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[54] **DEVICE FOR AUTOMATICALLY REGULATING THE OPERATION OF A DRILLING TURBINE**

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[51] **Int. Cl.** **E21b 3/12**

[58] **Field of Search** 175/25, 26; 173/12; 415/25, 49

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[57] **ABSTRACT**

A device for automatically regulating the operation of a drilling turbine which drives a tool and is supplied with hydraulic fluid at an essentially constant rate of flow from a source of fluid. The device includes a duct in the form of a bore provided in the shaft of the turbine wherein the lower part of the bore terminates in the immediate vicinity of the tool, a first communicating member directly connecting the source of fluid with an inlet of the turbine to provide a flow path for the hydraulic fluid therethrough and a second communicating member for providing a flow path for hydraulic fluid to the tool. The second communicating member includes at least one orifice having a variable cross section for communicating between the inlet of the turbine and the upper end of the duct, the cross section being variable in accordance with an operating parameter of the turbine to regulate the flow of hydraulic fluid to the inlet of the turbine and to the tool.

13 Claims, 9 Drawing Figures

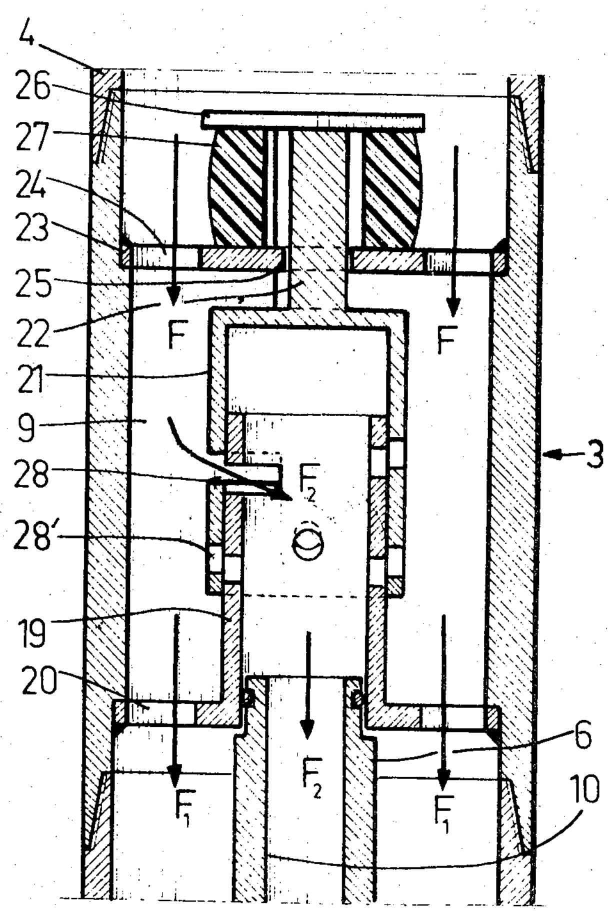


FIG.1

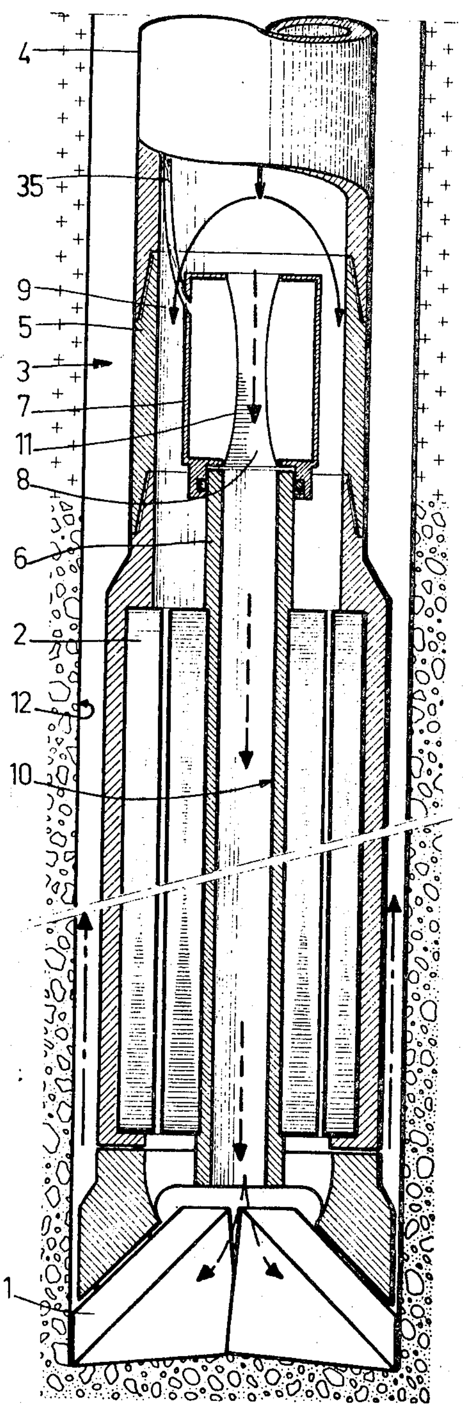


FIG.2

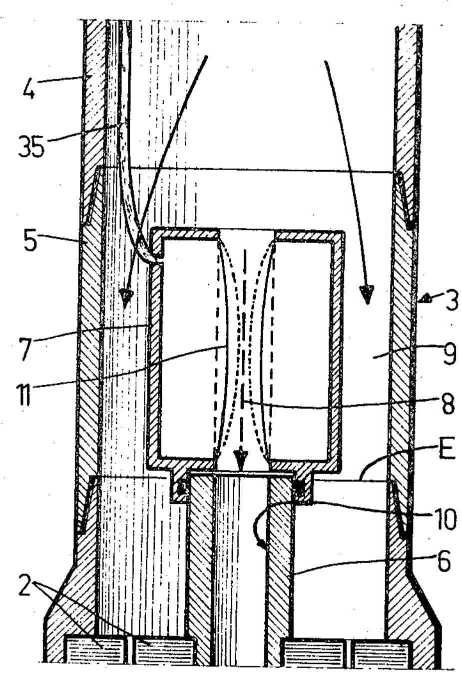


FIG.3

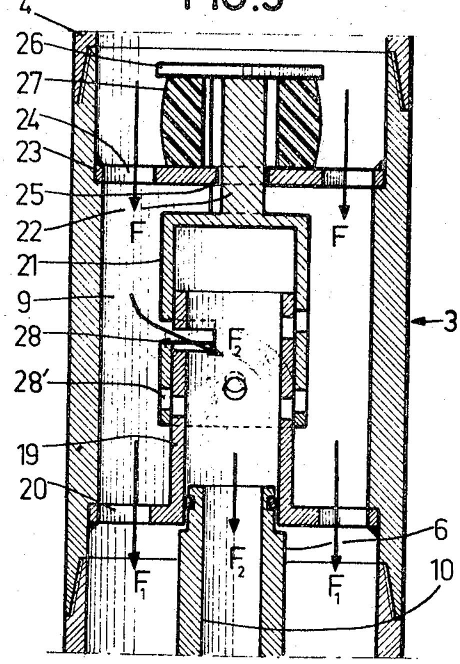


FIG.4

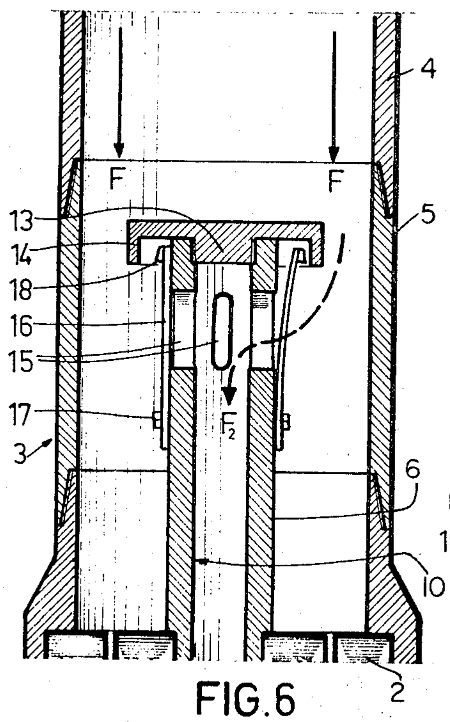


FIG.5

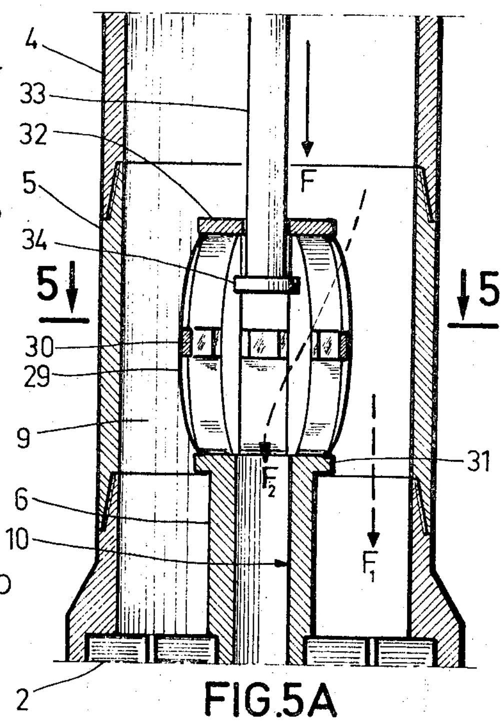


FIG.6

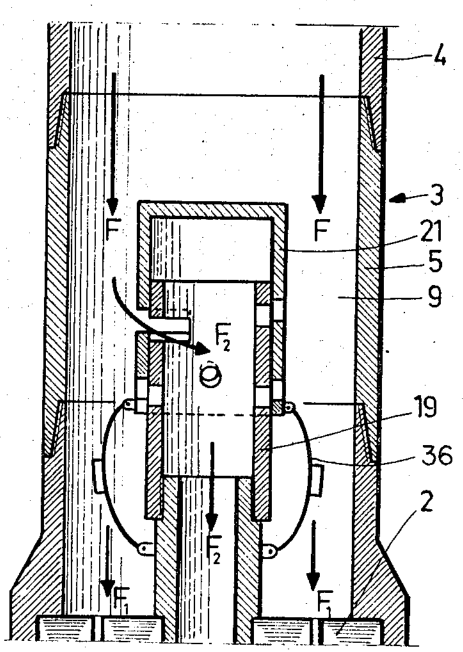


FIG.5A

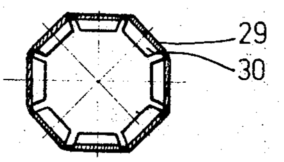


FIG.5B

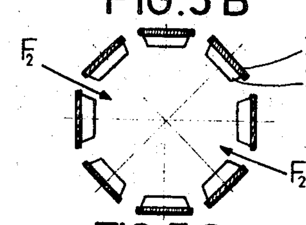
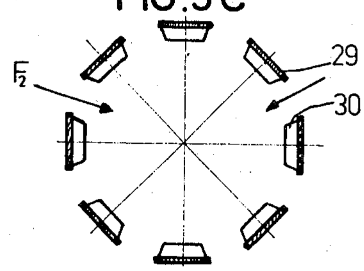


FIG.5C



DEVICE FOR AUTOMATICALLY REGULATING THE OPERATION OF A DRILLING TURBINE

The present invention relates to a device for automatically regulating the operation of a drilling turbine.

