Sept. 18, 1962 G. FORRESTER 3,054,613

SHEET DELIVERY SYSTEM

Filed Dec. 28, 1960 2 Sheets-Sheet 1

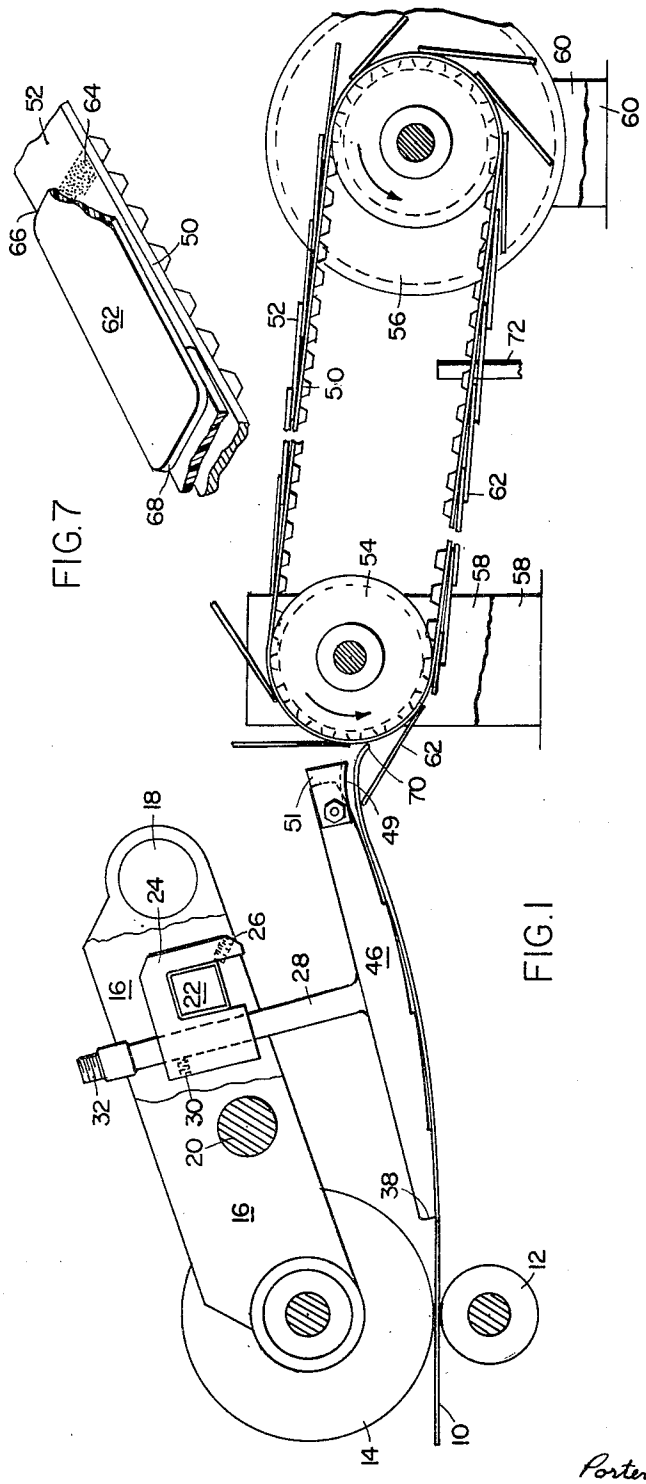


FIG. 7

FIG. 1

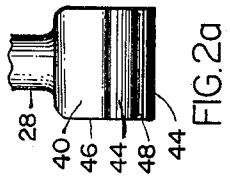


FIG. 2a

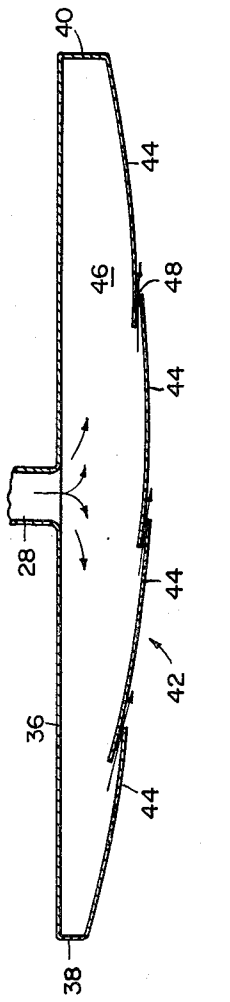


FIG. 2

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SHEET DELIVERY SYSTEM

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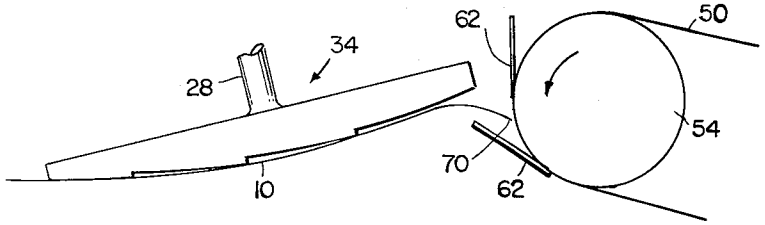


FIG. 3

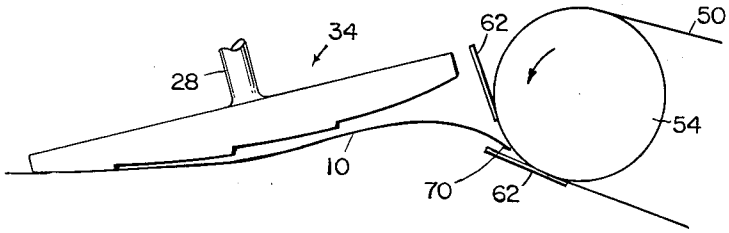


FIG. 4

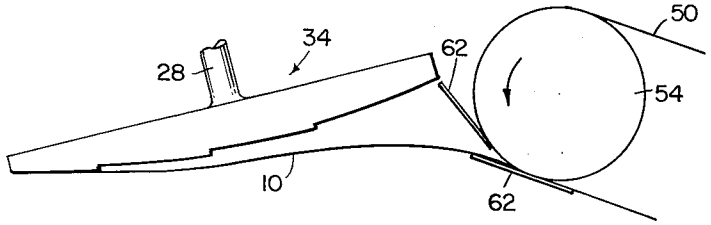


FIG. 5

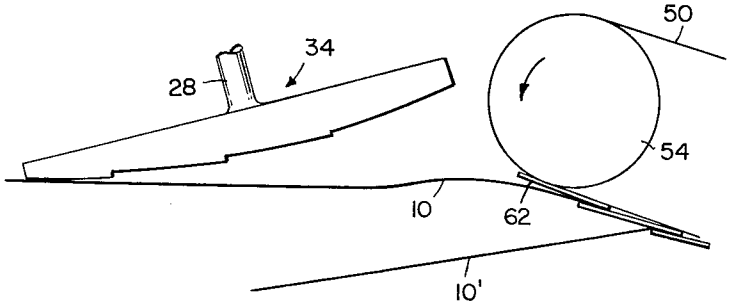


FIG. 6

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SHEET DELIVERY SYSTEM

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8 Claims. (Cl. 271—79)

This invention relates to machinery for handling sheets of flexible material and more particularly to apparatus for effecting the delivery of sheets of paper from a sheet-conveyor such as a conveyor attached to a sheet cutting machine or to a printing machine.

In papermaking it is frequently desirable to cut the paper which comes from the papermaking machines into sheets. This operation may be performed by high speed cutting machinery which produces a stream of cut sheets traveling at about 150 feet per minute or faster. It is consequently desirable to employ a layboy to stack and hold these sheets in order to have a stack of sheets suitable for transfer and packaging.

As the paper is traveling about 2.5 feet per second or faster as it approaches the layboy it is practically impossible to remove the moving paper from the machine manually without harming it. This is especially true of papers with special coatings. Even if it were possible to remove the sheets safely, the frequency of delivery is too fast for manual operation. Thus, an automatic sheet delivery system is required, especially where higher operating speeds are desired.

