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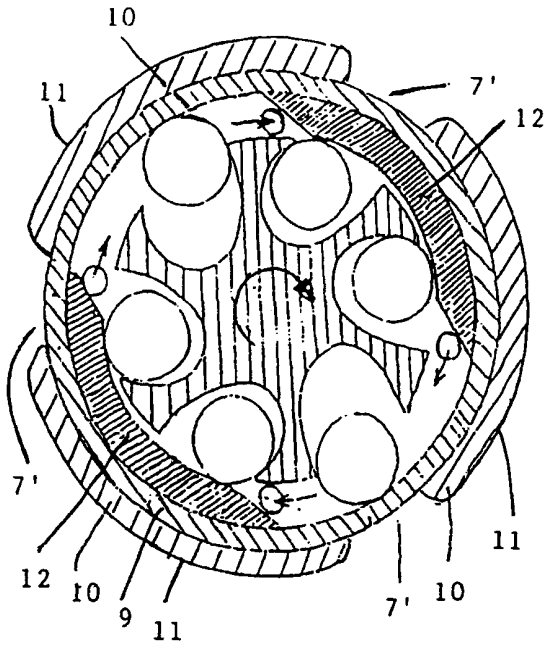
(54) Title: LONG GAUGE ROLLER VANE DRILLING MOTOR



(57) Abstract: A single-jacket roller vane drilling motor for downhole deviated and horizontal drilling has its jacket (9) provided at its circumgerence with one or more curved members (10) in such a way that a new, larger circular outside surface (11) is created with a diameter approximately equal to that of the drill bit below, and whereby one or more longitudinal recesses (7') are created for passage of the drilling fluid back to the surface. The curved members (10) may start below the lower end of the motor or at its lower end and may or may not extend to its upper end.

LONG GAUGE ROLLER VANE DRILLING MOTOR

The invention relates to a drilling motor and a system and method for drilling curved boreholes.

To drill curved boreholes, it is known to use a system as shown in fig. 1 of the drawing. A downhole drilling motor 1 is connected at its lower end to a drill bit 2 and at its upper end by means of a bent sub 3 with bend angle α to non-rotating drillpipe 4. Drilling fluid is pumped down the drillpipe 4 to drive the drilling motor 1 that rotates the drill bit 2. The drilling fluid passes through the drill bit 2 to cool and lubricate it and to carry the drill cuttings to the surface through the annular space between the drillpipe 4 and the borehole wall 5. The curvature of the borehole is obtained with the bent sub 3, that causes the drillpipe 4 not only to exert a longitudinal force on the drill bit 2, but also a sideways force. To obtain a curvature in the desired direction at the start of the curved borehole section, the bent sub 3 must be orientated in the desired direction.

Conventionally, the downhole drilling motor 1 is a positive displacement motor (PDM) based on the moineau principle: A rotor with a single external helix rotates inside a stator containing an internal double elastomeric helix. This arrangement creates a series of cavities. When drilling fluid is pumped down the space between rotor and stator, these cavities progress downward, turning the rotor.

A problem with this system of curved drilling is that, when using the rather long downhole drilling motors of the moineau type, the curved section is somewhat spiral-shaped, which slows down the drilling process. To solve this problem, attempts have been made to stabilize the drill bit by placing a long gauge sub between the drill bit and the drilling motor, or by using long gauge drill bits. Both methods failed, because it proved impossible to start or retain a borehole of the desired curvature under these circumstances.

