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

(11) EP 2 325 399 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
18.04.2012 Bulletin 2012/16

(51) Int Cl.:
E02D 29/12 *(2006.01)* ***E02D 29/14*** *(2006.01)*

(21) Application number: **09176791.3**

(22) Date of filing: **23.11.2009**

(54) **Manhole structure**

Schachtanordnung

Structure de regard de chaussée

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(43) Date of publication of application:
25.05.2011 Bulletin 2011/21

(73) Proprietor: **Furnes-Hamjern SCC AS**
2306 Hamar (NO)

(72) Inventor: **Refsahl, Johan Gudbrand**
2332 Åsvang (NO)

(74) Representative: **Roerboel, Leif**
Budde Schou A/S
Vester Søgade 10
1601 Copenhagen V (DK)

(56) References cited:
EP-A2- 0 826 834
CA-A1- 2 425 459
DE-A1- 19 505 130
DE-U1- 29 907 296
US-B1- 6 196 760

EP 2 325 399 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] Underground installations are important prerequisites for urban areas. These structures include sewers, water pipes, gas pipes, electric and fiber optic cables etc, and their placement underground conveniently allows the ground surface to be used for buildings, streets and recreational areas.

[0002] To access the underground installations, during their construction or for maintenance, a number of access structures are used. One example is the manhole which comprises a vertical access shaft or riser pipe extending between for example a road surface and an underground sewer pipe, a frame for mounting to the end of the riser pipe opposite the sewer pipe, the frame being placed in the road surface, and a cover for installation within the frame. The cover closes the manhole and provides a surface on which road traffic may drive.

[0003] Constructions of underground installations are costly endeavors, not only in material terms but also in time as sections of an urban area may need to be closed down during the construction works. Time is also consumed when underground installations need to be modified or moved to adjust to a new buildings on the ground or the resurfacing of a street or road. Especially resurfacing, where typically the level of the resurfaced road is higher than the level of the road prior to resurfacing, due to the thickness of the layer of new road surface material, has as a consequence that the frames of any manholes in the road will have to be lifted up to the new level of the road if they are to remain accessible and provide a smooth road surface.

[0004] To adjust the level of a frame, spacers or extension ring may be placed between the end of the riser pipe and the frame. Such techniques are described in amongst others US4188151, US6196760 and EP0529178.

[0005] Some limited movement of a manhole may also be possible according to the technique, for distributing forces on manholes to the surrounding ground, described in EP0900885.

[0006] The techniques described above are time-consuming to use, and further requires extensive excavation, disassembly, repositioning and reassembly in order to adjust the height of the manhole or frame to a resurfaced road. Further, as a consequence of the disassembly and assembly needed in the above techniques, there is a risk of surrounding earth or debris entering the manhole.

[0007] A self-levelling system for a manhole is known from CA2425459 where a gasket is used to seal between a riser pipe and a manhole frame and wherein the frame may slide along the riser pipe, however this technique only accommodate small variations in height of the manhole frame. Further it cannot surely prevent the ingress of water or debris into the joint between manhole frame and riser pipe, requires cutting the riser tube to a specific length prior to installation of the manhole frame onto the riser pipe, and do not prevent the manhole frame from being unintentionally removed from the riser pipe due to traffic loads or impacts on the manhole frame.

[0008] The height adjustment of sewer shaft end covers using a threaded cover skirt engaging mating threads provided by a ring-shaped part in the shaft end is known from EP826834, however threads are inherently sensitive to dirt and debris, and further do not provide an effective seal against the ingress of water into the joint between the cover and the sewer shaft end.

[0009] Further techniques known to the applicant in the field of manholes are described in DE29907296 and DE19505130.

[0010] An object of the present invention is to simplify adjusting the height of a frame of a manhole structure to accommodate a resurfaced road, thus making it less time consuming.

[0011] A further object of the present invention is to reduce the risk of surrounding earth or debris entering the manhole during the adjustment.

[0012] A still further object of the present invention is to provide a manhole structure, able to be adjusted, comprising few parts.

[0013] It is yet a further object of the present invention to provide a manhole structure which is able to accommodate movements, between frame and riser pipe, due to movements in the ground and loads applied to the frame or the cover, e.g. from cars running on the cover. Thus another object of the present invention is to prevent damage to, or breakage of, the riser pipe.

[0014] A further object of the present invention is to simplify the mounting of a manhole frame to a riser pipe.

[0015] The above objects together with numerous other objects, which will be evident from the below detailed description of preferred embodiments of the manhole structure according to the present invention, are according to a first aspect of the present invention obtained by a manhole structure comprising

a frame having a skirt,

a riser pipe at least partly inserted into the skirt, and,

a gasket being placed between the skirt and the riser pipe, wherein the gasket is adapted to retain the riser pipe,

and wherein the riser pipe is longitudinally extendable.

[0016] The manhole structure may be placed at ground level or may itself be submerged in a trench or hole or the like. The manhole structure may be placed in earth, gravel, soil, sand, concrete etc and may further be placed in a street, on a road, on the sidewalk, in a park, in a building, in a cellar etc. The manhole structure may, due to its construction, which will be further described below, be advantageously employed in situations where high loads are applied to the manhole structure, for example in streets or roads having intense traffic.

[0017] The frame is preferably a floating manhole frame, i.e. the frame is typically supported by an annular lip or flange which may rest on a fill, a ballast, or a road surface - material such as gravel, stone, asphalt, or concrete.

[0018] The frame may have a circular, an elliptic, a square, a rectangular or a polygonal aperture, the aperture having an inside diameter in the range of 50 - 1500 mm. The frame may be manufactured from cast concrete, cast iron, steel, galvanized steel, fiber reinforced plastics or other materials, but cast iron is preferred. The frame may receive a cover separate from the frame, or alternatively may comprise a cover pivotally or hingedly mounted to the frame. The cover may be manufactured from the same materials as the frame, or the frame and cover may be manufactured from different materials. The cover should conform to the dimensions of the aperture to cover the aperture and thereby prevent individuals or vehicles from unintentionally entering the manhole structure.

[0019] The skirt is preferably formed integrally with the frame as a single piece through molding, whereby the suitable materials include those materials mentioned above, i.e. cast concrete, cast iron or fiber reinforced plastics, cast iron being preferred. The skirt typically has the same or similar inside diameter as the frame aperture, but may be both wider and narrower. The skirt typically extends 20 - 1000 mm from the side of the frame opposite the side where the cover is received.

[0020] The aperture in the skirt is preferably circular, but it may also be elliptic, square, rectangular or polygonal, however a skirt having the same aperture as the frame is preferred.

[0021] As an alternative the skirt may be formed separate from the frame whereby it may be attached to the frame by mechanical connections such as screws, nuts and bolts etc.

[0022] The riser pipe is longitudinally extendable. The riser pipe may also be longitudinally retractable, i.e. having the having the ability to become shorter. It is preferred that the riser pipe is both longitudinally extendable and longitudinally retractable. Within the context of the present invention the term extendable should also comprise retractable. The riser pipe may be manufactured from plastic, fibre reinforced plastic, concrete, or iron etc, but plastic is preferred.

[0023] In the present context the term gasket is to be understood to comprise a material or a part used to make a joint fluid-tight. Examples of gaskets include pre-formed molded gaskets which may be manufactured separate from the skirt and the riser pipe and subsequently being mounted in the skirt or onto the riser pipe. Gaskets may also be understood as in situ molded gaskets which are molded in contact with the skirt or the riser pipe. Gaskets may be adhesives for sealing smaller distances between the skirt and the riser pipe. Finally gaskets may be a filler material disposed between the skirt and the riser pipe, typically for larger distances between the skirt and the riser pipe.

[0024] In one embodiment of the manhole structure according to the first aspect of the present invention the gasket comprises an adhesive. The adhesive may be applied along a portion of the length of the skirt, but may also be provided along the full overlapping length of the skirt and the riser pipe. The adhesive used may have a higher viscosity for wider distance between the skirt and the riser pipe, although adhesives are preferably used for small distances between the skirt and the riser pipe. The adhesive may be a thermosetting adhesive such as an epoxy adhesive which may be cured by heat or exposure to ultraviolet light (UV), a polyurethane adhesive, a cyanoacrylate adhesive, a non-vulcanized natural or synthetic rubber which may be vulcanized, i.e. cured, by heat and pressure, peroxides, or sulfur (for natural rubber), a hot melt adhesive such as ethylene-vinyl acetate copolymer, polyethylene, polypropylene, polyamide, polyester or other plastics, or an acrylic adhesive.

[0025] The above mentioned adhesives may optionally be reinforced by glass fibres, Kevlar fibres etc.

[0026] The adhesive may be coated onto the skirt of the frame prior to the insertion of the riser pipe into the skirt or vice versa. The adhesive may also be injected into the space between the riser pipe and the skirt after the riser pipe has been inserted into the skirt. Curing of the adhesive may be achieved in room temperature or below room temperature, for thermo setting adhesives heat may be applied to the adhesive or alternatively to the whole or parts of the manhole structure. Curing by ultraviolet radiation (UV) may be achieved by irradiating the adhesive with ultraviolet radiation.

[0027] One advantage of an adhesive is that the uncured adhesive may have a lubricating effect during the insertion of the riser pipe into the skirt, thereby rendering the insertion of the riser pipe into the skirt less strenuous, whereas the cured adhesive retains the riser pipe in the skirt.

[0028] Adhesives may be used where the distance between the skirt is too small to use a gasket. Further, adhesives may retain the riser pipe in the skirt stronger than a gasket. Preferably the cured adhesive is somewhat flexible to allow some flexibility in the connection between the skirt and the riser pipe, but an non-flexible adhesive may also be used.

[0029] In one embodiment of the manhole structure according to the first aspect of the present invention the gasket comprises caulk. Caulk comprises sealants such as silicone, silicone rubber, polyurethane, polysulfide, polyurethane, acrylics or rubber. The caulk may be provided between the skirt and the riser pipe. Further, the skirt may comprise a groove in its inner wall into which the caulk may be provided. Caulk may be used where the distance between the skirt and the riser pipe is too large for using an adhesive. A further advantage of caulk is that it may retain the riser pipe in the skirt stronger than a gasket since the adhesive strength of the caulk to the skirt and the riser pipe may be larger than the friction between a gasket and the skirt and the riser pipe. The caulk is preferably applied non-cured or non-solidified into the space between the skirt and the riser pipe. The subsequent curing of the caulk results in the riser pipe being securely retained in the skirt. Preferably the cured

or solidified caulk is flexible to maintain the flexibility of the connection between the skirt and the riser pipe. By using caulk a large flexibility of the connection between the skirt and the riser pipe with a maintained strong retention of the riser pipe in the skirt may be achieved.

[0030] In one embodiment of the manhole structure according to the first aspect of the present invention the riser pipe comprises a first pipe mounted to the frame, and a second pipe, the first pipe being connected to, and telescopically adjustable in relation to, the second pipe. The first pipe may be held within the second pipe or vice versa in a telescopic arrangement. The force needed to adjust the first pipe in relation to the second pipe is lower than the force by which the first pipe is retained to the frame by the gasket. This allows the height of the frame to be adjusted as will be described in more detail below as any adjustment of the height of the frame results in an adjustment of the first pipe in relation to the second pipe.

[0031] The first pipe of the riser pipe may have an annular groove on its outer surface adjacent the end of the first pipe mounted to the frame, the groove being engageable by the gasket which is described in more detail below, to increase the strength with which the gasket retains the first pipe in the frame. The first pipe may alternatively be surface treated to increase the friction between the first pipe and the gasket, for example by roughening the surface, or by coating the surface with high friction material such as for example rubber or sand.

