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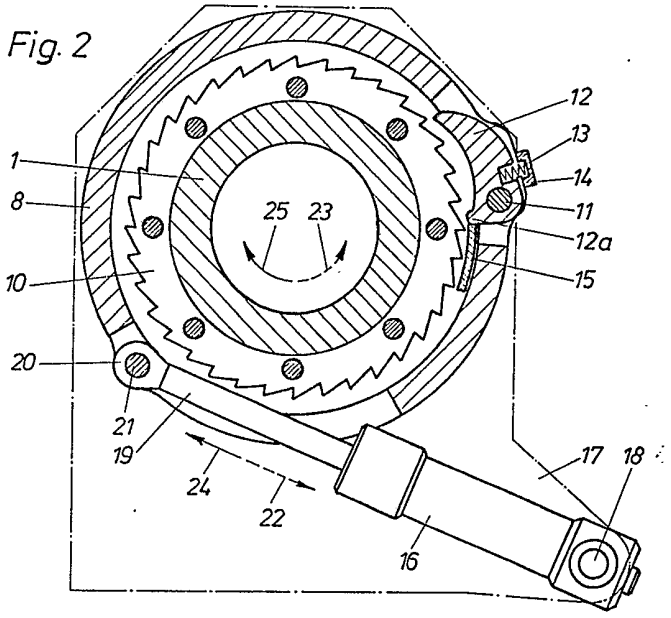
(58) Field of search
B3N
F2Q

(54) Equipment for making and breaking drill tube connections

(57) Drilling equipment comprises a drive device for a drilling rig having a drive shaft (1) rotatable in opposite directions (23, 25) and having a threaded journal for connection of drill tubes, a holding device for drill tubes and a drill-stem breaking device including a ratchet wheel (10) for rotation with the drive shaft (1) a pawl (12) carried on an annular member (8) concentrically arranged relative to the drive shaft (1) and carried on a housing member for rotation thereon, the pawl (12) connecting the annular member (8) to the ratchet wheel (10), and means (16) for rotating the annular member (8) so as to drive the ratchet wheel (10) through the pawl (12).

Fig. 2



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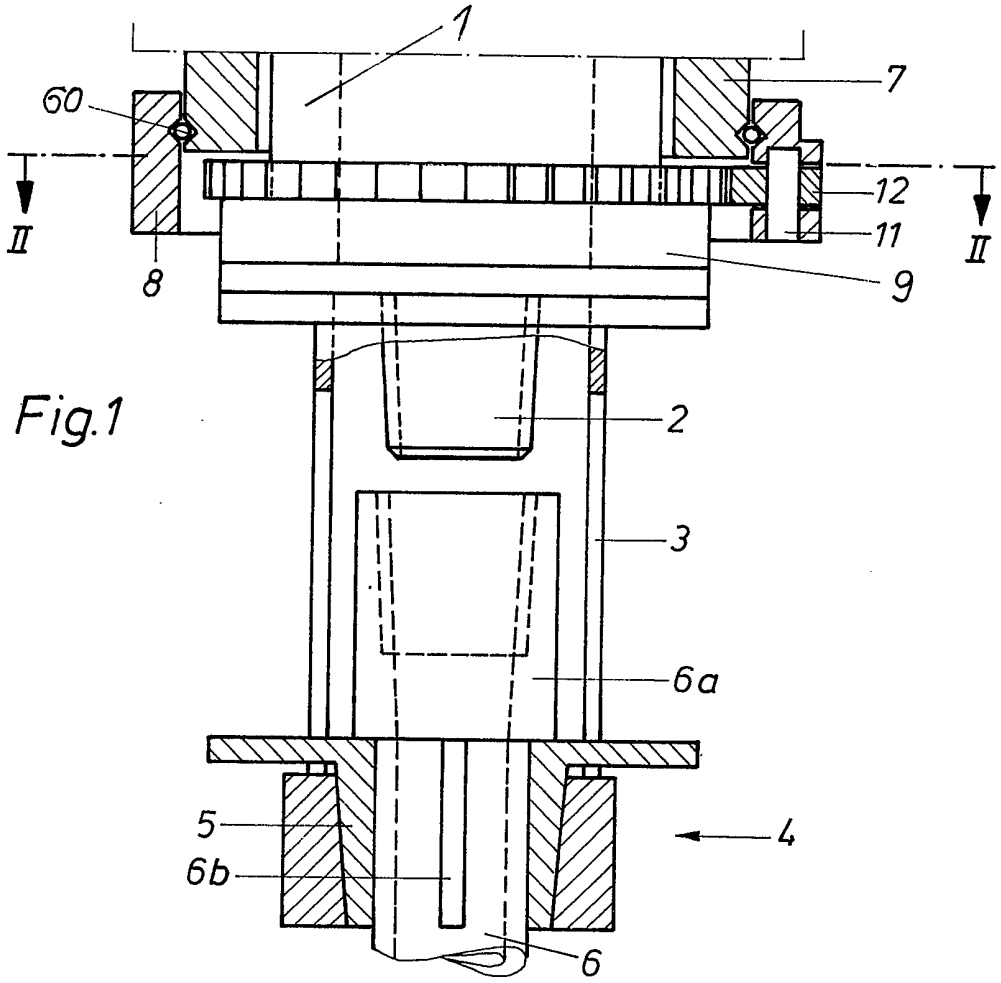