Conventional delivery systems in general provide a receptacle or layboy for the sheets as they come off the end of the cutter. The sheets are ejected and are carried by their momentum until they hit a stationary backstop on the layboy. One disadvantage inherent in such systems is that the paper sheets must slide in over the prior stacked sheets, thereby increasing the risk of harm to the surfaces of the paper. This is particularly true in the case of printing presses where the moving sheets may have undried ink on their surfaces. Another disadvantage is that the leading edge of a sheet travelling at high speed tends to be unstable due to being projected through the air, and to fold back upon itself, causing an intolerable condition in the paper pile. An alternative is to slow the moving sheets to a speed at which they may be assisted manually to be laid in a stack, but this necessarily slows the whole process and is therefore undesirable. One method of slowing the paper sheets without slowing the cutter is to cause the sheets to overlap as they leave the cutter, whereby the overall effect is to produce the same number of sheets moving more slowly at the delivery point. This overlapping, however, causes contact between the paper surfaces which may be injurious and is therefore undesirable. In the case of sheets whose surfaces tend to generate static electric charges when sliding in contact, this may even immobilize them. Another method of delivery which attempts to avoid contact between paper surfaces and also to control any unstable condition in the head of the sheet is to employ a system of "grippers" or mechanical clamps carried on endless chains disposed longitudinally over the paper piling position. These clamps open to receive the head of the oncoming sheet, close on it and carry it to its final position, where they open and release the sheet. Such gripper delivery systems are very complex and therefore very costly. Also they are not readily adjustable for varying sheet lengths, and are therefore feasible for use only in systems where the sheet size is never changed. The grippers also tend to mark the sheet where they have been attached, causing an undesirable blemish thereon.

Accordingly, one object of this invention is to provide means whereby sheets may be delivered with minimal contacts with their surfaces.

Another object of this invention is to deliver the sheets safely at a higher speed than is now possible without over-lapping the sheets.

A third object of this invention is to provide a system for controlling positively the forward edge of a sheet moving at high speed without such system being limited to a single sheet dimension, without causing a blemish where the sheet is gripped for such control, and without such system consisting of a complex mechanical system, costly in manufacture and in maintenance. The delivery system hereinafter described is simple and suited for all sheet dimensions.

A further object of this invention is to provide a novel paper handling arrangement in which an air stream is used to control the deflection of a moving paper sheet.

In the described embodiment of the present invention an air pressure head is employed for deflecting the moving sheets of paper without touching them, in combination with a belt delivery system. The belt delivery system is provided with means for grasping the leading edge of each sheet and pulling it along under the belt, which causes the sheet to float into position on a stack of sheets in a controlled fashion, and without harmful contact between the surfaces of adjacent sheets and without permitting the leading edge to flex backward upon itself. The air pressure head is arranged to draw the paper toward it rather than deflect the sheet by blowing against it, thereby providing a degree of control not heretofore available.

These and other objects and the features of the invention will appear as the description proceeds with the aid of the accompanying drawings in which:

FIG. 1 is a schematic view of the apparatus in side elevation with portions broken away for clarity;

FIG. 2 is a longitudinal vertical cross-section view of an air head constructed according to the invention;

FIG. 2*a* is an end elevation view of the air head of FIG. 2;

FIG. 3 is a fragmentary side elevation view of the apparatus showing a sheet of paper about to engage the moving belt;

FIG. 4 is a fragmentary side elevation view of the apparatus showing a sheet of paper engaging the moving belt;

FIG. 5 is a fragmentary side elevation view of the apparatus showing a sheet of paper in contact with the belt;

FIG. 6 is a fragmentary side elevation view of the apparatus showing a sheet of paper having been engaged on the belt by the gripping means; and

FIG. 7 is a fragmentary cut-away view in perspective of the belt and an associated gripping member.

Having further reference to FIG. 1 for a more particular description, a sheet of paper **10** is first positioned for delivery by being passed between two horizontal holding rollers **12**, **14** located on opposite sides of the sheet of paper **10**. The upper roller **14** is journaled for rotation in a pair of brackets **16** which are pivotally supported by a transverse pivot rod **18** attached to a suitable standard (not shown). The brackets **16** are joined together for rigidity at their mid-sections by a transverse cylindrical member **20**. A transverse support member **22**, having a substantially square cross-section, is secured between the brackets **16**.

