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

(11) Publication number: **0 443 988 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **91830012.0**

(51) Int. Cl.[5]: **E04H 9/02**, E01D 19/04

(22) Date of filing: **18.01.91**

(30) Priority: **20.02.90 IT 1941390**

(43) Date of publication of application:
28.08.91 Bulletin 91/35

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB LI NL SE

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(54) Load dissipating and limiting element.

(57) The present invention relates to a load dissipating and limiting element, for antiseismic devices and apparatus for bridges, viaducts, buildings and the like, comprising an elongated body (1) having restraining elements (2) at the ends thereof and, at an intermediate portion thereof, zones (3) tapering from the ends to the center portion thereof, and adapted to absorb elastic-plastic deformations.

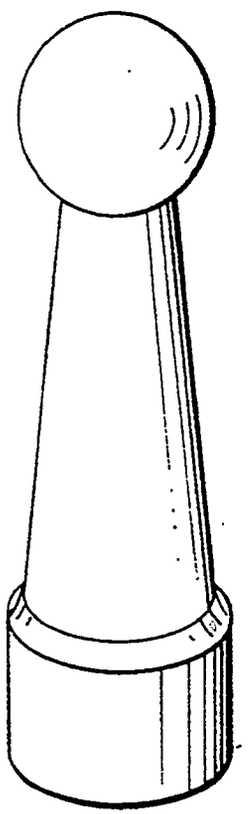

FIG. 1

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LOAD DISSIPATING AND LIMITING ELEMENT

BACKGROUND OF THE INVENTION

The present invention relates to a load dissipating and limiting element, which has been specifically designed for antiseismic devices and apparatus for bridges, viaducts, buildings and the like.

In prior Patent Applications in the name of the same Applicant (Italian Patent Applications No. 19538 A/86 and No. 19539 A/86 filed on February 26, 1986) and which are herein enclosed for reference, there are illustrated antiseismic devices comprising specifically designed pivot pins, shown in figures 1 and 2, which are substantially provided, at one end thereof, with a cylindric portion to which there is coupled a variable cross-section portion tapering toward the opposite end where a ball shaped portion ends.

The pivot pins, restrained in the cylindric portion, are deformed so as to be bent according to a given curvature, under the action of seismic forces applied to the ball shaped portion.

These embodiments provide multiple advantages, for example a comparatively reduced cost, a simple construction, reduced size, as well as multidirectional characteristics.

On the other hand, the mentioned pivot pins allow only rather limited sliding movements to occur, which drawback can be at least partially removed by using the arrangements shown in figures 3, 4 and 5, by diagrams which are statically and dynamically equivalent.

As it should be apparent, these constructions, while being operative, are very complex and expensive.

SUMMARY OF THE INVENTION

Accordingly, the aim of the present invention is to solve the above mentioned problem by providing a dissipating element which, owing to its specifically designed construction, affords the possibility of overcoming all of the difficulties associated with the mentioned limited sliding movements.

In fact, as is known, a seismic event generates abrupt displacements of the soil and, accordingly, abrupt accelerations which, as they are transmitted through foundation assemblies, will generate inertia forces because of the involved large masses forming the bridge, viaduct, building and the like construction.

Also known is that, by using suitable decoupling devices, as properly arranged, it is possible to reduce the inertia forces.

For example, in the case of bridges and viaducts, resilient restraining means have been adopted, which define a swinging element system, practically operating has a spring for the construction mass which has a proper resonance frequency which can be displaced away from the characteristic frequencies of the seismic events so as to greatly reduce the involved forces.

However, in the characteristic curve of the above mentioned restraining elements, after a first portion of proportionality between the stresses and strains, follows an abruptely raising portion thereby it is not possible to "control" the maximum force involved.

For solving this problem there have been designed further antiseismic restraining elements in which the above mentioned proportional portion is followed by a curve portion in which the force is independent from the strain, that is these elements have a substantially "plastic" performance.

