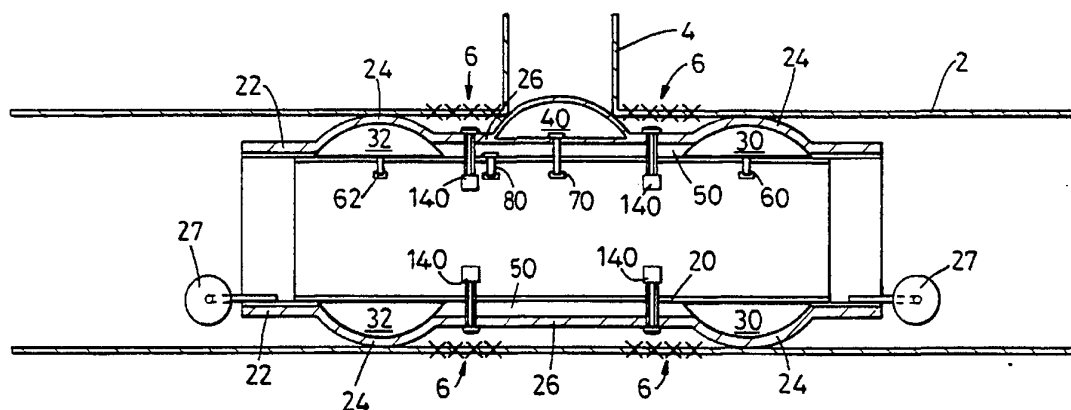


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(54) Title: REPAIR OF DRAINS AND PIPELINES



(57) Abstract

For the in situ repair of drains and pipelines where damage or defects (6) have occurred in close proximity to incoming lateral drain or pipe connections (4), a tubular ejector body (10) is drawn or pushed into the drain or pipeline (2) to such a position that it extends to either side of the lateral connection (4). A pair of inflation sealing units (30, 32) at either end of the ejector body (10) are inflated to seal the body on either side of the lateral connection (4) and a further inflation unit (40) is inflated to close off the lateral side connection (4). Then a sealing composition is pumped out of the body (10) through a plurality of ejector openings (140) to form, when set, a seal repair of the drain or pipeline (2), without a blocking of the junction with the lateral drain or pipe connection (4).

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REPAIR OF DRAINS AND PIPELINES

FIELD OF THE INVENTION

This invention relates to the repair of drains and pipelines, especially those which are located underground or enclosed in surrounding material, such as concrete, and intended to convey fluids such as potable water, waste-water, certain semi-solids, solids suspended in fluids, or gases. More particularly, the invention concerns an apparatus and method for the in situ repair of drains and pipelines where damage or defects have occurred in close proximity to incoming lateral drain or pipe connections.

BACKGROUND OF THE INVENTION AND PRIOR ART

For quite a number of years there have been known various devices for in situ repair of underground drains, pipelines or the like. Conventionally, a carriage would be drawn or pushed into the drain or pipeline to reach the site at which repair was needed, and then a sealing element would be expanded radially outwards so as to contact the pipe at each side of the leak, for example, and liquid grout would then be pumped to an outlet in the carriage so as to flow into the damaged region and form, once set and hardened, an effective sealed repair of the inner drain or pipeline wall.

In order to make it possible to utilise this basic idea for the repair of drain or pipeline defects which are of substantial size, GB-A-2122300 proposes the employment of a tubular ejector body which is sited at the desired location in the drain or pipeline and has a plurality of ejector openings therein out of which sealant composition is pumped to fill the defect. The sealant composition is contained at the required location over a limited length of the drain or pipeline by inflation, e.g. by compressed air, of respective sealing rings disposed around the ejector body at or near each of its ends. Once the drain or pipeline defect has been filled and has been allowed to partially set, the sealing rings are deflated, thereby allowing the ejector body to be removed from the repair site and

full setting and hardening of the sealant composition to take place, thus completing the repair of the drain or pipeline. Reaming of the passageway before and/or after the repair has been effected may be carried out in order to enhance the quality and finish of the job.

Practically speaking, the apparatus required to effect the above method of drain or pipe repair is relatively complicated and expensive and because of the somewhat crude way in which the sealant composition is put in place at the site of the defect, the resulting accuracy and efficiency of the repair is not always as good as many types of practical application demand.

As an improvement to this known proposal, therefore, GB-A-2169983 proposes an apparatus and method for in situ drain or pipeline repair, still based on the idea of employing an ejector body which is drawn or pushed into the drain or pipeline to the correct location and providing a plurality of outlets through which sealant composition is pumped to fill the defect, but in which the ejector body is constructed such that it comprises a sleeve of flexible material which is unsupported internally along its length and has, between its ends, an intermediate portion wherein the ejector openings are provided. The intermediate portion has less extensibility than the end portions on either side, so that for a given inflation pressure, a smoothly contoured inflated pressure sleeve is created whose end regions are more outwardly inflated than its central region, so that it seals the ejector body against the intact walls of the drain or pipeline either side of the defect and leaves an annular gap around the central region of the ejector body into which the sealant composition is pumped to fill the defect which is arranged to be located in that annular cavity. EP-A-0259518 discloses a similar system to this, utilising much the same principle.

These known in situ pipe repair apparatuses and methods generally perform satisfactorily where the damage or defect has occurred in a straight portion of the drain or pipeline where

there is a substantially continuous pipe inner wall against which the various sealing elements of the apparatus can abut and seal to generate the necessary closed region into which the sealant composition can be pumped. Even if pipe damage exists over a wide area or along a relatively long section of pipe, successful repair using these known systems is still possible, as one can simply employ an ejector body of increased length, for example.

There is, however, a problem associated with these known systems, and that is when the pipe damage or defect has occurred at or near the junction of the main drain or pipeline with an incoming lateral drain or pipe connection. When the known apparatus is used to repair a defect in such a position, it is difficult, if not impossible, to effect proper repair of the damaged area by application of the sealant composition to it without the incoming lateral connection itself becoming filled or blocked with the sealant material. As will be appreciated, it can be extremely difficult and time-consuming to drill out such a lateral connecting drain or pipe after repair of the main pipeline is completed, but hitherto this has often been inevitable when the known systems as described above are utilised for repairing damaged areas of pipe at locations in the neighbourhood of incoming side pipe connections.

It would be advantageous, therefore, if one was able to employ the ideas embodied in the above known pipe repair apparatuses and methods at damaged sites located in close proximity to incoming lateral connections, but without the problem of the latter themselves becoming filled or contaminated with the sealant material with which the main drain or pipe defect is repaired.

SUMMARY OF THE INVENTION

With this object in view, the present invention provides, in a first aspect, an apparatus for use in repairing a defect in a drain or pipeline at or near a junction with a lateral drain or pipe connection, the apparatus comprising:

a tubular ejector body adapted to enable it to be drawn

or pushed into the drain or pipeline to such a position that a leading end and a trailing end of the body are disposed respectively to one side and the other side of the defect and lateral connection combination;

a pair of primary inflation sealing units at or near the respective ends of the tubular body and which, when they are both inflated, seal the body against the drain or pipeline inner wall on each of the sides of the defect and lateral connection combination;

a secondary inflation sealing unit situated between the primary inflation sealing units and which, when it is inflated, substantially closes off and/or seals from the main drain or pipeline the junction therewith of the lateral drain or pipe connection; and

means for conveying a settable sealing composition from within the tubular body to and out of at least one, preferably a plurality of, ejector openings in the body between the primary inflation sealing units and the secondary inflation sealing unit, for forming, when set, a seal repair of the drain or pipeline defect without a blocking of the junction with the lateral drain or pipe connection.

In a second aspect of the present invention, there is provided a method of repairing a defect in a drain or pipeline at or near a junction with a lateral drain or pipe connection, the method comprising:

drawing or pushing into the drain or pipeline a tubular ejector body to such a position that a leading end and a trailing end of the body are disposed respectively to one side and the other side of the defect and lateral connection combination;

inflating a pair of primary inflation sealing units at or near the respective ends of the tubular body so that the body is sealed against the drain or pipeline inner wall on each of the sides of the defect and lateral connection combination;

inflating, either before, at the same time as or after the inflation of the primary inflation sealing units, a secondary inflation sealing unit situated between the primary inflation sealing units, so as to substantially close off and/or seal from the main drain or pipeline the junction therewith of the lateral

drain or pipe connection;

conveying a settable sealing composition from within the tubular body to and out of at least one, preferably a plurality of, ejector openings in the body between the primary inflation sealing units and the secondary inflation sealing unit so that the composition is ejected into the drain or pipeline defect; and

prior to complete setting of the sealing composition but whilst it is in a coherent condition, displacing the ejector body along the drain or pipeline, preferably subsequent to deflating at least the secondary inflation sealing unit and preferably also the pair of primary inflation sealing units.

