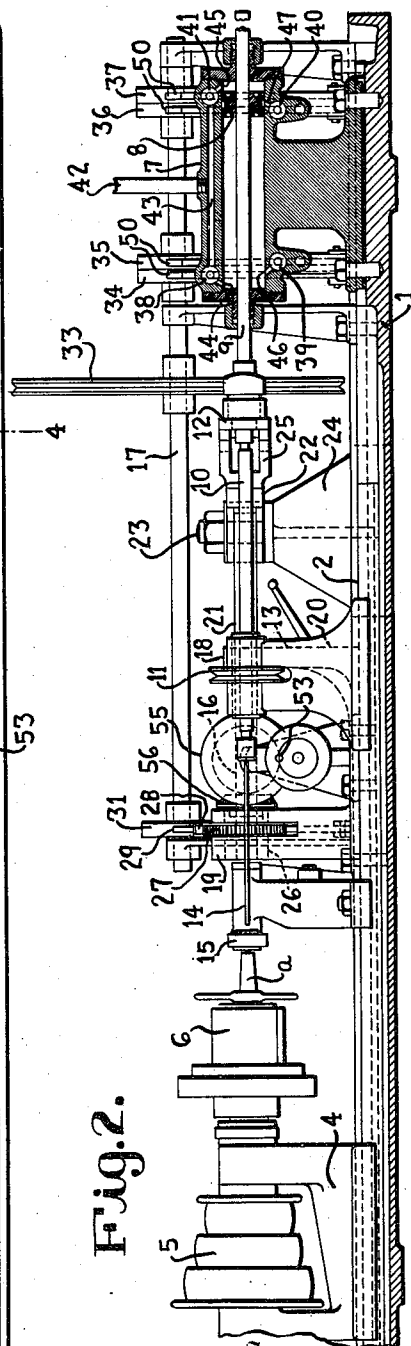


Fig. 2.