The problem of borehole spiraling in curved boreholes can be eliminated or minimized by using systems as shown in fig. 2 of the drawing. A shorter downhole positive displacement drilling motor 1' is directly attached to a long gauge bit 2' (fig. 2a) or is attached to a short gauge bit 2 by means of a long gauge sub 6, at its circumference equipped with

one or more longitudinal recesses 7 for passage of the return drilling fluid back to the surface (fig. 2b). These short downhole positive displacement drilling motors are preferably of the roller vane type with single jacket, with all the drilling fluid passing inside this jacket to the drill bit, as described in WO 99/20904 (PCT/NL 98/00598), which give a similar performance as the much longer moineau drilling motors. As a result, a curved borehole can be drilled with the same radius of curvature with a much smaller bend angle in the bent sub 3. In that way, the problem of too much sideways force on the drill bit is eliminated and little or no spiraling occurs in the curved borehole section. The present invention provides an adapted even shorter downhole positive displacement roller vane drilling motor with single jacket for drilling borehole sections of the same radius of curvature with a smaller bend angle in the bent sub above the motor, or for drilling borehole sections of smaller radius of curvature with the same bend angle in the bent sub above the motor. To this end, the motor is adapted to take over the stabilizing function of the long gauge bit or the long gauge sub shown in fig. 2.

The present invention will be elucidated below in more detail with reference to the drawing, showing in:

fig. 3 transverse sectional views from above of embodiments of a short downhole positive displacement drilling motor of the present invention;

fig. 4 systems for drilling curved borehole sections in which short downhole drilling motors of the present invention are used;

fig. 5 longitudinal cross sections of embodiments of a short downhole positive displacement drilling motor of the present invention.

Referring to fig. 3a, a single-jacket roller vane drilling motor as described in WO 99/20904 (PCT/NL 98/00598) has its jacket 9 provided at its circumference with one or more curved members 10 in such a way that a new, larger circular outside surface 11 is created with a diameter approximately equal to that of the drill bit 2 below, and whereby one or more longitudinal recesses 7' are created for passage of the drilling fluid back to the surface. The curved members 10 may start below the lower end of the motor or at its lower end and may or may not extend to its upper end. If the curved members 10 start below the lower end of the motor, the jacket 9 of the motor, and therefore the recesses 7', may also be extended below the lower end of the motor.

In the embodiment shown in fig. 3b, the recesses 7' are created in the motor jacket 9 itself, this jacket being of increased thickness. Here also, the increased thickness with recesses 7' may start at or below the lower end of the motor and may or may not extend to its upper end.

In the embodiment shown in fig. 3c, the wing deflector cams 12 of the motor are part of the motor jacket 9 and the recesses 7' are created in the motor jacket 9, opposite these wing deflector cams 12. In this embodiment, the recesses 7' must run the length of the motor, so that the motor jacket 9 above and below the wing deflector cams 12 must have an internal diameter approximately equal to that of the wing deflector cams 12.

Fig. 4 shows three schematic longitudinal side views of systems for drilling curved borehole sections in which motors of the present invention are used.

In fig. 4a a short downhole drilling motor 1" of the present invention is attached at its lower end to a drill bit 2 and at its upper end to a bent sub 3 and further to non-rotating drillpipe 4. The long gauge part of the motor with recesses 7' for the drilling fluid runs the full length of the motor.

In fig. 4b a short downhole drilling motor 1" of the present invention is attached at its lower end to a drill bit 2 and at its upper end to a bent sub 3 and further to non-rotating drillpipe 4. The long gauge part of the motor with recesses 7' for the drilling fluid extends only partly up the motor.

In fig. 4c a short downhole drilling motor 1" of the present invention is attached at its lower end to a drill bit 2 and at its upper end to a bent sub 3 and further to non-rotating drillpipe 4. The long gauge part of the motor is extended below the motor body to near the cutting edge of the drill bit 2 by extending the curved members 10. This improves the stabilizing effect of the motor-bit combination.

Fig. 4 also illustrates that the system from bit bottom to the bent sub above the short downhole drilling motor according to the present invention is much shorter than known stabilized systems shown in fig. 2. Firstly, (part of) the motor takes over the stabilizing function of the long gauge section of the drill bit or the long gauge sub. Secondly, the long gauge motor, in particular the embodiment shown in fig. 3c, has a substantially larger inside diameter. As a result, for the same power input and output, it is significantly shorter.

A further reduction in the length of the motor-bit combination is possible by eliminating the open space between the cutting edge of the drill bit and the motor. This can be achieved by incorporating the drive sub of the drill bit in the lower part of the motor as shown in fig. 5.

