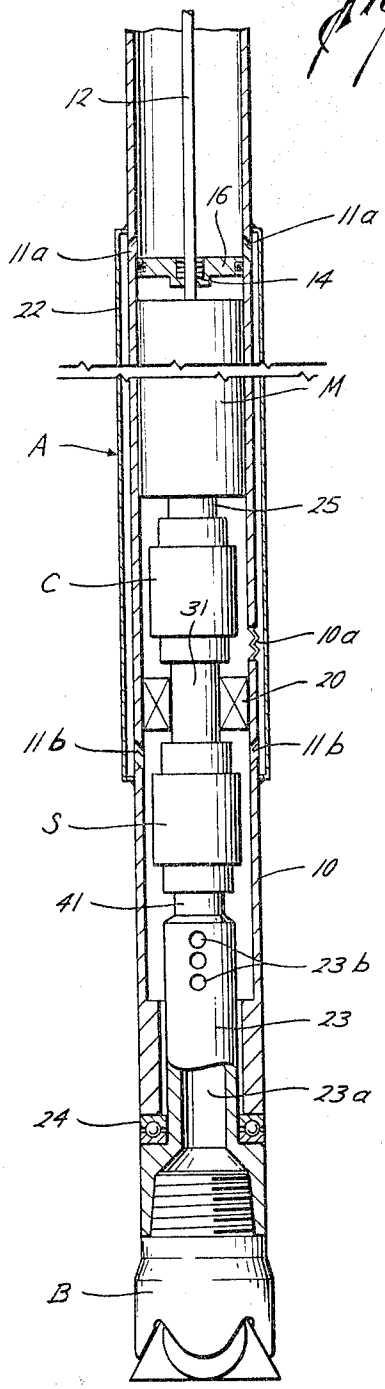
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WELL DRILLING APPARATUS