[0032] In another embodiment of the manhole structure according to the first aspect of the present invention a bellow-like structure is inserted in the riser pipe. Thus the riser pipe may comprise a first pipe mounted to the frame, a second pipe, and a bellow-like structure connecting the first and second pipe. The bellow-like structure may be extendable longitudinally, but may also be flexible allowing the riser pipe to bend. The bellow like structure typically comprises a length of flexible and/or elastic tubing, optionally reinforced by a spiral wound metallic wire provided in the wall of the length of tubing for example by molding. The bellow-like structure may be advantageous as it connects the first and the second pipes without any moving joint where high ground water pressures water could force water into the riser pipe.

[0033] In another embodiment of the manhole structure according to the first aspect of the present invention the manhole structure further comprises an underground installation mounted to one end of the riser pipe, the other end of the riser pipe being mounted to the frame. The manhole structure may be used to access an underground installation, such as a sewer, a water pipe, a gas pipe, or a pipe containing electric and/or fiber optic cables or the like. By mounting one end to the underground installation and the other end to the frame, an access way to the underground installation from a street surface or other surface where the frame is positioned is created, The underground installation may thus be accessed for, for example to conduct repairs, inspections or maintenance.

[0034] In another embodiment of the manhole structure according to the first aspect of the present invention the skirt comprises a groove or alternatively a recess, formed within its inner wall. The groove preferably extends all around the circumference of the skirt, but may also be provided in discrete segments. The groove may serve to receive a part of the gasket thus retaining the gasket more securely.

[0035] In another embodiment of the manhole structure according to the first aspect of the present invention the gasket has a first side oriented towards the inner wall of the skirt and a second side oriented towards the center of the skirt, the second side having a rib adapted to retain the riser pipe. A plurality of ribs may be provided to further increase the riser pipe retaining properties of the gasket, further the material used in the gasket may be varied to increase or decrease the retaining properties. The gasket is typically made of a resilient material such as rubber, plastic, polymeric material or the like.

[0036] The length of the rib or ribs may be adapted to retain pipes having a range of diameters, so that one gasket may be used to retain riser pipes of varying diameters. The rib or ribs are deformed by the pipe end as the riser pipe is inserted, into the gasket. After insertion, the force exerted by the rib striving to regain its non-deformed state surely retains the riser pipe in the manhole structure.

[0037] In another embodiment of the manhole structure according to the first aspect of the present invention the first side of the gasket is receivable within the groove of the skirt. By providing a groove within the inner wall of the skirt the gasket may be mounted firmly to the skirt, further, any risk of dislodging the gasket when inserting the riser pipe in the frame is removed as the bulk of the gasket is received within the groove. The gasket may further be retained within the groove by providing an adhesive on the first side of the gasket thus anchoring the gasket to the skirt. Further, an adhesive may be provided also on the second side of the gasket.

[0038] In addition to the adhesives listed above, concrete, grout or polymeric adhesives etc may be used to anchor the gasket to the skirt.

[0039] The adhesive may have a lubricating effect when uncured. When the uncured adhesive has a lubricating effect there is less need of a conventional lubricant to facilitate the insertion of installation of the gasket in the skirt and the insertion of the riser pipe in the gasket. Conventional lubricants such as oil or grease can decrease the friction between the riser pipe and the gasket and/or the friction between the skirt and the gasket also when the riser pipe is properly installed in the skirt, thus jeopardizing the strength of the connection between riser pipe and skirt.

[0040] By providing an adhesive on the first side of the gasket, the gasket is, in addition to being securely anchored to the skirt when the adhesive has cured, more easily installed within the skirt due to the lubricating effect

of the uncured adhesive provided on the gasket. Likewise an adhesive provided on the second side of the gasket may increase the strength with which the riser pipe is retained by the gasket when the adhesive has cured, while also lowering the friction between the gasket and the riser pipe when the adhesive is uncured to facilitate the insertion of the riser pipe through the gasket.

[0041] Alternatively the gasket may be attached to the skirt through molding in situ. The gasket may for example be molded to the skirt by placing a mold corresponding to the second side of the gasket within the manhole frame; injecting a curable or settable liquid or melted gasket material into the space between the frame and the mold, the space corresponding to the desired shape of the gasket, and curing or allowing to set the curable or settable liquid or melted gasket material to form the gasket molded to the frame. Alternatively the gasket may be molded as described to a skirt separate from the frame, the skirt subsequently being attached to the frame as described previously. Alternatively the gasket may be molded to the riser pipe.

[0042] It is further contemplated that the gasket may be attached to the skirt of the frame using bolts, screws etc.

[0043] When the gasket is molded to the skirt or to the riser pipe, or otherwise mounted to the skirt or riser pipe as described above, the free side of the gasket, i.e. the side facing the riser pipe when the gasket is molded to the skirt, or the side facing the skirt when the gasket is molded to the riser pipe, may be provided with an adhesive which may have a lubricating effect when uncured to facilitate the insertion of the riser pipe in the skirt.

[0044] When the skirt does not include a groove, the first side of the gasket is preferably flat. As described above such a gasket having a flat first side may be attached to the skirt of the frame through adhesives, molding or mechanical means as described above.

[0045] It is contemplated within the context of the present invention that there may be a small space between the groove and the gasket received in the groove so the gasket is allowed to shift or turn within the groove as the riser pipe is inserted through the gasket. This would result in an even greater range of riser pipe diameters retained by the gasket, as the rib on the gasket may be further lengthened. During the insertion of the riser pipe, the rib, in addition to being deformed may thereby be further deflected as the gasket shifts or turns within the groove. A gasket that is allowed to shift or turn within the groove also allows a greater angle between the riser pipe and the frame. Further, it also allows the use of a less flexible rib, such as a rib comprising a metal tip to further grip the riser pipe. The above may be achieved by using a skirt having a groove of semi-circular cross section and a gasket having a semi-circular part receivable within the groove.

[0046] The gasket may have a rigid first side to shift or turn smoothly within the groove.

[0047] The manhole structure according to the present invention may also be used with a *per* se known gasket, such as the gasket disclosed in EP1792110.

[0048] In another embodiment of the manhole structure according to the first aspect of the present invention the second side of the gasket has a groove for receiving a retaining ring. The gasket preferably has a retaining ring, either provided within a groove on the second side of the gasket, or alternatively provided as an in-molded ring or as a ring shaped reinforcement, such as glass or carbon fibers, provided within the gasket material. A further possibility of achieving a retaining ring effect is by a circumferential air compartment provided within the gasket, the air compartment being expandable by pressurization. The retaining ring is preferably expandable. The retaining ring may be constructed from metal or a polymeric material such as polypropylene or similar.

[0049] The retaining ring is advantageous in that it prevents the gasket from becoming dislodged from its position within the skirt, however, the retaining ring may be omitted when the risk of dislodging the gasket during insertion of the riser pipe in the skirt is small, such as when the gasket is molded to the skirt, the gasket is of a less flexible material, or when the gasket, and correspondingly the skirt and riser pipe, are of smaller dimensions.

[0050] The manhole structure according to the first aspect of the present invention has the advantage that it comprises few parts, thus rendering both fabrication and installation less complex, while still achieving the desired function of allowing the height of the frame to be adjusted. Furthermore, the manhole structure may accommodate small movements between the frame and the riser pipe, the movements being accommodated by the gasket, due to elasticity, or by the riser pipe which is longitudinally extendable. This prevents damage to, or breakage of, the riser pipe. The small movements mentioned above may be from natural movements in the ground, or from loads applied to the cover or frame, for example from vehicles driving on the cover or frame.

[0051] A further advantage of the manhole structure according to the first aspect of the present invention is that the need for providing a plurality of gaskets is lessened as each gasket may retain riser pipes of a range of diameters, thus decreasing the number of different gaskets needed, thereby saving costs in the manufacturing of the gaskets and further reducing the complexity of handling the manhole structure. A subsequent advantage is that the exact dimensions of the riser pipe become less critical as the gasket compensates for any deviation, dependent on the shape and material of the gasket, from the riser pipe specifications.

[0052] A yet further advantage of the manhole structure according to the first aspect of the present invention is that the manhole structure is still usable when the riser pipe is not inserted straight into the skirt of the frame, but instead is angled. This is for example useful when the road surface in which the frame is placed is not orthogonal to the riser pipe. Depending on the diameter of the riser pipe in relation to the diameter of the skirt and the

gasket, a larger or smaller tolerance may be achieved.

[0053] In a second aspect of the present invention a method of mounting a manhole structure according to the first aspect of the present invention is provided, comprising the steps of:

providing, in combination,
a frame having a skirt,
an longitudinally extendable riser pipe,
a gasket retained within said skirt, wherein said gasket is adapted to retain said riser pipe, and
inserting a part of said riser pipe through said gasket.

[0054] When the gasket comprises an adhesive the method according to the second aspect of the present invention may additionally comprise the step of curing, or allowing to cure, the adhesive.

[0055] In an alternative embodiment of the method according to the second aspect of the present invention the adhesive is applied to the space between the skirt and the riser pipe after the riser pipe has been inserted into the skirt.

[0056] When the gasket comprises caulk the method according to the second aspect of the present invention may additionally comprise the step of curing, or allowing to cure, the caulk.

[0057] In an alternative embodiment of the method according to the second aspect of the present invention the caulk is applied to the space between the skirt and the riser pipe after the riser pipe has been inserted into the skirt.

[0058] The method according to the second aspect of the present invention has the advantage that the connection of frame to riser pipe is simple to perform and does not require any specific tools or materials. No concrete or other sealing material is needed to achieve a sealed connection between the frame and the riser pipe.

[0059] In a third aspect of the present invention a method of adjusting the height of a frame in a manhole structure according to the first aspect of the present invention, from a first level to a second level, is provided, comprising the steps of:

adjusting said height of said frame from said first level to said second level, and
supporting said frame at said second level, wherein the distance between said first and second level is accommodated by said riser pipe.

[0060] During lifting or repositioning of the frame, for example to adjust to a new layer of road surface, the frame lifted whereby, for example when the riser pipe is telescopic riser pipe, the first pipe is extended out of the second pipe to follow the movement of the frame. When the new position or height for the frame has been reached, the new road surface material is placed under the lip or flange of the frame and around the skirt and any part of the telescopic riser pipe that has become unearthed during the repositioning of the manhole frame, thus the frame is repositioned to accommodate the new road surface without the need for disassembly of manhole frame from the telescopic riser pipe or the need for mounting a spacer to the riser pipe.

[0061] A limited excavation around the frame may be needed when the frame is lifted with manual means such as a spud bar, a crowbar, a shovel etc, but it is contemplated within the context of the present invention to simply lift the frame using a enough force, from a crane, an excavator or the like, out of the road surface to the height of the new road surface. Alternatively, the new road surface material may be applied to the road prior to lifting of the frame, whereby the new road surface material is removed from the frame and the frame is subsequently lifted.

[0062] The method according to the third aspect of the present invention has the advantage that the height of the manhole frame is simply and quickly adjusted, without any risk of surrounding earth, debris or water entering the manhole structure. Further there is no need of disassembly of the manhole structure during adjusting. The height of the frame may be adjusted by lifting, but the frame may also be lowered.

