

Sept. 21, 1965

H. HÜGEL

3,207,240

METHOD OF AND APPARATUS FOR THE DRILLING AND OF THE  
PROTECTION OF DRILL CORES IN DEEP-WELL-DRILLINGS  
PRIOR TO THE ACCESS OF THE DRILL FLUID  
Filed Oct. 31, 1961

FIG. 1.

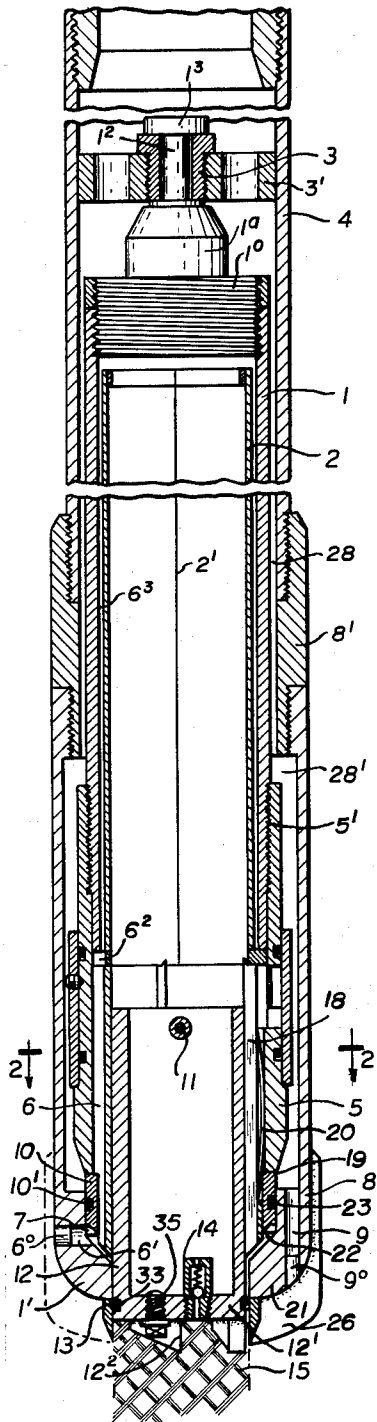
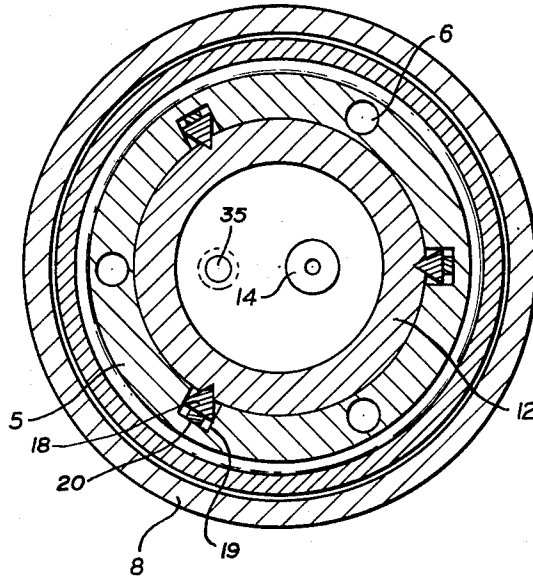


FIG. 2.



INVENTOR  
HELMUT HÜGEL  
BY  
*Ernest G. Huntague*  
ATTORNEY.

1

3,207,240

## APPARATUS FOR THE DRILLING OF AND THE PROTECTION OF DRILL CORES IN DEEP-WELL-DRILLING OPERATIONS

Helmut Hugel, Salvador-Bahia, Brazil, assignor to Tiefbohr-Messdienst Leutert & Hugel G.m.b.H., Luneburg-Erbstorf, Germany, a corporation of Germany

Filed Oct. 31, 1961, Ser. No. 148,912

5 Claims. (Cl. 175-44)

The present invention relates to an apparatus for the drilling of drill cores in deep-well drillings, and for the protection of the drill cores from contact with the drilling fluid during the drilling and removal of the cores from the deep-well drillings.

