Oct. 18, 1960 W. F. HUCK 2,956,802

SHEET FEEDING DEVICES

Filed May 5, 1958 5 Sheets-Sheet 1

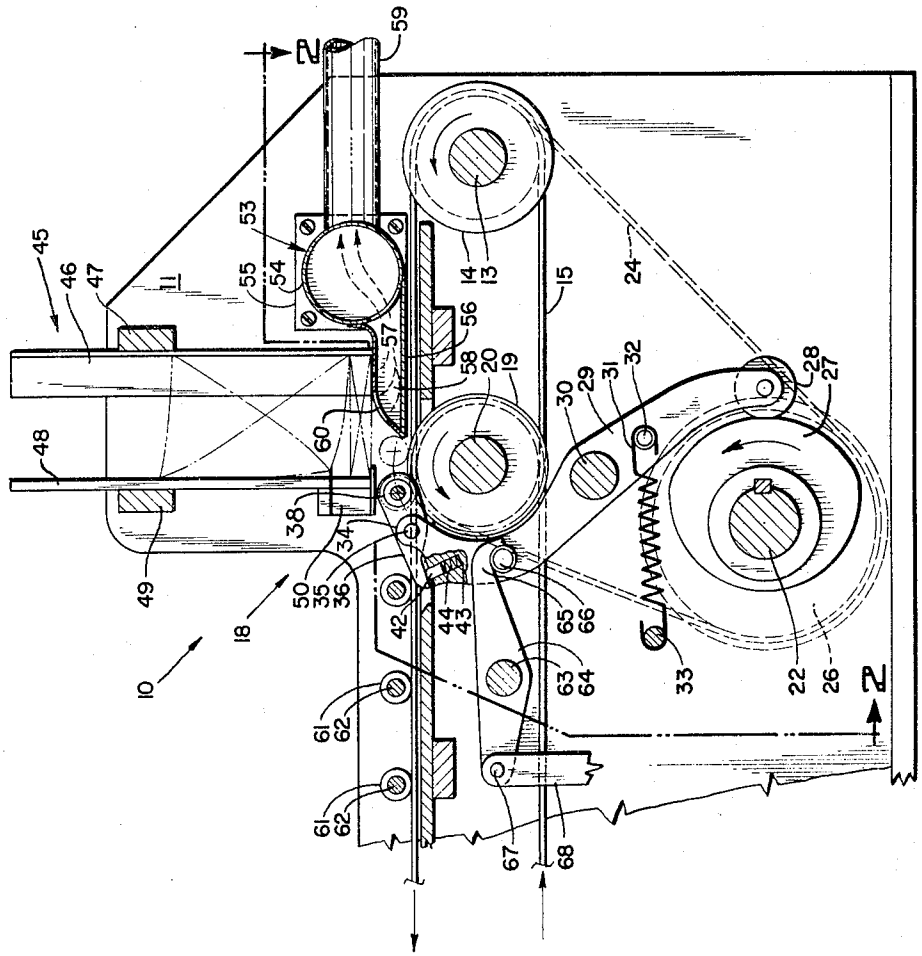

FIG. 1

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SHEET FEEDING DEVICES

Filed May 5, 1958 5 Sheets-Sheet 2

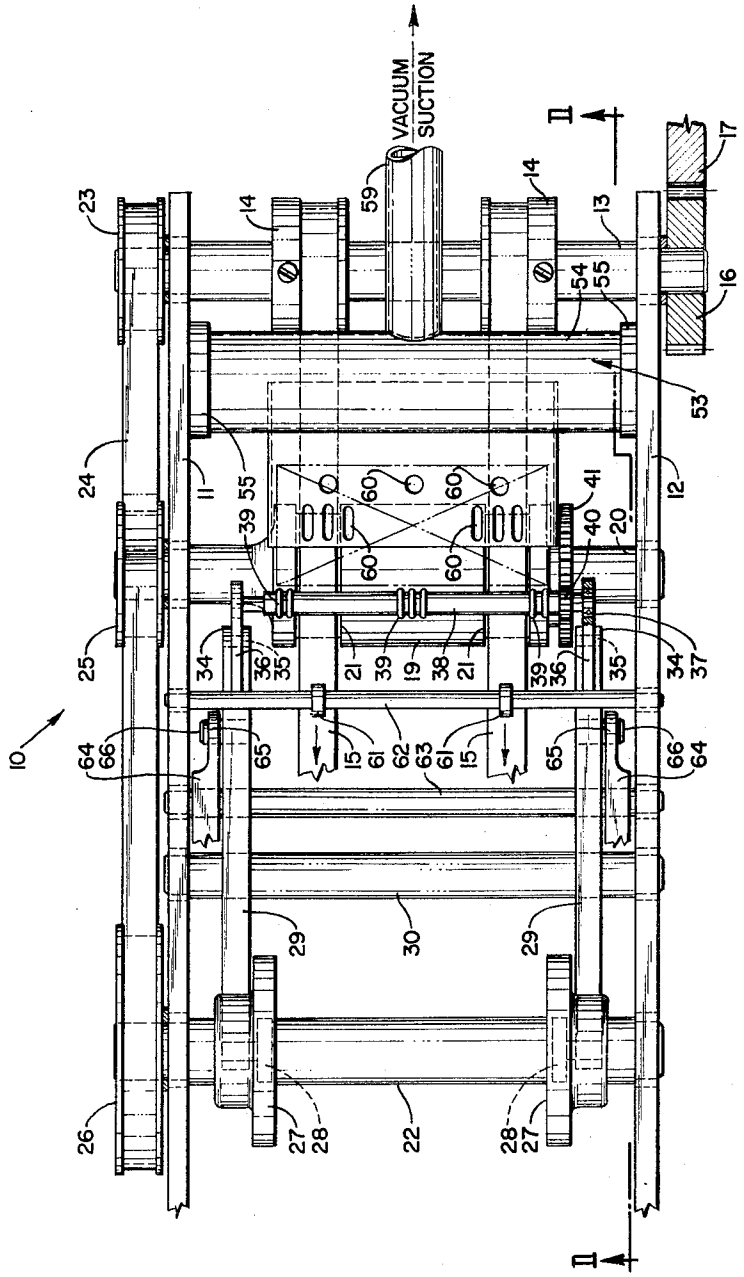

FIG. 2

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SHEET FEEDING DEVICES

