Title: **AN APPARATUS AND A METHOD TO PRODUCE A HOLLOW-CORE OR SOLID SLAB**

Abstract: The object of the invention is an apparatus (100) and a method to produce hollow-core or solid slabs. The apparatus (100) consists at least of a mass feeding organ (11) to feed mass (20) into the apparatus (100), a work space (7) limiting to stoppers and to the hollow-core slab (200) or solid slab under production to form the mentioned slab, and a row of screws (la, lb, etc.) which are set to rotate around their lengthwise axes to mix the mass (20) and to move it to the space between the stoppers that form the outer limits (200.2) and to tighten it there. When producing hollow-core slabs (200), the bushes (2) belong also to the apparatus (100) to form the hollows (200.1) in the slabs. Every screw (la, lb, etc.), the number of which is at least three, has been set to rotate into the opposite direction to its neighboring screw.
AN APPARATUS AND A METHOD TO PRODUCE A HOLLOW-CORE OR SOLID SLAB

The object of this invention is an apparatus and method to produce hollow-core or solid slabs. The mentioned apparatus consists of a feeding organ to feed material into the apparatus, at least certain stoppers, to the hollow-core or solid slab under production and to the base limited work space to form the hollow-core or solid slab, in a row placed, around their lengthwise axels rotating set screws to mix the mass and to move it into the space inside the stoppers forming the outer limits of the hollow-core or solid slab profile and to tighten there and as the bushes set to be continuation of the form the hollows to the slabs when hollow-core slab is being produced.

The usages of the invention are the hollow-core slabs that include the hollows inside the slab. Normally, these hollows are side by side holes from end-to-end and their meaning is to make the weight of the slab lighter. The hollows are designed and realized as a compromise of the weight, dimensions, and the tensile properties of the slab. A slab with a certain width and length that requires a certain bending resistance, maximum size and favourably shaped hollows are made to keep their weight as small as possible. The objects of the invention are also the solid slabs that do not have hollows.

The mentioned hollow-core and solid slabs are used in the construction industry very largely. As a one favourable usage example, the intermediate floors, roofs and floors can be mentioned. It is typical for the before mentioned usage places that the slabs in these places have a relatively long span length and thus the greatest bending load comes to the lengthwise centre of the slabs.
The hollow-core slabs are produced according to the known technique so that an apparatus, e.g. an extruder that includes a feed hopper for the material (concrete mass) which feed hopper is moved upon its bed that is upon the casting bed where the hollow-core slab is formed. Before extruding the mass, the pretension span cords to be situated inside the slab or corresponding parts that strengthen the slab are placed to their places. In a moving extruder there are the limiters or stoppers that limit the sides of the slab to be produced to a certain width and form, if needed, the side joint profiles, upper side to a certain height from the bed, and the end stopper that prevents the concrete from flowing into the direction where the extruder advances. Horizontal bushes have also been installed into the extruder in the work space between the before mentioned stoppers and the end limiter and screws in the same direction as their length axels and reaching the ends of the bushes. The mentioned screw can be found at the location of every hollow the shape of which is in the lengthwise direction conical so that its thicker end is in the side of the bush and the thinner end farther from it. As the slab is under production the extruder moves upon the place on rails where the slab is being formed in the lengthwise direction of the slab. The concrete mass is fed into the hopper, the mass flows evenly on the flat production surface of the slab and around the screws. The screws are rotated by the motors behind the end stoppers into different directions so that the screws at the different sides of the width wise centre of the slab rotate in groups into different directions. When the rotating directions of the screws are such that their upper parts turn into the direction of the sides of the slab under production, the concrete mass moves and gets tightened around the bushes and inside the stoppers into the direction of the sides of the slab to be formed. At the same time, the crowns of the screws press and tighten the concrete mass into the direction of the slab under production, that is in the opposite direction than where to the extruder is moving. According to the known technology, two or more screws side by side have the same motor and all
the screws have either same or almost same rotation speed or the outer screws have a slightly greater rotation speed. As the extruder moves forwards, readymade hollow-core slab appears from under if.

Solid slabs are produced nowadays with the same apparatus and methods, as described above. Naturally, the bushes to make hollows are not needed in that case.

The before mentioned known technique is used in the construction industry very much.

