US 20160047384A1

(19) **United States**

(12) **Patent Application Publication**

Pyatov et al.

(10) **Pub. No.: US 2016/0047384 A1**

(43) **Pub. Date: Feb. 18, 2016**

(54) **DEVICE FOR HYDRAULICALLY PROTECTING A SUBMERSIBLE ELECTRIC MOTOR OF A DOWNHOLE, PREFERABLY CENTRIFUGAL, PUMP (VARIANTS)**

(71) Applicant: **Ivan Solomonovich PYATOV**, (US)

(72) Inventors: **Ivan Solomonovich Pyatov**, MOSCOW (RU); **Evgeniy Ervandovich Grygorian**, Korolev (RU); **Anatoliy Vasilievich Sergienko**, PERM (RU); **Oleg Vyacheslavovich Komarov**, PERM (RU)

(21) Appl. No.: **14/778,873**

(22) PCT Filed: **Mar. 21, 2013**

(86) PCT No.: **PCT/RU2013/000235**

§ 371 (c)(1),
(2) Date: **Sep. 21, 2015**

Publication Classification

(51) **Int. Cl.**

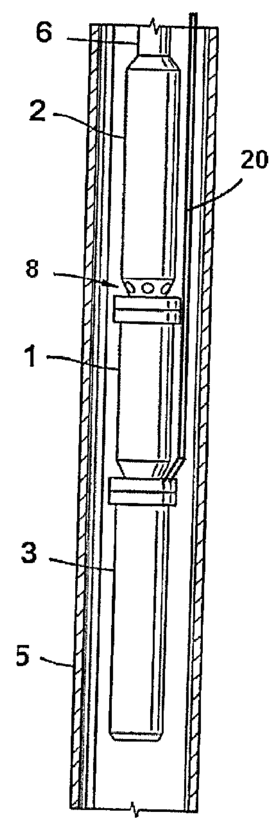
F04D 13/10	(2006.01)
F04D 1/00	(2006.01)
E21B 43/12	(2006.01)

(52) **U.S. Cl.**

CPC ***F04D 13/10*** (2013.01); ***E21B 43/128*** (2013.01); ***F04D 1/00*** (2013.01)

(57) **ABSTRACT**

The invention can be used in installations for extracting downhole fluid. The device is in the form of a protector which is arranged between an electric motor and a downhole pump and comprises at least one stage, which comprises a cylindrical body, a tube surrounding the drive shaft of the pump, nipples, a damping bushing, an annular piston in a chamber formed in the space between the body and the tube and dividing the chamber into two sections, which are filled with dielectric fluid and formation fluid, and a formation fluid and dielectric fluid divider which is mounted freely in the chamber at the end of the piston which is in contact with the formation fluid. The divider can move autonomously and is in the form of a single component consisting of two pipe lengths of annular elements which are arranged one in the other and are rigidly interconnected by means of a common base, which is mounted so as to adjoin the ends of the two lengths on the annular-piston side. The annular piston and the divider are mounted in an annular chamber so as to adjoin the internal surface of the cylindrical body and the external surface of the tube with a clearance. The clearance space is filled with a protective medium having hydrophilic properties. The efficiency and operating reliability of the device are increased.



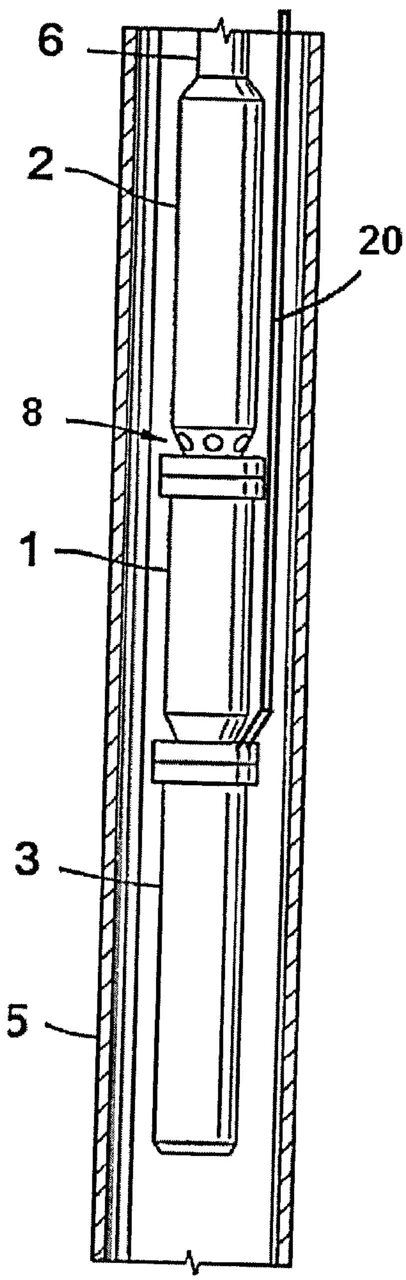


Fig. 1

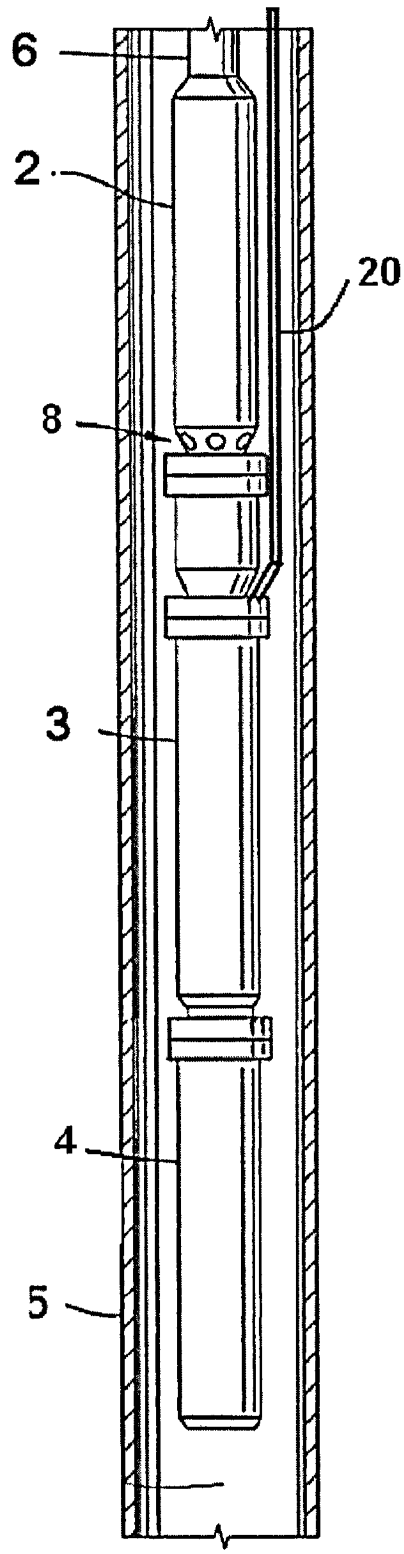


Fig. 2

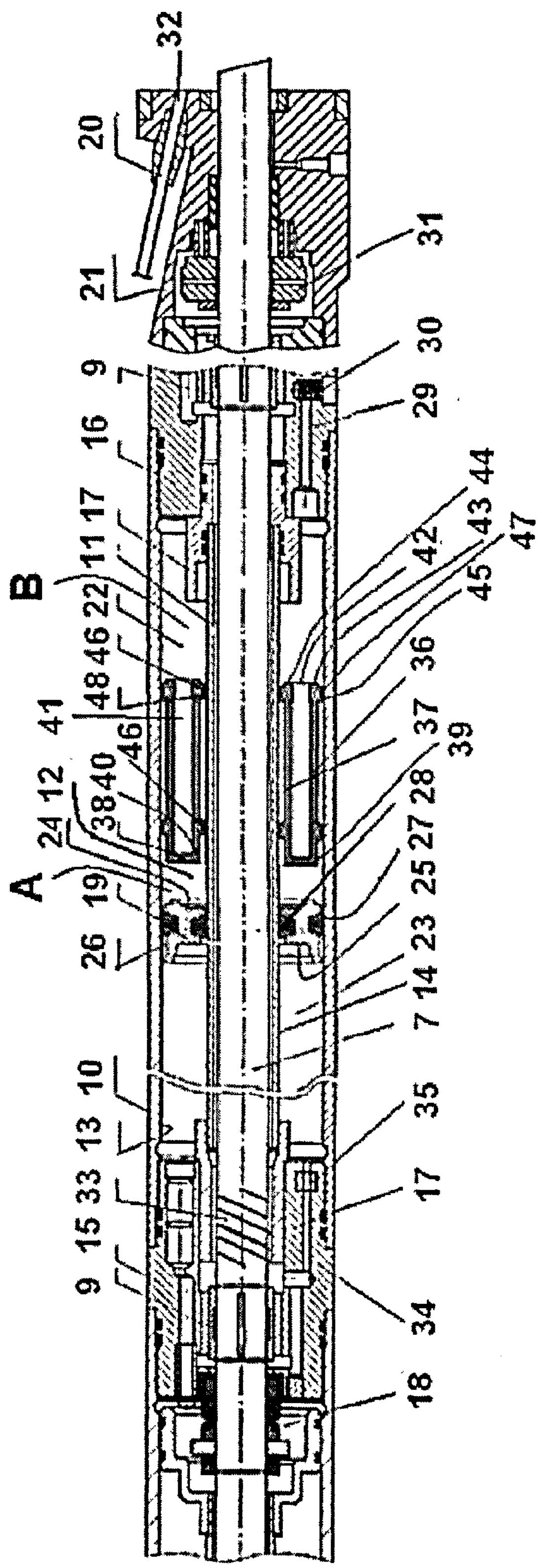

32
20
21
31
30
9
7
29
16
44
17
42
43
47
11
B
22
45
46
36
48
41
37
39
12
40
46
28
38
24
27
A
19
25
26
23
14
7
10
35
13
33
17
15
9
34
18

