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(54) **BUILDING STRUCTURE, METHOD AND DEVICE FOR PRODUCING SAID BUILDING STRUCTURE**

(57) The invention relates to the production of a building structure made of a hardenable composition and fibres. The inventive method consists of in applying at least one layer of said hardenable composition and one fibre layer to a rotatable mandrel and repeating said operations by applying subsequent layers, drying and releasing a final product from the mandrel. The fibre is applied to a prefabricated cellular fabric through the entire height of said mandrel, the hardenable composition being applied perpendicularly to the direction of fibre application. Said invention can be used for producing modular elements for constructing residential and industrial buildings, elevators, sewage pipes etc.

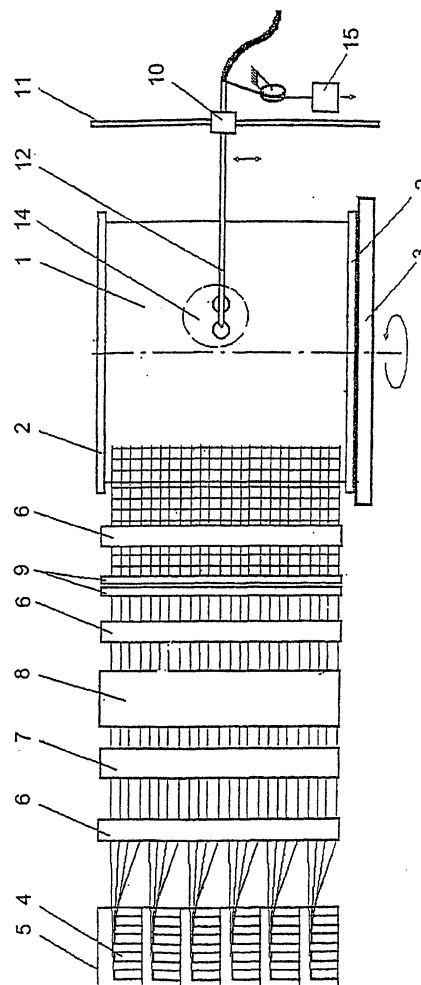


Fig.1

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Description

[0001] The present invention relates to the manufacture of building structures and more particularly to a method of manufacturing building structures made of a hardenable composition and fibre, a device for implementing such a method and a building structure of the above-mentioned type. It is useful for manufacturing modular elements intended for apartment houses and industrial buildings, elevators, sewer pipes, etc.

[0002] GB 2,155,389 discloses a method of producing a concrete sewerage liner comprising applying a slurry of chopped fibre reinforced concrete onto a rotating horizontal or vertical mandrel.

[0003] Disadvantage of this known method is that the fibre, even impregnated with polymers, has the unprotected ends formed during the process of chopping, said ends being subjected to the destructive effect of alkali contained in the concrete slurry.

[0004] In addition, the product obtained by said method may have microcracks reducing the mechanical resistance of the product.

[0005] Known is also a method of manufacturing a polymer pipe (see USSR Author's Certificate No. 1,549,773, Cl. B 29 C 53/56), which could be considered as the closest prior art of the present invention. This method comprises the steps of applying by layers a hardenable composition binding with a mineral filler and a fibre layer (glass rope) onto a rotating mandrel (form), repeating the above steps while applying the successive layers, drying (hardening) and removing the obtained article from the mandrel.

[0006] Although the above-described method has some advantages in fabricating polymer pipes, its drawback is that the building structure manufactured by this method exhibits insufficient strength since the fibre is applied in succession lengthwise, so that internal stresses are induced in the building structure.

[0007] An apparatus for manufacturing building structures from a cement concrete mix and glass fibres disclosed in GB Patent No. 1,497,834, Cl. B 29 G 23/12, which is also the closest prior art of the present invention, comprises a rotatably mounted mandrel, spools with fibres, means for impregnating the fibres with resins, pulling means for tensioning the fibres, and means for fabricating a fabric.

[0008] Taking into account however that this apparatus is aligned along a horizontal axis, which is quite suitable in case of impregnating fibres with resin, it becomes absolutely improper when impregnating the fibres with a cement type composition, because the fibres bearing cement composition become hanged down and scaled off the mandrel. At best, it would be possible to apply a single layer of cement composition, but the second one will already scale off.