The utilization of turbo-drilling requires means for regulating automatically the operating parameters of a drilling turbine.

One of these regulating means consists in providing the turbine with blades such that the drop of the driving pressure in the turbine decreases with the speed of rotation when the rate of flow remains constant, and in causing the flow that supplies or feeds the turbine to vary inversely with respect to the pressure for supplying the turbine a torque and power supplement when the speed of rotation decreases. The hydraulic power lost by the turbine in the form of pressure may be compensated for by assuring the circulation of the hydraulic fluid with the aid of pumps that are capable of automatically compensating the pressure variations by means of flow variations, such as, for example, axial pumps or pumping groups driven by Diesel motors and equipped with a torque converter. However, the efficacy of this type of regulation decreases when the depth increases and when the length of the drilling column which is interposed between the pumps and the turbine increases. In fact, the compensation of the hydraulic pressure variation by a variation in the inverse direction of the flow of the fluid injected from the surface, requires the use of the entire mass of liquid contained in the drilling pipe between the surface and the turbine, and this entails a time of response that may be very long and, consequently, incompatible with a good regulation. Furthermore, the speed of variation of the operating parameters of a turbine is generally higher than the speed of adaptation of the pumps to new values for these parameters.

Another solution for regulation consists in assuring flow variations for compensation of the pressure variations of the turbine by installing in proximity to the turbine and above the latter with respect to the trepan, a reservoir at the inside of which the pressure of the drilling fluid exerts itself. This reservoir whose volume is expansible in an elastic manner by virtue of deformable membranes serves as a flow-regulating fly-wheel by accumulating a certain volume of fluid under pressure which is restored at the time of a pressure drop at the inlet of the turbine, due to, or because of an operating drop. This device has had good results but may present drawbacks under certain circumstances in that it is necessary, in order to assure effectively a good regulation of the operation of the turbine, that the reservoir have a large capacity, and this makes the device cumbersome.

Another known solution for regulation consists in permanently supplying to the turbine an excess of hydraulic fluid and in feeding the fluid through a mechanical valve which is regulated to assure a constant pressure of the fluid supplying the turbine. However, such systems have major drawbacks and inconveniences including the systematic loss of the hydraulic power corresponding to the excess fluid which was eliminated by way of the valve directly toward the exterior annular space without having produced useful work; the destruction of the wall of the drilled shaft by the excess fluid during its evacuation into the annular space; as

well as the poor operation or functioning of the valves which became rapidly useless or unusable because of the particles contained in the drilling mud. All of these drawbacks have led to an abandonment of this solution in practice, even though it is theoretically susceptible to yielding excellent results.

It is therefore an object of the present invention to furnish a device for the automatic regulation of the operation of a slow drilling turbine which avoids the drawbacks and disadvantages of the prior art devices.

According to an embodiment of the present invention, there is provided a regulating device for the automatic regulation of the operating or functioning system of a hydraulic turbine having an internal pressure drop which decreases with the rotational speed, wherein the turbine drives a tool and hydraulic fluid is delivered at an essentially constant rate of flow from a fluid source. The regulating device comprises a duct formed by a bore provided in the shaft of the turbine and terminating with its lower part in the immediate vicinity of the tool, a first member directly connecting the source of fluid with the inlet of the turbine, a second member causing the inlet of the turbine and the upper end of the duct to communicate by means of at least one orifice having a regulable cross section which varies as function of the pressure of the hydraulic fluid at the inlet of the turbine in order to allow for irrigation of the tool by a portion of the flow or discharge of the hydraulic fluid. The first and second members respectively include a rigid cylindrical body or element, one of the ends of which is integrally connected with the turbine and the other end of which is integrally connected with a conduit or pipe connected to the source of fluid, and of an annular reservoir concentrically positioned within the aforementioned body or element. The reservoir is provided with a rigid external wall which together with the aforementioned body defines a first space through which the hydraulic fluid flows from the source of fluid toward the inlet of the turbine, and with an internal wall defining the orifice for the flow of the fluid from the first space toward the bore of the turbine shaft. The internal wall of the reservoir is formed of a material which is deformable under a pressure differential applied to the internal wall, and the reservoir is filled with a gas whose pressure is equal to the pressure of the hydraulic fluid at the inlet of the turbine corresponding to the system operation of the turbine.

According to a modified embodiment of the present invention, the first member includes a rigid cylindrical body or element,one of the ends of which is integrally connected with the turbine and whose other end is integrally connected with a conduit connected with the source of fluid, and the second member includes a first cylindrical sleeve coaxially positioned with respect to this body. The lower part of the first cylindrical sleeve is in communication with the bore of the shaft of the turbine and a second cylindrical sleeve closed at the upper part thereof is mounted on the first sleeve such that the sleeves nest within each other and are adapted to be displaced with respect to one another at least in the direction of their axis. The cylindrical walls of these sleeves are provided with orifices which cooperate with each other so as to form an orifice having a variable cross section establishing a communication between the bore and the inlet of the turbine as function of the relative position of the two sleeves. Additionally, elastic means is interposed between the sleeves for controlling the displacement of one of these sleeves as function of the pressure at the inlet of the turbine.