Fig. 3

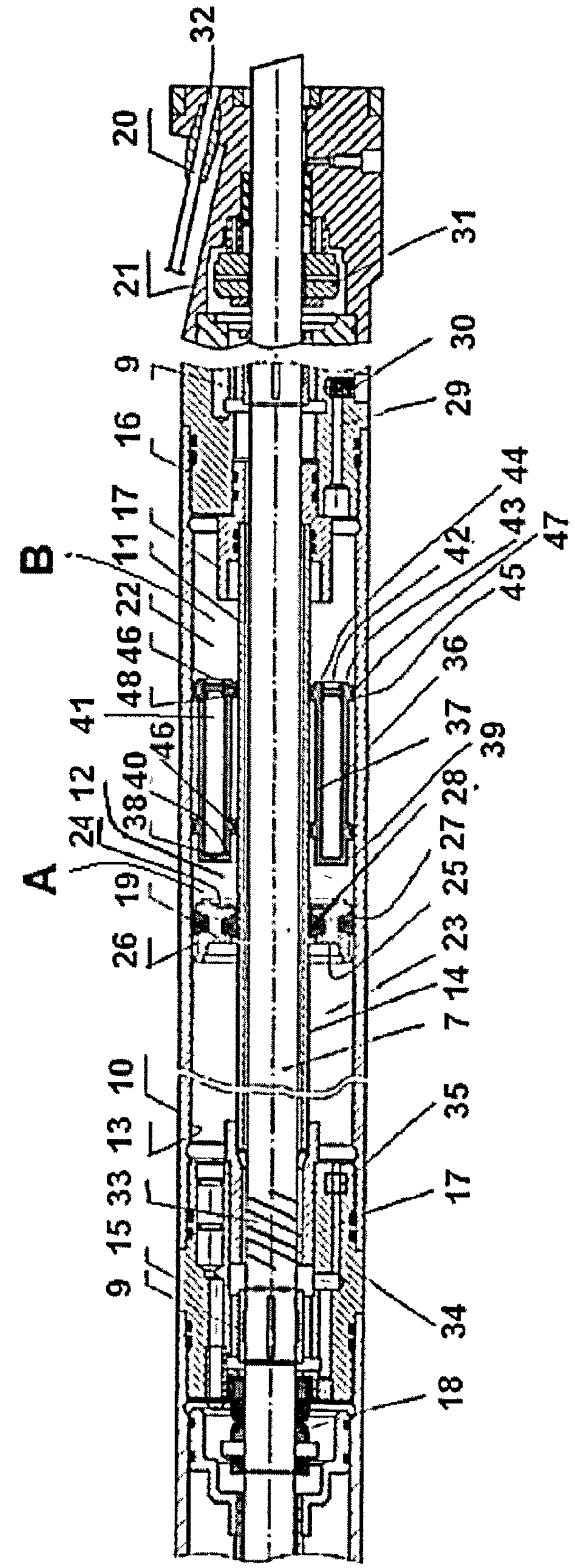

32
20
21
31
30
9
29
16
17
11
B
22
48
46
41
40
38
12
24
A
19
26
10
13
33
15
9
44
43
42
47
45
36
37
39
28
27
25
23
14
7
35
17
34
18

Fig.4

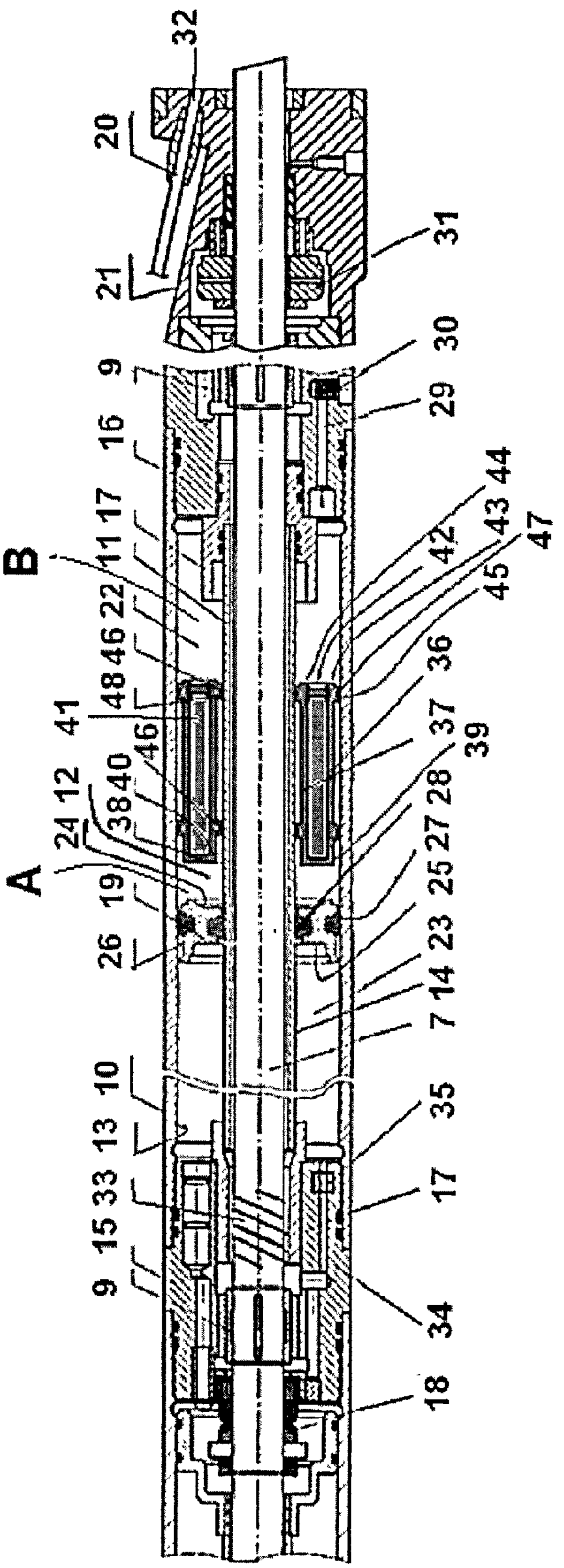

32
20
21
31
30
29
9
16
17
11
22
46
48
41
40
38
12
24
19
26
B
A
44
43
42
47
45
36
37
39
28
27
25
23
14
7
10
13
33
15
9
35
17
34
18

Fig. 5

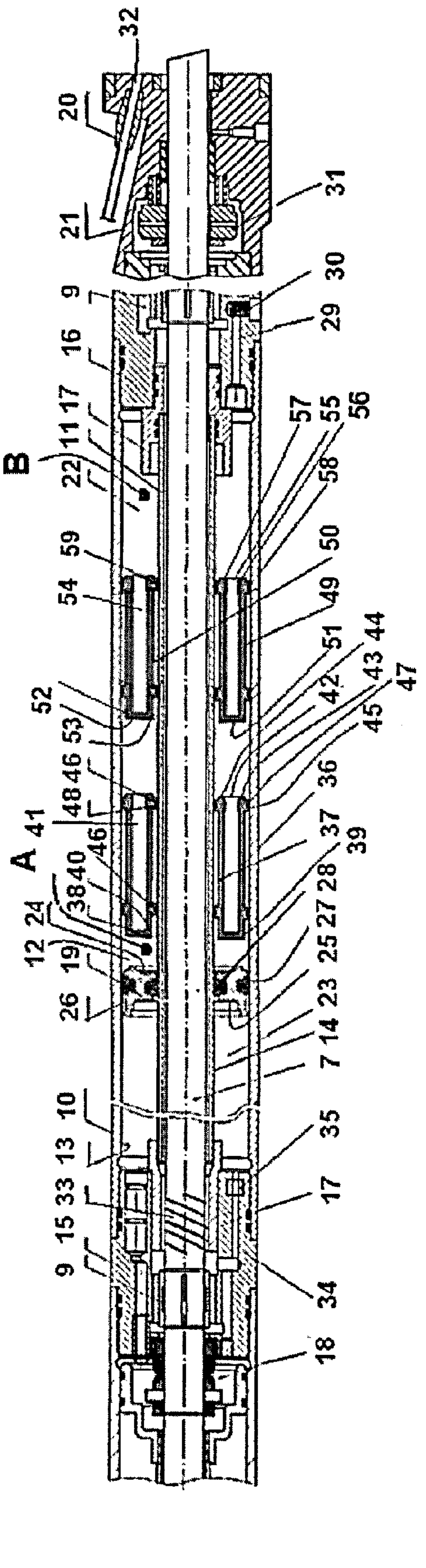

32
20
21
31
30
9
29
16
17
11
B
22
57
55
56
58
59
50
54
49
51
44
42
43
47
52
53
45
46
48
36
41
A
37
40
46
39
38
28
27
24
25
12
19
23
26
14
7
10
35
13
33
17
15
9
34
18

