Oct. 18, 1966 G. R. LINDEN 3,279,785

SHEET HANDLING MECHANISM

Filed July 26, 1963 4 Sheets-Sheet 1

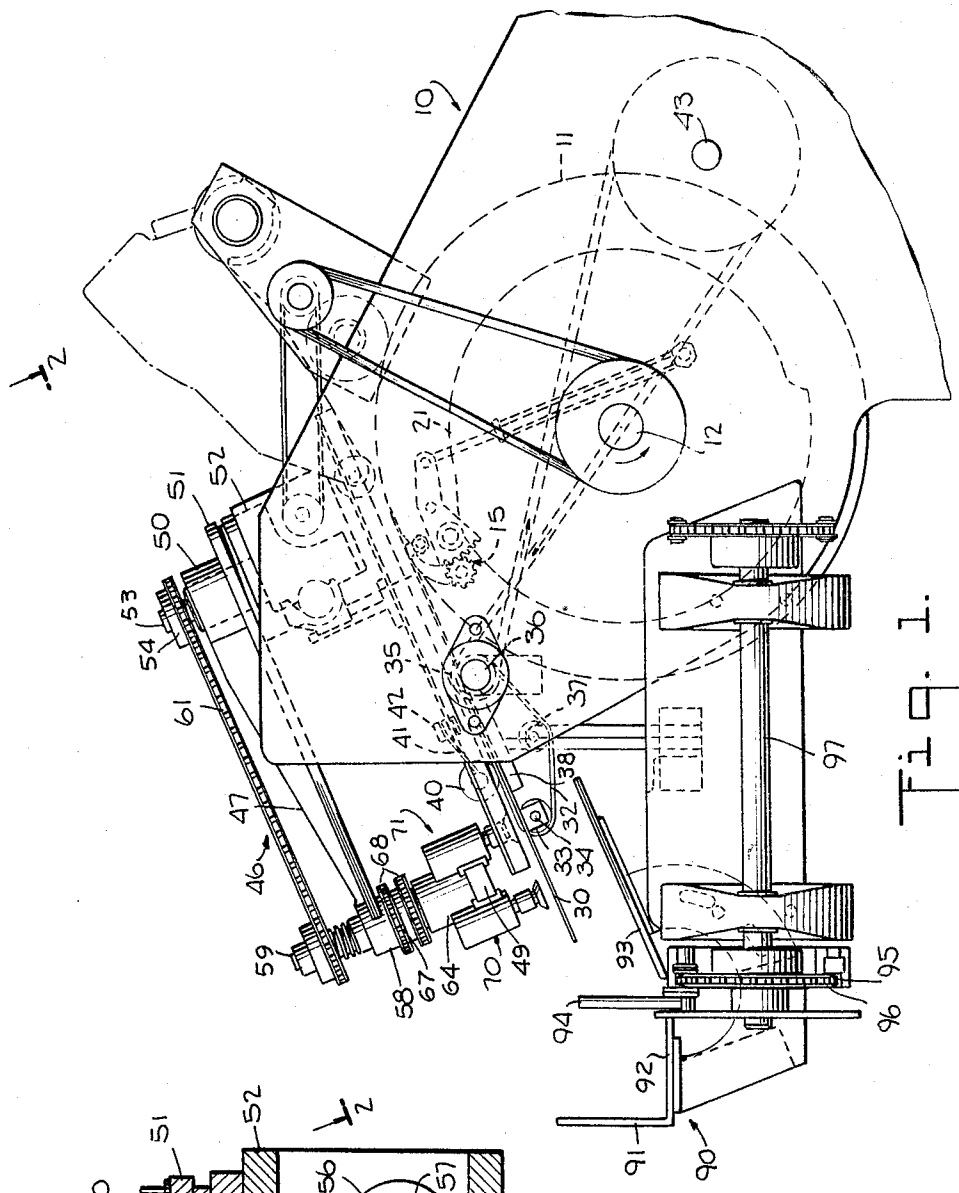

Fig. 1.

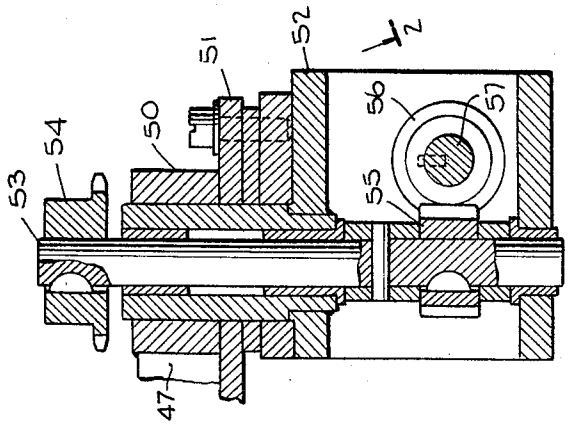

Fig. 4.

