

(19)



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(11)

EP 0 811 736 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

03.09.2003 Bulletin 2003/36

(51) Int Cl.7: **E04G 23/02**

(21) Application number: **97303835.9**

(22) Date of filing: **04.06.1997**

(54) **Reinforcement of masonry structures**

Armierung von Mauerwerk

Armature de maçonnerie

(84) Designated Contracting States:
AT BE DE FR GR IE IT

(30) Priority: **04.06.1996 GB 9611641**

(43) Date of publication of application:
10.12.1997 Bulletin 1997/50

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EP 0 811 736 B1

Description

Field of the Invention

[0001] The invention relates to a method of reinforcing a masonry structure such as a solid wall, cavity wall, arch, bridge, chimney or viaduct, and to a reinforcement for use in such a method.

Background Art

[0002] Masonry and like materials are generally strong in compression but weak in tension and are therefore used in structures where there is substantially no tensile loading. For example, masonry is appropriate for the construction of buildings where the forces are essentially vertical and compressive. It is necessary however to provide beams in the form of lintels over doors, windows and other openings.

[0003] Buildings and other masonry structures may suffer damage from a variety of structural failures, both above and below ground level, for example lintel failure, subsidence, thermal movement, differential movement, physical damage and design faults. This can cause a loss of support in some areas and result in tensile forces within the masonry. As the masonry is unable to withstand the tensile forces, cracks will form above the unsupported areas.

[0004] There have been a number of proposals for repairing and supporting masonry structures and most of these methods involve cutting into the external face of a wall to form a groove into which a reinforcement is inserted. The reinforcement usually consists of a bar or reinforcement of steel or similar material strong in tension. The rod or bar may be circular or rectangular in cross section and may include ridges or have a roughened surface to help retain it in a bonding material (EP-A-0 494 099).

[0005] The reinforcement is glued or bonded into position with resin cementitious mortars, wedges, plastic bonding agents or similar substances. This allows the tensile qualities of the reinforcement to be transferred to the masonry. This provides tensile restraint of the masonry, and may be used to provide a composite masonry/reinforcement beam which acts to support or transfer loads imposed upon it.

[0006] When reinforcing existing masonry structures, a hole or groove is cut to accommodate the reinforcement. Particularly in older masonry structures, the width of the groove may deviate from the desired dimensions, or may not be uniform.

The Invention

[0007] According to one aspect of the invention there is provided a reinforcement for insertion into a slot, groove or hole in a masonry structure, the reinforcement including a central elongate core and a plurality of spac-

ers on the central core for holding the central core away from the edges of the slot, groove or hole, wherein each spacer includes one or more projections extending radially outwards from the central core, the projections being positioned such that when the reinforcement is oriented horizontally its maximum vertical extent varies as it is twisted about its axis.

[0008] The projections may be relatively sharp such that they tend to snag against the edges of the slot, groove or hole, thus keeping the reinforcement firmly in place.

[0009] The spacers may consist of pieces of wire, which may be stainless steel, twisted around the central core such that the ends of the wire form projecting tails.

In this embodiment, the reinforcement may be twisted until it is tightly positioned in any of a number of grooves of varying thicknesses. For example, each spacer may include two projections approximately diametrically opposed to one another. When the reinforcement is to be inserted into a relatively narrow horizontal groove, it is positioned such that the projections extend horizontally away from the central core. When the reinforcement is to be inserted in a relatively wide horizontal groove, it is positioned such that the projections extend vertically. The reinforcement can be twisted by a varying amount depending on the thickness of the groove, such that the reinforcement is always held firmly within the groove. Although the above explanation refers to horizontal reinforcements, the principle is of course equally applicable to reinforcements located at any angle.

[0010] Alternatively, the reinforcement may include spacers having three, four or more projections located around the perimeter of the central core, to ensure that the core always lies away from the edge of a slot, groove or hole.

[0011] The central core may be solid or hollow, of straight or twisted shape, and may have a roughened or ridged surface to increase adhesion between the central core and a bonding material.

