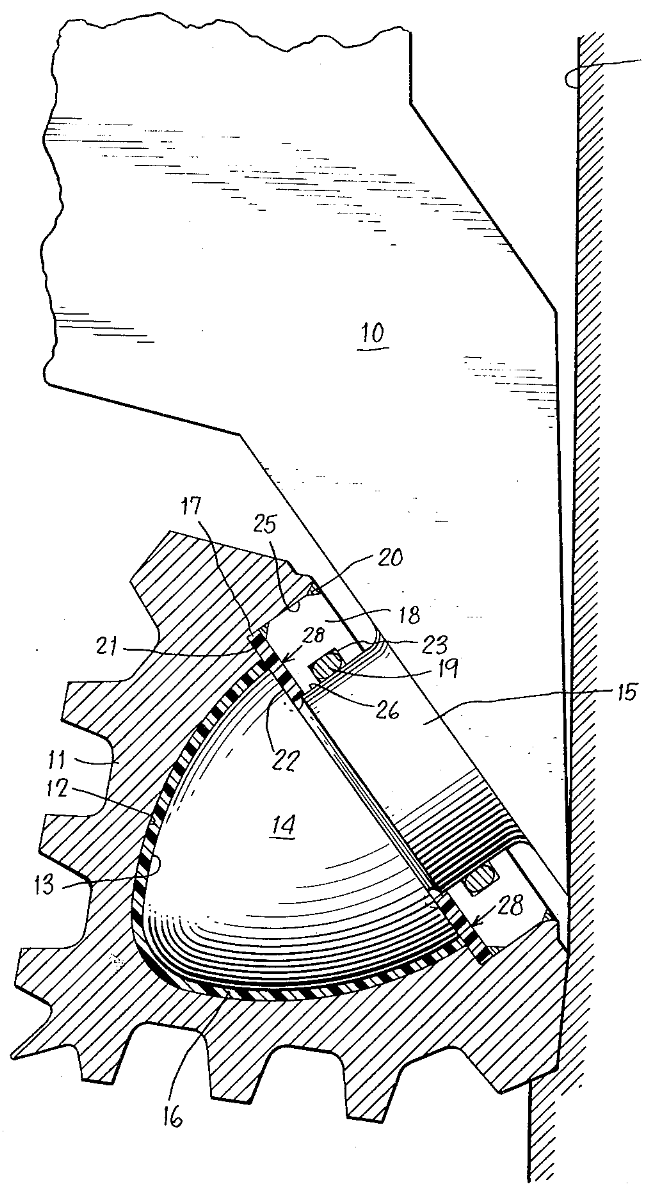
July 31, 1962 C. GROS 3,047,344

DRILLING TOOLS FOR TURBINE DRILLS

Filed April 7, 1959 2 Sheets-Sheet 1

Fig. 1.



