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⑤4 Manhole cover support having enhanced grip.

57) A new manhole cover support and its processes of manufacture and use are shown. Such cover supports are used to raise the effective grade of the existing manhole cover as before road resurfacing. The cover supports are mounted upon an existing manhole cover receiving structure which has an upwardly-extending shoulder surface and a sill therebelow for accommodating such cover and the new cover support. The new cover support has an expansible body (1) with flexible, compressible retention component (16) for increasing its frictional grip to the shoulder surface. Advantageously, the retention component and any seals comprise a curable polymeric material. The receiving structure can be an existing manhole cover frame or previously-installed cover support. Some embodiments of the cover support can be adjusted as to elevation; the bodies of some are one piece and others are segmented into a plurality of connected segments. They can be sealed against substantial water infiltration.

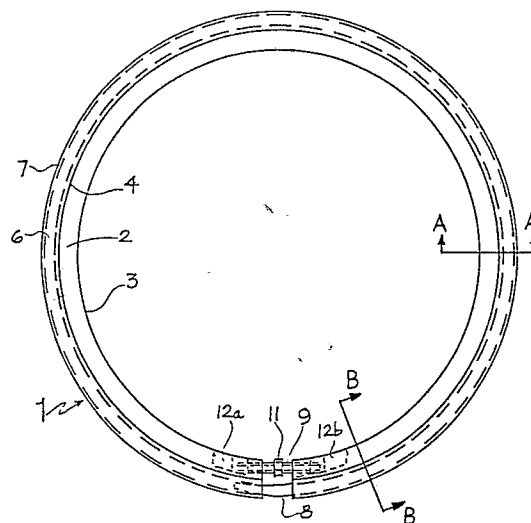


FIG. 1

Description**Manhole Cover Support Having Enhanced Grip**Background of the Invention

5 This invention relates to adjustable manhole cover supports for emplacing over and raising the effective grade of an existing manhole cover receiving structure.

For simplicity the terms "existing manhole cover receiving structure" and "manhole cover" herein are used to refer to the existing, i.e., fixed in-place frame or other existing seating receptacle for a removable cover or grating that covers an access hole (i.e., hand hole, tool hole, manhole, catch basin or the like), and to that cover or grating. The resulting assembly of a receiving structure and a manhole cover ordinarily is intended to bear vehicular traffic. The term "manhole cover support" or simply "cover support" here means a structure that fits over the existing manhole cover receiving structure, raises its grade, and thereby accommodates a cover or grating at the new grade. Advantageously, the cover or grating is the same one that was used at the lower grade. The access hole covered is a utility enclosure serving, e.g., an electric, gas, water, sewer or storm drainage system.

Ordinarily the instant cover support finds its use when a roadway such as a street or highway is resurfaced with an added layer of paving material, typically asphalt concrete or sheet asphalt, to establish a higher grade. It then is advantageous to mount the inventive cover support atop the existing manhole receiving structure. Prior art on manhole cover supports and manhole cover frames can be found in U.S. patents 4,281,944, 4,236,358, 3,968,600, 3,773,428, 4,097,171, 4,302,126, 3,891,337 and 1,987,502. The first four of these are for inventions of the applicant.

Axle loads up to 18,182 kg. must be resisted by many of these cover supports as well as serious impact loads from vehicles and snow plows, a variety of temperature effects, steam leaks, spillage, etc., without permitting a hazardous dislocation of the cover support or its cover. Often it is desirable also to cushion the cover for resisting wear or reducing noise, and/or to seal the cover and its cover support against a substantial and possibly overloading infiltration of surface water, e.g., storm drainage that otherwise would enter a sanitary sewer system at various manhole locations. Adjustability of the cover support in peripheral dimension and height also is important for accommodating the wide range of specifications to be met.

Clearly the resistance to displacement from traffic loading and impact is a paramount concern and a most general one. The supports often contain some reasonably thin (0.254 cm. or less) elements such as sheet steel elements. These can include upwardly projecting cover keeper wall portions, flanging, and bases. Such thin keeper portions can be fitted into an existing manhole cover frame and, normally, still leave a large enough opening at the new-grade to accommodate the same old cover or lid which was used on the existing frame. The lighter weight elements also can be effective for economy and/or ease of manufacture, handling and installation. However, a relatively low weight of the cover support, as compared to the usually thick solid cast iron fixture on which it is to rest, makes it a candidate for displacement in service. This is true even when a cover support can be expanded against the rising shoulder of a receiving structure such as a manhole cover frame in the manner of various prior art cover supports such as those in U.S. patents 4,281,944, 4,236,358, 4,097,171 and 4,302,126, noted above. Where the retention is mainly due to the weight of a cover and its support, displacement is even more of a risk.

The instant support can be made especially highly resistant to displacement and dislodgement in service without being made ponderous in weight, even when it has no mechanical fastening to the receiving structure. Thus, while the present cover support can be made to incorporate conventional structural or mechanical holddown means that are integral with it or easily attached, the cover support also can do a good job of holding in (being retained in the existing receiving structure while in service) by friction alone.

Installing, adjusting, loading and unloading and otherwise handling manhole cover supports and removing manhole covers usually is done with powerful and indelicate tools such as picks, pinch bars, crowbars, tongs, heavy hooks and the like. Deformation of the cover support can occur, particularly about its upper edge which is nearest the road surface. The upper edge usually is the handiest fulcrum area for applying lifting and other tools. Deformations of the edge never are good, and they can render the opening of the support unfit for service. Hence, overall ruggedness and stiffness against deformation, especially at or near the top rim, and resistance to displacement are major concerns about manhole cover supports.

On the other hand, a relatively light construction of the cover support, in comparison to the ponderous cast iron frame that usually initially supports the manhole cover when the first paving is laid, can be very desirable, provided, however, that an inordinate amount of the ruggedness, stiffness, and resistance to displacement or dislodgement is not sacrificed. Usually a main place for weight reduction is in the lateral keeper for the cover. Another place is in the base of the cover support. Clearly the economics of manufacture, handling and installation all are generally in favor of lower weight. A relatively thin wall keeper would normally be of steel, the wall rarely being more than about 0.254 cm. (12 ga.) thick, usually less.

The present adjustable support lends itself to being sealed off against water infiltration and to cushioning the cover. Furthermore, it can be made very stiff or especially durable even when employing relatively thin metal for some or all of the various body elements.

No previously proposed manhole cover supports are known by the inventor to be able to develop the retentional friction that this one can develop, let alone to include as well at least another of the additionally desirable features such as sealing off water infiltration, modest weight coupled with high stiffness and/or special durability.

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Broad Statement of the Invention

The instant manhole cover support is for emplacing over and raising the effective grade of an existing manhole cover receiving structure where that structure has an upwardly-extending shoulder surface extending from a sill that was made to accommodate a manhole cover. The new cover support has excellent retainability characteristics in service without its necessarily being ponderous and extremely heavy. It comprises:

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a body; and

a flexible, compressible retention component therefor,

the body having a seat and a lateral keeper for the manhole cover and a base with an outer wall that is adjustable in perimeter dimension,

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the base being formed to rest on the sill,

the retention component being integral with at least a part of the outer wall of the base or being interposed between the outer wall of the base and the shoulder surface of the receiving structure, exhibiting a coefficient of static friction with respect to the surfaces which it contacts frictionally that substantially exceeds the coefficient of static friction obtainable directly between steel and said surfaces, and being disposed to interact with the expansion of the base for enhancing substantially the frictional grip between the body and the existing receiving structure.

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A further aspect of this invention is a process for the installation of the foregoing manhole cover support in an existing receiving structure having an upwardly-extending shoulder surface. This process is characterized by placing against the shoulder surface a flexible, compressible retention component surface of the cover support that is capable under pressure of enhancing substantially the frictional grip between the base of the cover support and the shoulder surface and expanding the base against the constraint of the receiving structure.

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A still further aspect of this invention is an improvement in process for manufacturing the foregoing manhole cover support. The improvement comprises depositing over at least a portion of the outer wall surface of the cover support base or forming at least a part of that outer wall surface from a composition that is curable to leave a compressible and flexible solid surface which is capable of enhancing substantially the frictional grip between the cover support and the shoulder surface of the existing receiving structure, and curing the composition until said compressible and flexible surface is formed.

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Brief Description of the Drawings

Figures 1-4 illustrate an adjustable cover support with a practically vertically rising cover keeper wall. Such keepers necessarily must be thin-walled to fit into an existing frame and still accommodate the original cover. In other words, that cover must lie flat on the new seat that is bounded by the walls of such keeper. In various other embodiments of the invention the keeper walls can rise with a slight outward slant.

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Figure 1 is a top plan view of a preferred nominally 91 cm. diameter split-ring embodiment of the instant cover support adapted to fit a circular manhole and having a bonded-on outer seal element and retention component and a bonded-on polymer seat and seal element. The outer surfaces of this retention component will be in frictional contact with the shoulder of the existing receiving structure when this cover support is installed;

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Figure 2 is a vertical cross section of Figure 1 taken through Section A-A;

Figure 3 is a vertical cross section of Figure 1 taken through Section B-B;

Figure 4 is a side elevation view of the cover support of Figure 1;

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Figure 5 is a fragmentary perspective view of the joint area of a split ring cover support embodiment of the invention with the sealing plug for its joint gap shown detached from that gap. The right side of the ring is shown broken off, and the left side is drawn as being cut off (for simplicity); and

Figure 6 is a cross sectional elevation of a four-segment circular cover support of this invention installed in a resurfaced street, the exposed part of the body being mainly flexible polymer stressed from the inboard side with a metal body frame. The section is taken in the center of a segment between turnbuckle bolt expanders.