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Filed July 26, 1963 4 Sheets-Sheet 2

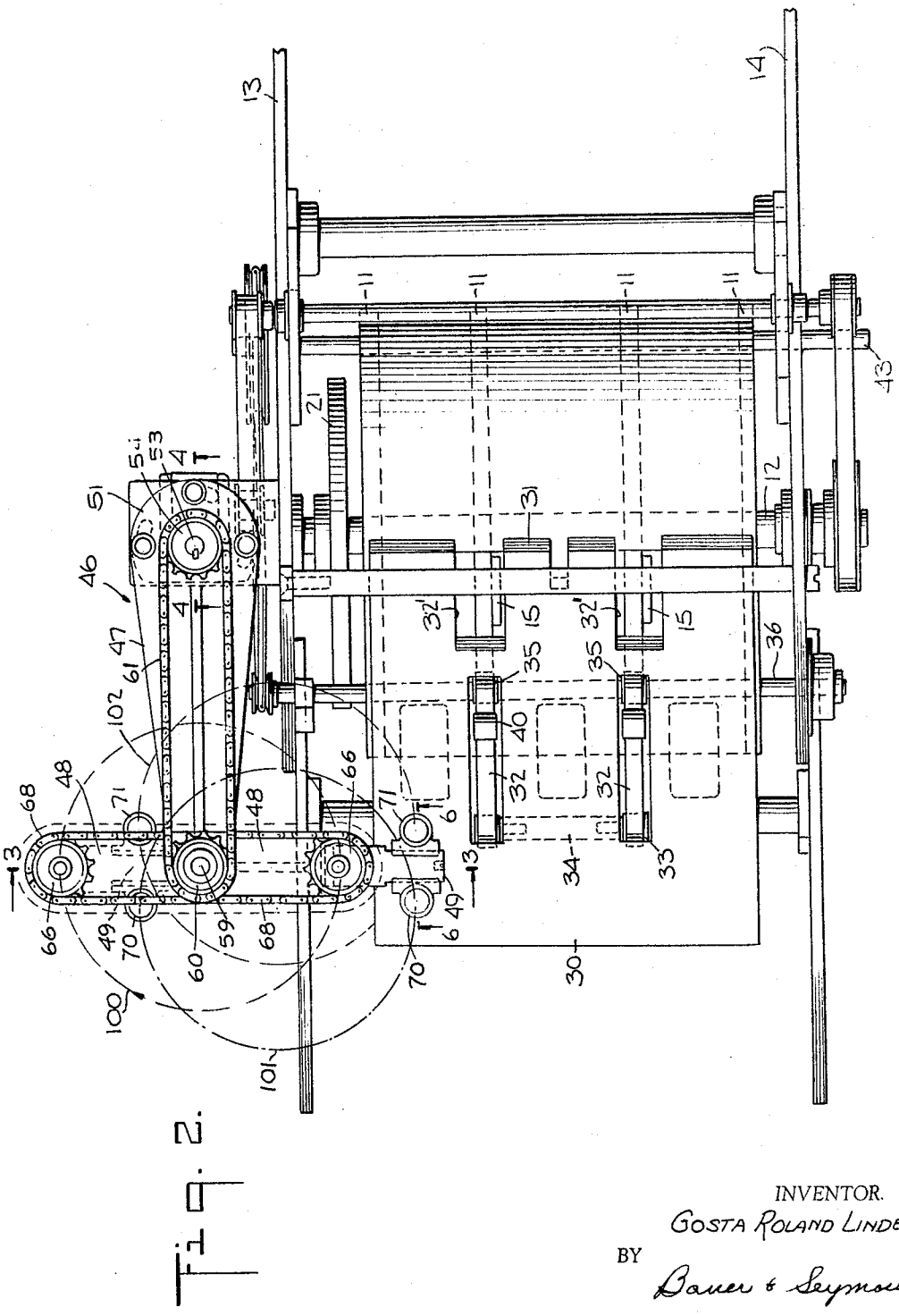

Fig. 2.

