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(54) Method of manufacturing intermediate concrete products, formwork for manufacturing said products, and apparatus for carrying out said method.

(57) The invention refers to a method of manufacturing intermediate concrete products, preferably tiles, which consists of casting non-segregable concrete mass of cast consistency into corresponding formworks. The concrete mass is cast by means of a charging head (4) and by discharging nozzles (6) arranged thereon, whereby the pressure of the concrete mass at the outlet of the nozzles (6) is adjusted to the largest cross-section of the product being cast and equals from 0,1 bar to 0,5 bar, preferably 0,2 bar. Nozzles (6) being pushed to the area of the bottom of the formwork (5) in the beginning of casting start to lift up when the concrete mass fills up the formwork (5) for essentially one third by the height. The lifting velocity of the charging head (4) and thereby of the nozzles (6) is adjusted to the cross-section of the product being cast, and equals from 0,05 ms^{-1} to 0,2 ms^{-1}, preferably 0,1 ms^{-1}. The invention also refers to a formwork for manufacturing concrete tiles and to an apparatus for carrying out said method.

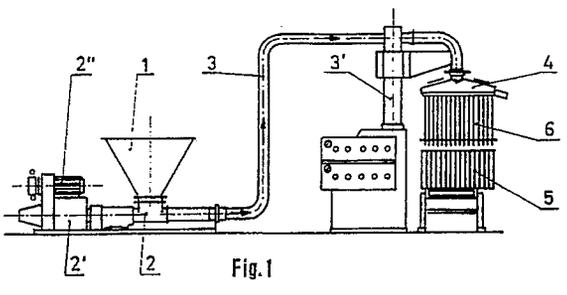

Fig.1

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METHOD OF MANUFACTURING INTERMEDIATE CONCRETE PRODUCTS, FORMWORK FOR MANUFACTURING SAID PRODUCTS, AND APPARATUS FOR CARRYING OUT SAID METHOD

The invention refers to a method of manufacturing intermediate concrete products, preferably tiles, to a formwork for manufacturing said products and to an apparatus for carrying out said method.

In building constructions as roofing tiles made of clay or concrete are used at most. Since in primary sense the production of clay tiles is locally bound to a basic stock of raw material and preferably to greater stationary plants characteristic of a high power consumption on the production spot, there asset themselves more and more concrete tiles which correspond to clay tiles both in form and quality.

The concrete tiles are manufactured according to a known method in such a manner that concrete of dry to damp consistency, having as a rule no additional dyes, is fed onto a horizontal formwork and consolidated into the corresponding form by means of vibrating and compressing. Further, raw tile formed in such a manner proceeds into a heating chamber in which there prevail specified climatic conditions (humidity of 95% and temperature of up to 65 °C) and reposes until it has won approximately 50% of its ultimate strength. Only then the tile can be lifted out of the horizontal formwork and proceeded to further treatment, e.g. sorting, colouring, storage.

Due to technological features of the concrete of dry to damp consistency, there exists at known methods a problem of how to attain good homogeneity and mixing of components of the concrete, particularly those which appear in small quantities (from 0,5% to 5% by weight of cement) in a concrete mixture. This problem is particularly obvious in chemical admixtures for improving the persistency of the concrete product and in adding dyes into the concrete mixture. Said problems result in a variable quality of the products both in technological and in visual sense. A disadvantage of the concrete of said consistency is also a relatively high sensitivity to changes of volume in loose and consolidated state, which results in a change of quality of the product even at the slightest changes of input material, e.g. humidity.

A further disadvantage of the known method lies in a high sound pressure level occurring at consolidating the concrete by means of vibrations, due to intensive vibrating of the concrete there also appear powerful vibrations in the surrounding of the tile producing machine. During consolidating the tiles, deformations of the horizontal metal formworks take place, which results in the necessity of frequently replacing the formworks to avoid deformed products.

Another disadvantage of the known method lies in the circumstance that the side of the concrete product-tile facing away from the formwork is free, i.e. unprotected, wherefore damages can occur on the tile. During the time in which the tile lies in the chamber, even the entire surface of the tile which at use is exposed to weather can be damaged due to possible change of humidity or temperature.

A further disadvantage lies in that a great amount of space is needed for the aforementioned method of manufacturing tiles as the daily production of e.g. 100.000 tiles requires approximately 12.000 m^3 of room which, in addition, should be heated to a temperature of approximately 65 °C, which results in a relatively high power consumption.

The object of the invention is to provide a method of manufacturing concrete products, preferably tiles, in which the aforementioned disadvantages will be avoided. This object is according to the invention gained by means of features given in the characterizing clause of claim 1.

Another object of the invention is to provide a formwork for manufacturing concrete products, preferably tiles. According to the invention this object is achieved by means of features given in the characterizing clause of claim 5.

Still another object of the invention is to provide an apparatus for carrying out said method. According to the invention this object is achieved by means of features given in the characterizing clause of claim 7.

All other features of the method and formwork for manufacturing the intermediate concrete products as well as of the apparatus for carrying out the method according to the invention are evident from the subclaims. It is understood that the present invention can be used for different intermediate concrete products too, although it is specifically described for concrete tiles.

