March 16, 1965 B. F. DAVID ETAL 3,173,681

SHEET HANDLING APPARATUS

Filed April 25, 1962 2 Sheets-Sheet 1

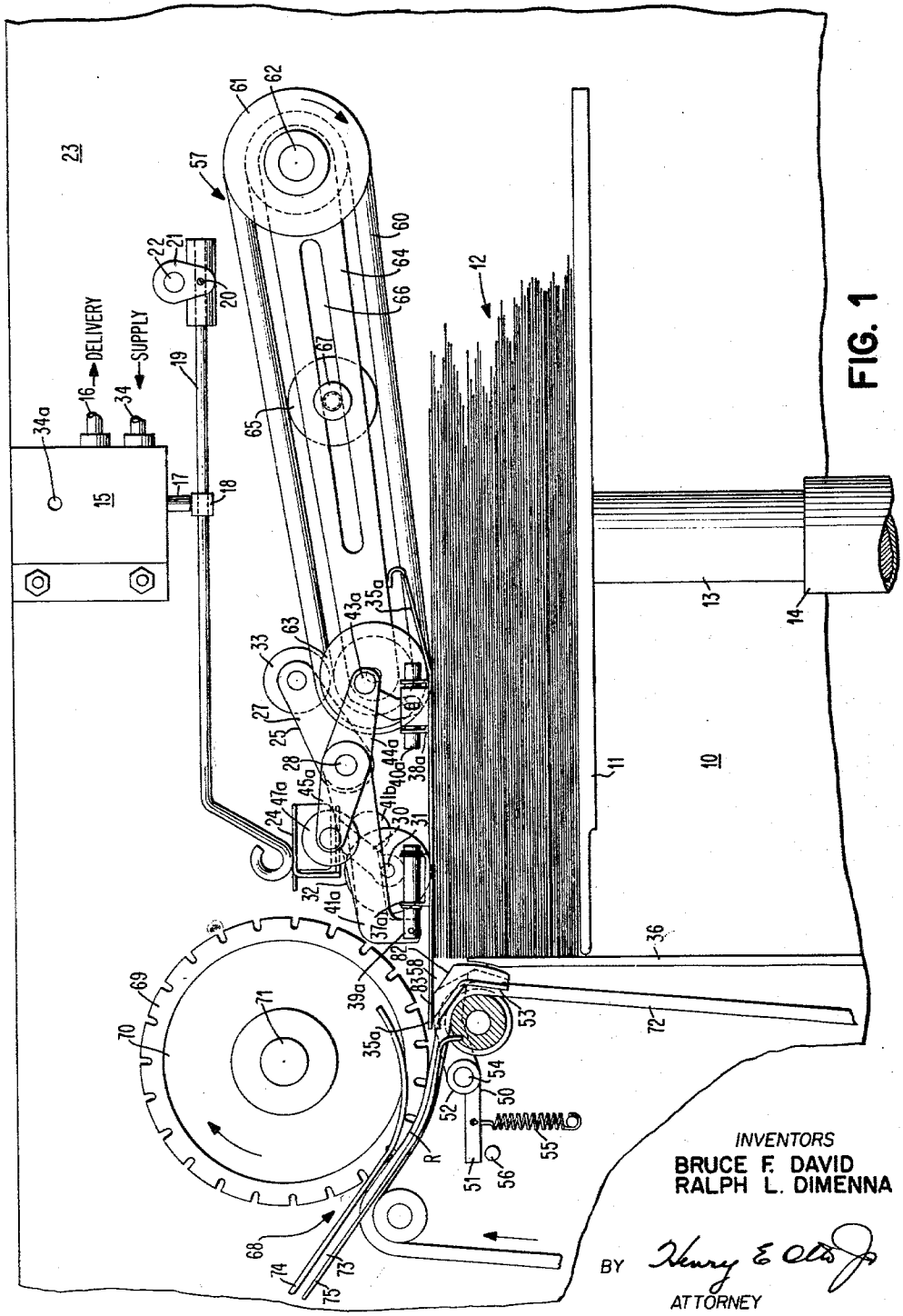



FIG. 1

INVENTORS
BRUCE F. DAVID
RALPH L. DIMENNA

BY Henry E Otis Jr
ATTORNEY

March 16, 1965 B. F. DAVID ETAL 3,173,681

SHEET HANDLING APPARATUS

Filed April 25, 1962 2 Sheets-Sheet 2

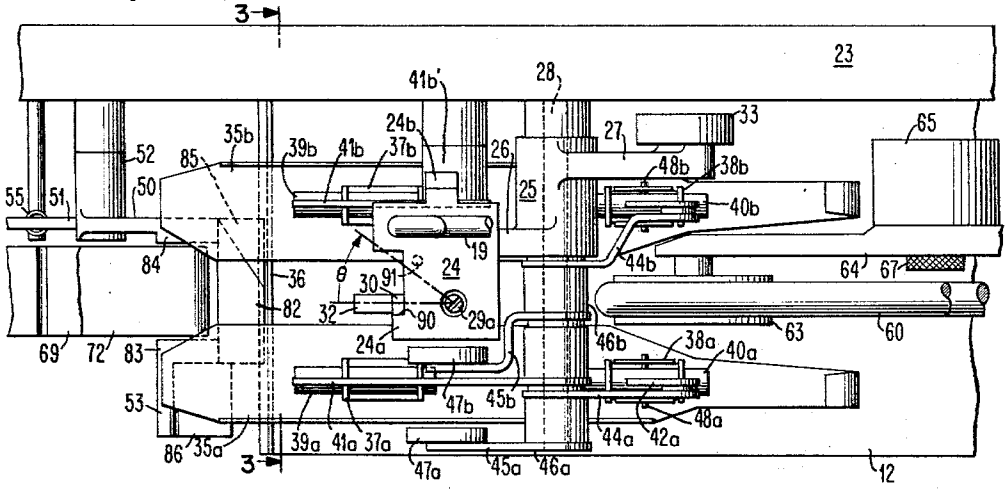



FIG. 2

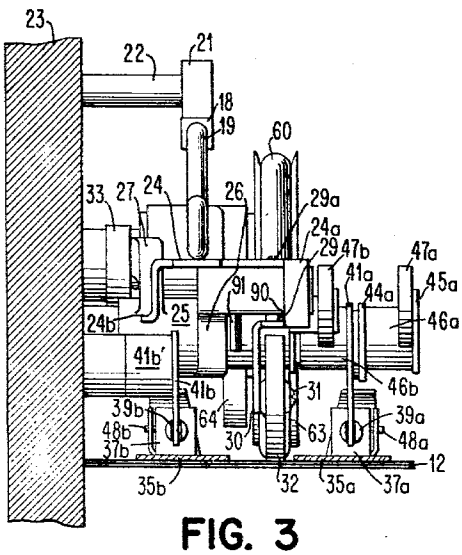



FIG. 3

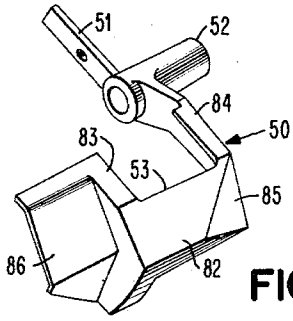



FIG. 4

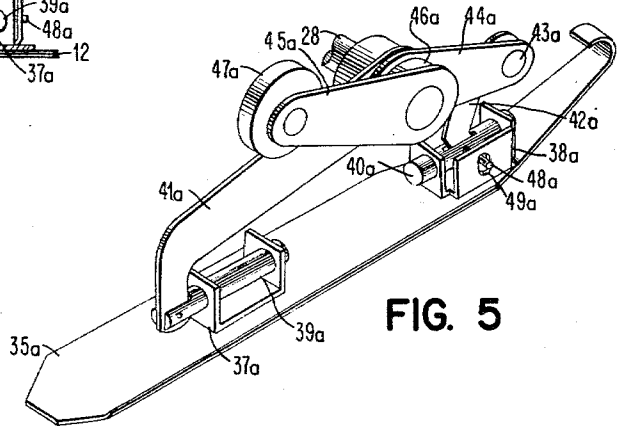



FIG. 5

United States Patent Office 3,173,681 Patented Mar. 16, 1965



3,173,681

# SHEET HANDLING APPARATUS

Bruce F. David, Vestal, and Ralph L. Dimenna, Binghamton, N.Y., assignors to International Business Machines Corporation, New York, N.Y., a corporation of New York

Filed Apr. 25, 1962, Ser. No. 190,011
16 Claims. (Cl. 271—34)

This invention relates to sheet handling apparatus and more particularly to apparatus capable of processing sheets at high speeds despite random variations in the size and degree of warpage and/or rigidity of the sheets.

Data processing machines are now widely used to read bits of information from bank checks and deposit slips and then sort them according to the information read therefrom. Some of these machines employ a picker belt which feeds checks from the top of a stack in a hopper. The picker belt advances the checks between fixed upper and lower guides and into the bite of a separator mechanism that delivers checks one at a time to an aligning drum. Sensing means is provided for contacting the topmost check near the leading edge thereof and at generally the mid-transverse point thereof. This provides a means of sensing the height of the stack with reasonable accuracy provided the stack is flat. This sensing means activates a stack height control mechanism that operates as necessary to maintain a substantially constant predetermined gap between the top sheet of the stack and the under side of said upper guide.

Such machines operate satisfactorily under most conditions. However, difficulties have been encountered in feeding checks and deposit slips under certain conditions, such as where the stack is warped, or the checks and slips are made from poor grade paper stock.

If a stack is warped convexly in a side-to-side or transverse direction, the gap between the side edges of the sheet and the upper guide will exceed said predetermined amount. The side edges of the sheet may therefore droop enough to cause one of the leading corners to strike some obstruction and prevent the sheet from entering the bite of the separator mechanism. However, if a stack is warped concavely in a transverse direction, the sensing means will maintain the predetermined gap between the low central section of the stack and the upper guide. Hence, the upwardly bowed side portions of the stack will be forced up against said upper guide. This may effectively pinch and brake the top sheet so that it cannot be fed by the picker belt. On the other hand, if the stack is warped concavely in a longitudinal direction, the sensing means (which senses near the now upwardly bowed leading edge of the top sheet) will respond as if the entire area of the sheet is level at that height. This, in turn, will result in an excessive gap between the low part of the stack and the upper guide. Conversely, if the stack is warped convexly in a longitudinal direction, the sensing means will provide too little gap. This may cause binding and possibly prevent feeding of the top sheet; or the downturned leading edge of the sheet may fail to enter the bite of the separator mechanism.

