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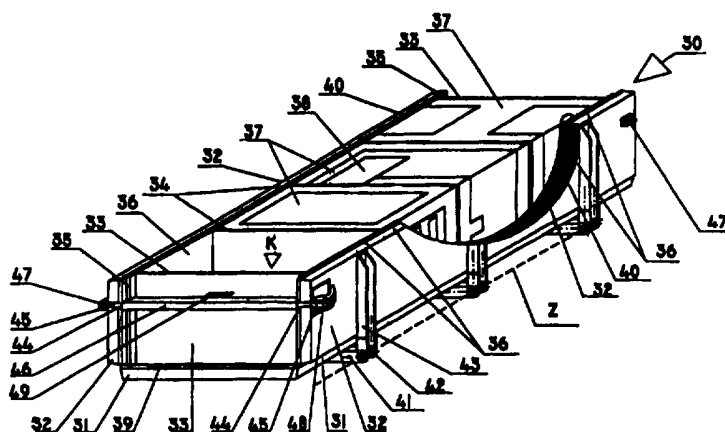
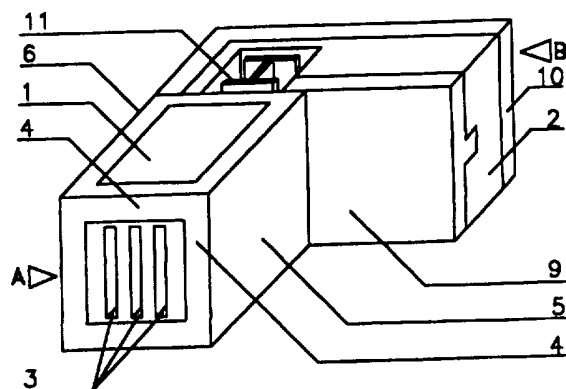
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : B28B 19/00, 7/36, 7/24, E04C 1/41		A1	(11) International Publication Number: WO 96/32238
			(43) International Publication Date: 17 October 1996 (17.10.96)
(21) International Application Number: PCT/PL96/00007		(81) Designated States: AL, AM, AT, AU, AZ, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KR, KZ, LK, LR, LT, LU, LV, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, UA, US, UZ, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 12 April 1996 (12.04.96)			
(30) Priority Data: P.308087 12 April 1995 (12.04.95) PL P.313696 11 April 1996 (11.04.96) PL			
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(54) Title: A METHOD FOR FORMING GYPSUM STRUCTURAL ELEMENTS BY USING THERMOINSULATING INSERTS, AND A MOLD FOR MANUFACTURING STRUCTURAL ELEMENTS

(57) Abstract

This invention relates to a method for forming gypsum structural elements (A, B) having a thermoinsulating fill, and to a mold for using this method. A method consists in pouring gypsum slurry into a mold, the component of which before said pouring is a thermoinsulating fill in a shape of an insert (1, 2), defining a component of said gypsum element after ending the process of at least initial gypsum slurry setting, whereas a one- or multi-part insert is used, having any selected outer shapes, advantageously provided with openings. A mold (30) formed as a multi-chamber box is characterized in that the inner surfaces of the side walls (32) are lined with a plane-parallel flexible and compressible separator (40), to which dismountable, rigid liner tiles (36) adhere, determining distances between particular inner partitions (34) and the side walls (33), while the inwardly directed surface of the basis (31) is lined with a replaceable plane-parallel and incompressible liner (39) made of material not adhering to gypsum slurry.



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**A method for forming gypsum structural elements by using
thermoinsulating inserts, and a mold for manufacturing
structural elements**

5 This invention relates to a method for forming gypsum structural elements by using thermoinsulating inserts to be used in the building industry, especially in housing. This invention relates also to a mold for manufacturing structural elements, especially gypsum structural elements having thermoinsulating inserts.

10 It is known to produce gypsum structural elements for erecting outer walls and roof constructions by casting them in molds having inserts being components of said molds, and making it possible to define rooms inside said structural elements. While erecting walls comprised of structural elements of this kind said rooms are filled with materials having the heat insulating power greater than in a case of gypsum, especially with sawdust, granulated foamed polystyrene, gas foamed gypsum,
15 and other similar materials. An essential problem when realizing such a technique consists in that repeatedly used inserts have to be precisely cleaned and smeared after casting every single structural element.

20 Another solution is the system known as "THERMODOM", according to which elements made of foamed polystyrene are used as a cladding on a ferroconcrete construction. This system needs the expensive protection for a façade and for an outside plaster. As well the inner as the outer surface of any wall made in this system is very sensitive to mechanical strokes of inconsiderable power, and any actions in order to hang even light household means on a wall made by this technique are extremely troublesome.

25 There are known devices for forming concrete, slag, and saw dust concrete structural elements having inner hollows shaped by rigid inserts disassembled before dismantling a mold, provided with mechanisms for consolidating a raw mate-

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rial supplied into the form. Similar devices are used for forming gypsum structural elements by filling with gypsum slurry watertight molds provided as well with all kinds of dismountable inner inserts that copy outer and inner shapes of those elements. Side walls of the boxes of those molds have rigid, hinge connections with a mold basis, located near the lower edges of the sides, and rigid, mechanical or hydraulic locks at upper parts of those molds.

The characteristic feature of the gypsum slurry setting process is its volume increase, what results in occurring great forces deforming the rigid mold structure. Another feature of forming gypsum elements is the necessity of using reusable inserts, the cross-section of which decreases in direction from a mold basis, and which are designed for forming inner shapes of hollows in those elements, generally provided for filling them with insulating materials while erecting walls.

Even especially reinforced and in result of it expensive molds are permanently deformed gradually and after a very short operation time, what exerts an essential influence on the significant scatter of dimensions of particular gypsum structural elements, on deteriorating the tightness of molds, as well as on difficulties in disassembling inserts of those molds converging to their bases.

It is an object of this invention to provide a method for manufacturing structural elements which thanks to their low costs are usable for erecting walls by simplest assembling techniques, especially outer walls of apartment houses and any other public utility objects having the heat permeability factor $k_0 < 0,2 \text{ W/m}^2 \text{ K}$, whereas said walls satisfactorily and sufficiently meet the mechanical strength requirements.

