(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 129 263 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
04.02.2004 Bulletin 2004/06

(21) Application number: **99944909.3**

(22) Date of filing: **20.09.1999**

(51) Int Cl.[7]: **E04C 3/26**, E04C 5/08

(86) International application number:
PCT/KR1999/000567

(87) International publication number:
WO 2000/028168 (18.05.2000 Gazette 2000/20)

(54) TENSION FORCE ADJUSTABLE PRESTRESSED GIRDER

VORGESPANNTER BINDER MIT EINSTELLBARER VORSPANNUNG

POUTRE PRECONTRAINTE A FORCE DE TENSION REGLABLE

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **07.11.1998 KR 9847661**

(43) Date of publication of application:
05.09.2001 Bulletin 2001/36

(73) Proprietor: **Interconstec Co., Ltd.**
Seocho-gu, Seoul 137-070 (KR)

(72) Inventor: **HAN, Man Yop**
Suwon-city, Kyungki-do 442-070 (KR)

(74) Representative: **Stanley, David William**
Stanleys
Intellectual Property,
Kings Court,
12 King Street
Leeds LS1 2HL (GB)

(56) References cited:
US-A- 4 604 003
US-A- 4 831 800
US-A- 5 313 749
US-A- 5 671 572

- **EIBL JOSEF. Externe Vorspannung und Segmentbauweise: Vortraege anlaesslich des Workshops "Externe und verbundlose Vorspannung-Segmentbruecken" an der Universitaet Fridericiana Karsruhe (TH) vom 5-7 Okt. 1998 Berlin: Ernst 1998 pages 71-90, XP002946477**

EP 1 129 263 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention relates to prestressed girders.

[0002] In general, when girders installed on a column of a concrete bridge become obsolete as time passes or heavy vehicles exceeding the originally designed weight allowance of a bridge pass over the bridge for a prolonged period, the beam of the bridge may become damaged and excessive sagging may occur at the girders. Concurrently, bending/tensile cracks are generated and, when such damage continues, the bridge may ultimately collapse. Thus, appropriate repair and reinforcement of the bridge is required.

[0003] It is known to repair and reinforce a prestressed concrete (PSC) bridge by means of an external steel wire reinforcement construction method (cf. US 5 671 572 A). In such a method, an externally installed steel wire is fixed appropriately at an end portion of a girder. However, it is difficult to install a wire fixing apparatus at the end portion of a girder and reliability of the wire fixing apparatus in respect of the load-resisting force is not assured. Thus, although other methods have been suggested and applied, no effective apparatus has yet been developed. That is, when cracks and sagging occur in a PCS bridge, it is very difficult to repair and reinforce the bridge.

[0004] Also, as traffic volume continuously increases and automobile manufacturing technologies develop, the weights of vehicles increase. With an increase in the weights of vehicles, the standard specifications for designing a bridge must be modified. Such modification may result in unbalanced load-resisting states, i.e. the load-resisting forces of existing bridges are not matched. In other words, in a state in which there are roads that allow the passage of heavy trucks, existing together with roads that do not allow the passage of heavy trucks, the efficiency of the transportation network system as a whole is severely lowered. Thus, to make the unbalanced load-resisting forces of these bridges consistent, an economical reinforcement method for upgrading the levels of bridges from 2 to 1 must be urgently found.

[0005] As the width of roads increases due to an increase in the number of lanes, the development of a wide span girder for constructing an elevated road or an overpass crossing a wide road has proceeded. Although a preflex beam has been developed and used for the above purposes, conveying the girder is inconvenient due to the length thereof and because the costs are high.

[0006] Currently, high strength concrete is used for a girder less than 30 m long that is not a wide span girder. However, as a high tension force is applied to the girder, the amount of creep generated becomes great. As the creep increases, the girder sags further, which directly affects the longitudinal alignment of the road. When the longitudinal alignment deteriorates, a coefficient of impact by passing vehicles increases. Thus, in the case of a high strength girder or a wide span girder, when the girder is used for a long time, an appropriate construction method for compensating for sagging of the girder is required.

[0007] Also, the height of a girder which is long in span is relatively high such that the girder itself is 2.00 m - 3.00 m high. Such a fact entails an increase in the height of an upper deck of an overpass so that, to secure a longitudinal alignment of the overpass matching the designed vehicle speed, the length of the overpass becomes longer, thus raising the construction costs. In the case of a bridge crossing a river, to lower the height of the girder as low as possible is inevitably needed for improving the usability and the economic value of the girder.

[0008] Figure 1 of the accompanying diagrammatic drawings is a perspective view to show the general structure of a bridge. As shown in the drawing, a plurality of I-type girders 12 are installed on a column 10. An upper deck slab (not shown) is installed on the girders 12 of the bridge.

[0009] Figure 2 of the accompanying diagrammatic drawings is a sectional view showing a girder in which steel wires are arranged according to conventional technology. As shown in the drawing, a girder 20 consists of a body portion 22, an upper flange 28, and a lower flange 24. A plurality of steel wires 26 are built in the body portion 22 in the lengthwise direction. An upper deck of a bridge is installed on the upper flange 28 and the bottom surface of the lower flange 24 is supported by a column 10 (as in Figure 1).

[0010] After the I-type girder 20 according to the conventional technology is constructed, when the bridge is damaged, that is, sagging or cracks are generated due to increased traffic volume passing over the bridge, or when the designed passage load must be increased according to a revised specification, reinforcement of the bridge is required. However, there are no known economical and reliable reinforcement methods applicable therefor.

