

July 22, 1958

R. G. DEXTER ET AL
SHEET COLLATING MACHINE

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6 Sheets-Sheet 1

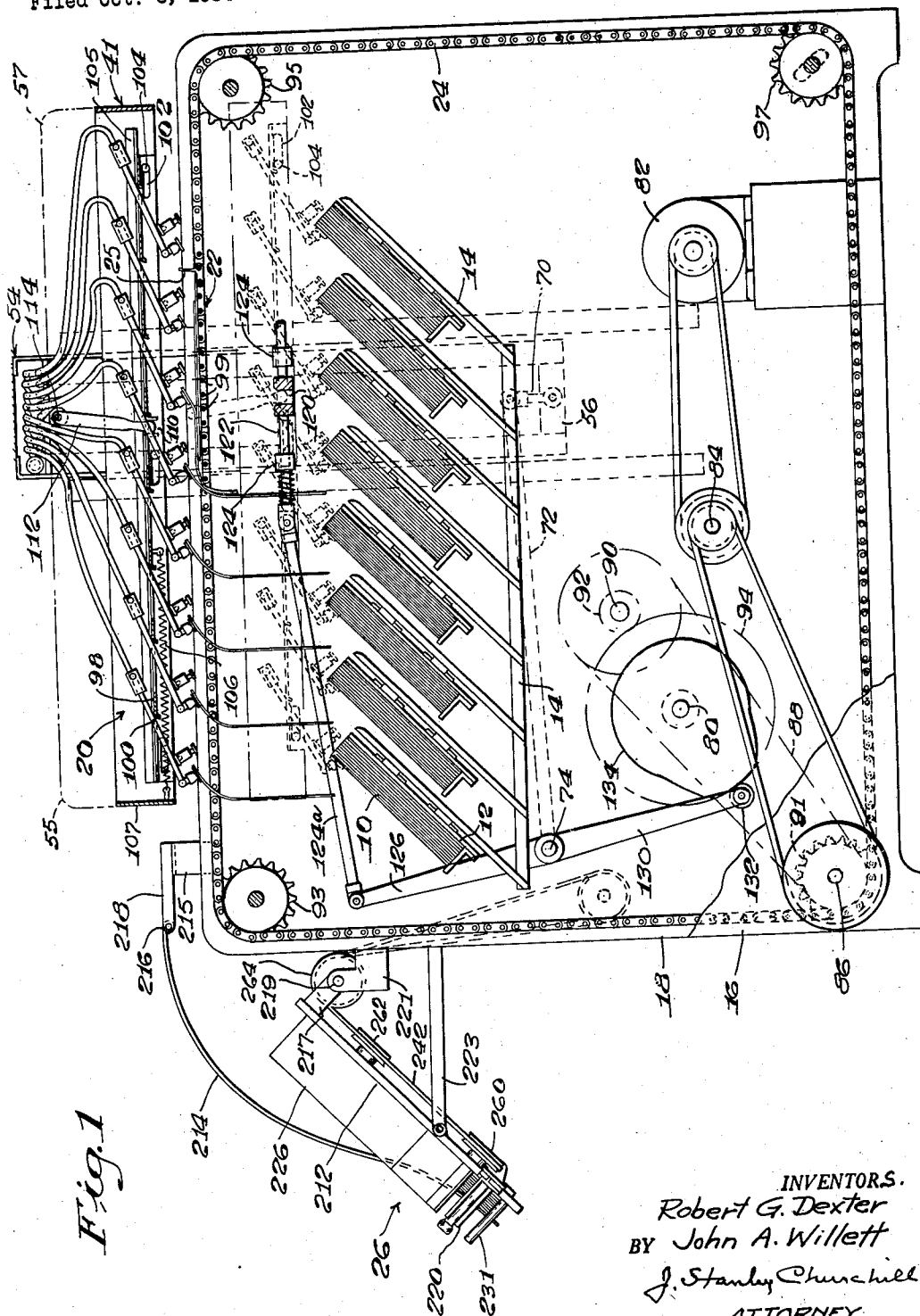


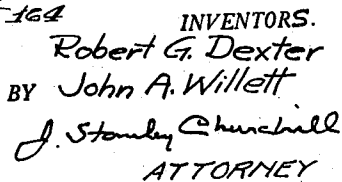
Fig. 1

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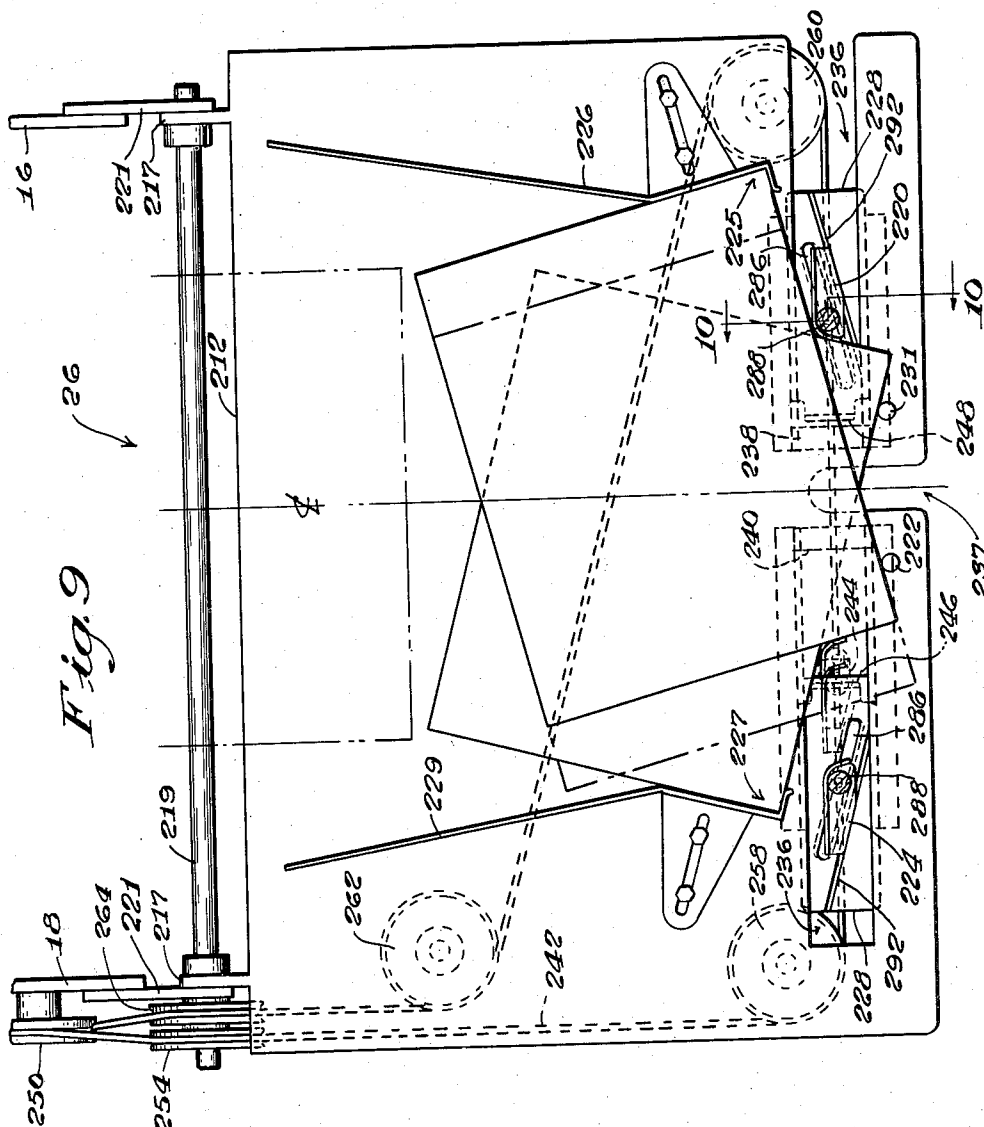