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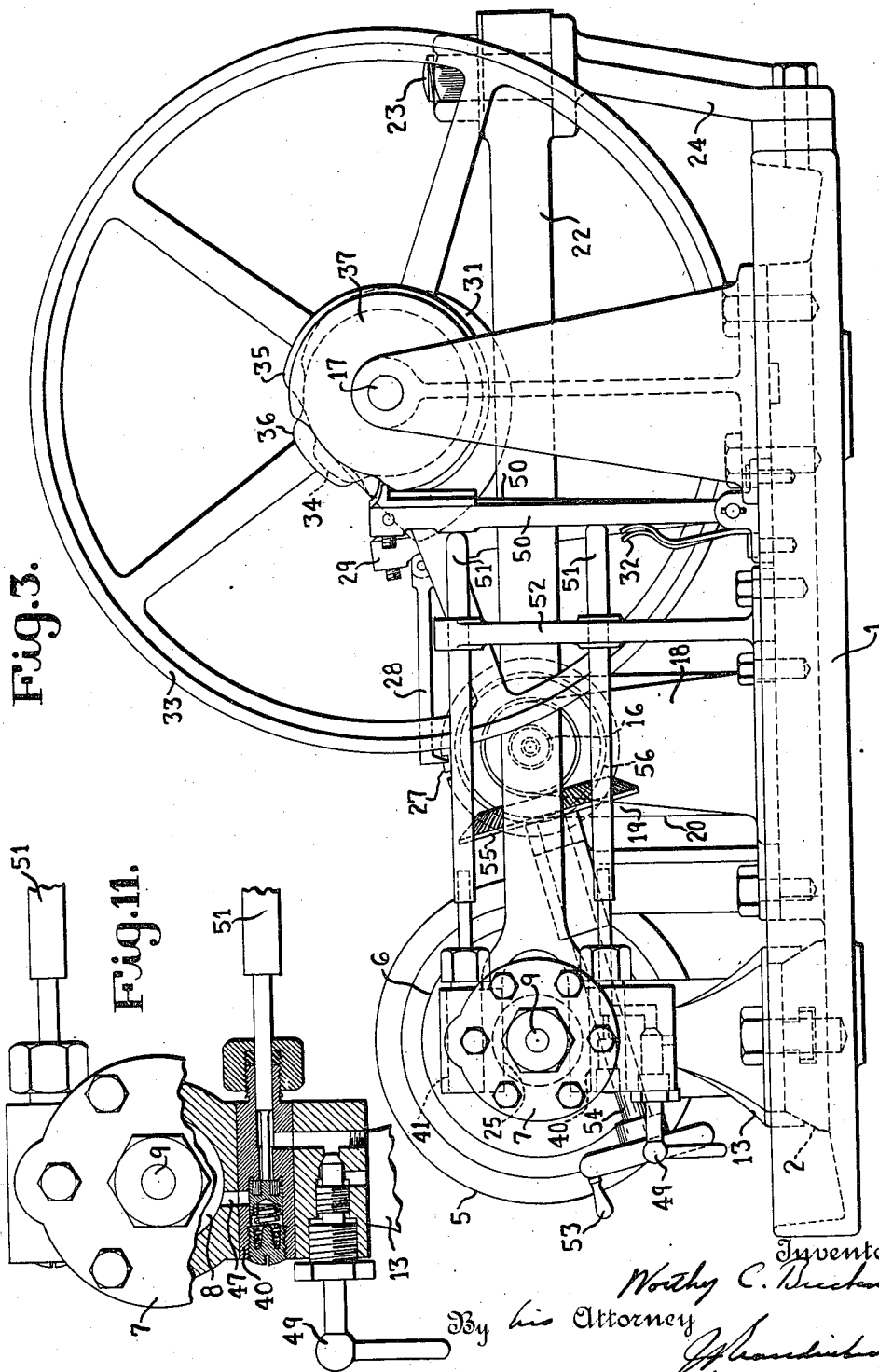
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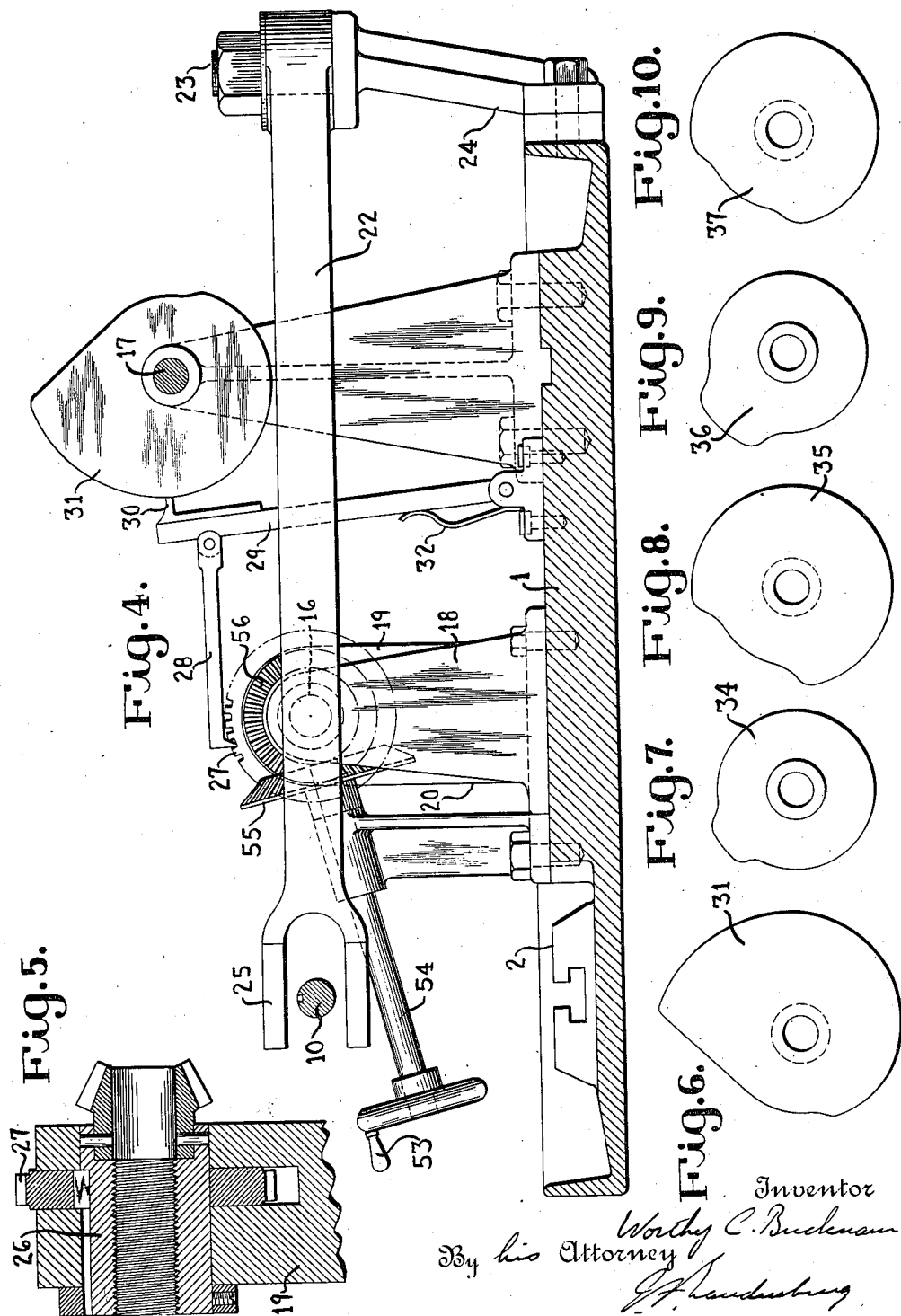
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Fig. 12.

