

July 7, 1964

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3,140,030

VACUUM DEVICE FOR PULLING A CONTINUOUS WEB

Filed April 26, 1962

5 Sheets-Sheet 1

Fig. 1.

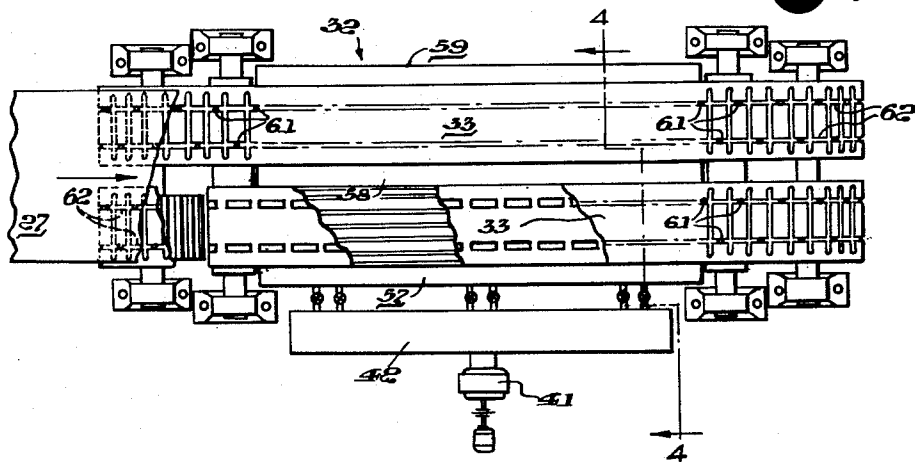
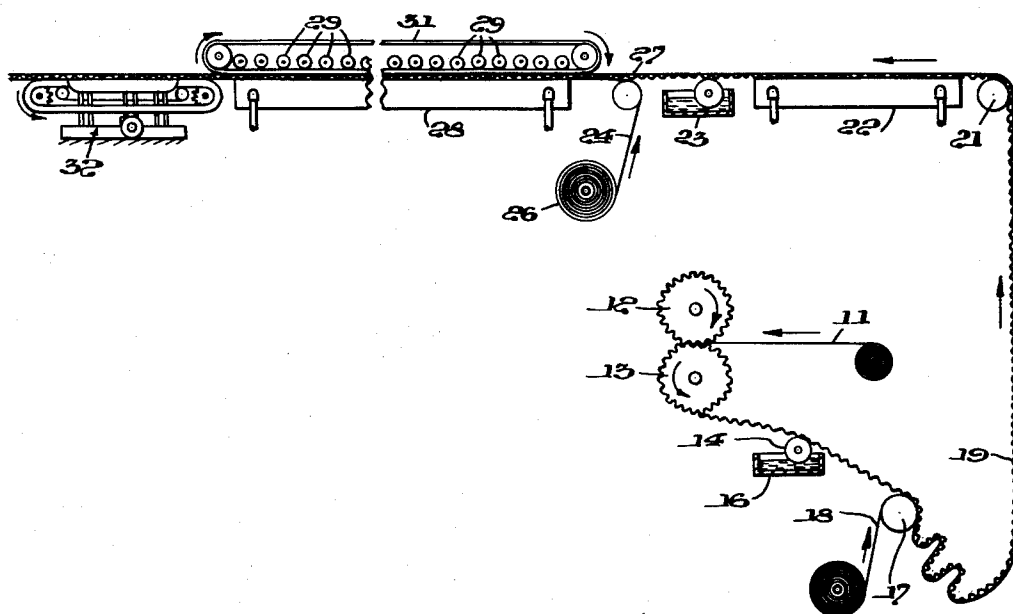


Fig. 2.

