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(54) A housed high strength core member.

(57) The invention provides a housed high strength core member suitable for supporting load. It consists of at least one core (C) made of high strength material adapted for the application of the compression load surrounded by a housing (H) with infils (G) provided in the space between the inner wall of the housing and the core, providing lateral restraint to the core member. The housing is shorter than the core at all stages of loading including the ultimate load of the core member to ensure that the compression load is applied only to the core member and there is no bond between the core member and the infil at all stages of loading, including the ultimate load.

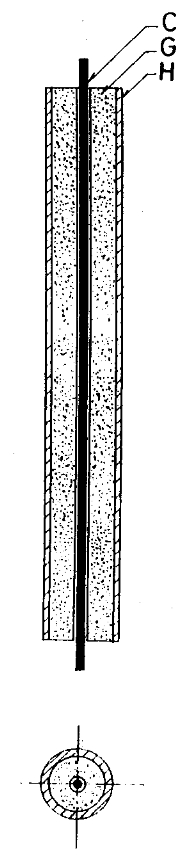

FIG.1

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This invention relates to a housed high strength core member having improved resistance to buckling on application of axial compression loads at the two ends.

Compression members are adapted to take compression loads and are used in a variety of civil and mechanical structures. For example such housed cores can be used in building columns, transmission towers, offshore platform legs, bridges, geodesic domes, scaffolding props, hydraulic jacks and many other applications that have a load applied on both ends. It is an established fact that the ability to carry compressive loads by a compression member depends on its yield strength and its buckling strength. While the yield strength is a mechanical property of the material, the buckling strength of the compression member is a geometric property and depends on the least moment of inertia of the cross section and the unsupported length of the compression member. The Euler's equation establishes the critical load for pin ended compression member as follows :

$$Pcr = \frac{\lambda^2 EI}{L^2}$$

in which Pcr is the critical load at which the compression member buckles, E is the modulus of elasticity of the material of the compression member, l is the length of the compression member and I is the least moment of inertia of the cross-section. Thus, the load at which buckling occurs depends on the stiffness of the member. In the case of a conventional compression member, both the required flexural stiffness and required cross-sectional area are provided by the cross section of the member resisting the applied axial load. High strength materials have a high strength to cost ratio and hence their use as compression member would result in economy if the material property can be fully utilised. In the case of conventional compression member of shorter length, use of such high strength materials would lead to very small cross-sectional area. The flexural stiffness requirement will dictate distribution of this area sufficiently away from neutral axis, resulting in large diameter tube having a very small shell thickness. This becomes impracticable because the tube may fail locally by crippling at a much lower load than the buckling or the yield load of the tube. Whereas in the case of longer length core, the buckling strength is less than the material yield strength. Hence in the case of conventional compression member the use of high strength steel economically is difficult.

It is therefore the object of this invention to provide for a core member of high strength to be placed inside the housing and laterally supported continuously or discretely by the housing through infills placed in the space between the housing and the core. This will improve the buckling strength of the core substantially.

It is also the object of this invention to reduce cost of erecting load bearing structures/devices and bring in ease of handling.

Definitions:

Core is a high strength member and can be made of materials such as steel, carbon fibres, kevlar etc.

Housing is a hollow section and can be made of high stiffness materials such as steel, aluminium, FRP etc.

Infills can be (a) grout and (b) spacers.

Grout can be cement slurry, cement mortar, cement concrete, cellular concrete, plaster of paris, epoxy, fly-ash and a variety of similar materials.

Spacers can be of steel or any material and should be closely spaced.

General Description of the Invention :

In this invention the flexural stiffness is provided by a housing within which at least one core is placed and the core provides the cross sectional area. The gap between the core and the housing is filled with infils.

There is a gap between the core and the infil and there is no bonding between the core and the housing. The compression load is applied only on the core member. The housing with the infils is not exposed to the compression load. Hence, the axial load is resisted by the core member alone. However, necessary flexural stiffness is provided to the core by the housing.

The invention also provides a method of making the high strength core member shorter than the housing and the core member will bear the axial load with the housing providing the flexural stiffness as described above.

The unique features of this invention are as follows :

A. A high strength core member is continuously/discretely supported laterally; thereby enhancing its buckling strength to a great extent. This ensures that the load carried by the core member is equal to the yield capacity of the core material. Thus, the advantage of high strength to cost of high strength material is fully realised.