In a third aspect, the present invention provides a drain or pipeline which has been repaired by the above-defined method or by use of the above-defined apparatus.

The essence of the present invention, therefore, as presently contemplated in its broadest sense, lies in the modification of the more recently generally known in situ pipeline repair systems to include a secondary, preferably independently inflatable, inflation sealing means which acts to close off (or substantially so) and preferably also seal the junction of the incoming lateral drain or pipe connection with the main drain or pipeline, thereby enabling the region of the main drain or pipeline at or near the side connection, where the defect is situated, to be repaired in a manner similar to that which is already known, but without blocking that side connection where it joins the main pipe. Most importantly, the system of this invention obviates the need for drilling out of the incoming side connection once the repair is complete, as would generally be required if the conventional systems were to be used in the repair of the particular sited defects with which we are here concerned. Employment of this invention may also improve the overall quality and finish of a repair job carried out on a defect in the neighbourhood of an incoming drain or pipe side connection, given the complete or substantial absence of ingress of sealant material into the side connection and of build up of sealant composition around the edges of the connection junction.

In preferred embodiments of the apparatus of the invention, the primary inflation sealing units extend around the full circumference of the ejector body, so that when inflated they assume an annular cross-section and seal the body against the inner wall of the pipe all the way round.

On the other hand, however, the secondary inflation sealing unit preferably extends over only part of the ejector body circumference, and most preferably it takes the form of an inflatable bubble which, upon inflation, presents a surface area sufficiently large to substantially close off and seal the incoming drain or pipe side connection, generally with at least a small extension all the way round past the junction so as to ensure a good sealing action. It is, however, within the scope of the present invention for the secondary inflation sealing unit to have a similar circumferential sealing ring configuration like the primary inflation sealing units, for example in the case where application of sealing composition to the damaged drain or pipeline is to be restricted to a narrow region to one side only of the lateral pipe connection junction.

The tubular ejector body of the apparatus preferably comprises an outer cylindrical sleeve which is resiliently flexible so as to permit radially outward expansion thereof into sealing contact with the inner wall of the drain or pipeline upon inflation of the primary inflation sealing units. Each of these primary inflation sealing units may be constituted by an annular (or short cylindrical) cavity formed within the sleeve wall towards the ends of the ejector body or, more preferably, each may be formed by virtue of a cylindrical section of the flexible sleeve not being bonded to an inner tube forming the core of the ejector body, as are portions of the sleeve which are not required to be expansible outwardly from the core, e.g. the ends of the sleeve. The secondary inflation sealing unit is preferably constituted by a cavity formed within the outer sleeve wall between the primary inflation sealing units. For the purpose of assisting correct outward expansion of the flexible sleeve to form the primary sealing rings at each end of the ejector body, the sleeve wall may, if desired, be constructed

with appropriate internal reinforcement or, alternatively, bonded constriction rings to the outer and/or inner walls thereof in the regions where lesser extensibility is required.

In one, less preferred embodiment of the apparatus of the invention the inner tube forming the core of the ejector body is a rigid tube, e.g. a unitary steel (especially stainless steel) tube. In more preferred embodiments, however, the core comprises a tubular body which is resiliently flexible, so as to enable it to deform and bend to assume a curved shape. This enables the ejector body to conform to deviations or bends in the drain or pipeline. Most suitably, for this purpose a most preferred ejector body core comprises a closed coil spring, especially a helical closed coil spring, which preferably has formed around it a stretchable intermediate sheath which conforms to the outer shape of the core as it passes through the drain or pipeline. The sheath is preferably made of rubber, e.g. nitrile rubber (which is particularly suitable for repair applications involving pipes which convey fuel gas) or natural rubber, and is preferably constructed and arranged so as to have a desired hardness and/or flexibility depending upon the degree of sealing required of the apparatus against the pipe or drain to be repaired and the amount of flexible deformability required of the core. Generally speaking, bends in the drain or pipe of up to about 90° may be accommodated by use of this coil core with rubber intermediate sheath feature of the apparatus.

In a particularly preferred embodiment of the apparatus of the invention, there is further provided a tertiary, independent inflation unit between the primary inflation sealing units and radially beneath the secondary inflation sealing unit which is also situated between the primary inflation sealing units. The tertiary inflation unit is preferably constituted by an independently inflatable cavity beneath that which forms the secondary inflation sealing unit, i.e. between the central region of the flexible outer sleeve and the inner tubular core of the ejector body and bounded on each side by the pair of primary inflation sealing units. The action of the tertiary inflation units is such that when it is inflated, there is a reduction in

the depth of the headspace formed between the primary inflation sealing units and into which the sealing composition is pumped for the purpose of repairing the drain or pipe defect. In other words, inflation of the tertiary inflation unit reduces the difference in diameter between the inflated primary inflation sealing units constituting the sealing rings at each end of the ejector body and the central region of the flexible outer sleeve between the end sealing rings. Inflation of the tertiary inflation unit, therefore, results in a reduction in the thickness of sealing composition ejected from the body into the cavity defined between the primary inflation sealing units. This leads to a reduction in the amount of sealant material used to repair a given area of defect and also means that once it is set and hardened, the sealing material of the repaired site protrudes less into the interior of the drain or pipeline, thereby reducing the necessary extent or even need for post-repair reaming and giving an overall better finish to the repaired site.

As a means of controlling the radially outward expansion of the section of wall of the cavity forming the tertiary inflation unit such that the wall remains substantially cylindrical, appropriate internal reinforcement or outer and/or inner bonded constriction rings may be employed, as already mentioned but in a different context. The cavity forming the tertiary inflation unit is preferably of annular cross-section, such that it extends around the whole circumference of the ejector body beneath the cavity into which the sealing composition will be pumped.

In the apparatus of this invention, inflation of the various inflation units may be achieved by use of any suitable pressure medium, but is preferably compressed air. Entry ports to each inflation unit can be connected up and the supply of compressed air to all or any of them controlled by conventional means, as will be known already in the art in the context of the prior art in situ pipe repair apparatuses described hereinabove. It is preferred that both of the primary inflation sealing units are inflatable together, in which case they may be supplied and controlled by a common source, but it is preferable that the

secondary inflation sealing unit and the tertiary inflation unit are both inflatable independently of each other and of the primary inflation sealing units.

One exception, however, to the conventional nature of the compressed air entry ports of the various inflation units of the apparatus is that in embodiments where the tertiary inflation unit is present, the entry port feeding the inflation cavity of the secondary inflation sealing unit is preferably constituted by a special injection port which is constructed to allow supply of compressed air from inside the ejector body into the secondary inflation cavity independently of the degree of expansion of the cavity formed therebeneath which constitutes the tertiary inflation unit and across which the compressed air supply duct for the secondary inflation cavity must therefore traverse.

This same requirement is true of the injection ports via which sealant material is ejected from within the ejector body into the radially outer cavity against the inner wall of the drain or pipeline under repair. Essentially, therefore, whilst compressed air injection ports for the primary and tertiary inflation units can be of known type, it is especially preferred in practical embodiments of the preferred apparatus of the present invention that the compressed air inlet port of the secondary inflation sealing unit and each of the sealing composition injection ports constituting the above defined ejector openings are all similarly constructed in accordance with what is a further definable aspect of the present invention, as will now be defined.

Accordingly, this invention also provides a fluid injection port for passage of fluid from a supply means to a first cavity across a second cavity which separates the first cavity from the supply means, the injection port comprising conduit means in communication with the fluid supply means and extending across the second cavity and into the first cavity, the conduit terminating in a headpiece fast with the wall separating the first and second cavities, and bush means fast with the wall separating the second cavity from the supply means and through

which the conduit means extends and is slidable with respect thereto, the bush means including sealing means which forms a seal against the conduit means as it slides relative thereto, whereby inflation or deflation of the second cavity causes piston-like sliding of the conduit means through and with respect to the bush means, and whereby communication between the fluid supply means and the first cavity is maintainable independently of the degree of inflation or deflation of the second cavity.