The known technique has a number of drawbacks. It can be said from experience that the miscibility of the concrete mass in the point where the slab is formed is inconvenient poor. A screw group rotating into the same direction is not able to mix the concrete mass efficiently. This drawback is emphasized even more as the concrete in the feeding hopper forms dryer or wetter parts in which case the need for mixing in the place where the slab is formed is higher that otherwise. It is known that it is possible that in the winter time some snow gets into the feeding hopper and then also the mixing of the contents of the hopper in the producing process is very important. The bad miscibility in the equipments of the known technique comes also as the in groups in opposite directions rotating screws cause in the mass flow the so called pyramid phenomenon, that is the flowing mass causes in its centre occur a flowing mass of the shape of a blunt point arrow, and then the forwards flow of the mass is slow but sideways strong. If is known that this phenomenon slows down the advancing of the process.

It can be said as a conclusion that the poor miscibility of the concrete mass is caused when using the equipments of the known technique by rotating of the screws in groups into the same directions and that all the screws have essentially the same rotation speed.
The before mentioned drawbacks lead into that the production speed of the hollow-core slabs must be kept relatively low. The standard value of the speed of the production of the hollow-core slabs can as known be kept 1.0-1.5 m/min.

The bad miscibility of the concrete mass leads also into that a relatively large number of the hollow-core slabs must be rejected when using the known technique apparatuses and methods.

The meaning of this invention is to obtain such a method to produce hollow-core and solid slabs that avoid drawbacks of the known technique. It is characteristic for the solution according to the invention that has been presented in the characterizing parts of the claims 1, 6 and 7.

The greatest advantage of the invention can be seen to be the efficient mixing of the concrete mass and a considerable rising of the flow volume in the production of the hollow-core and solid slabs. This leads into a significant rise of the production speed and a better quality. The mentioned rise of the speed and the lower discarding need mean direct economical savings in the production costs of the mentioned slabs. It has been found out in the praxis that using the apparatuses and the system according to the invention a speed of over 3.0 m/min can be reached in the production.

In this material, the term hollow-core slab means all kinds of construction elements with all kinds of shape of lightening hollows and the term solid slab means all kinds of construction slabs without any kinds and shape of hollows which slabs are used in the construction industry. The term motor means a motor rotating a screw either by itself or together with a transmission gear between the motor and the screw.
The invention is described in more detail in the enclosed figures where fig 1 presents a 3D picture of principle of the setting of the application of the method according to the invention, fig 2 presents the before mentioned setting seen directly from the side, fig 3 presents the same setting seen from the direction X, fig 4 presents the cut A-A from the figure 3, fig 5 presents the cut B-B from the figure 4, fig 6 presents the cut from the place of the middle axels of the screws according to the cut C-C of the figure 4, fig 7 presents a setting according to the known technique from the same point as has been presented in figure 6, fig 8 presents another situation according to the invention from the corresponding cut as has been presenting in figure 6, fig 9 presents the before mentioned setting realized according to the known technique.

Next, one favourable structure and working of the application of the invention is described referring to the before mentioned figures.

In figure 1, it has been presented the apparatus 100 according to the invention to produce the hollow-core slabs that is an extruder, and a hollow-core slab 200 under preparation and the bed 300 under the hollow-core slab. The parts of the apparatus are body 10, the feeding organ 11 that is used to feed the production material of the slab that is in this example a hopper and the wheels 12. The mass is concrete in this case. When the apparatus 100 moves upon the rails into the direction of the arrow thereon, from under if (from left) appears readymade hollow-core slab 200. In figure 2, the before mentioned setting has been described as seen directly from the side and in the figure 3 seen from the direction X of the figure 2. In figure 4, the cut A-A of the figure 3 has been presented and there can be seen the work space 7 that is formed under the feeding organ 11 and upon the bed 300. In this cut
figure, two cuts have been presented and the pictures of these cuts have been presented in figures 5 and 6. Figure 5 presents the cut B-B that is a horizontal cut of the before mentioned setting at the height of the middle lines of the screws and there can be seen the work space 7 where the greatest part of the organs of the apparatus 100 that produce the hollow-core slab are situated, like screws 1a-1d, bushes, side stoppers 3, the separate motors 4a, 4b, etc. for each screw etc. and the end stopper 6. In this example, four hollows 200.1 containing hollow-core slabs are made and then there are four bushes 2 forming the hollows and four screws 1a, 1b, etc. at the continuation of the bushes and the screws 1a, 1b, etc. cover the ends of the bushes. It can be seen in the figure 6 that when using the method according to the invention the screws are set to rotate around their middle axels so that every other screw rotates clockwise and every other counter-clockwise, that is every screw has the opposite rotation direction than its neighbour. The mass 20 coming from feeder 21 hopper around the screws in the work space 7 gets mixed efficiently as a result of the differing rotation directions of the screws and the rising crowns 1.1 push mass tightly between the stoppers, around the bushes 2. The apparatus has also a top stopper 5 that defines the height of the hollow-core slab that is produced.