On the other hand, to reduce costs, some banks use or would prefer to use inferior grades of paper stock for their checks and deposit slips; i.e., use paper of lighter weight and shorter grain than presently is recommended. However, in machines of the type above described, inferior grade paper will buckle and jam. This is because such paper is limp and flimsy and is inadequately supported as it is advanced from the hopper into the bite of the separator mechanism.

It is therefore one object of this invention to provide an improved sheet handling apparatus which is capable of use in high speed data processing machines.



Another object is to provide an improved sheet handling apparatus which is capable of processing sheets from stacks which are warped, either convexly or concavely, in longitudinal or transverse directions, and/or include mutilations such as folds, missing corners, staples, etc.

Another object is to provide an improved sheet handling apparatus capable of processing sheets of poorer grade paper stock than can be handled by machines of the types above described.

An additional object is to provide an improved sheet handling apparatus wherein the sheets are supported over substantially the entire distance from the hopper to the separator means, and wherein undesired binding and braking of the top sheet is eliminated.

Another object is to provide an improved sheet handling apparatus embodying means for preventing any skewed sheet from being driven toward one transverse side of the apparatus but permitting such sheet to move toward the opposite side of the apparatus.

A further object is to provide an improved sheet handling apparatus embodying a picker mechanism wherein the driving force of the picker mechanism is readily adjustable without requiring substitution of parts, thereby to facilitate selection of a driving force best suited for particular conditions.

According to these objects, the sheet handling apparatus comprises movable upper and lower guide elements for guiding sheets substantially the entire distance from a stack in a hopper to a separator mechanism. The upper guide elements, which are transversely spaced, rest on the top of the stack and project forwardly of the leading edge of the stack. The lower guide element, which is closely adjacent the leading edge of the stack, has a beveled surface that extends downwardly and forwardly toward the stack to provide a tapered entry to a throat; and the transverse sides of the beveled surface are chamfered or cut-back so sheets with drooping side edges will not snag against the lower guide element. The guide elements are yieldably biased toward each other so the throat can expand as necessary to pass a bunch of superposed sheets. Also, the throat can move up and down because the upper guide element will yield with a scissor-like action and the lower guide element can rock a limited degree toward the upper guide element. The upper guide elements also can rock transversely limited degrees to conform to the configuration of stacks with convex or concave transverse warp.

The apparatus also preferably includes a stack-height sensing element that is castered and yet swivelable through an angle so limited as to encourage sheets to move toward one lateral edge yet prevent them from moving toward the opposite lateral edge. Also, the driving force can conveniently be varied by shifting a force-adjusting weight relative to the fulcrum point of the rockable support for the sheet-driving means.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings, wherein:

FIG. 1 is a side elevation view of a sheet handling apparatus embodying the invention;

FIG. 2 is a plan view, to enlarged scale, of the apparatus shown in FIG. 1;

FIG. 3 is a view taken along the line 3—3 of FIG. 2; and

FIGS. 4 and 5 are enlarged perspective views of a rockable beveled lower guide element and a ski-like upper guide element, respectively, which normally are biased together to provide the intersecting surfaces of an ex-

pansible constriction or throat through which sheets are feedable.

*Description*

As illustrated in FIG. 1, the sheet handling apparatus embodying the invention comprises a hopper, designated generally **10**, having a platform **11** for supporting a stack of sheets **12**. The platform **11** is carried by an elongated piston **13** that telescopes into a cylinder **14**.

Suitable means is provided to maintain the top of the stack at a substantially constant height. As illustrated, this means includes a valve mechanism **15**, preferably comprising a spool valve (not shown), for controlling the volume of pressure fluid conveyed via a delivery line **16** to a chamber adjacent the lower end of the piston. The spool valve has an extension **17** which is resiliently biased into contact with a flat surface provided by a collar-like member **18** that is carried by, and between the ends of, a sensing rod **19**. Near its one end, this rod **19** is adjustably secured, as by a setscrew **20**, to a support or link **21**. This link **21** is rockably mounted on a pin or stud **22** that a carried by a stationary back plate **23** defining the rear wall of the hopper. Gravity, assisted by the bias force exerted on the sensing rod **19** via the extension **17**, is sufficient to maintain the free end of said rod in contact with the flat top surface of a piece **24**.

Referring now to FIGS. 1, 2 and 3, a lever **25** has two transversely offset arms **26**, **27**. Lever **25** has a central hub-like portion which connects the two offset arms and is rockably supported on a stud **28** carried by the back plate **23**. Lever arm **26** supports the piece **24** and also provides a socket or recess for receiving a vertical spindle **29**. This spindle projects from the upper end of a caster arm **30** that carries a horizontally disposed pin **31** on which a castered sensing wheel **32** is mounted. Wheel **32** rolls on the top sheet of the stack, and thus senses the height of the stack (at least at the point where it contacts said stack). A counterweight **33** is laterally secured, as by a pin or stud, to the lever arm **27**. This counterweight is provided to offset and counterbalance a substantial portion of the load on the sensing wheel **32**.

