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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : E04G 23/02

A1

(11) International Publication Number: WO 00/57001

(43) International Publication Date: 28 September 2000 (28.09.00)

(21) International Application Number: PCT/SG99/00019

(22) International Filing Date: 19 March 1999 (19.03.99)

(71)(72) Applicant and Inventor: TAN, Kee, Chye, Felix [SG/SG]; Block 414, Tampines Street 41 #08–319, Singapore 520414 (SG).

(74) Agent: SPRUSON & FERGUSON PTE LTD; 51 Bras Basah Road, #02–03 Plaza By The Park, Singapore 189554 (SG).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

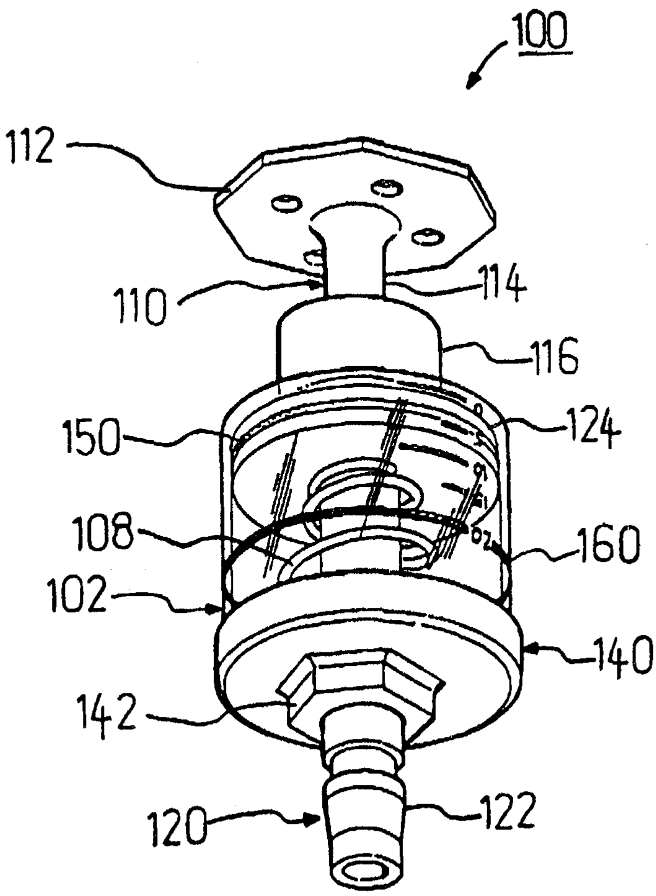
Published

With international search report.
With amended claims and statement.

(54) Title: CRACK INJECTOR SYSTEM

(57) Abstract

An apparatus (100) for injecting a fluid substance into a crack is disclosed. The apparatus (100) includes a housing (102) having an internal cavity. At least a portion of the housing (102) is at least partially transparent. The apparatus (100) also includes a substantially plate–like member (124) disposed within the internal cavity of the housing. The periphery of the plate–like member (124) contacts one or more internal surfaces of the housing defining the internal cavity. It also includes means for fluidly communicating the fluid substance between one side of the plate–like member and the crack. Further, the apparatus (100) has means for biasing the plate–like member in a first direction within the housing. The plate–like member and the biasing means are responsive to pressure created by the fluid substance in fluid communication with the crack and the plate–like member. The plate–like member is able to move in an opposite direction when the pressure exerted against the plate–like member exceeds a predetermined minimum pressure. Still further, at least a portion of the plate–like member is visible through the at least partially transparent portion of the housing to indicate the pressure exerted by the fluid substance against the plate–like member.



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CRACK INJECTOR SYSTEM

FIELD OF THE INVENTION

The invention relates to the field of crack repair of structures. In particular, the invention provides for the low-pressure injection of a crack repair substance into a crack above and including a predetermined minimum pressure and below and including a predetermined maximum pressure.

BACKGROUND

Buildings, bridges, tunnels, roads and facilities, water/sewerage works and facilities, port/harbour facilities and like structures undergo repair work everyday. One type of repair work that is constantly carried out is the repair of cracks formed in such structures. Since cracks can vary in magnitude and severity, from small hairline cracks in plaster walls to large faults in load-bearing structural elements, such as concrete columns or beams, it is imperative that the repair work is properly and correctly carried out. If the repair work is not properly and correctly carried out, adversities ranging from reduced aesthetics to safety hazards may occur.

Currently, a number of crack repair systems are commercially available. One such system is shown in Figs. 7 to 7F. A crack bond system 170 shown in Fig. 7 is assembled from several parts shown in Figs. 7A to 7F. Figure 7A shows a container holder 172 affixed to a close parallel container 178. The close parallel container 178 has an accordion-like collapsible wall or bellows-like section. A threaded body 184 with an injecting nozzle 182 and a non-return bulb 192, as shown in Fig. 7B, is screwed into the container holder 172, which has an aperture with internal threading (not shown) for mating engagement with the threaded body 184. The tip of a pump is required to be inserted into the injecting nozzle 182. The non-return bulb 192 is normally a ball restrained by webbing or a net and is disadvantageous because the ball frequently does not return to its proper position. The container 178 has a neck with external threading that is inserted into and projects through a hole in a push plate 194 shown in Fig. 7C. The projecting neck can be connected to a plug 200 shown in Figs. 7 and 7D. The plug 200 is affixed to the surface of the structure under repair for its crack. A biasing assembly of a nut 196, a bolt 198, and a spring 224, is shown in each of Figs. 7E and 7F. These biasing assemblies are used to bias the container holder 172 and the push plate 194 towards each other, when assembled as shown in Fig. 7.

The springs 224 in the biasing assemblies apply forces to collapse the accordion-like wall of the close parallel container 178 when the close parallel container 178 is empty. When the close parallel container 178 is injected with grout, a crack repair material for filling a crack, through the injecting nozzle 182, the accordion-like wall of the close parallel container 178 expands substantially in a lengthwise manner. When the accordion-like wall opens up, the container holder 172 and the push plate 194 are forced apart, resulting in compression of the springs 224. The springs 224 are compressed further when more grout is injected into the close parallel container 178. Compressive energy is stored in the springs 224.

While the crack bond system 170 provides for the repair of cracks in structures, it suffers from several disadvantages. From the foregoing description of the crack bond system 170, it is apparent that the internal surface of the accordion-like collapsible wall of the close parallel container 178 is capable of retaining residual grout. Also, the different springs 224 in the different biasing assemblies may have different properties and thus may store different amounts of compressive energy for the same amount of compression. Hence upon releasing the stored compressive energy, the extension in the different springs 224 may differ. Also, stronger springs are also normally heavier, and therefore because two springs are required the entire assembly becomes significantly heavier.

More importantly, however, the crack bond system 170 is unable to readily provide an accurate indication of the pressure of the grout injected into a crack under repair. Normally, a worker must visually gauge the length of the expanded close parallel container 178 and determine a pressure level equivalent to that displacement. Naturally, this is a highly imprecise pressure measurement mechanism and non-repeatability of accurate measurements is often encountered. In the field of crack repair, there are also conditions prescribed by relevant authorities under which crack repair must be carried out. One such condition is that the pressure of the injected grout must be more than or equal to a minimum prescribed pressure so that bubbles are not formed in the grout that fills the crack. Another such condition is that the pressure of the injected grout must also be less than or equal to a maximum prescribed pressure so that the crack will not be enlarged or deepened during the repair process. The system of Fig. 7 is disadvantageous in that any positive pressure is the minimum pressure with which the closed parallel container 178 begins to expand. Again, it is also only possible to determine a maximum pressure roughly by "eyeballing" the extension of the closed parallel container 178. Unfortunately, if too much pressure is exerted, grout can escape through the threading between the threaded body 184 screwed into the container holder 172. Consequently, excess pressure can lead to rupturing of and damage to the crack bond system.