The transverse support member **22** supports a plurality of blocks **24** formed to receive the transverse support member **22**. The blocks **24** are generally uniformly spaced across the transverse dimension of the sheet **10**. A set screw **26** is provided in each block **24** whereby they

may be securely engaged on the transverse support member 22 at appropriate transverse locations.

Each of the blocks 24 is also formed to receive a tubular shaft 28 and hold it perpendicularly to the line defined by the axis of the roller 14 and the axis of the pivot member 18. The tubular shaft 28 is held firmly in place by means of a set screw 30 positioned in the block 24.

The upper end of the tubular shaft 28 is provided with threads 32 whereby a connector and an air supply line, not shown, may be attached thereto. The lower end of the tubular shaft 28 is provided with an air head assembly indicated generally at 34.

The air head assembly 34 is employed to receive a supply of air under pressure and direct it for the purpose of deflecting the sheet of paper 10. The head 34 as shown in FIG. 2 is constructed with a flat rear plate 36 substantially rectangular in shape and formed to receive the tubular shaft 28. Substantially rectangular downwardly extending perpendicular end plates 38, 40 are positioned at the ends of the flat rear plate 36. In practice, the end plate 38 is positioned nearer the holding rollers 12, 14 and transverse to the moving sheet 10 as shown in FIG. 1. A front face, indicated generally at 42, of the air head assembly 34 next to which the paper sheet 10 moves, is formed of slightly curved plates 44 which are supported in place by the end plates 38, 40 and by side plates 46 completing the air head assembly.

The slightly curved front plates 44 are all arc segments of the same radius and are positioned in relation to each other to overlap slightly. Where the plates 44 overlap small narrow slit openings 48 into the interior of the air chamber 34 are formed. The openings 48 allow the air under pressure to escape from the air head 34. The escaping air travels tangentially to the front plates 44 and forms a high speed film of air on them. Thus, when a sheet of paper 10 is fed in close proximity to the curved faces 44 of the air assembly 34 as shown in FIG. 1, and the air head assembly 34 is canted at an angle to the line of travel of the paper sheet 10, the air film created will cause the paper sheet 10 to be deflected along the front face 42 of the air head assembly 34. This result is achieved because the front plates 44 in conjunction with the air passages 48 form one side of a venturi passage, the paper sheet 10 forming the other side thereof. Since the paper sheet is flexible it is drawn toward the curved faces 44 because of the well known venturi effect. The net result is to deflect the moving sheet 10 in an arc substantially that described by the curved front face 42 but separated therefrom by the moving film of air.

Vertical adjustment of the assembly 46 will determine the amount which the paper 10 can be deflected from its former line of travel. Thus, paper traveling at a high speed may be controlled to change its line of travel without touching and thereby harming the paper. A plurality of air heads 34 may be positioned across the width of the paper sheet 10 as required by the sheet width dimension. A deflecting surface 49 may be positioned as by a bracket 51 at the upper end of the air head assembly 34 to deflect the paper 10 downwardly toward the belt system hereinafter described.

The further delivery of the paper sheets 10 is effected by the driven belt system shown in side view in FIG. 1. An internally geared neoprene belt 50 is employed having a smooth outer surface 52. Several belts 50 may be used and in practice four are employed. The belts 50 are fitted over a pair of toothed rollers 54, 56 suitable for engaging them. The toothed rollers 54, 56 are journaled for rotation in spaced pairs of support standards 58, 60. On its bottom run in which the belt 50 moves away from the air head assembly 34, the belt 50 declines slightly from air head assembly 34 and therefore the standard 60 may be positioned lower than the standard 58 or, if the standards 58, 60 and associated axes of rollers 54, 56 are in the same horizontal plane, the toothed roller 56 should have a larger radius than the toothed roller 54. This arrangement permits the paper 10 to trail without surface contact as it is drawn through the apparatus. The belt 50 travels at 100% of paper speed which is accomplished by driving one of the toothed rollers 58, 60 at the appropriate speed.

Toothed rollers are employed instead of toothed pulleys, which would be acceptable, in order that the belts 50 may be more easily adjusted for varying widths of paper sheet. Geared belts are used because they facilitate transverse synchronization of the gripping members hereinafter to be described, and provide less chance of the belt 50 slipping.