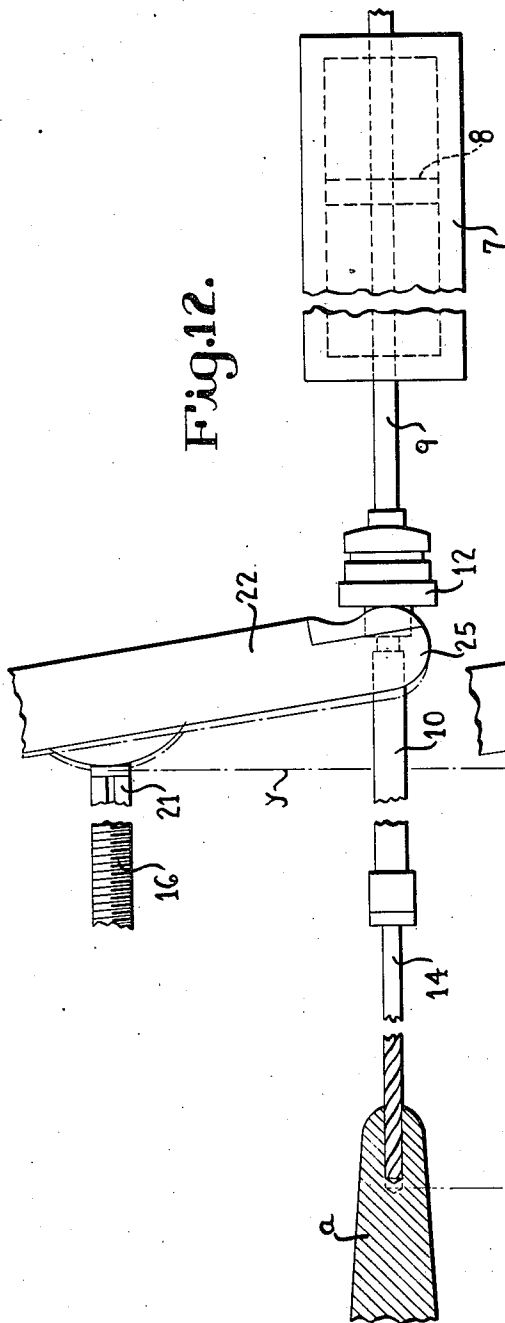
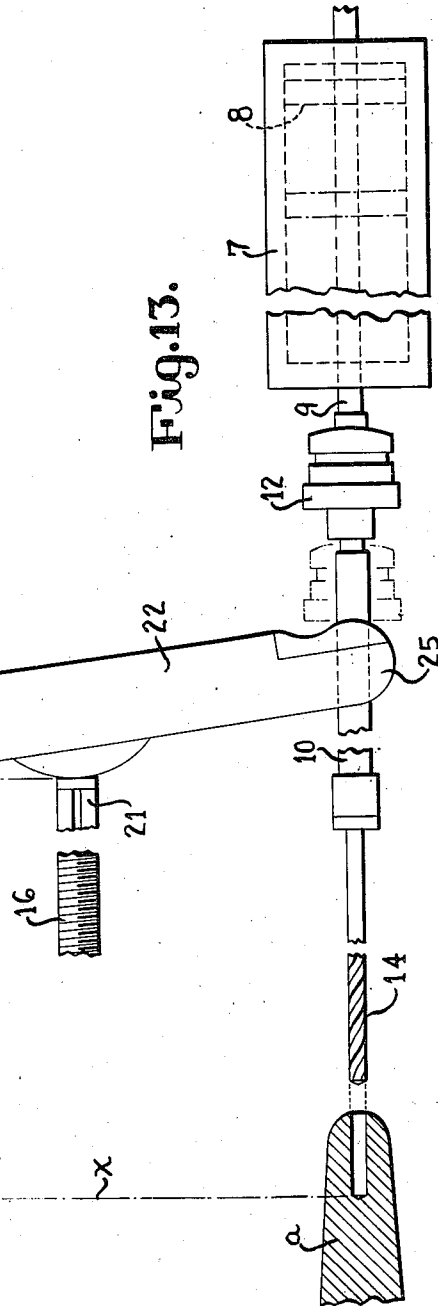