Filed May 5, 1958 5 Sheets-Sheet 3

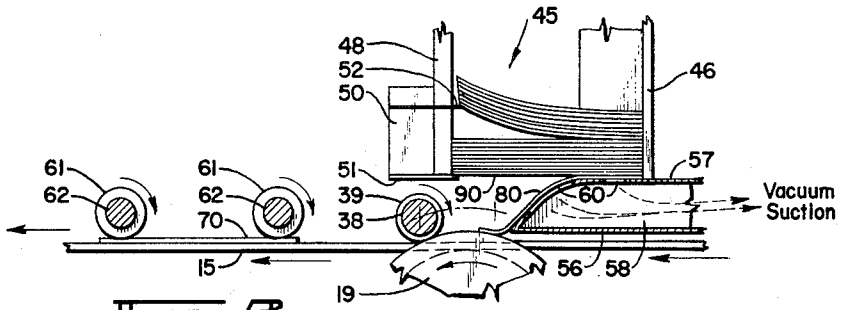

FIG. 3

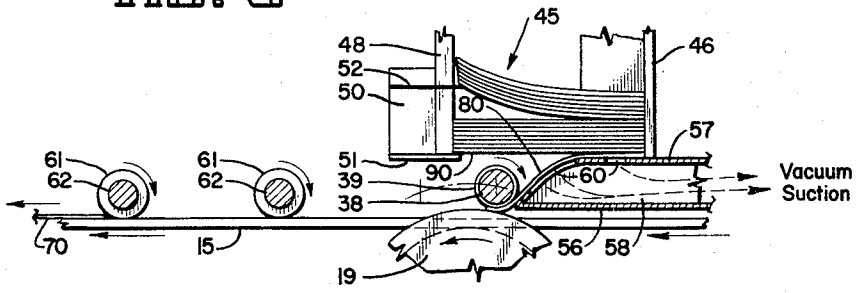

FIG. 4

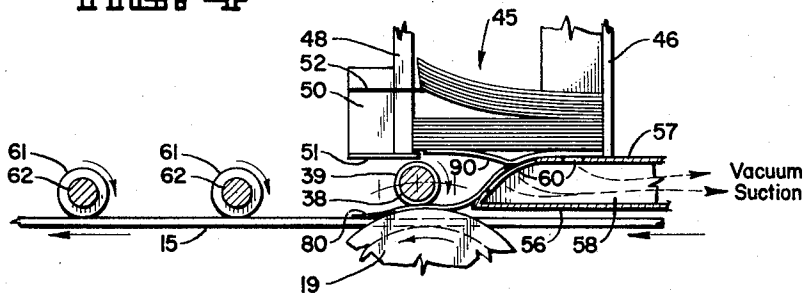

FIG. 5

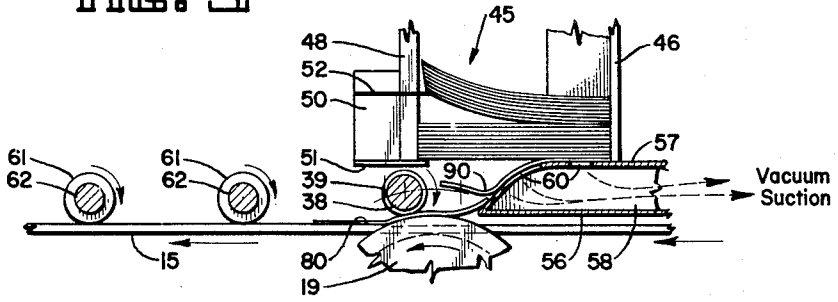

FIG. 6

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SHEET FEEDING DEVICES

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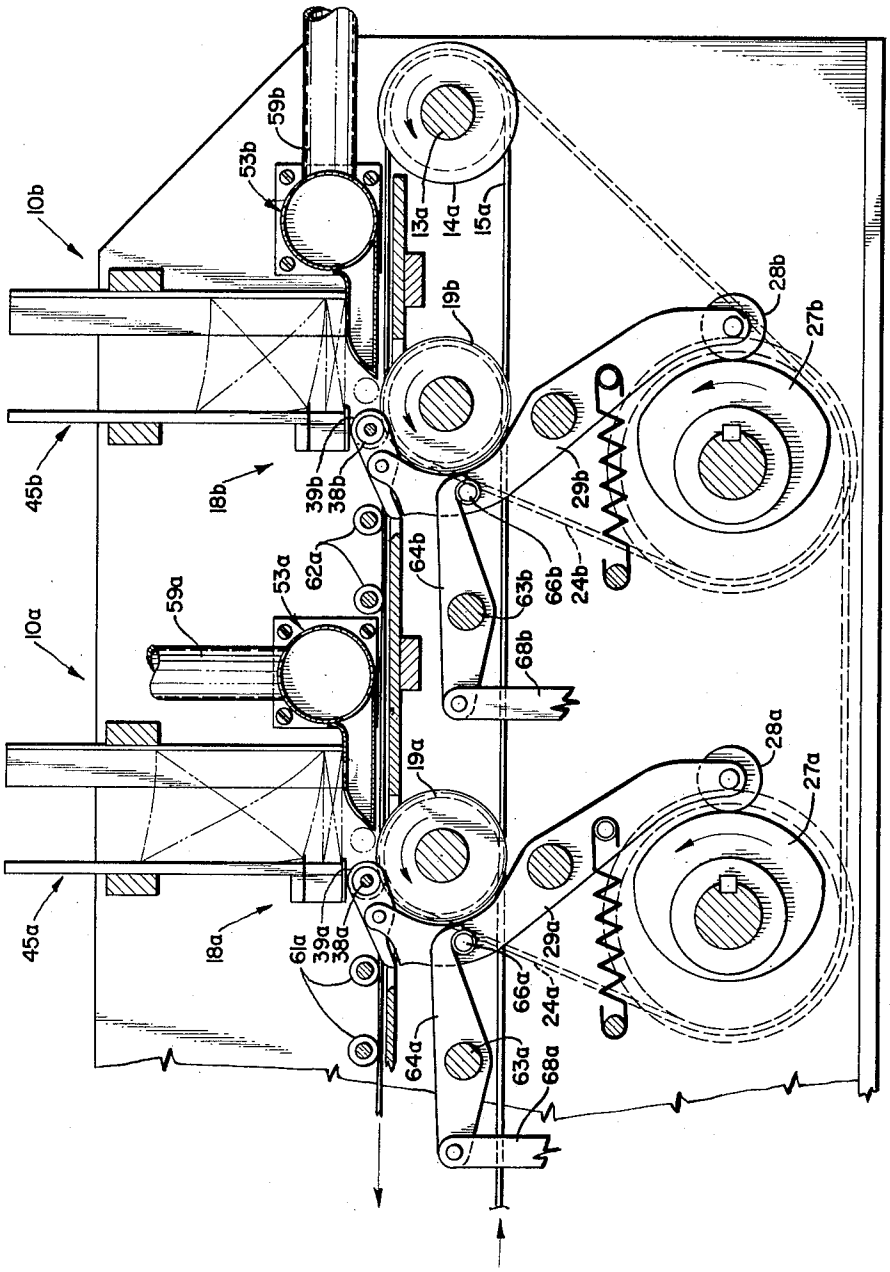