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SHEET HANDLING MECHANISM

Filed July 26, 1963 4 Sheets-Sheet 3

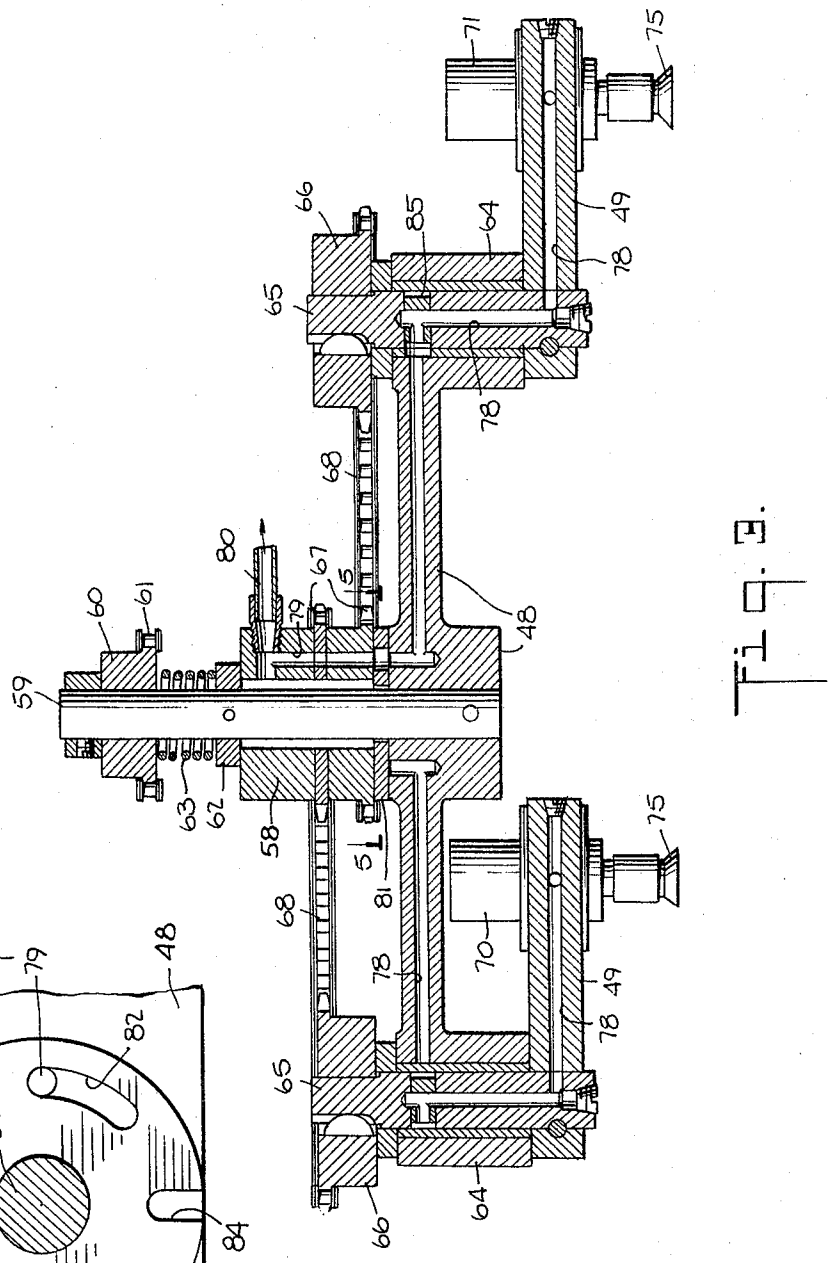

Fig. 3.

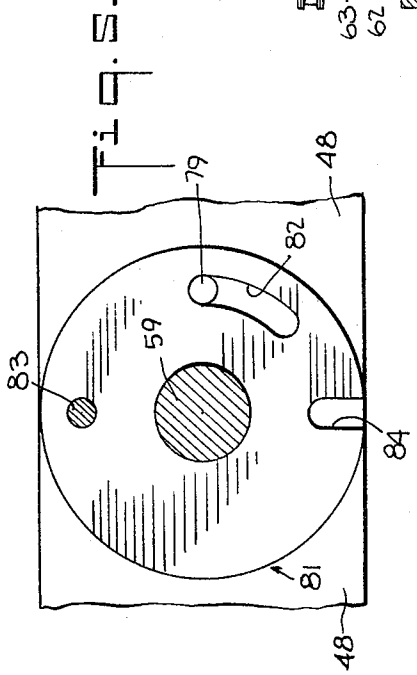

Fig. 4.

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Filed July 26, 1963 4 Sheets-Sheet 4

Fig. 6.

