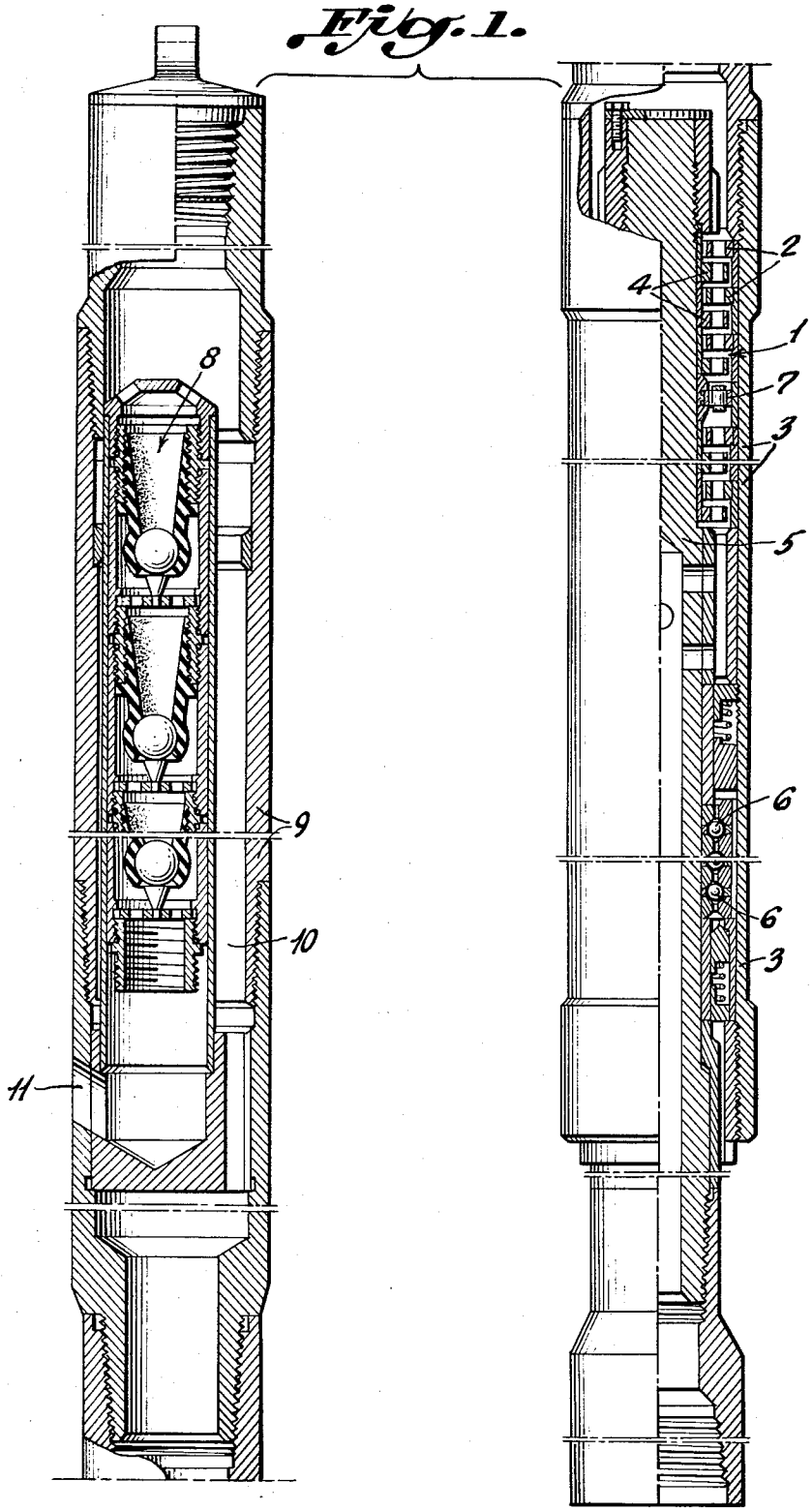
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TURBODRILL

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Fig. 1.

