Sept. 4, 1956 G. W. TEBBS 2,761,679

SHEET FEEDING APPARATUS

Filed April 13, 1953 6 Sheets-Sheet 1

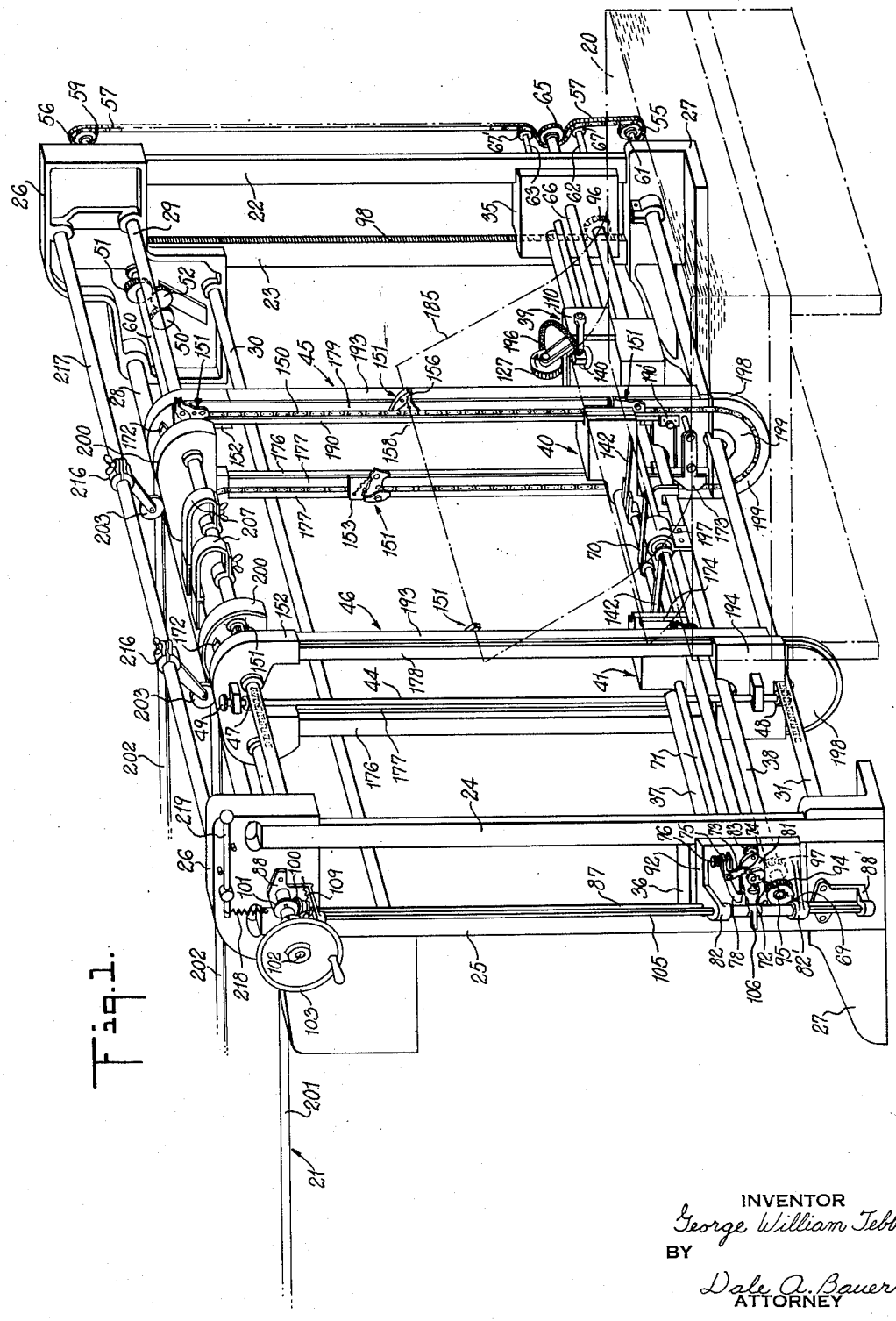


Fig. 1.

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SHEET FEEDING APPARATUS

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Fig. 2.

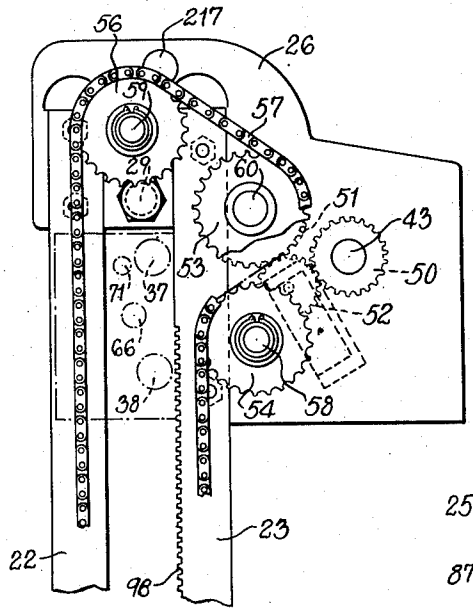


Fig. 3.

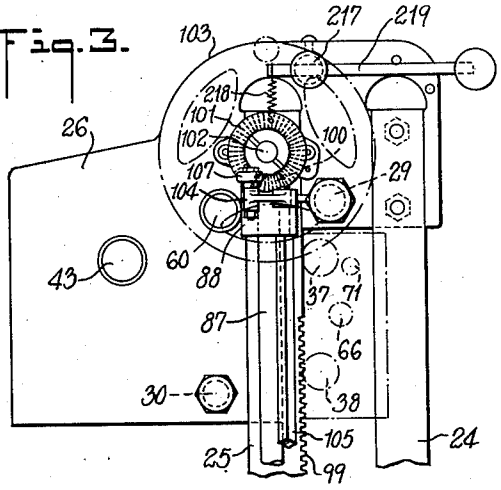


Fig. 4.

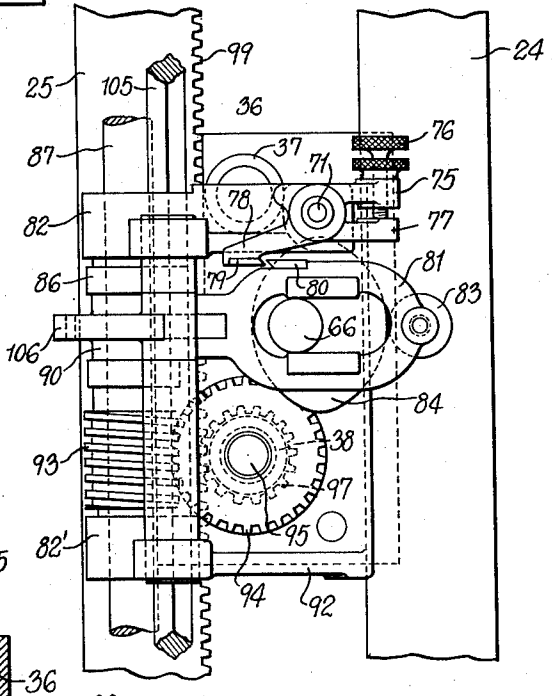
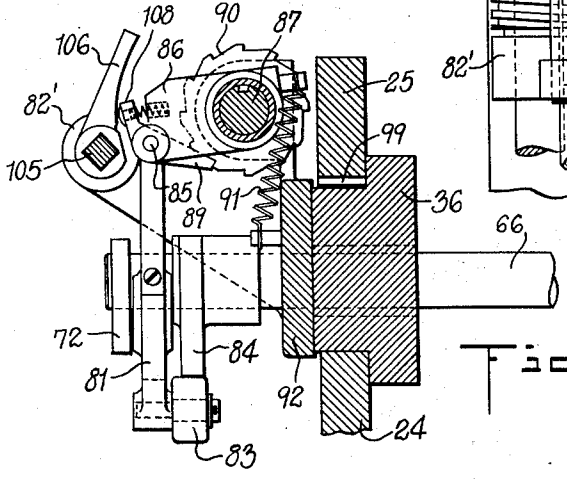


Fig. 5.



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SHEET FEEDING APPARATUS

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Fig. 6.

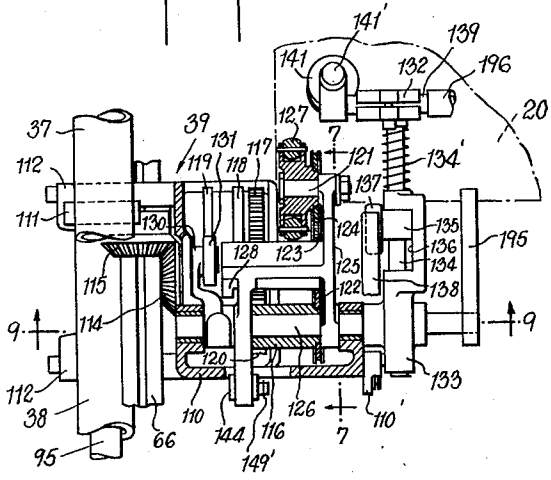


Fig. 7.

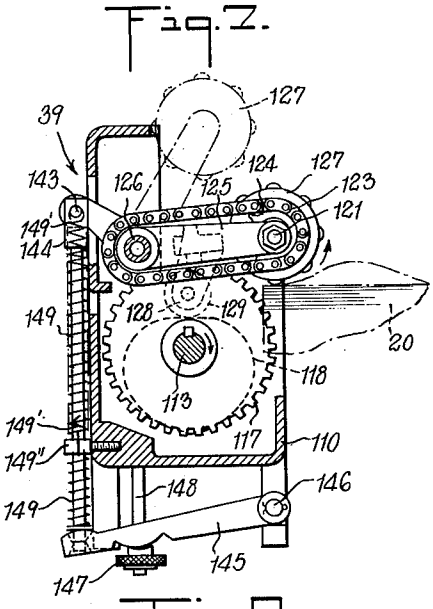


Fig. 8.

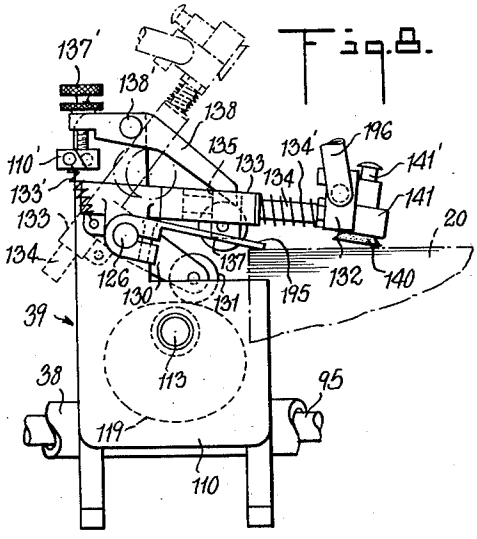
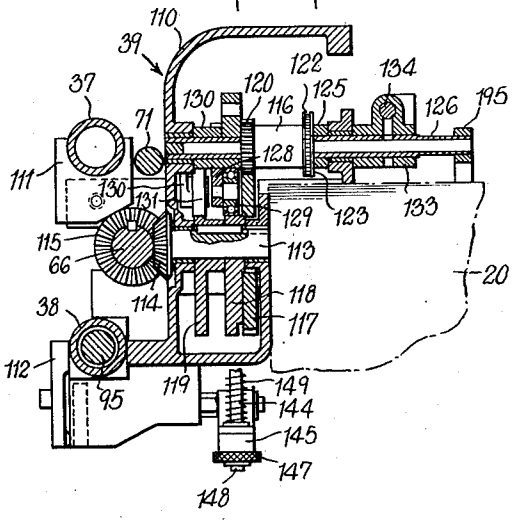


Fig. 9.



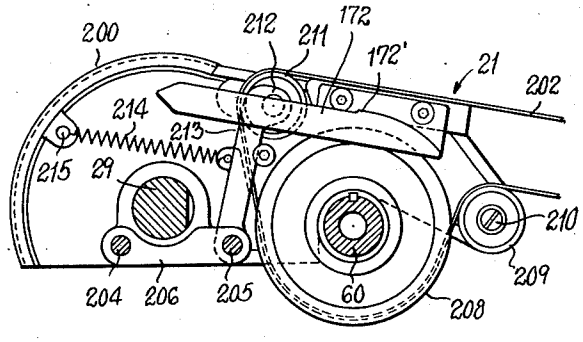


Fig. 10.

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Fig. 10.

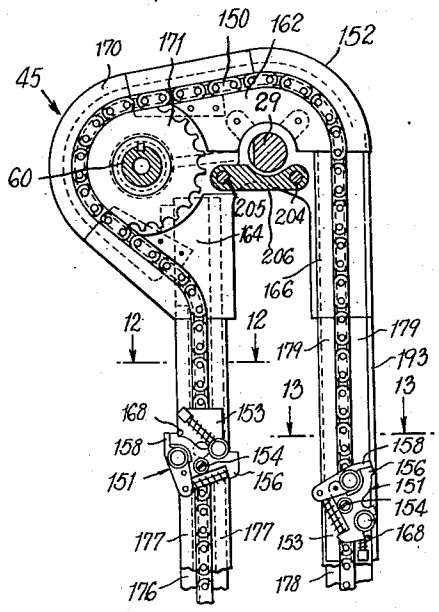


Fig. 11.

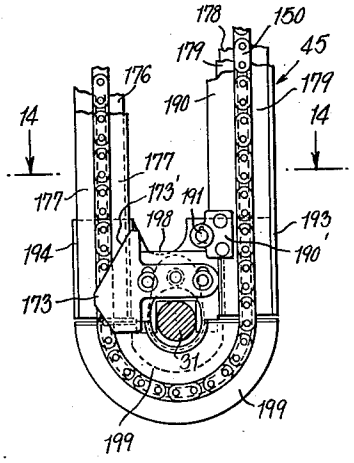


Fig. 14.

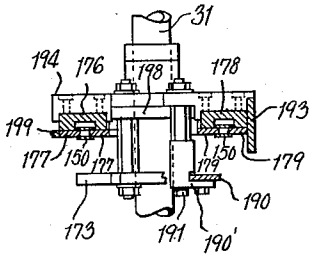


Fig. 12.

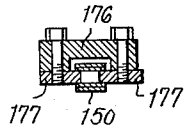


Fig. 13.

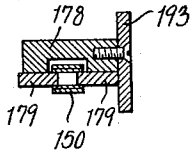


Fig. 15.

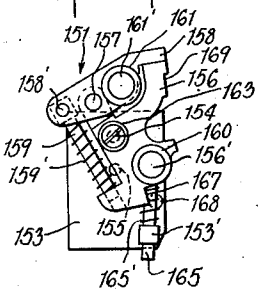
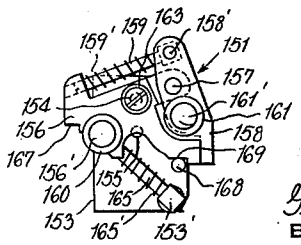


Fig. 16.



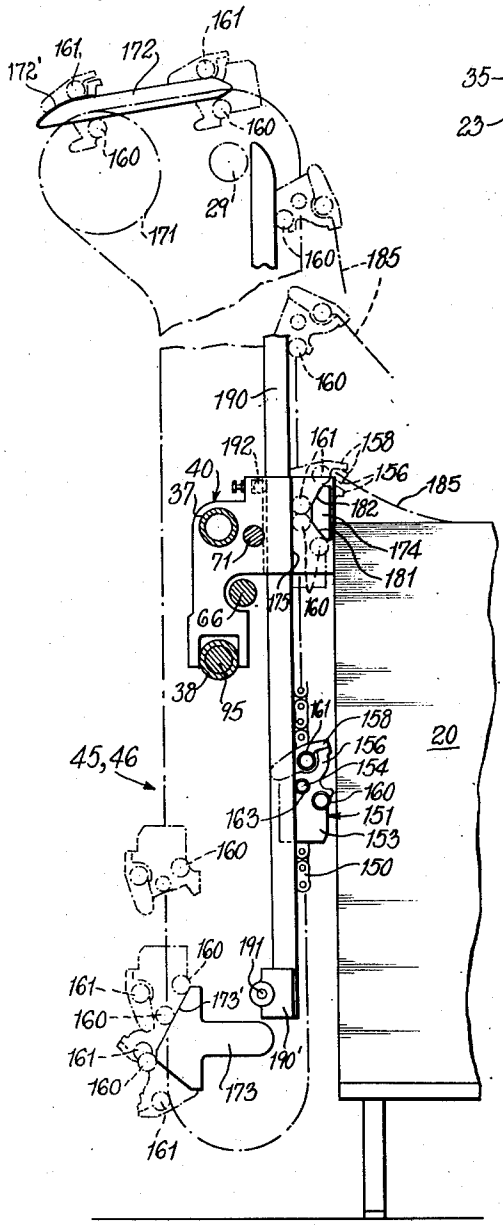
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Sept. 4, 1956 G. W. TEBBS 2,761,679

SHEET FEEDING APPARATUS

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Fig. 17.



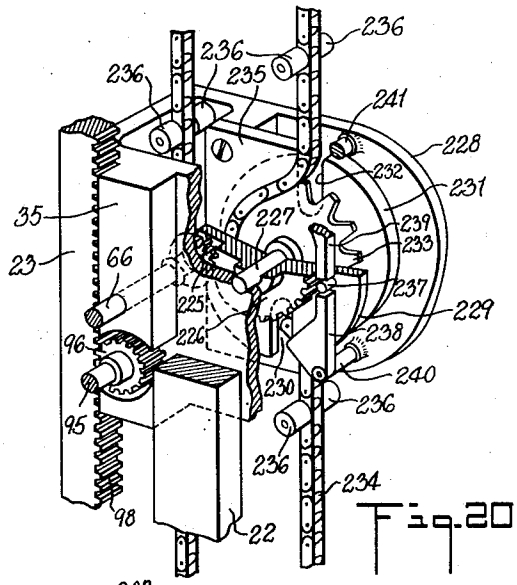


Fig. 20.

