(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 967 303 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
29.12.1999 Bulletin 1999/52

(51) Int. Cl.[6]: **C25F 3/16**, C25D 7/04

(21) Application number: 99201324.3

(22) Date of filing: 28.04.1999

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 28.04.1998 NL 1009026

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(54) Apparatus and method for electrolytically treating the inside surface of a portion of a vessel

(57) An apparatus for electrolytically treating an inside surface (2) of a vessel (1) having a constant cross section in an axial direction, with an axial guide in the vessel (1), an electrolyte holder (25) axially movable along the guide structure (3), for placement opposite an inside surface portion (27) to be treated of a vessel (1), and an electrode (30) in the electrolyte holder (25), for treating an inside surface-portion (27) of the vessel (1) using electrolyte retained therein. The guide structure (3), the supporting structure (21, 23) and the electrolyte holder (25) are arranged for displacement through an opening (38) in a vessel (1) in a different relative configuration than in the condition of use. Because the electrolyte holder (25) is designed to extend circularly around the guide structure (3), a vessel (1) can be treated very rapidly while yet using little electrolyte. A method for the use of the proposed apparatus is also described.

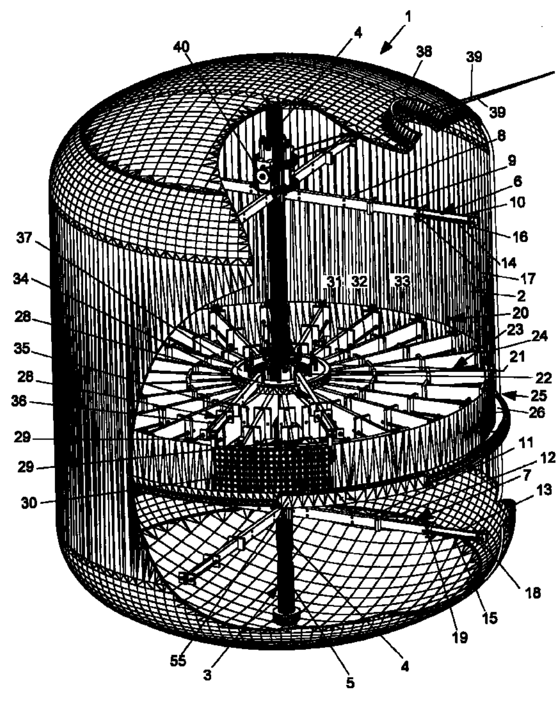

Fig. 1

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Description

[0001] This invention relates to an apparatus for electrolytically treating an inside surface of a vessel according to the introductory portion of claim 1, and to a method for electrolytically treating an inside surface of a vessel according to the introductory portion of claim 13.

[0002] Such an apparatus and such a method are known from U.S. Patent 4,001,094. Such an apparatus and such a method are also disclosed in U.S. Patent 4,082,638. In the use of the apparatus and the method as described in these patent specifications, the inside of a vessel is electrolytically treated by holding chamber units with a sealing edge against the wall of the vessel and, using electrolyte retained therein and an electrode immersed therein, treating an inside surface portion of the vessel located within the sealing. The chamber units are then displaced to a next, still untreated portion of the inside wall of the vessel, so that by increments the entire vessel is treated. Such apparatuses and methods are particularly suitable for the electrolytic polishing of wall surfaces from stainless steel having an austenitic structure, but can also be used for other galvanic treatments, such as anodizing and applying metallic layers.

[0003] A similar apparatus and method, which, however, utilize sponge units instead of chamber units sealed along the edges, are known from German patent application 33 45 278.

[0004] European patent specification 0,436,528 discloses a further variant of such an apparatus and such a method, which utilizes a double housing to enable radioactive electrolyte to be rinsed off the wall.

[0005] An advantage of the use of methods and apparatuses as has been discussed hereinbefore is that a considerably lesser amount of electrolyte is needed to treat a vessel without moving it. This is especially of interest for treating vessels which, due to their dimensions or their being fixedly built-in, cannot, or difficulty so, be rotated with their centerline in a horizontal position, about that centerline. However, a drawback of such apparatuses and methods is that treating a vessel in that way takes a very great deal of time. This is perhaps a reason why such methods and apparatuses are hardly used in practice.

[0006] The object of the invention is to treat a vessel within a shorter time without requiring essentially more electrolyte.

[0007] This is achieved according to the present invention by designing an apparatus of the initially indicated type in accordance with the characterizing portion of claim 1. The invention further provides for the design of a method of the initially indicated type in accordance with the characterizing portion of claim 13.

[0008] Because an electrolyte holder is used which is designed to extend circularly around the guide structure in a condition of use, circular inside surface portions of the inside wall of the vessel can be treated in one pass without intermediate displacement of the electrolyte holder. Moreover, because the electrolyte holder only needs to be displaced axially, operating the apparatus is simplified, fewer drive and transmission facilities are needed, and there is less risk of portions of the inside wall of a vessel remaining untreated.

[0009] Hereinafter, further objects, constructional features and details of the invention will be described and explained on the basis of an exemplary embodiment, with reference to the drawing. In the drawing:

Fig. 1 is a cutaway perspective view in a wire representation of a vessel having therein an exemplary embodiment of an apparatus according to the invention in a condition of use;

Fig. 2 is a schematic top plan view in cross section of a vessel having therein an apparatus according to an exemplary embodiment of the invention;

Fig. 3 is a view similar to Fig. 2, where the vessel has a smaller diameter than the vessel according to Fig. 2 and the apparatus is based on the same exemplary embodiment of the invention as the apparatus according to Fig. 2;

Fig. 4 is a side view in cross section of an electrolyte holder and a portion of a wall of a vessel;

Fig. 5 is a cut-off top plan view of a few elements of the apparatus according to Figs. 1, 2 and 4;

Fig. 6 is a cut-off side view of a few elements of the apparatus according to Figs. 1, 2, 4 and 5; and

Fig. 7 is a cutaway perspective view in a wire representation of a vessel having therein an apparatus for treating a ceiling portion of the vessel.

