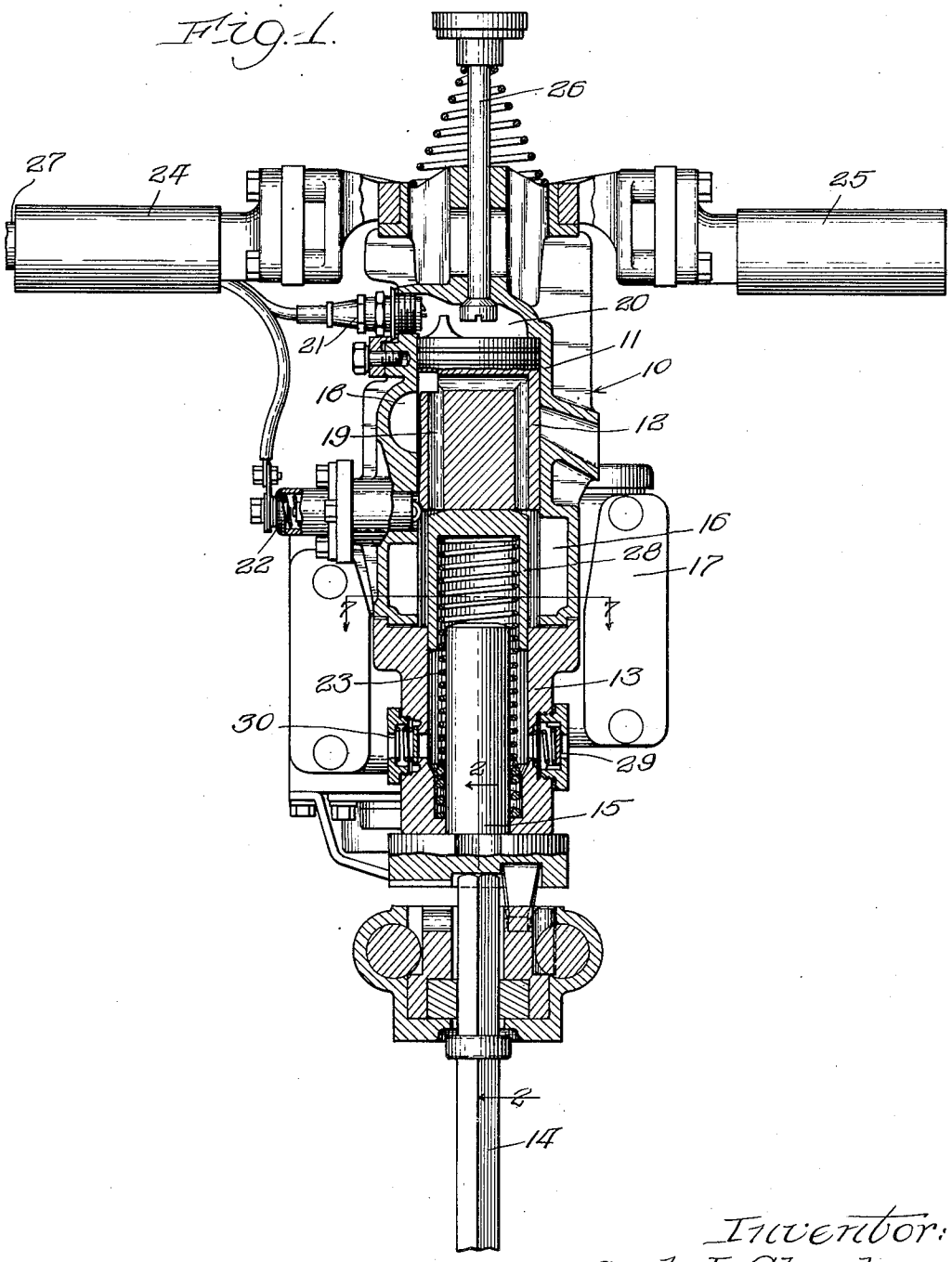
Nov. 26, 1940. C. L. CHARLES 2,223,095

INTERNAL COMBUSTION DRILL

Filed July 10, 1937 4 Sheets-Sheet 1

Fig. 1.



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INTERNAL COMBUSTION DRILL

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Fig. 2.

