

AN INJECTOR

Description of Invention

THIS INVENTION relates to an injector, and in particular concerns an injector for injecting a substance, such as an epoxy, into a crack to seal the crack.

The use of injectors to inject a filler or repair substance, such as epoxy, into cracks in concrete and other types of structures is relatively well known.

Conventional injectors, such as disclosed in GB2362684, use the force provided by a coil spring to eject the epoxy from the injector. These designs generally suffer from the disadvantage that the epoxy can only be injected under relatively low pressure. This means that it is difficult to inject epoxy effectively into certain types of cracks.

Injectors such as those disclosed in GB2362684 also suffer from the drawback that it is difficult to adjust or alter the pressure with which epoxy will be ejected.

It is an object of the present invention to seek to alleviate some of these problems.

Accordingly, one aspect of the present invention provides a apparatus for ejecting a fluid substance, the apparatus comprising: a housing having an internal cavity, the cavity having a first end and a second end; a divider located within the cavity and between the first and second ends thereof, the divider dividing the cavity into first and second chambers; an introduction arrangement for introducing fluid into the first chamber; a compression element located in the second chamber, between the divider and the second end of the chamber, the compression element being of sufficient size that, when the divider is

within a first distance from the second end of the housing, the compression element is placed under compression along a compression axis between the divider and the second end of the housing, the compression element taking the form of a substantially solid, elongate member formed from a resilient material, wherein the compression element has a first end and a second end and, in a substantially uncompressed state, occupies substantially every point along at least one axis that is parallel with the compression axis; and an ejection arrangement to allow ejection of fluid from the first chamber out of the apparatus.

Advantageously, the compression element takes the form of a substantially solid, elongate peripheral wall having a hollow internal core.

Preferably, the compression element is formed from a silicone material.

Conveniently, the introduction arrangement comprises a shaft passing through the second chamber.

Advantageously, the compression element is formed at least partly around the shaft.

Preferably, two or more compression elements are provided within the second chamber.

Conveniently, two compression elements are formed from materials having different elastic moduli.

Advantageously, the ejection arrangement comprises a fluid conduit passing from the first chamber to a delivery nozzle.

Preferably, the ejection arrangement comprises an elongate delivery member with an egress aperture at or near its distal end.

Conveniently, the elongate delivery member comprises a needle.

Advantageously, the egress aperture is provided on a side surface of the elongate delivery member.

Another aspect of the present invention provides a method of ejecting a fluid, comprising the steps of: providing an apparatus according to any of the above; introducing pressurised fluid into the first chamber via the introduction arrangement, so that the compression element is compressed; and ejecting the fluid, via the ejection arrangement, at least partly through an ejection force exerted by the compression element.

In order that the present invention may be more readily understood, embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows the components, in exploded view, of an injector embodying the present invention;

Figure 2 shows the components of figure 1 assembled into an injector; and

Figures 3a to 3c show fluid being introduced into the injector and subsequently ejected.

Figure 1 shows components of an injector 1 embodying the present invention in exploded view, and figure 2 shows the components assembled into a finished injector 1.

The injector 1 comprises a main body 2, which is generally hollow and elongate. At a first, forward end of the main body 2 a first, narrowed neck 3 is formed, having an egress aperture 4 formed at its end. Inclined screw threads 5 are formed on an external surface of the first neck 3.

At a second, rear end of the main body 2 a second, preferably wider neck 6 is formed defining a rear aperture 7 of the main body 2. The second neck 6 also has screw threads formed on its outer surface.

In cross-section, the internal chamber defined by the main body 2 is substantially circular in shape. The external cross-sectional shape of the main body 2 may be any suitable shape and, in the depicted embodiment, is generally hexagonal. An external cross-sectional shape such as a hexagon ensures that the main body 2 may be handled, tightened and loosened easily during use.

A delivery nozzle 8 includes a cup-shaped engagement portion 9 having an internal threaded surface, which is adapted to be matingly engaged with the screw threads 5 formed on the external surface of the first neck 3 of the main body 2.

Extending from the engagement portion 9 is a delivery conduit 10, which terminates in a substantially planar positioning plate 11, which is generally perpendicular to the main axis of the delivery conduit 10. A fluid path is defined from the interior of the engagement portion 9, through the delivery conduit 10 and out through a delivery aperture 12 formed roughly in the centre of the positioning plate 11.

