

[54] APPARATUS FOR SEPARATING SHEETS
FROM A STACK

622,076 10/1935 Germany 271/95

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[57] ABSTRACT

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271/99[51] Int. Cl.² B65H 3/12[58] Field of Search 271/95, 99, 100, 35, 9,
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Horizontally-spaced shuttles having a gap therebetween are mounted for conjoint reciprocal horizontal movement beneath an open-bottomed hopper for a stack of sheets. Vacuum cups deflect the edge portion of the bottom-most sheet downwardly toward said gap as the shuttles move under the hopper. A peeling strip mounted within the gap engages said deflected portion of the sheet and peels it from the bottom of the stack, allowing the peeled-off sheet to move through the gap and drop straight down into sheet processing means directly beneath the hopper. A plurality of said sheet-separating mechanisms are arranged in a row above a sheet-stacking conveyor to form a collator.

[56] References Cited

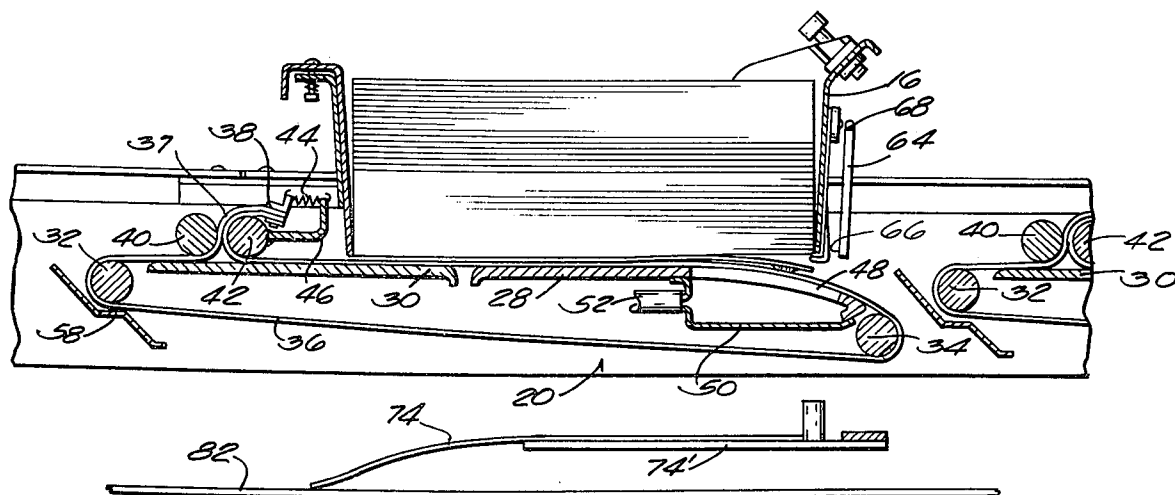
UNITED STATES PATENTS

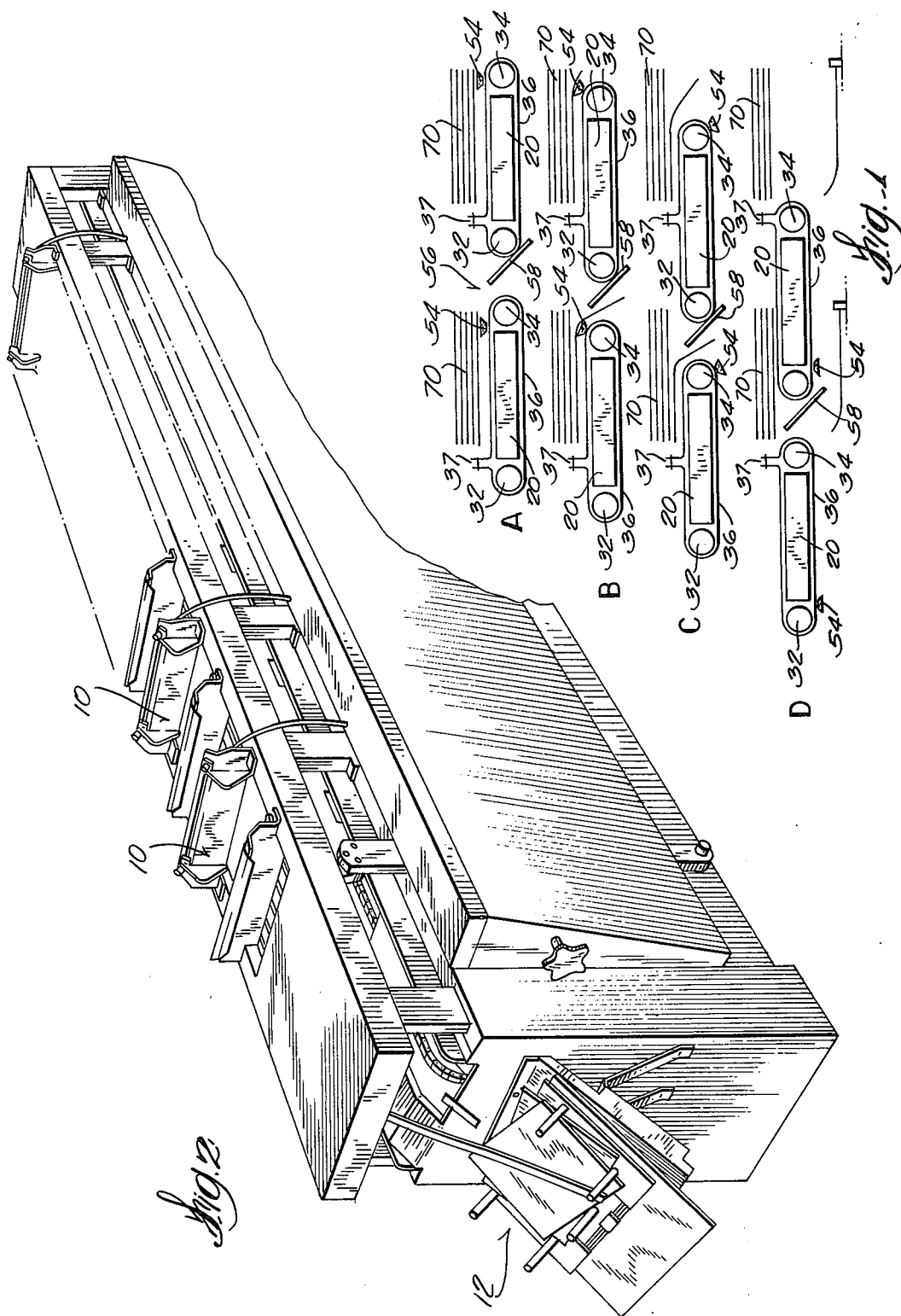
1,282,950	10/1918	Reifsnyder	271/100 UX
1,939,193	12/1933	Winkler et al.	271/95
3,559,982	2/1971	Eppers	270/58
3,718,328	2/1973	Comstock	271/99 X

FOREIGN PATENTS OR APPLICATIONS

897,056	5/1962	United Kingdom.....	271/95
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6 Claims, 16 Drawing Figures





