

Aug. 7, 1951

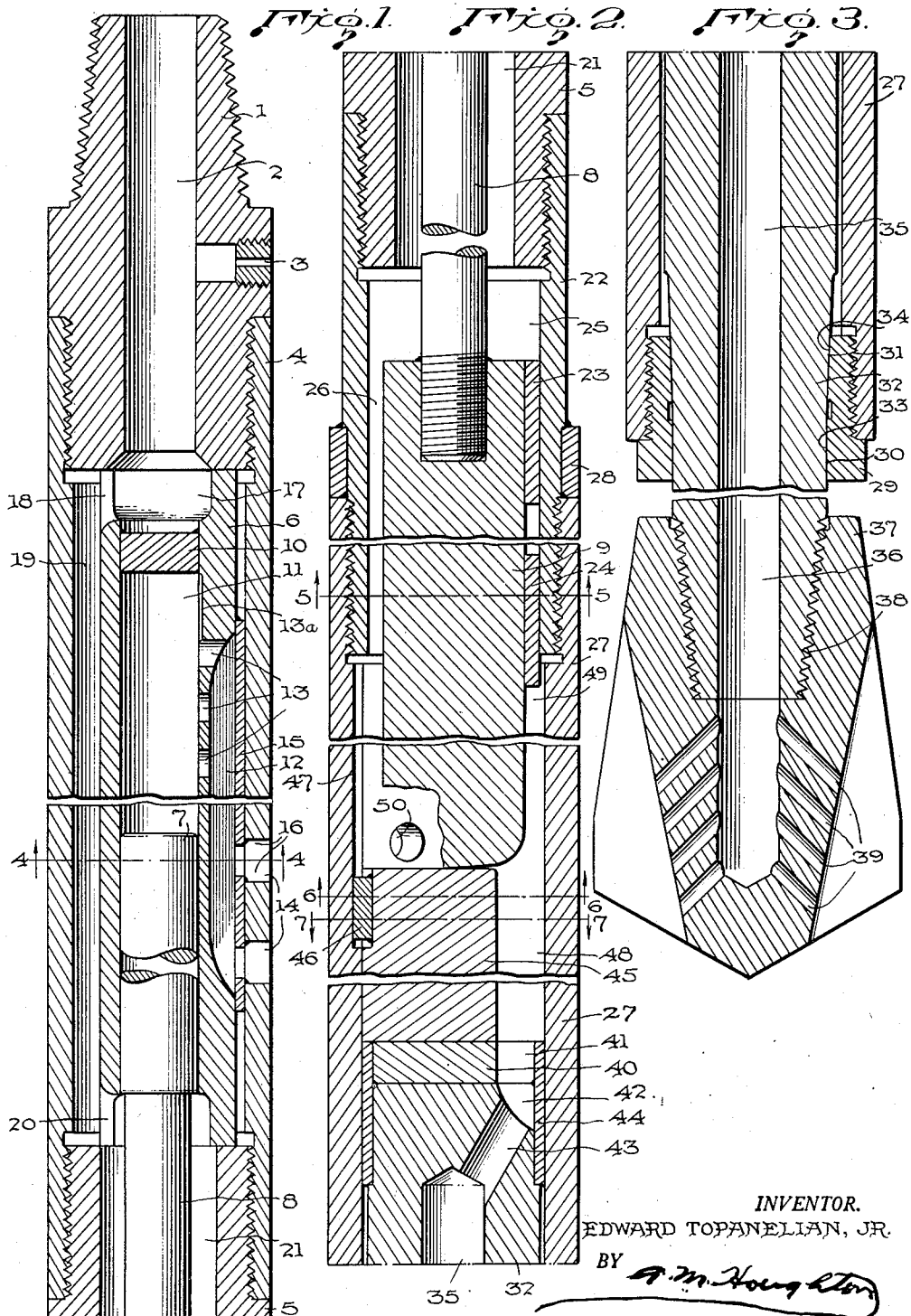
E. TOPANELIAN, JR

2,563,083

HAMMER DRILL

Filed Oct. 28, 1948

2 Sheets-Sheet 1



INVENTOR.
EDWARD TOPANELIAN, JR.

