

Sept. 25, 1956

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2,764,409

METHOD AND APPARATUS FOR FRICTION FEEDING OF SHEETS

Filed June 18, 1953

3 Sheets-Sheet 1

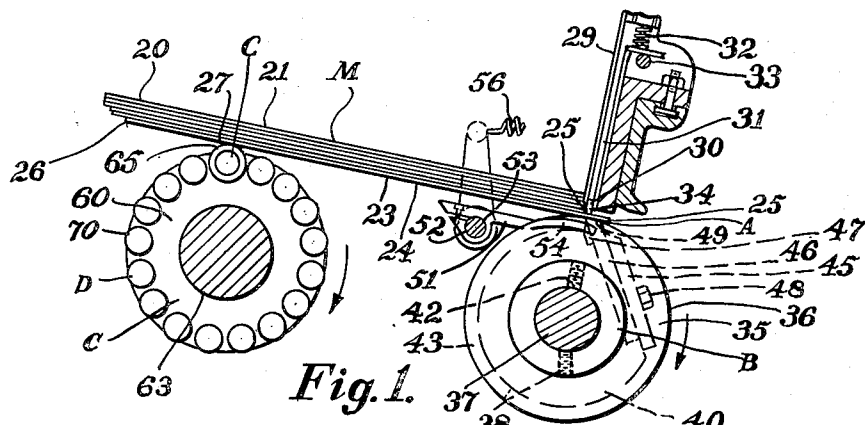


Fig. 1.

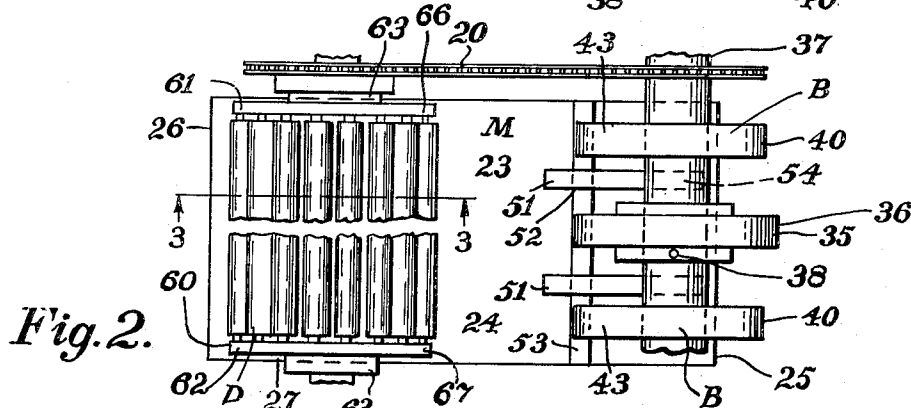


Fig. 2.

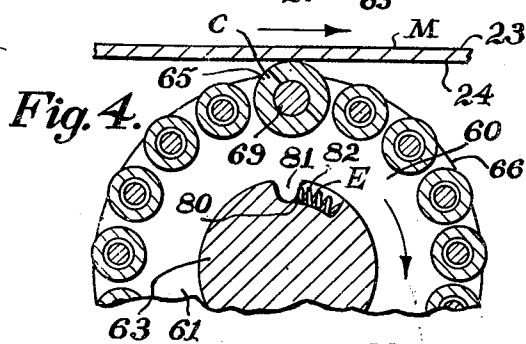


Fig. 4.

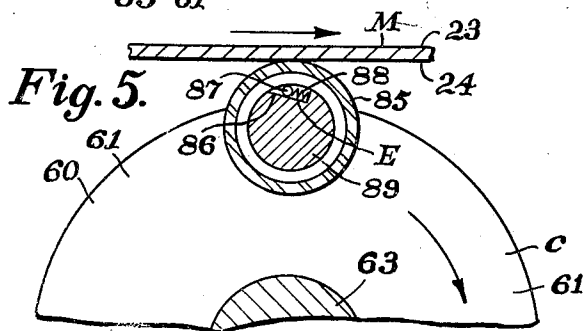


Fig. 5.

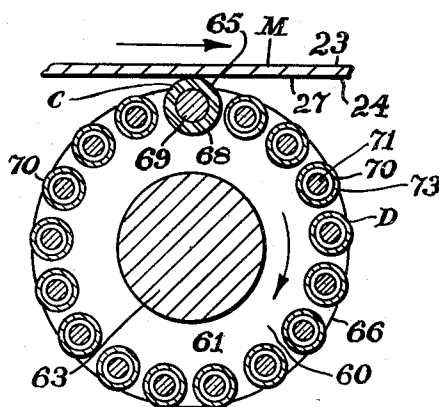


Fig. 3.

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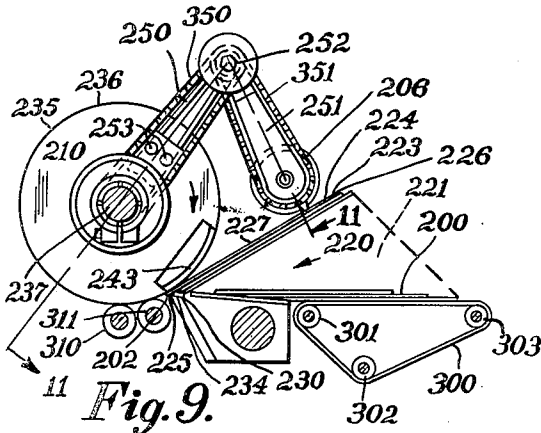


Fig. 9.

