United States Patent [19]

Fujimoto

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[54] **SHEET FEEDING ASSEMBLY INCLUDING AUTOMATIC STACK REPLACEMENT AND ALIGNING MEANS**

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[73] Assignee: **Ricoh Co., Ltd.,** Tokyo, Japan

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[30] **Foreign Application Priority Data**

July 24, 1972 Japan 47-73924

[52] **U.S. Cl.** ..... **271/30 R;** 198/35; 214/8.5 A; 271/152; 271/171

[51] **Int. Cl.** **B65h 3/08**

[58] **Field of Search** ..... 198/35; 214/8.5 R, 8.5 A, 214/8.5 C, 8.5 D; 271/98, 105, 152–155, 157, 171, 30 K

[56] **References Cited**

UNITED STATES PATENTS

2,108,613	2/1938	Rider	271/157
2,214,088	9/1940	Seybold	271/98
2,921,788	1/1960	Lawrence	214/8.5 A
3,404,790	10/1968	Brookhyser	214/8.5 A
3,708,165	1/1973	Gilev et al.	271/157
3,749,395	7/1973	Bazzarone et al.	271/153

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Assistant Examiner—Joseph E. Valenza
Attorney, Agent, or Firm—Cooper, Dunham, Clark, Griffin & Moran

[57] **ABSTRACT**

A sheet feeding assembly comprising means for producing a signal when the sheets of a stack on a sheet feed tray have all been fed out and signal responsive conveyor means for delivering to the sheet feed tray a new stack of sheets which is standing by on the conveyor means. A tilting plate aligns the sheets on the tray.

