The present invention relates to a drill tube element (10; 10') for percussive top hammer drilling. The drill tube element (10; 10') according to the invention is provided with a valve means that functions as a non-return valve for the drilling fluid when drilling upwards with the drill tube element (10; 10'). When drilling in a direction in the range from horizontal to downwards the valve means admit drilling fluid to travel in direction towards the bottom of the hole that is being drilled.
Drill tube element

The present invention relates to a drill tube element for percussive top hammer drilling, said element having a longitudinal extension, said element further having a male thread at one end and a female thread at the other end, said threads being used to connect tube elements with each other to form a drill string that transfers impact energy from the top hammer to a drill bit connected to the end of the drill string opposite from the top hammer, said drill tube element having internal, longitudinally through-going, passage means for flushing medium.

From EP-B-0 126 740 is previously known a method employed in long-hole drilling and a drill rod system. Said prior art technique uses drill tube elements having a considerably larger diameter than conventional drill rods also used for percussive top hammer drilling. This is illustrated in Figs.4-9 of EP-B-0 126 740. EP-B-0 126 740 is incorporated in the present application by way of reference.

When drilling with drill tube elements according to EP-B-0 126 740 the direction of the drilling can either be downwards, horizontal or upwards. The drilling fluid when drilling underground is normally water with some additive e.g. for lubrication purposes. Since the drill tube elements have a relative large inner diameter each drill tube element holds a considerable amount of water.

As the length of the drilled hole increases the drill string is extended by new drill tube elements that are
connected to the drill tube elements of the drill string by thread couplings, see Figs.10-14 of EP-B-0 126 740. When drilling upwards with an equipment according to EP-B-0 126 740 it is necessary to arrange for the water to stay in the drill tube elements of the drill string when a new drill tube element is connected to the drill string. This can be arranged with some type of a non-return valve. However, since it is often necessary also to drill downwards with the same equipment, said non-return valve arrangement must only work in one direction, i.e. the water is not allowed to flow downwards when drilling upwards but the water must be allowed to flow downwards when drilling downwards.

From SE-B-456 269 is previously known a non-return valve arrangement at a connection between two tubes, said connection being effected by friction welding. The non-return valve arrangement includes a ball and a holder device, said holder device being mounted in connection with the friction welding and axially locked by an upset from the welding cooperating with a groove in the holder. However, this non-return valve arrangement is especially adapted to be used in connection with friction welding of tubes and therefore not suitable for elements being connected to each other by thread couplings.

The aim of the present invention is to present a non-return valve means that allows a drill tube element as specified above to be used for drilling in all directions. This is achieved with a non-return valve that has been given the characteristics of the accompanying claims.
Below embodiments of the non-return valve according to the present invention will be described with reference to the accompanying drawings, where Fig.1 shows a preferred embodiment of a drill tube element according to the present invention, said element being in position for drilling upwards; Fig.1a shows a section along Ia-Ia in Fig.1; Fig.2 shows an exploded view of the upper part of the drill tube element according to Fig.1; Fig.3 shows the drill tube element according to Fig.1 in position for drilling downwards; Fig.4 shows an alternative embodiment of a drill tube element according to the present invention, said element being in position for drilling upwards; Fig.4a shows a section along IVa-IVa in Fig.4; Fig.5 shows an exploded view of the upper part of the drill tube element according to Fig.4; Fig.6 shows the drill tube element according to Fig.4 in position for drilling downwards; and Figs.7a-7d show different embodiments of a tube that constitutes an essential detail of the present invention.

The drill tube element 10 in Fig.1 is provided with a male thread 12 at one end and a female thread 14 at the other end. The portions 16, 18 holding the threads 12, 14 are separate portions that are connected to the central portion 20 of the drill tube element 10, e.g. by a friction weld 22. This technique is known from EP-B-0 126 740.

As is most clearly shown in Fig.2 the male thread portion 16 is provided with a first restriction 24 having a largest diameter D1 equal to the diameter of a first flushing bore 26 of the central portion 20 and a smallest diameter D2 equal to the diameter of a second
flushing bore 28 of the male thread portion 16.