In preferred embodiments a ring seal 13 is provided to help ensure that the threaded engagement between the main body 2 and the delivery nozzle 8 is fluid-tight.

A plunger 14 has a main spindle 15, in the form of an elongate, generally cylindrical rod. At a first end of the spindle 15 is a pushing plate 16, which is generally disc-shaped and formed to have an external diameter which is generally the same as, or slightly less than, the internal diameter of the main body 2. An O-ring 17 is preferably positioned within a peripheral groove of the pushing plate 16, to assist in forming a fluid-tight seal between the pushing plate 16 and the interior of the main body 2.

A fluid channel 18 is formed through the spindle 15 and pushing plate 16, with an aperture 26 being formed at or near the centre of the pushing plate 16. At a second end 19 of the spindle 15 a non-return valve 20 is provided. The non-return valve 20 allows fluid to pass along the spindle 15 from the second end 19 to the first end, but does not allow fluid to pass in the other direction.

A cap 21 has an internal threaded wall 22 which is adapted to engage the threads 6 provided on the second neck 7 of the main body 2. The cap 21 has a central aperture 23 formed therethrough. When the injector 1 is assembled, the pushing plate 16 is received within the interior of the main body 2, and the second end 19 of the spindle 15 protrudes from the rear of the injector through the aperture 23 formed in the cap 21. The pushing plate 16 is therefore captive within the main body 2.

A compression element 24 takes the form of a substantially solid peripheral wall forming a generally hollow cylinder. The external diameter of the compression element 24 is roughly the same as, or slightly less than, the internal diameter of the main body 2. The internal diameter of the compression element 24 is formed to be roughly the same as, or slightly larger than, the external diameter of the spindle 15.

When the injector 1 is assembled the compression element 24 is provided within the main body 2, positioned between the pushing plate 16 and the cap 21. The length of the compression element 24 is selected to be roughly the same as, or slightly less than, the internal length of the main body 2. This means that, if the spindle 15 is fully inserted into the main body 2 so that the pushing plate 16 lies close to the first neck 3 thereof, and the cap 21 is screwed onto the second neck 7 of the main body 2, the compression element 24 occupies substantially all of the space between the pushing plate 16 and the cap 21 in an uncompressed, or slightly compressed, state.

It will be understood that, if one attempts to exert a pulling force on the second end 19 of the spindle 15, with respect to the main body 2, the spindle 15 can only be moved with respect to the main body 2 by compressing the compression element 24 between the pushing plate 16 and the cap 21. When the spindle 15 is released, the spontaneous expansion of the compression element 24 will tend to force the pushing plate 16 back towards the first neck 3 of the main body 2, thus returning the spindle 15 to its default position.

Figures 3a, 3b and 3c show cut-away views of the injector 1.

Figure 3a shows the injector 1 in its "rest" position, with the pushing plate 16 lying against or close to the first end of the main body 2.

Use of the injector 1 will now be described, with reference to the filling of a crack line in a concrete surface with an epoxy material.

Firstly, the crack is sealed along its length except at an entry point where the injector 1 is to be used.

The injector 1 is then positioned at the entry point, so that the delivery aperture 12 is aligned with the entry point.

A nozzle of a fluid supply, for instance a pump to deliver the epoxy material (not shown) is attached to the non-return valve 20. Pressurised fluid is then introduced into the non-return valve 20.

Fluid flows along the fluid channel 18 formed in the centre of the spindle 15, and flows out through the aperture 26 formed in the pushing plate 16. The fluid firstly fills the interior of the first neck 3, and also the delivery conduit 10 of the nozzle 8. However, due to its viscosity, the fluid will not initially flow out of the delivery aperture 12 of the nozzle 8. Once these spaces have been filled, as the fluid continues to be introduced into the non-return valve 20, the fluid begins to exert a pressure against the pushing plate 16. This pressure will, at least to some extent, be resisted by the presence of the compression element 24, which lies against the other side of the pushing plate 16.

As more fluid is introduced, the fluid exerts a higher pressure on the pushing plate 16, and the pushing plate 16 will begin to move towards the second end of the main body 2, compressing the compression element 24 as it does so. It will be understood that, as the pushing plate 16 moves, the spindle 15 and non-return valve 20 will rise away from the top surface of the cap 21.