13 Claims, 14 Drawing Figures

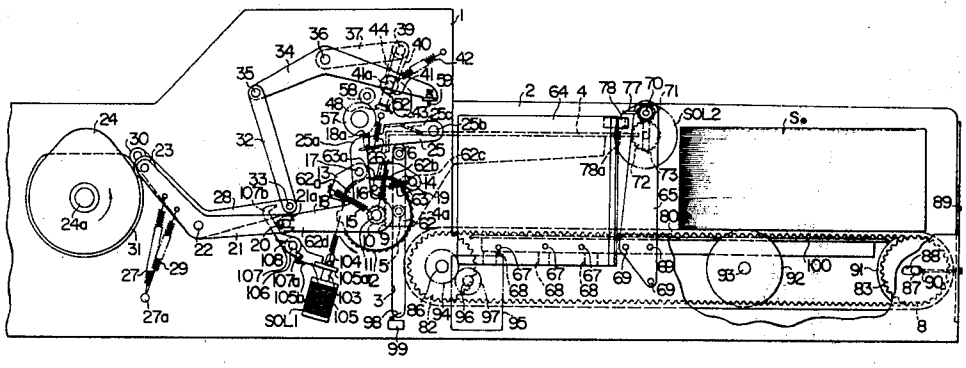

FIG. 1

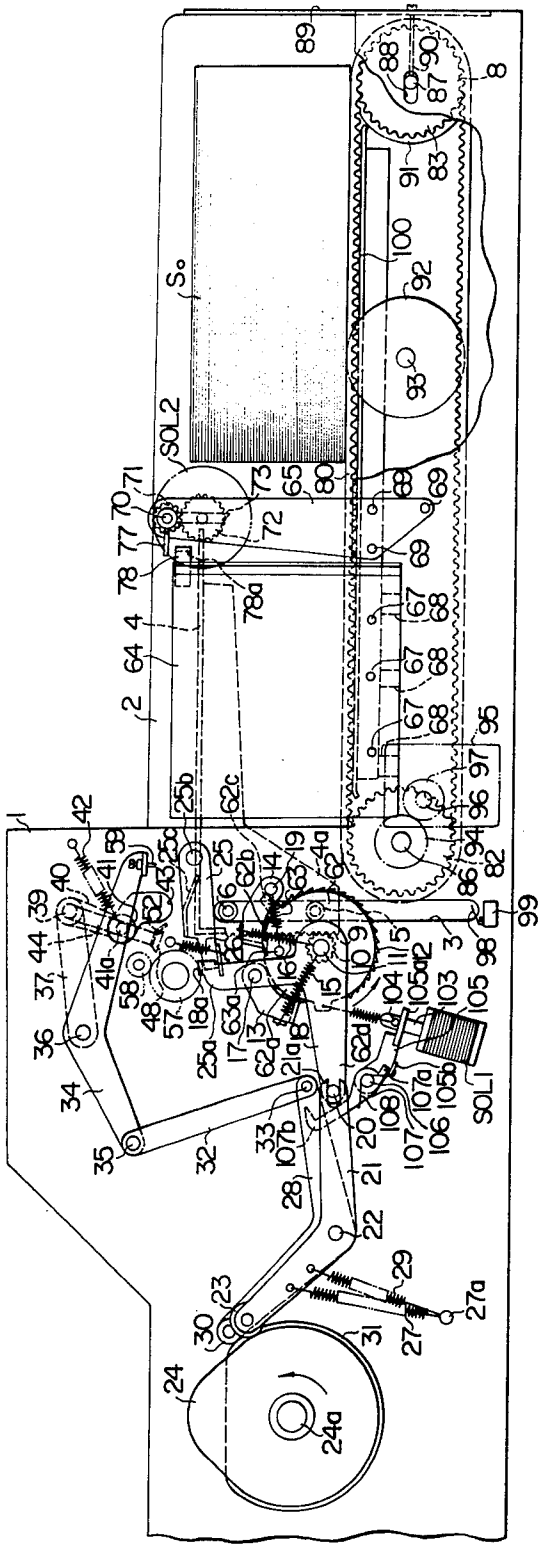
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FIG. 2