Fig. 13.



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UNITED STATES PATENT OFFICE.

WORTHY C. BUCKNAM, OF JERSEY CITY, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AIR REDUCTION COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

DRILLING MACHINE.

Application filed November 5, 1920. Serial No. 421,924.

To all whom it may concern:

Be it known that I, WORTHY C. BUCKNAM, a citizen of the United States, and resident of Jersey City, in the county of Hudson and State of New Jersey, have invented a new and useful Drilling Machine, of which the following is a specification.

This invention relates to the drilling of fine long bores in which the drill can be fed into the work only a short distance at a time, having to be withdrawn frequently to clear it of chips which otherwise pack and cause the drill to break, and finds particular application in making the longitudinal passages of the copper or alloy tips of autogenous welding and cutting torches. The object is to effect important saving in drills and material and substantially to increase the output of such operations. As at present manually performed, it rests with the judgment of the operator how far to advance the drill each time before clearing, and at what speed and pressure; and as the attack must be repeated many times before one bore is completed, and as some cutting tips contain a number of such passages, the loss in drills and tips is serious. Drills are also broken by striking them forcibly against the metal in returning them to the work after having been withdrawn, and, at the conclusion of drilling, by being caught and twisted off as the result of being suddenly projected through the metal at the end of the hole. The invention provides means of automatic or semi-automatic character for overcoming difficulties of this kind, and comprises a step-by-step feed device opposed to the forward movement of the reciprocatory spindle or part that is moved back and forth to progressively advance the drill in the work and alternately withdraw it. In this way the successive feed advances are limited and controlled in a predetermined manner, and means are also provided for arresting the free forward movements, at the points of last advance, so that impact is avoided. The invention further includes means for automatically reciprocating the spindle and furnishing the drilling pressure, and the coordination of such means and the feed control.

The invention is susceptible of numerous

embodiments, the present preferred embodiment being illustrated in the drawings, wherein:

Fig. 1 is a plan view of the machine, showing the drill retracted, and the feed device at one extreme of movement;

Fig. 2 is a front elevation, with a part broken away and another part in vertical section;

Fig. 3 is an end view on a larger scale;

Fig. 4 is a vertical transverse section on the line 4—4 of Fig. 1, showing parts in a different position;

Fig. 5 is an enlarged detail axial section through a feed nut and ratchet wheel and supporting bracket;

Figs. 6 to 10 are face views of cams;

Fig. 11 is an end elevation of an air cylinder with a portion broken away and in section; and

Figs. 12 and 13 are schematic views illustrating operation.

