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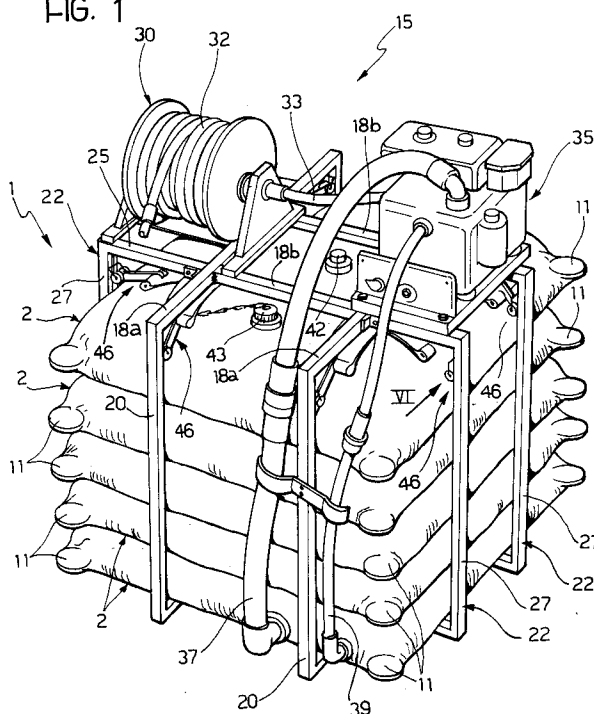
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**Via Cervino 8**(54) **A flexible tank for liquids and a process for its manufacture.**

(57) A flexible tank for liquids comprises superposed flexible containers (2) each constituted by a pair of sheets (2a, 2b) sealed together around their peripheries. Each container (2) is welded to the adjacent containers and its interior communicates with the interiors of the adjacent containers (2) through a

series of apertures. One of the flexible sheets (2a, 2b) which constitute each container (2) is more extensive than the other sheet and has projecting portions which are folded so as essentially to contain the sides of the less extensive sheet. Each container (2) has seal elements (11) welded to its vertices.

FIG. 1

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The present invention relates to flexible tanks for liquids.

In particular it relates to a tank of the type comprising:

- a plurality of superposed flexible containers which are substantially polygonal in plan, each being constituted by a pair of superposed flexible sheets sealed together along their peripheries, 5
- each container being welded to the adjacent containers along a weld line inside the periphery of the sheets, 10
- the interiors of the containers communicating with each other through a series of holes formed in the sheets inside the weld line and vertically aligned with each other, 15
- the interior of one of the containers communicating with the exterior of the tank through connector means. 20

A flexible tank of the type defined above is known, for example from Italian Patent Application No 53468-B/83.

The flexible tank described in this document comprises a plurality of containers each constituted by a pair of superposed flexible sheets having the same dimensions welded together around their peripheries. When the tank is full of liquid, the pressure of the fluid within it tends to open it and possibly to cause the welded flaps of the two flexible sheets constituting each container to come apart. 25

During transport of the tank full of liquid, in addition to the static load due to the pressure of the liquid alone, there is the added dynamic stress caused by the movement to which the entire tank is subjected which aggravates the tendency of the sheets forming a container to separate. 30

The object of the present invention is to provide a flexible tank in which the welding which joins the sheets constituting the various containers can better withstand the stresses produced by the liquid within the tank. 35

This object is achieved by virtue of the fact that one of the flexible sheets constituting each of the individual containers is more extensive than the other sheet and has projecting portions folded over the edges of the less extensive sheet so as to leave its vertices free, the projecting portions being welded to edge portions of the less extensive sheet and, also, each container being provided with seal elements welded at its vertices. 40

By virtue of this characteristic, the flexible containers forming parts of the tank of the invention do not have any tendency to separate even when acted upon by strong external stresses caused, for example, during transport of the tank full of liquid over broken roads. 45

A further subject of the present invention is a process for the manufacture of a flexible tank for liquids of the type comprising at least one flexible container having a substantially polygonal shape in plan and constituted by a pair of superposed flexible sheets sealed together along their peripheries, characterised in that it includes the following steps:

- arranging the two sheets, one of which is more extensive than the other sheet and has parts which project beyond the less extensive sheet, the projecting parts being able to be disposed in correspondence with the edges of the less extensive sheet leaving the vertices free, 5
- providing metallic strips of a length corresponding substantially to the sides of the less extensive sheet, 10
- superposing the said sheets with the metal strips interposed between them along the edges of the less extensive sheet, 15
- folding the projecting parts of the more extensive sheet over the edges of the less extensive sheet, 20
- welding the projecting parts of the more extensive sheet along the edges of the less extensive sheet in correspondence with the metal strips, leaving the vertices of the container open, 25
- removing the metal strips through the vertices of the container, and 30
- closing the vertices of the container by welding a seal element to each of them. 35