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Figure 7 shows a simplified perspective view of a four-segmented cover support being adjusted in exterior diameter by a wrench preparatory to installation on a manhole cover frame. The cover support differs from that of Figures 1, 2, 3 and 4 by having only very short outward flange portions at the top of the keeper portions and no connections between the tops of the keeper portions;

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Figure 8 shows in vertical cross section the installation in a roadway of an embodiment of the cover support like that of Figure 7. The section is taken on a vertical plane through the middles of diametrically opposite segments of the four-segment cover support;

Figure 9 shows a vertical cross section of an alternative cover support fitted with an elastomeric O-ring

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stretched around the outer periphery of its manhole cover supporting base and another resting in a notch on the top of the base. The peripheral O-ring will be in frictional contact with both the shoulder of the existing receiving structure and the outer wall of the base when this cover support is installed. The section is taken in a vertical plane through the middle of the pair of 180° segments making a two-segment circular cover support;

Figure 10 shows a vertical cross section of a all cast ductile iron-bodied circular cover support. The section is taken in a vertical plane through the middles of diametrically opposed segments of a four-segment circular cover support; and

Figure 11 shows a vertical cross section of a circular cover support fitted with an elevating screw, several elastomeric band-like retention components stretched around it and with an elastomeric seat for the cover. The retention components and the seat need not be bonded to the metal body of the cover support, but that is preferable. The section is taken through the middle of a split ring cover support opposite the adjustable joint.

Figure 12 is a fragmentary top plan view of a preferred form of a rectangular manhole cover support with box flanging running the length of tops of the straight lateral segments and water sealing elements bonded to cover seat portions and outside wall portions of those lateral segments. The sealing elements on the outer wall also act as a cover support frictional retention component when the cover support is expanded against the upwardly extending shoulder surfaces of the existing manhole cover receiving structure such as a manhole cover frame.

Figure 13 is a side elevation view of the cover support of Figure 12.

Figure 14 is a fragmentary plan view of the corner of the cover support of Figure 12 with its corner joint-sealing fitment removed. The fitment is of foamed elastomer that acts to plug the corner and stop surface water leakage at that point.

Figure 15 is a vertical cross-sectional elevation of the fitment taken through section Z-Z of Figure 14.

Best Mode for Carrying Out the Invention

Reference is made to Figure 1. The cover support broadly is indicated by arrow 1. Seat 2 for the cover is a polymeric seal and cushioning element on the top of the cast ductile iron (ASTM type 536, Grade 60-45-12) base of this cover support. Its inner vertical wall is 2.54 cm. in height, item 3. Welded to and rising up from the outside top edge of the base is a lateral keeper 4 for the cover. The keeper is of 13 ga. (0.24 cm.) steel. The top 6 of the keeper is formed into a hollow (1.91 cm. x 1.91 cm. inside dimensions) wale having outside wall 7.

The base and keeper, including the wale, form an almost complete circular pattern which is interrupted only by a joint that is connected with a turnbuckle bolt 9 and is bridged with tapered steel shaft 8.

The right end of the shaft is of essentially square cross section, and it makes a snug fit into, and is welded into the hollow channel part of the wale. The left end of the shaft 8 is somewhat tapered, and it makes a slidable fit into the other end of the hollow channel part of the wale. Thus the entire wale can be considered to be the box flanging around the upper periphery of the keeper and the shaft 8 across the joint.

The ends of the turnbuckle bolt 9 are threaded with opposite handedness to open up the gap of the joint when turned one way, and to close the gap when turned the other way with a wrench acting on wrench grip 11. For security in service, a nylon locking patch is applied to the bolt threads. The bolt 9 is of A.1.S.1 type 302 stainless steel; each end of it runs into a horizontal tapped hole in the base. The holes are tapped appropriately for bolt adjustment and extend to reach the notches 12a and 12b. The notches accept the protruding ends of bolt 9 when the gap is shortened.

If a greater amount of peripheral adjustment and greater frictional grip of the base into a manhole frame or the like is desired, a pair or two pairs (or more) of diametrically opposed joints of the type connected by bolt 9 can be used in the cover support. Thus, the cover support will be made of two or four (or more) segments, usually of equal size if the cover is circular. However, if the cover support is rectangular or otherwise polygonal or oval in plan, the joints can be at corners or on the sides; the resulting connected segments, while usually making a generally symmetrical whole in plan, will not necessarily be of equal size.

The elements of the cross section shown in Figure 2 include those with the same numbers as used in Figure 1 plus these: 17, the cast ductile iron base; 10, the top of the base; 19, the hollow channel of the wale; 14, the bottom of the wale which can be tack-welded along the outside of keeper 4; cover seat 2, a 0.32 cm. thick slightly foamed elastomer bonded to the top of the base; bottom 18 of the base which is to rest on the existing manhole cover receiving element; and a frictional retention member 16 which is about 0.32 cm. thick of slightly foamed elastomer bonded to the base all around its outer perimeter. Sheet steel keeper 4 is welded to base 17 and any lumps, spatter, etc. are removed, e.g., ground off the outer and inner seams that it makes with the base.

The elements of Figure 3 are the same as those of Figure 2 except that the wale at this zone includes shaft 8 as an integral (e.g., welded-in) part.

The elements of Figure 4 that also are shown in Figures 1, 2 and 3 have the same numbers as in those figures. Thus, item 16 is the retention component, 8 the shaft and 19 the hollow channel of the wale, 9 the turnbuckle bolt, 17 the wrench grip of the bolt, and 12a and 12b the left and right notches, respectively, for permitting protrusion thereinto of the bolt ends. If desired, the retention component can be a separate strip or strips of flexible, compressible polymer interposed between the base and the existing manhole cover

receiving structure instead of such polymer being bonded on. Furthermore, it can be in the form of one or more bands or O-rings surrounding and even elastically gripping the base, e.g., in grooves therein. Likewise, the seal element that makes the seat for the manhole cover can be in the form of a washer or gasket or one or more (concentric) rings, e.g., O-rings, and that element need not be bonded to the cover support.

The cover support embodiment shown in Figures 1, 2, 3 and 4 has a good frictional grip to an existing manhole cover frame. This is because the coefficient of static friction between the surface of many conventional flexible deformable polymers, including many foamed elastomers, and metal surfaces can be much greater than that between two metal surfaces. Thus, the coefficient of static friction for the contact of a desirable polymer to a metal should be at least about 0.4, and generally it can be as high as 0.6-0.7 or even higher. In a steel-to-steel instance it is unlikely to be as high as 0.35. Shore A Durometer hardness of the polymer composition for the frictional retention component preferably is at least about 20, and preferably it is about 50-70. Usually the thickness of a retention component will be between about 0.01 mm. and 10 mm. Oil resistance can be desirable for it and the other water-sealing elements in some installations.

The coefficient of static friction is the ratio of the maximum force parallel to the surface of contact which acts to prevent motion between two bodies at rest in contact with each other from sliding over each other, to the force normal to the surface of contact which presses the bodies together. Thus, the turnbuckle or other conventional spreader means, usually screwed types, at the joints supply a large measure of pressure, and the bonded elastomer heightens friction, thereby making a cover support that is unusually effective for resisting dislodgement or tilting in highway service. Means for locking down the cover support to an existing manhole cover flange, e.g., like the means shown in U.S. Patent 3,773,428, often are desirable in addition to simply a frictional grip.

In Figure 5 the 0.32 cm. thick slightly foamed elastomer (a cured vinyl plastisol) seat 32 for the manhole cover is bonded to the top of the cast ductile iron base 22. A like layer 33 is bonded on the outside of the base and runs a short way up the lower outside of keeper 24. The keeper rises with a slight outward slant and has a short lip or flanging 26 at its top.

Solid reaction post 28 projects inwardly from the base near the left side of the joint gap. Post 27 has a hole with tapped threads, and it projects in a similar way at the right side of the gap. Both are of cast ductile iron molded integrally with the rest of the base ring. The head 31 of the spreader bolt 29 rests against the reaction post 28; the bolt 29 screws into the threaded hole of the post 27. Lengthening of the bolt between the posts springs the base ends farther apart, i.e., the base end 23 makes a larger gap with its opposing end (that is not visible in this view).

Softer flexible polymer foam plug 36 fits into the gap with a very slight compression. The plug can be cemented into place, e.g., with suitable rubber cement on side 34 of the plug to adhere to the unseen side of the base and the keeper at the gap.

In Figure 6, tough, dense, slightly elastic composition compounded with Neoprene® (a trademark of E.I. duPont de Nemours and Company) polymer forms most of the flexible, compressible cover support body visible in this view. Thus, the seat 42 receives the cover. The cover support rests on sill 47 of existing cast iron manhole cover frame 48. The lower or base portion 46 of the cover support body is forced against the inner surface of the shoulder of the manhole cover frame 48 by stress from expanded steel body frame (ring) segment 41. The pressure makes a slight bulge (exaggerated in the drawings) at the top of the shoulder. Subsequently asphalt concrete is forced against the outer wall 44 of the cover keeper and brought flush with the keeper top 43. Under the asphalt paving layer is the original portland cement concrete paving 51.

Turnbuckle bolts (not shown but each like stainless steel bolt 9 of Figure 1) are disposed inboard of the flat side of the four equal-sized body frame segments such as the segment 41. The bolts have nylon locking patches and are threaded on each end. Each bolt screws into a pair of appropriately tapped steel lugs (not shown) that project inwardly from a segment near the opposing ends of a joint gap. The lugs on a segment are formed integrally with that segment. Where hold-down means, such as screw clamps running from the base down and under the existing sill are to be used, they can be fastened to the steel segments. The joints can be sealed in a manner set forth hereinafter.