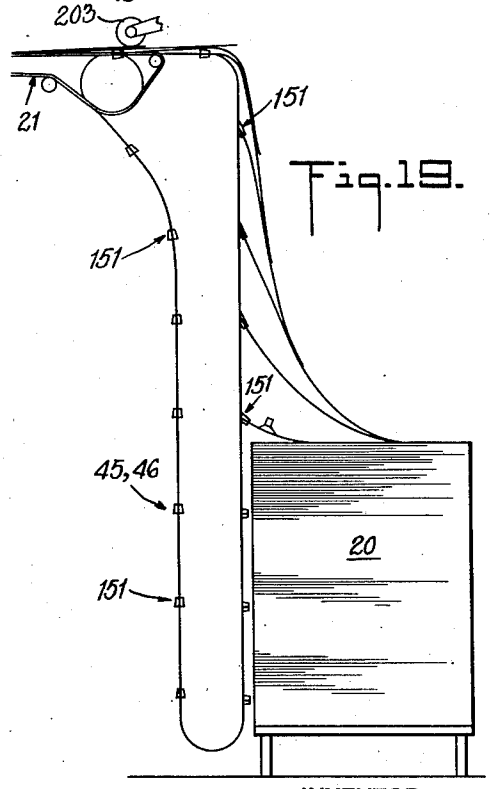


Fig. 19.

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SHEET FEEDING APPARATUS

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Fig. 21.

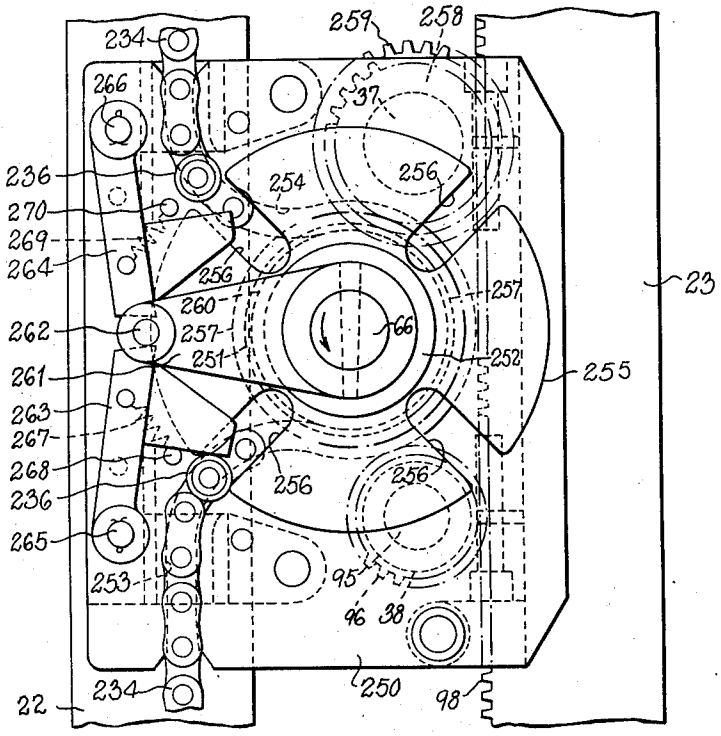


Fig. 22.

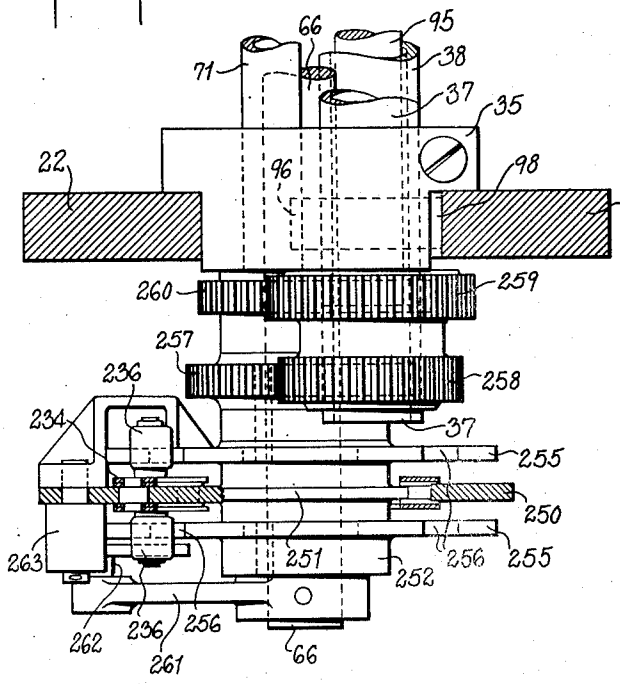
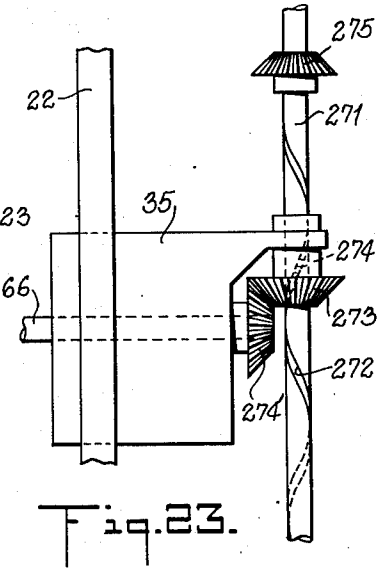


Fig. 23.



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United States Patent Office 2,761,679 Patented Sept. 4, 1956

2,761,679

SHEET FEEDING APPARATUS

George William Tebbs, Walthamstow, London, England, assignor to Headley Townsend Backhouse, Nassau, Bahamas

Application April 13, 1953, Serial No. 348,313
Claims priority, application Great Britain April 15, 1952
63 Claims. (Cl. 271—12)

This invention relates to sheet feeders for feeding sheets of paper, cardboard, and other materials of a similar character, to printing presses and various other machines for acting on such sheets.

As is well known, in sheet feeders of the pile type, as distinguished from sheet feeders of the continuous fanned-out bank type, the mechanism or mechanisms which act on the sheets to successively separate and feed the same from the top of the pile are customarily located at a fixed elevation, and the pile of sheets is carried on an elevator which, during feeding of the sheets from said pile, is intermittently raised by controlled power means to maintain the top of the pile at the proper feeding level for action of said mechanism or mechanisms on the sheets. This pile supporting elevator requires a relatively strong and rigid feeder framework to safely support the same and the heavy pile load of sheets thereon, and together with the actuating and control means therefor complicates the feeder structure and adds materially to the cost of the feeder.

It is accordingly one object of the present invention to provide a more simplified and less expensive sheet feeder of the pile type which, through novel construction thereof, does not require a pile elevator and is capable of feeding sheets accurately and rapidly one after another in timed relation from the top of a stationary pile thereof.

Another object of the invention is to provide a novel pile type of sheet feeder which is more simplified in design, lighter in construction, and more economical to manufacture and operate.

Another object is to provide a novel sheet feeder of the pile type wherein the pile station is completely exposed and readily accessible, thus facilitating loading and reloading of the feeder, and the making of desired or necessary adjustments or repairs.

Another object is to provide a novel sheet feeder of the above character which will effectively and reliably separate single sheets from the top of a stationary pile thereof and convey said sheets successively toward a printing press or other machine with substantially no variation in the distance between the leading edges of the successive sheets so that a sheet will be available in proper position at the start of each cycle of operation of said printing press or other machine.

It is also well known that in existing sheet feeders of various types the sheets separated from the top of the pile or supply thereof are fed from said pile or supply in a substantially horizontal direction. This horizontal movement of the sheets, in the case of stream feeding, necessitates the performance of the sheet separating and feeding operations on or near the rear edges of the sheets and does not readily lend itself to the desired performance of such operations on or near the front edges of the sheets. It is accordingly a further object of the invention to provide a novel sheet feeder so constructed and operated that the sheets are fed directly from the top of the pile or supply in a vertical or upward direction whereby a relatively wide space is immediately made available between the top sheet being fed and the next or underlying sheet on the pile or supply, which space advantageously enables the performance of the sheet separating and feeding operations on or near the front edges of the sheets and on each succeeding sheet while the preceding sheet is being fed and partly covers the succeeding sheet.

Another object is to provide a sheet feeder having novel sheet separating mechanism for separating sheets successively from the top of a stationary pile thereof, which is automatically lowered to enable continued separation of the sheets as the pile is consumed and the level of the top thereof changes through feeding of the sheets therefrom.

A further object is to provide a sheet feeder having novel sheet separating mechanism for separating sheets successively from the top of a stationary pile thereof, which is automatically lowered as the pile is consumed and is so controlled that the cyclic timing of the sheet separating operations thereof is progressively advanced as it descends whereby a substantially equal spacing between the leading edges of successive sheets on a receiving conveyor is assured.

A still further object is to provide a sheet feeder having a novel arrangement and association of a downwardly moving sheet separating mechanism and an upwardly moving sheet conveyor of the endless type which cooperate with each other to feed sheets successively from the top of a stationary pile thereof to sheet receiving means, said conveyor having timed sheet taking gripper elements thereon, and said sheet separating mechanism being so controlled that the cyclic timing of the operations thereof is progressively advanced as it descends whereby the timing relationship between said mechanism and said gripper elements is always maintained to insure accurate engagement of each separated sheet by said gripper elements and feeding of said sheet from the pile.

Another object is to provide a sheet feeder of the pile type wherein the supply of sheets to be fed rests stationary on the floor or foundation of the machine, which enables the supply of sheets to be quickly and conveniently replenished, and reduces to a minimum the time and labor incident to loading the feeder.

A further object is to provide an improved and simplified sheet separating mechanism for separating sheets successively from the top of a supply thereof and for stretching a transverse edge portion of each separated sheet.

Another object is to provide improved sheet conveying mechanism which is of the endless type and embodies sheet gripping devices of novel construction and operation for advancing sheets to sheet receiving means.

Still another object is to provide novel mechanism for operating a part of a sheet feeder or any other machine or instrumentality at timed intervals.

Another object is to provide novel mechanism including a continuously driven endless element for rotating a member, such as the cam shaft of a sheet feeder, one complete revolution at timed intervals.

Another object is to provide a sheet feeder embodying a vertically movable sheet separating unit, and novel mechanism including elements mounted on and movable with said unit and an independently mounted continuously driven endless element for operating said unit at timed intervals through one complete cycle, and for causing the timing of said cycle to be advanced as said unit descends and to be retarded when said unit is raised.

The above and further objects and novel features of the invention will more fully appear from the following detail description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

In the drawings wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a perspective view of a sheet feeder constructed in accordance with the present invention, said view being to some extent diagrammatic, and omitting certain of the feeder parts for purposes of clearer illustration;

Fig. 2 is a side elevational view of the upper portion of said sheet feeder looking at the gear side thereof or from the right of Fig. 1;

Fig. 3 is a side elevational view of the upper portion of said sheet feeder looking at the feed side thereof or from the left of Fig. 1;

Fig. 4 is a detail side elevational view of a worm and worm gear drive for lowering and raising the sheet separating mechanism, and including pawl and ratchet mechanism and control means for operating said drive to effect lowering of said sheet separating mechanism;

Fig. 5 is a top plan view, partly in section, of the structure shown in Fig. 4, with the control means omitted for purposes of clearer illustration;

Fig. 6 is a top plan view, partly in section, of the sheet separating unit located at the feed or left-hand side of the feeder;

Fig. 7 is a vertical transverse sectional view substantially on the line 7—7 of Fig. 6;

Fig. 8 is an end elevational view of said sheet separating unit looking from the right of Fig. 6;

Fig. 9 is a vertical longitudinal sectional view substantially on the line 9—9 of Fig. 6;

Fig. 10 is a side elevational view showing the upper portion of the mechanical gripper chain conveyor unit located at the gear or right-hand side of the feeder, said view being taken from the feed or left-hand side of the machine;

Fig. 11 is a view similar to Fig. 10, but showing the lower portion of said mechanical gripper chain conveyor unit;

Fig. 12 is a horizontal sectional view of the line 12—12 of Fig. 10;

Fig. 13 is a horizontal sectional view on the line 13—13 of Fig. 10;

Fig. 14 is a horizontal sectional view on the line 14—14 of Fig. 11;

Fig. 15 is a side elevational view of one of the sheet gripping devices showing the same in the position it occupies as it travels toward the top of the pile of sheets;

Fig. 16 is a view similar to Fig. 15, but showing the sheet gripping device substantially in the position it occupies as it approaches the upper end of its course with a sheet gripped thereby;

Fig. 17 is a diagrammatic side elevational view showing one set of sheet gripping devices and the operation of said devices at various positions along its course;

Fig. 18 is a detail side elevational view showing the rear portion of an endless tape conveyor at the top of the feeder;

Fig. 19 is a side elevational view showing diagrammatically the manner in which the sheets are separated and forwarded in lapped relation from the pile;

Fig. 20 is a fragmentary detail perspective view of a modified form of mechanism for driving and timing the sheet separating mechanism.

Figs. 21 and 22 are side elevation and top plan views, respectively, of a modification of the form of driving mechanism shown in Fig. 20, Fig. 22 being partly in section and having portion of certain of the parts broken away for purposes of clearer illustration; and

Fig. 23 is a rear elevational view of another modified form of mechanism for driving and timing the sheet separating mechanism.

Referring now to the drawings and particularly to Fig. 1 thereof, there is shown, by way of example, one form of sheet feeder constructed in accordance with the present invention, which is adapted for feeding sheets of paper, card stock, or the like, from the top of a stationary pile **20** thereof to a tape conveyor **21** in a manner such that the sheets are conveyed in the form of a stream of underlapped sheets to a printing or other machine for operating on the individual sheets of said stream.

The machine comprises a frame composed of four uprights **22**, **23**, **24** and **25** secured to pairs of top and bottom brackets **26** and **27**, respectively, said top brackets being interconnected by crossbars **28**, **29** and **30**, and said bottom brackets being interconnected by a crossbar **31**. Guided on the uprights **22** to **25** for vertical movement downwardly and upwardly is a carriage comprising guide blocks **35** and **36** interconnected by tubular crossbars **37** and **38**. Supported on the carriage for vertical movement therewith are two similar sheet separating mechanisms **39**, one only being shown in Fig. 1, which are slidably mounted on the crossbars **37**, **38** for adjustment toward and away from each other in accordance with the various sizes of sheets being handled and to locate said mechanisms at the desired points with reference to their operation upon front corner portions of the sheets at the top of the stationary pile **20**. Also supported on the carriage for vertical movement therewith are two similar cam units **40** and **41** which are also slidably mounted on and adjustable to various positions along the crossbars **37**, **38** of said carriage.

Disposed between the sheet separating mechanisms **39** and forwardly of and in close proximity to the stationary pile of sheets **20** is an upright conveyor which, in the illustrated embodiment, is in the form of a plurality of transversely spaced endless chain gripper type units, two only being shown and indicated at **45** and **46** (Fig. 1). These units **45**, **46** each have elements thereof, to be hereinafter described, slidably mounted on the crossbars **29** and **31** for adjustment of said units independently toward and away from each other by means of pinions **47** and **48** which have meshing engagement with rack teeth formed on said crossbars. The pinions **47**, **48** for each unit **45**, **46** are secured to the opposite ends of an upright shaft **44** which is journalled in a suitable manner on the respective unit and is rotated by means of a handwheel **49** secured to said shaft. The cam units **40**, **41** are preferably arranged for lateral adjustment in unison with the chain gripper units **45**, **46**, and for this purpose the cam unit **40** has portions thereof disposed at opposite sides of an upright portion of its associated chain gripper unit **45**, and the cam unit **41** has similar portions disposed at opposite sides of an upright portion of its associated chain gripper unit **46**.

The drive for the feeder is taken from a suitable source of power (not shown) suitably connected to a main drive shaft **43** (Figs. 2 and 3) which extends transversely of the feeder and is journalled in suitable bearings in the upper side frame brackets **26**. Fixed on the shaft **43** is a spur gear **50** (Figs. 1 and 2) which drives a similar gear **51** through a similar intermediate gear **52**. The intermediate gear **52** is journalled in a suitable manner on the adjacent upper side frame bracket **26**, and the driven gear **51** is fixed on and drives a shaft **60** which extends transversely of the feeder and is journalled in suitable bearings in the upper side frame brackets **26**. The gears **50** and **51** are so proportioned that the shaft **60** will make one complete revolution for each cycle of operation of the feeder.

Fixed on the single revolution shaft **60** at the gear side end thereof and disposed exteriorly of the adjacent upper side frame bracket **26** is a sprocket **53** (Fig. 2) around a portion of which passes an endless chain **57**. From the sprocket **53** the chain **57** passes downwardly over and around an idler sprocket **54** to the bottom of the feeder and then passes rearwardly under and around an idler sprocket or guide disk **55** (Fig. 1). From the sprocket or disk **55** the chain **57** passes upwardly then forwardly over and around an idler sprocket **67**, then upwardly around and in front of a drive sprocket **65**, then upwardly under and around a similar idler sprocket **67'**, and then upwardly and forwardly over and around another idler sprocket **56** to the driving sprocket **53**.