The illustrated embodiment will now be described.

A suitable horizontally elongated base 1 is provided with a slide 2, on which is adjustable a lathe head stock 4 containing a rotary work spindle and driving pulleys 5, the spindle bearing a chuck 6 for the tip *a* to be drilled. In line with the work spindle is an air cylinder 7 containing a piston 8 and piston rod 9. The drill spindle 10 passes through a pulley 11 by means of which it is rotated in the opposite direction to the work, and is connected to the piston rod by a thrust bearing, not necessary to illustrate, within a head 12 on the forward end of the rod. The pulley 11 is held in a bracket 13 through which the drill spindle reciprocates in splined engagement with the pulley. The drill is marked 14, and is guided adjacent the work in a customary drill guide 15. The piston rod may be regarded as a non-rotary rear portion of the drill spindle, and it will be understood that it is not always necessary that the drill be rotated, and that, in general, either the work or the drill may be rotated, or both as illustrated, and also that the effect will be the same if it is the work spindle which is reciprocated, and further that the parts may be arranged vertically instead of horizontally.

The diagrammatic views indicate the manner of drilling. In Fig. 12 the axial bore is to be understood as having been carried part way into the tip by a number of short advances. The drill has just been withdrawn to remove the chips and returned up to the point where drilling ceased, and is about to be fed into the work a distance represented illustratively by the dot and dash line *x*. Next the drill will be moved rearward again, entirely out of the work, as seen in Fig. 13, after which it will be returned up to the blind end of the partially formed bore, and then fed another short distance into the metal. These operations are repeated until the bore is completed. At each rearward stroke the drill is carried all the way back out of the work, and at the end of each free forward stroke it is fed a further short distance into the metal.

According to this invention the reciprocatory spindle, or a connection, at the end of each of its numerous free forward strokes, encounters a device which automatically controls the successive attacks of the drill upon the metal. In its preferred embodiment the device comprises a screw stop 16 parallel with the spindle and moved lengthwise intermittently by suitable connections from a constantly rotating shaft 17; but other forms of device opposed to the forward movements and having a step-by-step action, variously produced, may be employed.

The screw stop 16 is movable through spaced bearings 18, 19 of a bracket 20, and has an unthreaded projecting portion 21 which is splined in the bearing 18 so as to slide without turning therein. The end of the projecting portion cooperates with the spindle through the intermediary of a lever 22, which is fulcrumed at 23 on a bracket 24 at the back of the base, thence extending across the end of the stop and terminating in a forked extremity 25 which embraces the spindle 10 in position to receive the thrust of the head 12.

The threaded portion of the illustrated stop 16 is in engagement with a nut or female screw member 26, which is rotatable in the bearing 19 and held against longitudinal movement. Fast on the nut in a slot of this bearing is a ratchet wheel 27, upon which rests the tip of a pawl 28, the rear end of which is pivoted to an upstanding cam-follower lever 29 pivoted to the base. Said follower lever has a nose 30 in contact with a cam 31 on the shaft 17, to which it is pressed by a spring 32. This shaft is driven by power through suitable means, represented by a pulley 33 of appropriate size on the shaft to receive a belt from a countershaft, not shown; and through the intermitting pawl and ratchet connection

operating the nut, the stop is thus advanced to the left in Fig. 1 by definite distances and at a definite rate of speed, with intervals between the advances in which to withdraw the drill from the bore and then return it to the point where it was when it ceased drilling at the end of each preceding feed movement. The spindle 10 is thereby limited to corresponding advances at corresponding speed, and at pressure limited by the speed, since all pressure on the spindle above that needed to keep its connection against the moving stop is absorbed by the stop. Furthermore each time the spindle is thrust forward after being withdrawn, it is arrested by the stop, then stationary, at the point of contact with the metal, so that impact and consequent injury are prevented. In Fig. 12 of the diagrammatic views, the stop is to be understood as at or near the end of one of its intervals of rest; the head 12 of the spindle has just struck it, thereby taking the blow off the drill, which has been arrested at the precise point of encounter with the solid metal at the end of the partial bore. The stop will next be moved to the left a distance indicated by the dotted lines, permitting the pressure on the spindle to advance the drill to the line *x*. The stop ceases to move at the position indicated by the line *y*, and remains stationary in Fig. 13 while the spindle is moved all the way back and then forward again to return the drill to the position *x*, where it is stopped without striking the metal preparatory to another feeding-in movement.

