DEVICE FOR BREAKING UP THE CORES FORMED BY CORE DRILLS
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ABSTRACT OF THE DISCLOSURE
A core drill comprising means for breaking up the cores as it is formed which comprises a system for applying hydraulic pressure to the core-breaking member and regulating the pressure thus applied by controlling the drop in drilling fluid pressure across the tool.

SPECIFICATION
The present invention relates to a hydropneumatic tool for destroying the cores formed during the drilling of a well. It is an established practice to use drilling tools which cut out the rock or ground within an annular space with the aid of the rock or ground inside that space intact, and this remainder is commonly referred to as the "core." Related tools have been used to recover the cores, which are for practical purposes specimens of the formation being drilled.

It is also conventional to use core cutting tools provided with means for destroying the core. Such tools may be used for drilling. They permit an increase in the effective drilling speed because the destruction of the rock is directly related, especially in the case of diamond headed tools, to the linear speed of displacement of the diamonds in contact with the rock. It is well known to use for this destruction tools comprising a punch fixed to the core drill and either stationary or rotatable about an axis which may be, but is not necessarily parallel to the drilling axis. This punch may turn freely about its axis, and since it is fixed to the drill the reaction of the core-cutting tool against the punch reduces the effective weight applied to the head of the core drill. It is well known that an increase in the speed at which these tools "make hole" is dependent on the section and hardness of the core, and that the larger the section the greater the force required to break it up.

An adequate length of life for the punch and an increase in the maximum drilling speed are provided by holding the punching stationary with respect to the core, that is, so that it rotates with respect to the tool. A long length of life is insured by the positions of the thrust bearings. The best results stem from the use of a bearing in which the effective forces exerted against the bearing surfaces are minimal. Thus for a bearing having a given diameter (which is determined by the space available), the working life of the tool is increased and the diameter of the core is increased to a maximum. It is also known that drilling tools having bearings must be lubricated in order to prolong their useful life as long as possible.

These advantages which are of proven commercial value, have been attained by the tool according to the present invention.

In accordance with this invention, the core-destroying device comprises a punch which is free to rotate about an axis parallel to the drilling axis, said punch being subjected to hydraulic pressure through a chamber filled with an incompressible liquid, said chamber being formed to receive at its upper end a piston having a smaller section at its lower end than at its upper end. This piston thus serves as a pressure multiplier, when an easily compressed fluid is used in the intermediate chamber.

In accordance with one feature of the invention, the shaft carrying the punch is mounted inside a chamber of predetermined dimensions by means of an arrangement which permits it to rotate, said arrangement preferably comprising a set of roller bearings and tapered roller bearings so assembled that the average force exerted against the bearing races is very low.

In accordance with another feature of the invention the upper piston moves in a chamber having two different sections, the section of the lower part being less than or equal to the total surface of the upper part. The lower part of the piston slides in this chamber having two parts thereby defining an intermediate chamber.

In accordance with yet another feature of the present invention, the compressible fluid enclosed in the intermediate chamber is a gas, such as air, nitrogen, or any other suitable gas. A final feature is that the device embodying the invention is attached to the drilling tool by a screw threaded joint provided with sealing means, so that it may be used with any drilling tool.

In order that the invention may be more clearly understood, several embodiments thereof will now be described purely by way of example, with reference to the accompanying drawing, in which:

The figure represents an embodiment of the apparatus according to the invention in which the punch-carrying piston is rotatably mounted in a set of thrust bearings.

Reference numeral 1 indicates the threading by which the device may be attached to a diamond bit, a core drill or any other appropriate tool (not shown).

Reference numeral 2 indicates the body of the device, which may be attached by a second set of threads 3 to a "string" of pipes and/or collars as is conventional in drilling oil wells for example. The body 2 is formed from the two parts 4 and 5, which may be screwed or welded together.

The part 4 is provided at its lower end with one or more openings 6 through which debris resulting from the destruction of the core may be evacuated.

The punch 7 is fixed to the shaft 8 which is free to rotate about the axis 9, and turns freely in the roller bearings 10, and the tapered thrust bearings 11. This shaft is subjected to reaction pressure from the core 12, which fractures under the pressure of the punch along lines such as those indicated at 13. This shaft is also subjected to the hydraulic pressure of an incompressible fluid positioned in the chamber 14. The fluid in the chamber 16 is acted upon by an intermediate piston 15 which is itself subjected to the pressure of the fluid in the chamber 16, which is compressed by the upper piston 17. The upper surface 18 of which is subjected to the pressure of the drilling fluid and is responsive to the pressure differential through the tool created by whatever system is in use.