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5 Sheets-Sheet 2

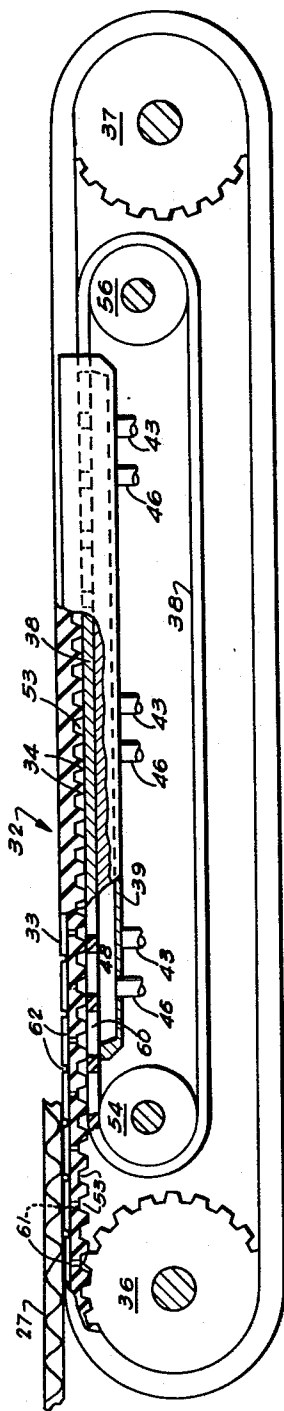


Fig. 3

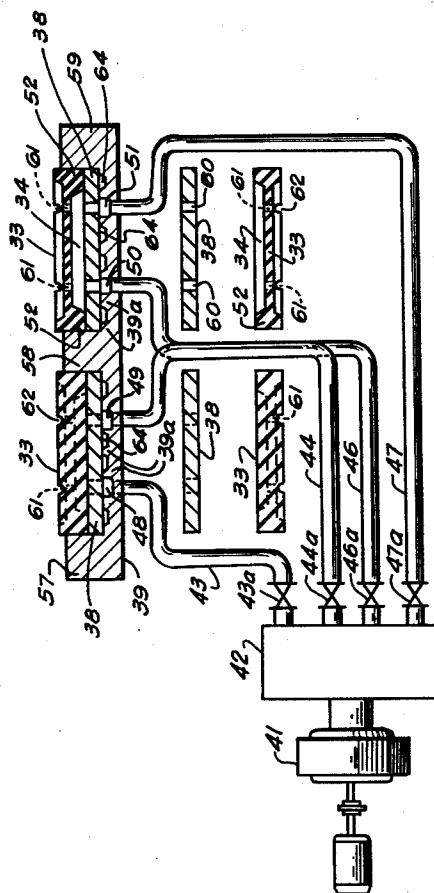


Fig. 4

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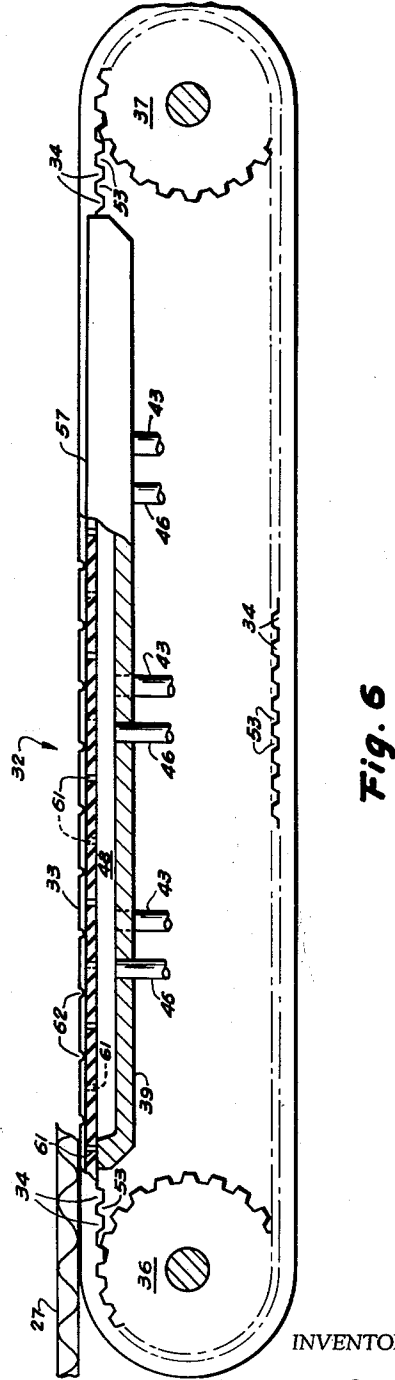
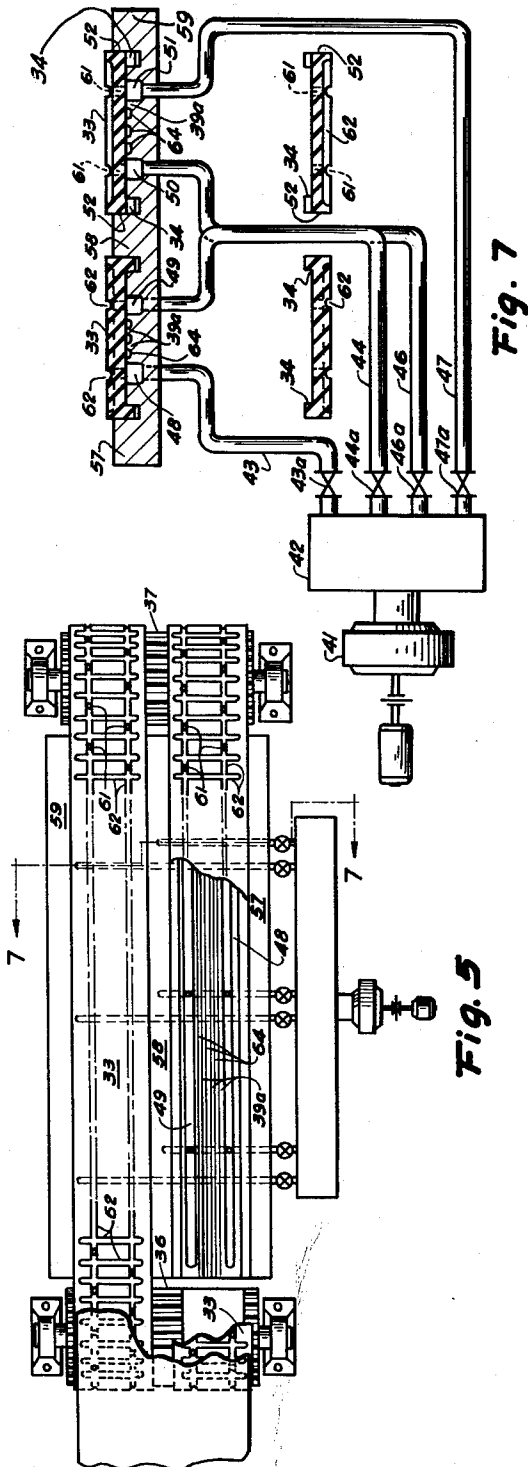
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VACUUM DEVICE FOR PULLING A CONTINUOUS WEB