[0063] In an embodiment of the method according to the third aspect of the present invention the first level comprises the level of a road surface before resurfacing, and said second level comprises the level of said road after resurfacing. Typically the road may be resurfaced by laying a new layer of asphalt or other paving or road surface material. The level of the road is then increased due to the thickness of the new material deposited on the road.

[0064] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purpose of illustration show some non-limiting embodiments and in which

Fig. 1 a shows in cross section a manhole structure according to a first embodiment of the present invention.

Figs. 1b - 1c show in cross section a manhole structure according to alternative embodiments of the present invention wherein the riser pipe is attached to the frame by adhesive (1 b) or alternatively, by caulk (1 c).

Fig. 2 shows in cross section a manhole structure according to a second embodiment of the present invention

Figs. 3a - 3c show in cross section a manhole structure comprising varying diameter riser pipes according to further embodiments of the present invention.

Fig. 4 shows in cross section a method of mounting

a manhole according to a first embodiment of the present invention.

Figs. 5a - 5c show in cross section a method of adjusting the height of the frame in a manhole structure according to a first embodiment of the present invention.

[0065] Fig. 1a shows a cross section of a manhole structure, in its whole designated the reference numeral 10, according to a first embodiment of the present invention, placed in a road for accessing an underground installation (not shown). The manhole structure 10 comprises a frame, designated the reference numeral 12, a skirt, designated the reference numeral 16 and a gasket, designated the reference numeral 50. The frame 12 further comprises a lip designated the reference numeral 14 which distributes the weight of the frame 12 to the ground in which the manhole structure 10 is placed. As shown in fig. 1, the frame 12 is supported by a layer of road surface material designated the reference numeral 30, which layer is further supported by a base layer, designated the reference numeral 32 which is placed in an excavation in the ground and surrounded by soil, designated the reference numeral 34.

[0066] The road surface material 30 is typically asphalt, concrete, or gravel and has a road surface designated the reference numeral 40 flush with the manhole structure. The base layer 32 typically consists of grave, concrete, sand or crushed rock etc.

[0067] The frame 12 further comprises a receiving aperture in its whole designated the reference numeral 18 positioned on a first side of the manhole structure. The receiving aperture 18 comprises a wall 20 and a shoulder 22 which supports a cover (not shown).

[0068] The skirt 16 as shown in fig. 1 a is integrally formed with the frame 12, and extends from a second side of the frame 12. The skirt comprises a receiver, in its whole designated the reference numeral 24 for receiving a riser pipe, in its whole designated the reference numeral 100. The skirt further comprises a groove designated the reference numeral 26 for receiving the gasket 50. The gasket comprises a first side, designated the reference numeral 52, which is oriented towards the groove 26 and receivable within the groove 26 by virtue of the complimentary shape of the first side 52. On the second side, in its whole designated the reference numeral 54, of the gasket 50, oriented towards the center of the skirt 16, are provided a minor rib designated the reference numeral 56, and a major rib, designated the reference numeral 58, each rib 56 and 58 creating a resilient restriction of lesser diameter than the diameter of the receiver 24. The ribs 56 and 58 are angled in the insertion direction of the riser pipe 100, thereby allowing an effortless installation of the manhole structure 10 on the riser pipe 100 while providing a high friction counter force to any movement in the direction of extraction of the riser pipe 100 from skirt 16.

[0069] A retaining ring designated the reference numeral 60 is shown positioned within a groove designated the reference numeral 62 formed on the second side of the gasket 50. The retaining ring 60 ensures that gasket 50 does not become dislodged from the groove 26 in the skirt 12. The retaining ring 60 may alternatively be inmolded into the gasket 50 in which case the groove 62 may be omitted.

[0070] The riser pipe 100 comprises a first pipe, designated the reference numeral 102, which is held within a second pipe, designated the reference numeral 106. The first and second pipe 102 and 106 are telescopically adjustable and longitudinally extendable in relation to each other. The first pipe 102 and its end, designated the reference numeral 104, is retained in frame 16 by the gasket 50, the second pipe 106 is connected to an underground installation (not shown). A fluid or collar (not shown) may be provided between the first pipe 102 and the second pipe 106 to lubricate and seal the joint between the pipes 102 and 106.

[0071] In fig. 1a the first pipe 102 of riser pipe 100 is fully inserted into the receiver 24 whereby the minor rib 56 has been compressed into the bulk of the gasket 50, and the major rib 58 has been compressed and bent towards the bulk of the gasket 50. The friction between the ribs 56 and 58 of the gasket 50 and the first pipe 102 ensures that the first pipe 102 is surely retained within the receiver 24 of the skirt 16.

[0072] A blow up of the connection between the gasket 50 and the riser pipe 100 is shown in the lower part of fig. 1 a and shows a tight fit. The connection is waterproof and further prevents any loose material from the base layer 32 being carried by water into the riser pipe 100, thus preventing damage to the underground installation (not shown) accessed through the manhole structure 10, and further preventing undermining of the base layer 32 which supports the layer of road surface material 30 supporting the frame 12. In addition, small movements between the manhole structure 10 and the underground installation (not shown), for example when a heavy vehicle drives over the frame, or a cover (not shown) installed in the frame 12, are accommodated by the resiliency of the gasket 50 and/or the longitudinal extension or retraction of the riser pipe 100, thus preserving the seal between the frame 12 and the riser pipe 100 and preventing breakage of the riser pipe 100. Further, the resilient nature of the material used in the gasket 50 accommodates first pipes (102) having a range of diameters, as will be described in relation to fig. 3b.

[0073] In fig. 1b an alternative embodiment of the manhole structure 10 is shown where the first pipe 102 is retained in the skirt 16 by a cured adhesive designated the reference numeral 50', provided between the skirt 16 and the first pipe 102. The adhesive 50' may be provided along a portion of the length of the skirt 16 as shown in fig. 1b, but may also be provided along the full overlapping length of the skirt 16 and the first pipe 102. Uncured adhesive 50' may be coated onto the skirt 16 of the frame

12 prior to the insertion of first pipe 102 into the skirt 16 or vice versa. The adhesive 50' may also be injected into the space between the first pipe 102 and the skirt 16 after the first pipe 102 has been inserted into the skirt 16. When the first pipe 102 is properly positioned in the skirt 16 the adhesive 50' may be cured.

[0074] A further alternative embodiment of the manhole structure 10 is shown in fig. 1c where first pipe is retained in the skirt 16 by cured caulk, designated the reference number 50", provided between the skirt 16 and the first pipe 102, in particular the caulk 50" is provided in the groove 50" in the skirt 16. The grove 26 ensures that the caulk 50" is securely retained within the skirt 16 so that it may surely retain the first pipe 102 in the skirt 16. Further, the added volume of caulk 50" may, when the caulk is elastic or flexible, increase the flexibility of the connection between the riser pipe 100 and the skirt 16 of the frame 12. Uncured caulk 50" may be applied to the skirt 16 prior to insertion of the first pip 102 into the skirt 16, or preferably injected into the space between the first pipe 102 and the skirt 16 after the first pipe 102 has been inserted into the skirt 16.

[0075] When the first pipe 102 is properly positioned in the skirt 16 the caulk 50" may be cured.

[0076] Fig. 2 shows in cross section a second embodiment, designated the reference numeral 10', of the manhole structure 10 shown in fig. 1, the difference being an alternative riser pipe, in its whole designated the reference numeral 100'. Riser pipe 100' comprises a first pipe, designated the reference numeral 102' connected to a second pipe, designated the reference numeral 106', through a bellow-like structure, designated the reference numeral 108', which is flexible and extendable and thereby accommodates movements between the first pipe 102' and the second pipe 106', thus allowing longitudinal extension of the riser pipe 100'.

[0077] The riser pipe 100' may be advantageous where the pressure of ground water is high as it may achieve a stronger seal between the first and second pipes 102' and 106' than the first and second pipes 102 and 106 of the riser pipe 100 shown in fig. 1.

[0078] Fig. 3a shows the manhole structure 10 where the first pipe 102 has not been fully inserted into the skirt 16. However, as can be seen, an equally successful connection between frame 16 and the first pipe 102 is achieved.

[0079] Fig. 3b shows a further embodiment, designated the reference numeral 10", of the manhole structure according to the present invention wherein a narrower riser pipe designated the reference numeral 100" is shown. The first pipe 102" of the riser pipe 100" is however still surely retained by the gasket 50 due to the ribs 56 and 58 which grip and retain the first pipe 102".

[0080] A blowup of the connection between the gasket 50 and the first pipe 102" is shown in the lower part of fig. 3b. By lengthening the ribs 56 and 58 an even larger tolerance of diameters of riser pipes may be used with the same manhole structure. The space, designated the reference numeral 64, between the inner wall of the skirt 16 and the pipe end 104" may be filled with a curable compound if desired to further anchor the end 104" to the frame 16.

[0081] Fig. 3c shows the manhole structure 10'" where the first pipe 102" has not been fully inserted into the skirt 16. However, as can be seen, an equally successful connection between frame 16 and the first pipe 102" is achieved. The space 64 may be filled with a curable compound if desired to further anchor the end 104" to the frame 16.

[0082] Fig. 4 shows in cross section a method of mounting the manhole structure according to an embodiment of the present invention. The first pipe 102 of the riser pipe 100 (not shown in fig. 4) is inserted the skirt 16 through the gasket 50. During the insertion, the ribs 56 and 58 are deformed, i.e. bent, compressed and/or stretched, thus forming a resilient seal between the frame 12 and the first pipe 102. The end 104 of the first pipe 102 may be chamfered as shown in fig. 4 to facilitate the insertion through gasket 50 and into the skirt 16 of the frame 12. The frame 12 with the first pipe 102 mounted in the skirt 16 may then be positioned so that the first pipe 102 is inserted in the second pipe 106 (not shown in fig. 4) and the frame 12 is supported by the road surface 30 (not shown in fig. 4) to create an access way from the road surface 30 to an underground installation (not shown) through the first pipe 102 and the second pipe 106.

[0083] Figs. 5a - 5c show in cross section a method of adjusting the height of the frame in a manhole structure according to a first embodiment of the present invention. Fig. 5a shows the manhole structure 10 prior to the adjustment of the height of the frame 12. The second pipe 106 of the riser pipe 100 is connected to an underground installation (not shown). The first pipe 102 of the riser pipe 100 is inserted in the skirt 16 and surely retained by the gasket 50. The frame 12 is supported by the road surface material 30 which is further supported by the base layer 32. The road surface 40 is flush with the frame 12.

[0084] In fig. 5b the frame 12 has been lifted up out of the layer of road surface material 30 to a position above the road surface 40. The frame 12 may be lifted using a shovel, spud bar or the like, but may also be lifted using a crane, an excavator or a tractor such as a backhoe loader (not shown). The riser pipe 100 is telescopically extended as the frame 12 is lifted in that the first pipe 102 of the riser pipe 100 slides out of the second pipe 106. Alternatively, for the second embodiment of the manhole structure shown in fig. 2, the riser pipe 100' is extended by the extension of the bellow-like structure 108' inserted between the first and the second pipe 102' and 106'. The gasket 50 retains the first pipe 102 surely so that the first pipe 102 does not slip out of the gasket 50 during the lifting of the frame 12 due to the friction force between the first pipe 102 and the second pipe 106, the friction force between the first pipe 102 and the surrounding soil 34, and the weight of the first pipe 102.

[0085] The height to which the frame 12 should be lifted is determined by the thickness of a layer of new road surface material, designated the reference numeral 36 in fig. 5c, which is to be provided on top of the road surface material 30 in order to resurface the road. The new road surface designated the reference numeral 42 should be flush with the frame 12 at the height to which the frame 12 has been lifted.

