Dec. 19, 1961 E. J. JUSTUS 3,013,605

TRAILING EDGE SEAL FOR MOVING SUCTION BELT APPARATUS

Filed July 13, 1959

Fig 1

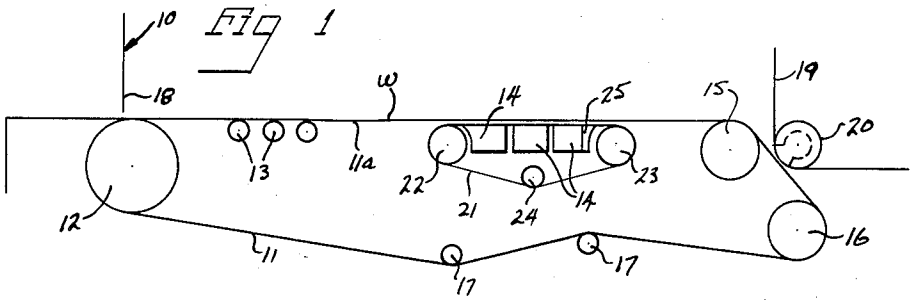


Fig 2

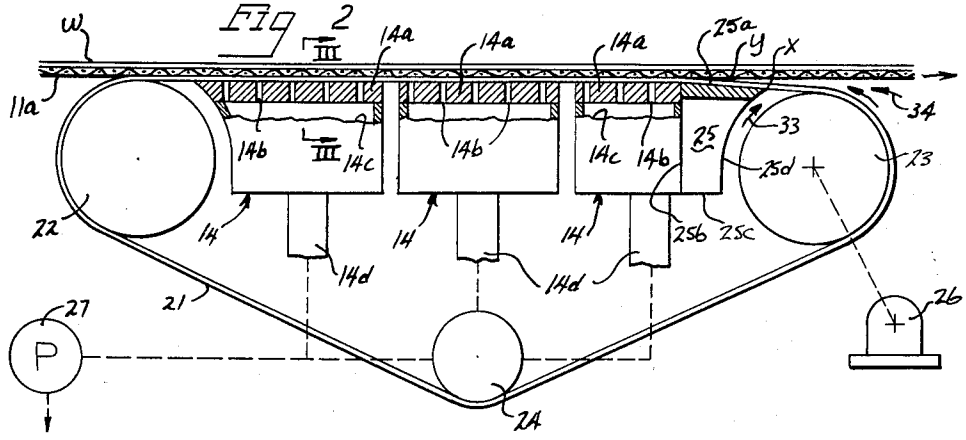


Fig 3

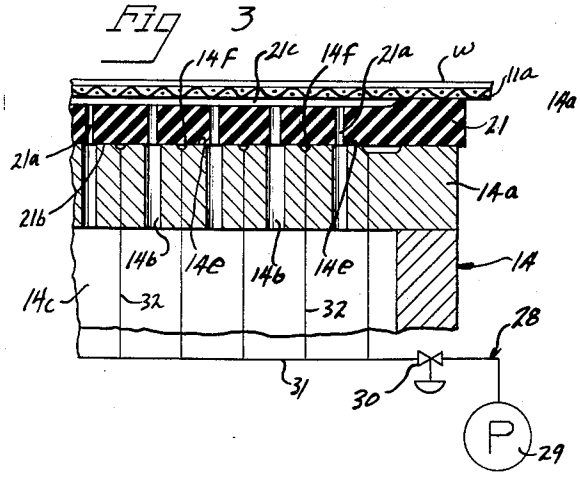
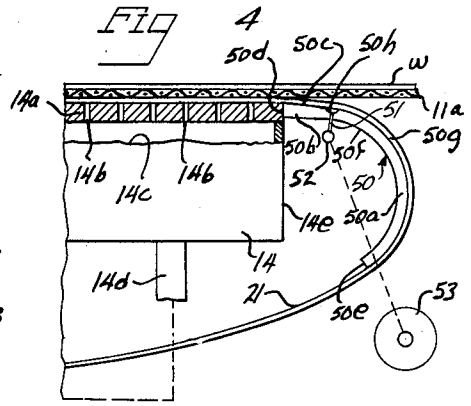


