



(51) International Patent Classification:

B01D 25/12 (2006.01) *F16J 15/02* (2006.01)
F16J 15/46 (2006.01) *F16K 7/10* (2006.01)

(21) International Application Number:

PCT/FI2017/050589

(22) International Filing Date:

23 August 2017 (23.08.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(71) Applicant: **OUTOTEC (FINLAND) OY** [FI/FI]; Rauha-
lanpuisto 9, FI-02230 ESPOO (FI).

(72) Inventors: **BÖHNKE, Bernd**; Niederkasseler Kirchweg
124, 40547 Düsseldorf (DE). **VÄNTTINEN, Kari**; Vehak-
senkuja 6, 02330 Espoo (FI). **ERONEN, Saku**; Korpimet-
säinkatu 10 A 4, 53850 Lappeenranta (FI).

(74) Agent: **BOCO IP OY AB**; Itämerenkatu 5, 00180 Helsinki
(FI).

(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,

KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

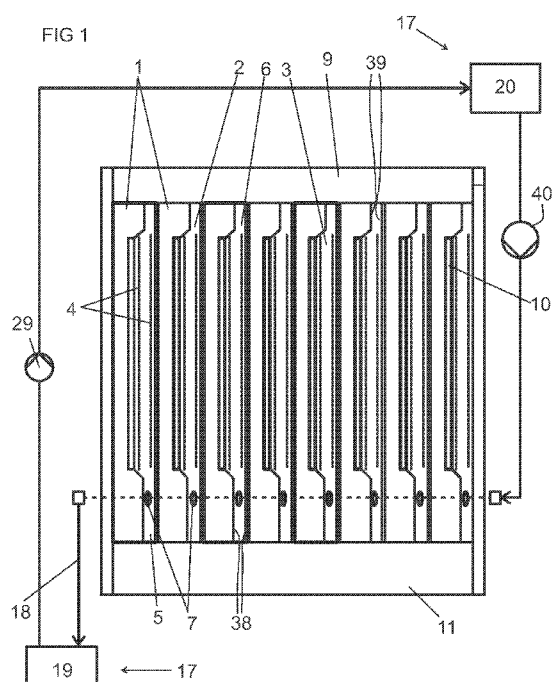
Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a
patent (Rule 4.17(ii))
- of inventorship (Rule 4.17(iv))

Published:

- with international search report (Art. 21(3))

(54) Title: LIQUID FILTRATION APPARATUS



(57) Abstract: Described is a liquid filtration apparatus comprising a series of upright filter plates (1) forming a filter plate pack. Filtering spaces (2) are formed in the filter plate pack. The liquid filtration apparatus comprises in at least one filtering space (2) a filter chamber (3) that is at least partly limited laterally by a filter media (4). Each filtering space (2) has an elongate bottom discharge opening (5) limited by two first opposite side walls (38) and is provided with a first inflatable and deflatable hose seal (7) extending across the elongate bottom discharge opening (5) and configured to selectively open and close the elongate bottom discharge opening (5) at the first inflatable and deflatable hose seal (7). The first inflatable and deflatable hose seal (7) in the elongate bottom discharge opening (5) is fastened at one of the first opposite side walls (38) of the elongate bottom discharge opening (5).

LIQUID FILTRATION APPARATUS

Field of the invention

The invention relates to a liquid filtration apparatus as defined in the preamble of independent claim 1.

More precisely, the invention relates to a liquid filtration apparatus comprising a series of upright vertical filter plates forming a filter plate pack. Filtering spaces is formed in the filter plate pack and the liquid filtration apparatus comprises in at least one filtering space a filter chamber that is limited laterally by a filter media. Said at least one filtering space has an elongate bottom discharge opening that can be closed and opened by means of a first inflatable and deflatable hose seal.

The liquid filtration apparatus can be configured to perform at least:

1. A filling stage, during which the elongate bottom discharge opening of said at least one filtering space is closed by means of the first inflatable and deflatable hose seals and material is fed into the filter chamber.

2. A filtration stage, during which the elongate bottom discharge opening of said at least one filtering space is closed by means of the first inflatable and deflatable hose seal, and pressure is by means of a pressure arrangements exerted to the material in the filter chamber to cause liquid of the material to flow through the filter media and to form filter cake of the material in the filter chamber.

3. A discharge stage, during which the elongate bottom discharge opening is opened by means of the first inflatable and deflatable hose seal to allow filter cake to fall by means of gravity out of the filter chamber.

Objective of the invention

The object of the invention is to provide a liquid filtration apparatus that on one hand provides for tight closing of the elongate bottom discharge opening of the filtering spaces but that on the other hand enables for effective flow of filter cake through the bottom discharge openings.

Short description of the invention

The liquid filtration apparatus of the invention is characterized by the definitions of independent claim 1.

Preferred embodiments of the liquid filtration apparatus are defined in the dependent claims 2 to 49.

The invention relates also to the use of the liquid filtration apparatus for filtering material in the form of tailings from mining, or in the form of products of bulk mining such as products containing iron, phosphate, or apatite, as defined in claim 50. The volume of such material is normally big and such material contains a lot of water that can be recycled for re-use in the mining

operation.

List of figures

In the following the invention will be described in more detail by referring to the figures, of which

Figure 1 is a side view of a first embodiment of the liquid filtration apparatus in a situation, where the first inflatable and deflatable hose seals are deflated,

Figure 2 is a side view of a first embodiment of the liquid filtration apparatus in a situation, where the first inflatable and deflatable hose seals are inflated,

Figure 3 is a side view of a first embodiment of the liquid filtration apparatus in a situation, where the first inflatable and deflatable hose seals are inflated and pressure is exerted on material in the filter chambers by means of the pressure arrangements to form filter cake,

Figure 4 is a side view of a second embodiment of the liquid filtration apparatus in a situation, where the first inflatable and deflatable hose seals and the second inflatable and deflatable hose seals are deflated,

Figure 5 is a side view of a second embodiment of the liquid filtration apparatus in a situation, where the first inflatable and deflatable hose seals and the second inflatable and deflatable hose seals are inflated,

Figure 6 is a side view of a second embodiment of the liquid filtration apparatus in a situation, where the first inflatable and deflatable hose seals and the second inflatable and deflatable hose seals are inflated and pressure is exerted on material in the filter chambers by means of the pressure arrangements to form filter cake,

Figure 7 is a side view of a third embodiment of the liquid filtration apparatus in a situation, where the first inflatable and deflatable hose seals and the optional second inflatable and deflatable hose seals are deflated,

Figure 8 is a side view of a third embodiment of the liquid filtration apparatus in a situation, where the first inflatable and deflatable hose seals and the optional second inflatable and deflatable hose seals are inflated,

Figure 9 is a side view of a fourth embodiment of the liquid filtration apparatus in a situation, where the first inflatable and deflatable hose seals and the optional second inflatable and deflatable hose seals are deflated,

Figure 10 shows the elongate bottom discharge opening in an embodiment of the liquid filtration apparatus in a situation, where the elongate bottom discharge opening is open, because the first inflatable and deflatable hose seal is deflated,

Figure 11 shows the elongate bottom discharge opening in an embodiment of the liquid filtration apparatus in a situation, where the elongate bottom discharge opening is closed, because the first inflatable and deflatable hose seal is inflated,

Figure 12 shows the elongate bottom discharge opening in an embodiment of the liquid filtration apparatus in a situation, where the elongate bottom discharge opening is open, because the first inflatable and deflatable hose seal is deflated,

Figure 13 shows the elongate bottom discharge opening in an embodiment of the liquid filtration apparatus in a situation, where the elongate bottom discharge opening is closed, because the first inflatable and deflatable hose seal is inflated,

Figure 14 shows the elongate bottom discharge opening in an embodiment of the liquid filtration apparatus in a situation, where the elongate bottom discharge opening is open, because the first inflatable and deflatable hose seal is deflated,

Figure 15 shows the elongate bottom discharge opening in an embodiment of the liquid filtration apparatus in a situation, where the elongate bottom discharge opening is closed, because the first inflatable and deflatable hose seal is inflated,

Figure 16 shows the elongate bottom discharge opening in an embodiment of the liquid filtration apparatus in a situation, where the elongate bottom discharge opening is open, because the first inflatable and deflatable hose seal is deflated,

Figure 17 shows the elongate bottom discharge opening in an embodiment of the liquid filtration apparatus in a situation, where the elongate bottom discharge opening is closed, because the first inflatable and deflatable hose seal is inflated,

Figure 18 is a side view of a deflatable and inflatable hose seal,

Figure 19 is a cut view of a deflatable and inflatable hose seal, and

Figure 20 is a side view of a support member.

Detailed description of the invention

The liquid filtration apparatus comprises a series of upright filter plates 1 forming a filter plate pack (not marked with a reference numeral). The number of filter plates can for example be between 10 and 500.

The upright filter plates 1 can, as shown in the figures, be arranged aligned and vertically in the filter plate pack.

The filter plates 1 can be arranged horizontally immovable in contact with each other in the filter plate pack, when the filter plates 1 forms the filter pack. Individual filter plates can however be removed from the filter plate pack for example for maintenance of filter plates 1, when the liquid filtration apparatus is not performing filtration of material.

Filtering spaces 2 is formed in the filter plate pack.

The filtering spaces 2 can be provided within the upright filter plates 1 of the filter plate pack and/or between two adjacent upright filter plates 1 of the filter plate pack.

The liquid filtration apparatus comprises in each filtering space 2 a filter chamber 3 that is

at least partly limited laterally by a filter media 4. The liquid filtration apparatus comprises preferably, but not necessarily, a filter media 4 in each filtering space 2 of the filter plate pack.

Each filtering space 2 of the filter plate pack has an elongate bottom discharge opening 5 limited by two opposite first side walls 38 and optionally by two opposite first end walls. The liquid filtration apparatus comprises preferably a filter media 4 in each filtering space 2 of the filter plate pack and an elongated bottom discharge opening 5 below each filter chamber 3 of the filter plate pack.

The liquid filtration apparatus comprises preferably, but not necessarily, additionally a material feeding arrangement 9 configured to feed material 31 to be filtered into filtering space(s) 2 of the filter plate pack.

The liquid filtration apparatus comprises preferably, but not necessarily, additionally a pressure arrangement 10 configured to exert pressure on material 31 fed into filtering space(s) 2 of the filter plate pack so as to remove liquid (not shown in the figures) from the material 31 and to form filter cake 30 of the material 31, as shown in figures 3 and 6. The pressure arrangement 10 can comprise a flexible and waterproof diaphragm provided in each filtering space 2 of the filter plate pack. Alternatively or additionally can the material feeding arrangement 9 function as the/a pressure arrangement 10. In such case material 31 is fed into filter chambers 3 of the filter plate pack so that pressure is built-up in filter chambers 3 of the filter plate pack causing liquid of the material to be separated from the material and to pass through the filter media 4 so that filter cake is formed in the filter chambers 3 of the filter plate pack.

The liquid filtration apparatus comprises preferably, but not necessarily, additionally a filter cake receiving arrangement 11 configured to receive filter cake 30 from filtering space(s) 2 of the filter plate pack through the elongate bottom discharge opening(s) 5 of the filtering space(s) 2.

At least one elongate bottom discharge opening 5 of one intermediate space 2 of the filter plate pack is provided with a first inflatable and deflatable hose seal 7 extending across said at least one elongate bottom discharge opening 5 and configured to selectively open and close said at least one elongate bottom discharge opening 5 at the first inflatable and deflatable hose seal 7. More preferable, each elongate bottom discharge opening 5 of the intermediate spaces 2 of the filter plate pack is provided with a first inflatable and deflatable hose seal 7 extending across the elongate bottom discharge opening 5 and configured to selectively open and close the elongate bottom discharge opening 5 at the first inflatable and deflatable hose seal 7.

The first inflatable and deflatable hose seal(s) 7, when inflated, are configured to exert pressure against the first opposite side walls 38 of the elongated bottom discharge opening 5. The pressure causes friction between the first inflatable and deflatable hose seal 7 and the first opposite side walls 38 of the elongated bottom discharge opening 5, and the friction facilitates closing the elongated bottom discharge opening 5.

The first inflatable and deflatable hose seal 7 are preferably, but not necessarily, made of

inflatable and deflatable hose seals having a circular cross-section having an outer diameter that is 120 to 400 % of the distance d between the two first opposite side walls 38. This to ensure a contact area between the first inflatable and deflatable hose seal 7 and the two first opposite side walls 38 that have a sufficient h as shown in figure 11 so as to provide sufficient friction between the first inflatable and deflatable hose seal 7 and the first opposite side walls 38 of the elongated bottom discharge opening 5.