FIG. 7

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SHEET FEEDING DEVICES

Filed May 5, 1958 5 Sheets-Sheet 5

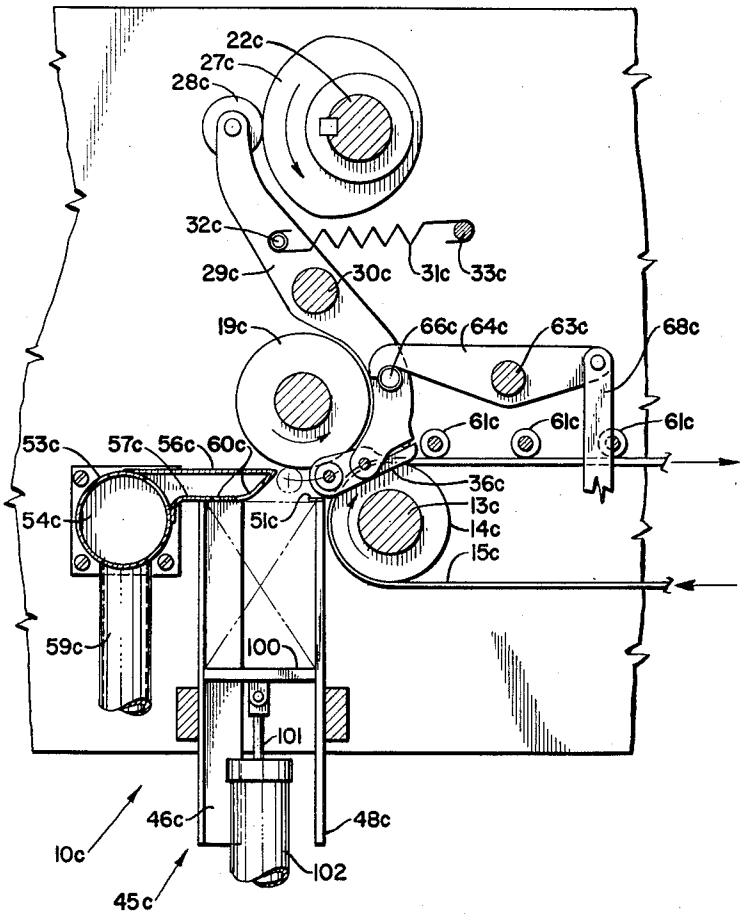

FIG. 8

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United States Patent Office 2,956,802 Patented Oct. 18, 1960

2,956,802

SHEET FEEDING DEVICES

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Filed May 5, 1958, Ser. No. 733,014

10 Claims. (Cl. 271—12)

This invention relates to devices for feeding sheets of paper, cloth or felt or other materials in sheet form.

Existing devices for feeding sheets one at a time from a stack or pile thereof include suction means movable from a first position, where the suction means engages the bottom sheet of the stack, to a second position, where the sheet adhering to the suction means and moved with the latter from the first position to the second position, is taken away by mechanical feeding means, such as, grippers, rollers and the like. The movement of the suction means necessarily complicates the construction and operation of the sheet feeding device and, accordingly, it is an object of this invention to provide a simple and reliable device for feeding sheets, one at a time, from a stack or pile thereof, and to perform this function through the use of a stationary suction means effective to separate the sheet to be fed from the remainder of the sheets in the stack or pile.

Another object of the invention is to provide a sheet feeding device of the described character which is constructed and arranged so that two or more of such devices may be installed in association with a common conveyor to feed sheets to the conveyor from stacks in respective magazines of such devices in any desired sequence.

A further object is to provide a sheet feeding device employing a stationary suction means for separating a sheet to be fed from the remainder of the sheets in a stack or pile, and a reliable pick-up mechanism for removing the separated sheet from the stack and discharging such sheet onto a conveyor, which pick-up mechanism is adapted for operation at very high speeds and can easily be made inoperative at the will of the operator or of an automatic feed selector device, without losing control of the sheets and without halting the feeding of sheets then on the conveyor.

In accordance with an aspect of the invention, a sheet feeding device includes a magazine for holding a stack of the sheets to be fed, with the stack being urged toward the feeding end of the magazine either by gravity, in the case where the sheets are fed from the bottom of the stack, or by mechanical means, in the case where the sheets are fed from the top of the stack, and with a narrow ledge being provided along the front of the magazine at the feeding end of the latter, a vacuum chamber having a wall thereof in the form of a perforated suction plate extending across the rear portion of the feeding end of the magazine and then curving away from the latter so that the leading edge and the trailing edge portion of a sheet at the feeding end of the magazine rests against the ledge and suction plate, respectively, and the suction acting on the sheet through the perforations of the suction plate urges the sheet to conform to the curved configuration of the suction plate, thereby to remove the leading edge of the sheet from the ledge and thus separate the leading edge of the sheet from the remainder of the stack, and a pick-up mechanism operative to engage the separated leading edge

of the sheet and to move the latter forwardly off the suction plate to a suitable conveyor so that the suction can then act through the perforations of the suction plate upon the next sheet at the feeding end of the magazine for separating the leading edge of that next sheet from the remainder of the stack.

In accordance with another aspect of the invention, the pick-up mechanism of the sheet feeding device includes a rotated cylinder which is disposed so that the leading edge of a sheet separated from the remainder of the stack by the action of the perforated suction plate rests against the surface of the cylinder, nipping rollers in rolling contact with the cylinder and oscillating between a forward position, where the rollers are spaced from the separated sheet leading edge resting against the cylinder, and a rearward position where the nipping rollers grip the leading edge of a sheet resting against the surface of the cylinder to initiate the feeding of the sheet between the cylinder and the nipping rollers, and a control means for releasably holding the nipping rollers in the forward position thereof so that the leading edge of a sheet separated from the remainder of the stack continues to rest against the cylinder and feeding of the sheets from the magazine is interrupted.

The above, and other objects, features and advantages of the invention, will be apparent in the following detailed description of illustrative embodiments thereof which is to be read in connection with the accompanying drawings forming a part hereof, and wherein:

Fig. 1 is a vertical sectional view taken along the line 1—1 of Fig. 2, and showing a sheet feeding device embodying the present invention for feeding sheets individually from the bottom of a stack thereof;

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1;

Figs. 3 to 6, inclusive, are similar, fragmentary sectional views showing a portion of the sheet feeding device of Fig. 1 and illustrating successive phases in an operating cycle of such device;

Fig. 7 is a vertical sectional view similar to that of Fig. 1, but showing two sheet feeding devices embodying the invention arranged in tandem for sequentially depositing sheets upon a common belt conveyor; and

Fig. 8 is a vertical sectional view similar to that of Fig. 1, but illustrating a sheet feeding device constructed in accordance with another embodiment of the invention so as to be adapted for feeding sheets individually from the top of a stack thereof.

Referring to the drawings in detail, and initially in Figs. 1 and 2 thereof, it will be seen that the sheet feeding device there illustrated and generally identified by the reference numeral **10** includes spaced apart, parallel, upstanding side frame members **11** and **12** with a horizontal shaft **13** extending laterally therebetween and rotatably journaled, at its opposite ends, in suitable bearings carried by the side frame members. Shaft **13** has pulleys **14** secured thereto at axially spaced apart locations, and another shaft (not shown) with similar pulleys thereon is rotatably supported by side frame members **11** and **12** and extends parallel to shaft **13** at a location spaced substantially horizontally forward from the latter so that endless belts **15** extending around the pulleys of that other shaft and around the pulleys **14** will have substantially horizontally extending upper and lower runs, as shown in Fig. 1. One end of shaft **13** projects outwardly beyond side frame member **12** and has a spur gear **16** secured thereto (Fig. 2) which meshes with a drive gear **17** mounted on a continuously rotated main drive shaft (not shown).

