A former of a paper or board machine comprises a lower wire loop (11) and an upper wire loop (12) defining between themselves a forming zone. A first forming roll (17) is placed inside the lower wire loop (11) and it turns the run of the wires (11, 12) downwards. A second forming roll (22) is placed inside the upper wire loop (12) and it turns the run of the wires (11, 12) to be horizontal. The wires (11, 12) run obliquely downwards over the distance between the forming rolls (17, 22). Inside the lower wire loop (11) there is a curved suction box (23) disposed against the second forming roll (22) such that the upper wire (12) is separated from the surface of a web (W) in the area of the curved suction box (23).
Former of a paper or board machine

The invention relates to a former of a paper or board machine comprising a lower wire loop and an upper wire loop defining between themselves a forming zone, in which forming zone there is a first forming roll placed inside the lower wire loop such that it turns the running direction of the wires downwards, and a second forming roll placed inside the upper wire loop such that it turns the running direction of the wires to be substantially horizontal, the wires running obliquely downwards over the distance between said first and second forming rolls.

A problem of board formers is insufficient dewatering capacity and a relatively steep gap, which makes it necessary for the headbox slice jet to have a high relative velocity. For this reason, the former cannot be operated at very low operating speeds. In a roll-gap former, the forming gap is located on the surface of a forming roll, and wires run over a curve sector of the forming roll, so that the pressure of the slice jet and the tension of the outer wire cause water to be removed from a pulp suspension fed between the wires. The forming roll is generally a suction roll having a relatively large diameter, at its largest up to 1800 mm. The dewatering distance on the forming roll can be lengthened by increasing the diameter of the roll, but it leads to an increased height of the former and to a higher price of the forming roll. Dewatering capacity can also be increased by increasing the number of different dewatering elements (dewatering blades, suction boxes, etc.) in the forming zone located after the forming gap. However, this increases the energy consumption, spare part costs and space requirement of the former.

FI patent 84734 describes a twin-wire former comprising a first forming roll and a second forming roll placed at a substantially lower level than the first forming roll. A twin-wire forming zone begins in the area of the highest point of the first
forming roll, from which the forming zone curves downwards in a sector the magnitude of which is less than 90°. After the second forming roll, inside a lower wire loop there is a forming shoe provided with a ribbed deck or an equivalent deflector combination, after which an upper wire is separated from the web, and by means of a separation suction box it is ensured that the web follows the lower wire after the twin-wire forming zone. The diameter of the first forming roll is relatively large. Such a forming roll is expensive, takes a large space and requires solid support structures. The forming gap provided by means of it is relatively steep.

US patent 6,267,846 describes a twin-wire former in which a forming gap is located in the area of the highest point of a first forming roll, the wires run steeply in an obliquely downward direction from the first forming roll to a second forming roll and on a horizontal portion after the second forming roll the upper wire is separated from the lower wire. In this arrangement the diameter of the first forming roll is also relatively large, of the order of 1500 – 2500 mm.

In the twin-wire formers described above, the twin-wire forming zone is continued by dewatering elements placed on the horizontal portion after the second forming roll, which increases the space requirement of the former. The arrangements also require that a separate separation suction box be placed in the area where the upper wire is separated from the web.

Publication EP-B1-1224356 discloses a twin-wire forming zone in which a first forming roll is inside an upper wire loop and a second forming roll is above it inside a lower wire loop, so that the wires run obliquely from below upwards up to the second forming roll. The second forming roll is an open roll, which is opposed by a suction box on the side of the upper wire loop, which suction box is curved at least in the running situation such that the tension of the upper wire reduces the normal force between the wire and the deck of the suction box caused by the vacuum of the suction box. The vacuum of the suction box keeps the web
at the suction box mainly off from the roll and from the lower wire while being adhered onto the underside of the upper wire and conforming to the curved shape of the suction box. The web leaves the twin-wire zone while being adhered onto the underside of the upper wire. A problem in this former construction is difficult control of the web in a break situation and control of couch trimming.