[0086] Once the frame 12 has been lifted as shown in fig. 5b, the new road surface material 36 is applied to the road in which the manhole structure 10 is placed, and further applied around the frame 12 and under the lip 14 to support the frame 12 as shown in fig. 5c.

[0087] As an alternative to the procedure described above in relation to figs. 5a - 5c, the new road surface material 36 may be applied to the road and the manhole structure prior to the lifting of the frame 12. In this case the frame 12 with a cover (not shown) received in the received in the receiving aperture 18 may be covered with a thin layer of sand or other loose material to prevent adhesion of the new road surface material 36 to the frame 12 or its cover (not shown) as the new road surface material 36 is applied to the road to resurface the road in which the manhole structure 10 is placed. After removal of the new road surface material 36 from the frame 12 and its cover (not shown), the frame may be lifted as described above in relation to fig. 5b, and new road surface material 36 may be applied around the frame 12 and below the lip 14 as described above in relation to fig. 5c.

List of part with reference to the figures

[0088]

10. Manhole structure
10'. Manhole structure (second embodiment)
10". Manhole structure (alternative embodiment)
12. Frame
14. Lip
16. Skirt
18. Receiving aperture
20. Wall
22. Shoulder
24. Receiver
26. Groove
30. Road surface material
32. Base layer
34. Soil
36. New road surface material
40. Road surface

(continued)

40. New road surface
50. Gasket
50'. Adhesive
50". Caulk
52. First side
54. Second side
56. Minor rib
58. Major rib
60. Retaining ring
62. Groove
64. Space
100. Riser pipe
100'. Riser pipe (second embodiment)
100". Riser pipe (further embodiment)
102. First pipe
102'. First pipe (second embodiment)
102". First pipe (further embodiment)
104. End
104'. End (second embodiment)
104". End (further embodiment)
106. Second pipe
106'. Second pipe (second embodiment)
106". Second pipe (further embodiment)
108'. Bellow-like structure (second embodiment)

Claims

1. A manhole structure (10) comprising
a frame (12) having a skirt (16),
a riser pipe (100) at least partly inserted into said skirt (16), and,
a gasket (50) being placed between said skirt (16) and said riser pipe (100), **characterized in that** said gasket (50) is adapted to retain said riser pipe (100), and said riser pipe (100) is longitudinally extendable.

2. The manhole structure (10) according to claim 1, **characterized in that** said gasket (50) comprises an adhesive.

3. The manhole structure (10) according to claim 1, **characterized in that** said gasket (50) comprises caulk.

4. The manhole structure (10) according to any of the

claims 1-3, **characterized in that** said riser pipe (100) comprises a first pipe (102) mounted to said frame (12), and a second pipe (106), said first pipe (102) being connected to, and telescopically adjustable in relation to, said second pipe (106).

5. The manhole structure (10') according to any of the claims 1-3, **characterized in that** a bellow-like structure (108') is inserted in said riser pipe (100').

6. The manhole structure (10) according to any of the claims 1-5, **characterized in that** said manhole structure (10) further comprises an underground installation mounted to one end of said riser pipe (100), the other end (104) of said riser pipe being mounted to said frame.

7. The manhole structure (10) according to any of the claims 1 or 3-6, **characterized in that** said skirt (16) comprises a groove (26) formed within its inner wall.

8. The manhole structure (10) according to any of the claims 1 or 4-7, **characterized in that** said gasket (50) has a first side (52) oriented towards the inner wall of said skirt (16) and a second side (54) oriented towards the center of said skirt (16), said second side (54) having a rib (58) adapted to retain said riser pipe (100).

9. The manhole structure (10) according to claim 8, **characterized in that** said first side (52) of said gasket (50) is receivable within said groove (26) of said skirt (16).

10. The manhole structure (10) according to any of the claims 8-9, **characterized in that** said second side (54) of said gasket (50) has a groove (62) for receiving a retaining ring (60).

11. A method for mounting a manhole structure (10) according to any of the claims 1-10, comprising the steps of:

providing, in combination,
a frame (12) having a skirt (16),
an longitudinally extendable riser pipe (100),
a gasket (50) retained within said skirt (16), wherein said gasket (50) is adapted to retain said riser pipe (100), and
characterized by inserting a part of said riser pipe (100) through said gasket (50).

12. A method for adjusting the height of a frame (12) in a manhole structure (10) according to any of the claims 1-10, from a first level to a second level, comprising the steps of:

adjusting said height of said frame (12) from said first level to said second level, and
supporting said frame (12) at said second level,
characterized in that the distance between said first and second level is accommodated by said riser pipe (100).

13. The method according to claim 12, **characterized in that** said first level comprises the level of a road surface (40) before resurfacing, and said second level comprises the level of said road surface (42) after resurfacing.

Patentansprüche

1. Eine Schachtanordnung (10), die
einen Rahmen (12) mit einem Rand (16),
ein Steigrohr (100), das wenigstens teilweise in den Rand (16) eingefügt ist, und
eine Dichtung (50), die zwischen dem Rand (16) und dem Steigrohr (100) angeordnet ist,
umfasst,
dadurch gekennzeichnet, dass die Dichtung (50) zum Festhalten des Steigrohrs (100) angepasst ist, und dass das Steigrohr (100) in Längsrichtung ausdehnbar ist.

2. Die Schachtanordnung (10) gemäss Anspruch 1, **dadurch gekennzeichnet, dass** die Dichtung (50) einen Klebstoff umfasst.

3. Die Schachtanordnung (10) gemäss Anspruch 1, **dadurch gekennzeichnet, dass** die Dichtung (50) Kalfatern umfasst.

4. Die Schachtanordnung (10) gemäss einem jeglichen der Ansprüche 1-3, **dadurch gekennzeichnet, dass** das Steigrohr (100) ein auf dem Rahmen (12) montiertes, erstes Rohr (102) umfasst, sowie auch ein zweites Rohr (106), worin das erste Rohr (102) mit dem zweiten Rohr (106) verbunden ist und demgegenüber teleskopisch einstellbar ist.

5. Die Schachtanordnung (10') gemäss einem jeglichen der Ansprüche 1-3, **dadurch gekennzeichnet, dass** eine Balgen-artige Struktur (108') in das Steigrohr (100') eingesetzt ist.

6. Die Schachtanordnung (10) gemäss einem jeglichen der Ansprüche 1-5, **dadurch gekennzeichnet, dass** die Schachtanordnung (10) ausserdem eine unterirdische Installation umfasst, die auf dem einen Ende des Steigrohrs (100) montiert ist, und wo das andere Ende (104) des Steigrohrs auf dem Rahmen montiert ist.

7. Die Schachtanordnung (10) gemäss einem jeglichen der Ansprüche 1 oder 3-6, **dadurch gekennzeich-**

net, dass der Rand (16) eine Rille (26) umfasst, die in der inneren Wand des Randes geformt ist.

8. Die Schachtanordnung (10) gemäss einem jeglichen der Ansprüche 1 oder 4-7, **dadurch gekennzeichnet, dass** die Wichtung (50) eine erste Seite hat (52), die auf die innere Wand des Randes (16) gerichtet ist, und eine zweite Seite (54), die auf die Mitte des Randes (16) gerichtet ist, und wo die zweite Seite (54) eine Rippe (58) hat, die zum Festhalten des Steigrohrs (100) angepasst ist.

9. Die Schachtanordnung (10) gemäss Anspruch 8, **dadurch gekennzeichnet, dass** die erste Seite (52) der Dichtung (50) aufnehmbar in der Rille (26) des Randes (16) ist.

10. Die Schachtanordnung (10) gemäss einem jeglichen der Ansprüche 8-9, **dadurch gekennzeichnet, dass** die zweite Seite (54) der Dichtung (50) eine Rille (62) hat für das Aufnehmen eines Halterings (60).

11. Verfahren zur Montage einer Schachtanordnung (10) gemäss einem jeglichen der Ansprüche 1-10, das folgende Schritte umfasst:

Beschaffung von, kombiniert,
einem Rahmen (12) mit einem Rand (16),
einem in Längsrichtung ausdehnbaren Steigrohr (100), einer in dem Rand (16) bewahrten Dichtung (50), worin die Dichtung (50) zum Festhalten des Steigrohrs (100) angepasst ist, und **dadurch gekennzeichnet, dass** ein Teil des Steigrohrs (100) durch die Dichtung (50) eingesetzt wird.

12. Verfahren zur Anpassung der Höhe eines Rahmens (12) in einer Schachtanordnung (10) gemäss einem jeglichen der Ansprüche 1-10 von einer ersten Ebene auf eine zweite Ebene, das folgende Schritte umfasst:

die Höhe des Rahmens (12) von der ersten Ebene auf die zweite Ebene anzupassen, und
den Rahmen (12) auf der zweiten Ebene zu unterstützen,

dadurch gekennzeichnet, dass der Abstand zwischen der ersten und der zweiten Ebene mit dem Steigrohr (100) angepasst wird.

13. Verfahren gemäss Anspruch 12, **dadurch gekennzeichnet, dass** die erste Ebene die Ebene des Strassenbelags (40) vor einer Neubelegung umfasst, und die zweite Ebene die Ebene des Strassenbelags (42) nach einer Neubelegung umfasst.

Revendications

1. Structure de regard de chaussée (10) comprenant un cadre (12) ayant une jupe (16),
une conduite montante (100) insérée au moins partiellement dans ladite jupe (16), et,
un joint d'étanchéité (50) étant placé entre ladite jupe (16) et ladite conduite montante (100), **caractérisé en ce que** ledit joint d'étanchéité (50) est adapté pour retenir ladite conduite montante (100), et ladite conduite montante (100) est extensible de manière longitudinale.

2. Structure de regard de chaussée (10) selon la revendication 1, **caractérisée en ce que** ledit joint d'étanchéité (50) comprend un adhésif.

3. Structure de regard de chaussée (10) selon la revendication 1, **caractérisée en ce que** ledit joint d'étanchéité (50) comprend du calfat.

4. Structure de regard de chaussée (10) selon l'une quelconque des revendications 1 à 3, **caractérisée en ce que** ladite conduite montante (100) comprend une première conduite (102) montée sur ledit cadre (12), et une deuxième conduite (106), ladite première conduite (102) étant raccordée à ladite deuxième conduite et étant réglable de manière télescopique à celle-ci (106).

5. Structure de regard de chaussée (10) selon l'une quelconque des revendications 1 à 3, **caractérisée en ce qu'**une structure de genre soufflet (108') est insérée dans ladite conduite montante (100).

6. Structure de regard de chaussée (10) selon l'une quelconque des revendications 1 à 5, **caractérisée en ce que** ladite structure de regard de chaussée (10) comprend en outre une installation souterraine montée à une extrémité de ladite conduite montante (100), l'autre extrémité (104) de ladite conduite montante (100) étant montée audit cadre.

7. Structure de regard de chaussée (10) selon l'une quelconque des revendications 1 ou 3 à 6, **caractérisée en ce que** ladite jupe (16) comprend une rainure (26) formée à l'intérieur de sa paroi interne.

8. Structure de regard de chaussée (10) selon l'une quelconque des revendications 1 ou 4 à 7, **caractérisée en ce que** ledit joint d'étanchéité (50) a un premier côté (52) orienté vers la paroi interne de ladite jupe (16) et un deuxième côté (54) orienté vers le centre de ladite jupe (16), ledit deuxième côté (54) ayant une ailette (58) adaptée pour retenir ladite conduite montante (100).