Fig. 9

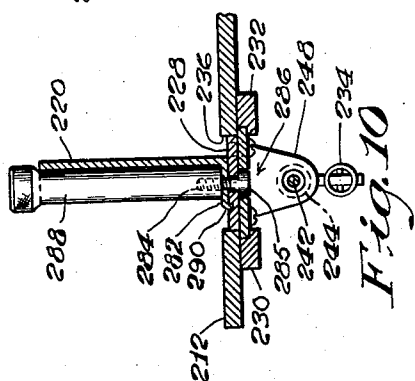


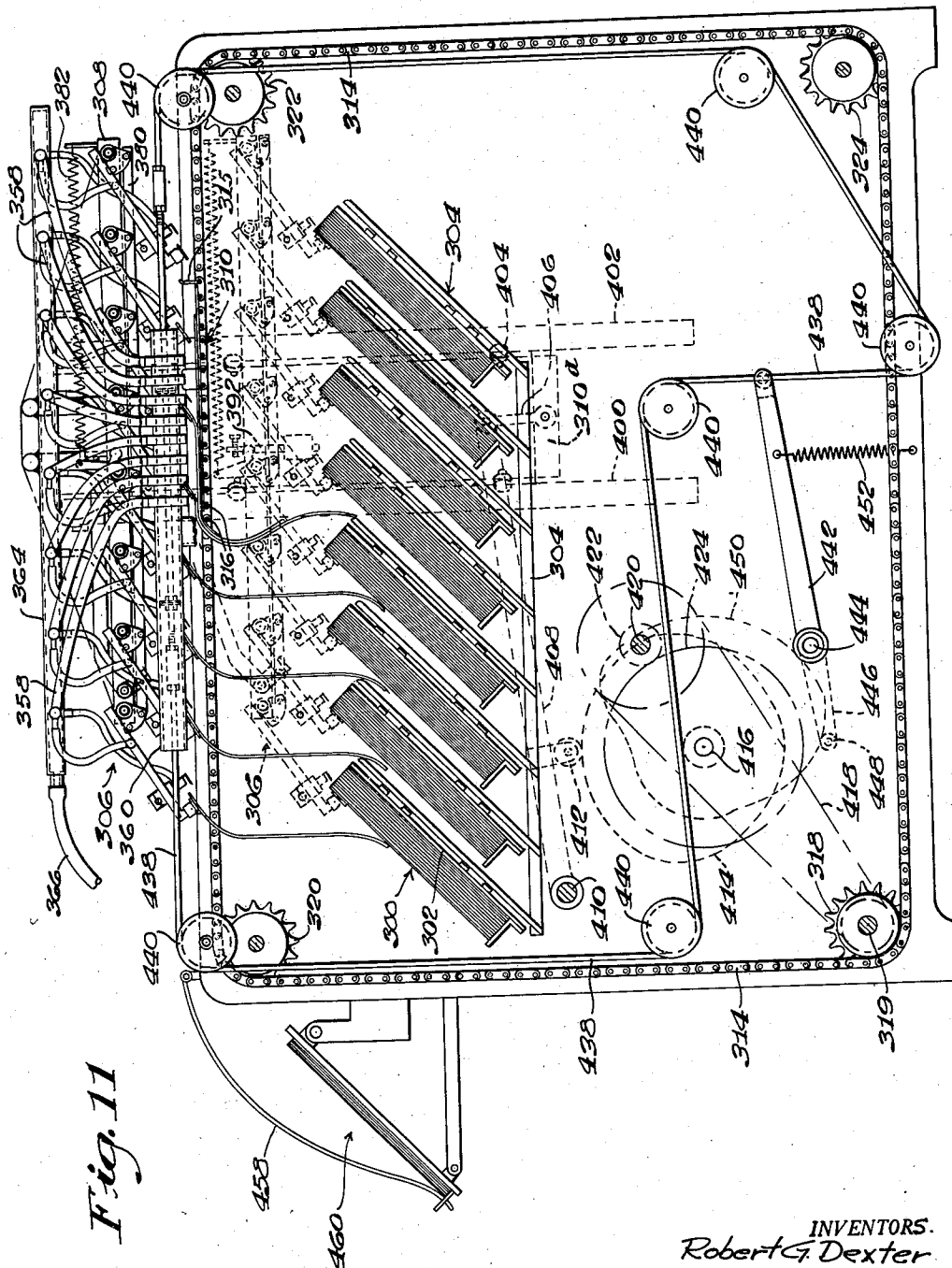
Fig. 10

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SHEET COLLATING MACHINE

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Application October 6, 1954, Serial No. 460,666

15 Claims. (Cl. 270—58)

This invention relates to a collating machine.

The invention has for an object to provide a novel and improved collating machine adapted to withdraw individual sheets from a plurality of different stacks thereof and to assemble the sheets thus withdrawn in superposed relation to form a group thereof in a simple and superior manner.

A further object of the invention is to provide a novel and improved collating machine of the character specified having novel provision for stacking successive collated groups of sheets in a manner such as to maintain their collated relationship in the stack whereby to facilitate subsequent separation of individual collated groups from the stack.

With these general objects in view and such others as may hereinafter appear, the invention consists in the collating machine and in the various structures, arrangements and combinations of parts hereinafter described and particularly defined in the claims at the end of this specification.

In the drawings illustrating the preferred embodiment of the invention:

Fig. 1 is a side elevation of a collating machine shown with the side frame removed;

Fig. 2 is a side elevation of the machine as seen from the side opposite to that shown in Fig. 1;

Fig. 3 is a cross-sectional detail as seen from the line 3—3 of Fig. 2;

Fig. 3a is a wiring diagram of a control circuit to be described;

Fig. 4 is a transverse sectional view of a portion of the machine shown in Fig. 1;

Fig. 4a is a front view of a suction unit shown in engagement with a stack of sheets;

Fig. 5 is a detail view in side elevation of a suction cup and riffer partly in cross section and shown in operative relation to a stack;

Fig. 6 is a similar view showing a paper hold down clip, the suction cup being shown in a different position of operation;

Fig. 7 is a rear view of the hold down clip shown in Fig. 6;

Fig. 8 is a front elevation of the stacking mechanism;

Fig. 9 is a plan view of the stacking mechanism;

Fig. 10 is a cross-sectional view taken on the line 10—10 of Fig. 9;

Fig. 11 is a side elevation of a modified form of collating machine embodying the present invention;

Fig. 12 is a plan view of one of the suction units shown in Fig. 11;

Fig. 13 is a cross-sectional view taken on the line 13—13 of Fig. 12;

Fig. 14 is a cross-sectional view taken on the line 14—14 of Fig. 12;

Fig. 15 is a detail view in side elevation of linkage connecting cooperating suction units in the modified construction; and

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Fig. 16 is a longitudinal cross-sectional view of valve mechanism shown in Fig. 11.