Fig 4



Inventor
EDGAR J. JUSTUS

by Hill, Sherman, Meroni, Gross & Simpson Attys

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TRAILING EDGE SEAL FOR MOVING SUCTION BELT APPARATUS

Edgar J. Justus, Beloit, Wis., assignor to Beloit Iron Works, Beloit, Wis., a corporation of Wisconsin

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The present invention relates broadly to paper machines, and is more particularly concerned with novel means having especial utility in eliminating wet streaks in the paper sheet or web during travel from moving belt suction apparatus to the couch roll of paper machines.

It is now known in the art that a Fourdriner type paper machine generally embodies dewatering devices beneath the forming reach presented by the looped traveling forming wire which extends from the breast to the suction couch rolls. One form of dewatering device performing well in commercial practice is known as a suction box which presents a flat perforate top to the bottom side of the wire and has its interior exhausted to draw water from the web through the wire and through the perforations in the suction box top. However, in this arrangement substantial wire wear results during movement of the forming wire in hugging contact with the flat stationary top of the suction box, and a solution to this problem is to provide relatively shallow grooves in the land areas of the suction box top and intermediate the perforations therein, and to mount an endless, flexible and driven belt between the bottom surface of the forming wire and flat top surface of the suction box. A liquid is then flowed under pressure to the shallow grooves in the suction box top to provide effective lubrication and thereby substantially reducing the power requirements to drag the belt across the suction box top.

While the structure described is a great step forward in the paper machine art, it has recently been found that wet streaks appear in the web as the forming wire with web thereon leaves the perforate endless belt and moves toward the couch roll, at which point the web is removed from the wire. An examination of the web indicates that the wet streaks therein correspond in location to the perforations in the flexible belt, and it is now believed that a cause of the wet streaks is the admission of air into the perforations of the belt from below before the belt and the wire are separated. During the passage of the belt perforations over the suction area, water and air are drawn into and through these perforations from (and through) the web overlying the wire. As the perforations travel off the suction area the web offers sufficient resistance to the flow of water and air to function as a seal, and a partial vacuum persists in the said perforations. If then the inner ends of the perforations are opened to atmosphere, while the outer ends remain in effect sealed by the web carried on the wire, the abrupt expansion and the air inrush tend to drive the residual water out of the perforations and back into the web. Furthermore, a slight amount of water carried by the downstream roll may be thrown into and through the perforated belt, assisted by the air flow generated by the rotation of the roll. These two effects are thought to cause the wet streak condition described.

It is, therefore, an important aim of the present invention to provide an improved paper machine incorporating

means at the off-running end of the suction box to essentially entirely eliminate wet streaks in the web.

Another object of this invention lies in the provision of seal means located at the downstream side of suction box structure and which provides an effective barrier against air flow into perforations from within the loop of the endless flexible belt, extending sufficiently downstream to at least the point at which the forming wire and flexible belt separate.

A further object of the instant invention is to provide a suction box for paper machines featuring a curved trailing surface forming an extension of the end wall of the suction box and generally coextensive therewith to seal the perforated belt against upward air flow therethrough until the forming wire supporting the web is spaced from the flexible belt.

Other objects and advantages of the invention will become more apparent during the course of the following description, particularly when taken in connection with the accompanying drawings.

In the drawings, wherein like numerals designate like parts throughout the same:

FIGURE 1 is an essentially diagrammatic elevational view of a paper machine having suction box structure constructed in accordance with the principles of this invention;

FIGURE 2 is an enlarged view of the suction box structure of FIGURE 1;

FIGURE 3 is an enlarged sectional fragmentary detail view taken substantially along the line III—III of FIGURE 2, and with parts therein shown diagrammatically; and

FIGURE 4 is an enlarged fragmentary view of another form of suction box structure embodying the concepts of this invention.

