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**METHOD OF AND APPARATUS FOR REPAIRING
DRAINS AND UNDERGROUND PIPELINES**

This invention concerns a method of and apparatus for use in repairing drains and underground pipelines, that is to say from small to relatively large-diameter high pressure or other pipe work,
5 usually underground or enclosed in some surrounding material such as concrete, and intended to convey fluids, such as potable water, waste water, certain semi solids, and solids suspended in fluids, or gases.

Various devices have already been proposed
10 for propulsion through underground drains and pipelines for various purposes. For instance arrangements have been devised which progress scrapers, corers, probes, obturators and the like along and through

pipes, e.g. to predetermined positions for performing predetermined operations. Insofar as to repair of drains and the like is concerned, however, arrangements as so far proposed have been suitable only for
5 stopping up relatively trivial leaks. Thus, for example, it has been proposed to provide an arrangement in the form of a carriage which is moved along the pipe of a drain and which has a surrounding cover sheet which is expanded radially into contact with
10 the pipe at each side of the leak (which may for instance be at a conventional joint between two adjacent pipe sections). This having been achieved, grout is pumped through a radial opening in the cover sheet so as to flow into the leak, and this eventually
15 sets and seals the leak.

As has already been mentioned, this proposal in general can be used only in relation to relatively trivial or small defects in the pipework. It would not be possible to use it, for example, in relation
20 to major collapse or disintegration of part of a pipe run, whether at a joint or otherwise, since by its very nature, it can be used only for the introduction of quite fluid grouts which will remain more or less in situ in narrow gaps or joints in the pipework being

repaired, and which are subject to slumping.

An object of the present invention is to provide a method of, and apparatus for use in, the repair of drains and other pipelines which, although they can, if desired, be used for repairing relatively minor defects, can be employed effectively for repairing and/or restoring very large and significant defects, such as collapse and/or disintegration of substantial lengths thereof, to the extent of replacing the defective portion.

With this object in view, the present invention provides, as a first aspect thereof, a method of repairing a defect in a drain or other pipeline which comprises drawing a tubular ejector body into said drain or pipeline to a position such that the leading end and the trailing end of said body are disposed respectively to one side and to the other side of the defect, in register with respective relatively intact portions of the drain or pipeline, sealing said leading end and said trailing end relative to their respective relatively intact portions of the drain or pipeline by inflating respective sealing rings disposed around the

body at or near said ends, supplying a multi-component setting compound to the ejector body so that its components mix in said body and are ejected thereby into the defect, and thereafter displacing the
5 ejector body along the drain or pipeline (e.g. by means of an attached rod or cable) prior to complete setting of said compound but whilst it is in a coherent condition.

Preferably during the displacement the inflatable
10 sealing rings are manipulatively deflated so as to taper to nothing, the residual setting compound thereby ensuring no flow restrictions in the repaired drain or pipeline.

If desired, the ejector body may be progressed
15 stepwise through the drain or pipeline from defect to defect, thereby carrying out as many repairs as may be required to renovate an entire drain or pipeline run.

To facilitate movement of the ejector body into position, and to shift away any debris which may be
20 present at the location of the defect, a reamer may be drawn through the drain or pipeline so as to traverse

the defect, prior to introduction of the ejector body. Alternatively such debris may be removed by high pressure water or sand jetting.

Moreover, a reamer or the reamer may be drawn
5 through the drain or pipeline so as to traverse the repaired defect or defects, after removal of the ejector body and during or after setting of the setting compound, so as to ensure circularity of the repaired drain or pipeline section.

10 Before and during the performance of the repair, scanning means may be introduced into the drain or pipeline to enable the repair operations to be observed, e.g. by television or other means such as fibre optics apparatus.

15 During the performance of the repair, mechanical, electronic and/or computerised equipment may be used to locate and relocate the repair site and to monitor and record the repair operation.

The invention includes, of course, a drain or
20 pipeline which has been repaired by the method as aforesaid.

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A second aspect of the invention provides apparatus for use in repairing a defect in a drain or pipeline comprising an ejector body of tubular configuration adapted to enable it to be drawn or
5 pushed into a drain or pipeline to such a position that the leading end and the trailing end thereof are disposed respectively to one side and to the other side of the defect, respective inflatable sealing rings disposed around said body at or adjacent
10 said ends, means enabling fluid (i.e. air or liquid) under pressure to be supplied to said sealing rings for inflating them, and ducts for supplying the components of a multi-component setting compound individually to the interior of said body so as to mix there-
15 in, the body having a plurality of ejector openings for permitting ejection of the mixed setting compound thereon around the outer curved surface of the body, between the sealing rings.

