May 20, 1969 H. G. WARRINGTON ETAL 3,444,937

BORING APPARATUS WITH VALVELESS IMPACTOR

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FIG. 1

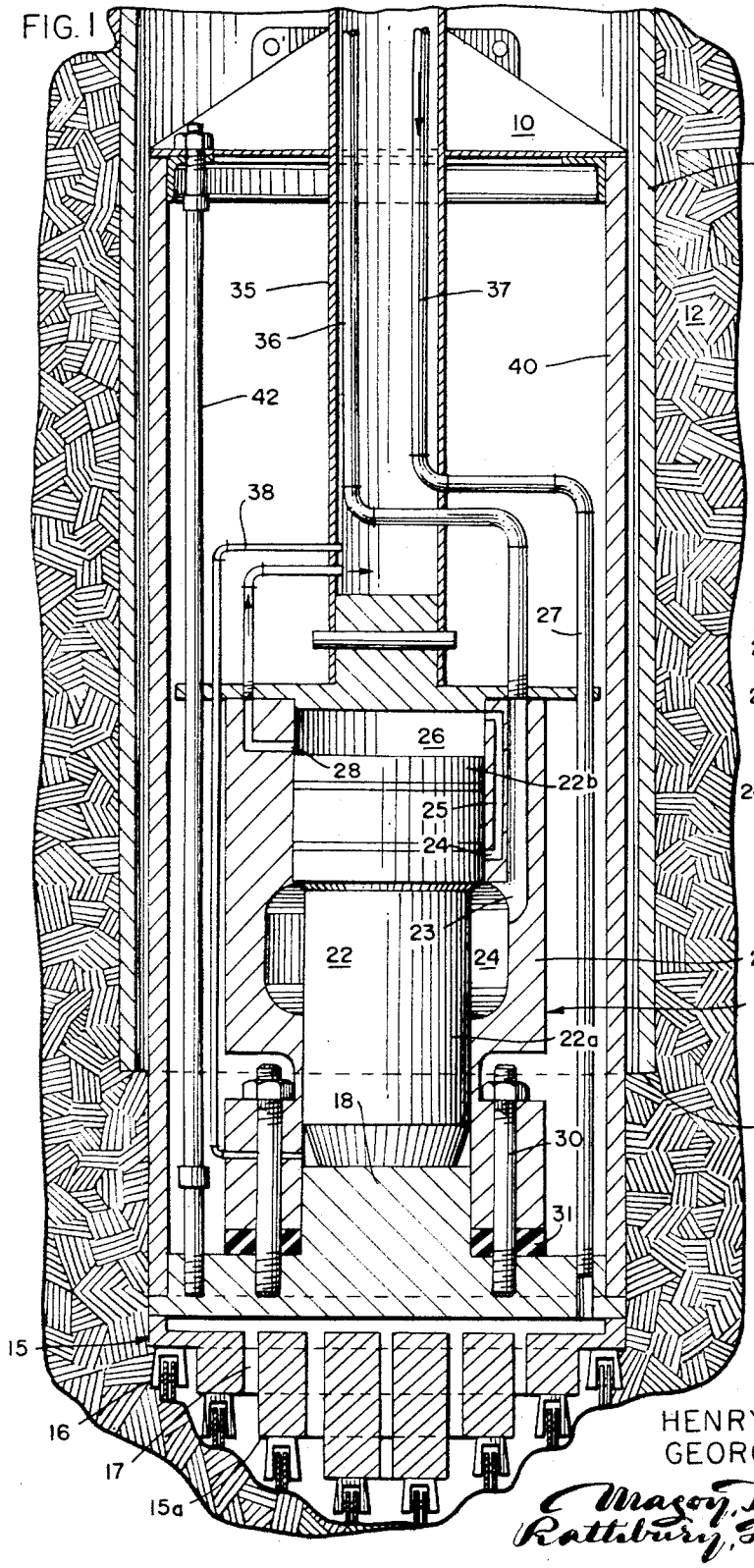
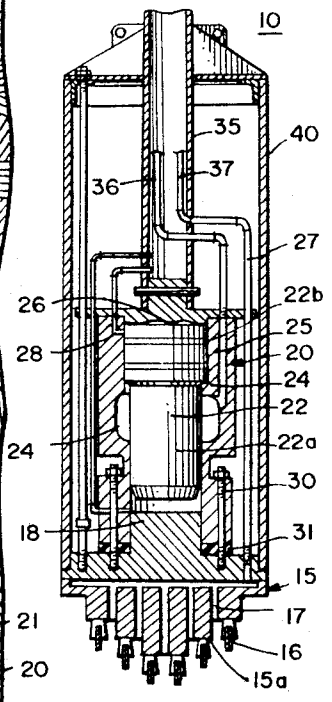


FIG. 2



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BORING APPARATUS WITH VALVELESS IMPACTOR

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U.S. Cl. 175—92 8 Claims

ABSTRACT OF THE DISCLOSURE

There is provided an improved drilling or boring device for use in a borehole for drilling or boring into rock and having both a drill head carrying conventional cutter bits provided with an impact pintle, and an impactor positioned to impart percussion impacts on the impact pintle. Thus there is provided simultaneous rotation and percussion impacts on the drill bits. The method of boring includes the simultaneous provision of such rotary motion to the drill bits and the imparting of the percussion impacts thereto.