It is also an object of this invention to provide a structure of a mold for manufacturing structural elements, especially gypsum elements with thermoinsulating inserts, that ensures the permanent repeatability of overall dimensions of produced structural elements, and at the same time eliminates destructive strains in

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mold components, multiplies the working life of a mold, its servicing facility, and maintainability, and additionally multiplies the single mold productivity.

This object has been achieved by putting together in a structural element gypsum with thermoinsulating material shaped as an insert lost during production, that means while manufacturing said structural element.

According to the invention a method for manufacturing gypsum structural elements comprises filling with gypsum slurry a mold, a component of which before filling is a thermoinsulating fill shaped as an insert defining a component of a gypsum structural element after gypsum slurry setting process (at least initial setting) is finished, whereas one uses a one- or multi-part insert having any selected outer shapes, advantageously provided with openings.

Said at least initial setting should be understood as such an advancement of the setting process, that a shaped gypsum structural element can be removed from its mold without disturbing its structure, especially without possibilities to disturb the connection between material defining said insert and gypsum surrounding partially or entirely said insert.

It has become unexpectedly evident that by using an insert of such a material gypsum structural elements are achieved in easier and simpler way, being simultaneously filled with thermoinsulating material, and moreover cleaning and smearing inserts of molds in each cycle of manufacturing said structural elements have been eliminated.

Also unexpectedly a possibility has been obtained to produce structural elements having shapes unachievable by using known techniques, or obtained only by methods unusually troublesome in realization and/or requiring substantial costs.

A solution according to the invention, while allowing to eliminate inner components of a mold for casting gypsum structural elements, makes it possible to sub-

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stantially decrease costs needed for manufacturing and maintaining molds, especially to reduce costs connected with cleaning and smearing inner parts of molds.

In comparison with other techniques for manufacturing gypsum structural elements a method according to the present invention makes it possible to obtain structural elements for erecting outer walls which do not require using additional means and techniques for protecting said walls from the cold, generally going together with wet processes increasing the time for realization of such objects.

By using disposable lost thermoinsulating inserts according to the present invention the application of repeatedly used inserts, made of metal, plastic and so on, as components of molds has been eliminated. Moreover, said thermoinsulating inserts used as a filling in a gypsum structural element, obtained by a method according to the present invention, eliminate entirely a need to protect monolithic walls made of them from the cold. It decreases substantially the labor consumption while manufacturing gypsum structural elements and while erecting walls of them.

A thermoinsulating insert inside a warm gypsum wall is the simplest and cheapest way to achieve outer walls and floors having the excellent heat and sound insulating power at sufficient mechanical strength of the façade of the building, protected only by means of a hydrophobic paint designed for the outside, and by other paints inside after floating wall surfaces with gypsum putty without a need to plaster inner and outer surfaces.

A mold for manufacturing structural elements, especially gypsum ones having thermoinsulating inserts, that is formed as a multichamber box comprised of a basis, two side walls, hinged in relation to longer basis edges, two headwalls, as well as inner partitions dividing said mold into individual chambers, in addition provided with locking and positioning means, is characterized according to the invention by that inner surfaces of side walls are lined with plane-parallel flexible and compressible separator on which abut dismountable rigid lining tiles determining

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distances between particular inner partitions and headwalls, whereas an inner basis surface is lined with replaceable, plane-parallel and incompressible liner made of a material not adhering to gypsum slurry.

5 A separator, advantageously made of rubber, is at its parts extending beyond headwalls pressed against side walls by means of stops permanently connected to said side walls, on which headwalls are supported.

Brackets are fastened to an outer lower surface of a basis. Ends of said brackets extending beyond the basis have hinges provided with elastic articulated joints having carrier arms extending from them and connected permanently to side
10 walls.

In end parts of side walls there are located retaining sockets having a pull rod removable in them, and slidable in a abutment link, one of the ends of this pull rod is provided with an elastic head connected to one of the side walls, and at another of its ends there is located a self-locking and articulated separable locking
15 mechanism engaged with another of side walls.

Between said abutment link and an outwardly directed surface of a headwall there is placed a washer, advantageously a flexible one.

It has become unexpectedly evident that a) by using thermoinsulating inserts made of flexible material, e.g. inserts of foamed polystyrene, as elements lost during
20 forming phase, but being flexible elements of a mold before filling, b) by using flexible separators together with liner tiles as an inner lining of the side walls of the mold, as well as c) by taking advantage of elasticity of retaining and locking means of the mold the permanent repeatability of dimensions of gypsum structural elements having precision, orthogonality, and outer surface quality of these elements in
25 each forming cycle not occurring till now, essentially not depending on the operation time of a particular mold or a group of identical molds.

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A design of a mold according to the present invention enables to eliminate technical difficulties while forming gypsum structural elements, to lower the production costs, and to increase productivity when manufacturing said elements, as well as to substantially decrease costs of erecting gypsum-concrete walls comprised of these elements.

The invention will be described in details thereunder in its embodiments shown in the drawing in which fig. 1 and 2 represent axonometric views of two inserts made of thermoinsulating material, fig. 3 represents the axonometric view of two gypsum structural elements shaped by using inserts shown in fig. 1 and 2, and then put together as corner elements in an erected building wall, fig. 4 and fig. 5 represent axonometric views of the third embodiment of an insert of thermoinsulating material and respectively a gypsum structural element defined by using said insert, fig. 6 and 7 represent respectively axonometric views of the fourth embodiment of an insert of thermoinsulating material as well as a gypsum structural element defined by using said insert, fig. 8 represents a front view of a gypsum structural element designed to be used as a floor element, fig. 9 represents an axonometric view of a mold partially cut out in its hinged side wall, and fig. 10 represents a top view of the same mold.

In fig. 1 and fig. 2 there are shown inserts 1 and 2 made of thermoinsulating material and being inserts of a mold to be filled with gypsum slurry. Before filling the mold these thermoinsulating inserts are positioned and optionally fixed in their needed position in the mold box, and then spaces determined by inner surfaces of this mold box as well as outer surfaces of the insert 1 or the insert 2 are filled with gypsum slurry. On ending the initial setting process of the gypsum slurry a gypsum structural element comprising the insert of an thermoinsulating material surrounded with gypsum is removed as a whole from the mold.