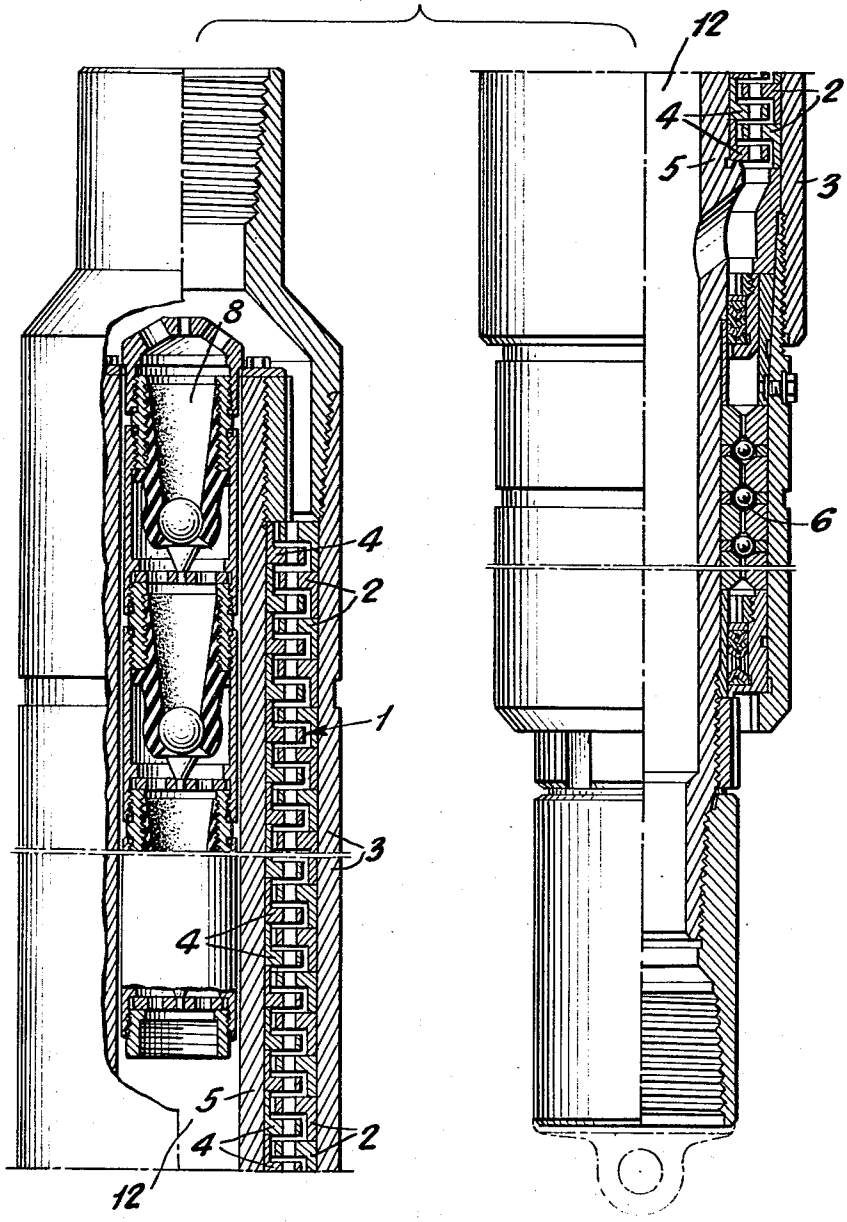


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Fig. 2.



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Fig. 3.

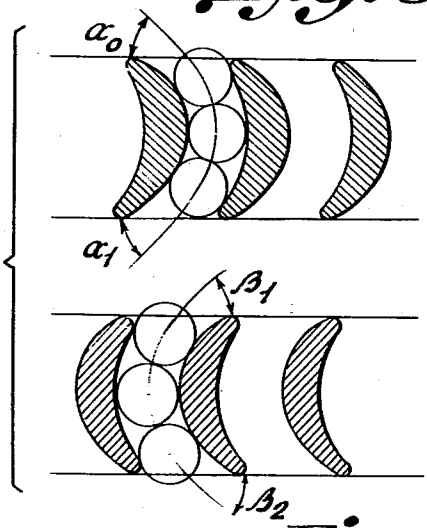


Fig. 6.