At least one intermediate space 2 of the filter plate pack can be provided with an elongate top opening 6 that is limited by two second opposite side walls 39 and optionally two second end walls. More preferably, each intermediate space 2 of the filter plate pack is provided with an elongate top opening 6 that is limited by two second opposite side walls 39 and optionally two second end walls. Such elongate top opening 6 can, as shown in the embodiments illustrated in figures 4 to 9, be provided with a second inflatable and deflatable hose seal 8 extending across the elongate top opening 6 and configured to selectively open and close the elongate top opening 6 at the second inflatable and deflatable hose seal 8.

The liquid filtration apparatus can be configured to perform at least:

1. A filling stage, during which the elongate bottom discharge opening 5 of the filtering spaces 2 are closed by means of first inflatable and deflatable hose seals 7 and material is fed from the material feeding arrangement 9 into the filter chambers 3.
2. A filtration stage, during which the elongate bottom discharge openings 5 of the filtering spaces 2 are closed by means of the first inflatable and deflatable hose seals 7, and pressure is by means of the pressure arrangements 10 exerted to the material 31 in the filter chambers 3 to cause liquid 32 of the material 31 to flow through the filter media 4 and to form filter cake 30 of the material 31 in the filter chambers 3.
3. A discharge stage, during which the elongate bottom discharge openings 5 are opened by means of the first inflatable and deflatable hose seals 7 to allow filter cake 30 to fall by means of gravity out of the filter chambers 3.

The first inflatable and deflatable hose seals 7 are in the elongate bottom discharge opening(s) 5 fastened at one of the first opposite side walls 38 of the elongate bottom discharge opening 5 so that the first inflatable and deflatable hose seal 7 is in a deflated state configured to be at the said one of the first opposite side walls 38 of the elongate bottom discharge opening 5 and so the first inflatable and deflatable hose seal 7 is in an inflated state configured to extend between the first opposite side walls 38 of the elongate bottom discharge opening 5,

The first inflatable and deflatable hose seal(s) 7 can be fastened in the elongate bottom discharge opening(s) 5 from the ends of the first inflatable and deflatable hose seal(s) 7.

The first inflatable and deflatable hose seal 7 can in the elongate bottom discharge opening 5 be arranged at least partly in a first recess 41 that preferably, but not necessarily, has an elongated configuration, in said one of the first opposite side walls 38 of the elongate bottom discharge opening 5. The first recess 41 provides for protection for the first inflatable and deflatable hose

seal 7 and provides for more space for discharging of filter cake from the filtering space 2 when the first inflatable and deflatable hose seal 7 is deflated.

The optional second inflatable and deflatable hose seals 8 can in the optional elongate top opening 6 be fastened at one of the two second opposite side walls 39 of the elongate top opening 6 so that the second inflatable and deflatable hose seal 8 is in a deflated state configured to be at the said one of the second opposite side walls 39 of the elongate top opening 6 and so the second inflatable and deflatable hose seal 8 is in an inflated state configured to extend between the second opposite side walls 39 of the elongate top opening 6.

The optional second inflatable and deflatable hose seal(s) 8 can be fastened in the elongate top opening(s) 6 from the ends of the second inflatable and deflatable hose seal(s) 8.

The optional second inflatable and deflatable hose seal (8) can be in the elongate top opening (6) arranged at least partly in a second recess 42 in said one of the second opposite side walls 39 of the elongate top opening 6.

A lower end of the filter media 4 is preferably, but not necessarily, at a level above the first inflatable and deflatable hose seal 7.

A lower end of the filter media 4 is preferably, but not necessarily, at a level below the first inflatable and deflatable hose seal 7, as shown in figure 9.

The first inflatable and deflatable hose seal 7 closes the filter media 4 to prevent material 31 from leaking out through the lower end of the filter media 4.

An upper end of the filter media 4 is preferably, but not necessarily, at a level above the second inflatable and deflatable hose seal 8, as shown in figure 9, provided that the liquid filtration apparatus is provided with such second inflatable and deflatable hose seals 8.

The optional second inflatable and deflatable hose seal 7 closes the filter media 4 to prevent material 31 from leaking out through the upper end of the filter media 4.

A first support member 12 is preferably, but not necessarily, provided for supporting the first inflatable and deflatable hose seal 7. Such first support member 12 extend at least partly, preferably fully, across the elongated bottom discharge opening 5. Such first support member 12 extend preferably, but not necessarily, in the same direction as the first inflatable and deflatable hose seal 7.

The first support member 12 is preferably, but not necessarily, provided in or at the first inflatable and deflatable hose seal(s) 7. The optional first support member(s) 12 prevents sacking of the first inflatable and deflatable hose seal(s) 7.

The optional first support member(s) 12 can, as shown in figure 20, be spring loaded by a first spring arrangement 36 so that the first support member 12 is configured to force the first inflatable and deflatable hose seal(s) 7 into a flat state to open the elongate bottom discharge opening 5 more when the first inflatable and deflatable hose seal(s) 7 is/are deflated. This provides for faster deflating of the first inflatable and deflatable hose seal(s) 7.

A second support member 13 is preferably, but not necessarily, provided for supporting

the second inflatable and deflatable hose seal 8. Such second support member 13 extend at least partly, preferably fully, across the elongated top opening 6. Such second support member 13 extend preferably, but not necessarily, in the same direction as the second inflatable and deflatable hose seal 8.

5 The second support member 13 is preferably, but not necessarily, provided in or at the optional second inflatable and deflatable hose seal(s) 8.

The optional second support member 13 prevents sacking of the optional second inflatable and deflatable hose seal(s) 8.

10 The optional second support member(s) 13 can, as shown in figure 20, be spring loaded by a second spring arrangement 37 so that the second support member(s) 13 is/are configured to force the optional second inflatable and deflatable hose seal(s) 8 into a flat state to open the elongate top feed opening 6 more when the optional second inflatable and deflatable hose seal(s) 8 is/are deflated.

15 The first inflatable and deflatable hose seal(s) 7 can, as illustrated in figures 14 and 15 be covered by a first outer flexible cover 14 that is fastened above and optionally also below each first inflatable and deflatable hose seal 7 to the same filter plate 1 at which the first inflatable and deflatable hose seal 7 is arranged.

The first outer flexible covers 14 forms protection for the first inflatable and deflatable hose seals 7.

20 The first outer flexible cover 14 can be spring loaded by a spring (not shown in the figures) that is configured to facilitate deflating or flattening of the first inflatable and deflatable hose seal 7. This provides for faster opening of the elongated bottom discharge opening(s) 5.

25 End plugs 16 can be provided at opposite ends of the first inflatable and deflatable hose seals 7, as shown in figure 18. The end plugs 16 forms fastening means for the first inflatable and deflatable hose seals 7 and supporting elements for the optional first support member 12.

The first inflatable and deflatable hose seals 7 can comprise a hose member comprising an inner rubber lining 33 and an outer rubber lining 34 and a textile or similar reinforcement 35. The first inflatable and deflatable hose seals 7 can have construction similar to fire hoses.

30 Each optional second inflatable and deflatable hose seal 8 can, as illustrated in figures 14 and 15, be covered by a second outer flexible cover 15 that is fastened above and optionally also below each optional second inflatable and deflatable hose seal 8 to the same filter plate 1 as the optional second inflatable and deflatable hose seal 8 is fastened to.

35 The second outer flexible covers 15 forms protection for the optional second inflatable and deflatable hose seals.

The second outer flexible cover 15 can be spring loaded by a spring (not shown in the figures) that is configured to facilitate deflating or flattening of the optional second inflatable and deflatable hose seal 8.

End plugs 16 can be provided at opposite ends of the optional second inflatable and

deflatable hose seals 8, as shown in figure 18. The end plugs 16 forms fastening means for the optional second inflatable and deflatable hose seals 8 and supporting elements for the optional second support member 13.

The optional second inflatable and deflatable hose seals 8 can comprise a hose member comprising an inner rubber lining 33 and an outer rubber lining 34 and a textile or similar reinforcement 35. The optional second inflatable and deflatable hose seals 8 can have construction similar to fire hoses.

The liquid filtration apparatus comprises preferably, but not necessarily, as illustrated in figures 1 to 3 an inflating and deflating system 17 configured to inflate and deflate the first inflatable and deflatable hose seals 7.

The optional inflating and deflating system 17 can comprise valve means (not shown in the figures) configured to initiate inflating and deflating of the first inflatable and deflatable hose seals 7.

The optional inflating and deflating system 17 is preferably, but not necessarily, configured to inflate the first inflatable and deflatable hose seals 7 with fluid such as dense fluid, preferably with liquid such as with water. Using dense fluid such as liquid provides for precise adjustment of pressures and pressure gradients.

The optional inflating and deflating system 17 comprises preferably, but not necessarily, as shown in figures 1 to 3, a barometric leg 18 in communication with the first inflatable and deflatable hose seals 7 and in communication with a lower tank 19 at a level below the first inflatable and deflatable hose seals 7. Such barometric leg 18 provides for complete and fast deflating (draining) of the first inflatable and deflatable hose seals 7.

The optional inflating and deflating system 17 comprises preferably, but not necessarily, as shown in figures 1 to 3, a top tank 20 at a level above the first inflatable and deflatable hose seals 7. The top tank 20 is configured to inflate (fill) the first inflatable and deflatable hose seals 7 by gravity with liquid. A booster pump 40 may be provided downstream of the top tank 20 to force liquid into the first inflatable and deflatable hose seals 7 so as to increase the pressure in the first inflatable and deflatable hose seals 7.

If the optional inflating and deflating system 17 comprises a lower tank 19 and a top tank 20, as presented, the optional inflating and deflating system 17 comprises preferably, but not necessarily, as shown in figures 1 to 3, a pump 29 configured to pump liquid from lower tank 19 to the top tank.

If the liquid filtration apparatus comprises both first inflatable and deflatable hose seals 7 and second inflatable and deflatable hose seals 8, as presented, the liquid filtration apparatus can, as illustrated in figures 4 to 6, comprise an inflating and deflating system 17 configured to inflate and deflate both the first inflatable and deflatable hose seals 7 and the second inflatable and deflatable hose seals 8.

If the inflating and deflating system 17 is configured to inflate and deflate both the first

inflatable and deflatable hose seals 7 and the optional second inflatable and deflatable hose seals 8, the inflating and deflating system 17 can comprise valve means (not shown in the figures) configured to initiate inflating and deflating of the first inflatable and deflatable hose seals 7 and of the second inflatable and deflatable hose seals 8.

5 If the inflating and deflating system 17 is configured to inflate and deflate both the first inflatable and deflatable hose seals 7 and the optional second inflatable and deflatable hose seals 8, the inflating and deflating system 17 is preferably, but not necessarily, configured to inflate the first inflatable and deflatable hose seals 7 and the second inflatable and deflatable hose seals 8 with fluid such as dense fluid, preferably with liquid such as with water. Using liquid provides for
10 precise adjustment of pressures and pressure gradients.

If the inflating and deflating system 17 is configured to inflate and deflate both the first inflatable and deflatable hose seals 7 and the optional second inflatable and deflatable hose seals 8, the inflating and deflating system 17 comprises preferably, but not necessarily, as shown in
15 figures 4 to 6, a barometric leg 18 in communication with at least one of the first inflatable and deflatable hose seals 7 and the second inflatable and deflatable hose seals 8 and in communication with a lower tank 19 at a level below both the first inflatable and deflatable hose seals 7 and the second inflatable and deflatable hose seals 8. Such barometric leg 18 provides for complete and fast deflating (draining) of the first inflatable and deflatable hose seals 7 and of the second inflatable and deflatable hose seals 8.

20 If the inflating and deflating system 17 is configured to inflate and deflate both the first inflatable and deflatable hose seals 7 and the optional second inflatable and deflatable hose seals 8, the inflating and deflating system 17 comprises preferably, but not necessarily, as shown in figures 4 to 6, a top tank 20 at a level above both the first inflatable and deflatable hose seals 7 and the second inflatable and deflatable hose seals 8. The top tank 20 is configured to inflate (fill) the
25 first inflatable and deflatable hose seals 7 and the second inflatable and deflatable hose seals 8 by gravity with liquid. A booster pump 40 may be provided downstream of the top tank 20 to force liquid into the first inflatable and deflatable hose seals 7 and into the second inflatable and deflatable hose seals 8 so as to increase the pressure in the first inflatable and deflatable hose seals 7 and in the second inflatable and deflatable hose seals 8.