Fig. 6

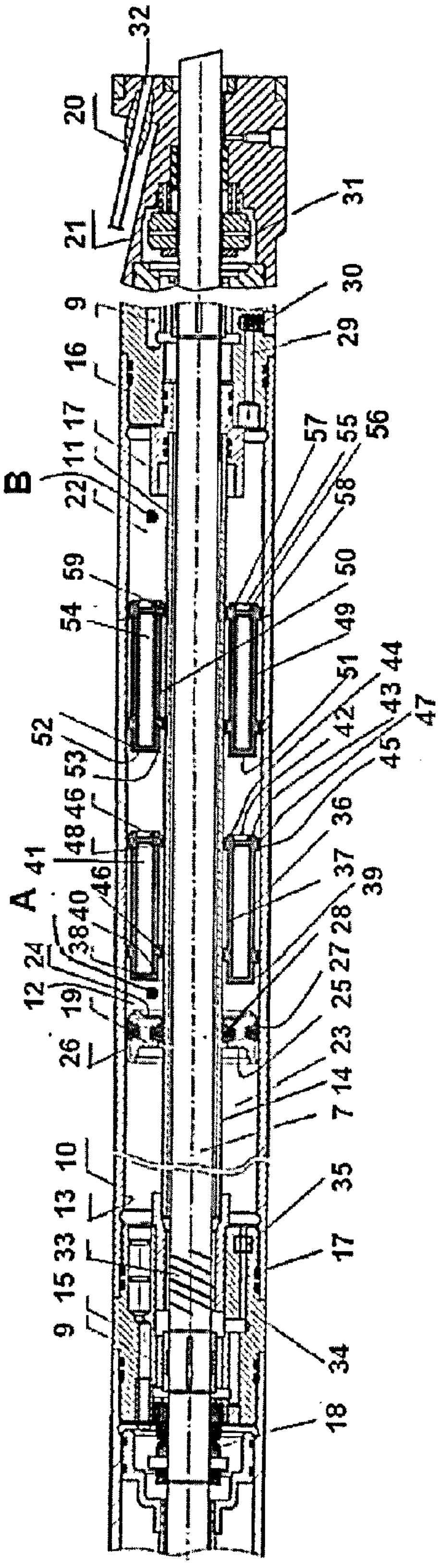


Fig.7

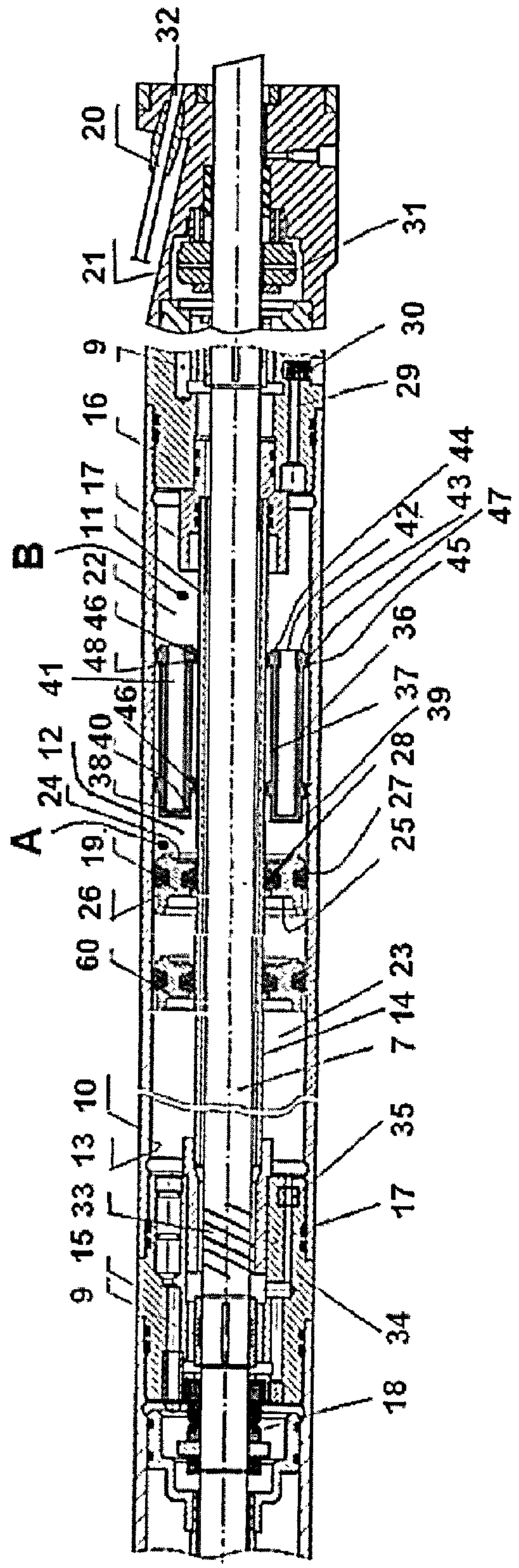

32
20
21
31
9
30
29
16
17
11
B
22
46
48
41
46
40
38
12
24
A
19
26
60
44
42
43
47
45
36
37
39
28
27
25
23
14
7
10
13
33
15
9
35
17
34
18

Fig. 8

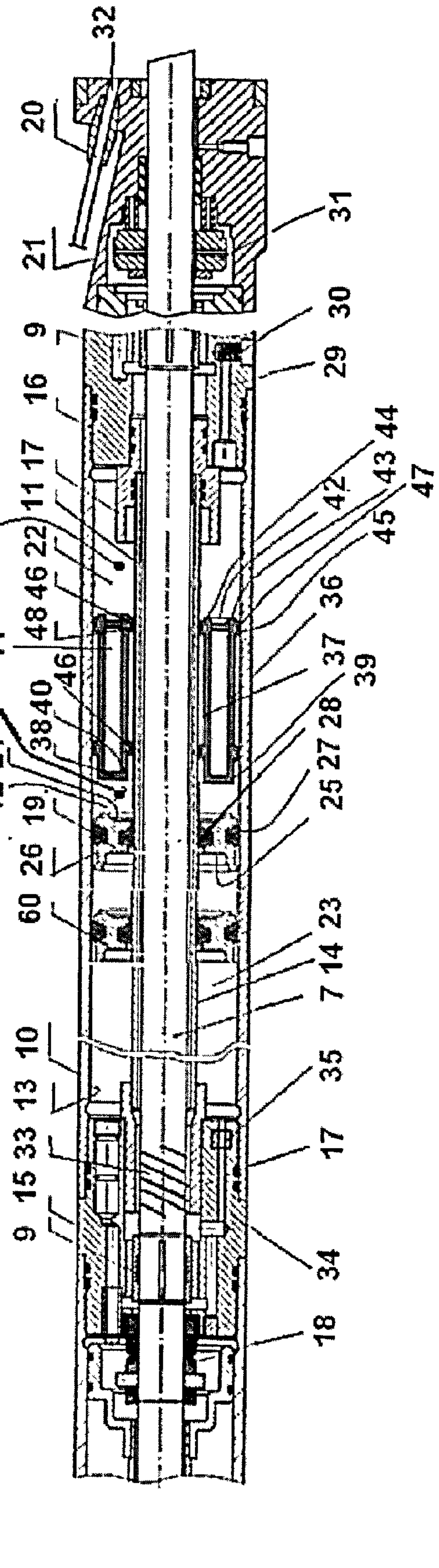

32
20
21
31
30
9
29
16
17
11
B
22
46
48
41
40
46
A
38
24
12
19
26
60
10
13
33
15
9
44
43
42
47
45
36
37
39
28
27
25
23
14
7
35
17
34
18

Fig. 9

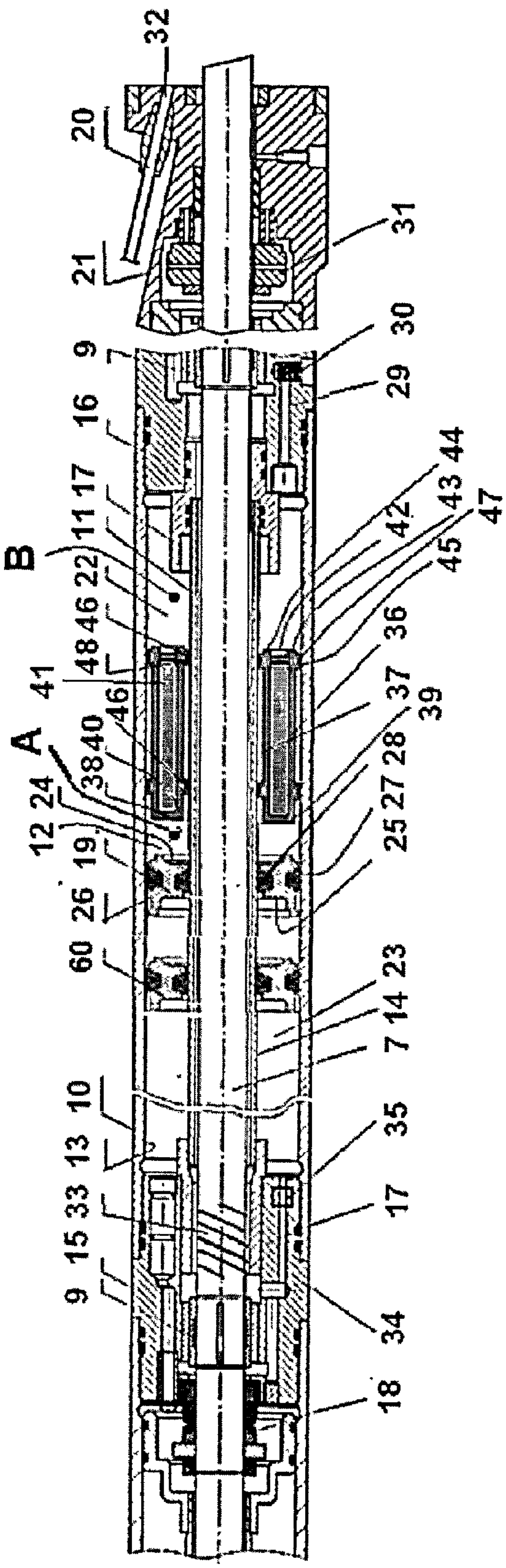

32
20
21
31
30
9
29
16
17
11
B
22
46
48
41
46
40
A
38
24
12
19
26
60
10
13
33
15
9
18
44
42
43
47
45
36
37
39
28
27
25
23
14
7
35
17
34

Fig. 10

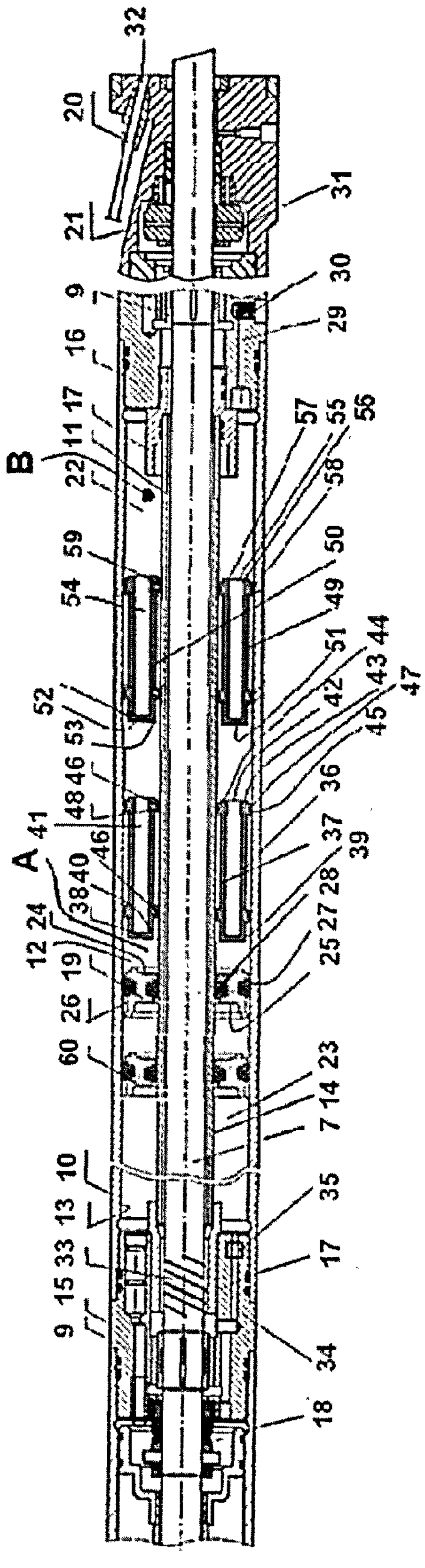

32
20
21
31
30
29
9
16
17
11
22
B
57
55
56
58
59
50
54
49
51
44
43
42
47
45
52
53
46
48
36
41
37
39
28
27
A
40
38
24
12
19
25
26
60
23
14
7
10
35
13
33
17
15
9
34
18