[0012] Because the reinforcement is held firmly in place, parts of the reinforcement are prevented from springing out of the groove as other parts are inserted into the groove. This has been found by the inventor to be a problem, particularly on corners or curved surfaces such as the intrados of an arched bridge or a round chimney or tank.

[0013] Further tests carried out by the inventor to establish the degree of bond between steel and masonry show that bonding material must be distributed evenly around the reinforcement and that bars lying on the bottom of the groove and not surrounded by bonding mortar will fail at relatively low tension levels. According to the invention bars can be held by the spacers away from the bottom of the groove thus overcoming this problem.

[0014] If the groove is too tight, the reinforcement may also be damaged as it is forced into the groove. The invention overcomes this problem as it is only the spacers which contact the edges of the groove.

[0015] When cutting grooves in masonry structures, a weakness is created in the wall, undermining its stability. The spacers of a reinforcement according to the invention mitigate this effect.

[0016] A further advantage of the spacers is that they increase the bonding force in a direction along the length of the reinforcement. They engage the bonding material and make it much more difficult to pull the reinforcement longitudinally out of the bonding material. The spacers may be attached to the central core before or after the central core is inserted into the masonry structure.

[0017] More than one reinforcement may be inserted in a single groove. The spacers then prevent the central cores touching and allow the bonding material to surround the reinforcement.

[0018] The reinforcement may be surrounded by a flexible sheathing material.

[0019] Where long runs of reinforcement are used, the reinforcements may be lapped, and in this case the reinforcing bars must be kept apart in order to allow the bonding material to surround the reinforcement.

[0020] The reinforcements may be tensioned after insertion into the slot, groove or hole.

The Drawings

[0021]

Figure 1 is a side view of a reinforcement according to the invention;

Figure 2 is a cross section of a structure reinforced with a reinforcement according to the invention;

Figure 3 is a cross section of a different structure reinforced according to the invention;

Figure 4 shows a double reinforcement according to the invention for use in a cavity wall;

Figure 5 shows a double reinforcement according to the invention for use in a joint between a horizontal and vertical reinforcement;

Figures 6 and 7 show two ways in which a spacer may be extended to accommodate a bracket; and
Figure 8 shows a four tailed reinforcement according to the invention.

[0022] Referring to Figure 1 a reinforcement 1 according to the invention includes a central core 2, the diameter of which varies according to the intended use. Diameters of between 2mm and 6mm are typical. Around the central core 2 is twisted a piece of stainless steel wire 3. The ends of the wire protrude radially from the reinforcement to form tails 4.

[0023] Figure 2 shows the reinforcement 1 inserted into a relatively narrow groove 5. The reinforcement 1 is inserted with the tails 4 in a horizontal direction. The groove is filled with bonding material 6 which is preferably thixotropic and hardens irreversibly thus bonding the reinforcement 1 within the structure. The width of the stainless steel wire 3 is sufficient to support the central

core in the groove such that it does not rest on the bottom or touch the top of the groove 5 even if there are irregularities in the shape or height of the groove. Because the central core is held away from the edges of the groove by the wire 3, the bonding material flows all around the central core and forms a strong bond.

[0024] Figure 3 shows a bar 1 according to the invention in a somewhat wider groove 7. In this case the bar 1 is twisted so that the tails 4 are no longer horizontal, but protrude almost vertically to jam against the upper and lower faces of the groove as the reinforcement is pushed into the groove. The reinforcement 1 is thus secured in the correct position and is suspended away from the upper and lower faces of the groove allowing the bonding material to flow around and to surround the reinforcement.

[0025] Even if the reinforcement 1 is inserted into a curved groove, the tails 4 hold the reinforcement firmly in place and prevent it from springing out of the groove as other parts of the reinforcement are being inserted.

[0026] Referring to Figure 4, a tail 4 of the wire 3 may be extended to form a tie between two reinforcements for use in the two leaves of a cavity wall. It is often necessary to tie together the two leaves in this way to increase stability.