The present invention relates to a method and apparatus for drilling or boring; and particularly for boring into rock or other frangible material commonly found in the earth.

An object of the present invention is to provide a new and improved boring apparatus combining the attributes of percussion boring and rotary boring.

Another object of the present invention is to provide a new and improved boring device for use in a borehole.

Another object of the present invention is to provide a new and improved apparatus for boring into rock or other frangible material commonly found in the earth.

Yet another object of the present invention is the provision of a new and improved method of boring into rock or other frangible material commonly found in the earth.

Further objects and advantages of the present invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with these and many other objects of the present invention, there is provided an improved boring device for drilling or boring into rock or other frangible material and including a drill head for carrying suitable cutter bits and having a portion defining an impact pintle. A fluid actuated impactor is positioned to impart percussion impacts on the pintle while the drill head is simultaneously rotated. Thus the invention combines the attributes of percussion drilling as well as those of rotary drilling.

The invention also relates to a new and improved method of boring or drilling into rock or other frangible material and including the steps of rotating a drill head carrying a plurality of cutter bits in a borehole and simultaneously imparting percussion impacts to the drill head.

For a better understanding of the present invention reference may be had to the accompanying drawings wherein:

FIG. 1 is a cross sectional view of an improved boring device in its operative position in a borehole; and

FIG. 2 is a fragmentary cross sectional view of the boring device of FIG. 1 illustrated with the ram of the impactor in a different operative position.

Referring now to the drawings there is illustrated an improved drilling or boring device **10** according to the present invention and positioned within a driven pile **11** in the earth **12**. The drilling or boring takes place beyond the lower open end **11***a* of the pile **11**.

To provide for the drilling and impact, there is provided a drilling head **15** having a stepped lower surface **15***a*. Conventional cutter roller bits **16** are radially located on the steps of the drilling head. Internal passages **17** in the drilling head **15** serve to supply lubricant such as bentonite to the roller bits **16** as they rotate. Additionally the bentonite provides a sealant to enter any interstices which may occur or which are existent in the walls of the hole being drilled. The upper end of the drill head **15** defines an impact pintle **18** for receiving percussion blows.

To provide the percussion blows to the drill head **15** there is provided an impactor **20** including a housing **21** defining a cylinder and having an impact ram or piston **22**. The impactor **20** may be of known design and, in the illustrated embodiment, is of the valveless type having the single moving part forming the ram **22**. The ram **22** is a differential diameter member having a lower ram portion **22***a* and an upper piston portion **22***b* of larger diameter. Motive fluid such as steam or compressed air enters through a fluid inlet **23** into a fluid chamber **24** acting on the area of the piston differential to the diameters of the ram portion **22***a* and the piston portion **22***b* to drive the ram **22** upwardly, as viewed in FIG. 1. The upward movement of the ram **22** uncovers a transfer port **24** in the wall of the cylinder communicating to a transfer passage **25** into a chamber **26** defined between the ram **22** and the cylinder head **27**. The upward travel of the ram **22** is also effective to close an exhaust port **28** from the chamber **26**.

From the above description, the operation of the impactor is believed clear. However, briefly, the impactor is of known type wherein the fluid pressure acting on the differential area between the ram portion **22***a* and piston portion **22***b* will drive the ram **22** upwardly from the position illustrated in FIG. 1 to the position illustrated in FIG. 2. Initial upward movement of the ram **22** will close the exhaust port **28** and open the transfer port **24** so that pressurized fluid may now enter through the transfer passageway **25** into the chamber **26** above the piston portion **22***b*. Since the area of the piston portion **22***b* opening into the chamber **26** is much greater than the differential area between the piston portion **22***b* and the ram portion **22***a*, the buildup of fluid pressure in the chamber **26** will drive the ram **22** downwardly to provide a percussion impact against the impact pintle **18** of the drill head **15**. Downward movement of the piston portion **22***b* is effective to open the exhaust port **28** and to recycle the tool.

The impactor **20** is vertically attached to the drilling head **15** by mechanical means such as a plurality of drill head bolts **30** and cushioned therefrom by a spacer **31** of urethane or other suitable material defining a cushion pad of resilient material.