The removal of drill cores, not contacted by the drilling fluid from deep-well drillings, is often of importance for purposes of geological investigations of the nature of the rock and/or the materials which constitute the drill cores. It is desirable, for economic reasons, to drill the longest possible cores within the shortest possible time, whereby the rate of core recovery, as related to the time expended in the core drilling process, is as high as possible.

During the drilling of cores, in accordance with a rotary system, an annular space is drilled by means of a core drilling bit and the loosened particles of the materials in which the drilling is taking place flow upwardly in the drill hole alongside the drilling apparatus along with the drilling fluid. Concurrently therewith, the core being drilled penetrates into a core tube, which is preferably secured against rotation relative to the core which is, at this point, still connected at its lower extremity to the ground in which the drilling is taking place. The provision of a non-rotatable core tube within which the core may penetrate, prevents grinding of the core and attendant damage thereto.

In many cases, a core protecting liquid is provided in the core tube to protect the core from contact with the drilling fluid, whereby it becomes necessary that the core displaces the protecting liquid upon the entry of the core into the core tube. In many core drilling apparatus which utilize a rotatable core tube, the liquid displaced by the entry of the core into the core tube is flowed through a one-way valve into the rising stream of drilling fluid in the space outside of the drill pipe; while in other core drilling apparatus, particularly those which use non-rotatable core tubes, the flow of the liquid is likewise displaced through a one-way valve into the space inside of the drill pipe through which the drilling fluid circulates. If an attempt is made to remove the protective liquid displaced by the core, in core drilling apparatus which utilize a stationary core tube, from the space inside of the drill pipe to the space outside of the drill pipe, sealing and frictional difficulties are encountered in the bearing assembly which provides for rotation of the drill pipe relative to the non-rotatable core tube. Since high pressure prevails in the space inside of the rotatable drill pipe in which the drilling fluid flows, and into which the one-way valve opens, relative to the pressure in the space in the drill hole outside of the drill pipe, this high pressure being caused by the relatively restricted discharge nozzles in the drill bit, the core of material which penetrates into the core tube is subjected to this high pressure, whereby an appreciable load is placed on the upper extremity or head of the core, particularly in the case of cores of desirably large cross-sectional area. This appreciable load has the tendency to substantially damage the core, especially in cases, wherein the core is constituted of relatively soft, or cracked, rock material, and in any event makes more difficult, or even

2

impossible, the penetration of the core into the core tube due to the wedging of the core in the core tube. A further disadvantage inherent in the use of one-way valves for the protective fluid displaced from the core tube by the penetration of the core thereinto resides in the fact that the one-way valve may lose its sealing properties due to the possibility that loose material may accumulate on the valve seat to prevent proper seating of the valve thereon. In this instance, the drilling fluid stream then has access to the core due to the inoperative condition of the one-way valve, whereby the drilling fluid can wash out a substantial portion, or all of the core from the core tube during the flow of the drilling fluid thereto. In addition, the weight of the drilling fluid accumulated in the core tube above the core due to the failure of the one-way valve can function to press the core downwardly and out of the core tube, resulting in a loss of the core during the raising of the drill pipe upon the termination of the core drilling process.

It is, therefore, one object of the present invention to provide an apparatus for the drilling and protection of drill cores in deep-well drillings which avoids the significant disadvantages of the core drilling apparatus used heretofore.

It is another object of the present invention to provide an apparatus for the drilling and protection of drill cores in deep-well drillings, prior to further drilling therein, wherein, particularly in connection with core drills utilizing non-rotating core tubes, fluid pressure on the upper extremity or head of the core is relieved to the extent that only the hydrostatic fluid pressure prevailing at the bottom of the drill hole due to the weight of the drilling fluid outside of the drill pipe is to be overcome. Thus, the danger of the fluid pressure pressing the core downwardly and out of the core tube upon termination of the coring operation is substantially eliminated, whereby the core catching means need only function to tear the core from the well upon termination of the core drilling apparatus, and to support the weight of the core during the raising of the drill pipe for retrieval of the core.