In particular, these elastic-plastic performance devices allow the possibility of reducing as well as controlling the maximum inertia forces transmitted by the restrained masses (such as a viaduct mass) to the supporting constructions (for example the pile and shoulder construction), with self-evident advantages in the case of a high intensity seismic event.

From a dynamic standpoint, the use of horizontal restraining elements, with substantially elastic-plastic characteristics, corresponds to the introduction, near a series type of "spring", of a power dissipating element provided with a very high power dissipating capability and which, owing to its plastic deformations, provides a very advantageous ductile performance.

Accordingly, by the above mentioned dissipation, it is possible to obtain a great reduction, under a high intensity seismic event, of the spectrum response, with respect to the accelerations of the overall construction system, with a consequent great reduction of the stresses on the supporting structures.

In this connection it should be pointed out that the antiseismic devices have been mainly used in the road and railway bridges since the present technique is to made the latter with a continuous truss type of construction.

To the foregoing it is to be added that it is not possible to define the main direction of the seismic movements, thereby it will be necessary to designe multidirectional antiseismic devices.

Within the scope of the above mentioned aim, a main object of the present invention is to provide a load dissipating and liming element which can be directly associated with the supporting structures and which allows to easily make antiseismic devices, differentiated from the supporting structures or apparatus, and adapted to provide an efficient restraining system exclusively on a horizontal plane.

Another object of the present invention is to provide such a load dissipating and limiting element which is very simple construction-wise and can be easily made and assembled with a comparatively

reduced cost.

According to one aspect of the present invention, the above mentioned aim and objects, as well as yet other objects, which will become more apparent hereinafter, are achieved by a load dissipanting and limiting element, for antiseismic devices and apparatus for bridges, viaducts, buildings and the like, characterized in that said element comprises an elongated body having restraining elements at the end portions thereof and, at an intermediate portion thereof being provided with regions tapering from said end portions toward the center thereof, and adapted to absorb elastic-plastic deformations.

BRIEF DESCRIPTION OF THE DRAWINGS

Further characteristics and advantages of the present invention will become more apparent hereafter from the following detailed description of a preferred, though not exclusive, embodiment of a load dissipating and limiting element, according to the invention, which is illustrated, by way of an indicative but not limitative example, in the accompanying drawings, where :

Figures 1 and 2 show prior art pivot pins by a perspective view and an elevation view respectively ;

Figures 3, 4 and 5 show prior art applications which afford satisfactory mutual sliding movements ;

Figure 6 is a perspective view showing the load dissipating or absorbing and limiting element according to the invention ;

Figure 7 shows an elevation view of the load dissipating and limiting element according to the present invention ;

Figure 8 shows the load dissipating and limiting element of the invention in an assembled condition which is conceptually analogous to those shown for the prior art ;

Figure 9 is a schematic view showing a possible embodiment of an antiseismic device using the load dissipating and limiting element according to the present invention ;

and

Figure 10 is a cross-sectional view taken along the line X-X of Figure 9.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the figures of the accompanying drawings, the load dissipating and limiting element, which has been particularly designed for antiseismic devices and apparatus for bridges, viaducts, buildings and the like according to the invention, comprises an elongated body, overally indicated at the reference number 1, which, advantageously, is made of a steel material having a high ultimate elongation characteristic.

At the end portions thereof, the body 1 is provided with restraining elements which, preferably though not necessarily, comprise cylindric portions 2.

At the central portion thereof, each load dissipating and limiting element, which will be more simply called "spindle" is provided with a double tapering region 3 converging from the ends toward the central portion thereof.

Each spindle will be designed so as to provide the desired displacements and reactions, and its shape is so designed as to use, under plastic deformations, the main portions of the material forming the stem thereof, that is the tapering region thereof, so as to provide the desired ductile performance.

The "spindles" are restrained by means of the end restraining elements 2 to the elements or plates 10 of the antiseismic devices or supporting constructions subjected to a relative displacement during the seismic event.

One of the two restraining elements can be withdrawn in order to allow the above mentioned relative displacement of the plates, without causing the spindle stem to be elongated.