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The thermoinsulating insert 1 shown in fig. 1 is shaped substantially as a rectangular prism having four recesses 1a parallel one to another and located at corners, as well as two through gap openings 3 located along the longitudinal axis X.

5 The second thermoinsulating insert 2 shown in fig. 2 comprises an asymmetrically situated channel 7 having a rectangular section with a horizontal plane, as well as a through opening 8 crossed with a groove 8' extending in a horizontal plane laying in the symmetry axis Y.

Two gypsum structural elements A and B of different shapes defined by using the thermoinsulating inserts 1 and 2 are set together in the exemplary wall corner system as shown in fig. 3. It should be noted that the structural element A has in
10 areas of the recesses 1a in the insert 1 links 4 being elements connecting outer layers 5 and 6 of one wall. The same function of connecting outer layers 9 and 10 of the second wall has a gypsum link defined in the through opening 8 in the insert 2 belonging to the structural element B. It should be noted too that while manufacturing
15 the structural element B the channel 7 in the insert 2 is not filled with gypsum slurry because that channel is designed to guard the vertical constructional corner column 11 made for example of a steel profile. A room defined by that channel 7 may be filled with any insulating material not before erecting walls of an object.

In fig. 4 there is shown the thermoinsulating insert 12 having recesses 13 at
20 both opposite shorter sides and a groove 14 at one of its longer sides. The insert 12 is preformed in the structural element C, shown in fig. 5, in such a way that it is surrounded with two adjacent outer layers 16 parallel one to another, and connected together with links 17 formed in the result of filling recesses 13 in the insert 12 with gypsum slurry.

25 In fig. 6 and 7 there is shown a further embodiment of the thermoinsulating insert 18 having recesses 20 in both corners of its shorter side and a projection 19 on its face near its line of intersection with the second shorter side. As is shown in fig. 6

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the insert 18 is preformed in the gypsum structural element D so that it adheres to and is integrally connected with two outer layers 21 and 22 combined by means of links 4 defined in said two recesses 20 of the insert 18, and by means of the opposite side layer 23, whereas in the outer layer 22 there is preformed said projection 19 of the insert.

In fig. 8 there is shown the gypsum structural element F, being a floor element having two channels 24 delimited by lost profile inserts 25, which in this case are also made of a thermoinsulating material and define a component of a mold before filling it with gypsum slurry.

Gypsum structural elements with a thermoinsulating insert, that is for example shown in fig. 4, are formed in the following way. The thermoinsulating insert 12 is placed in the mold box in the position shown in fig. 4, that means in the position where its longer side having the groove 14 is directed upwards. Then, after closing the mold, the formerly prepared gypsum slurry is poured into the space between the insert and the side walls of the mold. After initial setting of the slurry, usually after 15 minutes, the mold is opened, and the finished structural element C (fig. 5) is removed, two outer layers 16 of which are connected together by means of links 17 located in the recesses 13 of the insert 12.

As it is shown in fig. 9 and 10, a mold 30 is made as a multichamber box comprising in its lower part a basis 31, two side walls 32 hinged on rotation axes Z extending parallel to longer basis edges 31, two headwalls 33, as well as inner partitions 34 dividing the mold into individual chambers K. The headwalls 33 are retained in their position exactly perpendicular to the surface of the basis 31 by means of stops 35 permanently fastened to inner surfaces of the side walls 32 at their end parts.

The inner partitions 34 are located in channels determined between vertical edges of dismountable liner tiles 36 made advantageously of epoxide glass, what

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results in obtaining perfectly smooth surfaces of the structural elements being formed, whereas gypsum slurry adheres to said surfaces.

Particular chambers K of the mold 30 to be filled with gypsum slurry are determined by two opposite located liner tiles 36, by adjacent pairs of inner partitions 34 or by an inner partition 34 and an adjacent headwall 33, as well as by thermoin-
5 sulating inserts lost while casting and by removable inserts 38 set in chambers K in selected positions.

The basis 31 and the side walls 32 are formed from rigid plates made as a space structure with inner ribs shown in a partial cut out view in fig. 1, having
10 precisely plane-parallel inner surfaces, whereas the upper surface of the basis 31 is lined with a plane-parallel, incompressible, removable liner 39 having a smooth surface not adhering to gypsum slurry, e.g. made of PVC, while inner surfaces of the side walls 32 are covered with plane-parallel flexible and compressible separator 40 made of rubber or another similar raw material, pressed near shorter edges against
15 the side walls 32 by means of stops 35, and by means of liner tiles 36.

The brackets 41 are fastened to the lower surface of the basis 31. At the ends of these brackets 41 extending beyond the basis there are hinges enabling the side walls 32 to be rotated on the rotation axes Z parallel to the longer edges of the basis 31. Said hinges are provided with elastic articulated joints 42 with carrier arms 43
20 extending of them, said side walls 32 being permanently fastened to said arms.

In retaining sockets 44 located in the upper part of the shorter edges of the side walls 32 there are located tube pull rods 45 made of a steel profile having a rectangular cross-section, said pull rods being slid into the tube abutment link 46, made also of a length of a steel profile of rectangular cross-section, somewhat
25 greater than the cross-section of a profile of the pull rods 45, and slidable connected with said abutment link 46.

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Said abutment link 46 together with the pull rods 45 forms an element ensuring obtaining a repeatable distance between the inner surfaces of the side walls 32. The pull rods 45 at one ends of the abutment link 46 are engaged as separable elements with one of the side walls 32 by means of heads with spring washers 47, while
5 pull rods 45 at other ends of the abutment link 46 are connected with the self-locking articulated locking mechanisms 48, e.g. eccentric ones. Additionally, the abutment link 46 is formed as a supporting element for the flexible washer 49 located between said link and the outer surface of each of the headwalls 33.

In a mold designed as described above and prepared to be filled with gypsum
10 slurry, after filling it with a formerly prepared gypsum slurry the setting process occurs during which the already initially set slurry swells. This swelling is accompanied with increasing dimensions of gypsum elements filling chambers K of the mold. Forces caused by changes of dimensions of an initially formed structural element are essentially not transferred onto the main structural elements of a mold,
15 and first of all they are not transferred onto the side walls 32 of the mold but are compensated in a material of the separators 40, said material being compressible.