As the extruder moves forwards a hollow-core slab 200 is formed between the mentioned stoppers as a slip casting and its hollows 200.1 are formed according to the outer dimensions of the bushes. The mentioned stoppers form the outer limits 200.2 of the profile of the hollow-core slab.

As every screw has its own motor, the movement, mixing and tightening between the stoppers can be made more efficient and directed even better by regulating individually the rotation speed of the screws as needed. The mass 20 flow does not cause the so called pyramid effect of the known technique but the screws rotating according to the
invention break it and the forwards flow becomes more efficient considerably.

When solid slab is produced using the apparatus and method according to the invention the operation is the same as above, only the bushes 2 are not there. In that case, the mass 20 fills altogether the space between the outer limits of the profile 200.2 and the stoppers.

The rotation directions and speed of the screws 1a, 1b, etc. can be changed during the production of the hollow-core and solid slabs even completely arbitrarily, e.g. forwards, backwards, and thus the wanted properties can be boosted case by case in the flow of the mass. These changes in the operation of the screws can be programmed to take place as a time function and these programs can be made to happen in different forms in the connection of the different hollow-core and solid slabs. Especially, when using an unpaired amount of the screws this way of using the screws is very useful. As a whole, with these capabilities of the apparatus 100 the advance speed can be increased considerably and thus the production speed of the slab becomes faster.

The situation according to the known technique has been presented in the figure 7 for the comparison. There two left side screws are rotating in different direction than two right side screws. (Curved arrows indicate the rotation direction).

Such an application according to the invention is described in the picture 8 where a hollow-core slab of 6 hollows is produced and in the figure 9 the corresponding situation with the known technique application.
When applying the invention, the rising of the crown 1.1 is made into such a direction that it regardless of the screw rotation direction is capable of moving mass 20 into the direction of the bushes 2.

In one application of the invention where the screws 1a, 1b, etc. are rotating according to the known technology but every screw is set to be rotated by its own motor 4a, 4b, etc. or the power transfer of the mentioned screws is arranged in some other way that every screw 1a, 1b, etc. can be rotated individually with a desired speed. This application covers also the situation where a screw or the screws are rotated back and forth.

The mentioned screws can also be set to rotate around its middle axel or its any other lengthwise axel. And thus as one application of the invention wobbler shaft rotation can come in the question.

In a manner known per se parts can the apparatus 100 be made by any known way when applying the invention. The hollow-core 200 or solid slab made by the apparatus and method according to the invention can be of its dimensions any nowadays known slab.

When applying the invention it is possible to take advantage of all the nowadays known characteristics of the apparatuses of the production of the hollow-core and solid slabs by making best of them case by case with the practical characteristics of the invention.

It should be noted that even though this description sticks to one for the invention favourable application example, this does not intend to limit the usage of the invention only to this type of example, but instead many variations are possible within the scope of the inventive idea.
Claims

1. An apparatus (100) to produce hollow-core or solid slabs that apparatus consists of at least:
   a. mass feeding organ (11) to feed mass (20) into the apparatus,
   b. work space (12) that is limited to at least certain stoppers, the hollow-core slab (200) or solid slab and the bed (300) to form the mentioned hollow-core or solid slab,
   c. in a row formation put screws (1a, 1b, etc.) that have been set to rotate around their lengthwise axels to mix the mass and to move it to the space between the stoppers that form the outer limits (100.2) of the profile and the bottom (300) and to tighten it there and as the continuation of the mentioned screws set bushes (2) to form the hollows (200.1) in the slabs when the hollow-core slab is produced,

   characterized in that every screw (1a, 1b, etc.) that are at least three have been set to rotate into the opposite direction than its neighbour screw.

2. The apparatus (100) according to the claim 1 characterized in that the screws (1a, 1b, etc.) have been set to change the rotation direction during the production process as time function.

