CLAIMS

1. An underwater flow retaining device (100,200,300,400,410,420, 500) for retaining and blocking the outflow of a pressurized fluid from an outlet mouth (3) of a tubular extension (2) of an underwater well, said device comprising:

— a flow-retaining head (10) that is adapted to engage with said outlet mouth (3) preventing said pressurized fluid from flowing out of said tubular extension (2), said flow-retaining head having a lower portion (10') that in use faces said outlet mouth (3) and an upper portion (10") opposite to said lower portion (10');

— a support (20) of said flow-retaining head (10);

characterised in that it comprises:

— a fastening means (30) for fastening said support (20) to said tubular extension (2);

— an actuation means (40) for carrying out a sliding movement of said flow-retaining head (10) with respect to said support (20) along a slide axis (20') of said support (20) towards said fastening means (30) when said support (20) is fixed to said tubular extension (2) by said fastening means (30), between:

— a manoeuvre position (8), in which said flow-retaining head (10) is at a predetermined distance (D) from said outlet mouth (3) and said fastening means (30) is fixed to said tubular extension (2), and

— a retaining position (9), in which said flow-retaining head (10) engages said outlet mouth (3), said distance (D) of said manoeuvre position (8) selected in such a way that said support (20) is fixed to said tubular extension (2) by said fastening means (30) while said flow-retaining head (10) is still at a position where it is not affected by said outflow of said pressurized fluid,

and **in that** it has a channel (55) that extends within said flow-retaining head (10) between a lower passage port (56) that is made at said lower portion (10') and an upper passage port (57) that is made at said upper portion (10").

2. A device according to claim 2, wherein a feed means is provided for feeding a plugging fluid, said feed means comprising a feed duct (62) that has a first end hydraulically connected with said upper passage port (57) of said channel (55) of said flow-retaining head (10), and a second end of said feed duct (62) equipped with a fastening means for fastening to a duct or to a feed means of said plugging fluid.

3. A device (110,210) according to claim 1, wherein a discharge channel (75) is provided, which extends within said flow-retaining head (10), between a lower discharge port (76), which is made at said lower portion, (10'), and an upper discharge port (77), which is made at said upper portion (10").

4. A device (200,210,420) according to claim 1, comprising a shut-off valve (19), in particular said shut-off valve arranged proximate to the flow-retaining head (10) with an inlet port connected to said upper passage port (57) of said channel (55).

5. A device (200) according to claim 1, comprising a feed tube (69) for feeding a liquid into said channel (55) of said flow-retaining head (10), for feeding a liquid suitable for preventing a solid from forming within said channel (55) of said flow-retaining head (10).

6. A device (200,300,400,410,420,500) according to claim 1, wherein said flow-retaining head (10) comprises an elongated flow-retaining element (11) that is adapted to be inserted into said tubular extension (2), said elongated flow-retaining element (11) having a minimum cross section that is closer to a front end of said elongated flow-retaining element (11), and a maximum cross section that is closer to a rear end of said elongated flow-retaining element (11) opposite to said minimum cross section, and cross sections whose area increases intermediate between said minimum cross section and said maximum cross section.

7. A device (200,300,400,410,420,500) according to claim 6, wherein said elongated flow-retaining element (11) has a frusto-conical shape.

8. A device (300,400,410,420,500) according to claim 1, wherein said flow-retaining head (10) has a plastically deformable seal means (13), wherein a material is arranged on an outer surface of said flow-retaining

head (10), whose hardness is lower with respect to the material of which said tubular extension is made (2) at said outlet mouth (3), such that said plastically deformable seal means (13) is adapted to slidingly engage on said outlet mouth (3) buckling and creating a seal by plastic deformation.

9. A device (300,400,410,420,500) according to claim 8, wherein said plastically deformable seal means (13) comprises a layer (14") that is made of said lower hardness metal material, said layer deposited about a removable element (14) of said flow-retaining head (10).