The invention is further described in the following preferred embodiment, reference being made to the accompanying drawings. Therein show:

Fig. 1 a schematic diagram of an apparatus for carrying out the method according to the invention,

Fig. 2 a side elevation of a charging head of an apparatus according to the invention,

Fig. 3 a view of the charging head in the direction of an arrow III of Fig. 2,

Fig. 4 a vertical sectional view of the charging head,

Fig. 5 a view in the direction of an arrow V of Fig. 4,

Fig. 6 a detail of a blocking unit in closed position,

Fig. 7 a detail of a blocking unit in open position,

Fig. 8 a plan view of a formwork for manufacturing tiles according to the invention,

Fig. 9 a sectional view of a formwork taken along the line IX-IX of Fig. 8, and

Fig. 10 an element of a formwork according to the invention.

The feature of the present method according to the invention lies in the use of concrete of a cast consistency, which ensures uniformity of the composition and unsegregability of concrete, the possibility of forwarding under pressure to the charging head and filling up a row of formworks during one production cycle with exact material dosing. Cast concrete possesses the features of good and quick homogeneity even in the case when very small quantities of chemical or mineral additives are added. Thus, obtaining high degree of uniform quality, there are ensured the durability of the material, e.g. resistance to freezing and chemical influence resistance and high quality of pigmentizing of concrete mass. Components of the cast concrete ensuring the necessary features of fresh concrete admixture are as follows:

- cement, preferably highly active cement,
- stone aggregate with size gradation of at most 3,2 mm and sifting of 15% to 20% through a 0,25 mm sieve,
- usual chemical admixture for lowering the surface tension of the water,
- usual chemical admixture for introducing microporosity into the cement paste,
- mineral fine-grained admixture for preventing micro-mixing (micro-segregation) of concrete and decreasing permeability of the concrete admixture to water,
- mineral fine-aggregate admixture for volume reduction of concrete mass,
- water, and
- mineral dyes.

The method according to the invention will be further described in detail referring to Fig. 1 showing a schematic diagram of an apparatus for carrying out said method. Concrete of the aforementioned composition and consistency is prepared in a common counterflow concrete plant. Concrete prepared in such a manner is delivered into a storage bin 1 of a screw pump 2, by means of which it is conveyed through a pipe line 3 to a charging head 4 of an apparatus according to the invention. In the given case the charging head 4 is arranged for filling up a row of formworks 5 whereby concrete is contractionally discharged into each formwork 5 by means of discharging nozzles 6. Pressure required for operation of the system is maintained by means of automatic synchronised working of the pump 2 and of the unit for opening and closing the stops and unit for lowering and lifting the head 4, whereby it is particularly important that in all nozzles 6 for filling up the formworks 5 the same pressure is ensured. Its value at the outlet of each nozzle 6 equals from 0,1 bar to 0,5 bar, preferably 0,2 bar. Due to technological features of concrete, said formworks must be waterimpermeable and made of thermally insulating material, e.g. polyurethane resin. Each nozzle 6 of the charging head 4 is thrust to the area of the bottom of each formwork 5 and then concrete is conveyed therein.

When the formwork 5 is filled up for essentially one third by the height, the charging head 4 and the nozzles 6 are lifted up with constant velocity till the formworks 5 are completely filled up. The nozzles 6 may not be lifted over the level of the concrete being cast in any case. The lifting velocity of the charging head 4 and thereby of the nozzles 6 is adjusted to the largest cross-section of the product being cast, and in the particular case equals from 0,05 ms^{-1} to 0,2 ms^{-1}, preferably 0,1 ms^{-1}.

When the formworks 5 are filled up they are transferred to a setting place. As said formworks are made of thermally insulating material an intrinsic energy-hydration heat of the cement is exploited released during setting time for the concrete. In such a manner the concrete is aging practically in adiabatic conditions, and after approximately 24 hours reaches a temperature of approximately 55 °C above ambient temperature, which in the particular case equals 20 °C without additional heating wherefore any further thermal treatment is superfluous.

Figs. 8, 9, 10 show a formwork 5 for casting concrete tiles. Said formwork comprises a pair of frames 7, 8 clamping together a plurality of elements 9 made of waterimpermeable and thermally insulating material, e.g. polyurethane resin, the form of which corresponds to a product desired, and in the particular case corresponding to a tile. Each element 9 is along both vertical sides provided with a pair of thickenings 10, 11 whereby facing sides of each thickening 10, 11 of two adjacent elements 9 are parallel abutting slitlessly to each other. The element 9 is at its first, in the particular case its lower, end provided with a web 12 being essentially perpendicular to said element and running between the thickenings 10, 11. In the formwork assembled to a block of elements 9 said web slitlessly rests against the adjacent element 9 forming a bottom 13 of the formwork 5 in the essence. The elements 9 are formed in such a manner that their first flat side 14 corresponds to the first side of the tile, their second flat side 15

corresponding to the second side thereof. In the formwork 5 the elements 9 are arranged vertically, i.e. concrete is cast from the upper side. Two elements 9 are needed to produce one tile and n+1 of said elements are needed to produce n tiles.

