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(54) An outer protection and secondary containment system for an underground metal tank for liquid hydrocarbons and a structural element thereof

(57) An outer protection and secondary containment system for an underground cylindrical metal tank (1) for liquid hydrocarbons comprising two identical half shells (9,10) in plastics, having a generically cylindrical wall closed at one end by a cap (11,12), the half shells being force-fitted on the cylinder of the tank (1) so as to mutually couple with two flanges (13,14) formed at their open end, the cylindrical wall being provided with projections (45), extending inwardly or with bellows-like corrugations so as to form a space between the half shells and the tank, with spacing and coupling between the half shells (9,10), at one side and the tank (1) at the other, ensured by said projections (45) or said bellows-like corrugations (17,19).

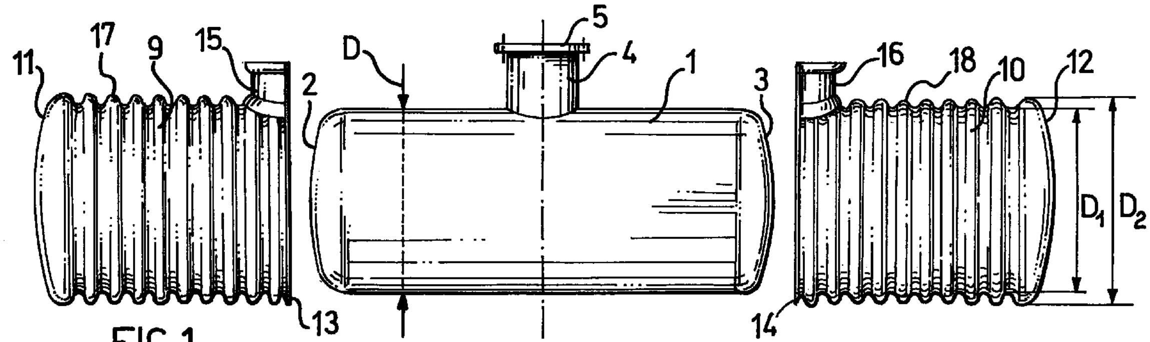

FIG.1

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Description

The present invention relates to an outer protection and secondary containment system for an underground metal tank for liquid hydrocarbons such as petrol, gas oil, naphtha and contaminant liquids in general, and to a structural element thereof.

It is known to store liquid hydrocarbons and contaminant liquids in general with the use of cylindrical metal tanks which are closed at the ends by generally rounded caps and have access turret or hatch and which are installed underground in pits with the turret housed in shaft also underground and accessible for connection to the tank by means of a closure plate.

Various solutions have been developed for preventing and reducing the corrosive and mechanical effects exerted directly on the tank by the soil.

According to a first solution which has now fallen into disuse, the pit is covered with a waterproofing concrete layer which forms a secondary containment for the tank with the formation of a space to prevent the tank, which is supported by suitable supports, directly contacting the soil and the walls of the pit and to ensure that any leakages from the tank due to breakage or perforation are contained in the space.

This solution does not provide any protection for the tank during its transportation and installation, presents considerable difficulties in the production of a removable cover for the pit, and is very expensive.

Current trends are therefore towards the production of tanks buried directly in the ground, with which it is necessary to ensure adequate cathodic protection against corrosion and mechanical protection against local stresses.

For example, the patent US-A-4,672,366 describes an underground tank around which a hermetically sealed plastics container constituted by a cylindrical cover and two end plates heat-sealed onto the cover is formed before installation.

Interposed between the secondary container and the metal tank are a spacer grid forming a suitable space and, locally near a liquid leakage sensor housed in the space, also an absorbent felt which concentrates any leakages close to the sensor.

This solution is also not completely satisfactory because it does not ensure adequate anchorage of the outer casing to the inner tank, does not offer sufficient mechanical protection, requires laborious assembly operations and is quite expensive.

For improved mechanical protection, tanks for underground installation have also been proposed, as described in the patents US-A- 4,739,659 and US-A-4,676,093, with double containment walls made entirely of plastics material reinforced with glass fibre, in which an inner cylindrical container has external annular ribs which act as anchoring spacers on which an outer container is formed and fixed.

This solution is also complex and expensive and does not satisfy the needs often imposed by applications which require the obligatory use of a metal tank.

These limitations are overcome and the requirement to ensure adequate protection and secondary containment for a metal cylindrical underground tank is satisfied by the outer protection and secondary containment system for an underground metal tank of the present invention in which two cylindrical socket-like plastics half-shells, preferably of high-density polyethylene, coupled axially by heat-sealing of the lips which advantageously are flanged, have cylindrical walls with internal projections forming spacers for bearing on the surface of the metal tank or, alternatively, cylindrical walls corrugated like bellows with the formation of hollow annular ribs projecting on a minimum inside wall diameter equal to, or advantageously less than, the diameter of the cylindrical metal tank, onto which the half-shells are forced without clearance, use being made of the resilience of the half-shells afforded partly by the resilience of the material and, more significantly, by the bellows-like shape of the cylindrical wall.

In the first case, a substantially continuous space is formed between the metal tank and the plastics container and is interrupted only at the localized bearing points constituted by the projections.

In the second case, the space is constituted by a plurality of annular cavities each disposed between the metal tank and one of the ribs and communicating with one another by means of annular contact regions between the metal tank and the outer plastics container, which regions are not impervious.

Advantageously, according to a further aspect of the present invention, intercommunication between the annular cavities is facilitated by grooves which interrupt the continuity of the annular contact regions transverse the ribs and inside the plastics container.

Advantageously, according to a further aspect of the present invention, two half-collars are formed integrally with the two half-shells and are coupled to form a sealing collar for partially housing the hatch.

