

March 25, 1969

N. L. YARGER ET AL
SHEET HANDLING APPARATUS

3,434,710

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Sheet 1 of 2

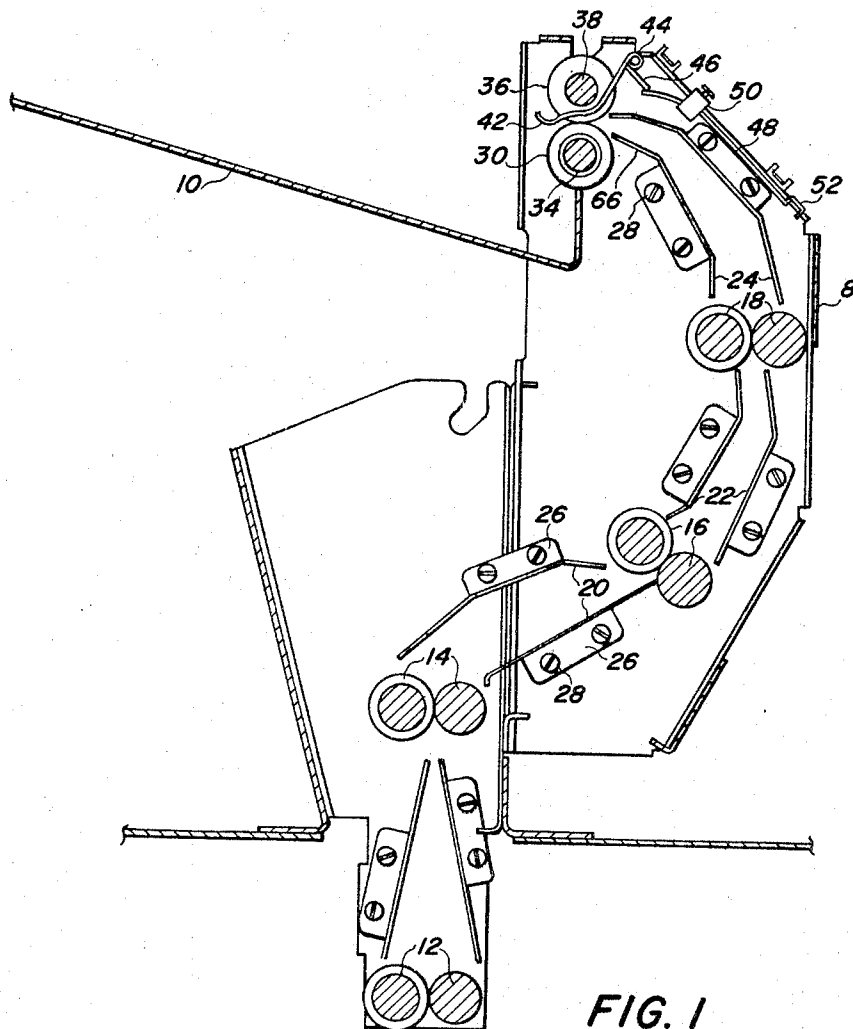


FIG. 1

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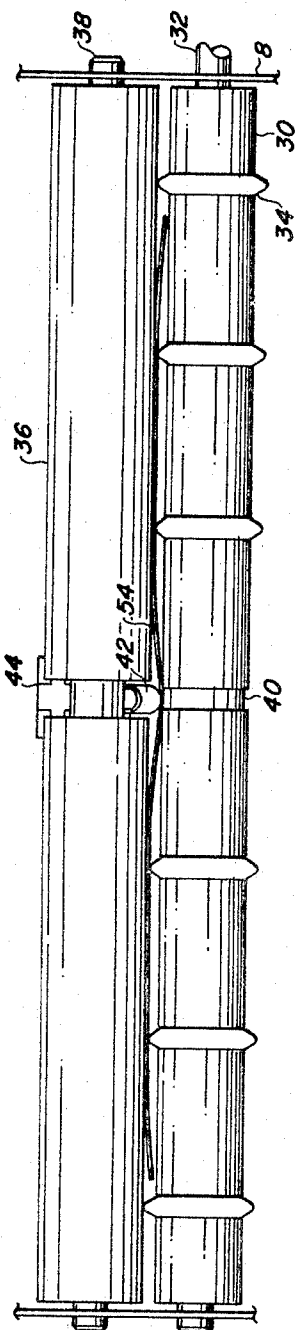