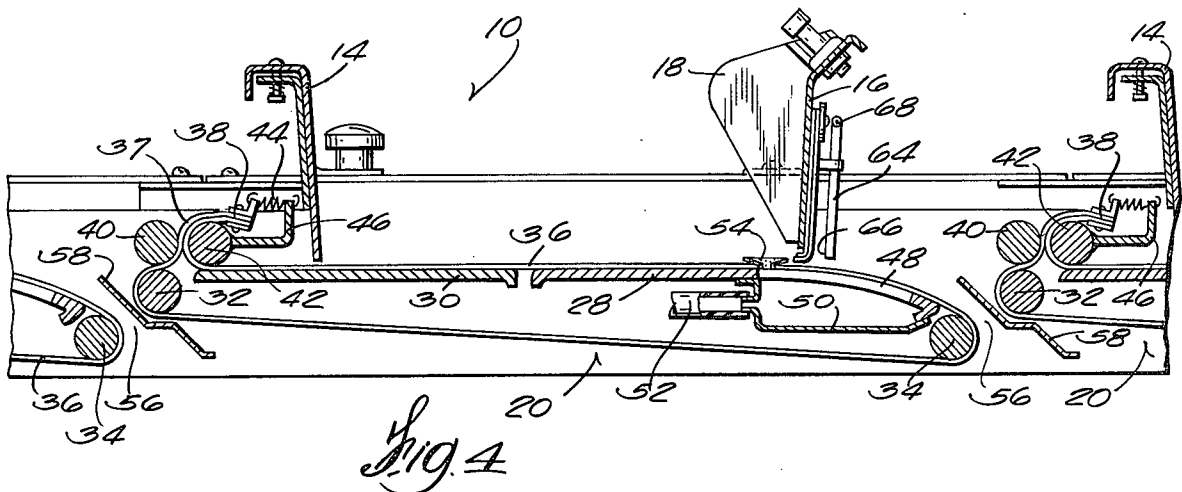
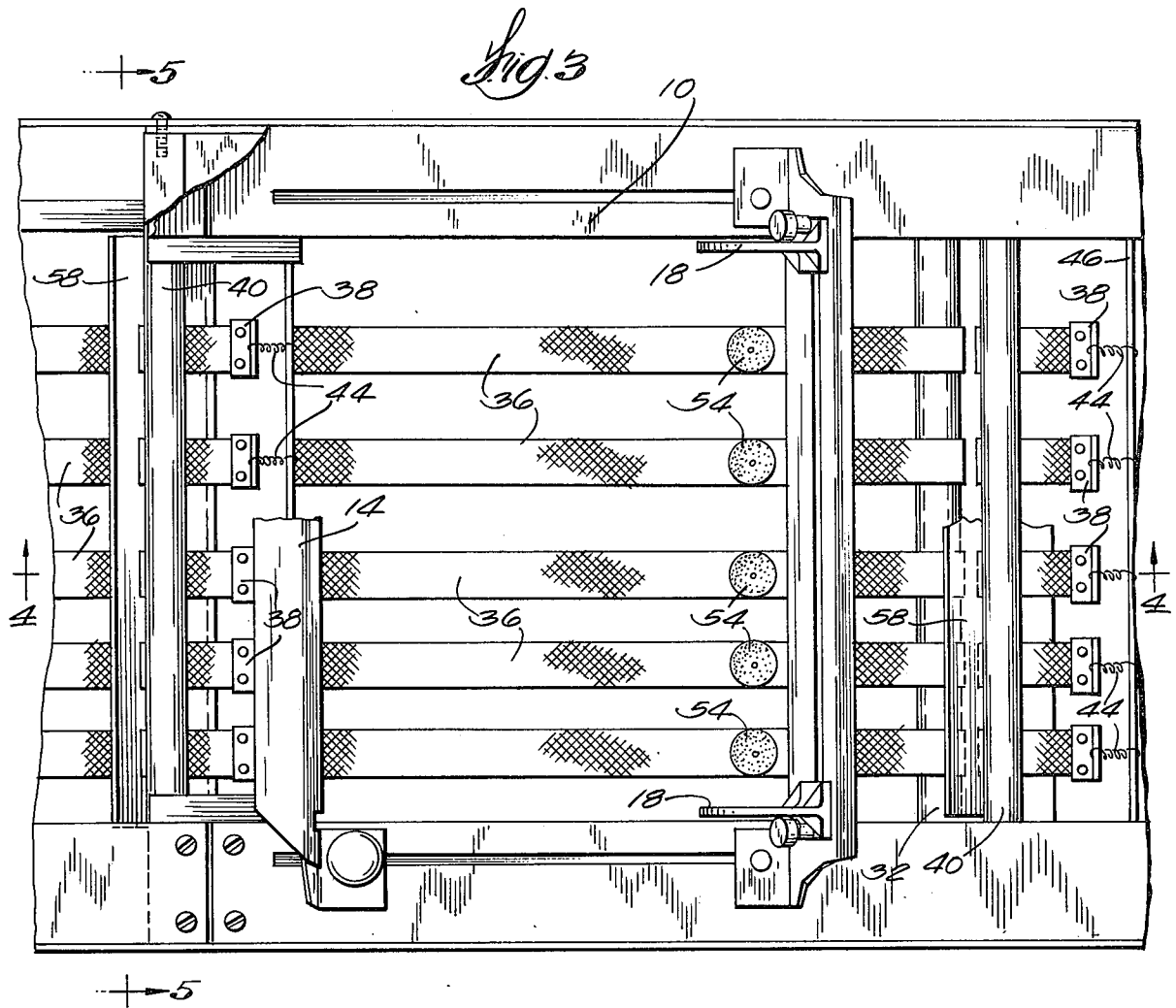
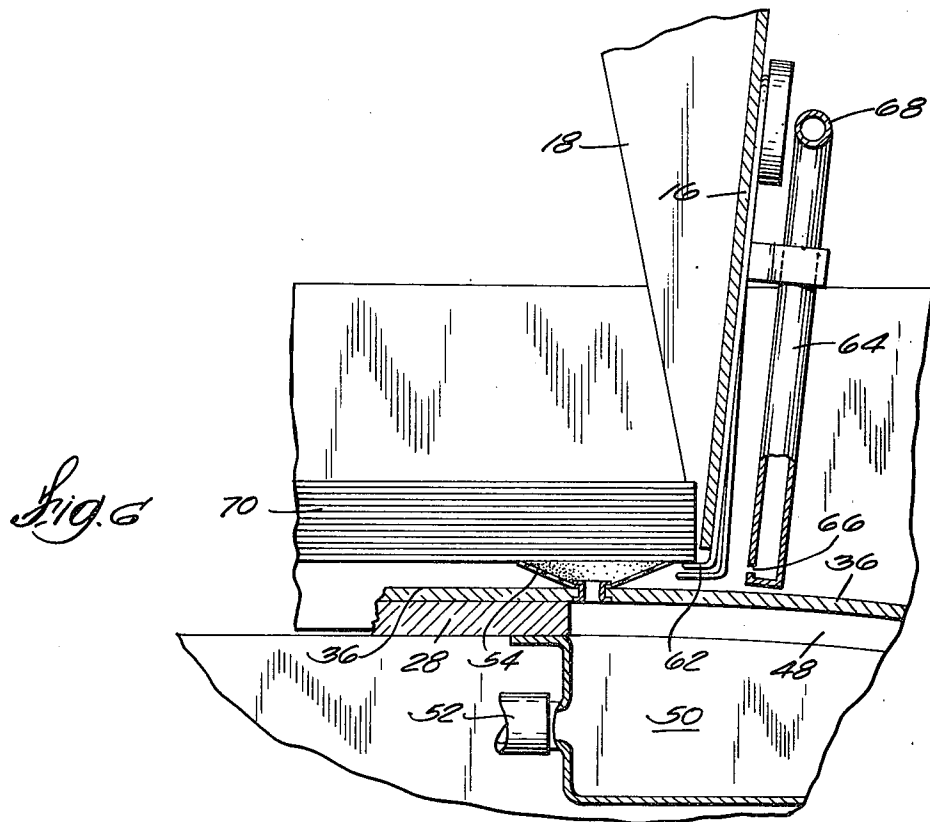