For simplicity Figure 6 the rubber part of the body of the cover support was shown without any reinforcing cloth, wire, or cord embedded in it, although this is often desirable, as is the compounding of the rubber material with special fillers such as carbon black.

In the embodiment shown in Figure 6 the main seal elements and retention component part shown are the seat portion 42 and the outer wall portion 46 of the segment of the base of the cover support. These surfaces are integral with the rest of the segment except the steel frame segment 41. These seal and retention component elements can be made softer or harder than the main depth of the rubbery part of the body, usually softer for sealing, e.g., by building up layers with the softest on the outside. Alternatively, a separate sealing and/or special retention component material (usually softer than the core, e.g., a foamed elastomer), can be used over them, either bonded to the rubbery body surfaces or simply interposed as separate elements where sealing and friction is particularly desired.

It is possible to use various conventional elevating means to adjust the level of the cover support. Thus, lifting bolts may be threaded into the bottoms of metal bases, or shims or gaskets can be put under the bottom of the base.

The simplified perspective view of Figure 7 shows a preferred four-segment cover support with an open-ended box wrench 62 fitted on the most distant wrench grip of a turnbuckle bolt, a grip that otherwise

would be seen and numbered as 61c. Clockwise turns reduce the outside diameter of the assembled segments when one is preparing to slide the new cover support into an existing manhole frame. The other such adjusting bolts shown are bolts 59a, b and d with their respective wrench grips 61a, c and d. The bolts are of A.I.S.I. type 302 stainless steel.

5 The top of the base portion of each segment has deformable polymer seat portions, 56a, b, c and d, each about 6.4 mm. thick, bonded thereto to cushion the cover. The seat portions also act as part of the water seal under the manhole cover. The bottoms 57a, b, c and d of the base portions will rest on the sill of an existing manhole frame when the cover support is installed.

10 The outside wall portions of the base portions, and the lower parts of keeper portions, terminating in slight outward flanges or lips 58a, b, c and d, are coated with about 3.2 mm. thick bonded-on polymer layers, 63a, b, c and d, like that making the cover seat, specifically a tough, heat-cured slightly foamed, elastomeric vinyl plastisol. These coatings act to grip the shoulder of the existing manhole frame as well as to form part of the water seal around the new cover support.

15 The gaps between base portion ends such as those marked "64a" and "64d" (corresponding ones at the end of each segment are not marked to avoid clutter) can be sealed or plugged as will be taught hereinafter to resist infiltration of much surface water.

20 The bolts joining the segments, and all other threaded bolts and screws in the cover support, have nylon locking patches on their threads for security in service. Conventional hold-down means such as screwed-on clamps running from the base down and under the sill of the existing manhole frame are not shown; they can be included when desired or needed.

In Figure 8 new paving layer 82 of asphalt concrete surrounds the upper part of the installed manhole cover support, while the outside of the existing manhole frame 78 is surrounded by the original portland cement concrete paving 81. Resilient polymer cushion-seal 73 lies under manhole cover 71 and is bonded to the top of cast iron cover support base 74. Welded onto and rising from the base is 13 ga. (U.S. Std.) steel keeper 76.

25 Resilient polymer gripper-seal 77 is bonded to the outside wall of the base and the lower part of the keeper. The cover support rests on the sill 79 of cast iron manhole frame 78. The bottom of the cast iron cover 71 is reinforced with integral bracing 72 that projects down into the manhole.

In Figure 9, both parts of the cast iron base 85 have an inner wall 87, a bottom 88, a top 86, and two grooves running for their full lengths. The welded-on strip steel keepers 92 have outward flanging 92 at their tops. Residing in groove 91 is an O-ring 93 to seal and cushion a cover. To seal most of the outer wall of the base and provide extra friction with the rising shoulder of an existing manhole cover receiving structure is an O-ring 94 fitting into groove 89 that runs around the outside of the base. Joint sealing will be dealt with later. The O-rings are not bonded to the metal.

35 In Figure 10, the cast ductile iron, type 60-45-12, segment has base 101 has bonded-on deformable polymeric retention component 103 and a pair of cavities, the presently empty lower one being denoted as 102. Projecting up from seat 96 is keeper 97. Projecting down from seat 96 is skirt 98 terminating in an enlarged lower rim 99. The rim can fit slidably into each of the cavities of the base. The cavities and rim have a trapezoidal cross section, and either cavity can support the upper seat portion of a segment for adjusting the seat elevation. More than two such cavities can be superimposed in the stack of them for greater adjustment, as is shown in Applicant's U.S. Patent 4,281,944.

40 In Figure 11, cast ductile iron base 106 has top 107, bottom 108, and a 302 stainless steel elevating screw 109 tapped into the base. The screw is one of thirty. Projecting up from the base is welded-on strip steel keeper 111 terminating in flange 112. Around the outer perimeter of the base are thick narrow bands of deformable polymer 114 and 116, fitting into peripheral grooves in the base, and a wider band of like material running around the outside of the keeper. The bottom of the wider band fits into the slight peripheral edge that the keeper makes with the base. On the top of the base is bonded seal-cushion element 113 of a tough, flexible water-resistant ionomer. The ionomer is bonded to the base. The other polymeric materials are not, although some or all of them can be so bonded, e.g., directly to the metal that has been cleaned and usually treated for bonding, or with the use of a permanent or even a temporary adhesive.

50 Referring to Figure 12, arrow 2 broadly indicates fragmentary view of one end of a preferred embodiment of a cover support made to accommodate a nominally 61 cm. x 122 cm. rectangular catch basin cover. The manhole cover here normally is perforated, often in the form of a grill. The body of the support is made of four straight-sided lateral segments (lateral members) joined at the corners with rods and spreader bolts. The surfaces 134a, 134b, and 134c are flat tough foamed elastomeric surfaces on the ledge elements thereunder; they are about 0.32 cm. thick and act as seat portions for the cover. The ledge elements form the top of the body's base portions. The base portions made of cast ductile iron, ASTM type 536, grade 60-45-12. Extending downwardly from the inside of the ledge elements are the inner wall portions of the bases. Extending upwardly from each ledge portion is a welded-on sheet mild steel collar element portion indicated as 131a, 131b, and 131c acting together as parts of a lateral keeper for the manhole cover. All sheet steel elements are 14 ga. (1.98 mm).

On the upper rim of the collar element portions are box member wales 129a, 129b and 129c. These impart ruggedness to the cover support. Welded inside the wales are rods 132a, 132b and 132c of rectangular cross section.

65 The adjustable corners are formed by pairs of opposing jaw surfaces 133a-133b and 133c-133d that are at the ends of the bases of each segment, each pair being joined by corner spreader bolts 127 and 127',

respectively. These bolts are threaded on each end with threads of opposite handedness and are driven by cranking their respective hexagonal-faced centers 126 and 126'. Bolt 127 screws into and out of suitably tapped holes 124a and 124b; bolt 127' screws into and out of like tapped holes 124c and 124d in the chamfered end ("jaw") surfaces 133a, 133b, 133c and 133d of the base portions of the lateral members. The longitudinal axes of the bolts are substantially horizontal and enter normal to the chamfered ends, which are mitered to make a 45° angle with the longitudinal axes of the lateral members. The perpendicular distance between the center of the hole tapped for spreader bolt and the contact periphery of the coating of the lateral member nearest it that presses outwardly against the existing frame or other receiving structure is 3.8 cm. This is the distance "X", and it is significant, as will be shown hereinafter.

Fitting into the wales are the ends of bent steel rods 128 and 128'. The rods have square cross section and make snug slidable fits with the sleeves.

The body also has a holddown clamp at each end. Holddown clamp 121 is shown. It is spaced outwardly from the base portion by spacer 122, and bolted the base portions using pairs of nuts 123 and 123'. The nuts screw down on threaded lugs projecting from the inside of the base portions of these lateral segments.

Figure 13 looks at the right end elevation of the cover support of Figure 12. Collar element portions 131a, 131b and 131c rise with a slight outward slant from the base portions of the cover support. Squared-off end parts of two longer base portions are indicated as 137a and 137b; these are the terminals of right end surfaces of the two longer lateral segments. The collar element portions shown in end view are 131a and 131c. The collar element portions are welded to the base portions of the lateral segments. They form seams with the base portions, the seams being slightly above the bottoms of the base portions. Elastomeric seat portions 134a, b and c are evident in the view. The thin collar element portions rise at a slight slope to form box flanging at their tops as represented by items 129a, 129b and 129c. Bent steel corner rods represented by 128 and 128', often slightly tapered at their ends, fit slidably into the flanging. Straight steel rods are tack welded inside the flanging. These rods are represented by 132b. Both kinds of rods here are substantially square in cross section, although it can be of advantage in some cases to taper the corner ones appreciably.

Holddown clamp 121 projects downwardly from the inside of base portion facing the viewer and can be forced against an underpart of an existing manhole cover frame with the pair of bolts 138 and 138' that are threaded through the bottom of the clamp 121.

Tough foamed elastomeric retention components and sealing elements, about 0.32 cm. thick, are on the outside of all collar portions. These elastomeric elements are represented by 136a, 136b and 136c in Figure 13.

In a less expensive embodiment like the one in this Figure 12, but not illustrated, the straight welded-in rods like 132b are totally dispensed with. Such box flanging rims, hollow or filled with resin, concrete, etc., are highly resistant to bending.

Figures 14 and 15 depict a way that the cover support of Figures 12 and 13 can be further modified to substantially prevent the infiltration of surface water under the cover edges and around the outer perimeter of the new support.