B. The core member is continuously/discretely supported hence, the presence of any initial imperfections in the core member will not adversely affect its load carrying capacity. It will ensure that the load resisted is closer to its yield capacity. (fig. 10)

C. Any accidental eccentricity of loading will not adversely affect the load carrying capacity of the system and the load resisted will be closer to the yield capacity of the core material.

D. The gap between the core member and the housing is such that even after the core bulges laterally due to the applied axial load, there is still no bond between the core member and the housing. For example if a hard rubber is used as a core, then under the ultimate load of the system, even though the rubber core shortens in length and bulges diametrically all round there will still be a gap between the core and the infils and the applied load is directly carried by the core member only.

E. The projection of the core beyond the housing is such that, at ultimate load, even when the core member gets shortened in length, there will still be a small projection of the core beyond the housing so that the ultimate load is still carried by the core only.

F. The housing can be out of high stiffness material.

G. Load carrying members can be designed based on this invention in such a way that the outer housing (H) is subjected to a pretension force, by applying a compression force to the high strength core (C) through the sliding lug (SL) and by securedly fastening the lug member to the housing while under compression by a clamp (K) and thereafter releasing the said compressive load. The housing so tensioned can along with the compressed core efficiently carry the externally applied axial load. Material capacity of high strength core and the housing is fully utilised in this case. This feature is unique as to the method of pretensioning the outer housing. (Fig. 11)

Brief description of the drawings :

The invention will further be explained but is by no means limited thereto, with reference to the accompanying drawings, in which :

Fig. 1 illustrates a high strength core member (C) placed inside a Housing (H) and with grout (G) as an infil.

Fig 2 illustrates a high strength core member (C) placed inside a Housing (H) closely surrounded by an Inner Housing (IH) the space between the outer surface of IH and inner surface of H are filled with grout (G).

Fig 3 illustrates a high strength core member (C) placed inside the housing (H) closely surrounded by an Inner Housing (IH) and the outer surface of IH and the inner surface of H being connected by spacers (T).

Fig. 4, the core member (C) is placed inside the housing (H) and surrounded by a series of concentric Inner Housing (IH). The interspaces between the housings being connected by spacers (T).

Fig 5 illustrates presence of multiple high strength core members C1, C2, C3 placed inside the housing (H), and also illustrates the load being transferred to the shorter core members by a sliding lug (SL). The space between C & H being infilled with grout.

Fig 6 illustrates the housings H1, H2, H3 braced together by bracing members (BR) to form a tower. Each of these housings contain a high strength core member or members with infils as explained in the earlier embodiments.

Fig 7 illustrates discrete core members placed in a zigzag manner placed inside a housing (H) and the space between the core (C) and Housing (H) filled with grout (G).

Fig 8 illustrates some possible cross sectional shapes of Housings.

Fig 9 illustrates some possible cross sectional shapes of core members.

Fig 10 illustrates the core member being continuously supported by outer housing (H) through grout (G) reducing the effective unsupported length thereby allowing the core member to carry its yield load. Curve A is the actual failure load of the core member. Line B is the yield load capacity and curve P gives the buckling load. It can be observed from the graph that curve A coincides with yield line B for very small effective lengths in the region Q.

The invention proposed herein is not confined to the following embodiments herein described and illustrated are by way of example. It is clear for person skilled in the art that various other embodiments are also possible without departing from the scope and ambit of this invention.

Preferred embodiments of the housed high strength core member :

1. In a preferred embodiment of the invention, the infils for laterally restraining the core is provided in the space between the core member and the inner wall of the housing which can be inert material such as group (fig. 1), or the infils can provide an inner housing closely surrounding the core member and the space between the outer wall of inner housing and inner wall of outer housing being filled with an inert material such as a grout (fig. 2). In order to avoid bonding between the core and the grout, the core may be coated with a lubricant oil or any other anti-friction material. It is also possible to break