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5 Sheets-Sheet 3



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VACUUM DEVICE FOR PULLING A CONTINUOUS WEB

Filed April 26, 1962

5 Sheets-Sheet 4

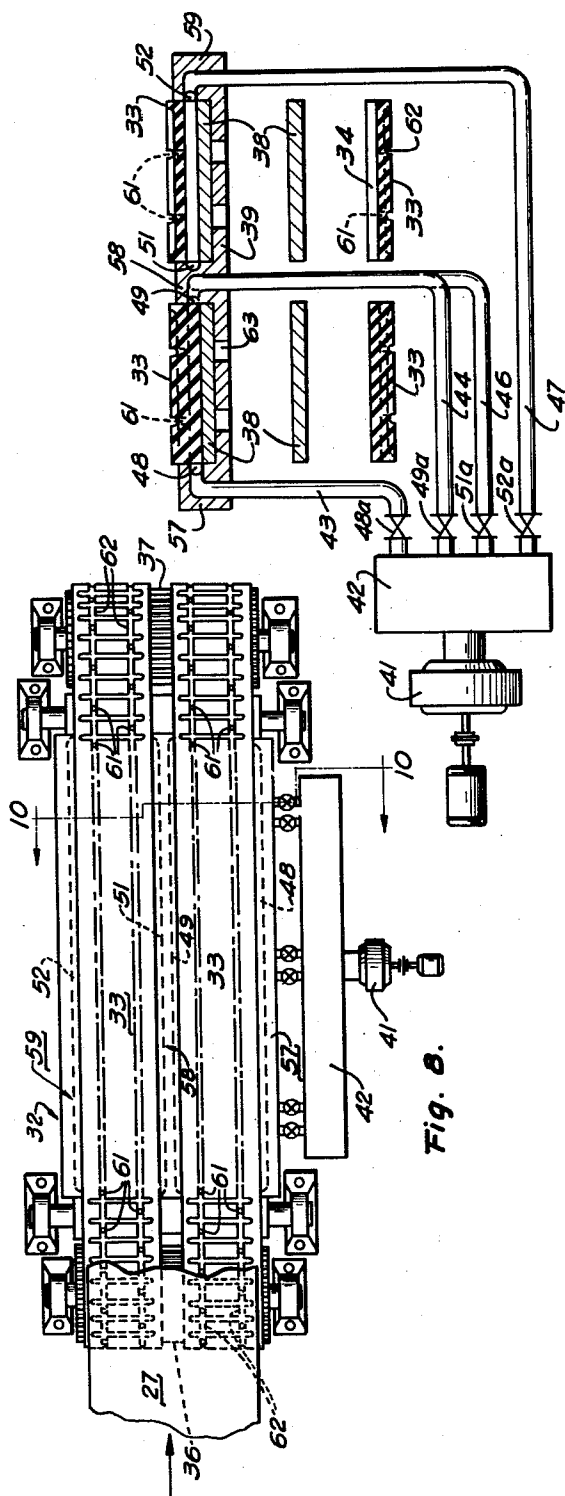


Fig. 8.

Fig. 10.

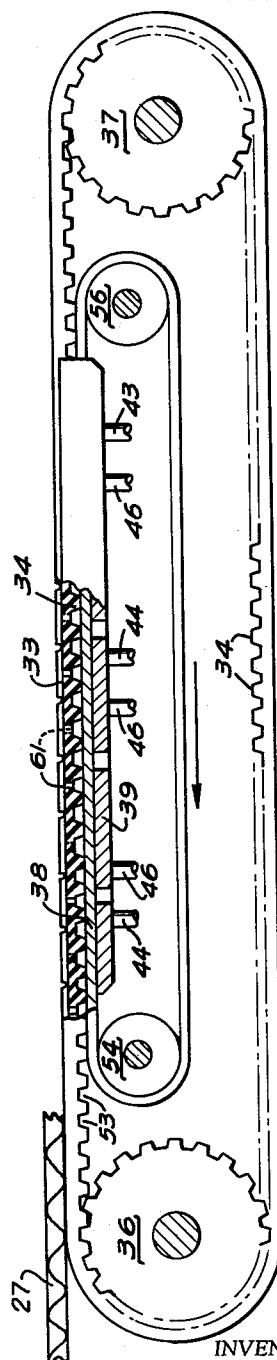


Fig. 9.