Shaft **13** is driven in the counter-clockwise direction, as viewed in Fig. 1, so that the upper runs of conveyor belts **15** move toward the left under a sheet feeding sta-

tion which is generally indicated at 18. A cylinder 19 located at sheet feeding station 18 has journals 20 at its opposite ends which are rotatably mounted in suitable bearings carried by side frame members 11 and 12, and the axis of rotation of cylinder 19 extends parallel to the axis of shaft 13 and is vertically disposed so that the surface of cylinder 19, at the top of the latter, projects above the upper surfaces of the upper runs of conveyor belts 15. In order to permit projection of the surface of cylinder 19 above the upper runs of conveyor belts 15, the surface of cylinder 19 is formed with annular grooves 21 (Fig. 2) which are axially located along the cylinder so as to receive the upper runs of belts 15.

A cam shaft 22 extending parallel to shaft 13 and the axis of cylinder 19 is located substantially below the latter and has its opposite ends rotatably mounted in suitable bearings carried by side frame members 11 and 12. Cylinder 19 and cam shaft 22 are both rotatably driven from shaft 13 by means of a pulley 23 secured on an end of shaft 13 which projects outwardly beyond side frame member 11 and drives an endless belt 24 which also runs around pulleys 25 and 26 secured on an end of a journal 20 of cylinder 19 and on an end of cam shaft 22, respectively, projecting outwardly beyond side frame member 11.

Cam shaft 22 has two identical radial cams 27 secured thereon adjacent the inner surfaces of side frame members 11 and 12, and each radial cam 27 has radially large and small portions and is engaged by a follower roller 28 which is rotatably mounted at the lower end of a related rocker arm 29. The rocker arms 29 associated with the cams 27 are mounted, intermediate their ends, on a horizontal shaft 30 which extends laterally between side frame members 11 and 12 and is rotatably mounted in suitable bearings carried by the latter so that the rocker arms 29 are movable in vertical planes adjacent the inner surfaces of the side frame members. A helical tension spring 31 is provided for each rocker arm 29 and is connected, at one end, to the latter, as at 32, and, at its other end, to an anchor or pin 33 carried by the adjacent side frame member (Fig. 1), so that each spring 31 urges the related rocker arm 29 in the clockwise direction, as viewed in Fig. 1, in order to maintain the follower roller 28 in contact with the related radial cam 27.

Each of rocker arms 29 has a bifurcated upper end 34 carrying a pivot pin 35 on which a lever 36 is rockably mounted intermediate the opposite ends thereof so that the lever 36 is free to swing relative to the related rocker arm 29 in the plane of movement of the latter. The rearwardly directed end of each lever 36 carries a bearing 37 (Fig. 2), and a laterally extending shaft 38 has its opposite ends rotatably journaled in the bearings 37 and carries nipping rollers 39 for rolling contact with the surface of cylinder 19 projecting above the upper runs of conveyor belts 15. A spur gear 40 is secured on one end portion of shaft 38 (Fig. 2) and meshes with a spur gear 41 secured on the journal 20 at the adjacent end of cylinder 19 so that shaft 38 is rotatably driven from cylinder 19 in the direction opposed to the rotation of the latter with the linear speed at the periphery of nipping rollers 39 being substantially equal to the linear speed at the surface of cylinder 19.

In order to ensure continuous contact of nipping rollers 39 with cylinder 19, a plunger 42 is slidably mounted in a bore 43 formed in the upper end of each rocker arm 29 and opening upwardly under the forwardly directed end of the related lever 36, and a helical compression spring 44 is disposed in the bore 43 under plunger 42 to urge the latter upwardly against the forwardly directed end of the related lever 36, thereby to urge the lever 36 to rock in the clockwise direction, as viewed in Fig. 1, for holding nipping rollers 39 on shaft 38 downwardly against the surface of cylinder 19.

Assuming that rocker arms 29 are free to rock under the influence of cams 27 and springs 31, shaft 38 repeatedly oscillates between the full line and broken line positions shown in Fig. 1.

A magazine generally identified by the reference numeral 45 and adapted to hold a stack or pile of the sheets to be fed is mounted above the upper runs of conveyor belts 15 at sheet feeding station 18 and includes upright angle members 46, defining the back corners of the magazine and secured to a cross member 47 extending between side frame members 11 and 12, and flat upright members 48 defining the front of the magazine and supported from a cross member 49 also extending between the side frame members. As is apparent in Fig. 1 and in Figs. 3 to 6, inclusive, the lower ends of members 46 and 48 defining the magazine 45 are spaced upwardly from the upper runs of conveyor belts 15, and a laterally extending block 50 is secured to the lower end portions of flat members 48 and carries a strip 51 and a blade 52 at its lower and upper surfaces, respectively, with the strip 51 and blade 52 projecting rearwardly beyond the back surfaces of members 48. Strip 51 defines a ledge that supports the pile or stack of sheets at the leading edge of the lowermost sheet, while blade 52 projects only a small distance into the magazine and assumes some of the weight at the front of that portion of the stack of sheets above the blade and thereby prevents the imposition of an excessive force upon the bottom strip 51 which might prevent the rearward removal of the leading edge of the lowermost sheet from such strip or ledge. The blade 52 further acts to shuffle the sheets of the pile or stack as they move toward the end of the magazine, thereby to prevent the sticking together of two or more successive sheets.

Sheet feeding device 10 further includes a stationary vacuum chamber generally identified by reference numeral 53 and consisting of a cylinder 54 extending laterally in back of magazine 45 and having flanged end walls 55 secured to side frame members 11 and 12, a flat solid plate 56 extending forwardly from the bottom of cylinder 54 above the path of the top runs of conveyor belts 15, and a suction plate 57 having a flat part extending forwardly from cylinder 54 above plate 56 and a downwardly curved part which is joined to plate 56 at its forward edge in order to define an auxiliary vacuum space 58 communicating with the interior of cylinder 54. A pipe or conduit 59 extends from cylinder 54 to the inlet or suction side of an air blower or pump (not shown) so that a vacuum is created within cylinder 54 and space 58.

The flat and curved parts of suction plate 57 are provided with openings 60 through which air can enter the space 58 in response to the creation of a relatively low pressure within the latter. As is apparent in Fig. 1 and Figs. 3 to 6, inclusive, the flat part of suction plate 57 extends under the rear portion of magazine 45 immediately below the lower ends of members 46 to support the trailing edge portion of the lowermost sheet of the stack of sheets in the magazine.

The sheet feeding device 10 further includes rollers 61 disposed above the upper runs of belts 15 and mounted rotatably on horizontal rods 62 that extend laterally between side frame members 11 and 12 at spaced apart locations in front of sheet feeding station 18 so that rollers 61 are effective to hold a sheet on conveyor belts 15 following the feeding of such sheet from magazine 45 to the conveyor belts in the manner hereinafter described in detail.