Sealing is advantageously achieved by a sealing ring clamped by a pivoted clamp which can be opened.

The characteristics and advantages of the invention will become clearer from the following description given with reference to the appended drawings, in which:

Figure 1 is an exploded section showing a preferred embodiment of the outer protection and secondary containment system according to the present invention,

Figure 2 shows, in section, the underground installation of the system of Figure 1,

Figure 3 is a section taken on the line I-I of Figure 2 showing a first structural detail of the system of Figure 1,

Figure 4 is a section taken on the line II-II of Figure 2 showing a variant of the secondary containment of the system of Figure 1,

Figure 5 is an exploded perspective view of a second structural detail of the system of Figure 1,

Figure 6 shows a variant of the structural detail of Figure 5 in diametral section,

Figure 7 is a mixed partial frontal view and partial diametral section of a first variant of the protection system according to the present invention,

Figure 8 is a section taken on the line I-I of Figure 2 showing a second variant of the system of Figure 1,

Figure 9 is a section according to the view of Figure 2 showing a structural detail of a preferred coupling for the thermoplastic welding of two half-shells forming the secondary containment of the system of Figure 1,

Figure 10 is a section according to the view of Figure 2 showing an improvement of the outer protection system of Figure 1 for the formation of a hatch-access shaft integral with the secondary containment,

Figure 11 shows the structural improvement of Figure 10 according to the view III-III of Figure 10.

With reference to Figures 1 and 2, a metal tank for liquid hydrocarbons, for installation underground, is constituted by a cylindrical body 1 of outside diameter D, closed at its ends by two generally hemispherical caps 2, 3, welded to the body 1.

In a central portion of the cylindrical body 1, relative to its axis, there is a cylindrical hatch 4 with a flanged lip closed by a plate 5 which is sealingly coupled with the flange of the hatch.

The plate 5 has members of known type, not shown, for the admission and extraction of liquid, for level measurements and for keeping the tank at atmospheric pressure.

As shown in Figure 2, the tank is installed underground in a pit in a horizontal position with the hatch 4 disposed at the top and housed in a shaft 6 formed by a concrete ring 7 disposed above the tank.

To ensure adequate protection of the tank from corrosion and mechanical stresses exerted locally by the ground on the tank (large stones and the like) and, at the same time, to form a secondary containment which, on the one hand, prevents contact of phreatic water with the tank, and on the other hand prevents any leakages of liquid from the tank being dispersed in the ground and contaminating it, a secondary container 8 of plastics material, preferably high-density polyethylene, is provided and encloses the entire metal tank.

The secondary container 8 is formed by two generally cylindrical half-shells 9, 10, each having an end closed by a generally hemispherical cap 11, 12 and an open end having a flat annular flange 13, 14.

At the open ends of the two half-shells, their generally cylindrical walls extend outwardly to form two cylindrical half-collars 15, 16.

The cylindrical walls of the two half-shells 9, 10 are corrugated with a plurality of annular corrugations 17, 18 like bellows.

These corrugations, which are distributed over the entire axial lengths of the half-shells 9, 10, form hollow annular ribs which have minimum inside diameters D1 and maximum diameters D2 and which increase the stiffness of the half-shells in a radial direction relative to the axis of the cylinder and confer a certain resilience to the half-shells in an axial direction.

The minimum inside diameter D1 of the half-shells at the minimum diameter of the ribs 17, 18 is advantageously equal to or slightly less than the diameter D of the tank 1.

The two half-shells 9, 10 can therefore be fitted on the tank 1 by being pulled gradually from the ends of the tank towards its central portion.

Although the minimum diameter D1 of the half-shells is less than the diameter of the tank, the operation is easy because, as is known, if a cylindrical bellows is subjected to tensile stress, the extension of the bellows also involves dimensional changes in a radial direction which decrease its maximum diameter and increase its minimum diameter.

When the half-shells 9, 10 are fully fitted on the tank, the two flanges 13, 14 are juxtaposed in contact with one another.

The joint is easily sealed by known plastics heat-sealing methods or by bonding with suitable resin.

This aspect will be considered in greater detail below.

When the half-shells are fully fitted on the tank 1 the two cylindrical half-collars 15, 16 are also juxtaposed in the plane of the flanges 13, 14 forming a collar which surrounds a portion of the tank hatch 4.

The juxtaposed ends of the two half collars 15, 16 may have flat lips, extensions of the flanges 13, 14, and the joint can be sealed by heat-sealing or bonding.

Clearly a secondary container which completely encloses the tank 1 and which is firmly anchored thereto by contact friction between the innermost portions of the ribs and the outer surface of the tank 1 is thus obtained.

A space of variable thickness constituted by the internal cavities of the various ribs is also formed between the tank 1 and the secondary container.

The internal cavities of the various ribs intercommunicate in the region of contact of the ribs with the outer wall of the tank, which region is not impervious.

Broader communication between the internal cavities of the various ribs can be provided, as shown in Figure 3, by at least one transverse groove 19 formed in the innermost portions of the ribs, preferably along a generatrix of the two cylindrical half-shells disposed below the tank.

More generally, as shown in the section of Figure 4, the ribs may be replaced by a plurality of advantageously rounded, crucible-shaped recesses formed in the outer walls of the plastics half-shells and corresponding to projections 45 inside the half-shells.

The heights of the projections, which are of the order of 50-60 mm, are defined according to the diameter of the tank so that the heads of the projections contact the surface of the tank.

The diameters of the projections may be of the order of 50-70 mm with interaxial spacings of the order of 150 mm between the projections which are distributed uniformly over the entire inner surface of the plastics half-shells at the junctions of a theoretical square-mesh network.

The presence of the projections ensures a certain radial resilience of the half-shells which enables the half-shells to be fitted easily on the metal tank and, at the same time, provides distributed contact and bearing points between the half-shells add the tank 1.