[0010] Figs. 1-3 each show a portion of a vessel 1, of which the inside surface 2 is being electrolytically treated. In the further description, this involves, by way of example, the electrolytic polishing of a vessel 1, of which the inside surface 2 has been cleaned and pickled. Through electrolytic polishing, a surface with a smooth and shining appearance and a strongly reduced roughness is obtained. Important advantages of electrolytic polishing are that it prevents adherence of substances to the inside surface of the vessel, so that the vessel is easier to clean, and that, when the contents of a vessel are drained, less of those contents remains behind in the vessel. For various applications, it is moreover advantageous that the hygienic condition of the vessel is better to control, and that the surface is hardened, so that the life of the vessel is prolonged. However, the proposed method and apparatus can also be used for other electrolytic treatments.

[0011] The vessel represented in Fig. 3 has a smaller diameter than the vessel represented in the other figures to show how the proposed apparatus is adaptable for treating vessels of different diameters. In general, the proposed method is suitable in particular for vessels having diameters of from 2.5 to 4.5 m, which vessels cannot be handled, or are difficult to handle, for rotating the vessel during an electrolytic operation, but on the other hand are not so large that the build-up of an apparatus as proposed would entail unduly high costs.

[0012] In each of the vessels 1 shown in Figs. 1-4, there is placed an apparatus for electrolytically treating an inside surface 2 of a portion of the vessel 1 with a constant cross section in an axial direction. In the proposed vessels, this inside surface is cylindrical in shape, but in the portion of the vessel having a constant cross section in axial direction, using an adapted version of the proposed apparatus, the inside surface to be treated can also be of a different shape, for instance oval, square or triangular.

[0013] The apparatus comprises a guide structure placed axially in the vessel in the condition of use shown, in the form of a length-adjustable rod 3. This rod 3 is made up of sections 4 (Fig. 1; not all sections are designated by reference numerals) for a rough choice of the length of the rod 3, and a telescopic section 5 (Fig. 1) for fine adjustment of the length of the rod 3, to enable the length of the rod 3 to be adapted to the height of the vessel 1. Adjacent the ends of the rod 3, supporting arms 6, 7 project radially from the rod 3. The supporting arms 6, 7 are each made up of sections 8-10 and 11-13, respectively, for keeping the rod 3 centered within the vessel 1. Depending on the diameter of the vessel 1, the arms 6, 7 are to be slid within each other to a greater or lesser extent. The lengths over which the outer sections 10, 13 of the rods 6, 7 project is moreover steplessly adjustable by means of threaded ends 14, 15 (see Fig. 1), over which nuts have been screwed which engage flanges of the outer two sections 9, 10 and 12, 13 of the arms 6, 7. The threaded ends 14, 15 connect the outer ends 16 and 18, respectively, of the outer sections 10 and 13, respectively, with an outer end 17 and 19, respectively, of the sections 9 and 12, respectively, adjacent thereto on the inside.

[0014] The guide rod 3 carries a supporting structure 20 which projects radially from that rod 3 and is axially movable along that rod 3, which supporting structure 20 is made up of a collar 21 with attachment points 22 and arms 23 projecting radially from at least some of the attachment points 21.

[0015] Terminal ends 24 of the arms 23 carry an electrolyte holder 25, which extends circularly around the guide rod 3 and has an open treatment side 26, remote from the guide rod 3, for placement opposite a vessel inside surface portion 27 to be treated. This appears most clearly from Fig. 4.

[0016] Further, at a level above the arms 23 carrying the electrolyte holder 25, arms 28 project radially from a ring 37 which forms part of the collar 21 and is rotatable about the guide rod 3. Mounted on the free ends 29 of these arms 28 is an electrode 30 which is located in the electrolyte holder 25 for treating an inside surface portion 27 of the vessel 1 using electrolyte retained in the electrolyte holder 25.

[0017] The arms 23 and 28, like the arms 6, 7 for centering the guide rod 3, are made up of sections 31-33 and 34-36, respectively. By variation of the number of sections, a rough adjustment of the lengths of the arms 23, 28 to the diameter of the vessel 1 can be obtained, while the distances over which outer sections project are adjustable by telescopic sliding in and out, for obtaining a stepless fine adjustment of the lengths of the arms 23, 28.

[0018] In demounted condition - i.e. in a different configuration than in the condition of use - the guide rod 3, the collar 21, the arms 6, 7, 23, 28, the electrolyte holder 25 and the electrode 30 can be passed through an opening 38 in a vessel 1 that is considerably smaller than the axial cross-sectional area of the vessel 1.

[0019] In the condition of use shown, the electrolyte holder 25 is designed to extend circularly around the guide structure 3, so that a circular portion of the inside surface 2 of the vessel 1 can be treated without moving the electrolyte holder.

[0020] For electrolytically treating the inside surface of the portion of the vessel 1 that has a constant cross section in an axial direction, the procedure using the proposed apparatus is as follows.

[0021] In a demounted condition, the required parts of the apparatus, including the guide rod 3, the collar 21, the arms 6, 7, 23, 28, the electrolyte holder 25 and the electrode 30, are separately introduced into the vessel 1 through the opening 38. Consequently, they can also pass through relatively small openings. It is noted that according to an alternative embodiment of the proposed apparatus, the mounting and demounted condition in which the apparatus is moved through the opening 38, instead of being a disassembled condition, can also be a folded condition, for instance a condition in which the arms are folded along the guide rod in the manner of ribs of an umbrella.

[0022] In the vessel 1 the apparatus is brought into a condition of use, which involves the guide rod 3 being brought into a position parallel to the longitudinal axis of the vessel 1, for guiding the collar 21, the arms 6, 7, 23, 28, the electrolyte holder 25 and the electrode 30 in axial direction. Further, the arms 6, 7, 23, 28 of the supporting structure are mounted and assembled into a condition where they project radially from guide rod 3; the lengths of the arms 6, 7, 23, 28 are set; the electrolyte holder 25 is brought into the condition shown, carried by the arms 23, with an open treatment side, remote from the guide rod 3, opposite a vessel inside surface portion 27 to be treated; and the electrode 30 is brought into a position located in the electrolyte holder 25.

[0023] To axially displace the collar 21 and the arms mounted thereon, hoisting cables 39 are attached to the collar 21 and led out of the vessel via diverting pulleys 40 and through the opening 38.