Fig. 11

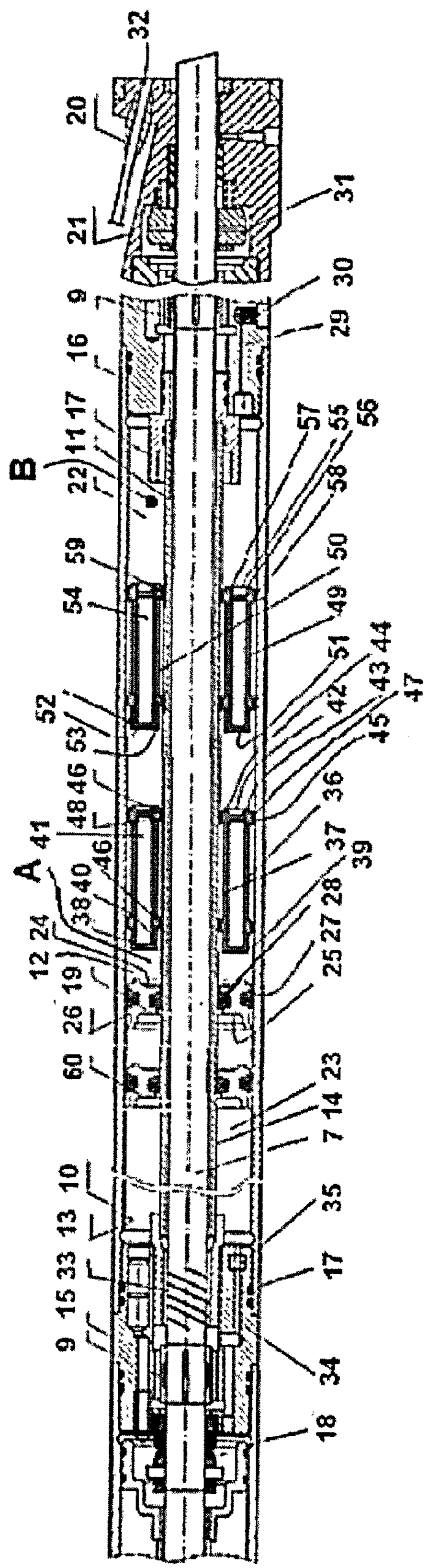

32
20
21
31
30
9
29
16
17
11
22
B
57
55
56
58
59
50
54
49
51
44
43
42
52
53
47
45
46
48
36
37
39
41
A
40
46
38
28
24
27
12
25
19
26
60
23
14
7
10
35
13
17
33
15
9
34
18

Fig. 12

DEVICE FOR HYDRAULICALLY PROTECTING A SUBMERSIBLE ELECTRIC MOTOR OF A DOWNHOLE, PREFERABLY CENTRIFUGAL, PUMP (VARIANTS)

[0001] The invention relates to oil production and can be applied in hydraulic protection for electric submersible centrifugal pumps used for extracting downhole fluid, including bituminous oil, at various depths in various size boreholes.

[0002] The prior art closest to the claimed invention is a device for hydraulically protecting a submersible electric motor of a downhole centrifugal pump in the form of a protector comprising a shaft, a thrust bearing, a radial bearing and at least one stage, which includes a cylindrical housing, a tube surrounding a shaft, the said tube being mounted coaxially inside the cylindrical housing so as to form an annular chamber between the housing and the tube, the first and the second nipples, at least one damping bushing, an end seal, an annular piston and two protective elements capable of reciprocal movement in the annular chamber, which piston performs the function of a moving mechanical module and divides the annular chamber into two sections, one filled with a reservoir fluid coming from the annulus and the other filled with a dielectric fluid, and which two protective annular elements are secured to the end of the annular piston in contact with the reservoir fluid, protrude beyond the profile of the piston and are located in the annular chamber so as to adjoin the inner surface of the cylindrical housing and outer surface of the tube, respectively, where the space/gap/between the protective elements and the surface of the adjoined elements of the protector is always filled with a protective lubricant, and the outer diameter of the protective annular element is approximately equal to the outer diameter of the piston.

[0003] The protective elements can be deformable tubes, corrugated elements, or rigid tubes from metal or plastic with a cylindrical or corrugated shape. In the embodiment with deformable tubes, the latter are made of elastomer, fabric or polymer film, and can retract or extend in longitudinal direction with movement of the annular piston, thus changing the length of the protective elements. Corrugations can be annular or screw ones.

[0004] In the known protector, the protective annular elements are two cylindrical tubes with coaxial arrangement of one inside the other.

[0005] On the side of the annular piston, which is in contact with dielectric fluid, the annular chamber can be provided with at least one additional reciprocal annular piston, which is also a part of the moving mechanical module, where the space between the primary annular piston and the additional annular piston is filled with a separation fluid. One of the pistons can have at least one filling orifice for the separation fluid with a locking device.

[0006] The separation fluid can be a dielectric fluid with a dielectric strength ranging from 4 to 90 kV/cm, or a gas selected from air, inert gas, hydrocarbon gas, or a dielectric fluid/gas mixture, or a protective lubricant.

[0007] To prevent jamming in the annular chamber, the primary and the additional annular pistons can have the outer side surface of a barrel-like shape. Pistons are preferably made of noncorrosive metal or noncorrosive and temperature-resistant polymer material.

[0008] Each annular piston of the protector can have a centering carrier ring, at least one seal in the point of contact of each piston with the inner surface of the cylindrical housing, and at least one seal in the point of contact of each piston with the outer surface of the tube.

[0009] The space between the outer surface of each annular piston and the inner surface of the cylindrical housing can be filled with a protective lubricant.

[0010] With corrugated protective annular elements inside the protective annular element adjoining the inner surface of the cylindrical housing, and outside the protective annular element adjoining the outer surface of the tube, spring elements, which are in mechanical contact with the adjoining surfaces, can be mounted to enable pressing the protective annular elements to the inner surface of the cylindrical housing and the outer surface of the tube.

[0011] With protective annular elements in the form of solid tubes at the surfaces adjoining the inner surface of the cylindrical housing and the outer surface of the tube, respectively, pockets can be made to accommodate a protective lubricant, while outside the protective annular element adjoining the inner surface of the cylindrical housing and inside the protective annular element adjoining the outer surface of the tube, seals can be mounted. Pockets may be annular or helical grooves, or holes.

[0012] The second nipple can have a port connecting the section of the annular chamber filled with the reservoir fluid with the annulus, which port can be provided with a reservoir fluid filter. The shaft between the section of the annular chamber filled with the dielectric fluid and the end seal can be provided with a pumping device, which is connected via the port of the first nipple with a dielectric fluid filter with the section filled with the dielectric fluid. /Russian Patent No. 2353812, F04D 13/10, published in 2009/

[0013] The known technical solution comprises an embodiment of the device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump. Thus, the known device can comprise:

- **[0014]** only a protector and no compensator, where the protector is accommodated between a downhole pump and its motor,
- **[0015]** a protector and a compensator, where the protector is accommodated between a downhole pump and its motor, and the compensator is accommodated directly beneath the motor.

[0016] The known device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump in the form of a protector to some extent prevents leakage of the reservoir fluid into the chamber with the dielectric fluid, and substantially prevents contamination and wear of the friction surfaces. However, when the device is used in extraction of oil with a high content of bituminous components, even removal of heavy deposits from the wall of the annular chamber is extremely difficult, and sometimes involves an increasing leakage of the reservoir fluid.

[0017] However, the increased weight of the pistons mechanically connected with the protective elements requires an increased breakaway torque of the pistons, and thus significantly reduces the operating speed of the moving module/pistons and the protective elements/and effectiveness of the device, especially in production of heavy bituminous oils.

[0018] Therefore, despite potential installation of additional pistons, which increase the reliability of separation of the reservoir and dielectric fluids, the reservoir fluid can still come in contact with the dielectric one, in particular, when the device for hydraulic protection is operated in production of oils with a high content of bituminous and wax components.

[0019] The said known technical solution is taken as a prototype of the proposed device.

[0020] The proposed invention is intended to improve the effectiveness of the device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump by increasing the operating speed of the pistons and the reliability of separation of the reservoir and dielectric fluids, and, consequently, enhance the lifetime of the device in production of any oils, including bituminous and wax-bearing oils.

[0021] The proposed device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump in the form of a protector in various embodiments is accommodated between a downhole centrifugal pump and its motor.

[0022] To achieve the claimed technical result, the proposed solution is the device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump in the form of a protector comprising a shaft, a thrust bearing, a radial bearing and at least one stage, which includes a cylindrical housing, a tube surrounding a shaft, the said tube being mounted coaxially inside the cylindrical housing so as to form an annular chamber between the housing and the tube, the first and the second nipples, at least one damping bushing, at least one pump shaft seal, an annular piston and two protective elements capable of reciprocal movement in the annular chamber, which are mounted at the end of the annular piston, which is in contact with the reservoir fluid, in the form of segments of the outer and inner tubes; the said annular piston divides the annular chamber into two sections, where one section is oriented towards the second nipple, connected with the annulus and filled with the reservoir fluid, and the other is oriented towards the first nipple, filled with the dielectric fluid of the motor and has at least one centering carrier ring, at least one seal in the point of contact of the annular piston with the inner surface of the cylindrical housing, and at least one seal in the point of contact of the annular piston with the outer surface of the tube; the space between the outer surface of the annular piston and the inner surface of the cylindrical housing is filled with a protective medium; the segments of the inner and the outer tubes of the annular elements are located at the end of the annular piston oriented towards the second nipple and adjoining, respectively, the inner surface of the housing and the outer surface of the tube with a gap between the same and the respective adjoining surfaces, filled with a protective medium; the port of the second nipple connecting the section of the annular chamber filled with the reservoir fluid with the annulus has a reservoir fluid filter; the points, where the segments of the inner and the outer tubes adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, have gaps against the respective adjoining surfaces, are located near the ends of these tube segments oriented towards the second nipple and being the farthest to the annular piston, and have seals; and the shaft between the section of the annular chamber filled with the dielectric fluid and the end seal can be provided with a pumping device, which is connected via the port of the first nipple with a dielectric fluid filter with the section filled with the dielectric fluid, in which pumping device, according to the first embodiment of the proposed invention, the segments of the inner and the outer tubes of the annular elements are rigidly interconnected by means of a solid common bottom at the end of the annular piston oriented towards the second nipple, where this side adjoins the ends of both tube segments of the annular elements so as to form a single piece freely accommodated in the annular chamber and capable of autonomous reciprocal movement independent of the annular piston and performing the function of a separator of the reservoir fluid and the dielectric fluid of the motor in the annular chamber; the protective medium is taken with hydro-oleophobic properties.