Clearly, a need exists for an improved crack repair system for low-pressure injection of a fluid, adhesive system into a crack.

SUMMARY

Various aspects of the invention are directed to ameliorating or overcoming one or more disadvantages of conventional crack repair systems. In particular, the aspects of the invention are directed to addressing the disadvantages associated with conventional crack repair systems that do not provide an indication of the pressure with which crack repair substances are injected by conventional crack repair systems into cracks.

In accordance with a first aspect of the invention, there is an apparatus for injecting a fluid substance into a crack, the apparatus including: a housing having an internal cavity, at least a portion of the housing being at least partially transparent; a substantially plate-like member disposed within the internal cavity of the housing, the periphery of the plate-like member contacting one or more internal surfaces of the housing defining the internal cavity; means for fluidly communicating the fluid substance between one side of the plate-like member and the crack; and means for biasing the plate-like member in a first direction within the housing, the plate-like member and the biasing means being responsive to pressure created by the fluid substance in fluid communication with the crack and the plate-like member, the plate-like member able to move in an opposite direction when the pressure exerted against the plate-like member exceeds a predetermined minimum pressure, at least a portion of the plate-like member being visible through the at least partially transparent portion of the housing to indicate the pressure exerted by the fluid substance against the plate-like member.

In accordance with a second aspect of the invention, there is disclosed A method of injecting a fluid substance using a housing having an internal cavity and a plate-like member for filling a crack in a structure, the method including the steps of: communicating fluidly the fluid substance between one side of the plate-like member and the crack; biasing the plate-like member to provide pressure in response to pressure exerted by the fluid substance in fluid communication with the side of the plate-like member and the crack, wherein the plate-like member is displaced in an opposite direction when the pressure exerted by the fluid substance exceeds a predetermined minimum pressure; and indicating visually the pressure exerted by the fluid substance against the plate-like member.

BRIEF DESCRIPTION OF THE DRAWING

Embodiments of the invention are described hereinafter with reference to the drawings, in which:

Fig. 1 is a perspective view of a crack injector system according to a first embodiment of the invention;

Fig. 2 is an exploded perspective view of the crack injector system of Fig. 1;

Fig. 3 is an elevational view of the crack injector system of Fig. 1;

Fig. 4A is an elevational view of the cylindrical body and spring of the crack injector system of Fig. 1;

Fig. 4B is an elevational view of a plug and rubber washer of the crack injector system of Fig. 1;

Fig. 4C is an elevational view of the stem of the crack injector system of Fig. 1;

Fig. 4D is an elevational view of a lid-like cap of the crack injector system of Fig. 1;

Fig. 4E is a bottom plan view of the lid-like cap of Fig. 4D;

Fig. 4F is a cross-sectional view of the lid-like cap taken along line 4F in Fig. 4D.

Fig. 5A is an elevational view of the crack injector system of Fig. 1 in an initial state of use where the system is empty;

Fig. 5B is an elevational view of the crack injector system of Fig. 1 partially filled with epoxy in used;

Fig. 6 is an elevational view of a non-return valve used in the crack injector system of Fig. 1; and

Fig.7 is a perspective view of a conventional crack injector system.

Fig. 7A-7B are perspective views of parts when assembled form the conventional crack injector system of Fig. 7.

DETAILED DESCRIPTION

A method and an apparatus for repairing cracks in structures are described hereinafter. In the following description, numerous specific details, such as the construction and shape of structures like a cap or a plug, are described in detail in order to provide a more thorough description of the present invention. It will be apparent, however, to one skilled in the art, that the present invention may be practiced without these specific details. In other instances, well-known features or structures, for example a coil-spring, are not described in detail so as not to unnecessarily obscure the invention.

The embodiment of the invention described hereinafter provides an apparatus for low pressure and low speed injection of a crack repair substance, grouting material, or other fluid adhesive substance into a crack in a structure. The crack injector system maintains pressure of the grouting material, preferably an epoxy resin, at a minimum of preferably 1 kgf/cm^2 and a maximum of preferably 3kgf/cm^2. The crack injector system when fully filled with epoxy resin, ejects the epoxy resin with the maximum pressure of 3 kgf/cm^2 into the crack and has a capacity of preferably 53 cc when fully filled with epoxy resin (see Table 1).

Table 1

Spring Extension (mm)	Pressure (kgf/cm^2)	Quantity (cc)
1	1.1	2.6
3	1.3	7.8
5	1.5	13.2
7	1.7	15.8
10	2.0	26.5
13	2.3	34.3
15	2.5	39.7
20	3.0	53.0

The crack injector system can be used for structural/non-structural crack repair of structures such as buildings, bridges and tunnels, roads and facilities, etc. In addition, the apparatus permits the use of both low and high viscosity grouting materials for finer and larger cracks, respectively. The crack injector system can be used with a grease-pump type device, foot pump, or similar device to low-pressure inject the epoxy resin.

Figs. 1-3 are perspective, exploded perspective, and elevational views of the crack injector system 100. The crack injector system 100 is an assembly of six parts. It includes a pusher 120, a lid-like cap 140, a cylindrical member 102, a coil spring 108, a plug 110 and a non-return valve 130. The dimensions of the crack injector system 100 are preferably 105 mm in length and 48 mm in diameter. The coil-spring 108 is coiled around the pusher 120 and disposed in the cavity of the cylindrical body 102. Epoxy resin or the like can be pumped through a cavity 128 of the pusher 120, which ejects the epoxy resin into a crack of a structure via the centre aperture of the plug 110. The non-return valve 130 is preferably made of a rubbery material and has a radially protruding ridge at the tip, which prevents the leakage or back flow of the epoxy resin, grouting or like material into the cavity 128.

Fig. 4A is an elevational view of the cylindrical member 102. The transparent cylindrical member 102, which is preferably transparent, has a cylindrical body 104. The cylindrical body 104 has an orifice at one end and an annular bottom with a central aperture at the other end defining an internal cavity. The cylindrical body 104 also has graduated markings 160 along the surface of its body for indicating the pressure of the grouting material within the crack. Preferably, the markings directly indicate the displacement of a plate in mm. Preferably, the body 104 also has a band marked circumferentially on its outer surface for indicating a desired maximum pressure level. The cylindrical member 102 also has a neck or skirt 106 with external threading that depends from the annular bottom of the cylindrical body 104. The neck 106 is integrally formed with the cylindrical member 102 and is preferably made of a rigid, largely transparent material, such as hardened plastic.

Fig. 4B is an elevational view of the plug 110 and an annular washer 118, the latter being preferably made of rubber. The plug 110 has a plate-like base 112, which is preferably octagonally shaped and substantially flat with an aperture in the center. Plug stem 114 extends between the base 112 and a cylindrical cap 116 of the plug 110. The stem 114 also has a cylindrical cavity formed lengthwise through the stem's center, which preferably has lengthwise ribs (not shown) protruding into the cylindrical cavity. The cylindrical cap 116 has internal threading, which can be matingly engaged with the external threading of the neck 106. The cap 116 also has an open orifice at one end and an annular bottom at the other. The plug 110 is made of a rigid material, preferably plastic. A rubber washer 118 can rest on the annular bottom of the cap 116 and provide a seal between the cap 116 and the neck 106 of the cylindrical body 104.