Figure 14 is the plan view of the right corner of Figure 12, and outboard of that, indicated by light broken lines, is a water-sealing fitment. The arrow labeled "3" indicates the molded fitment of moderately soft, especially compressible foamed elastomer having Shore A Durometer hardness of about 50-65. Its upper surface 141 at the top of side wall 143 is to fit under the bent rod 128. Seat pad 142 is to fit between the mitered jaws 133a and 133b and the ends of seat portions 134a and 134b. The tip of pad 142 is projectable to just short of the turning path of hexagonal wrench grip 126, and the upper flat portion of such tip is approximately flush with those seat portions; usually it is slightly convexly arcuate until the corner joint is spread, at which time the cover support makes a tight fit in the existing manhole cover receiving structure and the manhole cover is emplaced on the new seat.

Figure 15 is a vertical cross section of the fitment taken through plane Z-Z. Upper surface 141 of slightly flaring sidewall 143 is unitary with seat pad 142. With a like fitment plugging each corner to seal the gaps between the coatings of polymer bonded to the seat and sidewall portions, an effective seal is formed against appreciable ground water infiltration around the cover seat and the outer periphery of the new support.

Optionally one side of the fitment of Figure 14 can be attached to the end of the lateral segment it abuts, e.g., with a water-resisting adhesive or mechanical connection or both. Not shown, but also usable, are one or more short flange or peg elements projecting from the square and/or oblique ends of a pair of adjoining lateral segments into corresponding holes or slot in the vertical sides of fitment 3 or vice versa, going the other way, to help anchor the fitment in place. Also not shown are the expedients of: (a) forming the deformable sealing fitment around a stiffening steel core or armature, typically with the deformable material covering at least those parts of the fitment side wall 143 and/or the seat pad 142 which seal against water leakage around the outer perimeter of the cover support and/or under the cover rim, respectively; (b) stuffing in, and advantageously adhering, a deformable plug-like corner seal from the inside after the cover support is tightened into place; and (c) spraying a sealant into the corner after the cover support is tightened into place. Suitable sealants for this usually are elastomeric. Advantageously they should self-adhere or be adhered to most kinds of surfaces, e.g., with a cement, and advantageously also they can be self-expanding into a dense, closed cell foam upon their emplacement, dispensing or shortly after their in-situ deposition. Typical ones comprise polyurethane or a modified styrene-containing polymer.

Suitable polymers that can be formulated for use in the compressible retention component and water seals herein include natural and synthetic rubbers, water-resistant ionomers, various vinyl polymers and copolymers

such as polyvinyl acetate-polyethylene-acrylate copolymers and polyvinyl chloride homopolymers, plastisols such as a vinyl plastisol, polyurethanes, polyester resins, epoxy resins, styrene-containing copolymers such as ABS and butadiene-or isoprene-styrene copolymers, polyolefins and copolymers containing olefin units, and aminoplasts. Plasticizers, pigmentation, stains and/or mineral fillers such as talc, carbon black, etc. commonly are employed in their recipes. The preferred retention components appear to be elastomeric, i.e., resilient. Many of them can be foamed and preferably are foamed only very slightly; this can soften them a bit without reducing their toughness too greatly and it can help to allow for some thermal expansion, and it makes them slightly less dense than without the foaming. Latent foaming agents reactive upon warming and/or catalyzing, incorporated in a film of an uncured polymer-providing material coated on a cover support are preferred. Curing with heat, ultraviolet or electron beam radiation and/or catalysis can be practiced.

Customarily, it is of advantage to prime the metal with a bonding agent or use a bonding treatment to secure the best bond of the retention component or a water sealing element to metal. Some polymers can bond well without this, e.g., epoxy resins. However, the bonds of most are improved by such priming and/or treating.

A preferred foamed plastisol formulation for the retention component is of Shore A Durometer hardness about 20-70, and preferably about 50-65, as are the water seals. The plastisol is compounded principally from low molecular weight polyvinyl chloride resin plasticized heavily with a conventional phthalate ester plasticizer. It contains minute percentages of stabilizer, red pigment and ozodicarbonamide blowing agent. Another preferred formulation of about the same Shore A Durometer hardness is a flexible polyol-polyurethane foam, slightly elastomeric and rubbery. Some polymer recipes need heat to cure and foam, even with catalysis, and others cure and even foam at about room temperature (25° C.). The degree of foaming in both these plastisol and urethane formulations is very small, and it could be called almost microscopic and slight - the bubbles are closed-cell and tiny. In some cases, especially where sealing is to be maximized and strength considerations are secondary, a large degree of foaming and a resulting softened and less dense foamy structure can be tolerated, e.g., Shore A Durometer hardness of 20-55.

A recipe for a slightly-foamed polyurethane rubber that has been found to be quite effective here is as follows:

100 weight parts of Adiprene #L167 polyurethane, a product of the Uniroyal component of the F.G. Goodrich Company, Naugatuck, Connecticut
Compounded with these additives:

0.3 weight part of water;

0.3 weight part of Dabco-33LV, a product of Air Products, Inc., Allentown, PA;

1.4 weight parts of DC-193, a product of Dow-Corning Inc., Midland, Michigan; and

16.0 weight parts of "BC", a product of Palmer, Sieka Inc., Port Washington, N.Y..

This material can be applied to warmed, cleansed and bonding agent-treated cast iron and steel, then heated to 121° - 177° C. to develop the foam and full cure of the polymeric material.

Some preferred heat-curable plastisol retention component recipes for various Durometer hardness contain 100 parts of low molecular weight polyvinyl chloride resin plasticized with 60-70 parts of a conventional phthalate plasticizer such as dioctyl or dimethyl phthalate. With this 1-3 weight parts of a conventional stabilizer for polyvinyl chloride resin, e.g., a lead-based stabilizer, is used along with 1-2 weight parts of a red colorant (other pigments and colors, or none, can be used, if desired) and 0.5-3 weight parts of a conventional ozodicarbonamide heat-and water-activated blowing agent.

The preferred foamed plastisol usually is sprayed on the area to be coated. It is advantageous to spray it onto the hot metal cover support body (188-193°C.) and let it cure and foam a bit. If extra foaming and/or curing is desired, the coated part can be further warmed at 193-204°C. for up to a few minutes.

The deformable retention component should be at least about a 0.1 mm. thick for most effective gripping to contact surfaces (which normally have irregularities). Preferably it should not be more than about 10 mm. thick for economy and durability, although thicker retention components (or even portions of same) can be especially useful for sealing on some occasions. The same applies to cushioning components for cover seats, although these usually are at least about 1.2 mm. thick and easily can be as thick as 12 mm. or even more.

Metal surfaces should be cleaned to accept the polymeric material if it is to be bonded thereto. Then a customary bonding agent such as Chemlok #218 (Manufactured by Lord Corporation, Erie, Pa.) is applied, dried and warmed. Various other useful bonding agents are available such as a Pliobond type (made by the Goodyear Tire and Rubber Company).

As shown above, the preferred materials of construction for most of the cover support, i.e., the body and various elements of the body, are of a ferrous metal, e.g., steel and/or cast iron, particularly cast ductile iron. Other metals can be used where their special properties are desirable and their cost can be tolerated), e.g., stainless steel, high tensile strength steel, wrought iron, bronze, brass, etc. Also, suitable in some cases cover support parts can be, and even much of the main body structure can be fabricated from glass fiber-, aramid fiber-, or graphite fiber-reinforced resin, e.g., a thermosetting (curable) resin such as a polyester or epoxy resin. Also highly filled polymers including elastomers, or ABS plastic and the like, i.e., tough structural polymeric materials can be used in the invention. In some instances, it is possible to fit an expansible metal shape, e.g., a body frame such as an expansible steel hoop, to the inside part of a manhole cover support body. The body is otherwise almost entirely a tough, flexible polymeric material, optionally pigmented (filled) with, e.g., carbon black. Also, it may optionally be built up in plies with glass, nylon, cotton and/or steel cloth, wire and/or cords (like a truck tire carcass). In such instances, the outer part of the body can act as the

retention component, although softer polymer-containing films often can be used with advantage as special retention components over or bonded onto a harder cover support body.

Reference is made again to Figures 2, 3 and 4 which display a split-ring cover support with the bonded polymer retention component 16 and to Figure 7 which shows a four-segmented circular manhole cover support. In tests on related nominally 58 cm. diameter circular four-segmented manhole cover supports also joined with turnbuckle bolts and having a bonded-on slightly foamed elastomer retention component (actually a heat-cured vinyl plastisol retention component) the following significant fact was revealed: pulling directly upward on an expansible cover support that was held in a ring of steel by only the friction between its elastomer-coated (bonded on) periphery and the ring and its own weight (which was only an inconsequential minute percentage of the whole load to be pulled) took much more force (1477 kg.) to remove than a like four-segmented cover support held the same way in the ring with the same hoop stress exerted, but having no such retention member interposed. The force factor was about 1.38 times as much for the coated support as for the uncoated one.

This series of tests also showed that the force factor for the four-segmented, 58 cm. diameter cover support with the polymeric retention component was 1.41 times that of its split-ring counterpart which also had the same sort of retention component. Further, it was found that the force factor for that so-coated split-ring counterpart was roughly double that of a like steel split-ring cover support that had no such polymer retention component at all. Additionally, the tests indicated that the strain distribution around the four-segmented cover support was far more even than that around the split-ring cover support. In a further test, a nominally 61 cm. diameter four-segment cover support, like that of Figure 7 and having the preferred cured plastisol retention component, required 2159 kg. of vertical pull to pull it out of the steel test ring.

If the adjustable joints of such cover support are plugged with deformable polymer (e.g., elastomeric compositions like those discussed herein in connection with retention components and seats, and especially foamed elastomer, so that complete water seals result under the manhole cover 81 and all around either the outer perimeter of the cover support base or its cover keeper rising there around, or both) then the cover support with an imperforate cover can be used to resist stray surface water such as storm drainage.