Thus, in the context of the preferred apparatus of the primary object of the present invention as defined above, communication between the supply of compressed air or sealant composition, as the case may be, with, respectively, the cavity of the secondary inflation sealing unit and the external headspace region between the primary inflation sealing units into which the sealant composition is to be ejected is preserved regardless of the degree to which the tertiary independent inflation unit is inflated or deflated for the purpose of altering the depth of that headspace surrounding the central region of the ejector body.

A preferred construction of fluid injection port of the above defined aspect of the present invention will be described in detail further below in the context of an overall preferred embodiment of the apparatus of the present invention.

In practical embodiments of the invention, to prevent the sealing composition bonding to the outer sleeve of the ejector body during the repair process as the composition sets and before the apparatus is removed from the repair site, there is preferably employed a release agent which is applied to at least the outer surface of the outer sleeve prior to the repair process being commenced. Suitable release agents are well known in the art and include for example oil-based or silicone-based release agents such as MARLEASE 400 ex Marbo. The release agent may be applied by brush or spray to the sleeve before insertion of the apparatus into the pipeline to be repaired or may alternatively be impregnated into the sleeve material in a pre-soaking step, depending for example on the type of release agent used.

In practical embodiments of the apparatus of the invention the sealant composition, which can be of a conventional type, e.g. single component or more preferably multi-component, (e.g. a resinous compound, such as an epoxy resin, and a hardener) is pumped from a source to the ejector body through a supply line or lines using conventional apparatus and in a conventional manner as is known in the art. The components of a multi-component sealant composition may be separately pumped to the ejector body and mixed in a conduit or mixing chamber therein prior to injection of the sealant composition into the headspace defined by the apparatus. Alternatively, the components of a multi-component sealant composition may be mixed externally of the ejector body and pumped thereto as a pre-mixed composition.

Typically, when the settable sealing composition is conveyed to and out of the ejector openings in the ejector body and it subsequently sets, the ejector openings will be substantially blocked thereby. Consequently, cleaning or complete replacement of the ejector openings, generally requiring removal of the apparatus from the drain or pipe, will usually be necessary before further repair operations can be carried out using the apparatus. Therefore, and particularly where difficult access to a pipe is experienced, an apparatus which can be used for several repair operations, one straight after the other, without removal from the pipe, is highly desirable.

Accordingly, it is preferable that the means for conveying the settable sealing composition to the ejector body is constructed and arranged such as to be controllable to allow the sealing composition to be conveyable to a first group of one or more ejector openings independently of at least one other group of ejector openings, preferably two, three, four or even more other such groups of ejector openings, whereby when one or more of the ejector openings of the first group become(s) blocked by set or partially set sealing composition, the means for conveying the sealing composition to the ejector openings can be reconfigured to an alternative arrangement wherein the sealing composition is conveyed to a non-blocked group of ejector openings, and a further repair operation can thus be carried out

straightaway without the need for removal of the apparatus from the drain or pipe for cleaning or replacement of the ejector openings.

In preferred practical embodiments of the apparatus of the invention, therefore, the means for conveying the settable sealing composition may comprise a separate supply line for each group of ejector openings, each supply line and hence each group of ejector openings being independently and selectively connectable to the source of sealing composition by use for example of a "pneumatic ratchet", which may thus form part of the sealing composition supply means. A preferred construction of such a pneumatic ratchet is described further hereinbelow in the context of a specifically described preferred embodiment of the invention.

A preferred embodiment of the present invention, and in particular, preferred features of the various aspects thereof, will now be described in detail, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a part-sectional view of the principal constructional features of the preferred apparatus of the invention as it is being transported into the correct position in a pipeline requiring repair, ready for the repair process to begin;

Figure 2 is a part-sectional view corresponding to that of Figure 1 in which the apparatus is in position for the repair operation to begin, the primary inflation sealing units having been actuated by inflation to seal the ejector body in place in preparation for the next stage of the repair process;

Figure 3 is a part-sectional view corresponding to that of Figures 1 and 2, showing the apparatus with the secondary inflation unit having been actuated by inflation to close off and seal the incoming lateral side connection of the pipeline, in which condition the apparatus is ready for the introduction of

sealant composition into the region(s) of the pipe defect;

Figure 4 is a part-sectional view on an increased scale of the left-hand end section of the apparatus shown in Figures 1-3, in which the principal constructional features shown there are illustrated in further detail;

Figure 5 is an enlarged cross-sectional view of a preferred fluid injection port via which the secondary inflation sealing unit of the apparatus is actuated by inflation and also via which sealant composition is ejected from the body of the apparatus into the headspace surrounding the ejector body; and

Figure 6 is an enlarged part-sectional view corresponding to that of Figure 3, showing the preferred apparatus in position in a curved drain or pipe.

DETAILED DESCRIPTION OF THE INVENTION AND PREFERRED EMBODIMENTS

Referring firstly to Figure 1, a drain or pipeline 2, which will typically be cylindrical, has a lateral side drain or pipe connection 4 and in one or more of the illustrated regions 6 adjacent to the junction of these two pipe sections, some form of damage or defect is present. Typically, cracking, or breaking away or even major collapse or disintegration of the pipe wall at or near the junction with the lateral side connection 4 will be the application to which the repair system of the present invention can be applied. The system is applicable to repair of the pipe walls in a region on one side only or on both sides of the lateral side connection 4 simultaneously. It is when damage or a defect of the drain or pipeline has occurred in the region of a lateral side connection, as illustrated here, that the prior art in situ repair systems face practical difficulties and it is to this application that the present invention is particularly, but not exclusively, directed.

The apparatus which is transported into the pipe 2 for positioning at the desired site of repair comprises a tubular, preferably cylindrical, ejector body 10 which includes an inner core 20 comprising a closed coil spring 20a (Figure 4) surrounded

by an intermediate stretchable/resiliently flexible sheath 20b (Figure 4), for example of nitrile rubber, such that the core 20 is substantially rigid in the radial direction while being resiliently flexible out of the axial direction of the core, so as to be able to flex and deform as the ejector body 10 traverses a bend in the drain or pipe 2. Surrounding the core 20 is an outer sleeve 22 in the form of a generally continuous tubular sleeve extending substantially over the whole length of the tubular body 10. The outer sleeve 22 is securely anchored to the core 20 at each of its ends, for example by adhesive bonding, locking rings or alternatively by any suitable form of invasive attachment between the two members. The outer sleeve 22 is generally of a flexible material such as rubber or other elastomer, so that it can be subjected to the required differential inflation along its longitudinal length by the various inflation sealing units of the apparatus, as described further below.

The interior space within the tubular body 10 accommodates as much as is required of the various supply means, feed and control devices and any mixing apparatus which are used to supply compressed air to the various inflation units and sealant composition to the various ejector openings leading to the exterior of the outer sleeve 22. These components are generally not shown in the Figures for clarity and will, in certain cases, be entirely conventional. End plugs 12 and 14 are conveniently provided at each end of the tubular body 10. One of these end plugs will generally include means by which the apparatus can be drawn or pushed along the pipeline, for example, an eye for the attachment of a draw or push rod or cable, and the other of these end plugs will generally constitute a manifold for the connection to the above mentioned components of external compressed air and/or sealant composition supply means. The latter may, if desired, be provided by a separate unit introduced in the pipeline along with the repair apparatus or may be supplied from above ground in a conventional manner.

Prior to insertion of the ejector body 10 into the drain or pipe 2, the outer sleeve 22 is coated (or impregnated in a

pre-soaking step) with a release agent, e.g. MARLEASE 400 (ex Marbo). As shown by the arrow 100 in Figure 1, the ejector body 10 is drawn or pushed into the pipe 2 until it reaches the longitudinal position shown in Figure 2, where the leading and trailing ends of the body 10 are disposed to either side of the damaged region 6 in the vicinity of the side connection 4. To assist passage of the ejector body along the pipeline during this positioning step, castors, wheels or other suitable rolling elements 27 may be provided at the ends of the ejector body 10.