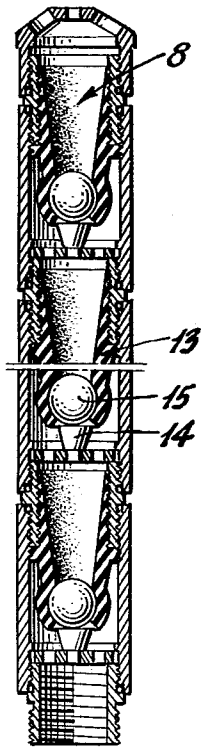


Fig. 5.

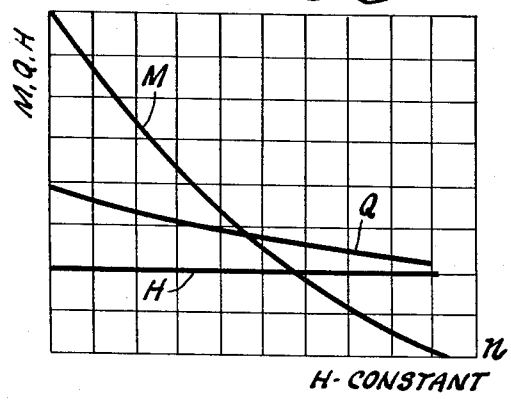
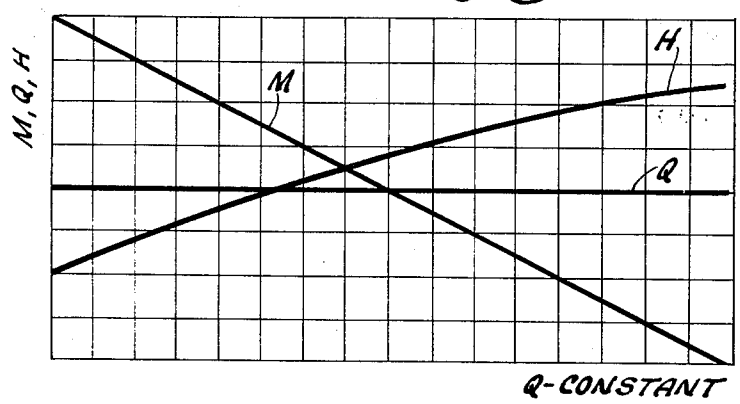


Fig. 4.



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TURBODRILL

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6 Claims. (Cl. 253—3)

ABSTRACT OF THE DISCLOSURE

A turbodrill having a multistage turbine, a multistage bypass valve serving for adjusting the flow of the drilling fluid through the turbine dependent upon the speed of its shaft, the turbine blades being so shaped that the angle of discharge of the drilling fluid from the stator equals or approaches the inlet angle of the drilling fluid to the rotor while stationary with the angle of discharge of the fluid from the rotor in movement equals or approaches the angle of the fluid inlet to the turbine stator.

The present invention relates to well drilling systems for boring deep wells in the surface of the earth with the object of finding oil, gas and other mineral resources, pertains more particularly to turbodrills with multistage turbines and bypass valves. Known at present are turbodrills of high rotational speed at a relatively low shaft torque. The reduction in speed and the increase in shaft torque of a turbodrill and the bit connected thereto assist in a radical improvement of footage per bit, and thus of the total efficiency of drilling.

The known types of turbodrills with multistage turbines and bypass valves have only been capable of restricting the idle rotation of the turbine with the aid of said valves without, however, increasing the shaft torque or reducing the shaft rotational speed during drilling.

It is an object of this invention to eliminate said disadvantages. Accordingly, a principal object of the present invention is to provide a turbodrill with such a multistage turbine and such a bypass valve which will be capable of radically increasing the shaft torque of the turbodrill while decreasing its rotational speed.