[0023] Another proposed solution is the device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump in the form of a protector comprising a shaft, a thrust bearing, a radial bearing and at least one stage, which includes a cylindrical housing, a tube surrounding a shaft, the said tube being mounted coaxially inside the cylindrical housing so as to form an annular chamber between the housing and the tube, the first and the second nipples, at least one damping bushing, at least one pump shaft seal, an annular piston oriented to the second nipple, an additional annular piston at the end of this piston in contact with the dielectric fluid and two annular elements, all capable of reciprocal movement in the annular chamber, which are mounted at the end of the annular piston, which piston is in contact with the reservoir fluid, in the form of segments of the inner and the outer tubes; the said annular pistons divide the annular chamber into two sections, where one section is oriented towards the second nipple, connected with the annulus and filled with the reservoir fluid, and the other is oriented towards the first nipple, filled with the dielectric fluid of the motor and has at least one centering carrier ring, at least one seal in the point of contact of the annular piston with the inner surface of the cylindrical housing, and at least one seal in the point of contact of the annular piston with the outer surface of the tube; the space between the two annular pistons is filled with a separation fluid and the space between the outer surface of the annular piston and the inner surface of the cylindrical housing is filled with a protective medium; the segments of the inner and the outer tubes of the annular elements are located at the end of the annular piston oriented towards the second nipple adjoining, respectively, the inner surface of the cylindrical housing and the outer surface of the tube with a gap between the same and the respective adjoining surfaces filled with a protective medium; the port of the second nipple connecting the section of the annular chamber filled with the reservoir fluid with the annulus has a reservoir fluid filter; the points, where the segments of the inner and the outer tubes adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, have gaps against the respective adjoining surfaces, are located near the ends of these tube segments being the farthest to the annular pistons, and have seals; and the shaft between the section of the annular chamber filled with the dielectric fluid and the end seal can be provided with a pumping device, which is connected via the port of the first nipple with a dielectric fluid filter with the section filled with the dielectric fluid, in which pumping device, according to the second embodiment of the proposed invention, the segments of the inner and the outer tubes of the annular elements are rigidly interconnected by means of a solid common bottom at the end of the annular piston oriented towards the second nipple, where this side adjoins both tube segments of the protective annular elements so as to form a single piece freely accommodated in the annular chamber and capable of autonomous reciprocal movement independent of the annular piston and performing the function of a separator of the reservoir fluid and the dielectric fluid of the motor in the annular chamber; the protective medium is taken with hydro-oleophobic properties.

[0024] In both embodiments of the devices, the annular cavity inside the single piece of two annular elements rigidly interconnected by an annular bottom between the walls of the inner and the outer tube segments can be open or closed at the end of the cavity oriented towards the second nipple, and filled with a protective medium.

[0025] In addition, both embodiments of the devices can be provided with additional points, where segments of the inner and the outer tubes of the annular elements adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, with a gap against the corresponding adjoining surfaces located along the length of these segments and provided with seals.

[0026] The outer surface of the inner and the outer tube segments of the annular elements in both embodiments can be provided with protrusions arranged in the gap between the respective surfaces of the two annular elements adjoining the inner surface of the cylindrical housing and the outer surface of the tube, and seals for the adjoining points of the tube segments of the two annular elements are located at the outer surface of each of these protrusions, and these protrusions are made near the ends of outer and the inner tube segments oriented towards the second nipple, or distributed along the length of the tube segments.

[0027] For more effective separation of the reservoir and the dielectric liquids, the device can be provided with at least one additional single piece of two additional annular elements in the form of segments of the inner and the outer tubes rigidly interconnected by a common solid bottom located on the side of the adjacent single piece of the two rigidly interconnected annular elements, which piece is nearest to the annular piston and where the bottom is adjoining, i.e. on the side of the annular piston, the ends of the two tube segments of the additional annular elements; where the additional single separating piece is freely located in the annular chamber and capable of autonomous reciprocal movement independent of the annular pistons and performing the function of a separator of the reservoir fluid and the dielectric fluid of the motor in the annular chamber; and both of its additional annular elements are mounted in the annular chamber adjoining with a gap the internal surface of the cylindrical housing and the outer surface of the tube, respectively; and points, where the inner and the outer tubes of the additional annular elements adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, have a gap between the same and the respective adjoining surfaces near the ends of the tube segments of the additional annular elements oriented towards the second nipple and being the farthest to the annular pistons, and have seals, where the annular cavity of the additional single piece between the walls of the inner and the outer tube segments of each additional annular element is filled with a protective medium, and the space between adjacent pieces of two rigidly interconnected annular elements is filled with a separation fluid.

[0028] In addition, both embodiments of the devices can be provided with additional points, where segments of the inner and the outer tubes of the annular elements adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, with a gap against the corresponding adjoining surfaces located along the length of these segments and provided with with seals.

[0029] The outer surface of the inner and the outer tube segments of the annular elements in both embodiments can be provided with protrusions arranged in the gap between the respective surfaces of the two annular elements adjoining the inner surface of the cylindrical housing and the outer surface of the tube, and seals for the adjoining points of the tube segments of the two annular elements are located at the outer surface of each of these protrusions, and these protrusions are made near the ends of outer and the inner tube segments oriented towards the second nipple, or distributed along the length of the tube segments.

[0030] The proposed device in both embodiments can be provided with at least one additional single piece of two additional annular elements in the form of segments of the inner and the outer tubes rigidly interconnected by a common solid annular bottom located on the side of the adjacent single piece of the two rigidly interconnected annular elements, which piece is nearest to the annular pistons and where the bottom is adjoining the ends of the two tube segments of the additional annular elements; where the additional single piece is freely located in the annular chamber and capable of autonomous reciprocal movement independent of the annular piston/in the first embodiment/or annular pistons/in the second embodiment/and performing the function of a separator of the reservoir fluid and the dielectric fluid of the motor in the annular chamber; and both of its additional annular elements are mounted in the annular chamber adjoining with a gap the internal surface of the cylindrical housing and the outer surface of the tube, respectively; and points, where the inner and the outer tubes of the additional annular elements adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, have a gap between the same and the respective adjoining surfaces near the ends of the tube segments of the additional annular elements oriented towards the second nipple and being the farthest to the annular piston, and have seals, where the annular cavity of the additional single piece between the walls of the inner and the outer tube segments of each additional annular element is filled with a protective medium, and the space between adjacent pieces of two rigidly interconnected annular elements is filled with a separation fluid.

[0031] The outer surface of the inner and the outer tube segments of the additional annular elements of the protectors in both embodiments can be provided with protrusions arranged in the gap between the respective surfaces of the additional annular elements adjoining the inner surface of the cylindrical housing and the outer surface of the tube, and seals for the adjoining points of the annular elements can be located at the outer surface of each of these protrusions, and these protrusions can be made near the ends of outer and the inner tube segments oriented towards the second nipple, or distributed along the length of the additional annular tubes.

[0032] The protective medium of the annular chamber in the area of movement of the single piece of two additional annular elements of the device in both embodiments between the end of the said annular chamber on the side of the second nipple and the end of the annular piston oriented towards the second nipple is a dielectric buffer fluid, preferably based on silicone compounds.

[0033] The space of the annular chamber of the device in both embodiments between the location area of the the dielectric barrier fluid and the area of the annular chamber near the second nipple is filled with a dielectric barrier fluid, preferably based on polyethylene oxides.

[0034] For both embodiments, the dielectric buffer fluid and the dielectric barrier fluid in the device are immiscible, and the density of the dielectric barrier fluid is at least equal to the density of the buffer fluid.

[0035] Separation fluid between the adjacent, including additional, annular elements is a dielectric buffer fluid.

[0036] The tube segments of the annular elements of the protectors in both embodiments can have various forms of generating lines.

[0037] In the second embodiment of the device with two adjacent pistons in the annular chamber, the inner and outer tube sections of the annular elements in the form of a single piece are located at the end of the annular piston oriented towards the second nipple.

[0038] Apart from that, in the said embodiments of the device, the location area of the dielectric buffer fluid is limited to the end of the piston oriented towards the second nipple and the end of the annular chamber on the side of the second nipple.

[0039] The annular cavity in the single piece of two annular elements between walls of the inner and the outer tube segments can be open at the end of the cavity oriented towards the second nipple and filled with a protective medium, or can be closed at the end of the cavity oriented towards the second nipple.

[0040] The essence of the invention is described in figures.

[0041] FIG. **1** shows the layout of the assemblies of the device for hydraulically protecting a submersible electric motor of a downhole centrifugal pump in the form of a protector with no compensator.

[0042] FIG. **2** shows the layout of the assemblies of the device for hydraulically protecting a submersible electric motor of a downhole centrifugal pump using a compensator.

[0043] FIG. **3** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with one annular piston and a single piece of two annular elements performing the function of a separator of fluids (reservoir and dielectric fluids) between the walls of the inner and the outer rigidly interconnected tube segments and having an open annular cavity at the end oriented towards the second nipple/ in the first embodiment/.

[0044] FIG. **4** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with one annular piston and a single piece of two annular elements performing the function of a separator of fluids (reservoir and dielectric fluids) between the walls of the inner and the outer rigidly interconnected tube segments and having a closed annular cavity at the end oriented towards the second nipple/ the first embodiment/.

[0045] FIG. **5** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with one annular piston and a single piece performing the function of a separator of fluids (reservoir and dielectric fluids) in the form of a plug/the first embodiment/.

[0046] FIG. **6** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with one annular piston and two adjacent annular elements each in the form of a single piece of two annular elements performing the function of a separator of fluids (reservoir and dielectric fluids) between the walls of the inner and the outer rigidly interconnected tube segments and having an open annular cavity at the end oriented towards the second nipple/the first embodiment/.