In this case also, a space is formed between the outer container and the tank.

A detector for detecting the presence of liquid may be disposed in the space, in known manner.

According to more sophisticated arrangements used for tanks with double containment barriers, the pressure in the space may also be kept at a controlled value which may differ from atmospheric pressure, so that variations of pressure in the space provide an indication of any leakages from the space (which reduce the pressure), and of any infiltrations into the space, which increase its pressure.

In this case it is necessary to ensure a perfect seal between the collar 15, 16 and the outer wall of the hatch 4 of the tank 1.

The seal can be achieved by the interposition between the half-collars 15, 16 and the hatch 4 of a band of resilient material or a resilient sealing ring (through which the connections to the liquid and/or pressure detector devices housed in the space can be passed).

A suitable compression of the seal can be achieved by making use of the relative resilience of the plastics material, with a pivoted clamp clamping the two half collars.

As shown in Figure 4, the upper ends of the two half-collars 15, 16 can be expanded radially to form a socket 20 for housing an O-ring 21 of resilient material and the socket 20 can be clamped by a pivoted two-part clamp 22, 23, closed by means of a bolt.

The two elements 22, 23 provide convenient recesses at the articulation 24 and at the two free ends 25, 26 to prevent interference with any welding flanges 27, 28, 29, 30 of the two half-collars.

Figure 6 shows in section a detail of an alternative embodiment of the seal clamp, similar to the previous one.

In Figure 6, the half-collars are expanded into a housing socket having a conical base 31 for supporting an O-ring 32 housed in the socket.

A clamp 33 with a tapered C-shaped cross section forming a hollow housing with a trapezoidal cross-section engages the base of the socket and the O-ring 32 between its two flanges forcing the O-ring into sealing contact against the base of the socket and against the outer surface of the hatch 4.

Figure 7 is a partially sectioned view of a system for sealing the space formed by a plastics container for a metal tank, in which the plastics container has no hatch collar.

In this case the container, again formed by two coupled half-shells has a through-hole for the hatch.

The edges of the hole are advantageously shaped like semi-toroidal seatings 34 housing a resilient seal 35 interposed between the seating 34 and the tank 1.

An annular rigid compression seating 36 is superimposed outside the container (in two pieces or with suitable recesses for the welding flanges of the two half-shells).

The compression seating 36 is urged against the tank 1 by suitable screw compression rods 37, 38 ... 41, engaged in threaded seats in a flange 42 fixed to the hatch 4.

Many variations and improvements may be made to the outer protection and secondary containment covering described.

For example, the hemispherical end caps 11, 12 of the half-shells 9, 10 may be reinforced by ribs, preferably radial ribs, or by combinations of radial and annular ribs, or may have single inwardly-projecting and suitably spaced projections of the type shown in Figure 5.

The dimensions of the ribs may be selected within wide limits and preferably, in the case of annular ribs of the half shells, have spacings of between 10 and 30 cm and sinusoidal or, in any case, rounded profiles without sharp corners and with a peak/peak height of between 5 and 10 cm.

The thickness of the walls of the container is conveniently between 5 and 10 mm, which can easily be achieved by rotational moulding processes for high-density polyethylene.

In this connection it must be pointed out that the formation of the secondary container with two identical half-shells enables optimal use to be made of a single forming mould of small dimensions, even if the container is intended to house large-capacity metal tanks of 30-40m^3 and hence with diameters and lengths of the order of several metres.

In the foregoing description, in order to achieve the axial resilience of the container and its radial stiffness, reference has been made to annular ribs disposed side by side but, clearly, the same effect, associated with a change in the minimum inside diameter in dependence on the elongation brought about can be achieved by ribs arranged helically and connected to one another to form a single continuous helical rib or several interlaced helical ribs as in the case of screws with one or more starts.

The secondary container may be fitted on the metal tank either at the place of installation or, as is preferable, at the place where the metal tank is produced.

In this latter case, the secondary container provides adequate protection for the tank against corrosion and any impacts throughout the stages subsequent to production such as transportation to a storage area or to a place of installation and related handling.

Figure 8 shows another possible variant which facilitates the handling and storage of the protection system and eliminates the need to provide supports.

In fact, the cylindrical configuration of the assembled system and the presence of the hatch clearly do not permit the system to be stored on a flat surface in a condition of stable equilibrium.

The container tends to rotate and adopt a stable position only when the end of the hatch is also bearing on the ground, taking up a larger storage area and involving the need to reorient the container with the hatch in the vertical position for transportation and installation.

In order to prevent this problem, as shown in Figure 8, the ribs of the container may have tips shaped to form a flat surface 43 diametrally opposite the hatch or may even be shaped to form support feet which ensure a stable attitude of the container supported on a surface.

The tips of the various ribs are spaced by recesses which facilitate the slinging of the system on metal cables passing through the recesses in order to lift it, to load it on transportation means and to install it in a suitable position.

In the case of a container in which the ribs are replaced by inwardly-oriented projections, in order to achieve the same effect, external projections of the cylindrical surfaces of the half-shells can be provided with the same function of ensuring stable support and, if necessary, spaces for the passage of slinging cables or belts.

The support feet thus formed may also constitute eyes for anchoring to a ballast plate outside the secondary containment disposed in the pit for the underground installation of the system. However, with regard to the large hydrostatic forces which may be exerted by waterlogged ground on large-capacity tanks installed underground, it is preferable for anchorage to ballast plates to take place by means of binding cables or belts which surround the secondary container externally.

The two plastics half-shells which form the secondary container are preferably coupled, as already stated, by thermoplastic welding of the open ends of the half-shells.

These can be turned outwardly to form flat annular flanges which are pressed against one another with suitable clamps and connected to one another by thermoplastic welding.

