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[54] **DEVICE FOR BUILDING UP DOWN-PRESSURE ON WELL FACE DURING DRILLING**

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Related U.S. Application Data

[63] Continuation of Ser. No. 102,674, Dec. 30, 1970, abandoned.

[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **175/321,** 267/168

[51] **Int. Cl.** **E21b 17/00**

[58] **Field of Search** ..... 175/321, 299; 64/23, 1 V, 64/1 R; 267/168, 137

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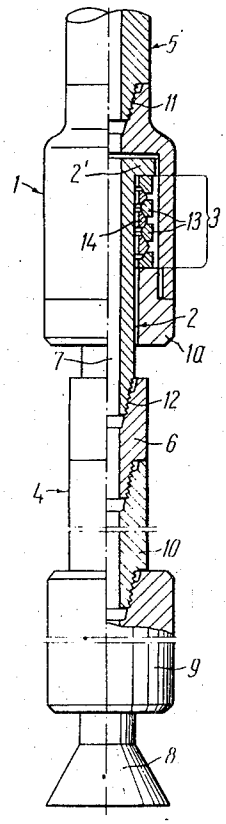
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[57] **ABSTRACT**

A well drilling rig provided with a device or detector capable of varying the shape and amplitude of dynamic forces acting upon the drill bit to raise the efficiency of well drilling in which the device is constituted by a cylinder-piston unit built into the drill string and the piston rod thereof having a through bore for the passage of the drilling fluid through the string.

3 Claims, 2 Drawing Figures



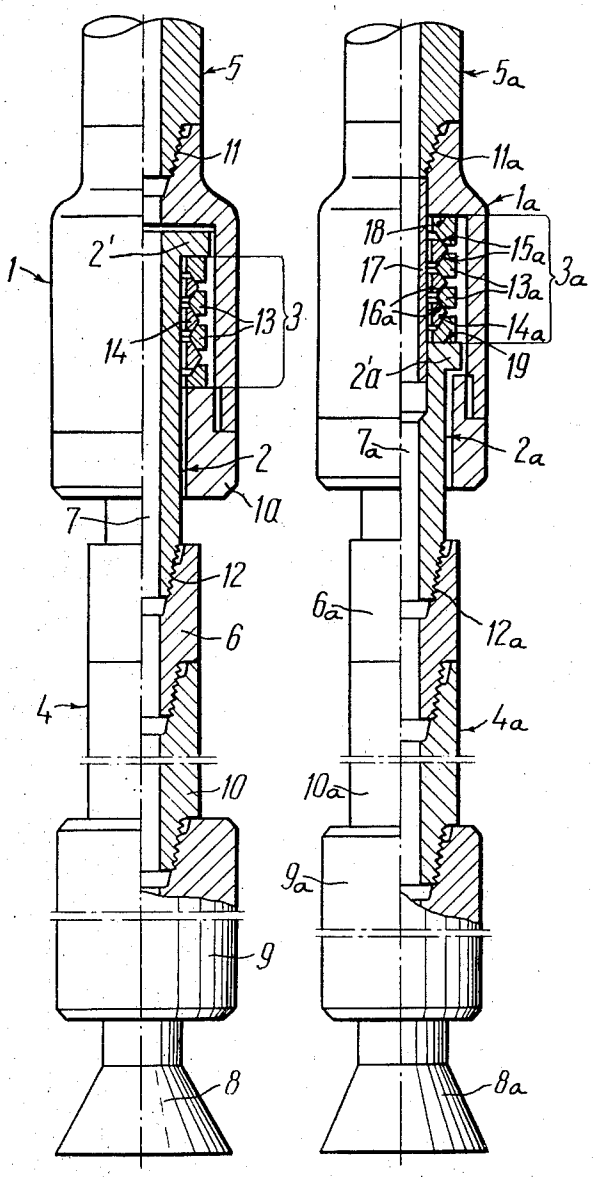

5
11
1
2'
13
3
14
2
10
7
12
6
4
10
9
8
5a
11a
1a
18
15a
17
13a
3a
16a
14a
19
2'a
7a
2a
6a
12a
4a
10a
9a
8a