[0027] Figure 5 shows the extension of the wire 3 to wrap around a further central core, forming a joint between a horizontal and vertical reinforcement.

[0028] Figures 6 and 7 show a reinforcement having a spacer with an extended tail used as a bracket 8. The fixing of brackets to masonry structures can be difficult and this method is advantageous because it fixes the bracket securely to the reinforcement, which is held firmly within the masonry structure.

[0029] Figure 8 shows a reinforcement including a spacer having four tails 4. Such spacers are particularly advantageous when the reinforcement is to be inserted in a hole 9 rather than a groove or slot.

[0030] The reinforcements 1 are preferably inserted into a groove by fitting an insertion tool to a protruding tail 4, moving the reinforcement into position at the edge of a groove and tapping lightly with a hammer or similar instrument, moving along the length of the reinforcement.

[0031] The reinforcement may be inserted into the inner leaf of a cavity wall by cutting through the outer leaf and making a groove in the inner leaf. An insertion tool is used to move the reinforcement through the cut in the outer leaf and to insert it into the groove in the inner leaf.

[0032] The number of reinforcing bars inserted into one groove may vary according to the requirements of the design and the thickness of the wall. The wire loops and tails prevent the central cores 2 of the bars 1 from touching one another and ensure that the bond material flows around the full perimeter of the central core.

Claims

1. A method of reinforcing a masonry structure, the method including the step of cutting a slot, groove or hole (5, 7, 9) in the structure and positioning therein a reinforcement (1) including a central elongate core (2) and a plurality of spacers on the central core (2) for holding the central core away from the edges of the slot, groove or hole, wherein each spacer includes one or more projections (4) extending radially outwards from the central core (2), the projections being positioned such that when the reinforcement is oriented horizontally its maximum vertical extent varies as it is twisted about its axis. 5
2. A method according to claim 1 wherein the projections (4) are shaped so as to snag or engage masonry. 10
3. A method according to claim 1 or claim 2 wherein each spacer includes two projections (4) approximately diametrically opposed to one another. 15
4. A method according to any preceding claim wherein each spacer consists of a piece of wire (3), twisted around the central core (2). 20
5. A method according to claim 4 wherein the wire is stainless steel. 25
6. A method according to any preceding claim wherein the central core (2) is machined or surface roughened or includes ridges to increase adhesion between the central core (2) and a bonding material. 30
7. A method according to any preceding claim wherein the reinforcement (1) is surrounded by a flexible sheathing material. 35
8. A method according to any preceding claim wherein the reinforcement (1) is tensioned after insertion into the slot, groove or hole (5, 7, 9). 40
9. A reinforcement (1) for insertion into a slot, groove or hole (5, 7, 9) in a masonry structure, the reinforcement including a central elongate core and a plurality of spacers on the central core (2) for holding the central core away from the edges of the slot, groove or hole (5, 7, 9), wherein each spacer includes one or more projections (4) extending radially outwards from the central core, the projections being positioned such that when the reinforcement (1) is oriented horizontally its maximum vertical extent varies as it is twisted about its axis. 45
10. A reinforcement (1) according to claim 9, wherein the projections (4) are shaped so as to snag or engage masonry. 50

11. A reinforcement (1) according to claim 9 or claim 10, wherein each spacer includes two projections (4) approximately diametrically opposed to one another. 55
12. A reinforcement (1) according to any of claims 9 to 11 wherein each spacer consists of a piece of wire (3), twisted around the central core (2).
13. A reinforcement (1) according to claim 12 wherein the wire is stainless steel.
14. A reinforcement (1) according to any of claims 9 to 13 wherein the central core (2) is machined or surface roughened or includes ridges to increase adhesion between the central core and a bonding material.
15. A reinforcement (1) according to any of claims 9 to 14 wherein the reinforcement (1) is surrounded by a flexible sheathing material.