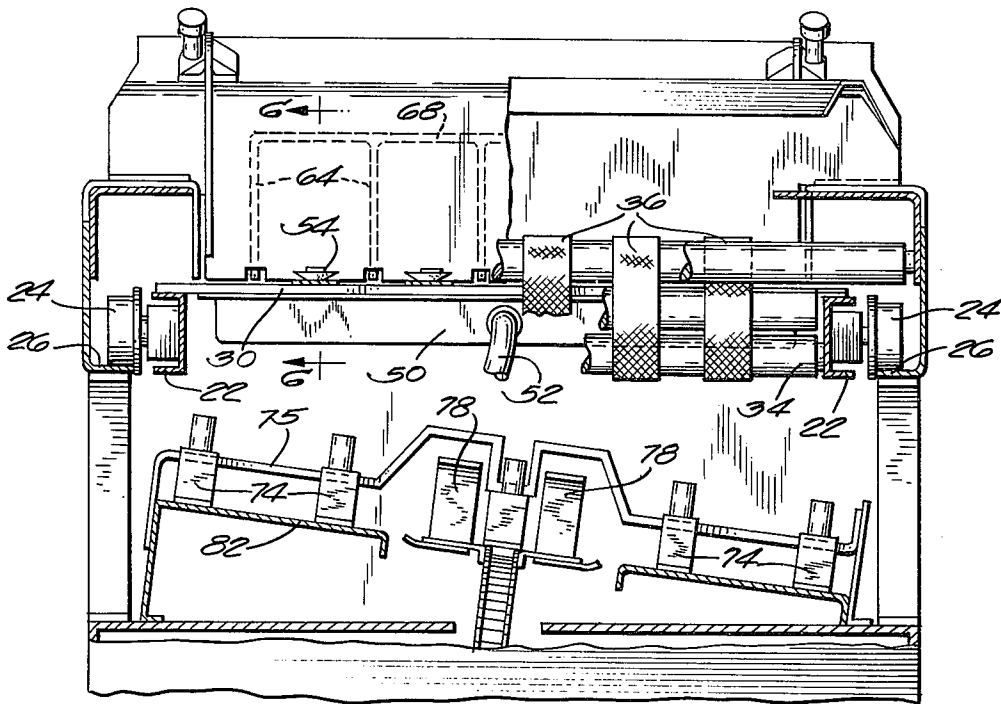
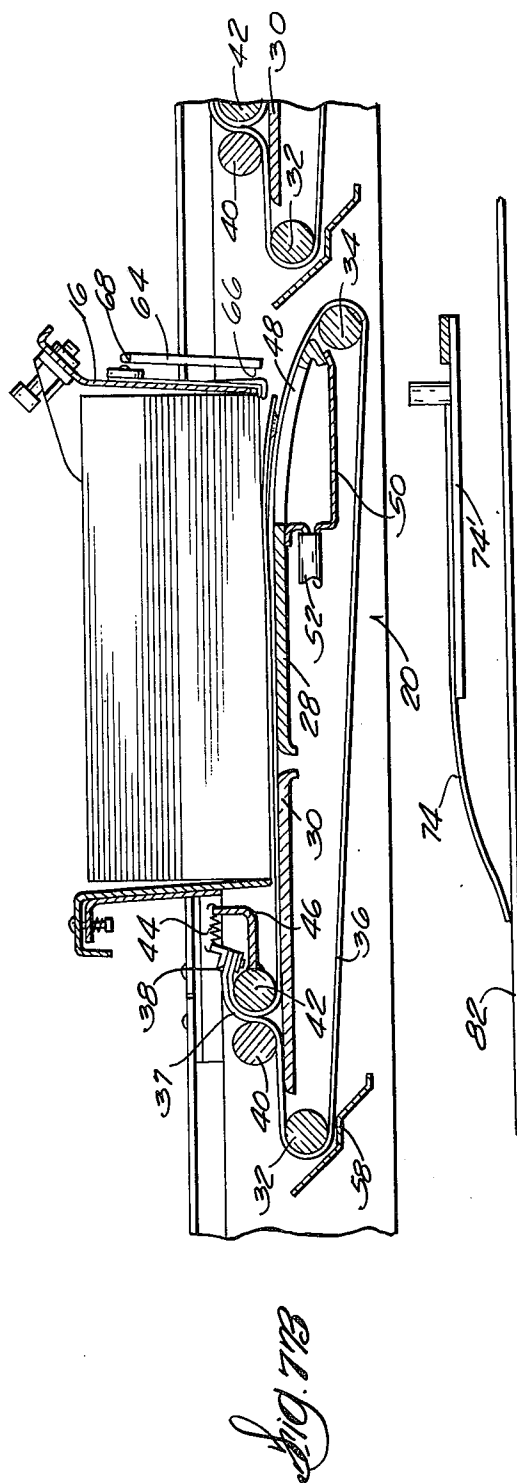
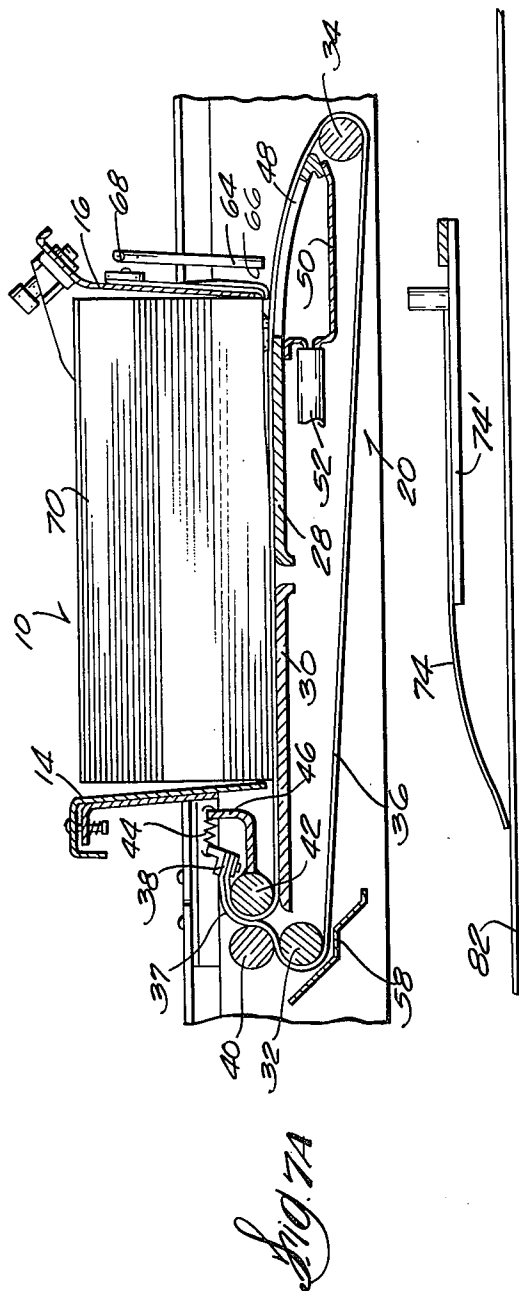
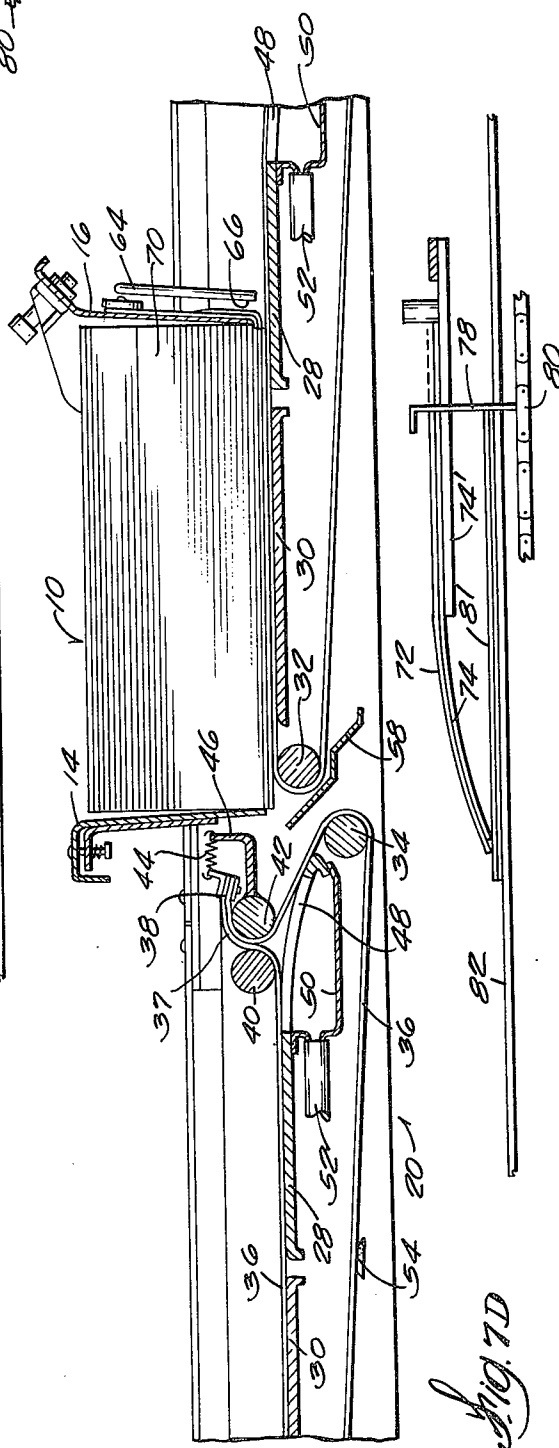
