Title: FRAME FOR A DRYING SECTION

Fig. 1

Abstract: According to the invention, a frame (1) for a drying cylinder group of a drying section of a web forming machine is provided, which comprises a pair of lower frame side elements (2) extending in machine direction and being provided on the driving side and the tending side of the web forming machine, wherein each lower frame side element (2) comprises a horizontal beam (21) adapted to support a group of drying cylinders of the web forming machine and a plurality of vertical beams (22) located below the horizontal beam (21) for supporting the same.
The invention relates to a frame for a drying cylinder group of a drying section of a web forming machine, e.g. for a paper or board machine, as well as to a drying section being built up from such frames.

In the prior art, frames for drying sections are known which frames are built up of vertical elements and horizontal elements. Bearing housings of drying cylinders are supported by the vertical elements in order to stably support the drying cylinders. The vertical elements are usually built up from pipe sections which are welded together to a column-like shape. An attachment is fixed at the vertical elements so as to provide a support for the bearing housings of the drying cylinders. The frames built up in such a manner have the disadvantage that they are very heavy in construction and that they are demanding, time consuming and expensive to manufacture.

Hence, it is the object of the invention to provide a frame for a drying cylinder group of a drying section of a web forming machine, which frame can be manufactured with low costs.

This object is solved by a frame for a drying cylinder group comprising the features according to claim 1.

Advantageous further formations are subject of the dependent claims.

According to the invention, the frame for the drying cylinder group of a drying section of a web forming machine
comprises a pair of lower frame side elements which extend in machine direction and which are provided on the driving side and the tending side of the web forming machine. Each lower frame side element comprises a horizontal beam adapted to support a group of drying cylinders of the web forming machine and a plurality of vertical beams located below the horizontal beam for supporting the same. In other words, the horizontal beam is located above the vertical beams in a vertical direction. In this connection, "adapted to support" means that the horizontal beam either directly or indirectly supports the drying cylinders.

Using one horizontal beam for supporting a group of drying cylinders has the advantage that it is not necessary to provide separate bearing attachments on the vertical beams for supporting individual drying cylinders of a group of drying cylinders. This makes it possible to easily provide a support for all drying cylinders of one group and to easily provide the drying cylinders on the same level. Furthermore, beams are easy to manufacture at low costs. Also, tailoring the beams is reduced to cutting a standard beam profile to the appropriate length. Accordingly, it is possible to manufacture the frames fast and with low costs. Both lower frame side elements, i.e. the lower frame side element on the driving side and the lower frame side element on the tending side, can be built up from an identical number of parts. It is, however, also possible to built up the lower frame side elements with a different number of parts.

Using the horizontal beams for supporting the drying cylinders leads to a construction, in which - when viewing the frame in cross machine direction - the horizontal beam
covers a part of the space formed between adjacent drying cylinders of a drying cylinder group just below the turning axes of the dryer cylinders. That is, the accessibility of the space between adjacent drying cylinders may be adversely affected by supporting the drying cylinders of a group on a single horizontal beam. For example, runnability components like suction/blow boxes are typically provided in the above-described space between adjacent drying cylinders, so that connection and maintenance of the same would be difficult. Therefore, the horizontal beams of opposite frame side elements are preferably provided at different level. In other words, the horizontal beams are provided with different distances to the turning axes of the drying cylinders. With such an arrangement of the horizontal beams, the space between two adjacent drying cylinders can be accessed on a different height. Accordingly, the accessibility of the space between two adjacent drying cylinders is enhanced so that the space can be used more efficiently. If the horizontal beams are provided on the same level, connections to said runnability component have to bypass at least one of said beams.

In order to make sure that the drying cylinders can be supported at the same level, the horizontal beam provided at lower level may comprise means for equalizing the difference in level with respect to the level of the other horizontal beam. Such means can be any suitable means as long as a sufficient strong support can be achieved, a spacer or a small U-shaped beam construction for instance. Using a spacer is beneficial in view of the manufacturing tolerance of the horizontal beam and the vertical beam because it is easy to balance any difference by providing a correspondingly adapted means for equalizing. In other
words, using a means for equalizing the level difference makes it possible to also compensate for a dimensional variation of the horizontal beam.

Advantageously, the horizontal beam provided at higher level is adapted to directly support bearing housings of drying cylinders and the lower horizontal beam is adapted to support the bearing housings via a spacer which forms the means for equalizing. By directly supporting the bearing housings on the horizontal beam on one side of the drying cylinders, it is possible to reduce vibrations which might occur when a spacer or the like is provided between the bearing housing and the horizontal beam. It is, however, also possible to support the cylinder bearings on both sides with suitably constructed spacers.