10. A device (300,400,410,420,500) according to claim 1, wherein said flow-retaining head (10) has an elastically deformable seal means (15) wherein a material is arranged on an outer surface of said flow-retaining head (10), which is more deformable with respect to the material of which said tubular extension is made (2) at said outlet mouth (3), such that said elastically deformable seal means (15) is adapted to elastically buckle creating a seal at a contour portion of said outlet mouth (3), in a final phase of said sliding approaching step.

11. A device (200,300,400,410,420,500) according to claim 1, wherein said fastening means (30) comprises a plurality of teeth (31) that are arranged along respective radial directions towards said axis (20'), said teeth (31) slidable along said respective radial directions within respective housings (32) that are integral to said support (20), said teeth (31) having respective inner ends that are adapted to engage with said tubular extension (2).

12. A device (200,300,400,410,420,500) according to claim 11, wherein said teeth (31) are adapted to engage with a protrusion of said tubular extension (2) according to an engagement mode selected from the group consisting of:

— an undercut engagement;

— a clamp engagement,

In particular, wherein said teeth (31) are adapted to engage with a flange (7) proximate to said outlet mouth (3).

13. A device (200) according to claim 11, comprising a hydraulic actuation means of said teeth (31), in particular said hydraulic actuation means

comprising for one of said teeth (31) a hydraulic cylinder-piston unit (35).

14. A device (300,400,410,420,500) according to claim 11, wherein each of said teeth (31) has an actuation means (31') arranged to be operated by a ROV-type remotely operated vehicle that is suitable for underwater operation,

in particular, said actuation means arranged at external ends (31') of said teeth (31).

15. A device (100,200,300,400,410,420,500) according to claim 1, wherein said actuation means (40) comprises at least one hydraulic actuator unit (41) comprising:

— a actuation chamber (43),

— an actuation piston (42) slidably arranged within said actuation chamber (43), and

— an actuation means for applying an actuation force (71) and for creating a sliding movement of said actuation piston (42) within said actuation chamber (43) between:

— a rearward position and

— an extended position, at which a portion of said actuation piston (42) extends outside of one end of said actuation chamber (43), which is longer than at said rearward position,

said actuation chamber (43) and said actuation piston (42) respectively integral to said flow-retaining head (10) and to said support (20), or vice-versa such that, by operating said actuation means and by bringing said hydraulic actuator unit (41) from said rearward position to said extended position, or vice-versa, said flow-retaining head (10) performs said sliding approach towards said fastening means (30) thus approaching, in use, said outlet mouth (3).

16. A device (220,230) according to claim 15, wherein said actuation means comprises a control circuit (47) that is hydraulically connected with a source (81) of an actuation fluid and with said actuation chamber (43) for transferring said actuation fluid from said source (81) into said actuation chamber and for creating a sliding movement of said actuation piston (42) within said actuation chamber (43), wherein said source (81) of said

actuation fluid has a pump means (81) in common with an actuation circuit of an auxiliary device or of a device associated with said well.

17. A device (220,230) according to claim 16, wherein said control circuit (47) is adapted to transfer an actuation mud into said actuation chamber (43).

18. A device (230) according to claim 16, comprising:

— a compensation container (73);

— a compensation element (74) movably arranged within said compensation container (73), said compensation element (73) defining within said compensation container (73) a primary room (73') and a secondary room (73"),

wherein said primary room (73') is hydraulically connected with said source (81) of an actuation fluid,

wherein said secondary room (73") is hydraulically connected with said actuation chamber (43).

19. A device (240) according to claim 15, wherein said hydraulic actuator unit (41) comprises furthermore:

— a balancing chamber (43'),

— a balancing piston (42') integral to said actuation piston (42) and slidably arranged within said balancing chamber (43'), and

— a balancing means (70) for applying a balancing force (71') to said balancing piston (42') responsive to an internal pressure of said tubular extension (2) of said well, said balancing force (71') having the same direction as said sliding approach,

in order to limit said actuation force (71) that acts on said actuation piston (42).

