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(56) Documents cited

EP 0027341	GB 1449390
EP 0027045	EP A 0078712
GB A 2055085	GB A 2126996
GB A 2042480	GB A 2109352
GB A 2040886	

(58) Field of search
B8R

(54) Compact High-Speed Sheet Feeder

(57) A compact high-speed sheet feeder, for interfacing with the infeed conveyor of a processing apparatus, such as a printer, sorter, collator or duplicator, comprises a tray (20) for receiving a stack of sheets, an endless belt drive belt (50) having openings (54) for cooperation with holes 52 in vacuum plenum (48) (not shown) contacting the bottom sheet of the stack and, with the aid of the vacuum plenum separating and driving the bottom sheet to a pair of opposed, adjustable separator rollers)62, 64) disposed one above the other and arranged to prevent passage of more than one sheet at a time. The sheet, after passage through the separator rollers (64), is fed to opposed spaced pairs of feed rollers (84) and then deflected onto the infeed conveyor or a processing apparatus. A detecting mechanism detects the passage of more than one sheet at a time.

FIG. 2

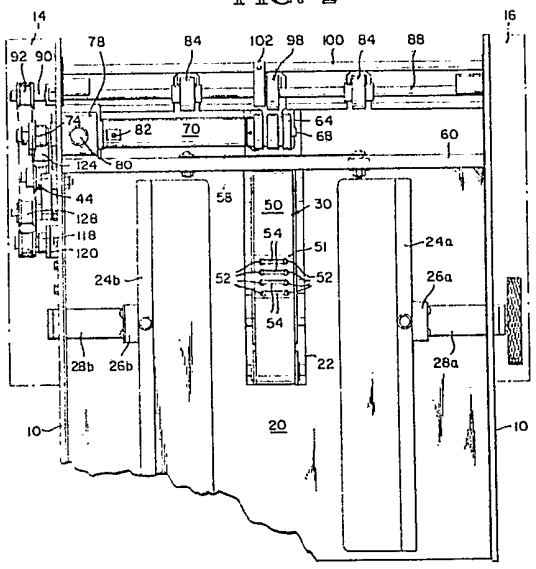

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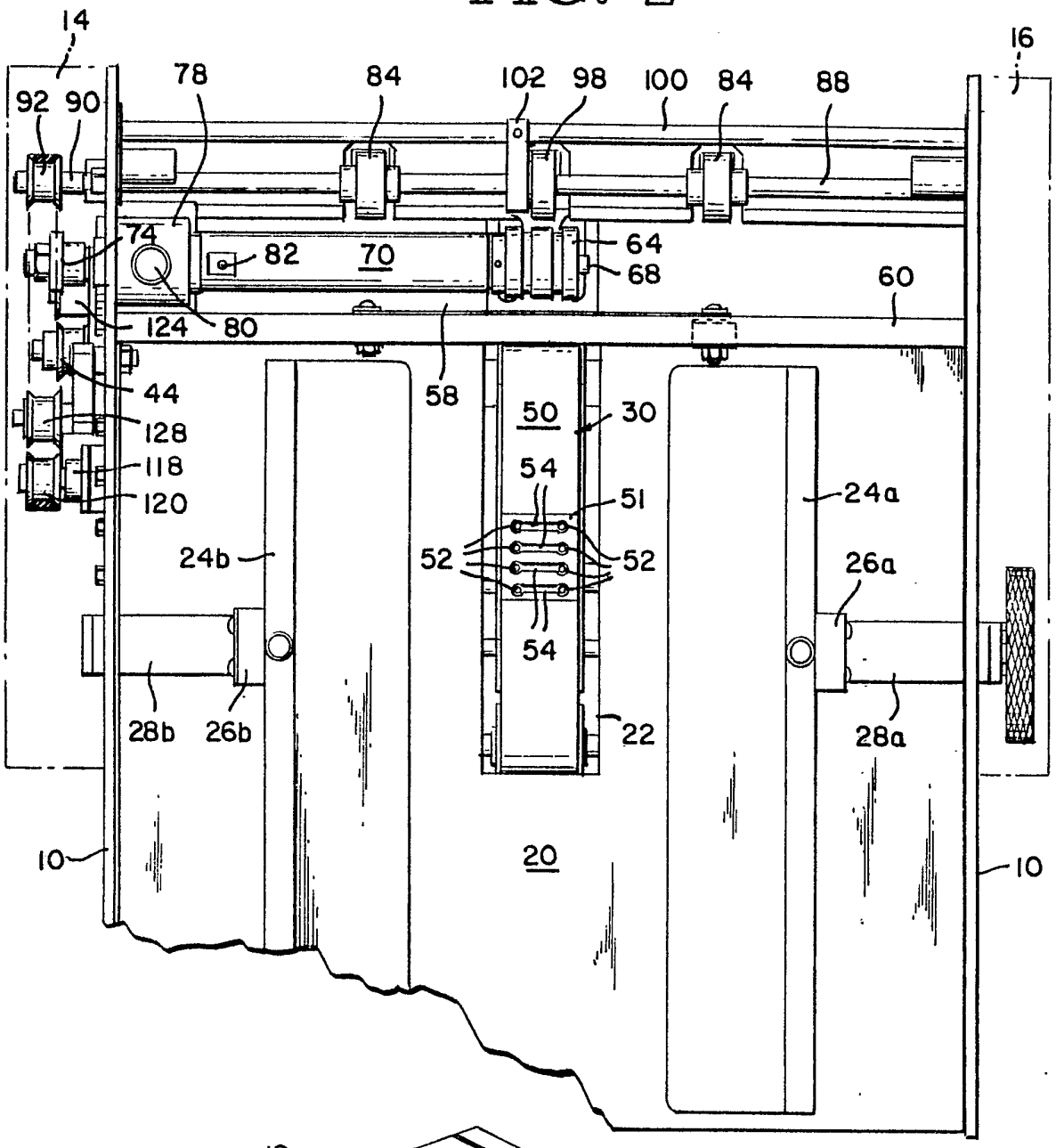
FIG. 2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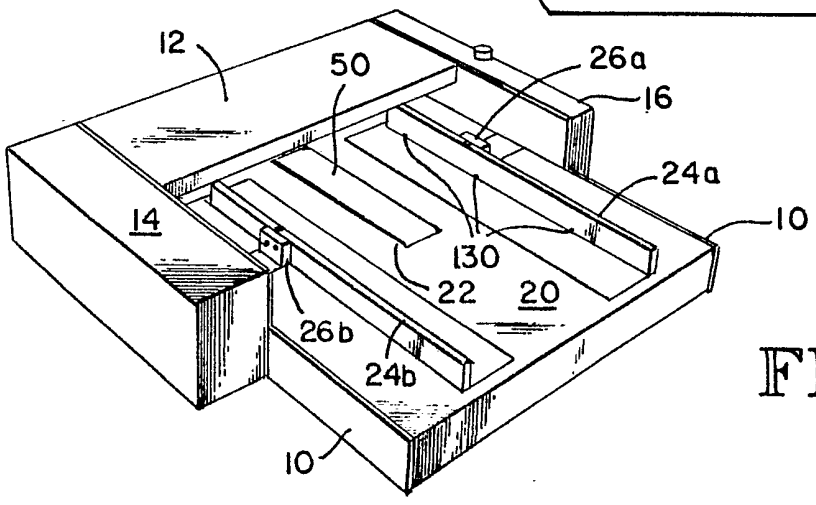
50
30
128
54
118
51
120
24a
24b
52
52
26a
54
28b
26b
22
28a
10
20
10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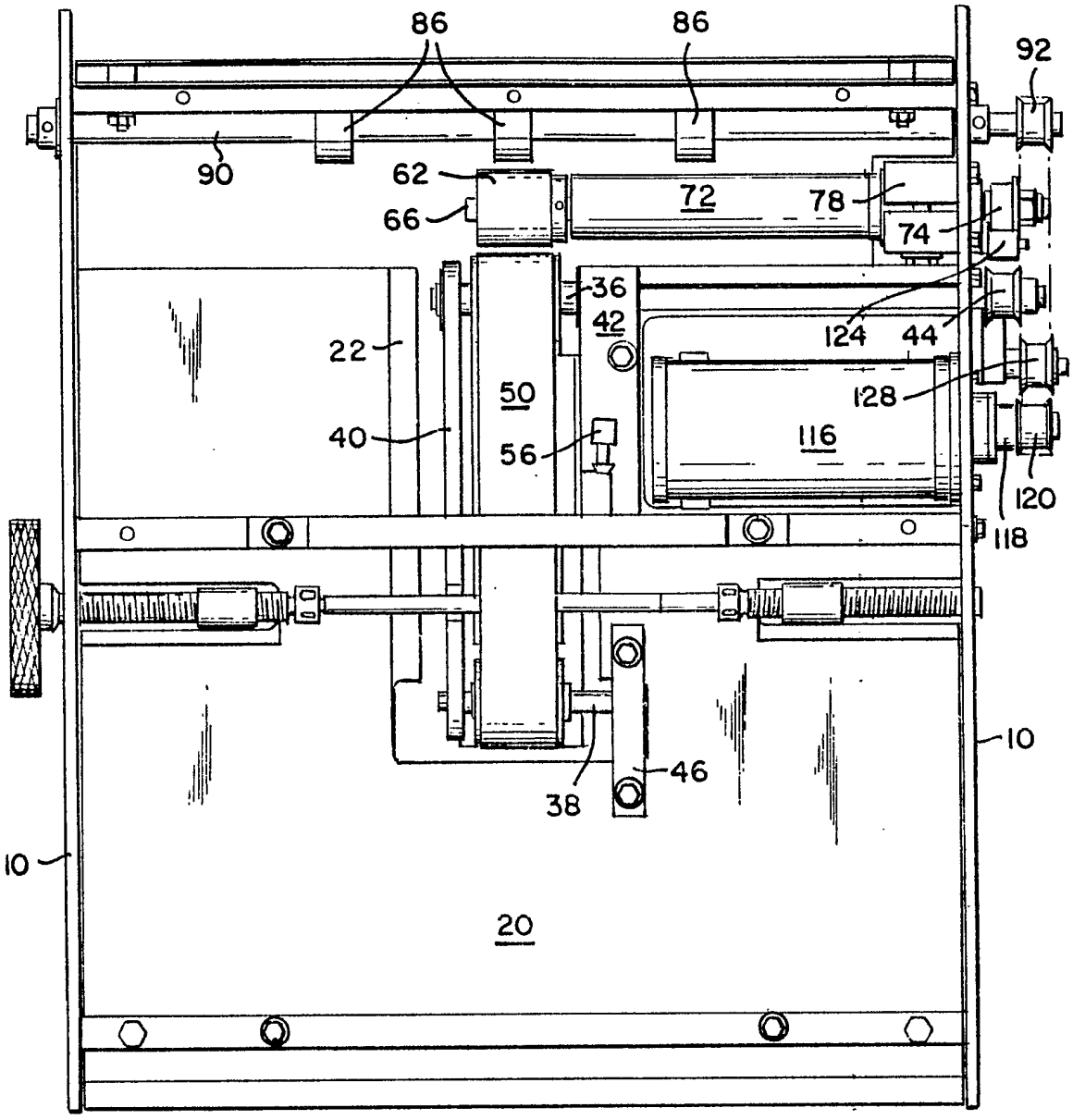
50
26a
16
24a
14
10
130
22
20
26b
24b
10