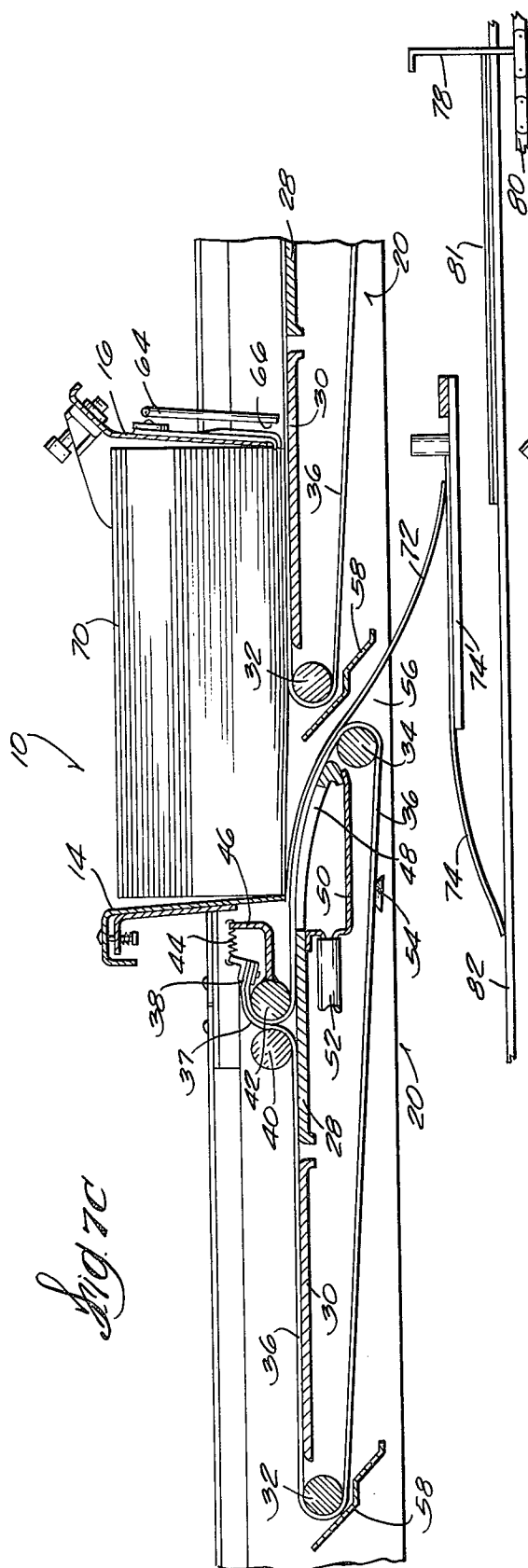
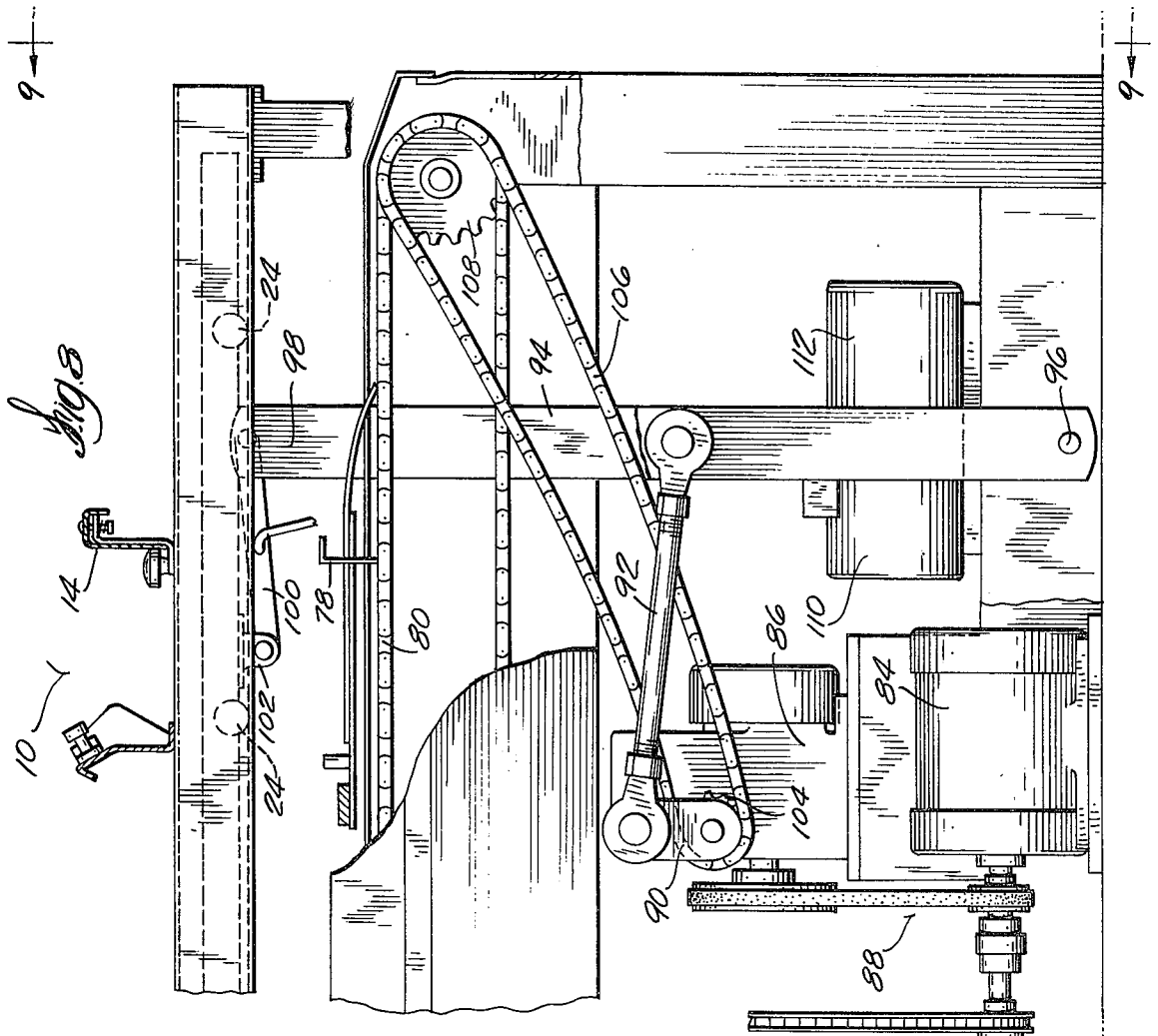
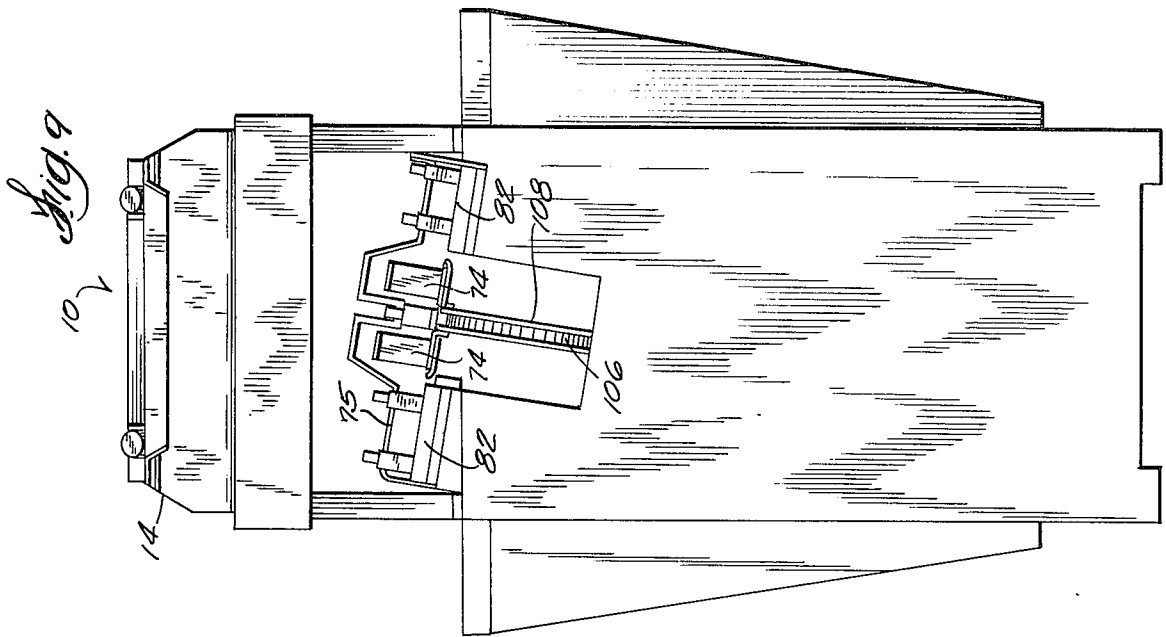