FIG. 1 FIG. 2

DEVICE FOR BUILDING UP DOWN-PRESSURE ON WELL FACE DURING DRILLING

This in a continuation of application Ser. No. 102,674, filed Dec. 30, 1970, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to the drill strings used in rigs for drilling wells in soil and rocks and more specifically it relates to a device for building-up a down-pressure on the well face during drilling.

Such devices can be employed most successfully while drilling wells in hard rock which calls for a heavy axial pressure to be applied to the well face.

PRIOR ART

Widely known in the art are devices for building-up a down-pressure on the well face comprising a cylinder with a rod and piston telescoping in said cylinder. This device is built coaxially into the drill string so that the cylinder is secured to the upper pipe of two adjacent drill pipes while the rod is secured to the lower pipe.

Before starting the operation of the device the rod with the piston are brought to the initial uppermost position. The lower part of the drill string connected to the rod of the device rests, by its bit, on the well face and is compressed whereas the upper part of the string, connected to the cylinder of the device, is suspended from the hook of the surface drilling rig and is under tension.

In such devices, the down-pressure on the well face during drilling is built up due to the difference of the hydraulic pressure of the fluid forced into the string and applied to the piston of the device. This pressure is, by its nature, a static force transmitted from the piston to the well face (via the rod of the device, the lower part of the drill string and the bit) and ensures the drilling of the rock.

As the well face is gradually worked out and the well becomes deeper, the lower part of the drill string with the bit moves down and carries down the rod and piston connected thereto, moving them with relation to the cylinder of the device. This continues until the piston reaches the downmost position in the cylinder after which the upper part of the drill string is fed down through the length of the piston travel and the drilling process is continued.

One of the disadvantages of the known devices for building-up a down-pressure on the well face during drilling lies in that they create and change only the static component of the axial load applied to the face in the course of drilling. Also, it is known that the axial pressure on the well face includes also a dynamic component in the form of pulses caused by the axial vibrations of the drill bit while its cutters roll over the well face.

The drilling efficiency (penetration rate and drilling progress per bit) depends to a considerable measure upon the magnitude and type of the dynamic component of the axial pressure applied to the face.

An object of the present invention resides in eliminating the aforesaid disadvantage.

The main object of the invention lies in providing a device for building-up a down-pressure on the well face during drilling which creates and changes not only the static component of the axial pressure applied to the well face, but also the magnitude and type of the dynamic component of said pressure.

SUMMARY OF THE INVENTION

This object is achieved, according to the invention, by constituting the piston of the device of coaxial alternating outer and inner cylindrical rings, with each of said rings being in the form of a movable wedge located between the two adjacent rings. It is practicable that the outer and inner rings have respective inner and outer conical surfaces on their contacting areas.

In one embodiment of the invention the outer and inner rings are installed movably on the rod between a circular flange located on the upper free end of the rod and a lower cover or closure of the cylinder.

In another embodiment of the invention, the outer and inner rings are installed movably on an extension of the upper pipe of the drill string, the lower end of said extension entering an axial channel of the rod with a provision for axial movement therein, and said rings are located between the upper end of the rod and the upper end-plate of the cylinder.

Such a design of the device, according to the invention, permits applying a dynamic pressure to the well face by converting the pulses of the axial vibrations arising in the pipes of the drill string when the bit cutters roll over the well face. These vibrations are extended along the string in the form of stretching and compression pulses and reach the device built into the string.

The set of coaxial cylindrical rings interacting with each other by their conical surfaces is a type of detector of drill pipe axial vibrations, with the detector either strengthening or weakening (as required) the compression (or stretching) pulses at the lower end of the drill string.