FIG. 1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10
46
38
10
20

FIG. 3

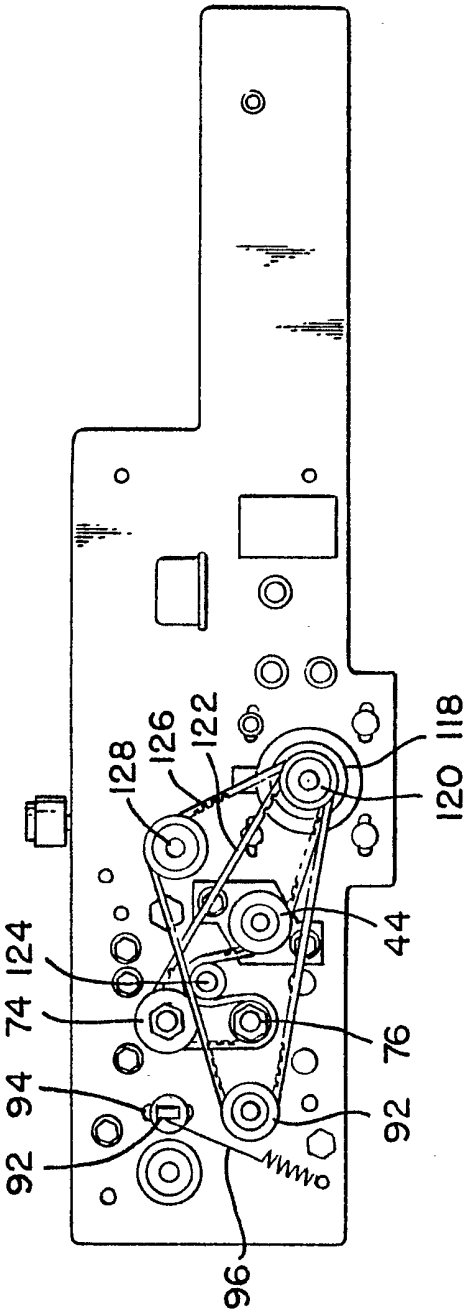
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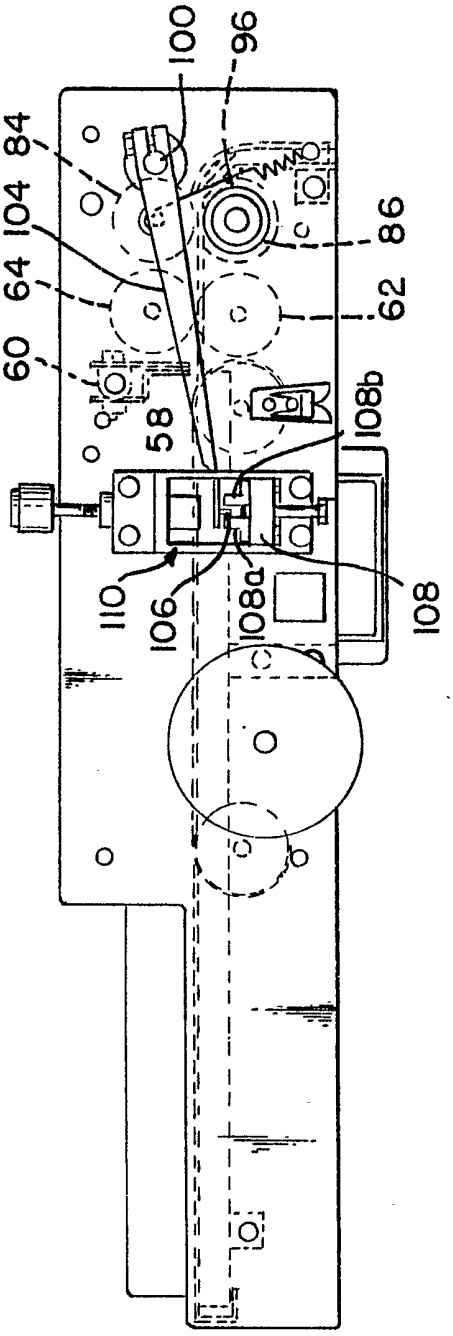
FIG. 4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60
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62
108b
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106
108a
108