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VACUUM DEVICE FOR PULLING A CONTINUOUS WEB

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5 Sheets-Sheet 5

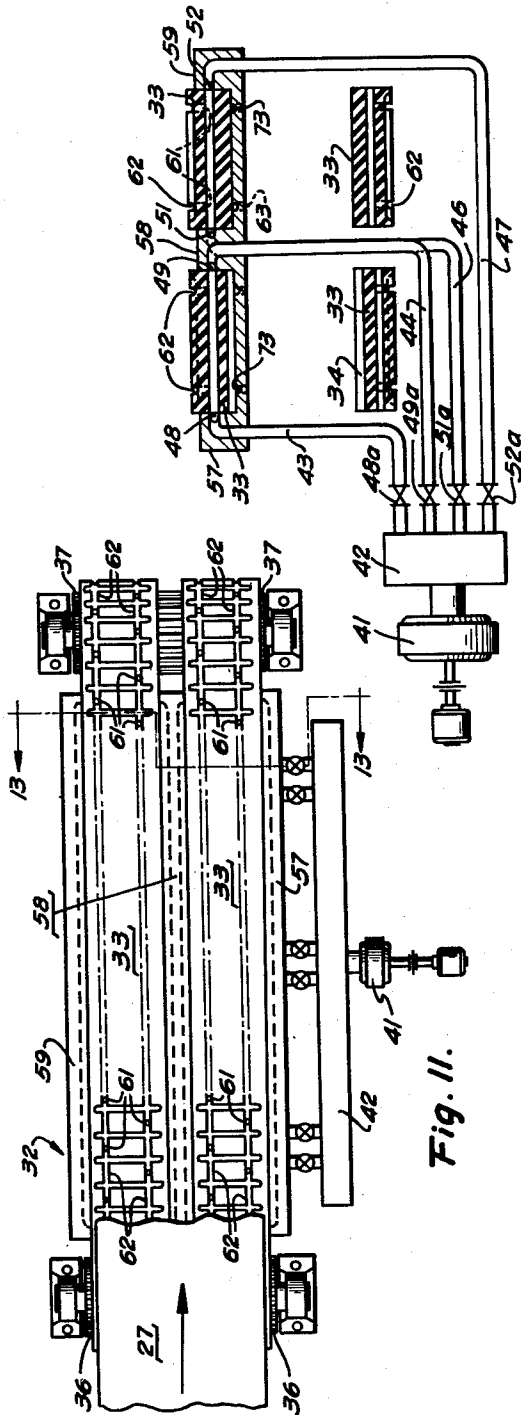


Fig. 11.

Fig. 13.

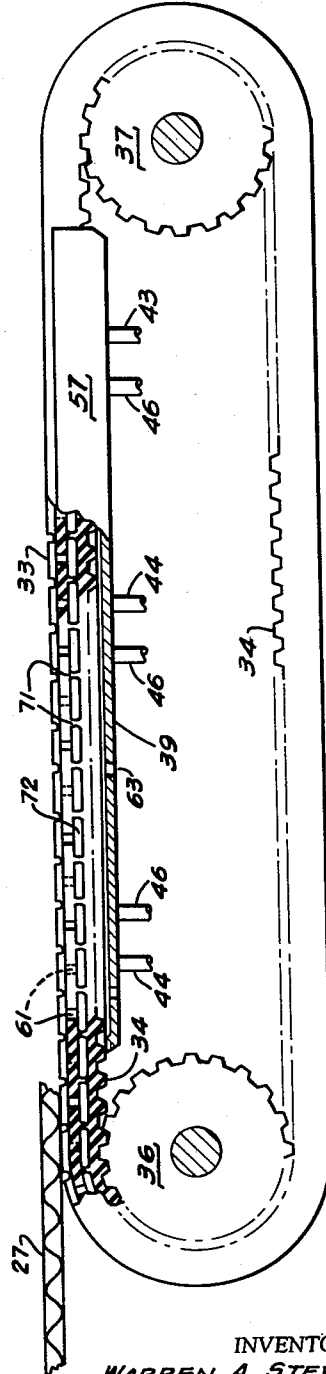


Fig. 12.

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3,140,030

VACUUM DEVICE FOR PULLING A CONTINUOUS WEB

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Filed Apr. 26, 1962, Ser. No. 190,315
4 Claims. (Cl. 226-95)

This invention relates to the manufacture of corrugated paperboard and, more particularly, to a device for applying a pulling force to a corrugated web to draw the web in a longitudinal direction against opposing forces such as friction forces acting on the web during the glue curing operation in the hot section.

In the manufacture of corrugated board, the fluted center element is first prepared, then attached to a liner in a gluing operation to produce single-face board. This single-face is heated and after a second gluing step is combined with a second liner in the double-backing operation. The completed corrugated web is drawn through a curing operation and finally slit into strips of the desired width and cut to the desired length in a cut-off mechanism.

At that stage of the manufacturing sequence during which the second liner is bonded to the single-face in the double-backer, glue is applied to the tips of the single-face flutes and the liner is pressed against the single-face. Because of the great speed of production of modern equipment employed in the manufacture of corrugated paperboard, it is vital that the curing of the glue bond between the single-face and the liner be accelerated substantially beyond its normal setting rate.

This acceleration can theoretically be produced by the application of heat. In the modern double-backer the technique is to draw the corrugated web over a long series of steamheated plates and simultaneously to apply pressure over the top side of the board by the use of weight rollers which press down on a belt which in turn travels on top of the continuous web in order to avoid crushing the newly formed board. The pressure is applied to urge the board toward the heating plates with a force applied as uniformly as the pressurizing equipment is capable of exerting. By this action better heat transfer is promoted, a uniform joint structure is produced and a stiff, unwarped board results.

Considerable heat must be applied to effect acceleration of the curing of the glue bond. Further, this heat must be gradually applied and, as a result, the series of hot plates over which the board is drawn during the curing operation is as a general rule about 40 feet in length. Great force must be applied to pull the web of corrugated board over this 40 feet of steamheated plates particularly in view of the friction generated between board and plates by the downward force of the weight rollers.