Towards each of the ends of the ejector body 10 is provided one of a pair of primary inflation sealing units 30,32. Each of these units is formed by an inflatable tube surrounding the core 20 of the ejector body 10 rather like the inner tube of a vehicle tyre. Each of the primary sealing units 30,32 is shown in Figure 1 in its deflated condition (see also Figure 4 which shows one of these primary inflation sealing units 32 in further detail in this deflated condition) and in their inflated condition in Figure 2. Each of the tubes forming the pair of primary inflation sealing units is situated in a space between the outer sleeve 22 and the inner tubular core 20, the two not being adhered or otherwise bonded together in these regions. If desired, the upper and lower surfaces of the inflation units 30,32 may be bonded such as by adhesive to the outer sleeve 22 and core 20 at the respective contact surfaces.

Each of the primary inflation sealing units is connected to a compressed air supply (not shown in the Figures) via respective ports 60,62 which may or may not themselves incorporate valves, depending upon the construction of the air supply hardware.

In the central region of the ejector body 10, in between the two primary inflation sealing units 30,32, is provided a single, secondary inflation sealing unit 40 which is preferably inflatable and deflatable independently of the primary inflation sealing units. In principle, the secondary inflation sealing unit 40 may be constructed and actuated in a similar manner to the primary inflation sealing units, except that instead of being

situated in a gap between the outer sleeve 22 and the inner core 20, it is positioned preferably in a cavity formed within the outer sleeve 22. This cavity may be formed as part of the integral construction of the outer sleeve 22, or it may be formed by a double-skin section of the sleeve formed by a patch-like attachment to the basic sleeve.

The function of the secondary inflation sealing unit 40 is to close off and seal the incoming side connection 4 of the pipeline and so the circumferential extent (relative to the ejector body) of the secondary inflation sealing unit is preferably only sufficient to fulfil that purpose. It therefore does not need to extend around the whole periphery of the ejector body and a bubble-like configuration is therefore typically the preferred form of secondary inflation sealing unit for most practical application. Of course, depending upon the area of the pipe side connection or the area required to be closed off and sealed during the repair process, any suitable size and shape of secondary inflation sealing unit may be employed within the scope of the invention.

The secondary inflation sealing unit 40 is supplied for the purposes of its inflation by compressed air via its own inlet port 70, which is fed and controlled independently of the ports 60,62 from which the primary inflation sealing units are supplied. The construction of the secondary inflation sealing unit's inlet port 70 is of a special form, as will be described in detail further below.

The central section 26 of the outer sleeve 22 between the primary inflation sealing units 30,32 is not bonded to the core 20 and there is thus formed beneath this central section 26 of the outer sleeve 22 between the primary inflation sealing units 30,32 a cylindrical cavity 50 which constitutes a tertiary inflation unit. This tertiary inflation unit 50 is supplied, again preferably independently of the primary and secondary inflation units, by compressed air from an independent source via its own inlet port 80. This tertiary inflation unit 50 provides a means of altering the depth of the headspace outside of the

outer sleeve 22 between it and the walls of the pipeline 2 and sealed off between the inflated primary inflation sealing units 30,32. It is into this headspace that sealant composition will be ejected for the purpose of filling the pipe defect or damaged area and thus by controlling the degree of inflation of the tertiary inflation unit 50, one is able to selectively control the depth of the headspace into which sealant will be pumped.

Bearing in mind that it is in the central section 26 of the outer sleeve 22 that the secondary inflation sealing unit 40 is provided radially outwardly of the tertiary inflation unit, for efficient operation of the secondary inflation sealing unit it is preferred that the central region 26 of the outer sleeve 22 is constructed so that upon inflation it does not tend to bulge radially outwardly, but maintains a predominantly cylindrical configuration as it is inflated or deflated. This behaviour may be achieved by appropriate construction of the sleeve 22, for example by providing the central section 26 with in-built reinforcement or alternatively by internally or externally bonded constriction rings or the like. With this kind of construction, the end sections 24 of the outer sleeve 22 either side of the central section 26 are preferably not provided with any such reinforcement or constriction means, so that these sections of the outer sleeve 22 are indeed able to configure themselves somewhat convexly upon inflation of the primary inflation sealing units 30,32, so that they form efficient seals against the inner pipe wall around the periphery of the apparatus.

A plurality of injection ports 140 are arranged in the central section of the apparatus in between the primary inflation sealing units 30,32 and it is these which form ejector openings via which sealant composition is pumped from within the ejector body 10 to the outside of the apparatus into the headspace formed between the central region 26 of the outer sleeve 22 and the inner pipe wall once the various inflation sealing units have been actuated.

Preferably a plurality of the ejector openings 140 are arranged in a plurality of groups, each of which group is

selectively and independently connectable to the sealing composition supply means outside the apparatus. Any number of injection ports 140 may be provided in each group, but preferably a sufficient number are provided in an appropriate distribution such that the ease and speed with which sealing composition is pumped into the headspace to completely fill the pipe defect are optimised. The Figures show schematically just one possible arrangement of injection ports 140, namely an arrangement of at least two banks of such injection ports spaced from one another in the longitudinal direction of the apparatus and each bank comprising at least two, and preferably three or four or even more, injection ports evenly spaced from one another circumferentially around the ejector body 10.

As already mentioned, the sealant composition injection ports 140 and the compressed air inlet port 70 of the secondary inflation sealing unit 40 have in common that they are required to deliver fluid to a given cavity from a respective supply means which is separated from that given cavity by a second cavity, namely the tertiary inflation unit 50. During inflation of the tertiary inflation unit 50, there is relative movement between (i) the wall separating the given cavity (i.e. the headspace outside the outer sleeve 22 or the inflatable cavity forming the secondary inflation sealing unit 40, as the case may be) and the cavity 50 of the tertiary inflation unit, and (ii) the wall (i.e. the core 20) separating that tertiary cavity 50 and the interior of the ejector body 10 which accommodates the respective fluid supply means. For this reason, a special construction of port is preferable for the ports 140 and 70 and a preferred construction of such a port which constitutes a further aspect of the present invention will now be described with reference to Figure 5 of the drawings.

Figure 5 in fact shows a preferred port which forms one of the sealing composition injection ports 140, but the compressed air inlet port 70 is of a corresponding construction. The device comprises two principal components:

Firstly, there is a conduit 142 which is in fluid

communication at its lower end with the respective fluid supply and at its upper end terminates in a head piece 143 which is situated within the cavity into which the fluid is to be supplied, in this particular case this being the exterior headspace formed between the outer sleeve 22 and the defective region 6 of the pipeline 2. In between these two extremities of the conduit 142, it traverses the cavity 50 of the tertiary inflation unit and penetrates both the partitioning wall 22 (i.e. the outer sleeve 22) which separates the tertiary cavity 50 from the outside and also the partitioning wall 20 (i.e. the inner core 20) which separates the tertiary cavity 50 from the interior of the ejector body 10. The upper end of the conduit 142 is held fast with the outer sleeve 22 by virtue of lock washer 148 which itself is clamped by piston tube 144 which is engaged for example, with screw threads on the exterior of the conduit 142. Thus, the piston tube 144 clamps the sleeve walls between the lock washer 148 and the headpiece 143. This fixing is sealed to prevent leakage of fluid through the hole in the outer sleeve 22 by means of flanged sealing washer 145. Thus, the upper end of the conduit 142 is fast with the outer sleeve 22 and moves with it upon inflation or deflation of the tertiary cavity 50;

Secondly, there is a the bush 146, for example of phosphor bronze, which is fitted into an aperture in the inner core 20, for example by screw threads or any other suitable mounting means, and the piston tube 144 which surrounds the conduit 142 passes through this bush 146 into the interior of the ejector body 10. The bush 146 is fitted with a rubber seal 149, which is preferably an "O"-ring, so that whilst the piston tube 144 is slidable within the bush, there is a seal formed between the respective sliding surfaces in order to prevent leakage of fluid between the tertiary cavity 50 and the interior of the ejector body 10.

Thus, upon inflation or deflation of the tertiary cavity 50, the elongate section of the conduit 142 slides in a piston-like manner within the bush 146. A shoulder 147 may advantageously be provided on the exterior of the piston tube 144 to act as a stop against the lower face of the bush 146, thereby

limiting its upward travel and thus defining a maximum inflation displacement of the sleeve 22 with respect to the metal core 20.

The lower end of the conduit 142 is mounted in a base 154 which provides connecting means for coupling to the respective fluid supply via access port 150.