Patentansprüche

1. Verfahren zum Verstärken einer Mauerwerks-Struktur, mit einem Schritt zum Schneiden eines Schlitzes, einer Rille oder eines Lochs (5, 7, 9) in der Struktur und Positionieren einer Verstärkung (1) darin, welche einen mittigen länglichen Kern (2) und eine Vielzahl von Abstandshaltern an dem mittigen Kern (2) enthält, um den mittigen Kern von den Rändern des Schlitzes, der Rille oder des Lochs fernzuhalten, wobei jeder Abstandshalter einen oder mehrere Vorsprünge (4) enthält, die sich radial auswärts von dem mittigen Kern (2) erstrecken, und wobei die Vorsprünge derart positioniert werden, dass sich bei horizontaler Ausrichtung der Verstärkung ihre maximale vertikale Ausdehnung verändert, wenn sie um ihre Achse verdreht wird.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** die Vorsprünge (4) so geformt sind, dass sie sich in dem Mauerwerk verhaken oder mit ihm in Eingriff gelangen.
3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** jeder Abstandshalter zwei Vorsprünge (4) enthält, die näherungsweise diametral entgegengesetzt zueinander sind.
4. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** jeder Abstandshalter aus einem Drahtstück (3) besteht, das um den mittigen Kern (2) herum verdreht ist.
5. Verfahren nach Anspruch 4, **dadurch gekennzeichnet, dass** der Draht aus rostfreiem Stahl be-

steht.

6. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der mittige Kern (2) maschinell bearbeitet ist oder eine aufgeraute Oberfläche hat oder Grate enthält, um die Haftung zwischen dem mittigen Kern (2) und einem Abbin- 5 dungs-
material zu erhöhen.
7. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Verstärkung (1) von einem biegsamen Schaftmaterial umgeben ist. 10
8. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Verstärkung (1) nach dem Einfügen in den Schlitz, die Rille oder das Loch (5, 7, 9) gespannt wird. 15
9. Verstärkung (1) zum Einführen in einen Schlitz, eine Rille oder ein Loch (5, 7, 9) in einer Mauerwerks-Struktur, wobei die Verstärkung einen mittigen länglichen Kern und eine Vielzahl von Abstandshaltern an dem mittigen Kern (2) enthält, um den mittigen Kern von den Rändern des Schlitzes, der Rille oder des Lochs (5, 7, 9) fernzuhalten, wobei jeder Abstandshalter einen oder mehrere Vorsprünge (4) enthält, die sich von dem mittigen Kern radial nach außen erstrecken, wobei die Vorsprünge derart positioniert sind, dass sich bei horizontaler Ausrichtung der Verstärkung (1) ihre maximale vertikale Ausdehnung verändert, wenn sie um ihre Achse verdreht wird. 20 25 30
10. Verstärkung (1) nach Anspruch 9, **dadurch gekennzeichnet, dass** die Vorsprünge (4) so geformt sind, dass sie sich in dem Mauerwerk verhaken oder mit ihm in Eingriff gelangen. 35
11. Verstärkung (1) nach Anspruch 9 oder 10, **dadurch gekennzeichnet, dass** jeder Abstandshalter zwei Vorsprünge (4) enthält, die näherungsweise diametral gegenüberliegend zueinander sind. 40
12. Verstärkung (1) nach einem der Ansprüche 9 bis 11, **dadurch gekennzeichnet, dass** jeder Abstandshalter aus einem Drahtstück (3) besteht, das um den mittigen Kern (2) herum verdreht ist. 45
13. Verstärkung (1) nach Anspruch 12, **dadurch gekennzeichnet, dass** der Draht aus rostfreiem Stahl besteht. 50
14. Verstärkung (1) nach einem der Ansprüche 9 bis 13, **dadurch gekennzeichnet, dass** der mittige Kern (2) maschinell bearbeitet ist oder an der Oberfläche aufgeraut ist oder Grate enthält, um die Haftung zwischen dem mittigen Kern und einem Abbin- 55

dungs-
material zu erhöhen.