At the present time, newly fabricated corrugated board is pulled through the glue curing, or "hot," section by sandwiching the board between a pair of continuous belts, one above and one below the web. These belts are so adjusted relative to the web so that only a light pressure is transmitted from the belts to the surface of the corrugated board to avoid crushing it. As these belts are driven, the friction force between the belts and the board serves to pull the board through the hot section. Since only a light pressure, in the order of 0.125 p.s.i., can be safely applied to opposite faces of the board to urge the two belts toward each other to grasp the board, it becomes necessary to offset this light pressure by applying the pressure over an extremely large area to generate sufficient over-all force.

Experience has shown that a gripping surface the width of the board and about 40 feet in length is required to

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pull the web at the speeds required in modern production, speeds in excess of 600 feet per minute. Of necessity, therefore, in addition to the expense of the equipment involved, a large amount of floor area remains occupied by the immense machine required at present for executing the pulling operation.

It is, therefore, an object of the present invention to provide a device for applying a pulling force to a corrugated web, which device employs a substantially greater contact pressure between the device and the web yet occupies a much smaller floor area.

Another object of the present invention is the provision of means for utilizing vacuum pressure for applying a pulling force to a corrugated web.

A further object of the present invention is the provision of a device for applying a pulling force to a continuous web by the use of a vacuum belt free of unbalanced forces acting normal to its contacting surface.

Still another object of the present invention is the use of a specially constructed vacuum belt for applying a pulling force to a continuous web while positively synchronizing the speed of the vacuum belt with the speed of the head roll driving the vacuum belt.

Still a further object of the present invention is the provision of a specially constructed vacuum belt by which extremely high pulling forces may be exerted by relatively small head rolls driving the vacuum belt.

These objects are realized in the present invention by the use of a hollow belt assembly with one face thereof in contact with the continuous web to be pulled at some point beyond the glue curing station, means for positively driving said belt assembly, openings providing communication from the hollow interior of the belt assembly to the surface of the belt assembly in contact with the continuous web, support means receiving said belt assembly thereon, means connected with the interior of said belt through said support means for exhausting air therefrom to create a vacuum therein whereby the continuous web is forced into contact with a surface of the belt by atmospheric pressure.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIGURE 1 is a schematic representation of the present invention embodied in the equipment employed in performing the sequence of operations for the manufacture of corrugated paperboard,

FIGURE 2 is a plan view of a preferred embodiment of the present invention with portions thereof cut away to show internal details of construction,

FIGURE 3 is an enlarged elevational view of the vacuum assembly of the embodiment shown in FIGURE 2 with portions of the view cut away to show internal construction,

FIGURE 4 is an enlarged sectional view taken on line 4-4 of FIGURE 2,

FIGURE 5 is a plan view of a second embodiment of the present invention with portions thereof cut away to show internal details of construction,

FIGURE 6 is an enlarged elevational view of the vacuum assembly of the embodiment shown in FIGURE 5 with portions of the view cut away to show internal details of construction,

FIGURE 7 is an enlarged sectional view taken on line 7-7 of FIGURE 5,

FIGURE 8 is a plan view of a third embodiment of the present invention,

FIGURE 9 is an enlarged elevational view of the vacu-

um assembly of the embodiment shown in FIGURE 8 with portions of the view cut away to show internal details of construction,

FIGURE 10 is an enlarged sectional view taken on line 10—10 of FIGURE 8,

FIGURE 11 is a plan view of a fourth embodiment of the present invention,

FIGURE 12 is an enlarged elevational view of the vacuum assembly of the embodiment shown in FIGURE 11 and

FIGURE 13 is an enlarged sectional view taken on line 13—13 of FIGURE 11.

In FIGURE 1 at the right hand side thereof is illustrated the sequence of forming the single-face. Stock strip 11, having been previously treated with steam is passed between toothed corrugator roll 12 and toothed corrugator roll 13 complementary therewith whereby corrugations or flutes are impressed in strip 11. After fluted strip 11 passes around roll 13, adhesive is applied to the outer tips of the flutes by doctor roll 14 which, as it rotates, picks up adhesive from pot 16.

As fluted strip 11 having adhesive applied thereto passes over roller 17, the outer tips of the flutes in strip 11 are brought into contact with liner 18 whereby these components are firmly joined to produce single-face web 19.

Single-face web 19 advances over idler roll 21, over the heating surface in steam chest 22, and past glue station 23 for initiation of the double-backing operation. As shown, single-face 19 is united with second liner 24 coming from roll 26 to produce the double-face board 27. Then newly formed board 27 is drawn over the heating surface in steam chest 28 which comprises a long series of steamheated plates (not shown). Pressure and heat are simultaneously applied to cure the doubleface assembly, the requisite pressure being supplied by a series of weight rollers 29 which press down on the top side of belt 31 disposed over and travelling in contact with the top side of the double-back board 27.

Steam chest 28 (or similar heating surface) is typically about 40 feet in length to supply heat at the requisite rate and intensity. Considerable dragging friction must be overcome to pull board 27 over the 40 foot series of hot plates particularly in view of the pressure of weight rollers 29 urging board 27 against the surface of these plates.

