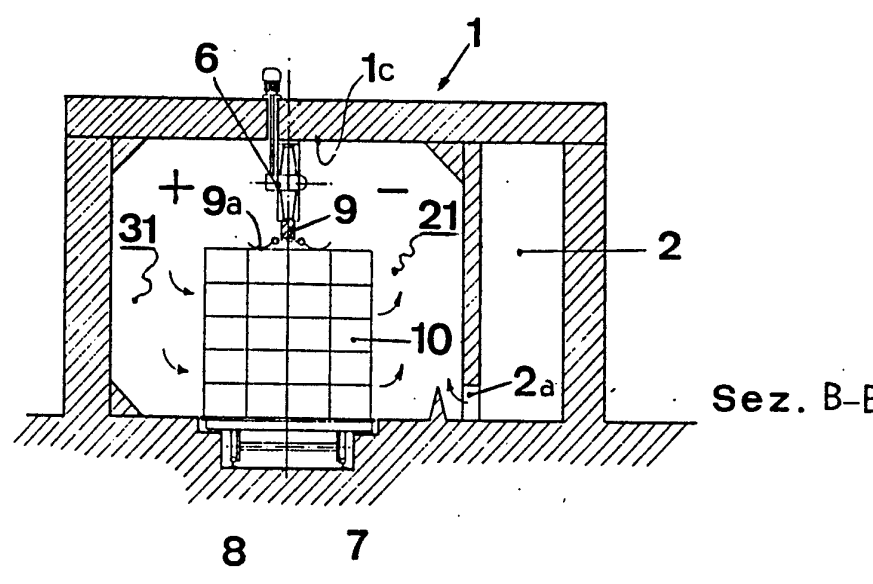




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B28B 11/00	A1	(11) International Publication Number: WO 94/04329 (43) International Publication Date: 3 March 1994 (03.03.94)
(21) International Application Number: PCT/EP92/02023 (22) International Filing Date: 24 September 1992 (24.09.92) (30) Priority data: 2520/92-2 12 August 1992 (12.08.92) CH (71) Applicant (for all designated States except US): BRIDGE-LANE LTD. [IE/IE]; Earlsfort Centre, Earlsfort Terrace 17, Dublin 2 (IE). (72) Inventor; and (75) Inventor/Applicant (for US only) : LANDMAN, Martin [GB/GB]; 51 Armitage Road, London NW11 7LB (GB). (74) Agents: BAGGIOLINI, Raimondo et al.; Fiammenghi-Fiammenghi, Via San Gottardo, 15, CH-6900 Lugano (CH).		(81) Designated States: AT, AU, BB, BG, BR, CA, CH, CS, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, PL, RO, RU, SD, SE, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG). Published <i>With international search report.</i>
(54) Title: PROCESS FOR THE DRYING OF PERFORATED BRICK BLOCKS AND PLANTS FOR CARRYING OUT THE PROCESS 		
(57) Abstract The process involves blowing in the drying air so as to make it flow only through perforations (10) of brick blocks (10) without substantially affecting the outer lateral surfaces of the blocks themselves. This process is carried out through drying tunnel (1) divided into two sides (21, 31) by the blocks stacked on a row of consecutive mobile trolleys (8) and by vertical diaphragms (9), sides (21, 31) between which the air is maintained in circulation by a series of fans (6), and of which one side (31) receives from opposite perforations (2a) the heated air which comes from conduit (2) parallel and alongside the tunnel.		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NE	Niger
BE	Belgium	GN	Guinea	NL	Netherlands
BF	Burkina Faso	GR	Greece	NO	Norway
BG	Bulgaria	HU	Hungary	NZ	New Zealand
BJ	Benin	IE	Ireland	PL	Poland
BR	Brazil	IT	Italy	PT	Portugal
BY	Belarus	JP	Japan	RO	Romania
CA	Canada	KP	Democratic People's Republic of Korea	RU	Russian Federation
CF	Central African Republic			SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovak Republic
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	UA	Ukraine
DE	Germany	MG	Madagascar	US	United States of America
DK	Denmark	ML	Mali	UZ	Uzbekistan
ES	Spain	MN	Mongolia	VN	Viet Nam
FI	Finland				

Process for the drying of perforated brick blocks and plants for carrying out the process

The invention relates to the field of drying perforated brick blocks inside drying tunnels into which air pre-heated to a pre-determined temperature is blown.

- 5 The main drawbacks exhibited by drying plants that use processes already known are twofold: the high energy consumption required by the process and the risk of deformations or cracks present on the finished product.

- Both these drawbacks are caused by the modalities of the process that is
10 carried out, as well as by the morphology of the plants itself.

- Presently, in fact, the drying of perforated brick blocks takes place through a process that involves the stacking of individual layers of blocks on levels of special metal shelving inside a tunnel or, more
15 commonly, a room of significant size in which two heating and ventilating units, either stationary or mobile, operate and direct streams of air onto the blocks to obtain their drying.

- No matter how accurate the study of the reciprocal arrangement of the
20 shelves and fans may be, still the drawback is observed that the brick blocks that are located in different positions undergo drying processes whose temperature and humidity parameters, in the course of the operation, end up being significantly different from one another, with the resulting differentiation in the quality of the blocks themselves.

- 25 In fact, since the drying essentially takes place through the dynamic action of the airflows pushed by the fans onto the shelving and the blocks, naturally phenomena of turbulence and choking of the stream on areas "in shadow" are observed that can cause uneven contractions in
30 different blocks, or even of different faces of the same block, and very often surface cracks and aberrations in the planarity of the outer surfaces of the blocks.