Preferably, the bearing housings are fixed on the horizontal beam by means of a nut and bolt connection. In this connection, it is particular advantageous if the bolt has a U-shape. That is, upon fixing the bearing housings to a beam, the bolt is placed so as to surround the beam. Such a connection is advantageous in that it is not necessary to provide threaded holes in the beam of the frame or to provide an attachment plate comprising threaded holes for fixing the bearing housings thereto. Thus, manufacturing the frames is easier. Furthermore, the use of such a nut and bolt connection is not limited to fixing the bearing housings to the horizontal frame but may also be used for fixing a cleaner, runnability component, wire tensioner/guide or even another frame or the like to the frame. Usually, the free ends of the U-shaped bolt are inserted into holes provided in the bearing housings. However, instead of providing holes in the bearing
housings, it is possible to provide a collar/groove in the bearing housing and to use a tie bar between the ends of the U-shaped bolt, where said tie bar is placed in a groove of the bearing housing and catches the bolt ends. Thus, the need for holes in the bearing housings is eliminated.

In order to establish such a connection, the bearing housings preferably comprise attachment holes into which the ends of the U-shaped bolt are inserted, wherein the attachment holes are arranged in cross-machine direction on opposite sides of the horizontal beam onto which the bearing housings are fixed. The attachment holes may be formed in a flange which is provided at the bearing housing and which extends from the bearing housing in cross-machine direction, i.e. in the direction crossing the beam perpendicular to the extension direction of the frame. When placed on the beam, the flange extends beyond the beam in cross-machine direction on both sides of the beam so that portions not being in contact with the beam protrude beyond the same. The attachment holes are provided in these portions. In order to fix the bearing housings to the frame, the U-shaped bolt is placed around the horizontal beam of the lower frame side elements such that each end is inserted in one of the two holes and the nuts are screwed onto each end, respectively. In other words, the U-shaped bolts are used as clamps for clamping the bearing housing onto the beam. Of course, the use of the U-shaped bolt for attaching the bearing housings on the frame is only exemplary and could also be used for connecting other parts to the frame. Furthermore, in case the bearing housings are casted parts, it is possible to form the attachment holes during casting so that no extra machining step, such as drilling, is necessary.
In order to provide a secure connection with the beam, it is advantageous when the U-shaped bolt is made of metal having high elasticity, for example. In such a case, it is possible to achieve a good tensioning when the nut is firmly screwed onto the ends of the U-shaped bolt so as to provide a strong connection.

Preferably, each of the lower frame side elements is an integral assembly in which the horizontal beam and the vertical beams are welded together. Welding the beams together provides an easy and strong connection therebetween. By forming integral assemblies, it is possible to provide frame side elements which are pre-mounted and which are designed in a way that easy transportation is possible. In other words, the lower frame side elements may be designed under consideration of the transport volume and transport weight. Furthermore, by providing the lower frame side elements as an integral assembly, the final assembly is much faster.

The frame may comprise a pair of upper frame side elements extending in machine direction, which elements are provided on the driving side and the tending side of the web forming machine and which are adapted to support lead rolls for guiding a dryer wire. Here, "adapted to support" means that the lead rolls are either supported directly or indirectly, for example by means of a spacer or further frame.

Each upper frame side element may consist of at least one horizontal beam supported on a plurality of vertical beams and, preferably, each upper frame side element is an integral assembly in which the horizontal beams and the
vertical beams are welded together. By providing the upper frame side element as an integral assembly, the final assembly to the lower frame side element involves less effort. It is particular advantageous if both the lower frame side element and the upper frame side element are integrally formed. Within one drying cylinder group, there is advantageously at least said lower integral assembly. Furthermore, the upper integral assembly covers a part of said group/lower integral assembly. In the group gap, lead rolls may be supported from the same upper integral assembly.

Advantageously, the upper frame side elements are detachably mountable to the lower frame side elements and it is even more preferable that vertical beams of the upper frame side elements are mountable onto the horizontal beam of the lower frame side elements.

In order to provide a detachable fixing of the upper frame side elements on the lower frame side elements, the connection between the vertical beams of the upper frame side elements and the lower frame side elements may be a nut and bolt connection. Such a connection is fast and easy to establish. However, it also possible to use other techniques for fixing the upper frame side elements to the lower frame side elements as long as the detachability of the upper frame side elements is assured.