Fig.1

Fig. 2

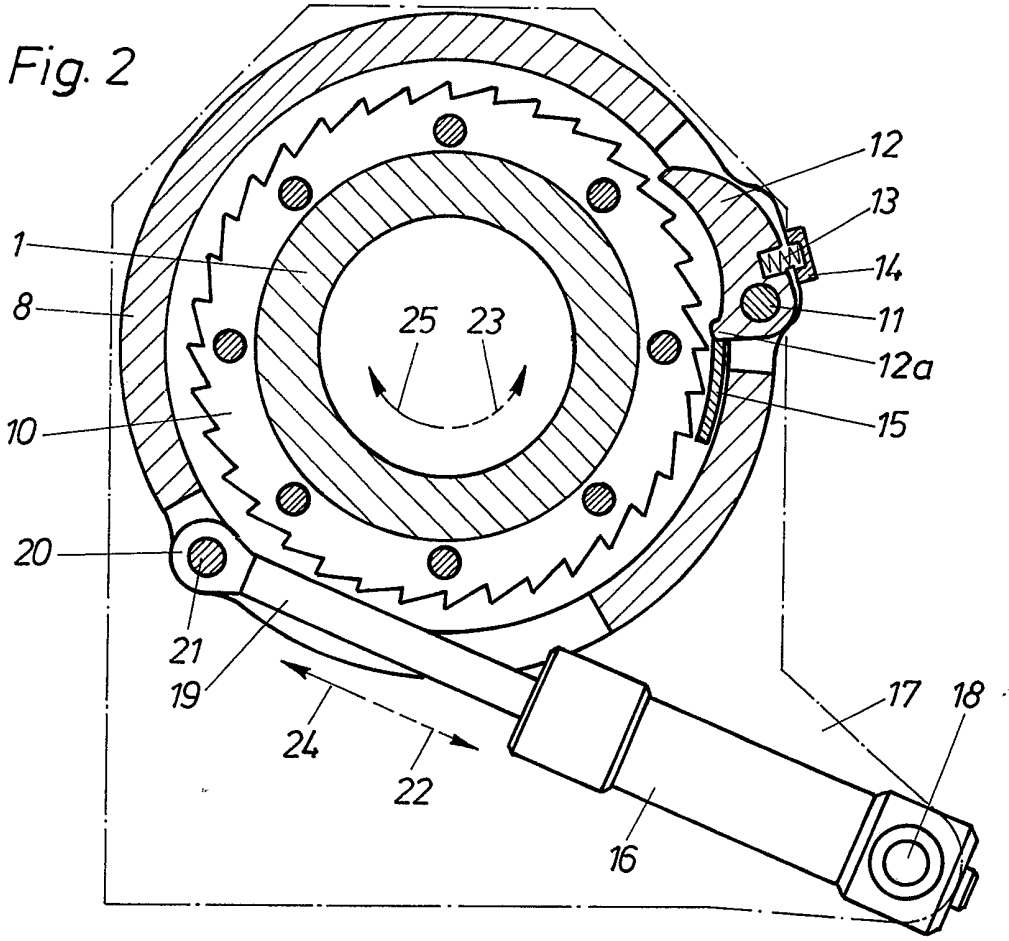

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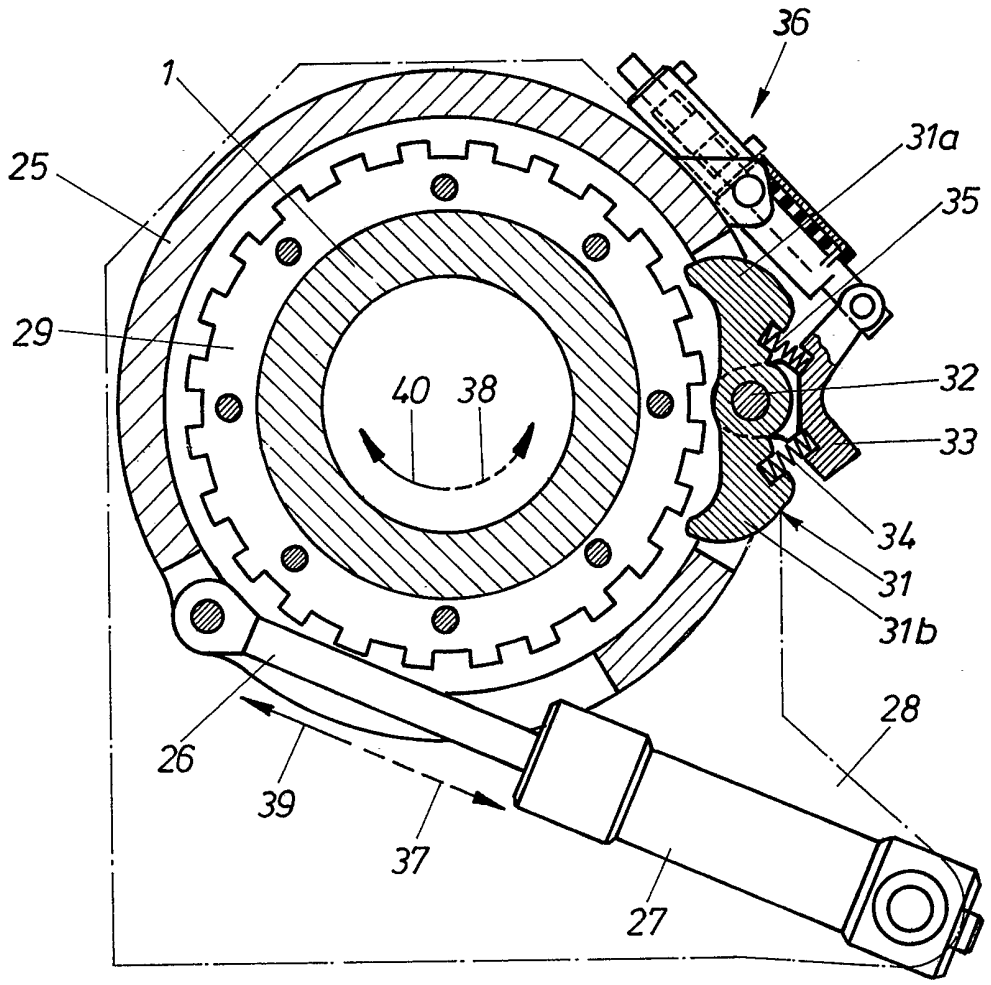
Fig. 3