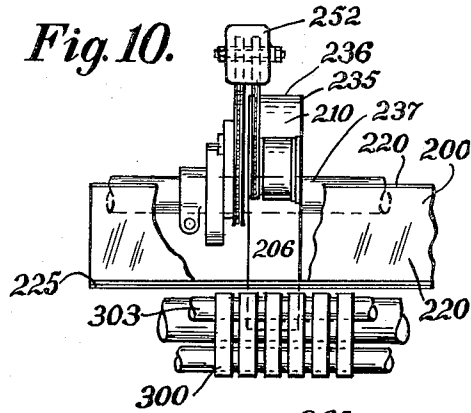


Fig. 10.

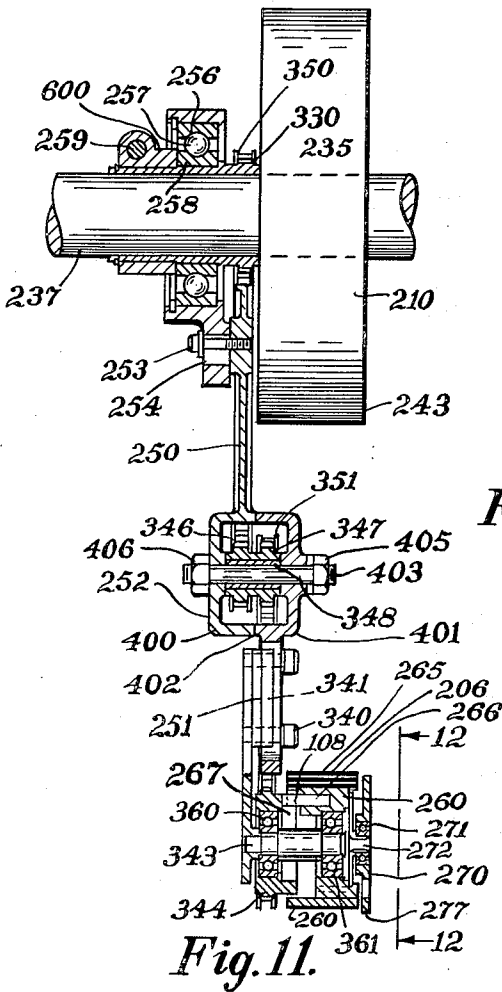


Fig. 11.

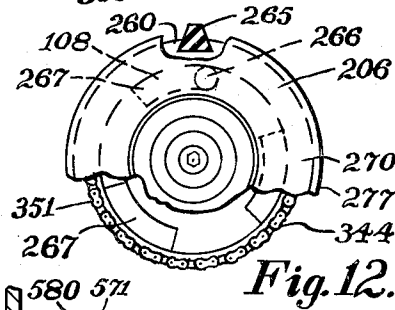


Fig. 12.

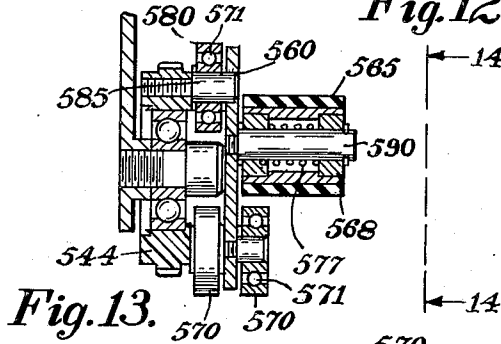


Fig. 13.

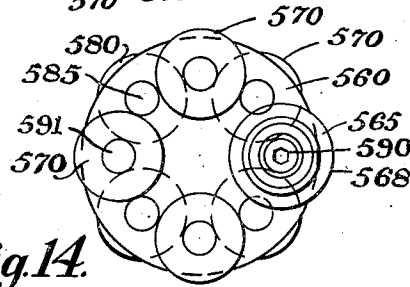


Fig. 14.

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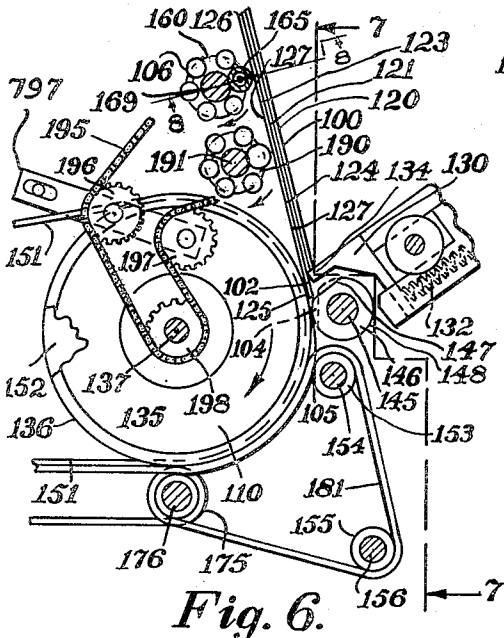


Fig. 6.

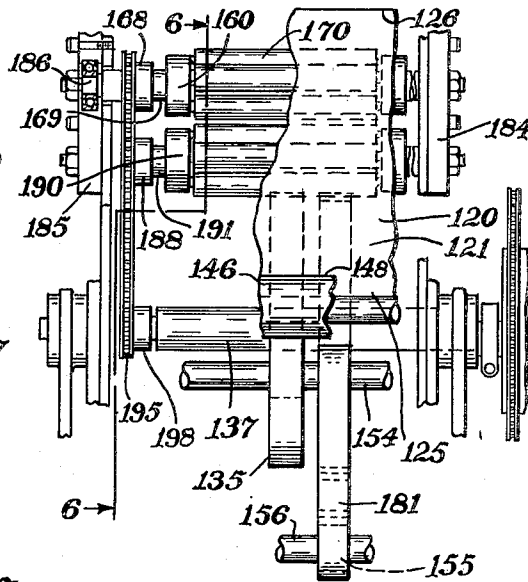


Fig. 7.