Referring now to the drawings, there is shown in FIGURE 1 a paper machine indicated generally by the reference numeral **10**, and comprising a looped forming wire **11** trained over a breast roll **12**, table rolls **13**, suction boxes **14**, a couch roll **15**, a turning roll **16**, and return rolls **17**. Stock is deposited on the upper wire run **11***a* from a head box **18** in the region of the breast roll **12**, and the stock is dewatered during its travel on the upper wire run **11***a* to form a web W which is removed from the wire **11** by a pickup felt **19** urged against the web W by a suction pickup roll **20**. A rotary belt **21** mounted on rolls **22**, **23** and **24** is interposed between the suction boxes **14** and the wire run **11***a*.

As best shown in FIGURE 2, the wire run **11***a* travels in the direction indicated by the arrow with the web W thereon. The traveling endless belt **21** engages the bottom side or lower surface of the wire and is mounted for traveling on a roll **22** closely spaced from the on coming side of the suction boxes **14**, and on a roll **23** closely spaced from seal means **25** (to be later described in detail) on the downstream or off-running side of the suction boxes **14**. Either or both of the rolls **22** and **23** may be driven, and as illustrated, the roll **23** is driven by suitable drive means **26**, shown somewhat diagrammatically. As will be noted later, the wire run **11***a* may also be used to drive the belt **21**.

The present invention is directed particularly to the seal means **25** of FIGURES 1 and 2 and seal means **50** of FIGURE 4 in association with a suction box and flexible

belt movable thereover in a Fourdriner type paper machine. The structural detail of the traveling belt and the suction boxes, except where they intimately cooperate with the seal means **25** or **50**, form no part of this invention, and the illustrative suction box and movable belt structure are shown in some detail only to facilitate a more complete understanding of the present invention. Accordingly, it will be appreciated that other suction boxes and movable belts may be substituted in lieu of the structure shown, although the illustrated constructions have proven in practice to have substantial advantages over the earlier arrangements.

Briefly, each suction box **14** is provided with a generally flat top **14***a* having perforations **14***b* therein which open into the interior **14***c*. Exhaust means in the form of a pump **27** (shown diagrammatically) connect to drop legs **14***d* of the suction boxes **14** for the purpose of exhausting the interiors **14***c* to effect the watering of the web W through the perforations **14***b*. If desired, the perforations may be countersunk at their upper ends.

As is shown, the perforations **14***b* in the suction box tops **14***a* are spaced longitudinally in the direction of wire travel and also laterally or transversely across the machine width. Land areas **14***e* are provided intermediate the perforations **14***b* in the box tops or covers **14***a*, and these land areas constitute the supporting surface for the traveling belt **21** moving thereover. The land areas **14***e* are provided with relatively shallow grooves **14***f* (FIGURE 3) which face the belt **21** traveling thereover and which are closed off from the interior **14***c* of each suction box **14**. The land areas **14***e* and the grooves **14***f* extend longitudinally of the direction of wire travel indicated by arrow in FIGURE 2, and these grooves extend from near the off-running edge of each suction box cover **14***a* to near the oncoming edge thereof. While not shown, the grooves **14***f* may communicate with relatively shallow longitudinally spaced and laterally extending grooves to provide a substantially increased lubricated area whereby resistance to belt movement is even further reduced.

As indicated diagrammatically in FIGURE 3, means connected to a source of liquid under pressure communicate with the grooves **14***f* for flowing liquid between the bottom side of the belt **21** and the suction box tops **14***a* to lubricate the same. Such means, generally indicated at **28**, may comprise a pump **29**, a pressure control valve **30** for maintaining a predetermined pressure in water header **31**, and conduits **32** extending from the header **31** to the grooves **14***f*. As is now apparent, water flows from the grooves **14***f* along the land areas **14***e* and ultimately to the perforations **14***b* in the covers **14***a*. This flow is very slight and is controlled in accordance with the pressure of the belt **21** against the land areas **14***e*. However, the flow is sufficient to lubricate the rubber belt **21** and to prevent its dragging over the dry land areas **14***e*. As is further appreciated, other grooving arrangements may be employed.