In a case the thickness of the separators 40 or the compressibility of a material used for these separators is not enough to transfer forces caused by swelling material of the formed element, the excessive forces can be compensated by sets of
20 heads with spring washers 47. The arrangement of those structural elements of a mold is so designed that while a material used for a formed element swells, the main components of a mold, that means the basis 31, side walls 32 and headwalls 33 are displaced without any change of the parallelism of the working surfaces of said components.

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Patent claims

1. A method for manufacturing gypsum structural elements having a thermoinsulating fill, consisting in filling a mold with gypsum slurry and leaving it to rest at least to a moment when gypsum slurry is initially set, characterized by
5 that gypsum slurry is poured into a mold, a component of which before said pouring is said thermoinsulating fill in a shape of an insert being a component of a gypsum element after the end of at least initial gypsum slurry setting, whereas a one- or multi-part insert is used, having any selected outer shapes, advantageously provided
10 with openings.

2. A mold for manufacturing structural elements, especially gypsum structural elements having thermoinsulating inserts, formed as a multichamber box comprised of a basis, two side walls, hinged in relation to longer edges of the basis,
15 two headwalls, and inner partitions dividing the mold into individual chambers, said box being additionally provided with locking and retaining means, characterized in that the inner surfaces of the side walls (32) are lined with a plane-parallel flexible and compressible separator (40), to which dismountable, rigid liner tiles (36) adhere, determining distances between particular inner partitions (34) and the side
20 walls (33), while the inwardly directed surface of the basis (31) is lined with a replaceable plane-parallel and incompressible liner (39) made of material not adhering to gypsum slurry.

3. A mold according to claim 2, characterized in that the separator (40), advantageously made of rubber, at its parts extending beyond the headwalls (33) is
25 pressed to the side walls (32) by means of stops (35) connected permanently to said side walls, on which the headwalls (33) are supported.

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4. A mold according to claim 2 and 3, characterized in that to the outer lower surface of the basis (31) brackets (41) are fastened, the ends of which extending outside the basis have hinges provided with elastic articulated joints (42) with the carrier arms (43) led out of them, permanently connected with the side walls (32).

5

5. A mold according to claim 2 to 4, characterized in that in end parts of side walls (32) there are retaining sockets (44) with a separable pull rod (45) set in them, and located as a slidable part in an abutment link (46), whereas one of the ends of that pull rod is provided with a spring head (47) connected with one of the side walls (32), while on the other of its ends there is located a self-locking and articulated locking mechanism (48) engaged with another of the side walls (32).

10

6. A mold according to claim 5, characterized in that between the abutment link (46) and the inwardly directed surface of the headwall (33) there is located a washer (49), advantageously an elastic one.

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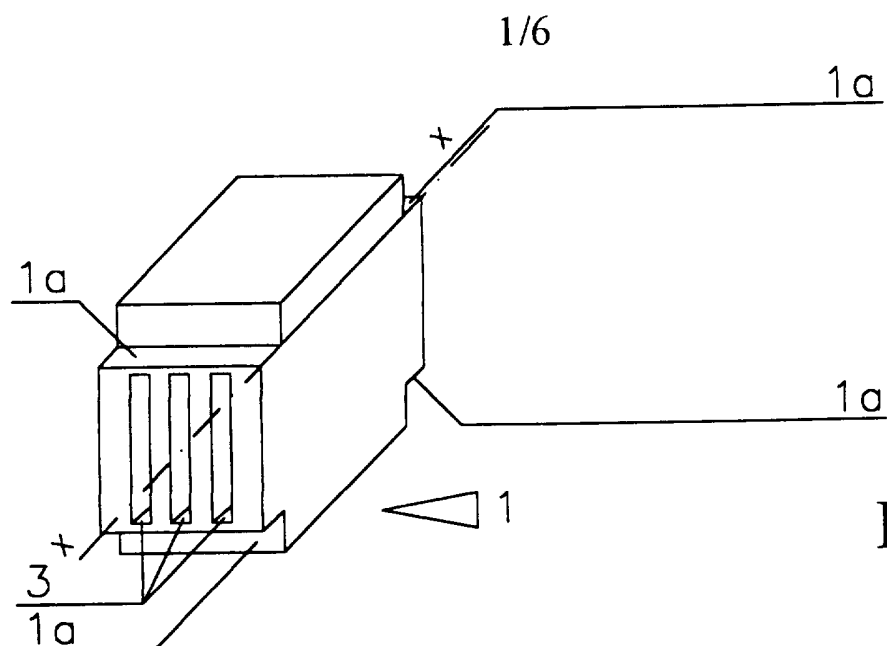