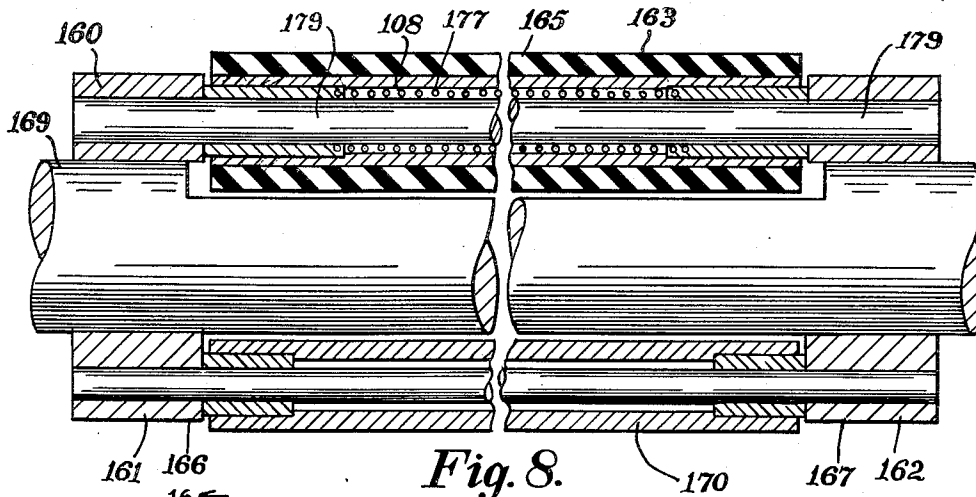


Fig. 8.

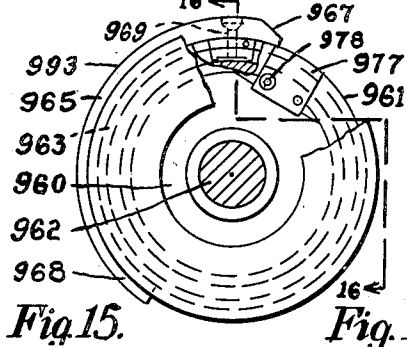


Fig. 15.

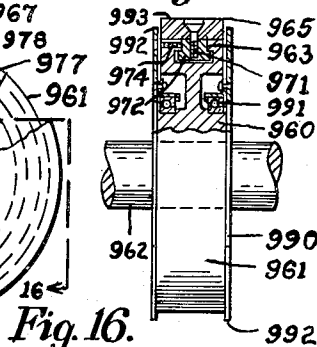


Fig. 16.

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## METHOD AND APPARATUS FOR FRICTION FEEDING OF SHEETS

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Application June 18, 1953, Serial No. 364,170

11 Claims. (Cl. 271-41)

This invention relates to an improved method and apparatus for automatically and successively sliding an individual sheet of box board, or similar material, from the end of a stack of such sheets at high speeds.

At present, the device generally used for the above purpose consists of a metal feed wheel having a high friction rubber insert in the circumference thereof and positioned at the forward or leading edge of a stack of sheets. A sheet separator is used in conjunction with the feed wheel and is formed of a low friction rubber positioned opposite the feed wheel to form a passage therebetween. The circumferential surface of the feed wheel is of smooth metal, whereby when this surface is in contact with a sheet, its grip is not sufficient to advance a sheet against the retarding effect of the low friction rubber sheet separator. However, when the high friction rubber insert on the feed wheel revolves into contact with a sheet, its friction is sufficient to advance the sheet past the low friction rubber sheet separator and away from the stack. Thus there is a critical balance between the friction of the separator and the friction of the insert on the feed wheel. In practice the balance is often upset by the collecting of lint or fibers on either rubber member, causing a slippage in the feeding, especially at high speeds of three hundred per minute or more, thereby affecting the timed operation of the machine.

In feeding thin sheets of paper at slow speeds to machines such as printing presses, a combing device has sometimes been used called a combing wheel. Such combing wheels are usually formed of a plurality of freely revolving, antifriction-surfaced rollers, cylindrically arranged around a pair of power driven discs. The combing wheel is lowered onto the top sheet of a stack of thin sheets and when the discs are revolved, a wave or ripple is produced in the top sheets, tending to fan, or comb out, the top sheets in the stack. The discs of such wheels have heretofore been closely spaced to form a narrow wheel and have had to be carefully centered to avoid twisting the sheet during advancement. Combing wheels of the above described type do not segregate the top sheet of a stack, but fan out all of the top sheets into an overlapping relation. They also do not function on the box board for which my invention is intended, which may be eighteen to thirty-five thousandths of an inch in thickness and incapable of being so waved or rippled.

In this invention the first feed mechanism is preferably a rotating feed wheel with a friction insert, or a rotating feed wheel which advances a sheet by engaging the same in a nip with another element, and it is positioned in advance of the leading edge of the stack of sheets whether that stack is contained in the magazine or hopper of top feeding, vertical feeding or bottom feeding mechanism. A sheet passage between a rotating sheet separator wheel and a rotating, or non rotating, sheet separator is also provided. The passage is normally equal to, or slightly less in height than the thickness of a single sheet or box blank and the passage is in advance of the leading edge of the endmost sheet in the stack and aligned to receive the edge portion of the end sheet when presented thereto. A portion of the circumferential surface of the feed wheel and/or separator wheel may be in tangential contact with

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the exposed surface of each end sheet, near the leading edge, as in prior devices, but the leading edge enters the passage only when the end sheet has been slidably advanced by what is called herein, the second feed mechanism.