An object of the invention is to solve the problems associated with the prior art. One aim is to provide a new and advantageous arrangement for separating the web from an upper wire at the end of a twin-wire zone directed from above downwards. Another aim is to increase the dewatering capacity of the former without an increase in the space requirement of the former.

With a view to achieving the objects described above as well as those coming out later, the former according to the invention is characterised by what is stated in the characterising part of claim 1.

In the former according to the invention, a curved suction box is placed inside a lower wire loop, which suction box is disposed against a second forming roll, and an upper wire is separated from the surface of the web in the area of this curved suction box. Advantageously, the curvature of the deck of the suction box is adjusted or adjustable to correspond to the curvature of the second forming roll. The curved suction box can be, for example, of the type described in publications EP-B1-1224356 and WO-A1-9829600.

The curved suction box facilitates the separation of the web from the upper wire and raises the dry matter content of the web before the web is transferred to a press section. Dewatering is accomplished, on the one hand, by the vacuum of the suction box and, on the other hand, by compression caused by the tension of the lower wire. Due to the effect of the tension of the wires, the vacuum of the suction box can be reduced, thus enabling the vacuum to be produced by a blower. A blower consumes considerably less energy than vacuum pumps. The friction
between the wire and the suction box is very small, which reduces energy requirement and wire wear. In addition, a benefit of the arrangement is a simple and compact structure that makes it possible to shorten the wire section.

The former can be a hybrid former provided with a single-wire initial dewatering section or it can be a gap former in which a pulp suspension is supplied directly into a forming gap between the wires.

When the former is a gap former, a curved forming shoe can be arranged in connection with the forming gap, before a first forming roll, which forming shoe is located inside either wire loop. The forming shoe guides the wires together on their upwardly directed run which precedes the first forming roll. The forming shoe is provided with an open surface and connected to a vacuum source, thus enabling the amount of water removed by the forming shoe to be affected efficiently by controlling the vacuum level of the forming shoe.

Advantageously, the deck of the forming shoe is provided with openings that are shaped and placed so that a substantially non-pulsating dewatering pressure is produced by means of them. A dewatering pressure that keeps constant is produced by means of a forming shoe having a deck whose openings are, for example, round or elliptical holes, slots extending substantially in a machine direction, wave-shaped slots, raised contact surfaces to support a fabric above the deck of the shoe, or any other similar structures. Alternatively, the deck of the forming shoe can be provided with slots that produce a pulsating dewatering pressure.

The forming shoe can be placed inside either an upper wire loop or a lower wire loop. In one embodiment of the invention there are two forming shoes, one of them being inside the upper wire loop and the other inside the lower wire loop.
The forming shoe can have a substantially larger radius of curvature than that of the first forming roll located after it. Advantageously, the radius of curvature of the forming shoe is 800 – 4000 mm. The diameter of the first forming roll has traditionally been 1600 – 2000 mm. In the arrangement in accordance with the invention, the large-sized and expensive forming roll can be replaced with a substantially smaller roll with a diameter of 600 – 1400 mm.

When dewatering is started at an early stage, i.e. on the deck of the forming shoe, the first forming roll can be a smooth-surfaced or open roll without vacuum. If it is desirable to increase the dewatering capacity of the former, a suction roll can be used as the first forming roll.

When ahead of the first forming roll there is a forming shoe that guides the wires together before they come to the forming roll, the forming gap becomes less steep and the headbox slice jet can be directed into the gap substantially parallel to the wires. The operating window of the former becomes broader, which allows operation with different speeds and basis weights. The arrangement gives an opportunity to increase dewatering capacity without an increase in the need for space in the wire section. Alternatively, it is possible to reduce the diameter of the first forming roll and/or dispense with the use of vacuum on the first forming roll. The controllability of dewatering is improved as compared with the traditional arrangement.