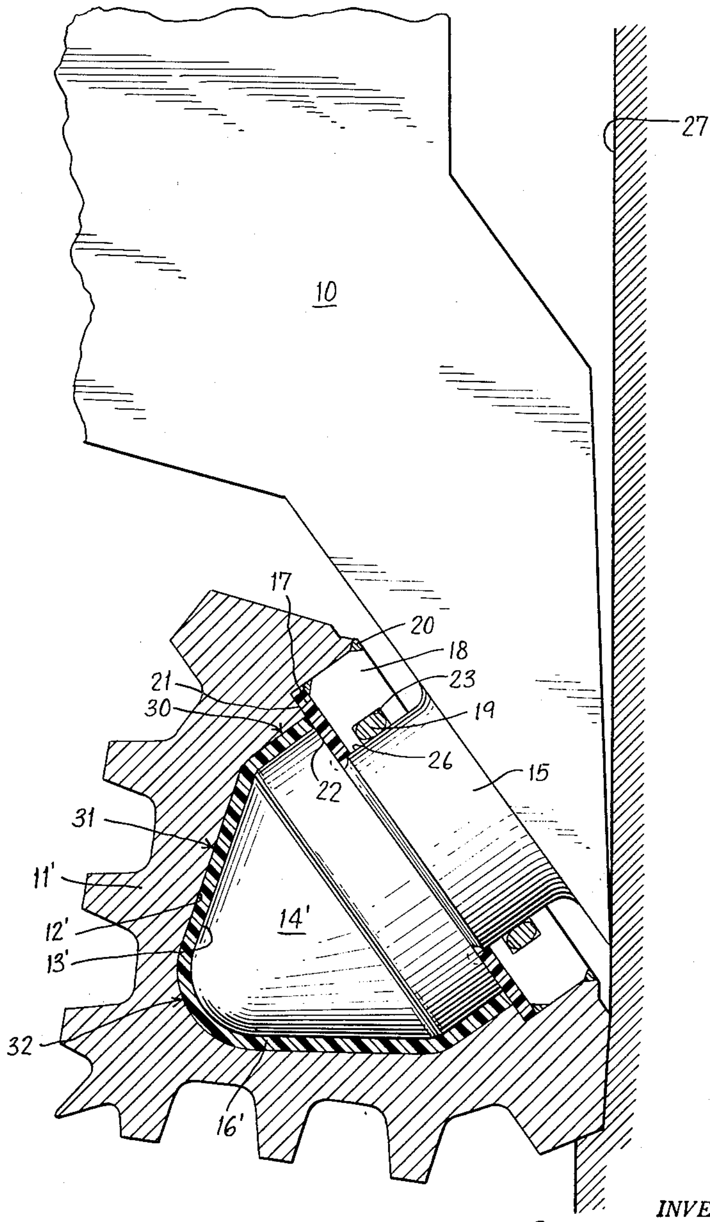
INVENTOR.
CHARLES GROS
BY Cory, Hart & Stemple
ATTORNEYS

July 31, 1962 C. GROS 3,047,344

DRILLING TOOLS FOR TURBINE DRILLS

Filed April 7, 1959 2 Sheets-Sheet 2

Fig. 2.



INVENTOR.
CHARLES GROS
BY Cuny, Hart & Stemple
ATTORNEYS

United States Patent Office

3,047,344

Patented July 31, 1962

3,047,344

DRILLING TOOLS FOR TURBINE DRILLS

Charles Gros, La Tronche, France, assignor to Etablissements Neyrpic, Grenoble, France, a corporation of France

Filed Apr. 7, 1959, Ser. No. 804,751
1 Claim. (Cl. 308—8.2)

This invention relates to turbine driven machines for drilling wells and more particularly to improvements in the drilling tools employed by such machines.

Turbine drills utilize the power of a fluid flowing under pressure through a turbine unit composed of stationary blades carried by the body of the turbine which itself is fixed to the lower extremity of the drill string and of rotor blades which are carried by a common shaft at the lower extremity of which is fixed the drilling tool. This type of drill has numerous economic and operating advantages over the conventional rotary system. One of its advantages is the greater turbine power which it makes available right at the hole bottom. This is due in large part to the fact that the turbine drill inherently turns faster than the rotary. It has been found, however, that this turbine drill advantage has not been fully realized due to the continued use in the same of the drilling tools which were designed and made for the rotary system. At the speeds of rotation at which drilling tools are used in the rotary system the bearings with which the cutting wheel of such tools are usually equipped, have a resistance to wear comparable to that of the working surfaces of the cutting wheels. Consequently, the life of the bearings in such tools is substantially the same as the life of the cutting wheels thereof when the drilling tools are employed in rotary systems. This is not the case, however, when such tools are used in turbine drilling in which operations the speeds of rotation imposed on the tools are much higher. At these higher speeds, the wear on the bearings is considerably faster than the wear on the cutting wheels. As a result of this more rapid wear of the bearings, it is necessary to more frequently change the drilling tools even though the working surfaces of the cutting wheels are only partially worn. As such replacement requires pulling up the drilling string and then restoring it to drilling position after the change has been made, it is evident that it entails substantial loss of time and expense.

It is the primary object of the present invention to eliminate the aforesaid drawback by providing an improved type of drilling tool which need not be changed until the working surfaces of the cutting wheel have been worn to the extent that a new cutting wheel is required.

Another object of the invention is to provide an improved drilling tool embodying a novel method of mounting the cutting wheels thereof.