[0011] Preferred embodiments of the present invention aim to provide prestressed girders in which a tension force can be adjusted to easily increase a load-resisting force of a bridge or building, when excessive sagging or cracks are generated in a girder due to long-term use or when there is a need to increase the load-resisting force of the bridge or building without damaging the bridge or building.

[0012] According to one aspect of the present invention, there is provided a girder comprising an upper flange for supporting an upper deck of a bridge or building, a body portion and a lower flange, said girder being prestressed by tension steel wires provided in a lengthwise direction of said girder and tensioned to compensate for a load-resisting force:

wherein at least one non-tension steel wire is provided in the lengthwise direction of said girder, so that the load-resisting force of said bridge or building can be increased by tensioning said non-tension steel wire.

[0013] In the context of this specification, and as will be understood from the description given below with reference to the accompanying drawings, the term "non-tension" wire means a wire that is installed initially with zero or small tension, for tensioning at a later time in order to augment the tension of wires that were installed initially under significant tension.

[0014] Preferably, the girder further comprises a cut-open portion at a predetermined portion in the lengthwise direction of said girder and a coupling member installed at said cut-open portion for coupling ends of said steel wires of which opposite ends are fixed at end portions of said girder.

[0015] Preferably, wherein said coupling member comprises a support member having holes formed therein through which respective ends of said steel wires penetrate, and wedges inserted between said steel wires and said support member.

[0016] Preferably, wherein one end of the or each said non-tension steel wire is exposed at a respective end portion of said girder to apply a tension force.

[0017] Preferably, the arrangement is such that the load-resisting force of said bridge or building can be increased by tensioning the or each said non-tension steel wire during construction of said girder and/or after the construction thereof.

[0018] In such a girder, during construction, the tension force of the or each said non-tension steel wire may be adjusted during or after slab casting and, after construction, the tension force of the or each said non-tension steel wire may be adjusted while said bridge or building is being used.

[0019] Although the present invention can be applied to any type of girder regardless of the shape of the section of the girder such as an I-type girder or a bulb T-type girder, the I-type girder is described in the below preferred embodiment.

[0020] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to Figures 3 to 7 of the accompanying diagrammatic drawings, in which:

Figure 3A is a sectional view showing the arrangement of steel wires in the middle portion of a girder according to one example of the present invention;

Figure 3B is a view similar to Figure 3A, but showing the arrangement of steel wires according to another example of the present invention;

Figure 4A is a sectional view showing the arrangement of steel wires at an end portion of the girder of Figure 3A;

Figure 4B is a sectional view showing the arrangement of steel wires at an end portion of the girder of Figure 3B;

Figure 5 is a view showing a cut-open portion located at the middle portion of a girder and the arrangement of steel wires in the girder;

Figure 6 is a side view showing an example of a steel wire fixed at an end portion of a girder; and

Figure 7 is a perspective view showing an example of steel wires in a cut-open portion.

[0021] In the figures, like references denote like or corresponding parts.

[0022] In Figure 3A, a girder 40 includes an upper flange 28, a lower flange 24, and a body portion 22. One or more tension steel wires 26 and non-tension steel wires 27 are built in and across the lower portion of the body portion 22 and the lower flange 24 of the girder 40 in the lengthwise direction of the girder 40.

[0023] Preferably, the non-tension steel wires 27 are built in the lower flange 28 horizontally parallel to each other, as shown in Figure 3A. The upper flange 28 is provided above the body portion 22 in the lateral direction in the section of the girder 40 and an upper deck (not shown) of a bridge is installed on the upper flange 28. The lower flange 24 is provided below the body portion 22 in the lateral direction in the section of the girder 40 and the bottom surface thereof is supported by a column (not shown).

[0024] Figure 3B shows the arrangement of steel wires according to another preferred embodiment of the present invention. As shown in the drawing, a plurality of non-tension steel wires 27a are provided in the lengthwise direction of the girder 40 outside the lower portion of the body portion 22. The non-tension steel wires 27a have the same function as that of an additional non-tension steel wire 27 provided in the lower flange 24. That is, after a bridge is constructed, sagging of the girder 40 is compensated for by tensioning the non-tension steel wires 27a. Also, the non-tension steel wires 27a can be more easily installed compared to a case of being installed inside the lower flange 24.

[0025] Figure 4A shows the arrangement of the steel wires at the end portion of the girder of Figure 3A. As shown in the drawing, the tension steel wires 26 and the non-tension steel wires 27 concentrated at the lower portion of the girder 40 are distributed throughout the entire sectional portion of the girder 40. That is, the steel wires are evenly distributed symmetrically in the girder 40 in the vertical and horizontal directions (as seen) so that the tension forces in the tension steel wires 26 and the non-tension steel wires 27 can be evenly distributed throughout the entire portion of the girder 40.

[0026] Figure 4B shows the arrangement of the steel wires at the end portion of the girder shown in Figure

3B. As shown in the drawing, the tension steel wires 26 and the non-tension steel wires 27 and 27a concentrated at the lower portion of the girder as shown in Figure 3B are evenly distributed symmetrically with respect to the girder 40 in the vertical and horizontal directions (as seen) so that the tension forces in the tension or non-tension steel wires 26, 27 or 27a are evenly distributed throughout the entire portion of the girder 40.

[0027] Figure 5 shows the arrangement of the steel wires in the lengthwise direction in the girder of Figure 3A and a cut-open portion 36 located in the middle of the girder. The tension steel wires 26 and the non-tension steel wires 27 provided inside the girder 40 are concentrated in the lower portion at the middle portion of the girder 40 and evenly distributed throughout the entire sectional portion of the girder 40 at both end portions of the girder 40. The tension and non-tension steel wires 26 and 27 are fixed at both ends of the girder 40 by a fixing means 32 which is an anchoring device. The fixing means 32 is covered with concrete (not shown) after the girder 40 is constructed.