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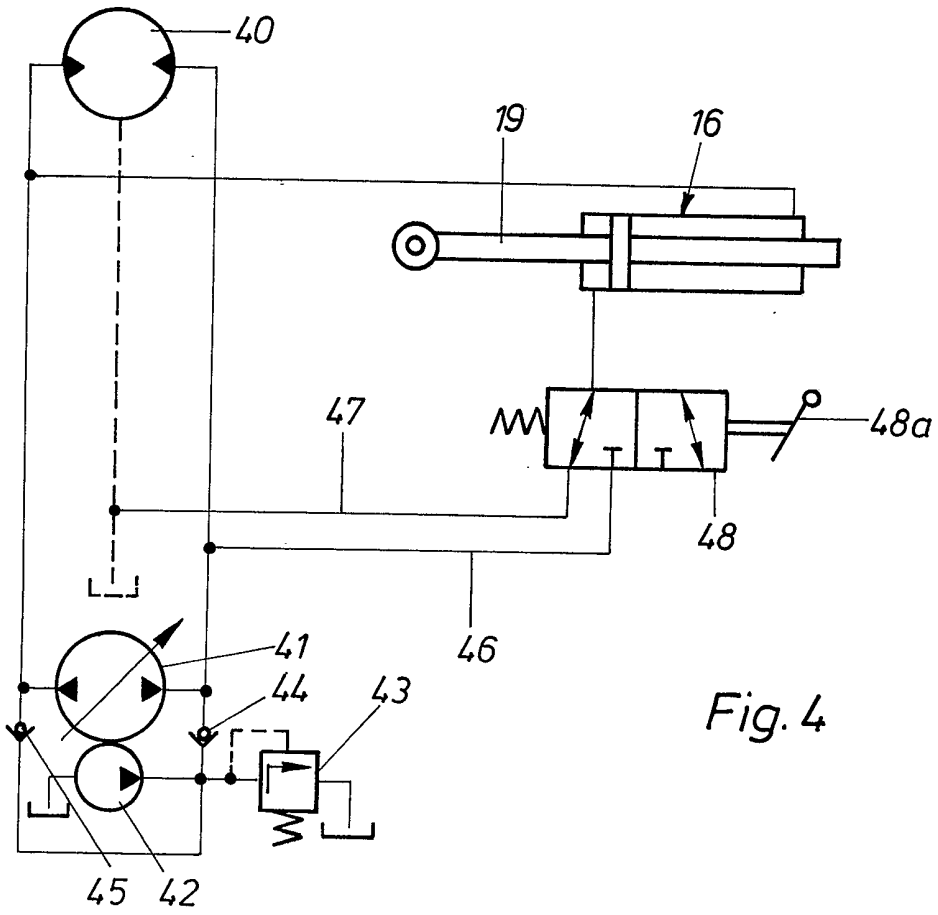