In accordance with the aforesaid objects, the drilling tool of this invention is so constructed that the rotation of the cutting wheels thereof about associated axial member is accomplished through a sliding action between the rotor metallic surface of a cutting wheel and/or the cooperating metal supporting surface of an associated axial member and a surface or surfaces of a lubricating material, preferably a solid, self-lubricating material such as is disclosed in copending U.S. application Serial No. 788,741, filed January 26, 1959, by Jacques Jean Caubet for Anti-Friction Material. The parts are so constructed that the contact between the metal and self-lubricating material takes place on a surface of revolution of large area and of such form that it is enabled to take care of both the applied axial and radial forces. Preferably the self-lubricating material is made in the form of a cap

so that it continuously extends over the entire area of contact between each cutting wheel and the axial member on which such wheel is rotatably mounted. This cap may be prefabricated and then fixed by any suitable means to either the cutting wheel or its associated axial member, or left free to turn both on the axial member and inside the cutting wheel.

In accordance with another feature of the invention, the drilling tool is so constructed, that the means for connecting the cutting wheels thereof to their associated axial members constitute thrust means adapted to absorb or cushion the reverse axial forces, and may also function as sealing means between the cutting wheels and the body of the tool.

A better understanding of the invention will be obtained from the following description when read in connection with the accompanying drawings which show two embodiments of the invention by way of example and in which

FIG. 1 is a side elevational view of a trepan arm fitted with its cutting wheel, the latter of which and parts associated therewith being shown in vertical section.

FIG. 2 is a similar view showing a modification of the drilling tool depicted in FIG. 1.

The numeral **10** indicates generally a trepan arm of usual construction for rotatably supporting a cutting wheel **11** of a construction suitable for boring shafts with turbine driven drilling machines. The arm **10** and its associated wheel **11** form part of the drilling tool which is used in such machines and which usually includes a plurality of such associated trepan arms and cutting wheels. As previously indicated, the drilling tool is provided at the lower extremity of the rotatable shaft which carries the rotor blades of the turbine unit. One form of turbine construction with which a drilling tool embodying the present invention may be associated is shown in copending U.S. application Serial No. 659,635, filed May 16, 1957, by Charles Gros for Turbines for Drilling and Coring, now Patent No. 2,944,792, it being understood that in the practice of the invention therein the drilling tool shown in the drawing of such application will be unchanged except for the construction of its trepan arms and associated cutting wheels in accordance with this invention.

As shown in FIG. 1 of the drawings herein, the cutting wheel **11** comprises an axial internal cavity or bore having a rotor surface **12** in the form of a paraboloid suitably designed to permit the transmission of both radial and axial forces. Located within the axial bore of wheel **11** is the end or head **14** of an axial member **15** secured in customary fashion to one of the trepan arms **10** of the drilling tool. The external supporting surface **13** of the end **14** has a configuration corresponding to that of the inner wheel surface **12**. The rotor and supporting surfaces **12** and **13**, respectively, are smoothly finished and conform with sufficient exactness to enable surface **12** to rotate relative to surface **13** about the central axis of the axial member **15** in the use of the drilling tool. Located between the two surfaces **12** and **13** is a cap **16** composed of a self-lubricating material such as the material known as lauron or the materials disclosed in the aforesaid copending Caubet application Serial No. 788,741. Self-lubricating materials of the indicated type have a high resistance to compression or to shocks and have a coefficient of friction of the order of 0.005 and which is substantially stable over a wide range of temperatures. Such materials are essentially constituted of a solid lubricant such as graphite or molybdenum bisulphide and a binding agent selected for its inherent qualities of resistance to mechanical forces or chemical attack such as the ethylenoxyd and superpolyamid resins, Araldite and Rilsan, respectively. With the solid lubricant and binding agent is associated a lubricant such as stearic acid or butyl stearate, and which frees the active molecules when local heating occurs, as in the boring operation.