[0028] Here, when the girders are installed having intervals therebetween, or when a portion of the end of the girder is cut away, as shown in the drawing, a space is formed between adjacent girders. Thus, tensioning can be performed in that space when the tension and non-tension steel wires 26 and 27 are to be re-tensioned later. However, in this case, the end portion of the girder 40 must not be covered with concrete. Here, one end of the tension and non-tension steel wires 26 and 27 is exposed at either end portion of the girder 40 to apply a tension force.

[0029] Also, in a preferred embodiment, the girder is provided with a cut-open portion 36 for adjusting the tension force of the non-tension steel wires 27 at the middle portion of the girder or at another appropriate position. The cut-open portion 36 is used as a space for accommodating a coupling member of the non-tension steel wires 27. That is, the cut-open portion 36 is used as a working space for adjusting the tension force of the non-tension steel wires 27 later.

[0030] When cracks 34 or excessive sagging 35 indicated by a dotted line is generated in the girder 40, as shown in Figure 5, one or more non-tension steel wire 27 and 27a installed inside or outside the girder 40 is additionally tensioned for reinforcement. Here, the additional tensioning work for the non-tension steel wires 27 and 27a is performed using a hydraulic jack. Also, the tension forces of the non-tension steel wires 27 and 27a are adjusted during or after slab casting and after construction, the tension force is adjusted while the bridge is in use. That is, in the case of a continuous bridge, re-tensioning can be performed before slab casting. However, in this example, the re-tensioning is performed shortly after the slab casting before slab concrete is hardened to prevent application of a tension force on the slab.

[0031] Figure 6 shows a preferred embodiment of fixing a steel wire at the end portion of a girder. The steel wire 26 is anchored using a support member 50 as an anchoring device. For example, the steel wire 26 is inserted into a hole formed at the centre of the support member 50 at one end of the girder 40. A plurality of wedges 52 are inserted between the steel wire 26 and the support member 50. Here, the steel wire 26 is tensioned by a hydraulic jack and the tensioned steel wire 26 is fixed by the wedges 52.

[0032] Figure 7 shows steel wires 26 coupled by a coupling member 62 as a preferred embodiment of a steel wire connection in cut-open portion 36. As shown in the drawing, the cut-open portion 36 is formed in the middle of the bottom surface of the girder 40 in the lengthwise direction. The steel wires 26 fixed at both ends of the girder 40 are connected to the coupling member 62 such that forces in different directions are applied. Here, the tension steel wires 26 connected at the coupling member 62 are connected using the support members 50 and the wedges 52 as shown in Figure 6.

[0033] As indicated previously, a coupling member such as 62 is provided at cut-open portion 36 for connecting together and adjusting the tension force of the non-tension steel wires 27. Thus, the non-tension steel wires 27 connected to each other by the coupling member 62 are tensioned and fixed by using the wedges 52 so that the tension forces of the tension steel wires 26 can be maintained. Also, by applying a tension force to the non-tension steel wires 27 and 27a provided at left and right sides of the girder 40, bending of the girder 40 to the left or right can be compensated for.

[0034] According to the above-described and illustrated arrangement of steel wires and coupling apparatus, when a bridge is constructed or at an initial stage of construction, steel wires 26 and 27 are connected by the coupling member 62 to be capable of moving to a degree, while steel wires installed outside the girder 40 are not tensioned at all or tensioned by a small tension force so as to increase the tension forces of the steel wires later.

[0035] Although a bridge is described as an example in the above preferred embodiments, adjustable tension forces adjustable according to other embodiments of the present invention can be applied to other prestressed concrete structures such as buildings.

[0036] It is noted that the present invention is not limited to the preferred embodiments described above, and it is apparent that variations and modifications by those skilled in the art can be effected within the spirit and scope of the present invention as defined in the appended claims.

[0037] For example, although I-type girders have been described above with respect to preferred embodiments, other embodiments of the present invention can be applied to any type of girder regardless of the shape of the section of the girder - such as a bulb T-type girder, for example.

[0038] As described above, according to preferred embodiments of the present invention, cracks and sagging of a bridge generated due to long-term deterioration, creep or overload can be corrected by additionally tensioning steel wires installed internally or externally at a girder of the bridge. Thus, repair and reinforcement of the bridge is easy so that the load-resisting force of the bridge can be easily increased. Also, by adjusting the tension force step by step, the girder can be economically manufactured or the height of the girder can be decreased.

[0039] In this specification, the verb "comprise" has its normal dictionary meaning, to denote non-exclusive inclusion. That is, use of the word "comprise" (or any of its derivatives) to include one feature or more, does not exclude the possibility of also including further features.

Claims

1. A girder comprising an upper flange (28) for supporting an upper deck of a bridge or a building, a body portion (22) and a lower flange (24), said girder (40) being prestressed by tension steel wires (26) provided in a lengthwise direction of said girder (40) and tensioned to compensate for a load-resisting force:

   characterised in that at least one non-tension steel wire (27) is provided in the lengthwise direction of said girder (40), so that the load-resisting force of said bridge or building can be increased by tensioning said non-tension steel wire (27).

2. A girder as claimed in claim 1, further comprising a cut-open portion (36) at a predetermined portion in the lengthwise direction of said girder (40) and a coupling member (62) installed at said cut-open portion (36) for coupling ends of said steel wires (26, 27) of which opposite ends are fixed at end portions of said girder (40).