Fig. 4C is an elevational view of the pusher 120. The pusher 120 has an elongated, cylindrical stem 122. The cylindrical stem 122 has a band-like groove formed circumferentially on its external surface and proximal to one end. It also has a frustum shaped portion formed between the one end of the cylindrical stem 122 and the band-like groove. The frustum portion and groove form a tip or nipple for "clip-on" connection with a nozzle, preferably a flexible one, of a pump for pumping epoxy or other fluid substance. This permits easy connection and removal of pump fittings from the injector system 100. The cavity 128 of the elongated stem 122 is cylindrical and has a diameter slightly larger at the end opposite the nipple for housing a non-return valve 130. A disc-like plate 124 extends radially from the stem 122 and is proximal to the end of the stem having the enlarged portion of the cavity 128. The plate 124 is formed integrally and concentrically with the stem 122. The outer peripheral edge of the plate 124 has an annular groove 126 for receiving an O-ring 126. The O-ring 126 is preferably made of a rubbery material. The pusher 120 is made of a rigid material, which is preferably hardened plastic.

Fig. 4D is an elevational view of the lid-like cap 140 of the crack injector system 100. The lid-like cap 140 has a flat upper surface and a ring-like outer skirt depending from the upper surface and concentrically aligned with a smaller diameter inner skirt that depends from a bottom surface of the cap 140. The inner and outer skirts 144 and 146 (shown in a bottom plan view in Fig. 4E and in cross-sectional view in Fig. 4F) thereby form an annular groove 148, which can receive the circular edge of the orifice of the cylindrical body 104. The lid-like cap 140 also has a circular aperture formed through the centre of the cap 140. An epoxy can be placed in the groove to fasten the cylindrical body 104 and cap 140 together. A hexagonal housing 142 is integrally formed with the upper-surface of the lid-like cap 140 and has a central circular cavity. The circular cavity extends through the centre of the hexagonal housing 142 and the cap 140 and permits reciprocal engagement between the cap 140 and the housing 142 on the one hand and the elongated cylindrical stem 122 on the other. The cap 140 and the housing 142 are made of a rigid material, preferably hardened plastic.

Fig. 6 is an elevational view of the non-return valve 130. The non-return valve 130 has a conical portion 130A at one end forming a radially protruding ridge. The conical portion 130A is followed immediately by a frustum portion 130B forming a second radially protruding ridge displaced from it. The frustum portion 130B is then followed by tapered mid-section 130C, and the non-return valve ends with a largely cylindrical portion 130D. The cylindrical portion 130D has four lengthwise grooves formed therein to provide four lengthwise outwardly protruding ribs between which epoxy can flow.

The crack injector system 100 is described hereinafter in greater detail with reference to Fig. 3. When the crack injector system 100 is assembled, the end of the elongated stem 122 having the disc-like plate 124 is disposed in the internal chamber or cavity of the cylindrical body 104 through its orifice. The O-ring 150 is disposed in the annular groove 126 of the plate 124 to provide a seal between the plate 124 and the internal surface of the cylindrical body 104 in its rest position. The plate 124 is preferably displaced from the end of the stem 122 opposite the nipple so that the end of the stem 122 opposite the nipple fits in the internal cavity of the neck 106 and the plate is near, or more preferably directly contacts, the annular bottom of the cylindrical body 104. The non-return valve 130 is disposed in the enlarged portion of the cavity 128 at the end of the elongated stem 122 opposite the nipple.

When inserted into the stem 128, a pin (not shown) can be passed through opposite holes in the stem 128 to hold the valve 130 in place within the stem 128. The coil-spring 108 is coiled around the longer portion of the pusher 120 on the opposite side of the plate and located in the cavity of the cylindrical body 104. The lid-like cap 140 inter-engages and is affixed to the cylindrical body 104 to enclose the coil spring 108 between the plate 124 and the bottom surface of the cap 140 with the cylindrical member 102. Preferably, the coil spring 108 is compressed enough to keep the plate 124 firmly pressed against the annular bottom surface of the cylindrical body 104 in the system's rest position. The external thread of the neck 106 of the cylindrical member 102 can be screwed into the cylindrical cap 116 of the plug 110.

Figs. 5A and 5B are elevational views of the crack injector system 100 in an initial state of use where the crack injector system 100 is empty and when the crack injector system 100 is partially filled with epoxy resin in use, respectively. To fill a crack with the epoxy resin or the like, a pump for injecting the substance is connected to the tip or nipple formed by the frustum and groove portions of the cylindrical stem 122. Specifically, the nozzle of the pump engages or clips on the tip or nipple of the cylindrical stem 122, and the epoxy resin is pumped into the cylindrical cavity 128 using well-known methods. The tip of the stem 122 allows manpower reduction.While the epoxy resin is pumped into the cylindrical cavity 128, the epoxy resin flows along the length of the cylindrical cavity 128 and over the portions 130A, 130B, 130C, and 130D of the non-return valve 130.

The epoxy resin first flows into and fills up the cylindrical cavity of the plug stem 114. Since the cylindrical cavity of the plug stem 114 is in fluid communication with the crack under repair, the epoxy resin also flows into the crack. Resistance or opposition to the flow of epoxy resin into the crack builds up pressure in the epoxy resin in the crack. Consequently, this pressure is transferred to the epoxy resin within the cylindrical cavity of the plug stem 114. This pressure is countered by a back pressure formed at the end of the stem 122 fitted into the internal cavity of the neck 106 by the coil-spring 108 biasing the plate 124 toward the crack. When this pressure exceeds the back pressure provided by the end of the stem 122 fitted into the internal cavity of the neck 106, the entire pusher 120 is pushed away from the epoxy resin building up in the cylindrical cavity of the plug stem 114. At this point, the pressure in the epoxy resin reaches a predetermined minimum pressure, preferably 1 kgf/cm^2. When the entire pusher 120 is pushed away bythe epoxy resin and more epoxy resin is pumped into the cylindrical cavity 128, the epoxy resin starts to fill up the neck 106. While the end of the stem 122 is continuously displaced from the neck 106, the stem 122 disengages from the neck 106 at a particular point. At this point, the epoxy resin starts to flow into the cavity of the cylindrical body 104. The pressure exerted by the increasing volume of epoxy resin then acts on the inner surfaces of the cylindrical body 104 and in particular the plate 124. The surface of the plate 124 in contact with the epoxy resin also develops a back pressure as such. While the pressure of the epoxy resin flowing into the cavity of the cylindrical body 104 continues to exceed that of the back pressure created by the coil-spring 108, the plate 124 is pushed rearwardly by the epoxy resin. The plate 124 compresses and therefore loads the coil spring 108.

The pressure of the epoxy resin flowing into the cavity of the cylindrical body 104 also acts on the non-return valve 130 in a direction against the flow of the epoxy resin over the non-return valve 130. Due to the construction of the non-return valve 130 and the internal chamber 128, the back flow of epoxy resin is unable to overcome the back pressure provided by both the frustum portion 130B and the conical portion 130A.

When the cavity of the cylindrical body 104 is filled with sufficient epoxy resin (shown in Fig. 5B) to a desired level, preferably 3 kgf/cm^2 or 20 mm, the introduction of the epoxy resin is stopped. Advantageously, the pressure of the epoxy resin within the crack can be visually checked in an accurate manner using the graduated markings 160 as described in the foregoing. That is, the position of the plate 124 within the cavity of the cylindrical body 104 relative to the fixed markings on the cylindrical body 104 indicates the pressure of the epoxy resin in the crack. It can also be used to determine the quantity of epoxy resin.