30 If the inflating and deflating system 17 is configured to inflate and deflate both the first inflatable and deflatable hose seals 7 and the optional second inflatable and deflatable hose seals 8 and if the inflating and deflating system 17 comprises a lower tank 19 and a top tank 20, as presented, the optional inflating and deflating system 17 comprises preferably, but not necessarily, as shown in figures 4 to 6, a pump 29 configured to pump liquid from lower tank 19 to the top
35 tank.

If the liquid filtration apparatus comprises both first inflatable and deflatable hose seals 7 and second inflatable and deflatable hose seals 8, as presented, and if the liquid filtration apparatus comprise an inflating and deflating system 17 configured to inflate and deflate both the first

inflatable and deflatable hose seals 7 and the second inflatable and deflatable hose seals 8, as presented, the inflating and deflating system 17 comprises preferably, but not necessarily, as shown in figures 7 and 8, a first barometric leg 21 in communication with the first inflatable and deflatable hose seals 7 and in communication with a first lower tank 22 at a level below the first inflatable and deflatable hose seals 7, and a second barometric leg 25 in communication with the second inflatable and deflatable hose seals 8 and in communication with a second lower tank 26 at a level below the second inflatable and deflatable hose seals 8.

The first lower tank 22 is preferably, but not necessarily, positioned 5 to 10 meters below the first inflatable and deflatable hose seals 7. Such first barometric leg 21 provides for complete and fast deflating (draining) of the first inflatable and deflatable hose seals 7. The second lower tank is preferably, but not necessarily, positioned 5 to 10 meters below the second inflatable and deflatable hose seals 8. Such barometric leg provides for complete and fast deflating (draining) of the second inflatable and deflatable hose seals 8.

If the liquid filtration apparatus comprises both first inflatable and deflatable hose seals 7 and second inflatable and deflatable hose seals 8, as presented, and if the liquid filtration apparatus comprise an inflating and deflating system 17 configured to inflate and deflate both the first inflatable and deflatable hose seals 7 and the second inflatable and deflatable hose seals 8, as presented, the inflating and deflating system 17 comprises preferably, but not necessarily, as shown in figures 3 and 4, a first top tank 23 at a level above the first inflatable and deflatable hose seals 7, and a second top tank 27 at a level above the second inflatable and deflatable hose seals 8. The first top tank 23 is configured to inflate (fill) the first inflatable and deflatable hose seals 7 by gravity with liquid and the second the top tank 27 is configured to inflate (fill) the second inflatable and deflatable hose seals 8 by gravity with liquid. A booster pump 40 may be provided downstream of the first top tank 23 to force liquid into the first inflatable and deflatable hose seals 7 so as to increase the pressure in the first inflatable and deflatable hose seals 7 and a booster pump 40 may be provided downstream of the second top tank 27 to force liquid into the second inflatable and deflatable hose seals 8 so as to increase the pressure in the second inflatable and deflatable hose seals 8.

If the inflating and deflating system 17 comprises a first lower tank 22 and a first top tank 23, as presented, the optional inflating and deflating system 17 comprises preferably, but not necessarily, a first pump 24 configured to pump liquid from the first lower tank 22 to the first top tank 23.

If the inflating and deflating system 17 comprises a second lower tank 26 and a second top tank 27, as presented, the optional inflating and deflating system 17 comprises preferably, but not necessarily, a second pump 28 configured to pump liquid from the second lower tank 26 to the second top tank 27.

It is apparent to a person skilled in the art that as technology advanced, the basic idea of the invention can be implemented in various ways. The invention and its embodiments are

therefore not restricted to the above examples, but they may vary within the scope of the claims.

Claims

1. A liquid filtration apparatus,
wherein the liquid filtration apparatus comprising a series of upright filter plates (1)
5 forming a filter plate pack,
wherein filtering spaces (2) is formed in the filter plate pack,
wherein the liquid filtration apparatus comprising in at least one filtering space (2) a filter
chamber (3) that is at least partly limited laterally by a filter media (4),
wherein the filtering spaces (2) having an elongate bottom discharge opening (5) limited
10 by two first opposite side walls (38), and
wherein the elongate bottom discharge opening (5) of the filtering spaces (2) being
provided with a first inflatable and deflatable hose seal (7) extending across the elongate bottom
discharge opening (5) and configured to selectively open and close the elongate bottom discharge
opening (5) at the first inflatable and deflatable hose seal (7),
15 **characterized**
by the first inflatable and deflatable hose seal (7) being in the elongate bottom discharge
opening (5) fastened at one of the first opposite side walls (38) of the elongate bottom discharge
opening (5) so that the first inflatable and deflatable hose seal (7) is in a deflated state configured
to be at the said one of the first opposite side walls (38) of the elongate bottom discharge opening
20 (5) and so the first inflatable and deflatable hose seal (7) is in an inflated state configured to extend
between the first opposite side walls (38) of the elongate bottom discharge opening (5).
2. The liquid filtration apparatus according to claim 1, **characterized**
by the first inflatable and deflatable hose seal (7) being in the elongate bottom discharge
25 opening (5) arranged at least partly in a first recess (41) in said one of the first opposite side walls
(38) of the elongate bottom discharge opening (5).
3. The liquid filtration apparatus according to claim 1 or 2, **characterized**
by a lower end of the filter media (4) being at a level above the first inflatable and deflatable
30 hose seal (7).
4. The liquid filtration apparatus according to claim 1 or 2, **characterized**
by a lower end of the filter media (4) being at a level below the first inflatable and deflatable
hose seal (7).
35
5. The liquid filtration apparatus according to any of the claims 1 to , **characterized**
by a first support member (12) for supporting the first inflatable and deflatable hose seal
(7), and

by the first support member (12) extending at least partly across the elongated bottom discharge opening (5).

6. The liquid filtration apparatus according claim 5, **characterized**

by the first support member (12) being arranged in the first inflatable and deflatable hose seal (7).

7. The liquid filtration apparatus according to claim 5 or 6, **characterized**
by the first support member (12) being spring loaded.

8. The liquid filtration apparatus according to any of the claims 1 to 7, **characterized**
by a first outer cover (14) fastened above the first inflatable and deflatable hose seal (7) to one of the first opposite side walls (38) of the elongate bottom discharge opening (5

9. The liquid filtration apparatus according to claim 8, **characterized**
by the first outer cover (14) being additionally fastened below the first inflatable and deflatable hose seal (7).

10. The liquid filtration apparatus according to claim 8 or 9, **characterized**
by the first outer flexible cover (14) being spring loaded.

11. The liquid filtration apparatus according to any of the claims 1 to 10, **characterized**
by end plugs (16) at opposite ends of the first inflatable and deflatable hose seals (7).

12. The liquid filtration apparatus according to any of the claims 1 to 11, **characterized**
by the first inflatable and deflatable hose seals (7) comprise a hose member comprising an inner rubber lining (33) and an outer rubber lining (34) and a textile reinforcement (35).

13. The liquid filtration apparatus according to any of the claims 1 to 12, **characterized**
by an inflating and deflating system (17) configured to inflate and deflate the first inflatable and deflatable hose seals (7).

14. The liquid filtration apparatus according to claim 13, **characterized**
by the inflating and deflating system (17) being configured to inflate the first inflatable and deflatable hose seals (7) with fluid such as with dense fluid, preferably with liquid such as with water.

15. The liquid filtration apparatus according to claim 13 or 14, **characterized**
by the inflating and deflating system (17) comprising a barometric leg (18) in
communication with the first inflatable and deflatable hose seals (7) and in communication with a
lower tank (19) at a level below the first inflatable and deflatable hose seals (7).

5
16. The liquid filtration apparatus according to any of the claims 13 to 15, **characterized**
by the inflating and deflating system (17) comprising a top tank (20) at a level above the
first inflatable and deflatable hose seals (7) and configured to fill the first inflatable and deflatable
hose seals (7) by gravity with liquid.

10
17. The liquid filtration apparatus according to claim 16, **characterized**
by a pump downstream of the top tank (20), and
by the pump being configured to press fluid into the first inflatable and deflatable hose
seals (7).

15
18. The liquid filtration apparatus according to claims 15 and 16, **characterized**
by a pump (29) configured to pump liquid from the lower tank (19) to the top tank (20).

19. The liquid filtration apparatus according to any of the claims 1 to 18, **characterized**
20 by filtering space comprising an elongate top opening (6) limited by two second opposite
side walls (39).

20. The liquid filtration apparatus according to claim 19, **characterized**
by each elongate top opening (6) being provided with a second inflatable and deflatable
25 hose seal (8) extending across the elongate top opening (6) and configured to selectively open and
close the elongate top opening (6) at the second inflatable and deflatable hose seal (8), and
by the second inflatable and deflatable hose seal being in each elongate top opening (6)
fastened at one of the two second opposite side walls (39) of the elongate top opening (6) so that
the second inflatable and deflatable hose seal (8) is in a deflated state configured to be at the said
30 one of the second opposite side walls (39) of the elongate top opening (6) and so the second
inflatable and deflatable hose seal (8) is in an inflated state configured to extend between the
second opposite side walls (39) of the elongate top opening (6).

21. The liquid filtration apparatus according to claim 20, **characterized**
35 by the second inflatable and deflatable hose seal (8) being in the elongate top opening (6)
arranged at least partly in a second recess (42) in said one of the second opposite side walls (39)
of the elongate top opening (6).

22. The liquid filtration apparatus according to claim 19 or 20, **characterized** by an upper end of the filter media (4) being at a level above the second inflatable and deflatable hose seal (8).

23. The liquid filtration apparatus according to any of the claims 20 to 22, **characterized** by a second support member (13) for supporting the second inflatable and deflatable hose seal (8), and by the second support member (13) extending at least partly across the elongated top opening (6).

24. The liquid filtration apparatus according to claim 23, **characterized** by the second support member (13) being provided in the second inflatable and deflatable hose seal (8).

25. The liquid filtration apparatus according to claim 23 or 24, **characterized** by the second support member (13) being spring loaded.

26. The liquid filtration apparatus according to any of the claims 20 to 25, **characterized** by a second outer cover (15) fastened above the second inflatable and deflatable hose seal (8) to one of the second opposite side walls (39) of the elongate top opening.

27. The liquid filtration apparatus according to claim 26, **characterized** by the second outer cover (14) being additionally fastened below the second inflatable and deflatable hose seal (8).

28. The liquid filtration apparatus according to claim 26 or 27, **characterized** by the second outer flexible cover (15) being spring loaded.

29. The liquid filtration apparatus according to any of the claims 20 to 29, **characterized** by end plugs (16) at opposite ends of the second inflatable and deflatable hose seals (8).

30. The liquid filtration apparatus according to any of the claims 17 to 24, **characterized** by the second inflatable and deflatable hose seals (8) comprise a hose member comprising an inner rubber lining (33) and an outer rubber lining (34) and a textile reinforcement (35).

31. The liquid filtration apparatus according to any of the claims 1 to 11 and any of the claims 20 to 30, **characterized** by an inflating and deflating system (17) configured to inflate and deflate the first inflatable

and deflatable hose seals (7) and the second inflatable and deflatable hose seals (8).

32. The liquid filtration apparatus according to claim 31, **characterized**

by the inflating and deflating system (17) being configured to inflate the first inflatable and deflatable hose seals (7) and the second inflatable and deflatable hose seals (8) with fluid, such as dense fluid preferably with liquid such as with water.

33. The liquid filtration apparatus according to claim 31 or 32, **characterized**

by the inflating and deflating system (17) comprising a barometric leg (18) in communication with the first inflatable and deflatable hose seals (7) and with the second inflatable and deflatable hose seals (8) and in communication with a lower tank (19) at a level below both the first inflatable and deflatable hose seals (7) and the second inflatable and deflatable hose seals (8).

34. The liquid filtration apparatus according to any of the claims 31 to 33, **characterized**

by the inflating and deflating system (17) comprising a top tank (20) at a level above both the first inflatable and deflatable hose seals (7) and the second inflatable and deflatable hose seals (8) configured to fill the first inflatable and deflatable hose seals (7) and the second inflatable and deflatable hose seals (8) by gravity with liquid.

