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van der Wijden

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[54] **DRILLING APPARATUS**

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[52] **U.S. Cl.** **175/215,** 175/60

[51] **Int. Cl.** **E21b 25/00,** E21b 9/20

[58] **Field of Search** 175/60, 207, 215, 212

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[57] **ABSTRACT**

A rotary drilling apparatus in which drilled cores are continuously transported to the surface by means of a flushing fluid. The apparatus comprises a rotatable inner pipe or pipe string provided near its bottom end with a cutting member. Spray openings are formed through the wall of the inner pipe near the cutting member and the pipe is connected at its top end with a stationary discharge tube for the flushing fluid carrying the cores. One or more extension pipes are adapted to be coupled to the inner pipe for forming the pipe string and an outer pipe or pipe string extends from the surface and surrounds the inner pipe (or extension pipes) with clearance. The outer pipe communicates with a supply of flushing fluid, and the outer pipe or pipe string extends over the full length of the inner pipe or pipe string and is drivingly connected with a driving means. The inner pipe is connected with the outer pipe, so that the inner pipe is carried into rotation by the outer pipe upon rotation thereof, a seal being provided between the two pipes near the lower end below the spray openings formed in the inner pipe.

9 Claims, 6 Drawing Figures

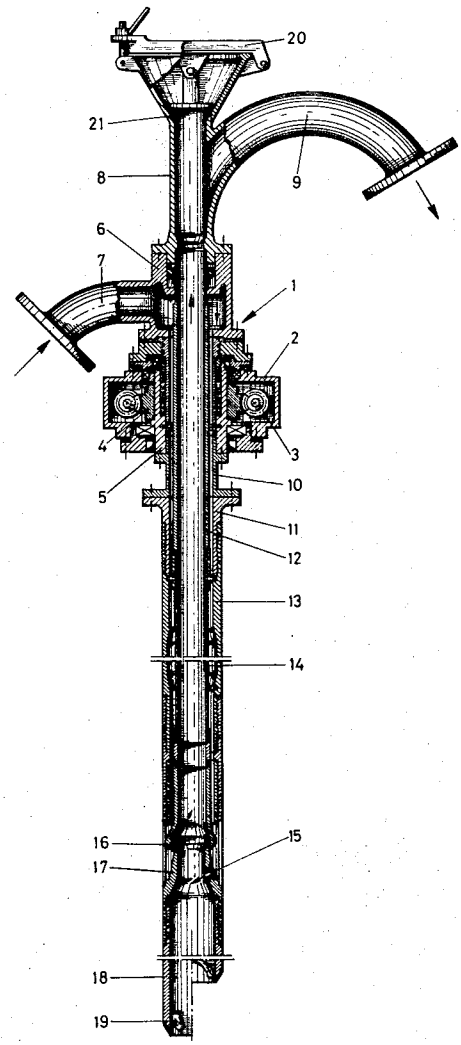


FIG. 1

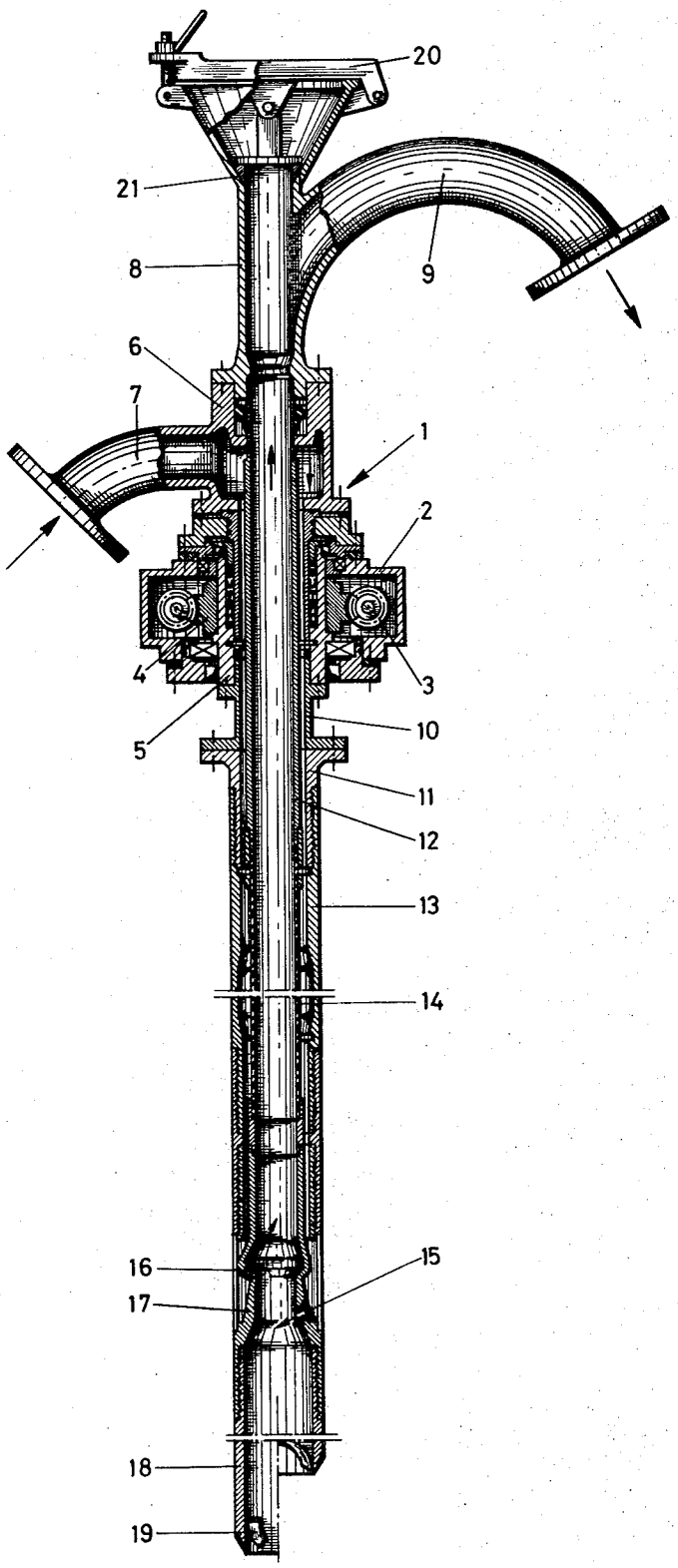


Fig. 2

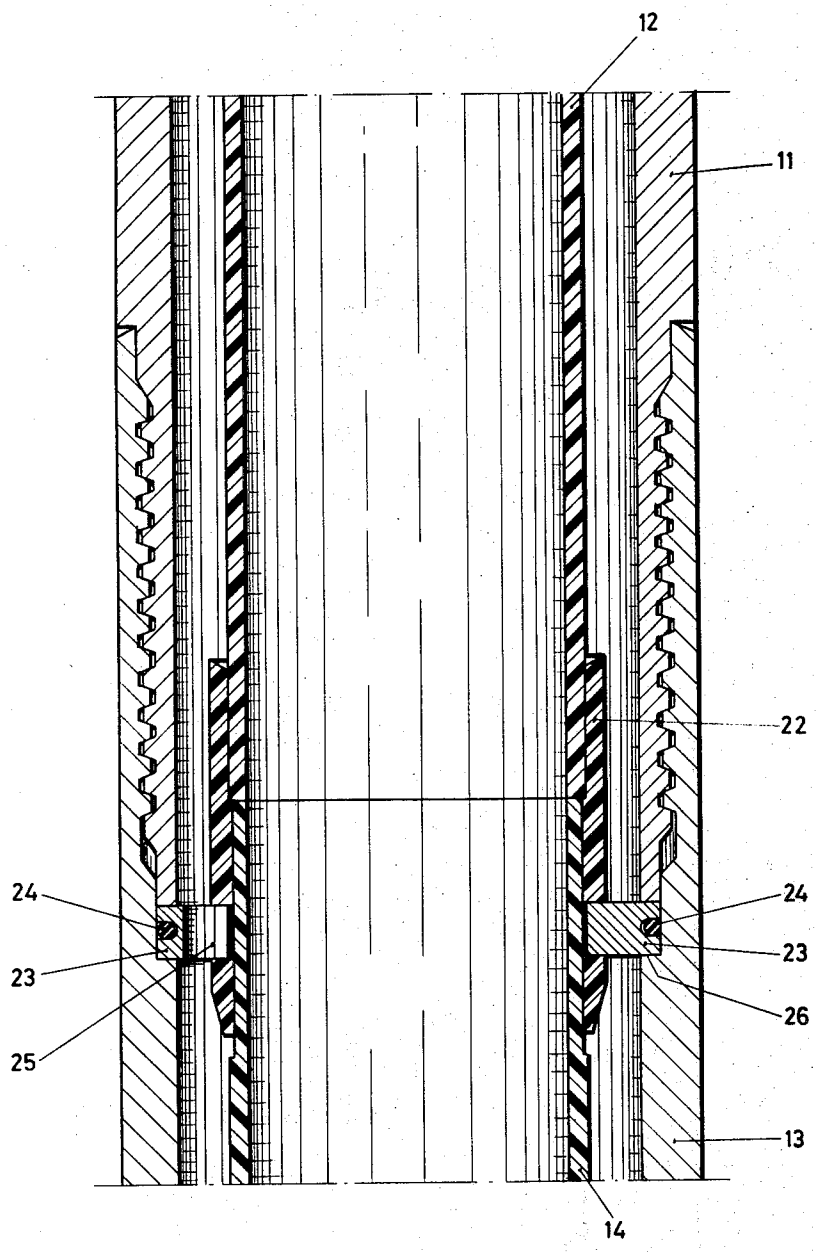


Fig - 3

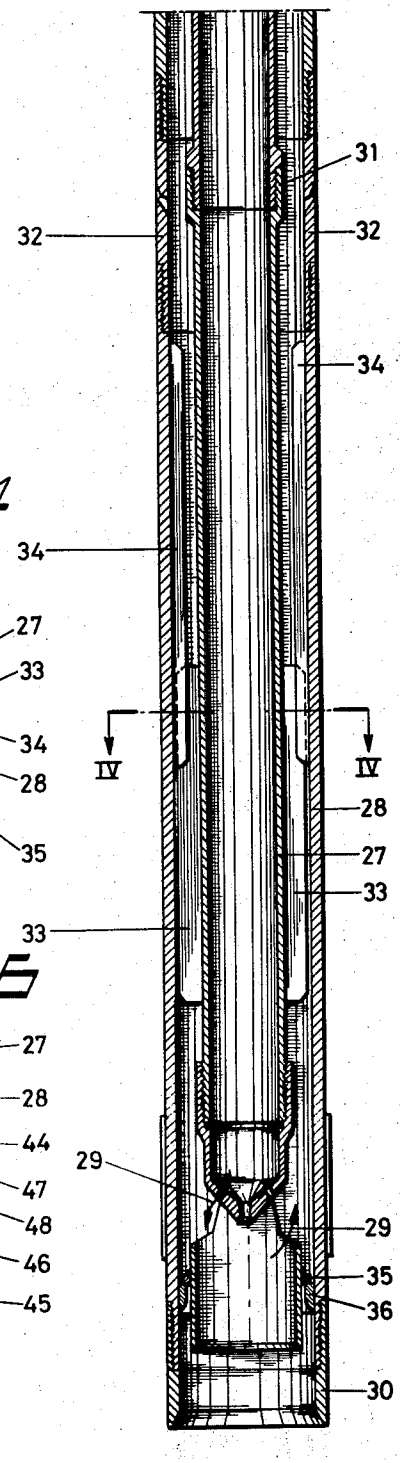


Fig - 4

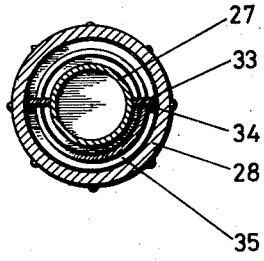
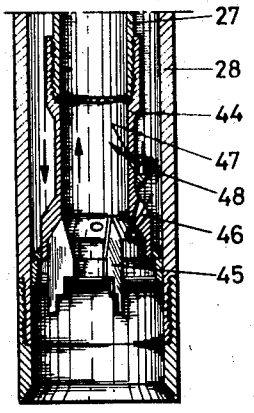


Fig - 6



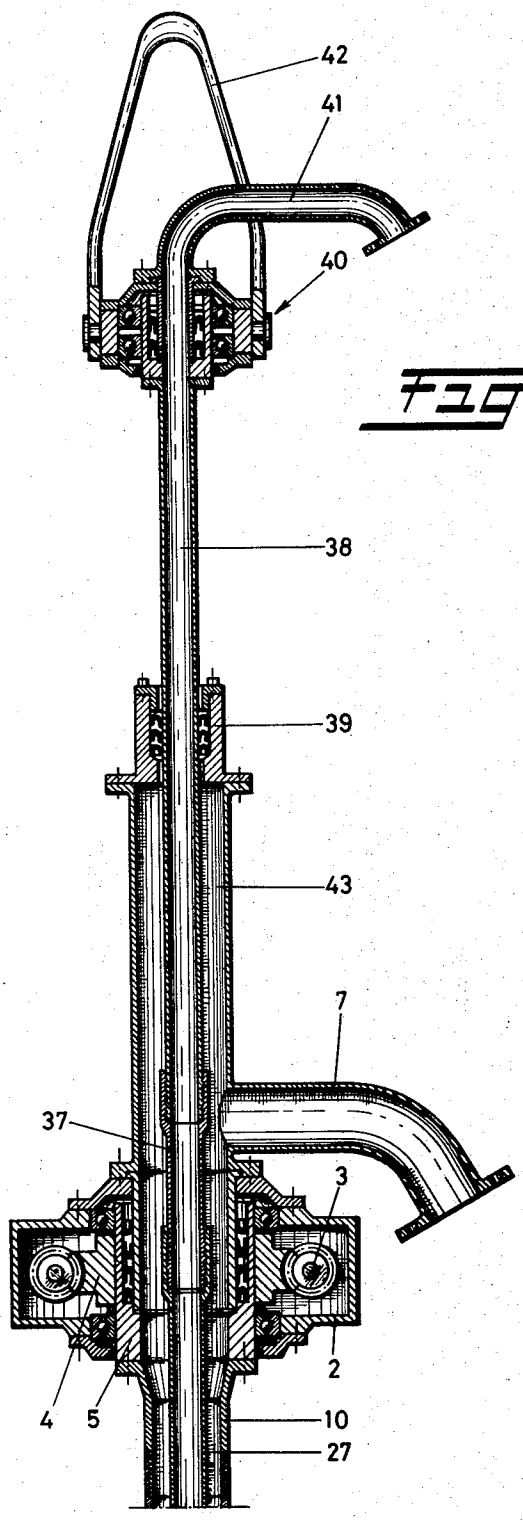


Fig - 5

DRILLING APPARATUS

The invention relates to a rotary drilling apparatus for continuously coring according to the so-called "counterflush system," in which cores of the drilled formation are continuously carried to the surface by means of a flushing fluid, said device comprising: an inner pipe adapted to be rotated by driving means and provided near its bottom end with a cutting member, openings extending through the wall of the inner pipe near this cutting member, said pipe being connected at its top end with a stationary discharge tube for flushing fluid carrying the cores; one or more extension pipes adapted to be coupled to said inner pipe for forming a pipe string; and an outer pipe or pipestring extending from the surface and surrounding said inner pipe or one or more extending pipes with clearance, said outer pipe communicating with a supply of flushing fluid.