In order to achieve a particular rigid structure, at least one of the vertical beams of each upper frame side element is aligned with a vertical beam of the corresponding lower frame side elements. With such an arrangement, the weight of the upper frame side element can be linearly transmitted.
onto the vertical beam of the corresponding lower frame side element so that no bending force acts on the horizontal beam of the lower frame side element.

The frame can be built up such that all beams are straight beams having a constant profile. Such a construction has the advantage that it is very simple and less cost-intensive since tailoring different sections of the frame mainly consists in cutting standardized straight beams to the correct length. Therefore, it is not necessary to tailor specific frame parts by bending steel plates into a rectangular shape or the like and an amount of welding can be significantly reduced compared to prior art welded frames. Also, the frame weight is reduced.

Here, it is very advantageous when all beams have the same profile. In this case, the construction is less cost-intensive because it is possible to buy beams of the same structure in greater amount. However, it is also possible to use beams having a smaller profile dimension for the upper assembly. Furthermore, the machining step of manufacturing frames is reduced to cutting the beams to the desired length and welding them together. Hence, the manufacturing process is also significantly facilitated. Furthermore, it is possible to use a simple welding jig for bigger frame parts since there is no variation in frame dimensions.

For example, for a web width up to 5 meters in a machine running up to 1200 m/min, a 200mm square profile with 10mm wall thickness is suitable. Wider machines can require special profiles, e.g. doubled dimensions or even bigger and a rectangular profile shape can be used.
A drying section of a paper machine according to the invention comprises a plurality of frames as described above and a plurality of drying cylinders which are groupwise supported by the horizontal beams of the lower frame side elements.

Other features and advantages of the invention will become obvious from the following description of a preferred embodiment of the invention which is described with reference to the appended drawings in which:

Fig. 1 is a schematic view from the tending side, illustrating a part of a drying section of a paper machine comprising a frame according to the invention.

Fig. 2 is a schematic view of the machine of Fig. 1 as seen from the driving side; and

Fig. 3 shows a bearing housing of a drying cylinder mounted on a horizontal beam.

In Fig. 1, a frame 1 of a drying section of a paper machine according to the present invention is shown. More precisely, Fig. 1 shows a part of a drying section of a web forming machine comprising a plurality of drying cylinders 23. The drying cylinders 23 are arranged in series, and a wire 25 is used for guiding the web through the drying cylinders 23. In the present arrangement, a single wire 25 is used to guide the web through a group of drying cylinders 23, i.e. the drying section is a single tier drying section. However, the present invention can also be used in a double tier drying section using two wires for
guiding the web through two rows of the drying cylinders 23.

In Fig. 1, the frame 1 for an exemplary group of drying cylinders 23 of a drying section of a web forming machine is shown from the tending side. In this group, six drying cylinders 23 and six turning rolls 24 are arranged in series, respectively. The drying cylinders 23 are all provided on the same level and above the turning rolls 24. The wire 25 is guided through the drying cylinders 23 and the turning rolls 24 in an alternating manner. The wire 25 enters the group of drying cylinders 23 on the left side in Fig. 1, i.e. on the upstream end in machine direction, and leaves the group of drying cylinders 23 on the right side in Fig. 1, i.e. on the downstream end in machine direction. The wire 25 is guided by means of four lead rolls 26 which guide the wire 25 in addition to the drying cylinders 23 and turning rolls 24 so that a closed loop of the wire 25 is formed. Here, all lead rolls 26 are located inside the loop of the wire 25.

The drying cylinders 23 are supported by the frame 1. The frame 1 comprise frame side elements which are provided on each side of the drying cylinders 23, i.e. on the tending side and the driving side of the drying cylinders 23. Fig. 1 shows one frame side element from the tending side. The frame side element consists of a lower frame side element 2 and an upper frame side element 3. The upper frame side element 3 is placed on the lower frame side element 2. Both frame side elements extend in machine direction.

The lower frame side element 2 comprises multiple vertical beams 22 which support a horizontal beam 21 on their upper
ends, respectively. At the horizontal beam 21, bearing
housings 8 of the drying cylinders 23 are supported, as
shown in Fig. 3. The vertical beams 22 are arranged at an
equal distance d. As is shown in Fig. 1, the vertical beams
22 are arranged at the positions where the bearing housings
8 of the drying cylinders 23 are supported. Such an
arrangement is advantageous in that bending of the
horizontal beam 21 is prevented and vibration during
operation is reduced. The vertical beams 22 and the
horizontal beam 21 are joined by welding. Accordingly, the
lower frame side element 2 is integrally formed of one
horizontal beam 21 and multiple vertical beams 22.