BY *A. M. Houghton*

Attorney ATTORNEY

Aug. 7, 1951

E. TOPANELIAN, JR

2,563,083

HAMMER DRILL

Filed Oct. 28, 1948

2 Sheets-Sheet 2

Fig. 4

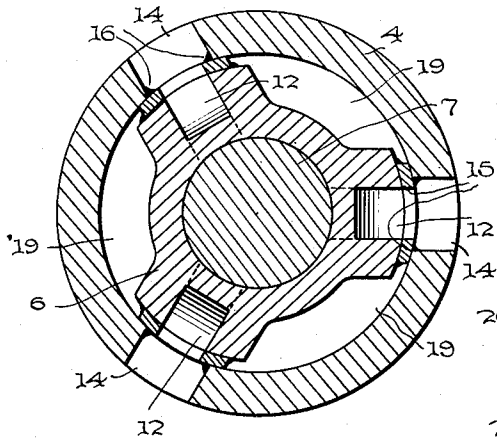


Fig. 5

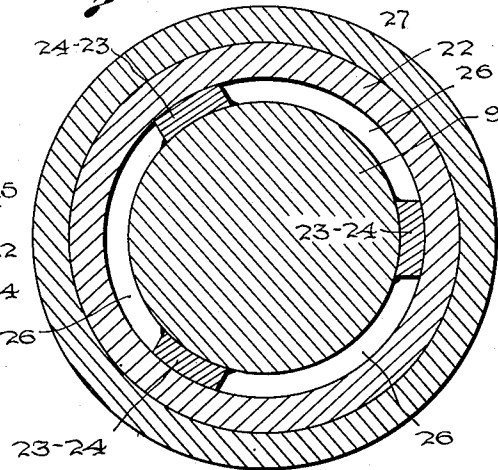


Fig. 6

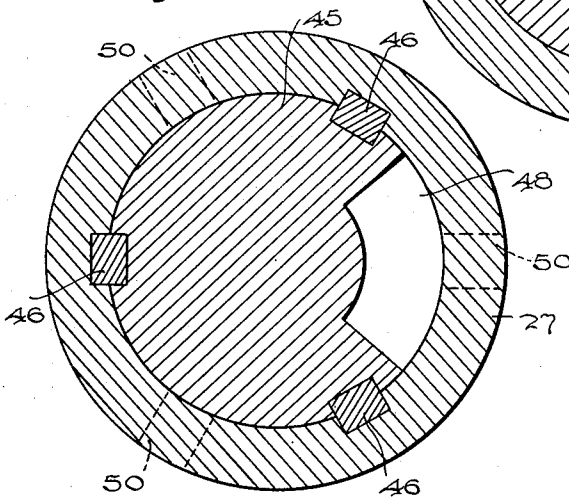
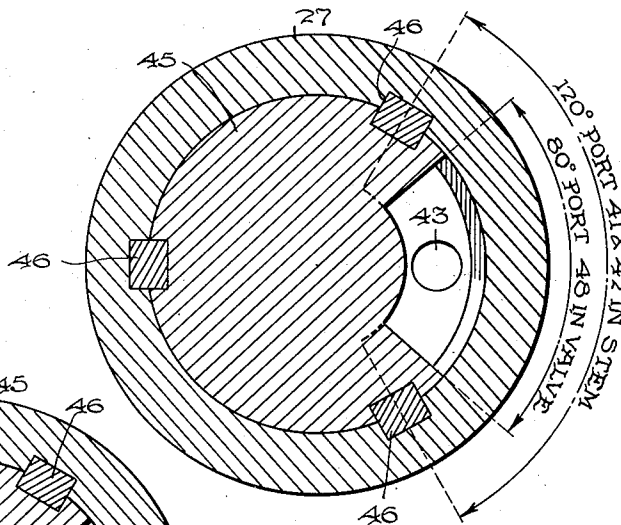


Fig. 7



INVENTOR.
EDWARD TOPANELIAN, JR.

BY A. M. Houghton

Attorney

UNITED STATES PATENT OFFICE

2,563,083

HAMMER DRILL

Edward Topanelian, Jr., Pittsburgh, Pa., assignor
to Gulf Research & Development Company,
Pittsburgh, Pa., a corporation of Delaware

Application October 28, 1948, Serial No. 57,035

3 Claims. (Cl. 255—4.4)

1

2

This invention relates to a well drill and more particularly to an impact-type well drill having an impact frequency which may be controlled by varying the speed of rotation of the drill pipe and drill casing.