the bondage between the core and the grout before the grout is set (fig. 1).
2. In another preferred embodiment, the infils can be in the form of an inner housing closely surrounding the core, and the said inner housing being provided with spacers along the length of the housing (fig. 3). The said spacers are rigidly connected with the outer surface of the inner housing and in contact with the inner surface of the outer housing. The outer housing and the inner housing with the spacers provide the flexural stiffness required by the core member. It is also possible to have infils for laterally restraining the core by having a multiple inner housings consisting of one housing closely surrounding the core along with plurality of concentric housings each of them being connected by spacers along the length of the housings and in contact with the outer housing (fig. 4).
3. A compression member, according to the invention, can have a plurality of core members located in a common housing. The space between the core member and the inner wall of the housing being filled with grout as infil for providing the lateral restraint for the core members. Embodiment's 1 & 2 are applicable here.
4. The fourth embodiment comprising 3, 4 or more housing braced together to form a tower and where each housing is as per this invention and its embodiments hereinabove (fig. 6).
5. Another embodiment of this invention is that the core can have plurality of discrete number of disjointed pieces arranged at random or in a zig zag manner, either in a single housing or in a tower of embodiment 4 (fig. 7).
6. Another embodiment of this invention is the core member instead projecting beyond the housing such that the applied load is carried by the core member only, can also be shorter in length than the housing and the load can be transferred to the core member only be means of a sliding lug (fig. 5 LL). Embodiments 1 to 6 are applicable here also.
7. Another embodiment of the invention is the housing need not be a circular tube but can be of other cross section such as a square hollow section, rectangular hollow section, elliptical hollow section, triangular hollow section etc. (fig. 8)
8. Another embodiment is that the gap between core member and housing is provided in such a way that if the core member is loaded beyond its yield strength, would bulge in excess diametrically but still not fill up the gap. This embodiment allows the core member to go into a plastic stage, stabilise after strain hardening and thus improve its yield strength.
9. Another embodiment of the invention is the core member can also be of mild steel wherein the applications are such that the load to be carried is not as high as in the embodiments described above.
10. Another embodiment of the invention is the said core member can be of any cross sectional shape namely solid circular, hollow circular, solid square or hollow square etc. (fig. 9).

The housed high strength core member according to the invention may be used effectively and economically in structures like off-shore drilling platforms, transmission towers, crane booms, hydraulic cylinders/jacks, pistons, compression members in mechanical equipments, bicycles, railway coaches, railway freight cars, automobiles, TV towers, building structures, geodesic domes, towers, bridges, scaffolding props, aerospace structures etc. to name a few.

Claims

1. A housed high strength core member comprising of at least one core made of high strength material adapted for the application of the compression load, the said core(s) being surrounded by a housing with infils provided in the space between the inner wall of the housing and the core, providing lateral restraint to the core member, wherein the housing is shorter than the core at all stages of loading including the ultimate load of the core member to ensure that the compression load is applied only to the core member and there is no bond between the core member and the infil at all stages of loading, including the ultimate load.

2. A core member as claimed in claim 1, in which the infil is an inert material such as a grout to provide the lateral restraint to the core.

3. A core member as claimed in claim 1, in which the infil is in the form of an inner housing series of concentric housings connected to the outer housing at spaced intervals with spacers.

4. A method of making the housed high strength core member comprising the steps of providing at least one core of high strength material with a housing shorter than the said core, placing infils in the space between the inner wall of the housing and the core and avoiding bondage between the core and the infil.

5. The method as claimed in claim 4, wherein the infil space between the core and the housing is an inert material such as grout.

6. A housed high strength core member, substantially as herein described and illustrated with reference to the accompanying drawings.