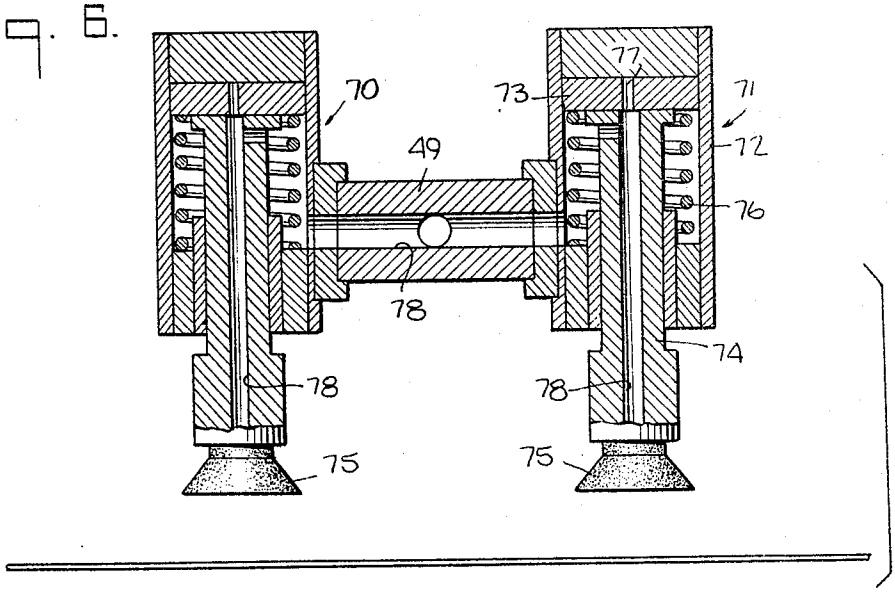
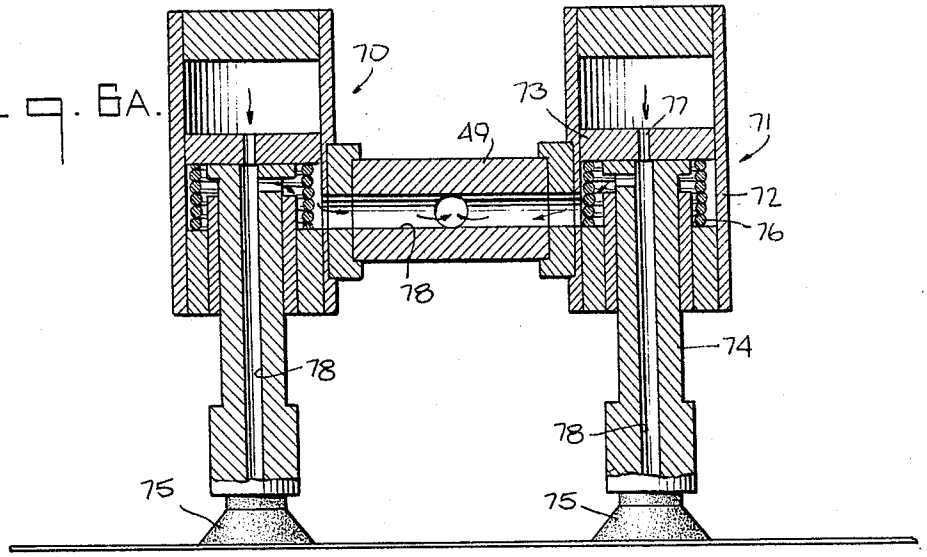


Fig. 6A.



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United States Patent Office 3,279,785 Patented Oct. 18, 1966

3,279,785

SHEET HANDLING MECHANISM

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Filed July 26, 1963, Ser. No. 297,932
15 Claims. (Cl. 271—5)

This invention relates to a sheet or signature handling apparatus and more particularly to an apparatus for changing the direction of the path of movement of a sheet or signature.

The making of books, pamphlets or the like involves the sequential assembling of a plurality of different signatures or sheets in a predetermined order. In the trade such sequential assembling of signatures or sheets is referred to as collating. A conventional signature collator consists of a series of horizontally aligned hoppers for holding similarly printed signatures or groups of signatures and a conveyor means moving in a horizontal plane beneath the hoppers. The conveyor usually has a series of spaced apart fingers each of which engages the rear edge of a signature so that the space between fingers constitutes a moving pocket to receive a signature from each hopper. Each hopper has a feed means co-ordinated with the conveyor so that a signature from each hopper is deposited into each conveyor pocket as it passes beneath the hoppers. The conveyor may be of the "saddle" type or the "flat gather" type. In the "saddle" type the signatures are opened into an inverted V shape and deposited onto the conveyor so that the leaves of the signature hang down on each side of the conveyor and the fold line is retained on the conveyor. Each succeeding signature is telescopically deposited onto the previously gathered signatures. In the "flat gatherer" type the signatures are fed into an inclined horizontally extending trough. The trough usually has a slotted area to permit the passage of the conveyor fingers. In this type the assembled signatures are stacked one on top of the other and are then fed to an appropriate binding apparatus. It is to the "flat gather" type of apparatus that the present invention is primarily directed. It is to be understood, however, that it can be adapted to other uses. In the present "flat gatherer" machines the signatures are fed into the conveyor trough in a path which extends at right angles to the trough. Such an arrangement requires that each signature must come to a stop in the trough and then be impelled in a path at right angles to its original path by the conveyor fingers. For some signature material the impact of the finger contacting its rear edge crumples the signature resulting in an unevenly stacked and damaged group of signatures. Also if the signature is fed into the trough at high speed the signature will be crumpled in a plane approximately parallel to its folded edge. Applicant's invention eliminates all of these difficulties by engaging each signature as it is being fed toward the conveyor, imparting the speed and direction of the conveyor to such engaged signature and releasing the signature in front of a conveyor finger while it is traveling at approximately the same speed as the finger.