FIG. 5

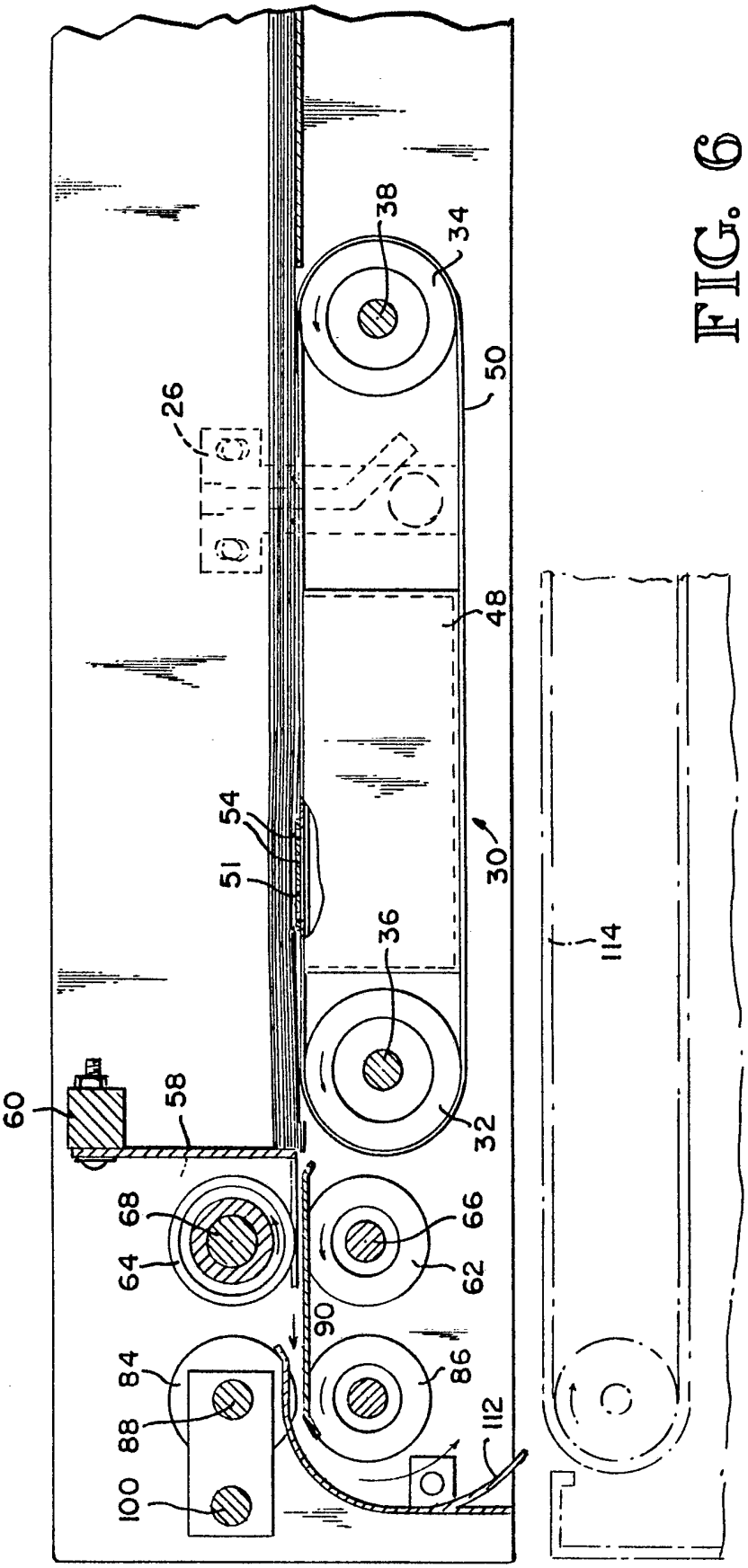

FIG. 6

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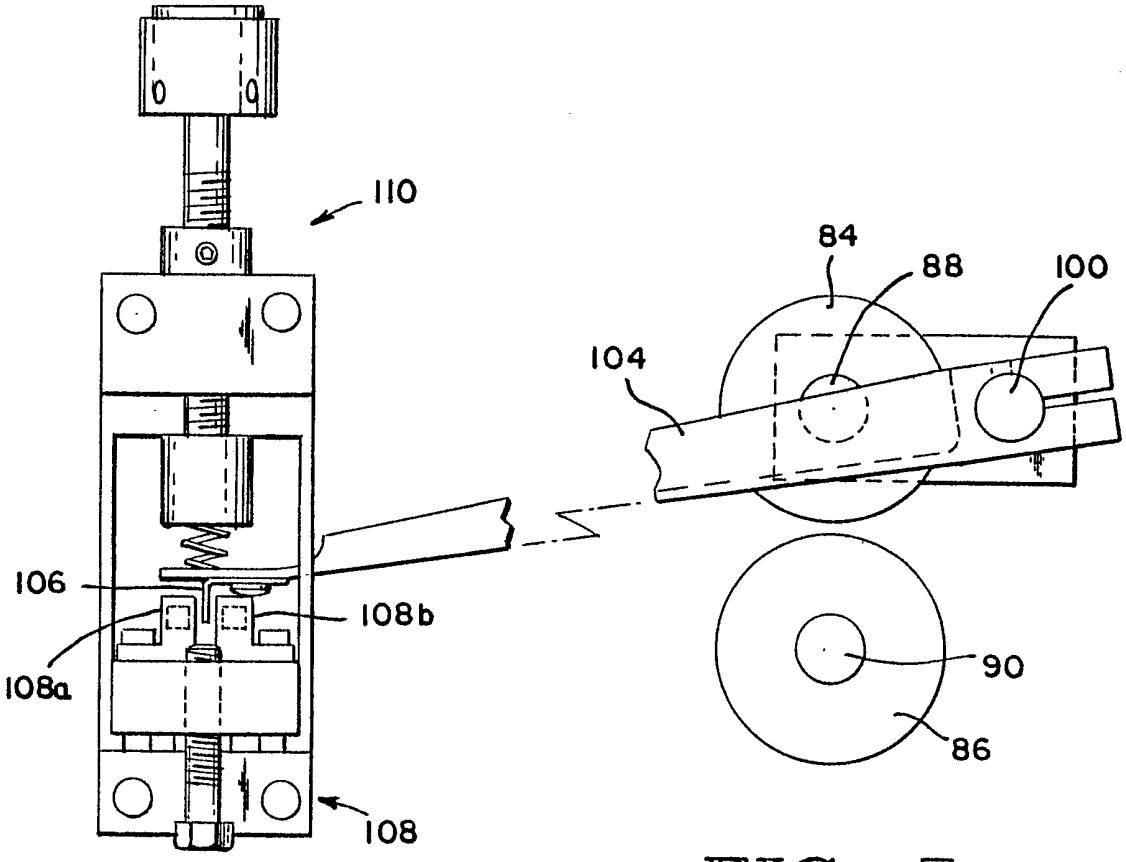

FIG. 7

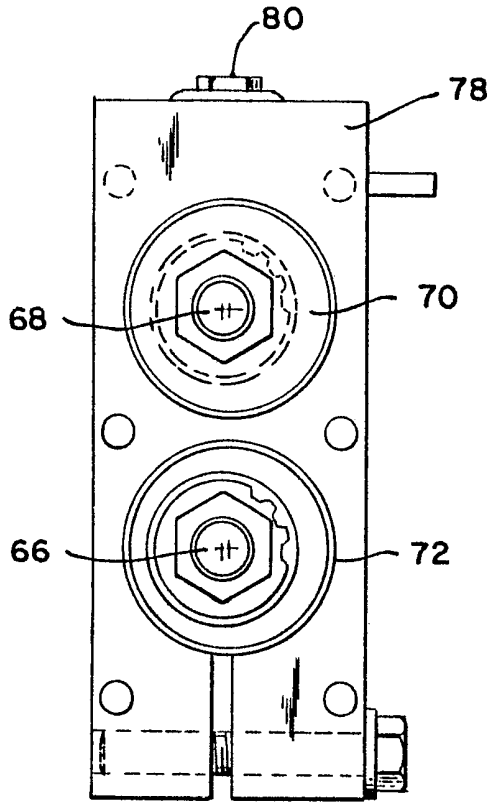

FIG. 8

SPECIFICATION

Compact High-speed Sheet Feeder

Technical Field

The present invention relates to a compact, lightweight, high-speed sheet feeder interfacing with the infeed conveying mechanism of a collator, sorter or other processing apparatus for conveying single sheets from the bottom of a stack of sheets onto the conveying mechanism of the collator, sorter or other processing apparatus.

Background Art

Sheet feeders for feeding sheets from the bottom of a stack of sheets are known. See, for example, the sheet feeder disclosed in U.S. Patent No. 3,385,593. Such feeders occupy a greater amount of floorspace, are less efficient and not capable of feeding single sheets at the high speeds needed. The feeder of this invention almost nearly always accomplishes separation of single sheets and can feed sheets at speeds of up to 10 sheets per second.

Disclosure of Invention

The compact, lightweight, high-speed feeder of this invention separates sheets from a stack and conveys the individual sheets to other processing apparatus, such as a collator, sorter, printer, etc. A stack of sheets is placed on a receiving tray. Individual sheets from the bottom of the stack are driven forward by an endless belt having a raised pad area which contacts the lower sheet of the stack with each revolution and which works in conjunction with a vacuum. Separating rollers downstream from the endless belt isolate a single sheet to be fed. Once separated, the sheet is conveyed through a detector sensing pasage of more than a single sheet and feed rollers for conveying the sheet to an additional processing apparatus.

A preferred embodiment of this invention utilizes an endless rubber belt having a raised pad area provided with slots therein which pass over openings in a plenum maintained under partial vacuum, the raised pad area contacting the bottom sheet of the stack of sheets on each revolution. As the belt revolves, the pad area with the slots therein passes over openings in the vacuum plenum, which sucks the lower sheet of the stack to the belt. The lower sheet is driven forwardly by the belt to a pair of separator rollers, the upper roller of which rotates in a direction opposite the direction of travel of the paper sheet. The sheet is driven forwardly by the bottom separator roller, while other sheets above the bottom sheet are driven rearwardly by the top separator roller. By properly adjusting the distance between the upper and lower separator rollers, separation and isolation of single sheets are accomplished at speeds of 20,000 to 30,000 sheets per hour. Once isolated, the individual sheets are fed through feed rollers which convey the sheet to other suitable conveying apparatus.