According to another embodiment of the present invention, there is provided a device for the automatic regulation of the operating or functioning system of a hydraulic turbine wherein the turbine drives a tool and hydraulic fluid is delivered at a constant rate of flow from a fluid source. The device of this embodiment comprises a duct including a bore provided in the shaft of the turbine and terminating with its lower part in the immediate vicinity of the tool, a first member directly connecting the source of fluid with the inlet of the turbine, and a second member for communicating between the inlet of the turbine and the upper end of the duct by means of at least one orifice having a regulable cross section which varies as function of the speed of rotation of the shaft of the turbine and which permits irrigation of the tool by a portion of the flow of the hydraulic fluid. The first member includes a rigid cylindrical body or element, one end of which is integrally connected with a conduit connected with the source of fluid, and the second member includes the bored shaft of the turbine having at least one orifice provided on the lateral wall of the shaft and at the level of the aforementioned body. The orifice is obstructed by a deformable resilient element having one end secured on the shaft, with the other end of the element being free such that upon rotation of the shaft, the centrifugal force exerted on the element causes the element to deform and the free end to progressively uncover or expose the orifice.

According to another embodiment which is a modification of the last-mentioned embodiment according to the present invention, the regulating device comprises a first member in the form of a rigid cylindrical body, one end of which is integrally connected with the turbine and the other end of which is integrally connected with a conduit connected with the source of fluid, and a second member including a plurality of resilient elements or laminae having one end integrally connected with the shaft of the turbine and forming an essentially fluid-tight prism in the absence of rotation of the shaft. The laminae are adapted to be deformed due to the action of the centrifugal force produced by the rotation of the rotor so as to become separated or spaced from each other so as to permit communication between the bore of the shaft and the inlet of the turbine.

According to another modification or embodiment of the present invention, the regulating device comprises a first member in the form of a rigid cylindrical body having one end integrally connected with the turbine and the other end integrally connected with a conduit connected to the source of fluid, and a second member including a first cylindrical sleeve integrally connected with the shaft of the turbine and communicating with the bore of this shaft, and a second cylindrical sleeve closed at the upper part thereof and mounted on the first sleeve such that the sleeves nest within each other and are adapted to be displaced with respect to one another at least in the direction of the axes thereof. The cylindrical walls of these sleeves are provided with orifices cooperating with each other so as to form the orifice having a variable cross section for establishing communication between the bore of the shaft and the inlet of the turbine as function of the relative position of the two sleeves. The second sleeve is connected with the shaft of the turbine by means of at least one elastically deformable element which deforms as a result of a centrifugal force, the deformation of this element causing a relative displacement of the two sleeves.

These and further objects, features and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings which show, for purposes of illustration only, several embodiments in accordance with the present invention, and wherein:

FIG. **1** schematically illustrates the device according to the present invention arranged in a slow drilling turbine wherein the internal pressure drop decreases with the speed of rotation;

FIG. **2** illustrates the device of FIG. **1** on an enlarged scale;

FIG. **3** schematically illustrates a second embodiment of the device according to the present invention and arranged in a slow drilling trubine wherein the internal pressure drop decreases with the speed of rotation;

FIG. **4** schematically illustrates a third embodiment of the device according to the present invention which may be arranged in any type of turbine;

FIG. **5** schematically illustrates a fourth embodiment of the device according to the present invention which may be arranged in any type of turbine;

FIGS. **5A**, **5B**, and **5C** are cross-sectional views taken along line **5—5** in FIG. **5** showing the operating positions of the device as function of the operation of the turbine; and

FIG. **6** schematically illustrates another embodiment of the device according to the present invention which is adaptable to any type of turbine.

Referring now to the drawings wherein like reference numerals are used to designate like parts throughout the several figures, there is shown in FIG. **1** a regulating device provided in a drilling turbine whose pressure at the inlet varies with the functioning or operating system, such as, for example, turbines with special bladings (the Z type) whose internal pressure drop decreases with the speed of rotation. In this figure. a drilling or boring tool **1** has been schematically shown which is driven in rotation by a turbine **2** equipped with a regulating device according to the present invention, the unit or assembly thus formed being suspended at the end of a drilling column **4**.

The device **3** is of the by-pass type and includes a body **5** connected by any known means, for example screwed connections, with the drilling column **4** and with the turbine **2**. At the interior of the body **5** and essentially in the extension of the axis **6** of the turbine **2**, a reservoir **7** is secured. The reservoir has an essentially annular shape, which delimits in the body **5** two distinct concentric spaces, an essentially cylindrical space **8** in the center of the reservoir **7**, and an annular space **9** arranged between the reservoir **7** and the wall of the body **5**. The annular space **9** serves for communicating between the drilling column **4** and the inlet of the turbine **2**, whereas the space **8** communicates at its upper portion with the drilling or boring column, and at its lower part with a central bore **10** disposed in the shaft **6** of the turbine. The bore **10** terminates at its other end in a zone situated in immediate proximity to the drilling tool **1** for reasons discussed hereafter. The internal face of the reservoir **7** delimiting the cylindrical space **8** consists of a wall **11** which is deformable in response to a pressure differential and the reservoir 7 is filled with a gas having a specific pressure.