15. Verstärkung (1) nach einem der Ansprüche 9 bis 14, **dadurch gekennzeichnet, dass** die Verstärkung (1) von einem biegsamen Schaftmaterial umgeben ist.

Revendications

1. Procédé de renforcement d'une structure de maçonnerie, le procédé comportant l'étape de découpe d'une fente, d'une gorge ou d'un trou (5, 7, 9) dans la structure, et de positionnement à l'intérieur de celui-ci ou celle-ci d'un renforcement (1) comportant une âme allongée centrale (2) et une pluralité d'écarteurs situés sur l'âme centrale (2) pour maintenir l'âme centrale loin des bords de la fente, de la gorge ou du trou, dans lequel chaque écarteur comporte une ou plusieurs saillies (4) s'étendant radialement vers l'extérieur à partir de l'âme centrale (2), les saillies étant positionnées de sorte que, lorsque le renforcement est orienté horizontalement, son étendue verticale maximale varie lorsqu'il est tordu autour de son axe.
2. Procédé selon la revendication 1, dans lequel les saillies (4) sont mises en forme de manière à s'accrocher ou à venir en prise avec une maçonnerie.
3. Procédé selon la revendication 1 ou 2, dans lequel chaque écarteur comporte deux saillies (4) sensiblement diamétralement opposées l'une par rapport à l'autre.
4. Procédé selon l'une quelconque des revendications précédentes, dans lequel chaque écarteur est constitué d'un morceau de fil métallique (3) tordu autour de l'âme centrale (2).
5. Procédé selon la revendication 4, dans lequel le fil métallique est en acier inoxydable.
6. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'âme centrale (2) est usinée ou rendue rugueuse en surface, ou comporte des nervures pour augmenter l'adhérence entre l'âme centrale (2) et un matériau de liaison.
7. Procédé selon l'une quelconque des revendications précédentes, dans lequel le renforcement (1) est entouré par un matériau de gainage souple.
8. Procédé selon l'une quelconque des revendications précédentes, dans lequel le renforcement (1) est mis en tension après insertion dans la fente, la gorge ou le trou (5, 7, 9).

9. Renforcement (1) destiné à être inséré dans une fente, une gorge ou un trou (5, 7, 9) dans une structure de maçonnerie, le renforcement comportant une âme allongée centrale et une pluralité d'écarteurs situés sur l'âme centrale (2) pour maintenir l'âme centrale loin des bords de la fente, de la gorge ou du trou (5, 7, 9), dans lequel chaque écarteur comporte une ou plusieurs saillies (4) s'étendant radialement vers l'extérieur à partir de l'âme centrale, les saillies étant positionnées de sorte que, lorsque le renforcement (1) est orienté horizontalement, son étendue verticale maximale varie lorsqu'il est tordu autour de son axe. 5 10
10. Renforcement (1) selon la revendication 9, dans lequel les saillies (4) sont mises en forme de manière à s'accrocher ou venir en prise avec la maçonnerie. 15
11. Renforcement (1) selon la revendication 9 ou 10, dans lequel chaque écarteur comporte deux saillies (4) sensiblement diamétralement opposées l'une par rapport à l'autre. 20
12. Renforcement (1) selon l'une quelconque des revendications 9 à 11, dans lequel chaque écarteur est constitué d'un morceau de fil métallique (3) tordu autour de l'âme centrale (2). 25
13. Renforcement (1) selon la revendication 12, dans lequel le fil métallique est en acier inoxydable. 30
14. Renforcement (1) selon l'une quelconque des revendications 9 à 13, dans lequel l'âme centrale (2) est usinée ou rendue rugueuse en surface, ou comporte des nervures pour augmenter l'adhérence entre l'âme centrale et un matériau de liaison. 35
15. Renforcement (1) selon l'une quelconque des revendications 9 à 14, dans lequel le renforcement (1) est entouré par un matériau de gainage souple. 40