In order to permit control of the operation of sheet feeding device 10, the latter has a shaft 63 extending laterally in front of rocker arms 29 and having its opposite ends rotatably mounted in suitable bearings carried by side frame members 11 and 12, and latch levers 64 mounted on shaft 63 adjacent the inner surfaces of the side frame members and having downwardly curved keepers 65 at their rearwardly directed ends which are adapted to engage over pins 66 projecting laterally from

the upper end portions of the adjacent rocker arms 29 when the latter are in the positions occupied thereby upon engagement of the related follower rollers 28 with the radially large portions of cams 27, as shown in Fig. 1. The forwardly directed ends of levers 64 are pivotally connected, as at 67, to links 68 which may be connected to a manual or automatic control (not shown) so that, when the links 68 are pulled downwardly, to rock the levers 64 in the counterclockwise direction, as viewed in Fig. 1, the keepers 65 of the levers are disposed above the paths of oscillation of the pins 65 to free the rocker arms for rocking movement in response to rotation of the related cams 27. However, when the latch levers 64 are rocked to their engaged positions shown in Fig. 1, keepers 65 engage pins 66 with the rocker arms in their positions corresponding to engagement of rollers 28 with the radially large portions of cams 27 and serve to retain the rocker arms in those positions while the cams continue to rotate.

Assuming that the levers 64 are rocked to their released position, as described above, the successive steps in the operation of sheet feeding device 10 will now be described with reference to Figs. 3 to 6, inclusive. In Fig. 3, a sheet 70 previously fed from the bottom of the pile or stack in magazine 45 is shown being carried toward the left by conveyor belts 15, while rollers 61 hold the sheet 70 in frictional contact with the conveyor belts. At this stage of the operation, shaft 38 with nipping rollers 39 thereon is in its foremost position corresponding to the engagement of follower rollers 28 of rocker arms 29 with the radially enlarged portions of the related cams 27, as in Fig. 1, and the lowermost sheet 80 of the stack or pile in magazine 45 has been drawn downwardly against the curved part of suction plate 57 by the suction force of the vacuum created within chamber 53 and acting upon the sheet through the openings 60 of suction plate 57. The suction plate 57 is disposed in relation to cylinder 19 so that, when the sheet 80 lies against the downwardly curved part of suction plate 57, the leading edge of sheet 80 extends forwardly beyond the forward edge of suction plate 57 and rests upon the surface of cylinder 19, as shown in Fig. 3.

When follower rollers 28 engage the radially small portions of related cams 27, rocker arms 29 are angularly displaced to move shaft 38 rearwardly to the position shown in Fig. 4, so that the leading edge portion of sheet 80 is then gripped between the nipping rollers 39 of shaft 38 and the surface of cylinder 19 which together form a pick-up mechanism. Since shaft 38 and cylinder 19 are continuously rotated by reason of the drive of pulley 25 by belt 24 and the meshing engagement of gears 40 and 41, the sheet 80 gripped between nipping rollers 39 and the surface of cylinder 19 is fed forwardly therebetween, as in Fig. 5. During the forward feeding of sheet 80, cam follower rollers 28 move from the radially small portions to the radially large portions of the related cams 27, so that shaft 38 carrying nipping rollers 39 is moved forwardly while being continuously pressed downwardly against the surface of cylinder 19 by the action of plungers 42 and springs 44 upon the levers 36 supporting shaft 38. As sheet 80 is fed forwardly between nipping rollers 39 and cylinder 19 into frictional engagement with the upper runs of conveyor belts 15, the movement of the trailing edge of sheet 80 along the downwardly curved portion of suction plate 57 serves to successively uncover the suction openings 60 of the latter. Such progressive uncovering of the suction openings 60 permits suction to act therethrough upon the sheet 90 which is then at the bottom of the stack in conveyor 45. Since the trailing edge portion of sheet 90 bears the entire weight of the rear portion of the stack of sheets in magazine 45 and is further held to the flat part of suction plate 57 which supports the rear portion of the stack by the effect of the suction acting through the initially uncovered suction openings in that part of the suction plate, and since the blade 52 serves to limit the downward force that can press the leading edge of sheet 90 onto ledge 52, uncovering of the suction openings in the downwardly curved part of suction plate 57, which tends to draw the middle portion of sheet 90 downwardly toward the curved part of the suction plate, serves to draw the leading edge of the sheet rearwardly off the strip or ledge 38, as shown in Fig. 5, so that the sheet 90 is then free to be progressively drawn against the curved part of suction plate 57 as the trailing edge of sheet 80 moves further toward the left, as in Fig. 6. When the trailing edge of sheet 80 is completely removed from suction plate 57, then sheet 90 will occupy the same position as did sheet 80 in Fig. 3. Upon movement of shaft 38 with the nipping rollers 39 thereon to its foremost position corresponding to engagement of follower rollers 28 with the radially large portions of cams 27, the operating cycle of the sheet feeding device is completed, and sheet 80 will then be fully deposited upon conveyor belts 15, as in the case of the sheet 70 in Fig. 3. When shaft 38 is again moved rearwardly, the nipping rollers 39 are once more effective to grip the leading edge of sheet 90 lying against the surface of rotated cylinder 19 in order to resume the feeding operation.

It will be apparent that, at any time following the feeding of a sheet from magazine 45 onto conveyor belts 15, links 68 may be actuated, either manually or automatically, in order to engage the keepers 65 of levers 64 with the related pins 66 of rocker arms 29, and thereby to retain shaft 38 in its foremost position so that, even though cams 27 continue to rotate with cam shaft 22, the shaft 38 can not move to its rearmost position, as in Fig. 4, where the nipping rollers 39 and cylinder 19 cooperate to grip the leading edge of a sheet for feeding the latter onto the conveyor belts. Thus, the pick-up mechanism constituted by cylinder 19 and rollers 39 is rendered inoperative, without halting the operation of conveyor belts 15, so that sheets previously delivered to the belts can be fed by the latter to the ultimate destination.

It will be understood that, by varying the relative diameters of pulleys 23, 25 and 26 engaged by belt 24 it is possible to obtain any desired relationship between the speed at which the belts 15 convey a sheet fed thereto from the magazine 45 and the speed at which the successive sheets are pulled out from under the stack or pile maintained in magazine 45.

The sheet feeding device described above in connection with Figs. 1 to 6, inclusive, is constructed and arranged so that two or more of such devices can be positioned to feed sheets from their respective magazines to a common conveyor in any desired sequence. Thus, by way of example, Fig. 7 of the drawings illustrates an arrangement wherein a single conveyor made up of endless belts 15*a* running around pulleys 14*a* on a driven shaft 13*a* and having horizontally extending upper runs, is combined with two sheet feeding devices 10*a* and 10*b* arranged in tandem to feed sheets from the respective magazines 45*a* and 45*b* in any desired sequence onto the upper runs of belts 15*a*. The sheet feeding devices 10*a* and 10*b* are each similar to the previously described sheet feeding device 10, and the various parts of the devices 10*a* and 10*b* are identified by the same reference numerals employed in connection with the description of the corresponding parts of sheet feeding device 10 but with the letters "*a*" and "*b*," respectively, appended thereto.