Further characteristics and advantages of the present invention will become apparent from the detailed description which follows, given with reference to the appended drawings, provided purely by way of non-limiting example, in which:

Figure 1 illustrates a flexible tank according to the present invention associated with a containing framework, 40

Figure 2 is a schematic elevational view of flexible containers forming part of the tank of Figure 1, 45

Figure 3 is a partially-sectioned side elevational view taken on the line III-III of Figure 2,

Figure 4 is a view similar to Figure 3 showing a detail indicated by the arrows IV-IV in Figure 2,

Figure 5 is a perspective view of the framework which surrounds the tank of the invention, 50

Figure 6 is a partially-sectioned side elevational view of a device for retaining the tank in the framework, indicated by the arrow VI in Figure 1, and 55

Figure 7 is a partially-sectioned elevational view of the device of Figure 6.

With reference to the drawings, a flexible tank for liquids is generally indicated 1. It includes a plurality of superposed flexible containers 2 which,

in the present embodiment, are substantially rectangular in shape.

Each container 2 includes an upper sheet 2a and a lower sheet 2b joined together around their peripheries by a weld 3 achieved, for example, by high-frequency vibrations.

The sheet 2a is more extensive than the sheet 2b and includes projecting portions 3a which can be folded so as to enclose the edges of the less extensive sheet 2b. The projecting portions 3a are shaped so as to enclose the edges of a sheet 2b leaving the vertices free. In order to achieve the welding 3 joining each of the sheets 2a to the respective sheet 2b, metal strips (not illustrated in the drawings) must be provided, the strips having a length approximately corresponding to the length of the sides of the less extensive sheet 2b and a width at least equal to the width of the weld which is wished to obtain. These metal strips are arranged along the sides of the less extensive sheet and then the two sheets 2a and 2b are superposed by the successive folding of the projecting portions 3a of the sheet 2a over the edges of the sheet 2b leaving apertures at the vertices of the container. The welding 3 is then effected so as to join the projecting portions 3a to the edge portions of the respective sheet 2b in correspondence with the metal strips. Subsequently the metal strips are withdrawn through the open vertices of the container. The open vertices of the container are then sealed in the manner which will be explained more fully in the description below.

Each of the containers 2 of the tank is made so that the pressure exerted by the liquid therein generates tangential forces between the sheets 2a and 2b in the welding zone 3. The welding achieved in the manner described above thus provides very good resistance to the stresses to which it is subjected, in which it differs from the welding in prior art containers in which the welds were, on the contrary, subjected to traction which tended to open the welds.

Each flexible container 2 is welded to the adjacent containers by a weld line 4 inside the weld lines 3.

Apertures 6 are formed inside the weld line 4 in each of the sheets 2a and 2b of adjacent containers 2, there being no less than five apertures as illustrated in Figure 2, each of these apertures having an edge 8 with projections 9 which extend perpendicular to the sheets and enable the sheets to be spaced from each other so as to facilitate the filling of the containers 2. The apertures 6 in the containers 2 of the tank are arranged so as to be vertically aligned with each other.

Seal elements 11 are provided at each vertex of the containers 2 and enable each container to be sealed after the welding of the sheets 2a and 2b.

Each element 11 includes two outer parts 11a located against the outer faces of the sheets 2a and 2b respectively and an inner portion 11b interposed between the sheet 2a and the sheet 2b of each container 2. The elements 11 are welded to the vertices of each container, for example by high-frequency welding.

The tank 1 is surrounded by a framework 15 (Figures 1 and 5) which comprises a rigid structure formed from upper cross-members 18a and 18b and lower cross-members 19a and 19b interconnected by uprights 20.

Pivotable frames 22 are articulated at 21 to the outwardly facing sides of the cross-members 18a and 19a, each frame including a pair of cross-members 25 which, in the open condition of the frames 22, can be arranged as extensions of the cross-members 18b and 19b of the rigid structure, the cross-members 25 being rigidly interconnected by uprights 27.

The uprights 20 and 27 are constituted by metal profiled sections having a longitudinal slot facing inwardly of the framework 15, in its open configuration, to allow access to the hollow interiors of the profiled sections for purposes which will be clarified below. Close to the articulations 21 of the frames 22 are anchoring devices 23 for clamping the frames 22 to the fixed structure of the framework 15 in their open position. These devices 23 for example comprise screws adapted to engage corresponding holes formed in the cross-members 25.