It is therefore an object of this invention to provide a signature feeding means whereby signatures may be collated at speeds higher than heretofore possible.

Another object is to provide a novel signature feeding apparatus whereby signatures are deposited in a conveyor when the signature and the conveyor have the same direction and speed.

Another object is to provide a novel apparatus for engaging a signature being fed in a first direction, changing the direction of feed to a second direction which coincides with the path of movement of a receiving conveyor and then releasing the signature.

Another object is to provide a novel signature feeding apparatus which quickly and efficiently engages a fed signature and aligns its speed and direction to coincide with the speed and direction of movement of the conveyor.

Another object is to provide an apparatus to transfer signatures to a signature receiving conveyor whereby the signature is accelerated to substantially the same speed and direction of the conveyor before being deposited therein.

Another object is to provide a novel signature transfer mechanism having an improved receiving conveyor operable at a much faster speed than heretofore possible.

A still further object of the present invention is to provide means for rapidly and efficiently successively transferring an endless series of signatures to a receiving means while preventing interference between successively fed signatures.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

In the drawings in which like reference characters refer to like parts throughout the several views,

FIG. 1 is a side elevational view of the novel signature direction changing mechanism;

FIG. 2 is a top plan view, omitting the conveyor mechanism;

FIG. 3 is a cross-sectional view of the signature direction changing mechanism taken along line 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view, partly in section, of the driving mechanism for the signature direction changer, taken along the line 4–4 of FIG. 2;

FIG. 5 is a top plan view of the vacuum control valve which regulates the vacuum in the suckers for engaging a signature, taken along line 5–5 of FIG. 3;

FIG. 6 is an elevational, cross-sectional view of the vacuum operated signature engaging means, taken along line 6–6 of FIG. 2, and showing the signature engaging means in a non-operative position; and

FIG. 6*a* is a view the same as shown in FIG. 6, except the parts of the signature engaging means are shown in initial signature engaging position.

Referring now to the drawings, and particularly to FIGS. 1 and 2, there is shown a signature transfer means **10** composed of a plurality of parallel and spaced apart circular discs **11** secured for rotation on a horizontally extending shaft **12**. Shaft **12** is rotatably mounted between frame members **13** and **14** by means of suitable bearings in said frame member. The signature transfer means **10** is operatively associated with any conventional signature feeding means (not shown) whereby individual signatures are sequentially fed to the transfer means and from the transfer means to the forwarding mechanism comprising the present invention. Each signature is temporarily secured to discs **11** by any number of pairs of signature gripping means **15**. The signature gripping means **15** are of any conventional type whereby the folded edge of each sequentially fed signature is engaged during a partial revolution of the discs **11** and arranged to selectively release the folded edge of each signature at a predetermined position along the circumferential path of the circular discs **11** so that each signature is fed onto a receiving plate **30**. In the disclosed embodiment, four pairs of grippers **15** are used, each pair being positioned 90° from the adjacent pair, so that four signatures are fed onto plate **30** for one complete revolution of the discs **11**.

The signature receiving plate **30** is positioned between the frame members **13**, **14** by means of a bracket **38**

which in turn is secured to the frame supporting a conveyor 90. The plate 30 is mounted at an angle to a horizontal plane and its upper surface is tangent to the circumference of the discs 11. The end of plate 30 which is adjacent the discs 11 has a beveled surface 31 for facilitating the transfer of signatures from said discs 11 to said plate. This same end of the plate 30 also has inwardly extending slotted areas 32' to permit the free passage of the signature gripping means 15 upon rotation of the discs 11. A pair of conveyor belts 32 are mounted to plate 30. The upper reaches of the conveyor belts 32 extend through suitable openings in plate 30 and are positioned slightly above and parallel to the upper plane surface of the plate to insure contact with signatures passing over the plate. The conveyor belts 32 extend between pulleys 33 mounted on an idler shaft 34 and pulleys 35 mounted on a drive shaft 36. A conventional take-up pulley 37 adjusts the tension of each of the conveyor belts 32. A roller 40 is mounted to an arm 41 pivotally mounted to a support 42 positioned above each of the belts 32 for free rotation with the belts 32. Each of rollers 40 preferably is retained in contact with its respective belt 32 by means of gravity but if desired it can be spring-loaded to increase the pressure applied thereby. Each roller 40 is adjustably positioned to accommodate a variety of sheet lengths whereby the rear of each fed signature leaves the bite of rollers 40 and belt 32 at the moment that a signature direction changing mechanism (to be hereinafter described) engages the signature. It can thus be seen that by means of the belts 32 and the rollers 40 a signature fed onto the plate 30 will be driven forward under control of the belts 32 and the rollers 40. The shaft 36, and consequently belts 32, are driven through a series of pulleys and belts from the shaft 43 which drives the means (not shown) for feeding signatures to the discs 11.