Brief Description of the Drawings

Fig. 1 is a perspective view of the sheet feeder of this invention;

Fig. 2 is a top view of the feeder, with the cover plates removed, showing the drive mechanism and the sheet feed mechanism;

Fig. 3 is a bottom view of the sheet feeder;

Fig. 4 is a left side view of the feeder, illustrating the drive mechanism;

Fig. 5 is a right side view of the feeder, illustrating the doubles-detecting mechanism;

Fig. 6 is a vertical cross-sectional view of a portion of the sheet feeder illustrating the endless drive belt, barrier plate, separating rollers and feed rollers.

Fig. 7 is a partial view of the assembly for detecting passage of more than one sheet at a time; and

Fig. 8 is a right side view of the mounting block for the separator rollers.

Best Mode for Carrying Out the Invention

The feeder of this invention is designed to be placed over any horizontally oriented conveying mechanism for conveying sheets to a collator, sorter, printer, duplicator or other processing apparatus. The feeder feeds individual sheets from a stack of sheets placed in the receiver tray of the feeder, inverts them, and deposits them on the conveyor for the collator, sorter or other processing apparatus. The sheet feeder works at very high speeds, is lightweight, compact, quiet and energy efficient.

As illustrated in Fig. 1, the sheet feeder includes spaced frame supports 10 between which a receiver tray 20 is mounted. An endless belt having a raised pad thereon contacts the bottom sheet of the stack of sheets placed on the receiver tray and feeds the sheets one at a time to a collator, sorter, printer or other processing apparatus. The separator and feed rollers of the feeder are covered by a cover plate 12 hinged at one end. The drive mechanism and double-detector mechanism for detecting passage of more than one sheet are protected by cover plates 14 and 16.

The receiver tray 20 is of a thin-gauge, lightweight metal and includes a central slot 22 within which is received an endless belt assembly 30. The receiver tray includes a pair of laterally adjustable paper guides 24a and 24b connected to respective mounting blocks 26a and 28b, which ride in slots 28a and 28b, respectively.

Referring to Figs. 3 and 6, the endless belt assembly is comprised of spaced rollers 32 and 34, each of which is journaled on respective shafts 36 and 38. The shaft 36 of forward roller 32 is journaled for rotation at one end to support plate 40, extends through mounting block 42 and through bearings in frame support 10 of the feeder. A pulley 44 is secured to the end of the shaft as illustrated in Fig. 3. The rear shaft 38 is journaled for rotation at one end to support plate 40 and at the other end in mounting block 46. A vacuum plenum 48 (see Fig. 6) is positioned

intermediate the front and rear rollers 32 and 34. The upper surface of the plenum, in contact with an endless belt 50 trained about the spaced rollers 32 and 34, has spaced openings 52 (see Fig. 2) therein which mate with corresponding slots 54 in a raised pad portion 52 secured to the belt, as illustrated in Fig. 2. The rollers 32, 34 and belt 52 are adjusted so that the upper run of the belt is just below the upper surface of the receiving tray and the pad is above the upper surface of the tray to make contact with the bottom sheet of the stack. Referring to Fig. 3, a connector 56 in mounting block 42 is connected to the chamber of plenum 48 and to a source of vacuum for pulling a vacuum within the chamber of the plenum. As the slots 54 of the raised pad 51 of the belt 50 pass over the openings 52 in the plenum 48, a suction is created to adhere the bottom sheet in the receiving tray against the pad 51 to transfer it forward of the remaining sheets. If desired, a thin sheet of Mylar may be placed across the rear half of the slot 22 in the receiving tray to prevent contact of the raised pad 51 with the bottom sheet until about the position illustrated in Fig. 2.

Referring to Fig. 6, a plate 58, loosely attached at its upper end to support 60, extends downwardly toward the receiving tray 20 and rests on the lower roller of the separator rollers (to be described). The plate may be L-shaped, as indicated in Fig. 6, with forward portions extending in the longitudinal grooves of the upper separator roller. The loose mounting of plate 58 allows as few sheets as possible to be exposed to the upper separator roller.

The lowermost sheet, driven forward by the endless belt 50, engages an opposed pair of separator rollers 62 and 64, which are spaced apart a predetermined distance to allow isolation of a single sheet. The lower roller 62 is rotated in the same direction as the travel of the endless belt 50 and contacts sheets brought forward by the endless belt. The lower roller 62 is mounted for rotation on shaft 66 and is preferably coated with a urethane coating to ensure better contact of the separating roller with the paper sheet. The upper separator roller 64 is mounted for rotation to shaft 68 and is preferably coated with a urethane or silicone rubber coating of lesser durometer than the lower roller 62. The upper roller 64 is rotated in a clockwise direction so as to impart a backward thrust to any sheets which may pass beneath plate 58 and contact the roller. Both the upper and lower shafts 66 and 68 extend through roller hub assemblies 70 and 72 (see Figs. 2 and 3) and through the frame support 10. Pulleys 74 and 76 are mounted on the respective ends (see Fig. 2) of the shafts 66 and 68. The hub assemblies 70 and 72 of the upper and lower separator rollers are adjustably and eccentrically mounted in openings in mounting block 78 (see Fig. 8). The eccentric mounting of these hub assemblies allows adjustment of the distance between the separator rollers. The lower roller and hub assembly 72 are adjusted and fixed in relation to sheets coming from the endless belt 50. The upper roller 64 and hub assembly 70 are manually adjustable by rotation of the hub assembly within the mounting block 78. Belleville washers are pressed against the hub assembly 70 by a set screw 80 threaded into an opening in mounting block 78. Rotation of the hub assembly 70 can be effected by securing a handle to an upstanding post 82 mounted on the hub assembly 70. The distance between the spaced separator rollers is adjusted to allow only a single sheet to pass through the separator rollers. It is generally necessary to adjust the separator rollers for different weights of paper.