The second feed mechanism of the invention is positioned to function before the first feed mechanism and is preferably opposite an intermediate area of the exposed flat face of the endmost sheet in the stack between the leading and trailing edges of said endmost sheet. It includes a rotating support, traveling in the same direction as the feed wheel, and having a friction element on its circumferential surface which periodically contacts the exposed flat face of the sheet and advances the sheet into the passage of the first feed mechanism. It also includes pressure-applying means which may have a friction or antifriction surface when freely rotating or an antifriction surface when non rotating. The pressure applying means thus has no appreciable tendency to advance a sheet but is in contact with the face of each successive end sheet, except when the friction element is in contact therewith, to press the remaining sheets of the stack flatwise against each other thereby creating friction between the same and holding back the next succeeding sheet while the end sheet is being segregated. Rotating stack agitation means, also having no appreciable tendency to advance a sheet, is preferably provided, said means preferably comprising a plurality of freely revolving rollers cylindrically arranged around the rotating support to vary the amount of pressure on the remaining sheets of the stack. No combing action is produced by this device because of the stiffness of the box board, the barrier to fanning out and the retarding effect of the friction of the sheet separator of the first feed mechanism and none is desired since the friction element on the rotating support of the second feed mechanism is provided to advance the end sheet. When the speed of the friction element of the second feed mechanism is equal to that of the first feed mechanism, it is obvious that each end sheet will be slidably segregated from the stack and then slidably removed from the stack, one sheet at a time with the remaining sheets in the stack under endwise agitation at all times.

However, efficiency and accuracy at high speed has been found to be increased by operating the first feed mechanism at comparatively high speed and the second feed mechanism at comparatively low speed. In its preferred embodiment, therefore, the friction element of the rotating support of the second feed mechanism is mounted to engage and advance the end sheet into the first feed mechanism and then to release any retarding effect when the sheet attains a higher rate of advance than the friction surface. When the friction element is in the form of a roller carried by the rotating support, the roller is provided with an overrunning clutch and when it is a non revoluble insert on the surface of the rotating support, the support itself is provided with an overrunning clutch. The clutch may be of the "free wheeling" type or may be a pin slidable in an elongated slot to permit the amount of release necessary.

Preferably, the second feed mechanism of the invention is approximately equal in width to the sheet being advanced thereby, so that the sheet-segregating, stack-pressing and stack-agitating elements contact the entire width of the sheet and thus have more operating surface and no tendency to twist the sheet out of alignment.

The principal object of the invention is to provide a feeding mechanism and method for positively sliding one sheet of box board at a time off the end of a stack at high speed such as three hundred or more per minute.

Another object of the invention is to provide a feeding mechanism and method which partially separates the

endmost sheet from the stack at comparatively low speed and then completely separates the sheet from the stack at high speed, the sheets being of boxboard of uniform thickness.

Still another object of the invention is to provide supplementary feeding mechanism which engages and retains control of an end sheet while slowly sliding the same forwardly off the next succeeding sheet, but releases its forward sliding control and has no retarding effect when the sheet is engaged and pulled away by a principal feed mechanism at a greater speed.

A further object of the invention is to provide feeding mechanism in which agitating means continuously exerts endwise pressure on the next succeeding sheets of a stack, thereby preventing double or triple feeding.

A still further object of the invention is to provide feeding mechanism in which a plurality of freely revoluble rollers exerts such endwise pressure in varying amounts on the next succeeding sheets of the stack, thereby agitating the stack and assisting in overcoming adhesion, friction, vacuums and similar forces which cause sheets to feed improperly at high speeds.

Another object of the invention is to overcome slippage, in feeding at high speeds by providing a rotating support with peripheral freely revoluble rollers and a friction element which initially engages the end sheet of a stack at a low speed and intermediate of the exposed face thereof, and then feeds the blank into higher speed feed mechanism, located in advance of the leading edge of the end sheet of the stack. Two rates of advancing speed in the same cycle of feeding can thus be achieved without tearing the blank or affecting the rate of production of the machine. Damage to any printing on the sheet and the collection of lint on friction elements caused by slippage of rotating rubber feeders when initially engaging an end sheet is also avoided by first sliding the sheet comparatively slowly and then sliding the sheet comparatively rapidly off the stack.

In the drawings, Fig. 1 is a side elevation partly in section of a typical bottom feed magazine with the invention applied thereto.

Fig. 2 is a bottom view of the device shown in Fig. 1.

Fig. 3 is an enlarged side elevation of the second feed mechanism shown in Fig. 1, in section on line 3—3 of Fig. 2.

Fig. 4 is a view similar to Fig. 3 of a second feed mechanism arranged to travel at less speed than the first feed mechanism and having a clutch on the rotating support shaft for releasing its drag.

Fig. 5 is a view similar to Fig. 4 showing the clutch mounted on the shaft of a revoluble sheet segregating member carried by the rotative support.

Fig. 6 is a side elevation partly broken away and in section of a typical vertical feed magazine with the invention applied thereto.

Fig. 7 is a front elevation of the device shown in Fig. 6 with parts broken away on line 7—7 of Fig. 6.

Fig. 8 is an enlarged sectional view on line 8—8 of Fig. 6 of the second feed mechanism shown in tandem in Figs. 6 and 7.

Fig. 9 is a side elevation partly in section of a typical top feeding magazine with the invention applied thereto.

Fig. 10 is a front elevation of the device shown in Fig. 9.

Fig. 11 is an enlarged front elevation in section on line 11—11 of Fig. 9 of the second feed mechanism shown in Figs. 9 and 10.

Fig. 12 is a side elevation partly broken away and from the direction of line 12—12 of Fig. 11.

Fig. 13 is a fragmentary sectional front elevation, similar to Fig. 11, of another form of the invention.

Fig. 14 is a side elevation from the direction of line 14—14 of Fig. 13.

Fig. 15 is a side view similar to Fig. 12 and Fig. 14 with parts broken away and showing a modification, and Fig. 16 is an end view, in section on line 16—16 of Fig. 15 of the device shown in Fig. 15.