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Fig. 1




Roy H. Cullen
Charles H. Elliott
Jimmie R. Aker
Thomas J. Gilchrist
INVENTORS

BY Hayden & Prevel

ATTORNEYS

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Fig. 2

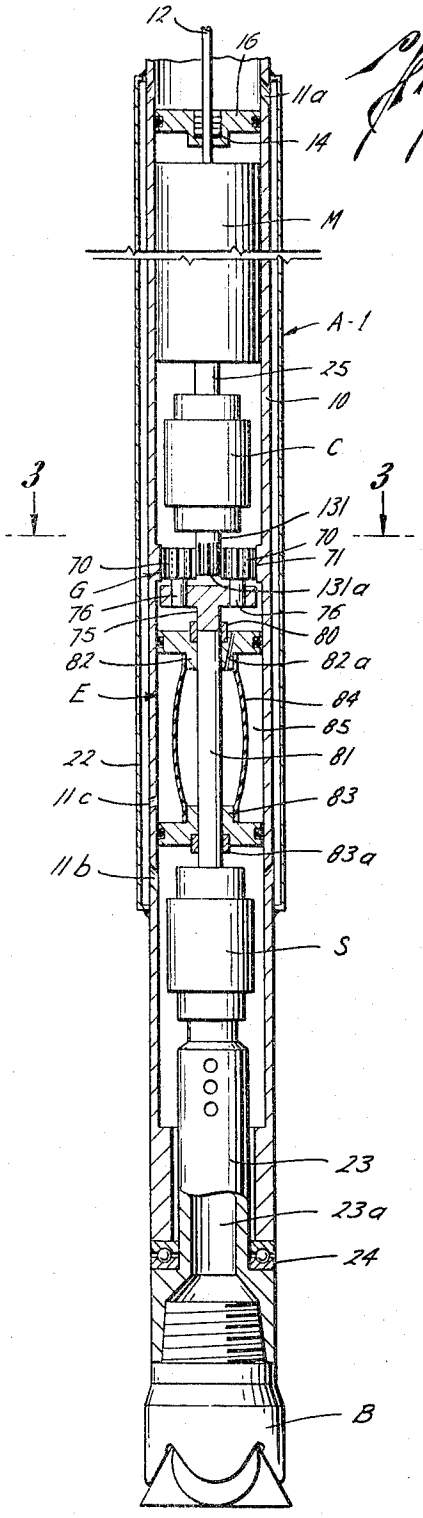



Fig. 3

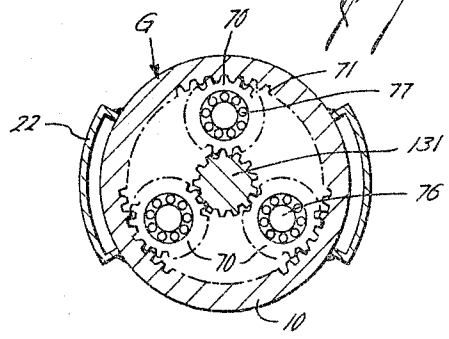
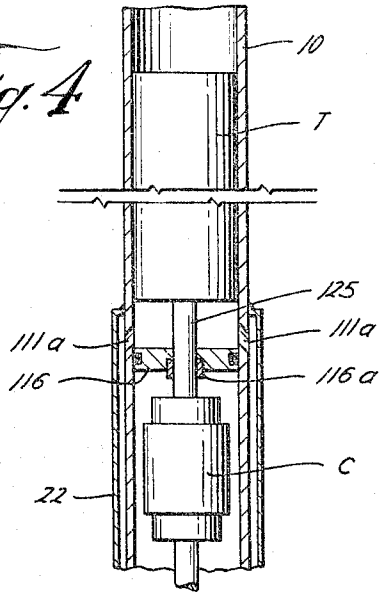



Fig. 4





Roy H. Cullen
Charles H. Elliott
Jimmie R. Aker
Thomas J. Gilchrist
INVENTORS

BY Hayden & Pravel

ATTORNEYS

United States Patent Office

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3,291,230

# WELL DRILLING APPARATUS

Roy H. Cullen, Charles H. Elliott, Jimmie R. Aker and Thomas J. Gilchrist, Houston, Tex.; said Elliott, said Aker, and said Gilchrist, assignors to said Cullen

Original application Nov. 12, 1963, Ser. No. 323,024. Divided and this application Oct. 18, 1965, Ser. No. 496,988

8 Claims. (Cl. 175—101)

This application is a division of copending United States Patent application Ser. No. 323,024, now Patent No. 3,232,362.

This invention relates to new and useful improvements in well drilling apparatus.

An object of the present invention is to provide a new and improved drilling apparatus wherein an oil bath is provided in a portion thereof and wherein means are provided for substantially equalizing the pressure of the oil in the oil bath with the pressure of drilling mud or other fluid disposed externally of the oil bath to inhibit intrusion of the drilling mud or other fluid into the oil bath.

Another object of this invention is to provide a new and improved drilling apparatus having a tubular body with upper and lower seal means defining an oil chamber, and an expansible means for imposing the pressure of fluid externally thereof on the oil in the oil bath while maintaining the fluid and the oil separated, such fluid and oil being at a pressure higher than the pressure of the fluid below the lower seal means to provide a positive pressure for inhibiting intrusion of the fluid into the oil chamber.

A particular object of this invention is to provide a new and improved drilling apparatus wherein a motor having a shaft operably connected therewith is disposed in an oil chamber with the shaft extending through a flexible sleeve and a lower seal, such flexible sleeve forming at least a portion of the wall of the oil chamber so that pressure of drilling mud or fluid externally of the oil chamber may be substantially equalized with the pressure of the oil in the oil chamber.

The preferred embodiment of this invention will be described hereinafter, together with other features thereof, and additional objects will become evident from such description.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

FIG. 1 is a view, partly in section and partly in elevation, schematically illustrating the well drilling apparatus of this invention;

FIG. 2 is a view, partly in elevation and partly in section, schematically illustrating a modified form of the invention;

FIG. 3 is a cross-sectional view taken on line 3—3 of FIG. 2; and

FIG. 4 is a view, partly in section and partly in elevation, schematically illustrating a portion of another modification of the present invention.