The construction of the ejector body is preferably
20 ably such that it comprises a central bore for the reception and mixing of the setting compound components, said central bore connecting with a plurality of

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axially-directed passages from which radial outlets lead to the outer curved surface of the body. This central bore may accommodate a succession of mixing elements which impart a swirling motion to the
5 components.

To enable the ejector body to be constructed, as desired, to any practical length according to the drain or pipeline defect to be repaired, it preferably comprises two end sections, substantially
10 of similar configuration, arranged in reversed relative disposition. Then, any desired practical number of further sections may be provided between these end sections to achieve the desired overall length of the body.

15 For drawing the body through a drain or pipeline, the leading end thereof is conveniently provided with an eye for attachment of a cable thereto. Further the leading end is preferably tapered to facilitate its entry into relatively intact pipework after
20 traversing a collapse.

The apparatus of the invention preferably

further includes a reamer assembly for drawing through the pipeline or drain, before repair thereof using the ejector body, and/or after such repair.

The apparatus of the invention preferably
5 further includes high pressure water/sand jetting equipment for introduction into the pipeline or drain for descaling or cleaning of the surfaces adjacent to and at the side of areas to be repaired.

The invention will be described further, by
10 way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a diagrammatic part-section side elevation illustrating a preferred embodiment of the drain or pipeline repairing apparatus according
15 to the invention;

Fig. 2 is a diagrammatic cross-section taken on the line II-II of Fig. 1;

Fig. 3 is an enlarged detail of one of the sections of the apparatus of Figs. 1 and 2;

Fig. 4 is a diagrammatic part-sectional side elevation illustrating the apparatus of Figs. 1 and 2 drawn into position in a drain or pipeline as a first stage in repairing a defect in the latter;

5 Fig. 5 is a view comparable with Fig. 4 but illustrating a subsequent stage in the repair of the drain or pipeline;

Fig. 6 is a view comparable with Figs. 4 and 5, but showing the drain or pipeline repair completed 10 and the apparatus being withdrawn;

Fig. 7 is an enlarged side elevation illustrating one of the mixing elements present in the apparatus of Fig. 1;

Fig. 8 is a front view, taken from the left 15 hand side considered in relation to Fig. 7, of the mixing element of Fig. 7;

Fig. 9 is a rear view, taken from the right hand side considered in relation to Fig. 7, of the mixing element; and

Fig.10 is a diagrammatic sectional side elevation illustrating a reamer assembly, which may be included in the apparatus of the invention, being drawn through a drain or pipeline after it has been repaired, the scale of this figure being slightly larger than that of Figs. 4, 5 and 6.

Referring firstly to Figs. 1 to 3 of the drawings, a preferred embodiment of the drain or pipeline repairing of the invention comprises an ejector body, indicated generally by the reference numeral 20, whose overall configuration is cylindrical or tubular and which is composed of two sections 22, 24 of which one is shown in more detail in Fig. 3. These two sections 22, 24 are substantially identical in form, and are disposed in reversed disposition, end-to-end, relative to one another. They may be, for example, of metal, or a moulded plastics material, preferably the latter so that they may economically be discarded after a small number of uses of the apparatus. The sections 22, 24 are preferably of flexible material to enable them to be used in curved drains or pipelines.

Each of the tubular sections 22, 24 has a relatively wide main bore portion 26 extending from one end thereof and merging into a narrower portion 28 having a threaded portion 30 accommodating a

5 connecting bush 32 whereby the two sections are coupled together. The main bore portion 26 accommodates a succession of mixing elements 34 of which the details are shown in Fig. 7, 8 and 9 and will be described later.

10 Adjacent one end, each body section has a circumferential recess 36 accommodating a respective inflatable ring 38 fitted with an inflation valve 40 (in a manner similar to the fitting of a valve into a bicycle tyre inner tube), this valve 40 and the

15 surrounding inflatable ring part being a push sealing fit in a radial opening 42, in the body section, leading to an axial inflation passage 44. Adjacent the inflatable ring 38, disposed in a groove defined between two circumferential ridges 46 is a respective

20 O-ring 48.

At its inner end, the wide main bore portion 26 connects with a plurality of radial passages

50 which communicate with a corresponding array of axial setting-material passages 52 which in turn connect with a multitude of radial outlets 54 which open to the outer curved surface of the body section.