When the epoxy resin stops flowing into the cavity of the cylindrical body 104, the plate 124, biased by the loaded coil spring 108, starts to exert a pressure on the epoxy resin in the cavity of the cylindrical body 104. This pressure acts to eject the epoxy resin from the cavity of the cylindrical body 104 through the cylindrical cavity of the plug stem 114 into the opening of the crack. As the self-injection system 100 is constructed to generate a predetermined minimum pressure, preferably 1 $kgf/cm^{2,}$ and a maximum pressure, preferably 3$kgf/cm^{2,}$ on the epoxy resin, the epoxy resin is hence ejected by a pressure within this range dependent upon the viscosity of the epoxy resin and its curing or hardening time rate. Also, since the plate 124 continuously exerts the pressure on the epoxy resin without any intervention until the predetermined minimum threshold pressure of 1 kgf/cm^2 is reached, the ejection of the epoxy resin ensures that a predetermined minimum pressure is produced in the crack. A further advantage of this invention is that the pressure within the system can be easily determined, ensuring that a user can accurately determine the pressure and prevent rupture or damage to the system.

In the forgoing manner, an apparatus and a method for repairing cracks in structures are disclosed. However, it will be apparent to one skilled in the art in view of this disclosure that numerous changes and/or modifications can be made without departing from the scope and spirit of the invention.

CLAIMS

1. An apparatus for injecting a fluid substance into a crack, said apparatus including:

a housing having an internal cavity, at least a portion of said housing being at least partially transparent;

a substantially plate-like member disposed within said internal cavity of said housing, the periphery of said plate-like member contacting one or more internal surfaces of said housing defining said internal cavity;

means for fluidly communicating said fluid substance between one side of said plate-like member and said crack; and

means for biasing said plate-like member in a first direction within said housing, said plate-like member and said biasing means being responsive to pressure created by said fluid substance in fluid communication with said crack and said plate-like member, said plate-like member able to move in an opposite direction when said pressure exerted against said plate-like member exceeds a predetermined minimum pressure, at least a portion of said plate-like member being visible through said at least partially transparent portion of said housing to indicate said pressure exerted by said fluid substance against said plate-like member.

2. The apparatus according to claim 1, wherein said communicating means includes a valve for controlling flow of said fluid substance in one direction.

3. The apparatus according to claim 2, wherein said at least partially transparent portion of said housing includes graduated markings for visually indicating said pressure exerted by said fluid substance against said plate-like member.

4. The apparatus according to claim 3, wherein said biasing means includes a coil-spring.

5. The apparatus according to claim 4, wherein said communicating means includes an elongated member having an internal cavity, said elongated member being coupled to said plate-like member and said valve being housed in said internal cavity.

6. The apparatus according to claim 5, wherein said graduated markings further include a substantially calibrated range of indication for indicating said pressure exerted by said fluid substance, said range being between and including 1kgf/cm^2 and 3kgf/cm^2 and said predetermined minimum pressure being 1kgf/cm^2.

7. The apparatus according to claim 6, wherein said graduated markings further include substantially calibrated range of indication for indicating the volume of said internal cavity of said housing, said range being between 2.6 cc to 53cc.

8. A method of injecting a fluid substance using a housing having an internal cavity and a plate-like member for filling a crack in a structure, said method including the steps of:

communicating fluidly said fluid substance between one side of said plate-like member and said crack;

biasing said plate-like member to provide pressure in response to pressure exerted by said fluid substance in fluid communication with said side of said plate-like member and said crack, wherein said plate-like member is displaced in an opposite direction when said pressure exerted by said fluid substance exceeds a predetermined minimum pressure; and

indicating visually said pressure exerted by said fluid substance against said plate-like member.

9. The method according to claim 8, wherein the biasing step includes the step of biasing said plate-like member using a spring.

10. The method according to claim 9, wherein the indicating step includes the step of using a partially transparent material to form at least a portion of said housing so that said plate-like member is visible through said at least partially transparent portion of said housing to indicate said pressure exerted by said fluid substance against said plate-like member.

11. The method according to claim 10, wherein the indicating step further includes the step of providing said at least partially transparent portion of said housing with graduated markings, at least one of said graduating markings indicating said predetermined minimum pressure.

AMENDED CLAIMS

[received by the International Bureau on 18 February 2000 (18.02.00); original claim 2 cancelled; original claims 1 and 8 amended; other claims unchanged (2 pages)]

1. An apparatus for injecting a fluid substance into a crack, said apparatus including:

a housing having an internal cavity, at least a portion of said housing being at least partially transparent;

a substantially plate-like member disposed within said internal cavity of said housing, the periphery of said plate-like member contacting one or more internal surfaces of said housing defining said internal cavity;

means for fluidly communicating said fluid substance between one side of said plate-like member and said crack, said communicating means includes a valve for controlling flow of said fluid substance in one direction; and

means for biasing said plate-like member in a first direction within said housing, said plate-like member and said biasing means being responsive to pressure created by said fluid substance in fluid communication with said crack and said plate-like member, said plate-like member able to move in an opposite direction when said pressure exerted against said plate-like member exceeds a predetermined minimum pressure, at least a portion of said plate-like member being visible through said at least partially transparent portion of said housing to indicate said pressure exerted by said fluid substance against said plate-like member.

2. (Cancelled)

3. The apparatus according to claim 1, wherein said at least partially transparent portion of said housing includes graduated markings for visually indicating said pressure exerted by said fluid substance against said plate-like member.

4. The apparatus according to claim 3, wherein said biasing means includes a coil-spring.

5. The apparatus according to claim 4, wherein said communicating means includes an elongated member having an internal cavity, said elongated member being coupled to said plate-like member and said valve being housed in said internal cavity.

6. The apparatus according to claim 5, wherein said graduated markings further include a substantially calibrated range of indication for indicating said pressure exerted by said fluid substance, said range being between and including 1kgf/cm^2 and 3kgf/cm^2 and said predetermined minimum pressure being 1kgf/cm^2.

7. The apparatus according to claim 6, wherein said graduated markings further include substantially calibrated range of indication for indicating the volume of said internal cavity of said housing, said range being between 2.6 cc to 53cc.

8. A method of injecting a fluid substance using a housing having an internal cavity and a plate-like member for filling a crack in a structure, said method including the steps of:

communicating fluidly said fluid substance between one side of said plate-like member and said crack;

controlling, with a valve, flow of said fluid substance in one direction;

biasing said plate-like member to provide pressure in response to pressure exerted by said fluid substance in fluid communication with said side of said plate-like member and said crack, wherein said plate-like member is displaced in an opposite direction when said pressure exerted by said fluid substance exceeds a predetermined minimum pressure; and

indicating visually said pressure exerted by said fluid substance against said plate-like member.

9. The method according to claim 8, wherein the biasing step includes the step of biasing said plate-like member using a spring.

STATEMENT UNDER ARTICLE 19(1)

With regard to International (PCT) Patent Application No. PCT/SG99/00019, Applicant submits that no new matter has been added to the Claims with new pages 14 and 15.

Amending Claim 1 by including the valve and amending Claim 8 by including the step of controlling are both supported by the specification and the drawings as originally filed for the above patent application. Claim 3 has only been amended to depend on amended Claim 1 instead of original Claim 2 because of cancellation of original Claim 2.

Applicant submits that no changes have been made to the specification and the drawings by amendment of Claims 1 and 8 and cancellation of Claim 2 in new pages 14 and 15.