The idler sprockets 54 and 56 are journalled on stub shafts 58 and 59, respectively, anchored in the adjacent upper side frame bracket 26, the stub shaft 59 being arranged for relative vertical adjustment whereby any slack in the chain 57 may be taken up and the desired degree of tightness of said chain may be obtained. The idler sprocket or disk 55 is journalled on a stub shaft 61 anchored in the adjacent lower side frame bracket 27, and the idler sprockets 67 and 67' which serve to hold the chain 57 in meshing engagement with the sprocket 65 are journalled on stub shafts 62 and 63, respectively, which are anchored in the guide block 35 of the vertically movable separator carriage. The drive sprocket 65 is fixed on the outwardly projecting gear side end of a shaft 66 which extends transversely of the feeder and is journalled in suitable bearings provided in the guide blocks 35 and 36 of the vertically movable separator carriage. The sprockets 53 and 65 are of the same diameter and hence shaft 66, like shaft 60, is driven to make one complete revolution for each cycle of operation of the feeder. The shaft 60 and sprocket 53 thereon are driven continuously in a clockwise direction, as viewed in Fig. 2, and hence the chain 57 will also be driven continuously by said sprocket and such that the rear vertically extending active reach thereof which meshes with and drives the sprocket 65 travels in an upward direction. Under these conditions, the shaft 66 which is carried by and vertically movable with the separator carriage will be driven by the chain 57 and sprocket 65 continuously and in a direction opposite to the direction of rotation of the shaft 60. The shaft 66 is utilized to drive the sheet separating mechanisms 39 and to operate other parts of the feeder, as will be hereinafter described.

The separator carriage is shown in broken lines in Figs. 2 and 3 in the extreme uppermost position which it occupies when a pile of sheets 20 of maximum capacity is loaded in sheet feeding position, and substantially when the sheet separating mechanisms 39 operate initially on the top of a pile 20 of maximum height. The separator carriage is shown in Fig. 1 in a lowered position after a major portion of the sheets have been fed from the top of the stationary pile 20 and said pile has depleted an appreciable amount. With a pile of sheets 20 loaded in feeding position, the separator carriage is lowered to properly locate the sheet separating mechanisms 39 with respect to the top of said pile for performance of the sheet separating operations thereon. As the sheets are separated and fed successively from the top of the stationary pile 20 during the normal operation of the feeder and said pile is consumed and decreases in height, the separator carriage and the sheet separating mechanisms 39 thereon are progressively lowered with the change in the level of the top of the pile to enable continued separation and feeding of sheets from said pile. It is thus to be noted that by virtue of the described arrangement and operation of the chain 57 and its driving connection with the sprocket 65 on shaft 66, rotation will be imparted to said shaft in all vertical positions that the separator carriage and sheet separating mechanisms 39 may occupy during normal operation of the feeder and feeding of sheets from the top of the stationary pile 20. It is also important to note that the sprocket 65 on the shaft 66 will roll along the upwardly traveling reach of the chain 57 upon vertical movement of the separator carriage. Accordingly, when the carriage and the sheet separating mechanisms 39 thereon are progressively lowered during the normal operation of the feeder, the shaft 66, due to the rolling action of the sprocket 65 along the chain 57, will be rotated in the direction of its normal rotation, thus progressively advancing the cyclic timing of the operations of the sheet separating mechanisms. Each time the separator carriage is lowered, the degree of relative advance rotation of the shaft 66 is commensurate to the extent of downward movement of said carriage so that when the latter has been lowered a distance equal to the spacing between the sheet gripping devices on the chain units 45, 46 of the upright conveyor, the shaft 66 will be advanced one complete revolution. To achieve this result, the sprocket 65 is so chosen that the circumference thereof on the pitch line is equal to the distance between the sheet gripping devices. In this manner, the timing relationship of the operations of the sheet separating mechanisms 39 with the operation and cycle of movement of the sheet gripping devices of the upright conveyor is maintained as said mechanisms descend so that separation of successive sheets at the proper time and proper engagement of said sheets by said gripping devices at the progressively changing level of the top of the pile is always assured. Similarly, when the separator carriage and the sheet separating mechanisms 39 thereon are raised, the shaft 66, due to the rolling action of the sprocket 65 along the chain 57, will be given a backward rotation, i. e., in the direction reversely to its normal rotation, thus retarding the cyclic timing of the operations of the sheet separating mechanisms relative to the operation and cycle of movement of the sheet gripping devices.

As previously stated, the separator carriage and the sheet separating mechanisms 39 thereon are lowered as sheets are fed from the top of the stationary pile 20, and in order to maintain said mechanisms at the proper level with respect to the top of the diminishing pile for continued separation and feeding of sheets from said pile, this lowering of the separator carriage is effected at suitable intervals under the control of the pile by mechanism constructed, mounted, operated, and controlled as follows. Extending transversely of the feeder and carried by the separator carriage for vertical movement therewith is a shaft 95 (Fig. 1) which is rotatably mounted within the tubular crossbar 38 and projects beyond opposite ends of said crossbar. The feed side end of the shaft 95 also projects through and is further journalled in a suitable bearing provided in a bracket 92 (Figs. 1, 4 and 5) which is secured to the outer surface of the guide block 36 of the separator carriage. Fixed on the shaft 95 and disposed exteriorly of the guide blocks 35 and 36 are spur pinions 96 and 97 which mesh with rack teeth 98 and 99, respectively, formed on and along a major portion of the rear edges of the uprights 23 and 25, respectively, said guide blocks being suitably recessed to receive said pinions. Rotation of the shaft 95 in opposite directions will thus impart lowering and raising movements to the separator carriage and the sheet separating mechanisms 39 thereon.

The single revolution shaft 66 on the separator carriage also projects through and beyond the bracket 92 on said carriage (Figs. 1, 4 and 5), and fixed on the outwardly projecting end of said shaft is a cam 84 which engages a roller 83 journalled on a cam strap 81 engaged over the shaft 66. The cam strap 81 extends between the furcations of a bifurcated pawl carrier 86 and is pivotally connected as at 85 to said pawl carrier. The roller 83 is biased toward the cam 84 by a coil extension spring 91 having one end thereof connected to the pawl carrier 86 and the opposite end connected to the bracket 92. The pawl carrier 86 is disposed between vertically spaced bearing portions 82 and 82' of the bracket 92 and is pivotally mounted for oscillating movement on a vertically extending shaft 87 which passes through and is journalled in suitable bearings in said portions. The shaft 87 is held against axial movement in a suitable manner and is journalled at opposite ends, thereof in suitable bearings in brackets 88 and 88' which are secured to the adjacent upper and lower side frame brackets 26 and 27, respectively. Pivoted at 85 on the pawl carrier 86 is a spring-pressed pawl 89 adapted to continuously and yieldingly engage a ratchet 90 which is disposed between the furcations of said pawl carrier. The ratchet 90 is mounted on the shaft

87 for sliding movement therealong and is drivably connected to said shaft as by a key and keyway connection to enable movement thereof along the shaft with the separator carriage and to impart rotation to said shaft in all axial positions thereof on the shaft.

Disposed between the pawl carrier 86 and the bearing portion 82' on the bracket 92 is a worm 93 (Fig. 4) which is mounted on the shaft 87 for relative sliding movement and is drivably connected, as by a key and keyway connection, to said shaft for rotation by the latter in all vertical positions of the separator carriage. This worm 93 meshes with and drives a worm gear 94 which is disposed exteriorly of the bracket 92 and is fixed on the outwardly projecting feed side end of the shaft 95. Through oscillation of the pawl carrier 86 by the cam 84 and spring 91, and engagement of the pawl 89 with the ratchet 90, the shaft 95 and pinions 96, 97 thereon are thus intermittently rotated in a clockwise direction, as viewed in Fig. 1, through the described worm and worm gear gearing between said shaft and the shaft 87, thereby imparting step by step downward movement to the separator carriage and the sheet separating mechanisms 39 thereon, including the shaft 66, cam strap 81, cam 84, pawl carrier 86, ratchet 90, bracket 92, worm 93, worm gear 94 and shaft 95, as well as the cam units 40 and 41. The drive between the worm 93 and the worm wheel 94 is self-locking.

During the normal operation of the feeder and as sheets are separated and fed from the top of the stationary pile 20, this step by step downward movement of the separator carriage and the sheet separating mechanisms 39 and other described parts thereon is controlled by a pile height determining feeler or finger 70 (Fig. 1) which is carried by said separator carriage and is preferably located to project over and engage the top of the pile of sheets at the front edge and substantially in the center thereof. The feeder 70 is adjustably secured to a rock shaft 71 (Figs. 1 and 4) which extends transversely of the feeder and is journalled in suitable bearings in the guide blocks 35 and 36 of the separator carriage. The feed side end of the shaft 71 also projects through and beyond a suitable bearing in the bracket 92. Fixed on the outwardly projecting feed side end of the shaft 71 is an arm 73 having journalled thereon a roller 74 which engages a cam 72 (Figs. 1 and 5) that is fixed on the single revolution shaft 66 and serves to hold the cam strap 81 in operating position with respect to the cam 84. The roller 74 is biased toward the cam 72 by a coil extension spring 69 having one end thereof connected to the arm 73 and the opposite end connected to the bracket 92. Once during each cycle of operation of the feeder the shaft 71 will thus be rocked in one direction by the cam 72 to raise the feeler 70 out of engagement with and clear of the front edge of the pile of sheets 20, and in the opposite direction by the spring 69 to lower the feeler 70 into engagement with the top of said pile. The operations of the feeler 70 are so timed that just prior to and during separation of the front edge portion of the top sheet from the pile 20 said feeler is moved upwardly and forwardly from and clear of said pile and held in its actuated position until the separated sheet is transferred to and taken by the upwardly moving chain gripper units 45, 46, and is then returned under the separated sheet into engagement with the top of the pile and held in this position until just prior to separation of the front edge portion of the next or underlying sheet on said pile.

Fixed on the feeler shaft 71 or formed integrally with the arm 73 is another arm 75 (Figs. 1 and 4) having threaded therein an adjustable tappet 76 which is adapted, under certain conditions, to engage one arm 77 of a double-armed latch lever which is pivotally mounted on the feeler shaft 71. The other arm of the latch lever is indicated at 78 and has secured thereto a hardened steel latch plate 79 which is adapted to normally engage the bevelled forward end of a companion hardened steel plate 80 secured to the upper surface of the cam strap 81. Engagement of latch plate 79 with plate 80 holds the cam strap 81 against return movement by the spring 91, thus preventing the roller 83 from following the low part of the cam 84 and operation of the pawl carrier 86 to engage the pawl 89 with the next tooth of the ratchet 90. The plate 80 is so located on the cam strap 81 that when the roller 83 is engaged by the high part of the cam 84, said plate is moved clear of the latch plate 79 so as to free the latter for pivotal movement out of engagement with the plate 80 and out of the path of return movement of said cam strap.

When the shaft 71 is rocked in the proper direction by spring 69 to engage the feeler 70 with the top of the stationary pile of sheets 20, the arm 75 with the tappet 76 thereon is also rocked in the same direction toward the latch lever arm 77. As long as the sheet separating mechanisms 39 are disposed at the proper level with respect to the top of the pile of sheets 20, the feeler 70 will be prevented by the pile from moving downwardly a distance sufficient to enable the tappet 76 on arm 75 to engage the latch lever arm 77. The separator carriage and the sheet separating mechanisms 39 thereon will thus remain stationary because the pawl carrier 86, through engagement of the latch plate 79 with the cam strap 81, will be held in its power stroke position and prevented from returning to enable the pawl 89 to engage the next tooth of the ratchet 90.

When the height of the pile of sheets 20 decreases sufficiently through removal of sheets from the top thereof so that lowering of the separator carriage and the sheet separating mechanisms 39 thereon is necessary, the tappet 76 on arm 75, through increased downward movement of the feeler 70, is enabled to engage the latch lever arm 77 and swing the latch lever sufficiently to disengage the latch plate 79 from the cam strap 81, thus rendering the pawl and ratchet mechanism operative to lower the separator carriage and the sheet separating mechanisms, as well as the cam units 40 and 41 on said carriage. When the feeler 70 is subsequently raised out of engagement with the top of the pile of sheets 20, the tappet 76 on arm 75 is swung away from the latch lever arm 77, whereupon the latch lever is released and allowed to return by gravity, aided by a light spring if necessary, to its original position so that the latch plate 79 is again positioned in the path of return movement of the cam strap 81, thus rendering the pawl and ratchet mechanism inoperative to further lower the separator carriage and the sheet separating mechanisms thereon. Upon each operation of the pawl and ratchet mechanism, the sheet separating mechanisms 39 will be lowered an extent sufficient to enable separation and feeding of a number of sheets from the top of the pile 20 before lowering of said sheet separating mechanism is again necessary.

The operating level of the sheet separating mechanisms 39 with respect to the top of the stationary pile of sheets 20 may be varied as desired to accommodate different stock conditions, and this is accomplished by rotating the adjustable tappet 76 which may be effected while the feeder is in operation. Adjustment of the tappet 76 toward the latch lever arm 77 will cause said tappet to engage said arm sooner with the result that the normal level of the sheet separating mechanisms will be disposed in a lower plane with respect to the top of the pile of sheets. Similarly, when the tappet 76 is adjusted away from the latch lever arm 77, said tappet is caused to engage said arm later with the result that the normal level of the sheet separating mechanisms will be disposed in a higher plane with respect to the top of the pile of sheets. If it is desired to lower the separator carriage and the sheet separating mechanisms thereon once during each cycle of operation of the feeder, as when handling thick sheets, such as cardboard, this may be accom-

plished by adjusting the tappet **76** toward the latch lever arm **77** to a position such that it engages said arm and actuates the latch lever each time the feeler **70** is moved toward and into engagement with the top of the pile of sheets **20**. In this case, the cam strap **81** will be released and the pawl and ratchet mechanism will be operated once during each cycle of operation of the feeder to lower the separator carriage and the sheet separating mechanisms thereon an appropriate amount as the sheets are fed one after another from the top of the pile **20**.

The described worm and worm gear drive **93**, **94** serves as an automatic brake and thus holds the separator carriage in all elevated positions and against sliding downward movement under the weight thereof. In lieu of the worm and worm gear drive, the separator carriage may, if desired, be attached to and suspended by suitable cables which are provided with suitable weights which tend to raise said carriage. In this case, a suitable self-locking type of pawl and ratchet mechanism is provided to check the separator carriage against upward movement by the weights, and to drive said carriage downwardly, said pawl and ratchet mechanism being drivably connected with the shaft **95** and being effective under the control of the feeler **70** in the manner above described. Also, if desired, the feeler **70** may be in the form of a blast nozzle connected with a source of compressed air so as to direct air under pressure rearwardly between each separated sheet and the pile and thereby completely separate and float said sheet while it is being removed or fed from the pile.

The separator carriage and the sheet separating mechanisms **39** and cam units **40** and **41** thereon may be manually raised and lowered to desired positions, and for this purpose the shaft **87** has fixed on the upper end thereof a bevel pinion **100** (Figs. 1 and 3) which meshes with a bevel gear **101** that is journalled on a short transversely extending shaft **102** fixed at the inner end thereof in the bracket **88**. Rotatably mounted on the outer end of the shaft **102** is a handwheel **103** which is also axially slidable on said shaft so as to permit it to be brought into clutching engagement with the hub of the bevel gear **101** to rotate the latter in either direction and thereby impart like rotation to the shaft **87** through the bevel pinion **100** to raise and lower the separator carriage. To free the ratchet **90** from the power operated mechanism when the handwheel **103** is employed to manually raise or lower the separator carriage, an arcuate pawl releasing arm **106** (Figs. 1, 4 and 5) is slidably fitted over a vertically extending square bar **105** and is held in operating relation to the pawl **89** between tubular extensions of the bearing portions **82**, **82'** of the bracket **92** on the separator carriage. The bar **105** passes through and is rotatable in the tubular extensions of the bracket **92**, and is provided at the opposite ends thereof with reduced annular portions which are journalled in suitable bearings in the brackets **88** and **88'** (Figs. 1 and 3). Fixed on the upper end of the bar **105** is an arm **104** which extends forwardly from said bar between the bevel gear **101** and the handwheel **103** and has journalled thereon a roller **107**. The arm **104** is biased in the direction of the handwheel **103** by a coil extension spring **109** having one end thereof connected to said arm and the opposite end connected to the adjacent upper side frame bracket **26**.

As the handwheel **103** is moved axially into clutching engagement with the bevel gear **101**, the hub of said handwheel engages the roller **107** on arm **104** and rocks said arm toward the feeder frame, thus rocking the square bar **105** in the same direction and causing the pawl releasing arm **106** on said bar to engage a tailpiece **108** of the pawl **89** (Fig. 5) and swing said pawl out of engagement with and clear of the ratchet **90**. The shaft **87** may then be rotated in opposite directions upon clutching engagement of the handwheel **103** with the bevel gear **101** and rotation of said handwheel to raise or lower the separator carriage. This manual raising and lowering of the separator carriage may be effected while the feeder is in operation and without disturbing the timing relationship of the various mechanisms. When the handwheel **103** is moved out of clutching engagement with the bevel gear **101**, the arm **104** is released and said arm, the bar **105**, and the pawl releasing arm **106** are then returned to their original positions by the contracting action of the spring **109**, thus releasing the pawl **89** to again engage the ratchet **90**.

The sheet separating mechanisms **39** are arranged for operation at opposite sides and near the front edge of the pile of sheets **20**, and act to preliminarily separate the front opposite corner portions of the top sheet from said pile and then to simultaneously stretch and lift the entire front edge portion of said sheet to a predetermined position above the pile for accurate transfer to and engagement by the gripping devices on the chain gripper units **45** and **46**. The sheet separating mechanisms **39** are constructed one right-hand and the other left-hand, the right-hand mechanism being diagrammatically shown in Fig. 1 and disposed outwardly of the chain gripper unit **45**, and the left-hand mechanism being shown in detail in Figs. 6 to 9 and occupying a corresponding position outwardly of the chain gripper unit **46**, and since the construction of said mechanisms are otherwise identical, a description of one will suffice for both.