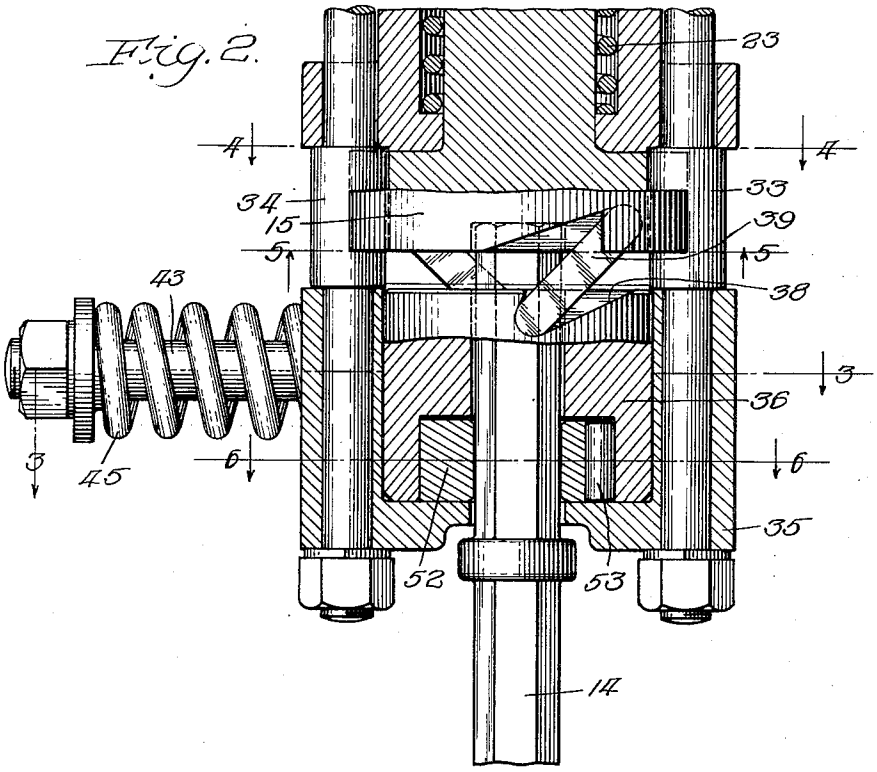
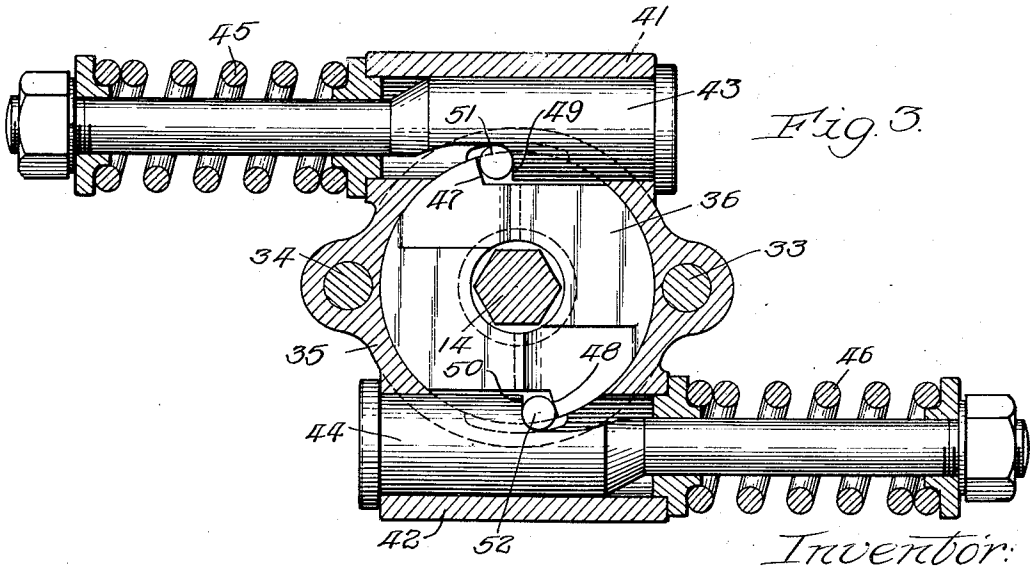


Fig. 3.



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INTERNAL COMBUSTION DRILL

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Fig. 4.