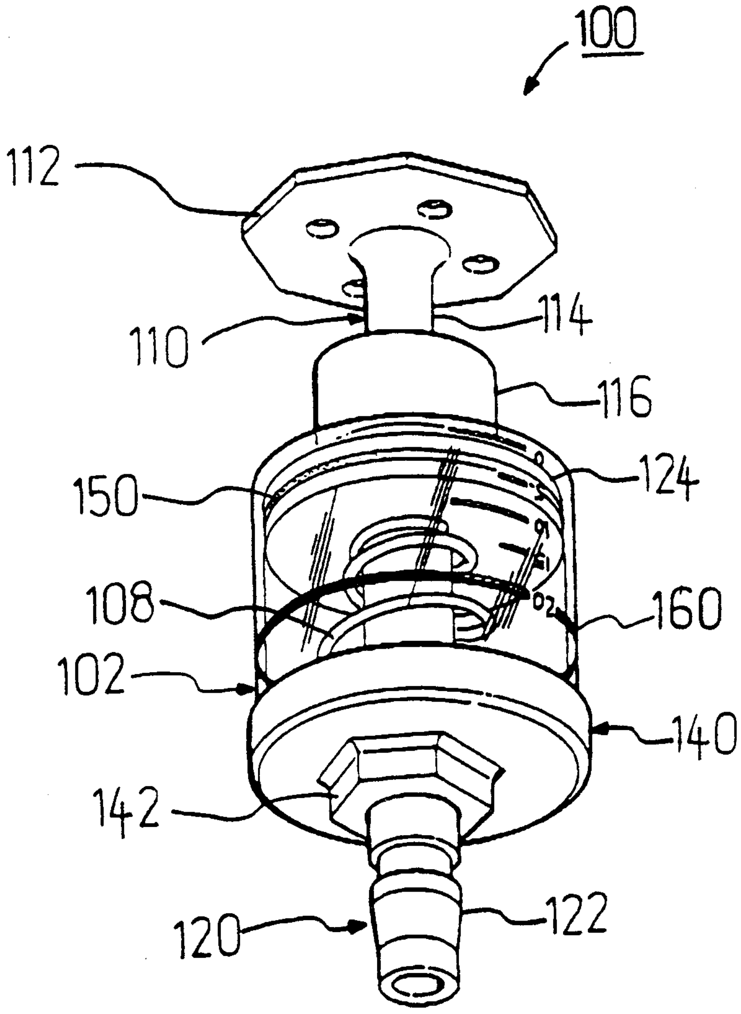

FIG. 1

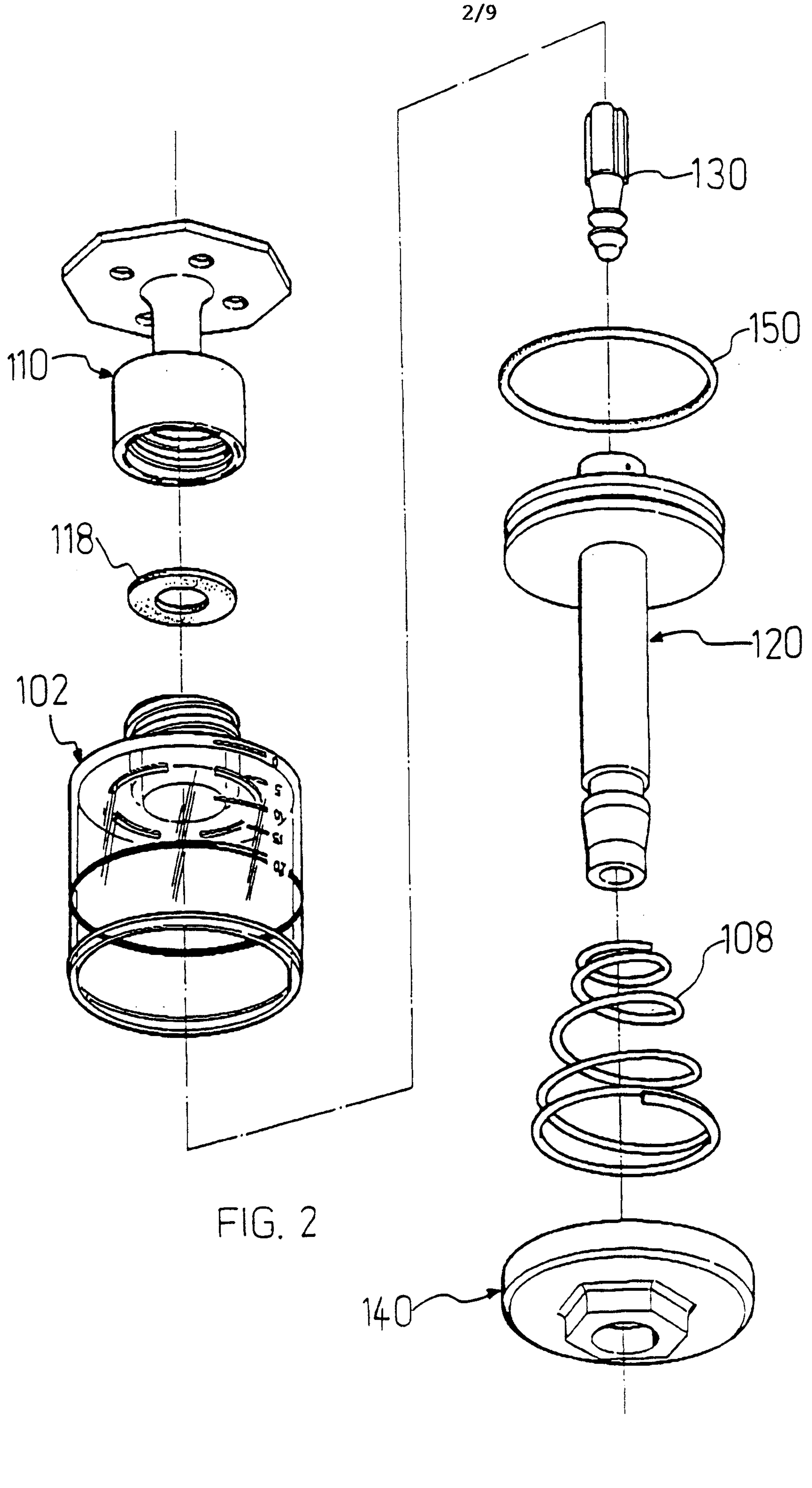

FIG. 2

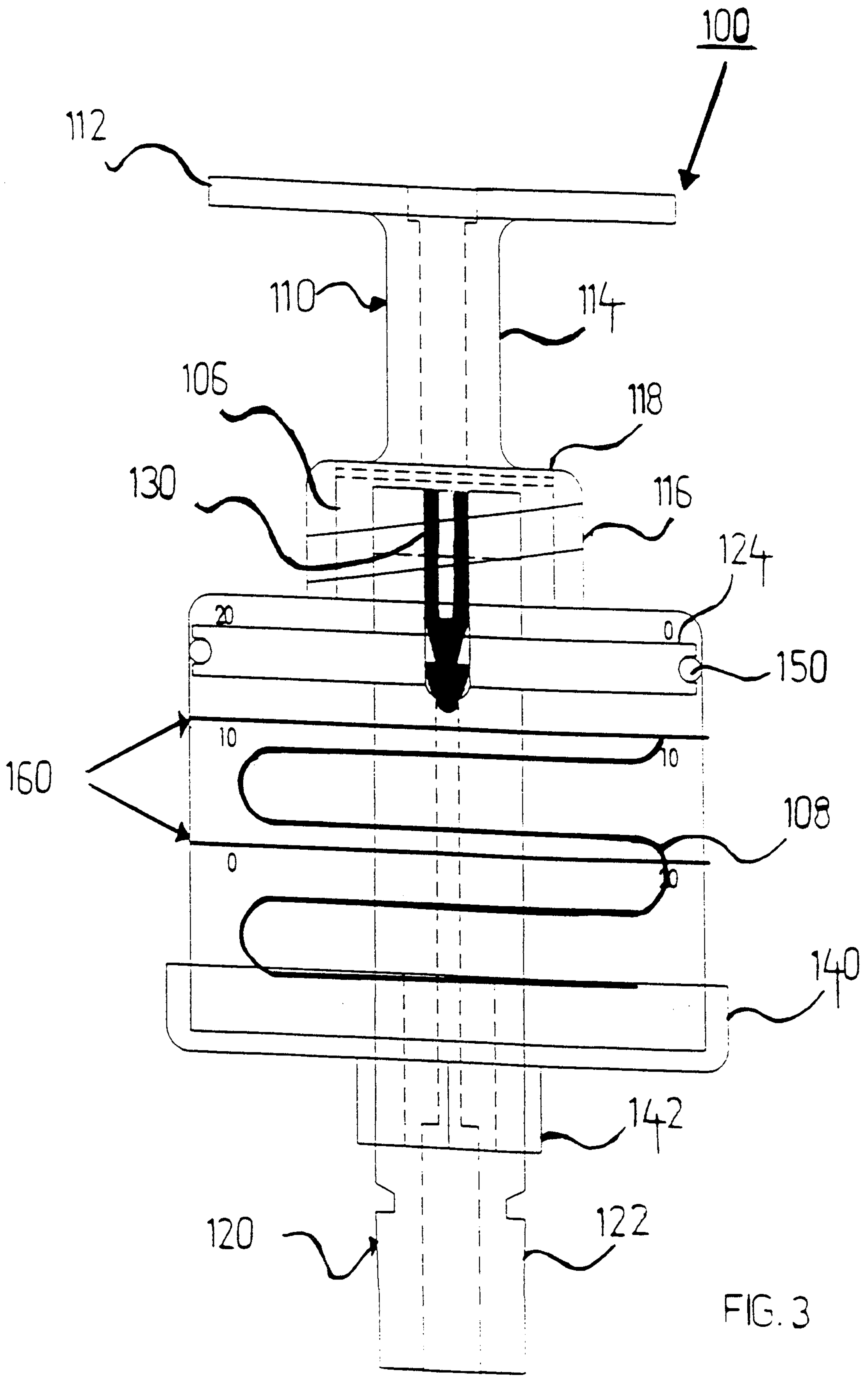
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FIG. 3