20. A device (240) according to claim 19, wherein said balancing means (70) comprises:

— a compensation container (60);

— a compensation element (64) that is movably arranged within said compensation container (60), said compensation element (64) defining within said compensation container (60) a primary room (60') and a secondary room (60"),

wherein said primary room (60') is hydraulically connected with said tubular extension (2),

wherein said secondary room (60") is hydraulically connected with said balancing chamber (43').

21. A device (240) according to claim 20, wherein said primary room (60') is hydraulically connected with said tubular extension (2) through said channel (55), in particular through said upper passage port (57).

22. A device (400,410,420) according to claim 1, comprising a stop means (50) for stopping said flow-retaining head (10) at said retaining position (9) such that, by releasing said actuation means (40), said flow-retaining head (10) remains at said retaining position (9), thus preventing said pressurized fluid from flowing out of said tubular extension (2).

23. A device (400,410,420) according to claim 22, wherein said actuation chamber (43) and said actuation piston (42) are arranged coaxially to the slide axis (20') and are respectively integral to said support (20) and to said flow-retaining head (10), and said stop means comprises at least one longitudinal guide element (51) integral to said support (20) and a movable element (52) integral to said flow-retaining head (11), said at least one longitudinal guide element (51) and said movable element (52) slidingly engaging each other, said at least one longitudinal guide element (51) and said movable element (52) adapted to be blocked with respect to each other, such that, by blocking said movable element (52) with respect to the at least one longitudinal guide element (51) after bringing said flow-retaining head (10) to said retaining position, said actuation means (40) can be removed by cutting said at least one longitudinal guide element (51).

24. A device (410,420) according to claims 3 and 19, wherein said portion of said piston (42'), which extends out of said actuation chamber (43), comprises a hollow end portion (36) that is adapted to contain said shut-off valve (19), said hollow end portion abutting against said movable element (52), and said feed duct comprises a passageway selected from the group consisting of:

— a passageway through said actuation piston (42) and said actuation chamber (43)

— a passageway made transversally with respect to said actuation piston (42).

25. A device according to claim 15, wherein said hydraulic actuator unit (41) is a double-acting actuator unit.

26. A device according to claim 15, wherein said hydraulic actuator unit (41) comprises a plugging fluid inlet duct adapted to operate at first said hydraulic actuator unit and to cause the sliding movement of said flow-retaining head (10) with respect to said support (20) along said slide axis (20') from said manoeuvre position (8) to said retaining position (9), and a shut-off valve is provided which is adapted to connect said duct with said channel (55) so that said plugging fluid floods and pressurizes said well starting from said outlet mouth (3).

27. A device (600) according to claim 1, wherein said actuation means (40) comprise at least one electric actuation unit.

28. A device (600) according to claim 27, wherein said actuation means (40) comprises a worm screw (59) adapted to be pivotally operated by the electric actuation unit (97), and said flow-retaining head (10) comprises a nut screw (59'), wherein said worm screw (59) engages said nut screw (59'), in order to provide said sliding movement of said flow-retaining head (10).

29. An underwater flow retaining method for retaining and blocking the outflow of a pressurized fluid from an outlet mouth (3) of a tubular extension (2) of an underwater well, comprising:

— providing a flow-retaining head (10) that is arranged to engage with said outlet mouth (3) and to avoid the outlet of said pressurized fluid from said tubular extension (2), said flow-retaining head having a lower portion that in use faces said outlet mouth and an upper portion opposite to said lower portion;

— providing a support (20) of said flow-retaining head (10);

fastening (30) said support (20) to said tubular extension (2);

— performing (40) a sliding movement of said flow-retaining head (10) with respect to said support (20) along a slide axis (20') of said support (20) towards said fastening means (30) when said support (20) is fixed to said tubular extension (2) by said fastening means (30), between:

— a manoeuvre position (8), in which said flow-retaining head (10) is at a predetermined distance (D) from said outlet mouth (3) and said fastening means can be fixed to said tubular extension (2), and

— a retaining position (9), in which said flow-retaining head (10) engages said outlet mouth (3), said distance of the flow-retaining head in the manoeuvre position such that the support is fixed to the tubular extension by said fastening means while the flow-retaining head is still at a position where it is unaffected by the outflow of the pressurized fluid;

providing a channel (55,75) that extends within said flow-retaining head (10) between a lower passage port (56) that is made at said lower portion (10') and an upper passage port (57) that is made at said upper portion (10").