3. A girder as claimed in claim 2, wherein said coupling member (62) comprises a support member (50) having holes formed therein through which respective ends of said steel wires (26, 27) penetrate, and wedges (52) inserted between said steel wires (26, 27) and said support member (50).

4. A girder as claimed in claim 1, 2 or 3, wherein one end of the or each said non-tension steel wire (27) is exposed at a respective end portion of said girder (40) to apply a tension force.

5. A girder according to any of claims 1 to 4, wherein the arrangement is such that the load-resisting force of said bridge or building can be increased by tensioning the or each said non-tension steel wire (27) during construction of said girder (40) and/or after the construction thereof.

6. A girder as claimed in claim 5 wherein, during construction, the tension force of the or each said non-tension steel wire (27) is adjusted during or after slab casting, and, after construction, the tension force of the or each said non-tension steel wire (27) is adjusted while said bridge or building is being used.

7. A bridge or building supported by one or more girder (40) according to any of the preceding claims.

Patentansprüche

1. Träger mit einem oberen Flansch (28) zum Tragen eines oberen Bodens einer Brücke oder eines Gebäudes, einem Körperabschnitt (22) und einem unteren Flansch (24), wobei der Träger (40) durch Spannungsstahldrähte (26) vorgespannt wird, die in Längsrichtung des Trägers (40) bereitgestellt werden und gespannt sind, um eine belastungsbeständige Kraft zu kompensieren,

   dadurch gekennzeichnet, daß zumindest ein Nicht-Spannungsstahldraht (27) in Längsrichtung des Trägers (40) bereitgestellt wird, so daß die belastungsbeständige Kraft der Brücke oder des Gebäudes durch Spannen des Nicht-Spannungsstahldrahtes (27) erhöht werden kann.

2. Träger nach Anspruch 1, des weiteren umfassend einen aufgeschnittenen Abschnitt (36) an einem bestimmten Abschnitt in der Längsrichtung des Trägers (40) und mit einem Kupplungselement (62), das an dem aufgeschnittenen Abschnitt (36) zum Kuppeln von Enden der Stahldrähte (26,27) montiert ist, wobei deren gegenüberliegenden Enden an Endabschnitten des Trägers (40) befestigt sind.

3. Träger nach Anspruch 2, wobei das Kupplungselement (62) ein Trägerelement (50) mit darin geformten Löchern, durch die entsprechende Enden der Stahldrähte (26,27) dringen, und Keile (52) umfaßt, die zwischen den Stahldrähten (26,27) und dem Trägerelement (50) eingefügt wurden.

4. Träger nach Anspruch 1, 2 oder 3, wobei ein Ende des oder jedes Nicht-Spannungsstahldrahtes (27) an einem entsprechenden Endabschnitt des Trägers (40) zugewandt ist, um eine Spannungskraft aufzubringen.

5. Träger nach einem der Ansprüche 1 bis 4, wobei die Anordnung derart ausgebildet ist, daß die belastungsbeständige Kraft der Brücke oder des Gebäudes durch Spannen des oder jedes Nicht-Spannungsstahldrahtes (27) während der Konstruktion

des Trägers (40) und/oder nach dessen Konstruktion erhöht werden kann.

6. Träger nach Anspruch 5, wobei während der Konstruktion die Spannungskraft des oder jedes Nicht-Spannungsstahldrahtes (27) während oder nach einem Rippenguß eingestellt wird und nach der Konstruktion die Spannungskraft des oder jedes Nicht-Spannungsstahldrahtes (27) eingestellt wird, während die Brücke oder das Gebäude verwendet wird.

7. Brücke oder Gebäude, das durch einen oder mehrere Träger (40) nach einem der vorhergehenden Ansprüche getragen wird.

Revendications

1. Poutre comprenant un flanc supérieur (28) pour le support d'un tablier ou plateau supérieur d'un pont ou d'un bâtiment, une partie de corps (22) et un flanc inférieur (24), ladite poutre (40) étant précontrainte par des câbles d'acier de tension (26) disposés en direction longitudinale de ladite poutre (40), et soumis à une tension pour créer une force de résistance à la charge, **caractérisée en ce qu'**au moins un câble d'acier (27) non tendu est prévu dans la direction longitudinale de ladite poutre (40) de façon que la force de résistance à la charge dudit pont ou bâtiment puisse être augmentée par la mise sous tension dudit câble (27) d'acier non tendu.

2. Poutre selon la revendication 1, comprenant en outre une partie découpée en une partie prédéterminée dans la direction longitudinale de ladite poutre (40) et un élément de couplage (62) installé en ladite partie découpée (36) pour le couplage des extrémités desdits câbles d'acier (26,27) dont les extrémités opposées sont fixées aux parties d'extrémité de ladite poutre (40).

3. Poutre selon la revendication 2, **caractérisée en ce que** lesdits éléments de couplage (62) comportent un élément de support (50) présentant des trous formés dans celui-ci au travers desquels les extrémités respectives desdits câbles d'acier (26,27) pénètrent, et des coins (52) insérés entre lesdits câbles d'acier (26, 27) et ledit élément de support (50).

4. Poutre selon l'une des revendications 1, 2 ou 3, **caractérisée en ce qu'**une extrémité du câble ou de chacun des câbles (27) d'acier non tendu(s), est exposée en une partie respective de ladite poutre (40) pour appliquer une force de tension.