In general the present invention contemplates a novel and improved collating machine for assembling a plurality of different sheets, such as an assembly of business forms, in consecutive order and in superposed relation in a rapid and superior manner. In the illustrated embodiment of the invention a plurality of stacks of the sheets to be collated are supported in an inclined position, and a plurality of suction units, one for each stack and disposed above the stacks, are arranged to be vertically reciprocated to withdraw a sheet from each stack, the sheet being suspended substantially vertically upon elevation of the suction units. The sheets thus suspended from the suction units are then successively engaged and raised to a horizontal position by the leading edge of a platform carried by a horizontally moving conveyer, the suction units being caused to release successive sheets in timed relation to the travel of the platform and with successive sheets coming to rest against a stop on the platform in superposed relation to form a group of assembled sheets. During the continued travel of the conveyer, the group of collated sheets may then be delivered onto an inclined stacking table having provision for stacking successive groups in crisscross relation whereby to facilitate manual separation of individual groups from the stack, enabling the sheets of the group to be stapled or otherwise fastened together. The present invention also includes sheet withdrawing mechanism in which provision is made for insuring engagement of the uppermost sheet in the stack each cycle of operation as the stack is depleted by continued withdrawals therefrom.

Referring now to the drawings, 10 represents a plurality of stacks of sheets to be collated, the stacks being arranged in spaced relation and supported in individual magazines 12 in an inclined position, as shown. The magazines 12 may be removably supported in a framework 14 secured to and extended between the side frames 16, 18 of the machine. The numeral 20 represents a plurality of spaced suction units mounted to be vertically reciprocated from an elevated position, as shown in full lines in Fig. 1, to a lowered position into engagement with the uppermost sheets of the stacks 10, as shown in dotted lines in Fig. 1. Upon subsequent elevation of the suction units 20 the uppermost sheets withdrawn are suspended in a substantially vertical position from their individual suction units, and while thus suspended the sheets are engaged successively by the leading edge of a horizontal travelling platform 22 carried by a pair of spaced chains 24. In operation the individual suction units 20 are caused to release the individual sheets in succession in timed relation to the movement of the travelling platform 22, the released sheets coming to rest against a stop 25 on the platform to form a collated group of sheets arranged in superposed relation. The group of sheets thus assembled may then be discharged from the platform 22 onto a stacking table, indicated generally at 26 in Fig. 1, preferably arranged to stack the groups in crisscross relation, as will be hereinafter described.

As best shown in Figs. 4, 5 and 6, each suction unit 20 comprises a plurality of suction cups 28 mounted in a transversely extended pipe 30 connected to longitudinally extended pipes 32, 34 which in turn are carried by a U-shaped bracket 36 pivotally mounted between the side walls 38, 40 of a suction unit supporting frame 41. The suction pipe 32, as shown in Fig. 4, communicates with the transverse pipe 30 and is connected by a flexible tube 42 to a suction manifold, indicated generally at 44. The manifold is provided with a valve 46 arranged to cut off the suction to successive suction units 20 and open the

units to the atmosphere during the operation of the machine as the platform 22 is moved past the individual suction units. As shown in Fig. 5, each suction cup 28 includes a rubber suction member 48 fitted into a metallic adapter 50 threadedly engaged with a nipple 51 angularly extended from the transverse pipe 30.

The suction unit supporting frame 41 is preferably hollow, being open at top and bottom, and may be connected to the upper end of an elevator 56 by an angle bracket 52 secured at one end to the top of the elevator and at its other end to the side wall 38 of the supporting frame 41. As shown in Figs. 2 and 3, the elevator 56 may comprise a reciprocating slide which includes opposed vertical angle iron members 58, 60 interconnected by tie pieces 61. The members 58, 60 are provided with rollers 62, 64 arranged to cooperate with stationary angle iron members 66, 68 secured to the side frame 18 by brackets 69. The lower end of the slide member 56 may be connected by a link 70 to an arm 72 pivotally mounted on a shaft 74 and provided with a cam roll 76 arranged to cooperate with a cam 78 fast on a cam shaft 80. As illustrated in Fig. 1, cam shaft 80 is arranged to be rotated through driving mechanism which may include an electric motor 82 belted to a jack shaft 84 which in turn may be belted to a shaft 86, the latter forming the driving shaft for the travelling platform chain 24. The shaft 86 may be connected by a chain and sprocket drive 88 to a pinion shaft 90 which is provided with a pinion 92 in mesh with a gear 94 fast on the cam shaft 80. The pair of chains 24 are arranged to run in a rectangular path, being guided over drive sprocket 91 fast on the shaft 86 and over idler sprockets 93, 95 and 97 disposed at each corner of the side frames, as shown. The platform 22 may comprise a plurality of spaced rods 99 extended between the chains 24, as shown in Fig. 4, and the upper runs of the chain may be guided on track bars 101 supported by brackets 103 extended from the side frames 16, 18. The platform 22 may also be provided with side guides 27, 29, as illustrated in Fig. 4, to position the sheets longitudinally on the platform.

From the description thus far it will be observed that in the operation of the machine each suction unit may be lowered into engagement with the uppermost sheet in its respective stack to withdraw the same therefrom, and in practice provision is made for controlling the movement of the suction units to effect rocking of the same into engagement with the sheets and for again rocking the units to remove the sheets from the stacks while the suction units are in their lowered position. As herein shown, each suction unit 20 is pivotally mounted, preferably by trunnion screws 96, to permit free rocking movement of the same. A slide member 98 having openings therein is provided with curved or turned-down cam portions 100 arranged to engage the pipes 32, 34 to rock the suction units. The slide member 98 is slidably mounted between the side walls 38, 40 of the supporting frame 41. The slide member 98 is preferably U-shaped, as seen in Fig. 4, having depending legs thereof provided with slots 102 arranged to receive pins 104 extended from the side walls 38, 40. A tie member 105 disposed above the slide 98 extends between the side walls 38, 40, and the slide member may be provided with a spring 106 connected between the slide and an end wall 107 of the frame 41 to normally urge the slide to a forward position. As herein shown, provision is made for operating the slide to effect retraction thereof when the suction units are in their lowered position and to permit the slide to move into a forward position to maintain the suction units in their upwardly rocked position as the suction units are elevated. The slide member 98 is provided with a slot or socket 110 at one side thereof, as illustrated in Fig. 4, and a rocker arm 112 cooperating with the slot is secured to one end of a rocker shaft 114 mounted in bearings 116 secured to the underside of the angle bracket 52. The other end of the shaft 114 is provided with a similar

rocker arm 118 fast thereon which is rocked to the left when the suction units are in their elevated position, as shown in Fig. 1, and which when lowered is arranged to engage a slot 120 formed in a horizontally reciprocated shaft 122 mounted to slide in bearings 124 secured to the inner face of the side frame 18, as best shown in Fig. 1. The shaft 122 is connected by a link 124a to one arm 126 of a two-armed lever pivotally mounted at 74 in the side frame 18. The second arm 130 of the two-armed lever is provided with a cam roll 132 arranged to cooperate with a cam 134 fast on the cam shaft 80.