These phenomena are also due to the fact that in the course of the process described, the drying essentially takes place starting from the outer surfaces of the blocks and proceeding toward the inside; moreover, as already explained, with uneven temperature and humidity gradients in the various parts of the same block. Thus this effects the quality of the final product; as to energy consumption, on the other hand, supposing a yield coefficient is established to indicate the relationship with the quantity (mass) of product dried and the quantity of thermal and electric energy employed in the process that have been used up to now, very low values are obtained that are due to the following concomitant factors:

- a high quantity of mechanical energy is required to move the huge volume of air that has to pass through the shelving on which the blocks are placed, with significant energy losses;

- the drying process has a relatively high duration, especially for pieces with significant thickness; this duration must be extended until the blocks in the least favored positions are completely dried;

- since it proceeds, as mentioned, from the outside of the block to the inside, the duration of the process requires in itself long stretches of time, with the resulting increase in energy losses per unit produced caused by losses of air to the outside or by thermal exchanges with the outside, etc.;

- an appreciable quantity of energy is used for the heating of the shelves, and then it is lost in the act of removing the hot shelves themselves from the drying chamber;

- for a medium value of productive capacity of the plant, a large-volume drying chamber is required, resulting in increased surfaces for heat exchanges with the outside and related losses.

The inventor of the invention according to the present patent

application has sought to work out a solution that makes it possible to eliminate all the drawbacks listed above. The solution consists in a process that provides for carrying out the drying of the blocks from the inside, corresponding to their perforations, and proceeding toward the outside, without affecting their outer surfaces.

More precisely, the object of the invention is a process for the drying of perforated brick blocks through the action of air pre-heated to a pre-determined temperature that is blown into a drying tunnel in which the blocks are placed, characterized in that the drying is obtained by causing the above mentioned air to flow only through the perforations of the blocks without substantially affecting the outside lateral surfaces of the blocks themselves, which are stacked on one another and laid down sideways beside one another.

The above process, as well as some preferred embodiments of plants for its execution will be described here referring to the attached drawings which represent:

- in figure 1, the view of the longitudinal section of a block while it is being dried with the process according to the invention;
- in figure 2, the side view of a mobile trolley on which blocks to be dried are stacked;
- in figure 3, an illustrative detailed view of how the perforations of the blocks in figure 1 are aligned in the stacked blocks;
- in figure 4, the overhead view of the trolley in figure 1;
- in figure 5, the front view;
- in figure 6, the side view of a drying plant for carrying out the process according to the invention;
- in figure 7, its middle longitudinal section;

- in figure 8, the overhead view of the same plant sectioned with a horizontal plane parallel to its floor;
- in figure 9, the transverse section of the plant done near the
5 entrance of the tunnel;
- in figure 10, its transverse section along A-A in one of its intermediate points;
- 10 - in figure 11, its transverse section corresponding to the main heating units and the auxiliary cooling units, near the exit of the tunnel;
- in figure 12, the transverse section of an intermediate point of a multiple plant consisting of two tunnels with a double line of trolley,
15 placed alongside one another without a dividing wall.

The concept which is at the basic of the invention is that of carrying out the drying of each block not through a more or less turbulent ventilation of its outer surfaces, but rather (see figure 1) by the
20 almost laminar running of flows of heated air through lightening perforations 10ⁱ of brick blocks 10; this flow is brought about by causing and maintaining a pre-determined difference in pressure between the two ends 12a and 12b of said perforations 10ⁱ. By operating suitably on the means (usually fans) that generate this difference in pressure in
25 order to vary their value, it is possible to vary the velocity of the flow so as to obtain, by a determined temperature of the drying air that can also be adjusted, the desired movement of the drying curve referred to time.

30 With the prevalent values found experimentally to be the most suitable for the efficiency of the plant as a whole, and for percentage areas of the perforations comprised between the mean values, it was observed how it would be possible to proceed to dry a row of blocks laid lengthwise and arranged with the perforations of one over those of the other, with
35 the row being up to about 120 cm long.

Blocks 10 themselves can be laid sideways and stacked directly on one another (see figures 2 to 5) up to a height which, with the types of blocks and materials used today, varies roughly between 95 and 110 cm.

5 It has also been found experimentally that the drying takes place relatively more quickly near the end of the perforation that functions as the entrance for the circulating air, but that this does not involve any drawback for the dimensional stability of the block during the drying process as a whole.

10

With reference to figures 6 to 11, we now proceed to the description of a preferred embodiment of a plant suitable for carrying out the process described above, including a single drying tunnel 1.

15 Such a plant, as already mentioned, is composed essentially of drying tunnel 1 with longitudinal development, on whose floor 1d is drawn and embedded guide path 7 designed to hold and guide during their conveyance mobile trolleys 8 that are used for the transport of blocks 10 during drying.

20

It is evident that a rail track fixed onto the above path (not represented), to better guide the wheels of trolleys 8.

25 These trolleys 8, connected to one another mechanically, are brought in on guide path 7, and on them are stacked, in direct contact with one another, several layers of blocks 10, with the blocks laid sideways and lengthwise, as already mentioned, so that the perforations of each block are aligned with the perforations matching those of the block that is adjacent lengthwise, thus forming a conduit for the passage of the drying air (see figure 5) from one side 21 of tunnel 1 to the other 31.

30

Indeed, tunnel 1 itself, thanks to vertical diaphragm 9 that is mounted on the center line of ceiling 1c, and that rests on brick blocks 10 below by means of suitable members 9a that exert a pre-determined seal on blocks 10, is separated from diaphragm 9 and from the row of trolleys

35

8 in two sides 21, 31 separated from stacked blocks 10, and communicating with one another only through all the perforations 10ⁱ of the blocks themselves, these blocks being arranged perpendicular to the direction of the movement of trolleys 8, as marked by a larger arrow in figures 6, 7 and 8.