At the trailing end of the body, which is provided by the section 22, an end plate or manifold 56 is bolted thereto and this embodies a coupling for supply ducts, indicated generally by numeral 58, 10 which may be of sectional extensible construction, and which serve to supply the components of a multi component (e.g. two-component) setting composition, for instance an epoxy resin and a hardener, to the main bore portion 26, and to supply compressed air 15 to the inflation passage 44.

As shown in Figs. 7 to 9, each of the mixing elements 34 disposed in the main bore portion 26 is of circular form in end view, so as to be a snug sliding fit in the bore portion 26, but is 20 shaped at its rear end to provide angled surfaces 62, 64 meeting on a diametrical line 66 along which is a series of holes 68, 70, 72 and 74. At its front end, the element 34 is of complementary

angled configuration, as at 176 in Fig. 7, to
interfit into the rear end of the next adjacent
said mixing element 34, but is formed with a generally
square recess 178 into which the holes 68 to 74 open
5 along an imaginary diametrical line which is at
right angles to the line 66. It will thus be
appreciated that this arrangement provides for there
to be a free space (defined by the respective recess
178) between each adjacent pair of the mixing elements
10 34, and that the holes 68 to 74 are generally in a
disposition approximating to a helical configuration,
so that liquid material passing through the successive
elements 34 from free space to free space will be
caused to swirl, and good mixing is achieved in the
15 free spaces.

At the leading end of the body, which is provided
by the section 24, a tapered head 76 is bolted thereto,
and this is provided with an eye 78 whereby a cable 80
(see Figs. 4 to 6) may be connected thereto.

20 Figs. 4, 5 and 6 illustrate the method of using
the apparatus as so far described for the repair of a
defect in a drain or pipeline 82, this defect being

illustrated as being a collapse of a portion of two adjacent drain or pipeline sections 84 and 86 in register with the usual joint therebetween, to the extent that a large part of the drain or pipeline, as well as the ground thereabove, has been washed away, as indicated at 88, 90.

For effecting the repair, after visual inspection of the drain or pipeline, e.g. by means of closed circuit television or other inspection equipment (not shown), the cable 80 is threaded through the drain or pipeline 82 from an appropriate location such as an inspection chamber (not shown) to one side of the defect 88, 90 and this is connected to the eye 78 of the body 20, the latter being registered with the drain or pipeline at a suitable location (again for instance, an inspection chamber, not shown). Thereupon, the body 20 is drawn along the drain or pipeline 82 to the position illustrated wherein its leading end and its trailing end are to each side of the defect 88, 90, sections of ducting 58 being added as appropriate. Alternatively or supplementarily, the body can be moved along the drain or pipeline by the use of interconnecting rods.

Upon the Fig. 4 position being achieved, the ducting 58 is connected to a compressed air or hydraulic liquid supply to supply air or liquid to the rings 38 to inflate them as shown in Fig. 5 thereby to centre
5 the body 20 and to seal the drain or pipeline 82 at each side of the defect 88, 90. If, as sometimes may be the case, the defect should register with or be disposed closely adjacent to a junction or side connection to the drain or pipeline 82, this junction
10 or side connection will be blocked off using a bag (not shown) which can be inflated from the same compressed air or liquid source.

Sealing of the drain or pipeline 82 having been achieved, the components of a two-component setting
15 composition is rapidly pumped, in accurately metered quantities, and at high pressure, through the ducting, separately to the manifold 56 to enter the main bore portion 26 separately and mix therein as they pass through the mixing elements 34. The components prefer-
20 ably comprise a resinous compound and a hardener respectively, being such that they will set to a relatively coherent mass preferably within two or three minutes and to a hard mass within six to eight minutes depending on ambient temperatures and quantities injected.