Further is, referring to Figs. 1 to 7, described an apparatus for carrying out the method of manufacturing concrete products, preferably tiles. An apparatus according to the invention comprises a storage bin 1 arranged on a screw pump 2. The latter is driven through a gearbox 2' by means of a drive 2". A pipe line 3 fixed on a stand 3' is connected to the discharge end of the pump 2. The other end of the pipe line 3 is connected to an essentially trapezoidal charging head 4 to which a row of discharging nozzles 6 is interconnected. Said nozzles are removably fixed to a bottom 7 of the head 4 which is in the area of penetration of each nozzle 6 therethrough provided with a wear resisting plate 8. Sides of the plate 8 facing away from the bottom 7 lie in the plane parallel thereto. A blocking unit 8' is slidingly and movably arranged on the plates 8 of each row of the nozzles 6. Said unit comprises closures 9 being mutually rigidly connected by means of a linkage 10 which is interconnected with the pneumatic or hydraulic working cylinder 11. The latter enables simultaneous moving of all closures 9 over the plates 8 and closing and opening the nozzles 6 respectively.

In the area above each closure 9 there are throttle knives 12 arranged slidingly and movably in the same plane as said closure and extending over the entire length of each row of nozzles 6. The throttle knives 12 are regarding the closure 9 staggered in their plane in the direction away from the working cylinder 11, the closures 9 being provided with a lug 9' cooperating with the knives 12. The side of the knives 12 facing away from the working cylinder 11 is shaped as a half-wave of a sinusoidal curve 13 the curvature of which is conditioned by mutual distance of the two utmost nozzles 6, by material cast and by the pressure for pressing material into the nozzles 6. On their side facing away from the bottom 7 the throttle knives 12 are reinforced by means of a brace fillet 14 and mutually connected by means of a linkage 15. On the linkage 10 there is provided a back stop 16 meshing with the linkage 15. The latter penetrates the wall 4' of the head 4 on the side facing away from the working cylinder 11 whereby the linkage 15 is between the said wall and a limit stop 17 provided with a tension-compression spring 18 which enables moving of the throttle knives 12. To a part of the linkage 15 projecting through the wall 4' a nut 18' is screwed thereon, the stroke of the throttle knives 12 being regulated therewith.

The operation of the blocking unit is further described with reference to Figs. 6 and 7. In the starting position the nozzles 6 are closed by means of closures 9. The lugs 9' arranged on said closures hold the throttle knives 12 in a closed position. Moving the closures 9 by means of the linkage 10 and the working cylinder 11 in the direction towards the cylinder 11 reflects in an opening of the nozzles 6. The spring 18, which is compressed in the starting position, repulses the throttle knives 12 by means of the limit stop 17 and the linkage 15 in the same direction as the closures 9 are moving. The spring 18 acts onto the throttle knives 12 until the nut 18' rests against the wall 4' of the head 4. Thus, the closures 9 continue to move so that they completely open the entrance into the nozzles 6. Between that side of each throttle knife 12 lying in front of the curve 13, and the lug 9' of each closure 9 there is a distance a at nozzles 6 completely open, in dependence upon the material cast. Thus, entries into the nozzles 6 due to curve 13 on the knives 12 overlap in a different degree when the closures 9 are in the open position. The more the entrance of each nozzle 6 lies away from the place of supply of the concrete mass into the charging head 4, the smaller the degree of overlapping. In such a manner the same pressure is ensured at the entrance into each nozzle 6 and, therefore, at the outlet thereof for, the smaller the degree of overlapping, the lower the pressure drop. The degree of overlapping thus represents the function of the mutual distance of the utmost two nozzles 6, of the material cast, and of the pressure for pressing material into the nozzles 6.

The entrance into the nozzles 6 is closed by means of the working cylinder 11 pushing the closures 9 through the linkage 10 and the lug 9' of each closure 9 pushing the throttle knives 12 into the starting position. The spring 18 is therefore compressed and the blocking unit 8' is ready for the next working cycle.

Claims

1. A method of manufacturing intermediate concrete products, characterized in that non-segregable concrete of cast consistency is pressed contractionally through at least one nozzle into at least one corresponding formwork made of a water-impermeable and thermally insulating material, whereby the nozzle is located in the bottom area of the formwork, at the latter being filled up for essentially one third by the height the nozzle is lifted up with a constant velocity from the formwork in such a manner that it is not lifted over the level of concrete being cast in any case, and that the concrete is aging practically in adiabatic con-

ditions.

2. A method according to claim 1, characterized in that the pressure value of dosing of concrete at the outlet of each nozzle (6) equals from 0,1 bar to 0,5 bar, preferably 0,2 bar.

3. A method according to claim 1, characterized in that the lifting velocity of the nozzles equals from 0,05 ms^{-1} to 0,2 ms^{-1}, preferably 0,1 ms^{-1}.

4. A method according to claim 1, characterized in that the hydration heat of the cement is exploited released during setting time for the concrete.