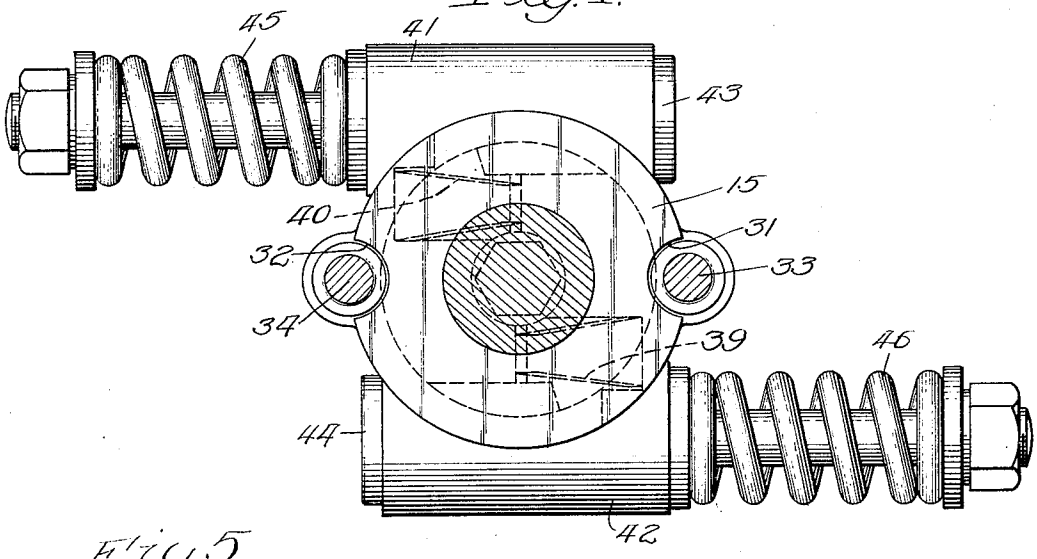


Fig. 5.

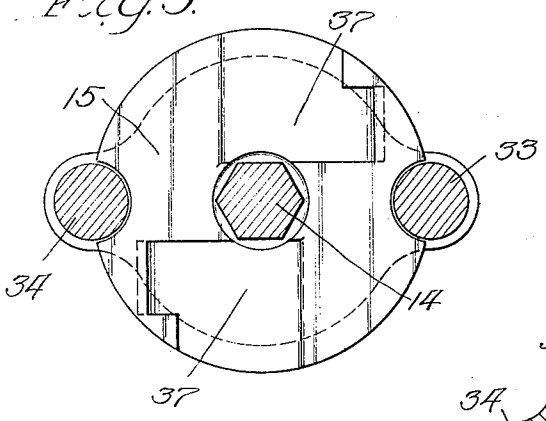


Fig. 6.

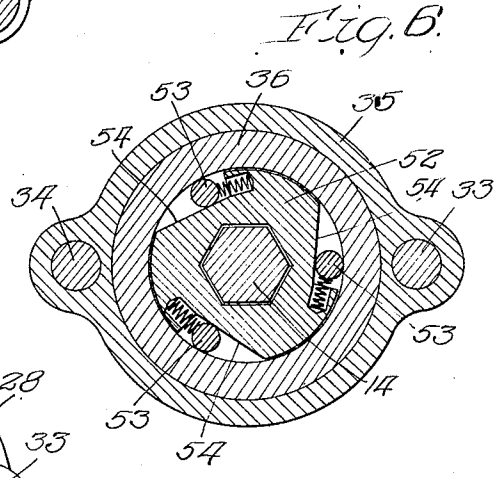
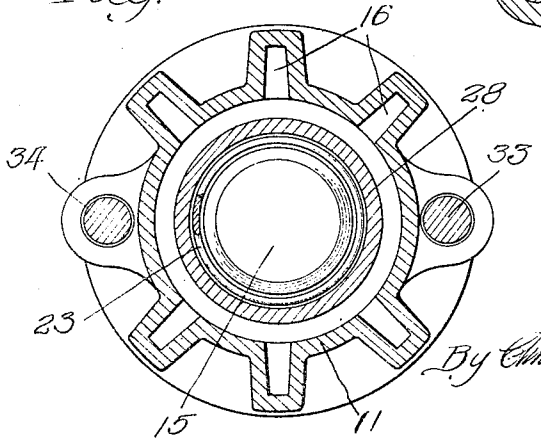


Fig. 7.



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INTERNAL COMBUSTION DRILL

Filed July 10, 1937 4 Sheets-Sheet 4

Fig. 8.

