FLUID ACTUATED PERCUSSION TOOL
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ABSTRACT OF THE DISCLOSURE

This invention relates to a fluid actuated percussion tool for use in such operations as oil well drilling, mine shafts, cores or pile drivers. It comprises in general an anvil and hammer arrangement with the hammer being alternatively lifted and dropped on the anvil by means of a fluid control system to drive the pile, drill a hole or the like.

The present invention relates to a new and useful device in the percussion tool art. In particular it relates to an improved mechanism for aiding in the drilling or driving of holes, as for example mining shafts, cores, oil wells, or piles, by the addition of a percussion mechanism.

The art of drilling or driving holes, whether they be in wood, in metal, in the earth, or anywhere else has long been confronted with the problem of providing an operable percussion mechanism that will aid the process and at the same time not interfere with the size or accuracy of the drilled hole.

Various percussion mechanisms have been proposed in the prior art. These mechanisms have not solved the problems for a variety of reasons. One of the primary difficulties with prior art devices is their complicated structure and large number of parts necessary for their operation.

It is evident that any percussion tool designed to be used in such operations as oil well drilling or pile driving must be able to withstand a great deal of wear and tear over a long period of time. The more delicate the parts, and the more parts there are, particularly moving parts, the more likely there is of a failure in the operation of the device. The prior art devices are complicated, and they are not able to stand up under actual operating conditions. Moreover, they are expensive to manufacture and maintain.

Prior art percussion tools are normally fluid activated using air, some other type of gas, or a more viscous fluid. Many drilling operations, such as oil well drilling, require that the percussion tool utilize the same fluid as is used in providing circulation for the drilling operation. The viscosity of the drilling fluid varies according to the nature of the formation being drilled, and this variation has in the past been a problem with prior art percussion mechanisms. Some of the mechanisms have been adapted to be used with light fluids, others have been adapted for use with heavier fluids. None have been adapted for use with all of the different viscosity fluids encountered.

The operating mechanisms of some of the leading prior art devices are so complicated that they become inoperable when a fluid having a heavy viscosity is used, or when a foam or mist type fluid is used. On the other hand, the prior art devices which are adaptable for use with heavy fluids are too large and cumbersome for operation with air or other gases within normal pressure ranges.

In addition, the drilling art has had to cope with the problem that if the bit gets stuck in the hole, or for some reason cannot rotate, the entire shaft twists off leaving a part of it in the hole.

Therefore, it is an object of this invention to provide a percussion tool to be used in conjunction with a drilling or driving device which tool is mechanically simple, easy to manufacture and assemble, strong, and readily adaptable to different needs.

It is a further object of this invention to provide a percussion tool that will not get out of adjustment over a long period of time, and which can be moved from one operation to another without the need of modification or adjustment.

It is a further object of this invention to provide a percussion drilling mechanism that can be attached to an existing drilling or driving device without the need of modification of that device.

It is a further object of this invention to provide a percussion drilling device that will not twist in two if the bit gets stuck in the hole or for some reason cannot rotate.

It will be obvious that our invention is readily adaptable to many and varied uses for drilling or driving holes, such as ground cores, pile driving or oil well drilling. We have chosen one mode of operation for the purpose of this description.

Our invention in general comprises a fluid actuated hammer designed to strike an anvil connected to a drilling bit, the force of which drives the bit deeper into the formation being drilled. In general, we have provided a valving system which consists of ports and channels within our hammer and its surrounding enclosure which valving system causes the hammer to rise above the anvil and then be alternatively propelled into engagement with the anvil which in turn drives the bit deeper into the formation being drilled. Our invention consists of only twelve major parts with only two moving parts. The valving system is uncomplicated and can be machined for any viscosity fluid with a minimum of effort. Moreover, the parts and passages will not become choked when a viscous fluid is introduced into the system. We have provided a new shear pin arrangement interposed between the anvil and the mainder of the drilling shaft so that in the event the drilling bit ceases to rotate, the pins will shear and thus prevent the drill pipe from twisting in two.