Advantageously, this preferred construction of the injection port is simple enough to allow it to be readily dismantled and removed from the apparatus for cleaning, etc, as and when required, which may typically be after each repair operation. The parts of the device can simply be unscrewed from each other and the conduit removed for cleaning, and subsequently it is easy to reassemble the port in the same simple manner.

Referring now to Figure 4, this shows diagrammatically in slightly greater detail the construction of one end of the ejector body 10 and in particular the spacial relationships between the various components of the primary inflation sealing unit 32 and the neighbouring parts of the apparatus. Towards the right-hand side of Figure 4 is seen one of the sealant material injection ports 140. The conduit 142 leading to the outside is connected at its lower end via base 154 to a respective supply conduit 88 through which the sealant composition, preferably a multi-component sealing composition which is supplied to the supply conduit 88 in a pre-mixed state, passes prior to ejection through the injection port 140 into the headspace surrounding the ejector body where the pipe repair is to be effected. Known means may be employed for coupling the respective supply conduits 88 with the necessary sealing composition supply line or lines via manifold 90.

In the preferred construction shown in Figure 4, it is desirable for there to be a flexible connection, e.g. by a length of flexible hose, between the supply conduit 88 and the injection port 140 (or constituting the supply conduit 88), because the latter moves relative to the ejector body core 20 as the tertiary inflation unit 50 is inflated or deflated, so such a flexible connection prevents any hindrance to such movement of the port

140.

The injection ports 140 in the apparatus are arranged in groups, each group having an independent supply conduit 88 such that the sealing composition may be pumped from its source to each group of injection ports 140 independently and selectively. The source may be selectively connected to each of the supply conduits 88 using a pneumatic ratchet. Such a device is already known in the art in various forms in the present and related arts and essentially allows for selective connection of a fluid supply source to one of a plurality of outlets, each of which is connectable to a given supply conduit 88 supplying a particular group of ejector openings 140 in the apparatus. Examples of constructions and operations of such devices are well described in the patent and technical literature, and will be readily available to persons skilled in the art. In one preferred form, however, two hoses supplying the two components of the preferred sealing composition are connected to a stationary plate with a centre shaft extending to another stationary plate approximately 60mm apart. The second stationary plate has connections for attachment to the plurality of mixing conduit outlets and is removable from the centre shaft by means of for example a screw thread. Between the two plates is a revolving section whose bearing is mounted on the centre shaft. On the first stationary plate are a plurality of stops in the form of teeth and the revolving section contains a pneumatic plunger which, after one injection, will withdraw sufficiently to pass over the first index stop. Compressed gas, e.g. air, will then spin the revolving section. Once the plunger has passed over the first index stop, the gas supply is automatically shut off, hence forcing the plunger out. This will then stop at the next index tooth. The two components of the composition will pass separately through the first plate and the revolving section, meeting only where the second plate and revolving section interface.

The overall repair process using the apparatus of the invention may be repeated up to for example a maximum of approximately six repair cycles, since the release agent used to

prohibit the sealant resin adhering to the outer sleeve 22 will generally no longer function subsequent to that number of repair operations.

The operation of the above described apparatus for effecting repair of the defective area or areas 6 of the drain or pipe 2 will now be outlined, though this will to a large extent already be clear from the foregoing description of the apparatus.

Initially, the ejector body 10 (with release agent already applied to the outer sleeve 22) is drawn or pushed into the pipe 2 to such a position that its leading and trailing ends 12,14 straddle the defect 6 and incoming side connection 4 combination. This lateral positioning is shown already completed in Figure 2.

Next, the pair of primary inflation sealing units are inflated, preferably together, but not necessarily so, so as to form inflated end sealing rings 24 at each end of the ejector body 10. Each of these end sealing rings, as illustrated in Figure 2, forms a circumferential seal against the intact (i.e. undamaged or undefective) inner wall of the pipe 2 so as to define between them a cylindrical cavity adjacent to the damaged or defective region or regions 6.

If desired, the tertiary inflation sealing unit may also be inflated to reduce the depth of the headspace into which the sealant composition is to be injected.

In order to seal off that cylindrical headspace cavity from the lateral pipe side connection 4, the secondary inflation sealing unit 40 is now inflated into the configuration as shown in Figure 3. The bubble-like inflated cavity 40 closes off and seals the lateral side connection 4 from the main drain or pipeline 2 and therefore now completely seals the generally cylindrical headspace cavity between the outer sleeve 22 and the inner wall of the pipe 2 between the inflated end seal rings 24.

The apparatus may be used to repair damaged sections in

both straight pipes, e.g. as shown in Figures 1 to 3, and curved pipes, e.g. as shown in Figure 6. In Figure 6, like parts as in Figure 3 are identified with like reference numerals.

With the apparatus in the fully sealing condition as shown in Figures 3 or 6, the sealant composition, which can be of conventional type, e.g. single component or (more preferably) multi-component (e.g. epoxy resin plus hardener), can now be pumped through the multiple walls of the apparatus via a single group of injection ports 140, independently selected by the pneumatic ratchet, into the headspace cavity between the outer sleeve 22 and the pipe defect region or regions 6. The sealant composition is forced into the defect(s) and is allowed to partially set so as to be able to maintain its shape before the next stage of the process.

Once sufficient setting of the sealant composition has taken place, the various inflation units of the apparatus can be at least partially deflated and the ejector body removed from the repair site, this being assisted by the release agent. Rather than complete removal, however, it is possible within the scope of the invention for the apparatus to be transported incrementally along the pipeline to effect multiple repair operations at adjacent sites, for example where a particularly large section of pipeline requires repair. Each step of such an incremental repair process can be carried out individually in the manner just described with the additional step of connecting the sealant composition source to the supply line of a clean group of injection ports between each incremental repair step, by means of the pneumatic ratchet.

As is known in prior art in situ pipe repair systems, reaming apparatus may be employed either before or after, or even both, the repair operation, in order to on the one hand clear the pipe of debris for example and clean the repair site ready for the repair operation and on the other hand for removing excess sealant material, or cleaning or polishing it, following the repair operation. Suitable reaming apparatus is well known in the art, for example in GB-A-2122300, so will not be described

further here.

The preferred embodiments of the various aspects of the present invention described above are by way of example only and it will be appreciated by those skilled in the art that many variations and modifications can be made to what has been specifically described within the scope of the present invention as claimed.

CLAIMS:

1. Apparatus for use in repairing a defect in a drain or pipeline at or near a junction with a lateral drain or pipe connection, the apparatus comprising:

a tubular ejector body adapted to enable it to be drawn or pushed into the drain or pipeline to such a position that a leading end and a trailing end of the body are disposed respectively to one side and the other side of the defect and lateral connection combination;

a pair of primary inflation sealing units at or near the respective ends of the tubular body and which, when they are both inflated, seal the body against the drain or pipeline inner wall on each of the sides of the defect and lateral connection combination;

a secondary inflation sealing unit situated between the primary inflation sealing units and which, when it is inflated, substantially closes off and/or seals from the main drain or pipeline the junction therewith of the lateral drain or pipe connection; and

means for conveying a settable sealing composition from within the tubular body to and out of at least one, preferably a plurality of, ejector openings in the body between the primary inflation sealing units and the secondary inflation sealing unit, for forming, when set, a seal repair of the drain or pipeline defect without a blocking of the junction with the lateral drain or pipe connection.

2. Apparatus according to claim 1, wherein the primary inflation sealing units extend around the full circumference of the ejector body, so that when inflated they assume an annular cross-section and seal the body against the inner wall of the drain or pipeline all the way therearound.

3. Apparatus according to claim 1 or claim 2, wherein the secondary inflation sealing unit extends over only part of the ejector body circumference.