The cross-sectional shape of the stem can be circular, in which case an isotropic performance will be obtained with respect to the displacements and reactions, or any desired shapes (for example an elliptical shape) in which case it will be obtained an anisotropic type of performance, while preserving the important features of a multi-directional characteristic.

Figures 9 and 10 show an antiseismic device made by using the above disclosed spindles, and comprising two end plates 10 restraining said spindles.

More specifically, the bottom plate is anchored to the understructure by means of restraining elements 11, whereas the top plate is coupled to the overstructure through a cup element 12 in turn anchored by restraining elements 13.

The mutual movement under the structure and above it will deform the spindles 1 and the provision of the cup element 12 allows to absorb the displacement toward one another of the end plates, which displacement is produced by second order effects deriving from the spindle deformations, without subjecting the latter to any tension stresses.

As stated, the same effect can also be obtained by using sleeve removable restraining elements.

In the embodiments shown in figures 9 and 10 there is provided a circular geometry ; of course any arrangements of the spindles will be possible, for example a square geometry, rectangular geometry and the like.

The use of the above disclosed spindle provides a solution equivalent to that of the prior art shown in figures 3 to 5 with much simpler constructional

means.

In fact, in the prior art diagram, the top and bottom hinges will rotate, by simmetry, for the same amount, under the effect of the displacements of the two end plates ; likewise, the load dissipating and limiting element according to the invention provides the same effect since it is adapted to increase the mutual displacements, the length being the same, with respect to the pins and with the same stiffness of the system.

To the foregoing it is to be added that the device according to the present invention can be also provided with other means, such as set-breakage small keys, in order to remove from the characteristic curve the resilient portion, as well as with plungers or other hydraulic means for absorbing the slow movement (for example due to thermal effects) without stressing the spindles.

The spindle elements according to the present invention can be applied to any supporting apparatus (for example made of neoprene, steel, polytetrafluoroethylene and so on) in a like way to that shown in the above mentioned patent applications.

The invention as disclosed is susceptible to several modifications and variations all of which will come within the scope of the invention.

Moreover, all of the details can be replaced by other technically equivalent elements.

In practicing the invention, the used material, as well as the specific size and shapes can be any according to requirements.

Claims

1. A load dissipating and limiting element, for antiseismic devices and apparatus for bridges, viaducts, buildings and the like, characterized in that said element comprises an elongated body having restraining elements at the end portions thereof and, at an intermediate portion thereof being provided with regions tapering from said end portions toward the center thereof, and adapted to absorb elastic-plastic deformations.

2. A load dissipating and limiting element according to claim 1, characterized in that said restraining elements have a substantially cylindrical shape.

3. A load dissipating and limiting element according to the preceding claims, characterized in that said tapering regions have a circular shape cross section, in order to provide an isotropic performance with respect to the displacements.

4. A load dissipating and limiting element according to one or more of the preceding claims, characterized in that said tapering regions have not circular cross sections in order to provide an anisotropic performance with respect to the displacements.

5. A load dissipating and limiting element according to one or more of the preceding claims, characterized in that at least one of the end portions of the body can be coupled to end plates by a removable restraining coupling of the sleeve type.

6. A load dissipating and limiting element according to one or more of the preceding claims, characterized in that said body can be arranged between movable portions of supporting apparatus, so as to cause said apparatus to follow a set antiseismic stress-strain characteristic curve.

7. A load dissipating and limiting element according to one or more of the preceding claims, characterized in that said bodies connect said plates, which are subjected to mutual displacements during a seismic event, so as to provide a set performance with respect to displacements and reactions.

8. An antiseismic device including at least a load dissipating and limiting element according to any preceding claims, characterized in that said device further comprises an element for compensating second order effects, adapted to allow the end plates coupling a plurality of load dissipating and limiting elements to move towards one another without subjecting said load dissipating and limiting element to any elongations or tension stresses.