The cap **16** is of substantial thickness, for example, from 1/16 to 1/4 inch thick, and is prefabricated to provide it with a configuration corresponding to that of the surfaces **12** and **13**. The cap **16** may be fixed in any suitable manner by appropriate known means to the cutting wheel **11**, or to the axial member **15**, or it may be left free to turn both on the axial member and inside the cutting wheel. The cap **16** and the associated surfaces **12**, **13** are substantially coextensive, the outer end of surface **12** being defined by an annular shoulder **21** which separates the inner portion of the bore in which is located the end **14** of the axial member, from the enlarged mouth portion of such bore in the head of the cutting wheel. The mouth portion of the bore is cylindrically-shaped and has a cylindrical side wall **25** disposed at right angles to the shoulder **21**. The outer end of surface **13** is defined by an annular shoulder **22** which is substantially flush with shoulder **21** and extends from such surfaces in a direction opposite to the direction in which shoulder **21** extends from such surfaces. Shoulder **22** is located at the juncture of the head **14** and the root portion of the axial member **15**, the latter of which is reduced and is defined by a cylindrical outer wall **26** coaxial with and disposed in opposed relation with side wall **25**. The shoulders **21**, **22** and the walls **25**, **26** together form an annular recess of substantially rectangular cross-section encircling the root portion of the axial member **15**. Within the recess is positioned a flat annular gasket **17** formed of two semi-circular pieces of self-lubricating material of the type employed in the construction of the cap **16** and of a thickness substantially the same as that of cap **16**. The gasket **17** is seated on the shoulders **21**, **22** which form the bottom wall of such recess and on the end edge of the cap **16** which is flush with such shoulders. Mounted on the gasket **17** is a two-piece annular ring **18** of such thickness that the mouth portion of the bore is completely closed thereby and the outer surface thereof is flush with the terminal end of the head of the cutting wheel. The annular ring **18** is provided internally with an annular recess **23** of rectangular cross-section encircling the wall **26** of the root portion of the axial member **15**. Within the recess **23** is positioned a resilient annular gasket **19** of circular cross-section. The annular gasket **19** is composed of any suitable resilient elastic material and has a cross-sectional diameter slightly greater than the depth of the annular recess **23** so that the gasket is slightly compressed between the inner wall or base of such recess and the wall **26**. In this way there is provided an effective pressure seal against leakage of the drilling fluid along wall **26** to the gasket **17**, the associated surfaces **12** and **13**, and the cap **16**. The gasket **17**, annular ring **18** and gasket **19** are permanently locked in position in the annular recess formed in the mouth portion of the bore by welding material **20** applied along the line of juncture of the annular ring **18** and the head of the cutting wheel. As shown in the drawings, the welding material also extends the entire depth of the ring **18** at annularly spaced intervals thereof to assure a firm bond between the annular ring and the cutting wheel.

It will be understood from the foregoing that the cutting wheel **11** is connected for rotational movement about the axis of the member **15** by the coaction of the annular ring **18** with shoulder **22**, the ring **18** during such movement rotating on the wall **26** of the reduced root portion of such axial member and on the ring **17** of self-lubricating material. Due to this arrangement, the frictional wear which might otherwise occur between the rotating ring **18** and shoulder **22**, is minimized by the self-lubricating material of the ring **17**. Because of this construction also the major portion of the axial and radial forces to which the tool is subjected in drilling operations are transmitted through the surfaces **12** and **13** of the cutting wheel **11** and axial member **15** respectively, and through the cap **16** or self-lubricating material. During the rotating action of the cutting wheel there is a sliding movement between at least one of such surfaces and a surface of the self-lubricating material dependent on whether such cap is fixed to either the cutting wheel **11**, or to the end **14** of the axial member **15**, or is able to turn both on the end **14** and inside the cutting wheel **11**. Thus, the rotation of the cutting wheel, instead of resulting in a rubbing action between two metal surfaces as is the case with the usual drilling tool fitted with conventional bearings, takes place because of the sliding action between a metal surface and a surface of a solid, self-lubricating material. Further, the parts are so constructed that the contact between the metal and the self-lubricating material is defined by a surface of revolution of large area and of such configuration that it provides support for both the axial and radial forces to which the tool is subjected in a drilling operation. Because the present invention provides at least one surface of revolution when the cap **16** is fixed to either the cutting wheel or the axial member, and possibly two surfaces of revolution when the cap is free to move relative to both of the surfaces **12** and **13** of such parts, and which surface or surfaces is or are defined by the engagement of a metal surface with a surface of self-lubricating material that are of substantially large area and fashioned to provide support for both axial and radial forces, the frictional wear between the cutting wheel and the axial member is reduced to the extent that the drilling tool so constructed need not be replaced until the working surfaces of the cutting wheels have been completely worn.