FIG. 1

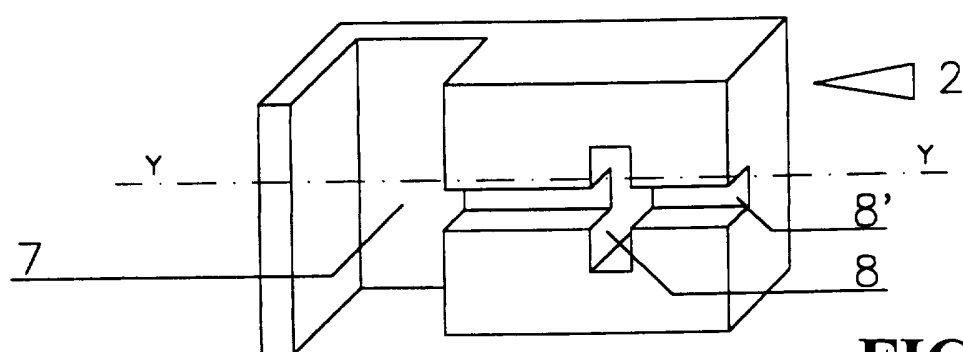


FIG. 2

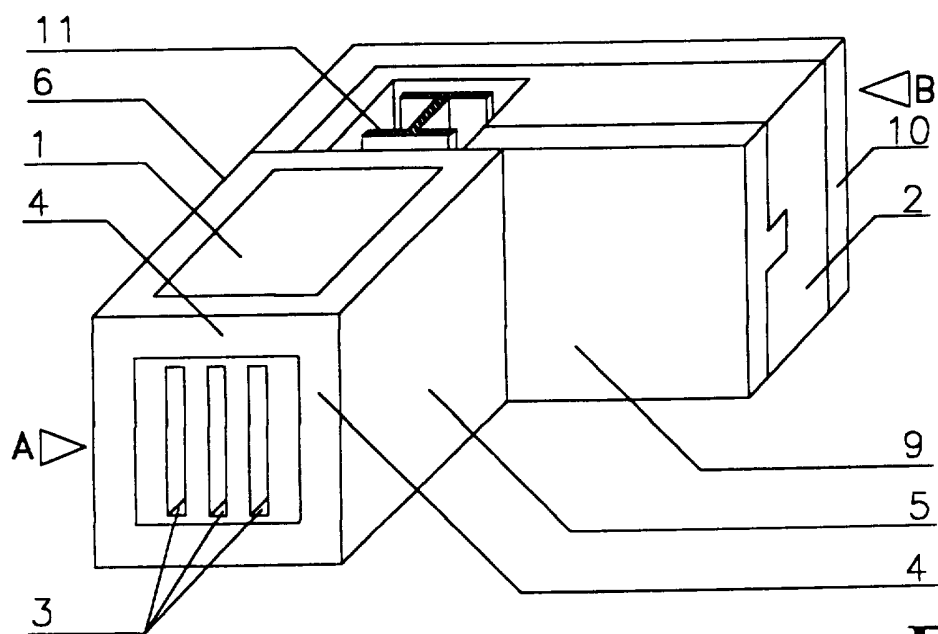


FIG. 3

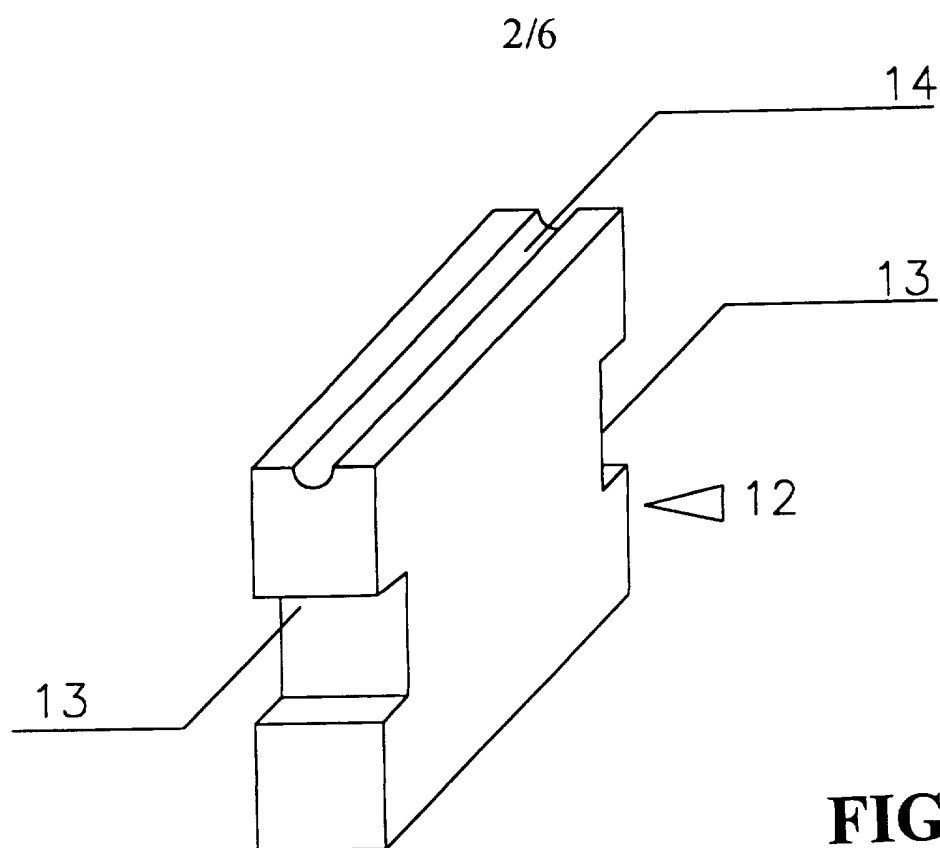