The spindle might be reciprocated by hand, but it is preferred to use an automatically controlled motor for the purpose. To this end the shaft 17 is provided with four cams 34, 35, 36, 37, controlling the inlet and exhaust valves of the air cylinder for forward and backward strokes. Thus cam 34 controls rearward stroke inlet valve 38, cam 35 controls forward stroke exhaust valve 39, cam 36 controls rearward stroke exhaust valve 40, and cam 37 controls forward stroke inlet valve 41. The valves may be reciprocatory spring-seated valves in the cylinder casting and do not require particular description. The air is supplied through pipe 42 and reaches the two inlet valves through a passage 43. The inlet ports are marked 44, 45, and the exhaust ports 46, 47. The area of the exhaust passages may be varied by hand-operated needle valves 48, 49. The valve cams operate the valves, to unseat them, through four cam-follower levers, marked generally 50, similar to the lever 29, but, instead of having the pawl 28 pivoted thereto, thrusting against valve push rods 51, guided in brackets 52, the inlet valves and rods being above in the illustrated construction, and

the exhaust valves below, each follower operating a single valve.

The several cams are so designed and arranged upon the shaft that the spindle 10 is driven rearward after each advance of the stop 16 has ceased; and while the spindle is retracted to clear the drill and while it is thereafter being returned to the position which it left, the stop remains stationary, the pawl 28 during this period being on its idle stroke. When the spindle is brought back it comes against the dead stop; and thereupon the stop begins to feed again and advances while the air pressure remains on the spindle urging it forward. The spindle thus follows slowly in contact with the moving stop, through its lever connection 22, until the stop comes to rest, owing to the cam 31 and pawl 28 reversing their movement. Thereupon the valve cams reverse their action and the spindle is driven rearward.

The operation is continued thus automatically until the bore is completed.

The air cylinder is shortened in the diagrammatic views for economy of space, for which reason also intermediate portions of the spindle, drill and stop are broken out; but it will be understood that the cylinder is to be long enough for the longest length of bore to be produced. The piston starts at the rear of the cylinder and in its reciprocations moves forward progressively greater distances as the drilling proceeds.

In order to run the stop back to starting position when the drilling is finished, and also to permit it to be brought up to the work at the beginning, a rotary handle 53 is provided, operating through a shaft 54 and bevel gears 55, 56, the latter secured to the nut, to run the stop in one direction or the other.

With this description of the illustrated construction, other forms of generally like nature will suggest themselves to the skilled mechanic.

What I claim as new is:

1. In a drilling machine in which a reciprocatory spindle is advanced in successive short movements in the drilling of a bore and withdrawn after each advance to clear the drill, the combination of such spindle, means whereby the spindle is reciprocated as just stated, and a step-by-step stop and feed-limit device opposed to the forward movements of the spindle and coordinated with the reciprocation thereof.

2. In a drilling machine in which a reciprocatory spindle is advanced in successive short movements in the drilling of a bore and withdrawn after each advance to clear the drill, the combination of such spindle, means whereby the spindle is reciprocated as just stated, a stop adapted to arrest the successive free forward movements of the

spindle at the points of last advance, and means whereby the stop is advanced, to determine successive definite feed advances.

3. In a drilling machine in which a reciprocatory spindle is advanced in successive short movements in the drilling of a bore and withdrawn after each advance to clear the drill, the combination of such spindle, means whereby the spindle is reciprocated as just stated, a step-by-step feed-limit device opposed to the forward movement of said spindle, and mechanically driven means for moving said device so as to restrain the drill to a definite rate of feed in its successive advances in the work.