5. A formwork for manufacturing intermediate concrete products, characterized in that it comprises frames (7, 8) clamping together row of elements (9), the form of which corresponds to the product desired, whereby each element (9) is along both vertical sides provided with a pair of thickenings (10, 11) whereby facing sides of each thickening (10, 11) of two adjacent elements (9) are parallel, abutting slitlessly to each other, and that a web (12) being essentially perpendicular to said element and running between the thickenings (10, 11) rests slitlessly against the adjacent element (9) therefore forming a bottom (13).

6. A formwork according to claim 5, characterized in that the elements (9) are made of water-impermeable, thermally insulating material, preferably polyurethane.

7. An apparatus for manufacturing concrete products, preferably tiles, characterized in that it comprises a storage bin (1) connected preferably to a screw pump (2), the first end of a pipe line (3) being connected to the discharge end thereof fixed to a stand (3'), and the second end of the pipe line (3) is connected to an essentially trapezoidal charging head (4) provided with a row of discharging nozzles (6), a blocking unit (8') being arranged therein.

8. An apparatus according to claim 7, characterized in that the blocking unit (8') comprises closures (9) provided with a lug (9'), which are slidingly and movably arranged on wear resisting plates (8) fixed in the area of penetration of each nozzle (6) through a bottom (7) of the head (4) whereby said closures are mutually rigidly connected by means of a linkage (10) which is interconnected with a pneumatic or hydraulic working cylinder (11), and that in the area above the each closure (9) there are throttle knives (12) arranged slidingly and movably and mutually interconnected by means of a linkage (15).

9. An apparatus according to claims 7 and 8, characterized in that the side of the throttle knives (12) facing away from the working cylinder (11) is shaped as a half-wave of a sinusoidal curve (13).

10. An apparatus according to claims 7 and 8, characterized in that the linkage (15) penetrates the wall (4') of the charging head (4) on the side facing away from the working cylinder (11) whereby between the said wall and a limit stop (17) the linkage (15) is provided with a tension-compression spring (18), to a part of the linkage (15) projecting through the wall (4') there being screwed a nut (18') thereon, the stroke of the throttle knives (12) being regulated therewith.