It is still another object of the present invention to provide a core drilling apparatus for the drilling and protection of drill cores in deep-well drillings, wherein contact of the drilling fluid with the core during the drilling of the core, and the penetration of the drilling fluid into the core tube is substantially inhibited to prevent contamination of the core by the drilling fluid. This prevents penetration of the drilling fluid into porous cores, as for example cores of oil saturated sand, which penetration would, of course, result in contaminated connate water conditions and seriously impair the accuracy of the geological investigations of the core material.

The objects of the present invention are achieved by the use of core drilling apparatus which comprises a non-rotatable protection tube supported within a rotatable drill pipe from suitable bearing means positioned therebetween. A core tube, which is preferably split along the longitudinal axis thereof to provide for the convenient removal of readily breakable cores therefrom, is supported within the said protection tube. The protection tube is tightly closed at its upper end, as for example by suitable plug means, and the annular space between the protection tube and the core tube is connected with an annular channel provided in a non-rotatable core-catching housing which may include marking knife means as in the case of core drilling apparatus which is used for raising oriented drill cores. The annular channel is disposed in the drill bit as close as possible above the core cutting edges of the drill bit, and lateral openings extend outwardly from the annular channel through the drill bit through

the exterior thereof. The annular channel is sealed by means of an O-ring having a low coefficient of friction with relation to steel, as for example Teflon, relative to the space between the drill bit and the core-catching housing in which the drilling fluid circulates, whereby easy rotation of the drill bit is possible about the non-rotating core-catching means during the core drilling operation. The protective liquid within the core tube displaced by the penetration of the core thereto will, in this arrangement, flow from the interior of the core tube into the space between the core tube and the protection tube and downwardly therefrom for flow from the core drilling apparatus through the above-mentioned channels in the core-catching housing and the outwardly extending lateral opening in the drill bit. The protective liquid will thus flow from the core drilling apparatus into the space between the drill pipe and the walls of the drill hole against the relatively low hydrostatic pressure prevailing therein due to the weight of the drilling fluid in the drill hole, and the friction between the drilling fluid and the opposed surfaces of the drill pipe and the drill hole wall.

In the use of a protective liquid to obtain a core which has not been subjected to contact with the drilling fluid, which is desirable, for example, in the drilling of cores in oil-bearing sand, the core tube and the space between the core tube and the protection tube can be filled with the protective liquid prior to the assembly of the core drilling apparatus. The said protective liquid may, for example, take the form of a paraffin or wax mixture which melts at a temperature to be expected at the bottom of the drill hole. Alternatively, the protective liquid may take the form of a suitable plastic material, which is introduced into the core tube in its liquid state and then polymerizes and solidifies after the expiration of a predetermined time period, or upon being raised to a predetermined temperature. To this end, a hollow, cup-shaped protection plug, secured at the lower extremity of the core catching housing through the use of a shear pin, is sealed by means of an annular O-ring, in order to retain the paraffin or liquid plastic material in the core tube until it is displaced by the protection plug upon the shearing of the shear pin and upward movement of the protection plug into the core-catching housing and core tube due to entry of the core thereto.