7. A method of making a housed high strength core member substantially as hereinabove described.

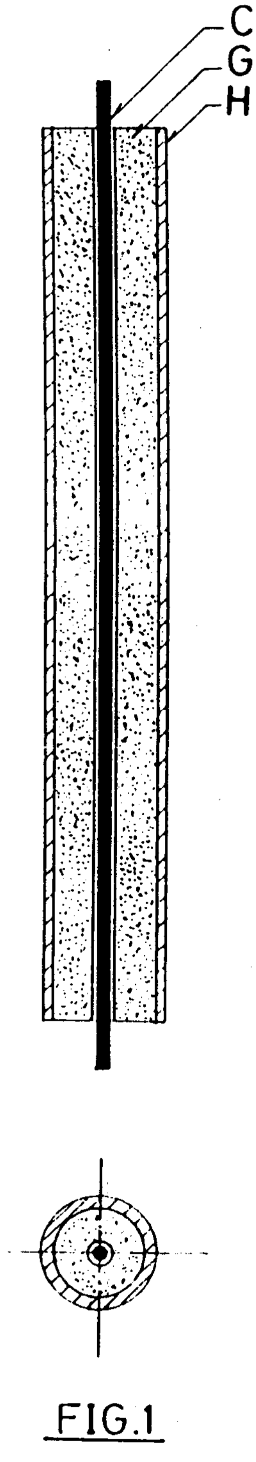


FIG.1

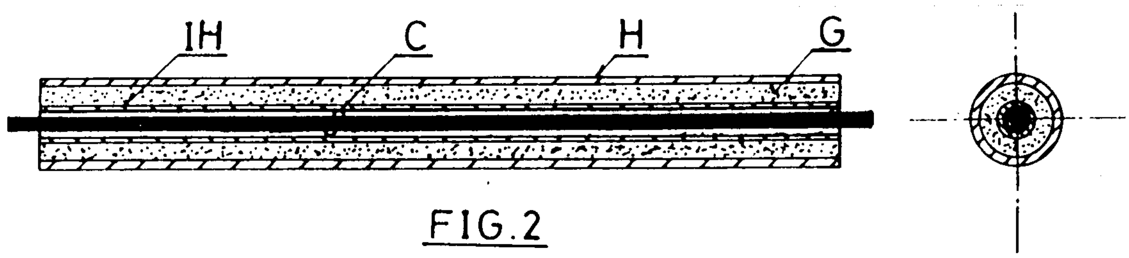


FIG.2

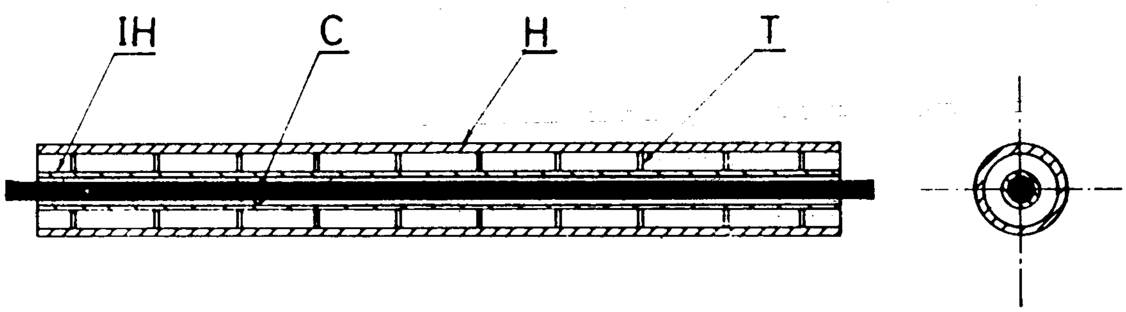