Common impact-type well drills are, generally speaking, rather inflexible from the standpoint of impact frequency. The impact frequency of such drills is generally fixed and uncontrollable once operation of the drill has commenced. Obviously, this does not permit of optimum drilling efficiency when it is recognized that a number of vastly different types of formations are usually encountered by a drill in every drilling operation.

Accordingly, the primary object accomplished by my invention is the provision of an impact or hammer-type well drill having an impact frequency which may be controlled by varying the speed of rotation of the drill pipe.

A further object accomplished by my invention is the provision of a well drill which is capable of automatically shutting off when "drilling off" or lowering the drill into the well.

A still further object accomplished by my invention is the provision of a drill of the character described capable of being closely controlled by the operators at the surface above the well.

These and other useful objects are accomplished by my invention as disclosed in this specification of which the accompanying drawings form a part. My invention is exemplified in the drawings and the descriptive matter relating thereto. In the drawings:

Fig. 1 is a longitudinal view in section showing the upper portion of a preferred embodiment of my drill;

Fig. 2 is a longitudinal section showing the intermediate portion of the drill shown in Fig. 1;

Fig. 3 is a longitudinal section showing the lowermost portion and bit of the drill shown in Figs. 1 and 2;

Fig. 4 is a transverse sectional view taken along line 4—4 of Fig. 1;

Fig. 5 is a transverse sectional view taken along line 5—5 of Fig. 2;

Fig. 6 is a transverse sectional view taken along line 6—6 of Fig. 2; and

Fig. 7 is a transverse sectional view taken along line 7—7 of Fig. 2.

Referring to the drawings, and particularly to Fig. 1, item 1 is an adapter piece provided with a tapered standard drill-pipe thread at its upper end to facilitate attachment to a drill stem or a drill collar (not shown), and is further provided with a passage 2 for conducting drilling fluid

therethrough into the drill mechanism. An orifice 3 may be inserted in adapter 1 to provide a by-pass which will bleed off drilling fluid if full pressure of the drilling fluid is not required for operation of the drill. The lower portion of adapter 1 is attached to a piston chamber housing or casing 4 which in turn is connected thereto below to a coupling piece 5. A cylinder block 6 is disposed within casing 4 and constrained from movement by adapter 1 and coupling 5 exerting pressure on the ends thereof. The purpose of cylinder block 6 is to accommodate a piston 7 which is adapted through piston rod 8 to reciprocate a hammer 9 (shown in Fig. 2), said hammer being the means provided to produce percussive blows on the drill bit. The upper portion of cylinder block 6 is sealed off by means such as plug 10 welded thereto so that a chamber 11 is formed above piston 7. The outer portion of cylinder block 6 is adapted to form sediment traps 12 which are connected to chamber 11 by passages 13. The upper end of cylinder block 6 forming chamber 11 is provided with a small passage 13a similar to a keyway to permit a controlled release of fluid from the dashpot pocket formed in the upper end of cylinder 6 when piston 7 is elevated past the passages 13. The sediment traps 12 are connected to the well bore by means of passages 14 in casing 4 located below passages 13 of the cylinder block. The portions of cylinder block 6 adjacent sediment traps 12 are faced with metal strips 15 welded thereto and overlapping weld beads 16 in passages 14 to provide a complete liquid seal between the sediment traps and other portions of the drill, as shown in Fig. 4. The uppermost portion of cylinder block 6 above plug 10 forms a chamber 17 connecting with passage 2. This chamber further connects through passages 18 with passages 19 formed between cylinder block 6 and casing 4. Passages 19 further connect through passages 20 of the cylinder block to passage 21 defined by the annular space between coupling 5 and piston rod 8.

Continuing to Fig. 2, the lower portion of coupling 5 is attached by means of threads to an upper guide casing 22 to provide a guiding surface for upper guide strips 23 and lower guide strips 24 welded to hammer 9 and accordingly form a guided path for the hammer in casing 22. A further passage for drilling fluid under pressure is provided by the annular space 25 between piston rod 8 and casing 22, which passage connects with passages 26, shown in Fig. 5, between the three sets of guide strips 23 and 24 on hammer 9. A lower main housing or casing 27 is attached by