[0009] Known are various building structures made of a hardenable composition and fibres, such as, for example, sewer pipes, which are produced by spraying a

chopped fibre reinforced cement concrete slurry onto a rotating mandrel (see GB 2,155,389).

[0010] Another building structure (composite panel), comprising a foamed plastic core, both sides of the core being covered with one reinforced layer of mortar (hardenable composition), is described in RU 2,102,240, Cl. B 32 B 13/02. Such members usually have a form of brick resulting in their limited use under overloads and within a wide range of temperatures.

[0011] It is therefore an objective of the present invention to eliminate the above-mentioned disadvantages in the manufacture of building structures of a hardenable composition and fibres by providing such a method of producing said building structures and device for implementing this method, that would provide a uniform applying the hardenable composition and the fibres onto the mandrel, good mechanical properties of the end product and safe labour conditions, as well as obtaining a building structure which might be used under overloads and within a wide range of temperatures.

[0012] Said objective is achieved by providing an improved method for producing a building structure of a hardenable composition and fibres, comprising applying at least one layer of hardenable composition and one layer of fibres onto a rotating mandrel with repeating the above steps while applying the successive layers, drying and removing the end product from the mandrel, characterized in that the fibres are applied to a pre-fabricated cellular fabric throughout the height of the mandrel, the hardenable composition being applied perpendicular to the surface of the mandrel throughout the height of the mandrel.

[0013] In accordance with Claim 2, particularly natural fibres are used as fibres, such as those of vegetable or animal origin.

[0014] In accordance with Claim 3, a layer of a light thermal- and/or sound-insulating and structure-forming material, for example, polyurethane foam, is placed between the layer of hardenable composition and the layer of the cellular fabric of fibres.

[0015] Such a method provides a uniform application of the hardenable composition and the fibres, and obtaining the end product having homogenous surface, and reducing the risk of microcracks formation, as well as the enhanced quality and the strength of the end product.

[0016] Also, the novelty of the invention is that the natural fibres are used, thus allowing to reduce the cost of the end product when working in dry and hot climatic conditions.

[0017] Further improvement consists in that a layer of a light thermal- and/or sound-insulating and structure-forming material, such as polyurethane foam, is placed between the layers composed of hardenable composition and fibres when applying onto the mandrel. Thus, the mechanical strength of the end product as well as its operating characteristics are improved.

[0018] The objective of the invention is also achieved

by providing a device for implementing the above-described method, comprising a rotating platform with driving means, a mandrel with flanges mounted on the platform, bobbins with fibres, means for impregnating the fibres with a polymer composition, means for drying the impregnated fibres, means for tensioning the fibres, and means for applying a hardenable composition, which device is further equipped with means for fabricating a cellular fabric, said means having the form of a vertical loom including a shuttle for weft yarn, and with a multi-level turret for arranging the bobbins with fibres, the mandrel being contractable, the flanges being removable, and the means for impregnating the fibres with polymers being made in the form of a vertical cylinder having two rows of holes arranged along the longitudinal axis of the cylinder and diametrically opposite, the means for applying the hardenable composition is secured on a carriage movable on a vertical support and comprises a guide carrying a hose with a nozzle for feeding the hardenable composition, a device securing the nozzle to be permanently perpendicular to the surface of the mandrel and equidistant therefrom, which device is fixed on the guide with possibility of swinging, and a counterweight.

[0019] According to Claim 5, the device securing the nozzle for feeding the hardenable composition to be permanently perpendicular to the surface of the mandrel and equidistant therefrom is made in the form of a plane equilateral triangle having its two sides formed by strips of a rigid material, the ends of the strips being interconnected and secured on the guide with the possibility of swinging, and the other ends of the strips are provided with spherical segments, while the third side of the triangle is formed by a strip of a rigid material with a hole, said hole accommodating the nozzle for feeding the hardenable composition, said third side of the triangle being secured in such a manner that the nozzle does not extend outside the external dimensions of the triangle.

[0020] Such a design of the device allows producing the building structures having uniform wall thickness and homogenous surface, enhanced mechanical strength and performance characteristics.

[0021] The objective of the invention is finally achieved by providing a building structure in the form of a box section made of a hardenable composition and fibres, said section having rounded opposite faces, said building structure comprising a layer of a light thermal- and/or sound-insulating and structure-forming material, such as polyurethane foam, between the layers of the hardenable composition and fibres.

[0022] According to Claim 7, this building structure contains fibres in the form of a cellular fabric.