FIG.3

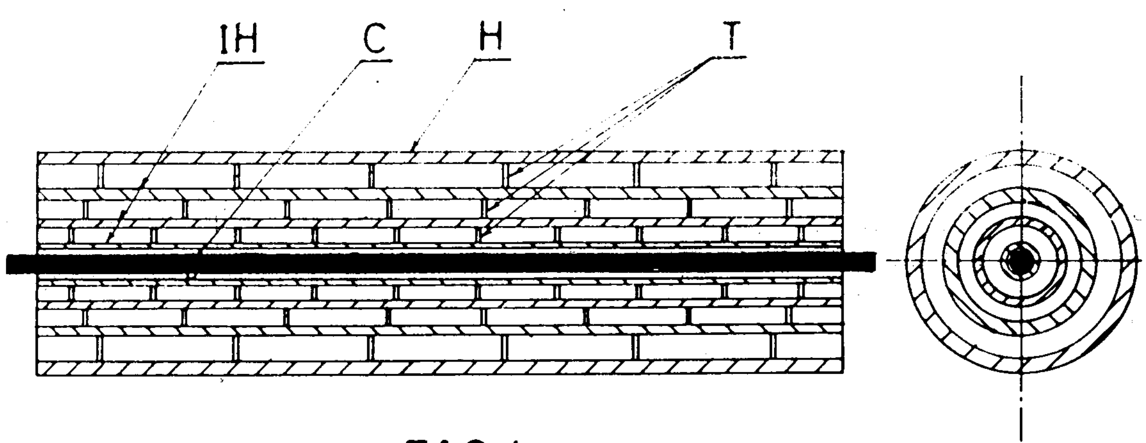
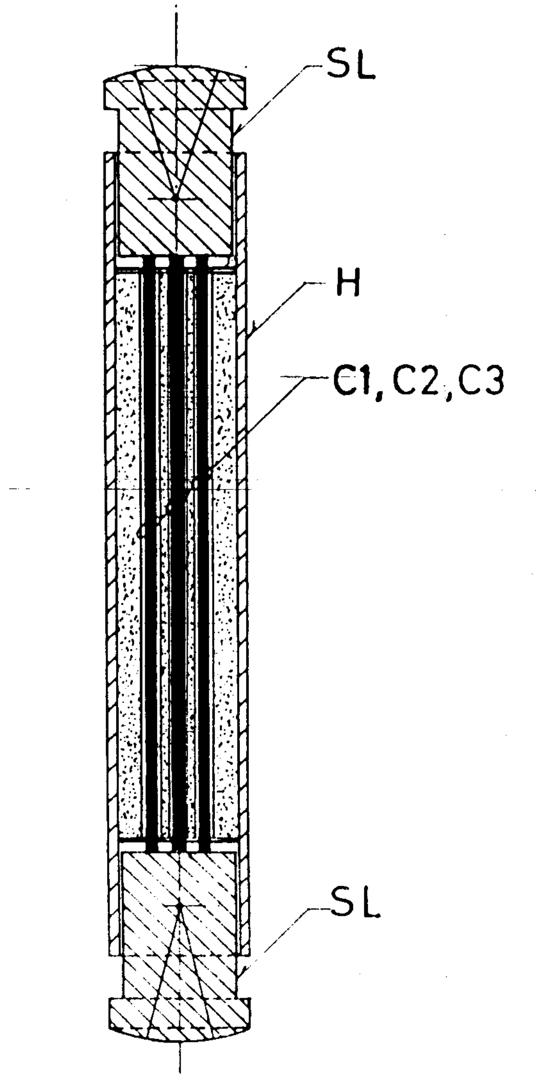


FIG.4



SECTIONAL ELEVATION

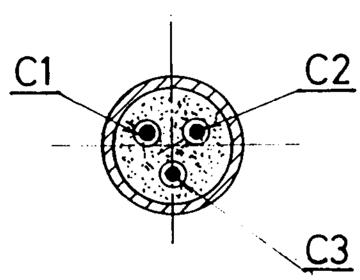
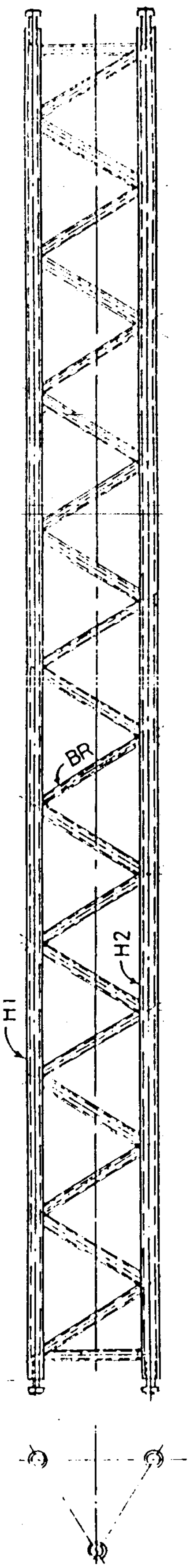