Fig. 5a shows a longitudinal section of the lower part of a short roller vane drilling motor with single jacket 9 and curved members 10 outside the lower part of the motor, according to the present invention. The rotor shaft 13 passes through the sealing member 14, and the drive sub 15 for attaching the drill bit 2 is attached to the rotor shaft 13 below the sealing member 14.

In fig. 5b the drive sub 15 is attached to the rotor shaft 13 below the lower bearing housing 16 of the motor, the drive sub 15 and the sealing member 14 forming one unit.

The drilling motors according to the present invention may not only be used for deviated drilling but also for horizontal drilling and for coring purposes. The invention includes therefore within its scope systems for drilling and coring deviated and horizontal borehole sections in which drilling motors of the present invention are used, as well as methods for drilling and coring deviated and horizontal borehole sections using a drilling motor of the present invention.

C L A I M S

1. Roller vane motor for downhole drilling with single jacket (9) and with all the drilling fluid passing inside this jacket (9) to the drill bit (2),
characterized in that its circumference is over its full length provided with one or more outwardly projecting curved members (10) in such a way that a new circular outside surface (11) is created, with a diameter approximately equal to that of the drill bit (2) below, in addition to one or more longitudinal recesses (7') for passage of the return drilling fluid.

2. Roller vane motor for downhole drilling with single jacket (9) and with all the drilling fluid passing inside this jacket (9) to the drill bit (2),
characterized in that the jacket thickness of the motor has been increased over the full motor length to an outside diameter approximately equal to that of the drill bit (2) below, the jacket (9) being provided at its outer surface (11) with one or more longitudinal recesses (7') for passage of the return drilling fluid.

3. Roller vane motor as claimed in claims 1 and 2, characterized in that the additional width of the motor occupies only part of the length of the motor.

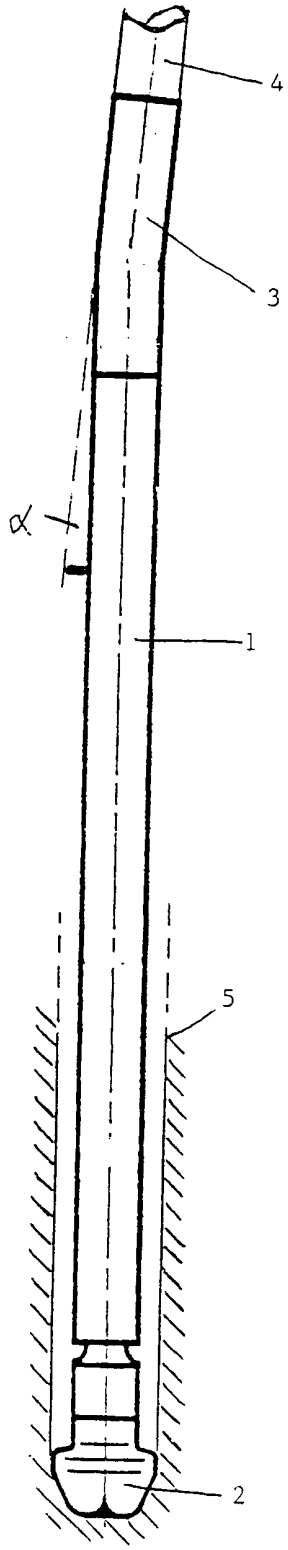
4. Roller vane motor as claimed in claims 1 to 3, characterized in that the additional width of the motor extends below the length of the motor.

5. Roller vane motor for downhole drilling with single jacket (9) and with all the drilling fluid passing inside this jacket (9) to the drill bit (2),
characterized in that the wing deflector cams (12) form part of the jacket (9) of the motor, that the outer surface (11) of the jacket (9) has a diameter approximately equal to that of the drill bit (2) below, and that a longitudinal recess (7') is provided at the outer surface (11) of the jacket (9) of the motor opposite one or more of the wing deflector cams (12), the recesses (7') running the length of the motor, the jacket (9) above and below the wing deflector cams (12) having an internal diameter approximately equal to that of the wing deflector cams (12).