FIG. 4

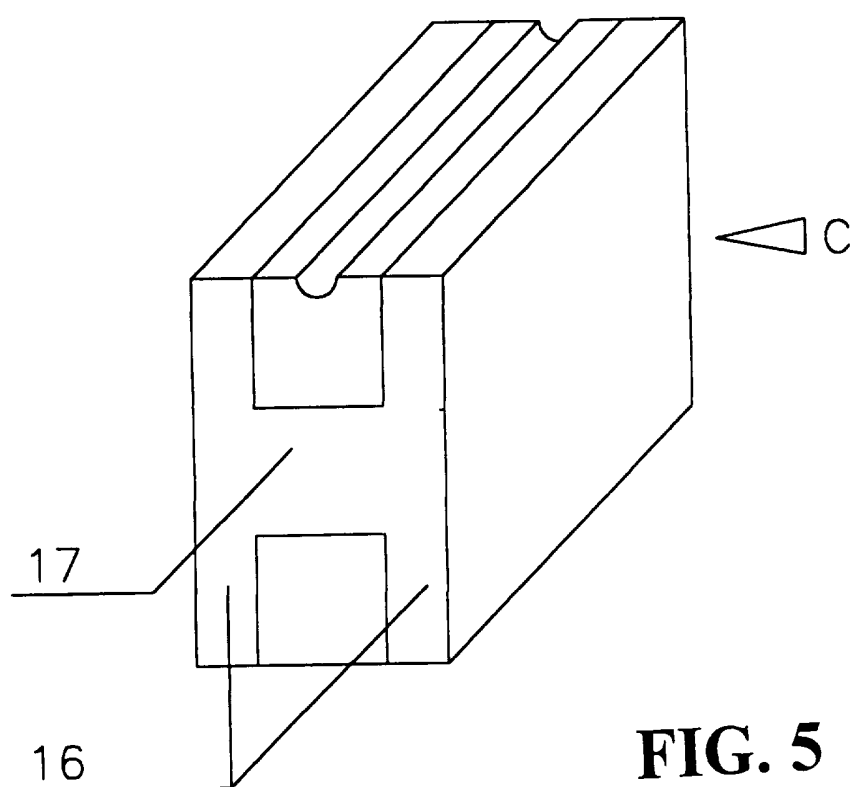
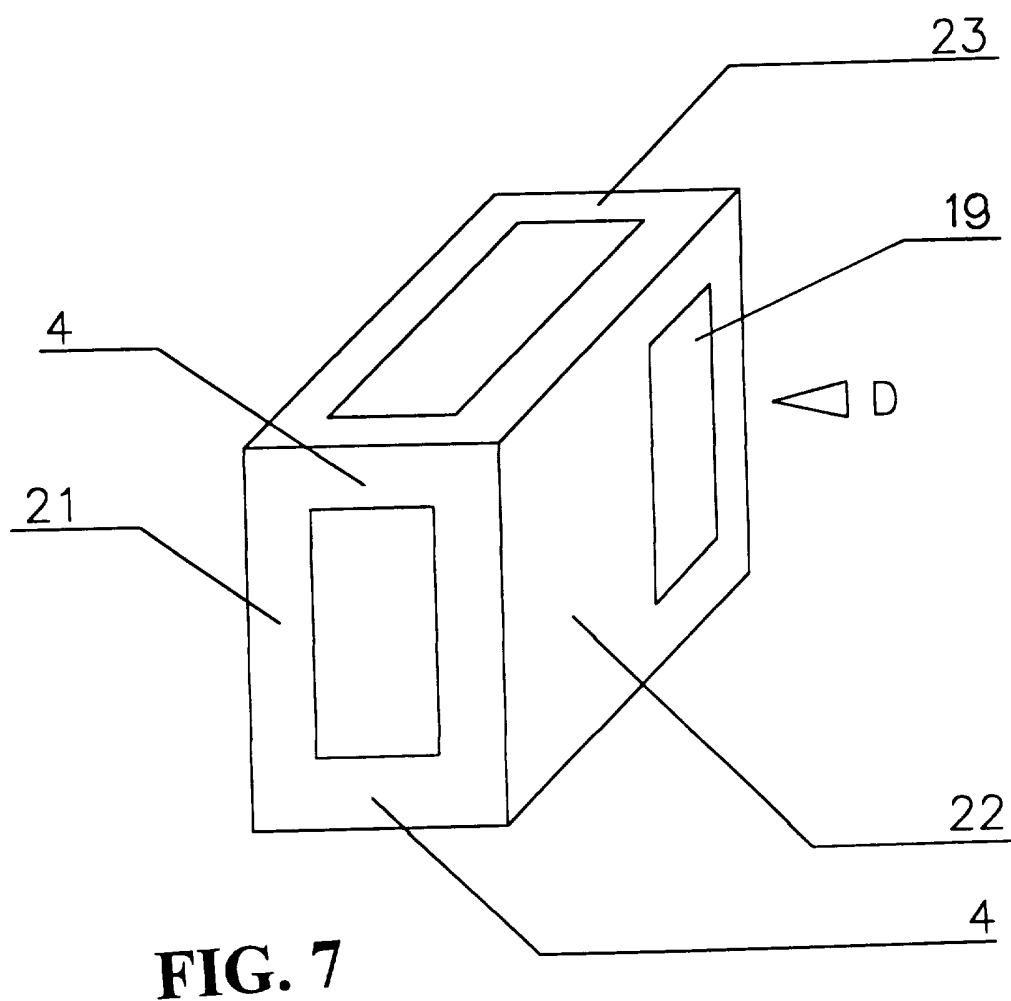
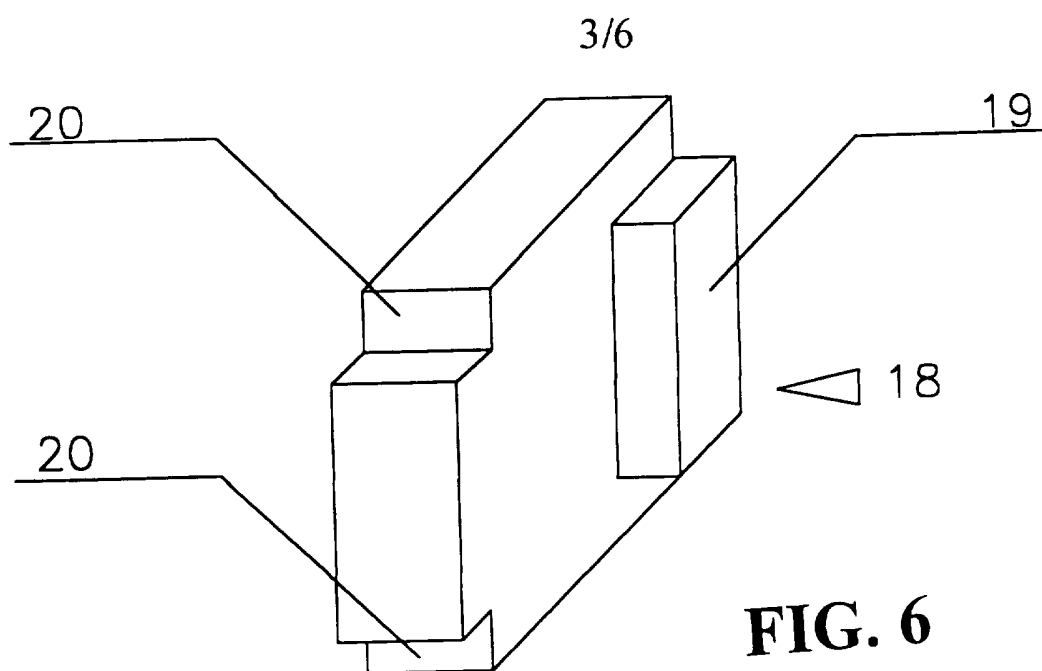