In Figs. 1 to 3 the invention is shown as applied to a bottom feeding magazine 20, in which a plurality of flat sheets, such as the flat sheet M, are arranged flatwise in a stack 21. Each sheet M is about eighteen thousandths of an inch or more in thickness, for example, a box blank of box board of the type used in making folded paper boxes and the endmost sheet in the stack is designated as 23. Endmost sheet 23 has an exposed face 24, a leading edge 25, a trailing edge 26 and the exposed face 24 has an intermediate area 27 between leading edge 25 and trailing edge 26. Suitable upright guides or posts, well known in the art, and therefore not shown, may be used to retain the stack 21 in magazine 20 along the opposite side edges of the sheets M. An upright guide 29 is provided along the forward edges of the sheets M, there being incorporated therewith a sheet separator, or gate, element 30 of metal or rubber and metal, slidable in a slot 31 and constantly urged downwardly therein by a spring 32, but having a stop member 33. The tip 34 of the sheet separator element 30 is preferably beveled away from the leading edge 25 of endmost sheet 23 in order that an edgewise push from the leading edge 25 will tend to lift the element 30 and compress spring 32.

Directly opposite the terminal tip 34 of the separator element 30, a separator wheel 35, having an antifriction circumferential surface 36 of smooth metal spaced from tip 34 about the thickness of a single sheet, is rotatably mounted on a shaft 37, the wheel being arranged to revolve with shaft 37 by a set screw 38. In the embodiment shown in Figs. 1-5 one separator element 30 and one separator wheel 35 are provided, located centrally of the path of an endmost sheet 23 and forming therebetween a passage or gauge A, proximate the leading edge of the endmost sheet 23 of stack 21 in magazine 20.

On each opposite side of separator wheel 35, a feed wheel 40 is rotatably mounted on shaft 37 and arranged to revolve therewith by means of set screw 42. Feed wheel 40 has an elongated portion of its circumferential surface in the form of a friction insert 43 and a segment of the wheel is cut away to accommodate a clamping bar 45, another insert 46, preferably of high friction rubber, a support 47 and a clamping bolt 48. The arcuate sheet-contacting surfaces 49 of rubber inserts 46 and 43 adhere to the leading edge portion of the face 24 of each endmost sheet 23 presented into passage A and move the sheet through the passage and away from the stack at a rate of advance equal to its rate of revolution around shaft 37.

Preferably a lever such as 51 is provided in each space between separator wheel 35 and the adjacent feed wheel 40, the levers 51 being each pivotally mounted at 52 on a shaft 53 and having a curved terminal end 54. A suitable cam, not shown, is provided to raise the ends 54 of levers 51 up into the path of an endmost sheet 23, at passage A, immediately after a sheet has passed through the passage, thereby providing a retarding force on the next succeeding endmost sheet 23. A spring 56 is also provided to move the ends 54 of levers 51 out of the path of a sheet 23 when the rubber inserts 43 and 46 of feed wheels 40 are ready to operate and during their operation.

Rotatably mounted feed wheels 40, 40 together with their friction inserts 46 and 43 form the first feed mechanism B of this embodiment of the invention.

The second feed mechanism C includes a rotating support 60 formed by a pair of identical discs 61 and 62 oppositely disposed on a shaft 63 and arranged to revolve therewith in the direction of the arrow, and in the same direction of rotation as wheels 35 and 40.

A sheet segregating element 65 preferably of rubber,

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extends between opposite points adjacent the circumferential surfaces 66 and 67 of discs 61 and 62 and includes a friction surface 68 extending radially beyond the circumference of the discs and extending transversely about the width of a sheet M.

In the form of the invention shown in Figs. 1-3, the sheet segregating element 65 encircles a shaft 69 but neither the element 65 nor the shaft 69 is mounted to revolve with relation to discs 61 and 62. The second feed mechanism C is positioned intermediate of the face 24 of each endmost sheet 23 of stack 21 and, in this bottom feed type, the stack rests thereupon. As shown in Fig. 5 the circumferential surfaces 66 and 67 of rotating discs 61 and 62 may form the rotating stack pressing means of the second feed mechanism because, as shaft 63 revolves in synchronization with shaft 37 of the first feed mechanism, the flat sheets M are pressed downward by their own weight which pressure is opposed by the surfaces 66 and 67. The rotating sheet segregating means of the invention includes the rotating supports or discs 61 and 62 and the sheet segregating element 65 carried therebetween. Each rotation of the second feed mechanism C causes element 65 to adhere to face 24 of an endmost sheet 23 and advance the leading edge portion thereof into the passage A, lifting the element 30 slightly in so doing. The surface 49 of high friction rubber insert 46 then rotates into position on shaft 37 to adhere to and advance the endmost sheet 23 further through passage A assisted by the elongated friction insert 43 of feed wheel 40. The second feed mechanism C is suitably synchronized in a manner well known in the art to periodically slide a sheet 23 into passage A just after the passage has been cleared by the previous sheet and at all other times, to continue to exert pressure on the sheets M of stack 21 to prevent double feeding of sheets.

As also shown in Figs. 1-3 the second feed mechanism C of the invention preferably includes rotating stack agitation means D comprising a plurality of identical rollers 70, 70 each mounted to freely revolve on a shaft such as 71, extending between discs 61 and 62. The circumferential surface 73 of each roller 70 is preferably of antifriction material such as smooth metal which together with its free revolving mounting substantially eliminates any tendency to advance a sheet 23. The surface 73 of each roller 70 is positioned outside the circumferential surfaces 66 and 67 of discs 61 and 62 in order that each contact of a roller 70 with the endmost sheet 23 will vary the pressure on the stack. Thus the revolution of second feed mechanism C also causes the stack to be continually pressed by the surfaces 73 of the spaced rollers 70 and to be repeatedly agitated thereby with a varying pressure. The agitation of the stack tends to break up any adhesion between the sheets and helps to prevent the next endmost sheet from accompanying the endmost sheet into and through passage A.