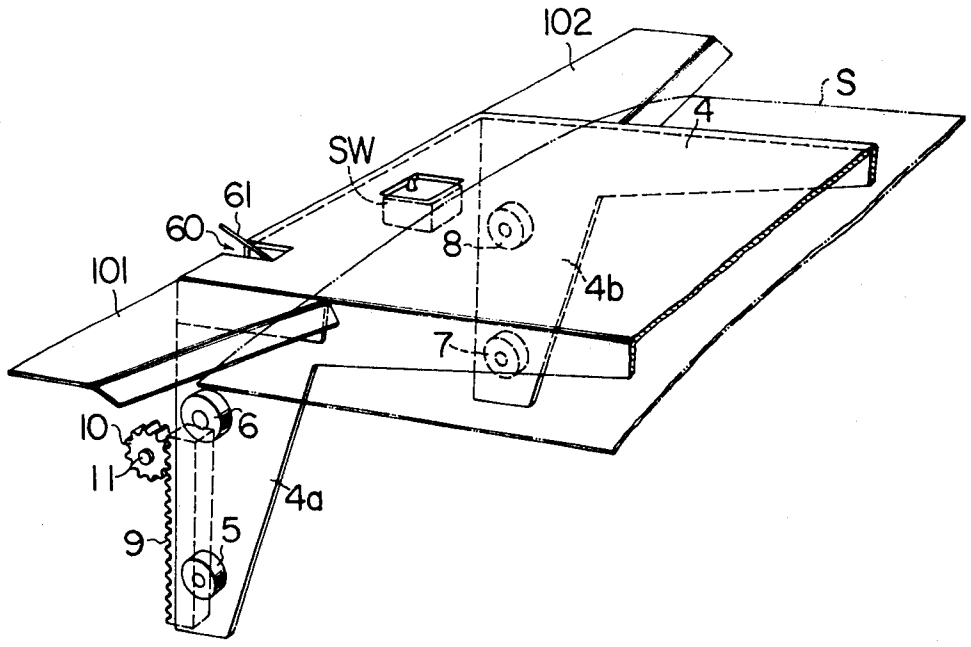

FIG. 3

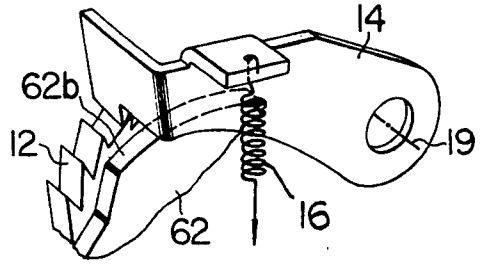

FIG. 4

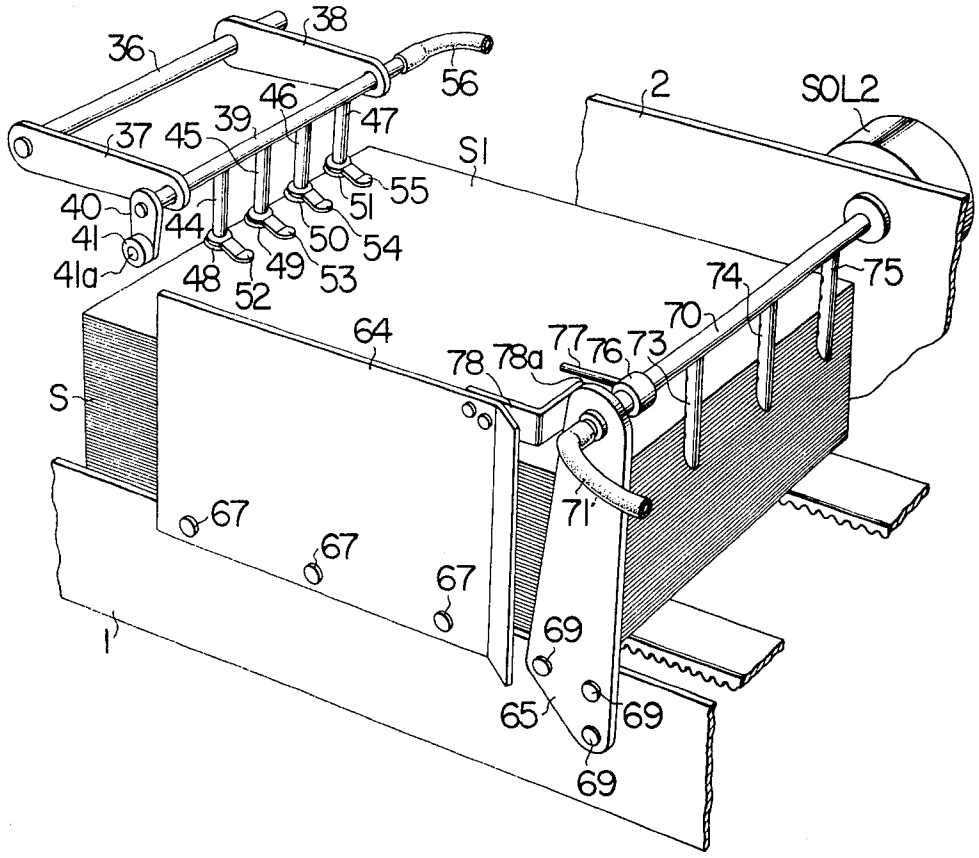
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FIG. 5

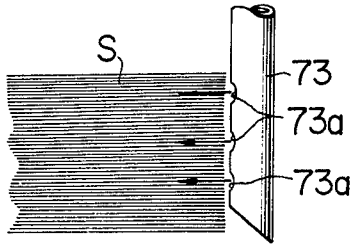
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FIG. 6