FIG. 4

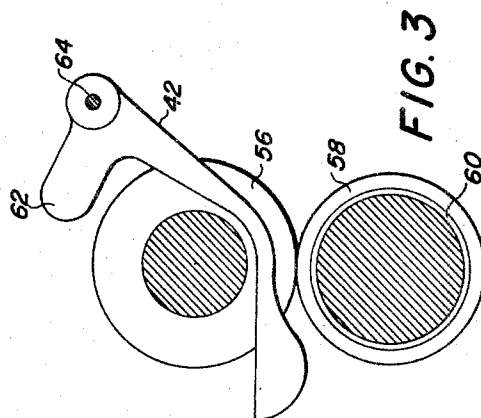


FIG. 3

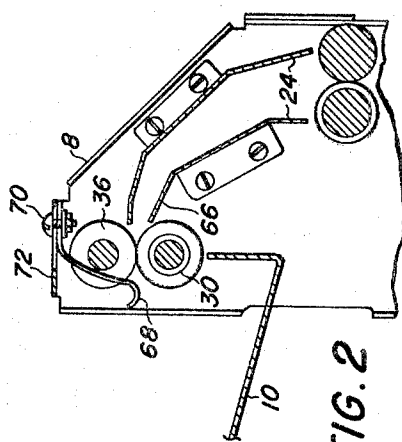


FIG. 2

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SHEET HANDLING APPARATUS

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11 Claims

ABSTRACT OF THE DISCLOSURE

Anti-buckling apparatus within a sheet transport system for moving flexible sheets. The sheets are prevented from buckling by inserting in the path of movement of the sheets a member that extends into the path of travel of the sheets and causes sheets passing the point where the member protrudes into the path of travel to bow adding beam strength to the sheet thus providing them with substantial rigidity.

This invention relates to sheet transport devices and particularly to apparatus for preventing the buckling of flexible sheets.

During the transport of sheet material, there is often a distance over which the sheet must travel where it is not supported by any member. If this distance is equal to more than a few inches, there is a tendency for the sheet to buckle or turn-under due to the force of gravity and moment arm created by its own weight. In machine feeding sheets of flexible material, e.g., paper or plastics, to a final depository, such as the copy holder tray of an office copier apparatus, this buckling causes a difficulty in stacking the final copy sheets. The problem becomes all the more critical if the copy holder tray is an "uphill" tray tilted rearward from the horizontal, being lower at the end nearest the emerging of a copy sheet than at the end adapted to maintain the front of the copy sheet.

Buckling of the sheets being deposited in the copy tray will cause succeeding sheets to be misaligned and perhaps fed, not into, but over and out of the depository tray as they slide over the previous buckled sheet causing a paper jam.

It is therefore an object of this invention to improve the transport of sheets over a gap in their path of travel.

Another object of this invention is to prevent the buckling of sheets under the force of gravity.

Yet another object of this invention is to impart a rigidity to a flexible sheet for prevention of buckling of the sheet.

A further object is to impart a beam strength to a sheet while preventing its creasing.

Still another object of this invention is to insure that flexible sheets will not buckle or invert when delivered to a depository tray.

These and other objects of the invention are attained by means of an apparatus for forcing the center of a flexible sheet material below the edges thereof, across its entire cross section, as the sheet is fed through its last set of guides and to maintain the sheet in this position with a force thereon readying it for engagement by the next operable member in its path while maintaining it in a rigid state.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in conjunction with the accompanying drawings wherein:

FIG. 1 is a side view, partly in section, of a sheet transport mechanism and depository tray;

FIG. 2 is a side view of a buckler finger in conjunction with a pair of pinch rollers;

FIG. 3 is a side view of another embodiment of a buckler finger in conjunction with a pair of pinch rollers; and

FIG. 4 is a front view of a sheet transport apparatus embodying this invention.

Referring now to the drawing, there is shown in FIG. 1 a sheet transport device of the type that would be found within the super structure 8 of an office copier type machine. It is comprised of guides and pinch rollers the latter being driven by a suitable drive means and belts and gear connections (not shown). The apparatus functions to bring flexible sheet material from a previous operation to be deposited in the sheet holder 10.