Rotational movement can then be transmitted to the drill head **15** through the casing **21** of the impactor **20** by means of a drive or square Kelly bar **35**. A pressure fluid conduit **36** extends through the inside of the Kelly bar **35** and is connected to the fluid inlet **23** of the impactor **20**. Additionally a conduit **37** extends through the inside of the Kelly bar connected to supply the bentonite drilling fluid to the passageways **17** in the drill head **15**. The hollow interior of the Kelly bar also serves as an exhaust for the spent motive fluid coming from the port **28**. The pressure and drilling fluids are rotatably admitted to the conduits **36** and **37** at the top of the Kelly bar in a known manner by means of a tiered pair of swivels. A conduit **38** also exhausts into the hollow interior of the Kelly bar to provide air relief to the impactor ram **22**.

The entire drilling machine assembly is contained within a cylindrical sleeve **40** interposed between the drilling head **15** and a head cap **41**. The entire assembly is held

together in the vertical by a plurality of radially placed post-tensioned cables **42** attached to the drilling head and passing through and secured to the head cap **41**.

Advantageously the present invention combines the attributes of percussion drilling as well as those of rotary drilling. The drilling operation may be performed as a dry hole operation or submerged in water. This type of drilling machine permits drilling beyond the limiting duct of the pile, caisson or sleeve. The impactive speed and rotational speed are independently variable and not coupled or dependent one upon another. A valveless type of impactor has only a single moving part. The control of the impactor is accomplished by change in the motive fluid pressure. The cable method of assembly provides quick disassembly and access to the impactor for service. The ingress of drilling fluid above the drilling machine provides suspended egress of the drilling waste and places the material available for airlift removal.

A specific embodiment of the invention was designed and specified to operate on compressed air having a delivery of temperature of 400° F. thus inducing a thermo-setting reaction in the bentonite drilling fluid to force closure and sealing of the walls of the hole so drilled. Moreover thermo-set bentonite drilling fluid sealing and lining the hole so drilled is acceptable as form material for concrete poured therein after the hole has been drilled.

By its nature and concept, there is no theoretical limit to the diametric size of the holes to be bored. The hole size may be increased in diameter merely by changing the drilling head.

The present invention also relates to an improved method of boring a hole into rock or other frangible material found in the earth. More specifically the improved method includes rotating a drill head carrying a plurality of radially disposed cutter bits, and simultaneously applying percussion impacts to the drill head so as to obtain the combined attributes of percussion drilling as well as those of rotary drilling.

Although the present invention has been described by reference to only a single embodiment thereof, it will be apparent that numerous other modifications and embodiments will be devised by those skilled in the art which will fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An improved boring device for use in a borehole comprising:

a rotary drill head having a portion defining an impact pintle and adapted to carry a plurality of cutter bits;

a valveless type impactor for imparting percussion impacts on said impact pintle including:

a housing defining a differential diameter cylinder closed at the top,

a differential diameter ram reciprocally positioned in said cylinder including an upper piston portion and a lower ram portion of reduced diameter,

inlet means for introducing fluid under pressure between the two portions of said piston,

exhaust means for said closed end of said cylinder including a port opening into the cylinder side wall positioned to be closed when said piston moves upwardly, and

fluid passage means communicating with the closed end of said cylinder and including a port in the side wall of said cylinder positioned to be opened and placed into communication with said inlet means when said piston moves upwardly;

means interconnecting said drill head and said impactor housing; and

means for transmitting rotary motion to said drill head.

2. A boring device as set forth in claim **1** wherein said drill head has a stepped lower surface for carrying said plurality of cutter bits.

3. A boring device as set forth in claim **1** including a plurality of cutter bits carried on said stepped lower surface.

4. A boring device as set forth in claim **1** wherein a cushion pad is positioned between said housing and said impactor.

5. A boring device as set forth in claim **1** wherein said drill head is carried at the lower end of a drill sleeve and said impactor is within said drill sleeve.

6. A boring device as set forth in claim **1** wherein the last mentioned means is a square Kelly.

7. A boring device as set forth in claim **1** and including means for supplying a drilling fluid to said drill head.

8. An improved boring device for use in a borehole comprising:

a rotary drill head having a portion defining an impact pintle and adapted to carry a plurality of cutter bits;

an impactor including a fluid actuated ram positioned for imparting percussion impacts on said impact pintle;

means interconnecting said drill head and said impactor;

a square Kelly for transmitting rotary motion to said drill head;

means for supplying a drilling fluid to said drill head, said means including conduit means in said square Kelly; and

additional conduit means provided in said square Kelly for supplying motive fluid to said impactor.

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