Each sheet separating mechanism **39** comprises a casing **110** slidably mounted on the cross bars **37**, **38** of the separator carriage and provided with a guiding member **111** engaged with the crossbar **37**, and with clamping members **112** engaged with the crossbar **38** for securing said casing in various positions of adjustment along said crossbars. Each casing **110** is suitably constructed to provide suitable clearance openings for the shafts **66** and **71** to extend therethrough. Disposed within each casing **110** is a bevel gear **115** which is keyed to the single revolution shaft **66** for rotation thereby and for sliding movement along said shaft with said casing. This bevel gear **115** meshes with and drives a bevel gear **114** which is fixed on a short horizontal cam shaft **113** journalled in suitable bearings in the casing **110**. The bevel gears **114** and **115** are of the same diameter and, hence, the cam shaft **113** of each separator mechanism will be driven to make one complete revolution for each cycle of operation of the feeder. The cam shafts **113** of the separator mechanisms are driven by the gears **114**, **115** so that they rotate in opposite directions, i. e., toward each other and the pile of sheets **20**, as indicated by the arrow in Figure 7.

Keyed to the shaft **113** of each separator mechanism **39** within the casing **110** is a cam **118** which engages a roller **129** journalled on one arm **128** of a bell crank having another arm **125** projecting transversely of said casing toward the pile of sheets **20**. The bell crank **125**, **128** is pivotally mounted on a rock shaft **126** extending longitudinally of the feeder and parallel to the shaft **113** and the adjacent side of the pile **20** and journalled in bearings in the casing **110**. Journalled as at **121** on the inner free end of the bell crank arm **125** is a combing wheel **127** having secured thereto a sprocket **124** around which passes a chain **123** which also passes around a sprocket **122** secured to one end of a sleeve **116**. This sleeve **116** is journalled on the shaft **126** and has secured to the other end thereof a spur pinion **120** which meshes with a spur gear **117** that is secured to the cam **118**. The combing wheels **127** are rotated in the direction of the arrows indicated in Figs. 1 and 7 through the described driving connections for said wheels with the cam shafts **113**.

Each bell crank arm **125** has pivotally connected therewith at **143** (Fig. 7) the upper end of a vertically disposed spring-pressed rod **144** the lower end of which extends through a suitable clearance opening in an arm **145** which is pivotally mounted at **146** on the casing **110**. The arm **145** rests on an adjusting nut **147** which

is threaded on the lower end of a stem 148 that projects through a suitable elongated opening in said arm and is secured at the upper end thereof in the casing 110. The coil compression spring for rod 144 is indicated at 149 and mounted thereon between the head of said rod and the arm 145. Each bell crank arm 125 has also connected therewith at 143 one end of a coil extension spring 149' the opposite end of which is connected at 149'' to the casing 110. This spring 149' operates to counterbalance the weight of the bell crank 125, 128 and parts carried thereby so that downward movement of the combing wheel 127 is effected solely by the spring-pressed rod 144, and the degree of pressure of said combing wheel on the pile 20 is solely under the control of the spring 149.

The combing wheels 127 are thus spring operated toward and into frictional engagement with the top of the pile of sheets 20, and cam operated away from and out of engagement with said pile, and the pressure of the springs 149 and resulting pressure of the combing wheels on the pile may be adjusted by rotating the nuts 147 and thereby vertically adjusting the arms 145. Once during each cycle of operation of the feeder, and at the proper time, the combing wheels 127 are lowered on to the top of the pile of sheets 20 and effect a preliminary separation of the top sheet by moving the front opposite corner portions of said sheet inwardly towards each other whereby small buckles or humps are formed in the sheet adjacent said corners. In order to confine this preliminary separation of the top sheet by the combing wheels 127 to the opposite corner portions of said sheet, two presser fingers 142 (Fig. 1) are lowered into engagement with the top of the pile a short distance, inwardly from said combing wheels. These presser fingers 142 are rocked by the feeler shaft 71 into and out of engagement with the top of the pile of sheets 20 in unison with the feeler 70, and are yieldingly mounted on said shaft so as not to affect the pile height sensing operation of said feeler.

After preliminary separation of the top sheet has been effected at its front opposite corners by the combing wheels 127, the sheet is engaged at its buckled corner portions by two suction devices which operate to lift said sheet from the pile and stretch the same in a direction transversely to the feeding direction. This stretching of each sheet straightens and raises its entire front edge portion for accurate engagement at spaced points along said edge by the gripping devices on the chain gripper units 45 and 46. The suction sheet lifting and stretching devices form a part of the sheet separating mechanisms 39 and are similar, and each of said devices is constructed, mounted and operated as follows.

Each cam shaft 113 has fixed thereon a cam 119 which engages a roller 131 journalled on an arm 130 which is secured to the rock shaft 126. Fixed on the projecting rear end of the rock shaft 126 is a lever 133 which projects from said shaft inwardly towards the pile of sheets 20. Fitted in the lever 133 for sliding movement lengthwise thereof is a rod 134 which is held against rotation relative to said lever by a square block 135 secured to said rod and disposed between spaced inner and outer portions of the lever and relatively close to a guiding surface 136 of said lever. The rod 134 projects beyond the inner end of the lever 133 and has secured to its inner end a clamp 132. Secured in the clamp 132 is a tubular fitting 139 which forms a part of a suction sheet gripping device which is preferably, but not necessarily of a well-known type comprising a cylinder 141 communicating with said fitting, a hollow piston stem 141' in and communicating with said cylinder and projecting downwardly beyond the lower end of the cylinder, and a rubber suction cup 140 fixed on the lower end of said stem and communicating with the latter and said cylinder. Stem 141' and cup 140 are actuated downwardly by a spring (not shown), and are actuated upwardly by vacuum when said cup has gripped and is sealed by a sheet. The rod 134 and the suction sheet gripping device carried thereby are yieldingly urged inwardly towards the pile of sheets 20 by a coil compression spring 134' surrounding said rod and having one end thereof engaging against the clamp 132 and the opposite end engaging against the inner end of the lever 133, said inward movement being limited through engagement of the block 135 with the inner portion of the lever 133. Engagement of the blocks 135 with the inner portions of the levers 133 serves to properly locate the suction sheet gripping devices for operation on the separated corner portions of the top sheet of the pile 20.

Each suction sheet gripping device is yieldingly urged downwardly into engagement with the top of the pile of sheets 20 by a coil extension spring 133' having one end thereof connected to the lever 133 outwardly of the pivotal axis 126, and the opposite end connected to a block or shelf 110' secured to or formed integrally with the casing 110, said spring also serving to yieldingly urge the roller 131 toward the cam 119. The levers 133 are thus raised by the cams 119 and lowered by the springs 133', thereby raising and lowering the suction sheet gripping devices at intervals such that following preliminary separation of the opposite front corner portions of the top sheet by the combing wheels 127, the suction cups 140 will, upon creation of vacuum in the cylinders 141, grip the inwardly combed humped portions of said sheet and further separate them through retraction of the stems 141' into said cylinders. Thereupon the suction devices are swung upwardly and outwardly away from each other toward the sides of the pile of sheets 20 to lift the sheet at its front edge, and at the same time transversely stretch the entire front edge portion of said sheet in a manner to be presently described. The cams 118 and 119 are so chosen that when the respective rollers 129 and 131 are engaged with the high parts of said cams, the combing wheels 127 and the suction sheet gripping devices are swung upwardly and outwardly beyond the vertical projection of the sides of the pile of sheets 20, as shown in broken lines in Figs. 7 and 8, so as to clear the separated sheet and not interfere with the removal thereof in an upward direction from said pile. The timing relationship of the combing wheels 127 and the suction sheet gripping devices is such that the lowering and raising operations of said combing wheels precedes the lowering and raising operations of said suction devices and that the combing wheels are raised substantially the instant the sheet is gripped by the suction devices.

Stretching of the entire front edge portion of the separated top sheet by the suction devices is effected through outward movements of said suction devices away from each other which occurs as the suction devices move upwardly and while said sheet is being lifted thereby a short distance away from the top of the pile 20. For this purpose, each block 135 has journalled thereon a roller 137 (Figs. 6 and 8) adapted to engage an inclined cam arm 138 which is pivotally mounted at 138' on the casing 110. The cam arm 138 has threaded therein outwardly of the pivot 138' an adjustable abutment screw 137' adapted to engage the upper surface of the shelf or block 110' and thereby prevent upward swinging movement of said arm about its pivot 138'. The cam arm 138 may be adjusted on its pivot 138' to various operating positions with respect to the roller 137 by rotating the abutment screw 137' in opposite directions.

The cam arms 138 continuously engage the rollers 137 and are so formed and located that the lower edges thereof engaged by said rollers are disposed inside the arc of swinging movement of the rollers about the axes 126. Accordingly, when the suction devices are moved downwardly as hereinbefore described, the rollers 137 will move downwardly along the cam arms 138 and permit the rods 134 to be axially extended by the expanding action of the springs 134' until the blocks 135 on said

rods engage the inner portions of the levers **133** and the suction devices are thereby properly positioned for gripping of the inwardly combed humped corner portions of the top sheet by the suction cups **140**. When the sheet is gripped by the cups **140** and the suction devices are thereafter raised to lift the front edge portion of said sheet, the rods **134** and therewith said suction devices, through upward movement thereof and engagement of the rollers **137** with the cam arms **138**, will be forced by said cam arms outwardly away from each other relative to the levers **133**, thereby stretching the entire front edge portion of the sheet substantially through equal outward movements of the suction devices to an extent depending on the slack or sag in the sheet, the cam arms **138** being so adjusted to effect this stretching operation during lifting of the sheet a short distance from the top of the pile **20** and without causing the suction devices to tear or slip on the sheet.

Immediately after the sheet is gripped, lifted and stretched by the suction devices as described, said sheet is transferred to and taken by mechanical grippers on the chain gripper units **45**, **46** of the upright conveyor hereinafter described, at which time the suction devices are released from the sheet and continue to move farther upwardly and outwardly to positions clear of the side edges of said sheet. It is to be noted that by virtue of the cam arm **138** and the relative outward or retracting movement of the rod **134** and suction device effected by said cam arm, the overall length of the lever **133** from the axis **126** to the extreme end of the suction device is in effect shortened as said suction device moves farther upwardly and outwardly after release of the separated sheet, thus requiring less upward stroke of each suction device to bring it to a position clear of the side edge of the sheet. After the separated sheet is taken by the mechanical grippers on the chain gripper units **45**, **46** and before said sheet is completely removed from the top of the pile of sheets **20**, the combining wheels **127** and the suction devices are returned beneath the separated sheet for action thereof on the next sheet in the next cycle of operation of the feeder. In this manner, each succeeding sheet is separated, lifted and stretched while still partly covered by a previously separated sheet and is taken by the upright conveyor and removed from the pile **20** in underlapped relation with the preceding sheet, with the result that the sheets are advanced by the upright conveyor in underlapped relation and in the form of a continuous stream thereof, as shown diagrammatically in Fig. 19.

In order to control the extent of downward movement of each suction device so that the suction cup **140** thereof will engage the humped corner portion of the sheet at its separated level and not depress said portion back onto the pile **20**, each rock shaft **126** has adjustably secured thereto for rocking movement therewith a finger **195** which is located adjacent to and rearwardly of the lever **133** (Figs. 6, 8 and 9). This finger **195** extends inwardly from the shaft **126** and is adapted to engage the top of the pile of sheets **20** when the suction cup **140** contacts the separated humped corner portion of the sheet, thus holding the shaft **126** against further rotation and the suction device against further downward movement by the spring **133'**.

Vacuum is created in the suction devices at predetermined intervals through flexible conduits **196** (Figs. 1 and 6) having corresponding ends connected to the fittings **139** and opposite ends connected to the vacuum side of a rotary valve mechanism **197** which is suitably secured to the crossbar **38** for movement with the vertically movable separator carriage. This valve mechanism **197** is of the general type disclosed in the United States Patent No. 2,333,934, granted March 4, 1941, to Headley Townsend Backhouse, and needs no detail description herein, except to say that said mechanism is suitably connected to a vacuum pump (not shown), and the rotor thereof is engaged over and suitably connected to the single revolution shaft **66** for rotation thereby to control the making and breaking of vacuum in the cylinders **141** of the suction devices.

The chain gripper units **45** and **46** of the upright conveyor for receiving the sheets successively separated from the top of the stationary pile of sheets **20** and for advancing said sheets from said pile in an upward direction are constructed one right-hand and the other left-hand, and since the constructions of said units are otherwise identical, a description of one will suffice for both. As herein shown, each chain gripper unit **45** and **46** is preferably constructed, mounted and operated as follows. Slidably mounted on the single revolution shaft **60** and drivably connected, as by a key and keyway connection, to said shaft for continuous rotation thereby is a sprocket **171** around which passes an endless roller chain **150** (Figs. 1, 10 and 19). The chain **150** is arranged and guided to travel in a fixed closed path defined by a straight upwardly travelling rear run located adjacent the front side of the stationary pile of sheets **20** and extending from the bottom of the feeder to the top thereof and terminating in a forwardly curved, forwardly travelling, downwardly and forwardly inclined run extending to the sprocket **171**, a downwardly and rearwardly travelling run extending from the sprocket **171** and terminating in a straight downwardly travelling front run extending to the bottom of the feeder, and a semi-circular run at the bottom of the feeder connecting said front and rear runs and leading from one to the other.

For this purpose, each chain gripper unit **45**, **46** includes an upper bracket **152** which is slidably mounted on the crossbar **29** and is provided with a suitable bearing to receive the shaft **60**. This bracket **152** carries the bearing for the upper end of the unit adjusting shaft **44** hereinbefore described. The bracket **152** encloses the sprocket **171** and is provided with an outer guide track **170** which is engaged by the rollers of the chain **150** and which, as shown in Fig. 10, is formed of several curved and straight elements secured to said bracket in abutting relation for guiding said chain and causing it to travel in the above described path. The bracket **152** has also secured thereto inner track elements **162**, **164** and **166** which are engaged by the rollers of the chain **150** and cooperate with the guide track **170** to constrain said chain and assure movement of the latter in the above described path. Secured to the bracket **152** and extending downwardly therefrom is an upright bar **176** (Figs. 10, 11, 12 and 14) having secured thereto two upright track bars **177** which are engaged by the rollers of the chain **150** and serve to guide the front run of said chain for straight-line downward movement, said bars forming continuations of the guide track **170** and the track element **164**. The bar **176** is undercut to provide sufficient clearance for the connecting-link-plates of the chain **150** at one side thereof. Secured to the bracket **152** and extending downwardly therefrom is an upright bar **178** having secured thereto two upright track bars **179** which are engaged by the rollers of the chain **150** and serve to guide the rear run of said chain for straight-line upward movement, said bars forming continuations of the guide track **170** and the track element **166**. The bar **178** is undercut to provide sufficient clearance for the connecting-link-plates of the chains **150** at one side thereof, and said bar has also secured thereto a relatively wide upright pile positioning bar **193** which extends the full length of the bar **178** and against the wide face of which the pile of sheets **20** is loaded in position for accurate feeding of the sheets from the top thereof. The rear face of the bracket **152** is suitably formed to provide an upward extension of the pile positioning bar **193**.

The support bars **176** and **178** of each unit **45**, **46** are secured at their lower ends to a bracket **194** which is slidably engaged over the crossbar **31**. This bracket **194** carries the bearing for the lower end of the unit ad-

justing shaft 44 hereinbefore described. Secured to the bracket 194 is another bracket 198 which has secured thereto two concentric semi-circular track elements 199 which are engaged by the rollers of the chain 150 and serve to guide said chain and cause it to travel in a semi-circular path from the front trackway defined by the bars 177, 177 to the rear trackway defined by the bars 179, 179. The bracket 198 is undercut to provide sufficient clearance for the connecting-link-plates of the chain 150 at one side thereof, and said bracket is mounted on the bracket 194 for vertical adjustment so that any slack in the chain may be taken up and the desired degree of tightness of said chain may be obtained. To enable vertical adjustment of the bracket 198 the latter is provided with a suitable elongated clearance opening through which the crossbar 31 extends.

The chain 150 of each unit 45, 46 is provided at intervals therealong with a plurality of mechanical grippers indicated generally at 151 (Figs. 1, 10, 15, 16, 17 and 19). These grippers 151 are equally spaced apart along the chain 150 and such that the distance between the same is equal to the distance desired between the leading or front edge of a preceding sheet and the leading or front edge of a succeeding sheet on the upright conveyor, said distance being less than the length of the shortest sheet which the feeder is designed to handle, whereby the sheets as they are carried upwardly from the pile 20 hang in underlapped relationship as diagrammatically indicated in Fig. 19. The sprockets 171 are so chosen that for each complete revolution thereof, i. e., for each cycle of operation of the feeder, the chains 150 will be advanced a distance equal to the distance between successive grippers 151, whereby successive sets of said grippers will pass in position to receive successive sheets separated from the top of the pile 20 during successive cycles of operation of the feeder.

As shown particularly in Figs. 10, 15 and 16 of the drawings, each mechanical gripper 151 comprises a plate 153 which is provided at one side thereof with two pins located thereon as at 154 and 155 and which are of the same pitch as the chain 150 and pass through corresponding links of said chain in place of the standard chain pins. Pivotally mounted at 154 on the other side of the plate 153 is a gripper jaw 156 having pivotally mounted thereon at 157 a companion gripper jaw 158. Pivotally connected as at 158' to the jaw 158 is one end of a short rod 159 the opposite end of which extends loosely through a suitable opening in the jaw 156. Surrounding the rod 159 is a coil compression spring 159' having one end thereof engaging against the head of said rod and the opposite end engaging against a surface of the jaw 156. The gripper jaw 158 is thus normally urged by the spring-pressed rod 159 into close contact with the gripper jaw 156. Eccentrically pivoted to the gripper jaw 156 as at 156' is one end of a short rod 165 the opposite end of which extends loosely through a suitable opening in a block 153' which is rotatably carried by the plate 153. Surrounding the rod 165 is a coil compression spring 165' having one end thereof engaging against the head of said rod and the opposite end engaging against the block 153'.