FIG.5



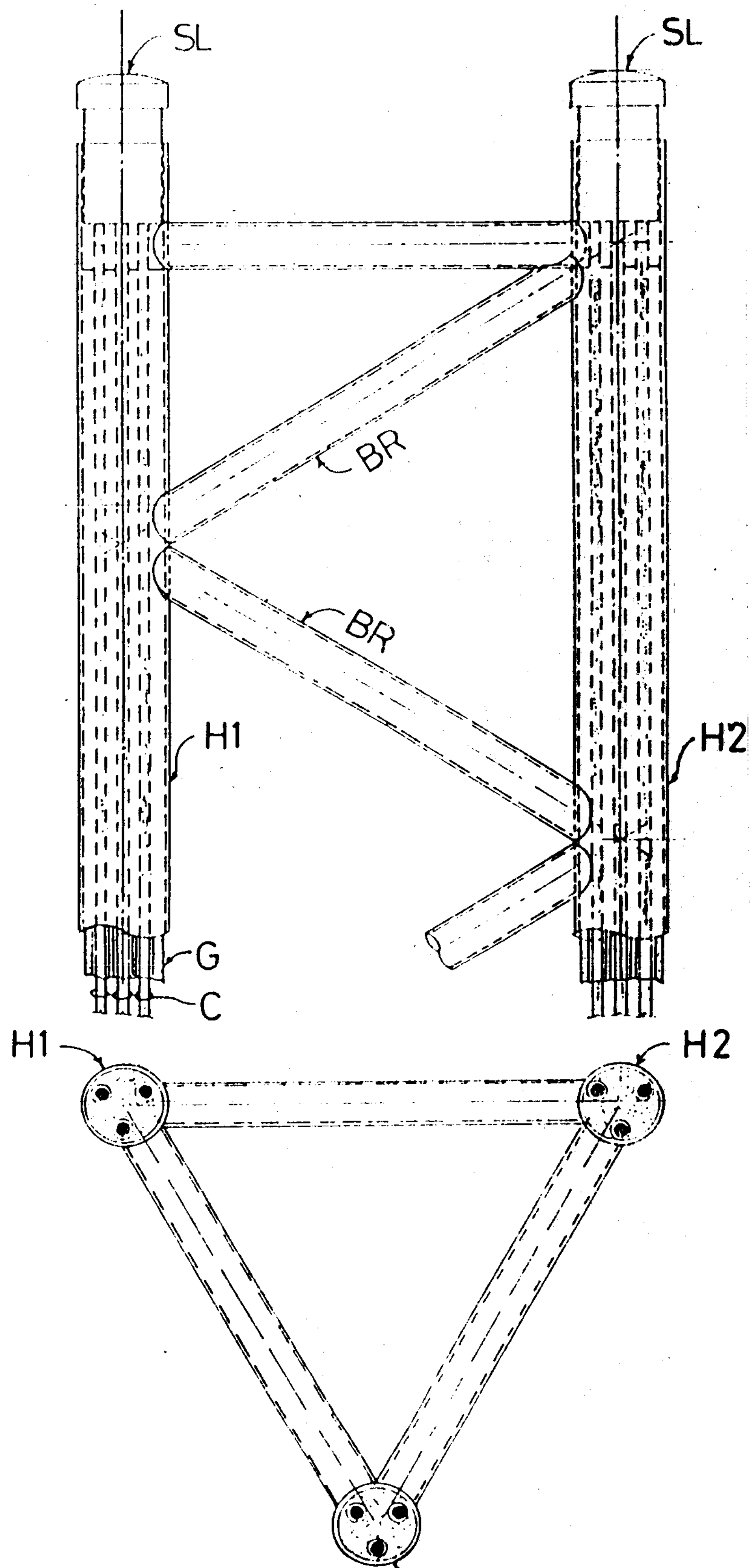


FIG.6

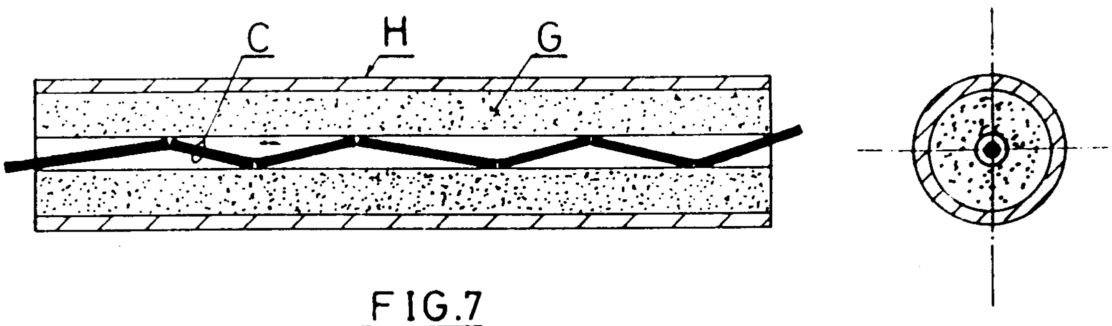


FIG.7