In the pull-off mechanism employed at present for pulling board 27 through this heating stage the requisite force is supplied by a device about 40 feet in length primarily comprising a pair of opposed driven continuous belts. These belts are disposed to receive the newly completed board between their opposed faces applying light pressure thereto so as to avoid crushing the board and to pull the board through the hot section by the friction forces applied between the belts and the board. As explained above, the total friction force required to pull the corrugated board through the hot section is substantial and can only be supplied in the prior art pull-off apparatus by the use of large contact area between the belts and the board since the friction force per unit area must remain at an extremely low value.

In place of the opposed driven continuous belts employed at present, the vacuum pull-off apparatus 32 provides a mechanism whereby about 40 times as much force per unit area can be applied to board 27 without damage thereto. As a result of its capacity to safely apply a force per unit area far in excess of that possible with the prior art opposed belt device, the requisite pulling force can be supplied by a compact structure the total length of which need not exceed about 7 feet.

As a method of comparing the effectiveness of the improved pull-off mechanism disclosed herein with the pulling device employed at present in the industry, the following calculations are indicative. By the use of pressure having a value of atmospheric pressure or less to press the double-face board 27 against the contact surface of vacuum pulling device 32, contact pressures between board

and surface of up to about 10 p.s.i. can be economically and safely maintained with the improved pull-off mechanism as opposed to the present arrangement wherein a maximum pressure of approximately 0.125 p.s.i. can be safely applied.

It is reasonable to assume that the coefficient of friction (μ) will remain essentially constant in comparing the two devices, therefore, the improved pulling force per square inch is represented by $F = \mu \times 10$. The present pulling force would be represented as $F' = \mu \times 2 \times 0.125 = .25\mu$. Comparing F and F', $F = 10/.25$ or $F = 40F'$.

Although the above-expressed mathematical relationship demonstrates the approximate maximum value of pulling force which can be produced with the present invention, an application of about 4 lbs. of net pressure is used in practical applications instead of the 10 p.s.i. employed in the calculations. As a result a pulling force of perhaps 16 times the present force for comparable lengths of pulling apparatus is produced.

FIGURES 2, 3 and 4 show in greater detail the preferred embodiment of the present invention. The web of corrugated board 27 after leaving steam chest 28 passes over the upper surface of driven continuous perforated belt 33 or a plurality of such belts as shown in the plan view of FIGURE 2 to accommodate a very wide web.

As is shown in the cut-away portions of FIGURE 3 this belt 33 is provided with cleats 34 whereby belt 33 is positively driven by the toothed head rolls 36 and 37 maintaining positive synchronism between these head rolls and belt 33. By a novel method and mechanism which will be more completely described below firm contact is maintained between board 27 and belt 33 eliminating slip therebetween. Having eliminated slip, the positive synchronism between head rolls 36, 37 and board 27 enables an accurate indication of the speed of board 27 by a measure of the speed of rotation of the head rolls by conventional speed measuring devices.

Briefly described, the novel method and mechanism operate in the following manner: during movement by the upper run of belt 33 in the direction of travel of board 27 belt 33 leaves head roll 36 and is brought into contact with the upper surface of flat continuous belt 38 which in turn contacts portions of the surface of support table 39. In this manner, belt 33 joining with and acting in combination with flat continuous belt 38 as a vacuum belt assembly converts the spaces between cleats 34 into a plurality of substantially closed chambers interconnected by common plenums. When a vacuum is created in this substantially closed system the portion of board 27 over belt 33 is forced firmly against moving perforated belt 33 under the pressure of the atmosphere and as the upper run of belt 33 moves forward driven by head rolls 36 and 37, board 27 is forced to move together with belt 33. As any given part of the portion of board 27 held against belt 33 is moved past the downstream end (right end in FIGURE 3) of support table 39 and thereby out of the vacuum zone, the vacuum under this small part of board 27 is destroyed and the force urging board 27 and belt 33 together at this point is likewise removed permitting board 27 and belt 33 to separate and be conducted along their separate paths.

The vacuum referred to above is produced by the coaction of several elements in a novel fashion hereinafter described in greater detail. Fan or vacuum pump 41 is employed to exhaust air from plenum 42 which in turn receives air through conduits 43, 44, 46 and 47 from the longitudinal-extending table plenums 48, 49, 50 and 51 located beneath belt 38. Valves 43a, 44a, 46a and 47a are provided to disconnect either of the two pull-off belts 33 (shown disposed side by side) from the evacuating mechanism when that particular belt is not in use.

Belt 33 is formed with solid rims 52 extending the full length of the belt along either side thereof. The cleats 34 extend laterally of belt 33 between these rims 52. As the laterally-extending tooth spaces 53 between cleats 34

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of belt 33 move into the vacuum zone over support table 39 during the rotation of belt 33, the undersides of rims 52 are brought into contact with the flat upper surface of belt 38 thereby converting spaces 53 into substantially closed chambers.

Head rolls 54 and 56 each having a plane surface drive the flat belt 38 at the same velocity as belt 33 is driven by toothed head rolls 36, 37 thereby eliminating relative motion between belts 38 and 33. Belt 38 moves with the under surface thereof in contact with ridges 39a of support table 39 and bridging over plenums 48, 49, 50 and 51 with the upper surface thereof in contact with the undersides of rims 52 and cleats 34. During this passage the edges or side surfaces of both belts 33 and 38 pass adjacent to upwardly extending portions 57, 58 and 59 of support table 39 without the necessity of very close clearances, since the vacuum is drawn from below belt 38.