30. A method according to claim 29, wherein a step is provided of feeding a plugging fluid, through a feed duct (62) that has a first end that is hydraulically connected with said upper passage port (57) of said channel (55) of said flow-retaining head (10), and a second end of said feed duct (62) that is equipped with a fastening means for a duct or for a feed means a fluid.

31. A method according to claim 30, wherein said plugging fluid is a mud, that is adapted to plug said well starting from said outlet mouth (3).

32. A method according to claim 30, wherein a step is provided of injecting said plugging fluid in order to cause, at first, the sliding movement of said flow-retaining head (10) with respect to said support (20) along said slide axis (20') from said manoeuvre position (8) to said retaining position (9), and then is also provided the a step of opening a shut-off valve such that said plugging fluid flood said well starting from said outlet mouth (3) at a determined pressure.

33. A method according to claim 29, wherein a discharge step is provided through a discharge channel (55 or 75) that extends within said flow-retaining head (10) between a lower discharge port (76) that is made at said lower portion (10') and an upper discharge port (77) that is made at said upper portion (10").

CLAIMS

1. An underwater flow retaining device for retaining and blocking the outflow of a pressurized fluid from an outlet mouth of a tubular extension of an underwater well, said device comprising:

— a flow-retaining head that is adapted to engage with said outlet mouth preventing said pressurized fluid from flowing out of said tubular extension, said flow-retaining head having a lower portion that in use faces said outlet mouth and an upper portion opposite to said lower portion;

— a support of said flow-retaining head;

— a fastening means for fastening said support to said tubular extension;

— an actuation means for carrying out a sliding movement of said flow-retaining head with respect to said support along a slide axis of said support towards said fastening means when said support is fixed to said tubular extension by said fastening means, between:

— a manoeuvre position, in which said flow-retaining head is at a predetermined distance from said outlet mouth and said fastening means is fixed to said tubular extension, and

— a retaining position, in which said flow-retaining head engages said outlet mouth, said distance (D) of said manoeuvre position selected in such a way that said support is fixed to said tubular extension by said fastening means while said flow-retaining head is still at a position where it is not affected by said outflow of said pressurized fluid,

and in that it has a channel that extends within said flow-retaining head between a lower passage port that is made at said lower portion and an upper passage port that is made at said upper portion;

wherein a feed means of a fluid plugging material is connected to the upper port and said channel of said flow-retaining head is arranged to transfer such a fluid plugging material into said tubular extension of the well through the lower passage port.

2. A device according to claim 2, wherein said feed means for feeding said plugging fluid comprises a feed duct that has a first end hydraulically connected with said upper passage port of said channel of said flow-retaining head, and a second end of said feed duct equipped with a fastening means for fastening to a duct or to a feed means of said plugging fluid.

3. A device according to claim 1, wherein a discharge channel is provided, which extends within said flow-retaining head, between a lower discharge port, which is made at said lower portion, and an upper discharge port, which is made at said upper portion.

4. A device according to claim 1, comprising a shut-off valve, in particular said shut-off valve arranged proximate to the flow-retaining head with an inlet port connected to said upper passage port of said channel.

5. A device according to claim 1, wherein said flow-retaining head comprises an elongated flow-retaining element that is adapted to be inserted into said tubular extension, said elongated flow-retaining element having a minimum cross section that is closer to a front end of said elongated flow-retaining element, and a maximum cross section that is closer to a rear end of said elongated flow-retaining element opposite to said minimum cross section, and cross sections whose area increases intermediate between said minimum cross section and said maximum cross section,

in particular, said elongated flow-retaining element has a frusto-conical shape.