The plant also includes conduit 2, parallel and adjacent over its entire length to tunnel 1 itself, equipped with a number of perforations 2a and of adjustable small openings placed at equal distances which put conduit 2 in communication with 31 of the two sides 21, 31 into which, as was mentioned, the tunnel is subdivided.

Inside this conduit 2, the drying air that is heated to pre-determined pressures and temperatures is delivered by main ventilation and heating unit 3, generally consisting of a fan and a device for heating the area (for example, a heat exchanger, a burner or similar means), placed near the exit of the tunnel.

This air which, as mentioned, is introduced from small openings 2a into side 31 of tunnel 1, enters into the field of action of a series of circulation fans 6 that, like diaphragm 9, are also mounted on the center line of ceiling 1c of tunnel 1, and that cause the air to circulate by the effect of determined pressure difference, between the two sides 21 and 31 of tunnel 1 (the direction of the various airflows is indicated on the drawings by the smaller arrows).

All the air, circulating cyclically and propelled by fans 6, between the two sides of the tunnel, is made to move with a pre-determined conveyance velocity toward entrance 1b of the tunnel and is evacuated, once it has yielded its heat and absorbed the humidity of the blocks, by means of suction fan 4 which serves as an evacuation unit, placed precisely at entrance 1b of tunnel 1.

Once they have reached the vicinity of exit 1a of tunnel 1, the blocks are then subjected to a stream of cooling air generated by cooling unit 5, placed on the opposite side from main unit 3, and including a

compressing fan, which is sized and aligned so that the stream of air, after being heated by cooling the dried blocks to a large extent, is conveyed into side 3l of the tunnel, mixing with the drying air generated by the main ventilation and heating unit 3 itself. By
5 operating in this way a good part of the heat from the cooling of blocks 10 is recovered, adding a further factor of energy saving. Of course, both entrance 1b and exit 1a of the tunnel must be designed so as to allow for the passage of mobile trolleys 8 without significant losses of air to the outside.

10

In some cases, for bricks having tongues of limited thickness and perforations with ample cross-section, and consequently with a tunnel of limited length, the vacuum created by the above mentioned evacuation unit 4 may already be sufficient to cause the hot drying air with an
15 appropriate conveyance velocity, without its having to be propelled by the compressing fan of ventilation and cooling unit 3. In such cases, this last fan can be eliminated. Any number of variations can be made to the embodiment just described to the various requirements relative to the drying of blocks with diverse morphological characteristics and made
20 with diverse materials.

This embodiment is therefore to be considered as purely exemplary and not limiting or binding with respect to the inventive concepts expressed in the attached claims.

25

In the case illustrated, for example, circulation fans 6 are of axial type, but radial fans equipped with suitable conveyors can also be used so as to obtain the same process with higher prevalent values.

30

The above inventive concepts also allow for the realizations of plants of greater complexity to increase the productive capacity by unit of time.

35

For example, considering figure 12, which represents a type of plant in which the tunnel is subdivided by two rows of trolleys 8 and diaphragms 9 into three parts.

Conduit 2 for the drying air, with respective perforations 2a, is embedded in floor 1d of the tunnel, and the circulation between the two sides 2l, 3l of the tunnel that are separated by a row of trolleys 8 is obtained through a series of axial fans 11 with vertical axes equipped with conveyor ducts 11a.

(In this drawing, as also in the remaining drawings, areas with higher pressures are marked with + signs, while those with lower pressures are marked with - signs).

Of extreme interest, for the purpose of increased productivity of the plant but with significant dimensional compactness and a limited cost for amortizing it and the possibility of placing two tunnels 1, 1' parallel to one another over their entire length that are subdivided as described above, without any dividing wall to separate them, thus forming a multiple tunnel 101. As can be seen (figure 12) from the movement of the pressures and from the directions of circulation, the process is identical, but allows for even greater advantages.

From the description that has been given to this point, it can also be appreciated how the drying of the brick takes place under optimal physical conditions for the necessary heat exchange. Indeed the heated drying air, introduced in essentially uniform quantity by all the small distribution openings 2a, ends up mixing with the circulation air moved by fans 6 and passes through the blocks and, in moving from exit 1a toward entrance 1b of the tunnel by the effect of the conveyance imposed by evacuation unit 4, such a mixture exhibits a gradually decreasing temperature and a rising degree of relative humidity. This means that, on its first impact with blocks 10 as they come into the tunnel through entrance 1b, the air that effects the drying has the lowest temperature and the greatest relative humidity, and this eliminates the initial "shock" of dehydration with its risk of deforming the blocks which is observed in traditional plants.

Thus the difference between the temperature of the air and that of the blocks, in the course of the process according to the invention, tends

to remain closer to a medium value, with good results for the purposes of the overall yield of the heat exchange.

5 The upper lateral surfaces of the blocks that make up the highest layer of the load, as well as the lateral surfaces of the blocks, which can be separated by gaps a few millimeters thick, are only affected marginally by the air in circulation, and this does not compromise the final result in any significant manner. Through the further use of light diaphragms or screens made with a material that tolerates a temperature of
10 approximately 100°C it is still possible to further reduce or even to practically eliminate the heat exchange relative to these surfaces in cases where an unusually high quality of the product is required.

15 It is added that both the differing temperature and pressure values of the air and the direction of circulation of the air itself, as well as the conveyance velocity (continuous or in successive steps) of the mobile trolleys can be selected, regulated and/or programmed from time to time to obtain the type of process most suited to the different type of product sought.