In such a drilling apparatus, the flushing fluid is pumped downwardly through the annular space formed in the upper portion between the outer pipe and the inner pipe and further downwardly between the wall of the borehole and the inner pipe, after which the flushing fluid flows through the openings in the wall of the inner pipe into said pipe, and through said inner pipe upwardly while entraining the drilled cores, so that said cores can subsequently be collected at the surface.

Heretofore, the outer pipe of the apparatus had to be cemented in the ground in order to prevent the outer pipe from being pushed out of the borehole due to the pressure of the flushing fluid, and also to avoid direct escape of the flushing fluid between the outer wall of the outer pipe and the wall of the borehole towards the surface, since the upper formations often consist of unconsolidated material. Therefore, the length of the outer pipe is determined by the depth at which the first solid formations occur, at which formations the risk of a direct escape of flushing fluid past the wall of the borehole is eliminated.

The prior art apparatus is satisfactory for continuous coring drilling operations on the mainland, but it is not suitable for offshore drilling operations, because then cementing the outer pipe, e.g., in the bottom of the sea gives rise to insuperable difficulties.

Therefore, an object of the invention is to provide a drilling apparatus of the kind referred to which is also suitable for continuous coring drilling operations at offshore locations.

According to the invention, the outer pipe or pipe string extends over the full length of the inner pipe or inner pipe string and is drivingly connected with the driving means, the inner pipe being connected with the outer pipe, so that the inner pipe is rotated with the latter upon rotation thereof, a seal being provided between the two pipes near the lower end below the openings in the inner pipe.

Hence, in the apparatus according to the invention, it is unnecessary to cement the outer pipe because this pipe substantially extends from the driving means to the bottom of the borehole, so that there is an annular passage fully confined by pipes for pumping down the flushing fluid.

Since in the apparatus in accordance with the invention it is no longer necessary to use mud as a flushing fluid in order to keep also open the part of the borehole which is not supported by the outer pipe (as in the known drilling apparatus) a flushing fluid of low viscosity, e.g., water, may be used which at the same time can be used for loosening the drilled cores by spray action before they are carried upwardly by the flushing fluid.

In order to achieve this, preferably two sets of spray openings are provided, the openings of one set being inclined downwardly and those of the other set being inclined upwardly.

It may then be advantageous that the cutting member only consists of a number of knives provided at the inner wall of the inner pipe which at the most protrude somewhat in radial direction from said inner wall. By this feature the possibility is created to lower a sampling device, such as an apple drill or a bailer, through the inner pipe and beyond the cutter member until it penetrates the undisturbed formation, for which a closable opening may be provided near the upper end of the stationary discharge tube.

In a preferred embodiment of the invention, there is arranged about the upper end of the inner pipe and of every extension pipe a sleeve extending beyond the terminal end of said pipe in which sleeve the lower end of a piece of tubing communicating with the discharge of flushing fluid or of an extension pipe can be received, a ring-shaped apertured member surrounding said sleeve, and protruding radially from the sleeve being provided, while the outer pipe near its upper end is provided with an inner thread, below which a shoulder is formed on the inner wall projecting from said wall so that the ring-shaped member can bear on this shoulder and can be clamped between said shoulder and the lower end surface of a piece of tubing connected with the driving means or of an extension pipe, threadedly engaged by an outer thread formed in the lower end portion of said piece and extension pipe, with the upper end of said outer pipe.

The inner pipe may be made of a synthetic material, for instance polyvinylchloride.

Preferably the ring-shaped member consists of two segments retained in abutting relationship in a groove formed in the sleeve by a resilient band. Then the apertures in the ring-shaped member may be formed by spaced recesses extending from the inner periphery of said ring.