In the operation of the machine the suction units 20 are normally retained in an upwardly rocked position by the spring 106 when in their elevated position, as shown in full lines in Fig. 1, the arms 112, 118 being rocked to the left at this time, and when the suction units are lowered the arm 118 is caused to enter the slot 120 formed in the reciprocal shaft 122. The slide member 98 may then be retracted by the cam 134 to the position shown in dotted lines in Fig. 1 to permit the suction units to freely rock into engagement with the uppermost sheets of their respective stacks, the pivotal arrangement and angular disposition of the suction cups being such as to permit the suction units to freely engage the uppermost sheets as the stacks are depleted by continued withdrawals of sheets therefrom to conform to variations in the heights of the stacks. As illustrated in detail in Fig. 5, provision is made for projecting a stream of air against the edge of the stack of sheets in order to separate the latter to prevent withdrawal of two or more sheets at one time, and as illustrated in Fig. 5, this may be accomplished by one or more riffling units indicated generally at 136. As shown in Fig. 4, each riffling unit 136 is connected to the pipe 34 and is provided with compressed air through a flexible pipe 138 connected to a manifold 140 mounted on the angle bracket 52. Compressed air may be supplied from any usual or preferred source through a pipe 142 connected to the end of the manifold 140. Each riffling unit includes a hollow housing 144 which may be threaded to a nipple extension 146 from the pipe 34 and is provided with one or more outlet openings 148 for directing a stream of air against the upper end of the stack. The air may be regulated manually by a threaded member 150 provided with a needle valve 152 which may cooperate with a valve seat 154 formed in the housing 144. In practice the compressed air pipe 34 may be plugged at the end connected to the transverse suction pipe 30. As shown in Fig. 4a, each suction unit 20 is provided with three aligned suction cups 28 arranged to engage the sheets adjacent the upper marginal edge thereof, and in practice the central suction cup adjacent the riffling unit 136 may and preferably will be disposed in a slightly elevated plane relative to the outer suction cups so that in operation the uppermost sheet separated from the stack by the riffling operation will be drawn upwardly by the central suction cup with a snapping action.

As illustrated in Figs. 6 and 7, provision is made for further assuring separation of two or more sheets inadvertently withdrawn by the suction units during the initial elevating movement of the suction units, and as herein shown, this may be accomplished by weighted clip members 156 disposed in spaced relation on both sides of the central suction cup and each of which may comprise a thin metal strip having one edge 158 bent laterally to extend over the top marginal edge of the uppermost sheet, as shown. The metal clip 156 may be carried by a weighted member 160 provided with grooves in its vertical edges arranged to slide between guides 162 formed in an upright member 164 secured to the underside of the stack supporting frame to permit the clips to maintain engagement with the top of the stack as the stack is depleted by continued withdrawal of sheets therefrom. In operation when a suction unit is permitted to rock into engagement with the uppermost sheet of a stack, the sheets are initially separated by the riffling unit so that the uppermost

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sheet may be drawn upwardly into engagement with the suction cups 28. In practice the elevating unit comes to rest in a predetermined position of descent with relation to the stacks, and after engagement of the uppermost sheet by the suction cups the entire elevating unit may then be caused to descend a short distance beyond said predetermined position. Such additional movement effects forward sliding of the uppermost sheet with the suction cup, such sliding movement of the uppermost sheet relative to an underlying sheet being further conducive to effect separation of such underlying sheet adhering thereto. As clearly shown in Fig. 6, the auxiliary descending movement is arranged to terminate in a position to present the upper marginal edge of the sheet a short distance within the outer edge of the clip extension 158. Thereafter the slide member 98 is again caused to be moved forward to rock the suction units upwardly, and when thus rocked, the marginal edge of the sheet being withdrawn is flexed or snapped out from under the clip, as shown in dotted lines in Fig. 6, such action tending to "peel off" an underlying sheet and assure separation of such underlying sheet which may still adhere to the sheet being withdrawn. Thereafter the elevator is again moved to withdraw the sheets and to present the suction units in their elevated position with the sheets suspended vertically therefrom, as illustrated in Fig. 1.

From the description thus far it will be seen that in the operation of the machine, while the withdrawn sheets are thus suspended vertically from their respective suction units 20 the leading edge of the continuously moving platform 22 is arranged to engage successive sheets as it moves past the suction units, and as illustrated in Fig. 4, the suction manifold 44 is arranged to effect release of successive sheets in timed relation to the travel of the moving platform 22. The suction manifold 44 may comprise a vertical pipe 170 supported in and movable with tie pieces 172, 173 extended from the elevating member 56. The pipe 170 is provided with spaced ports 174 surrounded by hollow collars 176, and the valve member 46 is connected to a cam operated valve rod 178. A second valve member 180 spaced from the valve member 46 and also secured to the rod 178 is arranged to maintain a continuous suction chamber between the two valves 46 and 180, said chamber being connected by a pipe 182 to any usual or preferred source of suction. As illustrated in Fig. 2, the suction manifold 44 is secured to and arranged to be reciprocated with the suction units 20, and provision is made for operating the valve rod 178 to effect opening of successive ports 174 to the atmosphere, the upper end of the pipe 170 being open. As herein shown, the lower end of the rod 178 is connected by an extension 184 to a tubular member 186 provided with spaced collars 188, 190. The tubular member 186 is slidably supported in the tie member 172 at its upper end and is arranged to slide on an upright rod 192 extended into the lower end thereof, the rod 192 being supported in a bracket 194 secured to the machine frame. The valve rod 178 is illustrated in Fig. 2 in its uppermost position immediately prior to being lowered, and in order to move the valve rod downwardly in timed relation to the movement of the travelling platform a cam lever 196 is provided to operate between the collars 188, 190. The cam lever 196 may be pivotally mounted at 74 and is provided with a cam roll 198 arranged to cooperate with a cam 200 fast on the cam shaft 80. In operation the rod is moved downwardly, as described, to effect relative movement of the valve with respect to the ports 174 in the pipe 170 to effect discontinuance of the suction to successive suction units, as described, and when the elevating unit is subsequently lowered, the cam 200 is operated to effect elevation of the valve rod 178 to its initial position by engagement with the upper collar 188. A spring 202 connected to the cam lever 196 is arranged to urge the lever downwardly. In order to maintain the rod 178 in its elevated position relative to the pipe 170 during subse-

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quent elevation of the suction units a friction member 204 may be provided at the lower end of the pipe 170, the friction member being secured to a flange 206 formed on the lower end of the pipe 170. An auxiliary friction device may be provided at the upper end of the pipe 170 and may comprise a collar 208 secured to the upper end of the rod 178 and which is arranged to be engaged by adjustable friction screws 210 carried by the upper end of the pipe 170.

As illustrated in Figs. 1 and 4, the multiplicity of suction tubes 42 and compressed air tubes 138 extending from their respective manifolds to each suction unit 20 may and preferably will be provided with suitable covers to protect and conceal the same, such as a transversely extended cover plate 54 curved downwardly to abut the side wall 34 of the supporting frame 41, as shown in Fig. 4, and longitudinally extended covers 55, 57, as shown in dotted lines in Figs. 1 and 2, and which extend over the upper open end of the supporting frame 41 on both sides of the transversely extended portion.

From the description thus far it will be seen that as the platform 22 travels past the suction units the leading rod 99 of the platform 22 will engage successive sheets to cause them to assume a horizontal position relative to the platform, and in operation just before the sheets are about to engage the stop 25 on the platform the suction is cut off from the corresponding suction unit to permit the sheet to slide against the stop member 25, successive sheets being similarly released sliding on top of the underlying sheets and against the stop 25 to form a collated group of sheets in superposed relation. It will be understood that the machine may be designed to collate any predetermined number of sheets and that variations in the number of sheets collated may be produced by merely removing one or more stacks and discontinuing the suction to the corresponding suction units, as desired.