Fig. 4

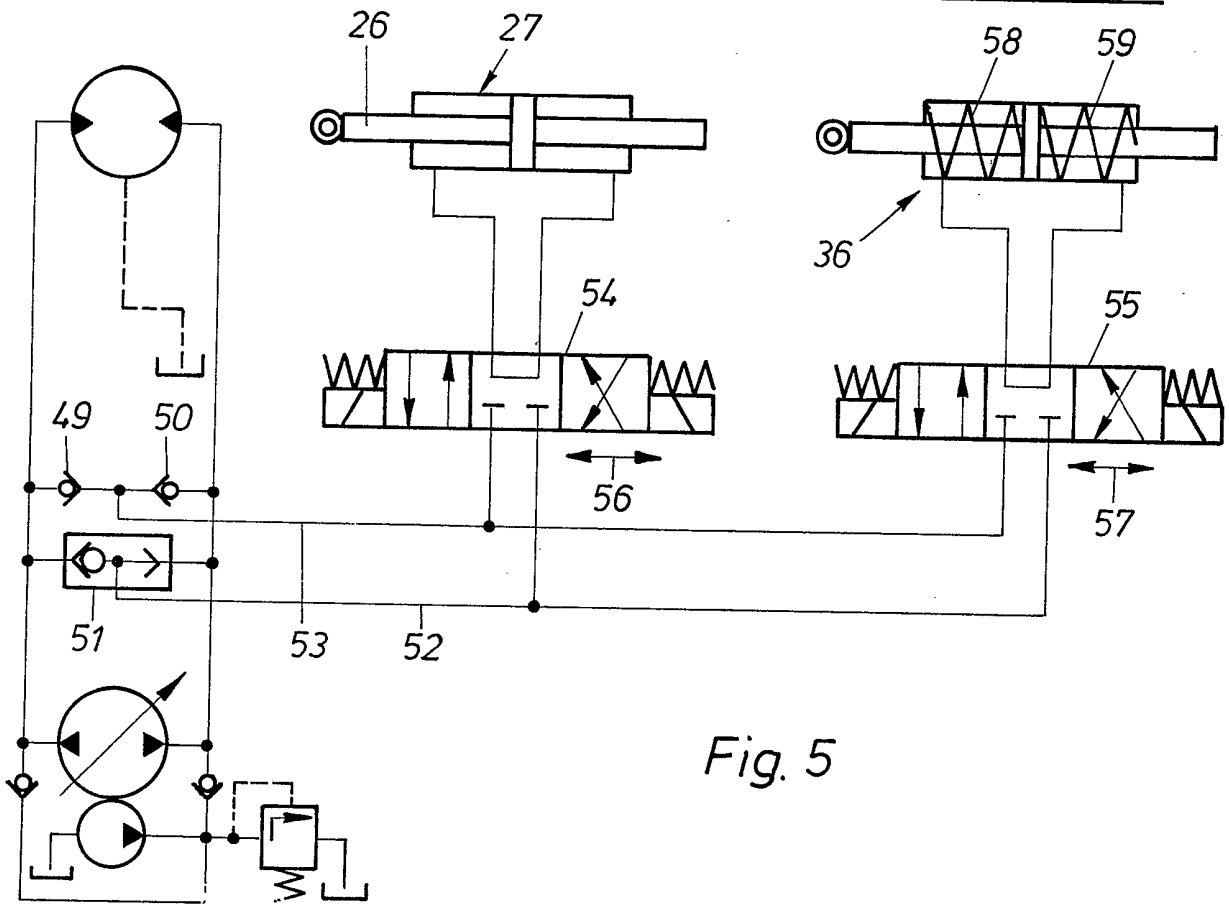

Fig. 5

SPECIFICATION

Drilling equipment

The invention relates to drilling equipment.

Such equipment may suitably comprise a drive device which is held on a drilling rig and of which the drive shaft, which is rotatable in the drilling direction and in the breaking direction, is provided with a threaded journal for the connection of a string of drill tubes, having a drill tube holding device which is disposed with axial spacing from the threaded journal and is connected to the drive shaft for rotation therewith but not relative thereto, to hold and rotate the string of drill tubes released from the threaded journal and having a drill-tube catching device which is disposed with further axial spacing and which co-operates with a drill-stem breaking device which comprises a ratchet wheel connected to the drive shaft for rotation therewith and a pawl which can be moved in the circumferential direction of the ratchet wheel by means of a lifting drive fixed to the housing and which is pivotable, against the force of a spring, about a pin parallel to the drive shaft and is held for engagement in and disengagement from the ratchet wheel in order to rotate this and is supported against a stop in the disengaged state.

In the known drilling equipment, which is preferably mounted on a carrier vehicle in order to increase the mobility, the drive device is constructed in the form of a hydraulically powered rotary head which is adjustable in height on a drilling mast. The rotary power head can be tilted forwards mechanically or hydraulically and, in conjunction with the drill-tube holding device and the drill-tube catching device, renders possible a rapid change of the drill tubes without auxiliary tools. The threaded journal of the drive shaft and the screw connections between the parts of the string of drill tubes are usually tapered in construction.