The outwardly extending lateral openings in the drill bit which provide for the flow of the protective liquid displaced by the entry of the core into the core-catching housing and core tube, as described above, may be plugged prior to the introduction of the protective fluid into the core tube by suitably yieldable plugs of any readily drillable material, as for example soft lead. The said protection plug is provided with a spring controlled check valve disposed in the bottom wall of the protection plug and permitting flow only into the core tube. The check valve functions as a pressure compensator for equalizing the pressure in the protective liquid inside the core tube with the pressure in the drill hole. Since the protective liquid is initially at atmospheric pressure, and the pressure in the drill hole as the core drilling apparatus is lowered thereinto becomes greater than atmospheric, a slight compression of the protective liquid may occur as the core drilling is lowered into the drill hole. Without provision for pressure compensation between the drill hole and the interior of the core tube, the higher pressure within the drill hole acting on the exterior of the protection plug might very probably cause premature shearing of the shear pin which secures the protection plug to the core-catching housing. As the core penetrates into the core tube, it pushes the protection plug ahead of it, whereby the protection plug functions as the piston to expel the protective liquid from the core tube. A coating of the protective liquid will, however, remain on the inner wall of the core tube to contact and protect the surfaces of the core as the latter penetrates into the core tube. The drill bit is equipped with a core cutting ring which is

adapted to protect the core during the cutting of the latter, with the cutting ring having an inner diameter which corresponds to the outer diameter of the core cut thereby. The lower edge of the core cutting ring may be disposed in the same horizontal plane as the lower edge of the drill bit. Alternatively, the lower edge of the cutting ring can be disposed below the lower edge of the drill bit, if the cores are being cut from relatively soft material, as for example soft rock, and rapid wear of the cutting edges of the core cutting ring is not to be expected. The cutting edges of the core cutting ring and the drill bit are preferably equipped in a conventional manner, with hard metal or diamond faces.

Upon the removal of the core drilling apparatus from the drill hole, the protective liquid remaining in the core tube which surrounds the core now penetrated thereto, will not flow from the core tube, since the density of the protective liquid is lower than the density of the drilling fluid which surrounds the drill pipe in the drill hole. Preferably, the protective liquid solidifies prior to the final removal of the core drilling apparatus from the bore hole to thus form a solid, protective coating around the core. It is not, however, necessary that the protective liquid solidify around the core under all circumstances.

With these and other objects in view, which will become apparent in the following detailed description, the present invention will be clearly understood in connection with the accompanying drawings, in which:

FIGURE 1 is an axial section of core drilling apparatus constructed in accordance with a presently preferred embodiment of the present invention; and

FIG. 2 is a horizontal section taken along the lines 2-2 of FIG. 1.

Referring now to the drawings, the depicted core drilling apparatus comprises a non-rotating protection tube 1, closed at its upper end by a plug 1<sup>0</sup>. A core tube 2 is positioned as shown within the protection tube 1, and is preferably split longitudinally as indicated at 2' to facilitate the removal therefrom of readily breakable cores, as discussed above. A rotatable drill pipe 4 surrounds the protection tube, and the drill pipe 4 includes a bearing 3 supported in the interior thereof by a bearing support assembly 3' extending therebetween. The plug 1<sup>0</sup> at the upper end of the protection tube 1 includes an extension 1<sup>a</sup> and a stub shaft 1<sup>2</sup> projecting therefrom for positioning of the stub shaft 1<sup>2</sup> within the bearing 3. The stub shaft 1<sup>2</sup> includes an enlarged end portion 1<sup>3</sup> which cooperates as shown with the bearing 3 to provide for the support of the protection tube within the drill pipe 4, and for the rotation of the latter relative to the protection tube 1. A core-catching and marking knife housing 5 is supported as shown within the drill pipe 4 by the attachment of the housing 5 to the protection tube 1 in any convenient manner, as for example the threaded connection indicated at 5'. A core drilling bit 8 is threadably attached to the lower extremity of the drill pipe 4 by an attachment member 8' so as to be rotatable with the drill pipe 4.

The core-catching and marking knife housing 5 is provided with a plurality of axially extending bores 6 which are in fluid-flow communication with an annular channel 7 formed between adjacent surfaces of the housing 5 and the drilling bit 8. The bores 6 are also in fluid-flow communication, as made clear at 6<sup>2</sup> in FIG. 1, with the axially extending, annular space 6<sup>3</sup> between the interior wall of the protection tube 1 and the exterior wall of the core tube 2.