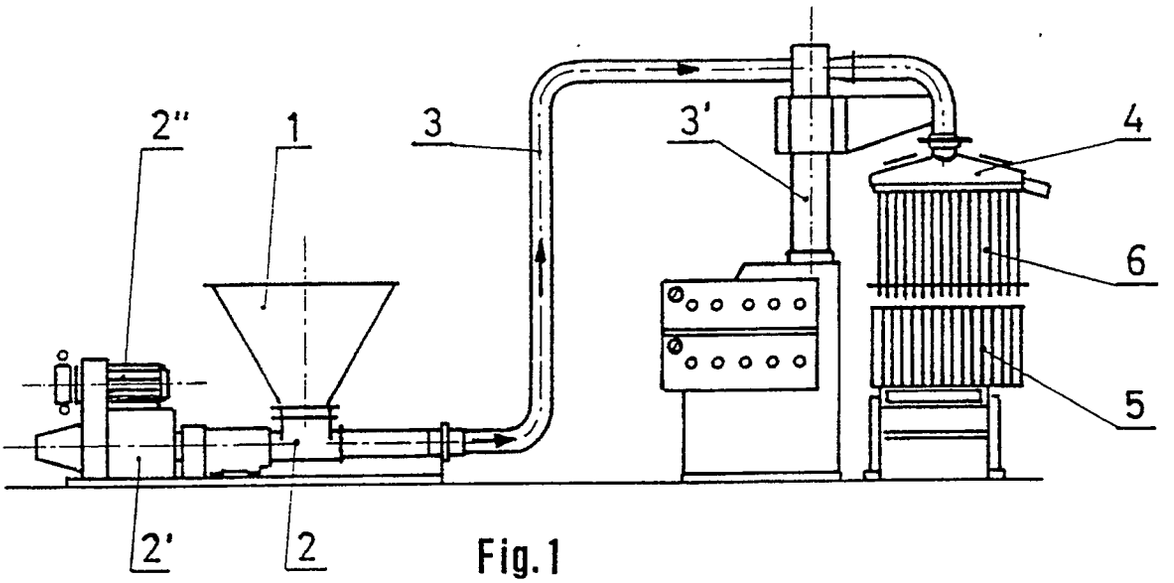

Fig.1

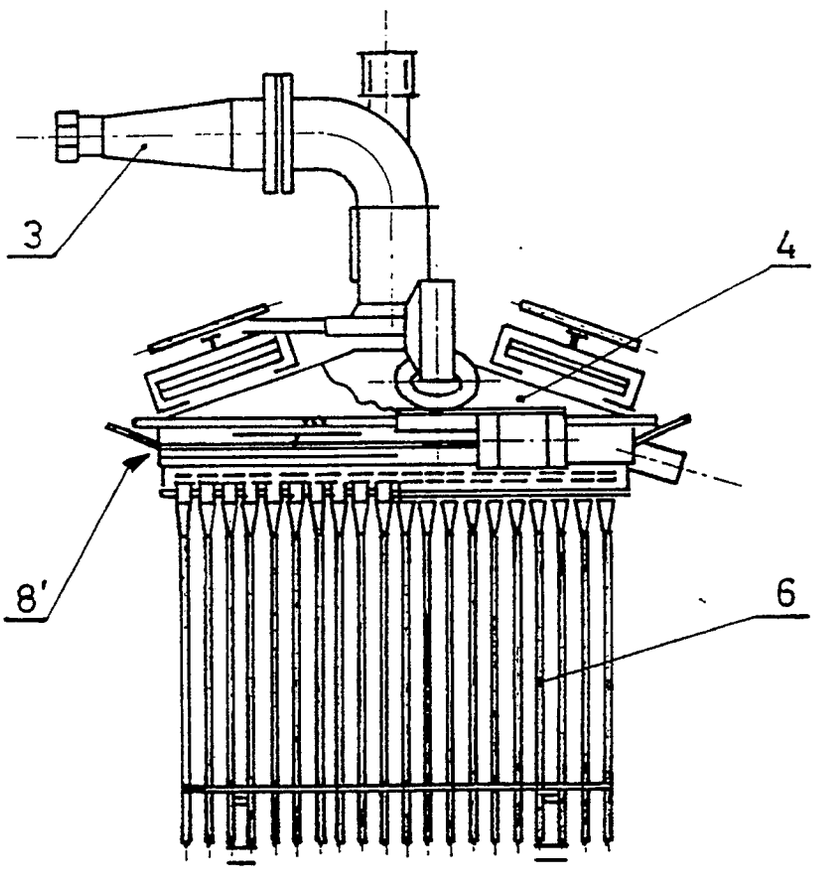

Fig.2

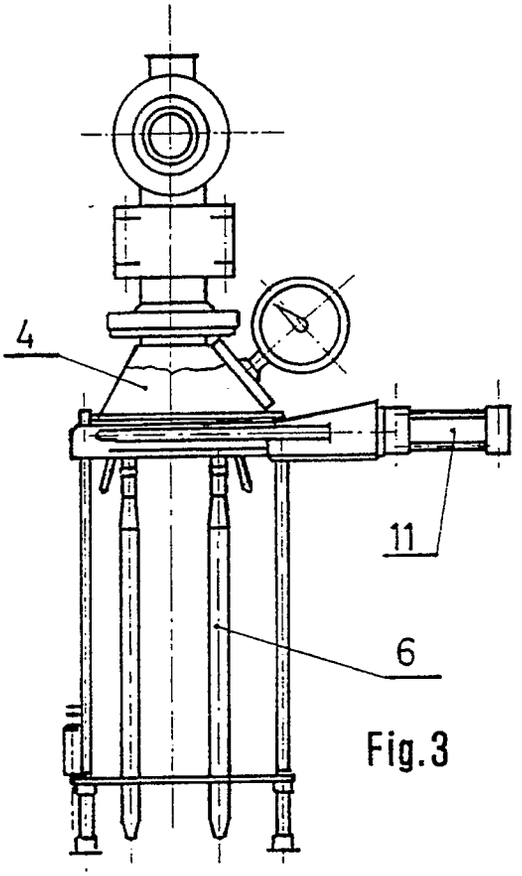

Fig.3

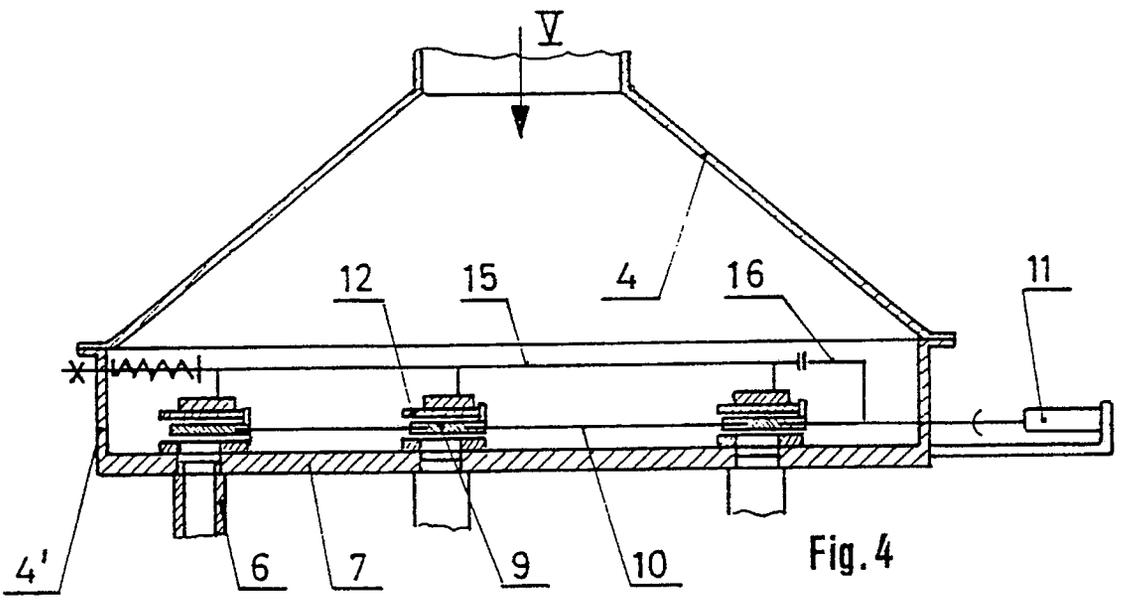

Fig.4

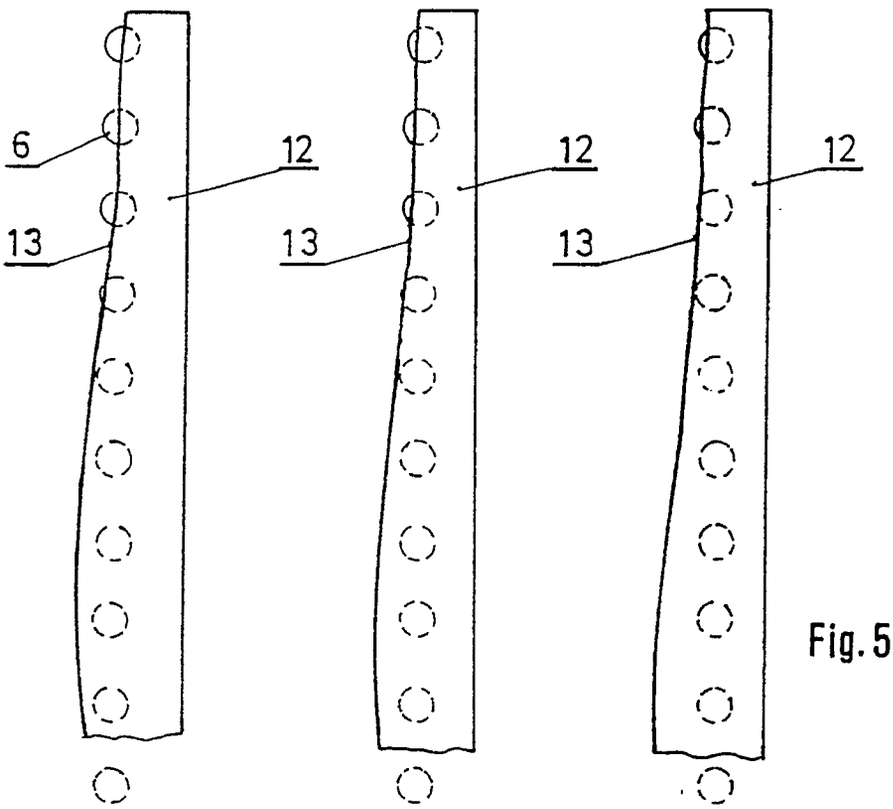

Fig. 5

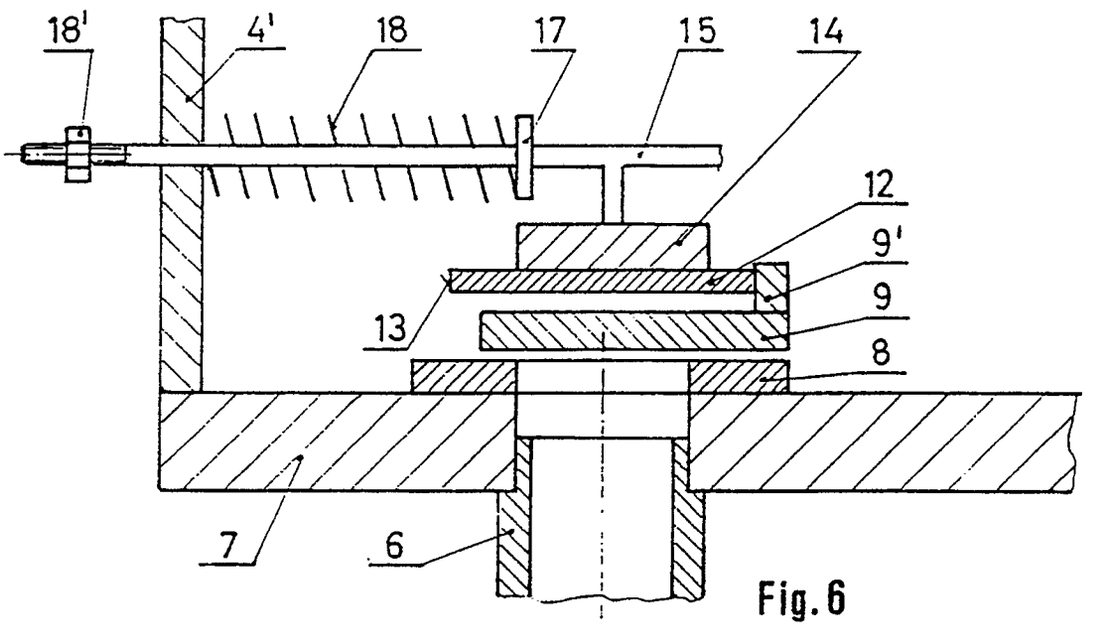

Fig. 6

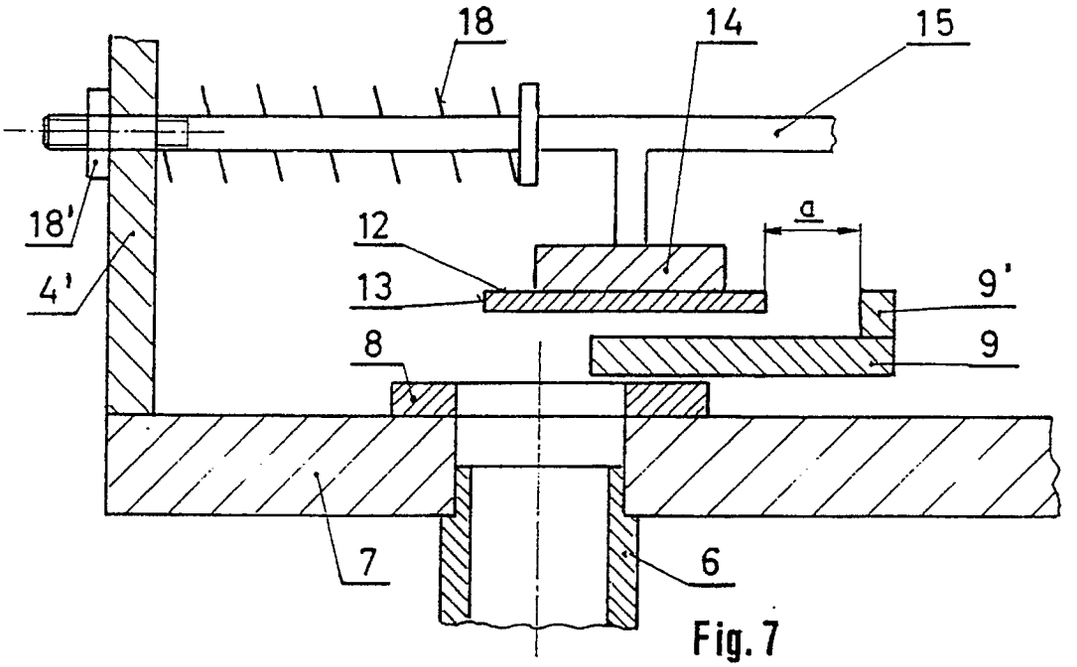