The belt **21** is constructed with perforations or drainage holes **21***a* which are so arranged that they do not align themselves with the grooves **14***f* in the suction box covers **14***a* to force water back up through the drainage holes **21***a*. Rather, the drainage holes **21***a* periodically align themselves with the perforations **14***b* in the box covers or tops **14***a*. The grooves **14***f* in the land areas **14***e* on the top side of the suction box covers **14***a* are covered by land areas **21***b* on the bottom side of the belt **21** and intermediate the drainage holes **21***a* therein. The belt land areas are urged downwardly against the suction box land areas **14***e* by the pressure differential created by the suction boxes **14**, and accordingly, water is urged into the grooves **14***f* under slight pressure to effect continuous seepage of water between the faces of the land areas **14***e* and **21***b*. The seepage is necessary to prevent the rubber belt **21** from wiping the land areas **14***e* dry, and thereby increasing frictional drag. However, the water seepage is preferably very slight so as not to over load the water removal system for the suction boxes **14**.

On the top side of the belt **21** there is preferably provided a plurality of longitudinally spaced and laterally extending grooves or channels **21***c*, one of which is shown in FIGURE 3. Each such groove **21***c* is provided with one or more of the drainage holes **21***a*, which as earlier noted, periodically communicate with the perforations **14***b* in the suction box covers **14***a*. And was also earlier noted, the specific described structure of suction boxes and moving belt is illustrative only, and other arrangements may be employed in connection with the seal means **25** and **50** which are the essence of the invention herein disclosed.

As appears in FIGURE 2, the seal means **25** is in the form of a curved trailing surface on the off-running side of the downstream suction box **14**, although of course the illustrative arrangement of three suction boxes is exemplary only and one continuous suction box may be provided between the rolls **22** and **23**. The seal means **25** may be of either solid or hollow metal construction, and is provided with a top surface **25***a* which is generally in horizontal alignment with the upper surface of the suction box cover **14***a*, although the seal means top surface **25***a* may be inclined slightly downwardly to facilitate separation of the belt **21** and wire run **11***a*. The seal means **25** further has an upstream end wall **25***b* which abuts against the downstream end wall of the suction box **14** and which may provide the mode of attachment thereto. Of course, there is no vacuum drawn in the seal means **25**.

The seal means **25** may have a lower surface **25***c* forming a continuation of the bottom surface of the suction box **14**, and the top surface **25***a* and bottom **25***c* of the seal means **25** are connected by an arcuate downstream or off-running front wall or surface **25***d*. It is important to note in this connection that the arcuate face **25***d* of the seal means has a degree of curvature closely corresponding to that of the roll **23**, and further, the surface **25***d* is of sufficient length in a downstream direction so that the farthest point downstream on the surface **25***d* is beyond the point of separation of the belt **21** and the wire run **11***a*. Specifically, it is to be seen in FIGURE 2 that the surface **25***d* terminates at a point designated at "*x*," whereas the point of separation of the belt **21** and wire run **11***a* is a substantial distance upstream therefrom as designated by the legend "*y*."