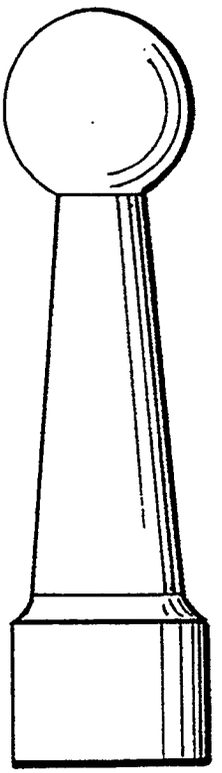

FIG. 2

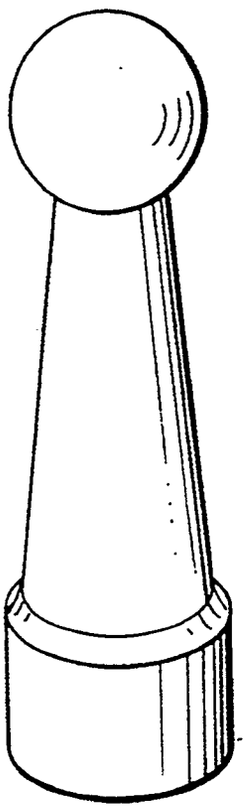

FIG. 1

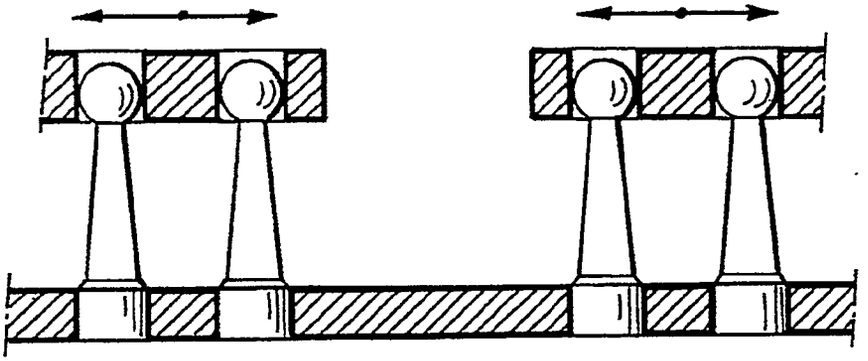

FIG. 3

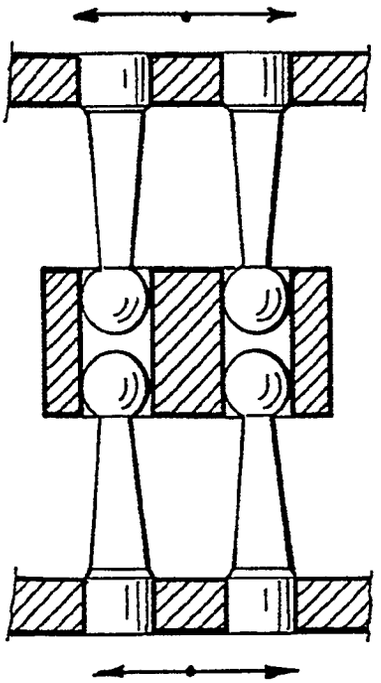

FIG. 4

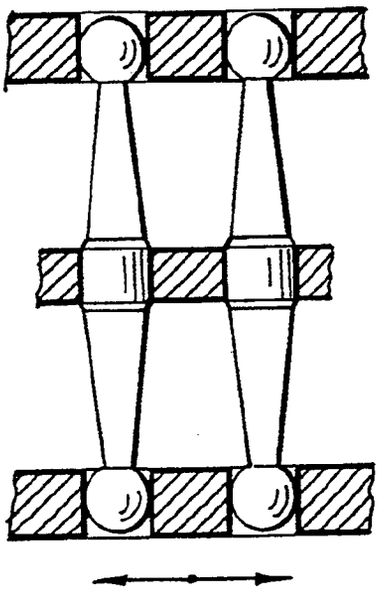

FIG. 5

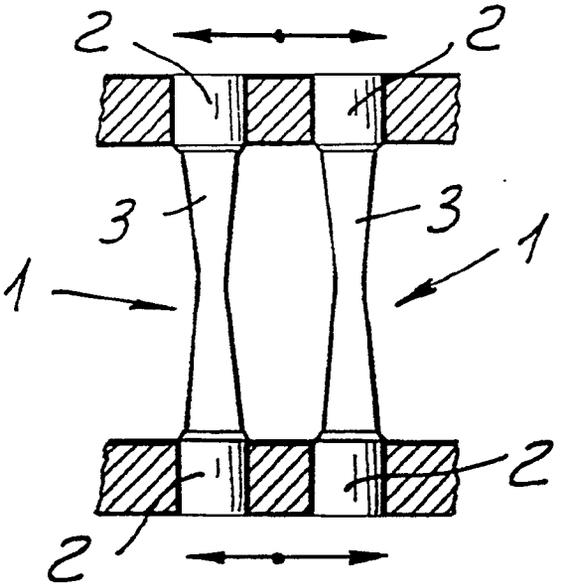

FIG. 8

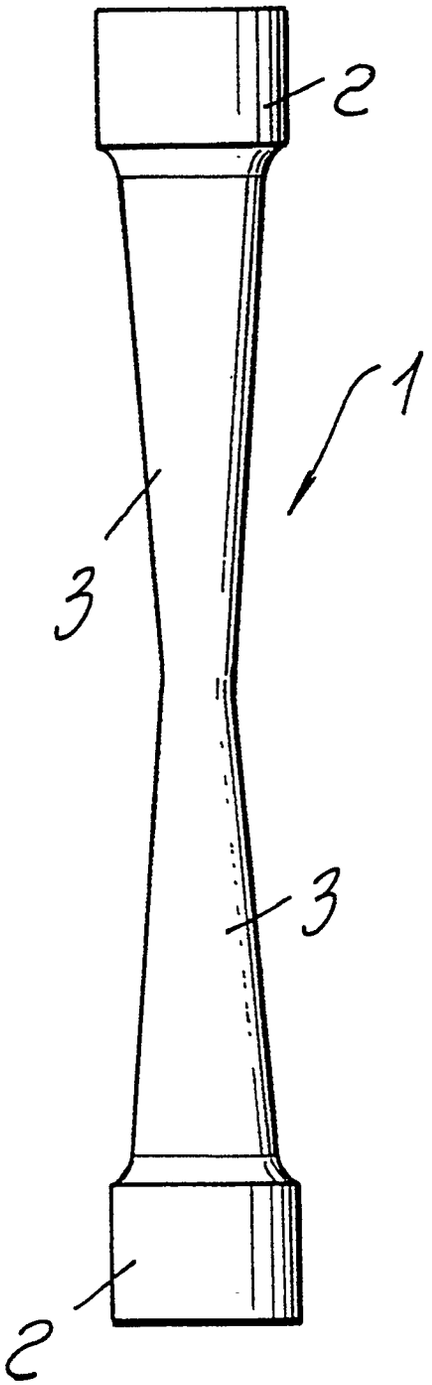

FIG. 7

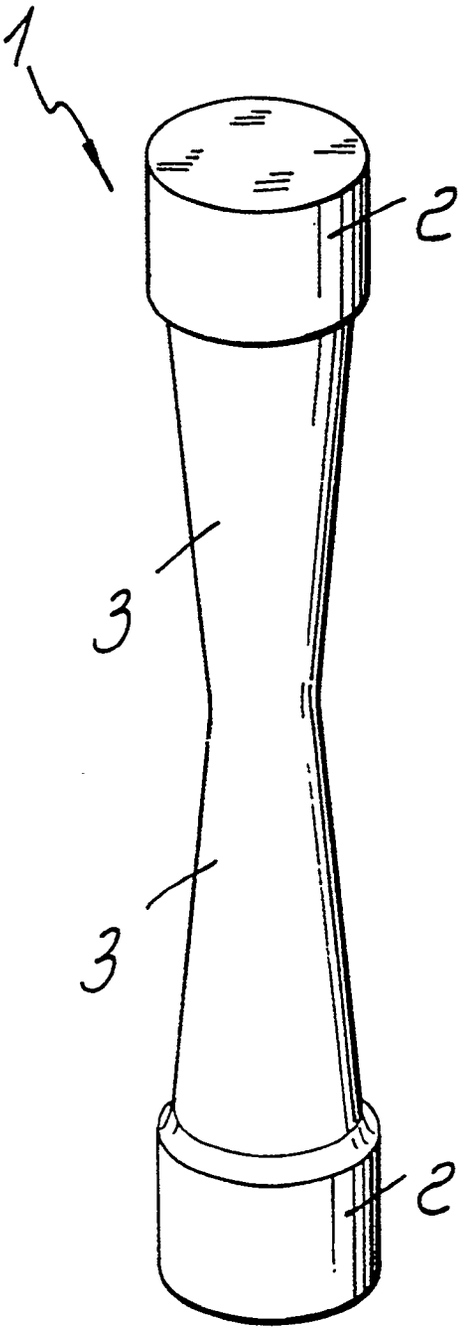

FIG. 6