In order to grasp the moving sheets of paper 10 there are attached to the outer surface 52 of the belt 50 a series of substantially rectangular gripping members 62. The gripping members 62 are equally spaced on the belt 50, and are constructed of rigid nylon plates or other similar suitable material. The gripping members 62 are cemented or otherwise attached to the belt 50 as shown in FIG. 7, the cement 64 being applied in such manner that the leading end 66 of the gripping members 62 is cemented far enough towards the trailing end 68 thereof, to cause the gripping members 62 to be more or less rigidly affixed to the belt 50. It will be noted, as seen in FIG. 1, that the gripping members 62 are positioned with the trailing end 68 of each gripping member 62 resting on top of the leading end 66 of the gripping member 62 following it on the belt 50. As a result, as the belt 50 passes over the toothed rollers 54, 56 the associated gripping members 62 assume a position tangential to the curved portion of the belt 50. This structure produces an opening of the gripping members 62 as the belt 50 passes over the toothed rollers 54, 56 with the gripping members 62 opening as the belt 50 begins to arc and closing as it comes off the toothed rollers 54, 56 as shown in FIG. 1.

It will be noted that where a plurality of belts 50 are employed, the gripping members 62 must travel in a synchronized transversely aligned relationship as between belts 50.

FIGS. 3, 4, 5 and 6 show the operation of the invention. In FIG. 3 a sheet of paper 10 is shown in the position it assumes immediately after its leading edge 70 passes under the air head assembly 34 and has been deflected thereby. As the leading edge 70 passes beyond the upper end of the air head assembly 34, the venturi effect ceases and the leading edge 70 is bent downwardly by the deflector 49 toward the toothed roller 54, associated belt 50 and gripping members 62. The belt 50 is driven at 100% of paper speed, and in order for the paper 10 to be engaged by the gripping members 62 the paper 10 must approach the belt 50 at the point where the gripping members 62 are traveling around the toothed roller 54 and consequently where the horizontal speed of the gripping members 62 relative to the paper 10 is less than 100%. In FIG. 3, the paper 10 is shown approaching the belt 50 at a point in its turn at which horizontal speed of the belt 50 is close to zero.

In FIG. 4 the toothed roller 54 is shown having rotated about 15 degrees. At this point, the leading edge 70 of the paper 10 has made contact with the belt 50 and is advancing on the belt 50 under a gripping member 62. The paper 10 thus makes contact with the belt 50 at a point at which the horizontal speed of the belt 50 is about 50% of the paper speed.

FIG. 5 shows the gripping member 62 beginning to close on the leading edge 70 of the paper 10, the toothed roller 54 having rotated an additional 15 degrees, more or less.

When the toothed roller 54 has rotated 90 degrees from its position prior to contact with paper 10, as shown in FIG. 6, the gripping member 62 has closed on the leading edge 70 of the paper 10 and is moving at 100% of paper speed carrying the paper 10 with it.

The belt 50 may be of any length necessary to carry a sheet of paper 10 to its place of deposit. The trailing

edge of the paper will float slightly lower than the leading edge as it is carried by the belt **50** as indicated by sheet **10'** in FIG. 6. The paper **10** is carried by the belt **50** in a line substantially the same as the line at which it approached the air head assembly **34**. Because the trailing edge of the paper **10** is slightly lower than the leading edge thereof, and because the belt **50** declines somewhat on its bottom run, the gripping members **62** following the one engaging the paper **10** do not beat against the surface of the paper **10**, which beating would occur if the belt **50** were traveling in a horizontal plane. Damage to the paper is thus prevented. It will be noted that the only surface of the paper **10** which is engaged is that area under the gripping members **62**.