The signature direction changing mechanism 46 comprises a stationary mounting arm 47, a rotating arm 48, and a revolving forwarder bracket 49 positioned at each end of the arm 48. The stationary mounting arm 47 has at one end a shaft housing 50 and a base plate 51 which is adjustably secured by means of a conventional slot and bolt arrangement to the top plate of a gear box 52. A shaft 53 is vertically mounted in the gear box 52 and extends through the shaft housing 50. A sprocket 54 is keyed to the upper end of shaft 53 and a gear 55 is keyed to the shaft 53 within the gear box 52. A worm gear 56 which meshes with gear 55 is mounted on a shaft 57 which has its ends mounted in suitable bearings. Shaft 57 is driven from shaft 12 which also drives the discs 11. A second shaft housing 58 is positioned at the opposite end of the stationary arm 47 and has a shaft 59 rotatably mounted therein. The lower end of shaft 59 is secured to the rotating arm 48 and a sprocket 60 is secured to the upper end of said shaft. A chain 61 operatively connects sprockets 54 and 60. A thrust washer 62 is keyed to shaft 59 adjacent the top surface of the shaft housing 58. A spring 63 is telescopically mounted over shaft 59 between the sprocket 60 and the thrust washer 62 and serves to retain the arm 48 in sliding rotational engagement with a vacuum valve 81 secured to the bottom surface of the housing 58. A shaft housing 64 is positioned at each end of the arm 48. Each of the housings 64 rotatably receives a shaft 65. One end of a revolving forwarding bracket 49 is secured to the lower end of each shaft 65 and a sprocket 66 is secured to the upper end of each shaft 65. A pair of sprockets 67 are secured to the shaft housing 58 in a vertically spaced apart and stationary position as shown in FIG. 3. Chains 68 operatively connect each of the sprockets 67 with its corresponding sprocket 66 so that upon rotation of the arm 48 in a clockwise direction as shown in FIG. 2 each of the forwarder brackets 49 will be rotated in a counterclockwise direction about its housing 64. At the outer end of each of the forwarder brackets 49 there is positioned a pair of vacuum operated signature engaging means 70, 71. Each of the vacuum signature engaging means 70, 71 comprises a cylinder 72, a piston 73, a piston rod 74 and a sucker 75 secured to the outer end of the piston rod 74. A spring 76 is telescopically mounted over the piston rod 74 between the piston 73 and the lower end of cylinder 72. Spring 76 normally retains the piston 73 upwardly against the top end of the cylinder 72. A passage 77 in piston 73 connects the space above the piston with the vacuum duct 78 within the rod 74. Vacuum is supplied to the suckers 75 by means of a duct 78 which extends through the piston rod 74, through the bracket 49 and through the arm 48 as shown in FIG. 3. A vacuum duct 79 formed within housing 58 is connected to a pipe 80 which in turn is connected to a source of vacuum (not shown). A vacuum valve 81 made of graphite or other self-lubricating material is secured to the lower end of the housing 58. An arcuately shaped chamber 82 is formed in the valve 81 and is held in stationary alignment with the end of vacuum duct 79 by means of a pin 83. A vent 84 provides an opening to the atmosphere. Upon rotation of the arm 48 the duct 78 will periodically be in alignment with the chamber 82 for an arcuate movement of approximately 70° at which time the source of vacuum will be connected to the suckers 75 at one end of the arm 48 and its bracket 49. The shaft 65 adjacent the interconnection of the duct 78 within the shaft 65 and the duct 78 within the arm 48 is chambered at 85 to permit a continuous interconnection between the ducts within the shaft 65 and the duct within the arm 48 regardless of the rotational movement of the shaft. As shown in FIG. 6 when no vacuum is supplied to the suckers 75 they are retained by means of spring 76 in their upward position. When, however, the vacuum is created within the duct 78 and when no signature is sealed into sucker 75 a suction is created on the underside of the piston 73 of a sufficient magnitude to overcome the resistance of spring 76 thus pulling the piston 73 and consequently its suckers 75 downwardly until the suckers 75 contact a signature being advanced by the conveyor belts 32. As soon as the signature is sealed onto the suckers 75 a suction is created at the top surface of each piston 73 of sufficient magnitude to overcome the vacuum on the underside of the piston so that the piston 73 is moved upwardly by a combination of the force of spring 76 and the vacuum on top of the piston. Thus, an edge of each signature is raised as soon as the suckers contact the signature. Not only does this raising of the suckers 75 and the sheet prevent a rubbing contact with plate 30 but it raises the edge of the signature which will be the leading edge in its new direction which prevents any interference with the trailing edge of the previously fed signature moving in its new direction.