6. A device according to claim 1, wherein said flow- retaining head has a seal means, wherein a material is arranged on an outer surface of said flow-retaining head, said seal means selected from the group comprised of:

— a plastically deformable seal means whose hardness is lower with respect to the material of which said tubular extension is made at said outlet mouth, such that said plastically deformable seal means is adapted to slidingly engage on said outlet mouth buckling and creating a

seal by plastic deformation,

in particular said plastically deformable seal means comprises a layer that is made of said lower hardness metal material, said layer deposited about a removable element of said flow-retaining head;

— an elastically deformable seal means wherein a material is arranged on an outer surface of said flow-retaining head, which is more deformable with respect to the material of which said tubular extension is made at said outlet mouth, such that said elastically deformable seal means is adapted to elastically buckle creating a seal at a contour portion of said outlet mouth, in a final phase of said sliding approaching step.

7. A device according to claim 1, wherein said fastening means comprises a plurality of teeth that are arranged along respective radial directions towards said axis, said teeth slidable along said respective radial directions within respective housings that are integral to said support, said teeth having respective inner ends that are adapted to engage with said tubular extension,

in particular, said teeth are adapted to engage with a protrusion of said tubular extension according to an engagement mode selected from the group consisting of:

— an undercut engagement;

— a clamp engagement,

in particular, said teeth are adapted to engage with a flange proximate to said outlet mouth,

in particular, each of said teeth of said device has an actuation means arranged to be operated by a ROV-type remotely operated vehicle that is suitable for underwater operation,

in particular, said actuation means arranged at external ends of said teeth.

8. A device according to claim 1, wherein said actuation means comprises at least one hydraulic actuator unit,

— in particular a double-acting actuator unit, comprising:

— an actuation chamber,

— an actuation piston slidably arranged within said actuation chamber, and

— an actuation means for applying an actuation force and for creating a sliding movement of said actuation piston within said actuation chamber between:

— a rearward position and

— an extended position, at which a portion of said actuation piston extends outside of one end of said actuation chamber, which is longer than at said rearward position,

said actuation chamber and said actuation piston respectively integral to said flow-retaining head and to said support, or vice-versa such that, by operating said actuation means and by bringing said hydraulic actuator unit from said rearward position to said extended position, or vice-versa, said flow-retaining head performs said sliding approach towards said fastening means thus approaching, in use, said outlet mouth.

9. A device according to claim 8, wherein said actuation means comprises a control circuit that is hydraulically connected with a source of an actuation fluid, in particular of a mud, and with said actuation chamber for transferring said actuation fluid from said source into said actuation chamber and for creating a sliding movement of said actuation piston within said actuation chamber, wherein said source of said actuation fluid has a pump means in common with an actuation circuit of an auxiliary device or of a device associated with said well,

in particular, said device also comprises:

— a compensation container;

— a compensation element movably arranged within said compensation container, said compensation element defining within said compensation container a primary room and a secondary room,

wherein said primary room is hydraulically connected with said source of an actuation fluid,

wherein said secondary room is hydraulically connected with said actuation chamber.

10. A device according to claim 8, wherein said hydraulic actuator unit comprises furthermore:

— a balancing chamber,

— a balancing piston integral to said actuation piston and slidably arranged within said balancing chamber, and

— a balancing means for applying a balancing force to said balancing piston responsive to an internal pressure of said tubular extension of said well, said balancing force having the same direction as said sliding approach, in order to limit said actuation force that acts on said actuation piston,

in particular, said balancing means comprises:

— a compensation container;

— a compensation element that is movably arranged within said compensation container, said compensation element defining within said compensation container a primary room and a secondary room, wherein said primary room is hydraulically connected with said tubular extension, wherein said secondary room is hydraulically connected with said balancing chamber,

in particular, said primary room is hydraulically connected with said tubular extension through said channel, in particular through said upper passage port.