The key components of the arrangement are cantilevered on the same frame structure, whereby the process area can be controlled more easily. The new arrangement is energy-efficient and compact in structure. Because of the compact structure, existing wire sections can be rebuilt to be in accordance with the invention. This means that because of improved dewatering capacity the running speed of the wire section can be raised and, at the same time, the properties of the web can be controlled in a better manner. The curved forming shoe enables a greater curvature of the dewatering surface, which makes it possible to affect
other parameters of the former, such as dewatering distance and dewatering pressure.

The former in accordance with the invention is suitable in particular for the manufacture of board, in which it can be used for forming a single-layer or a multi-layer (multi-layer headbox) web or as a primary former in the forming of a multi-layer web. The former in accordance with the invention can, of course, also be used in the manufacture of paper.

In the following, the invention will be described with reference to the figures of the appended drawings, to the details of which the invention is by no means meant to be narrowly limited.

Figure 1 is a schematic side view of one former in accordance with the invention.

Figure 2 is a side view of a former which produces a multi-layer web and in which the former shown in Fig. 1 is a primary former.

Figure 3 shows an alternative embodiment of the invention.

Figure 4 shows a second alternative embodiment.

Figure 5 shows a third alternative embodiment.

Figure 6 shows a fourth alternative embodiment.

The former of Fig. 1 comprises a loop formed by a lower wire 11 and a loop formed by an upper wire 12, which define a twin-wire forming zone between themselves. Inside the lower wire loop 11 there is a breast roll 15, a first forming roll 17 and dewatering elements 19, 21, 23, 25 and 27. In addition to them, the running of the lower wire loop 11 is guided by guide rolls 13. Inside the upper
wire loop 12 there is a breast roll 16, a curved forming shoe 18, a dewatering box 20 and a second forming roll 22. In addition to them, the running of the upper wire loop 12 is guided by guide rolls 14.

A pulp suspension jet is fed from a headbox 10 into a forming gap G defined by the wires 11, 12. Both the slice jet and the forming gap G are directed obliquely upwards. The breast rolls 15, 16 guide the running of the wires 11, 12 without actually participating in dewatering. The forming shoe 18 is on the side of the upper wire loop 12 and guides the upper wire 12 coming from the breast roll 16 and brings the upper wire together with the lower wire 11 such that the joint run of the wires 11, 12 begins on the surface of the forming shoe 18. The forming shoe 18 is connected to a vacuum source and its deck is provided with dewatering openings. The openings are holes or slots advantageously arranged so that dewatering is substantially non-pulsating. The radius of curvature R₃ of the deck of the forming shoe 18 is substantially larger than the radius R₁ of the first forming roll 17. The forming shoe 18 can be provided with zones, in which there are different vacuums and/or which have different radii of curvature and/or at which the deck has different perforations or openings.

After the forming shoe 18, the wires 11, 12 run obliquely upwards to the first forming roll 17 and over its curve sector, which turns the run of the wires 11, 12 obliquely downwards. The diameter of the forming roll 17 can be of the same order of magnitude as the diameters of the other rolls of the former. In that case, the space requirement of the former is considerably smaller than that of conventional formers, in which the first forming roll is usually considerably larger than the other rolls. The forming roll 17 can be smooth-surfaced or have an open surface or it can be perforated and provided with a vacuum zone.

On the downwardly oblique run of the wires 11, 12 after the first forming roll 17, dewatering boxes 19 and 21 are placed on the side of the lower wire 11 and the dewatering box 20 is placed on the side of the upper wire. After these dewatering
elements there follows the second forming roll 22, which is placed inside the upper wire loop 12 and which turns the run of the wires 11, 12 to be substantially horizontal.

At the second forming roll 22, inside the lower wire loop 11 there is a suction box 23, the surface of which forms, at least during running, a curved support surface for the wires 11, 12. In a running situation, a web W is, at the suction box 23, out of contact with the surface of the roll 22 and in contact with the lower wire 11, whose run follows the curved shape of the deck of the suction box 23. Advantageously, the curvature of the deck of the suction box 23 is adjusted to correspond to the curvature $R_2$ of the second forming roll 22. In this kind of suction box, the friction between the wire and the deck of the suction box is very small. The suction box 23 removes water efficiently from the web and facilitates the separation of the web from the upper wire 12. The web is separated without a transfer suction box or the separation can be ensured by means of a separation suction box 25, after which the upper wire 12 is separated by means of a guide roll 14 from the web W that remains on support of the lower wire 11. After the end of the twin-wire zone there is further a dewatering blade 27 that scrapes water from the bottom surface of the lower wire 11.