9. Structure de regard de chaussée (10) selon la re-

vendication 8, **caractérisée en ce que** ledit premier côté (52) dudit joint d'étanchéité (50) est recevable à l'intérieur de ladite rainure (26) de ladite jupe (16).

10. Structure de regard de chaussée (10) selon l'une quelconque des revendications 8 à 9, **caractérisée en ce que** ledit deuxième côté (54) dudit joint d'étanchéité (50) a une rainure (62) pour recevoir un anneau de rétention (60).

11. Procédé pour monter une structure de regard de chaussée (10) selon l'une quelconque des revendications 1 à 10, comprenant les étapes de:

fournir, en combinaison,
un cadre (12) ayant une jupe (16),
une conduite montante (100) s'étendant de manière longitudinale,
un joint d'étanchéité (50) retenu à l'intérieur de ladite jupe (16), dans lequel ledit joint d'étanchéité (50) est adapté pour retenir ladite conduite montante (100), et
caractérisé par l'insertion d'une partie de ladite conduite montante (100) à travers ledit joint d'étanchéité (50).

12. Procédé pour régler la hauteur d'un cadre (12) dans une structure de regard de chaussée (10) selon l'une quelconque des revendications 1 à 10, d'un premier niveau à un deuxième niveau, comprenant les étapes de:

régler ladite hauteur dudit cadre (12) dudit premier niveau audit deuxième niveau, et
supporter ledit cadre (12) audit deuxième niveau, **caractérisé en ce que** la distance entre ledit premier niveau et ledit deuxième niveau est accommodée par ladite conduite montante (100).

13. Procédé selon la revendication 12, **caractérisé en ce que** ledit premier niveau comprend le niveau d'une surface de rue (40) avant le resurfaçage, et ledit deuxième niveau comprend le niveau de ladite surface de rue (42) après le resurfaçage.

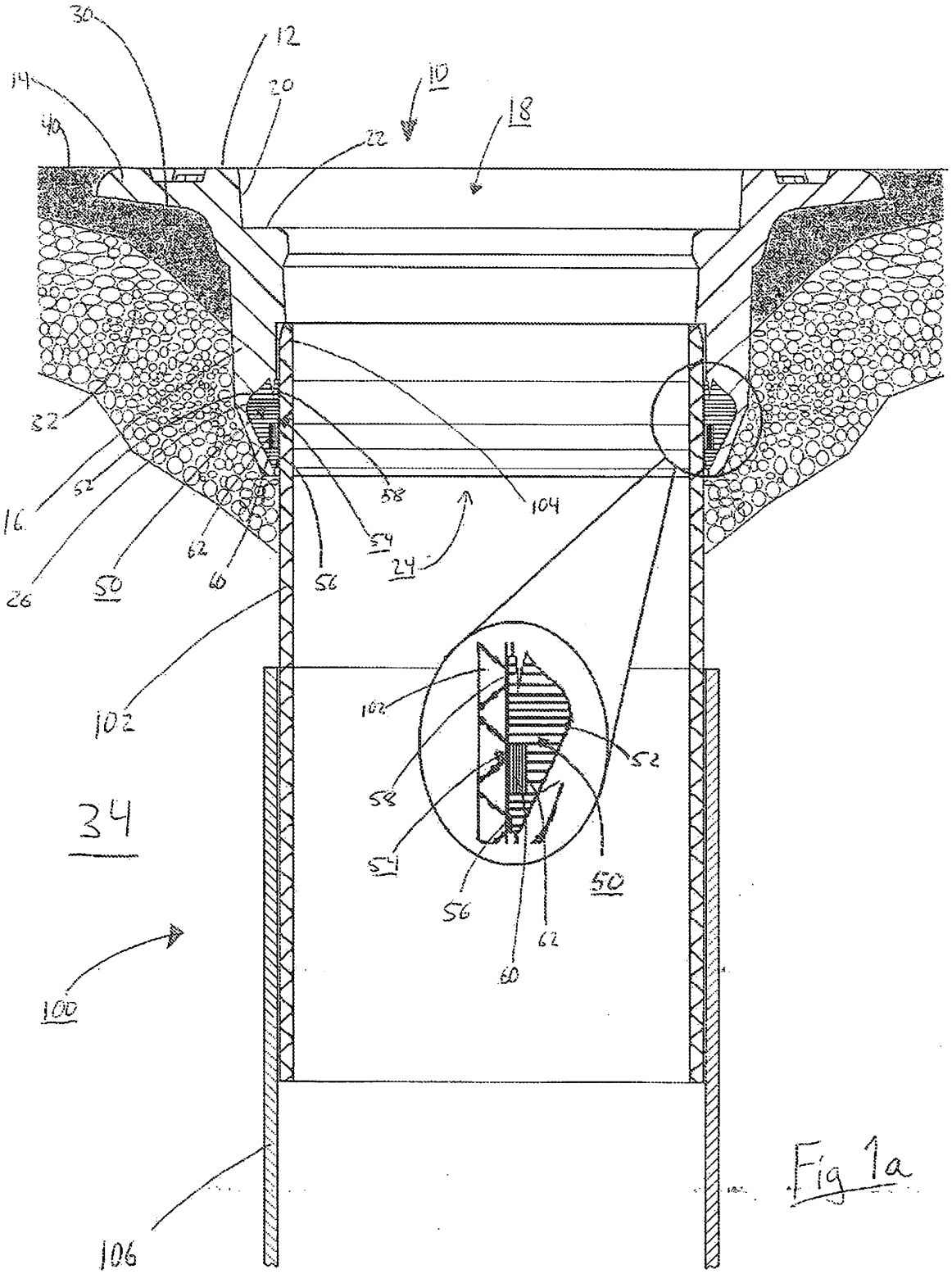
30
12
14
20
10
40
22
18
32
16
52
58
104
54
24
62
26
50
60
56
102
34
102
52
58
54
56
62
60
50
100
106