It is therefore to be now seen that a barrier or seal is provided from the point "*y*" to the point "*x*" representing the distance required to effect the desired amount of separation of the wire run from the belt so that the vacuum persisting in the perforations thereof is relieved by air entering the wire and the top of the belt and prevented from entering the inner ends of the perforations thus preventing the air inrush and expansion from driving water from the perforations back into the web. Furthermore, this permits obtaining a separation of the wire from the belt so that any normal air flow between the seal means surface **25***d* and the circumference of the roll **23** can have no harmful effects upon the web W. In other words, the length of the top surface **25***a* and the arcuate length of the surface **25***d* are calculated to dimensions so that no air penetration can take place through the belt perforations **21***a* until the wire run **11***a* with web W thereon is at a sufficient elevation above the belt that any residual water in the perforations cannot have sufficient force under actions described to create wet streaks in the web. In FIGURE 2 the numeral **33** has been applied to the arrow indicating the general direction of upward air flow between the surface **25***d* of the seal means **25** and the circumference of the roll **23**. It may be seen therefrom that the air flow has an arcuate path conforming to the confining surfaces and that the air is directed thereby in a generally downstream direction, so that if any water should remain in the belt perforations **21***a*, such water would have to travel through a substantial air space be-

tween the belt upper surface and the wire run lower surface, through the wire run itself, and then into the forming web. Experience has demonstrated that a distance of this degree is sufficient to dissipate to a non-harmful condition the impingement effects of any residual water.

In addition to effectively sealing the perforations in the flexible belt **21** until the forming wire and web are separated therefrom, the trailing edge surface **25** has the following further effects. By provision of the air block or barrier described, an air flow path having a generally upstream direction and substantially tangential to the roll **23** is created by the air required to restore the perforations in the belt to atmospheric pressure. This is indicated in FIGURE 2 by arrows to which the numeral **34** is applied, and it may be noted that this path of air flow follows generally the periphery of the flexible belt **21** during passage over the roll **23** and additionally has no harmful effects upon the web W since separation of the forming wire **11***a* from the belt **21** has occurred.

The seal means **50** of FIGURE 4 is representative of another form which the trailing edge surface may take. In this view, with the exception of the seal means **50** all parts therein are preferably identical to those shown in the preceding figures, and accordingly, like numerals have been applied to like parts. The seal means **50** may therefore be seen to be in substitution for the roll **23** and trailing edge surface **25**, and the belt **21** may be driven by the forming wire W. This view further illustrates a single suction box **14** extending along the forming reach, and of course, a plurality of suction boxes as in FIGURES 1 and 2 may be substituted therefor.

The seal means **50** is provided by a water lubricated belt supporting member or shoe having a generally arcuate body portion **50***a* integral with an end portion **50***b* abutting against off-running end wall **14***e* of the suction box **14**. The seal means **50** may be attached to either the paper machine or the suction box **14** in any suitable manner, and it may be seen in the FIGURE 4 that the end portion **50***b* of the seal means may have an inclined upper surface **50***c* receiving the belt **21** and lowering the same away from the wire run **11***a* to effect the desired separation therebetween in the manner earlier described. It may further be observed from FIGURE 4 that the seal means **50** has generally flat oncoming and off-running ends **50***d* and **50***e*, respectively, as well as generally flat and parallel inner and outer faces **50***f* and **50***g*, respectively. Preferably, the outer belt contacting surface **50***g* is smooth and polished to minimize frictional losses.

The seal means **50** is coextensive with the belt **21**, and spaced downstream from the oncoming end **50***d* of the seal means is groove or open passage **50***h* extending transversely of the shoe. The groove **50***h* is formed along the contacting face **50***g* of the seal means and is generally U shaped in cross-section. A particular configuration of groove **50***h* which works well includes a generally rounded groove bottom opening to an outwardly flared rounded discharge lip. However, in substitution for the groove **50***h* the shoe or seal means **50** may be passaged throughout with a plurality of relatively small spaced holes extending therethrough, and which has the advantage of reduced fabrication costs and avoiding the possibility of lubrication losses in the event the single groove **50***h* should become plugged. With this arrangement the seal means is most conveniently constructed with inner and outer walls **50***h* and **50***g* adapted to contain lubricating water, in lieu of the manifold **52**.

A suitable arrangement for supplying lubricant, which may be water, to the groove **50***h* may comprise a plurality of pipe lines or stems **51** connecting with a header **52** and leading to a suitable pump **53**.