Fig. 7

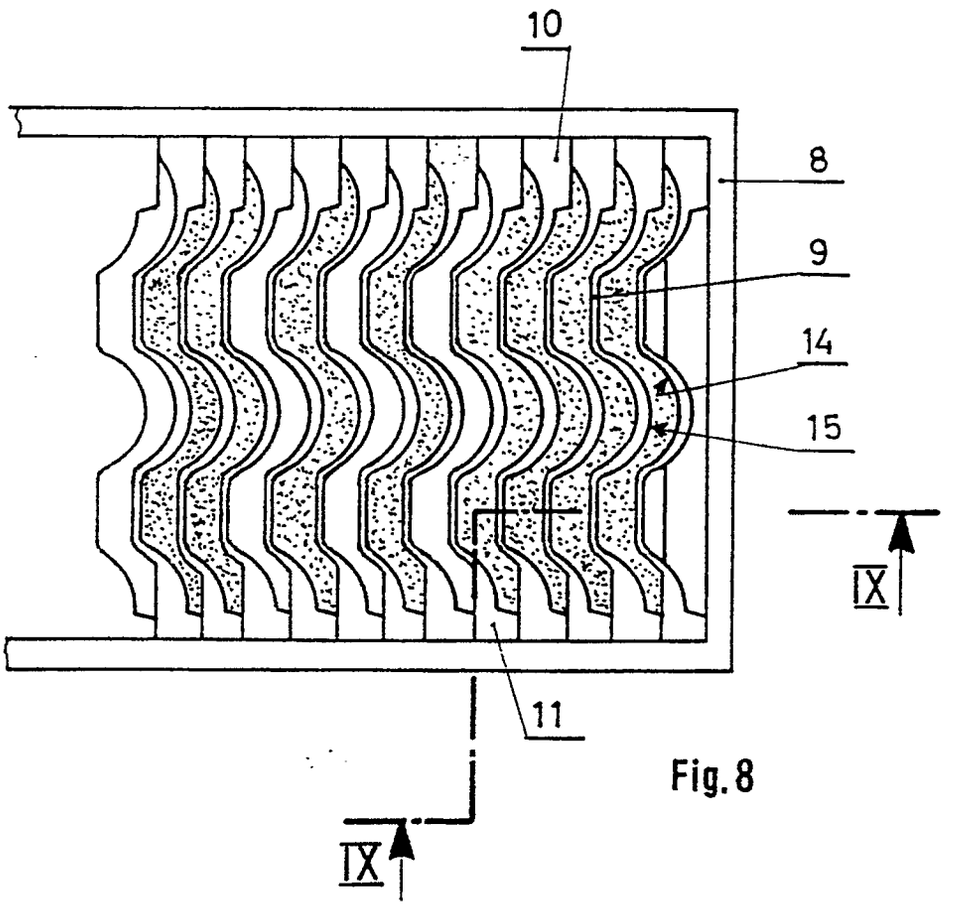

Fig. 8

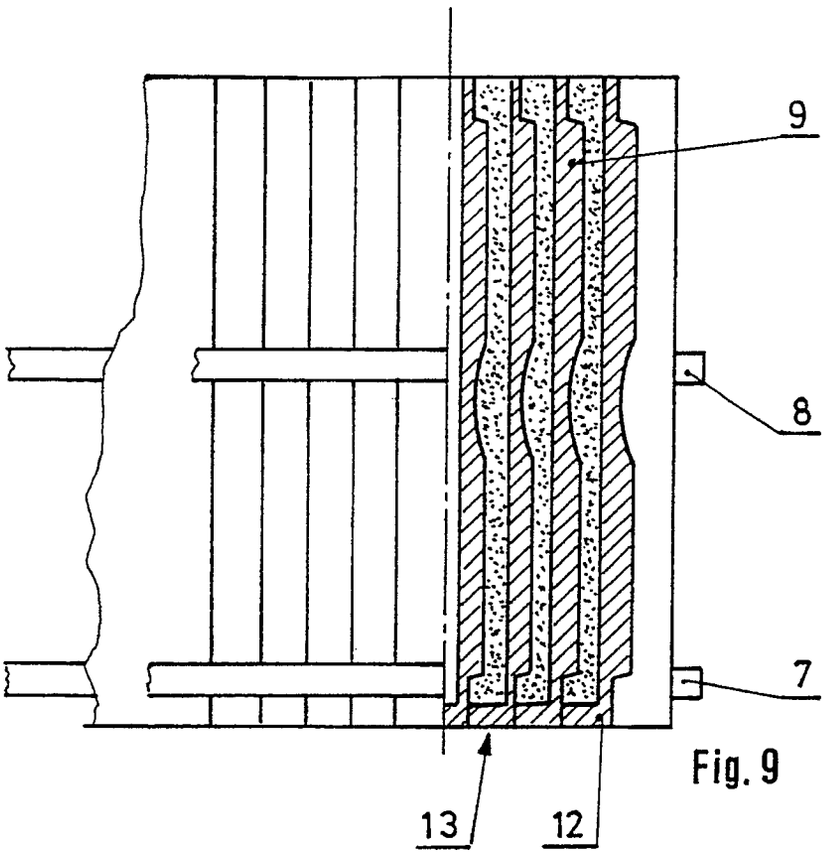

Fig. 9

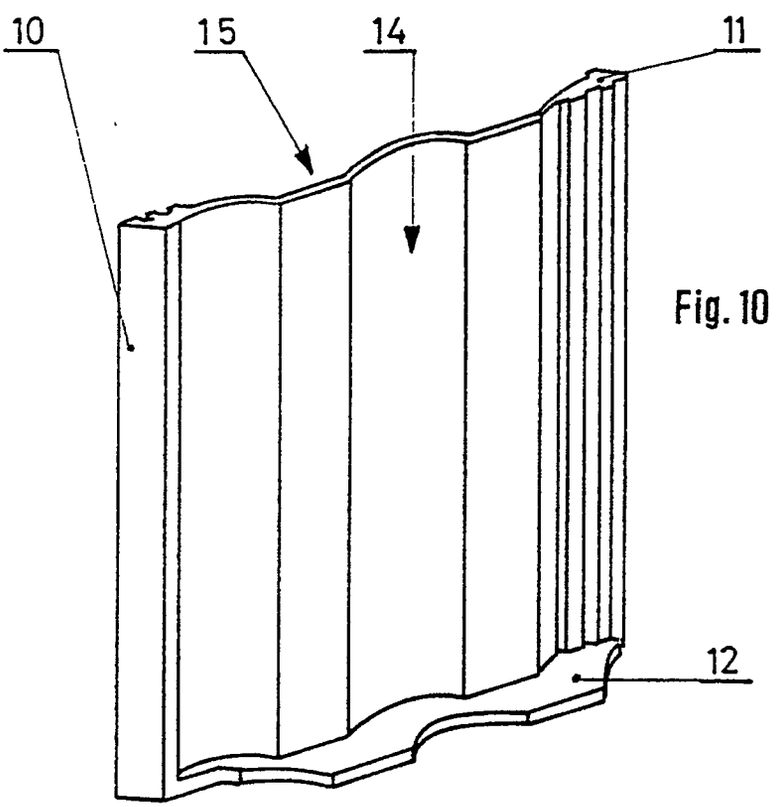

Fig. 10

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EUROPEAN SEARCH REPORT

Application Number EP 90114902.1

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	DER GRUNDBAU Armin SCHOKLITSCH, Verlag Julius Springer, Wien, 1932 pages 118-119 * Page 118, line 27 - page 119, line 3; fig. 136b *	1	B 28 B 1/14
A		2	
X	DIE GRÜNDUNG VON BAUWERKEN Wolf PLAGEMANN, Wolfgang LANGNER, Verlag B.G. Teubner, Leipzig, 1973 page 106 * Page 106, lines 18-19; fig. 10.10b *	1	
A		2	
A	DD - A - 259 576 (VEB) * Fig. 1 *	7	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	GB - A - 1 579 544 (CENTRE) * Fig. 6 *	7	B 05 C B 05 D B 28 B E 02 D E 04 C E 04 G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	17-04-1991	GLAUNACH

CATEGORY OF CITED DOCUMENTS

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