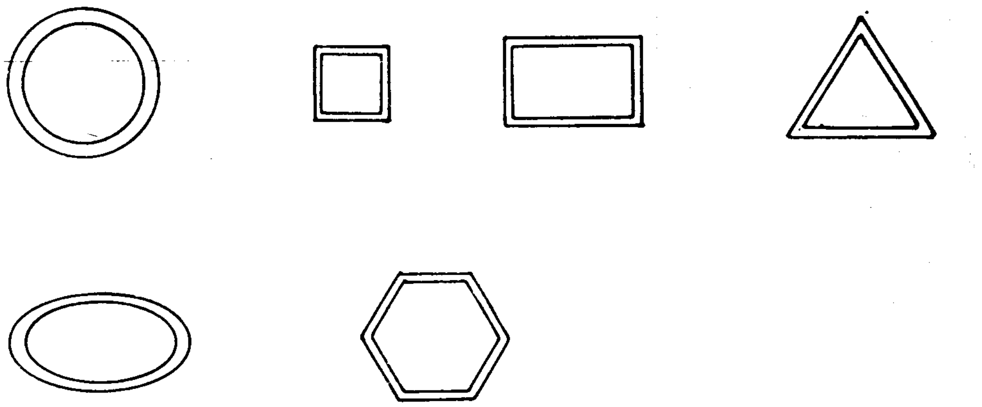


FIG.8

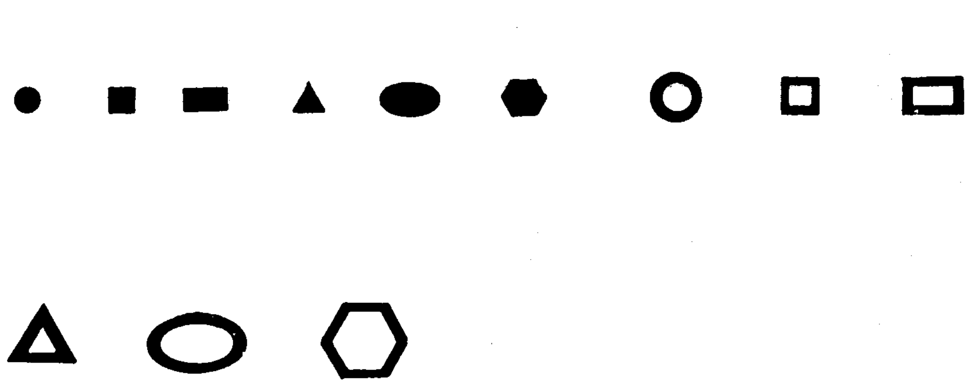
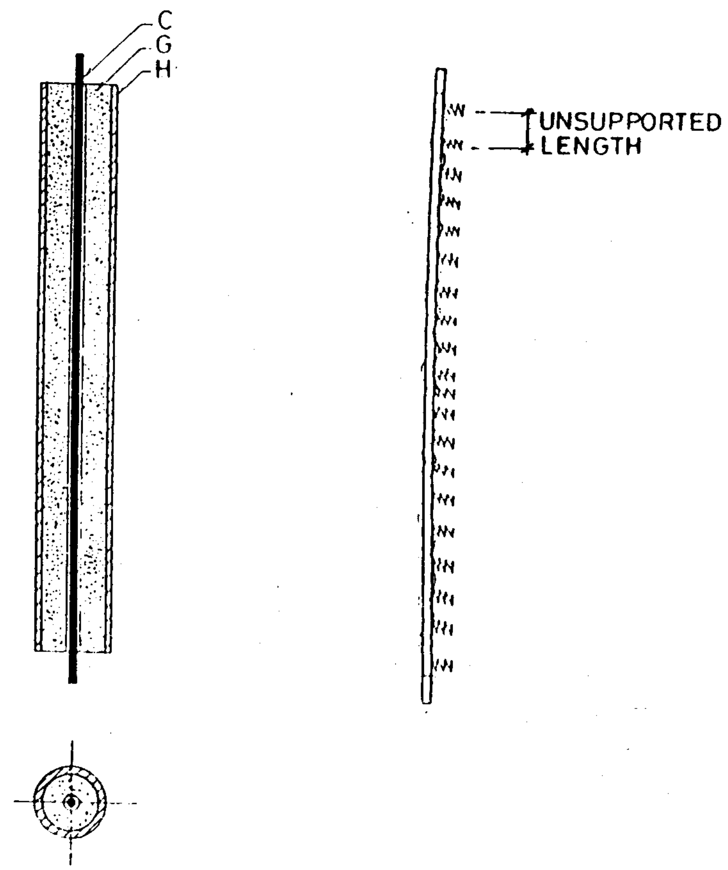