As shown in FIG. 2 the circle 100 represents the path of movement, in a clockwise direction, of the shafts 65 in the ends of arm 48 upon the rotation of arm 48. Any point on arm 49 will move in a path similar to path 100 but about a new center. Likewise, circle 101 represents the path of movement, in a clockwise direction, of the center of sucker 75 on each of the vacuum signature engaging means 70. Circle 102 represents the path of movement, in a clockwise direction, of the center of sucker 75 on each of the vacuum signature engaging means 71. It can therefore be seen that the longitudinal axes of the arms 49 always remain parallel to each other so that the suckers on the signature engaging means 70, 71 move together through paths 101, 102 respectively. The velocity of shafts 65 in path 100 is such that the velocity of suckers 75 in paths 101 and 102 is the same as the velocity of a signature being fed along plate 30. At the point of engagement of suckers 75 with a fed sheet the axis of arm 48 is in substantially longitudinal alignment with the axis of one of the arms 49 and the path of movement of each of the suckers 75 thereon is approximately tangent

to the path of movement of a fed sheet. At this point the sheet is being fed at the same speed and in the same direction as the suckers so that there is no relative movement between the suckers and the fed sheet. The vacuum valve **81** is positioned on housing **58** in such a manner that vacuum is supplied to the suckers at approximately the time that the path of suckers **75** and the path of the fed sheet are tangent as described above.

After the fed signature is engaged by the suckers **75** on each of the signature engaging means **70, 71** it moves with and is under the control of these suckers and can be released at any point desired in the path of movement of the suckers. It is desirable that this point of discharge be approximately the point of tangency of the path of movement of the suckers and the path of movement of the signature receiving means. In the disclosed embodiment the discharge point is shown as being 90°, in the path of movement of the suckers, from the point of sheet engagement because the longitudinal axis of conveyor **90** is disclosed as being 90° from the longitudinal axis of the sheet feed plate **30**. At the discharge point the vacuum duct **78** is positioned in alignment with the vent **84** of the valve **81** so that the signature is released from the suckers **75**. It is to be understood, however, that the point of discharge may vary depending upon the location of the signature receiving means in relation to the sheet feed means.

A gathering conveyor **90** comprises an end wall **91** and an adjacent horizontal bottom plate **92** and an inclined bottom plate **93** spaced from bottom plate **92** a sufficient distance to permit the passage of fingers **94** secured to chain **95** of conveyor **90**. End wall **91** and bottom plates **92, 93** extend horizontally at approximately 90° from the signature transfer means. Conveyor chain **95** is driven by a sprocket **96** and shaft **97**. Shaft **97** is in turn driven from shafts **43** and **36** by means of conventional belt and pulley mechanisms. Due to the fact that each signature is moving at approximately the same speed and in the same direction as the conveyor when it is deposited into the conveyor, the distance between the fingers **94** on the conveyor is reduced to practically the width of the signature travelling in its new direction.

Various widths and lengths of signatures or sheets may be accommodated on the above-described direction changing apparatus. Variations in the width of signatures fed into the described apparatus is compensated by having the arm **47** secured to the top of the gear box **52** by means of the above-described conventional slot and bolt arrangement. Thus the arm **47**, and the signature direction changing means, can be moved toward or away from the path of signatures being fed from the signature transfer means **10**. Compensation for a different length of fed signature is accomplished by movement of the roller **40**, as above described, so that the trailing end of each fed signature leaves the bite between rollers **40** and belts **32** at the time the suckers **75** engage the signature. Adjustments in the timing of the operation of the suckers **75** are accomplished by rotation of the vacuum valve on the lower end of housing **58**.

The operation of the apparatus constructed in accordance with the present invention will be clearly understood from the foregoing description, and while said description and the accompanying drawings set forth with more or less particularity one embodiment of the invention, it is to be expressly understood that said invention is not limited to said embodiment. For example, said invention is not confined to changing the direction of signatures but may equally be used on sheets of paper and other sheet materials. Also the invention is not confined to the type of conveyor into which the signatures are deposited after having undergone a direction change nor is the invention to be construed as being limited to use with a collating apparatus. Various other changes may be made in the design and arrangement of the parts illustrated, as well as in the mode of operation and manner of use, without departing from the spirit and scope of the invention, as will now be clear to those skilled in the art.