The female thread portion 18, see Fig.1, is also provided with a second restriction 30 having a largest diameter D3 equal to the diameter of the first flushing bore 26, i.e. the diameters D1 and D3 are equal. The smallest diameter of the restriction 30 is equal to the diameter D4 of a third flushing bore 32 extending between the second restriction 30 and the internal thread 14.

A ball 34 of a suitable material, preferably metal, is located inside the central portion 20 of the drill tube element 10. The diameter D5 of the ball 34 is smaller than the diameter D2 of the second flushing bore 28 and larger than the diameter D4 of the third flushing bore 32. Having the diameter D5 of the ball 34 smaller than the diameter D2 of the second flushing bore 28 makes it possible to insert the ball 34 through the second flushing bore 28. Since the diameter D5 of the ball 34 is larger than the diameter D4 of the third flushing bore 32 the ball 34 will cooperate with the restriction 30 to provide a non-return valve for the flushing medium, i.e. normally water.

In order to maintain the ball 34 within the central portion 20 but still allowing the flushing medium to flow in direction of the arrow 36 a barrier means in the shape of a tube 38 is mounted in the second flushing bore 28, said tube 38 having an internal diameter D6, see Fig.2, that is smaller than the diameter D5 of the ball 34. The tube 38 is made of a suitable material, preferably plastic or soft metal, e.g. alumina. It is important that the material of the
tube 38 is essentially lighter than the material of the
drill tube element 10, i.e. the tube 38 should have a
substantially lower density than the drill tube element
10. In order to lock the tube 38 in the second flushing
bore 28 against axial displacement the tube 38 is
provided with protrusion means, preferably an annular
protrusion 40, that cooperates with groove means,
preferably an annular groove 42, in the second flushing
bore 28. As a further means to prevent the tube 38 from
being displaced downwardly in Fig.1 the tube 38 is
provided with a shoulder 41. The dimension of the tube
38 is such that when the inner end 44 of the tube 38
cooperates with the ball 34 a barrier for the flushing
medium to enter through said inner end 44 in direction
of the arrow 36 is provided. However, in order to allow
flushing medium to flow in direction of the arrow 36
although the ball 34 is cooperating with the inner end
44 of the tube 38, said tube 38 is provided with a
number of openings 46 in its wall area between the
inner end 44 and the transition between the first
restriction 24 and the second flushing bore 28. The
total area of said openings 46 should at least be equal
to the internal cross sectional area of the tube 38 in
order to avoid a flow restriction.

The valve arrangement described above functions in the
following way. The flushing medium always flows in
direction of the arrow 36.

When upward-drilling is effected the male thread 12 is
at the upper end of the drill tube element 10. When
drilling fluid travels in direction of the arrow 36 the
ball 34 will be lifted from the position shown in
Fig.1. However, when drilling is interrupted, e.g. for
connecting a new drill tube element 10 to the drill string, then the pumping of the drilling fluid in direction of the arrow 36 is also interrupted. This means that the ball 34, due to gravity and pressure from the drilling fluid inside the drill tube element 10, will engage the restriction 30 to create a non-return valve. The flushing medium above the ball 34 in each drill tube element 10 will thus be maintained in the drill tube element 10.

In Fig. 3 downward-drilling is disclosed. In such a drilling mode the ball 34 will due to gravity and influence from the drilling fluid engage the inner end 44 of the tube 38. Although flushing medium will not enter via the inner end 44 of the tube 38, due to the cooperation between the ball 34 and said inner end 44, it is possible for the flushing medium to flow, via the openings 46, in the direction of the arrow 36 through the tube 38.

It is also possible within the scope of the present invention to locate the non-return valve means in the area of the male thread. In Figs. 4-6 such an embodiment is disclosed. The drill tube element 10' in Fig. 4 is provided with a male thread 12' at one end and a female thread 14' at the other end. The portions 16', 18' holding the threads 12', 14' are separate portions that are connected to the central portion 20' of the drill tube element 10', e.g. by a friction weld 22'. This technique is known from EP-B-0 126 740.

As shown most clearly in Fig. 4 the male thread portion 16' is provided with a first restriction 24' having a largest diameter Dl' equal to the diameter of a first
flushing bore 26' of the central portion 20' and a smallest diameter D2' equal to the diameter of a second flushing bore 28' of the male thread portion 16'.

