April 10, 1951 R. H. BLOOD 2,548,463

THERMAL SHOCK DRILLING BIT

Filed Dec. 13, 1947 2 Sheets-Sheet 1

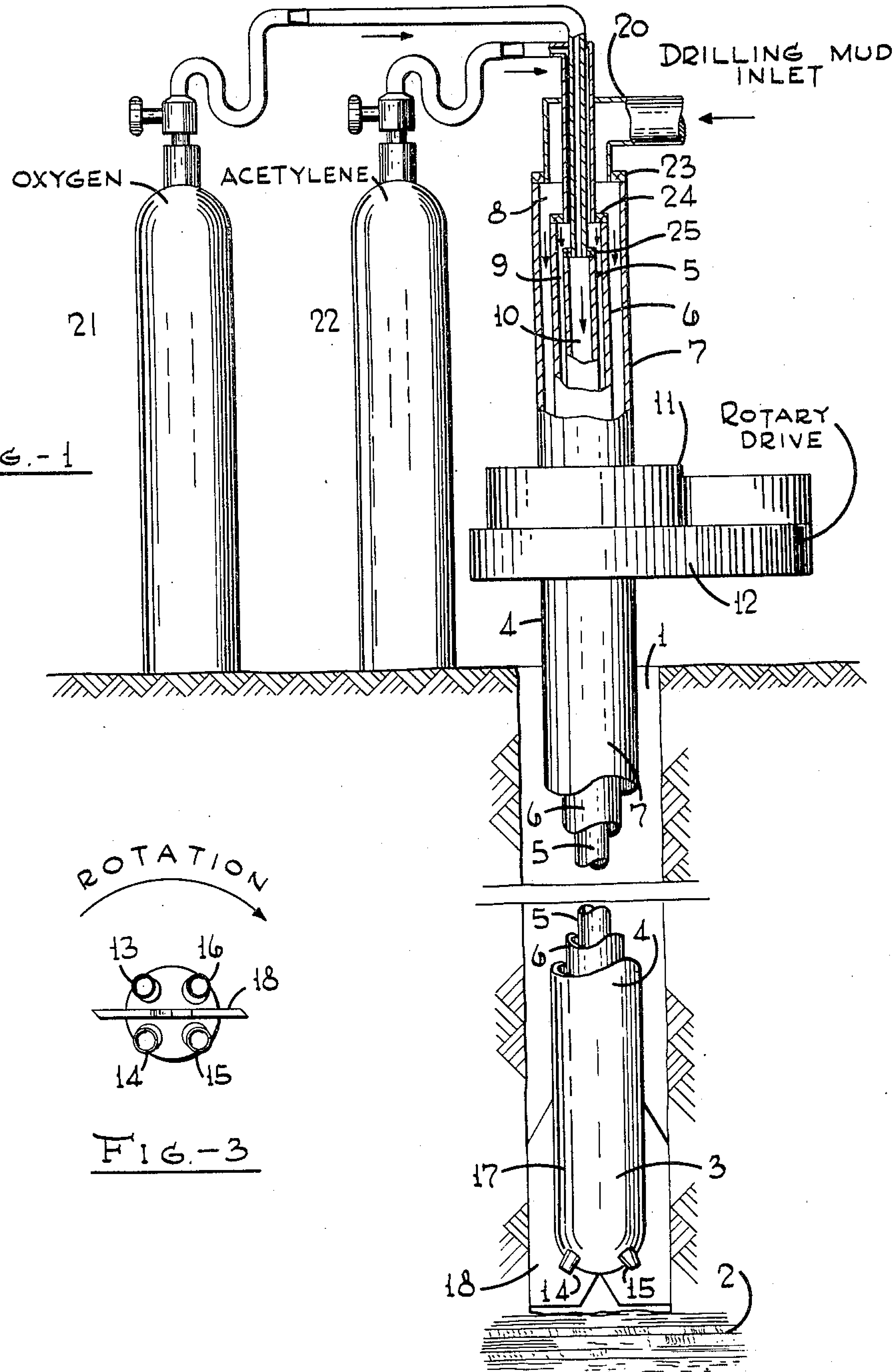