The core-catching and marking knife housing 5 includes a plurality of marking knives 18 slidably mounted in axially extending grooves 19 formed in the housing 5 and spring-biased radially inward by springs 20. A hollow, generally cylindrical protection plug 12, having an end wall 12' extending across one extremity thereof and being open at the other extremity thereof, is slidably positioned as shown in an axially extending, core re-

5

ceiving bore in the core-catching and marking knife housing 5, with the marking knives 18 projecting into grooves in the protection plug 12 in the manner made clear in FIG. 2. The protection plug 12 includes vertical edges 12<sup>2</sup>, attached to the end wall 12', which are pressed into the bottom of the drill hole at the start of the drilling process. The function of the marking knives 18 is three-fold; they prevent rotation of the protection tube 1 with the rotating drill pipe 4 and drill bit 8 due to the contact of the knives 18 with the grooves in the protection plug 12. They provide the core with longitudinal marks for orientation purposes in cases where core orientation is desired, as described in my co-pending application for U.S. Patent, S.N. 148,897 filed concurrently herewith, and U.S. Patents Nos. 2,489,566 and 2,628,816, respectively; and function as core-catchers due to the penetration of the upper points of the knives 18 into the core, when the core has penetrated into the core tube 2, in a manner described hereinbelow, and the core drilling apparatus is being removed from the bore hole. An abutment ring 21, longitudinally split in the manner of the core tube 2, is point-welded to the lower extremity of the core tube 2. The abutment ring 21 fits in part within a groove (not shown) in the core-catching and marking knife housing 5, to thus retain the core tube 2 stationary relative to the core-catching and marking knife housing 5.

A plurality of radially disposed bores 6' extend as shown through the drilling bit 8 from annular channel 22 to the exterior of the core drilling apparatus. The core-catching and marking knife housing 5 is provided with a wear ring 10 positioned around the lower extremities thereof. The wear ring includes an O-ring seal 23 mounted thereon for sealing cooperation with the adjacent rotating surface of the rotating drill bit 8. A drilling fluid passage 28 is formed by the axially extending, annular space between the interior wall of the drill pipe 4 and the exterior wall of the protection tube 1, and is in fluid-flow communication with drilling fluid passages 28' formed by the axially extending, annular spaces between the interior wall of the drill bit 8 and the exterior wall of the core-catching and marking housing 5. The latter of these drilling fluid passages terminates, as shown, in fluid discharge nozzles 9, which are formed in the drilling bit 8 and provide for the flow of the drilling fluid from the drilling bit 8 with attendant rotation thereof. Thus, it may be understood whereby the seal ring 23 enables rotation of the drilling bit 8 relative to the non-rotating core-catching and marking knife housing 5, while preventing the introduction of the relatively high pressure drilling fluid into the annular channel 22, from where it could conceivably flow into contact with the interior of the core tube 2 through axial bores 6 and the axially extending, cylindrical space 6<sup>3</sup> between the core tube 2 and the protection tube 1.

The drilling bit 8 is provided with cutting edges 26 for the drilling of the drill hole during the core drilling operation, and a core cutting ring 13 is attached to the lower extremity of the drilling bit 8 in any convenient manner, as for example by welding, to cut the core upon rotation of the drilling bit 8. The fluid discharge nozzles 9 and core cutting ring 13 are relatively positioned in and on the drilling bit 8, so that the drilling fluid discharged from the nozzles 9 will contact, and cool, the outer, cylindrical wall of the cutting ring 13 to cool it, and the core being cut thereby, to prevent heating of the core and attendant, serious damage thereto. At the same time, however, the vertical extent of the cutting ring 13 will prevent the direct flow of the drilling fluid from the discharge nozzles 9 into contact with the core being cut.