As shown in Figs. 4 and 5, the second feed mechanism C of the invention preferably includes overrunning or free wheeling clutch means E whereby the first feed mechanism may be rotated at high speed, such as three hundred sheets or more per minute, while the second feed mechanism is rotated at a lesser circumferential speed. This high speed of the first feed mechanism is made possible because instead of the mechanism having to segregate and then advance each end sheet, an operation sometimes accompanied by slippage, the first feed mechanism need only positively and accurately advance each sheet presented into passage A by the second feed mechanism C. In Fig. 4, clutch means E is provided between the rotating supports such as discs 61 and 62 and the power shaft 63, the clutch comprising a slot 80 in shaft 63, a pin or stud 81 on support 60 and a spring 82. In Fig. 5 the clutch means E is provided between the friction element, or rubber sleeve 85 and its shaft 89, the clutch comprising a recess 86 in shaft 89, a ball 87 and a spring 88. When the first feed mechanism B is revolved at

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higher speed than the second feed mechanism C and clutch means E is provided, it will be apparent that, in the position shown in Fig. 4, the rotating supports with the fixed sheet segregating element 65 will slidably advance an endmost sheet 23 but will cease any tendency to retard the sheet by means of overrunning clutch means E, as soon as the sheet advances more rapidly than the element 65. In the position shown in Fig. 5, the first feed mechanism is similarly permitted to pull a sheet away from the segregating element 85 at higher speed since the element 85 is enabled to freely revolve in a clockwise direction but is restrained from counterclockwise rotation by the ball 87 becoming wedged in its recess 86.

In Figs. 6-8 the invention is shown as applied to a vertical feeding magazine 120 for a plurality of flat sheets 100, the endmost sheet in the stack 121 being designated 123. Endmost sheet 123 has an exposed face 124, a leading edge 125, a trailing edge 126 and an intermediate area 127 of the exposed face 124. The terminal tip 134 of a sheet separator element 130, is slidably urged by a spring 132 toward the antifriction circumferential surface 136 of a sheet separator wheel 135, rotatably mounted on power shaft 137 and is spaced therefrom to form a passage, or gauge 102. The sheet separator wheel 135 has a smooth circumferential surface 136 and a rotating sheet separator element in the form of a wheel 146, mounted to revolve in the direction of the arrow on a power shaft 145, is provided. Wheel 146 has a flattened section 147 on its smooth circumference 148, which permits a sheet 123 to be presented into the gap 104, shown in dotted lines, formed thereby with surface 136 without bowing or buckling sheet 123. Upon further rotation of wheels 146 and 135 the sheet 123 is caught in the nip 105 formed between surfaces 148 and 136 and positively advanced away from the stack. An endless belt 151 is preferably trained around a pulley 152 rotatably mounted on power shaft 137 at one side of feed wheel 135 and a second endless belt 181 is trained around pulley 153 on shaft 154 and pulleys 155, 175 on shafts 156, 176 the pair of belts forming a conveyor for receiving the sheets from feed wheels 135 and 146 and carrying the sheets individually and successively through the machine. The first feed mechanism 110 of this construction thus includes a pair of rotating sheet separator wheels 135 and 146 forming therebetween a nip 105. The passage or gauge of this construction includes the gap between tip 134 of element 130 and surface 136 of wheel 135 as well as the gap 104 between flattened section 147 of wheel 146 and surface 136 of wheel 135, and the nip 105 between surface 148 of wheel 146 and surface 136 of wheel 135.

The second feed mechanism 106 of this construction is shown as it may be applied in tandem, there being two rotating supports 160 and 190 mounted on parallel shafts 169 and 191 and positioned in the intermediate area 127 of the endmost sheet 123 of stack 121. Supports 160 and 190 are identical and each is provided with a sprocket 168 and 188 revolved in the same direction as wheel 135 by a chain 195 trained around sprockets 196 and 197 and around sprocket 198 on power shaft 137. Sprockets 196 and 197 are mounted on a member 797 arranged for slidable adjustment of the chain 195. As best shown in Fig. 7, each end of each shaft 169 and 191 is supported in ball bearings such as 186 in side frame pieces 185 and 184 of magazine 100.

Each rotating support such as 160 (Fig. 8) includes a pair of oppositely disposed discs 161 and 162 spaced apart on shaft 169 and arranged to revolve therewith. A sheet segregating rubber roller 165 extends between the discs 161, 162, roller 165 having a friction surface 163 projecting beyond the smooth circumferential surfaces 166 and 167 of discs 161 and 162. A plurality of freely revolving rollers 170 are also spaced around discs 161 and 162 to form the pressure applying means and the stack agitation means of the device. As best shown in Fig. 8, overrunning clutch means 108 is provided for

element 165 between the sleeve-like rubber roller 165 and the shaft 179 thereof, the clutch comprising a coil spring 177 tightly fitting around shaft 179 and adapted to prevent rearward rotation of roller 165 but to permit forward rotation thereof in a well known manner. The second feed mechanism 106 thus includes rotating sheet segregating means at 165, rotating stack pressing means and rotating stack agitating means at 170 and overrunning clutch means at 177, as well as similar parts on the tandem rotating support 190.

In Figs. 9-14 the invention is shown applied to a top feeding magazine 220 for a plurality of flat sheets 200 of the same type of box board as sheets 100 and sheets M, the endmost sheet in the stack 221 being designated 223. Endmost sheet 223 has an exposed face 224, a leading edge 225, a trailing edge 226 and an intermediate area 227 of exposed face 224. The sheets 200 are fanned out by hand in inclined position and constantly advanced toward the feed mechanism by endless belts 300 trained around pulleys 301, 302 and 303 one of said pulleys providing the drive for the belt in well known manner.