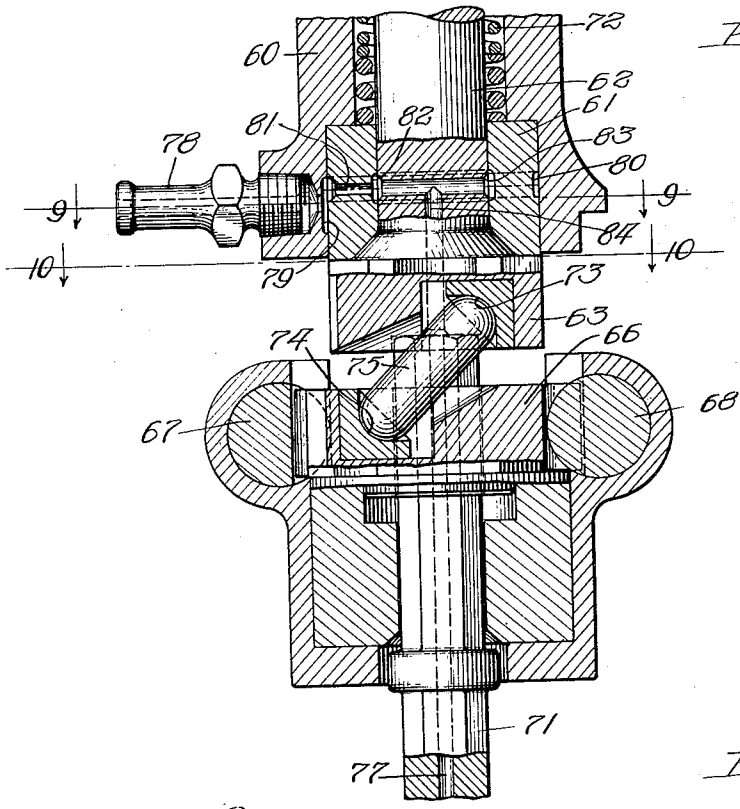


Fig. 9.

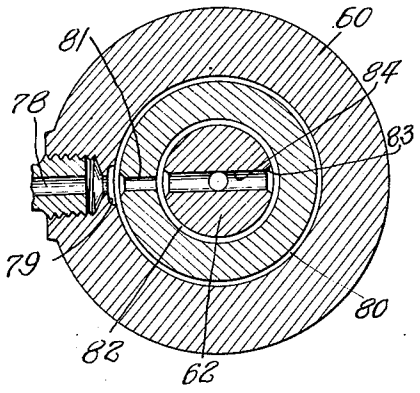
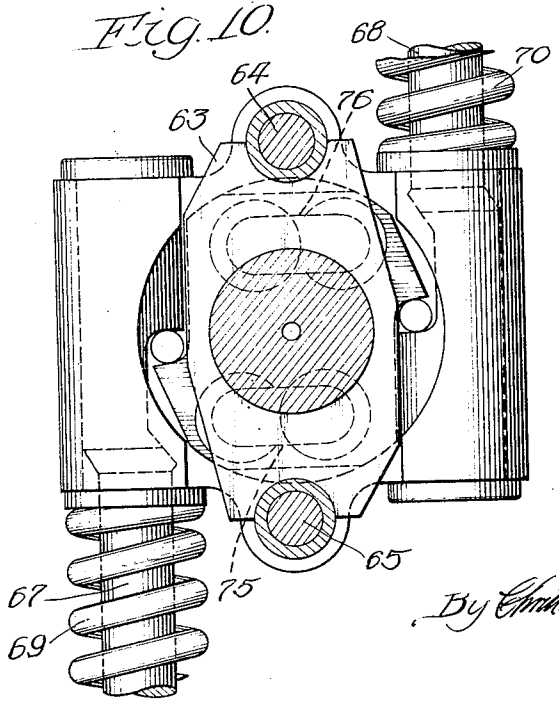


Fig. 10.



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Patented Nov. 26, 1940 2,223,095

UNITED STATES PATENT OFFICE

2,223,095

INTERNAL COMBUSTION DRILL

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Application July 10, 1937, Serial No. 153,049

10 Claims. (Cl. 121—7)

This invention relates to an internal combustion drill, and more particularly to an improved form of such a drill.