[0023] Such a structure of the member allows to prevent the layers from shifting with respect to one another, thus allowing the use of such members under overloads and within a wide range of temperatures.

[0024] The invention will now be explained in detail

with reference to the drawings, wherein:

Fig. 1 is a general view of the device for producing the building structures made of hardenable composition and fibres; and

Fig. 2 shows the device securing the nozzle for feeding the hardenable composition to be fixed permanently perpendicular to the surface of the mandrel and equidistant therefrom.

[0025] The claimed method is implemented as follows.

[0026] Fibres (e.g. glass fibres) in the form of separate filaments or a cellular fabric, preimpregnated with polymers (e.g. acrylic resins) and dried, are applied onto a mandrel previously coated with a layer of hardenable composition (e.g. cement concrete slurry, various hardenable resins, etc.). The fibre cellular fabric is applied throughout the full height of the mandrel onto the layer of hardenable composition before its hardening. The number of filaments is chosen depending upon the prescribed size of the end product, the desired spacing between the separate parallel filaments of 0.5 to 1.0 cm or the desired mesh size of the fabric of 0.5 cm × 0.5 cm to 1.0 × 1.0 cm. After applying the fibre cellular fabric onto the mandrel surface, a layer of the hardenable composition is applied over the fibres, the direction of applying the hardenable composition being perpendicular to the surface of the mandrel. At this point, the formation of the first layer composed of the hardenable composition and fibres is completed. Each successive layer is formed by applying a layer of the fibre cellular fabric on the previous layer of the hardenable composition before its hardening, followed by the applying a layer of the hardenable composition. The number of layers depends upon the required wall thickness of the end product. After the completion of the last layer and partial hardening the hardenable composition, the end product is removed from the mandrel and is allowed to get completely hardened.

[0027] In case of obtaining a building structure having enhanced mechanical resistance and thermal- and/or sound-insulating properties, at least one layer of a light thermal- and/or sound-insulating and structure-forming material, such as polyurethane foam, is placed between the layers composed of the hardenable composition and fibres.

[0028] A device for producing a building structure made of a hardenable composition and fibres (Fig. 1) comprises a contractable mandrel 1 fitted with detachable flanges 2, the mandrel being mounted on a rotating platform 3 with driving means (not shown), bobbins 4 with fibres wound thereon arranged on a multi-level turret 5, means 6 for tensioning the fibres, means 7 for impregnating the fibres with polymers made in the form of a vertical cylinder having two rows of holes arranged diametrically opposing along its longitudinal axis, means 8 for drying the polymer-impregnated fibres, means 9

for fabricating a cellular fabric having the form of a vertical loom including a shuttle for weft yarn, and means for applying a hardenable composition secured on a carriage 10 mounted movable on a vertical support 11, this latter means comprising a guide 12 carrying a hose with a nozzle 13 for feeding the hardenable composition, a device 14 securing the nozzle to be permanently perpendicular to the surface of the mandrel and equidistant therefrom, which device is fixed on the guide with possibility of swinging, and a counterweight 15. The device 14 (Fig. 2) is made in the form of a plane equilateral triangle having its two sides 16 formed by strips of a rigid material, the ends of the strips being interconnected and secured on the guide 12 with the possibility of swinging, and the other ends of the strips are provided with spherical segments 17, while the third side of the triangle is formed by a strip of a rigid material with a hole, said hole accommodating the nozzle 13 for feeding the hardenable composition, said third side of the triangle being secured in such a manner that the nozzle does not extend outside the external dimensions of the triangle.

[0029] The operation of the device is as follows.

[0030] One starts with applying a hardenable composition, for example, a cement concrete slurry, onto the mandrel 1 with detachable flanges 2 mounted on the rotating platform 3 through the nozzle 13 arranged in the device 14 and connected by means of a hose with a source of compressed air and with a tank containing the cement concrete slurry (not shown). The guide 12 is moved up and down, together with the carriage 10, along the vertical support 11, thereby providing the application of the cement concrete slurry throughout the height of the mandrel 1 between the detachable flanges 2. The device 14 fixed on the guide 12 with the possibility of swinging allows the nozzle 13 to be permanently perpendicular to the surface of the mandrel and equidistant therefrom, thus ensuring a uniform application of the cement concrete slurry on the rotating complex-shaped mandrel, whereas the counterweight 15 ensures a permanent contact between the spherical segments 17 and the surface of the rotating mandrel. The rotational speed of the platform 3 carrying the mandrel 1 and the speed of the carriage 10 with the guide 12 fixed thereon are chosen so as to allow a continuous and uniform application of the cement concrete slurry along the full height of the mandrel 1 between the flanges 2. After applying the first layer of the cement concrete slurry and before its hardening, a fibre cellular fabric is delivered via the third means 6 for tensioning the fibres and secured to the mandrel, the fibre cellular fabric being made of fibres coming from the bobbins 4 arranged on the multi-level turret 5, which fabric is passed through the first means 6 for tensioning the fibres, said fabric being impregnated with polymers in means 7 for impregnating the fibres, dried in means 8 for drying the impregnated fibres, passed through the second means 6 for tensioning the fibres and fed into means 9 for fabricating the cellular fabric, said means 9 being made in the form of a vertical