The terminal tip 234 of a sheet separator element 230 is spaced from the circumferential surface 236 of a sheet separator wheel 235, about the thickness of a single sheet, to form a passage or gauge 202. Sheet separator wheel 235 is rotatably mounted on a shaft 237, and is provided with an antifriction surface 236 of smooth metal which may, or may not have a section at 243 inserted therein of high friction rubber. The sheet separator wheel 235 is also a feed wheel in this construction. A pair of rolls 310 and 311 are provided on the delivery side of passage 202, forming nips with the surface 236 and/or with a rubber insert 243 into which sheets are received and carried away from the stack and through the machine. Wheel 235 and its surfaces 236 and/or 243, together with rolls 310 and 311 and/or tip 234 of element 230 form the first feed mechanism 210 at the passage 202 and the passage 202 is positioned adjacent an edge 225 of the endmost sheet 223 of stack 221 as in the other embodiments above described.

The second feed mechanism 206 of this construction includes a pair of arms 250, 251, connected at a fixed angular relationship by a housing 252. As best shown in Figs. 11 and 12, arm 250 is slidably adjustable in length by bolts 253 in slots 254 and its lower end carries the outer race 256 of ball bearings 257. The inner race 258 of ball bearing 257 is fixed to a split sleeve 600 attached to the shaft 237 by a bolt 259 as are a sprocket 330 and feed wheel 235. Thus the sprocket 330 and feed wheel 235 revolve with shaft 237, while arm 250 does not revolve but is urged in the direction of rotation of the shaft 237. The other arm 251 is also slidably adjustable in length by means of bolts 340 and slots 341 and carries a shaft 343 for a sprocket 344 at its free end. A pair of integral sprockets 346 and 347, mounted to revolve together around the same sleeve like bushing 348 are provided within housing 252 and the rotating support 260 of the second feed mechanism 206 is mounted to revolve with sprocket 344. A chain 350 connects the driving sprocket 330 with sprocket 346 and a chain 351 connects sprocket 347 with sprocket 344, thereby causing the support 260 to revolve in the same direction as feed wheel 235.

Housing 252 is formed by a circular cup portion 400 on arm 250 and a corresponding circular cup portion 401 on arm 251, the portions 400 and 401 abutting at the split 402 in housing 252. A bolt 403 passes through the cup portions 400 and 401 of housing 252 and through bushing 348 whereby the portions 400 and 401 may be tightened into friction engagement for various desired angular positions of arms 250 and 251 by nuts 405 and 406. Suitable openings, not shown, are provided in the circumferential walls of portions 400 and 401 to permit chains 350 and 351 to pass into and out of housing 252 regardless of the angular relation of arms 250 and 251. The sprocket 344 is mounted on ball bearings 360

and the rotating support 260 is mounted on ball bearings 361 carried by shaft 343 and the rotating support 260 is provided with a sheet segregating element 265 of rubber on the circumference thereof. A pin 266 extends axially from rotating support 260 into an elongated arcuate recess 267 in sprocket 344 to form the overrunning clutch means 108 of the second feed mechanism of this embodiment. When element 265 is rotated around shaft 343 to slidably advance a sheet 223 into passage 202, the pin 266 is at one end of recess or slot 267 but when the first feed mechanism pulls the sheet away at high speed, the slot 267 enables the element 265 to cease advancing the sheet and release its engagement with the sheet 223. The circumferential speed of element 265 may be comparatively low since its function is to boost or urge the leading edge of each endmost sheet 223 into the passage 202 whence the sheet may be advanced away from the stack at a higher speed by the first feed mechanism 210.

Rotating stack pressure means is preferably provided by a disc 270 mounted to freely revolve on ball bearings 271, the bearings 271 being carried by a shaft 272 on support 260. The smooth circumferential surface 277 of disc 270 is of less radius than the circular path of element 265 and bears against the face 224 of endmost sheet 223 except when element 265 is in contact therewith, thereby applying constant pressure on stack 221.

In Figs. 13 and 14 a modification is shown, in which a rotating support 560 is provided with a pin or shaft 590 carrying a free wheeling roller 565, the roller having a friction surface 568 of rubber. Pins 591 carry a plurality of freely revoluble rollers 570 spaced around the periphery of support 560. Similar rollers 580 are preferably alternately spaced on the opposite side of support 560 and are carried by pins 585 in sprocket 544, thus permitting overlapping and rollers 570, 580 are each supported on ball bearings 571. Rollers 570 and 580 form the pressure applying means and stack agitating means of this modification and the overrunning clutch means of element 565 is a spring 577 similar to spring 177 shown in Fig. 8.

In Figs. 15 and 16 another modification is shown in which a rotating support 960 is provided with an antifriction circumferential surface 961. Support 960 is rotated by a shaft 962 and includes an annular recess 963, preferably of inverted T shaped cross section, extending circumferentially therearound. A sheet engaging friction element 965, preferably of rubber, overlies a portion of the surface 961 and recess 963 and includes a tapered leading end 967 and a trailing end 968. At least one end of rubber element 965, such as leading end 967 includes a hole 969 for clamping means such as threaded bolt 971 and threaded nut 972, the nut 972 being slidably mounted in, and retained by, T shaped recess 963. Preferably the opposite end 968 of rubber element 965 is retained in recess 963 by identical clamping means not shown and preferably a set screw 974 is provided to lock the nuts such as 972 in place in recess 963. A removable block 977 is provided in support 960, held in place by set screws such as 978 and removable for the insertion of nuts 972 in recess 963.

By reason of the annular recess 963 and clamping means such as 971, 972, it will be apparent that the leading edge 967 of friction element 965 can be fixed in place on support 960 at any desired position around the circumferential surface 961. Similarly any desired length of friction element 965 may be extended around the surface 961 and its opposite end clamped in place. Replacement of elements such as 965 is also facilitated by the construction.