The sheet is carried by sets of pinch rollers 12, 14, 16 and 18, all formed of metal in a cylindrical shape and plates 20, 22, and 24 used to guide the lead edge of the sheet transported therethrough to the next set of pinch rollers and finally out of the transport mechanism. The rollers are journaled in the frames of the super structure 8 supporting the transport section and are free to rotate in a direction to carry the sheet from a previous operation to a next operation, such as deposition in the sheet holder 10. The rotation of each set is accomplished by suitable belts and gears attached to a drive motor (not shown). Only one roller of each set is driven while the other rotates due to friction against the O-rings, such as O-ring 34, of the driver roller. The guide plates 20 through 24 are formed and spaced to prevent buckling of the sheet as it is pushed by the rollers into contact with the guides. The guides may be formed by stamping and have attached thereto, either as an integral part thereof or in some other manner fastened thereon, brackets such as those indicated by reference numeral 26. The brackets may be fastened to the transport super structure 8 by any means such as screws 28.

The last set of pinch rollers in the super structure 8 is comprised of a lower drive roller 30 formed in a cylindrical shape and connected with a shaft 32 appropriately attached to drive belts connected to a motor causing the rotation of said lower drive pinch roller 30 in a counterclockwise motion as viewed from the right-hand side of the super structure as shown in FIG. 1. The roller 30 has several notches placed therein along its axis, the notches running normal to the axis around the circumference of the roller. Into these several notches are forced resilient O-rings such as O-ring 34. These O-rings maintain a tight non-slippage bond with the roller 30 and a low pressure contact with the upper idler roller 36 of the last set of pinch rollers. The idler roller is driven in a clockwise rotation, as viewed in FIG. 1, when the lower roller 30 is driven. The idler roller 36 rests on the O-rings positioned on the roller 30 by the force of gravity due to its own weight. Its shaft 38 is journaled through the super structure 9 in such a manner that a body of the roller 26 may maintain its touching contact with the O-rings 34.

A notch 40 in approximately the midpoint along the axis of the lower roller 30, formed generally in the same manner and to the same dimensions as the notches supporting the O-rings, is cut into the lower roller 30. The upper idler roller 36 is formed of a metal cylinder. The roller 36 is divided approximately at its linear midpoint and turned or otherwise formed to permit a groove thereat. The shafts 32 and 38 are positioned within the super structure 8 such that the center notch in the drive roller 30 and the grooved portion in the roller 36 approximately coincide.

A buckler finger 42 is fastened to the super structure 8 by hinge 44 such that the finger 42 may rotate in a

vertical direction. The finger is further positioned to lie between rollers 30 and 36 in the area of the groove on roller 36. The finger is generally arcuate in shape and extends from its hinge point, above and behind (relative to the path of travel of a sheet) the axis of rollers 30 and 36 extending through the portion therebetween, where notch 40 and the division of roller 36 coincide, to a point in front of the rollers and below the path that would be traveled by a sheet guided through the transport system.

At the hinge portion 44, there is a protrusion 46 appended to the finger 42 and extending rearward therefrom within the super structure 8 (see FIG. 1). Contacting the protrusion 46 is an adjustable spring arm 48 capable of exerting an upward force on the protrusion 46 (see FIG. 1) which in turn operates on finger 42 as a lever system the pivot point of which is at hinge 44. The force exerted causes the finger 42 to be biased downward toward roller 30 and below the tangent line which may be drawn through the contact points of the rollers 30 and 36 which would represent the path of a sheet traveling therethrough. The spring arm 48 is adjustable by moving clamp 50 relative to the spring arm pivot point 52 where the spring arm 48 is attached to the super structure 8. By moving the adjustment clamp 50 toward the pivot point 52 of the spring arm 48, and therefore, away from the hinge 44 and the protrusion 46, the tension exerted by spring arm 48 on the protrusion 46 is reduced, thereby causing a lesser downward bias on the finger 42. Likewise, a movement of clamp 50 toward the hinge 44 will cause a greater downward force on the finger 42.

As a sheet, for example sheet 54, is transported through the super structure 8 by the pinch rollers and guide plates positioned therein, it is brought to, and carried through, the rollers 30 and 36 until its lead edge contacts the lower arcuate surface of the finger 42. As the rollers continue to drive the sheet forward, the lead edge in contact with the finger 42 is depressed or buckled therebeneath and so remains throughout the drive thereunder. The passage of the sheet under the finger 42 causes an upward force on said finger and it is moved vertically upward to some extent, depending upon the bias put thereon, by spring 46 and spring arm 48. This bias may be adjusted by the adjusting clamp 50 so that the sheet 54 is depressed downward at its contact point with finger 42 to impart a sufficient force on the sheet to maintain it in a rigid state while it is expelled from the transport super structure 8. The force must not be so much as to crease the sheet along its line of contact with finger 52.