[0047] FIG. **7** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with one annular piston and two adjacent annular elements each in the form of a single piece of two annular elements performing the function of a separator of fluids (reservoir and dielectric fluids) between the walls of the inner and the outer rigidly interconnected tube segments and having a closed annular cavity at the end oriented towards the second nipple/the first embodiment/.

[0048] FIG. **8** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with two annular pistons and a single piece of two annular elements performing the function of a separator of fluids (reservoir and dielectric fluids) between the walls of the inner and the outer rigidly interconnected tube segments and having an open annular cavity at the end oriented towards the second nipple/the second embodiment/.

[0049] FIG. **9** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with two annular pistons and a single piece of two annular elements performing the function of a separator of fluids (reservoir and dielectric fluids) between the walls of the inner and the outer rigidly interconnected tube segments and having a closed annular cavity at the end oriented towards the second nipple/the second embodiment/.

[0050] FIG. **10** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with two annular pistons and a single piece performing the function of a separator of fluids (reservoir and dielectric fluids) in the form of a plug/the second embodiment/.

[0051] FIG. **11** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with two annular pistons and two adjacent annular elements each in the form of a single piece of two annular elements performing the function of a separator of fluids (reservoir and dielectric fluids) between the walls of the inner and the outer rigidly interconnected tube segments and having an open annular cavity at the end oriented towards the second nipple/the second embodiment/.

[0052] FIG. **12** shows the sectional drawing of the proposed device for hydraulic protection in the form of a protector with two annular pistons and two adjacent annular elements each in the form of a single piece of two annular elements performing the function of a separator of fluids (reservoir and dielectric fluids) between the walls of the inner and the outer rigidly interconnected tube segments and having a closed annular cavity at the end oriented towards the second nipple/the second embodiment/.

[0053] The devices for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump can be of two structural types according to the same layouts, as shown in FIGS. **1** and **2**.

[0054] One type of the device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump/FIG. **1**/comprises a device including only one protector **1** without a compensator, the protector **1** being accommodated between the downhole centrifugal pump **2** and the motor **3**. This embodiment of the device for hydraulic protection has been recently preferred in the oil industry.

[0055] Another type of the device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump/FIG. **2**/comprises a device including a protector **1** and a compensator **4**, where the protector **1** is accommodated between the downhole pump **2** and the motor **3**, and the compensator **4** is accommodated directly in front of the motor **3**.

[0056] The proposed device is accommodated inside the casing **5** and connected with the tubing string **6**.

[0057] The first type of the device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump/FIG. **1**/ is considered below.

[0058] FIG. **3-7** show the proposed device in the first embodiment/with one annular piston/.

[0059] FIG. **8-12** show the proposed device in the second embodiment/with two adjacent annular pistons/.

[0060] The device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump **2** shown in FIG. **1** and FIG. **3-12** comprises a drive shaft **7** of the centrifugal downhole pump **2** with the inlet **8** for the reservoir fluid, which transmits torque from the motor shaft **3** to the pump shaft **2**, thrust and radial bearings **9** and, for example, at least one stage which includes a cylindrical housing **10**, the tube **11** surrounding the shaft **7**, covering the shaft **7** of the pump drive **2** and coaxially mounted inside the cylindrical housing **10** to form the annular chamber **12** between the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, and the first and the second nipples **15** and **16**, respectively, for example, one damping bush **17**, for example, one seal **18** of the shaft **7**, and the reciprocal annular piston **19** and the single piece performing the function of separation of the reservoir and dielectric fluids consisting of two rigidly interconnected annular elements, which piece is capable of free autonomous movement in the annular chamber **12** with no mechanical connection with the annular piston **19**. The seal **18** of the shaft **7** can be end, radial or labyrinth, where the pressure of the dielectric fluid in front of the seal **18** of the shaft **7** exceeds the pressure of the reservoir fluid to ensure long lifetime of the device. The number of stages of the protector is preferably **1-3**.

[0061] Power to the motor **3** is supplied from the transformer/not shown/by the extension cable **20** connected to the head **21** of the motor **3**, which head is adjacent to the second nipple **16**.

[0062] The annular piston **19** is movable, capable of reciprocal movement inside the annular chamber **12** and divides the annular chamber **12** into two sections **22** and **23**, which section **22** is located at the end **24** of the annular piston **19** oriented towards the second nipple **16**, filled with the reservoir fluid coming from the annular space, and which section **23** is located at the opposite end **25** of the annular piston **19** oriented towards the first nipple **15** and filled with the dielectric fluid of the motor **3**. To prevent leakage of fluids from the sections **22** and **23** of the annular chamber **12**, the annular piston **19** is provided with a centering ring **26**, such as the seal **27** in the point of contact of the annular piston **19** with the inner surface **13** of the cylindrical housing **10**, and another seal **28** in the point of contact of the annular piston **19** with the outer surface **14** of the tube **11**.

[0063] In the second port **29** of the nipple **16** connecting the section **22** of the annular chamber **12** filled with the reservoir fluid, with the annulus, the reservoir fluid filter **30** is mounted. The head **21** of the motor **3** includes an axial carrier bearing **31** of the shaft **7** of the pump **2** and the input port **32** for the extension cable **20** of the motor **3**.

[0064] The shaft **7** of the pump **2** between the section **23** of the annular chamber **12** filled with the dielectric fluid and the seal **18** of the shaft **7** of the centrifugal pump **2** is provided with the pumping device **33** connected via the port **34** in the first nipple **15** with the motor dielectric fluid filter **35** with the section **23** of the annular chamber **12** filled with the motor dielectric fluid.

[0065] The pumping unit **33** pumps the motor dielectric fluid through the port **34** in the first nipple **15** and through the dielectric fluid filter **35** mounted in this port **34**, thus treating the dielectric fluid and providing a preset pressure differential to ensure reliable operation of the seal **18** of the shaft **7** of the pump drive **2** .

[0066] The aforementioned single piece performing the function of a separator of the reservoir and dielectric fluids and consisting of two annular elements is rigidly interconnected segment **36** of the outer tube and segment **37** of the inner tube coaxially arranged one inside the other in the annular chamber **12** at the end **24** of the annular piston **19** oriented towards the second nipple **16** and in contact with the reservoir fluid in the section **22** of the annular chamber **12**, adjoining the the inner surface **13** of the housing **10** and the outer surface **14** of the tube **11***c*, respectively, with a gap between the same and the respective aforementioned adjoining surfaces, where the gap space is filled with a protective medium with hydro-oleophobic properties.

[0067] The segments **36** and **37** of the outer and the inner tubes, respectively, of the two annular elements are rigidly interconnected to form a single piece by means of the solid bottom **38** accommodated at the end **24** of the annular piston **19** oriented towards the second nipple **16** and in contact with the reservoir fluid, and rigidly connected on this side with both ends **39** and **40** of these tube segments **36** and **37**, respectively. The generating line of the tube segments **36** and **37** of the annular elements can be different, i.e. tubes may be conical, with a winding line, and cylindrical.

[0068] The tube segments **36** and **37** of both annular elements are rigidly interconnected to form a single piece without any mechanical connection with the annular piston **19**, mounted inside the annular chamber **12** and capable of free autonomous, i.e. independent of the annular piston **19**, reciprocal movement in the annular chamber **12** and performing the function of a separator of the reservoir and dielectric fluids in the annular chamber **12**.

[0069] The annular cavity **41** inside the single piece of two annular elements between the walls of the outer and the inner tube segments **36** and **37**, respectively, which performs the function of a separator of fluids, can be open at the end **42** oriented towards the second nipple **16** and filled with a protective medium with hydro-oleophobic properties. In addition, the annular cavity **41** indide the single piece of the two annular elements performing the function of a separator of fluids can be closed at both ends, and therefore, the single piece performing the function of a separator of fluids can be a single solid ring, as shown in FIG. **5**, where the two annular elements are generating lines of the solid ring.

[0070] The points, where the outer **36** and inner **37** tube segments adjoin the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, respectively, have gaps against the adjoining surfaces and are located near ends **43** and **44** of these tube segments **36** and **37**, respectively, oriented towards the second nipple **16** and farthest to the annular piston **19**. The adjoining points are provided with seals **45** and **46** on the side of the inner surface **13** of the cylindrical housing **10** and on the side of the outer surface **14** of the tube **11**, respectively.

[0071] The protective medium with hydro-oleophobic properties, which is a dielectric buffer fluid preferably based on silicone compounds, is located in the area A of the annular chamber **12**, i.e. area of movement of a single piece performing the function of a separator of media and limited, on the one side, by the end **24** of the annular piston **19** oriented towards the second nipple **16**, and on the other side, by the ends **43** and **44** of the tube segments **36** and **37** rigidly interconnected to form a single piece, i.e. a separator of fluids.

[0072] Dielectric barrier medium preferably based on polyethylene oxides is located in the area B of the annular chamber **12** limited, on the one side, by the second nipple **16**, and the other side, by the surface of the tube segments **36** and **37** on the side of the second nipple **16** rigidly interconnected to form a single piece, i.e. a separator of fluids, where the dielectric buffer fluid and the dielectric barrier fluid are immiscible with each other, and the density of the dielectric barrier fluid is at least equal to the density of the dielectric buffer fluid.

[0073] In addition, the device can be provided with additional points, where the outer and inner tube segments **36** and **37** of the annular elements, adjoin the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, respectively, with a gap against the corresponding adjoining surfaces arranged along the length of the tube segments **36** and **37** and provided with the seals **45** and **46** at connection of each segment with the inner surface **10** of the housing **7** and the outer surface of the tube **11**, respectively. Such seals may be multiple, for example four.

[0074] To preserve the protective lubricant, the outer surface of the outer tube segment **36** and the inner surface of the inner tube segment **37** of the annular elements can be provided with the protrusions **47** and **48** arranged in the gap between the respective surfaces, where the two rigidly interconnected annular elements adjoin the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, respectively, and the seals **45** and **46** in the points, where the two annular elements adjoin the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, respectively, can be accommodated on the outer surface of each of the protrusions, where the protrusions are made near the ends **43** and **44** of the outer and inner tube segments **36** and **37**, respectively, oriented towards the second nipple **16**, and distributed along the length of these tube segments **36** and **37**.

[0075] The space inside the single piece of annular elements performs the function of a separator of the reservoir and dielectric fluids, is limited by the walls of the rigidly interconnected tube segments **36** and **37**, and filled with a protective medium with hydro-oleophobic properties, which is a dielectric buffer fluid.