The operation of each of the sheet feeding devices 10*a* and 10*b* will be apparent from the above detailed description of the operation of sheet feeding device 10, and it is further apparent that a sheet fed from magazine 45*b* of sheet feeding device 10*b* onto the upper runs of conveyor belts 15*a* is carried by such conveyor belts under the vacuum chamber 53*a* of sheet feeding device 10*a* and passes between nipping rollers 39*a* and cylinder

19*a* of device 10*a* before being further fed by belts 15*a* under rollers 61*a*.

When arranging two or more sheet feeding devices in tandem, as in Fig. 7, the cylinders 19*a* and 19*b*, and the cams 27*a* and 27*b* of the individual sheet feeding devices may all be driven from the shaft 13*a* either by a single belt engaging pulleys on shaft 13*a* and on shafts of the cylinders 19*a* and 19*b* and the cams 27*a* and 27*b*, or, as shown in Fig. 7, by separate belts 24*a* and 24*b* engaging a double pulley on shaft 13*a* and driving cylinder 19*a* and cams 27*a* of device 10*a* and cylinder 19*b* and cams 27*b* of device 10*b*, respectively.

Although cams 27*a* and 27*b* are shown to have the same angular relationship to their respective shafts 22*a* and 22*b*, so that the devices 10*a* and 10*b* simultaneously feed sheets from the magazines onto the conveyor belts 15*a*, it will be apparent that, by suitably spacing devices 10*a* and 10*b* along the path of the conveyor, a sheet fed from magazine 45*b* of device 10*b* can be made to pass under vacuum chamber 53*a* of device 10*a* and between nipping rollers 39*a* and cylinder 19*a* at a time when device 10*a* is in the stage of its operation illustrated in Fig. 3, where the nipping rollers are in their foremost position, so that the sheet fed from device 10*b* closely follows the sheet fed at the same time from the device 10*a* and the conveyor belts 15*a* transport a succession of sheets alternately received from the magazines 45*a* and 45*b*.

It is also to be noted that the spacing between the successive sheets on conveyor belts 15*a* received from magazines 45*a* and 45*b* can be controlled by suitably selecting the spacing between the devices 10*a* and 10*b* along the paths of the conveyor belts, and that the operating cycles of the devices 10*a* and 10*b* may be adjusted in relation to each other by angularly displacing the cams 27*a* or 27*b* of one sheet feeding device with respect to the cams of the other sheet feeding device. Further, it will be apparent that the sequence of operation of the devices 10*a* and 10*b* may be conveniently controlled by suitably regulating the actuation of the latch levers 64*a* and 64*b* which are effective to prevent the feeding of sheets from the related magazines to the conveyor belts, when in the positions illustrated in Fig. 7, without halting operation of the conveyor belts. Thus, the latch levers 64*a* of device 10*a* may be released to permit the feeding of a predetermined number of sheets from magazine 45*a* onto conveyor belts 15*a*, while the latch levers 64*b* are retained in their locking position, as shown, to prevent the feeding of sheets from magazine 45*b* during the operation of device 10*a*, whereupon, the condition of the latch levers 64*a* and 64*b* may be reversed to permit feeding of sheets from magazine 45*b* while device 10*a* is retained in its inoperative condition.

Although the embodiments of the invention illustrated in Figs. 1 to 6, inclusive, and in Fig. 7 are effective to feed sheets one at a time from the bottom of a vertical stack or pile onto a conveyor moving along a horizontal path therebelow, it is to be understood that sheet feeding devices embodying the present invention may be adapted to feed sheets from piles which are not vertical, so long as provision is made for moving the stack toward the feeding end of the magazine so that the leading edge of the end sheet rests against the ledge or strip 51 and the trailing edge of that sheet rests against the flat part of suction plate 57.

It is also to be understood that sheet feeding devices embodying this invention may be arranged for feeding sheets from the top of a pile, for example, as illustrated in Fig. 8. The sheet feeding device 10*c* illustrated in Fig. 8 is essentially an inverted arrangement of the device 10 of Figs. 1 to 6, inclusive, and the several parts of the device 10*c* are identified by the same reference numerals employed in connection with the description of the corresponding parts of the device 10, but with the letter "*c*" appended thereto.

In the sheet feeding device 10*c*, the magazine 45*c* holding a stack of sheets to be fed one at a time from the top thereof is provided with a vertically movable bottom wall or support plate 100 which is urged upwardly, for example, by the ram 101 extending from a cylinder 102 to which fluid under pressure is supplied. The vacuum chamber 53*c* is inverted relative to the chamber 53 of the previously described device 10 so that the suction plate 57*c* of chamber 53*c* extends forwardly over the back end portion of the magazine at the top of the latter and curves upwardly to meet the flat plate 56*c* at the forward edge thereof. Further, magazine 45*c* includes a strip or ledge 51*c* secured to the upper ends of the flat members 48*c* defining the front end of the magazine so that the uppermost sheet of the stack in magazine 45*c* is pressed against the ledge 51*c*, at its leading edge, and against the flat part of suction plate 57*c*, at its trailing edge portion.

In the device 10*c*, the pick-up mechanism formed by cylinder 19*c*, shaft 38*c* carrying nipping rollers urged against the surface of cylinder 19*c*, and rocker arms 29*c* carrying the levers 36*c* which support shaft 38*c* is also inverted with respect to the arrangement of the corresponding components in the device 10, while the shaft 13*c* carrying the driven pulleys 14*c* around which conveyor belts 15*c* extend is disposed so that, as a sheet is fed between the nipping rollers of shaft 38*c* and the surface of cylinder 19*c*, the leading edge of such sheet is projected onto the upper surface of the upper runs of belts 15*c* for transport by the latter while being held against the conveyor belts by the successive rollers 61*c*.

With the arrangement shown in Fig. 8, the suction acting through openings 60*c* of suction plate 57*c* is effective to draw the middle portion of the uppermost sheet in magazine 45*c* toward the upwardly curved part of the suction plate, thereby to release the leading edge of the uppermost sheet from under the ledge or strip 51*c*. When the leading edge of the uppermost sheet is released, the suction in vacuum chamber 53*c* causes the forward portion of the sheet to conform to the configuration of the upwardly curved part of suction plate 57*c* so that the leading edge of the sheet then rests against the surface of cylinder 19*c* at the bottom of the latter. When shaft 38*c* is oscillated toward the left, as viewed in Fig. 8, in response to engagement of the follower rollers 28*c* with the radially small portions of cams 27*c*, the leading edge of the sheet resting against cylinder 19*c* is gripped between the latter and the nipping rollers of shaft 38*c*, and the continuous rotation of cylinder 19*c* and shaft 38*c* causes the gripped sheet to be fed therebetween onto the upper runs of conveyor belts 15*c*. As in the first described embodiment of the invention, the movement of the trailing edge of the sheet being advanced along the surface of suction plate 57*c* by the pick-up mechanism serves to successively uncover the suction openings 60*c*, whereby the next sheet at the top of magazine 45*c* is drawn toward the surface of suction plate 57*c* in order to free the leading edge of that sheet from the ledge 51*c* and position the sheet for feeding by the cylinder 19*c* and the nipping rollers of shaft 38*c* upon the subsequent return of the latter to the broken-line position of Fig. 8.