4. Apparatus according to claim 3, wherein the secondary inflation sealing unit takes the form of an inflatable bubble which, upon inflation, presents a surface area sufficiently large to substantially close off and seal the incoming drain or pipe side connection.
5. Apparatus according to claim 1 or claim 2, wherein the secondary inflation sealing unit extends around the full circumference of the ejector body.
6. Apparatus according to any preceding claim, wherein the tubular ejector body comprises an outer sleeve which is resiliently flexible so as to permit radially outward expansion thereof into sealing contact with the inner wall of the drain or pipeline upon inflation of the primary inflation sealing units.
7. Apparatus according to claim 6, wherein the ejector body comprises an inner tubular core within the outer sleeve and united therewith at the ends thereof.
8. Apparatus according to claim 7, wherein the inner tubular core is a closed coil helical spring.
9. Apparatus according to claim 7 or claim 8, wherein the inner tubular core is surrounded by an intermediate sheath of resiliently flexible material.
10. Apparatus according to any one of claims 6 to 9, wherein the primary inflation sealing units are constituted by an annular cavity formed within the outer sleeve wall towards the ends of the ejector body.
11. Apparatus according to any one of claims 6 to 9, wherein the primary inflation sealing units are formed by virtue of a cylindrical section of the outer sleeve not being bonded to the inner core of the ejector body.
12. Apparatus according to any one of claims 6 to 11, wherein the secondary inflation sealing unit is constituted by a cavity

formed within the outer sleeve wall between the primary inflation sealing units.

13. Apparatus according to any preceding claim, wherein there is further provided a tertiary inflation unit between the primary inflation sealing units and radially beneath the secondary inflation sealing unit, such that when it is inflated, there is a reduction in the depth of the headspace formed between the primary inflation sealing units and into which the sealing composition is pumped for the purpose of repairing the drain or pipeline defect.

14. Apparatus according to claim 13, wherein the tertiary inflation unit is constituted by an independently inflatable cavity beneath that which forms the secondary inflation sealing unit.

15. Apparatus according to claim 14, wherein the cavity forming the tertiary inflation unit is of annular cross-section, such that it extends around the whole circumference of the ejector body beneath the cavity into which the sealing composition will be pumped.

16. Apparatus according to any preceding claim, wherein the means for conveying the settable sealing composition are configurable in a first arrangement, wherein the sealing composition is conveyable to a first group of one or more ejector openings, and at least one alternative arrangement, wherein the sealing composition is conveyable to a respective at least one alternative group of one or more ejector openings.

17. Apparatus according to any preceding claim, wherein inflation of the various inflation units is achieved by use of compressed air.

18. Apparatus according to any preceding claim, wherein both of the primary inflation sealing units are inflatable together.

19. Apparatus according to any one of claims 13 to 18,

wherein the secondary inflation sealing unit and the tertiary inflation unit are both inflatable independently of each other and of the primary inflation sealing units.

20. A fluid injection port, especially for use in the apparatus of claim 1, for passage of fluid from a supply means to a first cavity across a second cavity which separates the first cavity from the supply means, the injection port comprising conduit means in communication with the fluid supply means and extending across the second cavity and into the first cavity, the conduit terminating in a headpiece fast with the wall separating the first and second cavities, and bush means fast with the wall separating the second cavity from the supply means and through which the conduit means extends and is slidable with respect thereto, the bush means including sealing means which forms a seal against the conduit means as it slides relative thereto, whereby inflation or deflation of the second cavity causes piston-like sliding of the conduit means through and with respect to the bush means, and whereby communication between the fluid supply means and the first cavity is maintainable independently of the degree of inflation or deflation of the second cavity.

21. A method of repairing a defect in a drain or pipeline at or near a junction with a lateral drain or pipe connection, the method comprising:

drawing or pushing into the drain or pipeline a tubular ejector body to such a position that a leading end and a trailing end of the body are disposed respectively to one side and the other side of the defect and lateral connection combination;

inflating a pair of primary inflation sealing units at or near the respective ends of the tubular body so that the body is sealed against the drain or pipeline inner wall on each of the sides of the defect and lateral connection combination;

inflating, either before, at the same time as or after the inflation of the primary inflation sealing units, a secondary inflation sealing unit situated between the primary inflation sealing units, so as to substantially close off and/or seal from the main drain or pipeline the junction therewith of the lateral drain or pipe connection;

conveying a settable sealing composition from within the tubular body to and out of at least one, preferably a plurality of, ejector openings in the body between the primary inflation sealing units and the secondary inflation sealing unit so that the composition is ejected into the drain or pipeline defect; and prior to complete setting of the sealing composition but whilst it is in a coherent condition, displacing the ejector body along the drain or pipeline, preferably subsequent to deflating at least the secondary inflation sealing unit and preferably also the pair of primary inflation sealing units.

22. A method according to claim 21, further comprising the step of inflating a tertiary inflation sealing unit prior to the ejection of the sealing composition, so as to reduce the depth of the headspace formed between the primary inflation sealing units and into which the sealing composition is pumped for the purpose of repairing the drain or pipe defect.

23. A method according to claim 21 or claim 22, further including the step of applying, prior to insertion of the ejector body into the drain or pipeline, a release agent to the surface(s) of the ejector body which will contact the sealing composition ejected therefrom.

24. A method according to any one of claims 21 to claim 23, wherein the drain or pipeline has deviations or bends in its internal shape.

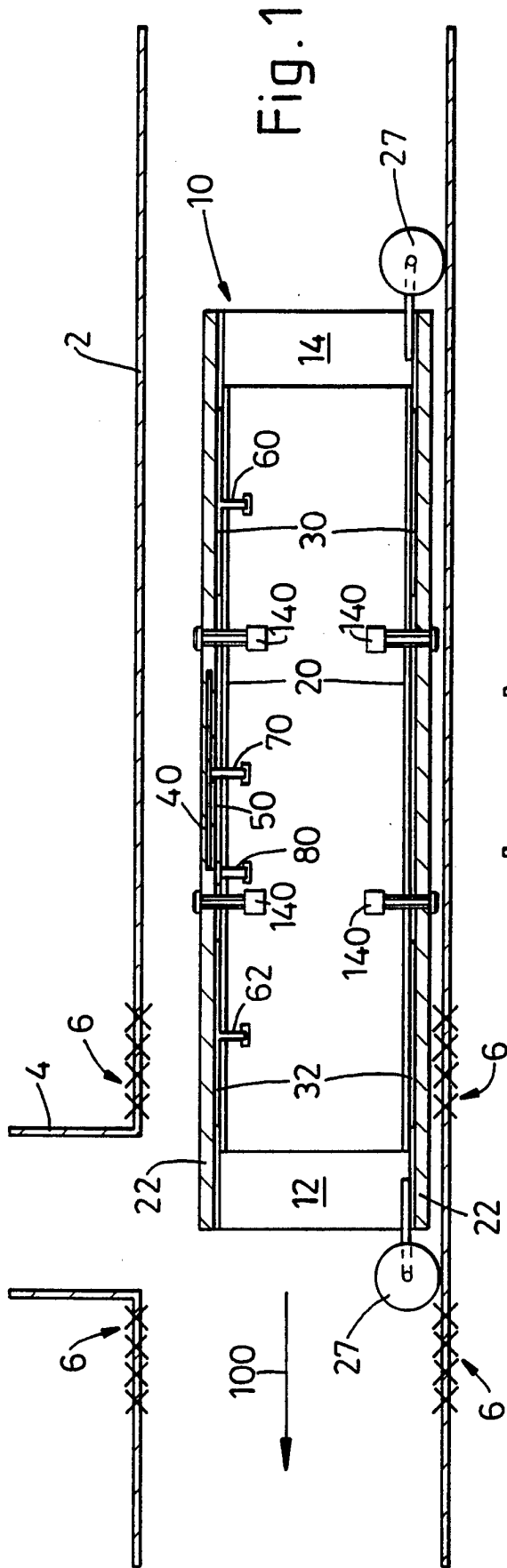
25. A method according to any one of claims 21 to 24, further comprising the steps of incrementally transporting the apparatus along the drain or pipeline and repeating the repair process to effect multiple repair operations at different sites.

26. A method according to claim 25, wherein the plurality of ejector openings in the apparatus are arranged in a plurality of groups, each said group being independently and selectively connectable to the source of sealing composition.

27. A method according to claim 25 or claim 26, wherein the

apparatus remains in the drain or pipeline between individual repair operations.

28. Apparatus or a method for the repair of drains and pipelines substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.