FIG. 5



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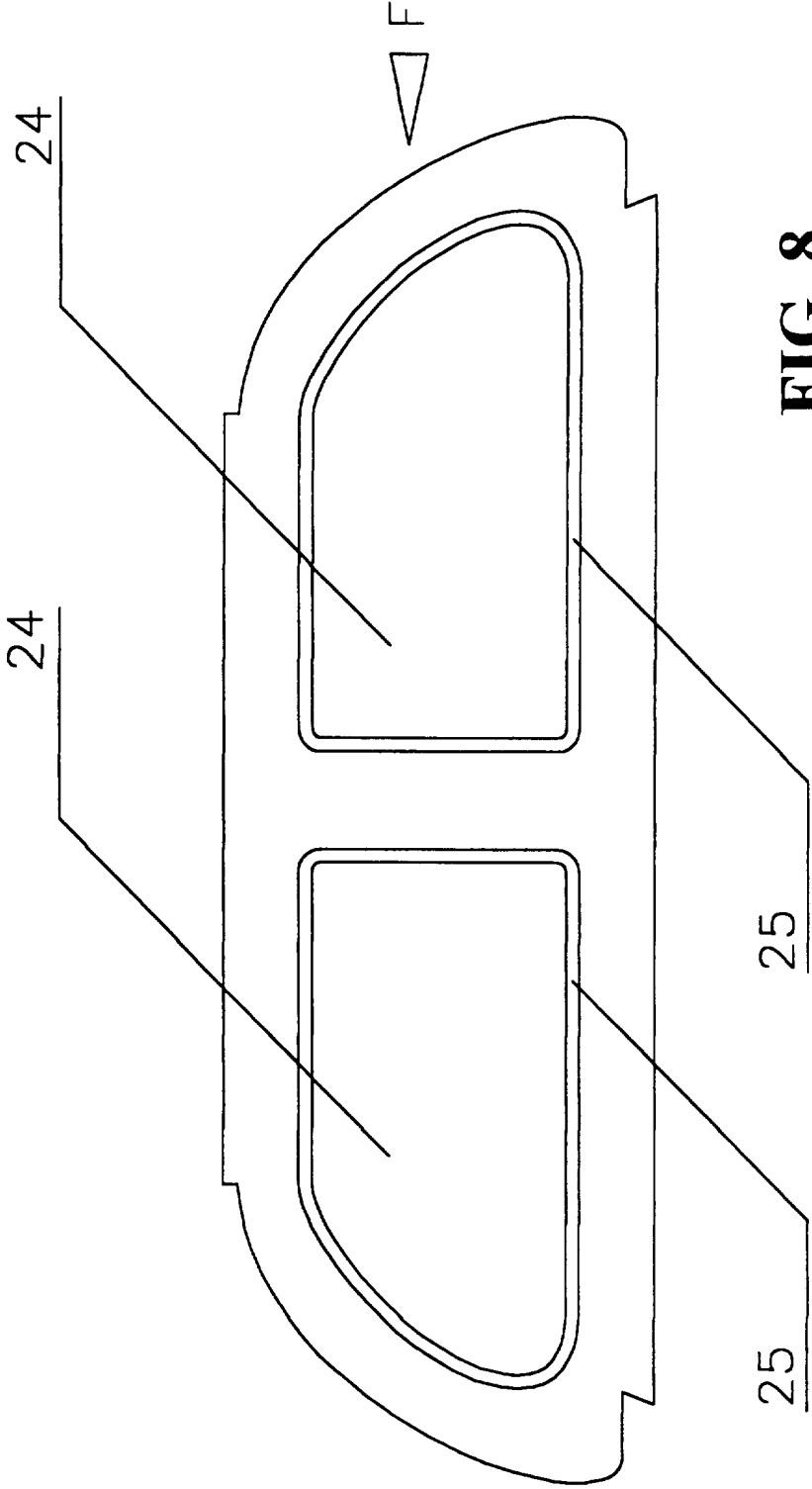
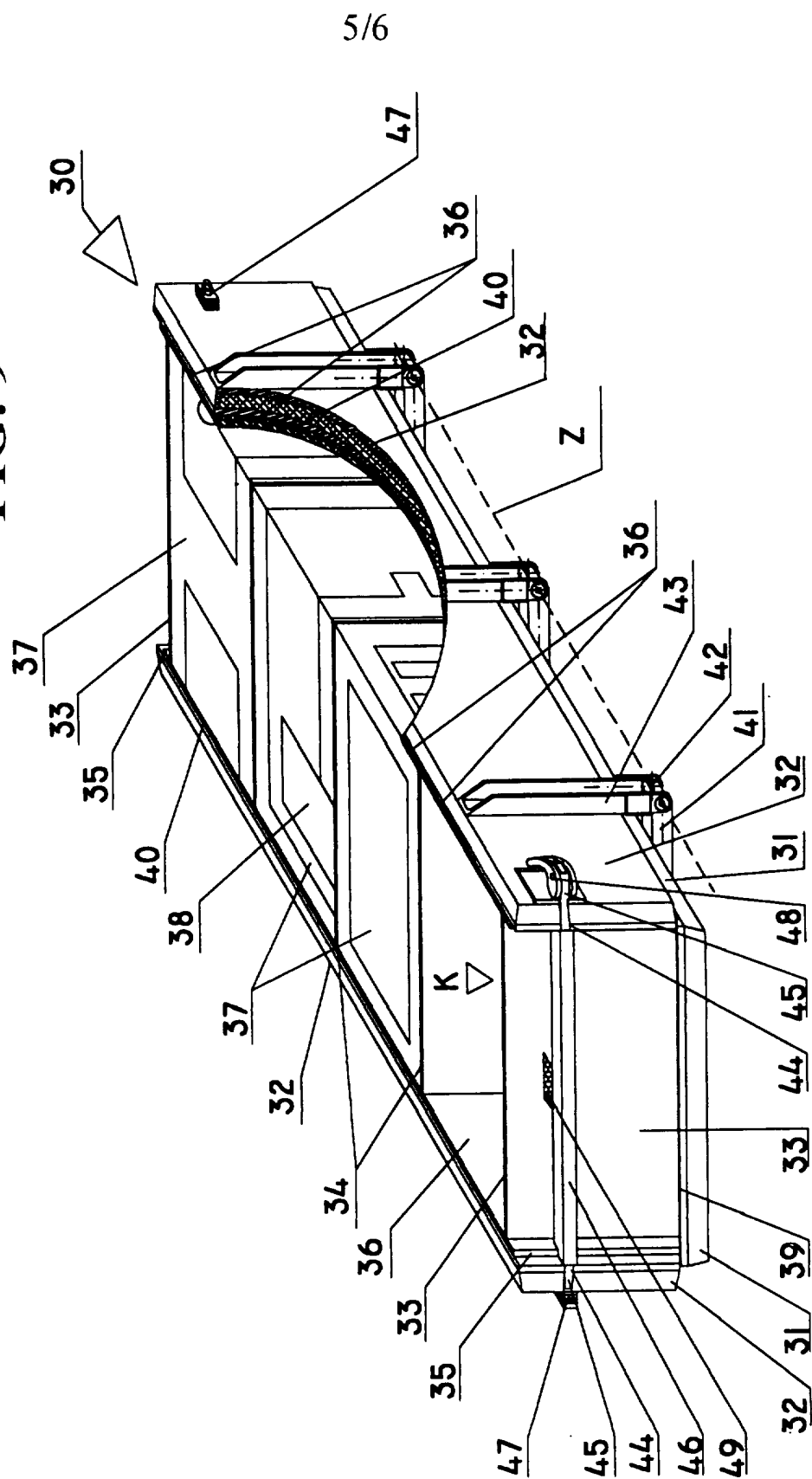