According to a preferred embodiment shown in the enlarged and partially sectioned view of Figure 9, each of the two half-shells 9, 10 has a flat annular flange 46, 47 turned inwardly at its open end, that is, extending towards the interior of the cylindrical walls of the two half-shells, whether these be of the type with annular ribs or of the type with projections extending inwardly relative to the half shells.

The flanges 46, 47 are juxtaposed, preferably but not necessarily in contact with one another, and their free edges bear against the outer surface of the tank 1, possibly with the interposition of a ring segment 48 of plastics material extending around the tank 1 and as far as the hatch.

The tank 1, with any interposed segment 48, provides a bearing surface for the edges of the flanges 46, 47 for the application of an external radial force exerted by thermoplastic welding devices operating with heating by contact with the supply plastics welding material.

The plastics welding material 49 supplied fills the space present between the flanges, welding them together.

Any plastics segment 48 contributes to the welding by partial fusion and, at the same time, forms a thermally insulating barrier with respect to the tank 1.

Figure 10 is a section of a detail showing a further improvement of the secondary container which enables a shaft 6 to be formed for access to the hatch 4, the shaft being isolated from the surrounding soil at the bottom and impervious to infiltrations of liquid and being formed by a ring 7 of plastics material welded to the secondary container.

Both in the case of a secondary container formed by half-shells 9, 10 with annular ribs and in the case of a secondary container with projections extending inwardly, the half-shells, one of which 9 is shown partially in Figure 10, form, near the half collar 15 (and 16, Figure 1) or the semitoroidal seating (34, Figure 6) for connection with the hatch 4, a semi-annular rib or collar 50 for supporting the half shell on the external surface of the tank 1.

The shape of the collar along the outer surface of the tank 1 up to the connecting flange between the two half-shells is indicated by the broken line 51.

A similar semi-annular collar 52 outside and concentric with the first is formed near the first and provides a fairly wide contact and bearing region, shown by the broken line 53, between the secondary container and the tank 1.

An annular space 54 is formed between the collars 50, 52 of the half-shell 9 and the corresponding collars of the half-shell 10 and communicates with the space formed between the two half-shells 9, 10 and the tank 1 by means of suitable recesses of the type shown in Figure 3, formed in the collar 52.

The collar 52 extends outside the half-shell 9 to form a semicylindrical rib 57 coaxial with the hatch. A similar rib, not shown, is formed outside the half-shell 10 (Figure 1).

A ring 7 of plastics material of suitable thickness, for example 15 mm, is engaged inside the rib 57 and bounds the space in the access shaft 6 to the hatch 4 peripherally.

The ring 7 is coupled with the rib 57 by thermoplastic welding with the supply of plastics welding material 55.

An access shaft impervious to the surrounding soil and to ground water is thus advantageously produced.

At least one connector 56 is formed in the half-shell 9 in the space 54 and is accessible from the shaft for the fixing of safety devices such as a manometer or pressure gauge 58 for indicating changes in pressure in the space which may advantageously be set at a pressure lower than the surrounding atmosphere.

For greater clarity, Figure 11 shows the open end of the half-shell 9 in the region which surrounds the hatch, sectioned on the line III-III of Figure 10.

The connecting flange 46 between the two half-shells which, in this case, is internal, extends up to the space 54 where it is interrupted ensuring the continuity of the space and then starts again from the collar 50 up to the collar 15 (or to the seating 34 of Figure 6).

In this region, the two half-shells are welded with the supply of thermoplastic material 59 to the external surfaces of the collar 15, of the rib 57 and of the half-shells 9, 10.

Claims

1. A external protection and secondary containment system for a cylindrical metal tank (1) installed underground and having an access hatch (4) in its central portion, characterized in that the secondary containment system is formed by two identical half-shells (9, 10) of plastics material formed by rotational moulding, each having a peripheral wall with a cylindrical portion formed with projections (45) extending inwardly or with bellows-like corrugations forming hollow ribs (17, 18) disposed annularly or helically and with a cap (11, 12) for closing one end of the cylindrical portion, the other open end of the cylindrical portion having a recess for housing the hatch and a flange (13, 14, 46, 47) for the mutual coupling of the two half-shells (9, 10), the two half-shells being force-fitted onto the tank (1) with the mutual coupling of the flanges (13, 14, 46,47), the half-shells (9, 10) forming a space between the secondary containment and the tank (1) and a plurality of spacers and supports distributed on the half-shells (9, 10) and bearing on the tank (10).

2. A system according to Claim 1, in which the flanges (46, 47) are bent inwardly relative to the half-shells (9, 10).

3. A system according to Claim 1 or Claim 2 in which the half-shells (9, 10) form two annular collars (50, 52) for bearing on the tank (1) around the hatch (4), with an interposed annular space (54).

4. A system according to Claim 3, in which at least one of the half-shells (9, 10) forms at least one connector (56) interposed between the annular ribs (50, 52) for the attachment of safety devices (58).

5. A system according to any one of Claims 1, 2, 3 and 4, in which the half-shells (9, 10) form a cylindrical rib (57) coaxial with the hatch (4), the system comprising a ring (7) welded thermoplastically to the cylindrical rib (57) and bounding an access shaft (6) to the hatch (4).

6. A system according to any one of Claims 1, 2, 3, 4, and 5, in which each half-shell (9, 10) comprises a semicylindrical collar (15, 16) extending from the recess, outside the half-shell (9, 10) for partially housing the hatch (4).

7. A system according to Claim 6, comprising a sealing ring (21) interposed between the semicylindrical collars (15, 16) and the hatch (4) and a clamp (22, 23) for clamping the collars.

8. A system according to Claim 7, in which the semicylindrical collars (15, 16) form a socket (20) for housing the sealing ring (21).