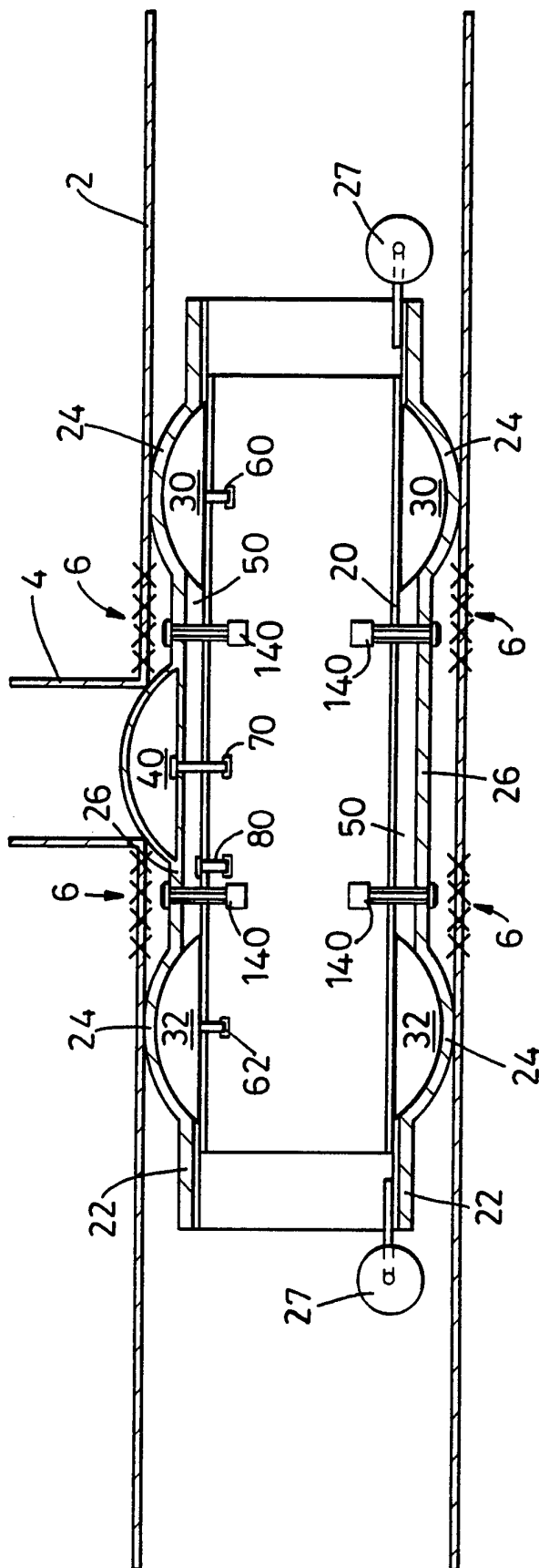


Fig. 3

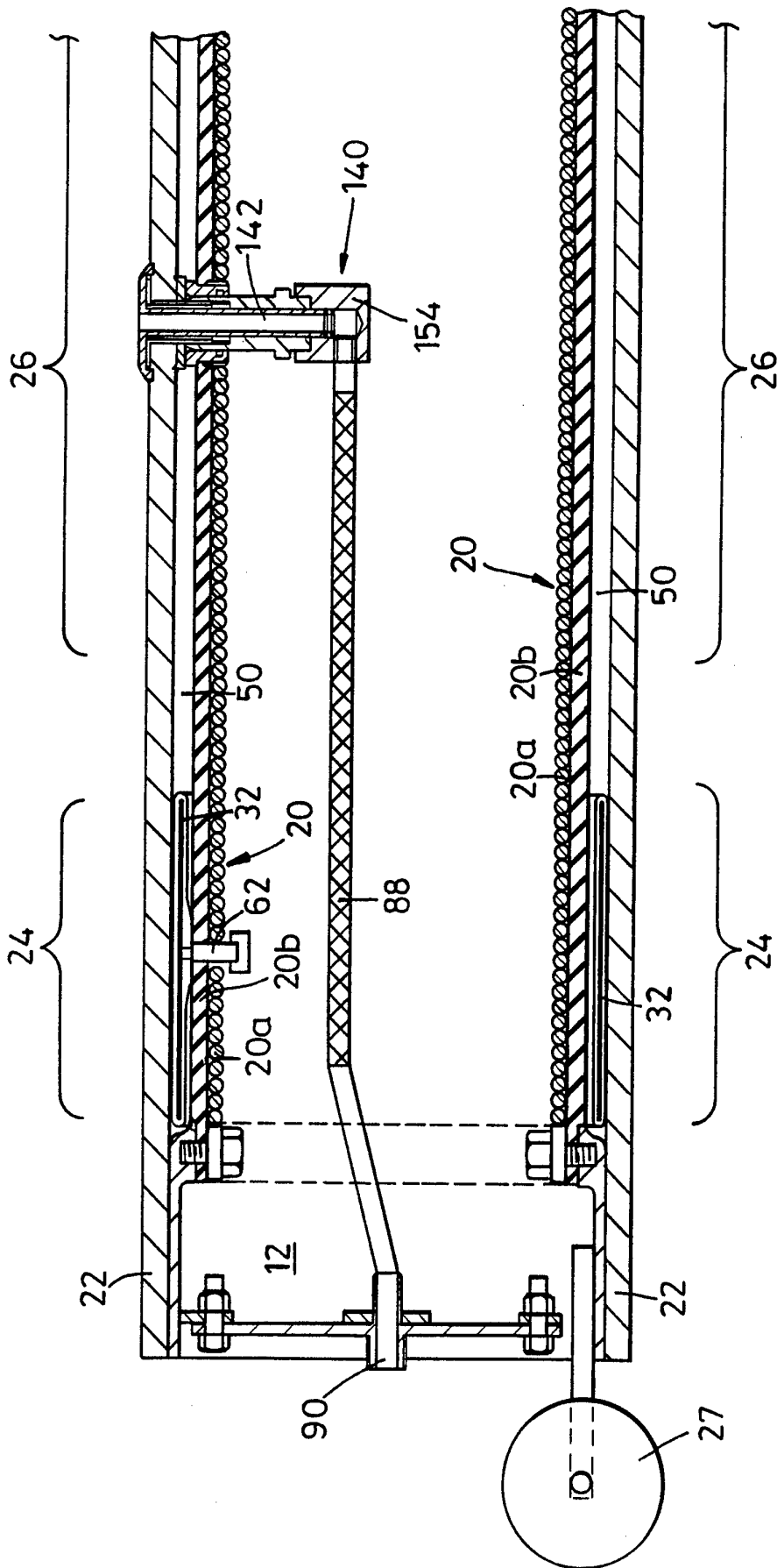


Fig. 4

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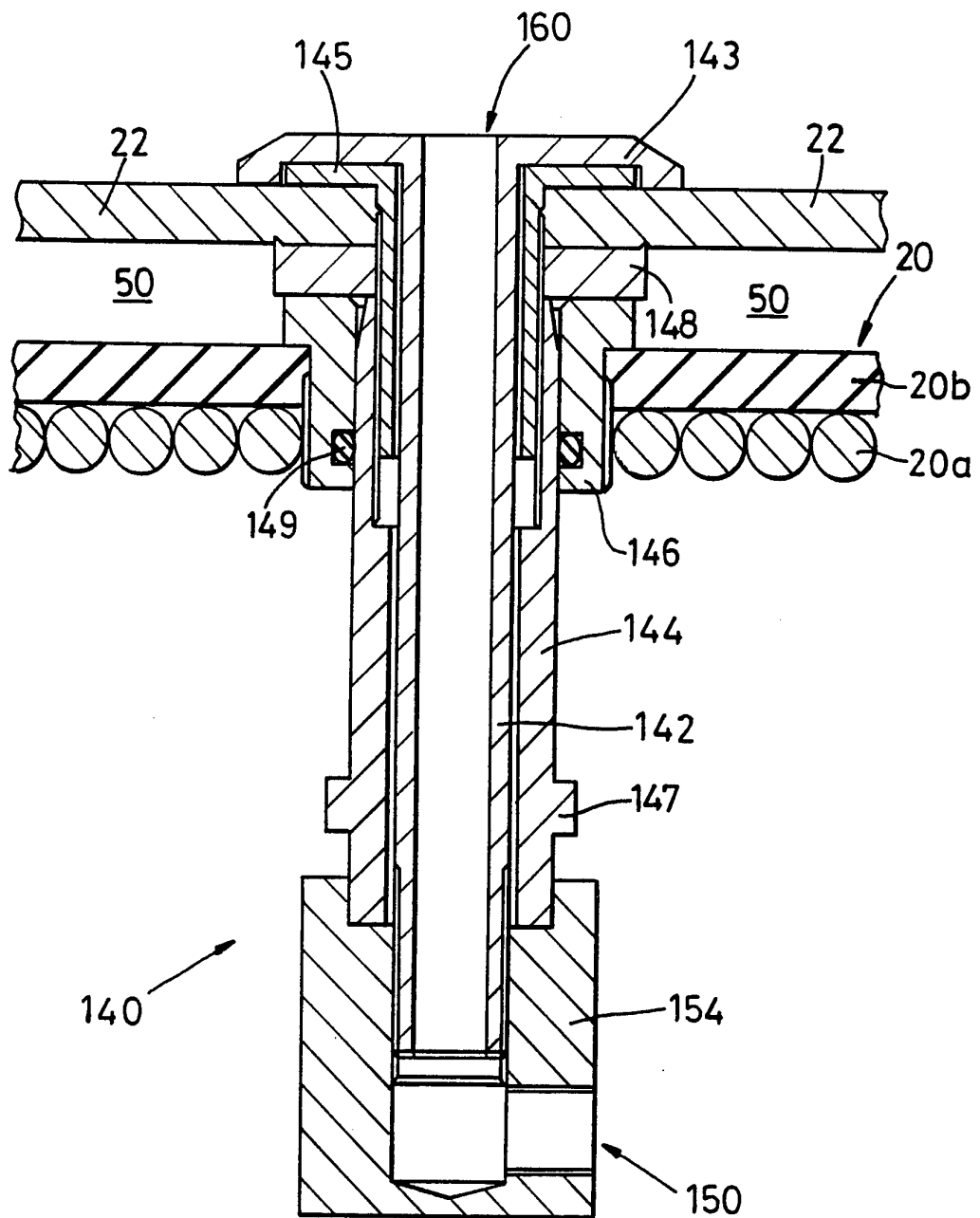