Suitable sealing plug fitments to be used with the cover support as it is being installed can be made of polymer or with a core or armature, e.g., one of metal, coated with polymer. Alternatively, the plug fitment can be formed after the cover support is installed by stuffing in or spraying into the gap a flexible sealant, preferably a foaming or foamable-in-place one.

Hollow box member flanging, i.e., peripheral encircling wales as reinforcing rim portions and hollow base portions can be filled or partly filled with a hard or tough resin, optionally mixed with a mineral filler such as mica or chopped glass fiber strand, to supply desirable further resistance to crushing and other deformation. Thermosetting resins such as polyester and epoxy resins can be useful in this connection. Also, thermoplastic ones such as ABS resin can be so used, or even a concrete such as a Gunnite type.

The cross section of the sleeves and wales and bases may be other than squarish or rectangular. They can be made with many other fairly rigid conformations, e.g., triangular or rounded, etc. The same applies to the cross section of solid or tubular wale-forming and base-forming members and joint-bridging rod or tube elements. While only solid bases have been illustrated, it should be clear that they can be made hollow, e.g., like the main part of the wale of Figure 1. They also can be formed with at least part of the hollow wale portion from a single piece of steel, e.g., 12-16 A.I.S.I. gauge, and optionally with the whole keeper portion, including the hollow wale portion, from a single steel piece that includes the hollow-channeled base.

Calculations have been made to estimate the stiffness (resistance to bending from top loading) of several conformations of the essentially horizontal hollow wales of this invention and closely-related wales. The results have indicated that the hollow steel wale in the instant invention is significantly stiffer than a solid steel bar wale having the same conformation and cross section as the empty channel of the hollow wale. Thus, a straight 13 gauge hollow steel wale enclosing a 1.91 cm. hollow square empty interior channel is stiffer than a straight solid steel wale of 1.91 cm. x 1.91 cm. cross section by a factor of 1.35. Additionally, the circular conformation of most wales here renders them very rigid to horizontal loads.

While the cover support embodiments depicted are for circular holes and a rectangle, other shapes such as triangles, squares, ovals, etc. are usable in accordance with invention principles, provided the cover supports are rendered adjustable as to their perimeter, usually with screw means.

It is especially desirable with polygonal (e.g., rectangular) manhole cover supports to have essentially horizontal turnbuckle bolts biased across the corners, and these bolts set inboard as much as is permissible, usually at least 2.54 cm., from the side of the cover support to which they directly deliver a component of their pressure.

The turnbuckle bolts biased at the corners impart components of force that are axial to and perpendicular to the straight lateral segments of the cover support that they connect. For the particular bias of 45° relative to the longitudinal axes of the straight sides of a rectangular or square cover support, the magnitude of each such component is 0.707 times the bolt force. Positioning these bolts in the same plane as, but at virtually any other angle oblique to the corner it connects, i.e., biasing the bolt, is, of course, possible and practical in accordance with this invention. The perpendicular component of force holds the lateral side (segment) directly against the existing manhole frame. The axial component of force, being located inboard from the outer edge of the cover support, provides a bending moment on the lateral segment that actually increases the holding force between the periphery of the cover support and the existing manhole frame.

The conventional positioning of an expansion element such as a turnbuckle or spreading bolt somewhere along the longitudinal axis of the lateral segment, usually in the middle, exerts essentially only an axial force. Also a deleterious bending moment can be imparted to such bolt and segment. The bolt and its segment are apt to bow-up, down, or in towards the center of the manhole when especially heavily forced. Accordingly, it can be said that corner-spreading makes the bending moment on the bolt work for improved retention in the existing manhole cover frame (or other existing cover-receiving structure such as an existing cover support) instead of being useless or possibly even deleterious to the new cover support.

For a rectangular nominally 61 cm. x 122 cm. cover support of this invention with turnbuckle bolts at the corner, the holding force has been calculated to be 12,091 kg. on each side, or a total of 48,366 kg. for the whole support. This compares quite favorably with that estimated for the same size cover support of the conventional (spread at the centers of the side lateral segments) design where both cover supports used the same kind of 12.7 mm. turnbuckle bolts. In the latter conventional instance, the holding force was only 11,364 kg. on each side or 45,455 kg. for the whole support.

The holding forces in pounds (sidewise force) for one side of a rectangular cover support with the corner spreaders can be calculated in accordance with the following formula "F", below, employing inch, pound and degrees of arc units:

$$H_c = \frac{4EA_t B_T l}{l_B} \cos + \frac{8 E A_t B_T l X \sin}{l_B S}, \text{ i.e., Formula "F"}$$

where:

H_c = the holding force in pounds perpendicular to the manhole cover frame (but limited in magnitude by the yield strength of the bolt)

E = Young's modulus of the bolt in pounds per square inch

A_t = tensile area of the bolt in square inches

B_T = the number of bolt turns after the cover support is seated

l = the lead (inches) of the bolt threads

l_B = the length of the exposed bolt in inches.

X = the perpendicular distance in inches from the contact periphery of the cover support to the center of the hole that is tapped therein for accepting the turnbuckle bolt

S = the length of one side of the cover support in inches

= the angle in degrees that longitudinal axis of turnbuckle bolt makes with the longitudinal axis of the side being held against the frame.

This equation, Formula F, can be simplified when the angle is 45° as it is in the embodiment shown in Figure 1. The equation becomes:

$$H_c = \frac{2 E A_t B_T l}{l_B} \left(1 + \frac{X}{S}\right), \text{ i.e., Simplified Formula "F"}$$

Relative to the foregoing force considerations is the realization that the placing of the turnbuckle bolt is significant for developing lateral force, the force that is important for cover support retention in highway service. Thus, keeping the bolt hole opening (or the end pivot point of a turnbuckle having a screw protruding obliquely into a female-threaded end of a center turning member of a more common turnbuckle bolt) far inboard makes for a higher force value than putting it closer to the contact periphery of the cover support (which contacts and presses against the existing cover frame -- or other existing manhole cover receiving structure). The inboard placement of any turnbuckle or like spreader mechanism, of course, permits longer threaded sections and allows for more peripheral adjustment. However, while many manhole covers have a reasonably flat top, they also can have a bottom that is reenforced by ribs, bracing, or like structure hanging down under; these cannot be interfered with, lest the cover won't seat in the newly-installed cover support. Accordingly, there can be a limit to the inboard placement of the spreader.

Advantageously, then, for developing improved retaining force and permitting substantial adjustment with such biased turnbuckle spreader means, the perpendicular distance from the contact periphery of the cover support to center point where the spreader means starts to shorten or lengthen should be at least about 2.54 cm. and preferably it is more, e.g., 3.81 cm.. Stated in another way, "X" in the above equations should be at least 2.54 cm.; or, as the force is being applied by the spreader to a zone near the end of a side segment, this

zone can be treated as having a practical center point, and the perpendicular distance from that center point to the contact periphery of the straight-sided segment should be at least about 2.54 cm. The 45° angle biasing tends to develop about equal force in two directions, and this generally is desirable.

Modifications and variations of the invention will be apparent to those skilled in the art in the light of the foregoing detailed disclosure. Therefore, it is to be understood that, within the scope of the appended claims, the invention can be practiced otherwise than as shown and described.

Claims

1. A manhole cover support having improved retainability for emplacing over and raising the effective grade of an existing manhole cover receiving structure, the receiving structure having an upwardly-extending shoulder surface and a sill therebelow for accommodating a manhole cover, the cover support comprising:
 - a body; and
 - a flexible, compressible retention component therefor,
 - the body having a seat and a lateral keeper for the manhole cover and a base with an outer wall that is adjustable in outer perimeter dimension,
 - the base being formed to rest on the sill,
 - the outer wall being adapted to react against the shoulder surface of the receiving structure,
 - the retention component being integral with at least a part of the outer wall of the base or being interposed between the outer wall of the base and the shoulder surface of the receiving structure,
 - said retention component having a coefficient of static friction with respect to the surfaces which it contacts frictionally that substantially exceeds the coefficient of static friction obtainable directly between steel and said surfaces, and
 - said retention component being disposed to interact with an expansion of the base for substantially enhancing the frictional grip between the body and the existing receiving structure.
2. The manhole cover support of Claim 1 wherein the retention component is between about a 0.1 mm. and about 10 mm. thick and has a coefficient of static friction to steel of at least about 0.4.
3. The manhole cover support of Claim 1 wherein the retention component is bonded to and covers a substantial area of the outer wall of the base.
4. The manhole cover support of Claim 1 wherein the retention component comprises of at least one band or O-ring around the outer wall of the base.
5. The manhole cover support of Claim 1 wherein the seat is integral with the base to form the upper surface thereof.
6. The manhole cover support of Claim 1 which is adjustable in height by elevating means in the base.
7. The manhole cover support of Claim 1 wherein the body is in the form of a split-ring that is adjustable in outer perimeter dimension.
8. The manhole cover support of Claim 1 wherein the body is in the form of a plurality of joined segments adjustable in outer perimeter dimension.
9. The manhole cover support of Claim 1 wherein the base and the seat constitute separate portions of the body that are adapted to engage adjustably for fixing the elevation of the seat.
10. The manhole cover support of Claim 9 wherein the seat has a skirt with an enlarged rim, the skirt extends downwardly into the base through a slot therein, and the rim is slidable into and is engaged with any one of a stack of like complementary cavity sets extending outwardly from the sides of the slot for permitting adjustment of the elevation of the seat.
11. The manhole cover support of Claim 1 wherein the body and the receiving structure comprise ferrous metal.
12. The manhole cover support of Claim 1 wherein the retention component comprises a polymer.
13. The manhole cover support of Claim 12 wherein the retention component comprises a foamed polymer and the component has Shore A durometer hardness between about 20 and about 70.
14. The manhole cover support of Claim 12 wherein the retention component is elastomeric, and the component has Shore A durometer hardness between about 20 and 70.
15. The manhole cover support of Claim 12 wherein the retention component comprises a cured plastisol.
16. The manhole cover support of Claim 15 wherein the retention component comprises a heat-cured vinyl plastisol having Shore A durometer hardness between about 50 and 65.
17. The manhole cover support of Claim 12 wherein the retention component comprises solid polyurethane.
18. The manhole cover support of Claim 12 wherein the retention component comprises an epoxy resin.
19. The cover support of Claim 1 wherein the top of the keeper is flanged outwardly.
20. The cover support of Claim 19 wherein the body comprises at least one adjustable joint, and overlapping each adjustable joint is an extension of the keeper.