As pressurised fluid continues to flow into the injector 1 through the non-return valve 20, an increasingly large fluid chamber 25 will form between the pushing plate 16 and the first end of the housing 2.

In preferred embodiments of the invention, the main body 2, or portions thereof, are formed from a transparent or translucent material which allows a user to see the level to which the pushing plate 16 has been pushed by the fluid 25. The distance by which the pushing plate 16 has been pushed will, as the skilled reader will appreciate, be representative of the pressure of the fluid in the fluid chamber 25. A series of markings representing different pressures

may be provided, for instance indicating 0, 5, 10 and 15 bars of pressure. Further, a "stop line" may be marked, indicating the maximum safe or recommended pressure.

In preferred embodiments, the pushing plate 16 (and also preferably the cap 21) are coloured or otherwise easy to identify visually, so that the distance by which the pushing plate 16 has been displaced can easily be seen during use.

When the pressure in the fluid chamber 25 reaches sufficiently high level, pressurised fluid will be forced from the injector 1 into the crack in the concrete surface. The fact that the length of the crack is sealed, aside from the entry point, will prevent the fluid from leaking out of the crack, and will ensure that the crack is filled.

One advantage of using a compression element of the type described above, rather than a coil spring, is that significantly higher pressures can be achieved. Conventional ejectors, such as those shown in GB2362684, can generally achieve a maximum fluid pressure of around three bars. By contrast, using a substantially silicone compression element, as described in connection with the above embodiment, it has been found that pressures of at least ten bars can be achieved. This allows fluid such as epoxy to be driven a greater distance into cracks, and also allows the use of fewer injectors to repair certain cracks.

In addition it can be understood that the pressure under which fluid will be ejected from an injector can be varied simply by using a different type of compression element. For instance, a compression element which is shorter, has a thinner wall, or is from a material having a higher elastic modulus, will allow the injector to be filled with the same quantity of fluid but under a lower pressure. Conversely, providing a compression element which is longer, has a

thicker wall, or has a lower elastic modulus, will mean that the same volume of fluid introduced into the injector will be placed under higher pressure.

Figures 4 and 5 show an alternative injector 27 embodying the present invention. The alternative injector 27 is similar to the injector 1 described above, but includes a hollow needle 28 which protrudes from the positioning plate 11. The interior of the needle 28 is in fluid communication with the fluid chamber 25 so that, when fluid is ejected from the fluid chamber 25 by forces exerted by the compression element 24, the fluid travels along the interior of the needle 28 and is ejected from an egress aperture 29 provided at or near the distal end of the needle 28. In preferred embodiments, the egress aperture is provided on a side surface of the needle 28. This ensures that, if the tip of the needle is pressed against a surface, the egress aperture 29 is not blocked. Two or more egress apertures 29 may be provided to allow fluid to escape from the needle 28 at or near its distal end.

In circumstances where cement, mortar or another bonding material between an exterior material (such as marble, tile, granite, plastering screed etc) and the cement below has not been evenly spread out such that the exterior material is not entirely bonded to the cement below, the hollow needle 28 allows the fluid to be forced with precision through exterior material so that the fluid can completely bind the exterior material to the cement below.

Markings 30 indicating the approximate pressure of the fluid within the injector can be seen on the exterior of the main body 2 in figure 4.

It is envisaged that a series of replaceable and interchangeable compression elements may be provided for use with injectors embodying the invention, with the different compression elements having different compressive strengths and/or elastic moduli. In preferred embodiments, the different types of compression elements are colour-coded (or otherwise provided with a clear

visual identifier, such as a number or other symbol) so that a user can quickly and easily identify a desired type of compression element.

In addition, once the injector has been used a compression element formed from a material such as silicone may readily be recycled. This is far easier than recycling coil springs. In preferred embodiments, all or substantially all of the components that make up the injector 1 are recyclable.

In preferred embodiments the compression element is substantially solid and does not have significant gaps or apertures along its length (the term "solid", in this context, refers to the fact that the compression element comprises a generally continuous piece or block of material, rather than to the fact that the compression element is not in the liquid or gaseous state). In other embodiments, however, one or more breaks or cut-out sections may be formed as part of the compression element. The compression element does not take the form of a coil spring.

In preferred embodiments the compression element presents a substantially continuous, linear presence between the two elements that place it under compression (in the depicted embodiment, these two elements comprise the pushing plate and the cap). In other words, the compression element has a first end and a second end, and occupies, in a substantially uncompressed state, substantially every point along at least one axis passing between the first and second end that is parallel with the compression axis.