The drill-tube holding device consists essentially of a bell-shaped part which is connected to the drive shaft and disposed concentrically to the threaded journal and which renders possible the bracing of the string of drill tubes released from the threaded journal for rotation at its lower free end, so that the torque of the drive shaft can be transmitted to the drill tubes even after detachment from the threaded journal. In this manner, in conjunction with the drill-tube catching device, which surrounds the drill tubes like pincers below the next screw connection, this screw connection can be undone or screwed up.

Hydraulically actuated tube wrenches which are secured to the drilling rig or drilling mast are known as drill-stem breaking devices, in which case either only one hydraulically operated pipe wrench is used or two pipe wrenches are provided of which one is provided as stationary and the other to transmit the torque. In the known constructions, such drill-stem breaking devices are disposed below the drill-tube holding devices and cannot be used to break the screw connection between the threaded journal of the drive shaft and the string of drill tubes. Their construction is complicated and involves very high production costs.

Drilling equipment comprising the features mentioned at the beginning is further known (DE-AS 17 75 409) having a breaking device which comprises a ratchet wheel connected to the drive shaft for rotation therewith and a pawl which is movable in the circumferential direction of the ratchet wheel by means of a lifting drive fixed to the housing and which is pivotable, against the force of a spring, about a pin parallel to the drive shaft, in order to bring the pawl into and out of engagement with the ratchet wheel. A double-armed lever serves as a power transmission member which is held in a bearing arrangement fixed to the housing and which is articulated by its one end on the lifting drive and by its other end on the pawl. A combined torque, which is applied, on the one hand by the actuation of the pawl and its power transmission to the ratchet wheel and on the other hand by the drive shaft string of drill tubes to be broken, by the known device. By this means, not only can the screw connections between sections of the string of drill tubes be broken but also the head connection between the threaded journal of the drive shaft and the threaded sleeve of the uppermost drill tube can be released.