The operation of the regulating device will now be discussed in connection with FIG. 2 which schematically illustrates the regulating device of FIG. 1, on an enlarged scale. During the operation of the turbine, the hydraulic fluid or drilling mud which actuates the turbine 2 flows at a constant rate of flow Q from the drilling column 4. During the normal operation of the turbine, the largest portion of this fluid is transmitted through the annular space 9 to the inlet E of the turbine 2 at a pressure P_o and at a rate of flow Q_o. This fluid, which circulates in the direction indicated by the arrows drawn in continuous lines, actuates the turbine 2 and follows an upward path in the annular space between the wall of the drilled well 12 and that of the drilling column 4 in the direction indicated by the arrows drawn in broken line in FIG. 1 while carrying the drilled excavations toward the surface. As shown in FIGS. 1 and 2, a portion of the fluid coming from the drilling column 4 is diverted through the cylindrical space 8 in the direction indicated by the arrows drawn in dashed line, and after passing through the bore 10 of the shaft 6, this fluid serves to irrigate the drilling tool 1 whose active parts are free from the drilled or excavated material. As will be apparent to experts in the field, this irrigating or washing effect of the tool is very important since it permits use of the drilling tool under optimum conditions so as to obtain a maximum speed of advance for the drilling tool.

The fluid flow Q_1 diverted through the space 8 depends upon the cross section of the space 8 and therewith upon the deformation of the membrane 11 in response to the pressure differential acting upon each of the faces thereof. The pressure P_r inside the reservoir 7 has a specific value so that under the normal operation of the system, the cross section of the cylindrical space 8 provides a flow Q_1 which is equal to $Q - Q_o$, Q being the total flow of fluid delivered by the drilling column, and Q_o the flow of fluid at the inlet of the turbine at the desired operating condition. When the operation of the operating system becomes slower than the nominal system operation corresponding to the maximal power of the turbine, an increase of the resistant torque applied to the tool causes a reduction in the system operation. Any reduction of the system operation causes a reduction in power which is not compensated for by a sufficient increase of the driving torque of the turbine which may lead to jamming or stalling of the drilling system. This effect results in a reduction of the pressure P_o at the inlet of the turbine. As a result of the pressure difference $P_r - P_o$, the membrane 11 is then deformed in such a manner that the cross section of the space 8 is reduced, causing a reduction of the flow Q_1, which causes an equivalent increase in the flow Q_o, the flow Q remaining constant. This flow supplement furnished or supplied to the turbine serves for restarting the latter and for avoiding jamming or stalling of the system.

Analogously, when the system or turbine operates faster the pressure at the inlet of the turbine increases, causing a deformation of the membrane 11 in such a manner that the flow Q1 diverted toward the tool also increases, entailing an identical reduction of the flow Q_o to the turbine, and consequently a reduction in the system operation. In this manner, a self-regulation of the flow introduced to the turbine is achieved as function of the pressure at the inlet of the turbine.

As is readily apparent from the above description, the regulating device according to the present invention affords a number of significant advantages as compared to the prior art devices in which an excess flow of fluid is employed for the regulation of the system operation. More particularly, the energy of the excess fluid which is not utilized for the drilling turbine is used for freeing the active parts of the tool from the drilling or excavating material. Additionally, the present regulating device is not very cumbersome and may be easily adapted to drilling turbines wherein the internal pressure drop decreases with the speed of rotation. However, it should be noted that it is possible for one of ordinary skill in the art to modify the above-described device without departing from the spirit and scope of the present invention. More particularly, it is possible to provide for means designed for the regulation of the pressure P_r, and such regulation may be effected at the surface, for example during the operations of replacing the drilling tool, depending upon the depth at which the turbine operates, and so as to take into account variations of the temperature in the well. This pressure regulation may also be effected in a continuous fashion and by any known means, for example, by means of a duct 35 schematically illustrated in FIGS. 1 and 2 which connects the reservoir 7 to the installation at the surface and which may be incorporated into the drilling column. It is also possible to replace the bore in the shaft of the turbine by a duct which is connected with the inlet of the turbine and terminates in the immediate vicinity of the tool.

FIG. 3 illustrates another embodiment of the regulating device in accordance with the present invention for use in a slow drilling turbine whose pressure drop decreases with the speed of rotation of the turbine. As shown, the regulating device is provided at the interior of the body 5 with a member of the type having variable orifices adapted to provide communication between the bore 10 of the shaft 6 of the rotor and the drilling column 4. This member includes a fixed cylindrical sleeve 19 whose inner bore is in communication with the bore 10 of the shaft 6, the cylindrical sleeve being integrally connected with the body 5 by means of fastening or attaching arms 20 shown schematically, and a cylindrical sleeve 21 which is axially movable with respect to the axis of the body 5. This sleeve is placed coaxially with respect to the sleeve 19 and has a slightly greater inside diameter than the outside diameter of the sleeve 19 such that it is axially slideable with respect to the latter. The sleeve 21 which is closed at the upper part thereof carries an axle 22 supported by a bearing 23 that is integrally connected with the body 5, for example by means of supporting arms schematically shown at 24. The axle 22 is prevented from rotating by means of a key-groove assembly 25, which is schematically illustrated. The upper part of the axle 22 is provided with a plate 26 and elastic means 27 are interposed between the plate 26 and the bearing 23. In the embodiment of FIG. 3, these elastic means may, for example, consist of a deformable elastic sleeve operating by compression as illustrated. However, it is understood that other elastic means may be used, for example a helical spring or the like.