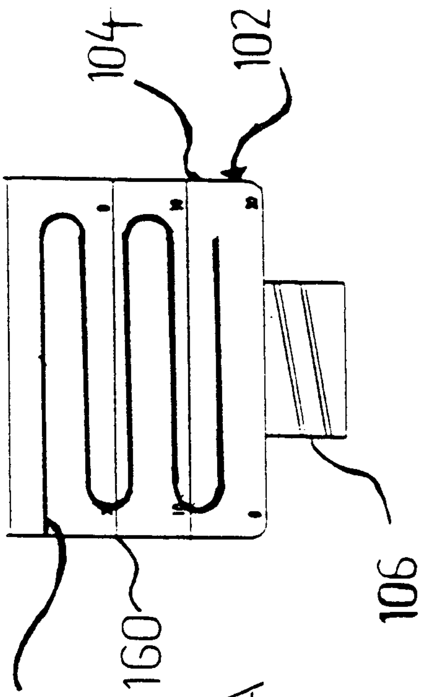

FIG. 4A

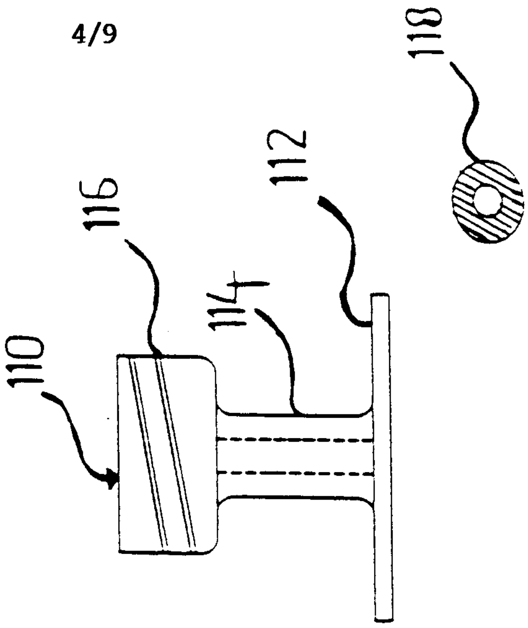

FIG. 4B

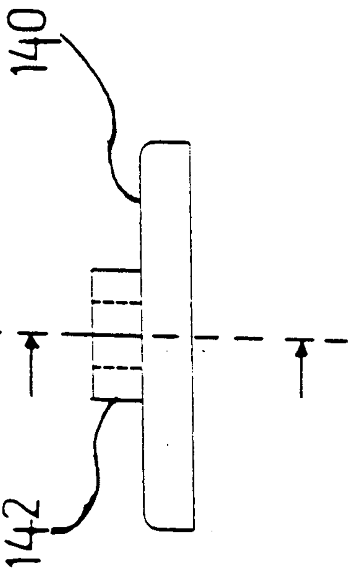

FIG. 4D

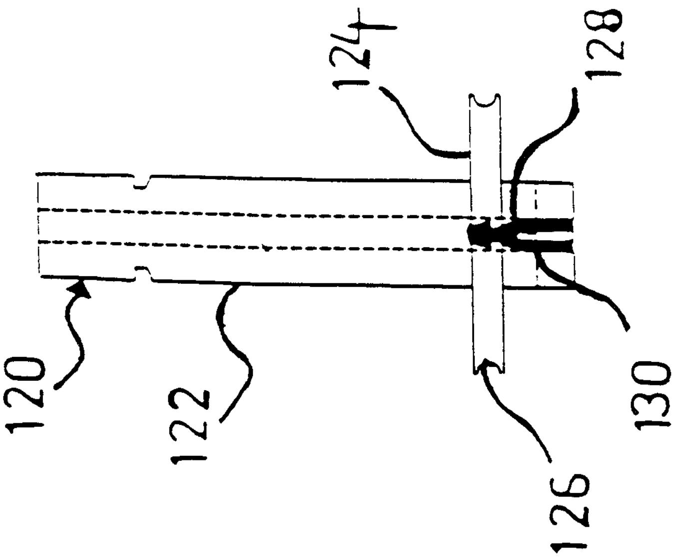

FIG. 4C

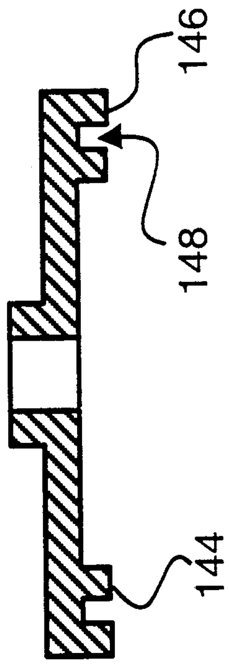

Fig. 4F