FIG. 8

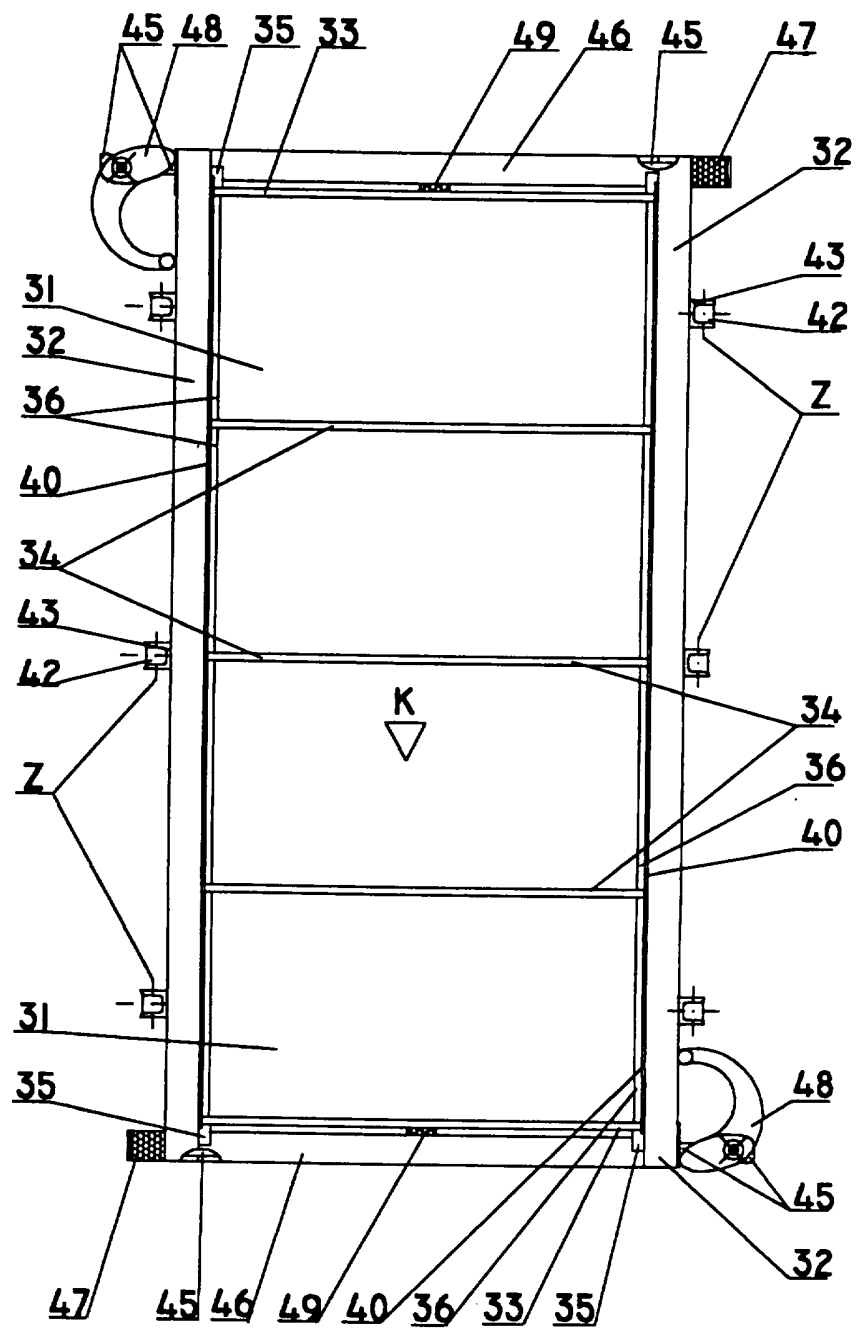
FIG. 9



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FIG. 10



INTERNATIONAL SEARCH REPORT

International Application No

PCT/PL 96/00007

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B28B19/00 B28B7/36 B28B7/24 E04C1/41

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

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Minimum documentation searched (classification system followed by classification symbols)

IPC 6 E04C B28B

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	---	2
X	US,A,2 030 998 (W. D. MANN) 18 February 1936 see the whole document see page 1, column 2, line 9 - page 1, column 2, line 32; figure 10	1
A	---	2
A	DE,A,24 58 075 (M. WAGNER) 10 June 1976 see the whole document see page 3, line 29 - page 4, line 6 ---	1-3
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A	DE,A,28 33 427 (PORELITH BAUSTOFFWERK GMBH & CO, KG) 7 February 1980 see the whole document ---	1-3
A	DE,C,231 137 (G. MAIER) 16 February 1911 see the whole document ---	1-3
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