Fig 1a

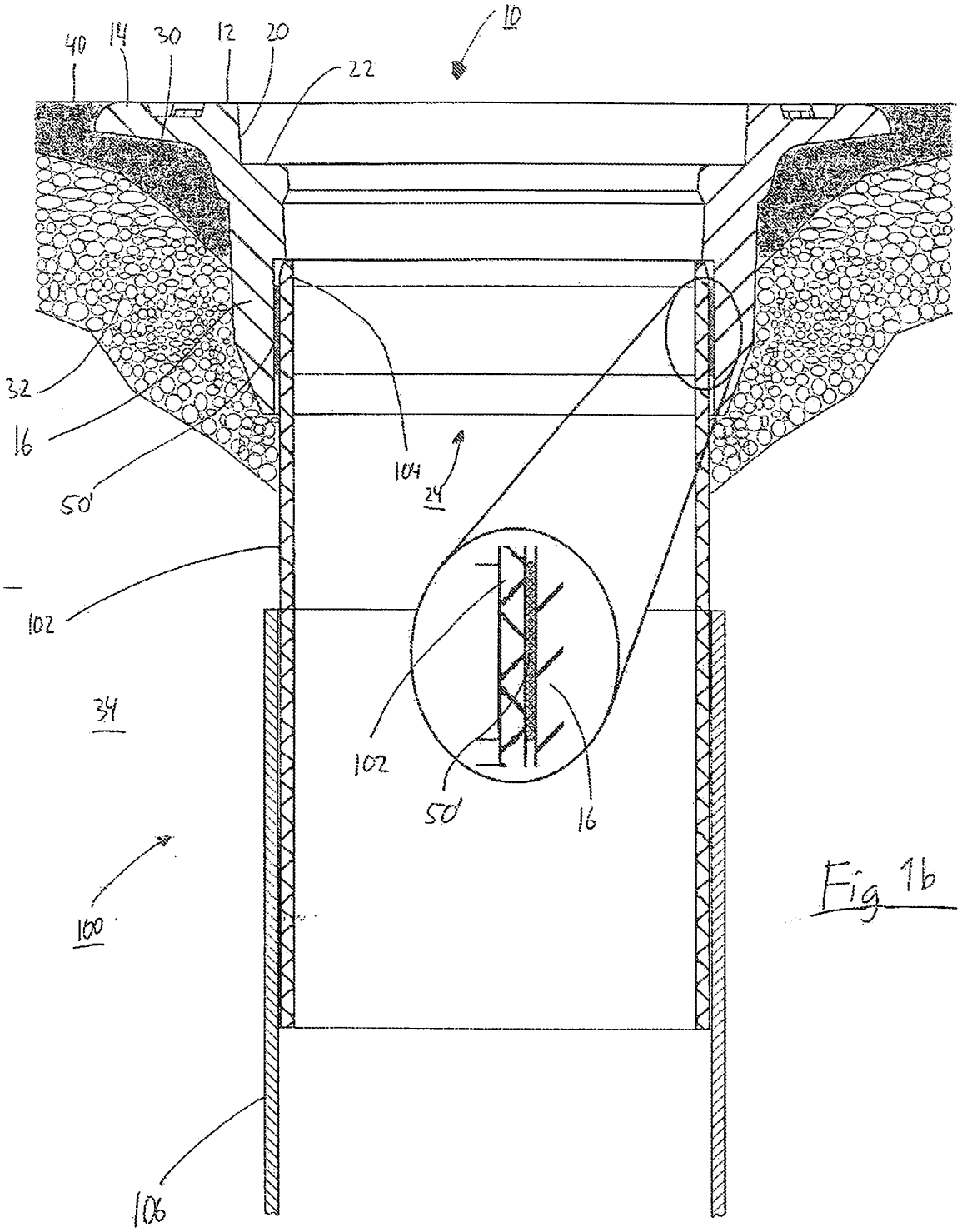

Fig 1b

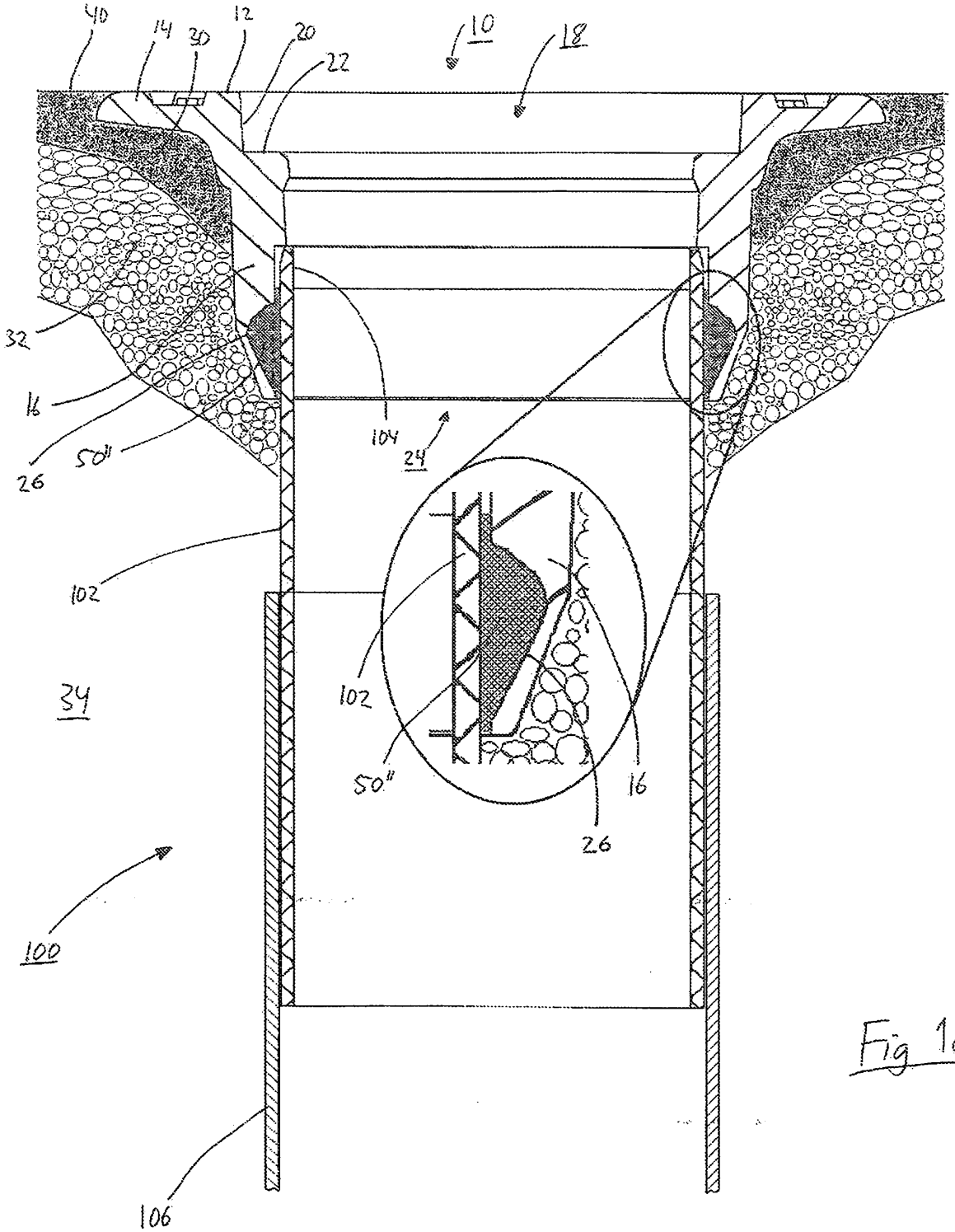

Fig 1c

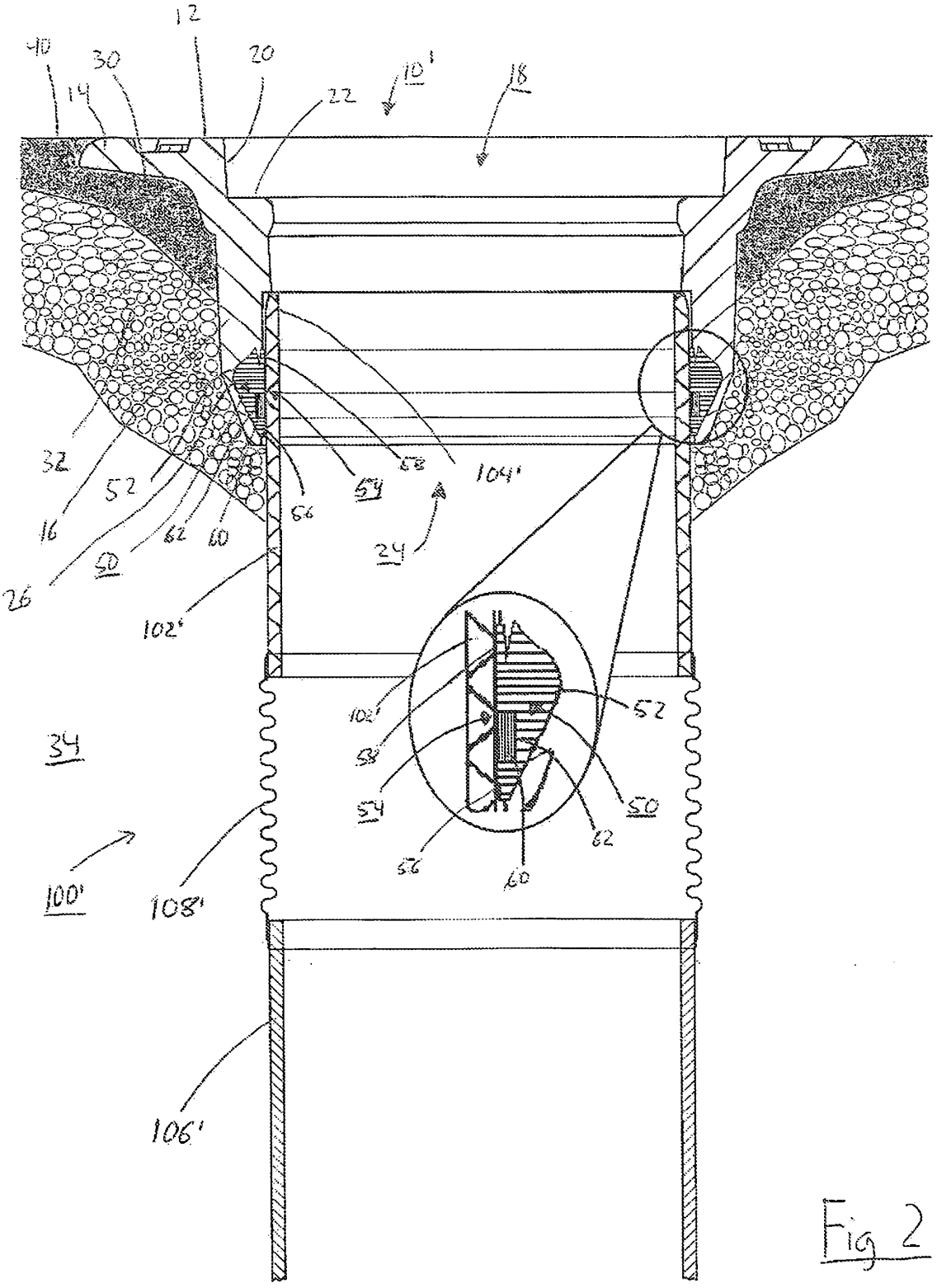
12
40
30
20
14
22
10'
18
32
52
16
54
58
104'
64
62
60
24
50
26
102'
34
102'
52
58
54
50
62
56
60
100'
108'
106'

Fig 2

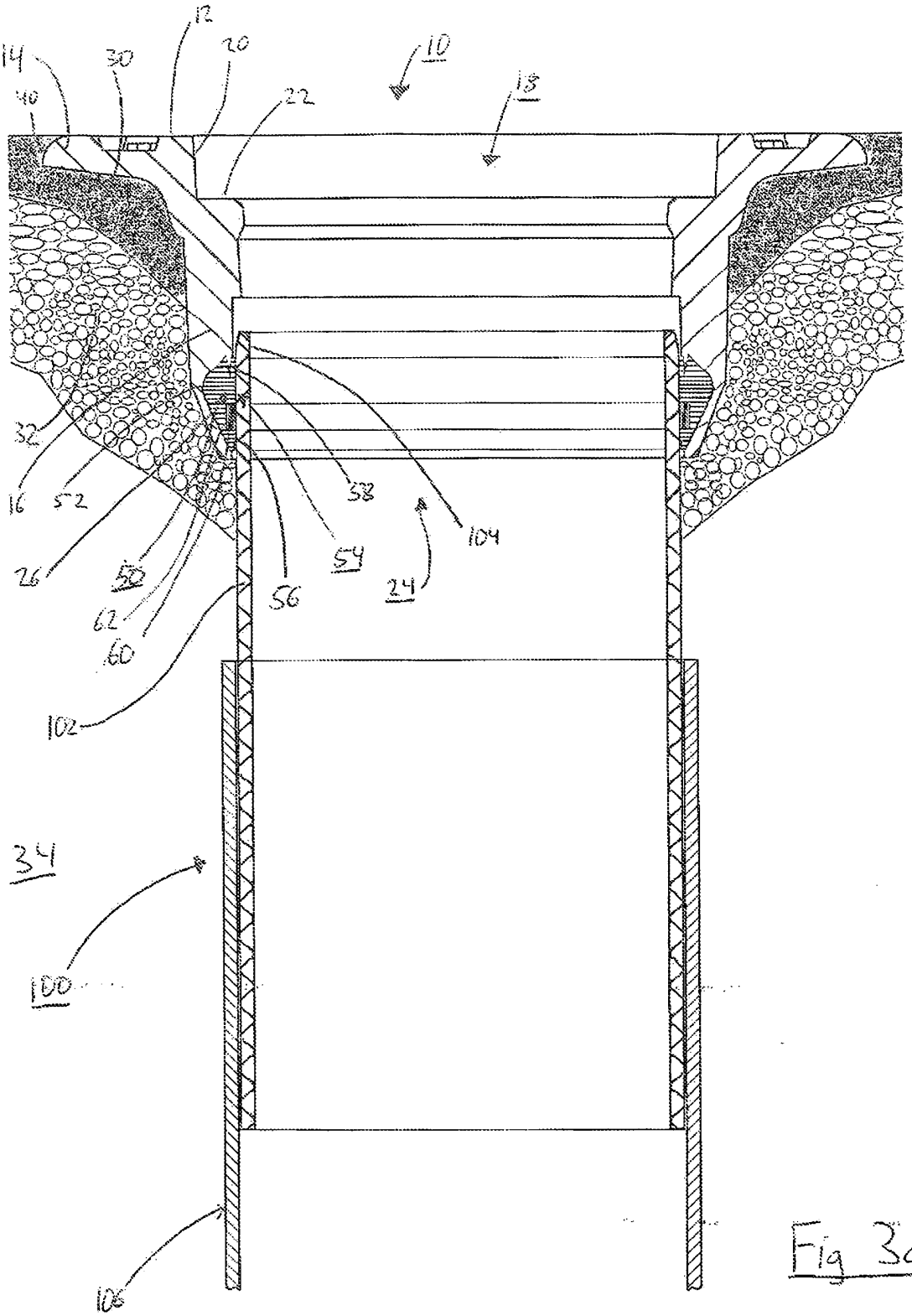
12
14
30
20
10
40
22
15
32
16
52
58
26
50
54
104
62
56
24
60
102
34
100
106