These objects are attained by having, according to the invention, the turbine blades shaped so that the angles at which the drilling fluid leaves the stator equal or approach the angles at which the fluid passes onto the rotor at rest, while the angles of the fluid flow leaving the immobile rotor equal or approach those at the inlet to the stator.

The bypass valve adjusting the circulation rate through the turbine is made multistaged. Such an embodiment of the turbine serves for a substantial decrease in pressure drop across the immobile rotor while radically increasing said pressure drop as the rotational speed is raised. This, in conjunction, with the bypass valve and working channels of the turbine of a special shape and cross-section (in comparison to conventional type turbines) allows for increasing the flow rate of the drilling fluid through turbine blades and sharply increasing the turbine shaft torque. Bypassing part of the fluid through the bypass valve the pressure drop with the turbine rotor in motion is maintained at the same value as that produced by the passage of the total stream through the turbine with the rotor immovable.

Each of the stages of the bypass valve is essentially a sleeve of a conical or a cylindrical shape made from an elastic material, such as rubber. A large diameter ball is inserted in said sleeve thus producing stresses in the

elastic material which represent the pressure drop in the valve stage.

The multistage valve can be mounted either in the hollow shaft of the turbine (if the turbine embodiment includes a hollow shaft) or if the shaft is built solid—in a cylindrical casing mounted above the turbine and provided with a channel for the passage of the drilling fluid into the turbine, and a port connected with the valve and intended for the discharge of drilling fluid into the borehole.

Embodiment of the present invention will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 is the turbodrill with the multistage turbine and bypass valve housed in a cylindrical casing above the turbine.

FIG. 2 is the turbodrill with the multistage turbine and bypass valve mounted in the hollow shaft of the turbine.

FIG. 3 is a cross-sectional view of the turbine blades shaped so as to prevent the surging shock against said blades with the rotor immovable.

FIG. 4 shows the turbine torque M and pressure drop H curves for various values of the rotational speed n at the constant circulation rate Q.

FIG. 5 shows the turbine torque M and circulation rate Q curves for various values of the turbine speed n at the constant pressure drop H.

FIG. 6 is a cross-sectional view of a multistage bypass valve.

The turbodrill shown in FIG. 1 includes: multistage turbine **1** comprising stators **2** accommodated in its housing **3** and rotors **4** keyed to shaft **5**, axial bearing **6**, radial bearings **7** and multistage bypass valve **8** mounted in cylindrical casing **9**, said casing embodying channel **10** for the passage of drilling fluid to the turbine, and port **11** connected with the valve and intended for the discharge of drilling fluid into the borehole.

The blades of stators and rotors of the turbine are shaped so (see FIG. 3) that the discharge angle α_1, of the drilling fluid stream from the stator equals or approaches the angle β_1, of the fluid flowing to the rotor, while the discharge angle β_2 of the fluid flowing from the immobile rotor equals or approaches the inlet angle α_0 of the flow to the stator.

The drilling fluid is admitted through a drill string into casing **9** of bypass valve **8**, and thence through channel **10** is passed to the drill turbine. This brings rotors **4** and shaft **5** into rotation. Since the turbine blades are so shaped that the flow without surging shock through said blades takes place with the rotor immovable, the increase in the turbine speed tends to build up pressure, as shown in FIG. 4. This effect, however, does not take place as the bypass valve **8** comes into action, thus discharging a part of the drilling fluid into the borehole through port **11** bypassing the turbine. The drill turbine operates at a constant pressure drop. The turbine embodied in the invention produces a low pressure drop at a low speed, and the rate of fluid flowing through turbine blades can thus be increased, which will raise the turbine torque at a low rotational speed.

Torque M of such a turbodrill does not vary along a straight line, it follows a concave curve which is very steep in the zone of slow speeds (as shown in FIG. 5) and flat in the zone of high speeds. Thus, such a turbodrill is capable of stable performance at a low speed, and vice versa, its performance being unstable at high speeds.