3. The apparatus (100) according to the claim 1 or 2 characterized in that an own motor (4a, 4b, etc.) has been set to rotate each screw (1a, 1b, etc.).

4. The apparatus (100) according to some of the claims 1-3 characterized in that the rotation speed of one or more screws (1a, 1b, etc.) has been set to be regulated independently.
5. The apparatus according to some of the claims 1-4 characterized in that the crowns (1.1) of the screws have been set to press and tighten the concrete mass into the direction of the hollow-core/solid slab (100/200) under formation.

6. The method to produce hollow-core slab (200) or solid slab characterized in that the apparatus (100) that has been defined in some of the claims 1-5 is used in it and that the mentioned method is performed as follows:

a. mass (20) is fed into the work space (7) which mass is the raw material of the hollow-core or solid slab,

b. mass (20) is mixed and moved and tightened between the bottom (300) and the stoppers that define the profile outer limits (200.2) of the hollow-core or solid slab in its part and around the bushes (2) that form the hollows (200.1) with the help of the screws (1a, 1b, etc.) when a hollow-core slab (200) is produced,

c. the screws that are at least three are set to rotate around their lengthwise axis so that each screw (1a, 1b, etc.) rotates into the opposite direction than its neighbouring screw.
INTERNATIONAL SEARCH REPORT

International application No.
PCT/FL2016/000006

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: B28B, B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base, and, where practicable, search terms used)

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>FI 200601 42 A (ELEMATIC OY AB) 15 August 2007 (15.08.2007) the whole document, especially page 3, lines 2 and 28-31; figure 2</td>
<td>1, 5, 6</td>
</tr>
<tr>
<td>Y</td>
<td>RU 2293650 C1 (SELIVANOY NIKOLAJ PAVLOVICH [RU]) 20 February 2007 (20.02.2007) especially figure 3 &amp; abstracts [online] EPOQUENET EPODOC &amp; WPI &amp; the whole machine translation into English by the EPO [online] [retrieved 15.4.2016], particularly page 3, 9th paragraph; claim 14</td>
<td>2-4</td>
</tr>
<tr>
<td>X</td>
<td>GB 2002284 A (PARAISTEN KALKKI OY) 21 February 1979 (21.02.1979) the whole document, especially figure 1</td>
<td>1, 5, 6</td>
</tr>
<tr>
<td>Y</td>
<td>WO 201128509 A1 (AHONEN JOUNI [FI]) 20 October 2011 (20.10.2011) the whole document, especially page 6, lines 12-22; page 9, lines 5-10; figures 1 and 2</td>
<td>2-4</td>
</tr>
</tbody>
</table>

☐ 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 application or patent 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 of 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

18 April 2016 (18.04.2016)

Date of mailing of the international search report

19 April 2016 (19.04.2016)

Name and mailing address of the ISA/FL

Finnish Patent and Registration Office
P.O. Box 1160, FI-00101 HELSINKI, Finland
Facsimile No. +358 9 6939 5328

Authorized officer
Vilja Voutilainen
Telephone No. +358 9 6939 500

Form PCT/ISA/210 (second sheet) (January 2015)
<table>
<thead>
<tr>
<th>IPC</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>B28B 3/22</td>
<td>(2006.01)</td>
<td></td>
</tr>
<tr>
<td>B28B 1/08</td>
<td>(2006.01)</td>
<td></td>
</tr>
<tr>
<td>B28B 17/00</td>
<td>(2006.01)</td>
<td></td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family members(s)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>FI 200601 42 A</td>
<td>15/08/2007</td>
<td>None</td>
</tr>
<tr>
<td>RU 2293650 C1</td>
<td>20/02/2007</td>
<td>EA 200602232 A2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EA 0091 37 B1</td>
</tr>
<tr>
<td>GB 2002284 A</td>
<td>21/02/1979</td>
<td>GB 2002284 B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 1092792 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 2833859 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 2833859 C2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FI 772406 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FI 62783 B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FI 62783 C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HU 180270 B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 4202658 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>YU 191478 A</td>
</tr>
<tr>
<td>WO 201 1128509 A1</td>
<td>20/11/2011</td>
<td>DK 2558257 T3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2558257 A1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2558257 B1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2533752 T3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FI 201 05400 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FI 122389 B</td>
</tr>
</tbody>
</table>