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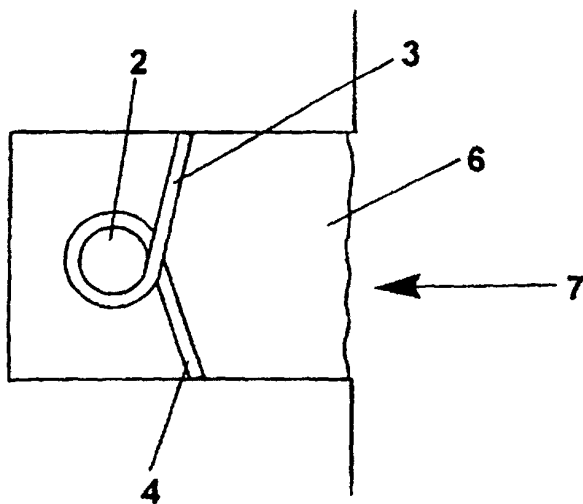
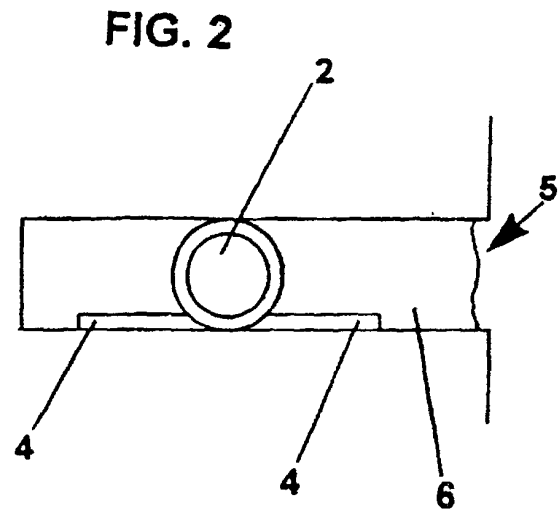
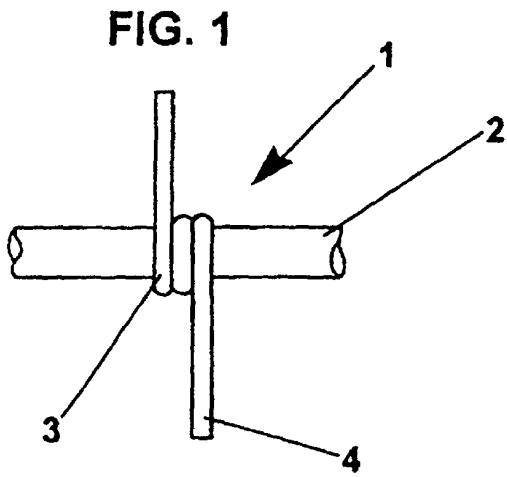