With the apparatus as thus far described, it will be apparent that the sensing wheel **32** and hence the piece **24** will drop as sheets are fed off the stack. Due to gravity and possibly the bias force exerted on the sensing rod **19** by the valve extension **17**, the sensing rod will rock counterclockwise a corresponding degree about stud **22**. This will permit the spool valve of valve mechanism **15** to move downward to a supply position. In this position, the valve mechanism will connect the delivery line **16** to a supply line **34**, for thereby supplying pressure fluid from a source (not shown) via the delivery line to the chamber (not shown) provided in cylinder **14** adjacent the lower end of piston **13**. Pressure fluid thus supplied to said chamber will raise the piston, and hence the platform **11** and the stack of sheets **12**, until the sensing wheel **32** and thereby rod **19** are raised sufficiently to operatively restore the spool valve to a neutral or lap position. In this position, the spool valve cuts off the delivery line **16** concurrently from the supply line **34** and from an exhaust port **34***a*. Hence, fluid under pressure will be bottled up in the chamber and thereby terminate upward movement of the stack.

It will thus be seen that, as sheets are fed off the platform **11**, the valve mechanism **15** will operate automatically to raise the platform as and when necessary to maintain the top of the stack at a substantially constant height.

Referring now to FIGS. 1, 2, 3, 5, two ski-like upper guide elements **35***a*, **35***b* are provided which straddle the castered sensing wheel **32** and have flat bottom surfaces that rest on the top of the stack. These elements extend generally parallel to the back plate **23** and project beyond the leading edge of the stack and over the end wall **36** of the hopper.

The structure associated with guide element **35***a* will now be described. Suitably secured to the upper side of element **35***a* are two longitudinally spaced U-shaped brackets **37***a*, **38***a* having pairs of aligned holes for receiving longitudinally aligned pins **39***a*, **40***a*, respectively. A lever **41***a* has its one end rockably supported on stud **28** and its other end staked to pin **39***a*. A link **42***a* has its lower end staked to pin **40***a* and its upper end pivotally connected by a pin **43***a* to one (**44***a*) of two transversely offset arms **44***a*, **45***a* of a lever **46***a*. Lever **46***a* has a central hub-like portion that joins the two offset arms and is rockably supported on stud **28**. A counterweight **47***a* is laterally secured, as by a pin, to the outer end of lever arm **45***a*. Counterweight **47***a* offsets and counterbalances a substantial part of the weight or load that would otherwise be imposed on the top of the stack by link **42***a* and the trailing portion of the ski-like guide element **35***a*.

It will thus be apparent that upper guide element **35***a* is movable up and down with a scissor-like action and also is rockable transversely relative to the axis of the longitudinally aligned pins **39***a*, **40***a*. Suitable means preferably is provided to limit the degree of such transverse rockable movement. As illustrated, this means comprises a pin **48***a* that not only stakes pin **40***a* to link **42***a* but also projects radially from pin **40***a* into an elongated slot **49***a* provided in a portion of bracket **38***a*. Thus, upper guide element **35***a* can rock to limit positions defined by the contact with opposite ends of the slot **49***a*.

Secured to the upper guide element **35***b* are components **37***b* through **49***b* which correspond in function, if not precisely in configuration, with the corresponding components **37***a* through **49***a*, respectively, that are secured to guide element **35***a*. Hence, these components **37***b* through **49***b* will not be redescribed in detail. It might be noted, however, that the offset arms **44***b* and **45***b* of lever **46***b* are bent, as shown in FIG. 2, to clear the piece **24** and the lever **25** that support the castered sensing wheel **32**. Also, the lever **41***b* has a laterlly projecting part **41***b'* to provide a stop under a condition hereinafter to be described.

As best shown in FIG. 4, a lower guide element **50** comprises a tail portion **51** that joins a hub portion **52** from which projects a generally U-shaped guide portion **53**. Portion **53** is disposed below the projecting end of the upper guide elements **35***a*, **35***b* and is directly adjacent the hopper wall **36**. A stud **54** passes through the hub portion **52** and a screw-threaded into the back plate **23**. A suitably anchored helical bias spring **55** pulls on the tail portion **51** to rock the element **50** counterclockwise about stud **54** toward a limit position defined by contact with a stop **56**. However, the counterweights **47***a*, **47***b* (acting through the overlying portions of the upper guide elements **35***a*, **35***b*) normally will exert sufficient force on the guide portion **53** to slightly overcome the force of spring **55**; and stop **56** will be effective only under a condition hereinafter to be described.

The unusual configuration of guide elements **35***a*, **35***b* and **50** is to provide practically continuous support for sheets **12** as they are fed off the stack by a sheet feed mechanism **57** and advanced into the apex of a generally tapered constriction or throat **58** (FIG. 1) defined between the intersecting surfaces of said elements. The lower guide element **50** also permits warped sheets with drooping edges to be fed reliably without jamming, as will become apparent from subsequent description of operation.