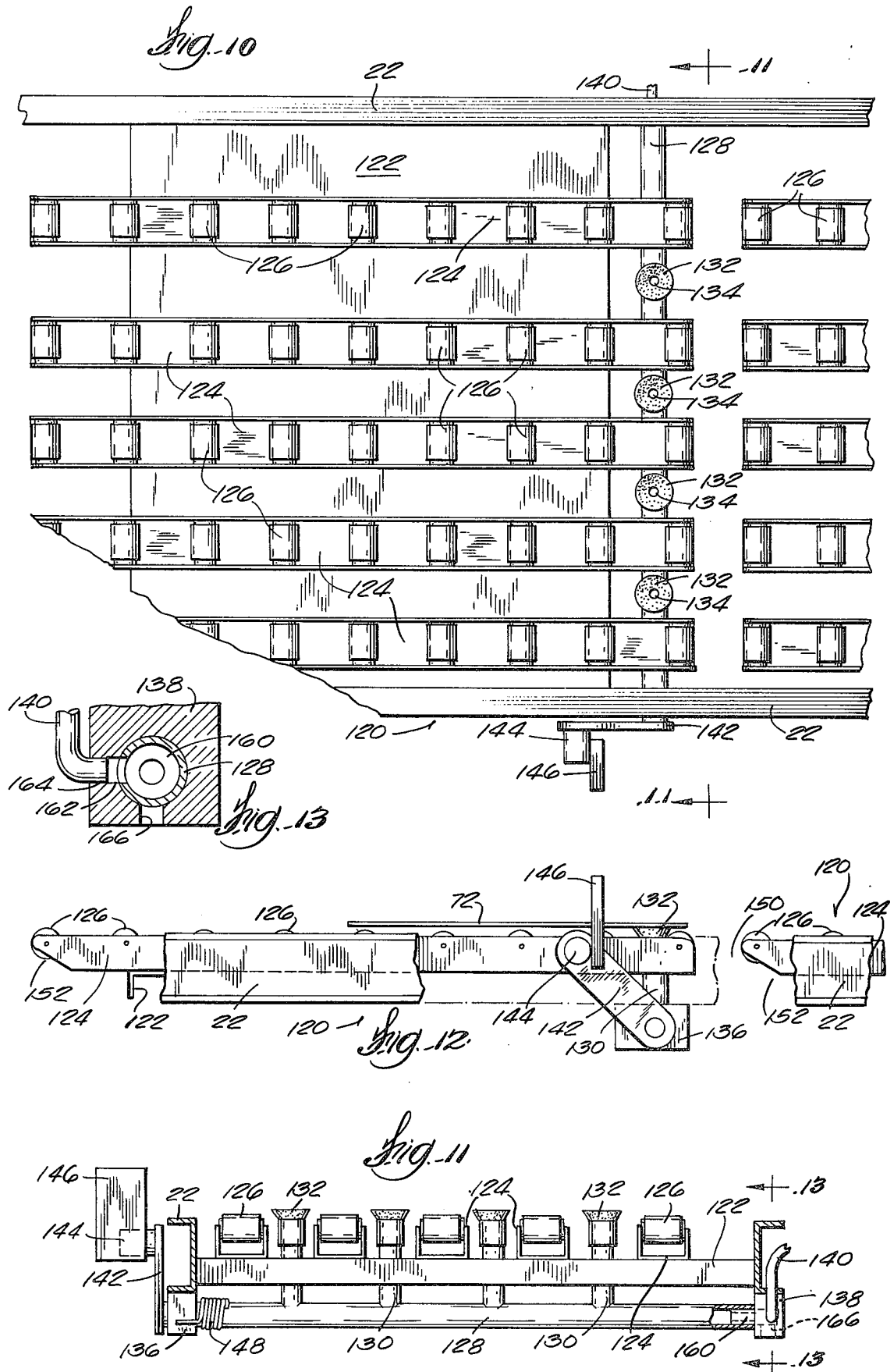
Fig. 5











APPARATUS FOR SEPARATING SHEETS FROM A STACK

BACKGROUND OF THE INVENTION

In the past, apparatus has been devised for feeding sheets one at a time off the top or the bottom of a stack of sheets. In the top-feeding apparatus, one or more vacuum cups are lowered down on the top sheet in the stack to grip the top sheet and lift it off the stack. The vacuum cups are moved upwardly and sidewardly until the top sheet is clear of the stack and in a position for further processing. The vacuum in the vacuum cups is then cut off to drop the separated sheet into suitable sheet-processing apparatus while the vacuum cups are again moved back to the stack of sheets. Top-feeding apparatus has the disadvantage that fresh sheets of paper cannot be loaded on top of the stack while the feeding apparatus is in operation. Accordingly, the feeding mechanism must be stopped whenever loading is necessary.

The prior art bottom-feeding apparatus circumvents the above-noted disadvantage but it introduces other disadvantages. In such prior art bottom-feeding apparatus, a stack of paper sheets is supported in a hopper having an open bottom. Vacuum cups are raised up into engagement with one edge portion of the bottom sheet to grip the sheet and are then moved downwardly to deflect the edge of the sheet below the structure that supports the stack. The deflected edge must then be gripped by one or more gripper fingers, with the vacuum then being released to permit the bottom sheet to be moved. The gripper fingers then draw the bottom sheet sideways until it is clear of the stack, at which time the gripper fingers release the sheet for processing by other processing means. The gripper fingers must then be moved back to the edge of the stack to grasp the next sheet, whose edge is deflected downward by the vacuum cups while the gripper fingers move back toward the stack. The disadvantages of this type of apparatus are that it is relatively complicated and expensive and the withdrawn sheets have to be laterally displaced from the stack. This increases the floor space required for the device. In addition, there is no way of insuring against withdrawal of more than one sheet at a time.