[0024] For rotating the ring 37 carrying the arms 28, a motor 57 is coupled to one of the arms 23. This motor and further components of the drive of the movement of the electrode 30 have been omitted from Figs. 1-3 for the sake of clarity and are represented only in Figs. 5 and 6. In Figs. 5 and 6, of the arms 23, only the arm carrying the motor 57 is shown. In addition, the electrolyte holder 25 is not shown in Fig. 6. A chain wheel 58, coupled to the motor 57, and which is rotatable about a shaft parallel to the guide rod 3, is brought into engagement with a chain 59. This chain 59 in turn is trained over a gear ring 60 which is coupled to the ring 37 supporting the arms 28, for carrying along that ring 37 and the arms 28 with the electrode 30 attached thereto. By driving-the motor 57, the arms 28 with the electrode attached thereto can be slowly rotated about the centerline of the guide rod 3. Because the gear ring 60 coupled to the ring 37 has a considerably greater diameter than the chain wheel 58 mounted on the shaft driven by the motor 57, a drive with a very slow reduction is obtained in a simple manner. This in turn makes it possible for a small simple motor to suffice for driving the rotation of the electrode 30.

[0025] Located within the ring 37 are sliding contacts 61, 62, via which the rotating electrode 30 can be supplied with current.

[0026] When the apparatus has been brought into a condition ready for use, via tubes (not shown) electrolyte 41 is supplied to the space between the electrolyte holder 25 and the wall of the vessel 1 and held there.

[0027] Through cables 42, 43 schematically represented in Fig. 4, the electrode 30 and the vessel 1 are coupled to poles 44, 45 of a voltage source 46 for applying a potential difference between the wall of the vessel 1 and the electrode 30, such that a portion of the wall 27 of the vessel opposite the treatment side 26 of the electrolyte holder 25 undergoes an electrolytic treatment. In the use of the apparatus according to the example shown, the electrode 30 is then rotated about the axis of the vessel 1, so that a circular strip 27 of the inside surface 2 of the vessel 1 is treated without moving the electrolyte holder 25. The electrode 30 is moved in a circular sense through a space bounded by the circular electrolyte holder 25.

[0028] Each time when, with the supporting structure in a particular position, an annular vessel inside surface zone 27 extending around the guide rod 3 has been treated, the collar 21 is shifted one step in axial direction for treating a next strip 27, until the entire inside surface 2 of the vessel portion of constant cross section has been treated.

[0029] Thereafter, all arms 23 except two, the electrolyte holder 25 and the electrode 30 are demounted, and between the arms 23 and an upper collar 47 located above the collar 21 mentioned earlier, an electrolyte holder 48 is arranged, as is represented in Fig. 7. After placement, this electrolyte holder 48 adjoins a segment-shaped portion of the ceiling 50 of the vessel 1 along a circumferential edge 49, while adjacent a highest portion of the electrolyte holder 48 adjacent the central axis, an opening between the ceiling 50 of the vessel 1 and the electrolyte holder 48 is left clear for filling electrolyte into the space between the electrolyte holder 48 and the ceiling 50 and for allowing escape of gasses released during the electrolytic process. In the electrolyte holder 48, a stationary electrode 51 is arranged which, similarly to the electrode 30, is connected to a voltage source.

[0030] Thereafter, electrolyte is introduced into the electrolyte holder 48 and a portion of the ceiling 50 that is covered by the electrolyte holder 48 is treated by activating the voltage source. After a portion of the ceiling 50 covered by the electrolyte holder 48 has been treated, the electrolyte holder 48 is swiveled about the guide rod 3 to a position opposite an adjacent segment of the ceiling 50, which is thereupon treated. This process is continued stepwise until the entire ceiling, with the exception of a small central portion, has been treated. In practice, this central portion generally does not come into contact with substances to be introduced into the vessel, so that it can be left untreated. If it is yet desired to also treat this small portion of the ceiling 50, to that end, for instance a sponge-shaped electrolyte holder 48, known per se, can be used.

[0031] After the sidewalls 2 and the ceiling of the vessel 1 have been treated, the guide rod 3, the arms 6, 7, 23, and the electrolyte holder 48 are demounted again, and in demounted condition are removed from the vessel via the opening 38. Given a corresponding design of connections between different parts of the apparatus, in this case too, the mounting and demounted condition, instead of being a disassembled condition, can be a folded condition.

[0032] Finally, the bottom of the vessel can be treated in a simple manner by introducing a layer of electrolyte into the vessel and, in a manner known per se, moving an electrode along the bottom or keeping it in a position adjacent to the bottom.

[0033] To enable the circular electrolyte holder 25 to be passed through the opening 38 in the vessel 1, the electrolyte holder 25 is divided into a number of sections 52 linking up with each other in a circular sense (see Figs. 2 and 3) and, if necessary, a closing section 53 (see Fig. 3) which is the last to be placed and, prior to placement, is reduced to the length of the residual opening. When the apparatus is brought into the condition of use, the sections 52, 53 of the electrolyte holder 25 are individually, or in subgroups, introduced into the vessel 1 via the opening 38, and within the vessel 1 brought into the configuration where they adjoin each other in a circular sense, while they are mounted on the arms 23.

[0034] Because the electrolyte holder 25 is capable of being disassembled, it can simply be brought into a configuration where it fits through the opening 38 and be adapted to vessels 1 of different diameters. To that end, as appears most clearly from a comparison of Figs. 2 and 3, the number of sections 52 is adjusted and the closing section 53 is made to the length of the residual opening.

[0035] The attachment points 22 of the supporting collar 21 are designed as circumferentially distributed coupling members for detachably coupling supporting arms 23 thereto. As appears from Figs. 2 and 3, the number of supporting arms 23 is adjusted to the number of sections of which the electrolyte holder 25 is made up.

[0036] Because the arms 23 are mounted when the apparatus is brought into the condition of use, the system for supporting the circular electrolyte holder can also be introduced into the vessel 1 through a very small opening 38. Further, the sections 52, 53 of the electrolyte holder can be made of highly compact design, because they are suspended from the ends of the arms 23 and consequently are not subject to high mechanical loading. This in turn makes it possible for the construction for electrolytically treating the wall of a vessel, to be introduced into the vessel through a very small opening. The low mechanical loading of the sections 52, 53 further makes it simply possible to use sections which have a shape adapted to fins and the like that extend along the wall of a vessel and which sections, to that end, are provided, for instance, with recesses.

[0037] To obtain in a simple manner a sealing of the electrolyte holder built up from sections 52, 53, the electrolyte holder is provided with a film 54 covering the sections 52, 53 (see Fig. 4).