As illustrated in FIGS. 1 to 3, the sheet feed mechanism **57** comprises a picker belt **60** which is driven by a pulley **61** from a shaft **62** and passes around an idler pulley **63** disposed just above the stack. Pulley **63** is rotatably mounted on a stud carried by a support arm **64** that is rockably supported on shaft **62**. A cylindrical weight **65** is adjustably positionable along a slot **66** in arm **64** and is clamped in a selected position by a screw-type clamping knob **67**. Thus, the driving force with which the picker belt **60** drives the sheets off the stack can be readily adjusted as necessary to suit differing conditions of humidity and/or frictional characteristics of a par-

ticular type of stock being fed. The driving force will, of course, increase as the weight 65 is moved farther from the shaft 62.

As shown in FIGS. 1 to 3, the picker belt 60 contacts the top of the stack at a point which is transversely aligned with and located between the trailing brackets 38*a*, 38*b* on the upper guide elements 35*a*, 35*b*, respectively. On the other hand, the castered sensing wheel 32 contacts the top of the stack at a point which is near the leading edge of the stack and is transversely aligned with and located between the leading brackets 37*a*, 37*b* on elements 35*a*, 35*b*, respectively.

As sheets enter the throat 58, they will force the guide elements 35*a*, 35*b* and 50 relatively apart against resistance of spring 55 and pass into the bite of a separator mechanism 68. This separator mechanism may, for sake of illustration, be of the type shown and described in the co-pending application of Bruce F. David, U.S. Ser. No. 67,029, filed November 3, 1960, Patent No. 3,052,465 and assigned to the assignee of the present invention.

This separator mechanism 68 comprises, briefly, a high-friction belt 69 mounted on a separator wheel 70 that is driven clockwise (as viewed in FIG. 1) by a shaft 71. Belt 69 drives any sheet in direct contact therewith in a sheet-advancing direction (i.e., away from the stack). Belt 69 impinges on a run R of a low friction restraint belt 72 that preferably is driven at a very slow speed in a direction tending to move any sheet in contact therewith back toward the stack. Thus, the restraint belt 72 assists in separating sheets which accumulate in the throat 58 and assures that sheets will be delivered one at a time and topmost sheet first into an exit channel 73 defined between stationary guides 74, 75 extending toward an aligning means (not shown). Also, since belt 72 moves, it presents a changing surface for engagement by the sheets (or by the rapidly moving separator wheel belt 69, if no sheets are in the bite between said belts) thereby distributing wear evenly over the entire outer surface of the long, low-friction restraint belt 72.

*Operation*

Assume initially that the valve mechanism 15 is in its neutral or lap position, in which it disconnects the delivery line 16 concurrently from both the supply line 34 and exhaust port 34*a*; that pressure fluid is consequently bottled up in line 16 and hence in the chamber below spindle 13; and that the platform 11 is therefore stationary and in the position shown in FIG. 1, for maintaining the top sheet 12 of the stack at a corresponding preselected height. Assume also that the weight 65 has been adjustably positioned along slot 66 to condition the picker belt 60 to provide a corresponding desired driving force for the sheets.

Under the assumed conditions, the various components will be in the respective positions in which they are shown in FIGS. 1 to 3 of the drawings.

Assume now that power is turned on to drive the picker belt 60, separator wheel 70, and restraint belt 72 in the directions indicated by the respective arrows.

As the picker belt 60 starts to turn, it will drive the leading edge of the top sheet 12 of the stack under the upper guide elements 35*a*, 35*b* and over the end wall 36 of the hopper and into the constriction or throat 58. As each sheet enterse throat 58, the central portion of its leading edge will be cammed upwardly by and along a beveled surface 82 (see FIG. 4) and then directed on to two transversely spaced rails 83, 84 that form part of guide portion 53 and are located at the narrowest point of the throat.

Meanwhile, the sheet will rock the lower element 50 clockwise enough to provide the necessary space for the sheet to move on to these rails. As the leading edge of the sheet moves beyond the rails 83, 84 it will pass into the bite between the separator belts 69 and the run R of the restraint belt 72.

Assume now, that instead of feeding just the top sheet from the stack, the picker belt 60 advances a bunch of superposed sheets which tend to become interlocked because of embossments or surface frictional characteristics. It will be apparent that lower guide element 50 will rock clockwise, against the bias of spring 55, and thereby expand the throat 58 to that degree necessary to permit passage of most, if not all, of the sheets through said throat.

If the stack has a convex transverse warp, the side edges of the sheets will droop. Therefore, the lower guide element 50 is chamfered at 85 (see FIG. 4) and has a stepped-down beveled surface at 86, so that the drooping side edges of the sheet or sheets can pass to either side of the central beveled surface 82. Hence, as the sheet or sheets advance toward the separator mechanism 68, they will contact the beveled surface 82 and be cammed gradually upward on to the rails 83, 84; and in the meantime, the drooping side edges will gradually be elevated to the plane of said rails. Thus, the drooping portions of the leading edge of the sheets will be prevented from striking any obstruction that might cause a jam or misfeed.