SUMMARY OF THE INVENTION

The invention comprises apparatus for separating sheets from a stack and comprises a hopper for the stack, means beneath the hopper for causing downward deflection of an end portion of the bottommost sheet in the stack, peeling means thereafter engageable with said deflected end portion for progressively peeling the remainder of the bottommost sheet from the bottom of the stack while the sheet stays in a position substantially directly below its original position in the stack, and means positioned below the stack for receiving the separated sheet as it falls by gravity. A plurality of these sheet-separating mechanisms may be arranged in a row above a sheet-stacking conveyor, forming a collator for the sheets.

DESCRIPTION OF THE DRAWINGS

FIG. 1 A, B, C and D are diagrammatic representations of the apparatus for feeding sheets off the bottom of a stack of sheets in accordance with this invention.

FIG. 2 is a perspective view of a collating machine utilizing a plurality of the sheet feeders.

FIG. 3 is a top view of one of the hoppers showing a sheet feeder used in the collating machine illustrated in FIG. 2.

FIG. 4 is a longitudinal sectional view taken on the line 4—4 of FIG. 3.

FIG. 5 is a cross-sectional view taken on the line 5—5 of FIG. 3.

FIG. 6 is an enlarged fragmentary longitudinal sectional detail view taken on the line 6—6 of FIG. 5.

FIG. 7A is a longitudinal sectional view through the sheet hopper and feeder showing the shuttle in its initial, or inactive, position.

FIG. 7B is a view similar to FIG. 7A showing the shuttle after it has shifted far enough to peel the bottom sheet of paper downward from the bottom of the paper stack in the hopper.

FIG. 7C is a view similar to FIGS. 7A and 7B showing the shuttle as it approaches its final sheet-separating position.

FIG. 7D is a view similar to FIGS. 7A, 7B, and 7C showing the shuttle at the end of its stroke just before it starts returning to its initial position.

FIG. 8 is a partially cutaway elevational view of the drive mechanism for the collating machine looking at the opposite side of the machine from that shown in FIG. 1.

FIG. 9 is an end elevational view looking as indicated by line 9—9 of FIG. 8.

FIG. 10 is a plan view of a modified shuttle using rollers instead of belts as the anti-friction means.

FIG. 11 is a front elevational view taken on the line 11—11 of FIG. 10.

FIG. 12 is a side elevational view, partially cut away, of the shuttle shown in FIGS. 10 and 11.

FIG. 13 is a sectional view taken on the line 13—13 of FIG. 11 showing the vacuum valve.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The basic principle of the apparatus of this invention is illustrated diagrammatically in FIG. 1. Two connected and reciprocable shuttles 20, which have a gap 56 therebetween, are mounted below corresponding stacks of paper 70. The shuttles 20 are joined to a common carriage (not shown) so that the two shuttles 20 can be reciprocated to the left as shown in FIGS. 1B, 1C, and 1D, and then returned as a unit to their initial position, as shown in FIG. 1A. The shuttles 20 have belts 36 extending around rollers 32 and 34. The ends 37 of belts 36 are fixed to a frame (not shown) so that said ends 37 remain stationary as the shuttles 20 reciprocate. A row of vacuum cups 54 is affixed to the upper portion of the belts 36 on shuttle 20. The vacuum cups 54 are activated with a vacuum to grasp the corner of the lowermost sheet 72 of the stack 70. The shuttles 20 are then reciprocated to the left. The end connection 37 for belts 36 remains stationary while the shuttles 20 are reciprocated. Therefore, the vacuum cups 54 get drawn downwardly around the end of the moving shuttles and then beneath the same to deflect the end of the lowermost sheet 72 into the gap 56 between the shuttles 20, as shown in FIGS. 1B and 1C. As the shuttles 20 are moved to the left, the suction being cut off, the deflected end of sheet 72 is contacted by a peeling strip 58 which peels the bottom sheet 72 off the stack 70 and allows it to drop directly beneath stack 70 into handling

apparatus below the shuttles 20. The shuttles 20 are then moved to the right, returning to the positions shown in FIG. 1A.

It should be understood, however, that the arrangement of this invention is not limited to the apparatus illustrated in FIG. 1 since various changes can be made in the details of the apparatus within the scope of the present invention. For example, the fixed belts 36 could be replaced by rollers if desired. Accordingly, it should be understood that the basic features of this invention involve mechanism for (a) moving a corner of the lowermost sheet of a stack of sheets downwardly into a gap between two reciprocable shuttles, and (b) reciprocating the shuttles relative to the stack while the lowermost sheet is peeled through the gap between the shuttles by a peeling strip in the gap, the peeled sheet falling by gravity directly beneath the stack.

THE HOPPERS

FIG. 2 is a perspective view of a collating machine which utilizes a plurality of the sheet feeders described above. The individual stacks of sheets are contained in hoppers 10 at the top of the collating machine. A plurality of peeling strips are fixed to a movable carriage, described hereinafter, and the peeling strips simultaneously peel one sheet from the bottom of each hopper 10. The individual peeled sheets are then conveyed toward the end of the machine, being collated as they move, and are deposited in complete sets in a tray 12 on the end of the machine.

FIGS. 3, 4, 5 and 6 show the structure associated with one of the feed hoppers 10. Referring first to FIGS. 3 and 4, each of the hoppers 10 has a front plate 14 and a back plate 16 which are connected to the frame of the collator by conventional means and are spaced apart by a distance equal to the width of the paper sheets to be used in the machine. The back plate 16 has two side wings 18 adjustably attached to opposite ends thereof. The side wings 18 may be moved toward and away from each other to accommodate sheets having different lengths. In the operation of this embodiment, the side wings 18 are set to the appropriate size for the paper used therein and help to keep the paper centered in the hopper.

THE SHUTTLES

Below the hoppers 10, a plurality of connected, spaced-apart shuttles 20 are movably mounted for conjoint reciprocating motion upon tracks 26 affixed to the frame of the machine. Referring to FIG. 5, the carriage which supports the shuttle plates comprises a pair of side rails 22 which have rollers 24 journaled to the side thereof which roll on tracks 26 on each side of the frame of the machine. Each of the spaced shuttles 20, which are fixedly supported at their sides on the side rails 22, has a top plate 28 with a downward curve at its trailing end (FIG. 4) and a flat plate 30 in front of and coplanar with the plate 28. A front roller 32 is journaled between the side rails 22 in front of the shuttle plate 30, and a rear roller 34 is journaled between the side rails at the rear of the curved plate 28. The rollers 32 and 34 move with the shuttle plates 28 and 30 as the shuttle plates 28 and 30 are reciprocated.

A plurality of spaced belts 36 are wrapped around each of the shuttles as shown in FIGS. 3 and 4. The belts 36 pass around the front roller 32 and the rear roller 34 and the belt ends 37 extend between rods 40 and 42 and are then gripped by a clamp 38. The rods 40

and 42 and the clamp 38 are attached to the frame of the machine above the shuttle and do not move when the shuttles 20 are reciprocated. The clamps 38 are preferably secured by springs 44 to fastening bars 46 which are attached to and project from the cross rod 42. The springs 44 hold the belts 36 in tension so that the belts 36 bear against the adjacent top surfaces of the plates 28 and 30.