5. Poutre selon l'une des revendications 1 à 4, **caractérisée en ce que** la disposition est telle que la force de résistance à la charge dudit pont ou dudit bâtiment peut être augmentée par la mise sous tension du ou de chacun des câbles (27) d'acier non tendu(s), lors de la construction de ladite poutre (40) et/ou après la construction de celle-ci.

6. Poutre selon la revendication, **caractérisée en ce que**, durant la construction, la force de tension du ou de chacun desdits câbles d'acier non tendu(s) (27) est ajustée lors de ou après la coulée et, après construction, la force de tension du ou de chacun desdits câbles d'acier non tendu(s) (27) est ajustée tandis que ledit pont ou ladite construction est en cours d'utilisation.

7. Pont ou construction supporté(e) par une ou plusieurs poutre(s) (40) selon l'une des revendications précédentes.

FIG. 1

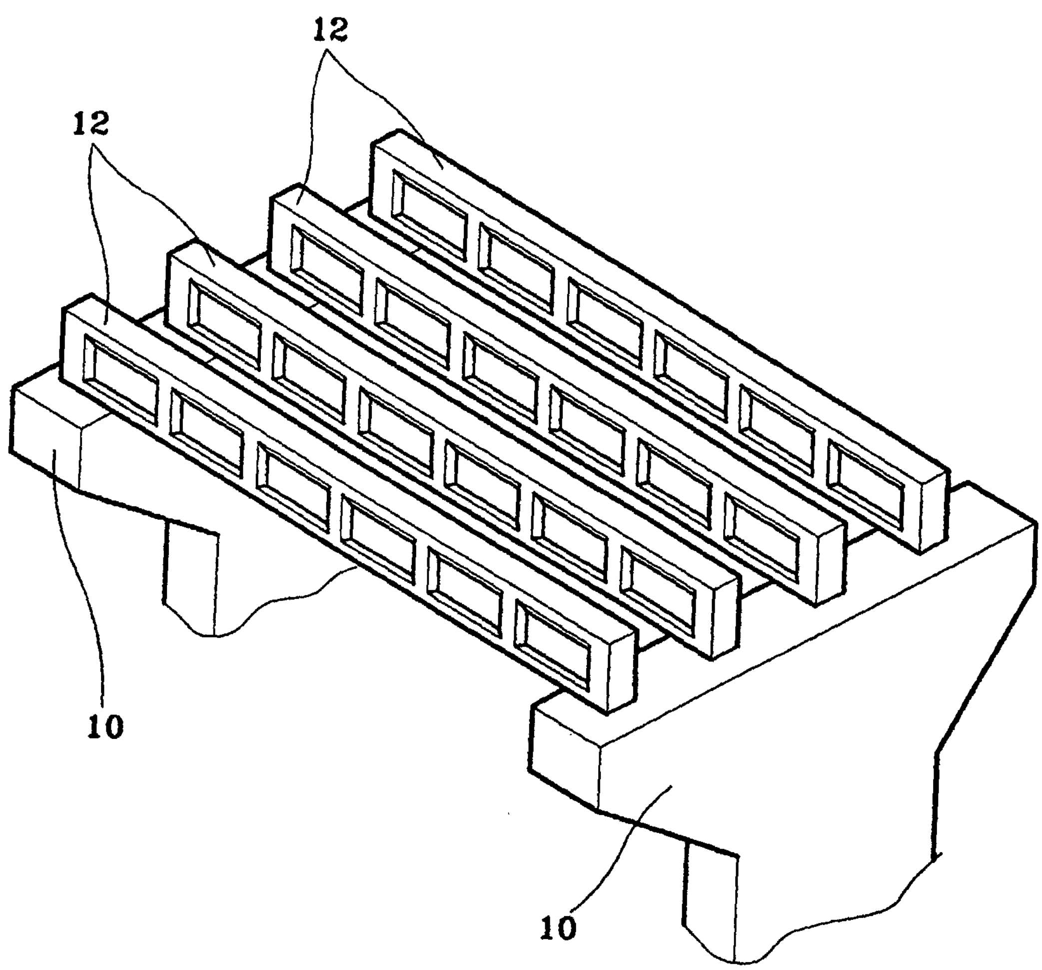

FIG. 2
(PRIOR ART)