As illustrated in Fig. 3a, control mechanism may be provided for assuring that each group of collated sheets is complete and this may be accomplished by causing the suction units to release all of the sheets in the event that one or more of the suction units fails to withdraw a sheet from its stack, thereby preventing formation of a collated group of less than a predetermined number of sheets being collated. As herein shown, the suction line 182 may be connected to the upper end of a pipe 183 to which a main suction supply pipe 185 is connected. The lower end of the pipe 183 is provided with a vacuum operated switch 187 in a circuit which also includes a cam operated switch 189 and a solenoid operated valve 191, the latter being connected by a pipe 193 to the vacuum pipe 183 and which is arranged to open the suction line to the atmosphere.

The vacuum operated switch 187 is arranged to be held open by the vacuum during the withdrawing operation when each suction unit is fully engaged with its sheet and may be adjusted so that if one or more units fail to fully engage their respective sheets the reduced suction resulting from the suction units open to the atmosphere at this time in the cycle will cause the vacuum operated switch 187 to close. Closing of the circuit at the switch 187 and at the cam operated switch 189 completes the circuit to the solenoid operated valve 191 which is energized to open the suction line to the atmosphere, thus causing all of the suction units to release their sheets while still in their lowered withdrawing position. The switch 189 may be operated by a cam 195 fast on the main cam shaft 80 and is timed to close the circuit at switch 189 just as the suction units start their upward rocking movement prior to being elevated. Thus, in operation if less than all of a complete group of sheets are engaged by the suction units at such time to be simultaneously withdrawn, all of the sheets are released to remain on top of their respective stacks until the next cycle of operation.

Referring now to Figs. 8, 9 and 10 which illustrate the stacking mechanism 26, it will be observed that a group of collated sheets carried by the travelling platform 22 will be discharged therefrom as the platform moving in a horizontal plane passes over the idler sprockets 93 to move into a vertical plane whereby to present the group onto a table 212 supported in an inclined position at the discharge end of the machine. As shown in Figs. 1 and 9, the upper end of the inclined table 212 is provided with depending lugs 217 and is supported for pivotal adjustment on a transverse shaft 219 extended between brackets 221 attached to the side frames 16, 18. The table 212 is connected adjacent its lower end by supporting arms 223 which may be adjustably secured to the side frames so as to permit adjustment of the incline of the table. The speed of the platform is such as to forcibly eject the group therefrom, and the leading edge of the group may be guided onto the inclined table 212 by a curved guide rail 214 pivotally supported at 216 in brackets 218 attached to a tie piece 215 supported between the side frames 16, 18, as shown. As best shown in Fig. 9, provision is made for arranging successive groups of sheets thus discharged in crisscross relation whereby to facilitate manual removal of individual groups from the stack. As herein shown, the sheets are discharged onto the table 212 with their side edges parallel to the side edges of the table 212, as indicated in dotted lines in Fig. 9, and when the leading edge of a group engages a slide member, indicated generally at 220, and disposed to the right of a longitudinal center line passing through the sheets the group will be rocked downwardly to the left to come to rest against a stop pin 222 fixed in the table 212. At this time a second slide member 224 is arranged to engage the left hand edge of the group and to jog the group into a pocket 225 formed in a guide member 226 which may be adjustably mounted on the table 212, as shown. As illustrated in Fig. 9, this procedure will arrange one group of sheets at an angle of approximately 15 degrees in one direction relative to the longitudinal center line, and in the continued operation of the machine a succeeding group of sheets being delivered onto the table 212 with its longitudinal edges parallel to the edges of the table may be engaged by the second slide member 224 which at this time will be moved to a position corresponding to the slide member 220 during the previous cycle of operation so that such second group will be rocked downwardly to the right against a pin 231 to cause the sheets to assume an angular position opposite to that assumed by the preceding group. The slide member 220 at this time effects jogging of the edges of the group of sheets to align the sheets and to push the group into an opposing pocket 227 formed in a guide member 229. As herein illustrated, each slide member 220, 224 may be adjustably secured to slide plates 228 guided in grooved members 230, 232 secured to the underside of the table 212, and the slide members 220, 224 may be connected by a common spring 234 to normally urge them inwardly toward each other. It will be observed that the slide plates 228 operate in slotted portions 236 formed in the table 212 and that their inward movement may be limited by stop members 238, 240. A central access opening 237 may also be provided to facilitate removal of individual groups. The slide members 220, 224 are arranged to be alternately retracted or moved outwardly and to then be slightly retracted and moved forwardly successively several times against the adjacent edge of the group in order to jog the sheets of the group into superposed alignment and to present a corner of the group into a pocket of the guide member. These operations may be effected by cam operated means which may include an endless cable 242 arranged to be reciprocated relative to the slide members. As herein shown, the cable 242 is provided with a collar 244, and upon movement of the cable in one direction the collar will engage a depending portion 246 of the slide

member 224 to retract the same, the other slide member 220 coming to rest against the stop 238 at this time, and upon movement in the other direction the collar 244 will engage the depending portion 248 of the slide member 220 to move the slide 220 outwardly, as described.

Referring to Figs. 2 and 9, it will be observed that the cable 242 is arranged to run over a pulley 250 rotatably secured to a stud 252 supported in the side frame 18 and then over a pulley 254 rotatably mounted on the end of the shaft 219. The cable then runs over pulleys 258, 260 to provide a parallel run beneath the slotted portion 236 of the table 212 whereupon the endless cable 242 runs around a pulley 262 and over a second pulley 264 rotatably mounted on the shaft 219 to continue around the pulley 250. In order to effect movement of the cable to cause the slide members to operate to arrange the successive groups in criss-cross relation, as described, the cable is secured to one end of a cam lever 266 which is pivotally mounted at 268 in the side frame 18. The cam lever 266 is provided with a roller 270 arranged to cooperate with a cam 272 rotatably mounted on a stud 274 secured in the side frame 18. The cam 272 is arranged to be rotated at a ratio of 2 to 1 relative to the cam shaft 80 by a chain and sprocket drive 276, as illustrated in Fig. 2. A spring 278 connected to an arm 280 extended from the cam lever 266 is arranged to rock the lever downwardly to effect movement of the cable 242 in one direction, and operation of the cam will effect rocking of the cable in the other direction. It will be observed that the cam 272 is provided with raised portions 273, 275 in diametrically opposed relation on the cam so as to effect the jogging movement described with relation to the stacking operation, the different positions of the slide members during the jogging operation being indicated in Fig. 9.

The slide members 220, 224 may be adjustably secured to their respective slide plates 228 in order to accommodate different sizes of sheets, and as illustrated in Fig. 10, the slide member 220 is provided with a base leg 282 having an opening therein. A stud 284 provided with a head 285 is extended through a slot 286 formed in the slide plate, then through the base leg opening to be threadedly received in the lower end of an elongated adjusting nut 288 having a knurled head at its upper end. Thus, by loosening the nut 288 the slide member may be moved in the slot 286 to a new position of adjustment and the nut again tightened. In order to prevent rotation of the slide member relative to the slot, a marginal edge of the base leg is bent down, as at 290, to engage a groove 292 formed in the upper face of the slide plate, as shown.