The sleeves 19 and 21 are each provided with orifices in the walls thereof with the orifices provided in the sleeve 21 arranged for cooperation with those of the sleeve 19, as will be described hereinbelow. The shape or configuration of these orifices is determined in accordance with the dimensions of the sleeves and the operating conditions. In FIG. 3, two types of orifices have been shown schematically for purposes of illustration only. The orifices 28 have an elongated shape in a plane perpendicular to the axis of the device, whereas the orifices 28′ are circular in shape and may be formed by a simple drilling operation.

During the normal operation or functioning of the turbine, the regulating device occupies the position shown in FIG. 3. The pressure of the fluid coming from the drilling column, as shown by the arrow F, acts upon the plate 26, thereby displacing the sleeve 21 toward the bottom of the figure, by compressing the elastic means 27. The orifices of the sleeve 21 partially uncover or expose the orifices of the sleeve 19, and a part of the drilling fluid is diverted toward the bore of the shaft 6, as indicated by the arrows F_2, whereas the principal portion of the fluid flows toward the inlet of the turbine — in the direction indicated by the arrow F_1 — which is supplied with a fluid flow Q_o. As indicated, Q designates the flow of fluid coming from the surface via the drilling column, this flow being constant, and $Q_1 = Q - Q_o$ represents the flow of fluid diverted toward the bore 10 of the shaft 6. When, due to the effect of an increase in the resistant torque applied to the drilling tool, the turbine slows down, the pressure P_o at the inlet of the turbine decreases, with the result that the elastic means 27 displaces the sleeve 21 in a manner such that the uncovered cross section of the orifices in the sleeve 19 decreases. This produces a reduction of the flow Q_1, and correlatively an increase of the flow Q_o, which serves for restarting the turbine. In contradistinction, when the resistant torque exerted on the drilling tool decreases, the system operation or functioning of the turbine increases, producing a pressure increase at the inlet of the turbine. This pressure increase causes the displacement of the sleeve 21 against the action of the elastic means which results in an increase of the uncovered or exposed cross section of the orifices provided in the sleeve 19, and therefore an increase of the flow Q_1 which entails a corresponding decrease of the flow Q_o for the turbine.

The embodiment of FIG. 3 is subject to modification without departing from the spirit and scope of the present invention. More particularly, the sleeve 19 may be integrally connected with the shaft 6 of the turbine and be rotatably driven by the latter with the orifices such as 28 being disposed in such a manner that, for a specific axial position of the movable sleeve 21, the uncovered or exposed cross section of the orifices provided in the sleeve 19 are independent of the rotation of this sleeve with respect to the sleeve 21 and independent of the speed rotation at which it is driven or carried along. The orifices may also be disposed in such a manner that, with the sleeve 19 being rotatably driven by the shaft 10, the duration for which the orifices of the sleeve 19 are uncovered by the orifices of the sleeve 21 is proportional to the speed of rotation of the turbine, and the elastic means 27 may be employed either simultaneously or not employed at all in order to regulate the position of the sleeve 21.

With reference to FIG. 4, there is schematically illustrated another embodiment of the regulating device of the present invention which is adaptable for use with any type of turbines, and more particularly for turbines whose internal pressure drop is independent of the operation thereof, such as turbines with normal bladings. In this embodiment, the hollow axle 6 of the rotor of the drilling turbine 2 is extended into the body 5 of the regulating device 3. The upper end of the axle 6 is closed by a stopper member or plug 13 integrally connected with the shaft 6, for example by a threaded connection. The plug is provided with a ring or crown 14 concentrically arranged with respect to the shaft 6 of the turbine 2. The lateral wall of the shaft 6 situated at the interior of the body 5 is provided with orifices 15 for communication between the bore 10 of the shaft 6 and the interior space of the body 5. Deformable flexible resilient elements such as laminae 16 are secured to the shaft 6 and which, in the absence of rotation of the shaft 6, obstruct the orifices as shown in the left portion of FIG. 4. These elements are secured at one end thereof, for example at the lower end, by any conventional means such as screws, a clamping ring, or by welding, as schematically indicated at 17. The length of the elements 16 is such that the free ends thereof which are herein illustrated as their upper ends are movable within the annular space between the shaft 6 and the crown 14. The elements 16 are provided with flyweights 18 at the free ends thereof which serve for making the elements responsive to the speed of rotation of the shaft 6 as discussed below.

When the turbine is stopped, the elements 16 occupy the position represented in the left portion of the figure, thus obstructing all of the orifices 15. In this case, all the hydraulic fluid passes into the annular space between the body 5 and shaft 6 and is thus utilized to start the turbine. Upon rotation of the shaft 6, the centrifugal force exerted by the rotation of the shaft on the weights 18 causes the elastic elements 16 to be deformed as shown in the right portion of FIG. 4, thus partially and progressively uncovering the orifices 15 through which the excess fluid flows so as to irrigate the drilling tool and the face of the cut. When the resistant torque applied to the tool increases, the system operation or functioning of the turbine slows such that the centrifugal force exerted on the weights 18 decreases and the elastic elements 16 approach the orifices 15. The movement of the elements 16 produces a reduction of the flow of excess fluid irrigating the tool through the bore 10 of the shaft 6, and consequently an increase of the flow of fluid for the turbine 2 through the annular space 9 for restarting the turbine.