loom provided with a shuttle for weft yarn. After winding the layer of the cellular fabric, said layer is coated with a layer of the cement concrete slurry, as described above. The device operates until the required wall thickness of the end product is achieved. After the completion of the work and partial hardening the cement concrete slurry, the mandrel is contracted and the end product is removed therefrom, the flanges 2 becoming then the integral part of this end product and are consequently removed from the mandrel.

[0031] After complete hardening the cement concrete slurry, the claimed building structure produced according to the above-described method using the above described device is ready to be used for the purpose it is designed.

[0032] Depending on the initial shape and size of the mandrel, on the wall thickness and on whether a layer of a light thermal- and/or sound-insulating and structure-forming material, such as polyurethane foam, is used, the building structure thus obtained may be used for erecting public and commercial buildings, household structures, as well as residential buildings such as private cottages and multistory buildings. It is to be noted that as shown by the experience, the buildings having up to four stories, erected using such building structures, are self-supporting, i.e. they do not require the use of additional load-carrying structures, so that the cost of dwelling is considerably reduced.

[0033] Besides, the proposed building structure is usable in constructing water pipelines, including those of pressure type, tower silos, elevators, tanks of various use and tunnel passageways of large diameter.

[0034] Therefore, the method of manufacturing building structures consisting of a hardenable composition and fibres, the device for implementing such a method and the building structure of the above-mentioned type allow to eliminate the known drawbacks of prior art solutions, thus increasing the quality of the end products.

Claims

1. A method for producing a building structure of a hardenable composition and fibres, comprising applying at least one layer of hardenable composition and one layer of fibres onto a rotating mandrel with repeating the above steps while applying the successive layers, drying and removing the end product from the mandrel, **characterized in that** the fibres are applied to a pre-fabricated cellular fabric throughout the height of the mandrel, the hardenable composition being applied perpendicular to the direction of applying the fibres.
2. The method according to claim 1, **characterized in that** natural fibres are used as the fibres, such as fibres of vegetable or animal origin.

3. The method according to claims 1 - 2, **characterized in that** a layer of a light thermal- and/or sound-insulating and structure-forming material, such as polyurethane foam, is placed between the layers of the hardenable composition and fibres. 5

4. A device for implementing the method of Claim 1, comprising a rotating platform with driving means, a mandrel with flanges mounted on the platform, bobbins with fibres, means for impregnating the fibres with a polymer composition, means for drying the impregnated fibres, means for tensioning the fibres, and means for applying a hardenable composition, **characterized in that** the device further comprises means for fabricating a cellular fabric, said means for fabricating a cellular fabric having the form of a vertical loom including a shuttle for weft yarn; a multi-level turret for arranging the bobbins with fibres; the mandrel being contractable; the flanges being removable; the means for impregnating the fibres with polymers being made in the form of a vertical cylinder having two rows of holes diametrically opposing arranged along the longitudinal axis of the cylinder; the means for applying the hardenable composition being secured on a carriage movable on a vertical support and comprising a guide carrying a hose with a nozzle for feeding the hardenable composition, a device securing the nozzle to be permanently perpendicular to the surface of the mandrel and equidistant therefrom, which device is fixed on the guide with possibility of swinging, and a counterweight. 10
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5. The device according to claim 5, **characterized in that** said device securing the nozzle for feeding the hardenable composition to be permanently perpendicular to the surface of the mandrel and equidistant therefrom is made in the form of a plane equilateral triangle having its two sides formed by strips of a rigid material, the ends of the strips being interconnected and secured on the guide with the possibility of swinging, and the other ends of the strips are provided with spherical segments, while the third side of the triangle is formed by a strip of a rigid material with a hole, said hole accommodating the nozzle for feeding the hardenable composition, said third side of the triangle being secured in such a manner that the nozzle does not extend outside the external dimensions of the triangle. 35
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6. A building structure composed of a hardenable composition and fibres, **characterized in that** it is made in the form of a box section made of a hardenable composition and fibres, said section having rounded opposite faces, said building structure comprising a layer of a light thermal- and/or sound-insulating and structure-forming material, such as polyurethane foam, between the layers of the hardenable composition and fibres. 55