BRIEF DESCRIPTION ON THE DRAWINGS

Now the invention will be described in detail by way of examples with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic view partly in elevation and partly in cross-section of a drill string with a built-in device for building-up the down-pressure on the well face, and;

FIG. 2 is a similar view of a second embodiment.

DETAILED DESCRIPTION OF THE INVENTION

The device for building-up down-pressure on the well face during drilling comprises a cylinder 1 (FIGS. 1 and 2) accommodating a hollow rod 2 provided with a piston 3 telescoping in the cylinder 1.

The device is built coaxially into the drill string 4 between two jointed pipes 5 and 6 and has a through axial channel 7 for the passage of the drilling fluid through the device and the pipes of the string 4, to a bit 8 which is rotated by a drill motor 9 secured to a lowermost pipe 10 of the string 4.

The upper part of the cylinder 1 is connected by a threaded joint 11 to the adjacent upper drill pipe 5 of the string 4 while its lower part is closed with a cover or end 1a having a bore for the passage of the hollow rod 2. The upper free end of the rod 2 located in the cylinder 1 is provided with a circular flange 2 while the lower end of the rod 2 is connected with the lower pipe 6 by means of a threaded joint 12.

The piston 3 of the device is constituted by coaxial cylindrical outer rings 13 and similar inner rings 14 of a smaller diameter located between said outer rings and serving as wedges between the adjacent pairs of the outer rings 13.

The contacting areas of these rings 13 and 14 have conical surfaces and each inner ring 14 has two outer conical surfaces 15 while each outer ring 13 has two inner conical surfaces 16. The upper and lower outer rings 13 are an exception, since each of these rings has only one conical surface 16 facing the adjacent inner ring 14.

In the first embodiment of the invention illustrated in FIG. 1 the outer and inner rings 13 and 14 are movably installed on the rod 2 between the circular flange 2 and the cover 1*a* of the cylinder 1. In this form, the rod 2 occupies the uppermost position in the cylinder 1.

The second embodiment of the device illustrated in FIG. 2, differs from the first one in that the rings 13a and 14a are installed on and extension 17 of the upper pipe 5a of the drill string 4a, with the lower end of said extension entering the axial channel in the rod 2a with a provision for moving therein. The rings 13a and 14a are located between an upper end plate 18 of the cylinder and an upper end 19 of the rod 2a which, in this form of the device, occupies the downmost position in the cylinder 1a.

The device for building-up down-pressure on the well face during drilling functions as follows:

When the cutters (not shown) of the bit 8 roll over the well face, this creates axial vibrations of the string 4 above the bit 8; extending upward along the string 4, and these vibrations reach the rod 2 of the device in the form of compression and stretching pulses.

Subsequent operation of the device depends on which one of the above-described embodiments of the invention has been selected for employment.

In the first form (FIG. 1) the stretching pulses move the rod 2 down and the circular flange 2 of the rod moves down the upper outer ring 13 which causes relative movement of the outer and inner rings 13 and 14 over their contacting conical surfaces 16 and 15. Owing to the forces of friction occasioned by the relative movement of the rings 13 and 14, the stretching pulses are damped to a considerable degree while the compression pulses reach the rod 2, are reflected by its upper free end (because the rings 13 and 14 function only under compression) and return to the bit 8 in the form of tension half-waves.

In the second form of the device (FIG. 2) the stretching pulses move the rod 2*a* down and, being reflected by its free end, return to the bit 8*a* in the form of compression pulses, while the compression pulses move the rod upward and are damped owing to friction arising when the rings 13*a* and 14*a* interact over their matching conical surfaces 16*a* and 15*a*.

The degree of damping of the type of pulses and the intensification of their other type as well as the type of dynamic loading of the bit depend on the place occupied by the device in the drill string and are determined by the vibration frequency of the bit.