The pivotable frames 22 are particularly useful, for example, when the tank 1, with its framework 15, must be introduced into a space provided with a narrow opening. In this case, the framework 15 is first inserted through the opening with the frames 22 folded, afterwards the frames 22 are moved into their open position and clamped in these position by means of the anchoring devices 23.

Subsequently the tank 1 is inserted through the narrow opening into the framework 15.

An assembly 30 is rigidly fixed to the top of the framework 15 (Figure 1) and includes a rotatable drum on which is wound a flexible tube 32 connected by a connector 33 to a motor-pump unit 35 also connected rigidly to the top of the framework 15 and to which are connected, in known manner, a pair of ducts 37 and 39 which open into the lowermost container 2 of the tank 1.

The ducts 37 and 39 allow the emptying and filling of the tank 1; more particularly, one of these acts as an air vent during filling of the tank through the other duct while, during emptying of the tank, it is used for discharging liquid to the exterior.

On the upper face of the uppermost container 2 of the tank 1 is an automatic valve 42 which enables any air present in the tank 1 to escape.

A cap 43 is also provided on the upper face and can be used to facilitate refilling of the tank 1.

The upper container 2 of the tank 1 has associated retaining devices 46 whose function is to limit both transverse movements and vertical movements of the tank 1 when it is located within the framework 15. The devices 46 are particularly useful when the tank 1 is partially full and when it is subjected to oscillations in transport. In fact, in this case, it is possible to adjust the position of the upper face of the upper container 2 of the tank relative to the uprights 20 and 27 of the framework and to clamp it in this position by means of the devices 46.

Flexible belts 48 each having an eyelet 48a at one end are welded at 49 to the upper face of the uppermost container 2 of the tank 1. Each eyelet 48a is traversed by a pin 50 which engages a through-hole 53 formed in a rigid stabilising arm 51. The end of the arm 51 opposite that having the hole 53 is inserted into the cavity in the respective upright 20 or 27 through the said longitudinal slot indicated 52. The end of the arm 51 within the upright 20 or 27 has a through-hole 54 formed transversely thereto and to the upright and engaged by a pin 56 which, on opposite sides of the arm 51, carries two wheels 58 of deformable material, for example an elastomer or the like. The wheels 58 have radially-outer concave surfaces 59 so as to generate less friction during their rolling within the upright 22 or 27 and to provide their radially outermost part with greater deformability.

A substantially square annulus, or ring, 62 is articulated at 64 to each of the arms 51 while its side 66 opposite that which is engaged at 64 can pivot between an inactive position, for example located above the arm 51 and nearer the hole 53 (shown in chain line in Figure 7), to an active position in which the side 66 engages a transverse groove 68 in the arm 51 close to the hole 54 (continuous line in Figure 7).

Two wheels 58a, of the same type as the wheels 58, are located in correspondence with the articulation 64, also on opposite sides of the arm 51, the wheels being traversed by the ring 62 and serving as spacers to keep the ring 62 in a substantially centred position with respect to the arm 51.

In operation of the device 46, when the tank is full of liquid, for example even only partly, the ring 62 is in its inactive position described above.

When a downward force is exerted on each of the arms 51, the belts 48 are tensioned. The arms 51 being kept in this position, the ring 62 is rotated so as to engage the corresponding groove 68 such that the outermost side 66 of the ring 62 contacts the wall of the upright 22 (or 27) facing the tank 1, preventing movement of the device 46 along the

respective upright. In this position, the wheels 58 of deformable material located within the uprights 22 (or 27) deform and, in particular, their radially outermost parts 59 having the outwardly concave surfaces which are more easily deformable, deform. The clamping of the devices 46 enables the upper face of the uppermost container 2 of the tank 1 to be secured extremely effectively so as to limit upward and transverse movements of the tank relative to the framework 15, giving the tank-framework system the maximum stability.

## Claims

1. A flexible tank for liquids, of the type comprising:
  - a plurality of superposed flexible containers (2) which are substantially polygonal in plan, each being constituted by a pair of superposed flexible sheets (2a, 2b) sealed together along their peripheries,
  - each container (2) being welded to the adjacent containers (2) along a weld line (4) inside the periphery of the sheets (2a, 2b),
  - the interiors of the containers (2) communicating with each other through a series of holes (6) formed in the sheets (2a, 2b) inside the weld line (4) and vertically aligned with each other,
  - the interior of one of the containers (2) communicating with the exterior of the tank through connector means (37, 39), characterised in that one (2a) of the flexible sheets (2a, 2b) constituting each of the individual containers (2) is more extensive than the other sheet (2b) and has projecting portions (3a) folded over the edges of the less extensive sheet (2b) so as to leave its vertices free, the projecting portions being welded to edge portions of the less extensive sheet (2b) and, also, each container (2) being provided with seal elements (11) welded at its vertices.
2. A tank according to Claim 1, characterised in that each of the seal elements (11) welded to the vertices of each container (2) has an inner portion (11b) interposed between the more extensive sheet (2a) and the less extensive sheet (2b) and two outer portions (11a) located outside the more extensive sheet (2a) and the less extensive sheet (2b) respectively, these outer portions (11a) and the inner portion (11b) being connected together.
3. A tank according to Claim 2, characterised in that the connector means comprise a first duct (37) and a second duct (39) both connected to

the lowermost container (2), the first duct (37) acting as an air vent during filling of the tank (1) effected through the second connector (39) and as an outlet for liquid during emptying of the tank (1).