3

means of threads to upper guide casing 22 and a collar 28 welded to casing 22 provides a seal against the face of casing 27. The lowermost portion of casing 27, shown in Fig. 3, is threaded to receive a guide bushing 29 having a straight bore 30 and a tapered portion 31. The function of this guide bushing is to act as a lower guide for a bit-stem 32 which in turn has a straight portion 33 and a tapered portion 34 adapted to slidably match and cooperate with the corresponding portions of guide bushing 29. Bit-stem 32 contains a central passage 35 for flushing fluid and this passage connects with the central passage 36 of a conventional bit 37 which is attached to the lowermost portion of bit-stem 32 by means of threads 38. Bit 37 is constructed to permit the passage of flushing fluid from central passage 36 through passages 39 into the well bore so that chips may be washed from the hole in the conventional manner. While I have shown a fish tail type of bit for purposes of illustration other types such as conventional roller bits may alternatively be used. Such roller bits also have central passages for flushing chips from the hole.

The upper portion of bit-stem 32, shown in Fig. 2, is welded to a valve-facing piece 40 containing a port 41 connecting through passages 42 and 43 to central passage 35 in bit-stem 32. A sleeve 44 pressed about valve-facing piece 40 and the upper portion of bit-stem 32 acts as a further guide for the longitudinal movement of bit-stem 32, said sleeve 44 having a close slidable fit with casing 27. A rotatable valve 45 is situated immediately above valve-facing piece 40. This valve, shown also in Figs. 6 and 7, is keyed to casing 27 by means of keys 46 and keyways 47 so that valve 45 will rotate with casing 27 and with respect to valve-facing piece 40, and in addition, so that valve 45 with keys 46 may be slidably moved in casing 27. Valve 45 is provided with a valve port 48 which during rotation of the drill stem is periodically connected with port 41 of valve facing piece 40. Port 48, however, is always connecting with passage 49 thereabove containing operating fluid under pressure. It is apparent that valve 45 considered with valve-facing piece 40 and bit-stem 32 comprises an anvil which will transmit percussive blows exerted by the hammer 9 thereon to bit 37 and the formation in the well.

To render the drill inoperative when "circulating in" or lower the drill into the well and to permit what is commonly known as "drilling off," casing 27 is provided with passages 50, shown in Fig. 2, immediately above valve 45 which is shown in its lowermost position. These passages 50 provide a relief for operating fluid under pressure when the valve and bit-stem are in the position as shown so that hammer 9 cannot be elevated by pressure fluid. Since both bit-stem 32 and valve 45 are capable of longitudinal movement with respect to casing 27, passages 50 will become sealed off by valve 45 when the bit rests against a formation and the casing 27 is further lowered about valve 45 and bit-stem 32. This permits operating fluid pressure to build up beneath hammer 9 and piston 7 rendering the drill operative and permitting the hammer to be elevated for a percussive blow.

The size of port 48 in valve 45 and the size of ports 41 and 42 in valve-facing piece 40 and bit-stem 32 may vary considerably. However, port 48 may advantageously be defined by an 80° sector of valve 45 and ports 41 and 42 may advantageously be a 120° sector, so that when the casing is rotated, valve 45 will be closed during about

4

160° of rotation and open during about 200° of rotation.

It is customary when operating deep well drills to first "rotate in" or "circulate in" the well drill.

This simply consists in establishing the circulation of operating fluid through the drill and into the well while rotating and lowering both the casing and drill in the well. Such a procedure would be accomplished by my drill in the following manner: Assuming the unit to be suspended vertically with the upper end of adapter 1 attached to a drill pipe, all loose parts will be free to assume their lowermost positions, such positions being as shown in the drawings. For example, bit-stem 32 will tend to rest with the taper 34 in contact with taper 31 in guide bushing 29 and the top of bit 37 will be some distance below bushing 29. Valve 45 will be resting on top of valve-facing piece 40 and hammer 9 will be in contact with the upper face of the valve, piston 7 also being in its lowermost position. Fluid may then be circulated through passages 2, 17, 18, 19, 20, 21, 25, 26 and 49, and out through passages 50 in casing 27, regardless of whether the port in the valve and the port in the bit-stem are in register or not. If ports 48 and 41 are in register, drilling fluid may also circulate there-through and through passages 42, 43, 35, 36, 39 and out into the well bore. This free circulation of fluid from beneath hammer 9 into the well prevents fluid pressure from building up sufficiently to raise the hammer. Thus, the position of the parts may be considered as a safety position which prevents hammer operation whenever the parts become so arranged. Owing to the friction between bit-stem 32 and guide bushing 29 in this position, the bit will be rotated along with the casing during this "rotating in" period. At the same time, fluid from the well bore will enter through passages 14 in the casing and proceed through passages 12 and 13 into chamber 11 above the piston. This serves to balance the pressures of the inner and outer columns of fluid on the top and bottom of piston 7.