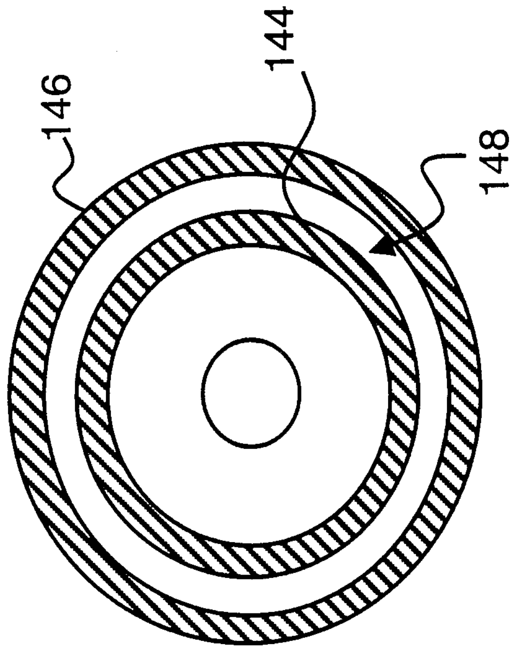

Fig. 4E

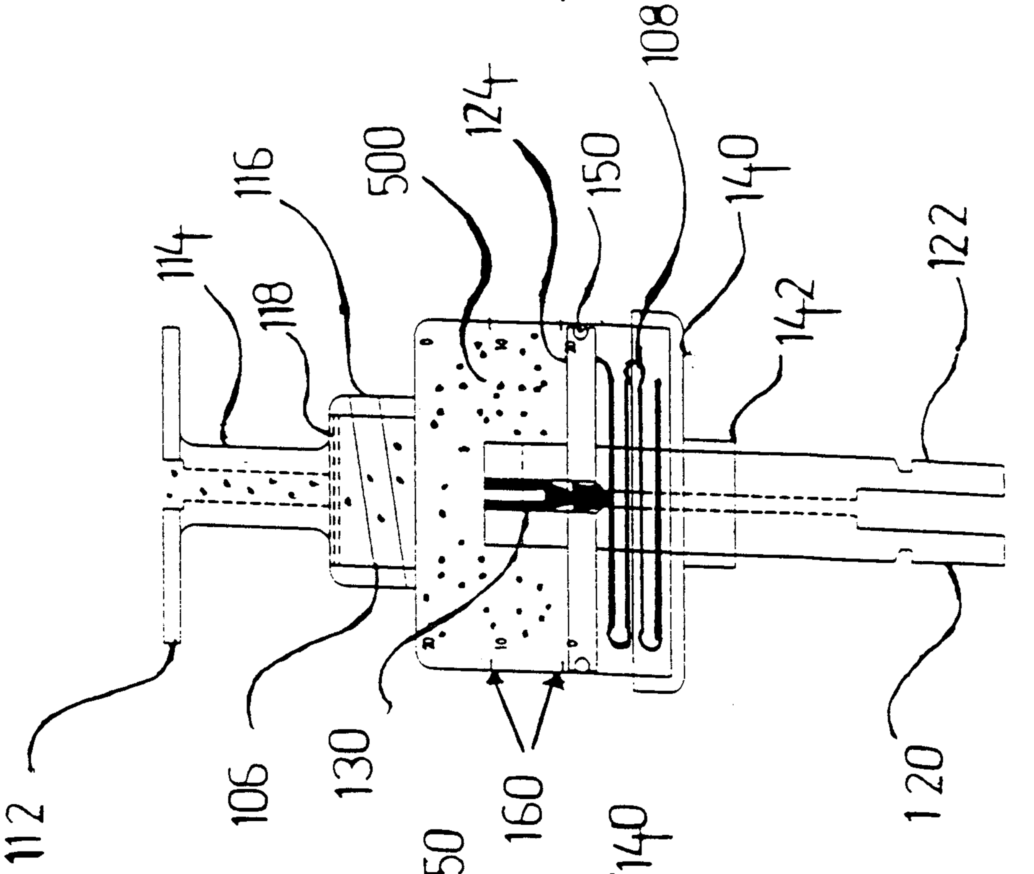
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FIG. 5B

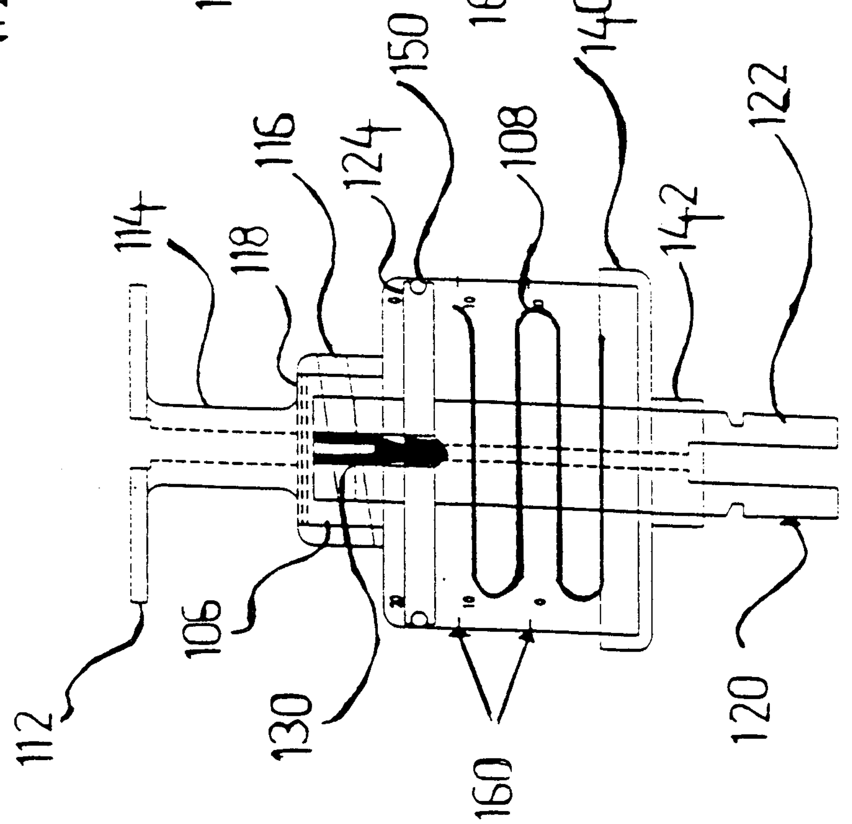
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FIG. 5A