[0038] To provide a reliable sealing of the circular electrolyte holder 25 against the wall 2 of the vessel 1, which sealing moreover is capable of sealing slits exhibiting relatively large differences in width, the electrolyte holder 25 is provided with an inflatable sealing 55, remote from the guide rod 3, having a chamber 56 which is expandable by inflation. When the apparatus is being brought into the condition of use, the electrolyte holder 25 is fitted with this sealing 55 remote from the guide rod 3, and the sealing is subsequently inflated until it is in sealing engagement with the wall 2 of the vessel 1. Each time after a zone 27 of the wall 2 of the vessel 1 has been treated, the electrolyte is pumped from the electrolyte holder 25, and subsequently air is let out of the sealing 55, so that the sealing 55 comes clear of the wall 2 again and the electrolyte holder 25 can be simply moved. After the electrolyte holder 25 has been moved to a position opposite a next zone 27 to be treated, the sealing 55 is inflated again, and subsequently the electrolyte (the same and/or fresh electrolyte) is pumped into the electrolyte holder 25.

[0039] It will be clear to one skilled in the art that within the scope of the present invention, many possible alternative embodiments exist. Thus, for instance, instead of the circular electrolyte holder 25 shown by way of example, which is made up of sections that are assembled within the tank, a holder can be used which consists of a flexible pre-bent profiled section, free ends of which are slid farther or less far over each other, depending on the diameter of the vessel.

Claims

1. An apparatus for electrolytically treating an inside surface (2) of a vessel (1) having a constant cross section in an axial direction, comprising:

   a guide structure (3) extending axially in the vessel (1) in a condition of use,
   at least one supporting structure (21, 23) projecting radially from said guide structure (3) and being axially displaceable along said guide structure (3),
   an electrolyte holder (25), carried by said supporting structure (21, 23) in a condition of use, having an open-treatment side (26) remote from said guide rod (3) in a condition of use, for placement opposite an inside surface portion (27) to be treated of a vessel (1), and
   an electrode (30) which in a condition of use is located in said electrolyte holder (25) for treating an inside surface portion (27) of the vessel (1) using electrolyte retained therein,
   wherein at least said guide structure (3), said supporting structure (21, 23) and said electrolyte holder (25) are designed for displacement through an opening (38) in a vessel (1) in a different relative configuration than in said condition of use,
   characterized in that the electrolyte holder (25) is designed to extend circularly around said guide structure (3) in a condition of use.

2. An apparatus according to claim 1, wherein the electrolyte holder (25) comprises a number of sections (52, 53) linking up with each other in a circular sense.

3. An apparatus according to claim 2, wherein at least one of said sections has a shape essentially different from at least one other of said sections (52, 53), for adaptation to obstacles present in a vessel.

4. An apparatus according to claim 2 or 3, wherein the electrolyte holder (25) comprises a film (54) covering the sections (52, 53).

5. An apparatus according to any one of claims 2-4, wherein the electrolyte holder (25) comprises a film (54) covering the sections (52, 53).

6. An apparatus according to any one of the preceding claims, wherein the electrolyte holder (25) is provided with a sealing (55) , remote from the guide structure, having a chamber (56) which is expandable under overpressure.

7. An apparatus according to any one of the preceding claims, wherein said guide structure (3), said sup-

porting structure (21, 23) and said electrolyte holder (25) are demountable from said condition of use.

8. An apparatus according to any one of the preceding claims, wherein the supporting structure (21, 23) comprises radially projecting arms (23).

9. An apparatus according to claim 8, wherein said arms (23) are length-adjustable.

10. An apparatus according to claim 8 or 9, wherein said arms (23) are each made up of at least two parts (31, 32, 33).

11. An apparatus according to any one of the preceding claims, wherein the supporting structure (21, 23) comprises a supporting collar (21) with circumferentially distributed coupling members (22) for detachably coupling supporting arms (23) thereto.

12. An apparatus according to any one of the preceding claims, wherein the electrode (30) is movable in a circular sense through a space bounded by the circular electrolyte holder (25).

13. A method for electrolytically treating an inside surface (2) of a vessel (1) having a constant cross section in an axial direction, comprising:

introducing, in a mounting and demounted condition, an apparatus having a guide structure (3), at least one supporting structure (21, 23), an electrolyte holder (25) and an electrode (30), into a vessel (1),
bringing said apparatus into a condition of use in the vessel (1), whereby the guide structure (3) is oriented for guiding the supporting structure (21, 23) in axial direction, the supporting structure (21, 23) is brought into a condition projecting radially from said guide structure (3), the electrolyte holder (25) is brought into a condition supported by said supporting structure (21, 23), with an open treatment side (26), remote from said guide structure (3), opposite an inside surface portion (27) to be treated of the vessel (1), said electrode (30) is brought into a position located in said electrolyte holder (25),
introducing an amount of electrolyte (41) into, and holding same in, a space between the electrolyte holder (25) and the wall of the vessel (1),
applying a potential difference between the wall (2) of the vessel (1) and the electrode (30), such that a portion (27) of the wall (2) of the vessel (1) opposite said treatment side (26) undergoes an electrolytic treatment,
repeatedly, incrementally displacing the supporting structure (21, 23), and treating successive portions (27) of the wall (2) of the vessel (1), with the supporting structure (21, 23) being displaced axially along the guide structure (3), and
bringing said apparatus in the vessel (1) from said condition of use back into said mounting and demounted condition,
characterized in that the electrolyte holder (25), when said apparatus is being brought into the condition of use, is brought into a configuration extending circularly around said guide structure (3), and
that in each incremental position of the supporting structure (21, 23) an inside surface portion (27) of the vessel (1) that extends endlessly around said guide structure (3) is treated.

14. A method according to claim 13, wherein, when said apparatus is being brought into the condition of use, a number of sections (52, 53) of the electrolyte holder (25) are brought into a configuration linking up with each other in a circular sense.

15. A method according to claim 13 or 14, wherein, when said apparatus is being brought into the condition of use, the electrolyte holder (25) is fitted with a sealing (55), remote from the guide structure (3), expandable under internal overpressure, in which sealing (55) subsequently an overpressure is applied.

16. A method according to any one of claims 13-15, wherein said guide structure (3), said supporting structure (21, 23) and said electrolyte holder (25) are separately introduced into the vessel (1) and, when said apparatus is being brought into the condition of use, are coupled to each other in the vessel (1).