FIG.-1

FIG.-3

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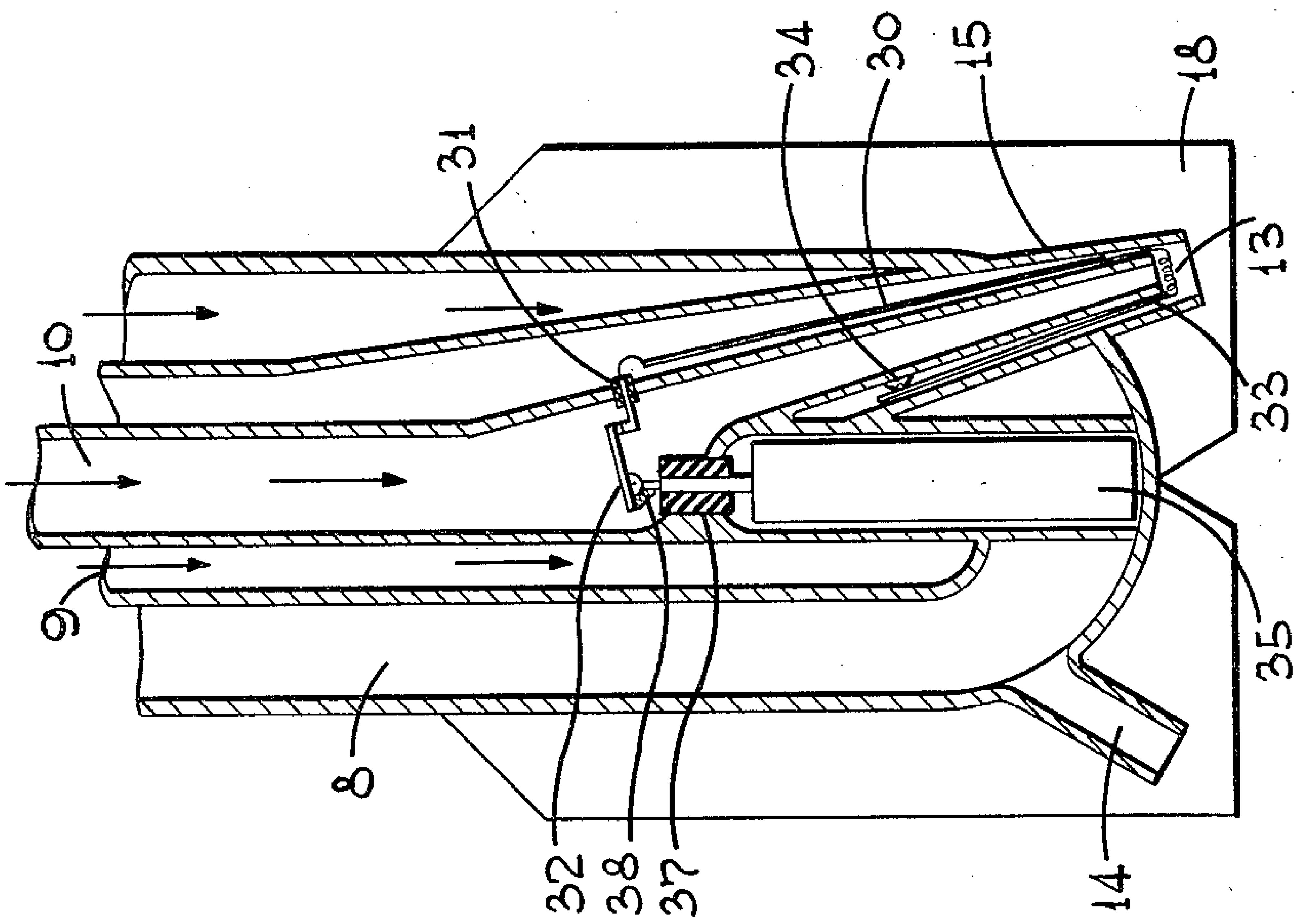