One feature of this invention is that means are provided for rotating the tool during drilling; another feature of this invention is that the rotating means is operated without the necessity of an independent supply of power, although the power for the drill is explosive in character; yet another feature is that the tool is rotated during the return stroke of the piston-hammer; a further feature is that the body of the drill is so arranged as to provide improved cooling for the piston return spring; other features and advantages of this invention will be apparent from the following specification and the drawings, in which:

Fig. 1 is a vertical view, principally in section, of a drill embodying the invention disclosed herein; Fig. 2 is a fragmentary transverse sectional view along the line 2—2 of Fig. 1; Fig. 3 is a horizontal sectional view along the line 3—3 of Fig. 2; Fig. 4 is a horizontal sectional view on the line 4—4 of Fig. 2; Fig. 5 is a view looking upward along the line 5—5 of Fig. 2; Fig. 6 is a sectional view of the groove along the line 6—6 of Fig. 2; Fig. 7 is a sectional view of the compression chamber along the line 7—7 of Fig. 1; Fig. 8 is a fragmentary sectional view of a modified form of the lower end of the drill; Fig. 9 is a transverse sectional view along the line 9—9 of Fig. 8; and Fig. 10 is a view along the line 10—10 of Fig. 8.

The drill disclosed herein is an internal combustion hammer of the free piston type. In the form of this invention illustrated in Figs. 1–7 the drill 10 comprises a cylinder proper 11 having a piston 12 reciprocable therein. The cylinder has rigidly fastened therebeneath and coaxial therewith an anvil housing 13, so arranged as to elongate the central bore provided for the cylinder 11.

The drill carries a tool 14 which is in contact with an anvil member 15 longitudinally but non-rotatably splined to the tie rods 33 and 34, whereby impacts from the piston hammer 12 during operation of the drill are transmitted to the tool 14 to effect the desired work. Tool-rotating means is provided at the bottom of the hammer, and will be more fully described hereafter.

The cylinder 11 has, adjacent the anvil housing 13, a portion having radial grooves or notches 16, which form a space or compression chamber adapted to have a combustible charge furnished thereto from the charge-forming unit 17, here shown as comprising a gasoline tank and carburetor, through an intake port not here shown. A transfer passage 18, in cooperation with the openings 19 through the piston 12, provides means for transferring the combustible charge to the combustion chamber 20 above the piston, where the charge is finally compressed on the upstroke of the piston and fired by a spark-plug 21 at a time determined by the timer device 22. The firing of this charge results in the downward or working stroke of the piston, which compresses the return spring means 23 and at the end of its travel strikes the anvil 15 to transmit a sharp blow to the tool 14. The energy stored in the return spring 23, aided by the rebound from the anvil, then returns the piston to repeat the operation. The drill or hammer is thus seen to work on the conventional two-strike cycle internal combustion principle.

A pair of handles 24 and 25 are provided to enable the operator to properly locate the tool 14 at the beginning of the drilling operation, and to maintain the travel of the tool in the desired direction during drilling. A starting rod 26 enables the device to be conveniently started, since manual depression of this rod depresses the piston 12. One or two operations of this rod thus draws in a charge, transfers it to the combustion chamber, and fires it to initiate operation of the drill. Ignition current is supplied from an outside source, not here shown, through the cable 27 entering the drill through the handle 24.

While drills of this general type are known in the art, they have been open to several objections. In the first place, the return spring means 23 has heretofore contacted the piston 12 directly, and has been customarily placed in the subpiston compression chamber. Such construction permitted the direct conductive transfer of the heat of explosion through the piston to the spring, and resulted in excessively high spring temperatures during operation. The nature of these temperatures may be realized from the fact that the outside walls of the cylinder 11, even though provided with cooling fins, frequently attain temperatures of five to six hundred degrees Fahrenheit when the device is working. Considerable difficulty with spring breakage was long encountered in devices of this type, and it was learned that the excessive temperatures of the spring contributed greatly to this difficulty.

The present invention provides improved

means for cooling the spring by placing it in a portion of the cylinder or bore separated not only from the piston but even from the subpiston compression chamber by an inverted cup member 28. This member is here shown as in closely fitted slidable contact with the internal wall of the anvil housing 13, so that even when the piston and member are at their uppermost position the portion of the bore in which the spring 23 lies is completely sealed from the compression chamber.

The anvil housing is so arranged as to permit circulation of air therethrough during operation of the drill, being here shown as provided with a pair of valved openings 29 and 30. These valves are so arranged that during upward travel of the member 28 air is drawn in through the opening 29, and during downward travel thereof on the working stroke of the piston this air is expelled through the opening 30. Thus, cooling air is constantly passing around the coils of the return spring means 23, and this spring is very efficiently cooled. Even though the member 28 is in contact with the piston 12, the fact that it is exposed to the cooling influence of air on its inner side and of the incoming fresh charge on its outer side prevents undue direct transfer of heat. While the bore is slightly larger in the compression chamber to provide sufficient room for the desired volume of charge, this space is here shown as increased by the previously mentioned radial grooves 16. The outer edge of the member 28, moreover, is tapered to permit admittance of the charge to the openings 19 in the piston, through which openings it is delivered to the transfer passage 18 when the piston registers therewith.