It will thus appear that by the described arrangement of the parts, the gripper jaws 156 and 158 are capable of rocking movement as a unit in opposite directions about the pivotal axis 154 relative to the chain 150, and the gripper jaw 158 is capable of rocking movement in opposite directions about the pivotal axis 157 relative to the gripper jaw 156 to opened and closed positions. It will also appear that the gripper jaw 156 and the spring-pressed rod 165 form in effect a toggle joint, and when said jaw is rocked by means to be presently described in one direction about the pivotal axis 154 thereof and the pivotal axis 156' of said rod passes the axis 154, the spring-pressed rod 165 operates to move the gripper jaws 156, 158 farther in said direction by a snap action to bring said jaws from the positions thereof shown in Fig. 16 to the positions shown in Fig. 15. Similarly, when the gripper jaw 156 is rocked in the opposite direction from the position thereof shown in Fig. 15, and the pivotal axis 156' of the spring-pressed rod 165 passes the axis of the block 153', said rod operates to move the gripper jaws 156, 158 farther in said direction by a snap action. Rocking movement of the gripper jaw 156 and therewith the gripper jaw 158 is limited in one direction through engagement of a surface 167 on the jaw 156 with a stop pin 168, and in the opposite direction through engagement of a surface 169 on said jaw with said pin, the latter being secured in the carrier plate 153. The gripper jaw 156 has journalled thereon at 156' a roller 160, and the gripper jaw 158 has journalled thereon at 161' a roller 161. The gripper jaw 156 has also journalled thereon at 154 a roller 163.

As previously stated, the cam units 40 and 41 are carried by and movable vertically with the separator carriage, and said units have fixed thereon for vertical movement therewith gripper introducing and opening cam blocks 174 (Figs. 1 and 17) which are disposed in the paths of upward movement of the grippers 151 on the chains 150. Each of the cam blocks 174 is constructed to provide a lower inclined cam surface 181 and an upper reversely inclined cam surface 182. Disposed at the tops of the chain gripper units 45, 46 and in the paths of forward movement of the grippers 151 on the chains 150 are gripper opening cam bars 172. Secured to the brackets 198 on and at the bottoms of the chain gripper units 45, 46 are gripper tumbling or turnover cam bars 173 which are disposed in the paths of downward movement of the grippers 151 on the chains 150, each of said cam bars being constructed to provide an upper inclined cam surface 173'.

Referring now to Fig. 17 of the drawings, which diagrammatically illustrates the gripper circuit and shows one gripper or one set of grippers 151 in the various positions it occupies as it travels around said circuit, let it be assumed that said gripper or set of grippers is travelling upwardly from the bottom of the feeder towards the top of the stationary pile of sheets 20 adjacent to but clear of the front side of said pile. At this time the gripper 151 is closed and the surface 167 of the jaw 156 is engaged with the pin 168, thus positioning the jaws 156, 158 that the bite thereof is substantially horizontal. As the gripper 151 reaches the top of the pile of sheets 20 at whatever level it may be, the roller 161 on the jaw 158 rides upwardly past, and out of contact with, the lower cam surface 181 of the cam block 174, and as the gripper 151 continues to move upwardly, the roller 160 on the jaw 156 engages and rides upwardly along the lower cam surface 181 of the cam block 174 and the roller 161 on the jaw 158 simultaneously engages and rides upwardly along the upper cam surface 182 of said cam block. Under these conditions the jaws 156, 158 are rocked as a unit rearwardly about the axis 154 towards the separated, lifted and stretched sheet 185 by the combined actions of the cam block 174 and the spring-pressed toggle rod 165, and the jaw 158, through such rocking movement thereof with the jaw 156 and engagement of the roller 161 with the cam surface 182, is caused to rock about its axis 157 farther away from the jaw 156, thus fully opening the grippers 151 and introducing the jaw 156 beneath the lifted and stretched front edge portion of the sheet and projecting the jaw 158 over said sheet portion. Thereafter, as the gripper 151 continues to move upwardly, the roller 161 on the jaw 158 rides off the cam surface 182 of the cam block 174, whereupon said jaw is rocked about its axis 157 toward the jaw 156 by the spring-pressed rod 159 to firmly grip the sheet 185 between the same and the jaw 156. During the described gripper opening and introducing operations the gripper 151 is steadied through engagement of the rollers of the chain

150 with the track bars 179 and engagement of the roller 163 with a surface 175 on the respective cam unit.

After the front edge portion of the separated, lifted and stretched sheet 185 is gripped by the transversely aligned set of grippers 151, said sheet, through continued upward movement of said grippers, is withdrawn from the top of the stationary pile 20 and advanced upwardly to the top of the gripper circuit. During this upward movement of the grippers 151 and the sheet 185 gripped thereby, said grippers are caused to gradually rock about the axes 154 downwardly towards the pile of sheets 20, whereby each gripper will assume a position such that the bite thereof more nearly approaches vertical position and thus conforms to the vertical attitude of the hanging sheet 185 gripped thereby. For this purpose, each chain gripper unit 45 and 46 includes a bar 190 which is secured at its lower end to a bracket 190' which, in turn, is pivotally mounted as at 191 on the bracket 194. The bars 190 extend upwardly to substantially the top of the crossbar 29 and are normally tilted forwardly at a slight angle with respect to the straight-line vertical upward movement of the chains 150 and the grippers 151 thereon. The bars 190 pass through and are guided in suitable bifurcated portions of the cam units 40, 41, and they engage adjustable balls 192 loosely carried in suitable sockets in said units.

It will thus appear that when the grippers 151 are rocked by the combined actions of the cam blocks 174 and the spring-pressed toggle rods 165 rearwardly into positions to grip the sheet 185 as above described, the rollers 160 on the gripper jaws 156 engage the bars 190 and are held in engagement with said bars under the influence of the toggle rods 165. Accordingly, as the grippers 151 travel upwardly with the gripped sheet 185 to the top of the gripper circuit, the rollers 160 being under the influence of the spring-pressed toggle rods 165 are caused to follow the inclined bars 190 and in so doing permit said grippers to progressively rock in a downward direction under the influence of said toggle rods an extent permitted by said bars. The degree of rocking movement of the grippers 151 which is required in conformity with the inclination of the bars 190 varies in accordance with the distance between the top of the pile of sheets and the top of the gripper circuit, i. e., according to the height of the pile. In order to achieve this variation the inclination of the bars 190 is adjusted in accordance with the elevated position of the cam units 40 and 41. This result is obtained by supporting the backs of the bars by adjustable balls 192 which rise and fall with the cam units and against which the bars 190 are pressed by the gripper rollers 160.

The sheet 185 taken by the grippers 151 is advanced upwardly to the top of the gripper circuit and then forwardly and delivered to the tape conveyor 21 between the latter and co-operating pressure rollers 203, at which time the grippers are opened to release said sheet for further movement by said conveyor toward the printing press or other machine with which the feeder is associated. As the grippers 151 enter the path of forward movement thereof they assume a natural position in which the bites of the jaws 156, 158 are trailing and are substantially tangential to said movement. Opening of the grippers 151 after the sheet 185 is delivered to and between the tape conveyor 21 and pressure rollers 203 is effected by the cam bars 172 which are so positioned in the path of forward movement of said grippers that the rollers 160 on the jaws 156 pass beneath said bars, and the rollers 161 on the jaws 158 pass above said cam bars. The opening of the grippers is effected by humps 172' on the cam bars 172, which humps lift the rollers 161 on the upper jaws 158 as they pass along the cam bars and so open the grippers, the rollers 160 being supported on the underside of the bars 172. After the grippers 151 have reached the end of their forward travel they begin their return travel around the sprockets 171 which occurs after the sheet 185 is delivered between the tape conveyor 21 and the pressure rollers 203. As the grippers 151 continue to move downwardly around the sprockets 171, the rollers 161 on the gripper jaws 158 move out of engagement with the cam bars 172, whereupon said grippers are again closed by the action of the spring-pressed rods 159 on said jaws. The grippers 151 then continue to move downwardly to the bottom of the feeder in a natural position in which the bites of the jaws 156, 158 are trailing and are substantially vertical.

As the grippers 151 approach the bottom of the feeder and before they enter their semi-circular path and begin their upward movements to act on another sheet separated from the top of the pile 20, the rollers 160 on the jaws 156 engage and ride downwardly along the cam surfaces 173' of the cam bars 173, whereupon said grippers are, through the combined actions of said cam bars and the spring-pressed toggle rods 165, tumbled or turned-over approximately 90° about their axes 154 from the positions thereof in which the bites of the jaws 156, 158 are vertical to positions in which said bites are horizontal and the jaws 158 are leading, as shown in Fig. 17, thus resetting the grippers for action on another sheet as the same again travel upwardly past the top of the pile of sheets 20. The described gripper operations are repeated for each set of grippers as the same travels along the described gipper circuit, whereby sheets separated successively from the top of the pile 20 are taken by successive sets of gripers, removed from said pile, and advanced upwardly in lapped relation, as shown diagrammatically in Fig. 19. It is to be noted that by virtue of the described upward removal of the sheets from the top of the pile 20, a relatively wide space is immediately created between the topmost sheet being removed and the next sheet on said pile, which space advantageously enables immediate return of the combing wheels 127 and the suction devices beneath said topmost sheet, and performance of the separating, lifting and stretching operations on said next sheet while the latter is still partly covered by the outgoing topmost sheet.

To facilitate the movement of the sheets in the forward direction, guide brackets 200 (Figs. 1 and 18) are slidably mounted on the crossbar 29 inwardly of the chain gripper units 45, 46. These guide brackets 200 are laterally spaced from the chain gripper units and are secured to the upper brackets 152 of said units by means of bolts 204 and 205, the bolts 204 passing through suitable clearance openings in the brackets 152 and being threaded into spacer brackets 206, and the bolts 205 passing through suitable clearance openings in the brackets 152 and 206 and being threaded into the brackets 200. The guide brackets 200 carry the gripper opening cams 172 and the outline of said brackets is similar to the outline of the brackets 152 in conformity with the path of forward travel of the sheets. To further support and guide the sheets in the forward movement thereof onto the tape conveyor 21, other curved guide brackets 207 are adjustably secured to the crossbar 29 between the guide brackets 200.

The tape conveyor 21 comprises a plurality of transversely spaced endless tapes 202, two only being shown, which travel over and along a feedboard 201 suitably supported on the feeder frame. The rear portions of the tapes 202 pass around and are driven by flanged pulleys 208 (Fig. 18) which are disposed between the brackets 152 and 200 and are keyed to the shaft 60 for rotation thereby and for sliding movement along said shaft. The tapes 202 are driven at the same surface speed as that of the grippers 151 so that the lapped relation of the sheets is maintained as said sheets are further advanced by the conveyor 21 to the printing press or other machine. The rear portions of the tapes 202 also pass over and around idler rollers 209 journalled at 210 on the guide brackets 200, and over and around tape tightening rollers 211 which are journalled as at 212 on the upper ends of arms 213 which are pivotally mounted at 205 on the spacer brackets 206. The arms 213 have connected therewith corresponding ends of coil extension springs 214 the op-

posite ends of which are connected as at 215 to the guide brackets 200. The pressure rollers 203 are journalled on arms 216 which are adjustably secured on a shaft 217 that extends transversely of the feeder and is rotatably carried by the upper side frame brackets 26. The pressure rollers 203 rest by gravity on the tapes 202, augmented by a coil extension spring 218 having one end thereof connected to a rod 219 which extends through and is secured in one end of the shaft 217, said rod being utilized to manually lift said pressure rollers out of engagement with said tapes and the sheets carried thereby. The opposite end of the spring 218 is connected to the adjacent upper side frame bracket 26.

The operation of the feeder will be clearly understood from the foregoing description and may be briefly summarized as follows. The continuously rotating combing wheels 127 are lowered onto the top of the stationary pile of sheets 20 and comb the front corner portions of the top sheet inwardly towards each other whereby small buckles or humps are formed in said sheet adjacent said corners and the sheet is separated from the next or underlying sheet at opposite front corners thereof. During this combing operation, the feeler 70 and presser fingers 142 are resting on the top of the pile, and the suction devices are being lowered towards said pile. When the combed top sheet is engaged and gripped at the humped corner portions thereof by the suction cups 140, the combing wheels 127 are raised to the broken line positions thereof shown in Fig. 7 clear of the side edges of said sheet, and the feeler 70 and presser fingers 142 are raised to positions clear of the front edge of the sheet. The suction devices are then raised to lift and stretch the entire front edge portion of the sheet which is then gripped by a set of upwardly travelling grippers 151 at spaced points along said edge and removed from the pile in an upward direction. When the lifted and stretched front edge portion of the top sheet is gripped by the grippers 151, said sheet is released by the suction cups 140 through the breaking of vacuum therein, and the suction devices are further raised to the broken line positions thereof shown in Fig. 8 clear of the side edges of the upwardly moving sheet. While the top sheet is being removed from the pile 20 by the grippers 151, the feeler 70, the presser fingers 142, the combing wheels 127 and the suction devices return beneath said sheet and the next sheet is separated, lifted and stretched at the front edge thereof and is taken by the next set of upwardly travelling grippers 151 before the preceding sheet has been completely removed from the pile so that there is formed on the upright conveyor a stream of lapped sheets which is delivered to the tape conveyor 21 and is advanced by said tape conveyor to the printing press or other machine which takes the forward uppermost sheets successively from said stream for performance of printing or other operations thereon.

As the height of the stationary pile of sheets 20 decreases through feeding of sheets from the top thereof, the sheet separating mechanisms 39 are automatically lowered, the cyclic timing of the operations of said mechanisms is automatically advanced in relation to the movement of the sets of grippers 151 and the advanced arrival thereof at the changing level of the gradually diminishing pile, and the sheet taking operations of said grippers are automatically controlled to occur as the grippers travel past said changing pile level, whereby separation of the sheets successively from the top of the pile and removal of said sheets from said pile is maintained and assured throughout the entire run of the pile of sheets and until said pile is exhausted.

A modified form of drive is illustrated in Fig. 20 of the drawings, which drive may be used in lieu of the described drive comprising the chain 57 and sprocket 65, for rotating the shaft 66 and for effectively advancing and retarding the cyclic timing of the operations of the sheet separating mechanisms 39 as the latter are lowered and raised, respectively. This modified form of drive is designed to rotate the shaft 66 one complete revolution at timed intervals and in timed relation with the operation and cycle of movement of the upright conveyor comprising the chains 150 and the sheet grippers 151 thereon. As shown, the modified form of drive comprises a spur pinion 225 which is fixed on the shaft 66 in place of the previously described sprocket 65. This pinion 225 meshes with and is driven by a spur gear 226 which is fixed on a short transverse shaft 227 having one end thereof supported by and journalled in a suitable bearing provided in the guide block 35 of the vertically movable separator carriage. The opposite end of the shaft 227 is supported by and journalled in a suitable bearing provided in a bracket 228 which is secured to or formed integrally with the guide block 35 of the vertically movable separator carriage. Hence, the gear 226, shaft 227 and bracket 228, through the described mounting thereof on the guide block 35, are caused to move vertically with the separator carriage which, as previously described, also carries the shaft 66 on which the pinion 225 is fixed. The ratio of the pinion 225 and gear 226 is 2:1 such that said pinion will make one complete revolution to each one-half revolution of said gear.

Secured to or formed integrally with the gear 226 is a disk 229 provided with two slots 230 disposed diametrically opposite each other and opening radially through the periphery of said disk. Spaced axially from the disk 229 and fixed on the shaft 227 is a second disk 231 provided with two slots 232 disposed diametrically opposite each other and opening radially through the periphery of said disk, said slots being aligned with the slots 230 in the disk 229. Disposed between the disks 229 and 231 and rotatably mounted on the shaft 227 is a sprocket 233 around the front half of which passes the rear reach of an endless chain 234 which is used in place of the previously described driving chain 57. The chain 234 at the upper end thereof passes around and is driven by the previously described driving sprocket 53, and also passes at said end over and around the previously described idler sprockets 54 and 56. The chain 234 at its lower end passes under and around the previously described guide sprocket or disk 55. The chain 234 will thus be driven by the sprocket 53 continuously and in the same direction and at the same surface speed as that of the chains 150 of the upright conveyor gripper units 45, 46. The rear upwardly travelling reach of the chain 234 is guided around and maintained in engagement with the sprocket 233 by a guide plate 235 which is secured to the bracket 228. This guide plate 235 leads the chain 234 through a gentle curve on to and away from the sprocket 233, thus reducing the acceleration and deceleration of the disks 229, 231 and of the shaft 66.

The chain 234 is provided at intervals therealong and at opposite sides thereof with a plurality of rollers 236 which are equally spaced apart so that the distance between the rollers is equal to the distance between the grippers 151 on the chains 150 of the upright conveyor gripper units 45, 46 the rollers on one side of the chain 234 being in alignment with the rollers of the other side of said chain. It will thus appear that as each pair of rollers 236 on the continuously moving chain 234 is about to pass around the sprocket 233, said rollers will enter the lower pair of radial slots 230, 232 in the disks 229, 231 and through movement thereof around said sprocket and engagement with said disks in said slots will rotate the disks 229, 231, the gear 226 and the shaft 227 one-half of a revolution and then pass out of the slots 230, 232 at the tops of said disks, thus rotating the shaft 66 one complete revolution through meshing engagement of the pinion 225 thereon with said gear. When the disks 229, 231 are rotated one-half of a revolution as described, the opposite pair of slots 230, 232 in said disks are brought into position for engagement by the next pair of rollers 236 on the chain 234 in the next cycle of operation of the

feeder. The phase relation of the operation of the rollers 236 to the operation and cycle of movement of the grippers 151 is so chosen to effect rotation of the shaft 66 and operation of the sheet separating mechanisms 39 at the appropriate time, and it will be noted that this phase relation will remain constant during the vertical movements of the sheet separating mechanisms, whereby the sheets will always be separated from the top of the stationary pile 20 in time for engagement by the grippers 151 as the latter travel upwardly past the changing level of said pile.