[0076] In addition, the device can be provided, for example, with additional annular elements intended for separating the reservoir and dielectric fluids in the form of a single piece consisting of the segments **49** and **50** of the outer and inner tubes of additional elements, respectively, which are rigidly interconnected by the common solid bottom **51** arranged on the side of the adjacent single piece of two rigidly interconnected annular elements nearest to the annular piston **19**.

[0077] The bottom **51** on the side of this single piece of two adjacent annular elements adjoins the ends **52** and **53** of both tube segments **49** and **50** of the additional ring elements, respectively, to form each single piece freely accommodated in the annular chamber **12** and capable of autonomous reciprocal movement independent from the annular piston **19** and performing the function of an additional separator of the reservoir and dielectric fluids. The generating line of the tube segments **49** and **50** of the additional annular elements can also be different, i.e. tubes may be conical, with a winding line, and cylindrical.

[0078] The annular cavity **54** inside the single piece of two rigidly interconnected additional annular elements performing the function of a separator of fluids between the walls of the inner and outer tube segments **49** and **50**, respectively, can be open at the end **55** oriented towards the second nipple **16**, and filled with a protective medium with hydro-oleophobic properties, which is a dielectric buffer fluid. In addition, the annular cavity **54** inside the single piece of two additional protective elements can be closed at both ends, and therefore, the single piece of two protective elements can be a single solid ring.

[0079] The points, where the outer surface of the outer tube segment **49** and inner surface of the inner tube segment **37** adjoin the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, respectively, have gaps against the adjoining surfaces and are located near ends **56** and **57** of these tube segments **49** and **50** of the additional annular elements, respectively, oriented towards the second nipple **16** and farthest to the annular piston **19**. The adjoining points are provided with seals **45** and **46** on the side of the inner surface **13** of the cylindrical housing **10** and on the side of the outer surface **14** of the tube **11**, respectively.

[0080] In addition, the device can be provided with additional points, where the the outer and inner tube segments **49** and **50** of the additional annular elements, adjoin the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, respectively, with a gap against the corresponding adjoining surfaces arranged along the length of the tube segments **49** and **50** and provided with the seals **45** and **46** at connection with the inner surface **13** of the housing **10** and the outer surface of the tube **14**, respectively. Such seals may be multiple, for example four.

[0081] The outer surface of the outer tube segment **49** and the inner surface of the inner tube segment **50** of the additional elements can be provided with the protrusions **58** and **59** arranged in the gap between the respective surfaces, where the two additional annular elements adjoin the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, respectively, and the seals **45** and **46** in the adjoining points of the two additional annular elements can be accommodated on the outer surface of each of the protrusions, where the protrusions are made near the ends **56** and **57** of the outer and inner tube segments **49** and **50**, respectively, oriented towards the second nipple **16**, and distributed along the length of these tube segments **49** and **50**.

[0082] The seals **45** and **46** of the points, where the additional annular elements adjoin the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, respectively, are located on the outer surface of each of these protrusions.

[0083] The spacer medium between the adjacent annular elements is dielectric buffer fluid, where the dielectric buffer fluid and the dielectric barrier fluid are immiscible with each other, and the density of the dielectric barrier fluid is at least equal to the density of the buffer fluid.

[0084] According to the second embodiment, to improve the reliability of separation of the dielectric fluid and the reservoir fluid in the annular chamber **12** at the end **25** of the annular piston **19** oriented towards the first nipple **15** and in contact with the dielectric fluid with no mechanical connection with the latter, the additional annular piston **60** is mounted being capable of autonomous reciprocal movement.

[0085] Filling the space between the annular piston **19** and the additional annular piston **60** with spacer medium is performed during the assembly of the device.

[0086] In the embodiment with adjacent annular piston **19** and additional annular piston **60**, their movement inside the annular chamber **12** is free and autonomous and involves a free and autonomous movement within the chamber **12** of at least one single piece performing the function of a separator of the reservoir and dielectric fluids and consisting of annular elements including the outer tube segment **36** and the inner tube segment **37**, which are rigidly interconnected by the common annular bottom **38** accommodated at the end **24** of the annular piston **19** oriented towards the second nipple **16** adjoining the ends **39** and **40** of the segments **36** and **37**, respectively, and/or a single piece of annular elements consisting of the outer tube segment **49** and the inner tube segment **50** rigidly interconnected by the bottom **51**. The generating line of the tube segments of the annular elements in the second embodiment can be different, i.e. tubes may be conical, with a winding line, and cylindrical.

[0087] To reduce friction between the movable and fixed structural elements of the protector, in particular, the cylindrical housing **10**, the space between the outer surface of the annular piston **19** and the inner surface **13** of the cylindrical housing **10**, and the space between the outer surface of the additional annular piston **60**, and the inner surface **13** of the cylindrical housing **10** and between the inner surface of the additional annular piston **60** and the outer surface **14** of the tube **11** is filled with a protective medium with hydro-oleophobic properties which is a dielectric buffer fluid.

[0088] The annular elements used in the device in the form of single pieces performing the function of a separator of fluids should be tightly pressed against the respective surface of the cylindrical housing **10** and the tube **11** lubricated by the same, but they should not be jammed in the annular chamber **12** during movement of the annular piston **19** and/or additional annular piston **60**.

[0089] The spacer medium between the two pistons/area C/is in the form of a dielectric fluid with a dielectric strength ranging from 4 to 90 kV/cm. The dielectric fluid of the motor has high electrical resistance and good antifriction properties, and prevents the wear of friction pairs in the motor **3**. The dielectric fluid of the motor is preferably oil with a min. dielectric strength 4 kV/cm, such as oil of MDPN grade. The separation fluid between pistons is a dielectric fluid with a dielectric strength ranging from 4 to 90 kV/cm (e.g. MDPN oil), or a gas selected from air, inert gas, hydrocarbon gas or dielectric fluid/gas mixture.

[0090] The protective medium with hydro-oleophobic properties, which is a dielectric buffer fluid preferably based on silicone compounds, is located in the area A of the annular chamber **12**, i.e. area of movement of a single piece performing the function of a separator of media and limited, on the one side, by the end **24** of the annular piston **19** oriented towards the second nipple **16**, and on the other side, by the ends **43** and **44** of the tube segments **36** and **37** rigidly interconnected to form a single piece, i.e. a separator of fluids.

[0091] Dielectric barrier medium preferably based on polyethylene oxides is located in the area B of the annular chamber **12** limited, on the one side, by the second nipple **16**, and the other side, by the surface of the tube segments **49** and **50** on the side of the second nipple **16** rigidly interconnected to form a single piece, i.e. a separator of fluids, where the dielectric buffer fluid and the dielectric barrier fluid are immiscible with each other, and the density of the dielectric barrier fluid is at least equal to the density of the dielectric buffer fluid.

[0092] The separation fluid between the adjacent annular elements functioning as separators of the reservoir and the dielectric fluid of the motor is a dielectric buffer fluid.

[0093] The annular pistons and the annular elements in the form of a single piece of rigidly interconnected tube segments performing the function of separation of fluids and autonomous movement inside the annular chamber, are made of noncorrosive metal or noncorrosive and temperature-resistant polymer material, preferably heat-resistant nonmetallic materials with high extreme-pressure properties that contain free carbon and have a thermal expansion factor not higher than the thermal expansion factor of the cylindrical housing of the device.

[0094] The device for hydraulic protection in the form of a protector of a motor of a downhole centrifugal pump operates as follows.

[0095] Before commencement of operation, the device for hydraulic protection of the motor **3** is completely filled with buffer and barrier dielectric fluids.

[0096] The shaft **7** of the centrifugal pump drive **2** mounted on the radial bearings **9** transmits torque from the motor shaft to the downhole pump shaft **3**.

[0097] 2. When oil production equipment is run into a well, the section **22** of the annular chamber **12** is filled with the reservoir fluid through the port **29** with the reservoir fluid filter **30** mounted in the second nipple **16**. Section **23** of the annular chamber **12** is pre-filled with dielectric fluid through the port **34** in the first nipple **15** and the dielectric fluid filter **35**. The tube **11** is mounted on damping bushings **17**. The annular piston **19** mounted in the annular chamber **12** with the seals **27** and **28** against the inner surface **13** of the cylindrical housing **10** and against the outer surface **14** of the tube **11**, respectively, and the thrust centering ring **26** prevents penetration of the reservoir fluid to the section **23** of the annular chamber **12** filled with the dielectric fluid and connected with the inner leak-proof cavity of the motor.

[0098] 3. In addition, the reservoir fluid is also separated from the dielectric fluid, for example, by means of the end seal **18** of the shaft **7** of the pump drive **2**. When the motor **3** is started or its rpm is increased, the dielectric fluid in its inner cavity is heated and starts gradual expansion, thus increasing in volume as a consequence of which, the pressure of the dielectric fluid in the interior cavity of the motor **3** and the hydraulically connected cavity of the device for hydraulic protection, i.e. section **23** with the dielectric fluid of the motor **3** of the annular chamber **12** increases. To prevent this pressure from opening the seal **18** of the shaft **7**, the pressure differential in the dielectric fluid filling the motor **3** should be damped out. For this purpose, the annular piston **19** is mounted, which is capable of reciprocal movement in the annular chamber **12**.

[0099] When the dielectric fluid pressure increases, it moves in the annular chamber **12** towards the section **22** with the reservoir fluid. When the dielectric fluid pressure decreases, it moves towards the section **23** with the dielectric fluid of the motor **3** and returns to the original position.

[0100] As the reservoir fluid contains large amounts of chemically active substances, when an oil well is operated, scale builds up at the walls of the annular chamber **12**, i.e. on the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, as a result of the reaction of the chemically active reservoir fluid with the walls of the annular chamber **12**.

[0101] This process of scaling is a significant obstacle for movement of the annular piston **19** and the additional annular piston **60** in the annular chamber **12**. Apart from a substantial increase in the wear of the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11**, there is a probability that the annular piston **19** or the additional annular piston **60** can get stuck to the said surfaces **13** and **14**. To avoid this effect, two annular pieces in the form of the tube segments **36** and **37** rigidly interconnected by the solid bottom **38**, which bottom is adjoining the ends **39** and **40** of both tube segments **36** and **37**, respectively, are mounted in the protective medium, which is a dielectric buffer fluid, freely with no mechanical connection with the annular piston **16** at least as a single piece capable of performing the function of a separator of the reservoir and dielectric fluids at the end **24** of the annular piston **19** oriented towards the second nipple **16** and in contact with the reservoir fluid.