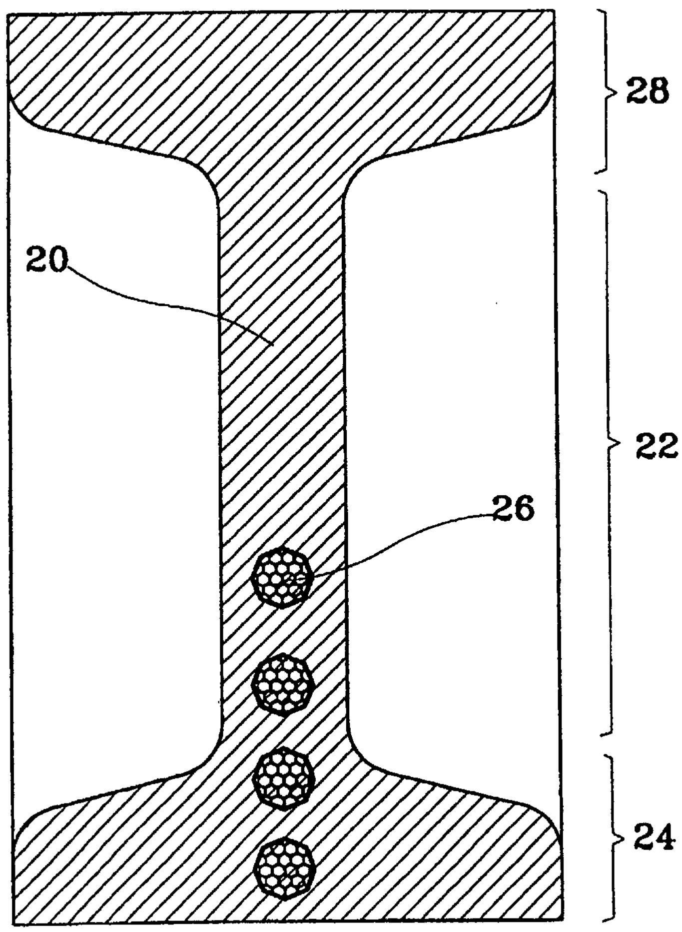

FIG. 3A

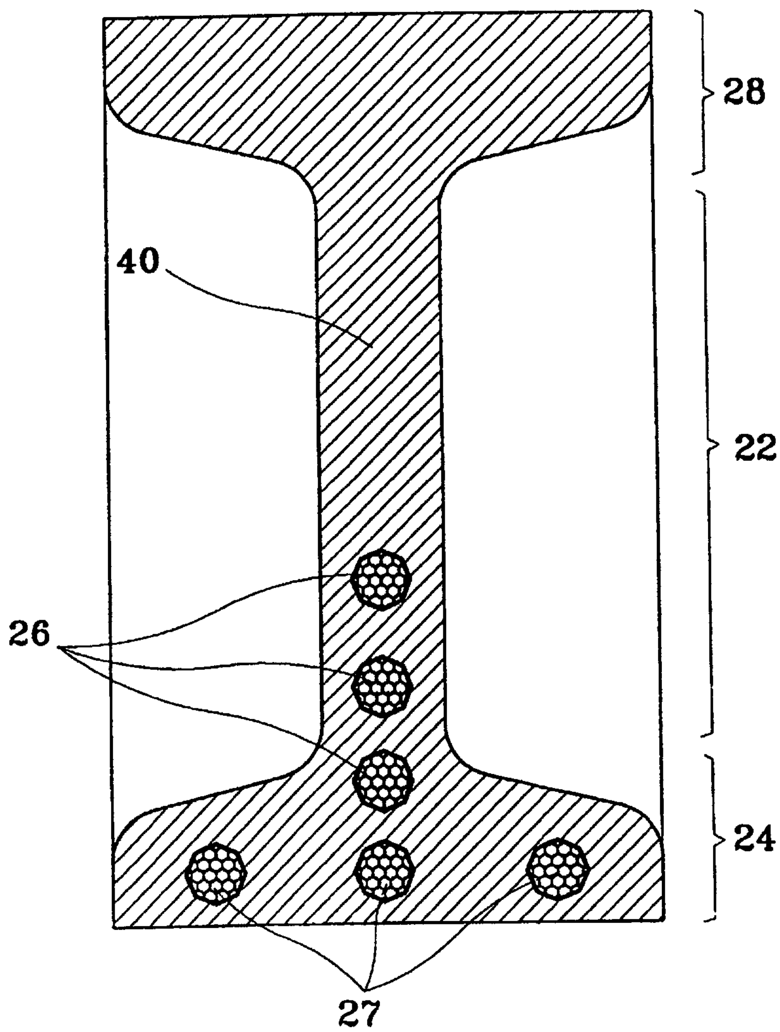

FIG. 3B