FIG. 3

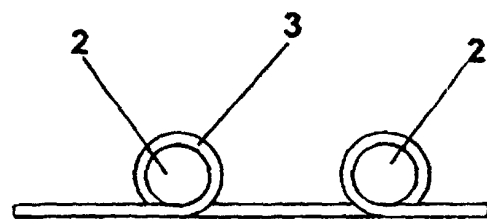
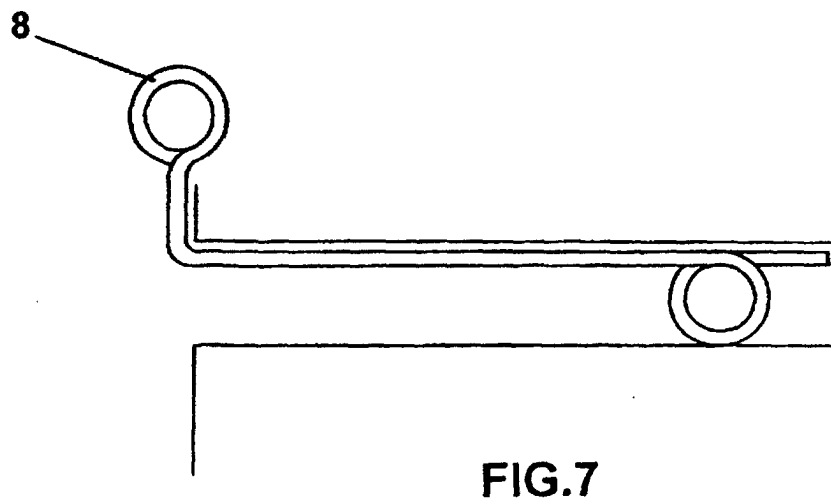
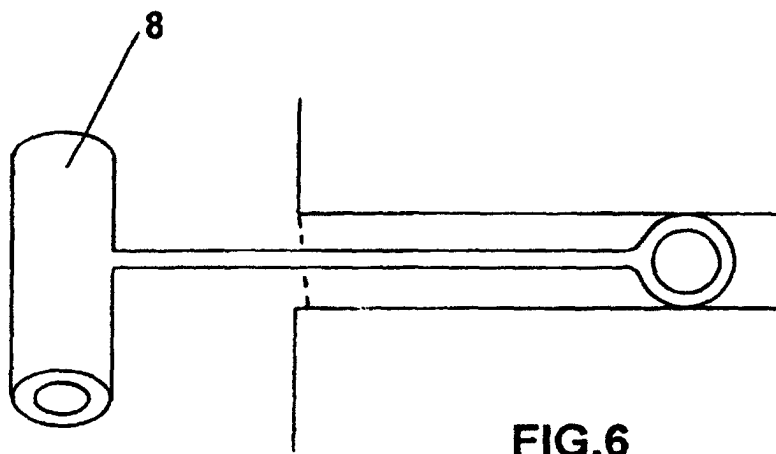
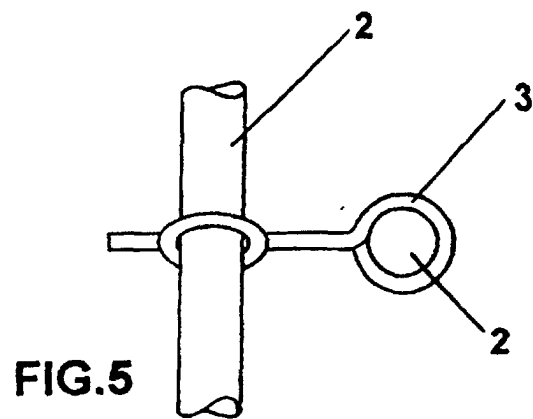


FIG. 4



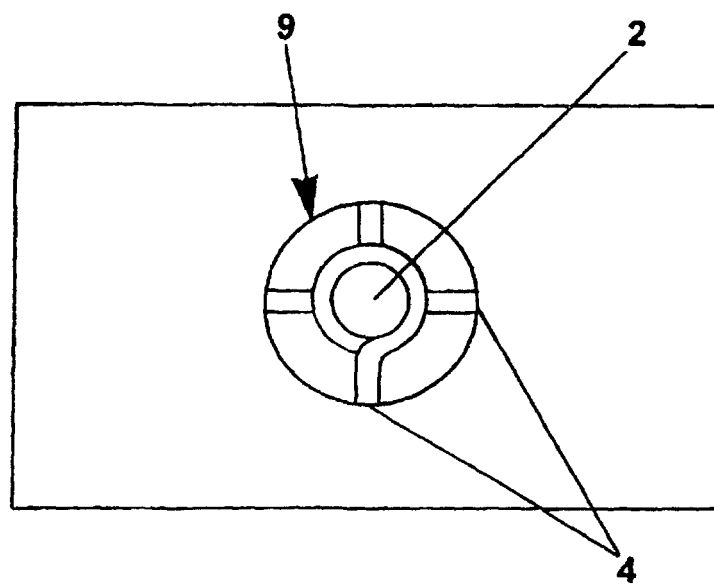


FIG.8