As is most clearly shown in Fig.5 the female thread portion 18' is also provided with a second restriction 30' having a largest diameter D3' equal to the diameter of the first flushing bore 26', i.e. the diameters D1' and D3' are equal. The smallest diameter of the restriction 30' is equal to the diameter D4' of a third flushing bore 32' extending between the second restriction 30' and the internal thread 14'. A ball 34' of a suitable material, preferably metal, is located inside the central portion 20' of the drill tube element 10'. The diameter D5' of the ball 34' is smaller than the diameter D4' of the third flushing bore 32' and larger than the diameter D2' of the second flushing bore 28'. Having the diameter of the ball 34' smaller than the diameter D4' of the third flushing bore 32' makes it possible to insert the ball 34' through the third flushing bore 32'. Since the diameter D5' of the ball 34' is larger than the diameter D2' of the second flushing bore 28' the ball 34' will cooperate with the restriction 24' to provide a non-return valve for the flushing medium, i.e. normally water.

In order to maintain the ball 34' within the central portion 20' but still allowing the flushing medium to flow in direction of the arrow 36' a barrier means in the shape of a tube 38' is mounted in the third flushing bore 32'. Said tube 38' is made of a suitable material, preferably plastic or soft metal, e.g. alumina. In order to lock the tube 38' in the third
flushing bore 32' against axial displacement upwards in Fig. 4 the tube 38' is provided with a protrusion 40' that cooperates with the transition edge between the restriction 30' and the third flushing bore 32'. In order to prevent axial displacement downwards in Fig. 4 the tube 38' is provided with an annular shoulder 41' that cooperates with the transition edge between a thread clearance 42' in the internal female thread 14' and the third flushing bore 32'. The dimension of the tube 38' is such that when the inner end 44' of the tube 38' cooperates with the ball 34' a barrier for the flushing medium to enter through said inner end 44' in direction of the arrow 36' is provided. However, in order to allow flushing medium to flow in direction of the arrow 36' although the ball 34' is cooperating with the inner end 44' of the tube 38', said tube 38' is provided with a number of openings 46' in the area between the inner end 44' and the transition between the first restriction 24' and the second flushing bore 28'. The total area of said openings 46' should at least be equal to the internal cross sectional area of the tube 38' in order to avoid a flow restriction.

The embodiment according to Figs. 4-6 functions in principally the same way as the embodiment according to Figs. 1-3 described above. Thus reference to the description above is made in that respect. In this connection it should, however, be mentioned that when upward-drilling is effected, see Fig. 4, the female thread 14' is at the upper end of the drill tube element 10' and when downward-drilling is effected, see Fig. 6, the male thread 12' is at the upper end of the drill tube element 10'.
Common for the two described embodiments is that all of the restrictions 24,30;24',30' for the flushing medium, some of said restrictions cooperating with a ball, are integral with the drill tube elements 10;10'. This is necessary since the drill tube elements 10;10' are used for percussive drilling. If the restrictions were in the shape of separate elements connected to the drill tube elements e.g. by a thread coupling, said coupling would in a short time be destroyed by the percussive energy.

For both embodiments described above the arrangements with the openings 46; 46' can be varied within the scope of the present invention. In Figs.7a-7d further possible embodiments of the tube 38 are shown.

In Fig.7a the tube 38 has the same arrangement of openings 46 as the tube 38 of Figs.1-3, i.e. the openings 46 are circular and located on the same level. However, the tube 38 according to Fig.7a has no annular protrusion 40 or shoulder 41 but the tube 38 has a slightly conical outer shape, i.e. the diameter of the tube 38 increases towards the end of the tube 38 remote from the openings 46. The conical shape ensures that a proper press fit is established when mounting the tube 38 to assure that a locking against axial displacement is provided.

In Fig.7b the tube 38 has openings 46 that are circular but located on different levels.

In Fig.7c the tube 38 has openings 46 that are extended in the longitudinal direction of the tube 38.
In Fig. 7d the tube 38 is provided with openings 46 in the shape of slots that are open at the end of the tube 38 that cooperates with the ball 34.