The protection plug 12 is initially connected to the core-catching and marking knife housing 5 by means of a shear pin 11 extending therebetween. The protection plug 12 includes an O-ring 33 positioned thereon, and the O-ring

6

33 cooperates initially with the interior wall of the cutting ring 13, and then with the interior wall of the portion 21 of the drilling bit 8, the wall of the axially extending bore in the core-catching and marking knife housing 5, and the interior wall of the core tube 2 respectively, to seal the interior of the core tube 2 from the drilling fluid within the drill hole as the core forces the protection plug 12 into the core tube 2 in the manner described in detail hereinbelow. A filling plug 35 is provided in the end wall 12' of the protection plug 12 and functions to enable the air-free filling of the interior of the protection plug 12 and of the core tube 2 with the paraffin, wax, or liquid plastic, protective liquid described above. A check valve 14 also extends as shown through the end wall 12' of the protection plug 12 and provides for limited flow of drilling fluid from the bore hole into the interior of the protection plug 12 for pressure compensation purposes in the manner described above.

Yieldable plug means 6<sup>0</sup> and 9<sup>0</sup> of any readily drillable material, as for example a lead alloy or plastic, are provided as shown in the radially extending bore 6' and the fluid discharge nozzles 9, respectively, which are formed in the drilling bit 8. The plug means 6<sup>0</sup> and 9<sup>0</sup> are each designed to yield upon the application of a predetermined pressure thereto, and function, in the case of plug means 6<sup>0</sup> to retain the protective fluid within the core drilling apparatus until a core commences the penetration thereinto, and in the case of plug means 9<sup>0</sup>, to prevent the entry of cuttings from previous drilling into the fluid discharge nozzles 9 as the core drilling apparatus is lowered to the bottom of the drill hole. Once the core drilling apparatus has been lowered to the bottom of the drill hole, and the core cutting operation commenced by the introduction of the highly pressurized drilling fluid to the drill pipe 4, the plug means 6<sup>0</sup> and 9<sup>0</sup> are readily forced from the depicted positions thereof into the drill hole by the respective pressures of the protective liquid, and drilling fluid.

In operation, with the core drilling apparatus of the present invention filled with the protective liquid, and the plug means 6<sup>0</sup> and 9<sup>0</sup> positioned therein in the depicted manner, the apparatus is lowered to the bottom of the drill hole and the highly pressurized drilling fluid introduced thereto through the drill pipe 4. As the plug means 9<sup>0</sup> are forced from the fluid discharge nozzles 9 by the highly pressurized drilling fluid, and the drilling bit 8 commences to rotate, the core cutting ring 13 will cut the core as indicated at 15 in FIG. 1. As the core is cut, it will force the protection plug 12 upwardly in the axially extending bore in the core-catching and marking knife housing 5 toward the core tube 2, due to the weight of the apparatus acting on the housing 5 and the core tube 2. As the protection plug 12 starts rising within the core-catching and marking knife housing 5, pressure will be exerted on the protective liquid within the interior of the protection plug 12 and of the core tube 2. This pressure will be communicated through the protective liquid to the plug means 6<sup>0</sup> in the radially extending bores 6', whereby the plug means 6<sup>0</sup> will be forced out of the radially extending bores 6' and the protective liquid will commence to flow from the interior of the core tube 2, over the top of the core tube 2 or through its axial slots, through the axially extending, cylindrical space 6<sup>3</sup>, the axially extending bores 6 in the core-catching and marking knife housing 5, the annular channel 7, and the radially extending bores 6', respectively, to the exterior of the drilling bit 8. As the protective liquid leaves the drilling bit 8, it will be carried upwardly by the drilling fluid, which is jetted through nozzles 9 and rises in the drill hole between the walls of the hole and of the drilling bit 8 and drill pipe 4 and upwardly back to the surface. Thus may be understood, that while the protective liquid does not contact the core once the liquid has left the core drilling apparatus, the space inside the core tube 2 and also the space between the tubes 2 and 3 including the entire

channel system described above down to the radial bores 6' in the core bit contain protective liquid, except for the space occupied by the volume of the core rising into the core tube 2, such liquid being always present around the core shown to the lower edge of the marking knife housing 5 and by downwardly directed displacement of the protective fluid even within the core bit, no drilling fluid having access to this space, as explained above. The protective fluid thus completely covers the core as the latter penetrates into the core bit and eventually into the core tube 2.