The beam strength required by a sheet of paper to prevent it from buckling may be discovered from the following formula:

$$\text{Stiffness} = \frac{ET^3}{12} \times \frac{W}{L^3}$$

where:

$$\begin{aligned} E &= \text{Young's modulus} = \frac{\text{tensile stress}}{\text{tensile strain}} \\ &= \frac{\text{force/area}}{\text{change of length/original length}} \\ &= \frac{\text{force} \times \text{original length}}{\text{area} \times \text{change of length}} \end{aligned}$$

and

T=effective thickness, i.e., dimension from uppermost segment to lowermost segment of cross-section; W=width of the sheet, and L=length. E would be affected by such external factors as the composition of the material of the sheet, the length of fibers, additives, moisture content, etc., of the sheet.

It is evident that, for a uniform cross-section, T, W, and L have a definite relationship affecting the stiffness or anti-buckle capabilities of the sheet. The length has

a severe anti-stiffness effect as the same is increased; therefore, making it more difficult to prevent buckling as more of a sheet passes the pinch rollers 34 and 36. However, an exponential increase in stiffness may be imparted to the sheet by increasing the effective thickness T by inducing a deflection across the cross-section as is accomplished by this apparatus.

In order to achieve the desired deflection to increase T with different stocks of sheet material fed through the transport, it is necessary to adjust the force exerted by the finger 42 on the sheet 54. It is for this reason that an embodiment such as that shown in FIG. 1 is beneficial in that the biasing force downward of the finger 42 is adjustable through spring 48. However, in some situations, such as may be found in copying machine apparatus, the variation in thickness or weight of stock being transported would not be great enough to necessitate a fully adjustable system. For this reason an anti-buckle apparatus such as that embodied in FIG. 3 would be sufficient to achieve the desired results. Here the finger 42 is again pivotally fastened above the path of travel of a sheet which would be coincidental with a tangent line drawn between roller 56 and O-ring 58, the latter being mounted on roller 60.

A downward bias is achieved on finger 42 by means of a protrusion 62 attached thereto and extending on the same side of an imaginary vertical line passed through pivot point 64 around which the finger 42 may vertically rotate. The protrusion 62 may be of a heavier material than the finger 42 or it may be formed of the same material but weighted in such a manner that it creates a moment arm in relation to the pivot point 64 forming a lever with point 64 as its fulcrum and exerting a downward force on the finger 42, such force directly related to its weight and the distance thereof from the fulcrum point. By pre-selecting the materials to be transported past a deflection finger one may determine the weight of the protrusion 62 which would most effectively operate in conjunction with the finger 42 to prevent buckling of the selected sheet material.

The surface of finger 42 which is contacted by the transported sheet should be a smooth, low friction surface formed not only to deflect the sheet as required for achieving the desired anti-buckle results but also to guide the sheet and prevent its catching on the finger and moving out of its predetermined path of rising along the lower surface toward the hinge for example.

The copy tray is back leaning in relation to the transport system. That is to say it is tilted from the horizontal rearward with its forward portion being at a point vertically higher than its most rear portion. The tilt is generally at 15° from the horizontal although this is not a limitation nor limiting feature. It is designed to have an angle with the horizontal approximately equal to the angle of the last flange 66 of the guide means 24 of the transport apparatus. Because the sheet emerges in a rigid state, due to the effect on it by the deflector finger 42, it maintains the same angle with the horizontal as the guide plate segment 66. Since this corresponds with the angle of the copy tray 10 to the horizontal, the sheet is presented parallel to the bottom of the copy holder tray and when released by the transport apparatus will fall flat onto the copy tray or the preceding sheet gathered thereon.