20

Claims

1. Process for the drying of perforated brick blocks (10) through the action of air at pre-determined temperature that is blown into drying tunnel (1) in which the blocks are placed, characterized in that the drying is obtaining by causing the air to flow only through perforations (10ⁱ) of blocks (10), without substantially affecting the outer lateral surfaces of the blocks themselves that are stacked on one another and laid sideways to one another.
2. Process according to claim 1, wherein the following phases are included:
- a) stacking on mobile trucks (8) of number of perforated blocks (10) placed on top of one another, laid sideways and lengthwise and aligned, with the longitudinal axes of the perforations (10ⁱ) arranged horizontally, with said axes of two perforations corresponding to two adjacent blocks laid next to one another arranged so that each is the extension of the other;
- b) introduction of trucks (8) into drying tunnel (1);
- c) conveyance of said mobile trucks (8) perpendicular to the direction of the above mentioned perforations (10ⁱ), along an essentially median axis of drying tunnel (1) equipped with diaphragm (9), so as to divide with the trucks and the diaphragm tunnel (1) into two opposite sides (21, 31) separated by the stacked blocks and communicating with one another essentially only through all the perforations (10ⁱ) of the blocks themselves;
- d) introduction of the heated drying air into one (21) of the two opposite sides of tunnel (1) and a resulting pressure that differs to a pre-determined extent from the temperature prevailing in the other side (31), so that the entire flow of the above mentioned drying air passes through all the perforations (10ⁱ) of the blocks to circulate through both of the above mentioned sides (21, 31) of tunnel (1);

e) cooling of blocks (10) once drying has taken place, with recovery of the relative heat from cooling;

f) extraction of mobile trucks (8) from tunnel (1).

5

3. Drying plant suitable for realizing the process according to the invention according to any one of the previous claims, wherein it includes:

10 a) drying tunnel (1) equipped at its ends (1a, 1b) with an entrance opening and an exit opening that are sized so as to allow for the passage of mobile trolleys (8) carrying stacked blocks (10) without substantial leaks of pressured air;

15 b) conduit (2) parallel to tunnel (1), adjacent to it over its entire length and equipped with a number of perforations (2a) placed at equal distances which make it communicate with one (21) of the two sides (21, 31) of tunnel (1) itself;

20 c) main ventilation and heating unit (3) located near exit (1a) of tunnel (1), which delivers the drying air, at pre-determined pressures and temperatures, in said conduit (2);

25 d) cooling unit (5) located near exit (1a) of tunnel (1), on the opposite side from the so-called main unit (3), comprising a compressing fan that delivers a stream of air on stacked blocks (10) that have been dried, cooling them, then directing it toward the inside of tunnel (1) so as to recover the heat from cooling;

30 e) evacuation unit (4), comprised of a suction fan located near entrance (1b) of tunnel (1);

35 f) a number of circulating fans (6) placed at equal distances and mounted roughly on the center line of ceiling (1c) of tunnel (1) over the entire length of the tunnel itself that maintain a pre-determined

difference in pressure between its two sides (21, 31);

5 g) guide path (7) that can be embedded in floor (1d) of tunnel (1), arranged essentially along its middle line, having a shape suitable for holding and guiding during their conveyance mobile trolleys (8) that transport blocks (10) to be dried;

10 h) a number of consecutive mobile trolleys (8) mounted on wheels, connected to one another, on which brick blocks (10) to be dried are stacked;

15 i) vertical diaphragm (9), essentially mounted in correspondence to the center line of ceiling (1c) of tunnel (1) and equipped with members (9a) suitable for creating sufficient pressure on the bricks stacked below (10) to create a seal that substantially prevents the passage of air from one side (21) of the tunnel to the other (31) through diaphragm (9) itself.

20 4. Plant according to claim 3 wherein said mobile trolleys (8), as well as the respective diaphragms (9), are aligned to form two parallel rows, subdividing tunnel (1) into three parts, with circulating fans (11) mounted on the center line of ceiling (1c) and equipped with conveyors (11a, 11b) suitable for putting in communication two sides (21, 31) of tunnel (1) that are separated by a row of trolleys, and said conduit (2) 25 for the drying air, with the respective outflow perforations (2a), made below floor (1a) of tunnel (1) in a position essentially facing the line formed by the above mentioned circulating fans (11).

30 5. Plant according to claim 4, wherein several tunnels (1) are placed parallel to one another, without any dividing wall to separate them from one another, thus forming a multiple tunnel (101) suitable for higher production speeds.