17. A method according to any one of the preceding claims, wherein, when said apparatus is being brought into the condition of use, radially projecting arms (23) of the supporting structure (21, 23) are mounted.

18. A method according to claim 17, wherein, when said apparatus is being brought into the condition of use, the lengths of said arms (23) are set.

19. A method according to claim 17 or 18, wherein, when said apparatus is being brought into the condition of use, said arms (23) are each built up from at least two parts (31, 32, 33).

20. A method according to any one of claims 13-19,

wherein the electrode (30) is moved in a circular sense through a space bounded by the circular electrolyte holder (25).

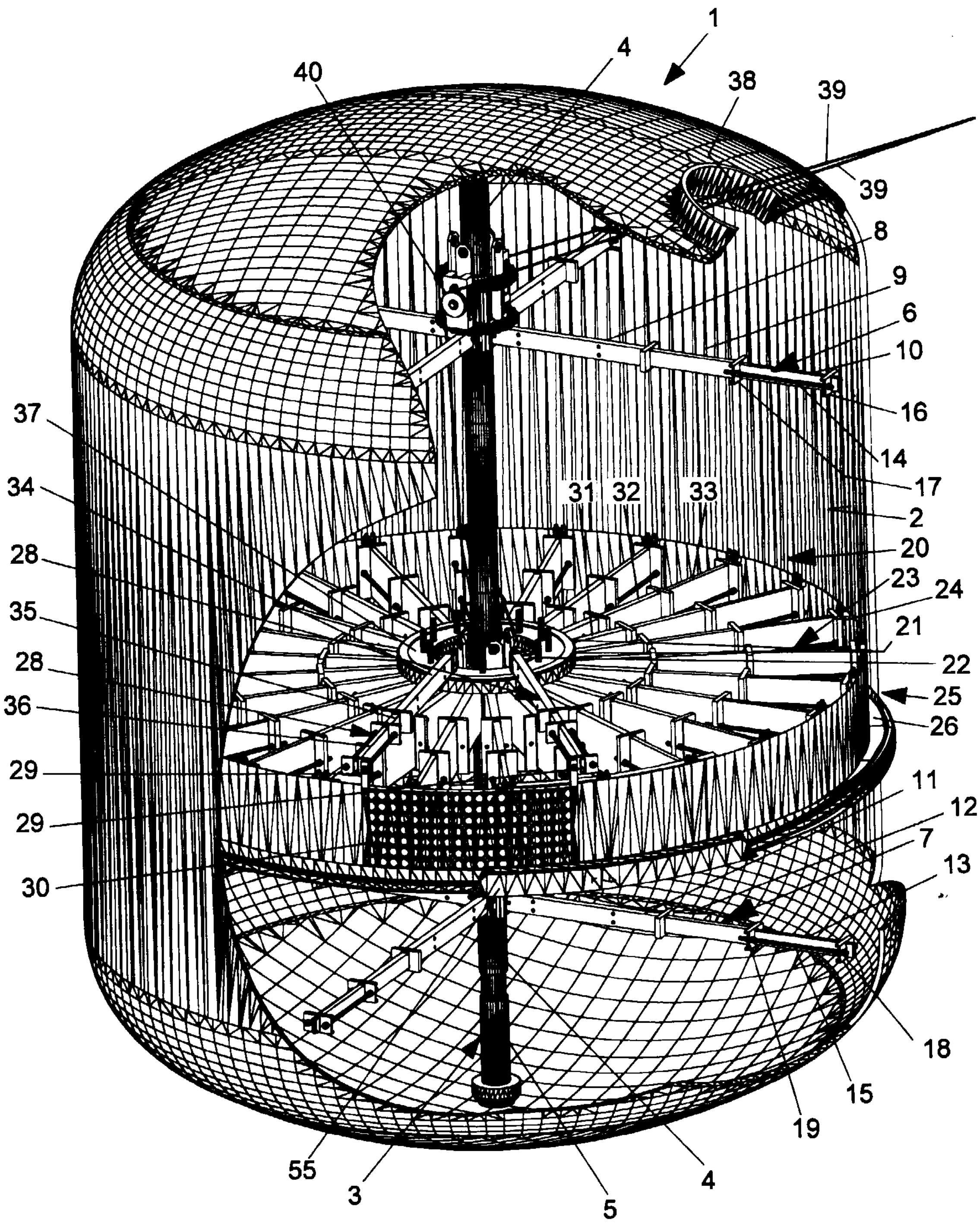
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Fig. 1