21. The cover support of Claim 1 wherein outer perimeter adjustment is responsive to screw means.
22. The manhole cover support of Claim 1 wherein there is at least one adjustable joint, there are deformable water seal elements adapted to interact with deformable plug means for the adjustable joints to block substantial infiltration of surface water, one of the seal elements is disposed as the seat, and at least another of the seal elements is disposed substantially around the outer perimeter of the body to act as a retention component.
23. The cover support of Claim 1 wherein said seal elements comprise a polymer having Shore A hardness of at least about 20.
24. The cover support of Claim 1 wherein said seal elements comprise a foamed elastomer.
25. The cover support of Claim 1 wherein said seal elements comprise a cured plastisol.
26. The cover support of Claim 1 wherein said seal elements comprise polyurethane.
27. The cover support of Claim 1 wherein said seal elements comprise epoxy resin.
28. The cover support of Claim 1 wherein at least a part of one of said seal elements is bonded to the body.
29. The cover support of Claim 1 wherein at least one of said seal elements is in the form of a band or an O-ring that is not bonded to the body.
30. The cover support of Claim 1 wherein each joint is provided with a sealing fitment as a deformable plug means.
31. The cover support of Claim 1 wherein the exposed part of the body comprises a flexible polymer, and it is stressed by an expansible metal body frame.
32. The cover support of Claim 14 wherein the exposed part of the body is a filled elastomer, and it is built with reinforcing plies of cloth, wire and/or cords.
33. The cover support of Claim 14 wherein an exposed part of the body perimeter has a coefficient of static friction to steel of at least about 0.4 and acts as an integral retention component against the shoulder of the existing manhole cover receiving structure.
34. The cover support of Claim 1 wherein a water sealing element disposed around the outer perimeter of the body is a gas-filled tube.
35. The cover support of Claim 16 wherein an exposed part of the body surface acts as the seat for support of the cover as well as an integral seal element for the cover placed thereover.
36. The manhole cover support of Claim 1 wherein the keeper is thin-walled and it has a hollow stiffening wale that is integral with and substantially coextensive with its top.
37. The manhole cover of Claim 36 wherein the base defines a hollow channel.
38. The manhole cover of Claim 36 wherein the base and the keeper including the wale are of a single piece of structural metal or structural material comprising polymeric material.
39. The manhole cover support of Claim 8 which is polygonal, comprises a plurality of straight lateral segments joined near their ends, and has an adjustable spreader in each corner that is adapted to move adjacent ends of the segments essentially horizontally in a direction that is biased with respect to the longitudinal axes of the lateral segments.
40. The manhole cover support of Claim 40 wherein the support is quadrangular.
41. The manhole cover support of Claim 40 wherein the corner spreaders are screw-operated, and the practical center of their zone of force is at least about 2.5 cm. from the nearest point of contact periphery of the cover support with the shoulder of the receiving structure.
42. In a process for installing a manhole cover support on an existing receiving structure for a manhole cover wherein the manhole cover support has a base with an outer wall that is adjustable in outer perimeter dimension and is placed in the receiving structure to face an upwardly-extending shoulder surface thereof, the improvement which comprises: placing against said shoulder surface a flexible, compressible retention component surface of the cover support base that is capable under pressure of enhancing substantially the frictional grip between the base and the shoulder surface; and expanding the base against the constraint of the receiving structure.
43. The process of Claim 42 wherein the retention component is integral with outer wall, is between about 0.1 mm. and about 10 mm. thick, and has a coefficient of static friction to steel of at least about 0.4.
44. The process of Claim 43 wherein the retention component comprises a polymer.
45. The process of Claim 44 wherein the retention component comprises a cured plastisol.
46. The process of Claim 44 wherein the retention component comprises a thermoset elastomer.
47. In a process for the manufacture of a manhole cover support for emplacement onto and raising the grade of an existing receiving structure, the receiving structure having an upwardly extending shoulder surface and a sill therebelow for accommodating a manhole cover, wherein the manhole cover support comprises a body and a compressible, flexible retention component therefor, the body having a lateral keeper for a manhole cover and a base, the base having an underside for resting on the sill of the receiving structure and an outer wall surface that is adapted to face the shoulder surface of the receiving structure, the improvement which comprises depositing over at least a portion of the outer wall surface or forming at least a part of the outer wall surface from a composition that is curable to leave a compressible and flexible solid surface capable of enhancing substantially the frictional grip between the cover support and the shoulder surface, and curing the composition until said compressible and flexible surface is formed.

48. The process of Claim 47 wherein the curing is effected by heat.	
49. The process of Claim 47 wherein the seat is connected to the base to form the upper surface thereof, and the outer wall and at least a portion of the outer surface of the keeper thereabove are coated with the composition for curing.	
50. The process of Claim 49 wherein the seat also is coated with the composition for curing.	5
51. The process of Claim 47 wherein the cured deposit comprises a polymer.	
52. The process of Claim 51 wherein the fluent composition deposited comprises a plastisol.	
53. The process of Claim 51 wherein the fluent composition is foamable upon curing.	
54. The process of Claim 47 wherein the body is in the form of a split ring that is adjustable in outer perimeter dimension.	10
55. The process of Claim 47 wherein the body is in the form of a plurality of joined sections adjustable in outer perimeter dimension.	
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	40
	45
	50
	55
	60
	65