4. A tank according to Claim 3, characterised in that the uppermost container (2) has an automatic valve (42) for allowing air to flow out of the tank (1).
5. A tank according to any one of Claims 1 to 4, characterised in that the tank has a framework (15) which surrounds the tank (1) and includes a plurality of uprights (20, 27) and an adjustable retaining device (46) for anchoring the upper face of the upper container (2) of the tank (1) to the framework (15), the device (46) including tie connecting means (48, 49, 50, 51) each having one end connected to the container (2) and its opposite end slidably engaged with a respective upright (20, 27) forming part of the framework (15).
6. A tank according to Claim 5, characterised in that the tie connecting means include a belt (48), each disposed in correspondence with an upright (20, 27) of the framework (15), an arm (51) being articulated to each of the belts (48) and adapted to engage slidably with a respective upright (20, 27).
7. A tank according to Claim 6, characterised in that the uprights (20, 27) are hollow and have a longitudinal respective slot (52) facing the tank (1), said slot (52) being traversed by one end of a respective stabilising arm (51), and in that the guide means are wheels (59) which can run within the uprights (20, 27), the wheels (58) being articulated at the opposite end of the respective stabilizing arm (51) from the belt (48).
8. A tank according to Claim 7, characterised in that the stabilising arms (51) include means (62, 68) for adjusting the height of the tank (1) relative to the framework (15).
9. A tank according to Claim 8, characterised in that the means for adjusting the height of the tank (1) include a clamping ring (62) articulated to the stabilising arm (51), the ring (62) being pivotable between an inactive position and an active position in which it engages a groove (68) in the respective stabilising arm (51) so as to interfere with the respective upright (20, 27) whereby movements of the top of the tank (1) longitudinally of the respective upright (20, 27)

are prevented.

10. A tank according to Claim 9, characterised in that the wheels (58) are resiliently deformable.

11. A tank according to Claim 10, characterised in that the radially-outer surfaces of the wheels (58) are outwardly concave (59).

12. A tank according to Claim 5, characterised in that the framework (15) includes pivotable frames (22) hinged to a ridged structure (18a, 18b, 19a, 19b, 20).

13. A process for the manufacture of a flexible tank for liquids of the type comprising at least one flexible container (2) having a substantially polygonal shape in plan and constituted by a pair of superposed flexible sheets (2a, 2b) sealed together along their peripheries, characterised in that it includes the following steps:

- arranging the two sheets (2a, 2b), one of which (2a) is more extensive than the other sheet (2b) and has parts (3a) which project beyond the less extensive sheet (2b), the projecting parts (3a) being able to be disposed in correspondence with the edges of the less extensive sheet (2b) leaving the vertices free,
- providing metallic strips of a length corresponding substantially to the sides of the less extensive sheet (2b),
- superposing the said sheets (2a, 2b) with the metal strips interposed between them along the edges of the less extensive sheet (2b),
- folding the projecting parts (3a) of the more extensive sheet (2a) over the edges of the less extensive sheet (2b),
- welding the projecting parts (3a) of the more extensive sheet (2a) along the edges of the less extensive sheet (2b) in correspondence with the metal strips, leaving the vertices of the container (2) open,
- removing the metal strips through the vertices of the container (2), and
- closing the vertices of the container (2) by welding a seal element (11) to each of them.

14. A process according to Claim 13, characterised in that each of the seal elements (11) comprises an inner portion (11b) adapted to be interposed between the more extensive sheet (2a) and the less extensive sheet (2b) and a pair of outer portions (11a) adapted to be located outside the more extensive sheet (2a)

and the less extensive sheet (2b) respectively,  
the outer portions (11a) and the inner portion  
(11b) being connected together.