During the drilling of the core, only the hydrostatic pressure due to the weight of the drilling fluid at the bottom of the drill hole, and the pressure due to the relatively low weight of the protection plug 12 acts upon the top of the core as it penetrates into the core tube 2, whereby the core drilling operation is significantly simplified, particularly in the drilling of the cores in soft, split, or fractured rock formations. During the removal of the core drilling apparatus from the bore hole upon the termination of the core drilling operation, the core-catching and marking knife housing 5 need only function, through the points on the marking knives 18, to tear the drill core from the ground providing it is not preferred to "burn off" the core by a short additional period of "dry" drilling—and to prevent the sliding of the core from the core tube 2 by its own weight. Thus may be understood whereby any hydraulic load on the core head, as for example those due to the highly pressurized drilling fluid within the core drilling apparatus, are completely eliminated by the closure of the top of the protection tube 1 by the plug 10, and the provision of a sealing ring 23 in the wear-ring 10 on the core catching and marking knife housing 5, and the sealing ring 33 on the protection plug 12.

While I have disclosed one embodiment of the present invention, it is to be understood that this embodiment is given by example only and not in a limiting sense, the scope of the present invention being determined by the objects and the claims.

I claim:

1. A core drilling apparatus for the drilling and recovery of cores from deep well drillings,
  - a rotatable drill tube,
  - a protection tube non-rotatably disposed within said drill tube and spaced therefrom at least in part to provide a first axially extending space,
  - an axially divided core tube disposed in said protection tube and spaced therefrom at least in part to provide a second axially extending space, the upper end of said core tube terminating freely in said protection tube,
  - means for filling the interior of said core tube with an air-free core protecting liquid,
  - means for sealing the upper end of said protection tube,
  - a drill bit connected to said drill tube for rotation therewith and having an axially extending bore formed therein,
  - cutting means formed on said drill bit,
  - a core-catching housing releasably connected to the lower end of said protection tube in fixed angular relationship therewith and extending into said axially extending bore in said drill bit in spaced relationship therewith at least in part to provide a third axially extending space in fluid flow communication with said first axially extending space,
  - sealing means positioned between said core-catching housing and said drill bit below said third axially extending space to provide a substantially fluid-tight seal therebetween, while enabling free rotation of said drill bit relative to said core-catching housing,
  - annular channel means formed between said core-catching housing and said drill bit below said sealing means and there being means preventing fluid communica-