Referring now to Fig. 11, a modified form of collating machine embodying the present invention, therein illustrated, may include a plurality of spaced stacks 300 of sheets to be collated supported in an inclined position in removable magazines 302 supported in a frame 304 secured between the side frames of the machine. A plurality of suction units 306, one for each stack, is supported above the stacks in a frame 308 supported at the upper end of a vertically reciprocated slide member 310a arranged to lower the suction units 306 into engagement with the uppermost sheets in the stacks and to elevate the same to withdraw said uppermost sheets and suspend the sheets in a substantially vertical position in the path of a horizontally moving platform 310 formed between chains 314. The travelling platform 310 may comprise rods 316 extended between the chains, and the chains are arranged to be driven by a drive sprocket 318 fast on a drive shaft 319 which may be rotated through any usual or preferred driving mechanism, the chains following a substantially rectangular path running over idler sprockets 320, 322, 324, as shown, in a manner similar to that described in the embodiment of the invention illustrated in Fig. 1.

As illustrated in Figs. 12, 13 and 14, each suction head may comprise a rubber suction cup 326 fitted into a metallic adapter 328. The two outer suction heads 323, 325

are threadedly secured to individual pipes 330, 332 which may be welded to collars 334 rotatably mounted on a tubular member 336 extended between side bars 338, 340 of the frame 308. A third suction cup 327 disposed intermediate the suction cups 323, 325 may be secured to a short pipe 342 mounted in a block 344 which may be clamped to a rod 346 extended between and clamped to blocks 337, 339 carried by pipes 330, 332 respectively. The intermediate block 344 also supports a riffling member 348, as shown. The suction pipes 330, 332, 342 may be connected by flexible tubes 350, 352, 354 to a manifold 356 which in turn is connected by a flexible tube 358 to a main suction manifold 360. The riffling member 348 is connected by a flexible tube 362 to an elongated manifold 364 which may be supplied with compressed air from any usual or preferred source through a flexible pipe 366. As illustrated in Fig. 12, the tube 336 may be rotatably mounted on an inner tube 368 which may comprise a spacer extended between the side bars 338, 340, the latter being connected by a through rod 370 supported at one end in the main supporting bar 338. In operation the suction pipes 330, 332 are thus free to rock on the outer tubular member 336, and provision is made for controlling the rocking movement of the suction units. As herein shown, each suction unit is provided with a transverse rod 374 supported between segmental arms 376, 378 fast on the outer tubular member 336 and arranged to engage the underside of the pipes 330, 332 to rock the suction unit. As best shown in Fig. 15, the segmental members 376 of each suction unit are connected by a link 380 to effect simultaneous operation of the same, the link 380 being urged forward by a spring 382 connected to an extension 384 from one of the segmental members 376 in order to normally maintain the suction units in an upwardly rocked position. The forward movement of the link 380 may be limited by an adjusting screw 386 mounted in a bar 388 and engageable with the extension 384.

In the operation of the machine when the suction units are lowered into engagement with the stacks 300 a lug 390 formed on the segmental member 376 is arranged to engage a stop screw 392 to effect rocking of the transverse bars 374 downwardly out of engagement with the suction pipes 330, 332 in order to permit free rocking of the suction units relative to their respective stacks of sheets. In this manner each suction unit is adapted to conform to the level of the uppermost sheet in each stack as its stack is depleted by continued withdrawals of the sheets. Thereafter when the suction units are elevated the spring 382 effects rocking of the linkage to cause the transverse rods 374 to rock their suction units upwardly with their respective sheets, the sheets assuming a substantially vertical position suspended from the suction units when in their elevated position. Provision is made for effecting a quick release of the suction units 306 when the lug 390 engages the stop screw 392 upon descent of the suction units to their lowered position, and as herein shown, a weighted member including an elongated bar 394 pivotally mounted at 396 in the supporting bar 338 is provided with a weight 397. A short arm 398 extending from and integral with the bar 394 is provided with a pin 395 at its outer end arranged to engage a slot 399 formed in the operating line 380. In operation when the lug 390 engages the stop screw 392 and the link 380 is rocked to the right, as shown in Fig. 15, the bar 394 is rocked upwardly, the pin 395 operating in the slot 399 which is formed to permit the pin to cam the link 380 to the right. The quick upward rocking of the weighted bar to present the pin 395 against the upper end of the closed slot tends to positively rock the linkage with a snap action in the manner described. Conversely, when the suction units are elevated the weight of the bar 394 will effect a quick forward rocking of the link 380 to rock the suction units upwardly away from the stack, and the pin 395 will engage the lower closed end of the slot 399. As

shown in Fig. 15, when the suction units reach their maximum position of elevation, the bar 394 is positioned under a stop bar 393 extended from the machine frame whereby to lock the bar in the position shown whereby to positively prevent rocking of the linkage to lower the suction units at this time. As indicated in Fig. 11, the elevating slide 310 may be supported between vertical angle pieces 400, 402 and is provided with rollers 404 for engagement therewith in a manner similar to that described with respect to the embodiment shown in Fig. 1. The elevator slide 310 may be connected by a link 406 to a lever 408 pivotally mounted at 410, the lever being provided with a cam roll 412 for cooperation with a cam 414 fast on a cam shaft 416. The cam shaft may be rotated through connections from the driven shaft 319 through a chain and sprocket drive 418 to an intermediate shaft 420. A pinion 422 fast on the shaft 420 meshes with a gear 424 fast on the cam shaft 416.

In the operation of the machine successive sheets are engaged by the leading edge of the platform 310 to lift the same to a horizontal position on the platform, and provision is made for discontinuing the suction to successive suction units in timed relation to the movement of the platform 310. As shown in Fig. 16, this may be accomplished by a valve structure which includes valves 426, 428 arranged to be reciprocated within the manifold pipe 360. The manifold pipe may be open at both ends and may be connected by a conduit 432 to any usual or preferred form of suction, the valves 426, 428 forming a suction chamber therebetween within the manifold pipe 360. As herein shown, the pipe 360 is provided with a plurality of spaced openings 434 surrounded by hollow collars 436 to which the flexible tubes 358 are connected, and in the operation of the machine when the valves are moved in one direction the openings 434 are successively opened to atmosphere to cause their respective suction cups 326 to release their sheets onto the platform 310. As shown in Fig. 11, the manifold 360 is mounted horizontally above the side frames of the machine, and the valves are arranged to be reciprocated by an endless cable 438 arranged to run over pulleys 440, the cable being connected to the ends of the valve rod 430. A lever 442 pivotally mounted on a stud 444 is connected to the cable 438, and a second arm 446 of the lever 442 is provided with a cam roll 448 arranged to cooperate with the cam 450 fast on the cam shaft 416. In operation when the arm 442 is rocked upwardly the valves are moved to the right within the manifold 360, and when the arm 442 is rocked downwardly the valves are moved to the left to discontinue the suction to successive suction units in timed relation to the travel of the platform 310. A spring 452 connected to the arm 442 is arranged to rock the same downwardly, the rate of downward rocking movement being controlled by the cam 450.