If the stack has a concave transverse warp as viewed in FIG. 1, the sensing wheel 32 will give a false reading of the average stack height. Thus, the valve mechanism 15 will operate to raise the upwardly extending side edges of the sheets to a height at which they would bind against the upper guide elements if the latter were stationary, as in apparatus heretofore proposed. However, under this condition, the levers 41*a*, 46*a* and 41*b*, 46*b* will spread apart with a scissor-like action and thereby permit the upper guide elements 35*a*, 35*b*, respectively, to yield upwardly and prevent such binding. As upper guide elements 35*a*, 35*b* thus move upward, lower guide element 50 will rock counterclockwise a limited degree until tail 51 strikes stop 56. Thus, the throat 58 will open up to facilitate advancement of sheets from the stack to the separator mechanism 68.

Meanwhile, whenever the stack has either a convex or concave transverse warp, the upper guide elements 35*a*, 35*b* will rock transversely relative to the axis of pins 39*a*, 40*a* and 39*b*, 40*b*, respectively, limited degrees determined by the slots 49*a*, 49*b* and tend to remain in substantially intimate guiding contact with the top of the stack.

On the other hand, if the stack is warped convexly in a longitudinal direction, the sensing wheel 32 (which senses the height of the stack at a point near the drooping leading edge of the top sheet) will respond as if the entire area of the check were at that relatively low height. Hence, the valve mechanism 15 will operate to raise the low central portion of the stack too high. However, the upper guide elements 35*a*, 35*b* will yield upwardly in the same manner as heretofore described for concave transverse warp, and thus assure that the sheets can be fed by the picker belt 60 without binding against the upper guide elements. Moreover, the downturned leading edge of the sheet will strike the lower end of the beveled surface 82 and then be advanced up said surface and on to the rails 83, 84 because the beveled surface is directly adjacent the leading edge of the stack.

If the stack is warped concavely in a longitudinal direction, the sensing wheel 32 will read the stack height at a point near the upwardly bowed leading edge of the top sheet. Thus, the low part of the stack will tend to be somewhat lower than the desired height. Since the upper guide elements 35*a*, 35*b* project beyond the leading edge of the stack, they will tend to depress the upturned leading edges of the sheets as they advance through the throat 58 and into the bite of the separator mechanism 68. Also, if the upper guide elements should be elevated above their nominal height due to the warpage,

the rails 83, 84 of lower guide element 50 will be raised to an upper limit position defined by contact of tail 51 with stop 56.

From the foregoing, it will be apparent that the upper guide elements 35*a*, 35*b* and the rails 83, 84 of lower guide element 50 can move upwardly and downwardly to suit the configuration of sheets being fed off the stack. Also, the sheets are guided over practically the entire distance from the leading edge of the stack to the bite of the separator mechanism 68. The sheets are guided in such manner by these guide elements that downturned leading edges or side edges are gradually elevated and upturned leading edges or side edges are depressed to direct the sheets through the narrow, yet expansible throat 58 and into the bit of the separator mechanism 68.

Assume now that the top sheet has wrinkles, tears, holes, staples, or other imperfections, or that the stack has a non-symmetrical warp, or that for these or other reasons the upper guide elements 35*a*, 35*b* exert significantly different pressures on the top of the stack. This will cause the leading end of the top sheet to tend to swing toward or away from the back plate 23 as it is being fed by the picker belt 60; it being noted that the back plate lies in a plane which is substantially coincident with the plane of a registration or aligning edge (not shown) against which the sheets are aligned after leaving the separator mechanism 68. The sensing wheel 32 is therefore castered so as to swivel between limit positions defined between a plane parallel to back plate 23 and another plane extending at an acute angle $\theta$ from the first plane toward the back plate and leading edge of the stack. One limit position is defined by lateral contact at 90 (see FIGS. 2, 3) of a forwardly projecting portion of caster arm 30 with a downturned and forwardly extending portion 24*a* of piece 24. The other limit position is defined by lateral contact of castered arm 30 with a stop pin 91. Thus, the castered sensing wheel 32 will operate to prevent the leading ends of the sheets from moving away from back plate 23, but will permit said leading ends to move toward the back plate.

Assume now that because of an inconsistent coefficient of friction of the sheet, or some other reason, the sheet tends to become skewed after entering the bite of the separator mechanism 68. So long as the sensing wheel 32 is in contact with the trailing part of the sheet, said wheel will prevent the sheet from swinging away from the back plate.

To complete the description, it might be noted that to place a new stack of sheets on the platform 11, the sensing rod 19 is manually raised. This will push the valve extension 17 upward and thus shift the spool valve of mechanism 15 upward to an exhaust position, in which delivery line 16 is connected to the exhaust port 34*a*. As the chamber below piston 13 is vented, the platform 11 will drop by gravity toward a lower limit position in which the platform rests on the top of cylinder 14.

Meanwhile, as the platform 11 is lowered, a laterally projecting tab 24*b* on the piece 24 will come to rest on the laterally projecting part 41*b*′ of the lever 41*b* that is rockably mounted on stud 28. Also, a screw 29*a* (FIGS. 2, 3)—which is inserted through a washer and a hole in piece 24 and is screwed into a suitable threaded bore in the spindle 29—will retain the spindle 29 in its socket so that the sensing wheel 32 will not drop as the platform is lowered.

It will also be noted that, when the platform 11 is lowered, the ski-like upper guide elements 35*a*, 35*b* will not drop because they are supported on stud 28. Moreover, these elements 35*a*, 35*b* will not tilt appreciably because their leading ends will extend into the confined space between the separator belt 69 and the lower guide element 50.