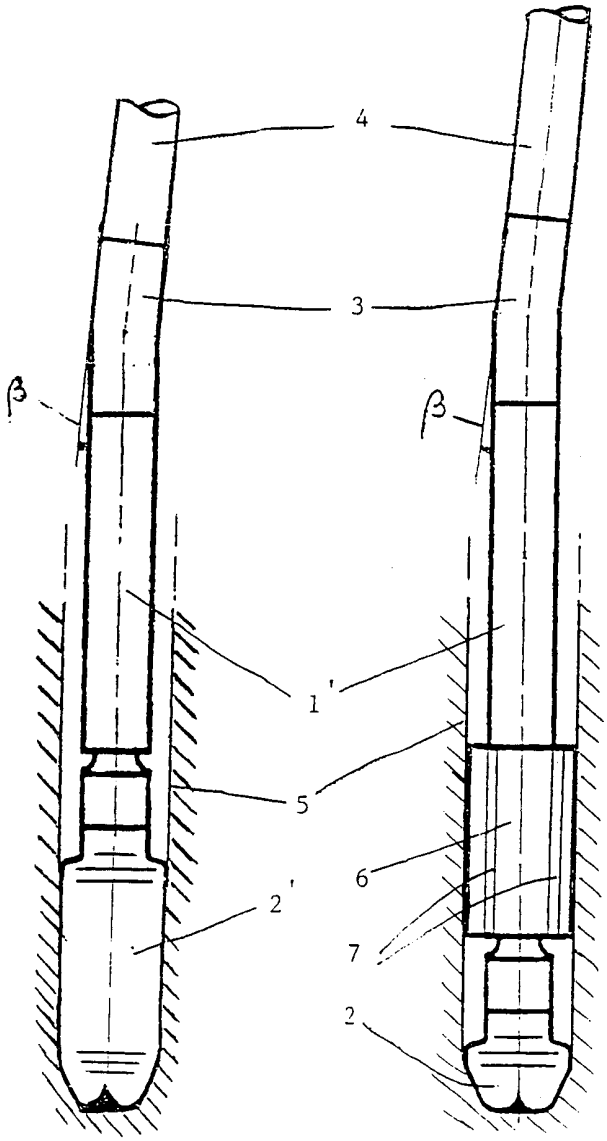
6. Roller vane motor as claimed in claims 1 to 5, characterized in that the drive sub (15) for driving the drill bit (2) that is attached to the lower part of the rotor shaft (13) is incorporated into the sealing member (14) that separates the downgoing drilling fluid inside the motor from the return drilling fluid in the annular space outside the motor.

7. System for drilling and coring curved and horizontal borehole sections using a roller vane drilling motor as described in any one of claims 1 to 6, at its lower end attached to a drill bit (2) and at its upper end to a bent sub (3) and non-rotating drill-pipe (4).

8. Method for drilling and coring curved and horizontal borehole sections, using a roller vane drilling motor in a system as described in claim 7.