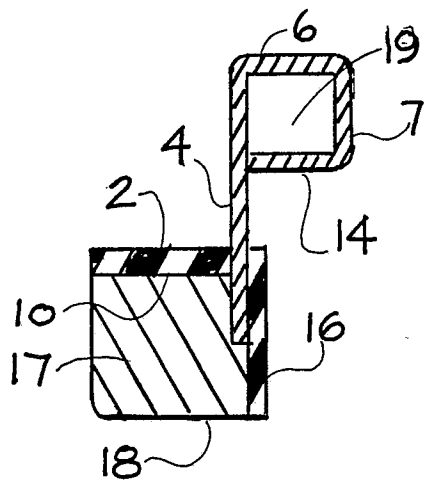


FIG. 2

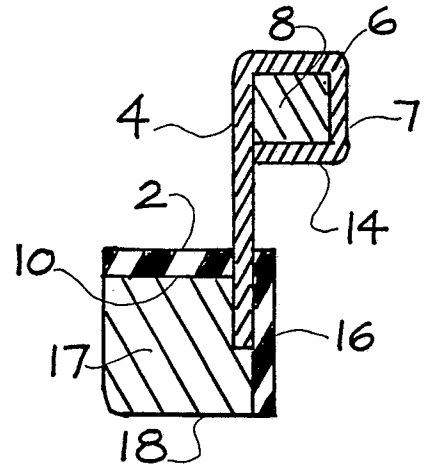


FIG. 3

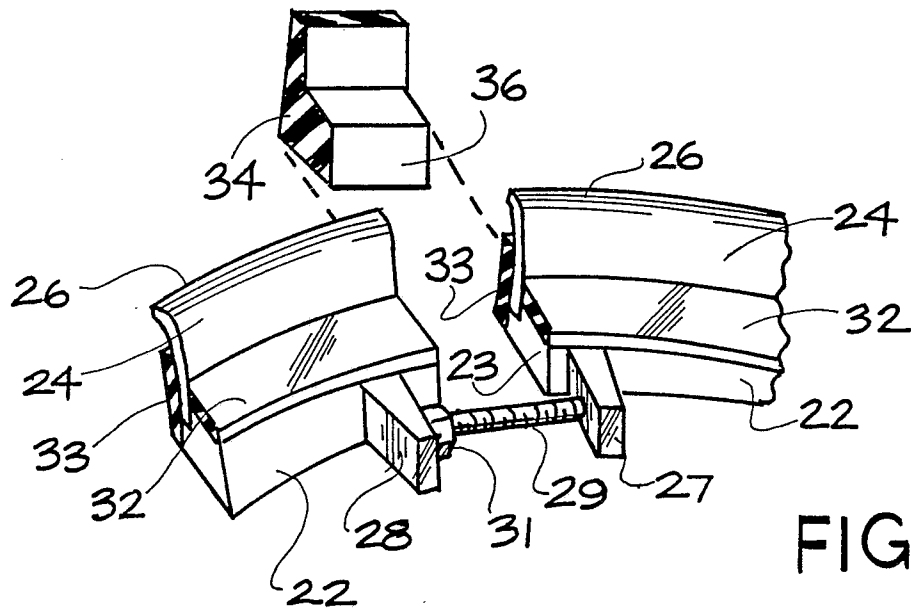


FIG. 5

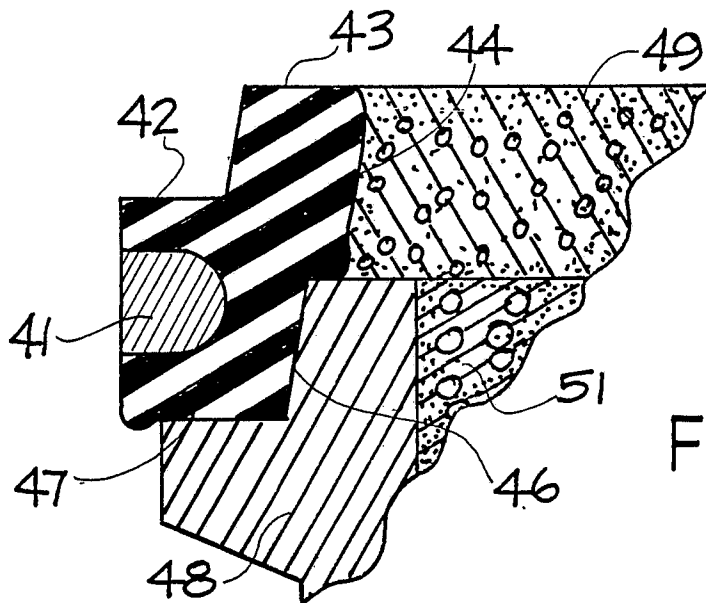


FIG. 6

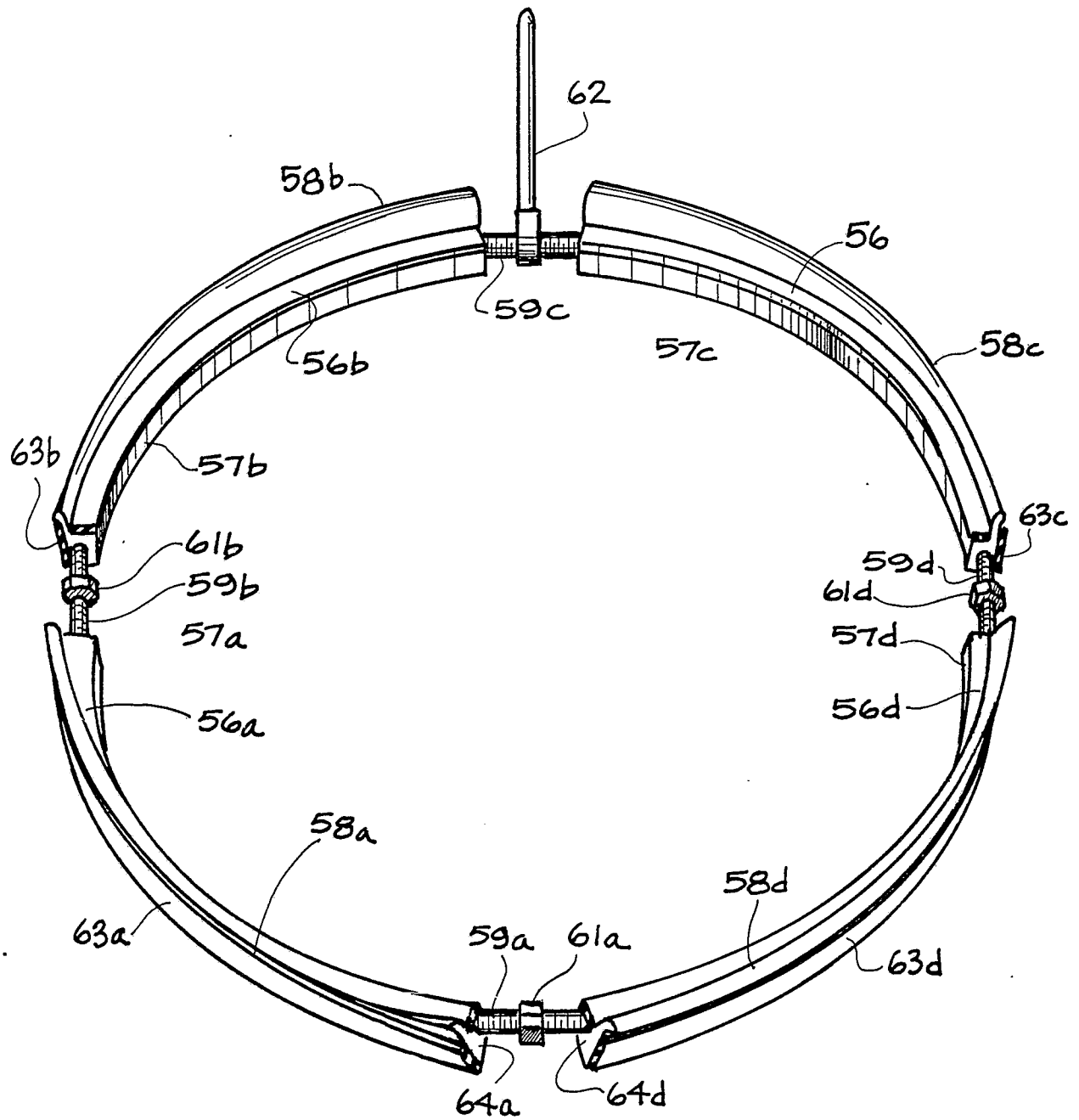
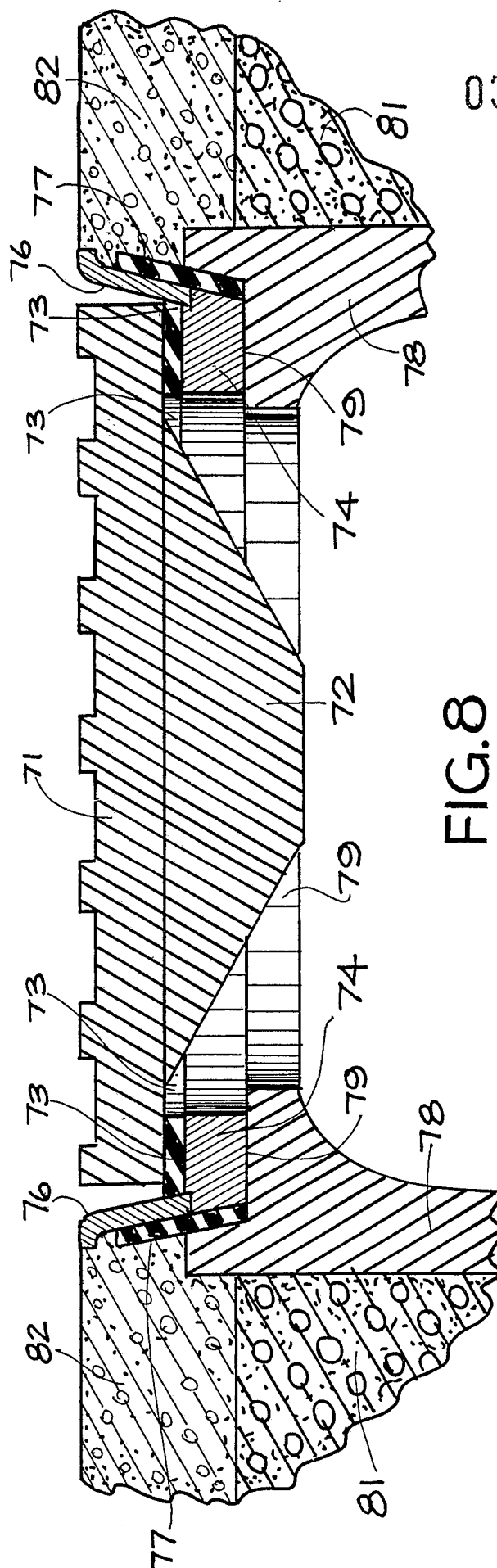