11. A device according to claim 1, comprising a stop means for stopping said flow-retaining head at said retaining position such that, by releasing said actuation means, said flow-retaining head remains at said retaining position, thus preventing said pressurized fluid from flowing out of said tubular extension,

in particular said actuation chamber and said actuation piston are arranged coaxially to the slide axis and are respectively integral to said support and to said flow-retaining head, and said stop means comprises at least one longitudinal guide element integral to said support and a movable element integral to said flow-retaining head, said at least one longitudinal guide element and said movable element slidingly engaging each other, said at least one longitudinal guide element and said

movable element adapted to be blocked with respect to each other, such that, by blocking said movable element with respect to the at least one longitudinal guide element after bringing said flow-retaining head to said retaining position, said actuation means can be removed by cutting said at least one longitudinal guide element.

12. A device according to claims 3 and 10, wherein said portion of said piston, which extends out of said actuation chamber, comprises a hollow end portion that is adapted to contain said shut- off valve, said hollow end portion abutting against said movable element, and said feed duct comprises a passageway selected from the group consisting of:

— a passageway through said actuation piston and said actuation chamber

— a passageway made transversally with respect to said actuation piston.

13. A device according to claim 8, wherein said hydraulic actuator unit comprises a plugging fluid inlet duct adapted to operate at first said hydraulic actuator unit and to cause the sliding movement of said flow-retaining head with respect to said support along said slide axis from said manoeuvre position to said retaining position, and a shut-off valve is provided which is adapted to connect said duct with said channel so that said plugging fluid floods and pressurizes said well starting from said outlet mouth.

14. An underwater flow retaining method for retaining and blocking the outflow of a pressurized fluid from an outlet mouth of a tubular extension of an underwater well, comprising:

— providing a flow-retaining head that is arranged to engage with said outlet mouth and to avoid the outlet of said pressurized fluid from said tubular extension, said flow-retaining head having a lower portion that in use faces said outlet mouth and an upper portion opposite to said lower portion;

— providing a support of said flow-retaining head;

— fastening said support to said tubular extension;

— performing a sliding movement of said flow-retaining head with respect to said support along a slide axis of said support towards said fastening means when said support is fixed to said tubular extension by said fastening means, between:

— a manoeuvre position, in which said flow-retaining head is at a predetermined distance (D) from said outlet mouth and said fastening means can be fixed to said tubular extension, and

— a retaining position, in which said flow-retaining head engages said outlet mouth, said distance of the flow-retaining head in the manoeuvre position such that the support is fixed to the tubular extension by said fastening means while the flow-retaining head is still at a position where it is unaffected by the outflow of the pressurized fluid;

— providing a channel that extends within said flow-retaining head between a lower passage port that is made at said lower portion and an upper passage port that is made at said upper portion;

wherein said method also comprises a step of

— feeding a fluid plugging material by a feed means connected to said upper passage port through said channel of said flow-retaining head in order to transfer such a fluid plugging material into said tubular extension of the well through said lower passage port.

15. A method according to claim 14, wherein said step of feeding a plugging fluid, in particular a mud, is carried out through a feed duct that has a first end that is hydraulically connected with said upper passage port of said channel of said flow-retaining head, and a second end of said feed duct that is equipped with a fastening means for a duct or for a feed means a fluid,

in particular, a step is provided of injecting said plugging fluid in order to cause, at first, the sliding movement of said flow-retaining head with respect to said support along said slide axis from said manoeuvre position to said retaining position, and then is also provided the a step of opening a shut-off valve such that said plugging fluid flood said well starting from said outlet mouth at a determined pressure,

in particular, a discharge step is provided through a discharge channel that extends within said flow- retaining head between a lower discharge port that is made at said lower portion and an upper discharge port that is made at said upper portion.