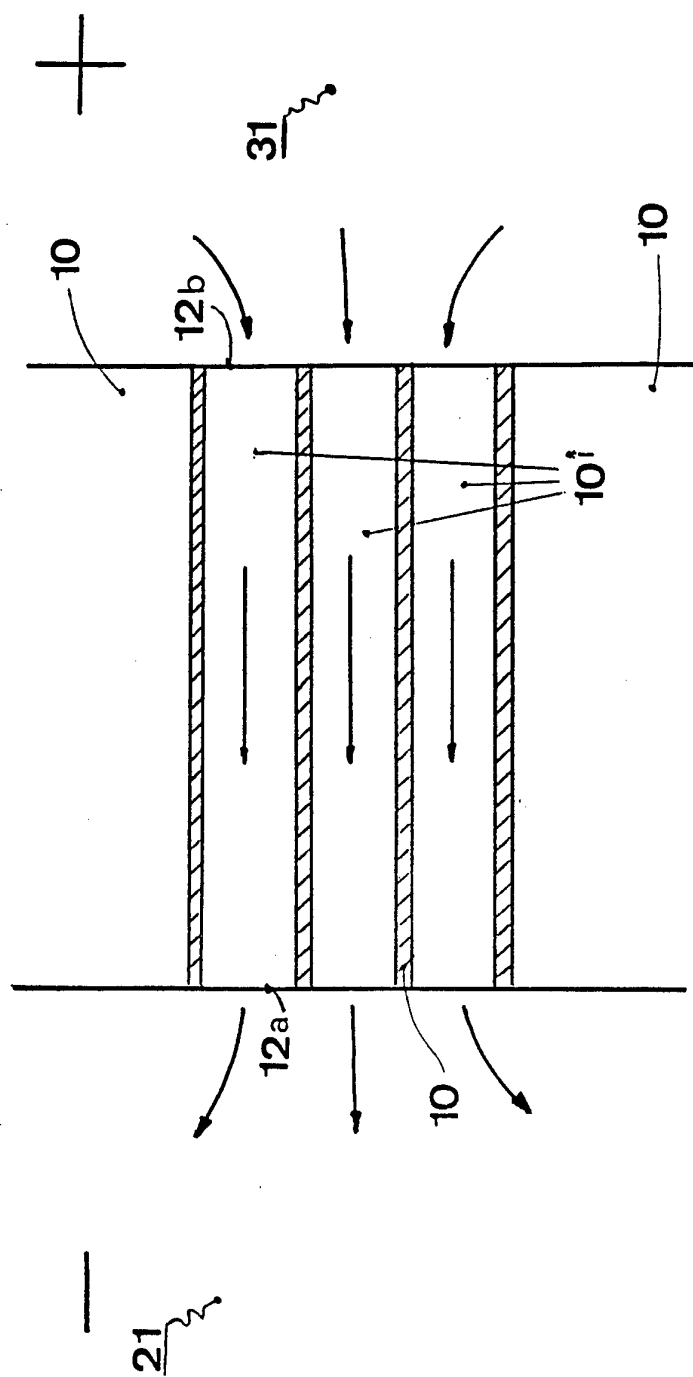
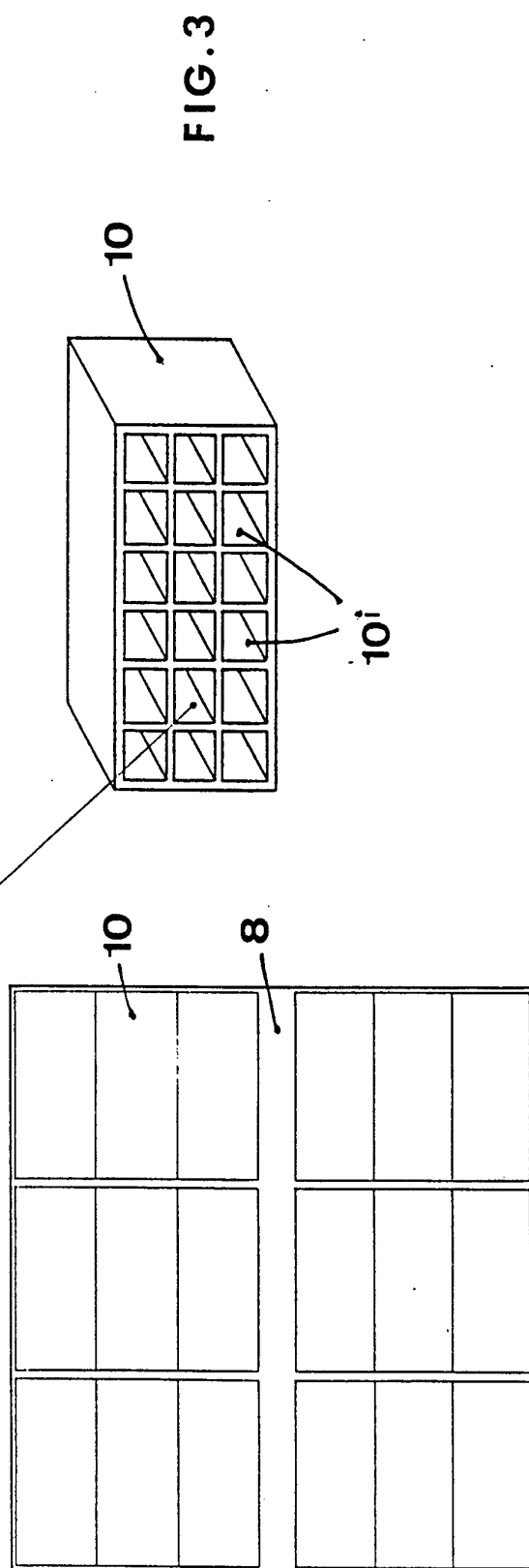
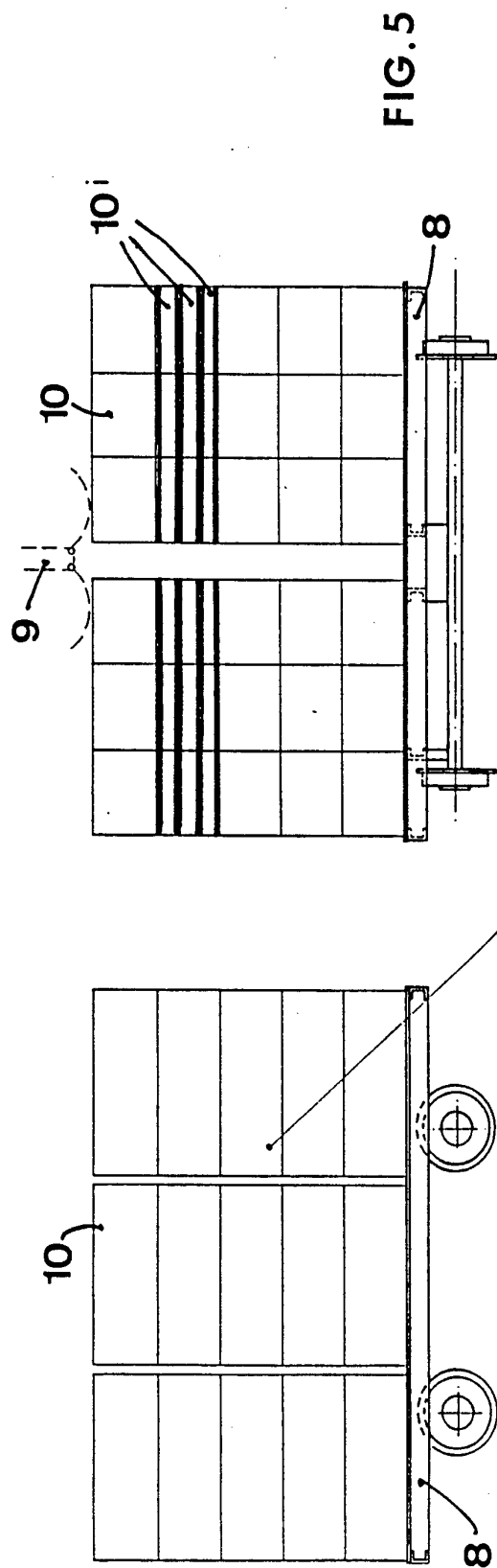