FIG.-4

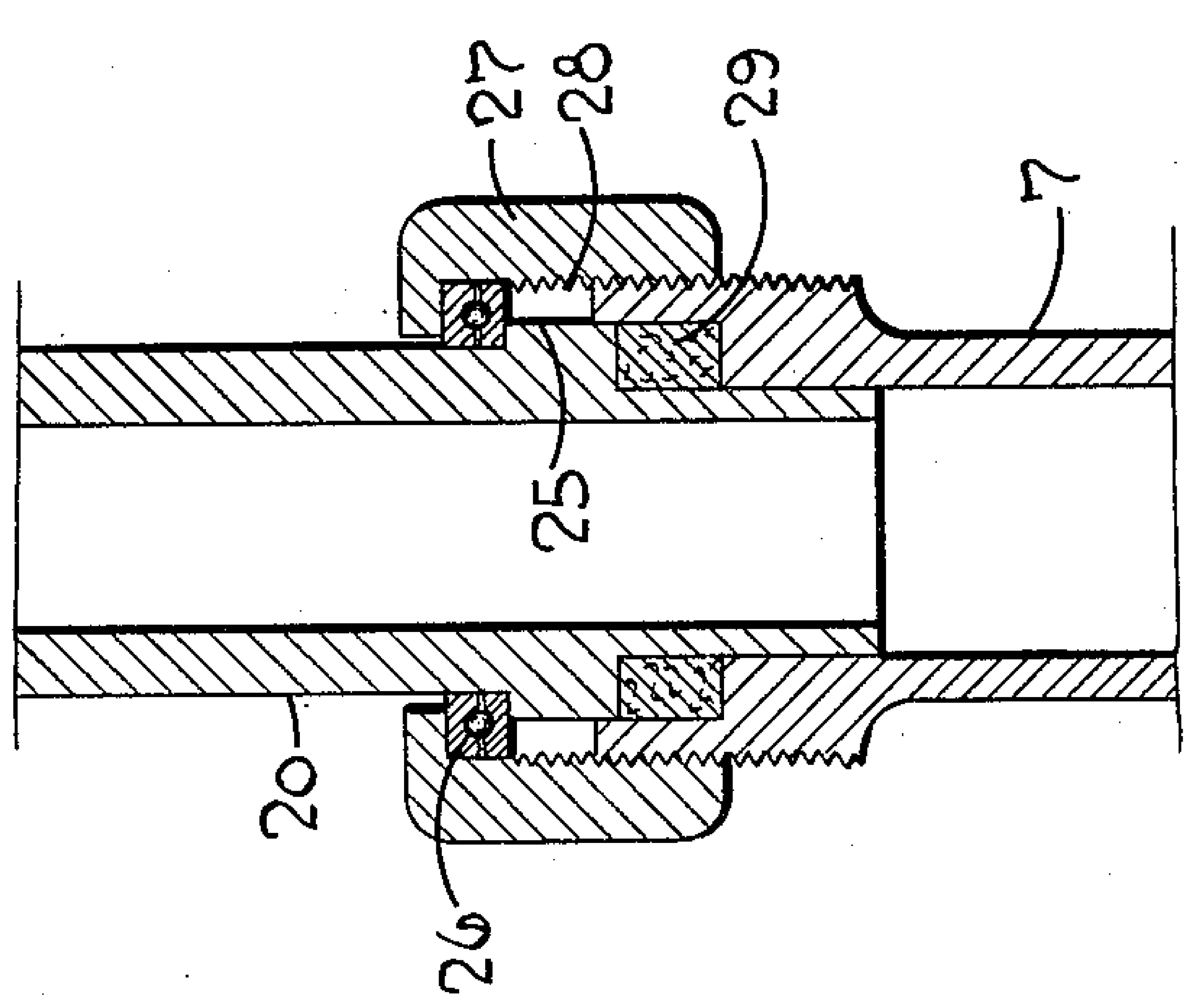

FIG.-2

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Patented Apr. 10, 1951 2,548,463

UNITED STATES PATENT OFFICE

2,548,463

THERMAL SHOCK DRILLING BIT

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Application December 13, 1947, Serial No. 791,553

3 Claims. (Cl. 255—61)

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This invention relates to improved means and method for drilling through hard formations. It particularly relates to the provision of a drilling mechanism designed to alternately heat and cool hard formations in oil drilling operations so as to cause fracture of the hard formations.

In accordance with the present invention heating and cooling means are spaced around the head of a drilling device designed to alternately subject formations in contact with the rotating drilling device to very high and reasonably low temperatures as the device is rotated. In particular it is proposed to maintain an oxyacetelene flame in one nozzle or a group of nozzles while a cooling meduim such as drilling mud is forced through another nozzle or group of nozzles positioned on the drilling device. As this device is rotated, formations in contact with the drill are periodically heated and cooled. This cooling and heating is operative to fracture hard formations.