The known construction has the disadvantage, however, that parts which project comparatively far have to be accommodated in the drive housing for the bearing arrangement of the pawl and of the double-armed lever, while a very strong securing of the pawl and also of the lever arrangement connected thereto is necessary. At the same time, with the known devices, the ratchet wheels can only be moved over extremely small angular distances for each stroke of the lifting drive. In the case of relatively light drill tubes, in particular, this leads to the fact that the breaking operation is not initiated because such relatively light drill tubes have a comparatively large angle of twist and so the force necessary for the breaking cannot be reached with small angular distances.

The invention seeks to construct drilling equipment such as that of the type described at the beginning so that large forces can be transmitted even over large angular distances with an exceptionally compact form of construction and little projection of the elements necessary for the breaking operation.

According to the invention, there is provided drilling equipment comprising a drive device for a drilling rig and having a drive shaft rotatable in opposite directions and having a threaded connection for connection of drill tubes, a holding device for drill tubes and a drill stem breaking device including a ratchet wheel for rotation with the drive shaft and a pawl for connecting the ratchet wheel to a drive means wherein an annular member is provided concentrically of the drive device and drive means is provided for rotating the annular member so as to drive the ratchet wheel through said pawl.

In one form of equipment the pawl is mounted with its pin in the ring and is provided with a stop dog which, on rotation of the annular member in the drilling direction, towards the end of the rotary movement bears against a stop member connected

to the housing of the drive device and releases the ratchet wheel.

Preferably the holding device for drill tube is axially spaced from the threaded journal and is connected to the drive shaft for rotation therewith to hold and rotate the drill tube released from the threaded hournal and a dril-tube catching device is disposed with further axial spacing and co-operates with the drill-stem breaking device.

As a result of the above-mentioned construction, a favourable transmission of power can be achieved, and, as a result of appropriate arrangement of the point of action of the lifting drive and of the pawl on the annular member mounted on the housing, the loading of the housing can be kept extremely light despite large breaking forces. The arrangement of the annular member on the housing in conjunction with the pawl held in the annular member further leads to the fact that rotary movements of large angular distances can be transmitted to the ratchet wheel and so to the drill tubes. On rotation of the annular member in the drilling direction, the stop dog on the pawl in co-operation with the stop member ensures a release of the pawl towards the end of the rotary movement, while on rotation of the ratchet wheel counter to the drilling direction, the pawl comes away from the stop member and engages in the ratchet wheel counter to the drilling direction, the pawl comes away from the stop member and engages in the ratchet wheel and so a connection is established between the annular member and the drive shaft for rotation in the breaking direction.

The drilling equipment mentioned at the beginning with the above-mentioned arrangement of the annular member disposed concentrically to the drive shaft and the lifting drive acting substantially tangentially on the annular member to transmit the necessary breaking forces to the drill tubes may also be used, for screwing up the screw connection if the pawl is constructed in the form of a double pawl for selective locking of the ratchet wheel in both directions of rotation and can be engaged in the ratchet wheel by means of a control device.

In this case, the double pawl and the ratchet wheel may co-operate in such a manner that the double pawl can engage in the ratchet wheel in both directions of rotation and, with appropriate adjustment of the double pawl, the ratchet wheel is freely rotatable in both directions. In this case, however, the double pawl cannot be transferred automatically into its particular engagement position. Instead it is necessary to provide a separate control device for the drive of the double pawl.

A suitable solution to this results if the control device is constructed in the form of a piston and cylinder device which is secured to the annular member and which is provided with a double-armed lever pivotable about the pin of the double pawl for the actuation of the latter. The piston and cylinder device, the lever and the double pawl may co-operate in such a manner that, apart from the selective locking in one of the directions of rotation of the drive shaft, a mid-position of the pawl is also possible for the free rotation of the drive shaft.

The piston and cylinder device for the actuation of the double pawl preferably may comprise a double acting piston which can be set in a mid-position by two helical springs each of which is supported on one end face of the piston. By this means, assurance can be provided that the double pawl does not engage in the ratchet wheel when the piston is in the position of rest so that the ratchet wheel is freely rotatable. Depending on the direction of movement of the piston out of the position of rest into the one actuating position or the other, the drive shaft can be locked either in the drilling direction or in the breaking direction.