Conversely, when the operation of the turbine increases, the centrifugal force exerted on the weights increases causing an outward movement of the elements 16 uncovering the orifices 15. This movement results in an increase of the flow of fluid irrigating the drilling tool and a decrease of the flow of fluid for the turbine which produces a decline in the system operation of the turbine.

As shown in the figure, the crown 14 serves as a stop to limit the deformation of the elastic elements 16 in order to avoid the deterioration thereof in case of extremely high speed rotation of the turbine. In this manner, the supply of fluid for the turbine is automatically adjusted to the desired value as function of the actual system operation of the turbine. As is well known in the art, the cross sections and shapes of the orifices 15 and of the elements 16 as well as the elasticity of the latter, and the values of the masses of the weights 18 are chosen in accordance with the desired function of the system operation of the turbine.

FIG. 5 schematically illustrates another embodiment of the regulating device, wherein a plurality of elastic elements **29** is utilized. As shown in this figure, one end of the elements is secured to the shaft **6** of the turbine, or to a ring **31** integrally connected with the shaft and the other end thereof is secured to a ring **32** which is adapted to slide along a rod **33** integrally connected, for example, with the body **5**, the connection not being shown.

As shown in FIG. **5**A, the elements **29** are disposed in the manner of the faces of a prism such that, in the absence of rotation of the shaft **6**, each element is in contact with the adjacent element in order to define a prismatic volume having a polygonal essentially fluid-tight base. Secured to each element is a weight **30** such that during the normal system operation or functioning of the turbine the centrifugal force exerted on the weights **30** deform the elements **29**, as shown in FIG. **5**, by driving or carrying the ring **32** downwardly. As is more clearly seen from FIG. **5**B which is a cross-sectional view with regard to FIG. **5**, the elements **29** are no longer in contact and a part Q_1 of the flow of fluid will proceed toward the bore **10** of the shaft **6**, as indicated by the arrow F_2. When the resistant torque applied to the drilling tool increases, the speed of rotation of the turbine decreases, causing in that case a decrease of the centrifugal force. The elements then approach the position illustrated in FIG. **5**A corresponding to a zero speed of rotation of the shaft **6**. In this manner, the flow Q_1 decreases, entailing a corresponding increase of the flow of fluid Q_o for the turbine.

On the other hand, when the system operation of the turbine increases, the deformation of the elements due to the action of the centrifugal force increases causing an increased separation of the elements **29**, as shown, for example, in FIG. **5**C. The result thereof is an increase of the flow Q_1 producing a corresponding reduction of the flow of fluid for the turbine. The deformation of the elements may be limited by limiting the sliding movement of the ring **32** in the downward direction by means of a shoulder portion **34** of the rod **33** which supports the ring for a maximal predetermined speed.

While we have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous modifications as known to those skilled in the art. For example, it is possible to combine some of the means described previously in connection with different embodiments in order to obtain an automatic regulation device for a turbine. More particularly, it is possible to replace the elastic means **27** of the regulating device shown in FIG. **3** by resilient elements **36** as shown in FIG. **6** secured on the one hand against the movable sleeve and on the other hand on the shaft of the turbine, these elements being deformed due to the action of the centrifugal force in order to produce an axial displacement of the movable sleeve as shown in FIG. **6**. We therefore do not wish to be limited to the details shown and described herein, but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

We claim:

1. A device for automatically regulating the system operation of a hydraulic turbine having an internal pressure drop which decreases with the speed of rotation, wherein the turbine drives a tool and hydraulic fluid is supplied at an essentially constant rate of flow from a source of fluid, the device comprising in combination first duct means in the form of a bore provided in a shaft of the turbine and having the lower part thereof terminating in the immediate vicinity of the tool, first communicating means directly connecting the source of fluid with an inlet of the turbine, second communicating means for communicating between the inlet of the turbine and the duct means at the upper end thereof, said second communicating means including at least one orifice having a variable cross section, the cross section being variable in accordance with a function of the pressure of the hydraulic fluid at the inlet of the turbine for permitting irrigation of the tool by a portion of the flow of the hydraulic fluid, said first communicating means being a rigid cylindrical body having one end connected with said turbine and having the other end connected with the source of fluid, said second communicating means including an annular reservoir concentrically positioned within said body, said reservoir having a rigid external wall and a deformable internal wall, said external wall and said body defining therebetween a first space through which hydraulic fluid flows from the source of fluid toward the inlet of the turbine, said internal wall of said reservoir defining said orifice through which the fluid flows from said first space toward the bore of said shaft, said internal wall of said reservoir being formed of a resilient material being deformable in response to a pressure differential applied to said internal wall, and said reservoir being filled with a gas having a pressure value equal to the pressure value of the hydraulic fluid at the inlet of the turbine.

2. A device according to claim **1**, further comprising second duct means connecting said reservoir to a surface installation for the continuous regulation of the pressure within said reservoir.