Referring now to the drawings of one embodiment of our invention useful in mining, coring, or oil well drilling operations:

FIGURE 1 is a cross sectional view of our invention in its inoperable state.

FIGURE 2 is a cross sectional view of our invention showing the hammer engaging the anvil;

FIGURE 3 is a cross-sectional view of our invention showing the hammer raised above the anvil just prior to its descent into engagement with the anvil;

FIGURE 4 is an exploded, partially sectional view of our invention wherein the various parts are shown prior to assembly.

Referring now to the drawings, wherein like numbers designate like parts: FIGURES 1-4 represent one embodiment of our invention which is particularly suited for rotary-percussion drilling, in applications such as mining, earth coring and oil well drilling. It will be obvious that the particular mechanism described is readily adaptable to many and varied uses from portable drills and pile drivers to oil well rotary rigs.

Referring to FIGURE 4, it is seen that our invention consists of only 12 basic parts numbered 11-23. The simplicity, relatively few parts and ease of assembly constitute one of the major novelties of our invention.

Our percussion tool 10 consists of a fluid tube 11 having upper tube ports 30 and lower tube ports 31 spaced about the periphery thereof, 1st O-ring 12, upper adapter tool
When our invention is assembled and in its inoperative position, as shown in FIGURE 1, anvil 23 rests on shoulder 45 of lower adapter slide sleeve 25 and it is adapted to slide within lower adapter slide sleeve 25 and over fluid tube 11. Anvil 23 will not rotate within lower adapter slide sleeve 25 because of the effect of shear pins 42 and intermediate gas cylinder 21, which retains anvil 23 and it is slideable within intermediate cylinder 15 and over fluid tube 11. All of the remaining parts of the device are fixed relative to each other thus eliminating friction and the wear and tear normally associated with moving parts. When shoulder 43 of anvil 23 rests on shoulder 45 of lower adapter slide sleeve 25, hammer ports 37 in hammer 17 are not aligned with lower tube ports 31 in fluid tube 11 and the actuating fluid passes through the entire device and out the bottom through anvil 23. The velocity of the fluid passing through fluid tube 11 is controlled by choke 21 which can be changed to adjust the flow of the fluid and thus the stroke of hammer 17.

When the bit attached to anvil 23 engages the formation anvil 23 and hammer 17 are stationary and the remainder of the tool slides downwardly until the bottom of lower adapter slide sleeve 25 rests on shoulder 52 of bit 53. Lower tube ports 31 are then aligned with hammer channels 37 as shown in FIGURE 2. The alignment of the ports allows actuating fluid to pass from fluid tube 11 into lower hammer channels 37, and the downward force of the fluid actuates hammer 17 upward. As shown in FIGURE 3 the fluid passes from hammer channels 37 thence out lower ports 34, into annulus 32 and out exhaust ports 50 in lower adapter slide sleeve 25.

The jetting effect caused by the passage of the actuating fluid through lower hammer channels 37 causes hammer 17 to rise so that upper hammer channels 36 are aligned with upper ports 30 thus allowing the fluid to enter upper hammer channels 36 and lower adapter slide sleeve 25 and retard or reverse the upward movement of hammer 17. The air trapped between hammer 17 and upper adapter tool joint 13 further impedes the upward movement of hammer 17 preventing damage to the tool joint. The passage of the actuating fluid from fluid tube 11 through upper hammer channels 36 combined with the cushioning effect described above reverses the upward movement of hammer 17 and impels it downward to strike anvil 23 driving it and its attached tool 53 into the formation being drilled. Lower hammer channels 37 are again aligned with lower tube ports 31 and the percussion operation is repeated over and over until the mechanism is removed from its engagement with the object being drilled and anvil 23 slides downwardly within lower adapter slide sleeve 25 so that lower hammer ports 37 are no longer aligned with lower tube ports 31 and the process stops.