As indicated in Fig. 13, the central suction cup 327 is arranged in a slightly elevated position with respect to the outer suction cups 323, 325 so that as the suction cups approach engagement with the uppermost sheet in the stack the riffler 348 is arranged to direct a stream of air against the edge of the sheets to effect separation of the same whereupon the suction cups engage the uppermost sheet. In order to assure withdrawal of one sheet only from the stack provision is made for engaging the upper edges of the sheet as it is being elevated, and as herein shown, this may comprise a pair of brass clip members 454 adjustably mounted in brackets 456 secured to the underside of the magazine 302. Thus in operation when the suction units are rocked upwardly during the initial elevating movement, engagement of the edge of the sheet by the brass clips as it is rocked upwardly will tend to remove any sheet or sheets below the uppermost sheet which may have been withdrawn from the stack by the suction cups 326 during the withdrawing operation.

In the operation of the modified form of the machine when the sheets are released by their respective suction units 306, successive sheets come to rest against a stop 315 in superposed relation, and the sheets thus assembled may be discharged as a group as the chains 314 change their direction from a horizontal plane to a vertical plane when passing over the sprockets 320. The collated group of sheets may be guided by a flexible curved spring guide 458 onto a stacking table indicated generally at 460 which may include stacking mechanism of the type shown in Fig. 1 for arranging the sheets in a manner such as to facilitate subsequent removal of individual collated groups of sheets therefrom.

From the above description it will be seen that the present invention provides a novel and improved construction of collating machine capable of collating a plurality of sheets in superposed and assembled relation on a travelling platform as they are released successively from their respective suction units in timed relation to the travel of the platform, and that successive collated groups of sheets discharged from the machine may be automatically stacked in a manner such as to facilitate subsequent removal of individual groups of collated sheets in a novel manner. It will also be observed that the present novel construction of sheet withdrawing mechanism which includes a rockingly mounted suction unit is capable of conforming to variations in the height of the stack as the stack is depleted by continued withdrawals therefrom and may be used with advantage in other types of machines embodying sheet withdrawing mechanism. While the illustrated machine has provision for collating a maximum of eight sheets it will be obvious that the machine may be designed to accommodate a greater number of sheets. In practice the machine may be operated to collate fewer than the maximum number of sheets by merely providing fewer stacks of sheets and discontinuing the suction to the corresponding suction units.

While the preferred embodiment of the invention has been herein illustrated and described, it will be understood that the invention may be embodied in other forms within the scope of the following claims.

Having thus described the invention, what is claimed is:

1. In a collating machine, in combination, a plurality of stacks of sheets disposed in spaced relation, vertically reciprocable suction units for withdrawing the uppermost sheet from each stack and for supporting the same in a substantially vertically suspended position and with the spaced and suspended sheets in substantially parallel relation and in alignment in one direction, a travelling platform having a stop thereon and movable in a horizontal plane to engage successive spaced and vertically suspended sheets and to move them to a horizontal position on the platform while retained by said suction units, means for releasing successive sheets from their respective suction units in timed relation to the movement of said platform, successive released sheets sliding on the platform and on adjacent underlying sheets and coming to rest against said stop whereby to form a collated group of sheets in superposed relation on said platform, said sheet releasing means including a suction manifold adapted for connection to a source of suction, a plurality of spaced ports in said manifold in movable valve means controlling said ports, and mechanism for operating said valve means to effect opening of successive spaced ports to the atmosphere in timed relation to the travel of said platform.

2. In a collating machine, in combination, a plurality of stacks of sheets disposed in spaced relation, vertically reciprocable means for withdrawing the uppermost sheet from each stack and for supporting the same in a substantially vertically suspended position and with the spaced and suspended sheets in substantially parallel relation and in alignment in one direction, a travelling plat-

form having a stop thereon and movable in a horizontal plane to engage successive spaced and vertically suspended sheets and to move them to a horizontal position on the platform while retained by said suction units, means for releasing successive sheets from their respective suction units in timed relation to the movement of said platform, successive released sheets sliding on the platform and on adjacent underlying sheets and coming to rest against said stop whereby to form a collated group of sheets in superposed relation on said platform, means for effecting vertical reciprocation of said suction units, said suction units being provided with a plurality of transversely aligned suction cups arranged to engage the stacks adjacent the upper marginal edges thereof when lowered to a predetermined position, a plurality of clips engageable with the upper marginal edges of the stack and slidably mounted to conform to variations in heights of the stacks, said reciprocating means being arranged to lower the suction units a slight distance beyond said predetermined point of descent after engagement of the upper sheet by the suction unit to effect a sliding separating movement of the upper sheet relative to an underlying sheet and to move the upper sheet relative to said clips to present the edge of the sheet just within the outer edge of said clips, whereby the marginal edge of said sheet will be flexed by said clips during subsequent elevation of the suction unit to withdraw the sheet, said flexing action operating to remove any underlying sheet which may adhere to the upper sheet during the withdrawing operation.

3. A collating machine as defined in claim 2 wherein an intermediate suction cup of each suction unit is offset upwardly relative to the remaining aligned cups, and means for directing a stream of air against the upper edge of the stack to effect initial separation of the sheets, the upper sheet being drawn up into engagement with said offset cup during said initial separation, said clips also serving to retain portions of the upper sheet in engagement with the stack during the initial separating operation.

4. In a collating machine, in combination, means for supporting a plurality of stacks of sheets in spaced relation, reciprocable means for withdrawing a sheet from each stack simultaneously and for supporting the same in spaced and aligned relation, a travelling platform engageable with successive aligned sheets as it is moved therepast, and means for releasing successive sheets one by one from their respective withdrawing means in timed relation to the movement of said platform into operative relation to successive of said sheets whereby to form a collated group of sheets in superposed relation on said platform, a table arranged to receive successive collated groups of sheets discharged from the machine, and stacking means including movable guide members operating in timed relation to the collating mechanism to alternately move the guide members to different positions on said table for arranging successive groups in non-aligned relation on said table whereby to facilitate subsequent removal of individual groups from the table.

5. In a collating machine, in combination, a plurality of stacks of sheets disposed in spaced relation, vertically reciprocable means including suction units for withdrawing the uppermost sheet from each stack simultaneously and for supporting the same in a substantially vertically suspended position and with the spaced and suspended sheets in substantially parallel relation and in alignment in one direction, a travelling platform having a stop thereon and movable in a horizontal plane to engage successive spaced and vertically suspended sheets and to move them to a horizontal position on the platform while retained by said suction units, means for releasing successive sheets one by one from their respective suction units in timed relation to the movement of said platform into operative relation to successive of said sheet, successive released sheets sliding on the platform and on adjacent underlying sheets and coming to rest against said stop

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whereby to form a collated group of sheets in superposed relation on said platform, a table arranged to receive successive collated groups of sheets discharged from the machine, and stacking means including movable guide members operating in timed relation to the collating mechanism to alternately move the guide members to different positions on said table for arranging successive groups in crisscross relation on said table whereby to facilitate subsequent removal of individual groups from the table.

6. In a collating machine, in combination, a plurality of stacks of sheets disposed in spaced relation, vertically reciprocable means for withdrawing the uppermost sheet from each stack and for supporting the same in a substantially vertically suspended position and with the spaced and suspended sheets in substantially parallel relation and in alignment in one direction, a travelling platform movable in a horizontal plane arranged to engage successive spaced and vertically suspended sheets to move them to a horizontal position on the platform while retained by said withdrawing means, means for releasing successive sheets from their respective withdrawing means in timed relation to the movement of said platform to form a collated group of sheets in superposed relation on said platform, a table arranged to receive successive collated groups of sheets discharged from the machine, and stacking means operating in timed relation to the collating machine for arranging successive groups in crisscross relation on said table whereby to facilitate subsequent removal of individual groups from the table, said stacking means including a pair of spaced fixed stop members and a pair of spaced movable stop members, said movable stop members being arranged in one position of operation to engage the leading edge of a group of sheets so as to effect rocking of the group to an angular position against one of said fixed members, said movable members in another position of operation being arranged to effect rocking of a succeeding group of sheets in an opposite angular direction whereby to arrange successive groups in crisscross relation, and means for operating said movable stop members to effect said arrangement of successive groups in opposite angular directions during alternate cycles of operation of the collating mechanism.