- tion between said annular channel means and said third axially extending space,
- radially extending third flow bores formed in said drill bit and extending therethrough above said cutting means in fluid flow communication with both said annular channel means and the exterior of said core drilling apparatus,
- means maintaining said core tube in fixed angular relation to said core-catching housing,
- a plurality of axially extending fluid flow bores formed in said core-catching housing and extending there-through in fluid flow communication with both said annular channel and said second axially extending space,
- a plurality of fluid nozzles extending in said drill bit from said third axially extending space to the exterior of said core drilling apparatus below said radially extending bores,
- a core cutting ring attached to the lower end of said drill bit radially inwardly of said nozzles,
- an axially extending, core-receiving bore in said core-catching housing,
- said bore being in communication with the exterior of said core drilling apparatus and in substantial alignment with the interior of said core tube, and
- a protection plug slidably mounted in said core-receiving bore in substantially fluid-tight relationship therewith and movable upwardly therefrom into the interior of said core tube upon the entry of a core into said core receiving bore, whereby drilling fluid may be introduced to the core drilling apparatus through said first axially extending space and flow therefrom, remote from the interior of said core tube, through said third axially extending space and from said third axially extending space through said fluid nozzles to the exterior of the core drilling apparatus when said drill bit is rotated to cut a core, and
- said protection plug may be moved upwardly into the interior of said core tube upon the entry of the core into said core receiving bore to displace said core protecting liquid from the interior of the core tube for the flow of the core protecting liquid over said freely terminating end of the core tube and through the axial division of the latter, respectively into said second axially extending space and therefrom to the exterior of the core drilling apparatus above said cutting edges and nozzles, through said axially extending, fluid flow bores, said annular channel, and said radially extending, third flow bores, respectively.
2. The core drilling apparatus, as set forth in claim 1, wherein
  - said protection plug comprises a hollow, generally cylindrical member open at its upper end in fluid-flow communication with the interior of said core tube,
  - an end wall extending across the lower end of said protection plug,
  - check valve means in said end wall permitting fluid flow only in the direction from the exterior of the core drilling apparatus to the interior of said core tube,
  - said check valve means being adapted to enable pressure equalization between the drilling fluid at the exterior of the core drilling apparatus and the core protecting liquid in the interior of said core tube during the drilling of a core,
  - said means for filling the interior of said core tube with an air-free, core protecting liquid comprising a filling plug removably positioned in said end wall of said protection plug.
3. The core drilling apparatus, as set forth in claim 1, further comprising
  - a shear pin extending between said core-catching housing and said protection plug to maintain the latter properly positioned in said core receiving bore prior to the start of the drilling of a core and to shear off as the core is drilled to enable the said protection

9

plug to move upwardly into the interior of said core tube upon the entry of a core into said core receiving bore, and

plug means yieldably positioned in said radially extending, third-flow bores and said fluid nozzles, respectively, and displaceable therefrom to the exterior of the core drilling apparatus by the pressure of said core protecting liquid and said drilling fluid, respectively, upon commencing the drilling of a core.

4. The core drilling apparatus, as set forth in claim 1, further comprising

sealing means disposed between said protection plug and said core receiving bore for preventing the entry of drilling fluid into said core receiving bore around the periphery of said protection plug.

5. The core drilling apparatus, as set forth in claim 1, wherein

said cutting means formed on said drill bit comprise drill hole cutting edges for cutting the drill hole during the drilling of a core, and

said core cutting ring and said fluid discharge nozzles being arranged on said drill bit such that the drilling fluid discharged from said fluid discharge nozzles will contact and cool the core cutting ring, to in turn cool

10

the core being cut, but is prevented by said core cutting ring from flowing directly into contact with the core being cut.

#### References Cited by the Examiner

##### UNITED STATES PATENTS

|           |       |                      |            |
|-----------|-------|----------------------|------------|
| 1,542,172 | 6/24  | Reed et al. ....     | 175—245    |
| 1,773,915 | 8/30  | Lydon .....          | 175—44     |
| 2,073,876 | 3/37  | Oliver .....         | 175—254    |
| 2,238,609 | 4/41  | Sewell .....         | 175—245    |
| 2,313,576 | 3/43  | Phillips et al. .... | 175—44     |
| 2,364,088 | 12/44 | Miller et al. ....   | 175—245 XR |
| 2,643,858 | 6/53  | Hardman .....        | 175—246    |
| 2,703,697 | 3/55  | Walker .....         | 175—245    |
| 2,862,691 | 12/58 | Cochran .....        | 175—245    |
| 3,064,742 | 11/62 | Bridwell .....       | 175—246 XR |

##### FOREIGN PATENTS

|         |      |                |
|---------|------|----------------|
| 296,352 | 8/28 | Great Britain. |
|---------|------|----------------|

CHARLES E. O'CONNELL, *Primary Examiner.*

BENJAMIN HERSH, *Examiner.*