*Summary*

It will thus be seen that the sheet handling apparatus embodying the invention comprises sensing means, including a castered sensing wheel 32, for sensing the height of a stack of sheets 12 supported on a platform 11 in a hopper 10. This sensing means controls operation of a valve mechanism 15 that operates to supply pressure fluid to or release pressure fluid from a chamber below a platform-supporting piston 13, as necessary to maintain the top of the stack at a substantially constant height. A sheet feed means, such as a picker belt 60, feeds the top sheets off the stack, and then over the leading wall 36 of the hopper and through a tapered expansible throat 58 and into the bite of a sheet-separating mechanism 68.



The throat 58 is defined between movable upper and lower guide means. The upper guide means preferably comprises two ski-like guide elements 35*a*, 35*b* which rest on the top of the stack and straddle the sensing wheel 32. Each upper guide element 35*a* or 35*b* is pivotally supported on two levers 41*a*, 46*a* or 41*b*, 46*b* which, like scissor blades, can move together and apart, thereby to permit said element to move up and down limited degrees. Hence, if the stack is warped, the false reading of the average stack height given by the sensing wheel 32 cannot cause undue pinching of the stack against the under side of the upper guide elements, because the upper guide elements can yield upwardly. Each upper guide element is connnected to its support levers by means providing a universal-joint-like connection which permits the guide element to swing limited degrees transversely. This permits the upper guide element to conform to the curvature of the top of the stack, even if it is warped convexly or concavely in a transverse direction.

The lower guide means preferably comprises a lower guide element 50 which is rockably disposed adjacent the leading wall 36 of the hopper and under the overlying portions of the upper guide elements 35*a*, 35*b* that project beyond said wall. The lower guide element 50 is resiliently biased so that its two transversely spaced rails 83, 84 (FIG. 4) will normally make flush contact with the projecting portions of the upper guide elements 35*a*, 35*b*, respectively. The lower guide element also has a beveled surface 82 which diverges downwardly at an acute angle from the rails and extends toward the leading wall 36 of the hopper. Thus, the throat 58 is tapered and of greatest height adjacent the hopper. This beveled surface 82 guides the leading edges of the sheets upward over the rails, even if they should tend to strike the lower guide element at a point substantially below the rails. At opposite transverse sides of the beveled surface 82, the lower guide element 50 is chamfered at 85 and cut down at 86. This asures that sheets with convex transverse warp and hence drooping side edges will be guided through the throat and into the separator mechanism, and will not be misdirected or cause jams.

Counterweights 33, 47*a*, 47*b* are provided to offset some of the weight and hence load that would be exerted on the top of the stack by the sensing wheel 32 and by the trailing portions of the upper guide elements 35*a*, 35*b*. This minimizes the amount of driving force which must be applied by the picker belt 60. Because of this reduction in required driving force and the fact that the upper and lower guide elements support the sheets over substantially the entire distance from the stack to the bite of the separator mechanism 68, this apparatus permits poor grade paper stock to be fed without buckling.

The driving force exerted by the picker belt 60 can be varied easily by manually adjusting the distance the weight 65 is disposed from the support shaft 62.

The castered sensing wheel 32 is constrained to swivel through an angle $\theta$ defined between a plane parallel to back plate 23 and another plane extending obliquely toward the leading edge of the stack and the back plate. Thus, the sensing wheel 32 will encourage movement of a sheet toward the back plate but prevent sheet movement away from the back plate.

While the invention has been particularly shown and described with reference to a preferred embodiment there-

of, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Sheet handling apparatus comprising
guide means including two movable elements urged relatively toward each other for providing a normally constricted throat expansible by sheets fed through the throat,
separator means distinct from said guide means for receiving sheets fed through the throat and delivering them singly and successively into a prescribed path,
means independent of the guide means for feeding sheets from one end of a stack and through the throat for delivery to the separator means, and
means including one of said elements for sensing said end of the stack and operatively causing the location of the throat to shift according to changes in the position of said end of the stack.

2. Sheet handling apparatus comprising
guide means providing an expansible throat into which the leading edges of the sheets are fed from a stack, said guide means including
one movable guide contacting the end of the stack and overlying the leading edge thereof, and
another movable guide adjacent said leading edge and cooperating with the overlying part of said one guide to define said throat,
means for biasing said guides relatively together, and
means for feeding sheet from the stack through the throat whereby the throat will expand substantially only to that degree necessary to permit passage of the sheets therethrough, and the situs of the throat will be controlled by the existing position and configuration of the stack.

3. Apparatus according to claim 2, wherein said other guide is mounted so its throat-providing surface is rockable a limited degree toward said one guide,
whereby the throat will spread progressively as the distance from the limit position of said surface to the end position of the stack increases.

4. Sheet handling apparatus comprising
guide means including at least two transversely spaced elements contacting one end of a stack of sheets and overlying the leading edges thereof, and at least one member adjacent the leading edge of the stack,
means yieldably urging said elements and member relatively toward each other to provide an expansible throat adjacent the leading edge of the stack,
means for feeding sheets from one end of the stack and through the throat, and
means for suspending at least one of said elements in a manner permitting such element to move in directions toward and away from said end of the stack and also concurrently rock transversely of the path of feeding of the sheets by the sheet feed means,
thereby to permit each such suspended element to conform to the configuration of said end of the stack despite convex or concave transverse warp of the stack.