The construction illustrated in FIG. 1 of the drawings provides the further advantage that it is enabled to cushion reverse axial forces that may be created in the tool during reaming operations. FIG. 1 indicates the manner in which the tool may be used to ream a defective bore hole **27** to its required dimensions. In such use of the tool, there are produced therein axial forces which are indicated by the arrows designated **28**, **28** and which act in a direction opposite to the direction of application of the axial forces created during normal drilling operations. The tool of this invention takes care of these reverse axial forces by the thrust means which is constituted of the metal thrust ring **18**, the ring **17** of self-lubricating material and the annular shoulder **22** of end **14**, as will be apparent.

The aforesaid results of the invention may be accomplished with surfaces of revolution of a configuration other than that shown in FIG. 1 of the drawings. An example of another form of surface capable of accomplishing the purposes of the invention is illustrated in FIG. 2 of the drawings, in which figure like reference numerals have been applied to those parts which are similar to parts shown in FIG. 1 of the drawings. The construction of the embodiment of FIG. 2 is similar to that shown in FIG. 1 except that the configuration of the contact surfaces **12'**, **13'** of the cutting wheels **11'** and **14'** of the member **15**, respectively, and consequently the form of the cap **16'** are different to provide a differently shaped surface of revolution. The surface or surfaces of revolution formed by such parts includes a cylindrical portion designated generally by the numeral **30** and located adjacent to the shoulders **21**, **22**, an intermediate conically-shaped section **31**, and a terminal rounded portion **32**. It will be apparent to those skilled in the art that surfaces of revolution of other configurations may be used to equal advantage and other changes in the constructions shown by way of example may be made without departing from the spirit of the invention or the scope of the appended claim.

I claim:

A turbine drilling tool operable at high speed and under heavy stress and wear conditions comprising a metal axial member having an exterior surface extending over the sides and outer end of said member and formed to provide a surface of revolution of large area and capable of supporting both axial and radial forces created during a drilling operation, a rotatable cutting wheel mounted on said axial member and having a metallic interior surface in spaced relation to the metallic exterior surface of said axial member and being coextensive with and enclosing said exterior surface, and a layer of self-lubricating material located between said spaced metallic surfaces of said axial member and said cutting wheel to enable the rotation of said cutting wheel on said axial member to take place by a sliding movement between a metal surface and a surface of said self-lubricating material, said layer of material having a coefficient of friction of the order of .005, and including a solid lubricant and a binding agent constituted of a resin having high resistance to mechanical forces and selected from the group consisting of ethylenoxyd and superpolyamid resins, said material being in the form of a continuous layer of substantially uniform constitution and of substantial thickness, and having a configuration corresponding to and coextensive with said surfaces so as to continuously occupy the area between said spaced metal surfaces of said axial member and cutting wheel, and to be subject to the axial and radial forces imparted by said cutting wheel in the operation of the tool, said axial member having a reduced root portion to provide an annular shoulder at the inner end of said exterior surface of said axial member, said cutting wheel having an annular shoulder at the inner end of the interior surface thereof and in substantial radial alignment with said axial member shoulder, a flat annular gasket of said self-lubricating material seated on both of said shoulders and extending transversely across the inner end of said layer of self-lubricating material, an annular locking ring seated on said gasket of self-lubricating material and both of said shoulders, the inner side of said locking ring in opposed relation to the exterior surface said reduced root portion of said axial member being provided with an annular recess encircling said root portion, and a resilient gasket of elastic material disposed in said annular recess and being in compressed condition between the inner wall of said annular recess and said exterior surface of said root portion to provide a pressure seal against leakage of the drilling fluid along said latter surface to said self-lubricating material.

References Cited in the file of this patent

UNITED STATES PATENTS

1,649,858	Reed	Nov. 22, 1927
1,747,394	Scott	Feb. 18, 1930
1,820,511	Van Patten	Aug. 25, 1931
2,058,624	Reed	Oct. 27, 1936
2,104,819	Schlumpf et al.	Jan. 11, 1938
2,654,577	Green	Oct. 6, 1953
2,686,155	Willis et al.	Aug. 10, 1954

FOREIGN PATENTS

695,195	Great Britain	Aug. 5, 1953
711,620	Great Britain	July 7, 1954