Fig 3a

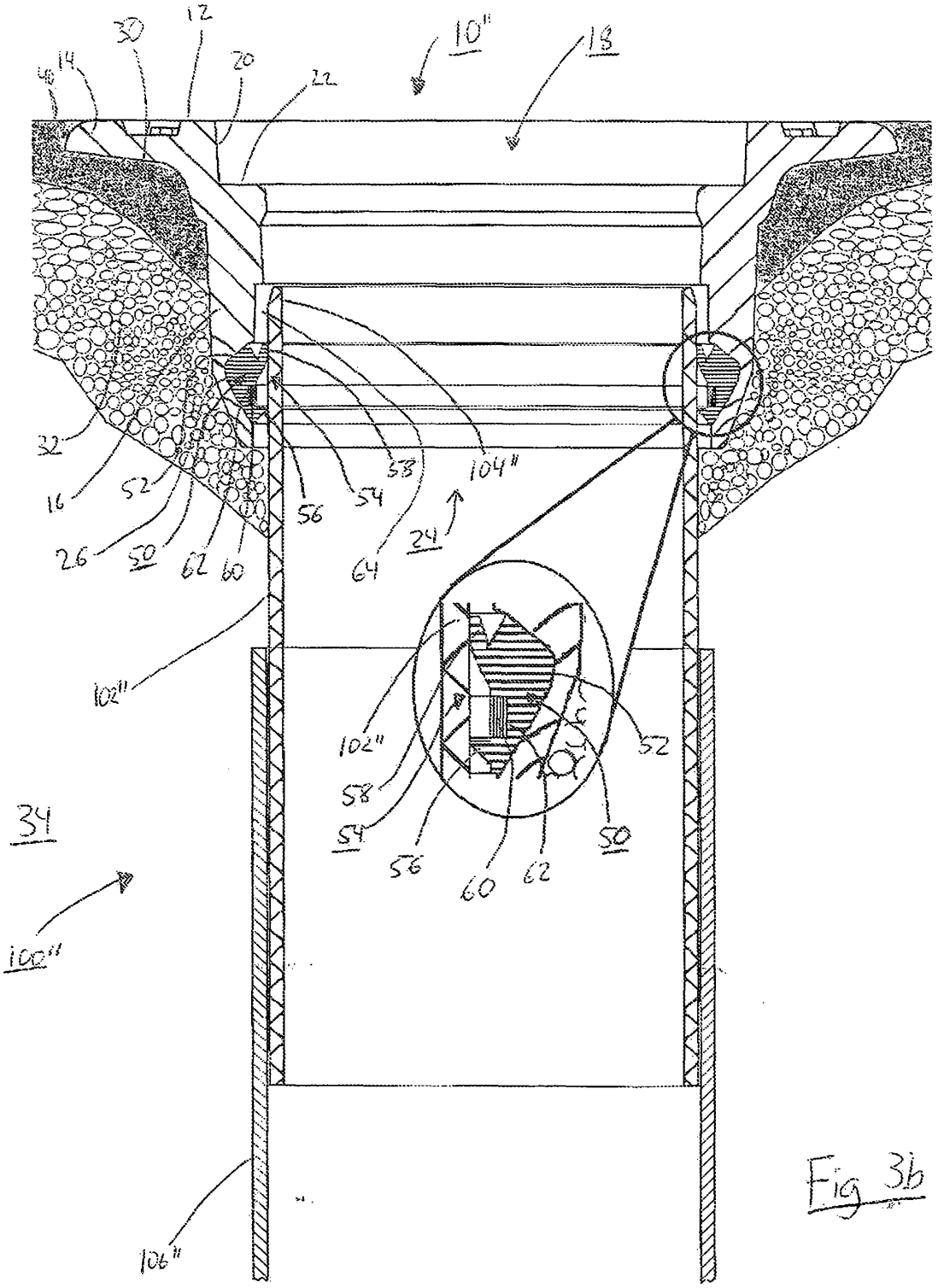
30
12
14
20
22
10"
13
32
16
52
26
50
62
60
56
54
58
64
104"
24
102"
102"
52
58
54
56
60
62
50
34
100"
106"

Fig 3b

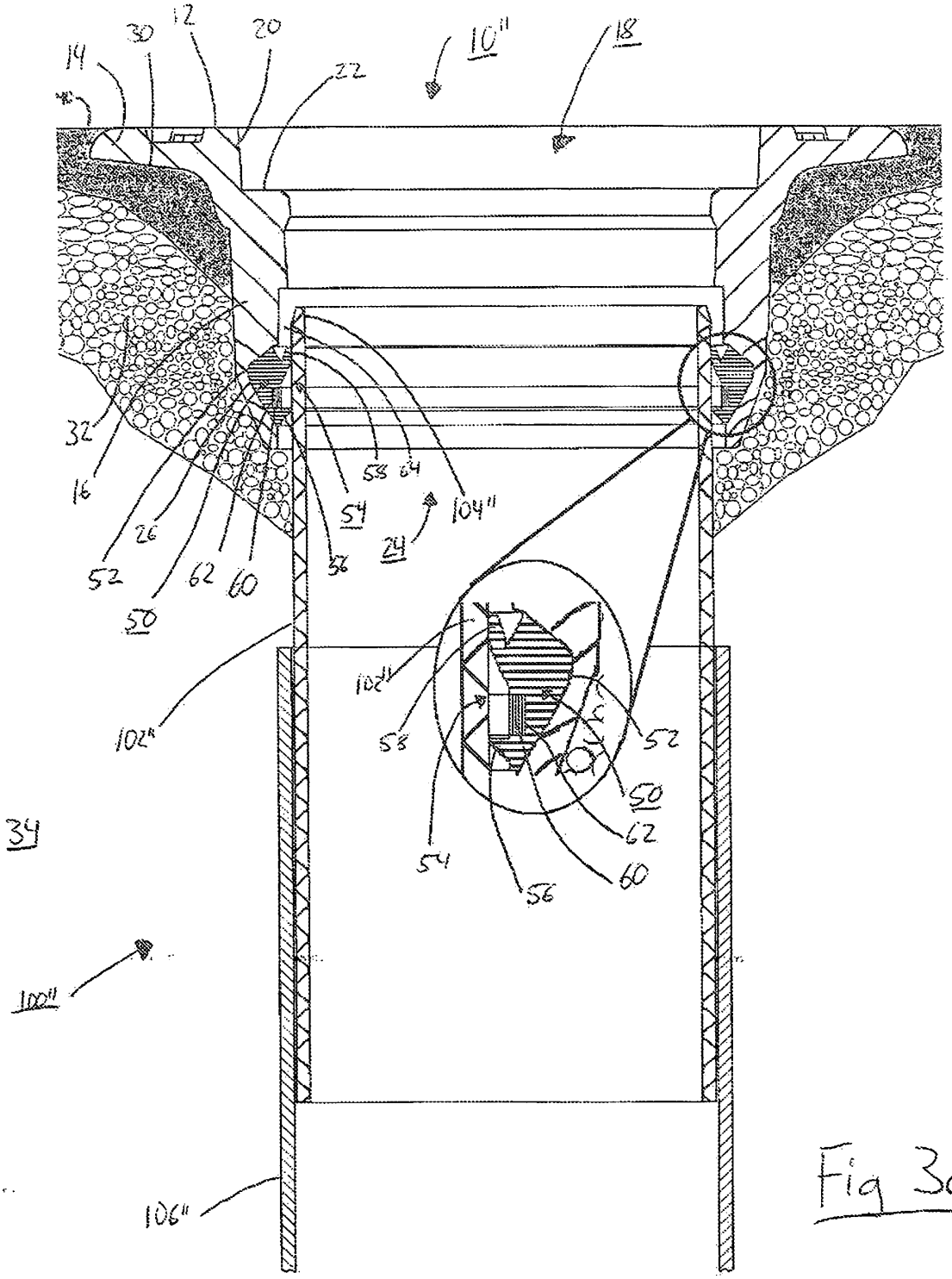
14
30
12
20
22
10"
18
32
16
26
52
62
60
50
58
64
54
56
24
104"
102"
102"
58
52
50
62
60
54
56
34
100"
106"