Downstream from the separator rollers are a pair of opposed feed rollers 84 and 86 (see Figs. 2, 3 and 6). These rollers are mounted at spaced intervals on shafts 88 and 90, respectively. It is preferable to coat the upper rollers with a urethane coating. The lower rollers are preferably stainless steel. The shaft of the lower roller extends through suitable bearings in the frame support 10, as illustrated in Fig. 3, and has a pulley 92 mounted on one end, the opposite end journaled in the opposite frame support 10. The upper feed roller is not driven. Shaft 88, on which the rollers 84 are mounted, extends through vertically slotted openings 94 in the frame upper rollers 84 into contact with the lower rollers one end to the frame support 10 and at the other end to the respective ends of shaft 92, bias the upper rollers 84 into contact with the lowe rollers 86. Midway between the upper rollers is a mechanism for sensing passage of more than a single sheet through the feed rollers. The sensing means includes a roller 98 mounted for rotation about shaft 88. Referring to Figs. 2, 5 and 7, a shaft 100, its respective ends journaled for rotation in frame supports 10, includes a linking member 102 secured to shaft 100 at one end and to shaft 88 at the other end in a manner allowing shaft 88 to freely rotate. An arm 104 is secured at one of its ends to one end of the shaft 100 extending through the frame support 10 (see Figs. 5 and 7). A downwardly extending finger 106 is secured to the other end of the arm. The finger 106 extends between the arms of a sensing mechanism mounted in a mounting block 108. One arm 108a of the mounting block houses a light source and the other arm 108b a photodetector. The finger 106, when extended between the arms of the mounting block, interrupts the light beam passing between the light source and the photodetector. In contact with the arm 104 is an adjustable screw assembly 110. The adjustable screw assembly is set so that a spring-loaded plate contacts the end of the arm with sufficient pressure to push the finger 106 of the arm 104 between the photodetector and light source to interrupt the light beam. If more than a single sheet passes the feed rollers, the extra thickness will cause roller 98, shaft 88 and link 92 to move upwardly, causing shaft 100 to rotate sufficiently to lift finger 106 from between the detector and light source, causing an electrical

signal to be passed to the collator, sorter, printer or the operator to indicate that more than a single sheet has passed that point. The signal may be used to shut down the feeder, operate a mechanism to direct the double-fed sheet to a proof tray, or merely notify the operator of passage of a double sheet.

After leaving the feed rollers 84 and 86, the sheet contacts a curved deflector plate 112 which deflects the sheet from 90—180° to deposit the sheet on an infeed sheet conveyor 114 of a collator, sorter, printer, duplicator or other processing apparatus. The sheet feeder is positioned immediately above the sheet conveyor 114. If necessary, spaced supports (not shown) may be used to support the feeder above the sheet conveyor 114.

Drive Mechanism

As illustrated in Figs. 3 and 4, the feeder is driven by a DC electric motor 114 mounted beneath the receiver tray 20. The output shaft 116 of the motor has pulleys 120 mounted thereon. The inner pulley 118 is connected to a clutch assembly attached to the output shaft 116 so that the endless belt 50 can be stopped apart from the feed rollers. One endless belt 122 is trained about inner pulley 118, pulleys 74 and 76 of the separating rollers, idler pulley 124 and pulley 44 for driving the endless belt. The other belt 126 is trained about the outer pulley 120, pulley 92 of the feed rollers, and idler pulley 128. These two belts drive the separating rollers and the feed rollers in the proper direction, such as driving the upper separator roller in a counterclockwise direction.

Vacuum and Compressed Air Systems

A vacuum pump must be provided to pull a vacuum within the chamber of the plenum located between the spaced rollers of the endless belt drive. A vacuum line (not shown) connects to the connector 56 in the mounting block 42 (see Fig. 3).

As illustrated in Fig. 2 and as described in Patent No. 3,385,983 (incorporated by reference), a source of compressed air directed through pin holes 130 (see Fig. 1) positioned immediately above the receiver tray 20 in the respective paper guides 24a and 24b directs compressed air at the bottom of the stack of sheets resting on the receiving tray to fluff the lowest sheets in the stack to aid in their separation for feeding. Each of the blocks 26a and 26b connected to the parallel paper guides 24a and 24b includes a hollow chamber therein (see Fig. 6) connected by suitable tubing to a source of compressed air, which enters the blocks and is directed through the pin holes 130.

The length of the run of the belt 50 is about 17 inches, such that one sheet will about complete its travel through the feed rollers before the next revolution of the belt and feed of the next sheet to the separator rollers. The pulley 92 of feed roller 86 is preferably slightly smaller than pulley 120 so that the feed rollers rotate a little faster.

The amount of vacuum needed to ensure that the lowest sheet of the stack will be positively driven forward is minimal—about 3″ water. Compressed air (about 1.5 psi) is sufficient to lift the remaining sheets away from the bottom sheet to aid in separation of the bottom sheet from the remaining sheets.