When the bottom of the hole has been reached, the hammer mechanism will begin to function to produce percussive blows on valve 45, bit-stem 32 and bit 37 which transmits the blows to the formation. This phase of operation will be as follows: Since the bit 37 is constrained from downward movement by the formation at the bottom of the well, further lowering of the drill pipe will result in a lowering of casing 27 about bit-stem 32 and valve 45, causing disengagement of the tapered portions 31 and 34 of guide bushing 29 and bit-stem 32, respectively. In other words, the bit-stem may be considered as moving relatively upward in the casing carrying valve 45 with it, so that shortly after bit 37 strikes the bottom of the well, valve 45 will be caused to slide upward and cover relief ports 50 in casing 27 causing operating fluid pressure to build up beneath hammer 9 and piston 7. Since the drill pipe and the drill casing are undergoing constant rotation, there will be relative movement between valve 45 which is keyed to the casing and bit-stem 32 as well as valve-facing piece 40 due to the fact that the bit-stem and bit are resting on the formation, which creates a drag against bit rotation. Casing 27 and bushing 29 will therefore turn freely about the bit-stem and maintain the bit-stem in a vertical position due to the guiding action of bushing 29 and sleeve 44, at the same time permitting free vertical movement as the bit is driven downward. In this stage of operation

5

6

the drill pipe and casing 27 may rest on the top of bit 37 or may be suspended slightly thereabove. When valve port 45 is in register with ports 41 and 42 on the bit-stem, free fluid flow will result through the bit and hammer 9 will rest against valve 45. However, when these ports are not in register, the pressure will build up in passages 49, 26, 25 and 21, causing a higher pressure to exist beneath piston 7 than exists on top of the piston in chamber 11 which is in communication with the well bore under static fluid pressure. This difference in pressure will cause piston 7, piston rod 8 and hammer 9 to be elevated, and such a condition will exist as long as the valve ports are not in register. However, when rotation of valve 45 with casing 27 again brings the ports into register, the flow of fluid through the bit-stem and out of the bit ports will resume, causing the pressure beneath the hammer to drop substantially. Thus, the pressure on both sides of the piston will become approximately equalized, permitting the hammer to fall under the gravitational forces acting thereon. Hammer 9 will then strike valve 45 with considerable impact, imparting a shock thereto which is transmitted through the bit-stem and bit to the formation. Drilling of the formation is accomplished by the repetition of these blows and the progressive rotation of bit 37 due to the gradual drifting of the bit. This drifting is possible since there is very little hydraulic pressure on the bit-stem during the fall of the hammer, leaving it relatively free to drift during this time interval.

If the weight of the drill pipe and drill casing is allowed to rest on the bit it will automatically follow the bit downward during a drilling operation. However, if the drill pipe and casing attached thereto are suspended and remain fixed for a period of time, the bit may be allowed to "drill off" or continue downward to the extent of its possible travel, whereupon operation will cease due to the exposure of relief passages 50.

It is apparent that complete control of the frequency of hammer impact may be had by simply controlling the speed of rotation of the drill pipe. It is therefore possible to select the most advantageous impact frequency for a given formation undergoing the drilling operation. Another advantage of my drill is that relatively little wear on the cutting edge of the bit is produced because of the very little rotation of the bit against the formation and the light weight on the bit when it is not being struck by the hammer. My drill is further advantageous in that automatic control of its operation is provided whereby hammering will be prevented while lowering the drill into the well and operation will automatically cease if the casing is suspended and the bit and bit-stem are permitted to "drill off." Other advantages lie in the novel construction and arrangement of parts which permits easy replacement and economic manufacture as well as efficient operation. The simplicity of construction extends the operational life before replacements are necessary. Furthermore my invention provides a drill which permits maximum utilization of fluid pressure.