In order to guard against accidental rotation of the shaft 66 during the interval between operations of said shaft, one of the disks, i. e., the disk 229, is provided with two axially projecting pins 237 which are disposed diametrically opposite each other and centrally between the radial slots 230. The pins 237 are arranged to clear the pinion 225 upon rotation of the disks 229, 231, and to enter between the opposed ends of two vertically aligned locking pawls 238 and 239 at the end of each half revolution of said disks. The pawls 238 and 239 are pivotally mounted as at 240 and 241, respectively, on the bracket 228, and said pawls are so shaped that when the rollers 236 on the chain 234 begin to enter the radial slots 230, 232 in the disks 229, 231, one of said rollers will engage the pawl 238 and rock the same out of the path of rotation of the pin 237 engaged therewith and thus release said disks for rotation. When the roller 236 moves out of engagement with the pawl 238, the latter immediately returns to its original position for engagement by the other pin 237 when the disks 229, 231 have completed a half of a revolution, thus temporarily locking said disks against accidental rotation until the pawl 238 is again released by the next pair of rollers 236. As each pin 237 approaches the pawl 238 it deflects the pawl 239 out of its path, which pawl 239 then immediately returns to its original position above said pin when the latter contacts the upper end of the pawl 238. The pawls 238, 239 cooperate to releasably lock the disks 229, 231 against rotation in both directions.

In Figs. 21 and 22 of the drawings there is shown a modification of the intermittent drive shown in Fig. 20, said modification utilizing the hereinbefore described drive chain 234, and comprising similar elements similarly operated, but constructed and mounted as follows. Spaced outwardly from the guide block 35 of the vertically movable separator carriage and suitably secured to said block for vertical movement with said carriage is a guide plate 250 which surrounds a guide wheel 251 that is rotatably mounted on a sleeve 252 which is engaged over and rotatably mounted on the projecting gear side end of the shaft 66. The guide plate 250 serves to guide the rear upwardly travelling reach of the chain 234 around one-half of the periphery of the guide wheel 251 and is provided at the bottom thereof with an entrance slot 253 for directing said chain reach in a gentle curve to said wheel, and at the top thereof with an outlet slot 254 for leading said chain reach in a gentle curve away from said wheel. Spaced axially from the guide wheel 251 and guide plate 250 and secured to the sleeve 252 at opposite sides of said wheel and said plate are identical disks 255 each of which is provided with four radially extending slots 256 which are spaced 90° apart and open outwardly through the periphery of the disk.

Secured to the sleeve 252 adjacent the inner disk 255 is a gear 257 which meshes with and drives a gear 258 that is rotatably mounted on the projecting gear side end of the tubular crossbar 37 of the separator carriage. Secured to or formed integrally with the gear 258 is a gear 259 which meshes with and drives a gear 260 that is fixed on and drives the shaft 66. The combined ratio of the gears 257, 258, 259 and 260 is such that the gear 260 fixed on the shaft 66 will make one complete revolution to each three-quarters of a revolution of the gear 257. In the normal position of the disks 255, two of the radial slots 256 thereof are in register with the slots 253 and 254, respectively, of the guide plate 250.

It will thus appear that as each pair of rollers 236 on the continuously moving chain 234 is about the pass around the guide wheel 251, said rollers will radially enter the lower pair of radial slots 256 of the disks 255 and in passing around the curved portion of the slot 253 of the guide plate 250 will initially rotate said disks in the direction of the arrow indicated in Fig. 21 at a gradually increasing speed through engagement of said rollers with said disks in the slots 256 thereof. As the rollers 236 proceed around the guide wheel 251 the disks 255 are further rotated by said rollers at a constant speed, and as the rollers 236 leave said guide wheel and travel along the curved portion of the slot 254 of the guide plate 250 and out of the slots 256 of said disks, the speed of the disks 255 is gradually reduced and said disks are stopped. This occurs when the disks 255 have completed three-quarters of a revolution, thus resulting in rotation of the shaft 66 one complete revolution in the direction of the arrow indicated in Fig. 21 through the described gearing between said disks and said shaft. When the disks 255 are rotated through three-quarters of a revolution and stopped as described, another pair of slots 256 of said disks is positioned to receive the next pair of rollers 236 on the chain 234 in the next cycle of operation of the feeder.

To guard against accidental rotation of the shaft 66 during the interval between operations of said shaft, the shaft has fixed thereon an arm 261 provided at its free end with a pin 262. This pin 262 is arranged to engage between the opposed ends of two vertically aligned locking pawls 263 and 264 at the end of each complete revolution of the shaft 66. The pawls 263 and 264 are pivotally mounted at 265 and 266, respectively, on the guide plate 250, and said pawls are so shaped that when the rollers 236 on the chain 234 begin to enter the radial slots 256 of the disks 255, one of said rollers will engage the pawl 263 and rock the same out of the path of rotation of the pin 262 and thus release the shaft 66 for rotation. When the roller 236 moves out of engagement with the pawl 263 and the shaft 66 begins to rotate, said pawl is immediately returned by a coil extension spring 267 to its original operative position determined by a stop pin 268 carried by the guide plate 250 and engaged by said pawl. The spring 267 has one end thereof connected to the pawl 263 and the opposite end connected to the stop pin 268. Just before the rollers 236 begin to leave the radial slots 256 of the disks 255, one of said rollers will engage the pawl 264 and rock the same out of the path of rotation of the pin 262 as the latter approaches the pawl 263. When the roller 236 moves out of engagement with the pawl 264 the latter is immediately returned by a coil extension spring 269 to its original operative position above the pin 262 determined by a stop pin 270 carried by the guide plate 250 and engaged by said pawl. The spring 269 has one end thereof connected to the pawl 264 and the opposite end connected to the stop pin 270. The pawls 263, 264 cooperate to releasably lock the shaft 66 against rotation in both directions.

In another modified form of separator drive shown in Fig. 23 of the drawings, a vertically extending drive shaft 271 may be effectively employed in lieu of the described chain drive shown in Figs. 1, 20, 21 and 22. This drive shaft 271 is arranged to extend above and below the range of upward and downward movements of the separator carriage and is suitably journalled in bearings carried by the feeder frame at the gear side thereof, said bearings also serving to hold said shaft against axial movement in either direction. The shaft 271 is provided substantially along the entire length thereof with a helical keyway or groove 272 of such design that the pitch of the helix is equal to the distance between adjacent sheet grippers 151 on the chains 150 of the upright conveyor. A bevel gear 273 is mounted on the shaft 271 for sliding movement

therealong and is drivably connected to said shaft for rotation thereby by a key 274 carried by said gear and slidably engaged in the helical keyway 272. This gear 273 is rotatably carried by an extension of the guide block 35 of the separator carriage and is connected in a suitable manner to said guide block so that it moves vertically with said carriage. The gear 273 meshes with a bevel gear 274 which is fixed on and drives the shaft 66 which, as hereinbefore described, drives the sheet separating mechanisms 39. The gears 273 and 274 are of the same size and, hence, the ratio of the shafts 66 and 271 is 1:1. Other ratios may be used provided that the single revolution of the shaft 66 is maintained and that the pitch of the helical keyway 272 is appropriately chosen. The shaft 271 is appropriately and continuously driven from the hereinbefore described shaft 60 in a suitable manner and by suitable driving means connecting said shafts including a bevel gear 275 or the like fixed on the upper end of the shaft 271.

It will thus appear that the described drive provides for continuous rotation of the shaft 66 and operation of the sheet separating mechanisms 39 in all vertical positions of the separator carriage. It will also appear that the bevel gear 273, by virtue of the helical keyway 272 in shaft 271, will be rotated in one direction relative to said shaft as the separator carriage is lowered, and will be rotated in the opposite direction relative to the shaft as said separator carriage is raised. Accordingly, each time the separator carriage is lowered, the shaft 66 is given a degree of forward rotation commensurate to the extent of downward movement of said carriage, thus correspondingly advancing the timing of the operations of the sheet separating mechanisms 39, and when the carriage has been lowered a distance equal to the spacing between the sheet grippers 151 the shaft 66 will have been advanced one complete revolution, thereby maintaining the timing relationship of the sheet separating mechanisms with the operation and cycle of movement of the sheet grippers. Similarly, when the separator carriage is raised a distance equal to the spacing between the sheet grippers 151, the shaft 66 is given a backward rotation of one complete revolution, thus correspondingly retarding the timing of the operations of the sheet separating mechanisms relative to the operation and cycle of movement of said sheet grippers.

Various other changes in or additions to the described feeder structure may be made. For example, the feeder driving shaft 43 may be driven so that it rotates one complete revolution for each cycle of operation of the feeder, and the sprockets 53, 65 and 171 accordingly selected and proportioned so that the shaft 66 will rotate one complete revolution for each feeding cycle, and that the conveyor chains 150 will be advanced a distance equal to the spacing between the sheet grippers 151 thereon for each feeding cycle. The upright conveyor may be of the gripper-bar type wherein the gripper jaws are mounted on separate transversely extending bars disposed between and carried by the chains. Also, preliminary separation of the topmost sheet may be effected by air blast devices, in lieu of the combing wheels, said air blast devices being arranged to direct blasts of air at and diagonally across the front opposite corners of the pile of sheets. Or, in lieu of the combing wheels, fingers may be employed at opposite sides of the pile of sheets to lift the corner portions of a plurality of the uppermost sheets for engagement of the topmost sheet at its elevated corner portions by the suction devices and stretching of the entire front edge portion of said sheet by said devices through outward movements thereof with or without any upward movement, said fingers releasing the remaining sheets to fall away from the topmost sheet and back on to the pile when said topmost sheet is gripped by the suction devices.

If desired, the forward extension of the upright conveyor may be eliminated, the chains of the upright conveyor then terminating at the top of the gripper circuit and passing around sprockets which are fixed on an equivalent driving shaft having a drum or an equivalent series of disks thereon around which the sheets are advanced to the tape conveyor. On the other hand, the tape conveyor may be eliminated by extending the forward extension of the upright conveyor.

The feeder may also be employed as a sheet by sheet feeder to feed sheets singly in spaced relation by simply increasing the surface speed of the upright chain conveyor and the horizontal tape conveyor, and by spacing the sets of grippers on said chain conveyor further apart, in accordance with the maximum size sheet to be handled.

Although only a single embodiment of the present invention has been illustrated in the accompanying drawings and described in the foregoing specification, it is to be expressly understood that the invention is not limited to said embodiment. Various changes may be made in the mechanical details, some of which have been illustrated, described and suggested herein, without departing from the spirit and scope of the invention, as will now be apparent to those skilled in the art. For a definition of the limits of the invention reference is had primarily to the appended claims.

What is claimed is:

1. In apparatus of the character described, vertically positioned conveyor means arranged adjacent a supply of horizontally disposed sheets for taking an edge portion of a sheet of said supply presented thereto and removing said sheet from said supply in a straight upward direction thereby providing and maintaining a space between said sheet and said supply, means engageable with the top surface of an edge portion of the uppermost sheet of said supply for lifting said edge portion and positioning it for reception by said conveyor means, and means for operating said sheet engaging and lifting means and for causing the same to move beyond the margin of the sheet just positioned thereby and taken by said conveyor means and return into said space beneath said sheet into position to operate on the next sheet of said supply.

2. In apparatus of the character described, means for engaging the top surface of the uppermost sheet of a supply of horizontally disposed sheets and lifting an edge portion of said sheet, vertically positioned endless conveyor means arranged adjacent said supply for taking said sheet at its lifted edge portion from said sheet engaging and lifting means and removing said sheet from said supply in a straight upward direction thereby providing and maintaining a space between said sheet and said supply, and means for operating said sheet engaging and lifting means and for causing the same to move beyond the margin of the sheet just lifted thereby and taken by said conveyor means and return into said space beneath said sheet into position to operate on the next sheet of said supply.

3. In a sheet feeder, an endless conveyor having a substantially vertical reach arranged adjacent a supply of horizontally disposed sheets and extending upwardly beyond the top of said supply, means for driving said conveyor so that said reach travels in an upward direction, said conveyor including sheet gripping means for gripping edge portions of successive sheets separated successively from said supply and removing said sheets from said supply in an upward direction thus providing and maintaining a space between each sheet being removed and said supply, means for engaging the top surface of each uppermost sheet of the supply in turn and lifting an edge portion of said sheet into position to be gripped by said gripping means as the latter travels along said reach, and means for operating said sheet engaging and lifting means and for causing the same to move beyond the margin of the sheet just lifted thereby and gripped by said gripping means and return into said space beneath said sheet into position to operate on the next sheet of said supply.

4. In apparatus of the character described, suction

means engaging the top surface of the uppermost sheet of a supply of horizontally disposed sheets and lifting the front edge portion of said sheet above the general level of the top of said supply, a vertically positioned endless chain conveyor arranged with a reach thereof adjacent said supply and extending from a level below the top of said supply to a level above said supply, means for driving said conveyor such that said reach travels in an upward direction, sheet grippers on said conveyor comprising complementary jaws movable as a unit relative to said conveyor towards said supply and over the top thereof to grip the lifted front edge portion of the sheet at spaced points along the same and remove said sheet from said supply in a substantially straight upward direction as said grippers travel along said reach thereby providing and maintaining a space between said sheet and said supply, and means for operating said suction means and for causing the same to move beyond the margin of the sheet just lifted thereby and gripped by said grippers and return into said space beneath said sheet into position to operate on the next sheet of said supply.

5. In apparatus of the character described, means for gripping the upper side of a horizontally disposed sheet and lifting an edge portion of said sheet without advancing said sheet, and travelling gripper means constrained to travel in a straight upward path for gripping the lifted sheet edge portion while in motion and advancing said sheet in a straight upward direction.

6. In apparatus of the character described, means for gripping the upper surface of a sheet disposed in horizontal position and lifting an edge portion of said sheet without advancing said sheet, and travelling gripper means constrained to travel in a straight upward path for gripping the lifted sheet edge portion while in motion and advancing said sheet in a straight upward direction with the leading edge of said sheet facing in said direction.

7. In a sheet feeder, suction means for lifting an edge portion of a sheet to partly separate the same from the top of a supply of horizontally disposed sheets without advancing said sheet, and gripper means travelling in a straight upward path spaced from said supply and operable on the run towards and over the top of said supply into position to grip the lifted sheet edge portion and remove said sheet from said supply.

8. In a sheet feeder, means for lifting an edge portion of a sheet to partly separate the same from the top of a supply of horizontally disposed sheets, and means for removing said sheet from said supply in a substantially straight upward direction and comprising an endless chain arranged with a reach thereof adjacent said supply and extending vertically from a level below the top of said supply to a level above said supply, a gripper comprising complementary jaws mounted on said chain for movement therewith and pivotal movement relative to each other and as a unit relative to said chain, biasing means acting upon one of said jaws and yieldingly urging the same toward the other of said jaws, means for driving said chain such that said reach travels in an upward direction, operative elements connected to said jaws, and cam means cooperating with said elements as said gripper travels upwardly along said reach for opening said jaws and swinging the same towards and over the top of said supply into positions with one jaw disposed above the lifted sheet edge portion and the other jaw disposed below said sheet portion and for causing said jaws to close on the sheet and grip the same.

9. A sheet feeder as defined in claim 8, comprising other cam means cooperating with one of said elements during upward movement of the gripper with the sheet gripped thereby for positioning the jaws so that the bite thereof is substantially vertical and conforms to the vertical attitude of the sheet suspended therefrom.

10. In apparatus of the character described, means for separating sheets successively from the top of a supply of horizontally disposed sheets through lifting of an edge portion of each sheet, and conveyor means for removing in an upward direction from said supply the sheets successively lifted by said separating means, said conveyor means comprising endless means having a substantially vertical reach disposed adjacent said supply and extending from a level below the top of said supply to a level above said supply, means for driving said endless means such that said reach travels in an upward direction, a series of sheet grippers mounted on said endless means for movement therewith and pivotal movement relative thereto, said grippers being spaced along said endless means equal distances apart and each comprising a first jaw element pivotally mounted on said endless means and a companion jaw element pivotally mounted on said first jaw element, biasing means acting upon said companion jaw element and yieldingly urging the same toward said first jaw element, projections on said jaw elements, and cam means cooperating with said projections as each gripper travels along said reach and passes the top of said supply for swinging the jaw elements thereof in opened condition towards and over said supply and for causing said jaw elements to close on and grip the lifted edge portion of the topmost sheet of said supply.

11. Apparatus as defined in claim 10, comprising other biasing means acting upon one of the jaw elements of each sheet gripper as the latter travels upwardly with the sheet gripped thereby for turning the jaw elements thereof downwardly to a position such that the bite thereof is substantially vertical and conforms with the vertical attitude of the sheet suspended therefrom, and other cam means cooperating with one of said projections of each gripper for controlling the movement of the jaw elements thereof by said other biasing means to said position.

12. Apparatus as defined in claim 10, comprising biasing means operably connected with and applying a yieldable force upon the first jaw element of each sheet gripper as the latter travels upwardly with the sheet gripped thereby, said force being applied in a direction tending to rotate said jaw element and its companion jaw element downwardly, and means arranged to be engaged by said first jaw element for controlling the extent of downward rotation thereof by said biasing means whereby said jaw elements are so positioned that the bite thereof is substantially vertical and conforms to the vertical attitude of the sheet suspended therefrom.

13. Apparatus as defined in claim 10, comprising a spring-pressed toggle member operably connected with and applying a yieldable force upon the first jaw element of each sheet gripper as the latter travels upwardly with the sheet gripped thereby, said force being applied in a direction tending to rotate said jaw element and its companion jaw element downwardly, and a bar extending along and inclined with respect to the path of upward movement of the gripper and disposed in the path of rotation of said jaw elements by said toggle member for controlling the extent of said rotation whereby said jaw elements are gradually rotated to a position such that the bite thereof is substantially vertical and conforms to the vertical attitude of the sheet suspended therefrom.