Although the sheet feeding device 10*c* of Fig. 8 is effective to feed sheets to the conveyor belts 15*c* from a single magazine 45*c*, it will be apparent that two or more of such sheet feeding devices may be arranged in tandem, as in Fig. 7, to sequentially feed sheets from the upper ends of two or more stacks or piles.

In all of the described embodiments of the invention, the vacuum chambers 53, 53*a*, 53*b* and 53*c* are stationary, thereby simplifying the construction of the sheet feeding device, while the shaft 38, 38*a*, 38*b* or 38*c* carries nipping rollers which cooperate with the rotated cylinder 19, 19*a*, 19*b* or 19*c* to form a simple and reliable pick-up mechanism for feeding the sheet to the conveyor fol-

lowing separation of its leading edge portion from the remainder of the stack by the action of the vacuum chamber, and it will be apparent that such mechanical pick-up mechanism may operate at very high speeds and may easily be made inoperative at the will of the operator or in response to an automatic feed selector device controlling the latch levers **64**, **64***a*, **64***b* or **64***c*, without requiring a halt in the operation of the conveyor or other sheet feeding devices associated with the latter.

Although illustrative embodiments of the invention have been described in detail herein with reference to the accompanying drawings, it is to be noted that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein without departing from the scope or spirit of the invention, except as defined in the appended claims.

What is claimed is:

1. In a sheet feeding device, the combination of a continuously operable conveyor, a magazine opening at one end toward said conveyor and adapted to receive a stack of sheets which are urged toward said one end, said magazine having a ledge along the edge of said one end which is at the front, considered in the direction of movement of said conveyor, a plate extending forwardly from the back of said one end of the magazine so that a sheet at said one end of the magazine has its leading and trailing edge portions resting against said ledge and plate, respectively, said plate having a series of openings therein and a front edge portion curving away from said one end of the magazine, means for creating a relatively low pressure at the side of said plate facing away from said magazine to cause a suction to act through said openings on the sheet at said one end of the magazine so that, as the sheet is made to conform to the shape of said front edge portion of the plate, the leading edge of the sheet is withdrawn from said ledge and thereby separated from the next sheet in the magazine, a rotated cylinder disposed adjacent said front edge of the plate so that the leading edge of a sheet conforming to the shape of said front edge portion rests against the surface of said cylinder, a rotated roller in rolling contact with said surface of the cylinder, means supporting said roller for oscillation along the cricumference of said cylinder between a first position remote from said front edge of the plate and a second position adjacent said front edge of the plate so that the leading edge of a sheet resting against said surface of the cylinder is gripped between the latter and said roller so as to be fed off said plate and onto said conveyor, actuating means normally effecting the oscillation of said roller between said first and second positions, and control means for inactivating said actuating means with said roller in said first position so that a sheet conforming to the surface of said plate remains on the latter.

2. In a sheet feeding device, the combination of a continuously operable conveyor, a magazine opening at one end toward said conveyor and adapted to receive a stack of sheets which are urged toward said one end, said magazine having a ledge along the edge of said one end which is at the front, considered in the direction of movement of said conveyor, a plate extending forwardly from the back of said one end of the magazine so that a sheet at said one end of the magazine has its leading and trailing edge portions resting against said ledge and plate, respectively, said plate having a series of openings therein and a front edge portion curving away from said one end of the magazine, means for creating a relatively low pressure at the side of said plate facing away from said magazine to cause a suction to act through said openings on the sheet at said one end of the magazine so that, as the sheet is made to conform to the shape of said front edge portion of the plate, the leading edge of the sheet is withdrawn from said ledge and thereby separated from the next sheet in the magazine, a rotated cylinder disposed with its surface adjacent said front edge of the plate so that the leading edge of a sheet conforming to the shape of said front edge portion rests against said surface of the cylinder, a rotated roller urged continuously against said surface of the cylinder, rocker arms supporting said roller for oscillation along the circumference of said cylinder between a first position remote from said front edge of the plate and a second position adjacent said front edge of the plate to grip the leading edge of a sheet resting against the surface of the cylinder between the latter and said roller and thereby feed the sheet off said plate and onto said conveyor, resilient means acting on said rocker arms to urge the latter in the direction moving said roller to said second position, cam means normally operative to periodically rock said rocker arms in the direction moving said roller to said first position, and latch means releasably engageable with said rocker arms when said roller is in said first position to hold the roller against movement to said second position by said resilient means so that a sheet conforming to the shape of said plate will remain on the latter until release of said latch means.

3. In a sheet feeding device, the combination of a continuously operable, substantially horizontal conveyor, a magazine disposed above said conveyor and adapted to receive a stack of sheets which are gravitationally urged toward the lower end of the magazine, a ledge along the edge of said lower end which is at the front, considered in the direction of movement of said conveyor, a plate extending forwardly from the back of said lower end of the magazine so that the bottom sheet in said magazine has its leading and trailing edge portions supported by said ledge and plate, respectively, said plate having a series of openings therein and a downwardly curved front edge portion, means for creating a relatively low pressure at the underside of said plate so that suction can act through said openings on the sheet at the bottom of the magazine to cause the sheet to conform to the shape of said plate and thereby withdraw the leading edge of the sheet from said ledge for separation from the next sheet in the magazine, a sheet carrier having a continuous surface disposed adjacent the front edge of said plate to receive the leading edge of a sheet conformed to the shape of said plate, said surface extending away from said plate in a path toward said conveyor, means for continuously moving said carrier surface through said path, a rotatable roller continuously urged against said surface in said path, means for oscillating said roller in said path and in rolling engagement with said surface between a first position wherein said roller is disposed away from said front edge, so that said leading edge may be received on said surface between said roller and said front edge, and a second position adjacent said front edge wherein said roller grips said leading edge against said surface, so that the moving carrier surface will then feed the sheet off said plate and through said path onto said conveyor.

4. In a sheet feeding device, the combination as in claim 3; wherein said conveyor includes parallel moving belts, said carrier comprising a cylinder mounted on a fixed axis with its peripheral surface projecting above the level of said belts and formed with annular grooves accommodating said belts.