By increasing the weight on the bit, the turbine speed of such a turbodrill can be lowered to the value characteristic of rotary drilling, while sharply increasing the shaft torque.

The multistage bypass valve **8** shown in FIG. 6 is formed by several rubber sleeves **13** of a conical or a

cylindrical shape, arranged in series. A ball **15** bears upon a rest **14** of each of the sleeves **13**. The ball diameter is selected so that the walls of sleeve **13** are under strain and stresses are thus produced in the sleeve rubber, said stresses representing the pressure drop in the valve **8** stage. Such an embodiment of valve **8** ensures trouble-free operation in handling abrasive fluids under high pressure, and its capacity to maintain the pressure constant within close limits, whereas the valve opening and closing pressures remain constant.

The fluid admitted into the first stage of valve **8** stretches the walls of sleeve **13** relative to ball **15** and passes into the next stage, where a similar process takes place.

If the embodiment of the turbodrill includes a hollow shaft, the bypass valve can be accommodated in the shaft bore, as shown in FIG. 2. In that case the drilling fluid bypassed by the valve flows through bore **12** of shaft **5** directly to the bit.

A large diameter turbodrill is preferably built with a bypass valve **8** mounted in the hollow shaft.

A small diameter turbodrill is preferably built with bypass valve **8** housed in cylindrical casing **9** above the turbine.

What we claim is:

1. A turbodrill including: a multistage turbine; a multistage bypass valve which serves to adjust the flow of the drilling fluid through said turbine depending on the speed of its shaft; the blades of said turbine being of such a shape that the angle of discharge of the drilling fluid from the stator of said turbine equals or approaches the angle of inlet of the drilling fluid to the rotor at rest, whereas the angle of discharge of the fluid from said rotor in motion equals or approaches the angle of the fluid inlet to the stator of said turbine.

2. A turbodrill including: a multistage turbine; a multistage valve, each stage of which is formed by a sleeve of an elastic material, preferably rubber, housing a ball of such a diameter that the walls of said sleeve are under strain, which produces stresses in the elastic material, these representing the pressure drop in each stage of said valve; the blades of said turbine being shaped so that the discharge angle of the drilling fluid from the stator equals or approaches the inlet angle of the fluid to the rotor at rest, whereas the discharge angle of the fluid flow from said immobile rotor equals or approaches the inlet angle of the fluid flow to said stator of the turbine.

3. The turbodrill as claimed in claim **2**, wherein said elastic material sleeve of the multistage valve is of a conical shape.

4. The turbodrill as claimed in claim **2**, wherein said elastic material sleeve of the multistage valve is of a cylindrical shape.

5. A turbodrill including a solid shaft multistage turbine; a multistage bypass valve which serves for adjusting the flow of the drilling fluid through said turbine depending on the speed of its shaft; the blades of said turbine being of such a shape that the discharge angle of the drilling fluid from the stator of said turbine equals or approaches the inlet angle of the drilling fluid to the rotor at rest, whereas the discharge angle of the fluid from said immobile rotor approaches or equals the inlet angle of the fluid to said stator; a cylindrical casing mounted above said turbine to house said multistage bypass valve; said cylindrical casing being provided with a channel for the passage of the drilling fluid to said turbine, and a port connected with said multistage bypass valve which serves for discharging the fluid into the borehole.

6. A turbodrill including: a hollow shaft multistage turbine; a multistage bypass valve housed in the hollow shaft of said turbine and serving for the adjustment of the flow of the drilling fluid through said turbine, depending on the speed of its shaft; the blades of said turbine being of such a shape that the discharge angle of the drilling fluid from the stator of said turbine equals or approaches the inlet angle of the drilling fluid to the rotor at rest, whereas the discharge angle of the fluid from said immobile rotor equals or approaches the inlet angle of the fluid to said stator.

References Cited

UNITED STATES PATENTS

1,097,752	5/1914	Fisher	253—77
2,426,270	8/1947	Howell	253—77 X
2,879,032	3/1959	Whittle	253—3 X

FOREIGN PATENTS

122,425	1/1928	Switzerland.

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