In order to drill to any depth into a substance such as rock it is necessary to rotate the tool during the drilling operation, so that it will cut a substantially flat bottom surface rather than wedging itself into the rock. In order to accomplish this rotation with internal combustion drills it has heretofore been common to manually rotate the tool by a hand lever or tool, but this requires two men to each drill. Conventional tool-rotating means of the type known and used in connection with pneumatic drills cannot be adapted to an internal combustion drill of the free piston type, since they operate on either the rifle bar principle or make use of the expansive force of some fluid such as air or steam. Where a rifle bar is used, the actual work of rotating the tool is done on the up or return stroke of the piston, and it is impracticable for the return spring 23 to be of sufficient strength to accomplish such rotation. The explosive force of the combustible charge, of course, is not adapted to operate drill rotating motor means of the type used in air hammers, for example.

The present hammer includes automatic means for rotating the tool during drilling, the rotation being accomplished during the return or upstroke of the piston but the energy therefor being delivered during the working stroke of the piston. That is, near the termination of its working stroke the piston stores a certain amount of energy by placing one or more springs under strain, and as soon as the piston starts on its upward stroke this stored energy effects rotation of the tool. Rotation of the tool immediately after a blow has been struck, is, of course, the preferable time, since the tool has then rebounded slightly and is not jammed or wedged in the rock at its lower end.

Referring more particularly to the embodiment of this drill-rotating means here disclosed, it will be seen that the anvil 15 has an expanded lower portion, which portion is provided with grooves 31 and 32 adapted to slidably contact and be splined on portions of the tie-rods 33 and 34 extending longitudinally of the drill on opposite sides thereof. The anvil is thus non-rotatably mounted in the drill body, but is so arranged as to permit limited movement longitudinally thereof. In this connection, it will be understood that all reference as to direction of motion of various parts is made on the basis of the drill here shown, and if the placement of the drill in general be changed, the absolute direction of such motions should be considered changed in accordance therewith.

Beneath the anvil and carried by the housing 35 is a rockable member 36, such member being arranged to rock or oscillate about an axis coinciding with that of the tool 14. The lower surface of the anvil 15 is provided with a pair of grooves or recesses 37, arranged to cooperate with similar grooves 38 in the rockable member 36. These grooves are arranged to provide sockets for connecting links 39 and 40, which links taper in one dimension toward the rockable member, and normally lie at a considerable angle to the direction of the movement of the anvil as a result of impact from the piston. It will be thus seen that longitudinal downward movement of the anvil member 15 causes the rockable member 36 to rotate in a clockwise direction, looking from above.

The housing 35 carries on opposite sides thereof a pair of cylinders 41 and 42, in which slide longitudinally movable plungers 43 and 44. A pair of coiled springs 45 and 46 are arranged under compression, so that movement of the plungers 43 and 44 serves to store energy therein. The rockable member 36 is provided with a pair of shoulders 47 and 48 adapted to lie in cooperating relation with shoulders 49 and 50 on the plungers 43 and 44, respectively. Anti-friction members 51 and 52, here shown as steel rollers, are interposed between the shoulders 47 and 49 and 48 and 50. It is thus apparent that clockwise rotation of the rockable member 36 (with particular reference to Fig. 3) will cause movement of the plungers 43 and 44 to place the springs 45 and 46 under compression strain, and thus to store in them energy imparted from the piston through longitudinal movement of the anvil. This longitudinal movement of the anvil, of course, is the striking movement which imparts the blow to the tool 14.

As soon as the blow of the piston has been completely absorbed, the rebound and the return spring 23 start it upwardly out of contact with the anvil, and the energy stored in the springs 45 and 46 is then able to move the rockable member 36 in a counter-clockwise direction to return it to its original position.