Because of the fact that the distance between the terminal end of the pipe which first engages the soil and the spray openings in the wall of the inner pipe determines the best conditions for an upward transport of the cores and consequently depends on the nature of the drilled formations, it may be desirable to provide for the possibility of varying this distance during drilling.

Therefore, in a second embodiment of the apparatus according to the invention, in which the inner pipe and the inner extension pipes are coupled by means of a conventional screw type connection, the inner pipe or the inner pipe string is coupled at its upper end to an inner length of tubing, which is shiftably disposed in an outer length of tubing connected with the driving means, the lower end of the inner pipe being provided with a set of ribs extending longitudinally on the inner wall of the pipe and adapted to be engaged by longitudinal ribs at the inner wall of the outer pipe during rotation thereof. By these features, the inner pipe can be displaced with respect to the outer pipe sothat as a consequence thereof the distance between the spray open-

ings in the inner pipe and the lower end of the outer pipe may be varied.

The invention will be further elucidated with reference to the drawing, in which:

FIG. 1 is a vertical section of a drilling apparatus according to the invention, the inner pipe being stationary in the outer pipe;

FIG. 2 is a vertical section on a larger scale of the connection between the inner pipe and the outer pipe;

FIG. 3 is a vertical section on a larger scale of the connection between the inner pipe and the outer pipe in a second embodiment of the invention;

FIG. 4 is a cross section taken along line IV—IV in FIG. 3;

FIG. 5 shows the upper part of the second embodiment and

FIG. 6 illustrates another embodiment of the lower part of the inner pipe.

The drilling apparatus according to the invention comprises a drilling head **1**, which is vertically movable by any suitable means (not shown). Said head comprises a housing **2**, in which two worms **3** connected with driving means are accomodated, said worms being in meshing engagement with a worm-wheel **4** mounted on a sleeve **5** supported by roller bearings, so that sleeve **5** is rotated by the worm-wheel and the worms. Above the casing **2** and secured thereto is a connecting piece **6**, which by means of a curved length of tube **7** may be connected with a pump for a flushing fluid. Connecting piece **6** is also connected to a member **8** having a curved length of tube **9** for discharging the flushing fluid and the cores carried therewith so that the cores can be collected.

At the lower part of sleeve **5** two short lengths of tube **10** and **11** are secured by means of flanges. Through sleeve **5** and tubes **10** and **11** an inner connecting tube **12** extends with clearance. Connecting tube **12** extends upwardly through connecting piece **6** and is connected at its upper end to the connecting piece **8**. In this manner the annular passage between the sleeve **5**, the tubes **10** and **11** and the inner connecting tube **12** is in communication with the pump for flushing fluid through the length of tube **7**, while the interior of the inner connecting tube **12** communicates with the tube **9** for the flushing fluid.

The length of pipe **11** is connected with the outer pipe **13** by means of a screwthread. The inner connecting tube **12** is connected with the inner pipe **14** in the manner illustrated more in detail in FIG. **2**. At the lower part of the inner pipe **14** and the outer tube **13**, a member **17** is secured, which is provided with nozzles **15** and **16** which are inclined downwardly and upwardly respectively. Member **17** carries a cutting member **18** which may be provided with cutting elements **19**.

Connecting piece **8** may be provided with an aperture **21** closed by a closure device **20**, which is adapted to be opened. Aperture **21** allows lowering into the borehole through pipes **12** and **14** a special tool, such as a corer for taking samples.

In operation of the drilling apparatus, outer pipe **13** is rotated by the worm gear **3**, said outer pipe **13** carrying the inner pipe **14** therewith, so that both pipes will be rotated. The flushing fluid is pumped through connecting piece **6** into the annular space between the outer pipe **13** and the inner pipe **14**. The fluid then flows through the spray openings **15** and **16** into the inner pipe **14** and through this pipe upwardly and leaves the drilling apparatus through connecting piece **8**. The cores drilled by the cutting member **18** are carried by the upwardly flowing flushing fluid, and can be collected after the flushing fluid is discharged through the length of tube **9**.