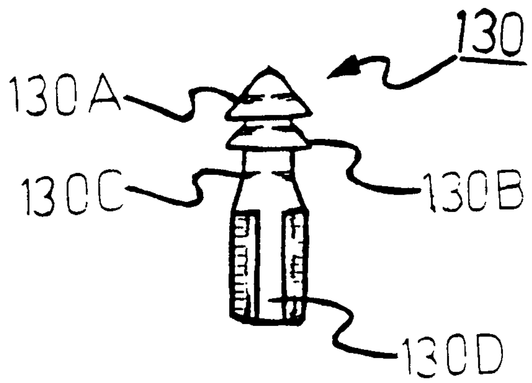

FIG. 6

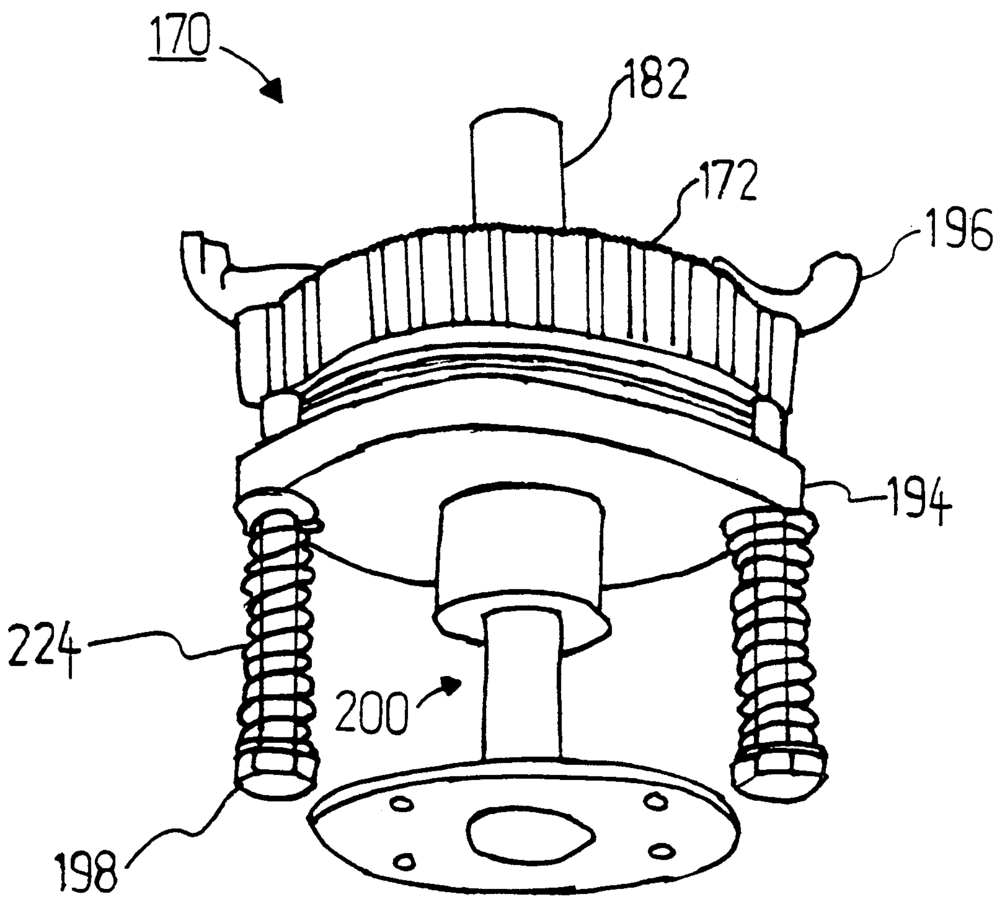

Fig. 7

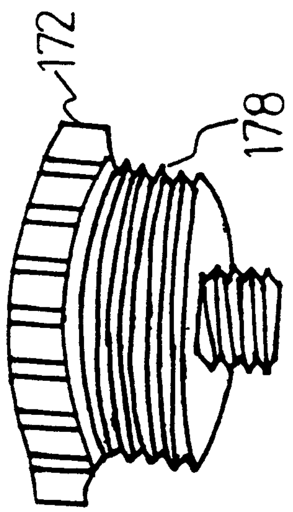

Fig. 7A

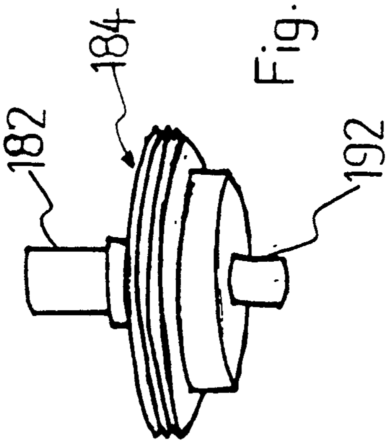

Fig. 7B

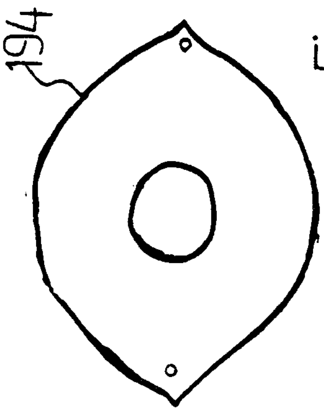

Fig. 7C

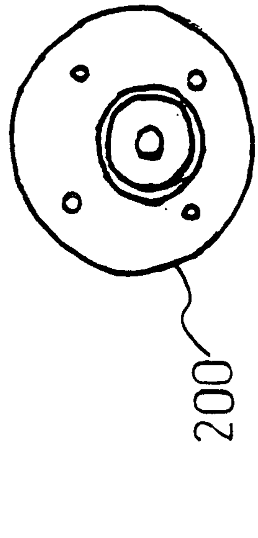

Fig. 7D

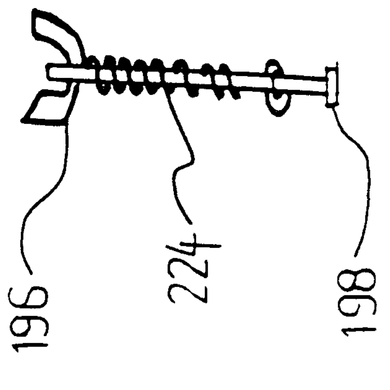

Fig. 7E

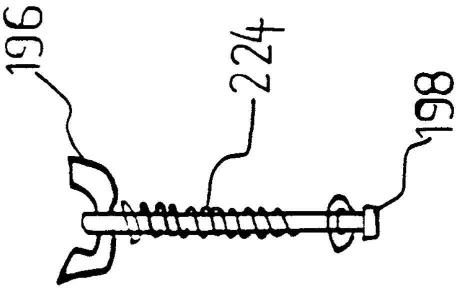

Fig. 7F

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG 99/00019

A. CLASSIFICATION OF SUBJECT MATTER

IPC[7]: E 04 G 23/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[7]: A 61 M; B 65 D; E 04 F; E 04 G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4612010 A (HAMACHER) 16 September 1986 (16.09.86) fig. 1-3, column 4, line 27.	1,3,4,8,9,10,11
A X	GB 2153443 A (L'OREAL) 21 August 1985 (21.08.85) fig.1, 3.	1,3,8,10,11, 4,9
X	GB 1568283 A (METATECH) 29 May 1980 (29.05.80) fig. 6, 2, 3, page 3, lines 2-4.	1,3,4,8,9,10,11
A	GB 1402428 A (PFIZER) 06 August 1975 (06.08.75) fig. 1, 2.	1-11
A	US 4758233 A (PHILLIPS) 19 July 1988 (19.07.88) fig. 1, 3A, 3B.	1-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
„A" document defining the general state of the art which is not considered to be of particular relevance
„E" earlier application or patent but published on or after the international filing date
„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)
„O" document referring to an oral disclosure, use, exhibition or other means
„P" document published prior to the international filing date but later than the priority date claimed
„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
„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
„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
„&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 November 1999 (19.11.99)	21 December 1999 (21.12.99)

Name and mailing adress of the ISA/AT	Authorized officer
Austrian Patent Office Kohlmarkt 8-10; A-1014 Vienna Facsimile No. 1/53424/200	Glaunach Telephone No. 1/53424/342

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SG 99/00019

Im Recherchenbericht angeführtes Patentdokument Patent document cited in search report Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung Publication date Date de publication	Mitglied(er) der Patentfamilie Patent family member(s) Membre(s) de la famille de brevets	Datum der Veröffentlichung Publication date Date de publication
US A 4612010	16-09-1986	keine - none - rien	
GB A 2153443		BE A1 901579	25-07-1985
		CH A 661489	31-07-1987
		DE A1 3502520	01-08-1985
		FR A1 2558801	02-08-1985
		FR B1 2558801	03-10-1986
		GB A0 8500830	20-02-1985
		GB A1 2153443	21-08-1985
		GB B2 2153443	25-03-1987
		IT A0 8567073	25-01-1985
		IT U0 8552901	25-01-1985
		IT A 1182382	05-10-1987
		US A 4664299	12-05-1987
GB A 1568283	29-05-1980	DE A1 2714818	27-10-1977
		FR A1 2347058	04-11-1977
		JP A2 52151287	15-12-1977
		US A 4064879	27-12-1977
GB A 1402428	06-08-1975	IE B 37614	31-08-1977
US A 4758233	19-07-1988	AU A1 71870/87	29-10-1987
		AU B2 586553	13-07-1989
		DE A1 3713508	05-11-1987
		DE C2 3713508	01-06-1995
		GB A0 8709431	28-05-1987
		GB A1 2189396	28-10-1987
		GB B2 2189396	17-10-1990
		NZ A 220053	28-06-1989