5. In a sheet feeding device, the combination of a continuously operable, substantially horizontal conveyor having an infeed end, a magazine disposed adjacent said infeed end of the conveyor and adapted to receive a stack of sheets, means for urging the stack of sheets upwardly in said magazine, the upper end of said magazine being at a level below that of said conveyor, a ledge along the edge of said upper end which is at the front, considered in the direction of movement of said conveyor, a plate extending forwardly from the back edge of said upper end of the magazine so that the top sheet in said magazine has its leading and trailing edge portions resting against said ledge and plate, respectively, said plate having a series

of openings therein and an upwardly curved front edge portion, means for creating a relatively low pressure at the upper side of said plate so that suction can act through said openings on the top sheet in the magazine to cause the sheet to conform to the shape of said plate and thereby withdraw the leading edge of the sheet from under the ledge for separation from the next sheet in the magazine, a cylinder mounted for rotation on a horizontal axis with a bottom part of its peripheral surface adjacent the front edge of said plate and intermediate the latter and said infeed end of said conveyor, in position to receive the leading edge of said sheet conformed to the shape of said plate, a rotatable roller continuously urged against said cylinder surface, means for continuously rotating said cylinder and for continuously moving said conveyor, and means for oscillating said roller circumferentially along said cylinder surface between a position adjacent said infeed end and a position adjacent said front edge to grip said leading edge against said surface in the latter position of said roller, so that the cylinder will then feed said sheet out of the magazine and onto said conveyor, and to allow the leading edge of the next sheet of the stack to be received on said surface in the former position of said roller.

6. The combination of a single, continuously operable conveyor including conveyor belts having substantially horizontal upper runs, and a plurality of sheet feeding devices arranged in tandem at spaced apart locations along the conveyor, each of said sheet feeding devices including a magazine disposed above said upper runs of the conveyor belts and adapted to receive a stack of sheets which are gravitationally urged toward the lower end of the magazine, a ledge along the front of said lower end, a plate extending forwardly from the back of said lower end so that the bottom sheet in said magazine has its leading and trailing edges supported by said ledge and plate, respectively, said plate having a series of openings therein and a downwardly curved front edge portion which terminates above said upper runs of the conveyor belts, means for creating a relatively low pressure at the underside of said plate so that suction can act through said openings on the sheet at the bottom of the magazine to cause the sheet to conform to the shape of said plate, whereby the leading edge of the bottom sheet is withdrawn from said ledge and thus separated from the next sheet of the stack, a rotated cylinder disposed with its surface, at the top of the cylinder, projecting above said upper runs of the conveyor belts in to the proximity of the front edge of said plate so that the leading edge of a sheet conforming to the shape of said plate rests against said surface of the cylinder, a roller urged against said surface of the cylinder above said upper runs and movable circumferentially along the cylinder between a first position remote from said front edge of the plate and a second position adjacent said front edge where said roller and cylinder cooperate to grip the leading edge of a sheet resting against said cylinder and to feed the sheet off said plate and onto said upper runs of the conveyor belts so that said openings of the plate are again uncovered to permit suction to act therethrough on the next sheet at the bottom of said magazine, and selectively opreable means for oscillating said roller of each sheet feeding device between said first and second positions thereof so that sheets may be fed in any desired sequence from the magazines of the sheet feeding devices.

7. In a sheet feeding device, a magazine to hold a stack of sheets and provided at one end with means for retaining the endmost sheet of the stack in position for withdrawal of a leading portion of such sheet from the magazine, a cylinder providing an endless sheet-receiving surface and mounted in a fixed location spaced away from said one end of the magazine, means for continuously rotating said cylinder to advance said surface through a fixed path confronting and leading away from said magazine, means between said one end and said surface for withdrawing from the magazine a leading portion of the endmost sheet of the stack and laying the leading edge of the withdrawn portion against said surface near the backward end of said path, means bearing against and movable bodily along said surface in said path to grip said leading edge of said withdrawn portion against said surface, so that said cylinder will then positively feed the endmost sheet out of the stack and deliver it through said path, and means for periodically moving said gripping means along said surface away from said backward end to assist the feeding of said sheet and to allow the leading edge of the next sheet of the stack to be laid against said surface.

8. In a sheet feeding device, a magazine to hold a stack of sheets and provided at one end with means for retaining the endmost sheet of the stack in position for withdrawal of a leading portion of such sheet from the magazine, a cylinder providing an endless sheet-receiving surface and mounted in a fixed location spaced away from said one end of the magazine, means for continuously rotating said cylinder to advance said surface through a fixed path confronting and leading away from said magazine, a sheet conveyor having a substantially horizontal flight position to receive and carry away a sheet delivered by said cylinder surface from the forward end of said path, means between said one end and said cylinder for withdrawing from the magazine a leading portion of the endmost sheet of the stack and laying the leading edge of the withdrawn portion against said surface near the backward end of said path, means bearing against and movable bodily along said surface in said path to grip said leading edge of said withdrawn portion against said surface, so that said cylinder will then positively feed the endmost sheet out of the stack and deliver it through said path onto said conveyor flight, and means for periodically moving said gripping means along said surface away from said backward end to assist the feeding of said sheet and to allow the leading edge of the next sheet of the stack to be laid against said surface.

9. In a sheet feeding device, a magazine to hold a stack of sheets and provided at one end with means for retaining the endmost sheet of the stack in position for withdrawal of a leading portion of such sheet from the magazine, a cylinder mounted for rotation on a fixed axis and spaced away from said one end of the magazine, means for continuously rotating said cylinder to advance its surface through a fixed path confronting and leading away from said magazine, an endless belt conveyor having a substantially horizontal flight positioned to receive and carry away a sheet delivered by said cylinder surface from the forward end of said path, means between said one end and said cylinder for withdrawing from the magazine a leading portion of the endmost sheet of the stack and laying the leading edge of the withdrawn portion against said surface near the backward end of said path, a roller bearing rollably against and movable bodily along said surface in said path to grip said leading edge of said withdrawn portion against said surface, so that said cylinder will then positively feed the endmost sheet out of the stack and deliver it through said path onto said conveyor flight, and means for periodically moving said roller along said surface away from said backward end to assist the feeding of said sheet and to allow the leading edge of the next sheet of the stack to be laid against said surface.

10. In a sheet feeding devices, the combination of a magazine for holding a stack of sheets urged toward one end of the magazine, means on the magazine for retaining movably and in partially exposed position the endmost sheet of the stack at said one end, a suction member having an outer surface sloped away from the exposed portion of the endmost sheet at said one end of the magazine and terminating in a free edge away from said end, said member having spaced apart openings therein extending through said surface and means for creating

a suction therethrough so that the suction will withdraw the exposed portion of said sheet from the magazine and dispose it along said surface, a cylinder mounted with its peripheral surface adjacent said free edge in position to receive the leading edge of the portion of said sheet disposed along said suction member surface, means for rotating said cylinder to advance its surface through a path extending away from said free edge, roller means continuously urged against said cylinder surface, and means for moving said roller means along said path toward and away from said free edge to grip said leading edge between said roller means and said cylinder as the former approaches said free edge, so that said cylinder then will positively feed said sheet out of the magazine and along and away from said suction member through said path, said roller means having a position against said cylinder surface but away from said free edge, in which a portion of said cylinder surface next to said free

edge is exposed to receive the leading edge of the next sheet of the stack.

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