There are at least two methods of releasing the paper **10** from the gripping members **62**. One method is to allow the paper **10** to drop out of the gripping members **62** as they turn upward over the toothed roller **56**. As the leading edge **70** of the paper **10** would be given an upward thrust thereby, this method is liable to lead to fouling and subsequent damage to the paper **10**. Preferably, however, downwardly extending stop members **72** (see FIG. 1) are positioned between the belts **50** at the point at which delivery is desired. As the gripping members **62** have only a relatively light grasp on the paper **10**, contact of the leading edge **70** with the downwardly extending stop members **72** readily releases the sheet **10**. This disengagement technique deposits the paper sheets **10** into the layboy without fear of fouling and no harm will result to the leading edge of most papers by abrupt disengagement at speeds up to 150 feet per minute.

It is my intention to cover all modifications and changes of the example of the invention herein chosen for purposes of disclosure which do not constitute departures from the spirit and scope of the invention.

Having thus described and disclosed a preferred embodiment of my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A flexible sheet material handling system comprising a belt, means associated with said belt for engaging a sheet of said flexible material for transport by said belt, means for driving said belt, and means including a surface having an air stream flow along said surface, said last-mentioned means being positioned to draw said sheet towards said surface and to deliver said sheet material to said belt and associated engaging means.

2. A system for delivery of paper comprising a belt, gripping means attached to said belt, means for driving said belt and said associated gripping means, and means for positioning said paper for engagement with said gripping means, said last named means including a chamber having a convex curved surface with ports in the face of said chamber for discharging air to flow along said surface and means for supplying air under pressure in said chamber.

3. A system for delivery of moving sheet paper comprising a set of spaced rollers, a belt mounted on said rollers, means for driving said rollers and associated belt at the speed of said sheet paper, a plurality of plates attached at the leading edges thereof to said belt to maintain a substantially tangential position to said belt at all times, means for positioning said sheet of paper for engagement between said plates and said belt including a chamber having a convex face with a plurality of spaced exit nozzles for exiting compressed air tangentially to said convex face, and means positioning said chamber in a spaced relationship to one of said rollers for delivering said paper to said belt where said belt is moving over said one roller, whereby said paper sheet is caused to advance on the said belt between said belt and said tangentially positioned plates.

4. Paper directing apparatus comprising an air chamber, means for supplying air under pressure to said chamber, and a series of faces on said air chamber having openings at their junctures, said openings positioned to emit a film of high speed air over said faces whereby paper passed by said faces is directed along the contour thereof.

5. Paper deflecting apparatus comprising a chamber to receive compressed air, one wall of said chamber having a curved outer face with ports defined in said surface, said ports being arranged in a relationship such that a high speed film of air is created on said surface by said compressed air exiting through said ports, and means for passing paper sheets close to said surface to be deflected by said film of air toward said surface.

6. Apparatus for deflecting a moving sheet of paper comprising an air chamber, overlapping longitudinal curved faces on said air chamber defining ports in said air chamber between the overlapping portions of said longitudinally curved faces, means for introducing air under pressure into said air chamber, and means for positioning said air chamber in a spaced relation to the line of travel of said paper for deflecting said paper toward said longitudinally curved faces.

7. A flexible sheet material transport apparatus comprising a set of spaced horizontal rollers, a belt positioned on said rollers, means for supporting said rollers to provide a downwardly inclined bottom run from one of said rollers to the other roller, means for driving said belt, a plurality of spaced transverse rows of thin flexible plates attached to said belt, said plates being bonded at the leading edge to said belt to maintain said plates substantially tangent to said belt, means for delivering the leading edge of a sheet of paper between said belt and a row of said plates at said one roller to be engaged between said plates and said belt and transported by said lower run of said belt, and means for disengaging said paper from between said plates and said belt.

8. A system for delivery of a moving flexible sheet comprising first and second spaced horizontal rollers, a belt positioned on said rollers, means for supporting said rollers to provide a downwardly inclined bottom run from said first roller to said second roller, means for driving said belt at the speed of said moving sheet, a plurality of spaced transverse rows of thin flexible plates attached to said belt, said plates being bonded at their leading edge to said belt to maintain said plates substantially tangent to said belt, means positioned for delivering the leading edge of a sheet between said belt and a row of said plates at said one roller to be engaged between said plates and said belt and transported by said lower run of said belt, said last means including a chamber having a convex face with a plurality of spaced exit nozzles for exiting compressed air tangentially to said convex face, and means for disengaging said paper from between said plates and said belt.

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