7. A collating machine as defined in claim 6 wherein the stacking means is provided with adjustably mounted corner aligning members arranged to receive an upper corner of alternate groups of sheets, said operating means being arranged to effect jogging of the lower edges of their respective groups into said corner aligning members to arrange the sheets of each group in aligned superposed relation.

8. A collating machine as defined in claim 6 wherein the movable stop members are adjustably mounted to accommodate collated groups of different sizes.

9. In a collating machine, in combination, a plurality of stacks of sheets disposed in spaced relation, vertically reciprocable means for withdrawing the uppermost sheet from each stack and for supporting the same in a substantially vertically suspended position and with the spaced and suspended sheets in substantially parallel relation and in alignment in one direction, a travelling platform having a stop thereon and movable in a horizontal plane to engage successive spaced and vertically suspended sheets and to move them to a horizontal position on the platform while retained by said suction units, and means for releasing successive sheets from their respective suction units in timed relation to the movement of said platform, successive released sheets sliding on the platform and on adjacent underlying sheets and coming to rest against said stop whereby to form a collated group of sheets in superposed relation on said platform, said suction units being rockingly mounted, means for rocking the suction units operative to maintain the units in an inoperative position until lowered and to then free the units to permit them to rock downwardly into

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engagement with their respective stacks whereby the suction units may conform to variations in the heights of the stacks as successive sheets are withdrawn therefrom, said rocking means being operative to rock the units upwardly after engagement thereof with their stacks, each unit including a plurality of aligned suction cups engageable with a marginal edge of the stack, an intermediate cup being offset upwardly relative to the outer cups, means for projecting a stream of air against said edge to separate the sheets, retaining means engageable with said edge, said suction units being moved downwardly a short distance after engagement with their stacks to effect a sliding movement of the sheets relative to the underlying sheets prior to being rocked upwardly, said retaining means being operative to flex the edge of the sheet being withdrawn during the upward rocking movement to effect removal of a second sheet which may inadvertently adhere to the sheet being withdrawn.

10. In a collating machine, in combination, a plurality of stacks of sheets disposed in spaced relation, vertically reciprocable means for withdrawing the uppermost sheet from each stack and for supporting the same in a substantially vertically suspended position and with the spaced and suspended sheets in substantially parallel relation and in alignment in one direction, a travelling platform having a stop thereon and movable in a horizontal plane to engage successive spaced and vertically suspended sheets and to move them to a horizontal position on the platform while retained by said suction units, means for releasing successive sheets from their respective suction units in timed relation to the movement of said platform, successive released sheets sliding on the platform and on adjacent underlying sheets and coming to rest against said stop whereby to form a collated group of sheets in superposed relation on said platform, said sheet releasing means including a suction manifold adapted for connection to a source of suction, a plurality of spaced ports in said manifold in communication with successive of said suction units, a valve rod having a pair of spaced valves thereon forming a suction chamber communicating with said ports and said suction connection, means for operating said valve rod to effect opening of successive spaced ports to the atmosphere in timed relation to the travel of said platform, and control means responsive to failure of at least one of said suction units to retain its sheet during the withdrawing operation for opening said suction chamber to the atmosphere to effect release of all of said sheets prior to elevation of the suction units.

11. In a collating machine, in combination, means for supporting a plurality of stacks of sheets in relatively closely spaced relation, reciprocable means for simultaneously withdrawing a sheet from each stack and for supporting the same in relatively closely spaced and aligned relation, a single travelling platform movable at a relatively fast rate engageable with successive aligned and closely spaced sheets as it is moved therepast, means for releasing successive sheets one by one from their respective withdrawing means in timed relation to the movement of said platform whereby to form a collated group of sheets in superposed relation on said platform, said platform travelling in a closed path having an upper and a lower run, said reciprocable means operating to withdraw the sheets during the travel of the platform through said lower run to dispose the sheets in readiness to be received by the platform upon arrival of the platform into the upper run, said closely spaced stacks being disposed in an inclined and parallel relation whereby to occupy a minimum of space longitudinally of the machine for collating a relatively large number of stacks of sheets in a relatively small space.

12. In a collating machine, in combination, means including removable magazines for supporting a plurality of stacks of sheets in an inclined and parallel position and in relatively closely spaced relation, vertically re-

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ciprocable means for withdrawing the uppermost sheet from each stack and for supporting the same in a substantially vertically suspended position and with the spaced and suspended sheets in substantially parallel relation and in alignment in one direction, a traveling platform movable in a horizontal plane in said direction arranged successively to engage the thus spaced and vertically suspended sheets to move them to a horizontal position on the platform while retained by said withdrawing means, and with each sheet disposed on the previously engaged sheet, and means for successively releasing said sheets from their respective withdrawing means in timed relation to the movement of said platform to form a collated group of sheets supported in superposed relation on said platform.

13. In a collating machine, in combination, a traveling platform, means for supporting a plurality of stacks of sheets in an inclined position below said traveling platform and in relatively closely spaced relation, bodily vertically reciprocable rockingly mounted suction units each having a plurality of transversely aligned suction cups adapted to engage the upper sheets in the stacks adjacent the top marginal edges thereof, said units operating to withdraw the uppermost sheet from each stack and to support the same in a substantially vertically suspended position and with the spaced and suspended sheets in substantially parallel relation and in alignment in one direction, said platform having a stop thereon and being movable in a horizontal plane in said direction successively to engage the thus suspended sheets and to move them to a horizontal position on the platform while retained by said suction units, means for rocking said suction units upwardly and operative to maintain the same in an upwardly rocked position when said units are elevated and for permitting the same to rock downwardly under the influence of their own weight when said units are lowered to permit free rocking thereof into engagement with their respective stacks whereby to permit the suction units to accommodate themselves to variations in the heights of the stacks as successive sheets

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are withdrawn therefrom, and means for successively releasing said sheets from their respective suction units in timed relation to the movement of said platform when a major portion of each sheet has assumed a position to be fully supported by said platform and with the trailing edge of each sheet spaced from said stop to permit successive released sheets to slide on the platform and on adjacent underlying sheets and to come to rest against said stop whereby to form a collated group of sheets in superposed relation on said platform.

14. A collating machine as defined in claim 13 wherein an intermediate suction cup of each unit is offset upwardly relative to the remaining suction cups, and including means for directing a stream of air against the upper edges of each stack to separate the upper sheet from the underlying sheets and to permit the separated sheet to be drawn upwardly into engagement with said suction cups.

15. A collating machine as defined in claim 13 wherein the rocking means is operative to rock the suction units upwardly after engagement of the suction cups with the stack to effect withdrawal of the uppermost sheet from the stack prior to the bodily elevation of the suction unit, and wherein a means is disposed to engage an edge of a sheet being withdrawn to cause the latter to flex whereby to effect separation of an underlying sheet inadvertently adhering to said upper sheet during the withdrawing operation.

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