At the present time in conventional oil drilling operations the expense of the procedure is greatly increased by the necessity for drilling through extremely hard formations. Conventionally it is necessary to employ specially constructed drilling tools having extremely hard cutting edges in order to cut through hard formations. The drilling rate attainable may be extremely slow and it is necessary to frequently replace the drilling tool. It is the purpose of the proposed invention to overcome these disadvantages of the conventional drilling processes for hard formations by providing a means for fracturing the rock by subjecting the rock to the application of rapid temperature differentials. By this means the rapid expansion and contraction caused by the applied temperature differential results in the fracture of particles of the rock. A conventional drilling device may then be used to remove the fractured rock.

It is a further object of my invention to increase the rate at which a hard formation may be drilled.

It is a further object of my invention to increase the life of conventional tools employed for drilling hard formations.

Further objects and advantages of my invention will be more fully understood from the following detailed description in connection with the accompanying drawings in which:

Figure 1 diagrammatically shows partially in section a complete embodiment of my invention;

Figure 2 shows in cross-section the construction of a swivel which may be employed to permit rotation of the drilling device;

Figure 3 shows an end view of the head of the drilling device; and,

Figure 4 shows a section of the drilling device through two adjacent nozzles of Figure 3.

Referring now to Figure 1, the numeral 1 designates a hole drilled in the earth. This hole may have been partially drilled by conventional drilling methods to such a depth that hard formations 2 are encountered. At this stage of the drilling operations the embodiment of my invention illustrated in Figure 1 may be employed. This consists of a drilling device 3 positioned at the bottom of the drill string 4. The drill string comprises 3 pipes, that is, pipes 5, 6 and 7, positioned one within another providing passageways 8, 9, and 10. Through these passageways or chambers the necessary combustible gases and the necessary cooling fluid are conducted to the drilling device 3. Conventional rotating means designated by the rectangles 11 and 12 are employed to rotate the drilling string. These means conventionally comprise a power driven rotating table which drives a gear fixed to the drilling string. As the means for driving or rotating the drilling stem is no part of my present invention, no details are given. The drilling device 3 consists of an outer casing 17 which may have 4 nozzles 13, 14, 15, and 16, extending from the casing. As illustrated in the drawing, two of these nozzles, 14 and 16, are connected to the chamber of the pipe string through which drilling mud flows. Two other nozzles, 13 and 15, are connected to the chambers through which the combustible gases such as oxygen and acetylene are conducted. Thus one set of nozzles provides a source of intense localized heat while the other set of nozzles provides a localized cooling effect. By virtue of rotation of the drilling string the drilling device 3 is caused to rotate, successively subjecting a particular portion of rock which is below the drilling device to the alternate action of the hot and cold nozzles. A conventional drilling bit 18 may be positioned on the casing of the drilling device, extending somewhat below the nozzles to aid in the removal of fractured rock. This drilling bit may comprise the usual type of drag bit or fish tail bit. As stated oxygen, acetylene, and drilling mud are separately conveyed through the chambers of the drilling string. Oxygen may be conducted through the chamber 10 while acetylene may be conducted through the annular space 9 while drilling mud may be conducted through the outer annular space 8. Alternatively, the oxygen and acetylene may be conducted through a common passage but this procedure is not desirable since the presence of the combined oxygen and acetylene streams throughout the length of the drilling stem would constitute a severe safety hazard. Drilling mud is introduced to the annular space 8 by means of the inlet line 20 pumped by a suitable pump. Oxygen and acetylene may conveniently be added to the spaces 9 and 10 from standard gas tanks 21 and 22. In order to permit the upper part of the assembly consisting of the line through which the mud and gases are introduced to be stationary, conventional swivels are employed. The swivels are diagrammatically illustrated in

Figure 1 by the packed joints 23, 24 and 25. Figure 2 shows, in cross-section detail a suitable construction for these swivels. As illustrated in Figure 2, the stationary line 20 may be connected to the rotating line 7 by means of the swivel construction illustrated. An outwardly extending collar 25 is provided on the line 20 so as to support a thrust bearing 26 resting on the uppermost portion of the thrust collar 25. Bearing against the upper part of the thrust collar 26 is a circular supporting means 27 providing internal threads 28 for the support of the lower drill pipe 7. The drill pipe 7 is screwed into the supporting member 27 so as to tightly compress packing 29 compressed between the outer surface of the line 20 and the inner surface of the line 7. By this means a fluid tight seal is provided between the lines 7 and 20 while at the same time rotation of the line 7 with respect to the line 20 is possible. Similar construction may be employed for the other swivels.