5. Apparatus according to claim 4, wherein said member has a surface which diverges from said elements in a direction generally toward the leading edge of the stack to give the throat a generally tapering entry configuration with maximum opening near the stack so that any sheets with downturned edges fed from the stack will be guided toward the narrowest part of the throat.

6. Apparatus according to claim 5, wherein the said surface is cut away at each transverse side thereof to permit sheets with transverse convex warp to be guided toward the apex of the throat.

7. Sheet handling apparatus comprising
means for feeding sheets successively from the top of a stack,
at least one ski-like guide element which rests on the stack and projects beyond the leading edge thereof,
support means operable in scissor-like fashion for permitting upward and downward movement of each guide element,
at least one rockable guide member providing a beveled surface closely adjacent the leading edge of the stack and cooperating with the projecting portion of each element to define a generally tapered throat, the widest part of which is nearest the stack, and
means yieldably biasing the elements and members toward each other such that the sheets normally will expand the throat only enough to permit passage thereof through the throat, and the sheets will be longitudinally supported for a distance sufficient to discourage buckling.

8. Sheet handling apparatus comprising
means, including a member, for sensing the height of a stack of sheets,
means controlled by the sensing means for maintaining the top of the stack at a substantially constant height,
guide means defining an expansible throat adjacent the leading edge of the stack for supporting sheets over a substantial length thereof as they are fed off the stack, and including
upper guide elements straddling said member and resting on the top of the stack and movable toward and away from the top of the stack and having portions projecting beyond the leading edge of the stack, and
at least one lower guide element adjacent the leading edge of the stack and biased toward said projecting portions to constrict said throat, and
sheet feed means for feeding sheets from the top of the stack into said throat,
whereby said guide elements can move relatively apart as necessary to permit passage of sheets through said throat.

9. Sheet handling apparatus according to claim 8, wherein
said lower guide element has a beveled surface that diverges downwardly at an acute angle from the upper guide elements and toward the leading edge of said stack,
thereby to provide a tapered throat of greatest height near the stack for guiding sheets into the narrowest part of the throat.

10. Sheet handling apparatus according to claim 9, wherein
the lower guide element has cut-away portions at each transverse side of said beveled surface to prevent sheets from snagging or jamming in the event the side edges of such sheets should droop.

11. Sheet handling apparatus according to claim 8, including means for permitting transverse rockable movement of each upper guide element so it can conform susbtantially to the configuration of the top of the stack if the stack is transversely warped.

12. Sheet handling apparatus according to claim 8, wherein
said member is a castered wheel, and including
means for so limiting the angle through which the wheel can swivel that the wheel in addition to performing a sensing operation will also serve to prevent sheets from moving toward one transverse side of the feed path and encuorage sheets to move toward the opposite side of said path.

13. Sheet handling apparatus comprising
means for feeding sheets one-edge first from a stack,
means defining a plane toward which another edge of the sheets are to be laterally aligned after feeding,
a rotatable castered element contacting the endmost sheet of the stack, and
means for permitting the element to swing through an arc defined between a line substantially parallel to

said plane and another line extending obliquely in the direction of feeding and toward said plane,

thereby to prevent said element from urging sheets away from said plane.

14. Sheet handling aparatus comprising

means defining a plane toward which sheets are to be directed for alignment,

a swivelable element contacting the endmost sheet of a stack,

means for feeding sheets from the stack, and

means for constraining swiveling of said element to cause said element to prevent movement of sheets away from said plane and encourage movement of sheets toward said plane as they are being fed by the feeding means.

15. Sheet handling apparatus comprising

means including a picker belt for feeding sheets from one end of a stack,

guide means providing an expansible throat into which sheets are advanced by the picker belt,

means controlled by the position of the end of the stack for correspondingly varying the location of the throat to maintain it substantially registered with said end of the stack and adjacent the leading edges of the sheets,

means including a rockable support for supporting the picker belt, and

an adjustably positionable weight movable toward and away from the point of such rockable support to vary the driving force imparted by the picker belt according to the distance of said weight from said point.



16. Sheet handling apparatus comprising

means for feeding sheets from one end of a stack,

guide means separate from the feeding means and including two elements urged relatively toward each other for providing a normally constricted throat adjacent said one end of the stack and expansible by the sheets fed thereinto by said feeding means as necessary to permit one or more of such sheets to pass through the throat,

separator means including a moving endless member separate from the guide means to receive sheets fed through the throat and deliver them singly and successively into a prescribed path, and

means including one of said elements for continuously sensing the position of said end of the stack to operatively cause the angular position of the entry end of the throat to change according to changes in the position of said end of the stack.

**References Cited by the Examiner**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,174,739 | 3/16 | Langston | 271—43 |
| 2,665,906 | 1/54 | Johnson | 271—36 |
| 2,989,307 | 6/61 | Weidenhammer | 271—62 |

SAMUEL F. COLEMAN, *Acting Primary Examiner.*

ROBERT A. LEIGHEY, WILLIAM B. LA BORDE, *Examiners.*