It will be apparent to those skilled in the art who have familiarized themselves with this disclosure of my invention that numerous modifications thereof may be made without departing from the spirit thereof. For example, in most instances the number of passages used for operating fluid are not critical. Rather, the volume of fluid capable of being accommodated by such

passages is the controlling factor in determining their number and size. The valve 45 and valve-facing piece 40, together with bit-stem 32 may be provided with more than one passage to further control the frequency of the hammer stroke. The embodiment illustrated in the drawings is entirely lacking in any kind of spring, but should it be desirable to increase the impact force of the hammer a spring may be employed above the hammer to return it with greater force and in shorter time. When such a spring is used above the hammer it becomes desirable to shorten the valve ports so that the open register time will be correspondingly decreased.

The preferred embodiment specifically shown and described herein is intended to be merely illustrative of my invention and in no manner should it be considered as a limitation thereof or as limiting the scope of the appended claims hereinafter made.

What I claim is:

1. A fluid-operated rotary reciprocating drilling mechanism comprising a cylindrical hollow casing adapted to be rotated and supplied with operating fluid under pressure, a bit-stem sealed to said casing and free to turn and slide therein and extending below the lower end thereof, said bit-stem having a longitudinal passageway therethrough with an eccentric opening on the upper face of said bit-stem, an anvil sealed to said casing and slidably disposed in and adapted to rotate with said casing above said bit-stem, a longitudinal passageway through said anvil with an eccentric opening on the lower face of said anvil, a reciprocable hammer freely sliding in said casing above said anvil, a cylinder attached to said casing and with its upper end open to the exterior of said casing and with its lower end open to the interior of said casing, an upward-extending plunger attached to said hammer and entering the lower end of said cylinder, and a passageway by-passing said cylinder to permit operating fluid access to the lower end of said hammer to elevate the same whenever said openings in said anvil and said bit-stem are not in register.

2. A fluid-operated rotary reciprocating drilling mechanism comprising a cylindrical hollow casing adapted to be rotated and supplied with operating fluid under pressure, a bit-stem sealed to said casing and free to turn and slide therein and extending below the lower end thereof, said bit-stem having a longitudinal passageway therethrough with an eccentric opening on the upper face of said bit-stem, an anvil above said bit-stem sealed to said casing and having limited sliding movement therein and adapted to rotate with said casing, a longitudinal passageway through said anvil with an eccentric opening on the lower face of said anvil, a passageway through the wall of said casing proximate the lower limit of the top of said anvil and adapted to become obstructed upon upward movement of said anvil, a reciprocable hammer freely sliding in said casing above said anvil, a cylinder attached to said casing and with its upper end open to the exterior of said casing and with its lower end open to the interior of said casing, an upward-extending plunger attached to said hammer and entering the lower end of said cylinder, and a passageway by-passing said cylinder to permit operating fluid access to the lower end of said hammer to elevate the same whenever said openings in said anvil and said bit-stem are not in register.

7

3. A fluid-operated rotary reciprocating drilling mechanism comprising a cylindrical hollow casing adapted to be rotated and supplied with operating fluid under pressure, a bit-stem sealed to said casing and free to turn and slide therein and extending below the lower end thereof, said bit-stem having a longitudinal passageway therethrough with an eccentric opening on the upper face of said bit-stem, means limiting the downward movement of said bit-stem with respect to said casing, means engaging said casing and said bit-stem to prevent relative rotation therebetween when the latter is at its lower limit, an anvil sealed to said casing and slidably disposed in and adapted to rotate with said casing above said bit-stem, a longitudinal passageway through said anvil with an eccentric opening on the lower face of said anvil, a reciprocable hammer freely sliding in said casing above said anvil, a cylinder attached to said casing and with its upper end open to the exterior of said casing and with its lower end open to the interior of said casing, an upward-extending plunger attached to said hammer and entering the lower end of said cylinder,

8

and a passageway by-passing said cylinder to permit operating fluid access to the lower end of said hammer to elevate the same whenever said openings in said anvil and said bit-stem are not in register.

EDWARD TOPANELIAN, JR.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,065,298	Currell	June 17, 1913
1,861,042	Zublin	May 31, 1932
1,881,258	Bayles	Oct. 4, 1932
1,891,416	Harris	Dec. 20, 1932
1,892,517	Bennington	Dec. 27, 1932

FOREIGN PATENTS

Number	Country	Date
328,629	Great Britain	Apr. 30, 1930
351,457	Italy	Aug. 11, 1937
697,466	Germany	Oct. 14, 1940