SUCTION MECHANISM

On the trailing curved end of the shuttle plate 28 is a series of slots 48, each slot 48 being positioned under a corresponding one of the belts 36. A vacuum manifold 50 is attached to the underside of the curved plate 28 under the slots 48 and is in communication with a vacuum hose 52 which is coupled by means, not shown, to a source of vacuum. A row of vacuum cups 54 is attached to each of the belts 36 to be near the rear of each hopper 10 when the shuttles are in the position of FIG. 3. Each vacuum cup has a tubular stem extending through its belt so that, as long as the vacuum cups 54 are above the slots 48, a vacuum is communicated thereto, but when the cups 54 are no longer in communication with the slots 48, as when the shuttle 20 is reciprocated far enough to the left, the vacuum to cups 54 is interrupted. The purpose of applying the vacuum to vacuum cups 54 is to draw the bottom sheet of the stack in the hopper 10 downwardly far enough so that it will move into a gap 56 between the adjacent shuttles 20. Once the lower sheet is drawn down far enough to enter the gap 56, it is contacted by a peeling strip 58 which moves with the shuttles 20 and peels the lowermost sheet downwardly as the shuttles 20 reciprocate to the left under the hopper 10 as illustrated in FIGS. 7A-7D.

FIG. 6 is an enlarged view of the structure adjacent to the rear corner of the stack of sheets in a hopper 10. The stack of sheets 70, which may be either single or folded sheets, is held at its bottom rear corner by a plurality of fingers 62, which are shown as wire but which may be of any other suitable form, which project forwardly from beneath the bottom edge of the rear plate 16. When removing the lowermost sheet of the stack 70, vacuum is applied to the vacuum cups 54, and the cups 54 are shifted downwardly to cause the edge of the lowermost sheet of paper to snap beneath the fingers 62, while the sheets of paper above it remain resting upon the fingers 62. In order to insure that only one sheet separates off the bottom during this operation, a plurality of compressed air nozzles 64, located between the wire fingers 62 and each having an outlet opening 66, blow streams of air into the lower rear end of the stack 70 to separate the lowermost sheet from the other sheets just prior to the lowermost sheet being drawn downwardly, thereby insuring that only one sheet at a time is peeled off the bottom of the stack 70. Compressed air for the nozzles 64 is fed in through a compressed air hose 68 from a suitable source of compressed air, which is shown in FIG. 6.

OPERATION

FIGS. 7A, 7B, 7C and 7D show successive steps in the reciprocating motion of the shuttles 20 which causes the lowermost sheet of paper to be peeled off the stack 70 and to be deposited below the stack 70. FIG. 7A shows the initial relationship of the parts. The parts which reciprocate to the left with the shuttle 20 include the plates 28 and 30, the rollers 32 and 34, and

the peeling strip 58.

A vacuum is applied to the cups 54 through the vacuum manifold 50 and slots 48. This vacuum may be continuously applied so that it will be always present at the vacuum cups 54 when they are in communication with the vacuum slots 48, or the vacuum may be automatically applied shortly before the reciprocal movement of the shuttles 20 begins. The vacuum applied to vacuum cups 54 draws the lowermost sheet of paper 72 downward as the shuttle 20 is reciprocated to the left, as shown in FIG. 7B. The downward movement of vacuum cups 54 is due to the fact that the ends of the belts 36 are fixed to the clamps 38 and that the cups pass around the downwardly-curved part of the shuttle plate 28.

From the configuration of parts in 7B, it will be clear that as the plates 28 and 30 and rollers 32 and 34 move to the left, the belts 36 roll around the rollers 32 and 34 and draw the vacuum cups 54 straight down so that the edge of the lowermost sheet 72 is deflected down into the gap 56 between the two adjacent shuttles 20. The peeling strip 58 then contacts bottom sheet 72 and peels it off the bottom of stack 70 as the shuttles 20 move to the left. FIG. 7C shows the position of the parts after the two adjacent shuttles 20 have been moved slightly more than halfway through their travel to the left. The lowermost sheet 72 that was peeled off the bottom of the stack of sheets 70 has fallen down so that its lowermost end rests upon tapes 74 which cover supporting strips 74' carried by frame elements 75 (FIG. 5), said strips forming a temporary platform. The strips 74' are spaced as shown in FIG. 5 to admit upstanding fingers 78 therebetween which are drawn along by an endless conveyor chain 80, to be described hereinafter, for collating the sheets which are dropped down onto the tapes 74. The ends of the tapes flex down into contact with sheet-receiving surface 82. FIG. 7D shows the configuration of parts at the end of the shuttle stroke to the left immediately before the shuttles 20 are reciprocated back to the starting position shown in FIG. 7A. All of the shuttles 20, one under each sheet hopper 10, are reciprocated together because they are attached to the same rails 22 forming a common carriage, and when the carriage is reciprocated between the position shown in FIG. 7A and the position shown in FIG. 7D, there is simultaneous peeling of the bottom sheet 72 from the stack 70 of each hopper 10, and the depositing of each of these bottom sheets on the platforms 74 immediately below each hopper 10.

THE COLLATING

The collating portion of the machine includes the spaced strips 74' (FIG. 5), which form a platform to temporarily hold the sheets peeled off the bottom of the stacks 70. Collection fingers 78 are attached to the endless chain 80 and move along in the spaces between strips 74' to move the sheets 72 off the strips 74' and deposit them on top of a collated stack 81 which is being conveyed by the fingers 78. Each stack 81 receives one sheet from each of the stacks 70, and these are deposited in the same order as the relative location of the stacks 70 in the length of the collating machine. These individual stacks 81 (FIG. 7D) are slid along the surface 82 and are deposited in a stacking tray 12 at the end of the collating machine, as shown in FIG. 2. The stacking tray 12 may include means for rotating the position of each adjacent stack 81 so as to separate the

stacks 81 from each other, each stack 81 containing one each of the sheets in the hoppers 10 of the collating machine arranged in properly collated order.

THE DRIVE

FIG. 8 shows the power drive arrangement for reciprocating the shuttles 20 and driving the conveyor chain 80. An electric motor 84 drives a gear box 86 by means of a drive belt and pulley arrangement 88. A pair of rotating crank arms 90, which rotate at a relatively low speed, project from both sides of the gear box 86, only one of the crank arms 90 being visible in FIG. 8. An identical pair of connecting rods 92 connects the end of the crank arms 90 to the center of a pair of oscillating arms 94 which are pivoted at their lower ends about a pivot point 96. The upper end 98 of each oscillating arm 94 is coupled via a pair of pivotal linkage arms 100 to a pair of lugs 102 which are pivotally attached to the carriage upon which the shuttles 20 described above are mounted. As the crank arms 90 rotate, the oscillating arms 94 are oscillated, which causes a reciprocating motion of the carriage to which the shuttles 20 are attached, thereby causing the reciprocating motion described above in connection with the shuttles 20. A sprocket drive 104 is attached to the drive shaft for the rotating crank arms 90 and drives a chain 106, which is turn drives a sprocket 108 that is keyed to and drives the endless conveyor chain 80. This provides the motive power for all of the operations described above. A second electric motor 110 is mounted on the frame and drives an air compressor and vacuum pump 112 to provide the compressed air and vacuum used in the above-described mechanisms.

FIGS. 10-12 show a modified form of the shuttles 20 in which rollers are used as the anti-friction elements in place of the belts 36. In this modification, a plurality of modified shuttles 120 are connected in horizontally-spaced relationship between the two side rails 22, the latter being rollably supported on the machine frame as shown in FIG. 5. Each shuttle 120 includes a flat base 122 which is rigidly attached between side rails 22 as best shown in FIG. 11. Supported on the top surface of base 122 is a plurality of U-shaped channels 124 which extend substantially parallel to the side rails 22. In each channel 124, a plurality of rollers 126 is journaled to form an anti-friction supporting surface for the paper stacks (like those shown in FIGS. 6 and 7) immediately above shuttles 120.