Prior art
Fig. 1



Prior art
Fig. 2a

Prior art
Fig. 2b

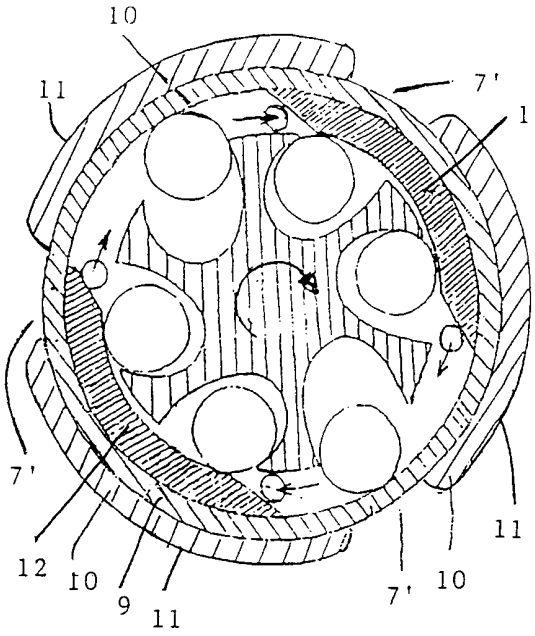


Fig. 3a

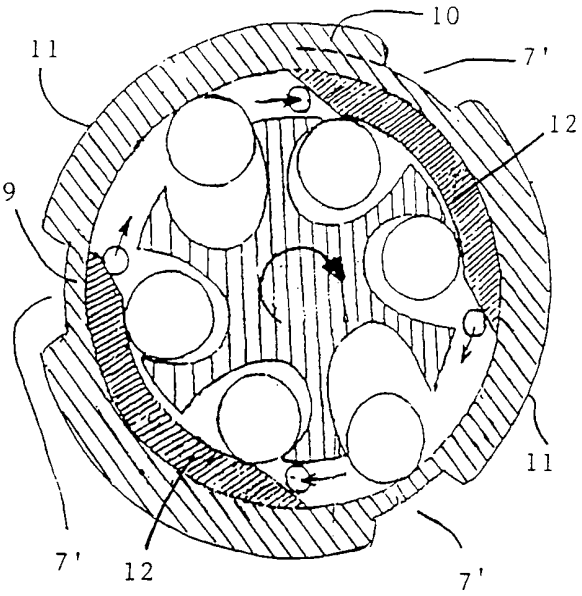


Fig. 3b

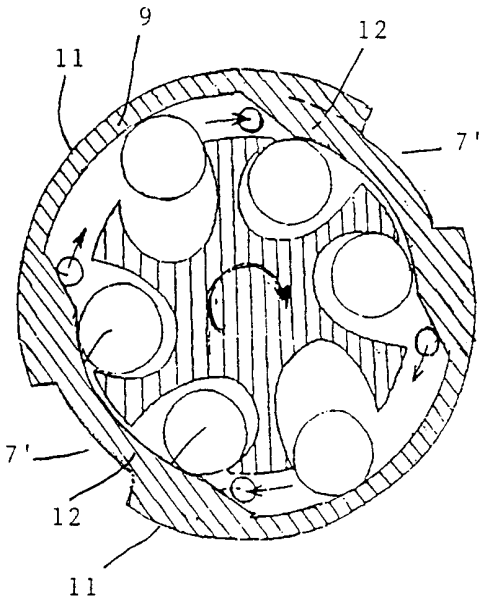


Fig. 3c

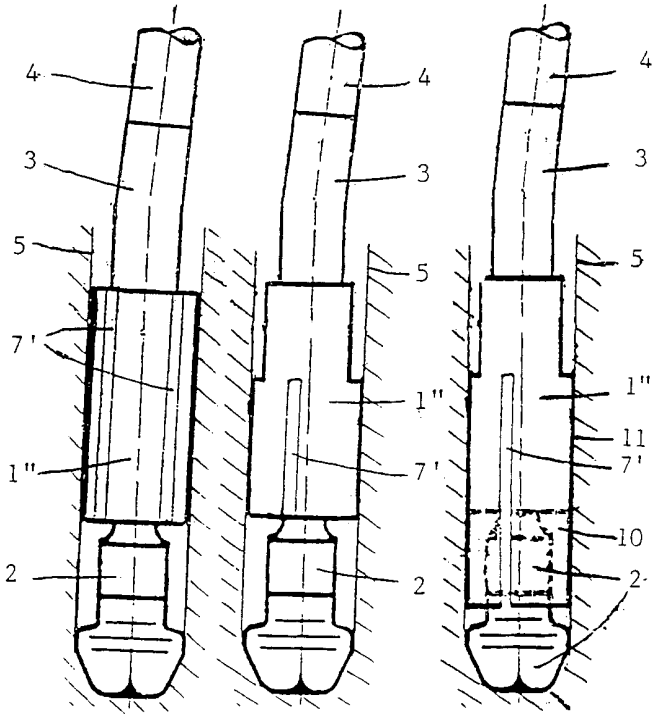


Fig. 4a Fig. 4b Fig. 4c

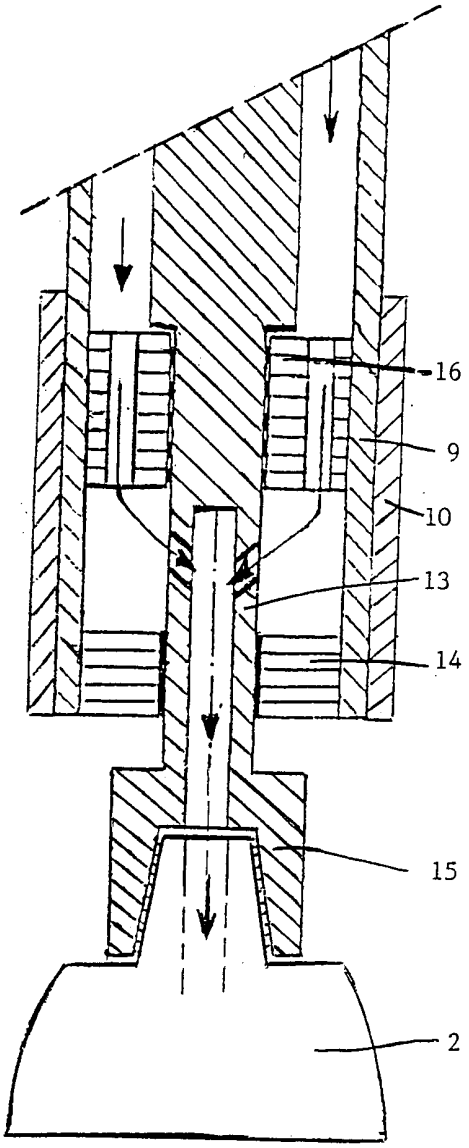


Fig. 5a

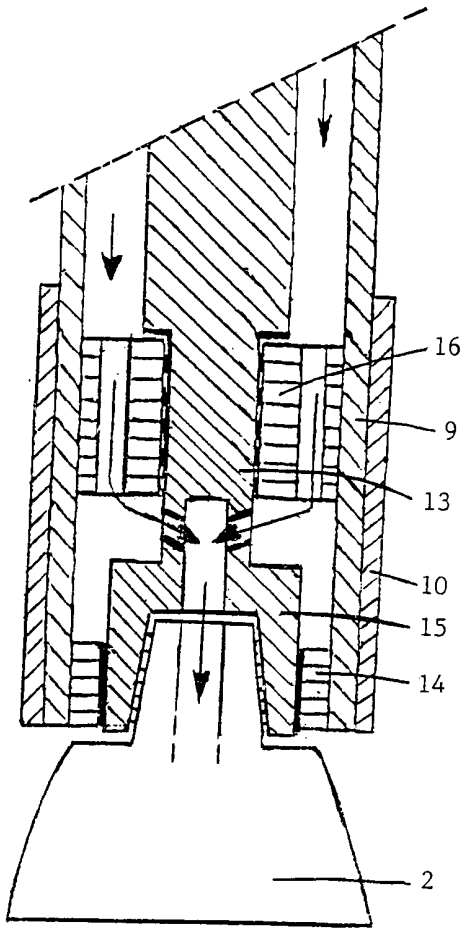


Fig. 5b

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/NL 00/00010

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B4/02 E21B17/10

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)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5 853 053 A (DOWNIE ANDREW MCPHERSON ET AL) 29 December 1998 (1998-12-29) column 3, line 32 - line 48 ---	1-8
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A	EP 0 427 437 A (BOTTOM HOLE TECH) 15 May 1991 (1991-05-15) column 1, line 5 - line 34 --- -/--	1-8

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 August 2000	28/08/2000

Name and mailing address of the ISA	Authorized officer
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Inter ›nal Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

...nformation on patent family members

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