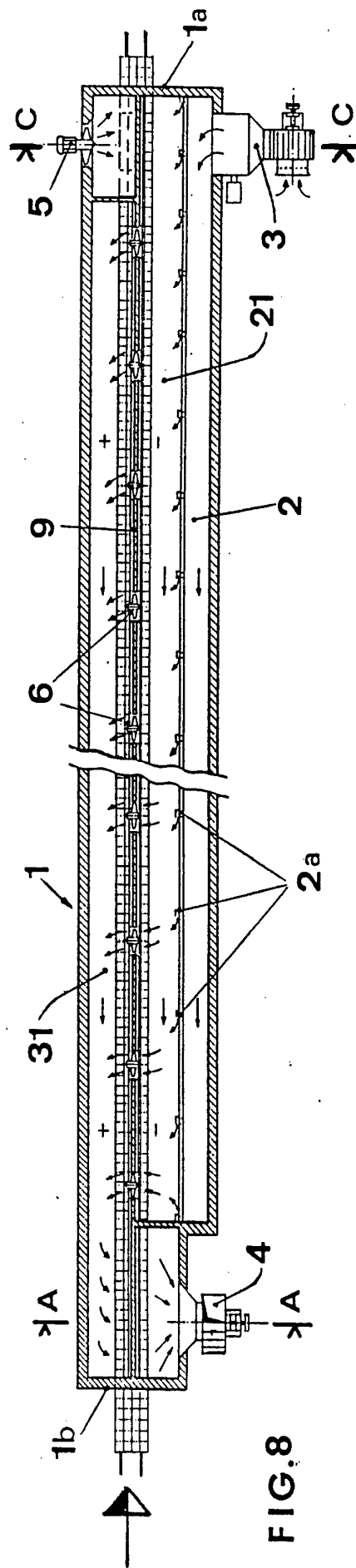
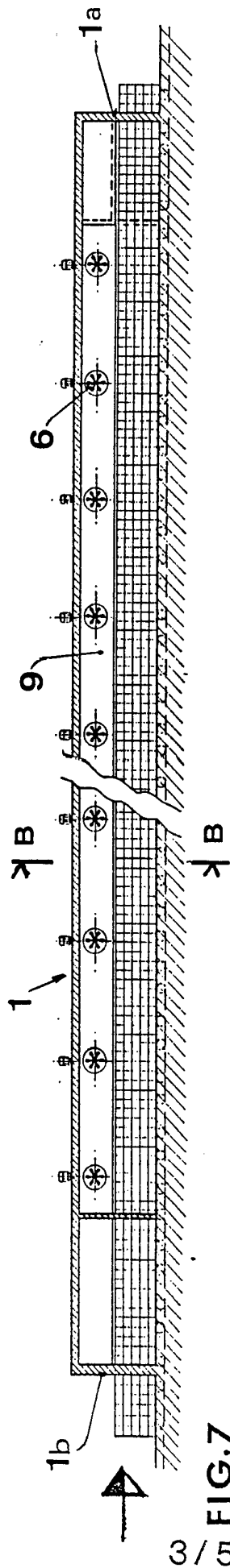
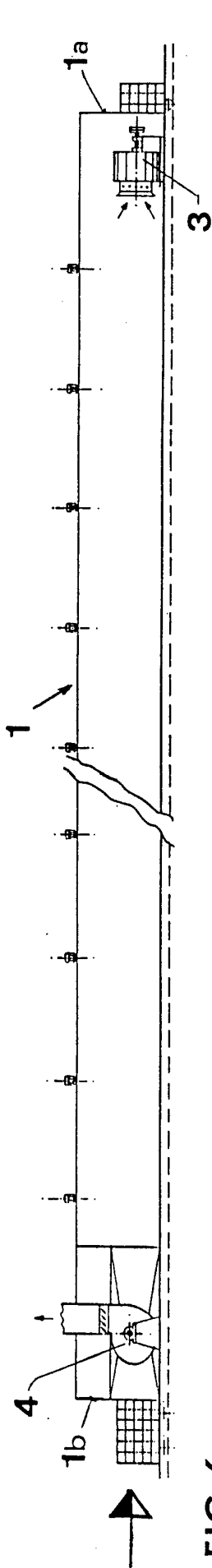