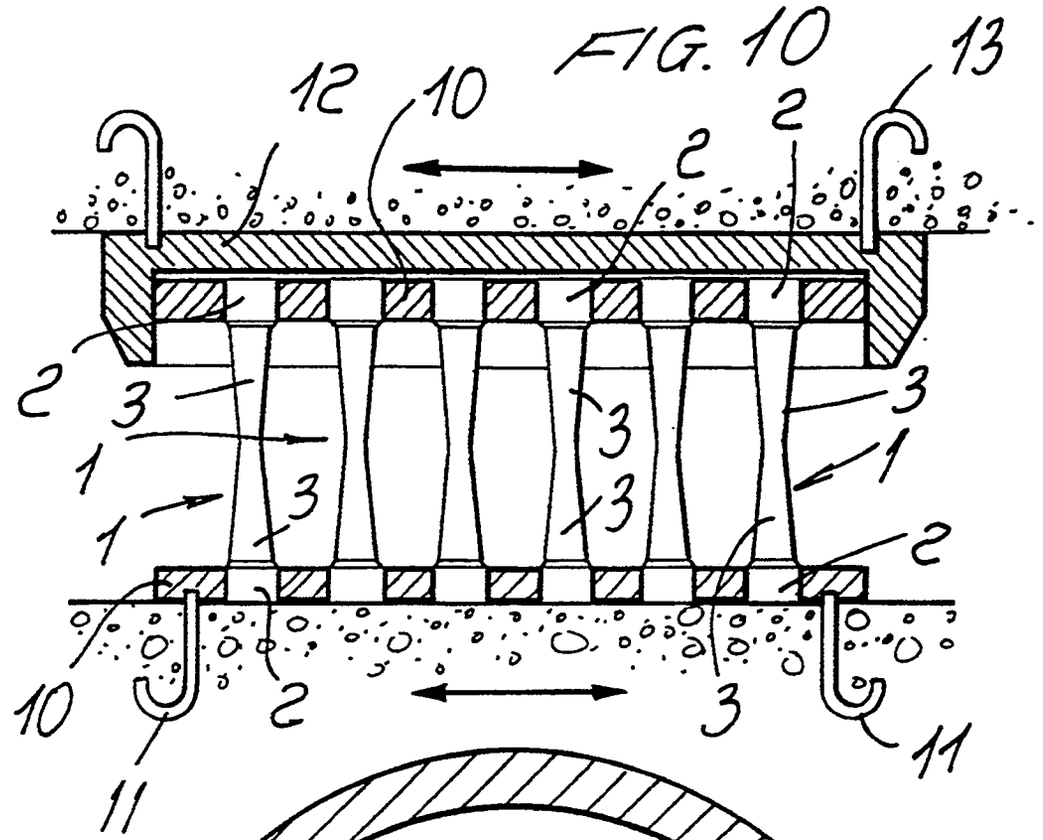

FIG. 10

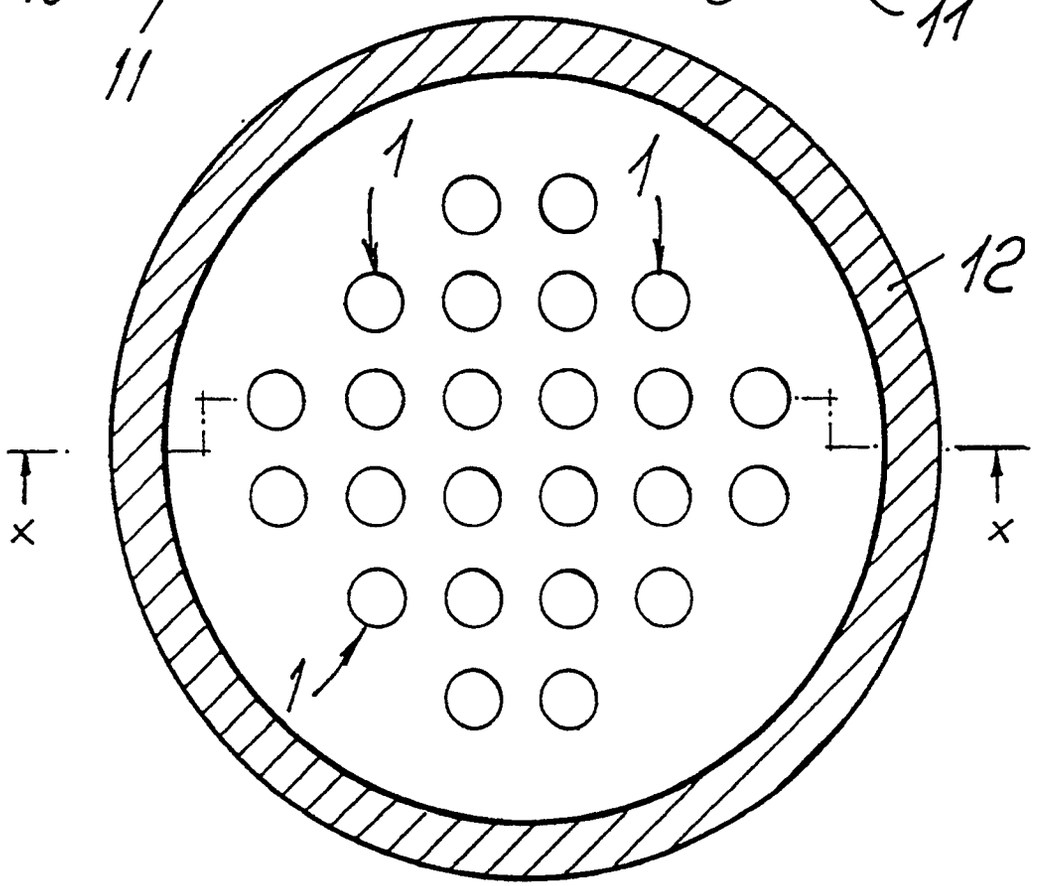

FIG. 9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 83 0012

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.5)
X	US-A-4 117 637 (ROBINSON)	1-4,6,7, 8	E04H9/02 E01D19/04
Y	* column 6, line 27 - column 7, line 41 * * column 7, line 53 - line 66 * * column 8, line 52 - column 9, line 2; figures 1-3 *	5	
Y	EP-A-206 183 (FUJITA,TAKAFUMI)	5	
A	* page 1, line 24 - page 2, line 13 * * page 4, line 24 - page 5, line 3 * * page 15, line 19 - line 34; figure 28 *	1-3,6-8	
A	DE-A-3 047 762 (GERB GESELLSCHAFT FUR ISOLIERUNG) * page 6, line 16 - page 8, line 5; figure 1 *	6-8	
E A	US-A-4 901 486 (TAKUJU KOBORI) * column 1, line 43 - column 2, line 34 * * column 9, line 1 - line 16 * * column 9, line 56 - column 10, line 16 * * column 10, line 32 - line 50 * * column 11, line 31 - line 40 * * column 12, line 24 - line 29; figures 18,19,33,50 *	1,4,6,7 3	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E04H
E04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 MAY 1991	GUILLAUME G.E.P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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