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Accordingly, the pumping-in of the setting composition components is effected rapidly to fill the defect 88, 90, as shown in Fig. 5, and the body 20 is allowed to remain in position just sufficient time for coherence to be 5 achieved. Thereupon, as shown in Fig. 6, the body 20 is drawn back along the drain or pipeline 82 by means of the ducting 58 or by connected cable or rods (not shown) which, of course is dismantled or rewound appropriately. The moving body 20, as it is drawn 10 back, may deposit a thin layer of the setting material on the interior of the non-defective drain or pipeline part, but this need not be a disadvantage. In practice, the inflatable rings 38 can be controlledly deflated or inflated during the moving-back of the body 20 so as to 15 ensure that there is a taper of the setting material surface, merging smoothly with the inner surface of the drain or pipeline 82, and no step or obstruction is created.

Upon withdrawal, the body 20 can be cleared 20 of setting composition components, provided they have not set hard, and may be reused a number of times. The pipelines to the body remain full of the separately

delivered resinous compound and hardener and do not require to be cleared between operations, of course.

As will be evident from Fig. 6, the nature of the repair which has been achieved is a full restoration of the missing portion of the drain or pipeline, and simultaneous filling of any adjacent cavity in the adjacent ground, earth or other surrounding environment which, of course, has not been generally possible in non-man entry pipes with prior known drain repair proposals which have been suitable only for relatively small joint leaks and the like. Of course, the method and apparatus as above discussed can, if desired, be used for such repairs if so desired.

Turning now to Fig. 10 of the drawings, this figure illustrates a practical embodiment of a reamer which may be employed in conjunction with the apparatus above described. This comprises an air motor, indicated generally by the reference numeral 100, located by one end in a tubular adapter 102 whose size is selected according to the size of the drain 104 which is being repaired and which has

its own inflatable circumferential ring 106 inflation of which serves to fix the reamer axially within the drain or pipeline 104. The other end of the motor 100 has bolted thereon a steadying and centring disc 5 108 serving rotatably to support, by a bearing 110, an intermediate stub 112 with a shank 114 thereof slidably, but non-rotatably, engaged into a sleeve 116 secured to shaft 118 of the motor 100. A spring 120 abuts by one end against a shoulder on the sleeve 10 116 and by the other end against a collar 122 on the stub 112 whereby the latter is yieldingly loaded forwardly in the axial direction away from the motor 100.

Secured onto the front end 124, which is non- 15 round, of the intermediate stub 112 is a boss 126, whereby a cylindrical reaming tool 128, which may be toothed at its front end away from the motor 100, is secured to the stub 112 by way of a rear end disc 130 of the tool 128. In turn a cleat 132 is rotatably 20 fixed axially to the boss 126, within the tool 128, and this enables attachment of a hauling cable 134 to the reamer.

The rear of the reamer may be provided with a rodding connector to facilitate pushing through a drain or pipeline and also withdrawal as may be necessary, in cases where pulling through may be
5 impracticable.

Connected to the rear end of the air motor 100 is a fluid supply duct arrangement 136 whereby air or liquid can be supplied (a) to the inflatable ring 106 for arresting the reamer in the drain or pipeline 104
10 and (b) for driving the motor 100 so as to rotate the tool 128.

This reamer may be used either before use of the apparatus already described, or after the use of such apparatus, or both. As has already been explained,
15 usually an internal inspection will be made of the drain or pipe line 104 to determine what repair(s) may be necessary, for example by use of closed circuit television scanning. If this should reveal the presence of any obstruction, such as debris fallen into
20 and lodged in the drain or pipeline, or external matter such as rocks projecting into the opening of the drain or pipeline, or the fact that the shape of the drain

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or pipeline has been deformed from its intended round cross-section, the reamer will then be drawn through the drain or pipeline, so as to pass and clear the region to be repaired, thereby preparing the drain 5 or pipeline for the repairing operation above described.

After the repairing operation has been effected (as has been shown at 138) the reamer may then be drawn through so as to ensure that the inner cross-section is trued up, and if desired a polishing tool 10 may be employed in the place of the tool 128 for polishing the internal surface of the newly-introduced hardening compound.

The invention is not restricted to the precise details of the foregoing example and variation may 15 be made thereto within the scope of the following claims. Thus, it will readily be understood that the ejector body 20 may be adapted to be pushed through the pipeline instead of being pulled as in the described embodiment. It may be of unitary construction; 20 in the form illustrated, one or more intermediate sections may be incorporated between the body sections 22 and 24 to achieve an overall body length as may be

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desired or dictated according to the extent of the repair to be effected. The body sections may, if desired, be produced as cheap disposable plastics mouldings which can, if necessary, be discarded after 5 only one or two uses; moreover they may be made of flexible materials for use in curved drains or pipelines.