Furthermore, at least the lower frame side element 2 or the
upper frame side element 3 comprises inclined beams 27
which extend in machine direction and which are provided in
an inclined manner with respect to the horizontal beam 21
and the vertical beams 22. The inclined beams 27 are fixed
to the horizontal beam 21 at one end and are fixed to
vertical beams 22 of the drying section at the other end,
respectively. As is shown in Fig. 1, other arrangements of
the inclined beams 27 are also possible, for example an
arrangement, in which the inclined beam 27 is fixed to a
vertical beam 22 at one end and in which the other end of
the inclined beam 27 is fixed to a base plate 4. Such
inclined beams 27 reinforce the structure of the lower
frame side element 2 in horizontal direction so that a
vibration occurring during operation of the drying section
can be reduced. Accordingly, the rigidity of the whole
frame construction is enhanced. Furthermore, the turning
rolls 24 are supported on the base plate 4 either directly
or indirectly, e.g. via a spacer.
The upper frame side element 3 comprises multiple vertical beams 32 and a horizontal beam 31 which is supported by the vertical beams 32. The upper frame side element 3 further comprises upper horizontal beams 33 and upper vertical beams 34 which support the upper horizontal beams 33. As it is the case in the lower frame side element 2, all beams of the upper frame side element 3 are joined by welding in order to form an integral upper frame side element 3. The horizontal beam 31 is adapted to support lead rolls 26. In the construction shown in Fig. 1, the horizontal beam 31 indirectly supports the lead rolls 26 via the upper horizontal beams 33 and the upper vertical beams 32.

The lower frame side element 2 and the upper frame side element 3 are integrally formed taking into consideration the problems involved with the transportation of such frame parts and the assembly of the frame elements at their destination. That is, the lower frame side elements 2 and the upper frame side elements 3 are constructed in such a manner that an easy transport of the frame side elements is possible. On the other hand, by preassembling the frame side elements, the final assembly of the whole drying section can be performed significantly faster and with a lower risk of assembly errors.

Fig. 2 shows the frame 1 of the drying section as seen from the driving side of the web forming machine. More precisely, Fig. 2 shows one frame side element provided on the opposite ends of the drying cylinders 23 and turning rolls 24 shown in Fig. 1. The construction of the lower and upper frame side elements 2, 3 is similar to those shown in Fig. 1 and, therefore, equal parts are designated with the same reference signs and their description is omitted. In
the following, the difference between the frame side elements on the tending side and the frame side elements on the driving side are pointed out.

As can be seen from Fig. 2, the overall height of the lower frame side element 2 has been reduced by using vertical beams 22 being shorter than the vertical beams 22 used on the tending side. In other words, the horizontal beam 21 of the frame side element 2 is arranged at a lower level compared to the horizontal beam 21 of the frame side element 2 on the tending side. In order to equalize the height difference caused by lowering the horizontal frame 21 on the driving side, a spacer 5 is provided, which - according to the embodiment - is formed of two vertical beams 52 and one horizontal beam 51 for each drying cylinder 23. The horizontal beam 51 of the spacer 5 is adapted to support the bearing housing 8. It is, however, also possible to use any other spacer as long as the height difference between the horizontal beams 21 is equal.

As can be gathered from Fig. 2, the latter construction enhances the accessibility of suction boxes 6 being arranged between adjacent drying cylinders 23. More precisely, on the tending side, the horizontal beam 21 almost completely covers the suction boxes 6 as is shown in Fig.1. By arranging the horizontal beam 21 on a lower level as is the case in Fig. 2, the suction box 6 can be accessed easily.

The connection between the lower frame side element 2 and the upper frame side element 3 is realized by means of a nut and bolt connection 7. It is, however, also possible to provide any other connection for joining the upper frame
side element 3 to the lower frame side element 2 as long as a sufficiently strong and detachable connection can be realized and a change of the cylinders is possible. However, in low cost machines, these joints can also be welded.

An example of a nut and bolt connection 7 is shown in Fig. 3. As can be seen from this figure, a bearing housing 8 of a drying cylinder 23 is supported on the horizontal beam 21 of the lower frame side element 2 and is fixed on the horizontal beam 21 by means of bolts 71 which is formed in U-shape. The bolts 71 are made of a specific steel which is very elastic and has a good tensioning property. Furthermore, the bolts 71 are formed in such a manner that the contact surface between the bolts 71 and the beam 21 is as large as possible. This is achieved by forming the inner surface of the bolts 71 in accordance with the outer surface of the beam 21. In this example, the U-shaped bolts 71 are formed rectangular and flat with the exception of the free ends of the bolts 71 which are of a round shape and are threaded, respectively. With such a construction, a large contact surface can be provided. The bearing housing 8 comprises two flange portions 81 and 82 having openings into which the free ends of the U-shaped bolts 71 can be inserted. The openings are formed in the flange portions 81 and 82 at a distance larger than the width of the horizontal beam 21.