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FIG. 1

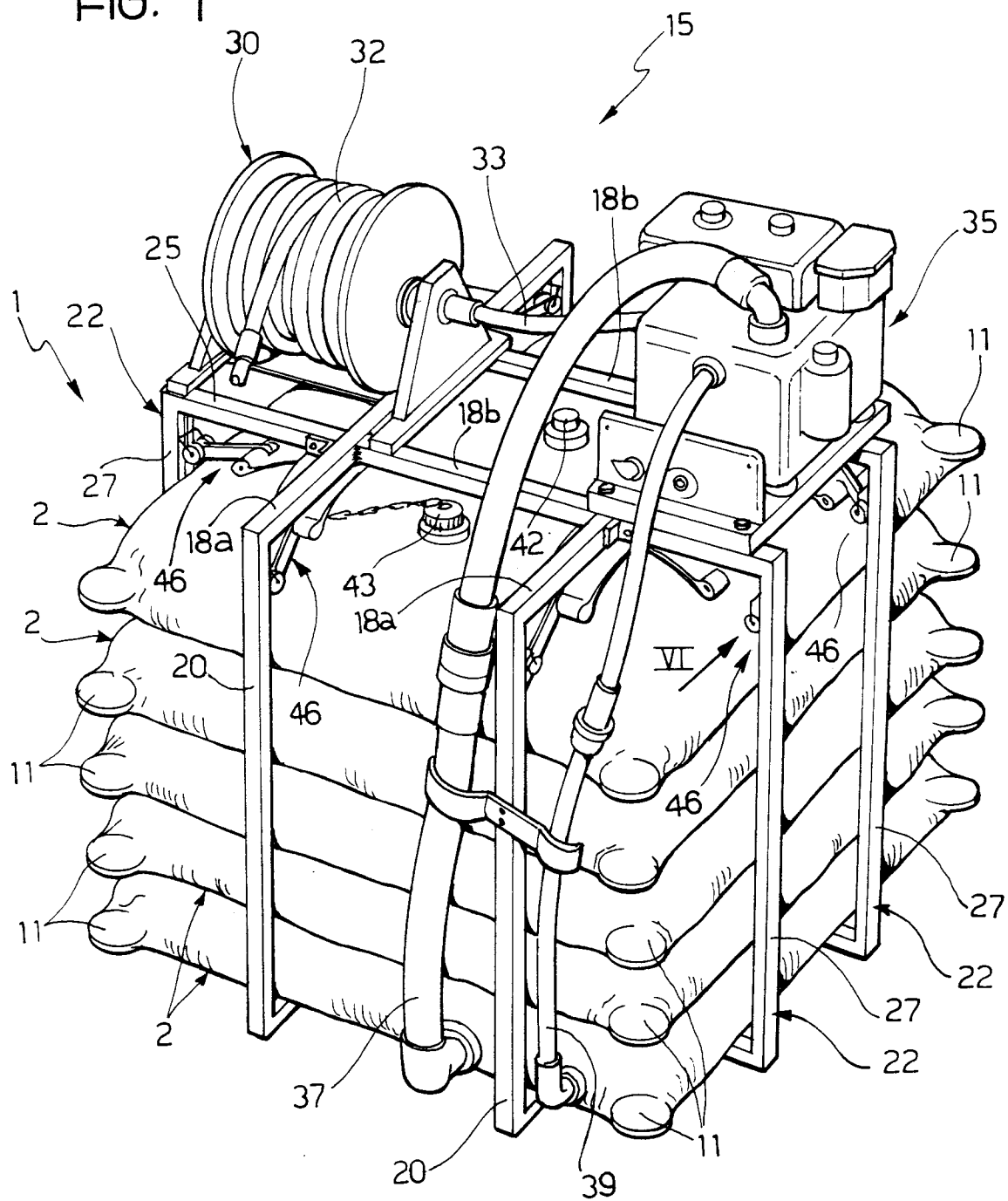


FIG. 2

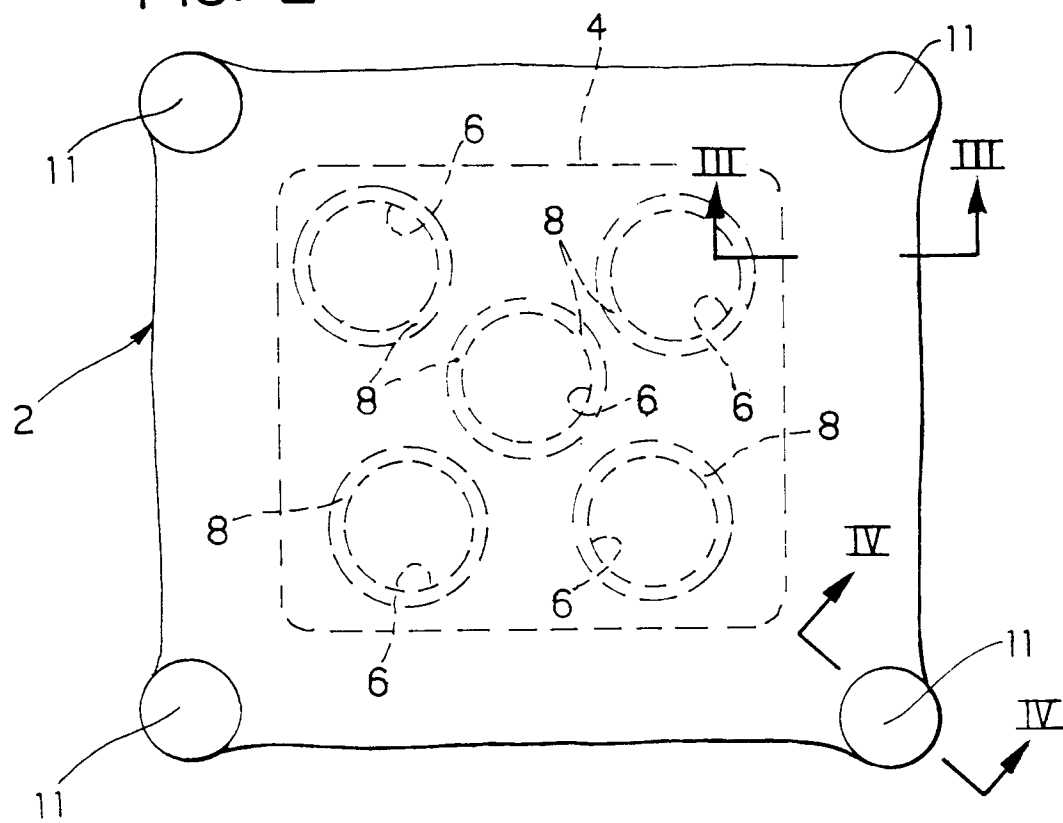


FIG. 3

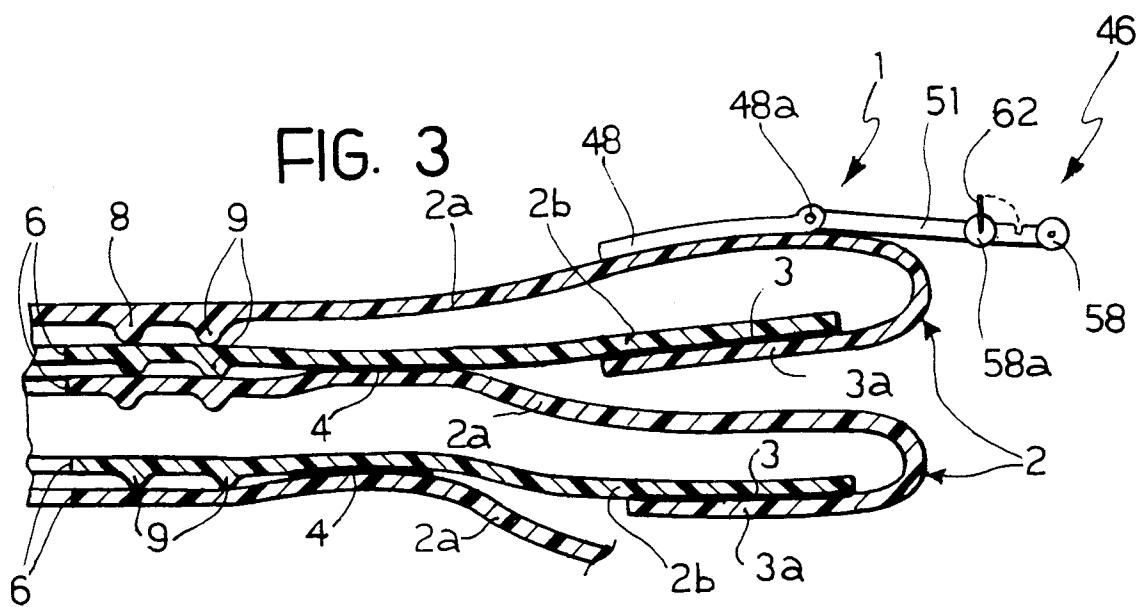


FIG. 4

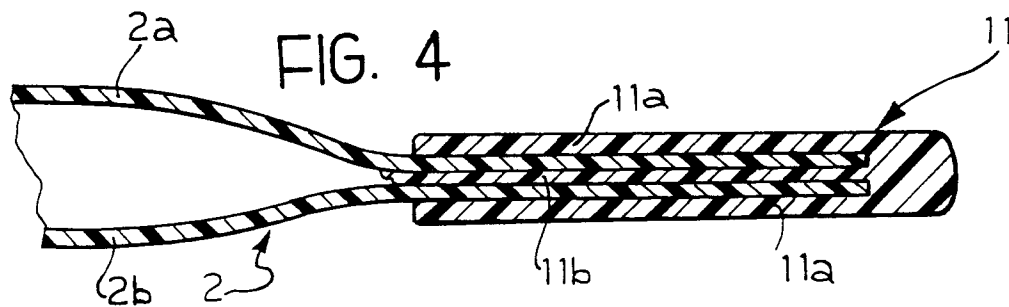
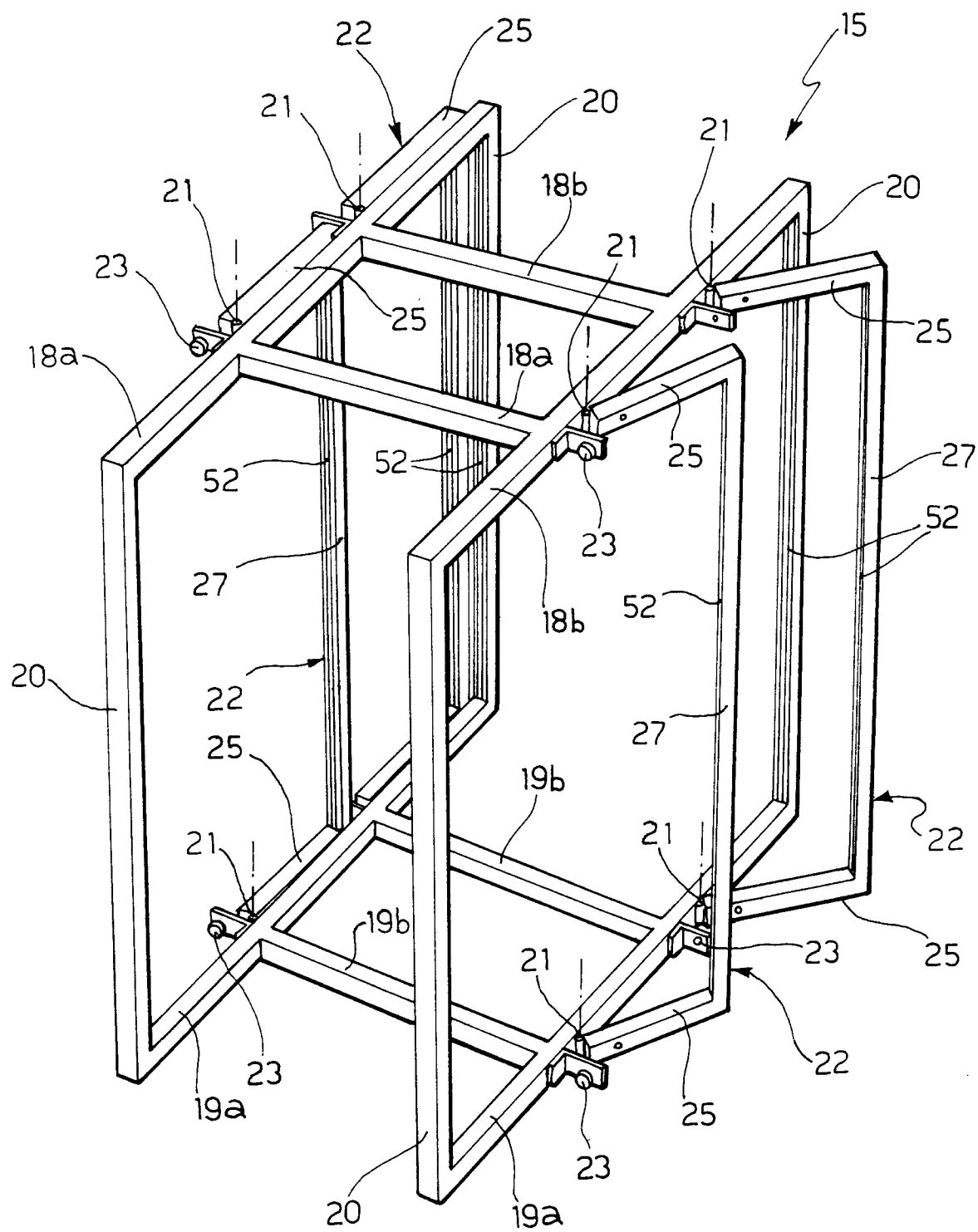
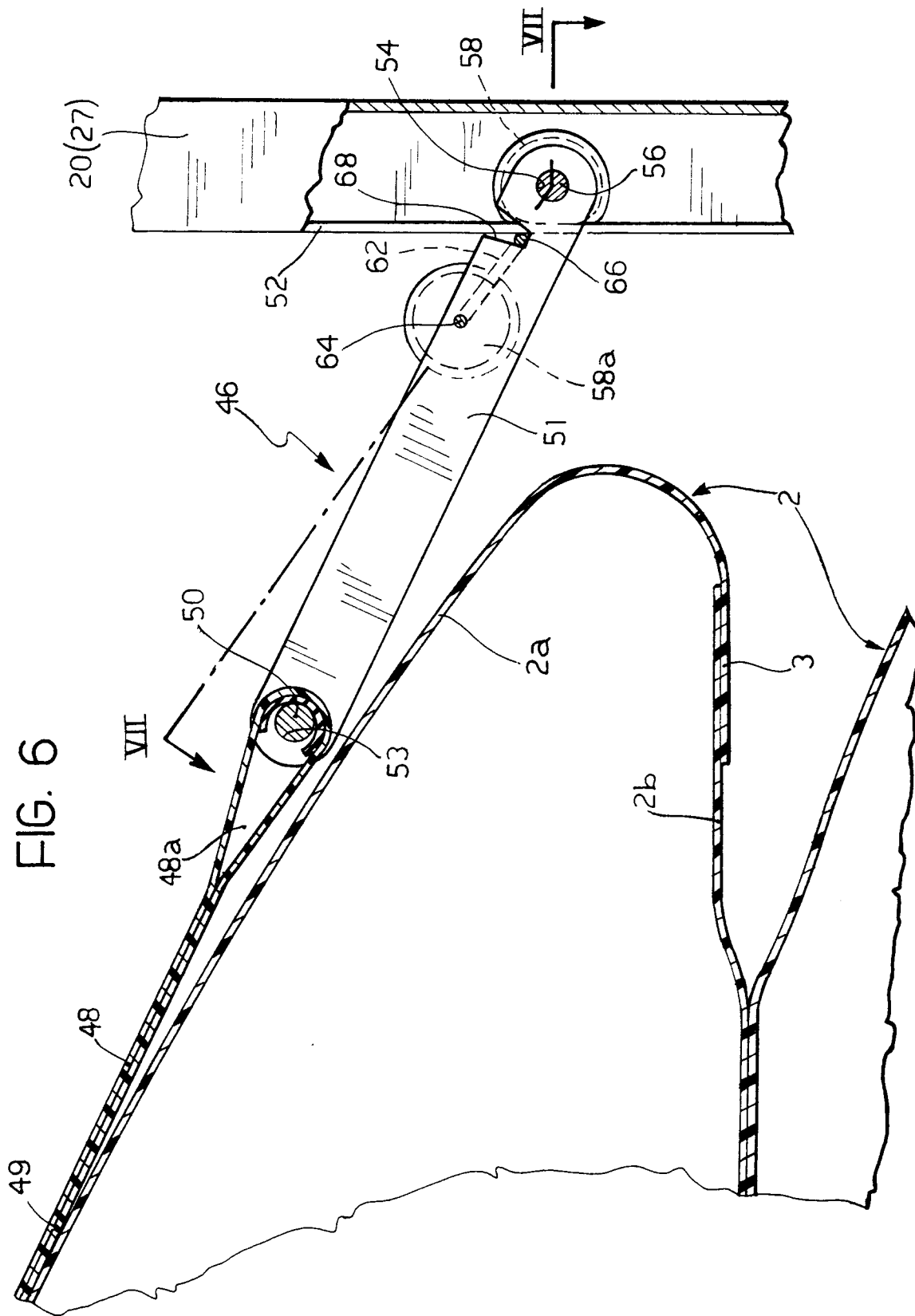




FIG. 5









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# EUROPEAN SEARCH REPORT

Application Number

EP 93109766.1

## DOCUMENTS CONSIDERED TO BE RELEVANT

| 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.5) |
| A                                                                                | <u>US - A - 3 724 497</u><br>(FEDERER et al.)<br>* Abstract; fig. 1 *<br>---                         | 1, 5              | B 65 D 88/22                                  |
| A                                                                                | <u>FR - A - 2 547 562</u><br>(PROMETEO SRL)<br>* Abstract; fig. 1-5 *<br>D & IT-B-53 468/83<br>----- | 1                 |                                               |
|                                                                                  |                                                                                                      |                   | TECHNICAL FIELDS SEARCHED (Int. Cl.5)         |
|                                                                                  |                                                                                                      |                   | B 65 D<br>B 29 C                              |
| The present search report has been drawn up for all claims                       |                                                                                                      |                   |                                               |
| Place of search<br>VIENNA                                                        | Date of completion of the search<br>24-09-1993                                                       |                   | Examiner<br>WIDHALM                           |
| CATEGORY OF CITED DOCUMENTS                                                      |                                                                                                      |                   |                                               |
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