Fig. 5

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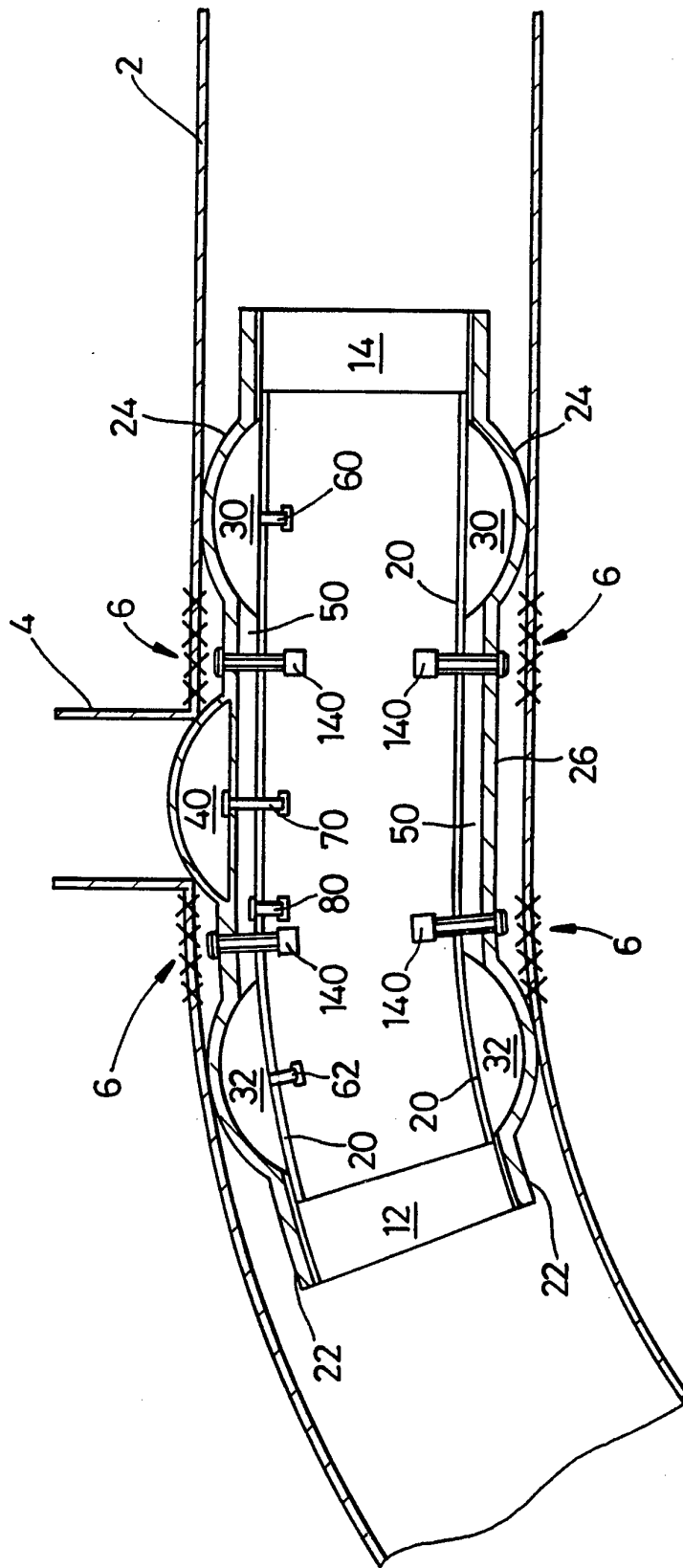


Fig. 6

INTERNATIONAL SEARCH REPORT

Intern. Application No
PCT/GB 94/01932

<p>A. CLASSIFICATION OF SUBJECT MATTER IPC 6 F16L55/162</p> <p>According to International Patent Classification (IPC) or to both national classification and IPC</p>																	
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) IPC 6 F16L</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched</p> <p>Electronic data base consulted during the international search (name of data base and, where practical, search terms used)</p>																	
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:10%;">Category *</th> <th style="width:70%;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="width:20%;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td style="text-align:center;">X</td> <td>FR,A,2 659 720 (D. LEMARCHAND) 20 September 1991 see the whole document ---</td> <td style="text-align:center;">1-4, 14-19, 21,22, 25,27,28</td> </tr> <tr> <td style="text-align:center;">A,P</td> <td>DE,A,42 07 038 (H. MUELLER) 23 September 1993 see abstract; figures 1-5 ---</td> <td style="text-align:center;">1-4,6,7, 17,18, 21,25-28</td> </tr> <tr> <td style="text-align:center;">A</td> <td>EP,A,0 126 648 (BRITISH GAS CORPORATION) 28 November 1984 see abstract; figures 1-3 ---</td> <td style="text-align:center;">1,2,5-7, 9-12, 16-19, 21,25-28</td> </tr> <tr> <td></td> <td style="text-align:center;">-/--</td> <td></td> </tr> </tbody> </table>			Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X	FR,A,2 659 720 (D. LEMARCHAND) 20 September 1991 see the whole document ---	1-4, 14-19, 21,22, 25,27,28	A,P	DE,A,42 07 038 (H. MUELLER) 23 September 1993 see abstract; figures 1-5 ---	1-4,6,7, 17,18, 21,25-28	A	EP,A,0 126 648 (BRITISH GAS CORPORATION) 28 November 1984 see abstract; figures 1-3 ---	1,2,5-7, 9-12, 16-19, 21,25-28		-/--	
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<p><input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.</p>																	
<p>* Special categories of cited documents :</p> <table style="width:100%;"> <tr> <td style="width:50%; vertical-align: top;"> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </td> <td style="width:50%; vertical-align: top;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p> </td> </tr> </table>			<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&" document member of the same patent family</p>													
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<p>Date of the actual completion of the international search</p> <p align="center">16 December 1994</p>		<p>Date of mailing of the international search report</p> <p align="center">03.01.95</p>															
<p>Name and mailing address of the ISA</p> <p align="center">European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016</p>		<p>Authorized officer</p> <p align="center">Angius, P</p>															

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 94/01932

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO,A,82 04086 (HAXEY ENGINEERING LTD) 25 November 1982 see abstract; figures 1,2 ---	1
A	WO,A,90 05874 (KUNSTSTOFF-TECHNIK AG) 31 May 1990 see abstract; figures 1-7 ---	1
A	DE,A,41 15 563 (H.-P. LINCK) 19 November 1992 see figures 1-8 -----	1

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/GB 94/01932

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