7. The building structure of Claim 7, **characterized in that** it contains fibres in the form of a cellular fabric.

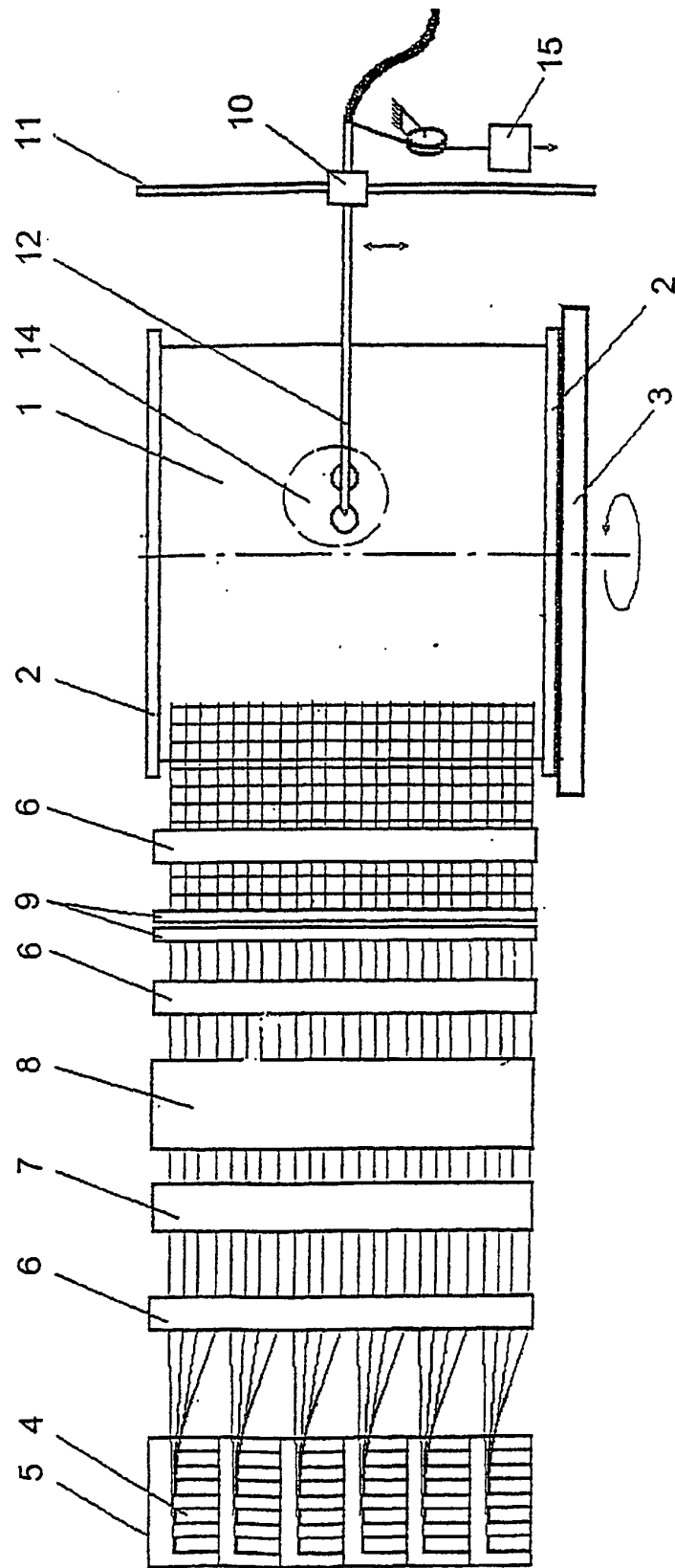


Fig.1

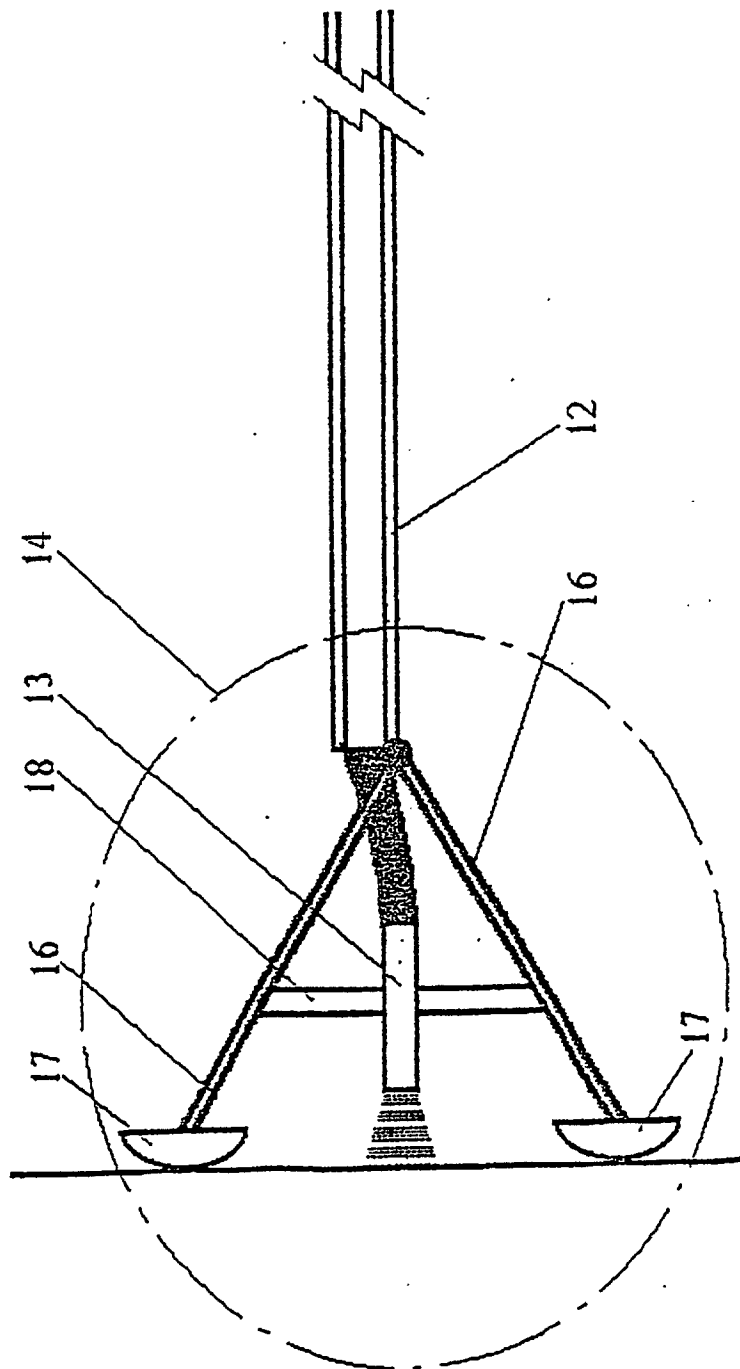


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 02/00296

A. CLASSIFICATION OF SUBJECT MATTER B28B 21/48		
According to International Patent Classification (IPC) or to both national classification and IPC 7)		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) B28B 21/48, 1/40, 1/42, 21/66, 21/72, 21/44, E04C 2/24		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	SU 1549773 A1 (UKRAINSKY NAUCHNO- ISSLEDOVATELSKY INSTITUT GIDROTEKHNIKI I 15.03.1990, the claims	1, 3
A		2, 4-7
Y	SU 232069 A (G. YA. ANDREEV et al) 3.iv. 1969, column 3, lines 8-15	1, 3
Y	SU 133383 A (G. E. SHERZHUKOV et al) 10.11.1960, page 1, paragraph 2, The drawings	1, 3
X		
Y	SU 870633 A (I. A. EGORENKOV et al) 17.10.1981, Column 2, lines 12-21, column 3, lines 8-18	6-7 3
A	US 4183724 A (DAVID LARIVE) Jan. 15, 1980	1-7
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 26 August 2002 (26.08.02)		Date of mailing of the international search report 29 August 2002 (29.08.02)
Name and mailing address of the ISA/ RU		Authorized officer
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