Although the tool 14 projects through the rockable member 36, it is loosely mounted therein, and does not move therewith. Instead, a clutch member 52 is provided which is non-rotatably splined to the tool 14. This clutch member is rotatable within the rockable member 36 in one direction only, rotation in the opposite direction being prevented by the action of the spring-urged rollers 53 with the surfaces 54, which converge toward the inner surface of the rockable member 36. Thus, rocking or oscillating of the member 36 results, through the inter-

position of this clutch means, in unidirectional rotation of the tool 14. That is, when the rockable member rotates in a clockwise direction (again looking down from above), it merely idles with respect to the clutch member 52, the tool standing still in the hole as a result of the friction of its contact with the rock. When the springs drive the rockable member back in a counter-clockwise direction, however, the rollers 53 serve to lock the members 36 and 52 together, so that the tool is rotated throughout a small portion of arc. The use of a clutch of the type disclosed is highly advantageous, since any small movement of the rockable member is sufficient to cause the desired rotation of the tool. Were a conventional ratchet device to be used, it would be necessary to have a considerable range of motion of the rockable member to insure engaging the next tooth of the ratchet device, or else the teeth would have to be so small or so close together as to result in frequent breakage thereof.

It will be seen that a very efficient and rugged method of automatic drill rotation is thus provided in the embodiment of the drill disclosed herewith. Various parts are balanced so that undue transverse strains are not imposed on the mechanism. That is, there are two links on opposite sides whereby longitudinal movement of the anvil is transformed into rotational movement of the rockable member; there are two springs on opposite sides in which the energy is stored; and two connections on opposite sides of the rockable member to balance the translation of its rotational movement into longitudinal movement of the plungers 43 and 44. While the movement of the anvil member 15 is spoken of as longitudinal or downward, this is again with reference to the body of the drill. In actual practice, the drill body bounces or jumps somewhat during drilling, as a result of the reaction of the explosion against the cylinder head, and thus the change of relationship between the anvil member and the rest of the drill body is really composed partly of downward movement of the anvil and partly of upward movement of the rest of the drill body.

An improved lower end construction achieving automatic tool rotation during drilling is shown in Figs. 8–10. The drill is here shown only in a fragmentary way, the other portions thereof being similar to that illustrated more fully in Figs. 1–7.

The drill is here shown as comprising a cylinder 60 having journalled therein a sleeve bearing 61. This sleeve bearing is longitudinally movable in the cylinder and abuts a shoulder therein at the upper extremity of its travel, in the position illustrated in Fig. 8. Within the sleeve bearing is mounted for longitudinal movement an anvil 62, which anvil has an enlarged base portion 63 splined on either side on the tie rods 64 and 65, so that it may be moved longitudinally but not rotatably with respect to the cylinder.

The lower end of the drill carries a rockable member 66 adapted to cooperate with members 67 and 68 to store energy in springs 69 and 70 on the down or working stroke of the piston, which energy subsequently effects rotation of the tool 71 while the piston is being returned to firing position by the spring 72. A clutch device similar to that illustrated in the previous form is employed between the member 66 and the tool 71, so that although the member 66 rocks or oscillates about its axis the movement of the tool is unidirectional only.

The expanded portion 63 of the anvil and the rockable member 66 are provided with cooperating recesses or sockets, as for example 73 and 74. Links 75 and 76 are here shown as rod members having hemispherical ends adapted to be received by the sockets. It will be noted that these links lie at an angle to the movement of the anvil, and thus serve to translate the longitudinal movement thereof into rotational movement of the rockable member, as described in connection with the previous modification of such a drill. The particular form of links shown here, in connection with the two-piece anvil, has been found to give improved translation of the longitudinal force resulting from the impact of the piston into the rotational force storing energy in the springs 69 and 70 to rotate the tool 71.

The particular modification of this drill shown in Figs. 8–10 also includes means for supplying a fluid under pressure to an opening 77 axial of the tool 71. Standard tools of the type used for deep rock drilling, for example, are provided with the central bores and it is desirable to admit fluid under pressure thereto at intervals in order to blow out the dust and the like from the hole to prevent clogging thereof during drilling.

The cylinder 60 of the drill is here shown as provided with a connector 78 adapted to have supplied thereto a fluid under pressure, as for example, by a flexible air hose leading from a tank or other source of compressed air. The inner wall of the cylinder adjacent the sleeve bearing 61 is provided with a groove 79 of a length equivalent to the normal travel of the sleeve bearing. The sleeve bearing is provided with an annular groove 80 of smaller width adapted to register with the groove 79, and this groove is connected by a drilled opening or bore 81 to a second annular groove 82 on the inner face of the sleeve member. The anvil 62 has a counterbore or groove 83 adapted to register with the groove 82, and a T-shaped bore 84 serves to deliver the fluid to the bore or opening 77 in the tool, registering therewith at the anvil surface which contacts the upper end of the tool to deliver the impacts thereto.