In preferred embodiments the cross-sectional shape of the compression element is substantially the same along its length. This cross-sectional shape need not be round, and indeed need not match the internal cross-sectional shape of the main body 2.

In some embodiments of the invention a series of compression elements, arranged end-to-end, may be used. It will be understood that this will allow a great deal of flexibility in controlling the pressure of fluid within an injector – at the manufacturing stage, a supply of generally half-length compression elements can be used. A first supply of compression elements may have a first relatively high elastic modulus, and the second supply of compression elements may have a second, relatively low elastic modulus. It will be understood that three different pressure levels can be achieved by using two first compression elements, two second compression elements, or one first compression element and one second compression element. By increasing the number of different types of half-length compression elements available, a wide range of different pressures may be achieved.

Three or more compression elements may also be used, arranged end-to-end.

It will be understood that flexibility of this nature would be very difficult to achieve using coil springs.

Suitable materials for the compression elements include silicone materials, including silicone rubber, but the skilled person will understand that other materials having similar properties may also be used with the invention.

It will be understood that embodiments of the invention provide robust and practical injectors, which will be useful in many different applications.

When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Claims:

1. A apparatus for ejecting a fluid substance, the apparatus comprising:
 - a housing having an internal cavity, the cavity having a first end and a second end;
 - a divider located within the cavity and between the first and second ends thereof, the divider dividing the cavity into first and second chambers;
 - an introduction arrangement for introducing fluid into the first chamber;
 - a compression element located in the second chamber, between the divider and the second end of the chamber, the compression element being of sufficient size that, when the divider is within a first distance from the second end of the housing, the compression element is placed under compression along a compression axis between the divider and the second end of the housing, the compression element taking the form of a substantially solid, elongate member formed from a resilient material, wherein the compression element has a first end and a second end and, in a substantially uncompressed state, occupies substantially every point along at least one axis that is parallel with the compression axis; and
 - an ejection arrangement to allow ejection of fluid from the first chamber out of the apparatus.
2. An apparatus according to claim 1 wherein the compression element takes the form of a substantially solid, elongate peripheral wall having a hollow internal core.
3. An apparatus according to claim 1 or 2 wherein the compression element is formed from a silicone material.
4. An apparatus according to any preceding claim wherein the introduction arrangement comprises a shaft passing through the second chamber.

5. An apparatus according to claim 4 wherein the compression element is formed at least partly around the shaft.
6. An apparatus according to any preceding claim wherein two or more compression elements are provided within the second chamber.
7. An apparatus according to claim 6 wherein the two compression elements are formed from materials having different elastic moduli.
8. An apparatus according to any preceding claim, wherein the ejection arrangement comprises a fluid conduit passing from the first chamber to a delivery nozzle.
9. An apparatus according to claim 8, wherein the ejection arrangement comprises an elongate delivery member with an egress aperture at or near its distal end.
10. An apparatus according to claim 9, wherein the elongate delivery member comprises a needle.
11. An apparatus according to claim 9 or 10, wherein the egress aperture is provided on a side surface of the elongate delivery member.
12. An apparatus according to any preceding claim, wherein the divider is coloured, or otherwise formed to be easy to identify visually, compared to surrounding components.
13. An apparatus according to any preceding claim wherein all or substantially all of the components making up the injector are recyclable.

14. A kit comprising an apparatus according to any preceding claim, along with at least further compression element, the or each further compression element being interchangeable with the compression element.
15. A kit according to claim 14, wherein the or each further compression element has a different elastic modulus, or is differently-sized in at least one dimension, to the compression element.
16. A kit according to claim 14 or 15, wherein the compression element and the or each further compression element has a visual identifier relating to its properties.
17. A kit according to claim 16, wherein the compression element and the or each further compression element is colour-coded.
18. A method of ejecting a fluid, comprising the steps of:
 - providing an apparatus according to any preceding claim;
 - introducing pressurised fluid into the first chamber via the introduction arrangement, so that the compression element is compressed; and
 - ejecting the fluid, via the ejection arrangement, at least partly through an ejection force exerted by the compression element.
19. An apparatus substantially as hereinbefore described, with reference to the accompanying drawings.
20. A method substantially as hereinbefore described, with reference to the accompanying drawings.