The sheet feeder of this invention is compact, lightweight, capable of high-speed feeding of sheets of paper of various weights and sizes at speeds ranging up to 10 sheets per second, and energy efficient (approximately 2 amps v. 10 amps for the feeder of Patent No. 3,385,983).

CLAIMS

1. A high-speed, compact, lightweight sheet feeder for interfacing with the conveying mechanism of a collator, sorter, printer or other processing apparatus, comprising:

(a) a receiving tray holding a stack of sheets;

(b) an endless driven belt mounted for rotation about spaced rollers, the belt having openings therein which intermittently pass over a vacuum plenum having openings therein mating intermittently with the openings in the belt, the belt positioned to contact the lower surface of the stack of sheets to suck the lowest sheet from the stack by means of the vacuum and convey the sheet in the direction of rotation of the belt;

(c) separator means receiving the sheet conveyed by the endless belt for preventing passage of any but the lowest sheet of the stack;

(d) means accepting the single sheet from the separating means and conveying the single sheet to conveying apparatus of a collator, sorter, or other processing apparatus, the sheet feeder adapted to be positioned above and over the conveying apparatus of a collator, sorter or other processing apparatus.

2. The sheet feeder of claim 1 wherein the separator means includes a pair of opposed spaced upper and lower rollers between which single sheets are conveyed and a vertically adjustable plate positioned to contact the forward edge of the sheets resting on the receiver tray except for the lower one or two sheets of the stack, to aid in preventing feeding of more than one sheet at a time from the stack.

3. The feeder of claim 1, including a single drive means to simultaneously drive the endless belt, the separator rollers and the means accepting the single sheets.

4. The feeder of claim 3, wherein the single drive means includes a power means and means coupling the power means to the (1) at least one of the spaced rollers about which the endless drive belt is trained, (2) the separator rollers and (3) the means accepting the single sheet.

5. The feeder of claim 1, wherein the upper roller of the separator rollers is vertically adjustable to adjust for the gap between the upper and lower rollers.

6. The feeder of claim 5, wherein the lower roller is coated with a urethane coating having a

durometer of from 75—85 and the upper roller is coated with a silicone rubber or urethane coating having a durometer of from 50—60.

7. The feeder of claim 1, wherein the means accepting the single sheet includes a pair of opposed upper and lower feed rollers in contact with each other, the lower roller being driven, for accepting sheets from the separator rollers and conveying them against a curved deflector plate adjacent the feed rollers for deflecting the sheet from 90° to 180° to deposit them on a conveying apparatus of a processing means located immediately beneath the feeder.

8. The feeder of claim 1, including vacuum means provided to the plenum for controlled application of suction to enhance separation of a single sheet from the stack.

9. The feeder of claim 1, including means for directing compressed air transversely at the bottom of the stack to aid separation of the sheets.

10. A high-speed, compact, lightweight sheet feeder for interfacing with the conveying mechanism of a collator, sorter, or other processing apparatus comprising:

(a) a receiving tray for holding a stack of sheets;

(b) an endless driven belt mounted for rotation about spaced rollers, the belt having openings therein which intermittently pass over a vacuum plenum containing mating openings, the belt positioned to contact the lower surface of the atack of sheets and suck the lowest sheet from the stack by means of vacuum during rotation of the belt when the openings in the belt mate with the openings in the plenum and convey the sheet in the direction of rotation of the belt,

(c) a vertically adjustable plate positioned adjacent the discharge end of the endless drive belt to contact the forward edges of the sheets on the receiving tray, minus the bottom sheets, to aid in preventing conveying of more than one sheet,

(d) a pair of opposed spaced upper and lower separator rollers between which the single sheets conveyed by the endless driven belt are conveyed, the upper roller of the separator rollers being vertically adjustable to adjust the gap between the upper and lower rollers, and wherein the lower roller of the separator rollers is coated with a polyurethane coating having a durometer of between 75—85 and the upper roller of the separating rolls is coated with a silicone or urethane rubber having a durometer of from 50 to 60;

(e) a pair of opposed feed rollers downstream from the separator rollers both rotating in the same direction as the endless driven belt for accepting sheets from the separator rollers and conveying them forwardly; and

(f) a deflector plate adjacent the opposed pair of feed rollers for deflecting sheets from 90° to 180° to deposit them on a conveying apparatus of a collator, sorter, or other processing mechanism located immediately beneath the feeder.

11. The sheet feeder of claim 1, including means for detecting feeding of more than one sheet at a time.

12. The sheeet feeder of claim 11, wherein the means for detecting passage of more than one sheet includes sensing means which are caused to move whenever more than one sheet passes between the feed rollers,

means to amplify the movement of the sensing means, and

means for generating an electrical signal indicating passage of more than one sheet.

13. The sheet feeder of claim 12, wherein the sensing means includes a roller mounted on the upper shaft of the feed rollers in contact with a lower feed roller, a link connected to a second shaft parallel with the shaft on which the roller is mounted, an elongated arm connected at one end to the second shaft and having a finger at its opposite end which interrupts the beam between a light source and photo detector, passage of more than one sheet between the feed rollers resulting in rotation of the second shaft and lifting of the finger from between the light source and the photo detector to generate an electrical signal.

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