9. A system according to any one of Claims 1, 2, 3, 4 and 5, in which the cylindrical portion forms, near the recess, a housing (34) with a semitoroidal seating for a sealing ring (35) interposed between the peripheral wall and the tank (1), the system comprising means (36, 37, 38, ... 41, 42) for compressing the sealing ring.

10. A system according to the preceding claims in which the hollow ribs (17, 18) have at least one transverse groove (19) forming a communication duct between adjacent chambers.

11. A system according to the preceding claims, in which the half-shells have external projections (43) for the stable support of the system on a flat surface.

12. A plastics half-shell for forming a protection system according to the preceding claims.

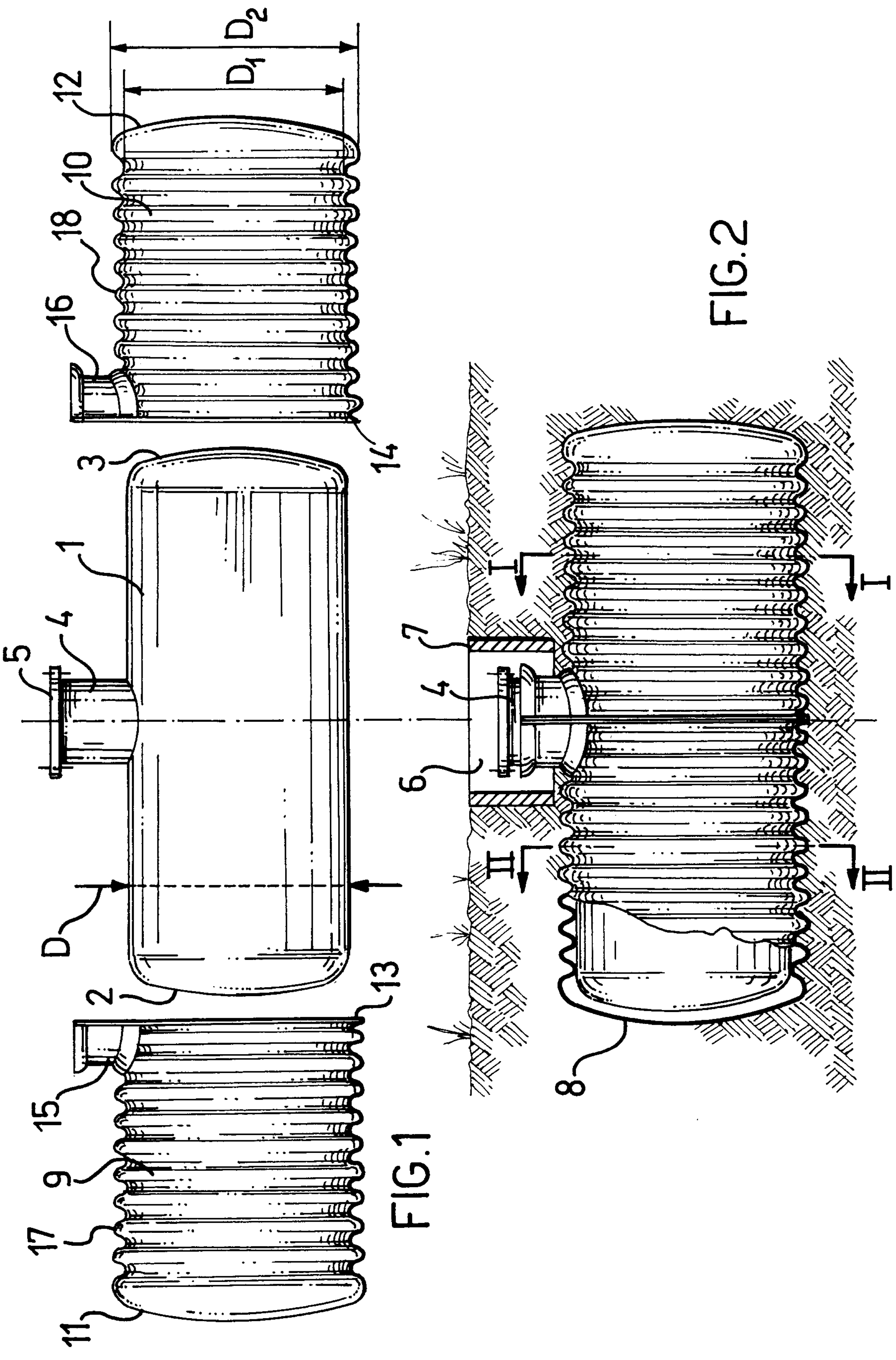

FIG.1

FIG.2

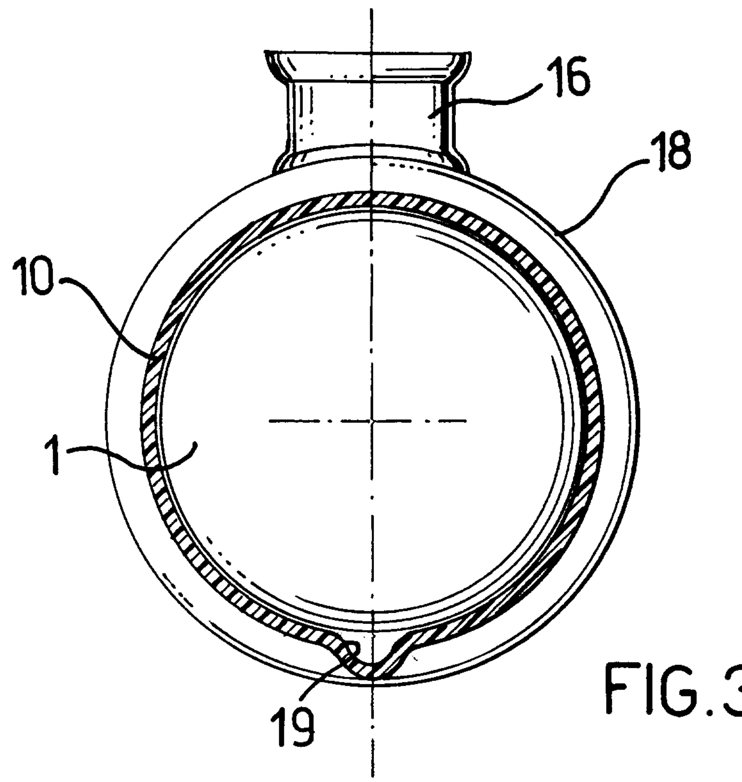

FIG.3

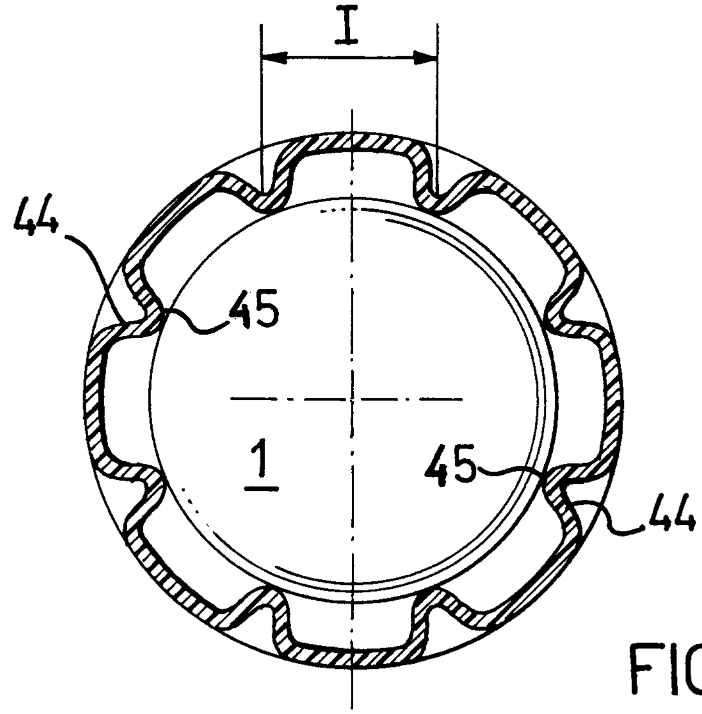

FIG.4