What is claimed is:

1. The method of handling sheets mechanically which comprises the steps of laterally conveying a sheet edgewise in a first direction at a predetermined speed in the plane of the broad surface of the sheet, engaging the sheet with gripper means while the sheet is moving in said first direction at said speed and, without changing the orientation of said sheet, conveying the same in an arcuate path in said plane, thereby progressively decreasing the speed of the sheet in said first direction and progressively increasing the speed thereof in a second direction perpendicular to said first direction, and releasing said sheet at a predetermined position along said arcuate path.

2. The method of handling sheets as defined in claim **1**, wherein the sheet is conveyed along said arcuate path at a speed equal to said first speed.

3. The method of handling sheets as defined in claim **1**, wherein the sheet is released onto continuously operating conveyor means for moving the sheet in a direction tangent to said arcuate path.

4. The method of handling sheets as defined in claim **1**, wherein the sheet is released onto continuously operating conveyor means for moving the sheet in said second direction at a speed approximately equal to the speed of the sheet in said second direction at the moment of release.

5. The method of handling sheets as defined in claim **4**, wherein the sheet is released when its speed in said second direction is equal to said first speed.

6. The method of handling sheets as defined in claim **1**, wherein the sheet is engaged by suction gripper means while moving in said first direction.

7. Sheet handling apparatus comprising means for feeding sheets successively one at a time edgewise in a first direction at a predetermined speed and generally in the plane of the broad surface of the sheet, continuously operating conveyor means for moving said sheets in a different direction, and transfer means operating continuously at said predetermined speed for engaging each said sheet while it is moving in said first direction at said speed and transferring the same onto said conveyor means without changing the orientation of the sheet with respect to an axis perpendicular to said broad surface thereof.

8. Sheet handling apparatus comprising means for feeding sheets successively one at a time edgewise in a first direction at a predetermined speed, continuously operating conveyor means for moving said sheets in a different direction, and transfer means operating continuously at said predetermined speed for engaging each said sheet while it is moving in said first direction at said speed while it is moving in said first direction at said speed and transferring the same onto said conveyor means, said transfer means comprising first and second parallel rotatable shafts, said first shaft being supported by said second shaft, a fixed sprocket wheel concentric with said second shaft, a sprocket wheel secured to said first shaft, a chain drivably connecting said sprocket wheels, and means carried by said first shaft for gripping said sheets.

9. Sheet handling apparatus comprising means for feeding sheets successively one at a time edgewise in a first direction at a predetermined speed, continuously operating conveyor means for moving said sheets in a different direction, and transfer means operating continuously at said predetermined speed for engaging each said sheet while it is moving in said first direction at said speed and transferring the same onto said conveyor means, said transfer means comprising a fixed support, a first shaft rotatably mounted on said support, means for rotating said first shaft, an arm secured to and extending laterally from said first shaft for rotation therewith, a second shaft rotatably supported by said arm eccentric to said first shaft, sheet gripping means, a support for said gripping means carried by said second shaft, a sprocket wheel fixedly mounted

on said fixed support concentric with said first shaft, a sprocket wheel secured to and concentric with said second shaft, and an endless chain meshing with and operatively connecting said sprocket wheels, whereby upon rotation of said first shaft in one direction relative to said fixed support said second shaft is rotated in the opposite direction relative to said arm.

10. Sheet transfer apparatus comprising a fixed support, a first shaft rotatably supported by said support, means for rotating said first shaft, an arm secured to and extending laterally from said first shaft for rotation therewith, a second shaft rotatably supported by said arm eccentric to said first shaft, sheet gripper means, support means for said gripper means carried by said second shaft, a sprocket wheel fixedly mounted on said fixed support concentric with said first shaft, a sprocket wheel secured to and concentric with said second shaft, and an endless chain meshing with and operatively connecting said sprocket wheels, whereby upon rotation of said first shaft in one direction relative to said fixed support said second shaft is rotated in the opposite direction relative to said arm.

11. Sheet transfer apparatus as defined in claim **10**, wherein said sprocket wheels have equal diameters.

12. Sheet transfer apparatus as defined in claim **10**, wherein said fixed support is mounted for angular adjustment about an axis spaced from and parallel to the axis of said first shaft.

13. Sheet transfer apparatus as defined in claim **10**, wherein said sheet gripper means comprise suction cups engageable with the sheets.

14. Sheet transfer apparatus as defined in claim **13** comprising connecting means including passages in said supports arm and second shaft for connecting the suction cup gripper means to a source of vacuum.

15. Sheet transfer apparatus as defined in claim **14**, wherein said connecting means includes valve means interposed between said fixed support and said arm for alternately connecting said suction cup gripper means to said source of vacuum and to atmosphere through said passages.

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