4. In a drilling machine in which a reciprocatory spindle is advanced in successive short movements in the drilling of a bore and withdrawn after each advance to clear the drill, the combination of such spindle, a stop adapted to arrest the successive free forward movements of the spindle at the points of last advance, and mechanically driven means for moving the stop, whereby the drill is saved from impact and advanced in the work successive definite distances at definite speed.

5. In a drilling machine, the combination with a reciprocatory spindle, of a movable feed stop, and mechanically driven means for intermittently advancing said stop at definite speed through successive definite feed distances, with intervals between in which to clear the drill, the stop remaining stationary during each clearing and return movement of the spindle.

6. In a drilling machine, the combination with a reciprocatory spindle, of a movable feed stop, a constantly driven rotating shaft, and an intermittent drive means between the shaft and the stop for advancing the latter step by step, the reciprocations of the spindle taking place during the intervals between the intermittent movements of the stop.

7. In a drilling machine wherein the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a motor and motor control means for reciprocating the same and supplying the drilling pressure, and means determining successive uniform feed advances at the forward ends of the strokes.

8. In a drilling machine wherein the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a motor and motor control means for reciprocating the same and supplying the drilling pressure, and mechanically driven stop mechanism co-ordinated with the reciprocatory movement of the spindle for arresting the free forward strokes at successive points of advance and thereupon governing the feed movements.

9. In a drilling machine wherein the drill

is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a motor for reciprocating the same and supplying the drilling pressure, screw stop means, and mechanically driven means for intermittently advancing said stop means in timed relation to the operation of the motor.

10. In a drilling machine wherein the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a fluid pressure motor for reciprocating the same and supplying the driving pressure, driven valve operating mechanism for the motor, a movable feed stop adapted to arrest each free forward movement of the spindle at the point of last advance, and intermittent operating means coordinated with the valve operating mechanism for advancing the feed stop step by step.

11. In a drilling machine wherein the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a fluid pressure motor for reciprocating the same and supplying the driving pressure, a movable feed stop, a cam shaft and cams for operating the motor valves and the feed stop, the cams being so designated that the feed stop arrests each free forward movement of the spindle at the point of last advance and is then advanced a predetermined feed distance.

12. In a drilling machine wherein the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of an air cylinder and piston connected therewith, an intermittently advancing feed stop, and mechanism operating the piston control and the feed stop in timed relation.

13. In a drilling machine in which the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a screw stop opposed to the forward movement of the spindle, constantly running driving means, and an automatic intermitting connection between the driving means and the stop the reciprocations of the spindle taking place during the intervals between the intermittent movements of the stop.

14. In a drilling machine in which the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a screw stop opposed to the forward

movement of the spindle, a rotary nut on the stop held against longitudinal movement, and an automatic intermitting connection between the driving means and the nut, the reciprocations of the spindle taking place during the intervals between the intermittent movements of the stop.

15. In a drilling machine in which the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a screw stop opposed to the forward movement of the spindle, a rotary nut on the stop held against longitudinal movement, and a cam and pawl and ratchet connection between the driving means and the nut, the reciprocations of the spindle taking place during the intervals between the intermittent movements of the stop.

16. In a drilling machine in which the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a screw stop opposed to the forward movement of the spindle, a rotary nut on the stop held against longitudinal movement, an automatic intermitting connection between the driving means and the nut, and a handle geared to the nut for shifting the stop, the reciprocations of the spindle taking place during the intervals between the intermittent movements of the stop.

17. In a drilling machine in which the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a movable stop opposed to the forward movement of the spindle, constantly running driving means, and an automatic intermitting connection between the driving means and the stop, the reciprocations of the spindle taking place during the intervals between the intermittent movements of the stop.

18. In a drilling machine in which the drill is cleared repeatedly in the drilling of a bore, the combination with the reciprocatory spindle, of a movable stop opposed to the forward movement of the spindle, constantly running driving means, an automatic intermitting connection between the driving means and the stop, and manual means for shifting the stop, the reciprocations of the spindle taking place during the intervals between the intermittent movements of the stop.

WORTHY C. BUCKNAM.