FIG. **2** shows in more detail the connection between the inner connecting pipe **12** and the inner pipe **14** or the connection between the inner pipe **14** and an extension inner pipe or the connection between two extension inner pipes. A sleeve **22** is provided around the upper end of the inner pipe **14**, said sleeve extending beyond the terminal end of said pipe **14**, so that the lower end of the inner pipe **12** can be inserted in the protruding part of sleeve **22** until the lower end of the pipe **12** abuts the upper end of the pipe **14**. A ring-shaped member **23** is received by sleeve **22**, said ring **23** consisting of two segments, which are retained against each other by means of a resilient band **24** disposed in a recess formed in the outer peripheral surface of the sleeve **22**. A number of spaced recesses **25** are formed in the inner peripheral surface of the ring **23** so that after mounting the ring around the sleeve **22**, there are continuous apertures in the ring. The ring **23** is clamped between a shoulder **26** formed on the inner wall of the outer pipe **13** and the lower terminal end of pipe **11**, which is connected with the outer pipe **13** by means of an outer screw thread formed on pipe **11** threadedly engaging an inner screw thread formed on pipe **13**. In this manner the outer pipes **11** and **13** and the inner pipes **12** and **14** are coupled, whereas at the same time the inner pipe **14** is connected with the outer pipes **11** and **13**. The inner pipes are made of a synthetic material, such as polyvinylchloride.

FIGS. **3** and **4** show a second embodiment of the drilling apparatus according to the invention. In this embodiment, the inner pipe **27** can be reciprocated inside the outer pipe **28** in order to vary the distance between the spray openings and the cutting member **30**. It is also possible to draw the inner pipe **27** completely out the outer pipe **28** and to replace the member having the spray openings by another member, for instance by the member shown in FIG. **3** in which the spray openings **29** are directed outwardly, so that if desired the apparatus can be operated not according to the counterflush system but according to the system in which the flushing fluid is pumped downwardly through the inner pipe and flows through the annular space between the inner and the outer pipe to the surface.

In this embodiment, the inner pipes are coupled to each other by means of a conventional screw connection **31**, while the outer pipes are connected by means of a socket **32**.

The inner pipe **27** has protruding ribs **33** formed on its outer surface and the outer pipe **34** has a set of protruding ribs **34** formed on its inner surface, so that upon rotation of the outer pipe the ribs **34** engage the ribs **33** of the inner pipe carrying pipe **27** into rotation. A sealing ring **35** is mounted around the member having the spray openings, which ring **35** in the outermost position of the inner pipe **27** abuts an abutment **36** formed on the inner wall of the outer pipe **28**.

The upper part of the inner pipe **27** is connected by means of a connecting member **37** (FIG. **5**) with a hollow shaft **38** extending through the gland **39** and being connected with the flushing head **40**. On said head **40**

a stationary discharge pipe **41** is mounted and head **40** is suspended on a device (not shown) by means of a hook **42** attached to the head so that said head and inner pipe can be reciprocated and the distance between the spray openings and the cutting member can be varied.

For the rest, the drilling head shown in FIG. **5** is similar to the head shown in FIG. **1** with the exception of the connecting member **43,** which is longer than the member **6** in FIG. **1.** Therefore, like elements in FIG. **5** are denoted by like reference characters.

FIG. **6** shows another embodiment of the lower portion **44** of the inner pipe. Here vertically extending knives **45** are provided which protrude axially as well as radially. Spray openings **46** directed downwardly are arranged between the knives. Upwardly directed spray openings **47** are provided in a cylindrical part of the member **44.** Protruding members **48** are mounted on the outer wall of the lower portion **44** in front of the spray openings. In these members **48** a trough-shaped recess is formed so that part of the flushing fluid flowing downwardly is deflected towards and through the spray openings **47** as indicated by the arrows.