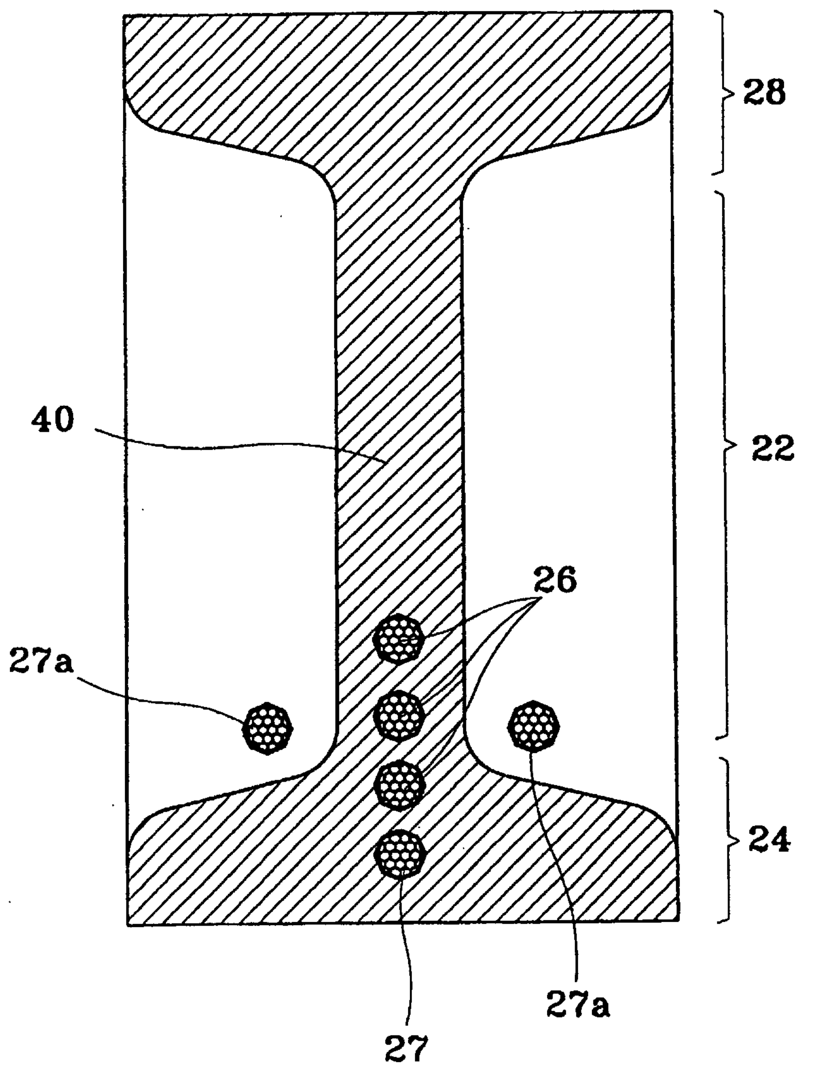

FIG. 4A

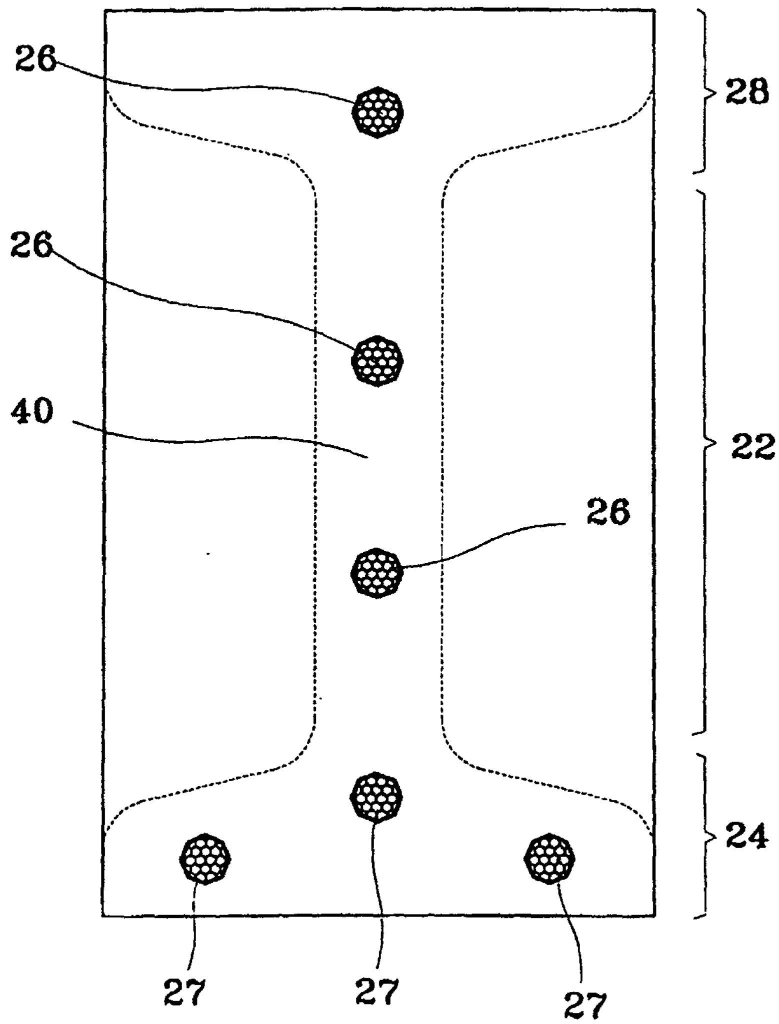

FIG. 4B

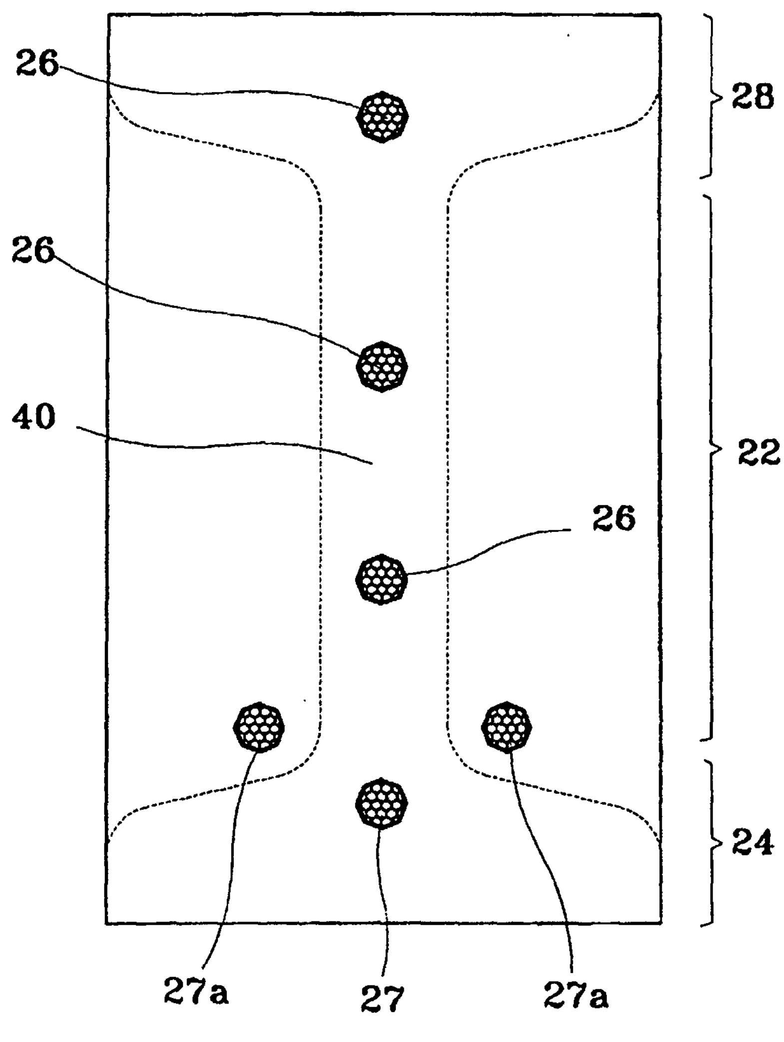