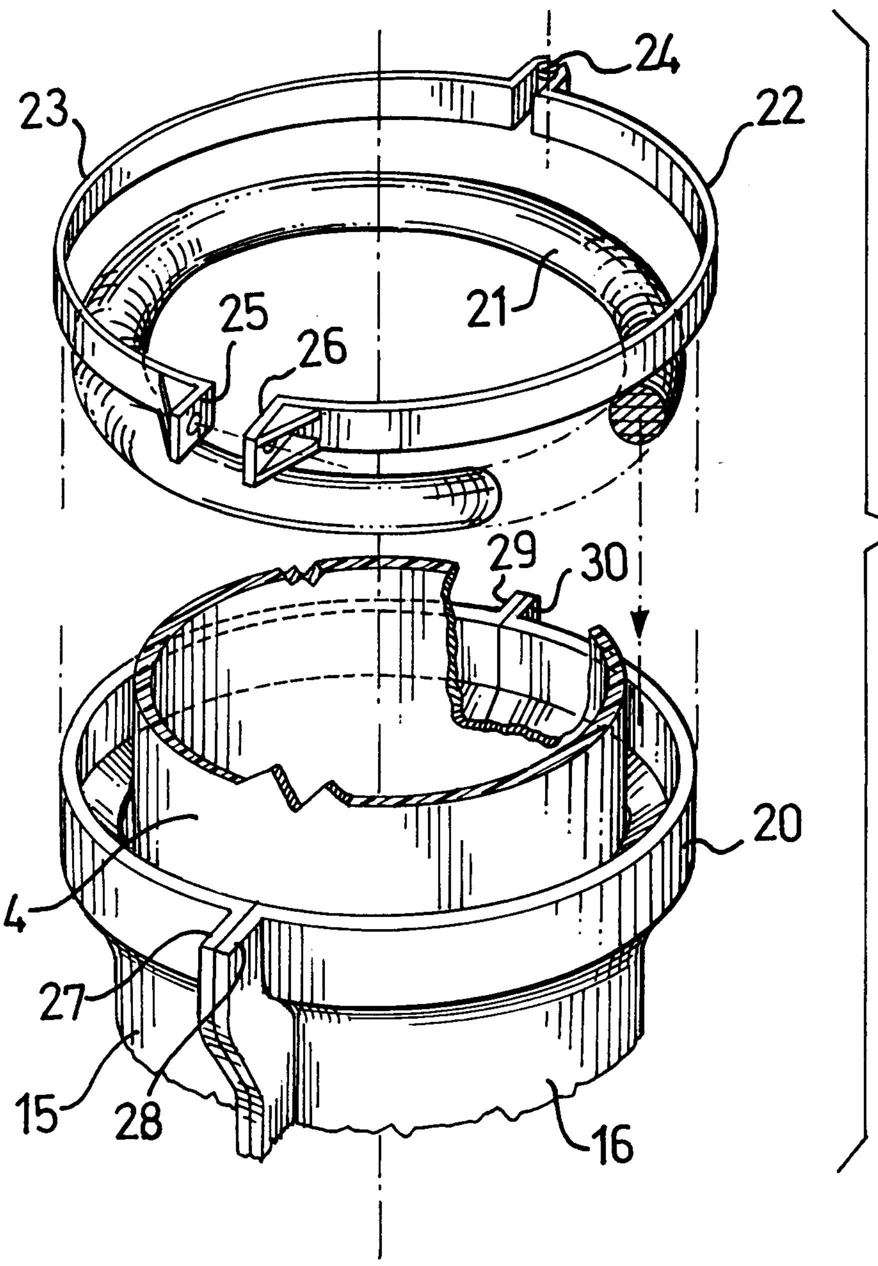

FIG.5

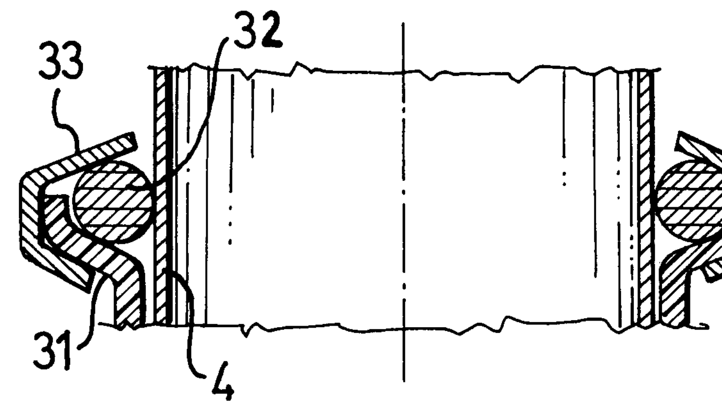

FIG.6

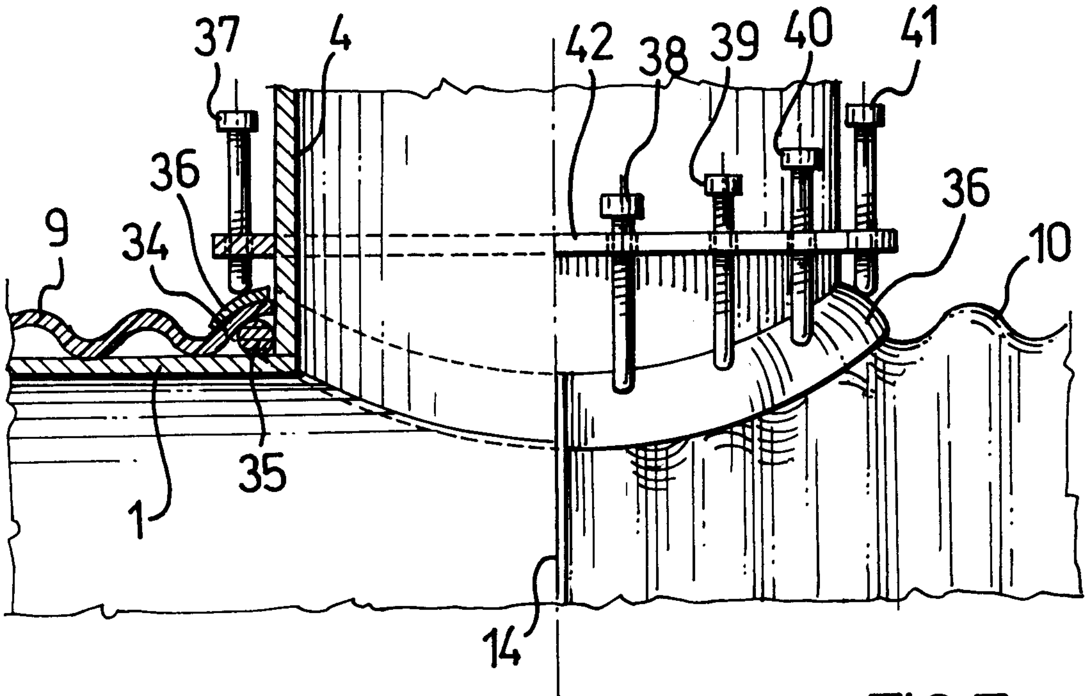

FIG.7

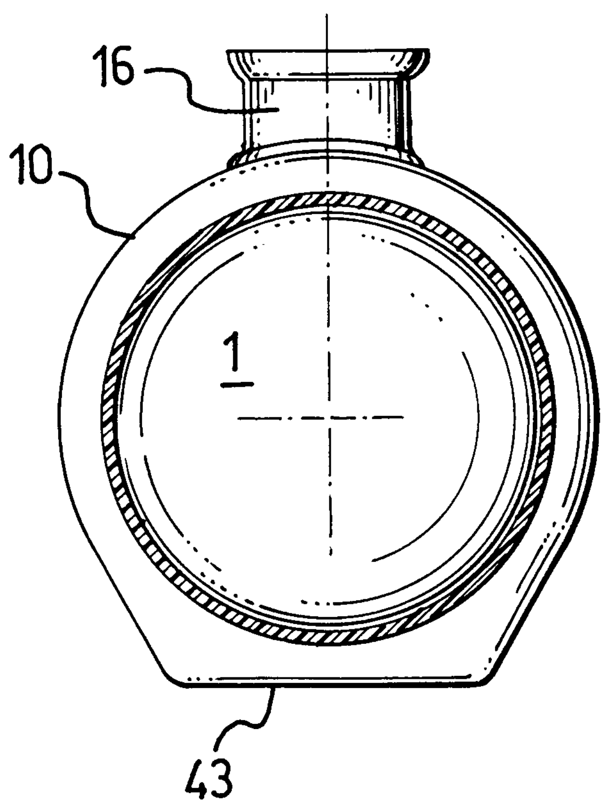

FIG.8

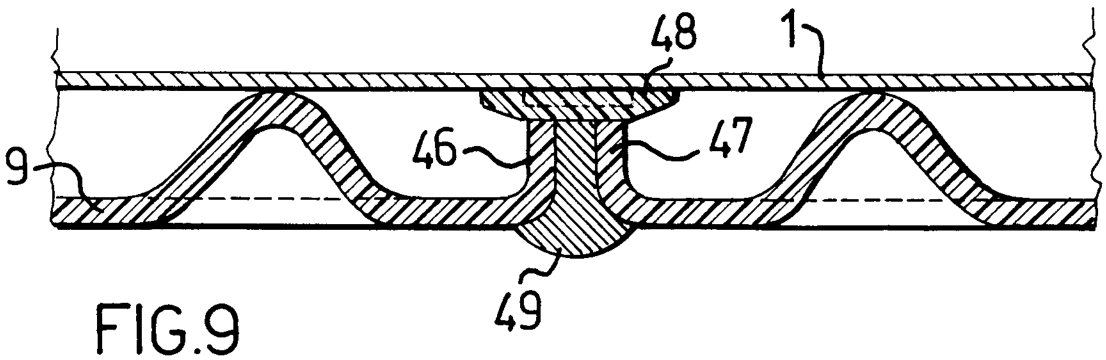

FIG.9

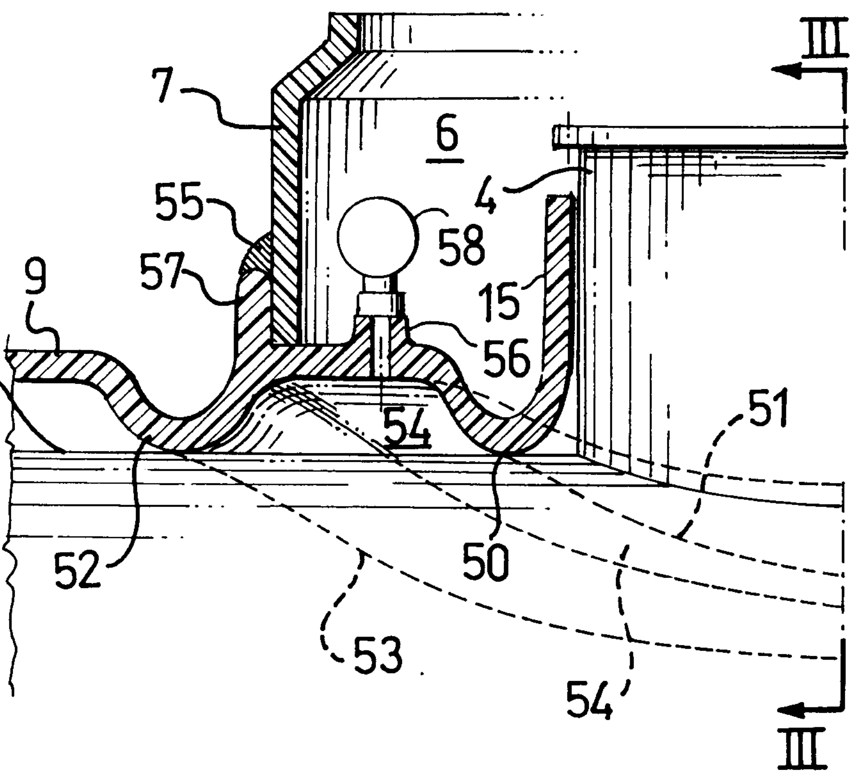

FIG.10

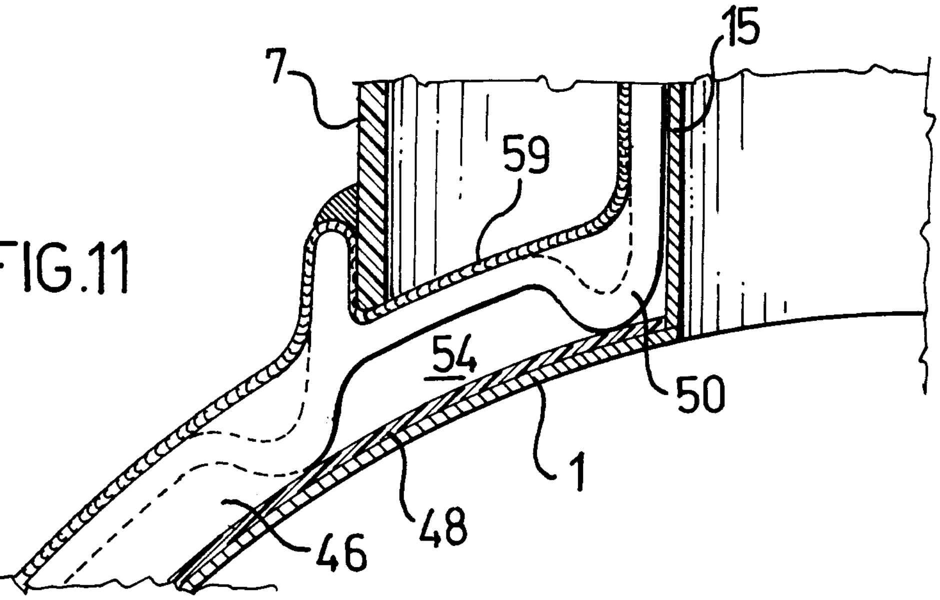

FIG.11

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 83 0383

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-A-5 335 815 (JOSSELYN) * the whole document * ---	1	B65D90/00 B65D90/50 B65D88/76 B65D90/02
A	US-A-5 033 638 (CRUVER) * the whole document * ---	1	
A	US-A-5 115 936 (BARTLOW) * the whole document * ---	1	
A	DE-A-17 52 912 (HAUTMANN) * the whole document * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
B65D
G01M
B29D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 February 1996	Ostyn, T

CATEGORY OF CITED DOCUMENTS

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