For fixing the bearing housing 8 to the horizontal beam 21, the bearing housing 8 is placed on the horizontal beam 21 such that the openings of the flange portions 81 and 82 are placed on both sides of the horizontal beam 21 in cross machine direction. After that, the U-shaped bolts 71 are
placed around the horizontal beam 21 with the free ends being inserted into the openings of the flange portions 81 and 82. Then, nuts 72 are screwed onto the threaded free ends of the U-shaped bolts 71 in order to fix the bearing housing 8 at the horizontal beam 21. After the connection has been tightened, it is possible to provide small welded stoppers in order to lock the connection. In order to make it easier to fix the preassembled frame parts to each other, it is possible to provide markings and adjustable stoppers for the connections.

The preceding description of the present invention is merely exemplary and is not intended to limit the scope of the claims in any way. Various details of the present invention may vary within the scope of the invention defined in the claims and may differ from the exemplary details described above in accordance with the knowledge of a person skilled in the art.
CLAIMS

1. A frame for a drying cylinder group of a drying section of a web forming machine, comprising
   a pair of lower frame side elements which extend in machine direction and which are provided on the driving side and the tending side of the web forming machine, wherein
   each lower frame side element comprises
   a horizontal beam adapted to support a group of drying cylinders of the web forming machine and a plurality of vertical beams located below the horizontal beam for supporting the same.

2. A frame according to claim 1, wherein the horizontal beams of opposite frame side elements are provided at different level.

3. A frame according to claim 2, wherein
   the horizontal beam provided at lower level comprises means for equalizing the difference in level in relation to the other horizontal beam so that the cylinders can be supported at the same level.

4. A frame according to claim 3, wherein the horizontal beam provided at higher level is adapted to directly support bearing housings of drying cylinders, wherein said lower horizontal beam is adapted to support the bearing housings via a spacer which forms said means for equalizing.
5. A frame according to claim 4, wherein the bearing housings are fixed by means of a nut and bolt connection, wherein the bolt has a U-shape.

6. A frame according to claim 5, wherein the bearing housings comprise attachment holes into which the ends of the U-shaped bolt are inserted, wherein the attachment holes are arranged in cross-machine direction on opposite sides of the horizontal beam.

7. A frame according to one of the preceding claims, wherein each of the lower frame side elements is an integral assembly in which the horizontal beam and the vertical beams are welded together.

8. A frame according to one of the preceding claims, further comprising a pair of upper frame side elements extending in machine direction, which elements are provided on the driving side and the tending side of the web forming machine and which are adapted to support lead rolls for guiding a dryer wire.

9. A frame according to claim 8, wherein each upper frame side element consists of at least one horizontal beam supported on a plurality of vertical beams and wherein each upper frame side element is preferably an integral assembly in which the horizontal beams and the vertical beams are welded together.

10. A frame according to one of claims 9, wherein the upper frame side elements are detachably mountable to the lower frame side elements and wherein the vertical beams of the
upper frame side elements are preferably mountable on the horizontal beam of the lower frame side elements.

11. A frame according to claim 10, wherein the connection between the vertical beams of the upper frame side elements and the lower frame side elements is a nut and bolt connection.

12. A frame according to claim 11, wherein at least one of the vertical beams of each upper frame side element is aligned with a vertical beam of the corresponding lower frame side elements.

13. A frame according to one of the preceding claims, wherein all beams are straight beams having a constant profile.

14. A frame according to one of the preceding claims, wherein all beams have the same profile.

15. A drying section of a paper machine comprising a plurality of frames according to one of the preceding claims arranged in a row, and a plurality of drying cylinders which are groupwise supported by the horizontal beams of the lower frame side elements.
## INTERNATIONAL SEARCH REPORT

### A. CLASSIFICATION OF SUBJECT MATTER

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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)

- D21F
- D21G

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 practical, search terms used)

- EPO-Internal

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>X</td>
<td>US 5 829 159 A (HODGINS GARY W [CA] ET AL) 3 November 1998 (1998-11-03) column 4, line 64 - col umn 5, line 61; figures 3, 4</td>
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### Further documents are listed in the continuation of Box C. X 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.
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### Date of the actual completion of the international search

23 August 2011

### Date of mailing of the international search report

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