Preferably at least one disc 990 is mounted to freely revolve on rotating support 960 by means of ball bearings such as 991. Disc 990 preferably has a smooth antifriction circumferential surface 992 below the surface 993 of friction element 965 and above the surface 961 of support 960. The free revolving disc 990 thus forms the

rotating stack pressing means of this form of the invention, the surface 992 thereof being in rolling engagement with the end sheet of a stack of sheets whenever the surface 993 of element 965 is not advancing a sheet. As shown, two discs such as 990 may be used, one on each side of the support 960. It will also be apparent that support 960 may be connected to shaft 962 by over-running clutch means if desired as in certain of the other embodiments of the invention.

It should be noted that any combing action of the agitating means of the invention is prevented from fanning out the endmost sheets in the stacks by the separator elements which form the substantially non yielding passage. In the bottom feed magazine shown in Figs. 1 and 2 the guide 29 and gate element 30 prevent any sliding advance of the sheets above the endmost sheet 23. In the vertical feed magazine shown in Figs. 6 and 7 the sheet separator element 130 forms a barrier to any slidable advance in the direction of feeding of the sheets behind the endmost sheet 123. In the top feed magazine 220 shown in Fig. 9, the bottom of the magazine and the sheet separator element 230 prevent fanning of the endmost sheets relative to each other due to any combing action of the device shown in Figs. 13 and 14.

I claim:

1. Apparatus for automatically and successively sliding an individual sheet from the end of a stack of such sheets said apparatus including magazine means for supporting a stack of sheets; sheet separator means, including a sheet passage positioned along the leading edge of the endmost sheet in said stack for permitting the advance of a single endmost sheet while barring the advance of the next succeeding sheets in the stack; friction feed mechanism engaging each successive endmost sheet and advancing the same through said passage, said feed mechanism including a rotating support, a friction surface member on said support adapted to engage the exposed flat surface of each successive endmost sheet and advance the same through said passage with each revolution of said rotating support, and a plurality of freely revoluble rollers, spaced around said support and adapted to successively contact the exposed face of each successive endmost sheet in said stack for endwise agitation of said stack with each revolution of said support.

2. Apparatus as specified in claim 1 wherein the friction surface member on said rotating support is a roll substantially identical in size to said freely revoluble rollers but mounted in fixed, non revoluble relationship to said support.

3. Apparatus as specified in claim 1 wherein said rotating support comprises a pair of discs spaced apart on a common shaft a distance substantially equal to the width of a sheet and said friction surface member and freely revoluble rollers extend laterally from one said disc to the other.

4. Apparatus as specified in claim 1 wherein said feed mechanism includes a pair of said rotating supports, in tandem, one in rear of the other, each support having a friction surface member thereon and a plurality of said freely revoluble rollers, spaced therearound.

5. Apparatus as specified in claim 1 wherein said freely revoluble rollers are each provided with a smooth, anti-friction circumferential surface for engaging an endmost sheet.

6. Apparatus as specified in claim 1 plus release means connecting said friction surface member to said rotating support for permitting said member to move forwardly, but not rearwardly, with relation to said rotating support.

7. Apparatus as specified in claim 6 wherein said friction surface member is a friction surfaced roll having a shaft and said release means is an overrunning clutch associated with said shaft for permitting forward rotation but preventing rearward rotation of said roll relative to said rotating support.

8. Apparatus as specified in claim 7 wherein said over-

running clutch includes a tapered slot and a spring pressed ball adapted to wedge in said tapered slot to prevent rearward rotation of said friction surfaced roll with relation to said rotating support.

9. The method of feeding individual sheets from the end of a stack of such sheets which comprises the steps of continuously applying an endwise stack vibratory force, having an inappreciable sheet sliding component on the exposed surface of the endmost sheet of said stack; individually and successively frictionally engaging the exposed flat surface of each endmost sheet of the stack and imparting a sliding movement thereto to expose the leading edge portion thereof; continuously barring the next succeeding sheets from fanning out in the direction of feeding due to the application of said vibratory force and individually and successively seizing the exposed leading edge portions of said sheets and imparting a further sliding movement thereto, thereby completely separating the same from said stack.

10. Apparatus for automatically and successively sliding each foremost sheet in a stack of such sheets away from said stack, said apparatus comprising stack controlling means, including a substantially non yielding sheet passage, for permitting only the sliding advance of a single foremost sheet at a time and for preventing the sliding advance of the next succeeding sheets in the stack; sheet advancing means including a feed friction element operating in a circular path for frictionally engaging the exposed surface of each successive foremost sheet and advancing the same into said passage and stack agitating means including a plurality of cylindrical anti-friction elements spaced in circular relation with said friction element for agitating said stack in an endwise direction.

11. Apparatus for automatically and successively sliding an individual sheet from the end of a stack of such sheets said apparatus including magazine means for supporting a stack of sheets; sheet separator means, including a sheet passage positioned along the leading edge of the endmost sheet in said stack for permitting the advance of a single endmost sheet while barring the advance of the next succeeding sheets in the stack; first friction feed mechanism proximate said passage and in advance of the leading edge of an endmost sheet of said stack for engaging each successive endmost sheet presented thereto through said passage and advancing said sheet away from said stack at a predetermined speed; and second feed mechanism, positioned in rear of the leading edge of, and operable on the exposed face of, the endmost sheet of said stack, said second feed mechanism including a rotating support, a friction surface member on said support adapted to engage the exposed flat surface of each successive endmost sheet and advance the same at a predetermined speed partially through said passage with each revolution of said rotating support, and a plurality of freely revoluble rollers, spaced around said support and adapted to successively contact the exposed face of each successive endmost sheet in said stack for endwise agitation of said stack with each revolution of said support.

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