14. Apparatus as defined in claim 10, wherein the sheet grippers are spaced apart a distance less than the length of the sheets so that each succeeding sheet being removed from the supply is lapped by a preceding sheet and the sheets are carried upwardly in lapped relationship by said grippers.

15. In a sheet feeder, suction means for separating sheets successively from the top of a supply of horizontally disposed sheets through lifting of an edge portion of each sheet, a series of grippers for successively gripping the sheets at the lifted edge portions thereof and removing said sheets from said supply, an endless chain for supporting said grippers and imparting movement

thereto through a defined path including a straight vertical course arranged adjacent said supply, means for driving said chain such that said grippers travel upwardly along said course, said grippers each comprising a first jaw element pivotally mounted on said chain and a companion jaw element pivotally mounted on said first jaw element, biasing means operably connected with the companion jaw element of each gripper for yieldingly urging the same towards its associated first jaw element, said grippers being closed and so positioned that the bites of the jaw elements thereof are substantially horizontal as the grippers travel along said course towards the top of said supply, projections on the jaw elements of each gripper, cam means disposed in said course and cooperating at the locality of the top of said supply with said projections for swinging the jaw elements of each passing gripper towards and over said supply, opening said jaw elements to receive therebetween the lifted edge portion of the sheet, and permitting said jaw elements to close on said sheet portion under the influence of said biasing means, other biasing means acting upon the first jaw element of each gripper as the latter travels further upwardly along said course with the sheet gripped thereby for rotating the jaw elements thereof downwardly to a position such that the bite thereof is substantially vertical, cam means cooperating with the projection on the first jaw element for controlling the movement of the jaw elements of each gripper by said other biasing means to said position, cam means disposed in and cooperating at a further locality of said path with the projection on the companion jaw element for opening the jaw elements of each passing gripper to release the sheet, each gripper after release of the sheet returning along said path to said course with the jaw elements closed and the bite thereof substantially vertical and trailing, and cam means disposed in said path and in advance of said course and cooperating with the projection on the first jaw element for tumbling each passing and returning gripper to position the jaw elements thereof for subsequent upward movement along said course.

16. A sheet gripping and conveying device comprising an endless chain constrained to travel in a defined path, a sheet gripper comprising a first jaw element pivotally mounted on said chain and a companion jaw element pivotally mounted on said first jaw element, biasing means operably connected with said companion jaw element for yieldingly urging the same toward said first jaw element, said gripper being closed and so positioned that the bite of said jaw elements is substantially at right angles to said chain as the gripper travels along one reach of said chain, projections on said jaw elements, cam means disposed in said path and cooperating at one locality of said reach with said projections for swinging said jaw elements relative to said chain towards a sheet to be gripped and conveyed, opening said jaw elements to receive the leading edge of said sheet therebetween, and permitting said jaw elements to close on and grip said sheet under the influence of said biasing means, cooperating spring and cam means respectively acting upon the first jaw element and arranged to be engaged by the projection on said first jaw element for rotating said jaw elements in the direction of the sheet gripped thereby to a position such that the bite thereof is substantially parallel to said chain reach as said gripper travels further along said reach, cam means disposed in and cooperating at a further locality of said path with the projection on said companion jaw element for opening said jaw elements to release the sheet, said gripper after release of the sheet returning along said path to said reach with the jaw elements closed and the bite thereof trailing and substantially parallel to said chain, and cam means disposed in said path and in advance of said reach and cooperating with the projection on said first jaw element for tumbling said jaw elements and resetting the same for subsequent movement along said reach with said jaw elements closed and the bite thereof disposed at right angles to said chain.

17. A sheet gripping and conveying device as defined in claim 16, wherein the cooperating cam and spring means for positioning the bite of the jaw elements of the gripper substantially parallel to the chain reach comprises a bar extending along and inclined with respect to said reach, and a spring-pressed toggle member operably connected with the first jaw element for yieldingly urging the same towards said bar.

18. A sheet gripping and conveying device as defined in claim 17, comprising means for pivotally mounting said bar, and means for adjusting said bar about its pivot to vary the inclination thereof.

19. Sheet feeding apparatus for feeding sheets one after another from the top of a stationary upright pile thereof, comprising sheet separating means arranged for vertical up and down movement and operable upon the top of said pile for separating the sheets successively from said pile, sheet conveying means arranged adjacent said pile and extending from substantially the lowermost sheet of said pile upwardly to a level above the top of said pile for removing in succession from said pile in an upward direction the sheets successively separated by said sheet separating means, said conveying means advancing the sheets a predetermined distance for each cycle of operation of the feeder, mechanism for lowering said sheet separating means relative to said pile and said sheet conveying means as the sheets are removed from said pile and the latter is consumed to maintain said sheet separating means in proper operating position in relation to the height of the diminishing pile, and actuating means for operating said sheet separating means at timed intervals in timed relation with the cycle of movement of said conveying means and for advancing the timing of said sheet separating means relative to the cyclic movement of said conveying means a degree commensurate with the extent of downward movement of said sheet separating means by said mechanism, whereby said timing relationship between said sheet separating means and said conveying means is maintained as said sheet separating means descends relative to said pile and said conveying means.

20. Sheet feeding apparatus as defined in claim 19, comprising control means including a feeler element operatively connected with said actuating means for rocking movement in timed relation with said sheet separating means and said sheet conveying means across one edge of the pile into and out of engagement with a marginal portion thereof for controlling the operation of said mechanism.

21. Sheet feeding apparatus as defined in claim 19, wherein the sheet conveying means comprises vertically positioned endless means arranged with a reach thereof adjacent the pile and with the lower turn at a level below the lowermost sheet of said pile and with the upper turn at a level above the top of said pile, and means for driving said endless means so that said reach travels in an upward direction.

22. Sheet feeding apparatus for feeding sheets one after another from the top of a stationary upright pile thereof, comprising a sheet separating mechanism arranged for vertical up and down movement and including means operable toward and away from the top of said pile for engaging and lifting an edge portion of each sheet in turn from said pile, an endless sheet conveyor having an upwardly travelling reach arranged adjacent said pile and extending from substantially the lowermost sheet of said pile to a level above the top of said pile, said conveyor carrying sheet grippers at spaced intervals therealong and operable successively to grip the lifted edge portions of successive sheets and remove said sheets from said pile in an upward direction as said grippers travel along said reach, means for lowering said sheet separating mechanism relative to said pile and said conveyor

arranged in opposed relation and adapted to receive between the opposed ends thereof one of said pins at the end of each operation of said disk and said shaft to releasably hold said disk and shaft against rotation in opposite directions during the interval between operations thereof by said abutments, one of said pawls being constructed and arranged for pivotal movement out of operative position by and through movement of said abutments towards said disk to release the first of said pins, and the other of said pawls being constructed and arranged for pivotal movement out of operative position by the second of said pins as the latter moves into locking position upon rotation of said disk.

35. Sheet feeding apparatus for feeding sheets successively from the top of a stationary upright pile thereof, comprising sheet conveying means arranged adjacent said pile and extending from substantially the lowermost sheet of said pile upwardly to a level above the top of said pile for taking corresponding edge portions of sheets presented successively thereto and removing said sheets in succession from said pile in an upward direction, sheet separating means arranged for vertical up and down movement and operable upon the top of said pile for engaging and lifting an edge portion of each top sheet in turn and positioning it for reception by said sheet conveying means, means for lowering said sheet separating means relative to said pile and said sheet conveying means as the level of the top of said pile changes through removal of sheets therefrom to maintain said sheet separating means at a constant elevation and in proper operating position with relation to the top of the diminishing pile, and means for operating said sheet separating means in timed relation with the cycle of movement of said sheet conveying means and for progressively advancing the cyclic timing of said sheet separating means relative to the cycle of movement of said sheet conveying means as said sheet separating mechanism progressively descends, whereby a substantially equal spacing between the leading edges of successive sheets on said sheet conveyor means is maintained.

36. Sheet feeding apparatus for feeding sheets one after another from the top of a stationary upright pile thereof, comprising a frame, a carriage slidably mounted on said frame for vertical up and down movement, suction devices mounted on said carriage for relative movement towards and away from said pile to grip each top sheet in turn at opposite front corner portions thereof and lift the front edge portion of said sheet from said pile and for relative movement laterally away from each other to stretch said gripped and lifted sheet portion transversely thereof, at least two vertically positioned transversely spaced chains arranged with corresponding reaches thereof adjacent the front of said pile and extending from substantially the lowermost sheet of said pile to a level above the top of said pile, means for continuously driving said chains such that said reaches travel in an upward direction, said chains carrying sheet grippers at spaced intervals therealong and movable successively into position to grip the lifted and stretched front portion of each sheet in turn and remove said sheet from said pile in an upward direction as said grippers travel along said reaches, means for lowering said carriage relative to said pile and said chains as the sheets are removed from said pile to maintain said suction devices at a constant elevation and in proper operating position with relation to the top of the diminishing pile, actuating elements for said sheet grippers traveling therewith, cam means on said carriage and cooperating with said actuating elements for operating said grippers to grip a sheet as they successively travel past the top of said pile, means including a driven single revolution shaft journalled in said carriage for operating said suction devices, and means drivably connected with said shaft for rotating the latter to effect operation of said suction devices in timed relation with the cycle of movement of said chains and the operation of said grippers as they reach the top of said pile and for maintaining said timing relation as said carriage descends.

37. Sheet feeding apparatus as defined in claim 36, wherein said chains are independently mounted on said frame and each is provided with a series of sheet grippers equally spaced therealong and having projections thereon, and separate cam means cooperating with said projections are provided and mounted on the carriage for operating said grippers, and comprising means for independently adjusting each chain and its associated cam means as a unit transversely of the frame to accommodate sheets of different sizes.

38. Sheet feeding apparatus as defined in claim 36, wherein said means for lowering said carriage comprises rack means on said frame, a shaft journalled in said carriage, gears on said shaft meshing with said rack means, a worm wheel on said shaft, an upright shaft journalled on said frame, a worm on said upright shaft and meshing with said worm wheel, a ratchet on said upright shaft, a pawl carrier loosely mounted on said upright shaft, a pawl pivotally mounted on said carrier and continuously engaged with said ratchet, means including a cam on the driven single revolution shaft and a cam strap pivotally connected with said pawl carrier for oscillating said pawl carrier, a latch for holding said cam strap against following said cam, a rock shaft journalled in said carriage, a pile engaging pile height testing feeler on said rock shaft, means including a cam on said single revolution shaft for rocking said rock shaft to move said feeler into and out of engagement with the top of said pile inwardly and outwardly of the front edge of said pile, and means on and operated by said rock shaft for controlling the action of said latch to prevent or permit operation of said cam strap and the pawl and ratchet thereby.

39. Sheet feeding apparatus as defined in claim 36 wherein the sheet grippers are spaced apart a distance less than the length of the sheets so that the sheets are carried upwardly by the chains in lapped relationship.

40. Sheet feeding apparatus as defined in claim 36, comprising preliminary separators mounted on the carriage for relative movement toward and away from the pile and operable on each top sheet in turn to buckle the opposite front corner portions of said sheet for engagement of said sheet by the suction devices at the buckled portions thereof, and means operatively connected with said separators and actuated by the single revolution shaft for operating said separators in timed relation with said suction devices.

41. Sheet feeding apparatus as defined in claim 40, comprising presser fingers rocking across the front edge of the pile into and out of engagement with the front marginal portion of said pile at points spaced inwardly from the side edges of said pile for confining the buckling of the sheet by the preliminary separators to the corner portions of said sheet, means for operating said fingers in timed relation with said separators and the suction devices, and other fingers movable in unison with the suction devices toward and away from said pile and arranged to engage the top of said pile to limit the downward movement of said suction devices to substantially the separated levels of the buckled corner portions of the sheet.

42. In a sheet feeder, a pair of suckers, means mounting said suckers at opposite sides of a supply of sheets and exteriorly of said sides for pivotal movement downwardly and upwardly to engage the top sheet of said supply at opposite corner portions thereof and lift an edge portion of said sheet from said supply, means mounting said suckers for sliding movement inwardly and outwardly relative to said supply, biasing means for yieldingly urging said suckers inwardly, means for swinging said suckers toward and away from said supply, and means disposed in the path of upward swinging motion of said suckers for sliding said suckers outwardly away from each other to effect transverse stretching of said edge portion of the sheet gripped by said suckers.

as the sheets are removed from said pile and the latter is consumed to maintain said sheet separating mechanism at a constant elevation and in proper operating position with relation to the top of the diminishing pile, actuating elements for said sheet grippers traveling therewith, cam means cooperating with said actuating elements for operating each of said sheet grippers to grip a sheet as the same travels past the top of said pile, said cam means being arranged for downward movement in unison with said sheet separating mechanism a corresponding distance, and means for operating said sheet separating mechanism in timed relation with the cycle of movement of said conveyor and the operation of each sheet gripper as the latter passes the top of said pile and for maintaining said relation as the sheet separating mechanism descends.

23. Sheet feeding apparatus as defined in claim 22, wherein said cam means is carried by said sheet separating mechanism for vertical up and down movement in unison therewith.

24. Sheet feeding apparatus as defined in claim 22, comprising control means for controlling the operation of said separator lowering means and the downward movement of said sheet separating mechanism, said control means including a feeler element movable vertically with said sheet separating mechanism and operatively connected to the operating means for said mechanism for movement by said operating means once during each cycle of operation of the machine inwardly beneath a lifted sheet edge portion across the adjacent edge of the pile and into engagement with the adjacent marginal portion thereof, and outwardly across said pile edge and out of engagement with said marginal portion before the edge portion of each sheet is lifted from said pile.

25. Sheet feeding apparatus as defined in claim 22, wherein the sheet separating mechanism lowering means comprises fixed rack means, rotatable gear means meshing with said rack means and carried by said mechanism, worm and worm gear means drivably connected with said gear means and carried by said mechanism, and pawl and ratchet means drivably connected to said worm and worm gear means and carried by said mechanism, and comprising control means carried by said mechanism and movable in one direction to render said pawl and ratchet means effective and in the opposite direction to render said pawl and ratchet means ineffective, a feeler element carried by said sheet separating mechanism and movable into and out of engagement with the top of the pile, means actuated by the sheet separating mechanism operating means for operating said feeler element in timed relation with said mechanism, and means carried by said mechanism and operated by said feeler element and controlling the movement of said control means in said directions.

26. Sheet feeding apparatus as defined in claim 22, wherein the means for operating the sheet separating mechanism comprises a driven shaft carried by said mechanism and operatively connected with the sheet engaging and lifting means, and driving means connected with said shaft for intermittently rotating the latter at timed intervals one complete revolution for each cycle of operation of the machine and effective to initiate said rotation of said shaft progressively sooner as the sheet separating mechanism descends.

27. Sheet feeding apparatus as defined in claim 22, wherein the means for operating the sheet separating mechanism comprises a driven shaft carried by said mechanism and operatively connected with the sheet engaging and lifting means, a driving shaft carried by said mechanism, driving connections between said shafts, an endless flexible element having a vertically extending reach travelling in the same direction and at the same surface speed as that of said gripper conveyor reach, guide means on said mechanism and disposed concentric with said driving shaft and around which a portion of said element reach is directed and caused to travel in a substantially semi-circular path, a series of abutments carried by said endless element at spaced intervals therealong, said abutments being equal in number to the number of sheet grippers on said conveyor and the spacing between the same being equal to the spacing between said sheet grippers, and a member fixed on said driving shaft and having portions thereof disposed diametrically opposite each other and arranged to be successively engaged by successive abutments on said endless element as said abutments travel upwardly along said element reach to impart rotation to said member and said driving shaft as said abutments travel around said semi-circular path.

28. Sheet feeding apparatus as defined in claim 27 wherein said endless flexible element is a chain, and said guide means is a sprocket loosely mounted on said driving shaft.

29. Sheet feeding apparatus as defined in claim 27, comprising means carried by the sheet separating mechanism for holding said driving shaft against rotation during the interval between operations thereof, said locking means being arranged to be actuated by said abutments to release said shaft for rotation as said abutments travel upwardly and prior to engagement thereof with said member.

30. Sheet feeding apparatus as defined in claim 27, comprising opposed cooperating pawls pivotally mounted on the sheet separating mechanism and arranged to receive between the ends thereof one of two diametrically opposite projections on said member for locking said member and said driving shaft against rotation in opposite directions during the interval between operations thereof, one of said pawls being constructed and arranged for pivotal movement out of operative position by said abutments as the latter travel upwardly and prior to engagement thereof with said member, and the other of said pawls being constructed and arranged for pivotal movement out of operative position by the other of said projections as the latter moves into locking position upon rotation of said member by said abutments.

31. In combination, a shaft, a driven endless flexible element, guide means disposed concentric with said shaft and around which a portion of a reach of said endless element is directed and caused to travel in an arcuate path concentric with said shaft, a series of abutments carried by said endless element at spaced intervals therealong, and a member fixed on said shaft and having portions thereof arranged to be successively engaged by successive abutments on said endless element to impart intermittent motion to said member and said shaft as said abutments travel around said arcuate path.

32. The combination as defined in claim 31, including means for holding said member and said shaft against rotation during the interval between operations thereof by said abutments, said holding means being arranged to be actuated by and through movement of said abutments towards said member to release said member and said shaft for rotation prior to engagement of said abutments with said member.