Referring now to Figure 4 a section of the embodiment of Figure 1 taken substantially through the line 4—4 of Figure 3 is illustrated. The nozzle 14 is one of the nozzles adapted to eject a flow of drilling mud towards the formation directly below the drilling device. The drilling mud, or other cooling fluid, flows through the string of pipe in the annular space 8 and is pumped through the nozzle 14. The nozzle 15 adjacently positioned on the drilling device, is adapted to burn the oxygen and acetylene conducted to the nozzle through the passages 9 and 10. It is preferable to conduct the oxygen through the innermost passage 10 while conducting the acetylene through the outer passage 9 combining the flow of gases at the tip of the nozzle 15. As it is not desired to continue the burning of the acetylene during periods when the device is not in operative position, a special igniting means is included in the nozzle adapted to ignite the acetylene when desired. A high resistance wire 13 is fixed across the tip of the nozzle 15. An insulated conductor 30 connects one side of the heating wire 13 to a fixed contact 31 of a switch 32. The other side of the heating wire 13 is connected to a bimetallic strip 33 which is constructed to serve as a second switch. When the bimetallic strip 33 is cool, the strip contacts the extending lug 34 while the strip when hot, will bend away from this lug. A battery 35 is connected so that one pole is connected to the metal structure of which the lug 34 is a part, while the other pole is connected to the switch 32. Suitable insulating means 37 are employed to properly insulate the electrical circuit. The switch 32 consists of a vane-like make and break member which is normally maintained in the open position by means of the spring 38. When it is desired to start the operation of the drilling device, a flow of oxygen and acetylene is initiated through the passages 9 and 10. This flow is operative to act upon the vane-like switch 32 closing the switch. At this point in the operation the bimetallic strip 33 will also be in the closed position, the device being relatively cool. Consequently the battery circuit will be completed through the resistance wire 13 which will heat sufficiently to ignite the oxygen-acetylene stream. On ignition of the acetylene, the nozzle 14 will of course become hot. This heat will be effective in causing the bimetallic strip to change shape sufficiently to open the electrical circuit through the wire 13. The heat will cause the bimetallic strip to bend away from the contact 34 discontinuing the flow of current through the

heating wire. The wire 13 used to ignite the acetylene may consist of any suitable high resistance electrical wire. The battery 35 employed to supply current to the wire may also consist of any suitable voltage source. It may be desirable to employ an induction coil in connection with the battery to supply higher voltages to the resistance wire.

In the operation of my invention, conventional drilling rates may be employed. In general the drill will be rotated between 60 to 400 revolutions per minute. For drilling through particularly hard formations it is preferred that the drilling rate be about 60 to 120 revolutions per minute. In any event, a drilling rate may be maintained which is somewhat greater than that attainable using conventional hard formation drills.

As described, my invention comprises the method and apparatus for subjecting a hard formation to rapid changes in temperature. It is apparent many modifications may be made of the embodiment particularly illustrated and described. For example, any suitable gas other than acetylene may be employed. Again any desired arrangement of nozzles or passageways may be used. Consequently it is desired that the appended claims be given a broad interpretation commensurate with the prior art.

Having now fully described my invention, I claim:

1. Apparatus for the drilling of hard formations comprising a rotatable elongate casing provided with a plurality of separate passageways at least one of which is adapted to conduct cooling fluid to the lower end of said casing and others of which are adapted to conduct combustible gases and combustion supporting gases to the lower end of said casing, a plurality of nozzles affixed adjacent the lower portion of said casing and extending in a generally downward direction therefrom, said nozzles being arranged in circumferential relation about the lower end of said casing, alternate nozzles communicating with the passageway adapted to conduct cooling fluid and the remaining nozzles communicating with the passageways adapted to conduct combustible gases and combustion supporting gases, and a metallic bit affixed to the bottom of said casing and extending below said nozzles.

2. Apparatus defined by claim 1 wherein each of said nozzles communicating with said passageways for combustible gas and combustion supporting gas comprises an outer tubing communicating with one of said passageways and an inner tubing terminating short of the outer tubing and communicating with another of said passageways.

3. Apparatus defined by claim 2 wherein electrical means for igniting combustible gases is disposed within each of said nozzles adjacent said inner tubing.

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