FIG. 2 manifests a more simplified version of the deflector finger embodied in a transport apparatus super structure 8. The guide means and pinch rollers may be the same as those shown in FIG. 1 including the set of final pinch rollers 36 and 30. Here, however, the deflector finger 68 is rigidly fastened to the super structure 8 at the top front portion thereof in a position in front of the final set of pinch rollers. The finger is positioned to interfere with the path of travel of the sheet being transported through the super structure and does not ride up as a sheet passes therebeneath, but is precisely positioned to

maintain the exact deflection necessary to achieve the desired result of rigidity of the sheet passing thereunder by imparting to the sheet the requisite beam strength.

The amount of interference between the bottom portion of finger 68 and the path of travel of a sheet transported through the super structure is predetermined and pre-set by moving the fastening screw 70, and with it the finger 68, forward and back in relation to the pinch rollers 30 and 36 along an elongated slot 72 in the super structure 8. Once adjusted, the finger will so remain until a further external adjustment is made. If, however, the apparatus is used for a single stock of sheet material it would not be necessary to provide easily accessible adjustment means since a single setting will be all that is necessary to impart the proper deflection in the sheet to cause it to be rigid but not to crease under the force exerted by the deflection finger.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth; and this application is intended to cover such modifications or changes as may come within the purposes of the improvements or scope of the following claims.

What is claimed is:

1. A sheet handling apparatus for preventing sheets from buckling while being transported in a partially unsupported condition comprising

a transport means of a predetermined width adapted to move a sheet along a predetermined path of travel,

a resilient member interposed in the path of travel of the sheet and positioned between the edges of the transport means to urge the sheet out of and below the path of travel at the contact point causing the sheet to be depressed with the portion of the sheet contacting said member moved to a plane below the remainder of the sheet, and

means to maintain said member in a position that extends through the path of travel as a sheet is transported past the member so that the sheet contacts said member and is depressed at the area of contact therebetween, said member increasing the beam strength of the sheet sufficiently to prevent the buckling thereof,

said member being shaped and positioned to prevent the marring of the sheet by forming a crease therein.

2. The apparatus of claim 1, wherein said member is an elongated finger having a biasing means associated therewith to maintain said member in a position wherein it extends into the path of travel of a sheet.

3. The apparatus of claim 1, said transport means having associated therewith a sheet receptacle, said receptacle tilting rearward toward said transport from the horizontal.

4. The apparatus of claim 1, wherein said transport means includes at least one pair of pinch rollers and said member is positioned in the path of travel developed by said pinch rollers such that it contacts a sheet traveling along the path of travel.

5. The apparatus of claim 1 wherein said means to maintain said member in a position that extends substantially into the path of travel includes means to pivotally mount said member to resiliently extend into

the path of travel of a sheet whereby it is urged away from the path though maintained therein as a sheet passes into operable contact therewith.

6. The apparatus of claim 1 wherein said member has associated therewith means to fasten said member above the path of travel of a sheet, said member extending through the path of travel and adapted to move slightly toward said means to fasten said member as a sheet passes beneath said member, contacting the surface thereof.

7. The apparatus of claim 1 wherein said means to maintain said member in a position that extends substantially into the path of travel includes

means to mount said member to extend into the predetermined path of travel, said means to mount adapted to move said member to a position being relatively greater removed from the predetermined path of travel as a sheet passes into operable contact with said member.

8. The apparatus of claim 1, wherein said member is positioned approximately midway across the width of said transport means.

9. A sheet handling apparatus for preventing sheets from buckling while being transported in a partially unsupported condition comprising

a transport means of predetermined width adapted to move a sheet along a predetermined path of travel,

an elongated finger having a biasing means associated therewith to maintain the finger in a position wherein it extends into the path of travel of the sheet and is positioned between the edges of said transport means to urge the sheet out of the path of travel at the contact point,

a spring in biasing contact with said elongated finger adapted to exert a force thereon in a direction opposite to that exerted by a sheet being moved in contact therewith, said force being capable of overcoming the force exerted on the finger by a sheet, whereby said member depresses the sheet in the area of contact sufficiently to prevent the buckling thereof.

10. The apparatus of claim 9, wherein said spring is a cantilever bar and has further associated therewith a movable fulcrum for varying its effective length and, therefore, the force it exerts on said member.

11. The apparatus of claim 9, wherein said means to maintain said member in a position that extends substantially into the path of travel includes

a weighted arm intimately attached to said member, said weighted arm arranged to exert a force on said member in the same direction as the force of gravity exerts on said weighted arm whereby said weighted arm acts as a lever in relation to said member.

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