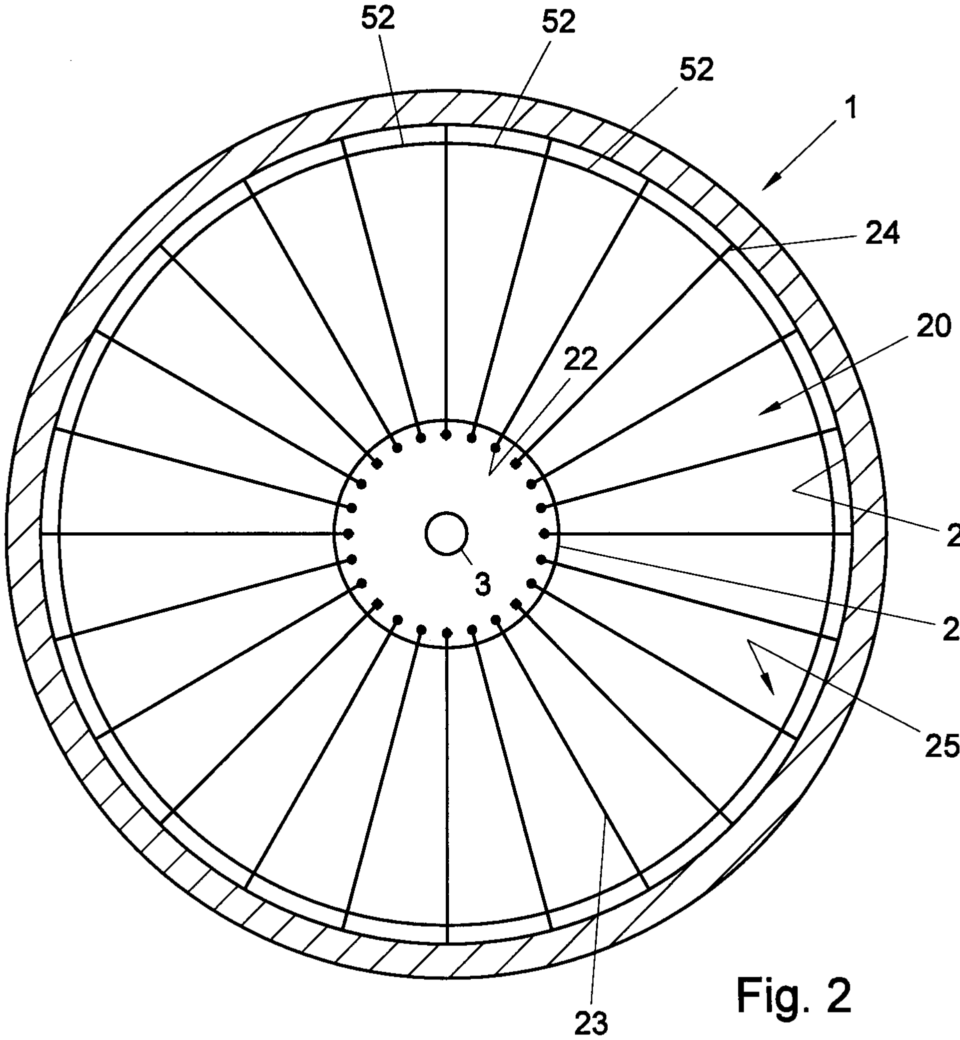

Fig. 2

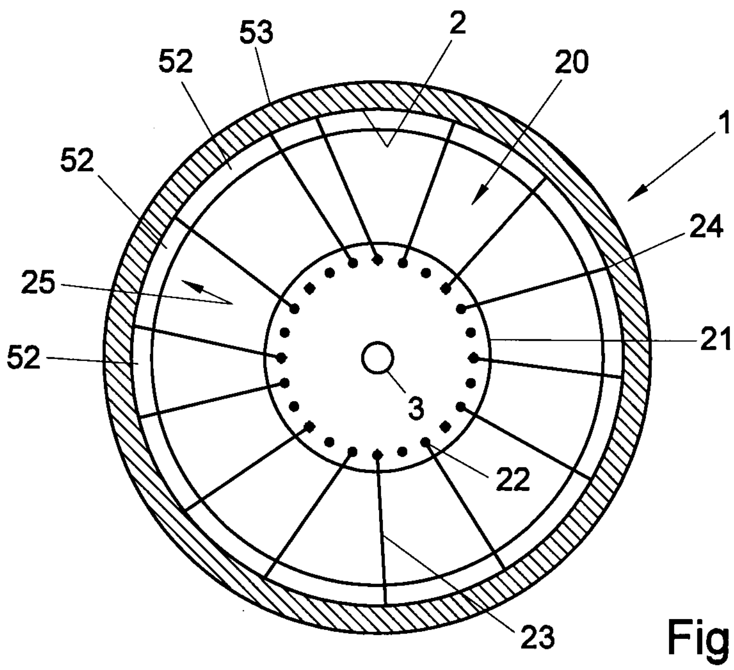

Fig. 3

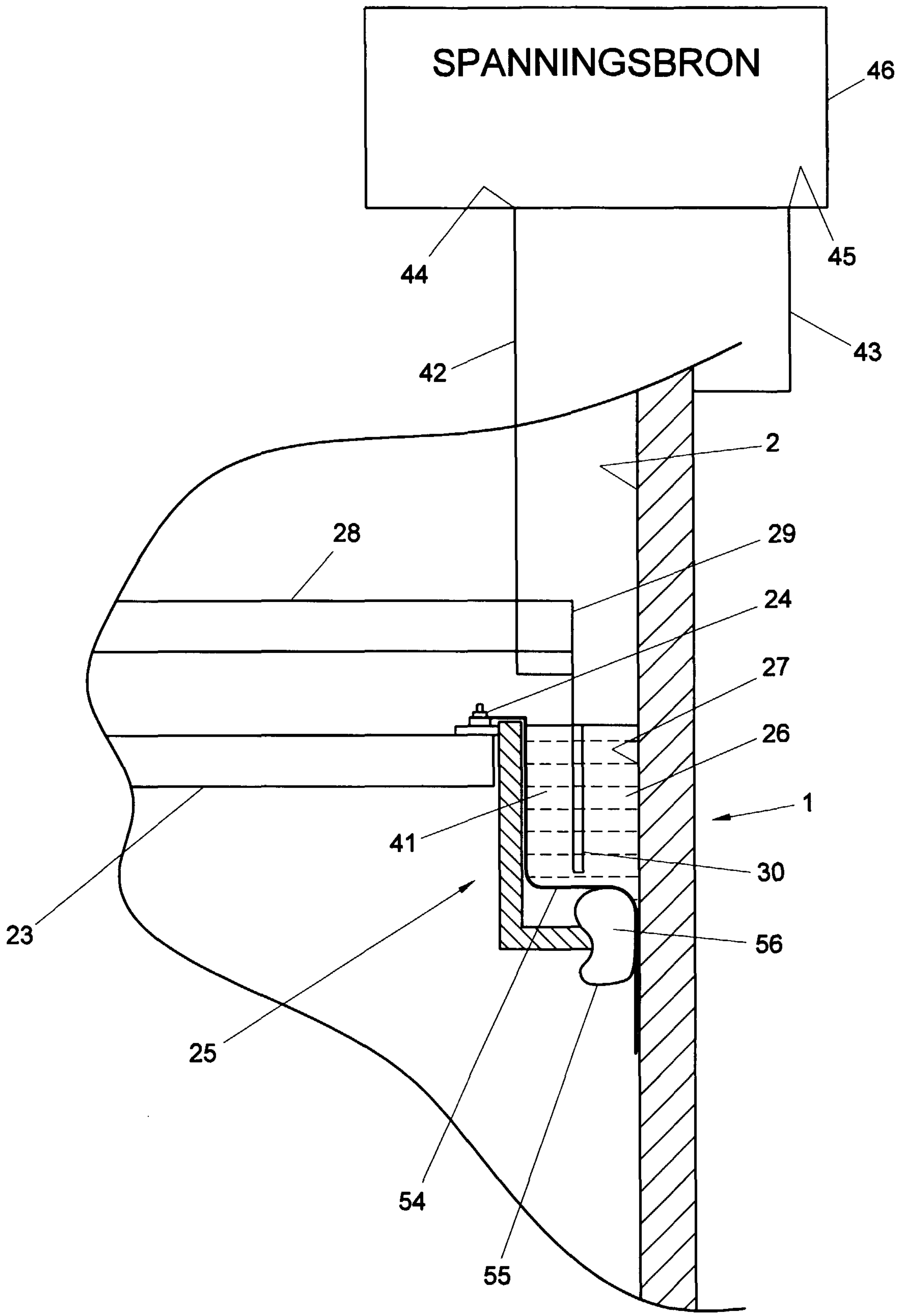

Fig. 4

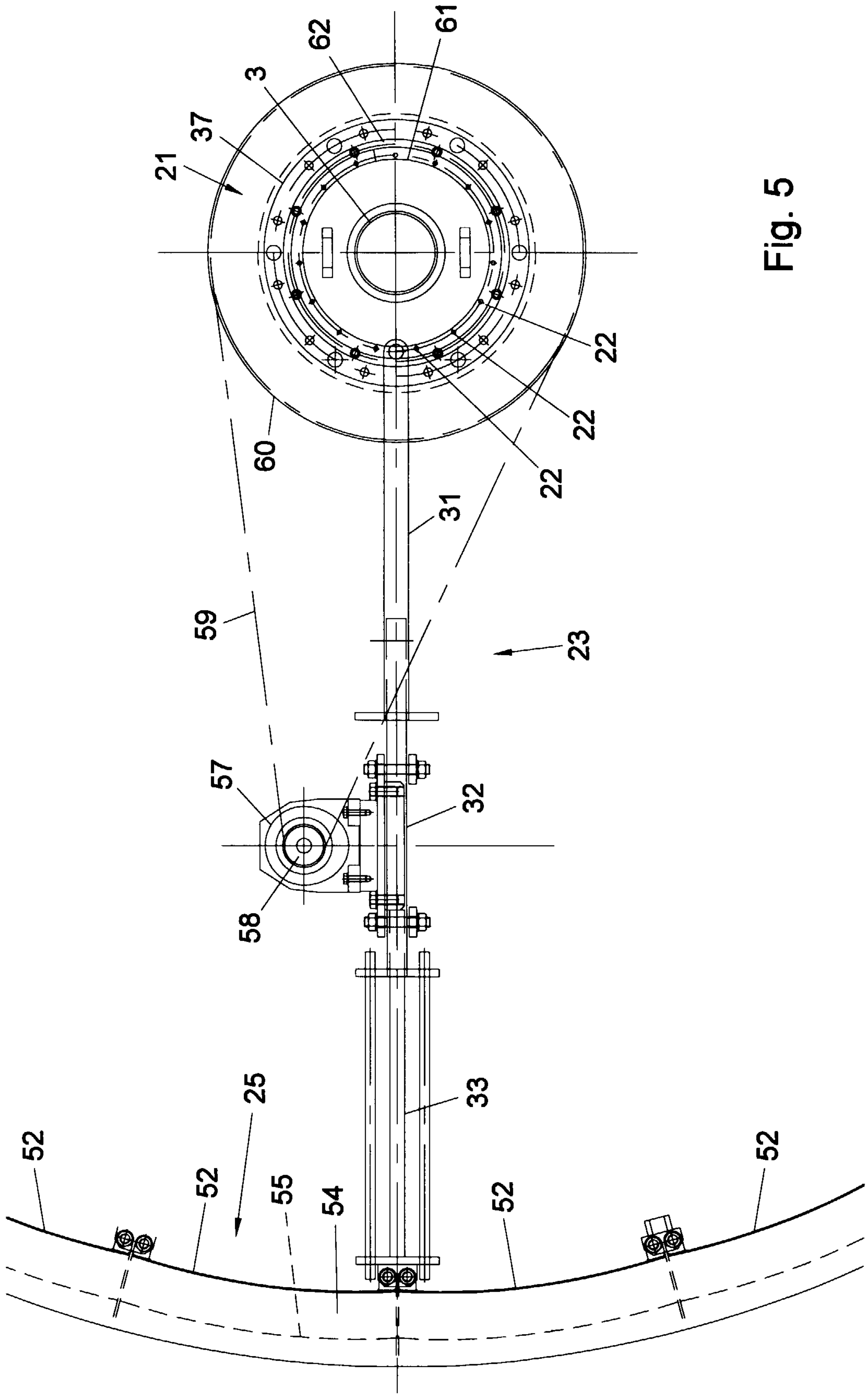

Fig. 5

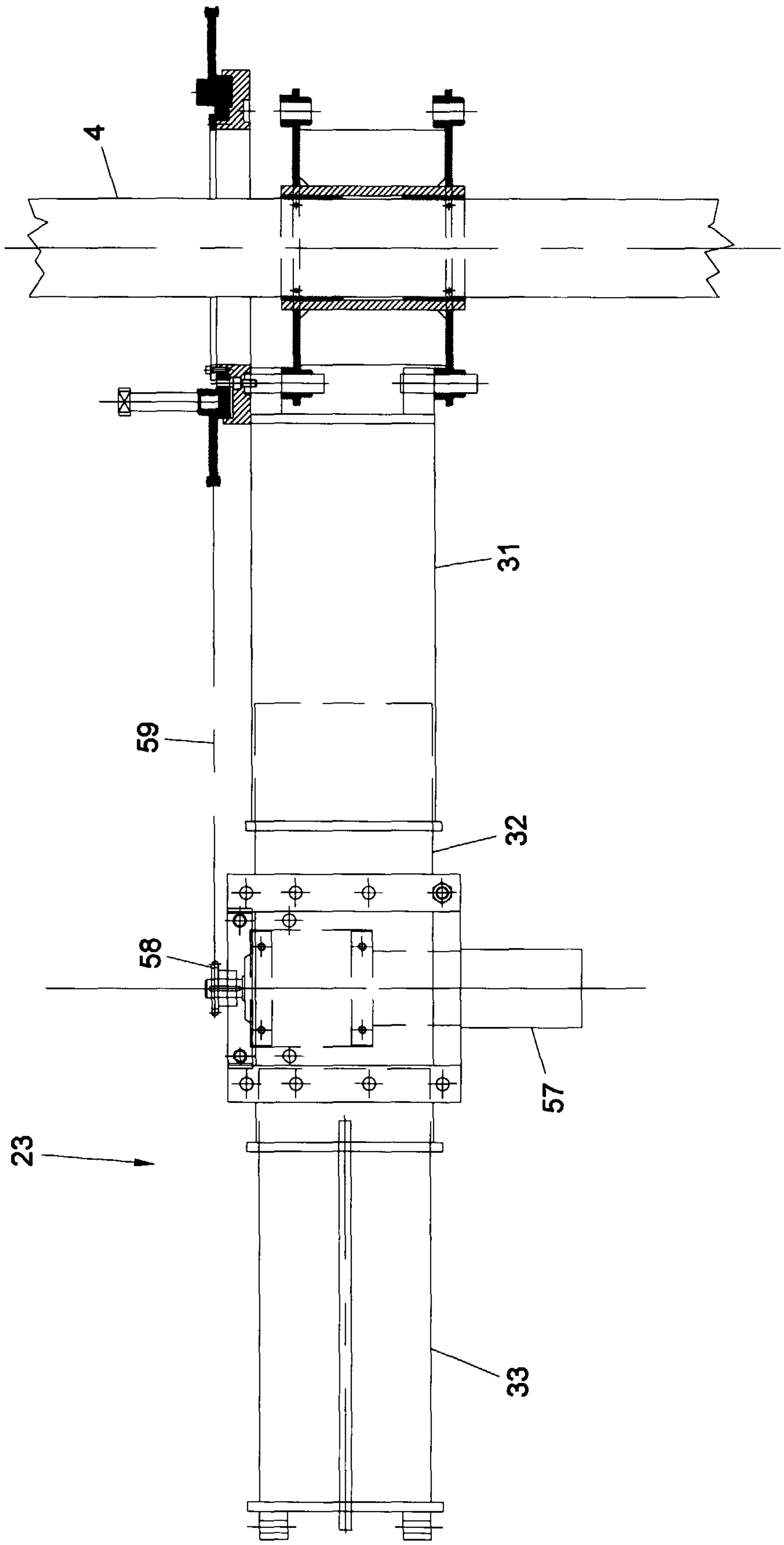

Fig. 6