Journalled between the side rails 22 near the trailing end of each shuttle 120, is a vacuum manifold tube 128 (FIG. 11) having upstanding hollow vacuum stems 130. Vacuum cups 132 having central openings 134 (FIG. 10) are fitted over the ends of vacuum stems 130. Vacuum manifold tube 128 is rotatably secured between side rails 22 by means of a bearing retainer 136 and a rotary vacuum valve 138 (FIG. 11) which are each welded to the bottom of a corresponding side rail 22. A vacuum hose 140 is attached to the inlet of rotary valve 138, with the outlet of rotary valve 138 being connected to the vacuum manifold tube 128. Rotary valve 138 is of a type that permits vacuum to be communicated into manifold tube 128 when the vacuum stems 130 are positioned at any angle between vertical and 90° from the vertical, but blocks the vacuum when vacuum stems 130 are positioned at an angle that is equal to or greater than 90° from the vertical. One way of accomplishing this is illustrated in FIGS. 11 and 13. There is a tubular plug 160 projecting from the end of

the manifold tube 128 into the valve 138. This tube has a closed outer end and has its inner end communicating with the interior of the manifold tube 128. There is a lateral port 162 in the tube which is communicable through the duct with the vacuum inlet tube 140, as shown in FIG. 13. This communication takes place through a predetermined number of degrees of rotation with the inlet port 164 of the valve. When the manifold is in a position of rotation so that the lateral port 162 of the valve plug is in the position of FIG. 13, the vacuum will be effective in the suction cups. As the tube 160 rotates in a clockwise direction, it will eventually move out of communication with the vacuum inlet, shutting off the suction to the vacuum cups. This will occur when the stems 130 are in an approximate horizontal position. In other words, the vacuum will be effective for about 90°. At this point the port 162 is in communication with the atmosphere through an exhaust port 166 to break any vacuum in the manifold 128.

Vacuum manifold tube 128 can be rocked about its axis by a rocker arm 142 which is rigidly attached at its inner end to vacuum manifold tube 128 and has a roller 144 journaled to its outer end. Roller 144 is adapted to engage a stationary cam plate 146 which is rigidly attached to the frame (not shown). The plate 146 remains in fixed position while the shuttles 120 and side rails 22 are being reciprocated. A torsion spring 148 (FIG. 11) is connected between base 122 and vacuum manifold tube 128 in such orientation as to tend to rotate the vacuum stems 130 clockwise in FIG. 12. This causes a portion of the lowermost sheet 72 in a stack to be gripped by vacuum cups 132 when the latter are in vertical position. The sheet portion is thus drawn down into the gap 150 between adjacent shuttles 120. When the vacuum stems 130 reach a position of 90° from the vertical, the vacuum is cut off by rotary vacuum valve 138 and the sheet 72 is released for downward movement.

The leading edge 152 (FIG. 12) of the adjacent shuttle 120 then acts on the edge of the sheet 72 and causes it to be peeled off the bottom of the stack (not shown) as the shuttles 120 continue their movement to the left in FIG. 12. In this particular embodiment, the leading edge 152 of each shuttle 120 acts as a peeling strip so there is no need to mount separate peeling strips in the gaps 150 between adjacent shuttles 120.

Various changes and modifications may be made without departing from the spirit of the invention, and all of such changes are contemplated as may come within the scope of the claims.

What we claim is:

1. Apparatus for separating sheets from a stack comprising a fixed hopper for a stack of sheets, means beneath said hopper for causing downward deflection of an end portion of the bottommost sheet in said stack, peeling means thereafter engageable with said deflected end portion for progressively peeling the remainder of the bottommost sheet from the bottom of the stack, a shuttle which has a transverse gap supporting the remainder of the sheet being peeled and supporting the other sheets in the stack during peeling, said peeling means including said gap for intercepting the deflected portion of the sheet, means for reciprocating said shuttle, belt means passing over and around said shuttle, said belt means having a portion secured in fixed position with respect to said hopper and above the shuttle while the shuttle is being reciprocated, and roller means on said shuttle rollably engaging said belt

means to shift the latter from a position where the major portion of its length is beneath the hopper to a position where the major portion of its length is forwardly of said hopper, said means for causing downward deflection of an end portion of the bottommost sheet in the stack including a plurality of vacuum cups attached to said belt means and normally positioned under said end portion of said bottommost sheet and shiftable with said belt means.

2. Apparatus as claimed in claim 1 in which there are slots in said shuttle under the initial portion of the path followed by said vacuum cups as said shuttle is moved, a vacuum outlet for each vacuum cup communicating with the slot below, and a vacuum manifold below all of the slots in said shuttle whereby the vacuum cups grip said end portion of said bottommost sheet when the cups are over said slots.

3. Apparatus as claimed in claim 1 wherein the trailing edge of said shuttle is curved downwardly so as to cause said vacuum cups to move downwardly as the shuttle commences its motion, thereby deflecting said end portion of said bottommost sheet downwardly.

4. Apparatus for separating sheets from a stack comprising a hopper for a stack of sheets, means beneath said hopper for causing downward deflection of an end portion of the bottommost sheet in said stack, peeling means thereafter engageable with said deflected end portion for progressively peeling the remainder of the bottommost sheet from the bottom of the stack, a pair of shuttle sections connected for conjoint movement and having a transverse gap therebetween, said peeling means including said gap for intercepting the deflected portion of the sheet, means for reciprocating said shuttles horizontally below the hopper, rollers between each shuttle section and the bottom of the stack positioned to support the stack and prevent transmission of undesired moving forces from the shuttles to the bottom of the stack during movement of the shuttles, said means for causing downward deflection including vacuum cups carried by at least one of said shuttle sections and normally projecting from the upper portion and positioned for gripping engagement with an end portion of said bottommost sheet, said vacuum cups being mounted for oscillatory swinging movement to deflect said end portion of a sheet downwardly into said gap, means for applying a vacuum to said vacuum cups, valve means for terminating said vacuum when said end portion of said bottommost sheet is at a predetermined position within said gap, said vacuum cups being each mounted on the end of a tubular vacuum stem and said vacuum applying means including a vacuum manifold tube journaled near one end of said shuttle section adjacent the gap between shuttles, each of said vacuum stems being rigidly attached to said vacuum manifold tube, a rocker arm rigidly attached to one end of said manifold tube, a cam follower journaled to the end of said rocker arm, and a stationary cam plate positioned to act on said follower when said shuttle sections are reciprocated.

5. Apparatus for separating sheets from a stack comprising a fixed hopper for a stack of sheets, a shuttle mounted for movement below said hopper and having a transverse gap therein, belt means having opposite loop portions forming an anti-friction support for the sheets of the stack extending over and around said shuttle and having a portion secured in fixed position above the shuttle and adjacent the hopper, means connected with said shuttle and responsive to movement of

9

the shuttle for causing downward deflection of an end portion of the bottommost sheet in the stack into said transverse gap, roller means in each of the opposite loop portions of said belt means, and means for reciprocating the shuttle in a direction to cause the roller means to shift the belt means from a position where the major portion of the length of the belt means is beneath the hopper to a position where the major portion of its length is forwardly of the hopper, said means for causing said downward deflection comprising suction cups mounted on said belt means for shifting movement with the belt as the belt means is shifted.

6. Apparatus for separating sheets from stacks comprising first and second longitudinally-spaced hoppers each having forward and rearward ends, each for a stack of sheets, first and second shuttle sections, one normally positioned beneath each hopper, with said sections connected for conjoint movement and there

10

being a transverse gap therebetween, means on each shuttle section forming an anti-friction support for the sheets of the stack, means connected with said shuttle and responsive to movement of the shuttle for causing downward deflection of an end portion of the bottommost sheet in the stack into the gap between shuttle sections, and means for reciprocating the shuttle in a direction to cause the anti-friction support of the first shuttle section to shift from a position where the major portion of its length is beneath the first hopper to a position where the major portion of its length is forwardly of said first hopper, with the anti-friction support of the second shuttle section shifting from a position beneath the second hopper to a position beneath the first hopper to support the stack of said first hopper.

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