This arrangement provides a path for fluid under pressure from the connector 78 to the opening 77 in the tool. This path is not disturbed by movement of the parts during operation of the drill, since the annular registering grooves permit the parts to rotate with respect to each other without blocking the flow of fluid and the wide groove 79 prevents longitudinal movement of the sleeve bearing 61 without any choking of the flow. This is important, since deep holes are best blown by the delivery at intervals thereto of a comparatively large volume of air in a very brief period. That is, it is desirable to supply a cubic foot or more of air at an initial pressure of fifty pounds per square inch within a few seconds.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. A percussive drill of the character described, including: a cylinder; a piston reciprocable therein; means for effecting working strokes of said piston; a tool; an anvil adapted to receive

blows from said piston on the working stroke thereof and transmit them to said tool; a rockable member; means whereby movement of said anvil with respect to the drill rocks said member; and clutch means between said rockable member and said tool whereby uni-directional rotation of said tool is effected.

2. Apparatus of the character claimed in claim 1, wherein downward movement of said anvil as a result of the blow of said piston effects movement of said rockable member in one direction, and said drill includes a spring for effecting movement of said rockable member in the opposite direction.

3. A percussive drill of the character described, including: a cylinder; a piston reciprocable therein; means for effecting working strokes of said piston; a tool; an anvil adapted to receive blows from said piston on the working stroke thereof and transmit them to said tool; a rockable member; means whereby downward movement of said anvil as a result of the blow of said piston effects movement of said rockable member in one direction; a pair of opposed springs placed under strain by said movement of the rockable member for effecting return movement thereof; and clutch means between said rockable member and said tool whereby uni-directional rotation of said tool is effected, said clutch comprising a spring-urged roller between a pair of converging surfaces.

4. Apparatus of the character claimed in claim 3, wherein the means for effecting movement of the rockable member comprises a link between said anvil and said rockable member, said link being inclined to the direction of movement of said anvil.

5. Apparatus of the character claimed in claim 3, wherein the means for effecting movement of the rockable member comprises a pair of links received by grooves in said anvil and said rockable member, said links tapering toward said rockable member and being inclined to the direction of movement of said anvil.

6. A percussive drill of the character described, including: a cylinder; a piston reciprocable therein; means for effecting working strokes of said piston; a spring for returning said piston after said stroke; a tool; a sleeve bearing; an anvil longitudinally movable in said sleeve bearing and non-rotatably splined with respect to said cylinder, said anvil being adapted to receive blows from said piston on the working stroke thereof and transmit them to said tool; a spring; means for placing said spring under strain during downward movement of said anvil; and means whereby said spring effects rotation of said tool during return of said piston.

7. A percussive drill of the character described, including: a cylinder; a piston reciprocable therein; means for effecting working strokes of said piston; a tool; a sleeve bearing; an anvil longitudinally movable in said sleeve bearing and non-rotatably splined with respect to said cylinder, said anvil being adapted to receive blows from said piston on the working stroke thereof and transmit them to said tool; a rockable member; means whereby downward movement of said anvil as a result of the blow of said piston effects movement of said rockable member in one direction; a pair of opposed springs placed under strain by said movement of the rockable member for effecting return movement thereof; and clutch means between said rockable member and said tool whereby uni-directional rotation of said tool is effected, said clutch comprising a spring-urged roller between a pair of converging surfaces.

8. Apparatus of the character claimed in claim 7, wherein the means for effecting movement of the rockable member comprises a pair of links received by sockets in said anvil and said rockable member and inclined to the direction of movement of said anvil, said links being rods with spherical end portions.

9. An internal combustion drill of the character described, including: a cylinder; a piston reciprocable therein; a tool; an anvil adapted to receive blows from the piston and transmit them to the tool, the anvil being non-rotatably mounted in the drill for limited longitudinal movement; a member mounted for uni-directional rotation, said member having the tool non-rotatably splined thereto; and means connecting the anvil and the member for translating longitudinal movement of the anvil into rotation of the member between the blows, including means for storing energy during downward movement of the anvil, and wherein rotation of the tool is effected, after it has been struck a blow, by such stored energy.

10. An internal combustion drill of the character described, including: a cylinder; a piston reciprocable therein; a tool; a member interposed between said piston and said tool and adapted to transmit blows to said tool, said member being longitudinally movable in said drill; means for storing energy during downward movement of the member; and rotatable means for rotating said tool, said means being actuated by the stored energy.

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