35. The liquid filtration apparatus according to claim 34, **characterized**

by a pump downstream of the top tank (20), and
by the pump being configured to press fluid into the first inflatable and deflatable hose seals (7) and the second inflatable and deflatable hose seals (8)

36. The liquid filtration apparatus according to claims 33 and 34, **characterized**

by a pump (29) configured to pump liquid from the lower tank (19) to the top tank (20).

37. The liquid filtration apparatus according to claim 31 or 32, **characterized**

by the inflating and deflating system (17) comprising a first barometric leg (21) in communication with at least one of the first inflatable and deflatable hose seals (7) and in communication with a first lower tank (22) at a level below the first inflatable and deflatable hose seals (7), and

by the inflating and deflating system (17) comprising a second barometric leg (25) in communication with at least one of the second inflatable and deflatable hose seals (8) and in communication with a second lower tank (26) at a level below the second inflatable and deflatable hose seals (8).

38. The liquid filtration apparatus according to claim 37, **characterized**

by the inflating and deflating system (17) comprising a first top tank (23) at a level above the first inflatable and deflatable hose seals (7) and configured to fill the first inflatable and deflatable hose seals (7) by gravity with liquid, and

5 by the inflating and deflating system (17) comprising a second top tank (27) at a level above the second inflatable and deflatable hose seals (8) and configured to fill the second inflatable and deflatable hose seals (8) by gravity with liquid.

39. The liquid filtration apparatus according to claim 38, **characterized**

10 by a pump downstream of the top first top tank (23),

by the pump being configured to press fluid into the first inflatable and deflatable hose seals (7),

by a pump downstream of the second first top tank (17), and

15 by the pump being configured to press fluid into the second inflatable and deflatable hose seals (8).

40. The liquid filtration apparatus according to claims 37 and 38, **characterized**

by a first pump (24) configured to pump liquid from the first lower tank (22) to the first top tank (23), and

20 by a second pump (28) configured to pump liquid from the second lower tank (26) to the second top tank (27).

41. The liquid filtration apparatus according to any of the claims 1 to 40, **characterized**

25 by the upright filter plates (1) being arranged aligned and in parallel in the filter plate pack.

42. The liquid filtration apparatus according to any of the claims 1 to 40, **characterized**

by the upright filter plates (1) being arranged vertically in the filter plate pack.

43. The liquid filtration apparatus according to any of the claims 1 to 42, **characterized**

30 by the upright filter plates (1) being arranged immovable in contact with each other in the filter plate pack.

44. The liquid filtration apparatus according to any of the claims 1 to 43, **characterized**

35 by the filtering spaces (2) being provided within the upright filter plates (1) of the filter plate pack.

45. The liquid filtration apparatus according to any of the claims 1 to 44, **characterized**

by the filtering spaces (2) being provided between two adjacent upright filter plates (1) of

the filter plate pack.

46. The liquid filtration apparatus according to any of the claims 1 to 44, **characterized** by a material feeding arrangement (9) configured to feed material (31) to be filtered into filtering spaces (2) of the filter plate pack.

5 47. The liquid filtration apparatus according to any of the claims 1 to 46, **characterized** by a pressure arrangement (10) configured to exert pressure on material (31) fed into filtering spaces (2) of the filter plate pack.

10 48. The liquid filtration apparatus according to any of the claims 1 to 47, **characterized** by a filter cake receiving arrangement (11) configured to receive filter cake (30) from filtering space (2) of the filter plate pack through the elongate bottom discharge openings (5) of the filtering spaces (2).

15 49. The liquid filtration apparatus according to any of the claims 1 to 47, **characterized** by said at least one first inflatable and deflatable hose seal (7) being made of an inflatable and deflatable hose seal having a circular cross-section having an outer diameter D that is 120 to 400 % of the distance d between the two first opposite side walls (38) the elongate bottom discharge opening (5).

20 50. Use of a liquid filtration apparatus according to any of the claims 1 to 49 for filtering material in the form of tailings from mining, or in the form of products of bulk mining such as products containing iron, phosphate, or apatite.