The arrangements of openings 46 shown in Figs. 7a-7d are only exemplifying and can of course also be applicable to the tube 38' disclosed in Figs. 4-6.

One major advantage of the present invention is that the non-return valve means can easily be mounted in or dismounted from the drill tube elements 10;10'. This means that one can use the same drill tube element 10;10' regardless if a non-return valve means is necessary or not. If there is no need for a non-return valve means the drill tube element 10;10' is used without mounting the ball 34;34' and the barrier means 38;38'. On the other hand if a non-return valve means is necessary the ball 34;34' and the barrier means 38;38' are readily mounted.
Claims

1. Drill tube element (10;10') for percussive top hammer drilling, said element (10;10') having a longitudinal extension, said element (10;10') further having a male thread (12;12') at one end and a female thread (14;14') at the other end, said threads being used to connect tube elements (10;10') with each other to form a drill string that transfers impact energy from the top hammer to a drill bit connected to the end of the drill string opposite from the top hammer, said drill tube element (10;10') having internal, longitudinally through-going, passage means (26,28,32;26',28',32') for flushing medium, characterized in that a valve means is located inside the tube element (10;10'), that said valve means includes a ball (34;34') and a restriction means (30;24'), that the ball (34;34') due to gravity is intended to cooperate with said restriction means (30;24') when upward-drilling is effected so as to provide a non-return valve means for the drilling fluid, that a barrier means (38;38') is located inside said tube element (10;10') and spaced apart longitudinally from the restriction means (30;24'), that the barrier means (38;38') is so designed that when drilling is effected in the range from horizontal to downward direction a cooperation between the ball (34;34') and the barrier means (38;38') will prevent the ball (34;34') from travelling in direction of the drilling fluid and simultaneously admit the drilling fluid to bypass the barrier means (38;38').

2. Drill tube element according to claim 1, characterized in that the barrier means
(38;38') is provided with openings (46;46') not affected by the cooperation between the ball (34;34') and the barrier means (38;38').

3. Drill tube element according to claims 1 or 2, characterized in that the barrier means (38;38') is provided with means (40,41;40',41') for axially locking the barrier means (38;38') relative to the drill tube element (10;10').

4. Drill tube element according to any of the preceding claims, characterized in that the barrier means is in the shape of a tube (38;38') extending in the longitudinal direction of the drill tube element (10;10'), that one end (44;44') of the tube (38;38') engages the ball (34;34') when drilling is effected in the range from horizontal to downward direction.

5. Drill tube element according to claim 4, characterized in that the wall of the tube (38;38') is provided with openings (46;46') to allow drilling fluid to pass through said openings (46;46').

6. Drill tube element according to claims 4 or 5, characterized in that the tube (38) is provided with a protrusion (40) that in mounted position of the tube (38) cooperates with a groove (42) in the drill tube element (10).

7. Drill tube element according to claim 6, characterized in that the protrusion (40) and the groove (42) are annular.
8. Drill tube element according to any of the preceding claims, characterized in that a central portion (20;20') of the drill tube element (10;10') has an internal diameter that decreases towards the ends of the central portion (20;20').

9. Barrier means (38;38') to be mounted in a flushing medium passage means (28;32') of a drill tube element (10;10'), characterized in that said barrier means (38;38') decreases the diameter of said passage means (28;32'), that the barrier means (38;38') at one end (44;44') is provided with means (46;46') to allow flushing medium to bypass the barrier means (38;38') even if said one end (44;44') is closed.

10. Barrier means (38;38') according to claim 9, characterized in that said barrier means is in the shape of a tube (38;38') having two open ends, that said tube (38;38') is provided with means (40,41;40',41') for locking the tube (38,38') against axial displacement, and that the tube (38;38') at one end is provided with openings (46;46') that perforate the wall of the tube (38;38').
A. CLASSIFICATION OF SUBJECT MATTER

IPC5: E21B 21/10
According to international Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: E21B, F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPAT, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.

See patent family annex.

Date of the actual completion of the international search: 15 July 1994

Date of mailing of the international search report: 03-06-1994

Name and mailing address of the ISA/ Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer
Christer Bäcknert
Telephone No. +46 8 782 25 00

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