In the drawings, the letter A designates generally the well drilling apparatus of this invention which is adapted to be disposed in a hole for the drilling of an oil well or the like. As schematically illustrated in FIG. 1, the apparatus A includes a housing or drill collar 10 into which a motor M is press-fitted or otherwise secured for driving a drill bit B to drill the well. The motor M is interconnected with the drill bit for imparting rotation thereto, and for accomplishing such drive, a slip clutch C and a shock absorber S are included in the connection between the motor and the bit. By reason of the present invention, the motor M is located in the well in proximity to



the drill bit B and is protected against damage during drilling by the interaction of the shock absorber S and the slip clutch C, while at the same time drilling fluid is circulated to dissipate heat generated by the motor M and other apparatus, as will be more evident hereinafter.

In FIG. 1 of the drawings, a housing or drill collar 10 is schematically illustrated. The upper end of the housing 10 is connected to a drill string which preferably is a flexible hose type of drill string. For conducting electrical power to the motor M, an electrical cable 12 extends from the surface of the well to the motor M as seen in FIG. 1. Such electrical cable thus extends inside of the flexible hose or other drill string so that the drilling mud or other drilling fluid which flows through the drill string to the drill bit flows around such cable 12. The cable 12 is of course insulated to prevent any short circuiting. In order to prevent the mud within the drill string from entering the area where the motor M and the clutch C are located, a seal or packing 14 is mounted in the housing 10 above the motor M for providing a fluid-tight seal around the cable 12. Such packing 14 is preferably carried by a disc or plate 16 having the packing as a central opening through which the cable 12 extends. An additional seal 20 is provided below the slip clutch C so that the area between the seal 14 and the packing or seal 20 is sealed off from the drilling mud or fluid.

In order to convey the drilling mud or fluid around such sealed off area and deliver it to the drill bit B for drilling purposes, an annular sleeve 22 or alternatively, longitudinal tubes, are welded or otherwise formed on the housing 10 for bypassing fluid from above the plate 16 to the area below the packing 20 through housing openings 11*a* and 11*b*.

Preferably the sealed off area between the packing elements or assemblies 14 and 20 is filled with oil or other lubricant which further assists in preventing an intrusion of the drilling mud into the vicinity of the motor M and the slip clutch C. To allow for fluctuations in mud and oil pressures in the system, any suitable compensating means such as indicated by the flexible diaphragm 10*a* may be employed. A more detailed type of pressure compensating apparatus is illustrated in FIG. 6, which may be used in the FIG. 1 form of the invention if desired.

The drilling mud is discharged from the housing 10 into a bore 23*a* of a drill bit shank 23 through suitable lateral openings 23*b*. The drilling mud then flows through the drill bit B for discharge therefrom during the drilling operation in a conventional manner. Bearings such as indicated at 24 may be provided to facilitate the rotation of the drill bit B with respect to the housing 10 and the rest of the drill string connected thereabove.

In the use or operation of the drilling apparatus of this invention, the apparatus A is preferably lowered into the well bore or hole on a flexible hose or similar type of drill string. With the drill bit B positioned on the bottom of the hole for drilling, the drilling mud or other fluid, liquid or gas, is circulated through the drill string and down through the bypass tubes or sleeve 22 to the drill bit B. The electrical power is supplied to the motor M through the electrical cable 12 which thereby drives the drill bit B in a rotational direction through the drive connection which includes the clutch C and the shock absorber S.

During the drilling, a large amount of heat is generated by the various parts of the apparatus, particularly the motor M, the slip clutch C and the shock absorber S. The circulating fluid which flows in the sleeve 22 around the oil bath dissipates the heat generated in the oil bath so as to continuously remove heat from the motor M and slip clutch C. Also, the mud or other fluid removes heat generated by shock absorber S.

In FIGS. 2 and 3, the invention is illustrated wherein the apparatus A–1 corresponds with the apparatus A of

FIG. 1, except that a gear train G and a pressure equalizing section E are incorporated in the apparatus A–1. The parts of the apparatus A–1 which are identical or similar to the apparatus A of FIG. 1 are indicated with the same letters or numerals.