25

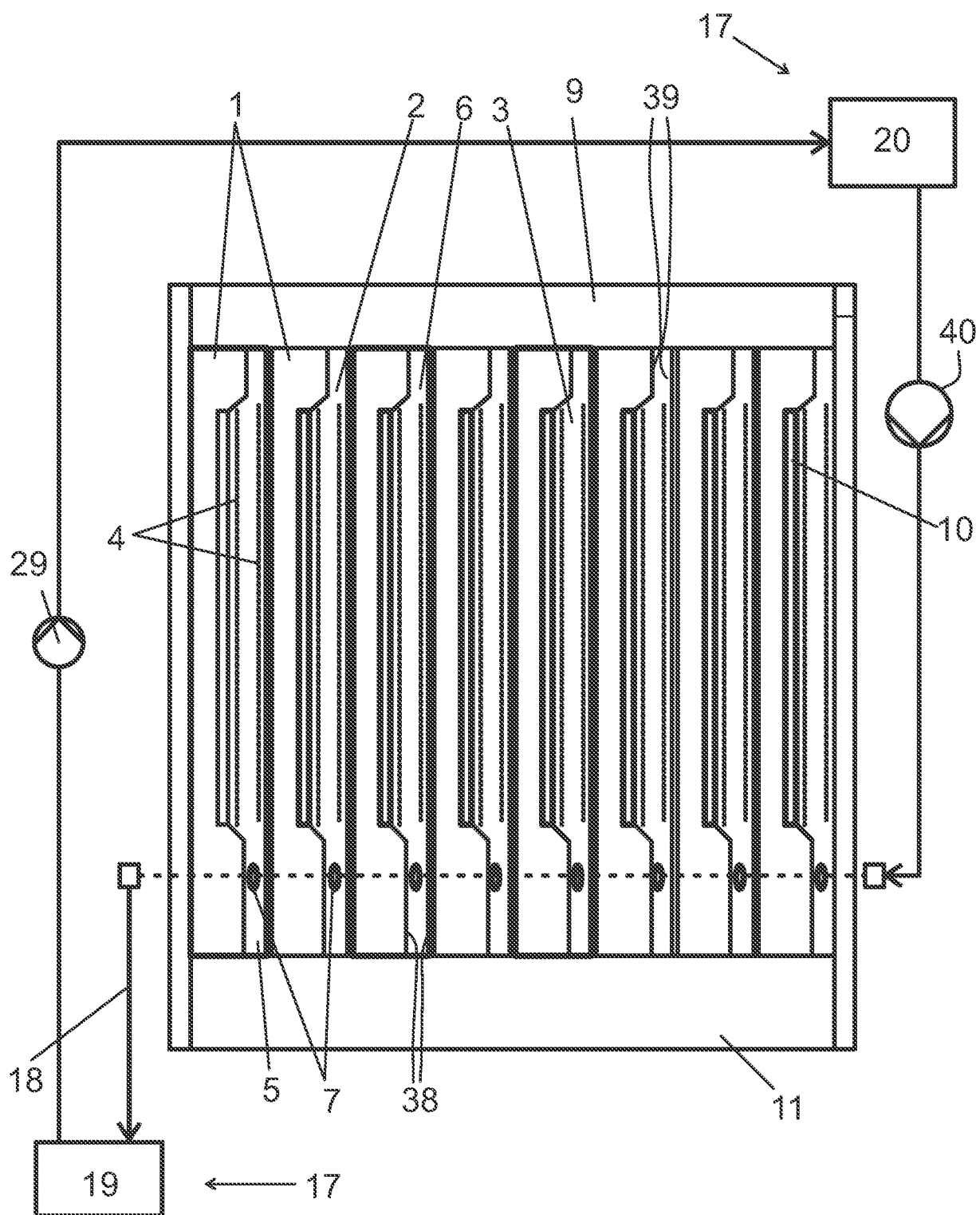


FIG 1

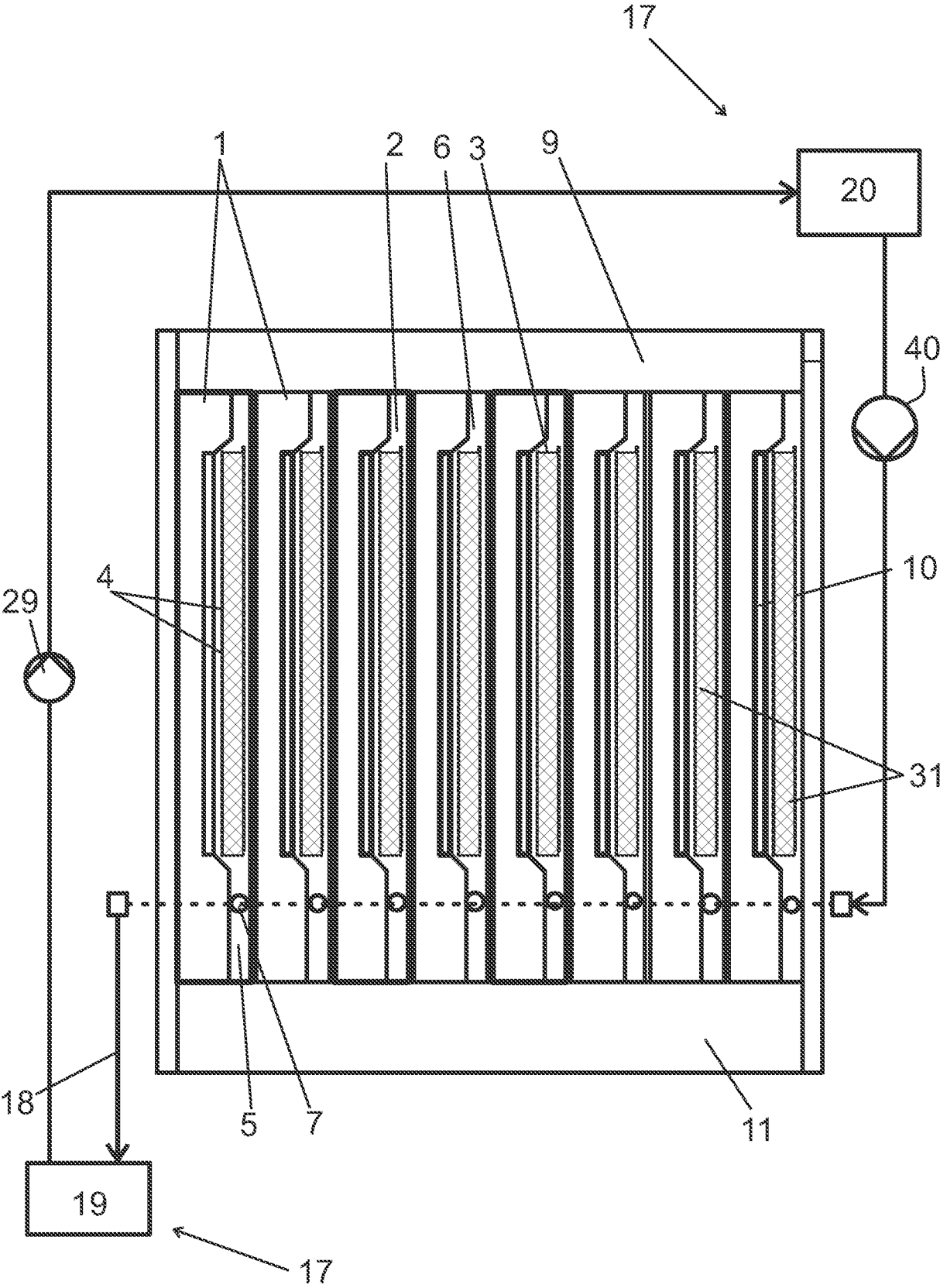


FIG 2

3 / 14

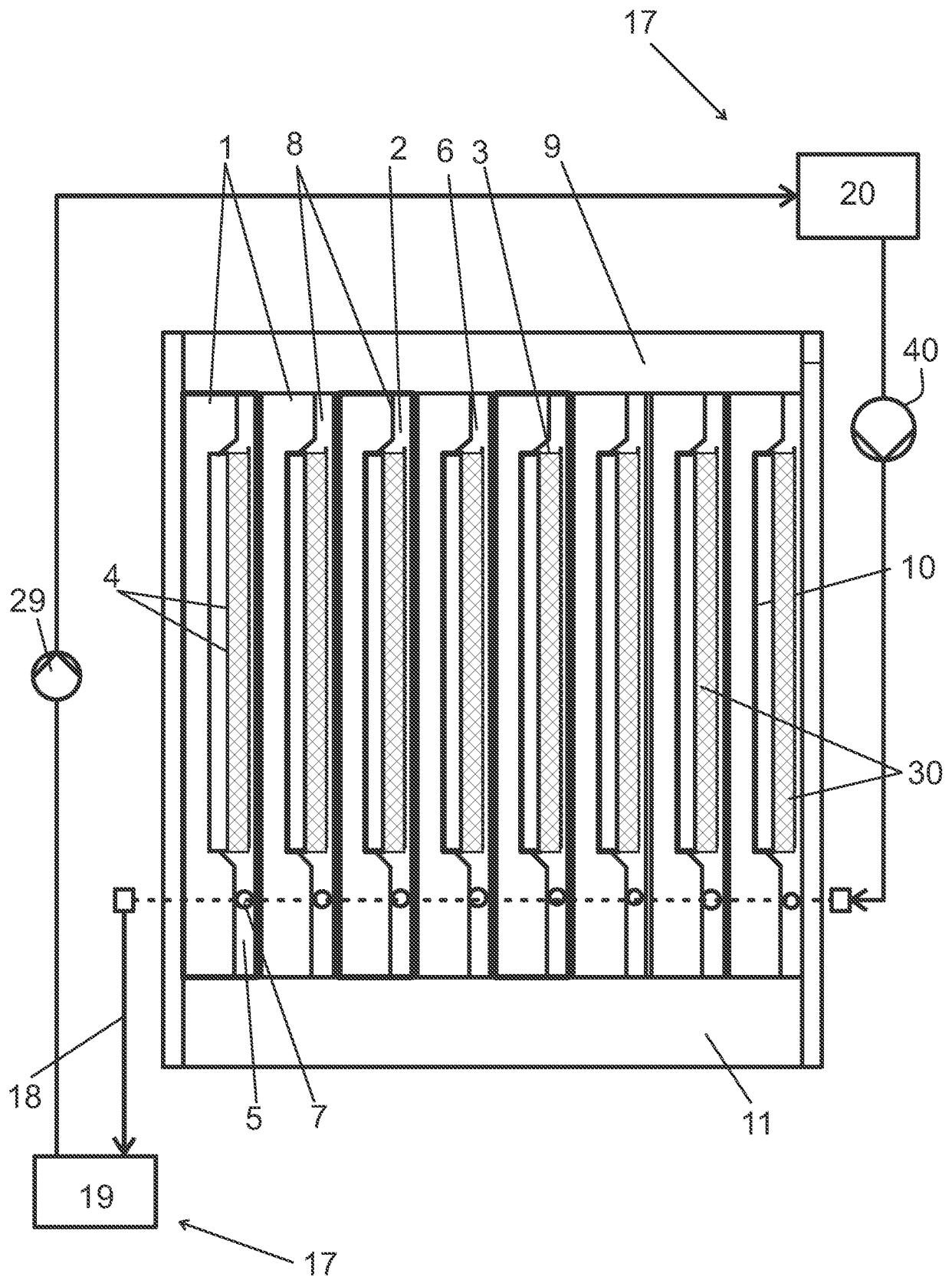


FIG 3

4 / 14

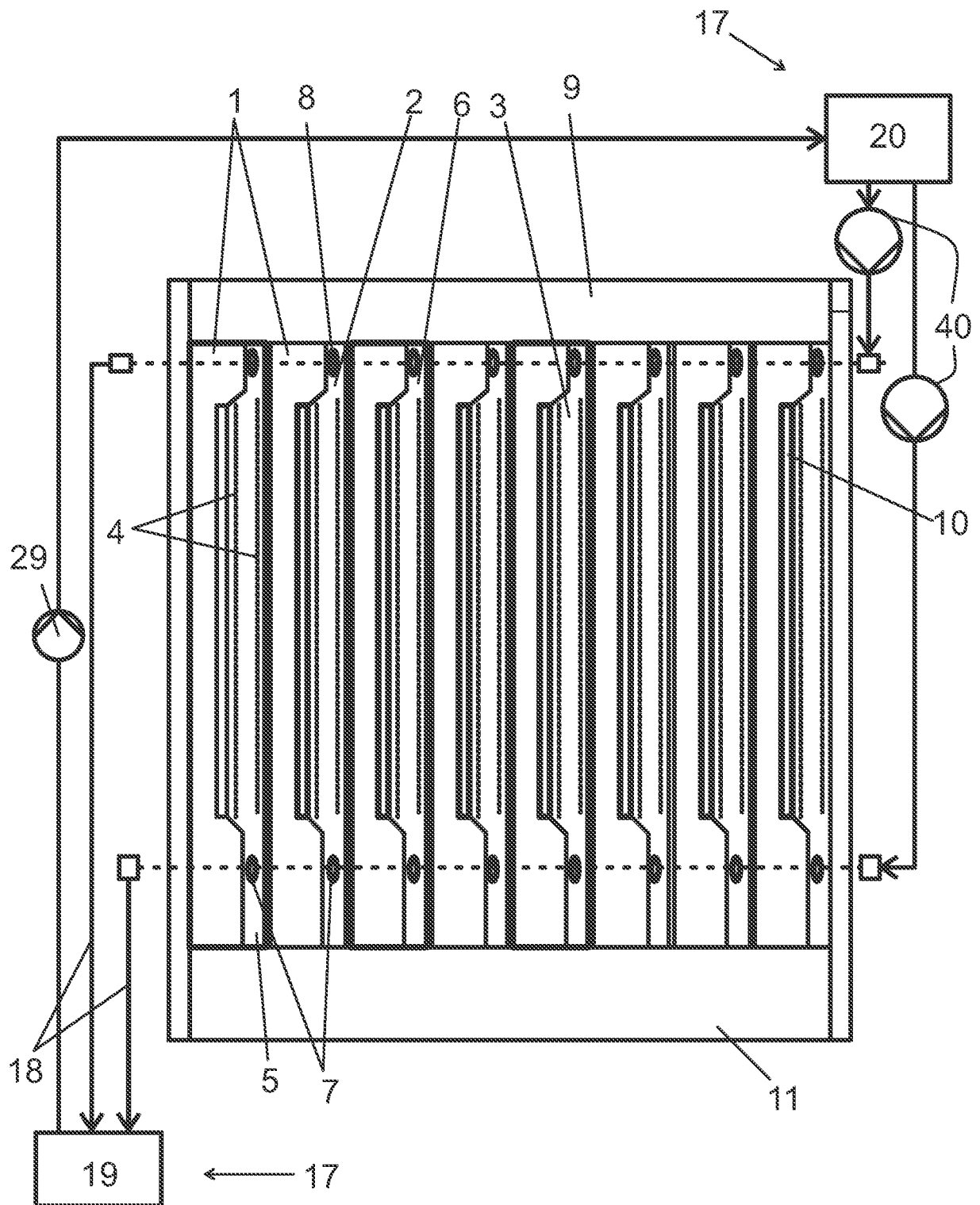


FIG 4

5 / 14

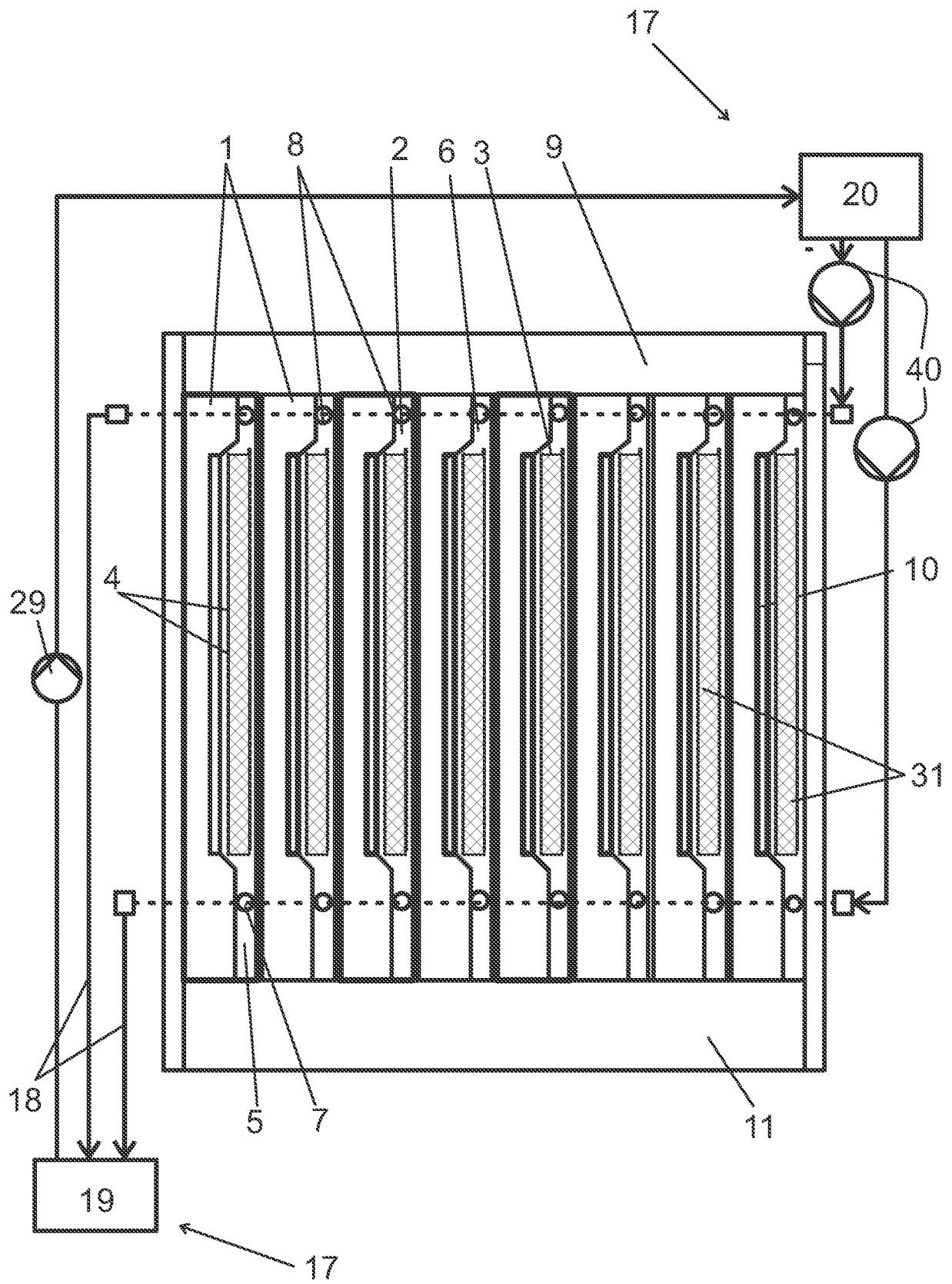


FIG 5

6 / 14

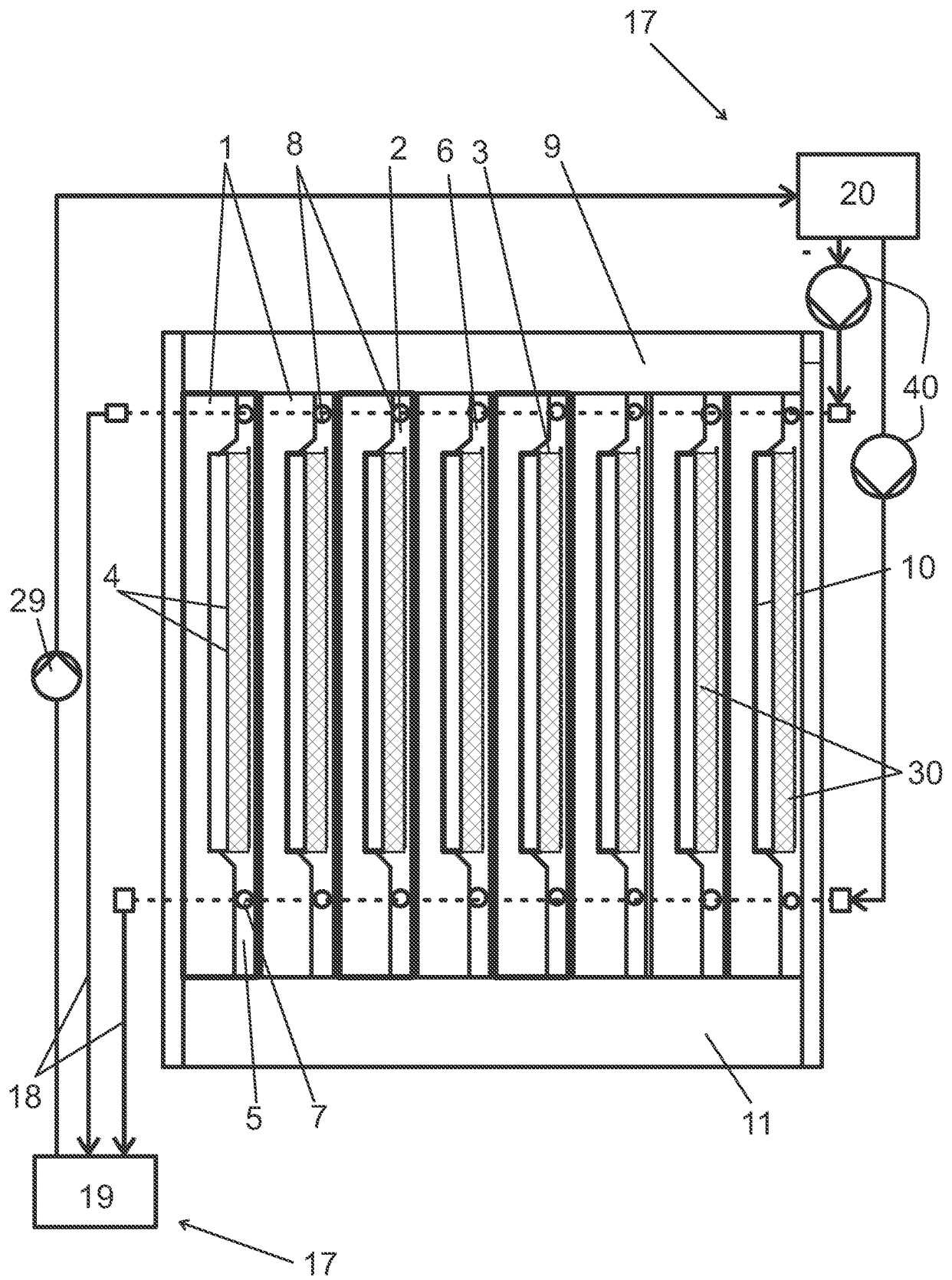


FIG 6

7 / 14

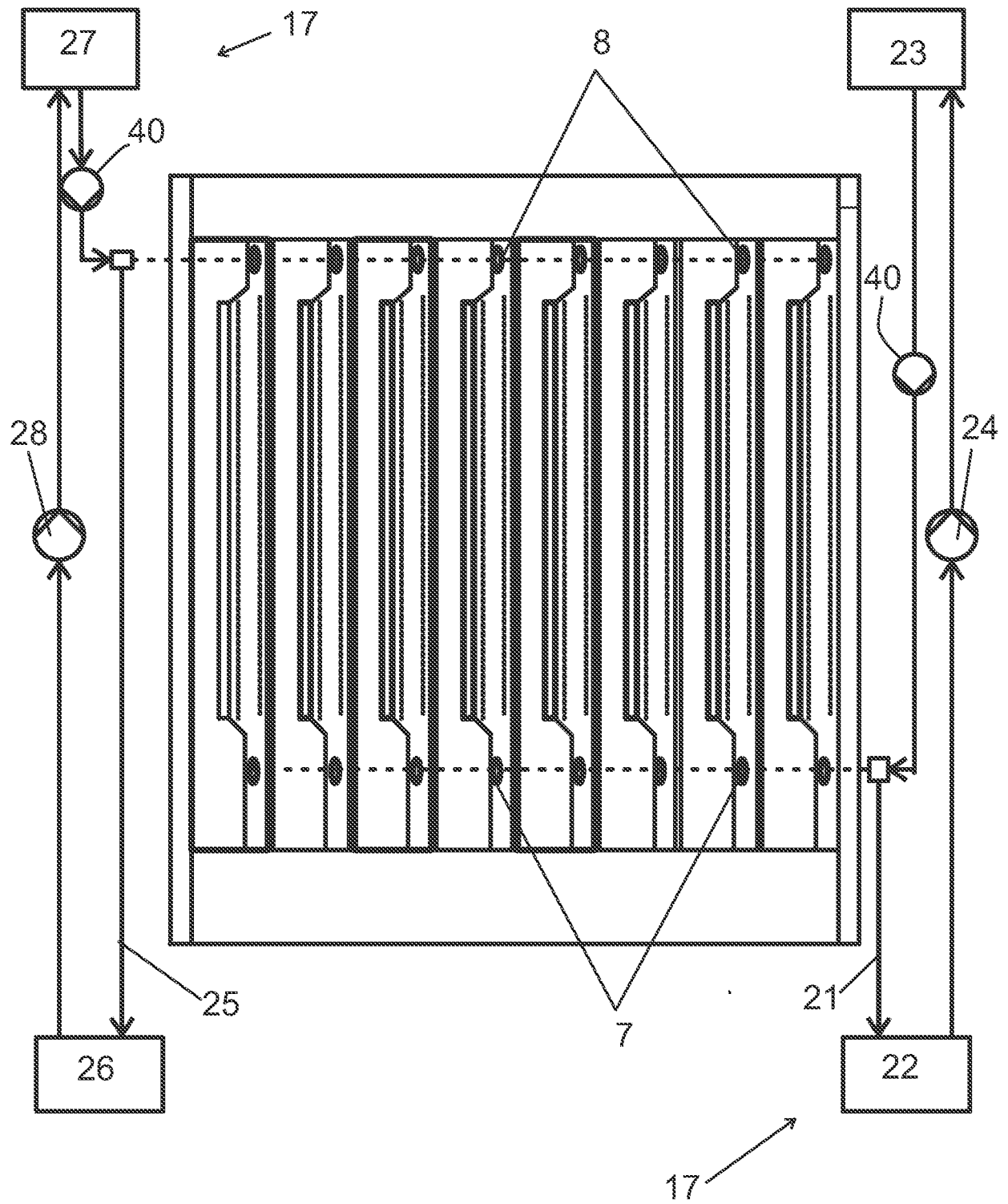


FIG 7

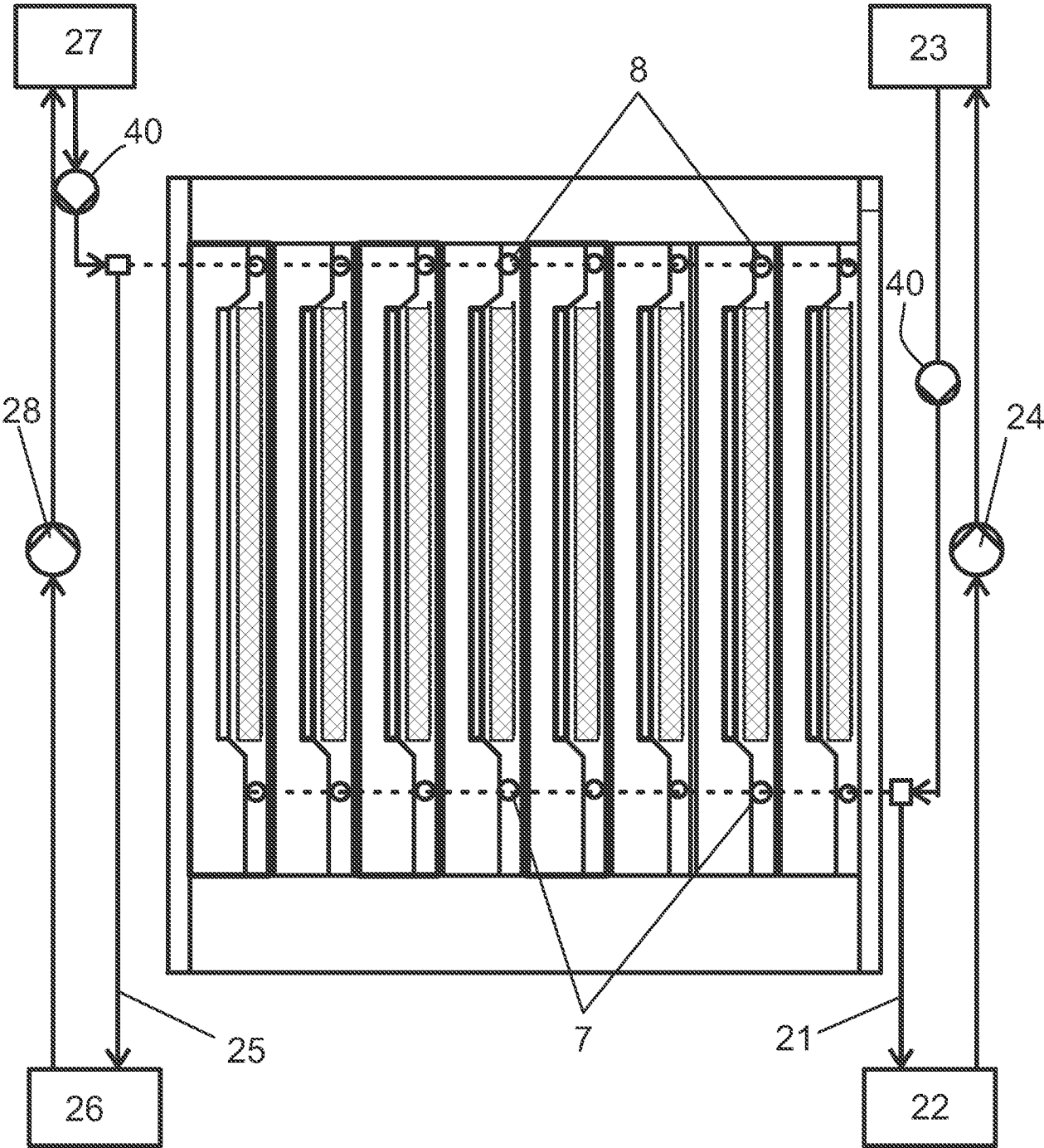


FIG 8

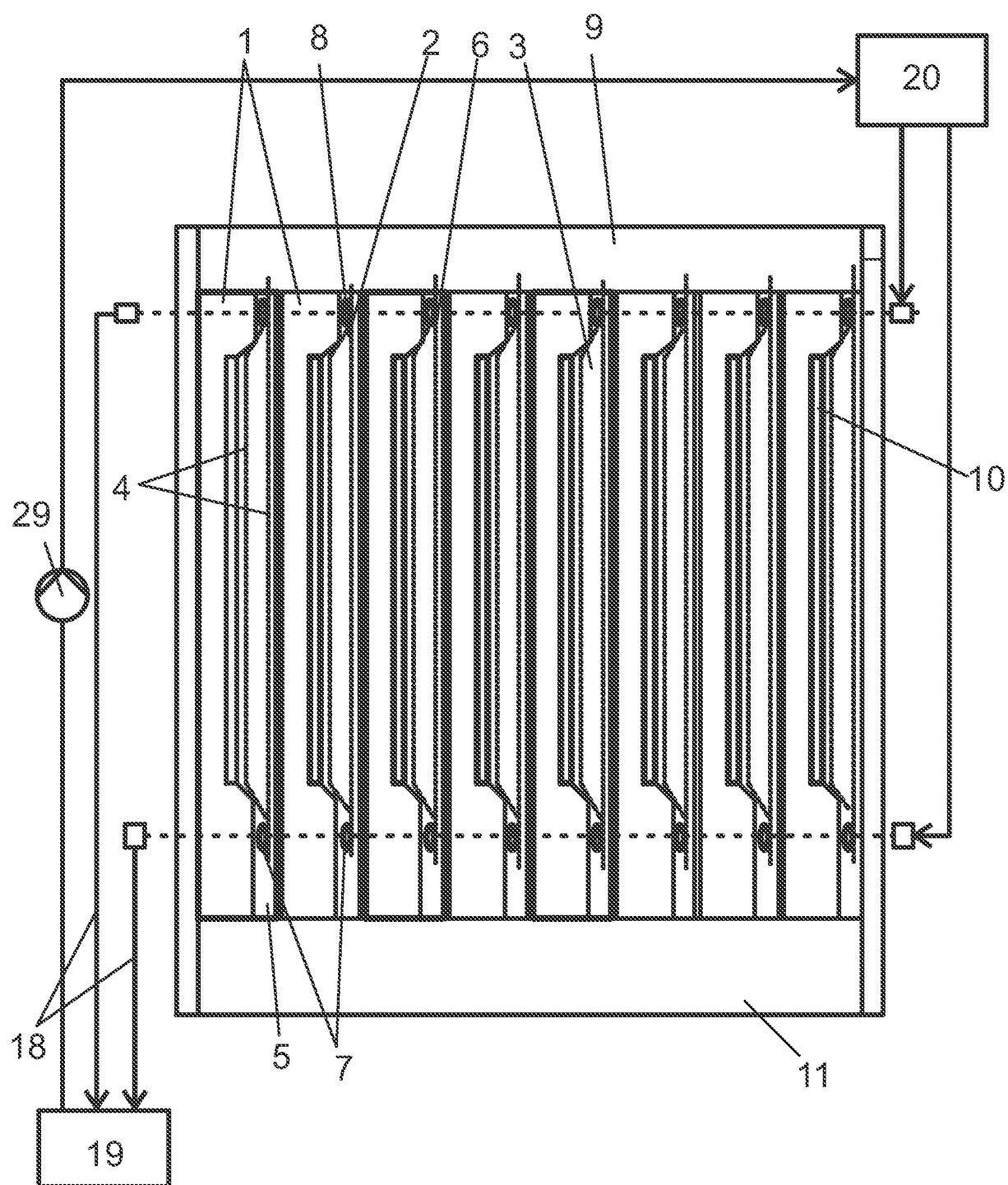


FIG 9

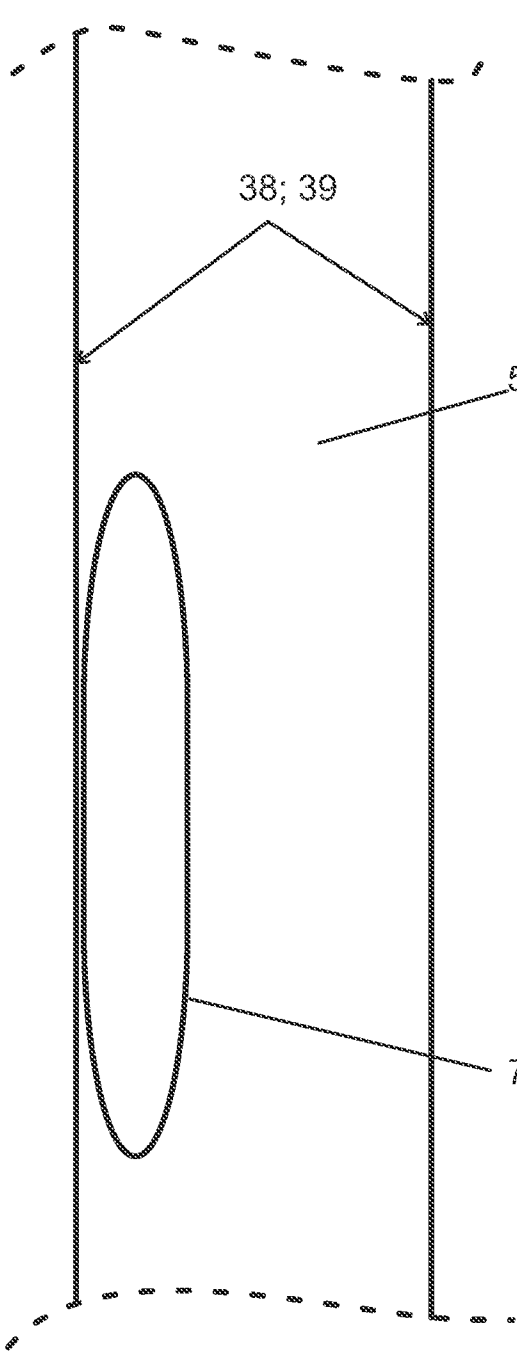


FIG 10

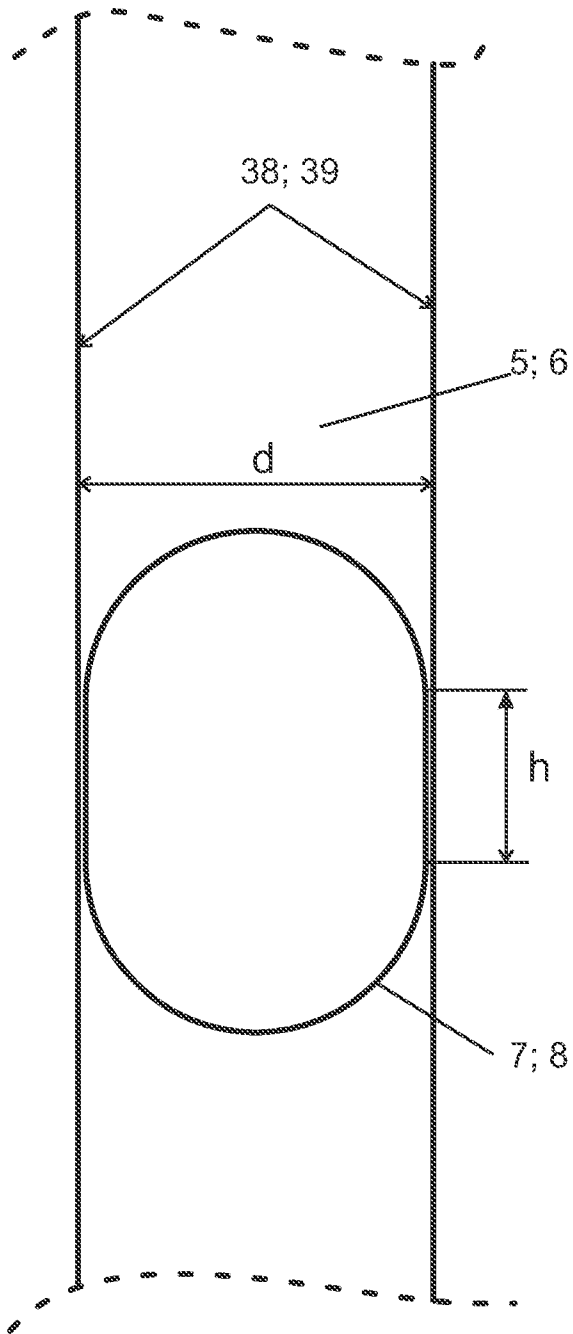


FIG 11

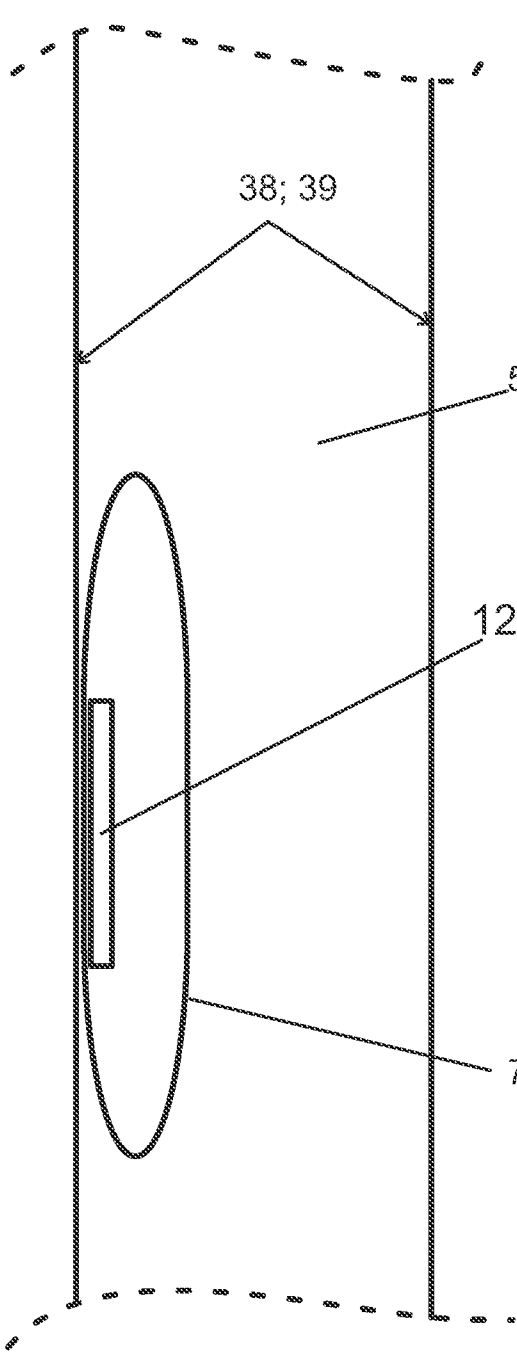


FIG 12

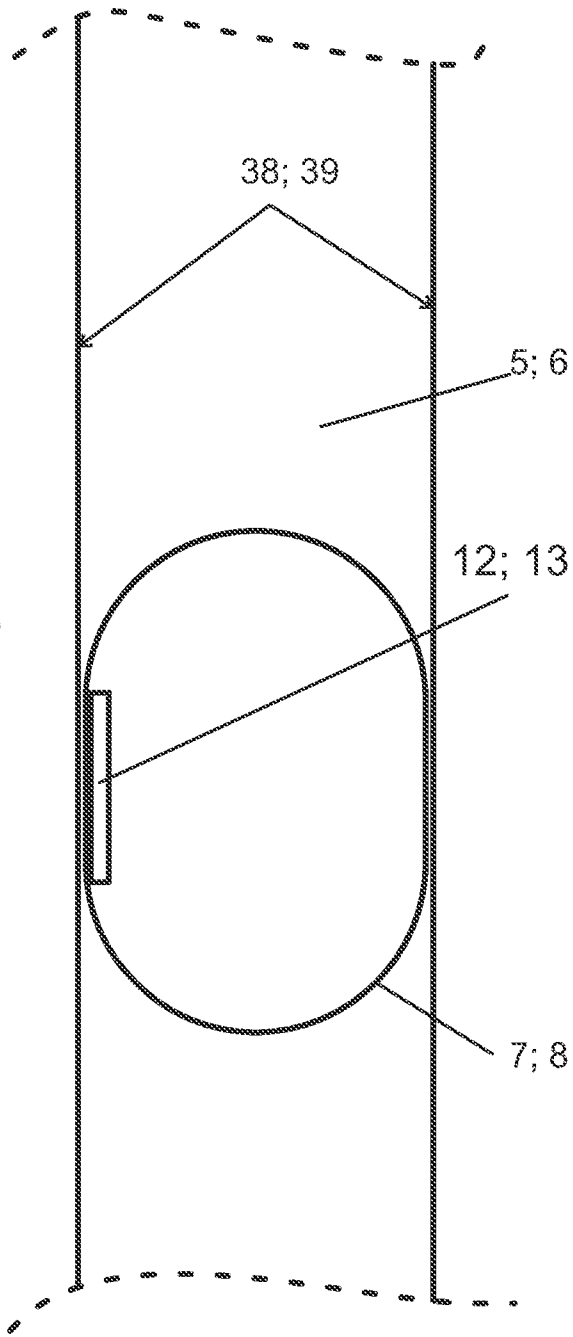


FIG 13

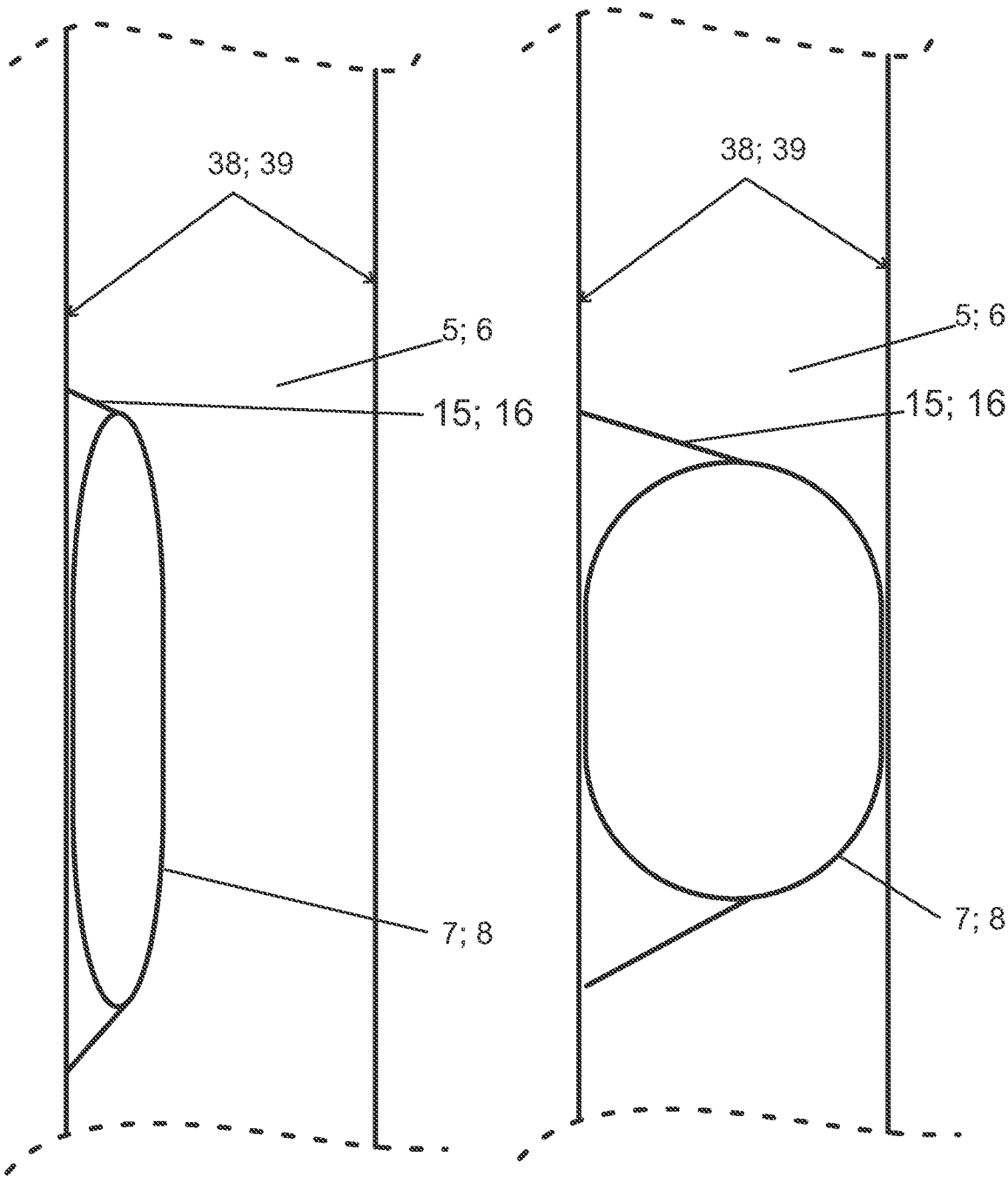


FIG 14

FIG 15

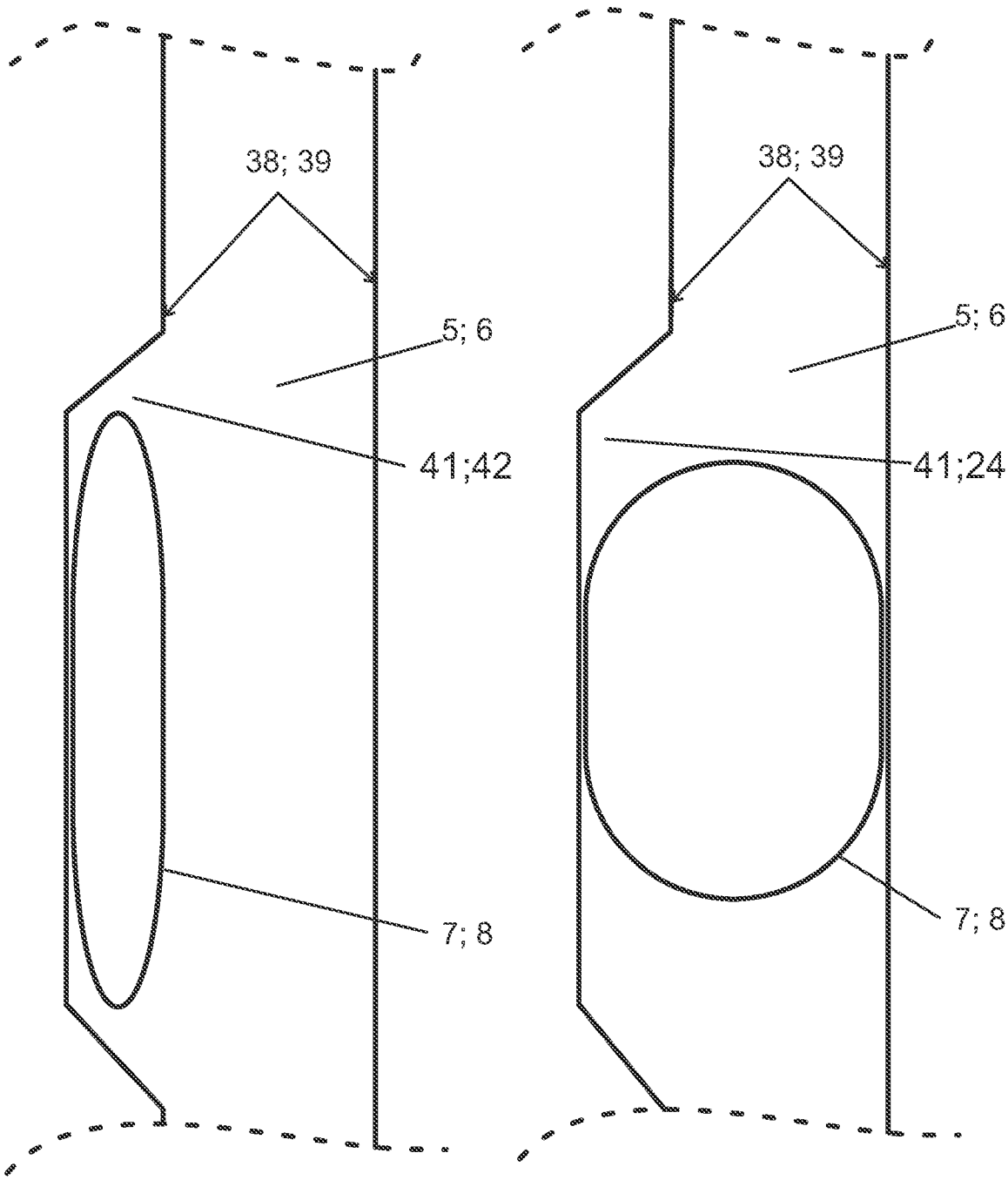


FIG 16

FIG 17

14 / 14