FIG. 7

ਘੰਟਾ



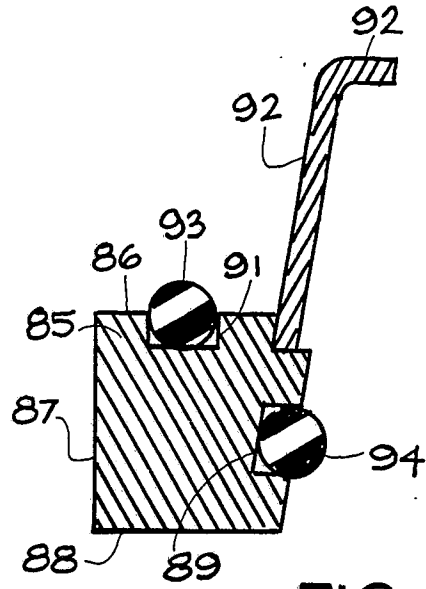


FIG. 9

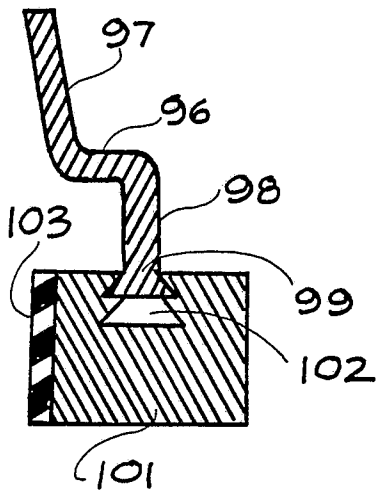


FIG. 10

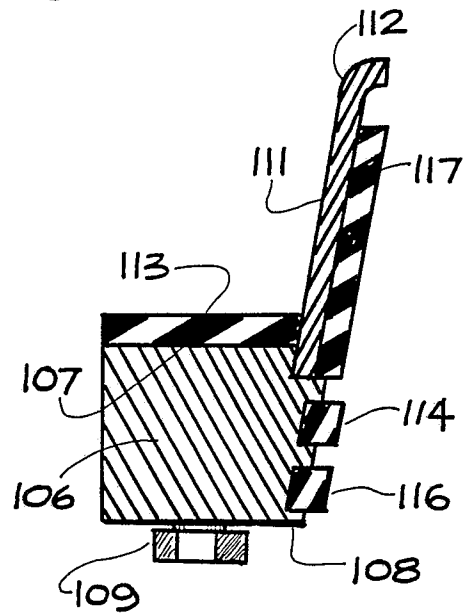


FIG. 11

03 00829

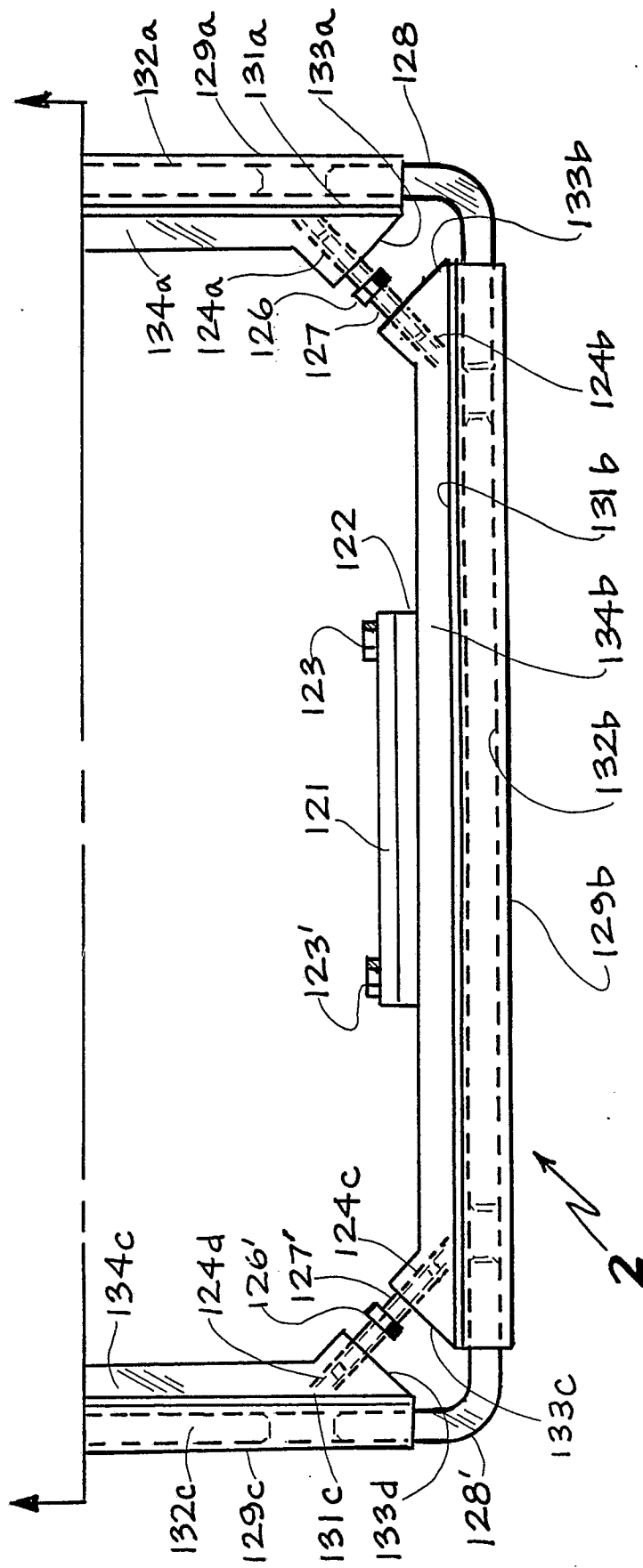


FIG. 12

03 008 29

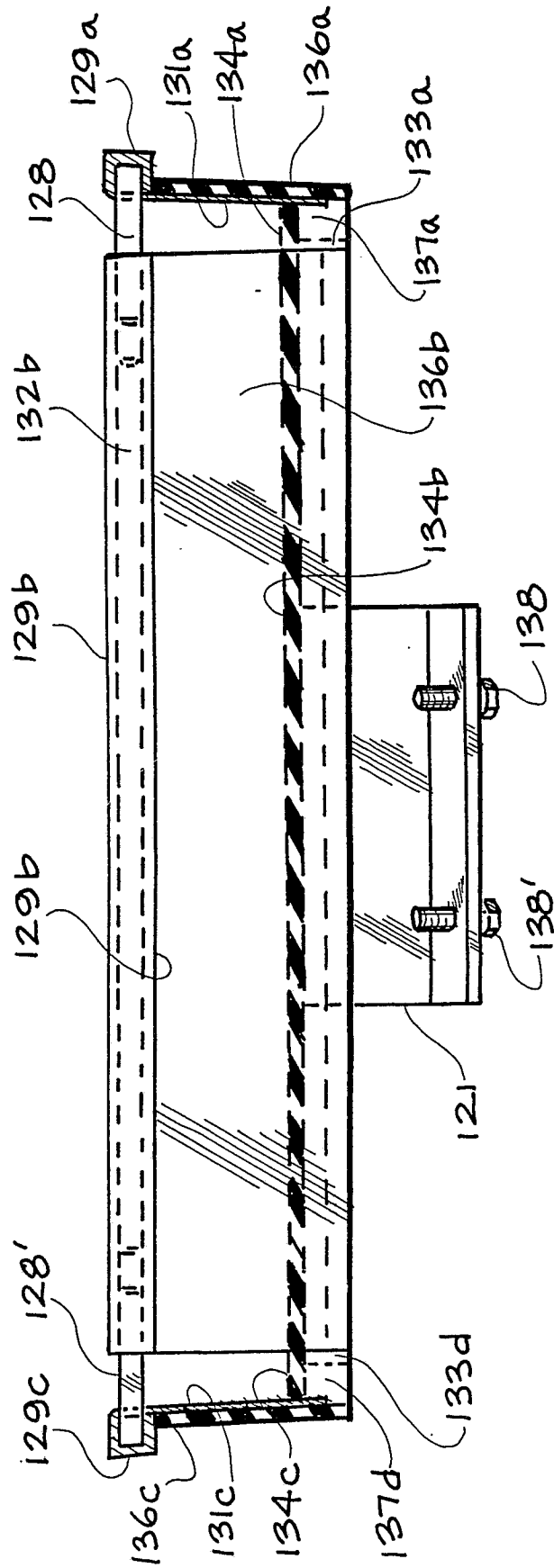


FIG. 13

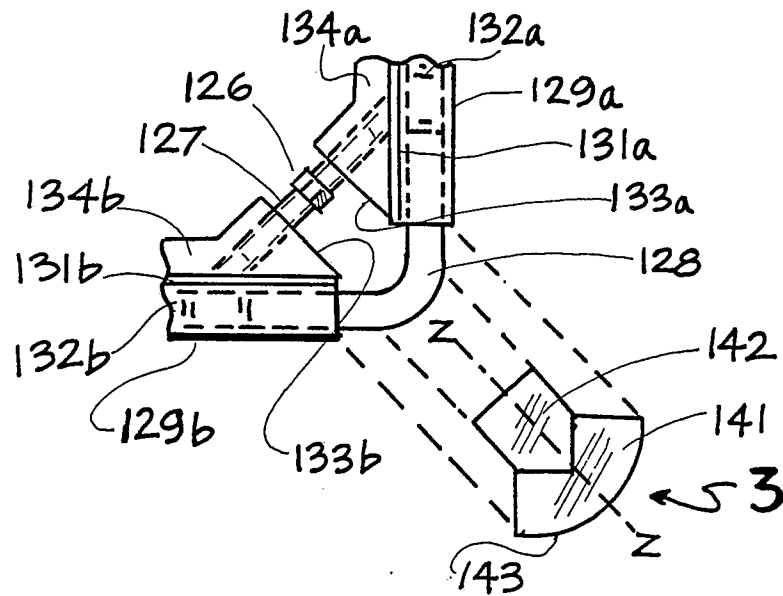


FIG. 14

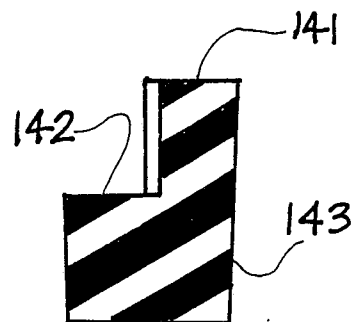


FIG.15



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. 4)
Y	US-A-3 911 635 (TRAUPE) * Column 2, line 3 - column 4, line 40; figures 1-3 *	42	E 02 D 29/14
A	---	1,7,21, 40	
Y	US-A-3 969 847 (CAMPAGNA) * Column 3, line 16 - column 4, line 37; figures 1-4 *	42	
A	---	1,3,4,8 ,22	
D,A	US-A-4 097 171 (FIER) * Column 3, line 20 - column 5, line 14; column 5, lines 52-62; figures 1-7,11 *	1,35,40	
D,A	US-A-3 773 428 (BOWMAN) * Column 2, line 38 - column 3, line 22; figures 1-12 *	6,8	
D,A	US-A-4 281 944 (BOWMAN) * Column 2, line 24 - column 3, line 33; figures 1-4 *	9,10	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A	US-A-4 582 449 (VOSSWINKEL) * Column 2, line 7 - column 3, line 50; figures 1-3 *	47,54, 55	E 02 D H 02 G
A	CH-A- 446 210 (VON ROLL) * Column 1, line 6 - column 2, line 2; column 2, line 11 - column 3, line 43; column 4, lines 3-19; figures 1-4 *	47,48	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 31-10-1988	Examiner KERGUENO J.P.D.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	