The invention will now be described in greater detail, by way of example with reference to the drawings, in which:-

Figure 1 shows a side view, partially longitudinal sectioned, of the lower portion of the drive device of drilling equipment with a drill-stem breaking device and a drill-tube holding device;

Figure 2 shows a section through the drive device on the line II-II of Figure 1;

Figure 3 is a view similar to Figure 2 showing adrill-stem breaking device in combination with a drill-tube screwing device;

Figure 4 shows an hydraulic circuit diagram for the arrangement as shown in Figures 1 and 2, and

Figure 5 shows an hydraulic circuit diagram for the arrangement shown in Figure 3.

The drive device illustrated in Figure 1 is held on a drilling rig so as to be adjustable in height. Projecting from the housing of the dirve device is a drive shaft 1 with a tapered threaded journal 2. Rigidly connected to the drive shaft 1, via a cylindrical member 3, is a drill-tube holding device 4. Wedges 5 can be inserted in the drill-tube holding device 4 in such a manner that a drill tube 6 with a threaded sleeve 6a is held in the axial direction after being detached from the threaded journal 2. The drill tube 6 is equipped with opposite ribs 6b which serve to transmit a torque from the drive shaft 1 to the drill tube 6.

An annular member 8, belonging to a drill-stem breaking device is mounted by means of balls 60 for rotation on a bearing flange 7 rigidly connected to the housing of the drive device.

The construction of the drill-stem breaking device can be seen, in particular, from Figure 2. From this it can be seen that the annular member 8 is disposed concentrically to the drive shaft 1. The drive shaft 1 is rigidly connected to a ratchet wheel 10 via an intermediate flange 9. A pawl 12, which is mounted on the annular member 8 so as to be pivotable about a pin 11 can be engaged in the ratchet wheel 10. The necessary pressure for this is produced by a compression spring 13 which is supported in an abutment 14 held on the annular member 8. Also rigidly connected to the housing of the drive device via the bearing flange 7 is a stop member 15 which determines the end position of the pawl 12 via a stop dog 12a thereon. Furthermore, Figure 2 shows a piston and cylinder device 16 which is pivotable about a pin 18 in a bearing support 17 connected to the housing of the drive device. The pistion rod 19 of the piston and cylinder device 16 is equipped, at its

free end, with an articulated head 20 which is connected to the annular member 8 via a pin 21.

On movement of the piston rod 19 in the direction of the broken arrow 22, the annular member 8 is turned in such a manner that the stop dog 12a of the pawl 12 is moved away from the stop member 15 and engages in the ratchet wheel 10 with a locking action. Thus a torque for breaking the screw connections can be transmitted to the drive shaft 1 in the direction of the broken arrow 23. On movement of the piston rod 19 in the direction of the arrow 24, the annular member 8 is turned in such a manner that, when the stop dog 12a bears against the stop member 15, the pawl 12 is lifted out of the corresponding locking tooth of the ratchet wheel 10, against the force of the compression spring 13, and so releases the ratchet wheel 10. Thus the drive shaft 1 is freely rotatable in the drilling direction as indicated by the arrow 25.

In Figure 3, a drill-stem breaking device is illustrated which can also be used for screwing up the string of drill tubes. In this device, too, an annular member 25 is connected to a piston rod 26 of a piston and cylinder device 27 which is likewise supported on a bearing support 28 rigidly connected to the housing of the drive device. As distinct from Figure 2, in the device illustrated in Figure 3, a ratchet wheel 29 is provided with symmetrically shaped locking teeth. The ratchet wheel 29 is likewise connected to the drive shaft 1 via an intermediate flange.

A symmetrical double pawl 31 is mounted on the annular member 25 for pivoting about a pivot pin 32. The pivot pin 32 serves simultaneously as a bearing arrangement for a two-armed lever 33 which is connected to the double pawl 31 via compression springs 34 and 35. A control device 36, held on the annular member 25, serves to actuate the double pawl 31 via the lever 33 and has a central position of rest for the double pawl 31, illustrated in Figure 3, as well as possibilities for adjustment in opposite directions.

In order to break a screw connection in the string of drill tubes, the control device 36 ensures engagement of the portion 31a of the double pawl 31 in the ratchet wheel 29. Then the piston rod 26 is moved in the direction of the broken arrow 37 so that a torque can be transmitted to the drive shaft 1 in the direction of the broken arrow 38. In this case, as in the arrangement shown in Figure 2, the driving shaft's 1 own torque forms an additional force for the breaking of the string of drill tubes.