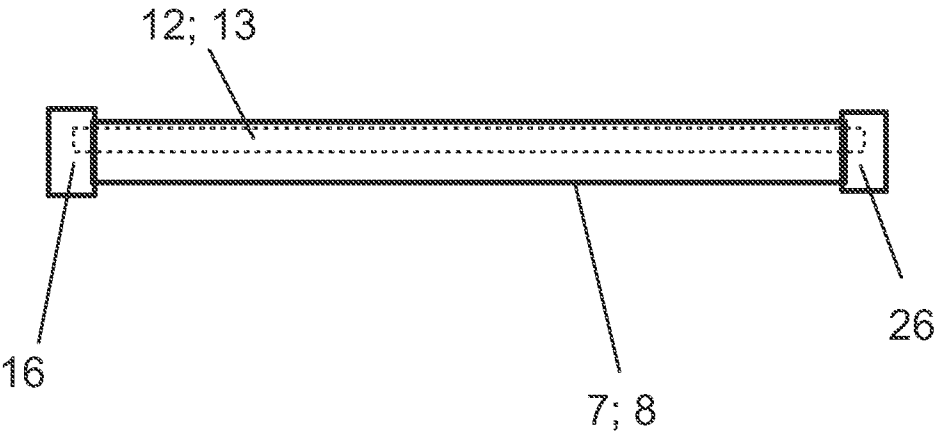


FIG 18

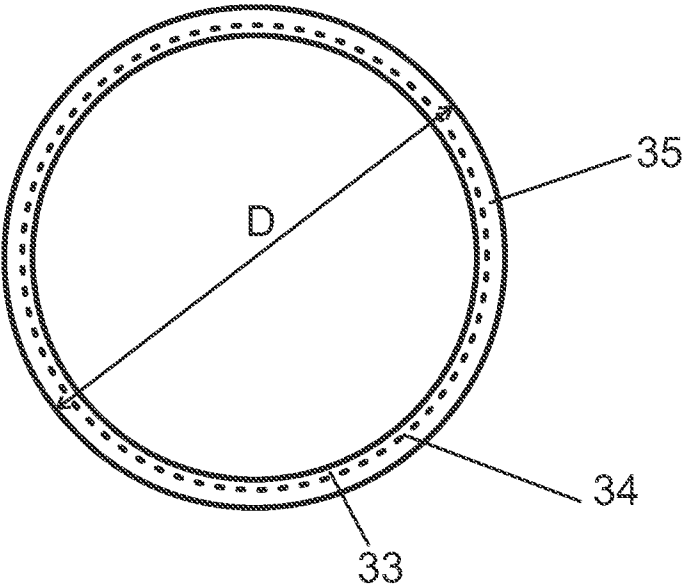


FIG 19

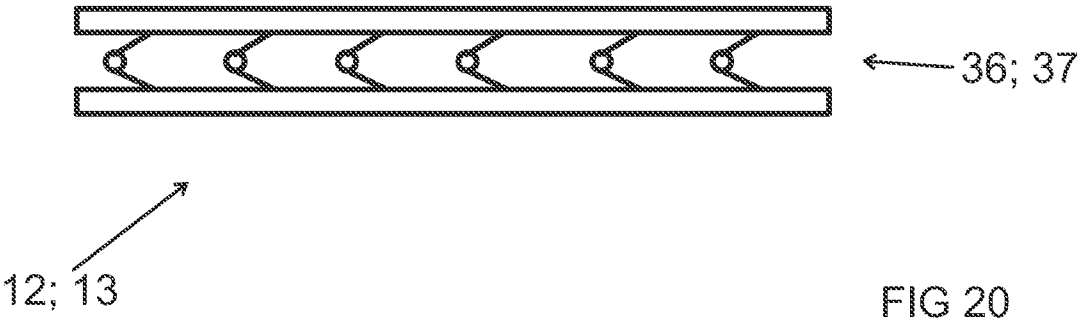


FIG 20

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2017/050589

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B01D, F16J, F16K

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

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

EPODOC, EPO-Internal full-text databases, Full-text translation databases from Asian languages, WPIAP

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3117083 A (IOSIFOVICH PRZHILENSKY JURY) 07 January 1964 (07.01.1964)	1-5, 7-9, 11-23, 25-27, 29-50
Y	the whole document, especially column 2, lines 23-30 and 60-68; column 3, lines 8-19; figure 6	6, 10, 24, 28
Y	EP 0479315 A1 (BRATTEN JACK R [US]) 08 April 1992 (08.04.1992) the whole document, especially column 8, lines 21-34; figures 1 and 5	6, 24