In order to create the required vacuum table plenums 48, 49 and 50, 51 communicate with substantially closed chambers 53 via slots 60 which pass through belt 38. In this manner, the network of interconnected conduits and chambers comprises a substantially closed volume from which air may be exhausted by pump 41 through plenum 42 and conduits 43, 44, 46 and 47.

To create the vacuum in the desired location, which is between belt 33 and board 27, belt 33 is provided with perforations or holes 61 which penetrate its upper surface and communicate with chambers 53. The upper surface of belt 33 is constructed of a special layer of rubber or similar material into which a network of grooves 62 have been cut extending longitudinally and laterally of belt 33. By this means an entire network of localized zones lying between belt 33 and board 27 are evacuated whenever openings 53 have air withdrawn therefrom via openings 61 extending between grooves 62 and openings 53.

Thus, as any given opening 53 passes over support table 39 at the left hand end thereof (as viewed in FIGURE 3), this opening or space is converted into a substantially closed chamber forming an integral part of a substantially closed volume as a result of the cooperative positioning of belts 33 and 38 and the communication provided by slots 60 in register with table plenums 48, 49 and/or 50, 51. As this given opening 53 continues to move to the right under the driving action of head rolls 36 and 37 this substantially closed volume including opening 53 is subjected to the action of pump 41 which through plenum 42, conduits 43, 44 and/or 46, 47, table plenums 48, 49 and/or 50, 51 and slots 60 exhaust air therefrom. Air is in turn drawn in through holes 61 from the network of grooves 62 thereby withdrawing the air from between board 27 and belt 33 and creating the desired vacuum.

Those chambers 53 which are not provided with holes 61 to communicate directly with the upper surface of belt 33 are still able to function to provide passage for the air being exhausted and aid in the formation of the necessary vacuum because of the individual length and staggered arrangement of slots 60 for by this means all chambers 53 are interconnected by the longitudinally extending table plenums common thereto.

When a vacuum is developed in the network of grooves 62 between board 27 and the surface of belt 33, the pressure of the atmosphere provides a very large force which pushes board 27 against the upper surface of belt 33. As a result, the entire assembly of belts 33 and 38 (referred to as the vacuum belt assembly) is forced down. Ridges 39a of table 39 provide a reduced area of contact to minimize the friction force between the vacuum belt assembly and table 39. Also preferably the grooves 64 are extended to the far ends of table 39 and communicate with the atmosphere. With this arrangement, the generation of undesirable heat as a result of friction between the surface of support table 39 and the vacuum belt assembly is greatly reduced.

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By the use of this novel mechanism, as belt 33 is positively advanced by toothed head rolls 36 and 37, a very high tensile force is transmitted to web 27 to supply the necessary pull to draw board 27 through the hot section. The magnitude of the pulling force which can be applied will, of course, depend upon the differential in pressure between atmospheric pressure and the vacuum created in the network of grooves 62, chambers 33 and table plenums 48, 49, 50 and 51.

It is important to note that since the flutes of the corrugated board 27 are perpendicular to the direction of board travel, air is free to enter the flutes of the corrugated web from either side and consequently the pressure of the atmospheric air on the corrugated web will be applied only to the lower liner. As a result no force other than normal air pressure will be exerted on the upper surface of board 27 and crushing of the board is avoided.

Since, in the dual opposed belt web-pulling device which is used at the present time, the corrugated board frequently slips with respect to the moving belts and the belts also slip with respect to the rolls employed to drive them, the simple expedient of measuring the speed of the drive roll to detect the speed of the moving web is unable to provide an accurate measure of board speed. Complex mechanisms have been proposed to accurately detect web speed to enable cutting of the web into precise lengths. The present invention, on the contrary, positively synchronizes belt speed (and, therefore, board speed) with the speed of the head roll driving the belt by the use of a cleated belt. Also, because of the positive nature of the drive the present invention enables the use of smaller head rolls to exercise extremely high pulling forces. Other specially constructed belts using the same principle and constructed of various materials may be employed so long as the requisite positive drive between head roll and belt are maintained.

Instead of employing the two-belt vacuum belt assembly system shown in the preferred embodiment, a single-belt vacuum belt assembly may be used. Such a mechanism is illustrated in FIGURES 5, 6 and 7 as a second embodiment of the present invention. By eliminating the second belt, the smooth head rolls 54 and 56 and their driving mechanism are also eliminated. In all other respects, the operation of the device shown in FIGURES 5, 6 and 7 is analogous to the description already given above for the preferred embodiment.

The upper surface of belt 33 in this embodiment is substantially identical to the upper surface of belt 33 in the preferred embodiment. However, as is more clearly seen in FIGURE 7, the arrangement of cleats 34 for the belt 33 is different. Cleats 34 are formed only along the rims 52 of belt 33 and these cleats project into recesses 66 provided in the surface of table 39. In this construction, the volume to the underside of board 27 to be evacuated consists solely of the network of grooves 62, holes 61, longitudinally extending table plenums 48, 49, 50 and 51, conduits 43, 44, 46 and 47 and plenum 42 which is evacuated by pump 41.

As in the preferred embodiment grooves 64 are provided in the surface of table 39 in contact with the underside of belt 33 to minimize the friction force by limiting the area of table 39 in contact with belt 33 to that of ridges 39a. These grooves 64 are preferably extended to the far ends of table 39 to communicate with the atmosphere.