In order to screw up the string of drill tubes, the double pawl 31 is pivoted in the opposite direction by the control device 36 so that the portion 31b engages in the ratchet wheel 29. In this position of the double pawl 31, a torque can likewise be applied on movement of the piston rod 26 in the direction of the arrow 39. This torque in the direction of the arrow 40 can also be reinforced by the torque of the drive shaft 1 peculiar to the drive.

The device represented in Figure 2 is connected to the hydraulic circuits of the drive device. This hydraulic circuit, illustrated in Figure 4, is of closed construction so that the operating pressure for the drive device is also available for the drill-stem breaking device, with the minimum expenditure on pipelines. A pump 41, which co-operates with a feed pump 42, serves to supply the drive motor 40. Furthermore, a feed pressure valve 43 and non-return valves 44, 45 are provided. A two-way valve 48 is connected via the pipelines 46 and 47. The piston rod 19 of the piston cylinder device 16 can be brought into the breaking position or drilling position according to the position of a lever 48a of the valve 48.

The hydraulic circuit diagram illustrated in Figure 5 for the device shown in Figure 3, which is also suitable for screwing up the string of drill tubes, corresponds substantially, in its left-hand portion, to the hydraulic circuit diagram shown in Figure 4 so that it will not be described again. In addition, non-return valves 49 and 50 as well as a changeover valve 51 are provided, which latter ensures that an adequate pressure always prevails in the pipeline 52. The control both of the piston and cylinder device 27 and of the control device 36 is effected via the pipelines 52 and 53. The piston and cylinder device 27 is connected to the pipelines 52 and 53 through a threeway solenoid valve 54. The control device 36 is in communication with the pipelines 52 and 53 through a solenoid valve 55 of the same construction. According to the position of the valve 54 in the direction of the double arrow 56, the piston rod 26, which is connected to a double acting piston can be set in a breaking direction, a drilling direction or in its mid-position. The control device 36 for the double pawl 31 is connected in the same manner to the solenoid valve 55 which can likewise be switched over in the direction of the double arrows 57. In the case of the control device 36, constructed in the form of a piston and cylinder device, the central position of rest is stabilized by springs 58 and 59 which are supported at the end face of the piston and cylinder.

For the tube-stem breaking device shown in Figure 2, and for the device shown in Figure 3, a drill-tube catching device, not illustrated in the drawings, is necessary. This embraces the drill tubes below the thread to be broken or screwed up and so forms a means of securing the corresponding portion of drill tube against rotation. The torque from the drill-stem breaking device is applied to the portion of drill tubes above the screw connection and is additionally reinforced by the torque of the drive shaft.

CLAIMS

1. Drilling equipment comprising a drive device for a drilling rig and having a drive shaft rotatable in opposite directions and having a threaded connection for connection of drill tubes, a holding device for drill tubes and a drill stem breaking device including a ratchet wheel for rotation with the drive shaft and a pawl for connecting the ratchet wheel to a drive means wherein an annular member is provided concentrically of the drive shaft and supported for rotation on a housing member of the drive device and drive means is provided for rotating the annular member so as to drive the ratchet wheel through said pawl.

2. Equipment as claimed in claim 1, wherein the pawl is mounted with its pin in the ring and is provided with a stop dog which, on rotation of the annular member in the drilling direction, towards the end of the rotary movement bears against a stop member connected to the housing of the drive device and releases the ratchet wheel.

3. Equipment as claimed in claim 1, wherein the pawl is constructed in the form of a double pawl for the selective locking of the ratchet wheel in both directions of rotation and can be caused to engage in the ratchet wheel by a control device.

4. Equipment as claimed in claim 2 or 3, wherein the holding device for drill tube is axially spaced from the threaded journal and is connected to the drive shaft for rotation therewith to hold and rotate the drill tube released from the threaded journal and a drill-tube catching device is disposed with further axial spacing and co-operates with the drill-stem breaking device.

5. Equipment as claimed in claim 2, 3 or claim 4, when appendent thereto, wherein the control device is constructed in the form of a piston and cylinder device which is secured to the annular member and which is provided with a two-armed lever pivotable about the pivot pin of the double pawl to actuate the latter.

6. Equipment as claimed in claim 5, wherein the piston and cylinder device comprises a double acting piston which can be set in a mid-position by two helical springs each of which is supported on one end face of the piston.

7. Drilling equipment substantially as described herein with reference to the drawings.

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