The gear train G is connected to the slip clutch C through a shaft **131**. The shaft **131** is a pinion shaft which has a pinion gear **131***a* formed at its lower end for meshing with a plurality of idler gears **70**. The idler gears are adapted to engage the internal gear teeth of an internal ring gear **71** which is preferably formed integrally within the housing or tubular body **10**.

The idler gears are supported and are connected to a carriage shaft **75** through suitable support rods **76** having bearings **77** of the needle type or any other suitable bearing construction. Thus, as the shaft **131** is rotated, the idler gears **70** are caused to rotate and impart a rotation to the carriage shaft **75**. By reason of such planetary gear system G, the speed of the shaft **75** is reduced as compared to the speed of the shaft **131** and the motor shaft **25**. In addition, the torque developed at the shaft **75** and therefore at the bit B is increased by reason of the gear train G as compared to the torque developed at the motor shaft **25**.

The shaft **75** is suitably connected with any coupling such as indicated at **80** to a shaft extension or shaft **81** which joins with the upper end of the shock absorber S.

The pressure equalization apparatus E includes upper and lower heads **82** and **83** and a flexible sleeve **84** formed of rubber or other similar elastic material. A passage **82***a* in the head **82** communicates the area internally of the sleeve **84** with the area in the vicinity of the motor M and the clutch C, as well as the gear train G. The area **85** externally of the sleeve **84** is in communication with the drilling mud or other fluid which is circulating in the apparatus A–1 by means of a mud port **11***c*, the number of which may be varied as desired. The lower head **83** preferably carries a flexible packing **83***a* which seals off the oil in the sleeve **84** from the mud below the head **83**. Since the mud circulating downwardly through the sleeve or tube **22** passes into the body **10** through the port or ports **11***b*, there is a pressure drop across such port or ports **11***b*. The higher mud pressure acts on the flexible sleeve **84** through the port **11***c* so that the pressure of the oil in the oil bath is substantially equal to the pressure of the fluid in the sleeve **22** but is higher than the pressure of the fluid in the body **10** below the seal **83**. Such higher oil pressure inhibits or prevents mud from entering into the oil in the oil bath through the seal **83** around the shaft **81**. Thus, with the equalizing apparatus E, the variations in the mud and oil pressures may be compensated automatically while maintaining such mud and oil separately from each other.

The operation of the apparatus of FIGS. 2 and 3 is identical with that described heretofore in connection with the apparatus A of FIG. 1, except for the function of the gear train G which provides the lower speed and increased torque at the bit B for a given motor speed at the motor M. The gear train G develops a considerable amount of heat during its operation and such heat is dissipated to the oil and then to the circulating mud which flows downwardly through the sleeve or cylinder **22** surrounding the housing **10**, in the same manner as described heretofore in connection with FIG. 1. The other portions of the apparatus A–1 are likewise cooled by the circulating drilling mud or fluid, which may be liquid or gas, during the drilling operation.

In FIG. 4, a further modification is illustrated wherein a turbine T is operated by drilling mud and is used in place of the electric motor M. Thus, the turbine T is operated by the drilling mud or fluid which flows downwardly through the drill string and into the housing **10** for imparting rotation to the turbine T in a known manner. The turbine discharge flows into the housing or tubular body **10** below the turbine T in the vicinity of the turbine shaft **125** and is directed through inlet ports **111***a* to the sleeve or cylinder **22** for conducting the drilling mud or fluid as in the previous forms of the invention. It is to be noted that the shaft **125** is connected to a slip clutch C and that the apparatus below the slip clutch C is identical to that illustrated in FIG. 2.