FIG. 5

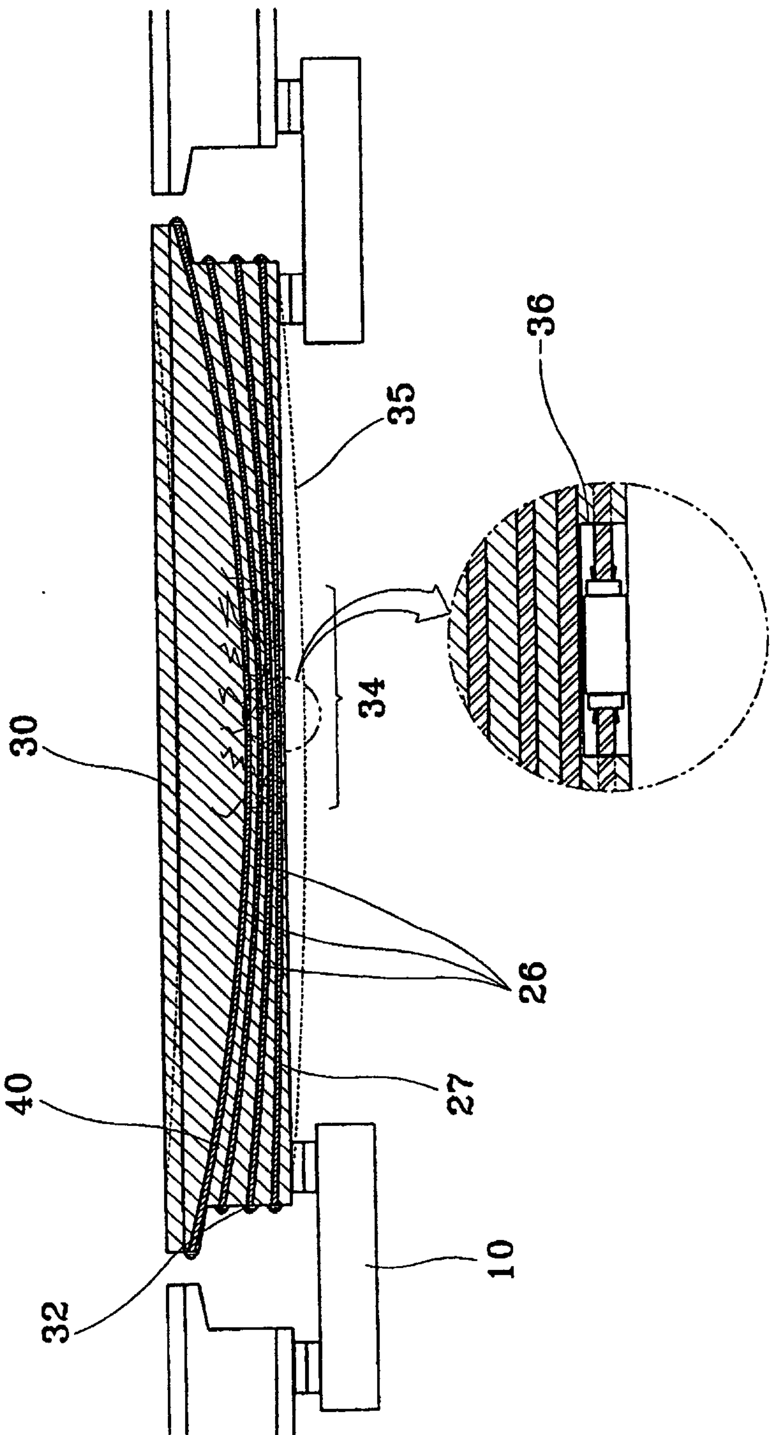

FIG. 6

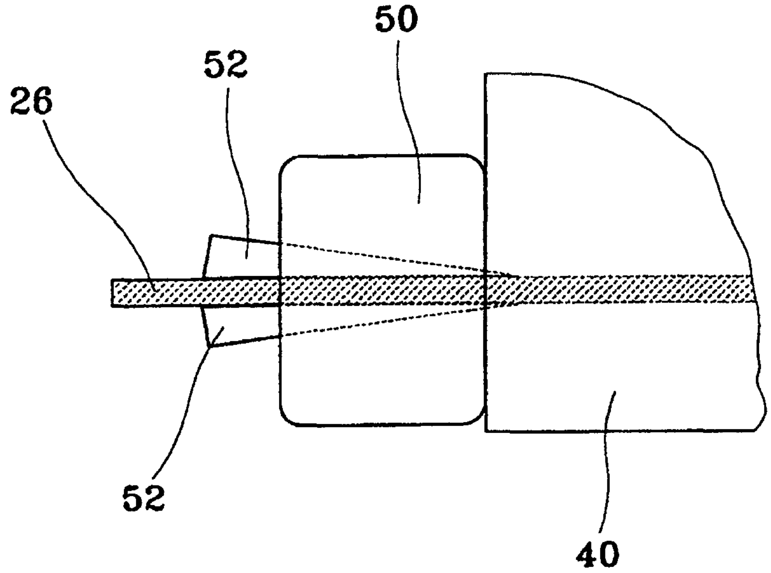

FIG. 7