The chamber 20 is filled with compressed air, which results in pressure multiplication by the cylinder 17.

In order to provide a more convenient mounting for the bearing races for the punch-carrying piston, the intermediate rings 21 and 22 are mounted inside the body 4, which permits the sealing rings such as 23 to be very fluid-tight. The sealing rings 24 are mounted on the piston 17 so as to insure effective sealing in of the gas.

The operation of this system may be described as follows: Assuming the pressure of the drilling fluid on the surface 18 to be $P_0$, the pressure in the chamber 16 is $P_0 \times S/s$, if $S$ and $s$ are the upper and lower surfaces of the piston 17.

All of this pressure is exerted on the shaft 8 and
through said shaft there is exerted on the punch a force equal to

\[ \left( P_3 \frac{S}{\sigma} - P_2 \right) \sigma \]

in which \( P_2 \) is the pressure of the drilling fluid under the punch and \( \sigma \) the section on which the pressures act. It will thus be seen that by creating a relatively small pressure difference \( P_3 - P_2 \) through the tool a relatively hydraulic force is provided.

When the core punch according to the invention contacts the core, the reactive force exerted on the punch increases as the core drill advances into the ground. This force increases until it reaches the value required to break up the core.

In the absence of hydraulic pressure this reactive force is resisted by a plain thrust bearing. Thanks to the presence of hydraulic pressure, the value \( P \) of which is regulated so that it equals half the pressure required to break up the core, a double-acting thrust bearing is used which makes it possible for each element of the bearing to operate under half the load of a plain bearing, and the working time of each bearing is likewise divided by two. In this case the bearing lasts about four times as long as a plain bearing.

This improvement is obtained only when hydraulic pressure is present. The component parts are separate from each other, which permits a minimum operating cost. The advantages of such an arrangement are obvious, since it permits the cutting heads of the core drills to be interchanged when the diamonds or cones are worn. This makes it possible to salvage the device according to the invention and reuse it with a new head.

In a particular embodiment of the invention the piston 17 is provided with a concentric piston 25, of relatively small diameter, which is freely slideable and provided with a shoulder at its upper end.

In the normal operation of the apparatus the piston 25 (FIG. 1) remains stationary, being held against the shoulder by the pressure exerted on its lower face. This pressure is applied to the punch-carrying shaft through a fluid such as a grease.

If a leakage of the fluid results, the piston 17 is forced to the bottom of the chamber 20, and at this moment the piston 25 leaves its seat so that the pressure of the fluid in the passage 19 may be applied directly to the piston 15.

Leakage is held to a minimum by means of sealing rings and labyrinths.

What is claimed is:

1. Core-breaking means for use in combination with a core drill adapted to cut a core from material into which it is driven and comprising a fluid pressure system which develops a pressure drop across said drill when it is being operated, together with means for regulating said drop, said core-breaking means comprising a punch mounted for rotatable and axial movement within said drill with its lower end positioned to engage a core in said drill, and a transfer system for applying to said punch a pressure derived from said pressure drop, said transfer system comprising a pressure multiplier for multiplying the pressure from said fluid pressure system applied to said punch.

2. Apparatus as claimed in claim 1 in which said punch is mounted in thrust bearings and the fluid pressure applied to said punch is so applied as to at least partially counterbalance the load resulting from the pressure of said punch on said core, thereby reducing the load on said thrust bearings.

3. Apparatus as claimed in claim 1 in which said transfer system comprises a free piston interposed between said punch and the fluid pressure system which develops said pressure drop.

4. Core-breaking means as claimed in claim 1 in which said pressure multiplier comprises a piston having a pressure receiving face subjected to pressure from said fluid pressure system and a pressure exerting face having substantially the same total area, said pressure-exerting face being divided into a first portion which acts on a chamber containing a compressible fluid and a second portion which transmits pressure to said punch through a relatively incompressible fluid.

5. In a core drill adapted to cut a core from material into which it is driven and comprising a fluid pressure system which develops a pressure drop across said drill when it is being operated, together with means for regulating said drop, the improved core-breaking means which comprises a punch mounted for rotatable and axial movement within said drill with its lower end positioned to engage a core in said drill, and a transfer system for applying to said punch a pressure derived from said pressure drop, said transfer system comprising a pressure multiplier in said transfer system for multiplying the pressure from said fluid pressure system applied to said punch.

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