The curved suction box 23 disposed in connection with the second forming roll 22 makes it possible to control the asymmetry of dewatering. In addition, a higher dry matter content is imparted to the web before a press section, which makes it possible, when desired, to shorten the wire section because, for example, one suction box located on the run of the wire can be omitted as a result of increased dewatering capacity.

The surface of the second forming roll 22 is preferably smooth, but in certain sites of application it can also be open and possibly provided with suction if it is required that the former have a particularly high dewatering capacity.
Fig. 2 shows a forming section of a paper or board machine manufacturing a two-layer web. It comprises a first former 100 for forming a first layer \( W_1 \) of the web, and a second former 200 for forming a second layer \( W_2 \) of the web. The component webs \( W_1 \) and \( W_2 \) are joined to each other on a couch roll 42 to produce a two-layer paper or board web \( W \).

The first former 100 substantially corresponds to the former described in connection with Fig. 1 above. The second former 200 comprises a first wire loop 31 and a second wire loop 32, which define between themselves a twin-wire forming zone. Inside the first wire loop 31 there is a breast roll 35, a third forming roll 37 and dewatering boxes 39 and 41. In addition to them, the running of the wire 31 is guided by means of guide roll 33. Inside the second wire loop 32 there is a breast roll 36, a forming shoe 38 provided with a curved deck, a dewatering box 40 and the couch roll 42. In addition to them, the running of the wire 32 is guided by means of guide rolls 34.

A pulp suspension is fed from a second headbox 30 into a forming gap between the wires 31 and 32. The wires 31 and 32 meet each other on a curved deck of the second forming shoe 38, after which they run over a curve sector of the third forming roll 37, which turns the wires 31 and 32 to run downwards. On this wire portion running obliquely downwards, inside the first wire loop 31 there are two dewatering boxes 39 and 41 and inside the second wire loop 32 there is a dewatering box 40. At the end part of the dewatering box 40, the first wire 31 is passed so that it is separated from the component web \( W_2 \), which is left to follow the second wire 32. The component web \( W_2 \) is guided on support of the second wire 32 onto the component web \( W_1 \) located on the lower wire 11. The component webs \( W_1 \) and \( W_2 \) are joined together by means of the couch roll 42, thereby forming the two-layer web \( W \). In connection with the couch roll 42 and after it there are several suction boxes 43 inside the loop of the lower wire 11, the function of the suction boxes being to ensure that the combined web \( W \) follows
the lower wire 11 at the stage when the second wire 32 is separated from the web W using a guide roll 34.

Figs. 3-5 show three alternative ways of accomplishing a former in accordance with the invention. The figures correspond in the main to Fig. 1 but, for the sake of simplicity, they do not show the dewatering elements placed between the first and the second forming roll.

In the former of Fig. 3, in the position of the first forming roll there is a conventional large-diameter forming roll 117, which enables efficient dewatering of the web. On an obliquely upward run of wires 11 and 12 before the first forming roll 117 there is a curved forming shoe 18 placed inside an upper wire loop 12. A curved suction box 23 is placed in connection with a second forming roll 22. Both of these arrangements increase substantially the dewatering capacity of the former as compared with a traditional forming section where these elements are lacking. When pre-dewatering is started on the curved surface of the forming shoe 18, the dewatering distance and the dewatering pressure on the forming roll 117 can be controlled more freely than in conventional formers.

In the former of Fig. 4, a forming shoe 118 is disposed inside a lower wire loop 11 between a breast roll 15 and a first forming roll 17. The first forming roll 17 has a smaller diameter than the conventional forming roll of Fig. 3.