Still a third embodiment of the present invention is illustrated in FIGURES 8, 9 and 10. This embodiment and the fourth embodiment shown in FIGURES 11, 12 and 13 withdraw air from the sides of the vacuum belt assembly rather than from beneath the belt assembly as in the previous embodiments.

In order to provide for the removal of air from the side of the assembly cleats 34 extend transversely from edge to edge of the cleated belt 33 employed in this

embodiment. As the upper run of belt 33 passes into the evacuation zone the underside of belt 33 is brought into juxtaposition with the upper side of flat, imperforate continuous belt 38 over support table 39 in the manner illustrated in the preferred embodiment thereby converting openings 53 between cleats 34 into open-ended chambers. The edges or side surfaces of the vacuum belt assembly formed by juxtaposed belts 33 and 38 pass with relatively small clearance adjacent upwardly extending portions 57, 58 and 59 of support table 39. Table plenums 48, 49, 50 and 51 are formed in portions 57, 58, 59 disposed in juxtaposition with the open ends of spaces or chambers 53.

In this manner, a substantially closed volume consisting of chambers 53 interconnected by table plenums 48 and 49 or 50 and 51 are produced from which air is exhausted by pump 41 through conduits 43, 44, 46, 47 and plenum 42.

As in the previous embodiments, holes 61 are provided penetrating the upper surface of belt 33. These holes communicate with chambers 53 on the one hand and the network of grooves 62 on the other hand.

In all other respects the operation of this device is analogous to the description already given for the preferred embodiment. However, in order to insure a minimum of friction force between the underside of the vacuum belt assembly and the upper surface of support table 39, holes 63 are provided in table 39 to conduct atmospheric pressure to the underside of the belt assembly.

The fourth embodiment shown in FIGURES 11, 12 and 13 substitutes a single component vacuum belt assembly for the two-component vacuum belt system employed in the embodiment in FIGURES 8, 9 and 10.

Air is withdrawn from the edges of the belt assembly in the manner shown and the upper surface of belt 33 in this embodiment is identical to the upper surface of the other embodiments. However, as shown in the cut-away view in FIGURE 12, the interior of belt 33 is hollow being provided with lateral ribs 71 at intervals to insure structural integrity and also to define a plurality of open-ended laterally-extending chambers 72.

In this embodiment cleats 34 are provided solely to provide the requisite positive synchronization between the movement of belt 33 and toothed head rolls 36, 37. As shown in FIGURE 13, the longitudinally extending table plenums 48, 49, 50 and 51 are so located in the upwardly-projecting portions 57, 58, 59 of table 39 that as open-ended chambers 72 pass over the flat supporting surface of table 39, these chambers 72 are placed in juxtaposition with the table plenums. Since upwardly-extending table portions 57, 58 and 59 also close the ends of inter-toothed spaces 53 between cleats 34 in that portion of the belt in juxtaposition therewith, provision must be made to vent all such openings 53 to the atmosphere. This venting is provided by holes 63 in communication with longitudinal slots 73 extending the length of table 39 as shown in FIGURE 13. A vacuum is created in grooves 62, holes 61, chambers 72, and table plenums 48, 49, 50 and 51 via conduits 43, 44, 46, 47 and plenum 42 by pump 41.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. Apparatus for successively applying a pulling force to advance subsequent portions of a continuous web against opposing forces comprising in combination

(a) a continuous belt assembly driven in a fixed path,

(1) said belt assembly comprising a continuous cleated belt and a continuous smooth belt, said smooth belt having the outer surface thereof in contact with the ends of a plurality of the inwardly-directed cleats of said cleated belt,

(2) said continuous belt assembly being located along the path of advance of said web, said path being linear at least in part,

(b) a portion of said web being in contact with the surface of said continuous belt assembly,

(c) drive means in engagement with said continuous belt assembly for continuously driving said continuous belt assembly in said fixed path, and

(d) evacuating means in juxtaposition with said continuous belt assembly for evacuating gas from that area of said surface contiguous with said portion of said web while said continuous belt assembly is in motion.

2. Apparatus substantially as recited in claim 1 wherein the contact of said inwardly-directed cleats and the surface of said smooth belt provides a plurality of interior chambers and said cleated belt has a plurality of passageways therethrough connecting said chambers with the outer surface of said belt.

3. Apparatus substantially as recited in claim 2 wherein the evacuating means comprises a housing enclosing a plenum, said plenum providing intercommunication between the interior chambers, a pump and a collecting system connected between said pump and said plenum.

4. Apparatus substantially as recited in claim 2 wherein the chambers are open-ended and extend laterally through the belt assembly and one plenum is aligned along each edge of said belt assembly in juxtaposition with and communicating with the open ends of a plurality of said chambers.

References Cited in the file of this patent

UNITED STATES PATENTS

1,077,399	Droitcour	Nov. 4, 1913
1,118,552	Honiss	Nov. 24, 1914
1,610,818	Spadone et al.	Dec. 14, 1926
1,954,098	Powers	Apr. 10, 1934
2,425,210	Stokes	Aug. 5, 1947
2,731,262	Morrow	Jan. 17, 1956
2,753,181	Anander	July 3, 1956
2,852,255	Fischer	Sept. 16, 1958
2,954,911	Baumeister et al.	Oct. 4, 1960
2,987,314	Monaghan	June 6, 1961
3,057,529	Fitch	Oct. 9, 1962