FIG.9



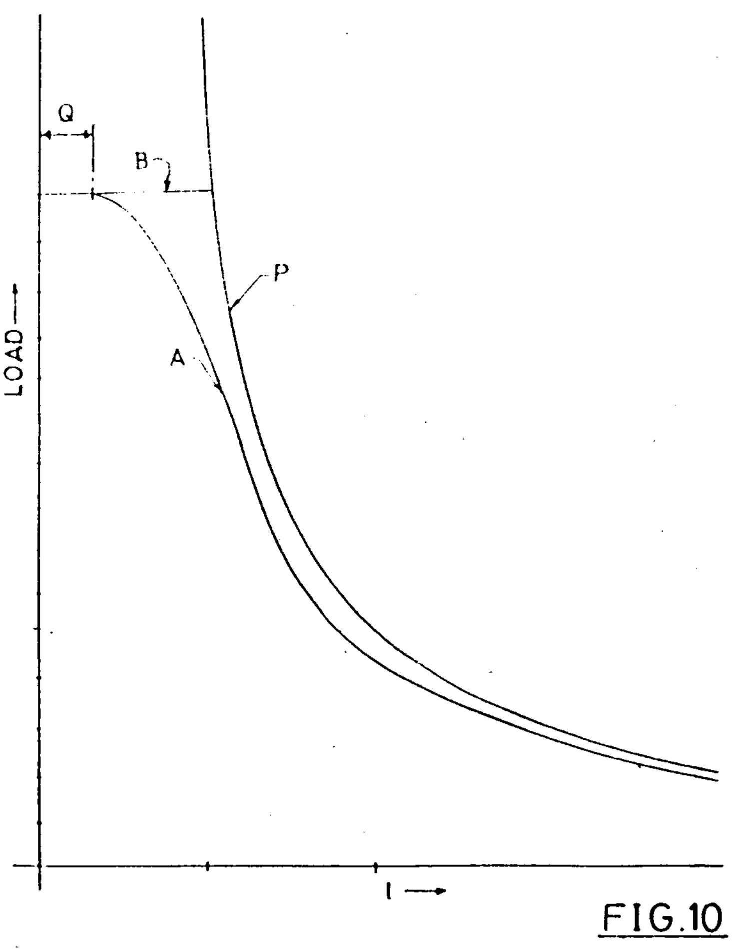


FIG.10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 3525

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X Y	DE-A-27 19 487 (H. BORSDORF) * page 10, last paragraph - page 11, last paragraph; figures 15-17 *	1,2,4-7 3	E04C3/34 E04C3/293 E04C3/10
X A	DE-A-27 27 698 (H. BORSDORF) * page 7, line 13 - page 8, line 12; figures 1-4 *	1,4,6,7 2,3,5	
Y	DE-A-25 46 893 (E. JOCHUM) * page 8, paragraph 4; figures *	3	
A	DE-A-27 23 534 (H. BORSDORF) * page 5, last paragraph - page 6, paragraph 1; figures *	1	
A	FR-A-1 537 471 (ACIER-BETON S.A.) * page 1, column 1, last paragraph - column 2, paragraph 1; figures *	1,4	**TECHNICAL FIELDS SEARCHED (Int.Cl.6)**
A	GB-A-M17206 (H. JAMES-CARRINGTON) * page 1, last paragraph; figures *	1,2,5	E04C
A	US-A-5 175 972 (SRIDHARA) * abstract; figures *	1	
A	EP-A-0 518 771 (FREYSSINET) * abstract; figures *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 October 1994	Righetti, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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