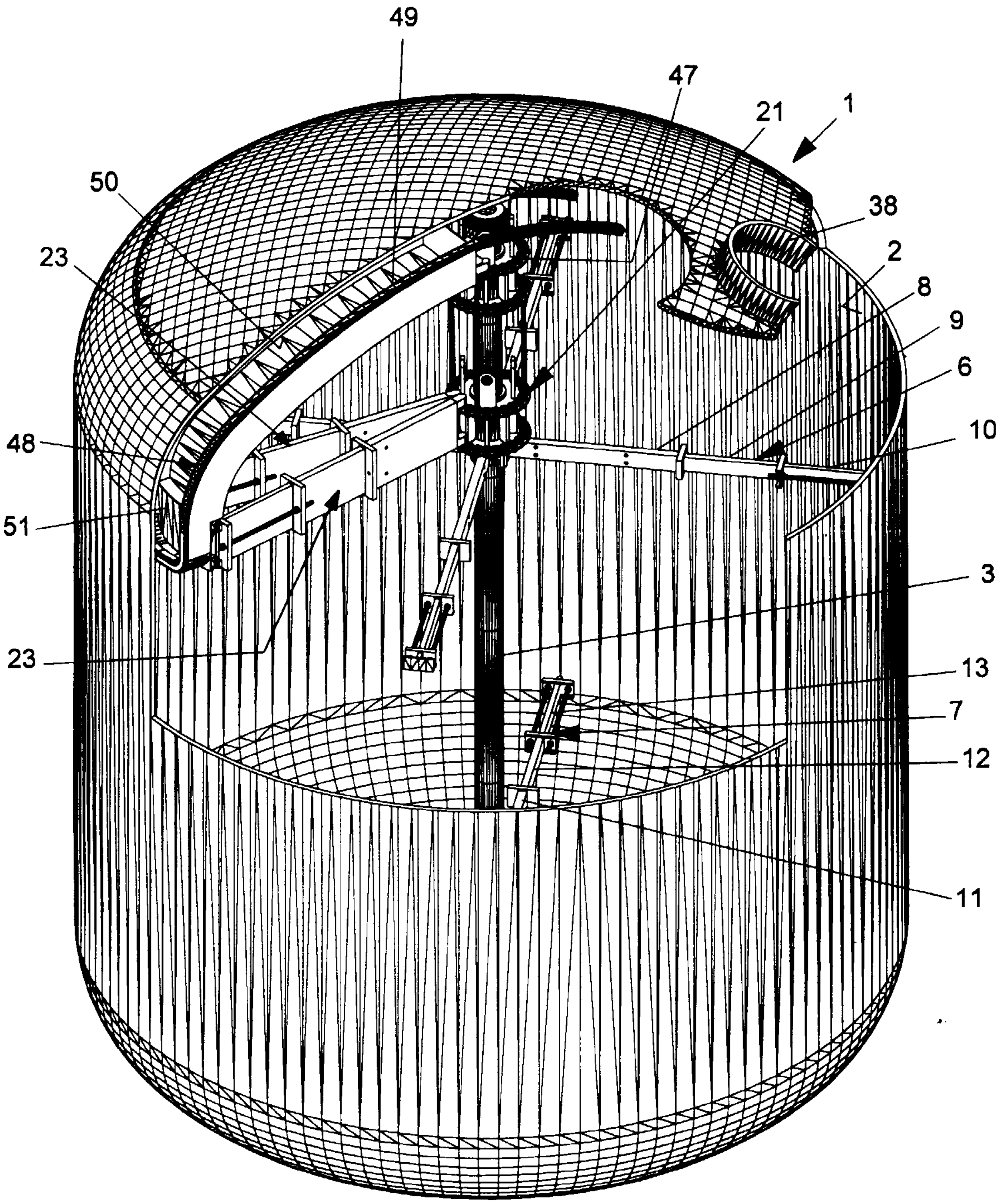

Fig. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 20 1324

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US 1 793 069 A (DUNKLEY) 17 February 1931 (1931-02-17) -----		C25F3/16 C25D7/04

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
C25D C25F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	3 August 1999	Van Leeuwen, R

CATEGORY OF CITED DOCUMENTS

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 1793069 A	17-02-1931	NONE	

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