Occasionally a drill bit gets stuck within the drilled hole or for some reason it cannot rotate. Such a problem has in the past caused the drill pipe to twist in two or "twist off" resulting in the loss of the bit and other material in the hole. When such a "twist off" occurs the operators are required to remove the drill pipe from the hole and remove or "fish" the lost material from the hole. If the material cannot be removed the hole might have to be abandoned. In either event much time is lost and resultant inconvenience is costly.

We propose to eliminate this problem by inserting shear pins 19 between anvil 23 and lower adapter slide sleeve 25. The shear strength of these pins is less than that of the drill pipe so that if the bit for some reason stops rotating shear pins 19 will shear and lower adapter slide sleeve 25 will rotate freely over anvil 23. The free rotation will indicate to the operator that the pins have sheared and the drill string can be removed from the hole and the problem corrected without having to "fish" the lost material from the hole.
As a matter of fact any drilling or percussion operation has basically the same problems when a fluid actuated percussion tool is used. Thus our invention is adaptable to many different uses in connection with drilling or percussion operations whether they be portable drills, pile drivers, rotary oil well drilling rigs or any other similar devices.

Our invention is relatively simple in construction, easy to assemble, but adapted for use with a multiplicity of fluids of different viscosities. The velocity of the fluid flow through the tool is controlled by the size of the opening in choke 21, and, of course, the velocity of the fluid flow in turn controls the stroke of hammer 17. When a fluid of light viscosity is used, the opening in choke 21 would be relatively small, but if a heavy viscosity fluid were used the opening would be relatively large or it could be removed altogether.

The various parts of our invention are easily replaceable which parts having different size exhaust ports and channels for extreme variations in fluid viscosity due to the relatively few number of parts and the ease in assembling them. Under normal working conditions, our invention will operate satisfactorily with a reasonable variation of fluid viscosity since that is not a critical feature of our invention. If, however, the variation is so extreme that proper operation is not obtained, then a substitution of parts having the proper size exhaust ports and passages can easily be made, such a substitution could also be made in the event of damage to a particular part.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In a fluid actuated percussion tool the combination comprising:
   a casing having an upper end and a lower end; a fluid carrying tube removably inserted into the upper end of said casing and forming a seat therewith; means for introducing fluid into said fluid carrying tube; a hammer within said casing and slidably attached to said fluid carrying tube; an anvil slidably inserted into the lower end of said casing and adapted to engage said hammer; and a fluid coupling system connecting said fluid carrying tube, said hammer and said casing for alternatively introducing fluid below and above said hammer whereby it will rise and fall and strike said anvil on its downward stroke; and

2. The combination as defined in claim 1 wherein:
   said fluid coupling system comprises a plurality of upper and lower exhaust ports in said fluid carrying tube, a plurality of upper and lower exhaust passages in said hammer, and exhaust passages in said casing, whereby, when the combination is in operating position, each of the lower exhaust ports in said fluid carrying tube are aligned with one of the lower exhaust passages in said hammer to allow the actuating fluid to pass from said fluid carrying tube through the lower exhaust passages in said hammer and out of the exhaust passages in said casing, whereby the force of the fluid causes said hammer to rise so that at a predetermined time the upper exhaust passages in said hammer are aligned with the upper exhaust ports in said fluid carrying tube to allow the actuating fluid to pass from said fluid carrying tube through said upper exhaust ports which causes said hammer to move downwardly to strike said anvil.

3. The combination as defined in claim 1, including:
   shear pins connecting said anvil to said casing whereby said anvil is fixed against rotation within said casing by said shear pins until the shear strength of said shear pins is exceeded.

4. The combination as defined in claim 2, wherein:
   said anvil is adapted to slide within said casing from an upper limit to a lower limit whereby when said anvil is at its upper limit the lower exhaust passages in said hammer are aligned with the lower exhaust passages in said fluid tube and the tool is in its operable position, and when said anvil is at its lower limit the lower exhaust passages in the hammer are positioned below the lower exhaust ports in said fluid carrying tube and the tool is inoperative.

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