I claim:

1. A rotary drilling apparatus for continuous coring according to the counterflush system, in which cores of the drilled formation are continuously transported to the surface by means of a flushing fluid, said apparatus comprising: an inner pipe means having upper and lower ends, an outer pipe means having upper and lower ends, a driving means for rotating said outer pipe means, a cutting member connected to said lower end of the inner pipe means at the inner surface thereof, said inner pipe means having a wall with spray openings extending through said wall near said cutting member, at least one extension pipe coupled to said inner pipe means at the upper end thereof for forming a pipe string, a stationary discharge tube connected to said extension pipe at the upper end thereof for receiving flushing fluid carrying the cores, said outer pipe means extending from the ground surface and surrounding said inner pipe means and extension pipe with clearance, said outer pipe means communicating with a supply of flushing fluid, said outer pipe means being connected to said driving means, said inner pipe means being connected with said outer pipe means so that the inner pipe means is carried into rotation by the outer pipe means upon rotation thereof, a seal between the two pipe means near the lower ends thereof and below the spray openings formed in the wall of the inner pipe means, a sleeve arranged about the upper end of the inner pipe means and said extension pipe, said sleeve extending beyond the terminal end of said extension pipe and receiving said discharge tube therein for the discharge of flushing fluid, a ring-shaped apertured member surrounding said sleeve and protruding radially from the sleeve, said outer pipe means being provided at its upper end with an inner thread and a shoulder therebelow, and a tube connected in driving relation with said driving means and having an outer thread engaged with the inner thread of said outer pipe means, said ring-shaped member bearing on said shoulder and being clamped between said shoulder and an end surface of the lower end of said tube.

2. Apparatus according to claim **1,** wherein the inner pipe means is made of a synthetic material.

3. Apparatus according to claim **1,** wherein said stationary discharge tube has a closable opening at the upper end thereof for insertion of a sampling device through the inner pipe means.

4. Apparatus according to claim **1,** wherein said ring-shaped member comprises two segments supported in abutting relationship in a groove provided in said sleeve, and a resilient band extending around said segments to hold the same in said groove.

5. Apparatus according to claim **4,** wherein said apertures in the ring-shaped member are formed by spaced recesses extending from the inner periphery of said ring-shaped member.

6. Apparatus according to claim **1,** wherein two sets of said spray openings are provided, the openings of one set being inclined downwardly and those of the other set being inclined upwardly.

7. Apparatus according to claim **6,** wherein said cutting member comprises a plurality of knives mounted at the inner wall of the inner pipe means and protruding in radial direction.

8. A rotary drilling apparatus for continuous coring according to the counterflush system, in which cores of the drilled formation are continuously transported to the surface by means of a flushing fluid, said apparatus comprising: an inner pipe means having upper and lower ends, an outer pipe means having upper and lower ends, a driving means for rotating said outer pipe means, a cutting member connected to said lower end of the inner pipe at the inner surface thereof, said inner pipe means having a wall with spray openings extending through said wall near said cutting member, at least one extension pipe coupled to said inner pipe means at the upper end thereof for forming a pipe string, a stationary discharge tube connected to said extension pipe at the upper end thereof for receiving flushing fluid carrying the cores, said outer pipe means extending from the ground surface and surrounding said inner pipe means and extension pipe with clearance, said outer pipe means communicating with a supply of flushing fluid, said outer pipe means being connected to said driving means, said inner pipe means being connected with said outer pipe means so that the inner pipe means is carried into rotation by the outer pipe means upon rotation thereof, a seal between the two pipe means near the lower ends thereof and below the spray openings formed in the wall of the inner pipe means, said inner pipe means including a plurality of pipe sections coupled by a screwtype connection, the inner pipe means being axially displaceable within the outer pipe means, a first set of ribs extending longitudinally on the outer pipe means at the inner surface thereof, and a second set of longitudinal ribs on the inner pipe means at the outer surface thereof engaged with the first set of ribs during rotation thereof.

9. Apparatus according to claim **8,** wherein said cutting member comprises a plurality of knives mounted at the inner wall of the inner pipe means and protruding in radial direction.

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