When the turbine T is used as the means for imparting rotation to the drill bit B, the clutch C and the shock absorber S serve primarily to protect the gear train G. In the absence of the slip clutch C and the shock absorber S, the gear train G could be severely damaged in the event the drill bit is intermittently subjected to extreme loads or is suddenly stopped, as explained heretofore in connection with the form of the invention shown in FIG. 1. Thus, the gear train life and dependability are appreciably enhanced by the inclusion of the clutch C and the shock absorber S in the driving connection from the turbine T to the drill bit B. The oil is employed below a head or plate **116** having a fluid-tight seal **116***a* around the shaft **125** (FIG. 4) so as to operate the turbine T within the drilling mud or fluid while still separating such mud or fluid from the oil bath or chamber provided within the housing **10**.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

**1.** A drilling apparatus, comprising:
(a) a tubular body adapted to be supported in a well bore,
(b) upper and lower seal means in said body for confining oil therein to form an oil chamber,
(c) a flexible sleeve in said body between said lower seal means and said upper seal means,
(d) said flexible sleeve forming at least a portion of the wall of the oil chamber, and
(e) means establishing communication between the area in said body externally of said flexible sleeve and the area externally of said body for exposing the flexible sleeve and the oil therein to the pressure of the fluid in the area externally of said body to substantially equalize the pressure of said oil with that of said fluid.

**2.** The apparatus set forth in claim **1**, wherein:
(a) said flexible sleeve is adapted to be disposed around an elongate object.

**3.** The apparatus set forth in claim **1**, including:
(a) passage means with said tubular body for bypassing circulating drilling mud externally of said tubular body from a point above said upper seal means to a point below said lower seal means, and
(b) said means establishing communication including a port in said tubular body communicating said passage means with the area externally of the flexible sleeve within said tubular body.

**4.** The apparatus set forth in claim **1**, including:
(a) passage means with said tubular body for bypassing circulating drilling mud externally of said tubular body from a point above said upper seal means to a point below said lower seal means, and
(b) means for reducing the pressure of the drilling mud as it flows from said passage means into the tubular body below said lower seal means so that the pressure of the oil in the oil chamber is higher than the fluid below the lower seal means.

**5.** The apparatus set forth in claim **1**, including:
(a) passage means with said tubular body for bypassing circulating drilling mud externally of said tubular body from a point above said upper seal means to a point below said lower seal means, and
(b) orifice means connecting said passage means with the area in said tubular body below said lower seal

means for reducing the pressure of the drilling mud as it flows from said passage means into the tubular body below said lower seal means so that the pressure of the oil in the oil chamber is higher than the fluid below the lower seal means.

6. A well drilling apparatus, comprising:

(a) a tubular body adapted to be supported in a well bore,

(b) a motor having a shaft operably connected therewith,

(c) upper and lower seal means in said tubular body for confining a lubricant in a bath around said motor and at least a portion of said shaft,

(d) a flexible sleeve disposed around said shaft in said body and enclosing a portion of said lubricant, and

(e) means establishing communication between the area in said body externally of said flexible sleeve and the area externally of said body for exposing the pressure of drilling mud to said flexible sleeve for equalizing such pressure with the pressure of the lubricant in the tubular body.

7. The apparatus set forth in claim 6, including:

(a) an annular bypass sleeve surrounding a length of said tubular body within which the lubricant bath is disposed,

(b) the tubular body having an upper port above said upper seal means for the flow of fluid from the tubular body into said annular bypass sleeve, and

(c) the tubular body having a lower port below said lower seal means for the discharge of fluid from said annular bypass sleeve into said tubular body, whereby fluid flowing through said annular bypass sleeve serves to cool the lubricant and parts therein.



8. The apparatus set forth in claim 6, including:

(a) an annular bypass sleeve surrounding a length of said tubular body within which the lubricant bath is disposed,

(b) the tubular body having an upper port above said upper seal means for the flow of fluid from the tubular body into said annular bypass sleeve,

(c) the tubular body having a lower port below said lower seal means for the discharge of fluid from said annular bypass sleeve into said tubular body, whereby fluid flowing through said annular bypass sleeve serves to cool the lubricant and parts therein,

(d) said lower port serving to reduce the pressure of the fluid as it is discharged into the tubular body from the annular bypass sleeve, and

(e) said tubular body having an intermediate port located between the upper port and the lower port and communicating the annular bypass sleeve with the external surface of the flexible sleeve for maintaining the lubricant at a pressure substantially equal to the pressure of the fluid flowing through the bypass sleeve and slightly higher than the pressure of the fluid in the tubular body below the lower seal means.

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

D. H. BROWN, *Assistant Examiner.*