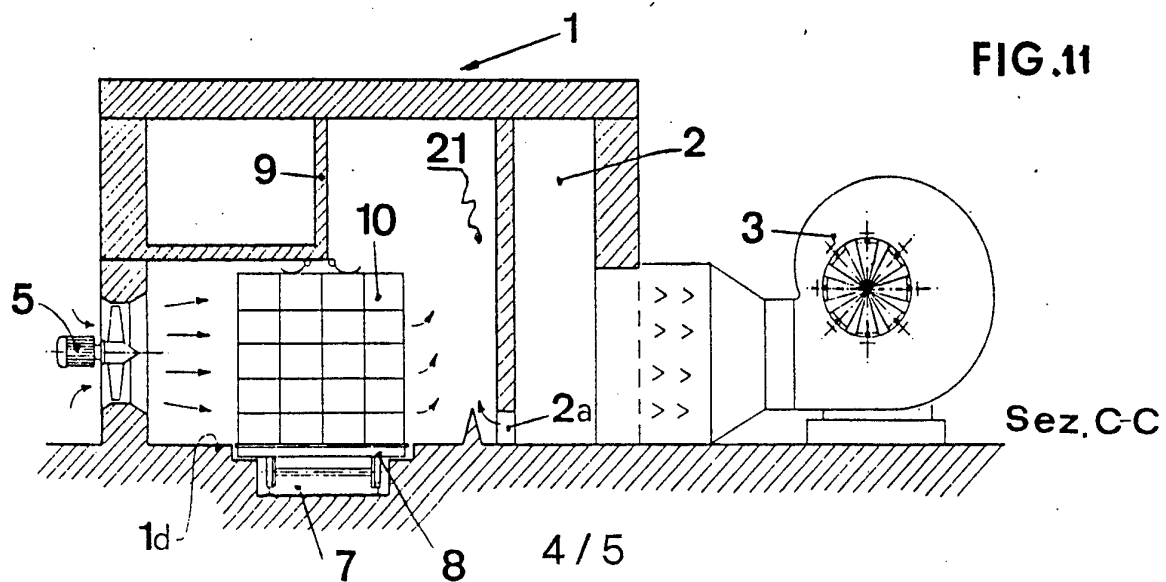
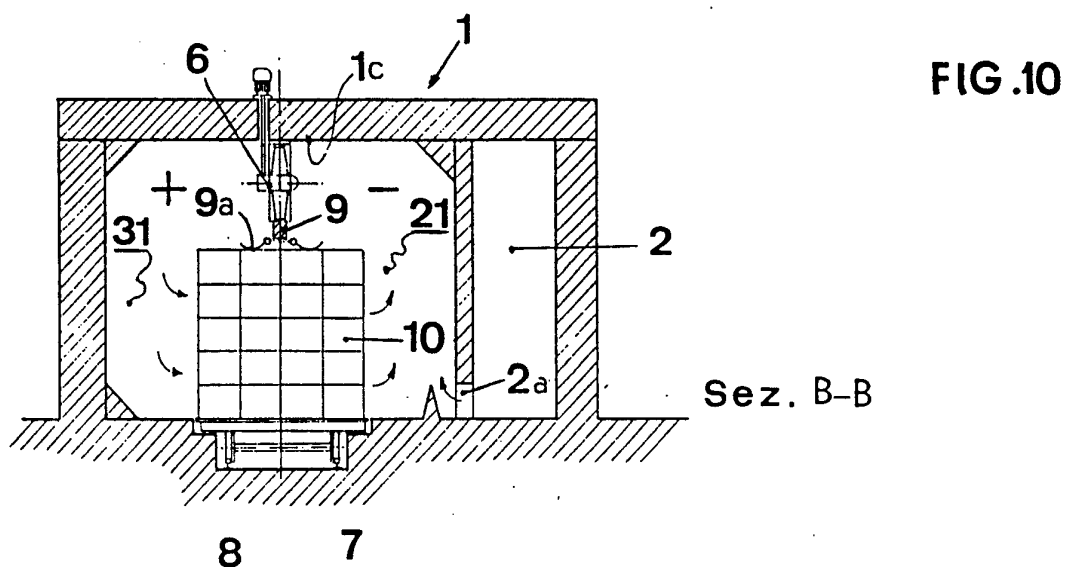
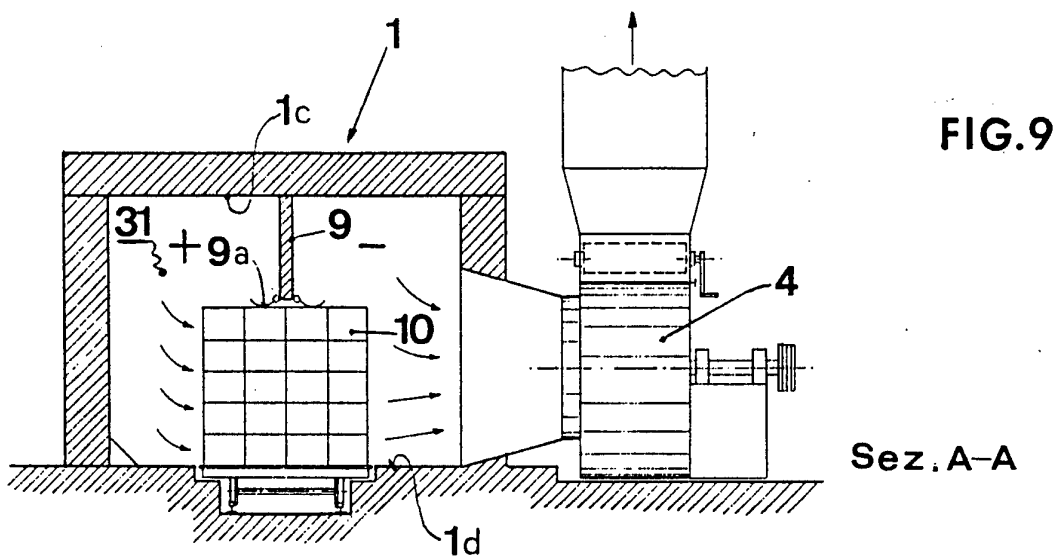