The apparatus can, of course, be used to repair all kinds of defects from very minor cracks or leaks 10 up to major collapses as illustrated. The ejector body and/or the reamer arrangement may, if desired, be adapted to be positioned in and/or progressed through the drain or pipeline by means of a tractor which may be driven pneumatically, electrically or in any other suitable way.



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CLAIMS

1. A method of repairing a defect in a drain or other pipeline which comprises drawing a tubular ejector body into said drain or pipeline to a position such that the leading end and the trailing end of
5 said body are disposed respectively to one side and the other side of the defect, to register with respective relatively intact portions of the drain or pipeline, sealing said leading end and said trailing end relative to their relatively respective intact
10 portions of the drain or pipeline by inflating respective sealing rings disposed around the body at or near said ends, supplying a multi-component setting compound to the ejector body so that its components mix in said body and are ejected thereby into the
15 defect, and thereafter displacing the ejector body along the drain or pipeline prior to complete setting of said compound, but whilst it is in a coherent condition.

2. A method as claimed in claim 1 wherein, during
20 the displacement, the inflatable sealing rings are



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deflated so as to create taper on the setting compound.

3. A method as claimed in claim 1 or 2 wherein the ejector body is progressed stepwise through
5 the drain or pipeline from defect to defect, carrying out a respective repair at each said defect.
4. A method as claimed in claim 1, 2 or 3 wherein a reamer is drawn through the drain or pipeline so as to traverse the defect, prior to
10 introduction of the ejector body.
5. A method as claimed in any preceding claim wherein a reamer or the reamer is drawn through the drain or pipeline so as to traverse the repaired defect or defects, after removal of the ejector body and setting
15 of the setting compound.
6. A method as claimed in any preceding claim wherein scanning means is introduced into the drain or pipeline to enable the repair operations to be observed.



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7. A method of repairing a defect in a drain or pipeline substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

5 8. A drain or pipeline which has been repaired by the method of any preceding claim.

9. Apparatus for use in repairing a defect in a drain or pipeline comprising an ejector body of tubular configuration adapted to enable it to be
10 drawn or pushed into a drain or pipeline to such a position that the leading end and the trailing end thereof are disposed respectively to one side and to the other side of the defect, respective inflatable sealing rings disposed around said body at or
15 adjacent said ends, means enabling fluid under pressure to be supplied to said sealing rings for inflating them, and ducts for supplying the components of a multi-component setting compound individually to the interior of said body so as to mix therein,
20 the body having a plurality of ejector openings for permitting ejection of the mixed setting compound therefrom, around the outer curved surface of the body between the sealing rings.



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10. Apparatus as claimed in claim 9 wherein the ejector body comprises a central bore for reception and mixing of the setting compound components, said central bore connecting with a plurality of axially-
5 directed passages from which radial outlets lead to the outer curved surface of the body.
11. Apparatus as claimed in claim 9 or 10 wherein the ejector body comprises two end sections, substantially of similar configuration, arranged in
10 reversed relative disposition.
12. Apparatus as claimed in claim 11 wherein one or more further sections are provided between said end sections.
13. Apparatus as claimed in any of claims 9 to 12
15 wherein an eye is provided on the leading end of the body to enable it to be drawn into the drain or pipeline.
14. Apparatus as claimed in any of claims 9 to 13 wherein the leading end of the body is tapered to facilitate its entry into relatively intact pipework
20 after traversing a collapse.



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15. Apparatus as claimed in any of claims 10 to 14 wherein the central bore accommodates a succession of mixing elements which impart a swirling motion to the components.

5 16. Apparatus as claimed in any of claims 9 to 15 further including a reamer assembly for drawing or pushing through the drain or pipeline, before repair thereof using the ejector body, and/or after such repair.

10 17. Apparatus for use in repairing a defect in a drain or pipeline substantially as hereinbefore described with reference to and as illustrated in Figs. 1 to 9 of the accompanying drawings.

15 18. Apparatus as claimed in claim 17 further including a reamer substantially as hereinbefore described with reference to and as illustrated in Fig. 10 of the accompanying drawings.