3. A device according to claim **1**, wherein said reservoir is integrally connected with said rigid cylindrical body.

4. A device according to claim **1**, wherein said reservoir is integrally connected with said shaft of the turbine.

5. A device for automatically regulating the system operation of a hydraulic turbine having an internal pressure drop which decreases with the speed of rotation, wherein the turbine drives a tool, and hydraulic fluid is supplied at an essentially constant rate of flow from a source of fluid, the device comprising in combination a first duct means in the form of a bore provided in a shaft of the turbine and having a lower part thereof terminating in the immediate vicinity of the tool, first communicating means directly connecting the source of fluid with an inlet of the turbine, second communicating means for communicating between the inlet of the turbine and the first duct means at an upper end thereof, said second communicating means including at least one orifice having a variable cross section which is variable in accordance with a function of the pressure of the hydraulic fluid at the inlet of the turbine for permitting irrigation of the tool by a portion of the flow of the hydraulic fluid, said first communication means being a rigid cylindrical body having one end connected with said turbine and having the other end connected with the source of fluid, said second communicating means including a first cylindrical sleeve coaxially positioned with respect to said body and having a lower portion thereof in communication with the bore of said shaft of the turbine, second cylindrical sleeve closed at the upper part thereof, said first and second sleeves being mounted in a nesting arrangement within one another and being adapted to be displaced with respect to one another at least in the direction of the axis thereof, the cylindrical walls of each of said sleeves being provided with orifices cooperating with the orifices of the other sleeve to form said orifice having a variable cross section and establishing communication between said bore and the inlet of said turbine as a function of the relative position of said two sleeves, and resilient means connected to at least one of said sleeves for controlling the displacement of one of said sleeves as function of the pressure at the inlet of the turbine.

6. A device according to claim **5**, wherein said first sleeve is connected with said shaft of the turbine, and said second sleeve being connected with said cylindrical body and axially displaceable with respect thereto against the action of said resilient means.

7. A device according to claim **6**, wherein said resilient means is in the form of a helical spring having one end secured to said second sleeve and the other secured to said cylindrical body.

8. A device according to claim **6**, wherein said resilient means is in the form of a tubular element being elastically deformable by a compression force, said element being supported between a shoulder portion of said second sleeve and a shoulder portion of said cylindrical body.

9. A device according to claim **5**, wherein said first sleeve is integrally connected for rotation with the shaft of said turbine.

10. A device according to claim **9**, wherein the cross section of the orifices of said first sleeve uncovered by the orifices of said second sleeve is independent of the relative angular position of said sleeves.

11. A device for automatically regulating the system operation of a hydraulic turbine, wherein the turbine drives a tool and hydraulic fluid is supplied at an essentially constant rate of flow from a source of fluid, the device comprising in combination first duct means in the form of a bore provided in the shaft of the turbine and having the lower part thereof terminating in the immediate vicinity of the tool, first communicating means directly connecting the source of fluid with an inlet of the turbine, second communicating means for communication between the inlet of the turbine and an upper end of the first duct means, said second communicating means including at least one orifice having a variable cross section, the cross section being variable in accordance with a function of the speed of rotation of the shaft of the turbine for permitting irrigation of the tool by a portion of the flow of the hydraulic fluid, said first communicating means being a rigid cylindrical body having one end connected with said turbine and having the other end connected with the source of fluid, the second communicating means including the bored shaft of the turbine, said at least one orifice being provided in the lateral wall of the shaft and in the region of said body, and at least one deformable resilient element for covering said orifice, said element having one end secured to said shaft and the other end being unsecured, said resilient element adapted to be deformed to progressively uncover said orifice in response to the centrifugal force provided by rotation of said shaft.

12. A device for automatically regulating the system operation of a hydraulic turbine, wherein the turbine drives a tool and hydraulic fluid is supplied at an essentially constant rate of flow from a source of fluid, the device comprising in combination duct means in the form of a bore provided in the shaft of the turbine and having the lower part thereof terminating in the immediate vicinity of the tool, first communicating means directly connecting the source of fluid with an inlet of the turbine, second communicating means for communication between the inlet of the turbine and an upper end of the duct means, said second communicating means including at least one orifice having a variable cross section, the cross section being variable in accordance with a function of the speed of rotation of the shaft of the turbine for permitting irrigation of the tool by a portion of the flow of the hydraulic fluid, said first communicating means being a rigid cylindrical body having one end connected with said turbine and having the other end connected with the source of fluid, said second communicating means including a plurality of elastic elements connected with the shaft of the turbine and forming an essentially fluid-tight prism in the absence of rotation of said shaft, said elements being deformed in response to the centrifugal force produced by the rotation of the shaft so as to become separated from each other for communication between the bore of the shaft and the inlet of the turbine.

13. A device for automatically regulating the system operation of a hydraulic turbine, wherein the turbine drives a tool and hydraulic fluid is supplied at an essentially constant rate of flow from a source of fluid, the device comprising in combination duct means in the form of a bore provided in the shaft of the turbine and having the lower part thereof terminating in the immediate vicinity of the tool, first communicating means directly connecting the source of fluid with an inlet of the turbine, second communicating means for communication between the inlet of the turbine and an upper end of the duct means, said second communicating means including at least one orifice having a variable cross section, the cross section being variable in accordance with a function of the speed of rotation of the shaft of the turbine for permitting irrigation of the tool by a portion of the flow of the hydraulic fluid, said first communicating means being a rigid cylindrical body having one end connected with said turbine and having the other end connected with the source of fluid, said second communicating means including a first cylindrical sleeve connected with the shaft of the turbine and communicating with the bore of said shaft, a second cylindrical sleeve closed at the upper part thereof, said sleeves being mounted in a nesting arrangement within each other and adapted to be displaced with respect to each other at least in the direction of the axes thereof, the cylindrical walls of said sleeves being provided with orifices cooperating with each other for forming said orifice having a variable cross section for establishing communication between said bore and the inlet of said turbine as function of the relative position of the two sleeves, said second sleeve being connected with said shaft of the turbine by at least one resilient deformable element, said element being deformable in response to the centrifugal force produced by rotation of the shaft wherein the deformation of said element produces a relative coaxial displacement of the two sleeves.

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