It follows from the above that the present device functions as a detector of axial vibrations of the drill string. This distinctive feature raises considerably the efficiency of well drilling.

What we claim is:

1. The combination with a drill string constituted by a plurality of interconnected pipes and a bit operably associated with the lower end of the drill string, of a device located in the drill string for building-up a down pressure on the well face during drilling, said device comprising: a cylinder, a rod provided with a piston located in said cylinder, said piston rod being provided with a through axial bore for the passage of a drilling fluid, and said piston being defined by coaxial alternating outer and inner rings, with each of said inner rings constituting a wedge between the two adjacent outer rings whereby under the influence of a compression pulse, the movable rings enter into contact with one another partially passing and partially dissipating the compression pulse while an extension pulse causes the rings to disengage from one another and define a boundary free surface from which the extension pulse is reflected and returns to the bit, subjecting the bit to a dynamic load, the drill string including a pipe adjacent the cylinder, said pipe having an extension, said outer and inner rings being installed movably on the extension, said extension having a lower end entering the axial bore of said rod with a provision for moving therein, said rod having an upper end and an end plate on the upper end of the cylinder, said rings being located between the upper end of said rod and the end plate of said cylinder.

2. The combination with a drill string constituted by a plurality of interconnected pipes and a rotary bit operably associated with the lower end of the drill string, of a device located in the drill string for controlling a dynamic load on the rotary bit, said device comprising a hollow cylinder mounted coaxially between two adjacent pipes of said drill string, said cylinder having upper and lower end plates, said upper end plate rigidly connecting the cylinder with an upper adjacent pipe of said drill string, said upper end plate having an axial through opening, said lower end plate of said cylinder having an axial through opening, a hollow cylindrical rod coaxially mounted in said cylinder with a possibility of axial movements, a circular flange on the upper end of said rod, the lower end of the rod passing through the opening in said lower end plate and being rigidly connected with a lower adjacent pipe of said drill string, outer rings mounted with a possibility of axial movements on said rod between said circular flange and said lower end plate of said cylinder, inner rings each of which is mounted with a possibility of axial movements on said rod between two adjacent outer rings, each of said outer rings being provided on its inner side with a wedge-shaped projection defined by two conical surfaces, each of said inner rings being provided on its outer side with a wedge-shaped projection defined by two conical surfaces which, during the bit's operation, periodically contact with the corresponding conical surfaces on the inner sides of said adjacent outer rings thereby resulting in suppressing the stretching pulses and during periodic intervals between contacts of said conical surfaces, stretching impulses reflect from the free end of the rod and return to the bit.

3. The combination with a drill string constituted by a plurality of interconnected pipes and a rotary bit operably associated with the lower end of the drill string, of a device located in the drill string for controlling a dynamic load on the rotary bit, said device comprising a hollow cylinder mounted coaxially between two adjacent pipes of said drill string, said cylinder having upper

and lower end plates, each of said end plates having a through opening, said upper end plate rigidly connecting the cylinder with an upper adjacent pipe of said drill string, a hollow cylindrical rod mounted coaxially in the cylinder with a possibility of axial movements, a circular flange on the upper end of the rod, the lower end of the rod passing through the opening in the lower end plate and being rigidly connected with a lower adjacent pipe of the drill string, a branch pipe mounted within said rod and rigidly connected at its upper end with said upper adjacent pipe of the drill string, outer rings mounted with a possibility of axial movements on the branch pipe between the circular flange on the rod and the upper end plate of the cylinder, inner rings each of which is mounted with a possibility of axial movements on the branch pipe between two adjacent outer rings, each of said outer rings being provided on its inner side with a wedge-shaped projection defined by two conical surfaces which, during the bit's operation, periodically contact with corresponding conical surfaces on the inner sides of said adjacent outer rings thereby resulting in suppressing the stretching pulses and during periodic intervals between contacts of said conical surfaces, stretching pulses reflect from the free end of the rod and return to the bit.

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