FIG.1







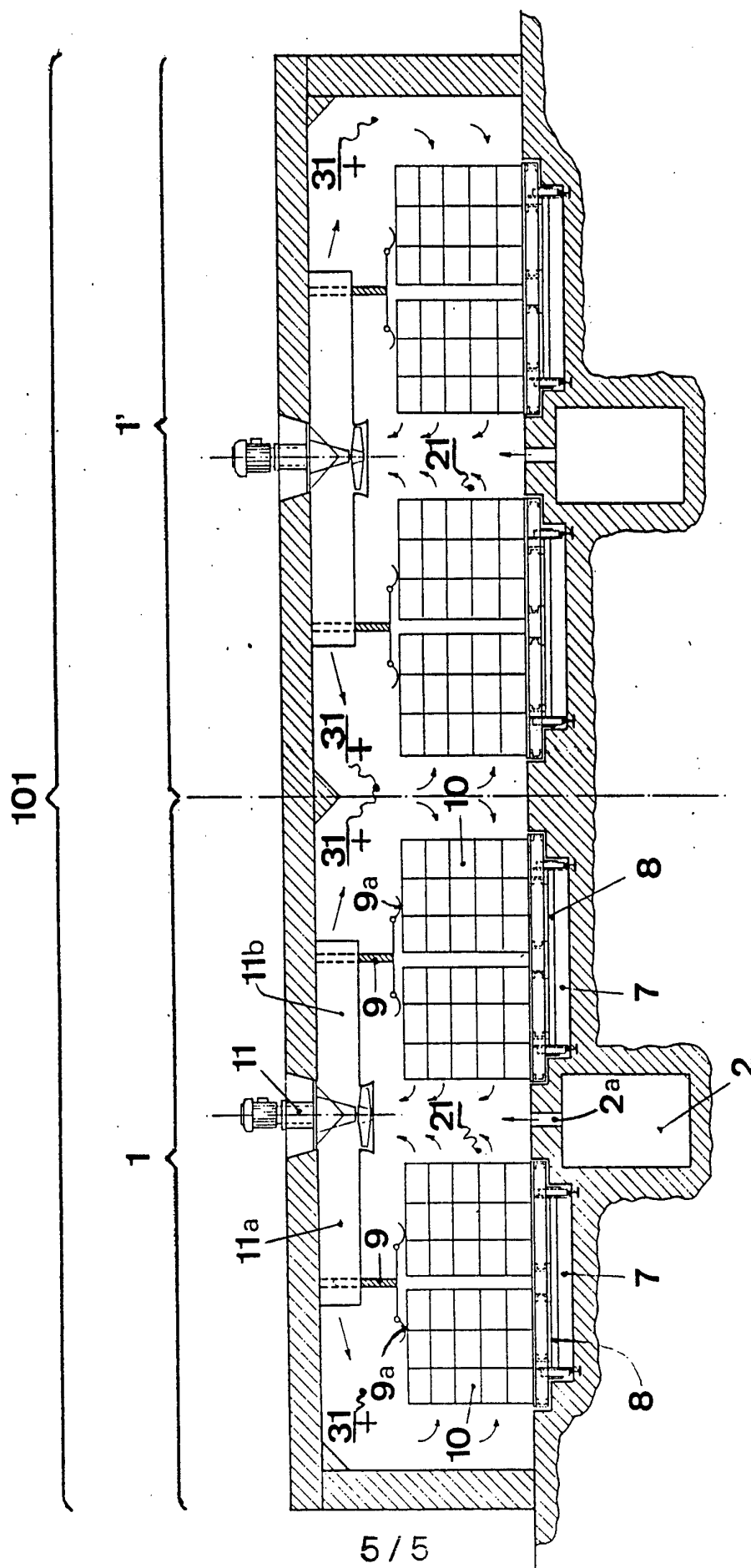


FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP 92/02023

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: B28B 11/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: B28B, C04B

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	US, A, 2170936 (C.F. BARON), 29 August 1939 (29.08.39), page 3, right column, line 56 - line 69; figures 1, 7	1-3

Y	DE, C, 858655 (G. JUNGE), 8 December 1952 (08.12.52), page 2, line 56 - line 60, figure 1, detail 1	1-3

A	DE, A1, 3147582 (HÄSSLER, A.), 9 June 1983 (09.06.83), figure 1, claim 1	1-5

☒ 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

5 March 1993

Date of mailing of the international search report

01.04.93

Name and mailing address of the ISA/



European Patent Office, P.B. 5818 Patentaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Vilho Juvonen

INTERNATIONAL SEARCH REPORT

International application No.

PCT/EP 92/02023

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, C2, 3545498 (ITTNER, H.), 8 October 1987 (08.10.87), column 9, line 51 - line 65, figures 2, 3 --	1-5
A	DE, A1, 4010850 (ZIEGELWERK KLOSTERBEUREN LUDWIG LEINSING GMBH & CO.), 10 October 1991 (10.10.91), column 3, line 31 - line 40 --	1-5
A	GB, A, 2085425 (TSELINOGRADSKY INZHENERNO-STROITELNY INSTITUT), 28 April 1982 (28.04.82), page 2, line 25 - line 30, figure 1 -- -----	1-5

INTERNATIONAL SEARCH REPORT
Information on patent family members

29/01/93

International application No.
PCT/EP 92/02023

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US-A-	2170936	29/08/39	NONE		
DE-C-	858655	08/12/52	NONE		
DE-A1-	3147582	09/06/83	NONE		
DE-C2-	3545498	08/10/87	NONE		
DE-A1-	4010850	10/10/91	EP-A-	0450433	09/10/91
GB-A-	2085425	28/04/82	NONE		