Y	US 4430231 A (BRATTEN JACK [US]) 07 February 1984 (07.02.1984) the whole document, especially column 5, lines 23-36; column 5, line 55 - column 6, line 2; figures 1 and 3	6, 24
Y	US 3687292 A (MIURA MITSUGI) 29 August 1972 (29.08.1972) the whole document, especially column 1, line 54 - column 2, line 6; column 2, lines 35-49; column 2, line 66 - column 3, line 15; figures 3-6B	10, 28
A	US 4861494 A (BRATTEN JACK R [US]) 29 August 1989 (29.08.1989) the whole document, especially figures 1 and 3	1-50

☐ Further documents are listed in the continuation of Box C.
☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
05 December 2017 (05.12.2017)Date of mailing of the international search report
07 December 2017 (07.12.2017)Name and mailing address of the ISA/FI
Finnish Patent and Registration Office
P.O. Box 1160, FI-00091 PRH HELSINKI, FINLAND
Facsimile No. +358 29 509 5328Authorized officer
Vilja Voutilainen
Telephone No. +358 29 509 5000

INTERNATIONAL SEARCH REPORT
Information on Patent Family Members

International application No.
PCT/FI2017/050589

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US 4430231 A	07/02/1984	CA 1265065 A DE 3479788 D1 EP 0151288 A2 EP 0151288 B1 ES 8606003 A1 JP S60183016 A JP H0615008 B2 US 4568460 A	30/01/1990 26/10/1989 14/08/1985 20/09/1989 16/04/1986 18/09/1985 02/03/1994 04/02/1986
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.....			
US 4861494 A	29/08/1989	None	
.....			

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI2017/050589

CLASSIFICATION OF SUBJECT MATTER

IPC

B01D 25/12 (2006.01)

F16J 15/46 (2006.01)

F16J 15/02 (2006.01)

F16K 7/10 (2006.01)