33. In combination, a shaft, a driven endless chain, a sprocket loosely mounted on said shaft and around which a portion of a reach of said chain is passed, a guide for causing said chain portion to travel around one-half the periphery of said sprocket, a series of abutments carried by said chain at spaced intervals therealong, and a disk fixed on said shaft and having two radially extending slots therein disposed diametrically opposite each other, said slots being adapted to successively receive successive abutments on said chain whereby said disk and said shaft are intermittently rotated by said abutments as they travel around said sprocket.

34. The combination as defined in claim 33, including two axially extending pins carried by said disk and disposed diametrically opposite each other and centrally between said slots, and two pivotally mounted locking pawls

43. In a sheet feeder, a pair of suckers, means mounting said suckers at opposite sides of a supply of sheets and exteriorly of said sides for pivotal movement downwardly and upwardly to engage the top sheet of said supply at opposite corner portions thereof and lift an edge portion of said sheet from said supply, means mounting said suckers for sliding movement inwardly relative to said supply to sheet engaging position and outwardly away from each other to transversely stretch said edge portion of the sheet gripped thereby, biasing means for yieldingly urging said suckers inwardly towards each other, a plurality of grippers movable upwardly in a substantially straight path for gripping said sheet in the region of the stretched portion thereof and removing said sheet from said supply in a substantially straight upward direction, cam means disposed in the path of upward swinging motion of said suckers for sliding said suckers outwardly to effect said stretching operation of the sheet and to bring said suckers to position clear of the side edges of said sheet when taken by said grippers, and means for swinging said suckers toward and away from said supply and for causing said suckers to return beneath said sheet when taken by said grippers into position to act on the next sheet of said supply.

44. In a sheet feeder, sheet separating mechanisms operable upon corresponding edge portions of the top sheets of a supply thereof, each of said mechanisms comprising a casing disposed at one side of said supply and exteriorly of said side, a cam shaft journalled in said casing, a rock shaft journalled in said casing, said shafts being in parallel relation to each other and to said side of said supply, a cam on said cam shaft, a cam follower connected with said rock shaft riding on said cam, an arm fixed on said rock shaft and extending therefrom towards the adjacent side of said supply, a rod slidably mounted in said arm and projecting inwardly therefrom over the top of said supply, a sucker carried by said rod, biasing means for yieldingly urging said rod inwardly relative to said arm, a stop on said rod and engageable with said arm to limit the inward movement of said rod by said biasing means, said cam acting to rock said rock shaft in one direction to swing said arm, said rod and said sucker away from the top of said supply to lift a corner portion of the top sheet from said supply, biasing means for yieldingly urging said arm, said rod and said sucker downwardly toward the supply, a follower on said rod, and a cam arm on said casing and disposed in the path of upward swinging motion of said last-named follower so as to be engaged by said follower during upward movement of said sucker for causing sidewise outward movement of said rod and said sucker to effect transverse outward movement of the corner portion of the sheet gripped by said sucker.

45. A sheet feeder as defined in claim 44, wherein each of said sheet separating mechanisms includes a second cam on said cam shaft, a lever pivotally mounted on said rock shaft adjacent said sucker carrying arm and extending inwardly from said rock shaft over the adjacent corner portion of the sheet supply, a combing wheel journalled on the inner end of said lever, a gear on said cam shaft, a pinion journalled on said rock shaft, driving connections between said pinion and said combing wheel to rotate the latter, and biasing means for yieldingly urging said lever and said combing wheel toward the top of the sheet supply and for yieldingly pressing said combing wheel on said supply, said combing wheel acting to preliminarily buckle the adjacent corner portion of the top sheet of the supply, and said second cam acting to rock said lever and said combing wheel to lift said combing wheel out of engagement with the sheet supply, said sucker cam and said combing wheel cam being so related that said combing wheel buckles the corner portion of the sheet prior to engagement of the sucker therewith and that said combing wheel is lifted after engagement of said sucker with the buckled corner portion of the sheet.

46. Sheet feeding apparatus for feeding sheets successively from the top of a stationary upright pile thereof, comprising a frame, a carriage slidably mounted on said frame for vertical up and down movement, means on said carriage operable to buckle front corner portions of the top sheet of said pile, suction means on said carriage operable to grip the buckled portions of the sheet, lift the front edge portion of said sheet, stretch said front edge portion transversely thereof and hold it in raised stretched condition momentarily, a conveyor including a plurality of grippers adjacent the front of said pile and movable upwardly in a substantially straight path for gripping said sheet in the region of the stretched portion thereof and removing said sheet from said pile in a substantially straight upward direction, means for lowering said carriage relative to said pile and said conveyor as the lever of the top of said pile changes through removal of the sheets successively therefrom to maintain said sheet buckling means and said suction means in proper operating positions with relation to the top of the diminishing pile, means including a driven shaft on said carriage for operating said sheet buckling means and said suction means in timed relation with each other and in timed relation with the cycle of movement of said conveyor as the level of the top of said pile changes through sively advancing the cyclic timing of said buckling means and said suction means relative to the cycle of movement of said conveyor as said carriage is progressively lowered.

47. Sheet feeding apparatus for feeding sheets successively from the top of a stationary upright pile thereof, comprising conveyor means spaced above and extending forwardly of said pile to which the sheets are fed one after another, vertically positioned endless conveyor means arranged adjacent the front of said pile and extending from substantially the lowermost sheet of said pile to said first-named conveyor means for taking sheets successively presented thereto, removing said sheets from said pile and delivering them upwardly and forwardly to said first-named conveyor means, said endless conveyor means traveling a predetermined distance for each cycle of operation of the feeder, sheet separating means arranged for vertical up and down movement and operable to separate the front edge portions of the sheets successively from said pile and position them for reception by said endless conveyor means, means for lowering said sheet separating means relative to said pile and said endless conveyor means as the sheets are removed from the top of said pile and the level of the top of said pile thereby changes to maintain said sheet separating means properly positioned with relation to the top of the diminishing pile, and actuating means for operating said sheet separating means at timed intervals in timed relation with the cycle of movement of said endless conveyor means and for advancing the timing of said sheet separating means relative to the cyclic movement of said endless conveyor means a degree commensurate with the extent of downward movement of said sheet separating means, whereby said timing relationship between said sheet separating means and said endless conveyor means is maintained as said sheet separating means descends relative to said pile and said endless conveyor means.

48. Sheet feeding apparatus as defined in claim 22, wherein the means for operating the sheet separating mechanism comprises a driven shaft carried by said mechanism and operatively connected with the sheet engaging and lifting means, an endless flexible element having a reach thereof travelling in the same direction and at the same surface speed as that of said gripper conveyor reach, guide means on said mechanism and disposed concentric with said shaft and around which a portion of said element reach is directed and caused to travel in an arcuate path, a series of abutments carried

by said endless element and spaced therealong equal distances apart, the spacing between said abutments being the same as that of said sheet grippers, a member rotatably mounted on said shaft and having radially extending portions arranged to be successively engaged by successive abutments on said endless element to impart intermittent rotation to said member as said abutments travel around said arcuate path, and driving connections between said shaft and said member for transmitting the rotation of said member to said shaft.

49. Sheet feeding apparatus as defined in claim 48, wherein said endless flexible element is a chain, and said guide means comprises an annular member rotatably mounted on said shaft, and a plate-like member carried by said mechanism and surrounding said annular member, said plate-like member being provided with slots for receiving said chain and leading the latter toward and away from said annular member.

50. Sheet feeding apparatus as defined in claim 48, wherein said member is rotated a portion of a revolution by each of said abutments, and said driving connections comprises gearing effective to rotate said shaft one complete revolution for each operation of said member.

51. Sheet feeding apparatus as defined in claim 22, wherein the means for operating the sheet separating mechanism comprises a horizontally disposed shaft carried by said mechanism and operatively connected with the sheet engaging and lifting means, a driven vertically disposed shaft having a helical groove extending along the length thereof, said helical groove being of a design such that the pitch of the helix is equal to the spacing between said sheet grippers, a gear carried by said mechanism and slidably engaged over said driven shaft, key means carried by said gear and slidably engaged in said groove for drivably connecting said gear to said driven shaft. and a gear fixed on said horizontally disposed shaft and having meshing engagement with said first-named gear.

52. Sheet feeding apparatus as defined in claim 35, wherein the means for operating said sheet separating means comprises a horizontally disposed shaft operatively connected with said sheet separating means and arranged for vertical up and down movement in unison with said sheet separating means, a driven vertically disposed shaft having a helical groove extending along the length thereof, a gear slidably engaged over said driven shaft and arranged for vertical up and downward movement in unison with said sheet separating means and said first-named shaft, key means carried by said gear and slidably engaged in said groove for drivably connecting said gear to said driven shaft, and a gear fixed on said first-named shaft and having meshing engagement with said first-named gear, said helical groove being of a design such that the pitch of the helix will cause rotation of said first-named gear relative to said driven shaft and in a direction to advance said first-named shaft a degree comensurate with the extent of downward movement of said sheet separating means, whereby the cyclic timing of the operation of said sheet separating means is correspondingly advanced relative to the cycle of movement of said sheet conveying means.

53. A sheet, feeder as defined in claim 44, wherein each of said sheet separating mechanisms includes a second cam on said cam shaft, a lever pivotally mounted on said rock shaft adjacent said sucker carrying arm and extending inwardly from said rock shaft over the adjacent corner portion of the sheet supply, a combing wheel journalled on the inner end of said lever, a gear on said cam shaft, a pinion journalled on said rock shaft, driving connections between said pinion and said combing wheel to rotate the latter, means for counterbalancing the weight of said lever and said combing wheel, and biasing means for yieldingly urging said lever and said combing wheel toward the top of the sheet supply in opposition to said counterbalancing means and for yieldingly pressing said combing wheel on said supply, said combing wheel acting to preliminarily buckle the adjacent corner portion of the top sheet of the supply, and said second cam acting to rock said lever and said combing wheel to lift said combing wheel out of engagement with the sheet supply, said sucker cam and said combing wheel cam being so related that said combing wheel buckles the corner portion of the sheet prior to engagement of the sucker therewith and that said combing wheel is lifted after engagement of said sucker with the buckled corner portion of the sheet.

54. In combination, a shaft, a driven endless flexible element, guide means disposed concentric with said shaft and around which a portion of a reach of said endless element is directed and caused to travel in an arcuate path concentric with said shaft, a series of abutments carried by said endless element at spaced intervals therealong, a member rotatably mounted on said shaft and having radially extending portions arranged to be successively engaged by successive abutments on said endless element to impart intermittent motion to said member as said abutments travel around said arcuate path, and gearing between said member and said shaft for transmitting the rotation of said member to said shaft.

55. In combination, a shaft, a driven endless chain, an annular member rotatably mounted on said shaft and around which a portion of a reach of said chain is passed, a fixed guide surrounding said member for causing said chain portion to travel around substantially one-half the periphery of said member, said guide being slotted to receive said chain and direct the latter toward and away from said member, a disk rotatably mounted on said shaft and having a plurality of radially extending slots therein adapted to successively receive successive abutments on said chain whereby said disk is intermittently rotated by said abutments as they travel around said member, a gear secured to said disk, a gear secured to said shaft, and gearing having meshing engagement with said gears.

56. In combination, a fixed vertically disposed driving shaft having a helical groove formed therein and extending along the length thereof, a vertically movable support, a horizontally disposed driven shaft journalled in said support and continuously maintained in alignment with said driving shaft, a bevel gear fixed on said driven shaft, a bevel gear rotatably carried by said support and engaged over and slidable along said driving shaft and having continuous meshing engagement with said first-named gear, and a key carried by said second-named gear and slidably engaged in said helical groove for drivably connecting said second-named gear with said driving shaft whereby rotation of said driving shaft is transmitted by said second-named gear to said first-named gear and said driven shaft, said helical groove being effective to rotate said second-named gear in one direction relative to said driving shaft when said support and therewith said driven shaft and said gears are lowered relative to said driving shaft, and in the opposite direction relative to said driving shaft when said support and therewith said driven shaft and said gears are raised relative to said driving shaft.

57. Sheet feeding apparatus for feeding sheets one after another from the top of a stationary upright pile thereof, comprising a sheet separating mechanism arranged for vertical up and down movement and including means operable toward and away from the top of said pile for engaging and lifting an edge portion of each sheet in turn from said pile, an endless sheet conveyor having an upwardly travelling reach arranged adjacent said pile and extending from substantially the lowermost sheet of said pile to a level above the top of said pile, said conveyor carrying sheet grippers at spaced intervals therealong and operable successively to grip the lifted edge portions of successive sheets and remove said sheets from said pile in an upward direction as said grippers travel along said reach, means for lowering said sheet

separating mechanism relative to said pile and said conveyor as the sheets are removed from said pile and the latter is consumed to maintain said sheet separating mechanism at a constant elevation and in proper operating position with relation to the top of the diminishing pile, lug elements on the grippers, cam means cooperating with the lug elements for operating each of said sheet grippers to grip a sheet as the same travels past the top of said pile, said cam means being arranged for downward movement in unison with said sheet separating mechanism a corresponding distance, the sheet separating mechanism lowering means comprising fixed rack means, rotatable gear means meshing with said rack means and carried by said mechanism, worm and worm gears means drivably connected with said gear means and carried by said mechanism, and pawl and ratchet means drivably connected to said worm and worm gears means and carried by said mechanism, and comprising control means carried by said mechanism and movable in one direction to render said pawl and ratchet means effective and in the opposite direction to render said pawl and ratchet means ineffective, a feeler element carried by said sheet separating mechanism and movable into and out of engagement with the top of the pile, feeler rocking means powered by a connection to the endless sheet conveyor for operation in timed relation therewith, and means carried by said mechanism and operated by said feeler element and controlling the movement of said control means in said directions.

58. In a sheet feeder, a feedboard at a fixed elevated level, a low level support for a stationary pile of sheets, an upstanding endless conveyor disposed between the support and feedboard, a carriage movable up and down parallel to said conveyor, cam shaft means journalled in said carriage, a vertically disposed operating member driven in timed relation with the machine to which sheets are being fed, means on said cam shaft means operatively connected to said member for turning said cam shaft means one revolution for each machine cycle, sheet separating means on said carriage, sheet grippers spaced at regular intervals along the length of said conveyor, actuating elements for said grippers traveling therewith, the grippers on the upgoing run of said conveyor being adapted to take separated sheets from said pile, move them up to and place them upon said feedboard, means on said cam shaft means functioning to actuate said separating means, means on said carriage cooperating with said actuating elements for operating said sheet grippers as the latter on their upward travel pass said carriage, means on said carriage and actuated by said cam shaft means for lowering said carriage an increment at a time, and means on said carriage for disabling said lowering means when the difference between the height of the carriage and that of the pile becomes less than a predetermined amount.

59. Sheet feeding mechanism as defined in claim 58, wherein said operative connection between said vertically disposed operating member and said cam shaft means automatically advances the timing of said cam shaft means as said carriage is lowered and the distance between the same and the feedboard increases.

60. In a sheet feeder, a feedboard at a fixed elevated level, a low level support for a stationary pile of sheets, an upstanding endless conveyor disposed between the support and feedboard, a carriage movable up and down parallel to said conveyor, cam shaft means journalled in said carriage, a vertically disposed operating member driven in timed relation with the machine to which sheets are being fed, means on said cam shaft means operatively connected to said member for turning said cam shaft means one revolution for each machine cycle, sheet grippers spaced at regular intervals along the length of said conveyor, actuating elements for said grippers traveling therewith, the grippers on the upgoing run of said conveyor being adapted to take sheets from said pile, move them up to and place them upon said feedboard, cam plate means on said carriage cooperating with said actuating elements for actuating said grippers to take a sheet from the pile as they pass the carriage on their upward travel, a feeler mounted on said carriage, means on said carriage and actuated by said cam shaft means for lowering said feeler into engagement with the top of said pile once for each cycle of the machine, and means on said carriage and actuated by said cam shaft means and controlled by said feeler for lowering said carriage an increment at a time, whereby the height of the carriage as controlled by said feeler determines the timing of the gripper actuation.

61. In a sheet feeder, a feedboard at a fixed elevated level, a low level support for a stationary pile of sheets, a carriage movable up and down, cam shaft means journalled in said carriage, vertically disposed endless chain means for conveying sheets upward and operating said cam shaft means, means on said cam shaft means operatively connected with said endless chain means for turning said cam shaft means one revolution for each machine cycle, sheet separating means on said carriage, said endless chain means comprising a conveyor having sheet grippers spaced at regular intervals therealong, projections on said grippers, the grippers on the upgoing run of said conveyor being adapted to take separated sheets from said pile, move them up to and place them upon said feedboard, means on said cam shaft means functioning to actuate said sheet separating means, means on said carriage cooperating with said projections for operating each of said sheet grippers as the latter on its upward travel passes said carriage, means on said carriage and actuated by said cam shaft means for lowering said carriage an increment at a time, and means on said carriage for disabling said lowering means when the difference between the height of the carriage and the height of the pile becomes less than a predetermined amount.

62. Sheet feeding apparatus for feeding sheets successively from a stationary pile thereof, comprising sheet separating means arranged for vertical up and down movement and operable upon the top of said pile for separating the sheets one after another therefrom, sheet conveying means arranged adjacent said pile and extending from substantially the lowermost sheet of said pile upwardly to a level above the top of said pile for removing said sheets from said pile in an upward direction, said conveying means advancing the sheets a predetermined distance for each cycle of operation of the feeder, mechanism power actuated to lower said sheet separating means relative to said pile and said conveying means as the sheets are removed from said pile and manually actuated to raise said sheet separating means relative to said conveying means, and means for operating said sheet separating means at timed intervals in timed relation with the cycle of movement of said conveying means and for controlling said operation such that the timing thereof is advanced relative to the cycle of movement of said conveying means as said sheet separating means is lowered and is retarded as said sheet separating means is raised.

63. Apparatus as defined in claim 62 wherein the timing of said sheet separating means is advanced and retarded a degree commensurate with the extent of downward and upward movement, respectively, of said sheet separating means.

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