Fig 3c

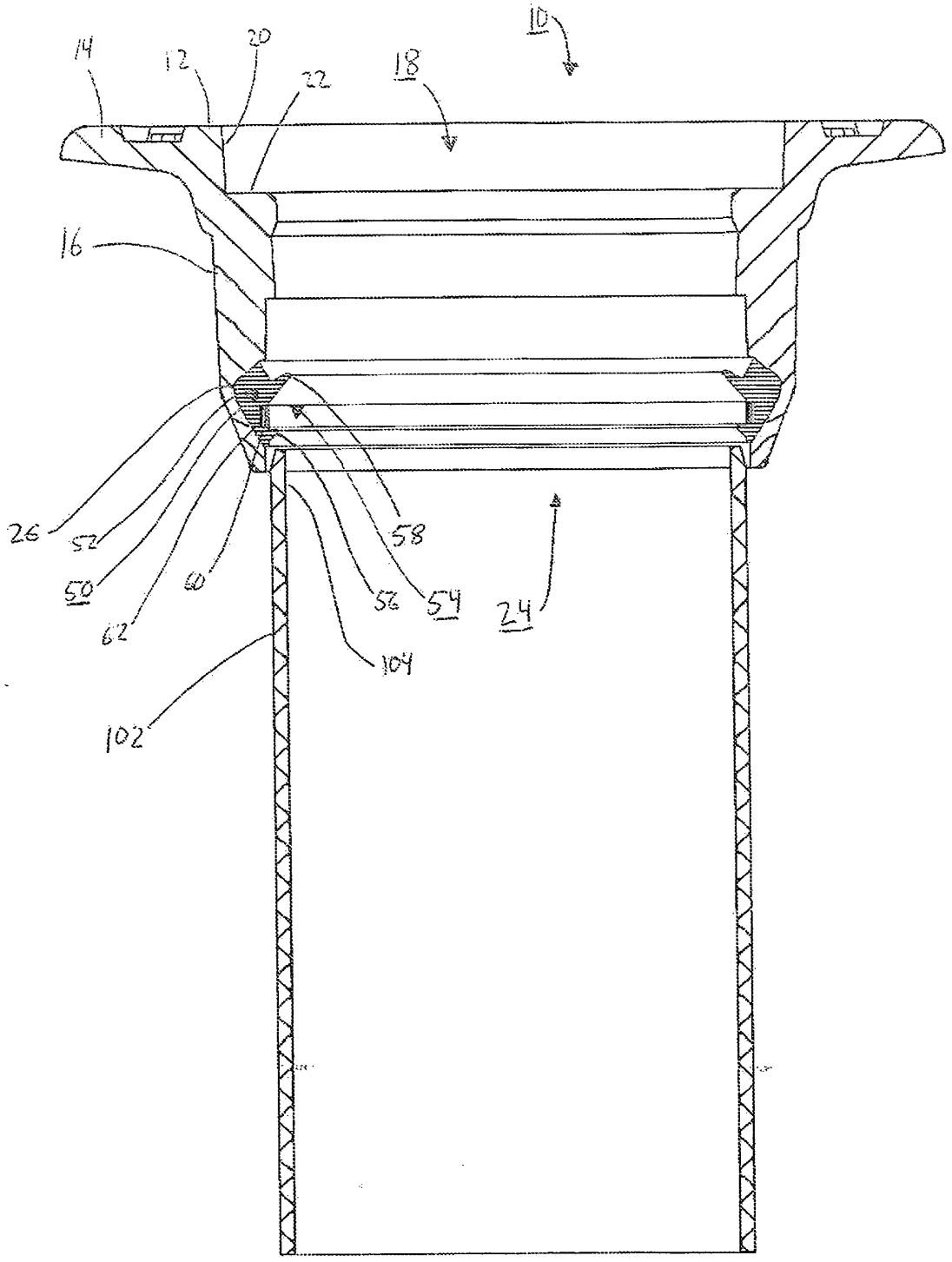

Fig 4

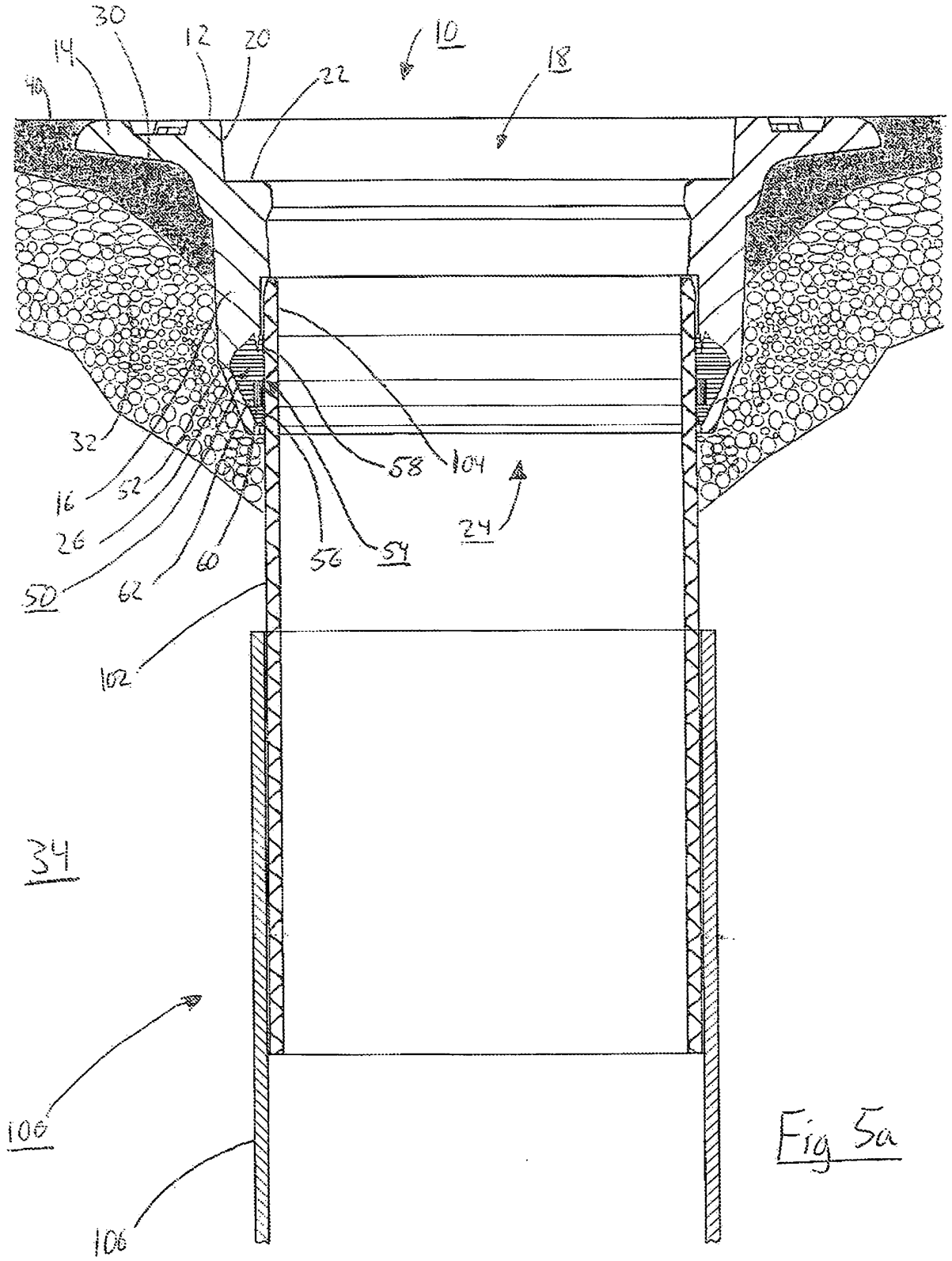
30
14
12
20
10
22
18
40
32
16
52
26
50
62
60
58
104
24
56
54
102
34
100
106

Fig 5a

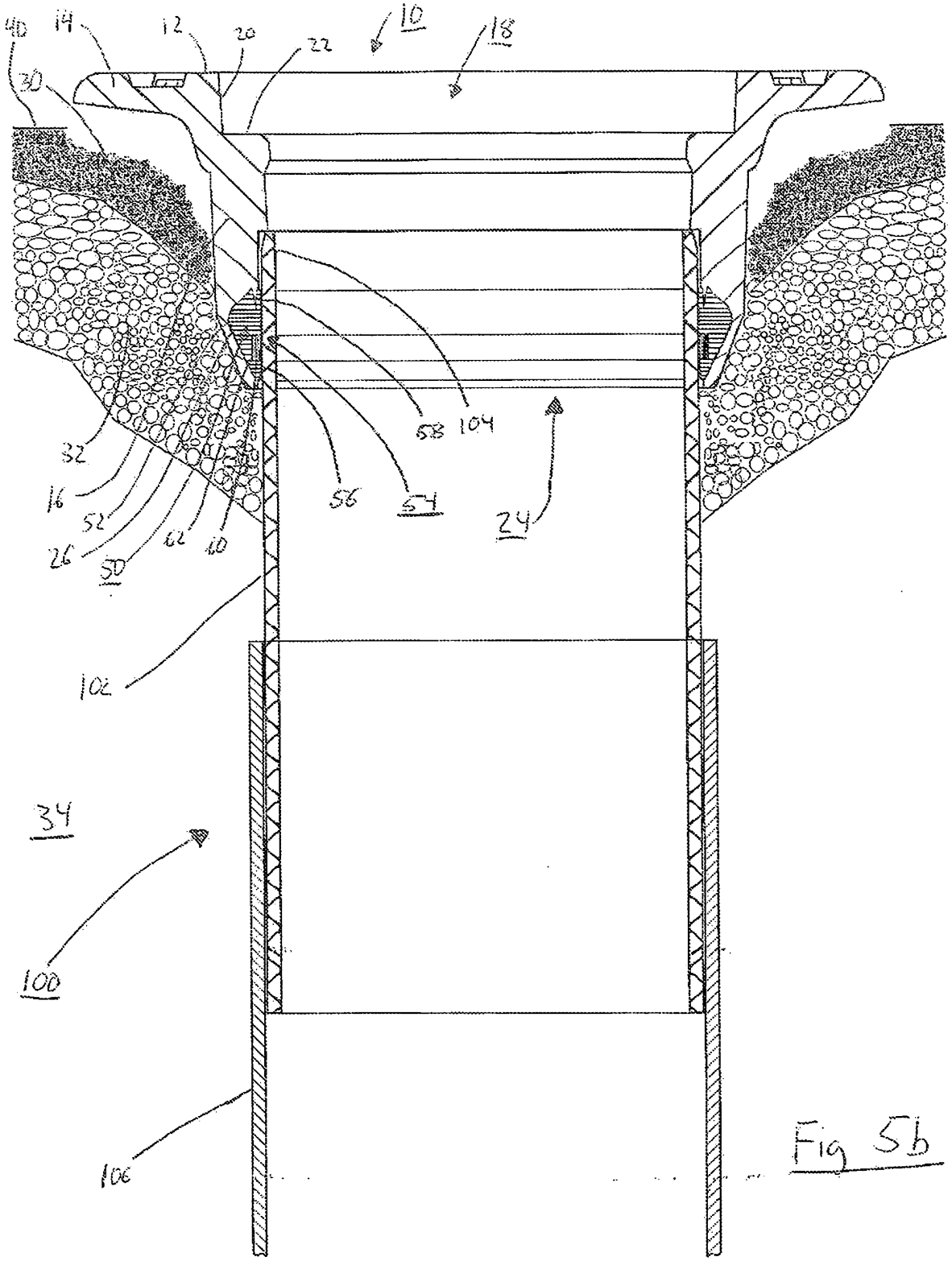
40
14
12
20
22
10
18
30
32
16
52
26
50
62
40
56
54
58
104
24
102
34
100
106

Fig 5b

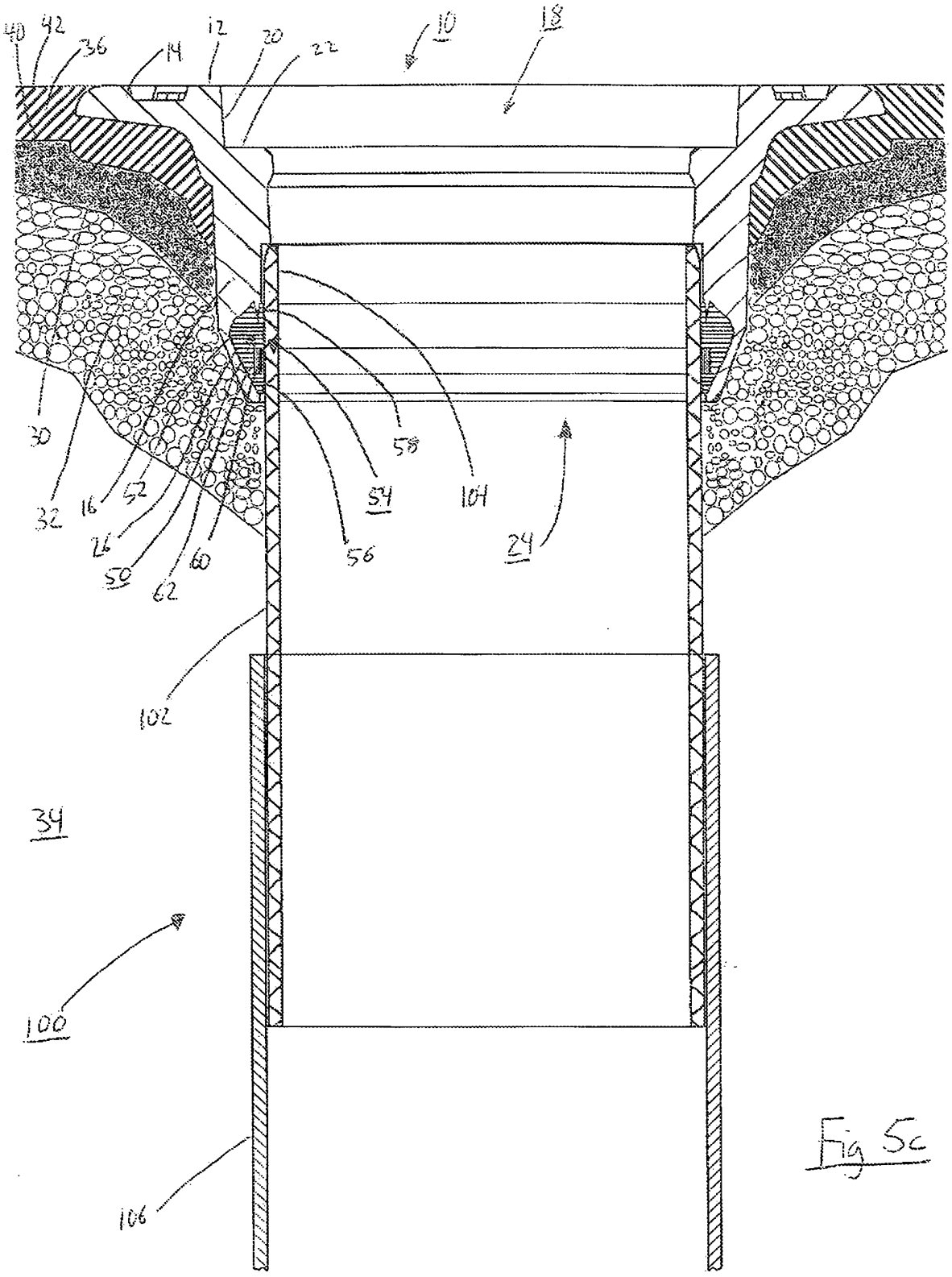
40
42
36
14
12
20
22
10
18
30
32
16
52
26
50
62
60
58
54
56
104
24
102
34
100
106

Fig 5c

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 4188151 A **[0004]**
- US 6196760 B **[0004]**
- EP 0529178 A **[0004]**
- EP 0900885 A **[0005]**
- CA 2425459 **[0007]**
- EP 826834 A **[0008]**
- DE 29907296 **[0009]**
- DE 19505130 **[0009]**
- EP 1792110 A **[0047]**