It may now be seen that the seal means **50** provides a complete barrier against entry of deleterious air flow into or through the belt **21** and into the web W on the wire run **11***a*. The seal means **50** by being coextensive with the belt **21** and by abutting against the suction box **14** thereby shields the web W until sufficient separation has been effected between the wire run **11***a* and the belt **21** so that wet streaks in the web cannot occur. In this connection, the inner face **50***f* of the seal means **50** is impassable and air accordingly cannot pass therethrough to impinge against the web. The curved trailing surface **50** thereby provides an effective seal, and in addition, by elimination of one of the rolls **23** a possible out-of-balance condition is removed, and by having the seal means **40** lubricated, frictional losses are reduced to a minimum.

There has been described herein two exemplary forms of seal means, and it is of course appreciated that their particular configurations can readily be varied. In addition, other changes and modifications will become apparent to those versed in the art, and such variations as come within the spirit and scope of the novel concept of the present invention are intended to be covered hereby.

I claim as my invention:

1. In a paper machine which includes a suction box, a traveling wire and an endless perforate belt movable over said box with the wire thereon, the improvement which comprises a curved trailing imperforate surface abutting the off-running end of the suction box and having a length sufficient in a downstream direction to firmly support the belt until said belt and wire separate, so that the belt and wire are sealed against the entry of air upwardly thereinto until said belt and wire separation takes place.

2. In a paper machine which includes a suction box, a traveling wire and an endless perforate belt movable over said box with the wire thereon, the improvement which comprises seal means having an arcuate surface extending downstream from the off-running end of the suction box in the direction of the belt travel to at least the point of belt and wire separation and preventing air flow upwardly into the belt and wire until said belt and wire part one from the other.

3. In a paper machine which includes a suction box, a traveling wire and an endless perforate belt movable over said box with the wire thereon, the improvement which comprises seal means having a surface forming a continuation of the suction box upper surface extending downstream therefrom to at least the point of belt and wire separation and receiving the perforate belt to support and seal the same against the entry of upwardly directed air streams therethrough and prevent any residual liquid in the belt perforations from impinging against the paper web to cause wet streaks therein.

4. In a paper machine which includes a suction box, a traveling wire and an endless perforate belt movable over said box with the wire thereon, the improvement which comprises a body impassable to air having an upstream end wall abutting the suction box, a top wall receiving the belt from the suction box, and a downstream wall converinging with the top wall at a point substantially downstream from the point at which the traveling wire and endless belt separate, whereby generally upwardly directed air streams pass through the belt perforations only beyond the point at which wire and belt separation occur and wet streaks in the paper web are thereby prevented.

5. In a paper machine which includes a suction box, a traveling wire and an endless perforate belt trained about a pair of rolls and movable over said box with the wire thereon, the improvement which comprises an imperforate body having an upstream end wall abutting the suction box, a top wall receiving the belt from the suction box, and a downstream wall of arcuate shape conforming to the curvature of the downstream roll and closely spaced thereto, said arcuate wall converging with the top wall at a point substantially downstream from the point at which the traveling wire and endless belt separate upstream of the roll, whereby generally upwardly directed air streams follow the arcuate downstream wall and roll

circumference and pass through the belt perforations beyond the point at which wire and belt separation occurs and wet streaks in the paper web are thereby prevented.

6. A paper machine, comprising a suction box, a traveling wire, an endless perforate belt movable over said box with the wire thereon, a roll at the upstream end of the box training said belt, and a relatively slender stationary seal member of arcuate shape abutting the downstream end of the suction box and supporting the belt during travel from said downstream end, the seal member having an inner wall impassable to air which extends a substantial distance downstream from the point at which the wire and belt separate so that generally upwardly directed air streams cannot pass through the belt perforations until said belt and wire have separated, whereby wet streaks in the paper web are prevented.

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