[0102] The annular elements of single pieces protect the inner surface **13** of the cylindrical housing **10** and the outer surface **14** of the tube **11** from scaling without hindering the smooth reciprocal movement of the annular piston **19** and the annular chamber **12** and following the annular piston **19** by means of vacuum formed in the annular chamber **9** between the forcedly moving annular piston **19** and the single pieces of the annular elements mounted successively to the same, but without slowing down the movement of the annular piston **19** and/or additional annular piston **60**, as there is no mechanical connection between the annular piston **19** and the single pieces performing the function of separators of fluids capable of autonomous reciprocal movement across the annular chamber **12**.

[0103] In the embodiment with the additional annular piston **60**, the protector operation scheme is almost the same. In this case, the dielectric liquid of the motor **3** in the section **23** of the annular chamber **12** will have an impact on the additional piston **60**, and the piston will, in turn, transmit the said pressure to the annular piston **19** through the separation fluid between the two pistons. In this case, the probability of a loss of pressurization in the annular chamber **12** and the probability of the reservoir fluid leaking into the same is significantly reduced.

[0104] The pumping device **33** mounted on the shaft **7** of the pump **2** between the section **23** of the annular chamber **12** filled with the dielectric fluid of the motor **3** and the seal **18** of the shaft **7** of the drive pump **2**, pumps the dielectric fluid of the motor **3** through the port **34** in the first nipple **15** and the motor dielectric fluid filter **35**, and thus cleans the motor dielectric fluid and provides the pressure differential between the motor dielectric fluid and the reservoir fluid necessary for reliability and long life of the end seal **18**, where the seal **18** is cooled and washed by clean motor dielectric fluid **3** instead of the reservoir fluid, which contains solid mechanical inclusions.

[0105] For a better separation of the motor dielectric fluid from the reservoir fluid and substantial reduction of friction between the moving elements of the structure in the proposed device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump **2**, a protective medium with hydro-oleophobic properties is used in the annular chamber **12** in the area of movement of the pistons and single elements (separators of fluids) between the end **24** of the annular piston **19** from the side of the second nipple **16** and the area B filled with dielectric barrier fluid, where the protective medium with hydro-oleophobic properties is a dielectric buffer fluid, which is preferably based on silicone compounds.

[0106] The use of at least one single-piece separator of fluids in the form of two rigidly interconnected tube segments **36** and **37** or **49** and **50** functioning as separator of the reservoir fluid and the motor dielectric fluid, and the capability of free autonomous movement of pistons and separators of fluid across the annular chamber **12** allow to achieve a more reliable separation of fluids and enhance the life of the device.

[0107] The space of the annular chamber **12** between the area, where the dielectric buffer fluid is located, and the area of the annular chamber **12** near the second nipple **16**, is filled with barrier fluid preferably based on polyethylene oxide, where the dielectric buffer fluid and the dielectric barrier fluid are immiscible.

[0108] The cavities within each single piece of annular elements are also filled with a protective medium with hydro-oleophobic properties, which is dielectric buffer fluid.

[0109] The proposed device for hydraulically protecting a submersible electric motor of a downhole, preferably centrifugal, pump has been tested and prepared for deployment.

[0110] Use of the proposed invention will significantly improve the effectiveness of the protector by increasing the operating speed of the pistons and the effectiveness and reliability of separation of the reservoir and dielectric fluids and, consequently, enhancing the life of the device in production of any oils, including bituminous and wax-bearing oils.

1-30. (canceled)

31. A device for hydraulically protecting a submersible electric motor of a downhole, comprising:

a shaft;

a thrust bearing;

a radial bearing and at least one stage, which includes a cylindrical housing;

a tube surrounding the shaft, the tube being mounted coaxially inside the cylindrical housing so as to form an annular chamber between the cylindrical housing and the tube;

first and the second nipples;

at least one damping bushing;

at least one shaft seal; and

an annular piston and two protective elements capable of reciprocal movement in the annular chamber, which are mounted at an end of the annular piston, which is in contact with reservoir fluid, in the form of segments of outer and inner tubes;

wherein the annular piston divides the annular chamber into two sections, wherein one section is oriented towards the second nipple, connected with an annulus and filled with the reservoir fluid, and the other is oriented towards the first nipple, filled with dielectric fluid of the motor and has at least one centering carrier ring, at least one seal in a point of contact of the annular piston with an inner surface of the cylindrical housing, and at least one seal in a point of contact of the annular piston with an outer surface of the tube;

wherein a space between the outer surface of the annular piston and the inner surface of the cylindrical housing is filled with a protective medium;

wherein the segments of the inner and the outer tubes of the annular elements are located at the end of the annular piston oriented towards the second nipple and adjoining, respectively, an inner surface of the cylindrical housing and an outer surface of the tube with a gap between the same and respective adjoining surfaces, filled with a protective medium;

wherein a port of the second nipple connecting the section of the annular chamber filled with the reservoir fluid with the annulus has a reservoir fluid filter;

wherein the points, where the segments of the inner and the outer tubes adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, have gaps against the respective adjoining surfaces, are located near ends of the tube segments oriented towards the second nipple and being the farthest to the annular piston, and have seals;

wherein the shaft between the section of the annular chamber filled with the dielectric fluid and the end seal can be provided with a pumping device, which is connected via the port of the first nipple with a dielectric fluid filter with the section filled with the dielectric fluid;

wherein the segments of the inner and the outer tubes of the annular elements are rigidly interconnected by means of a solid common bottom at the end of the annular piston oriented towards the second nipple, where this side adjoins the ends of both tube segments of the annular elements so as to form a single piece freely accommodated in the annular chamber and capable of autonomous reciprocal movement independent of the annular piston and performing the function of a separator of the reservoir fluid and the dielectric fluid of the motor in the annular chamber;

wherein the protective medium includes hydro-oleophobic properties.

32. The device according to claim **31**, wherein the annular cavity inside the single piece of two annular elements rigidly interconnected by an annular bottom between the walls of the inner and the outer tube segments is open at the end of the cavity oriented towards the second nipple, and filled with a protective medium.

33. The device according to claim **31**, wherein the annular cavity inside the single piece of two annular elements rigidly interconnected by an annular bottom between the walls of the inner and the outer tube segments is closed at the end of the cavity oriented towards the second nipple, and filled with a protective medium.

34. The device according to claim **31**, further comprising additional points, where segments of the inner and the outer tubes of the annular elements adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, with a gap against the corresponding adjoining surfaces located along the length of these tube segments and provided with seals.

35. The device according to claim **31**, wherein the outer surface of the outer tube segment and the inner surface of the inner tube segment of the annular elements are provided with protrusions arranged in the gap between the respective surfaces of the two annular elements adjoining the inner surface of the cylindrical housing and the outer surface of the tube, and seals for the adjoining points of the tube segments of the two annular elements are located at the outer surface of each of these protrusions, where these protrusions are made near the ends of outer and the inner tube segments oriented towards the second nipple.

36. The device according to claim **31**, wherein the outer surface of the outer tube segment and the inner surface of the inner tube segment of the annular elements are provided with protrusions arranged in the gap between the respective surfaces of the annular elements adjoining the inner surface of the cylindrical housing and the outer surface of the tube, and seals for the adjoining points of the tube segments of the two annular elements are located at the outer surface of each of these protrusions, where these protrusions are distributed along the length of these tube segments.

37. The device according to claim **31**, further comprising:

at least one additional single piece of two additional annular elements in the form of segments of the inner and the outer tubes rigidly interconnected by a common solid annular bottom located on the side of the adjacent single piece of the two rigidly interconnected annular elements, which piece is nearest to the annular piston and where the bottom is adjoining the ends of the two tube segments of the additional annular elements;

wherein the additional single piece is freely located in the annular chamber and capable of autonomous reciprocal movement independent of the annular piston and performing the function of a separator of the reservoir fluid and the dielectric fluid of the motor in the annular chamber;

wherein both of its additional annular elements are mounted in the annular chamber adjoining with a gap the internal surface of the cylindrical housing and the outer surface of the tube, respectively;

wherein points, where the inner and the outer tubes of the additional annular elements adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, have a gap between the same and the respective adjoining surfaces near the ends of the tube segments of the additional annular elements oriented towards the second nipple and being the farthest to the annular piston, and have seals, where the annular cavity of the additional single piece between the walls of the inner and the outer tube segments of each additional annular element is filled with a protective medium, and the space between adjacent pieces of two rigidly interconnected annular elements is filled with a separation fluid.

38. The device according to claim **31**, further comprising additional points, where segments of the inner and the outer tubes of the additional annular elements adjoin the inner surface of the cylindrical housing and the outer surface of the tube, respectively, with a gap against the corresponding adjoining surfaces located along the length of these tube segments of the additional annular elements and provided with seals.

39. The device according to claim **31**, wherein the outer surface of the outer tube segment and the inner surface of the inner tube segment of the additional annular elements are provided with protrusions arranged in the gap between the respective surfaces of the additional annular elements adjoining the inner surface of the cylindrical housing and the outer surface of the tube, and seals for the adjoining points of the annular elements are located at the outer surface of each of these protrusions, where these protrusions are made near the ends of outer and the inner tube segments oriented towards the second nipple.

40. The device according to claim **31**, wherein the outer surface of the outer tube segment and the inner surface of the inner tube segment of the additional annular elements are provided with protrusions arranged in the gap between the respective surfaces of the additional annular elements adjoining the inner surface of the cylindrical housing and the outer surface of the tube, and seals for the adjoining points of the additional annular elements are located at the outer surface of each of these protrusions, where these protrusions are distributed along the length of these tube segments of the additional annular elements.

41. The device according to claim **31**, wherein the protective medium of the annular chamber in the area of movement of the single piece of two additional annular elements between the end of the said annular chamber on the side of the second nipple and the end of the annular piston oriented towards the second nipple is a dielectric buffer fluid, preferably based on silicone compounds.

42. The device according to claim **31**, wherein the space of the annular chamber between the location area of the dielectric barrier fluid and the area of the annular chamber near the second nipple is filled with a barrier fluid, preferably based on polyethylene oxides.

43. The device according to claim **31**, wherein the dielectric buffer fluid and the dielectric barrier fluid are immiscible with each other, and the density of the dielectric barrier fluid is at least equal to the density of the buffer fluid.

44. The device according to claim **31**, wherein the separation fluid between the adjacent annular elements is a dielectric buffer fluid.

45. The device according to claim **31**, wherein the tube segments of the annular elements have various forms of generating lines.

* * * * *