In the former of Fig. 5 there are two forming shoes 18 and 118 on an obliquely upward run of wires 11, 12 remaining between breast rolls 15, 16 and a first forming roll 17, the first forming shoe 18 being placed inside an upper wire loop 12 and the second forming shoe 118 being placed inside a lower wire loop 11.

In the former of Fig. 6, a pulp suspension jet is fed from a headbox 10 directly between wires 11, 12 into a forming gap G. Dewatering begins at a curve sector of a first forming roll 117. After the first forming roll 117, the joint run of the wires
11, 12 is directed obliquely downwards towards a second forming roll 22. On this joint run of the wires, water is removed from the web W by means of dewatering boxes 19 and 21 placed on the side of the lower wire 11 and by means of a dewatering box 20 placed on the side of the upper wire 12. The joint run of the wires ends at a curve sector of the second forming roll 22, after which the lower wire 11 and the web W supported by it move forward substantially horizontally, and the upper wire 12 is separated from the web by means of a guide roll 14. The separation of the web from the upper wire 12 is accomplished by means of a forming shoe 23 disposed against the second forming roll 22.

Many different modifications of the invention are feasible within the scope of protection defined in the following claims.
Claims

1. A former of a paper or board machine comprising a lower wire loop (11) and an upper wire loop (12) defining between themselves a forming zone, in which forming zone there is a first forming roll (17, 117) placed inside the lower wire loop (11) such that it turns the running direction of the wires (11, 12) downwards, and a second forming roll (22) placed inside the upper wire loop (12) such that it turns the running direction of the wires (11, 12) to be substantially horizontal, the wires (11, 12) running obliquely downwards over the distance between said first and second forming rolls (17, 117, 22), characterised in that inside the lower wire loop (11) there is a curved suction box (23) disposed against the second forming roll (22), and the upper wire (12) is separated from the surface of a web (W) in the area of the curved suction box (23).

2. A former as claimed in claim 1, characterised in that the curvature of a deck of the suction box (23) is adjusted or adjustable to correspond to the curvature (R₂) of the second forming roll (22).

3. A former as claimed in claim 1 or 2, characterised in that on the obliquely downward portion of the forming zone between the first forming roll (17, 117) and the second forming roll (22) there are one or more other dewatering elements (19, 20, 21).

4. A former as claimed in claim 1, characterised in that a single-wire initial dewatering section precedes the forming zone.

5. A former as claimed in claim 1, characterised in that the forming zone begins with a forming gap (G).

6. A former as claimed in claim 5, characterised in that in connection with the forming gap (G), before the first forming roll (17) there is a curved forming shoe
(18) which is placed inside either wire loop (11, 12) and provided with an open surface and connected to a vacuum source, which forming shoe (18, 118) guides the wires (11, 12) together on their upwardly directed run that precedes the first forming roll (17, 117).

7. A former as claimed in claim 6, characterised in that the forming shoe (18, 118) has a deck provided with openings that are shaped and placed so that a substantially non-pulsating dewatering pressure is produced by means of them.

8. A former as claimed in claim 6, characterised in that the forming shoe (18, 118) has a deck provided with slots that produce a pulsating dewatering pressure.

9. A former as claimed in any one of claims 6 to 8, characterised in that it comprises two forming shoes (18, 118), one (18) of which is placed inside the upper wire loop (12) and the other (118) of which is placed inside the lower wire loop (11).

10. A former as claimed in any one of claims 6 to 9, characterised in that the radius of curvature ($R_3$) of the forming shoe (18, 118) is substantially larger than the radius ($R_1$) of the first forming roll (17, 117).

11. A former as claimed in any one of the preceding claims, characterised in that the diameter of the first forming roll (17) is 600 – 1400 mm.

12. A former as claimed in any one of claims 1 to 10, characterised in that the diameter of the first forming roll (117) is 1600 – 2000 mm.

13. A former as claimed in any one of the preceding claims, characterised in that the first forming roll (17, 117) is a smooth or open roll or a suction roll.
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 8; D 21F

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

FI, SE, NO, DK classes as above

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

EPODOC, WPI, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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