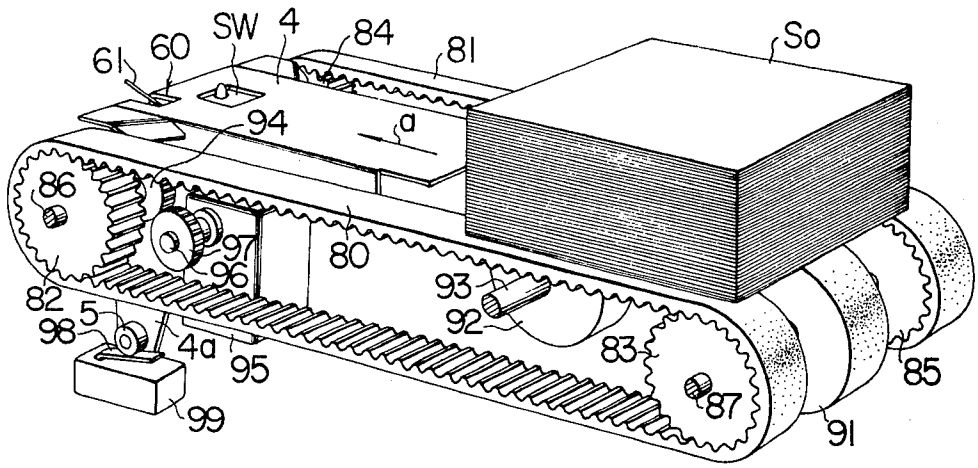


FIG. 7

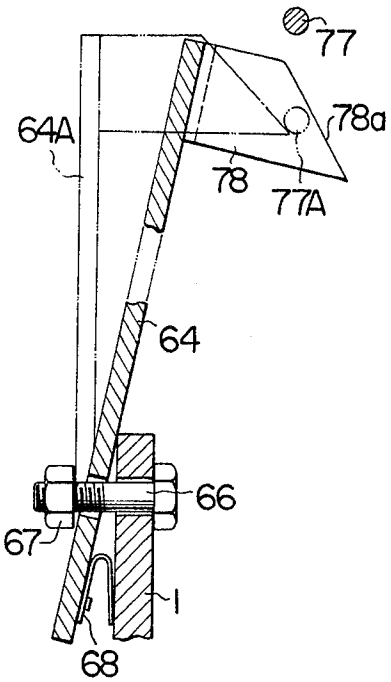


FIG. 8

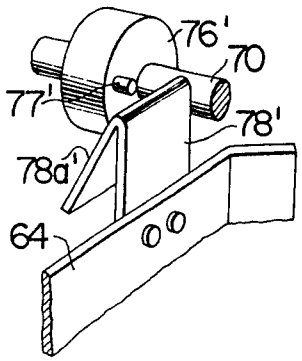


FIG. 9

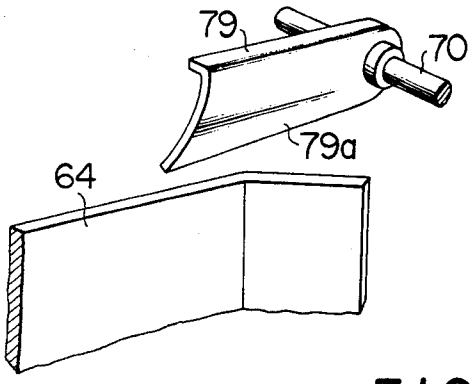


FIG. 10

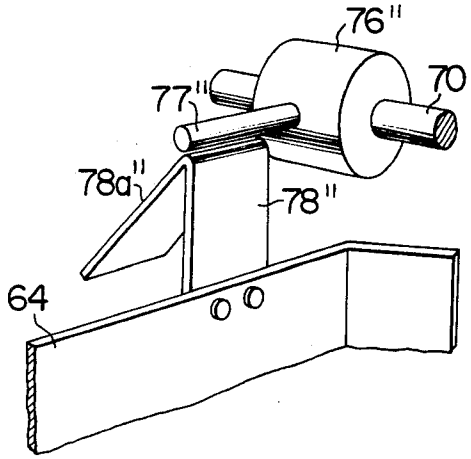
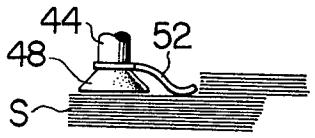


FIG. 11



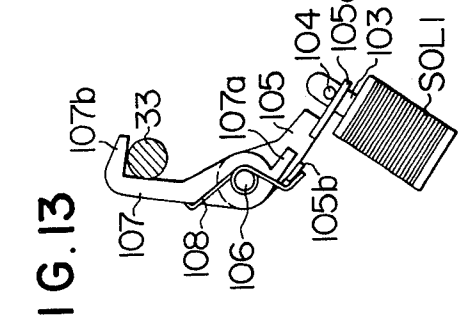


FIG. 13

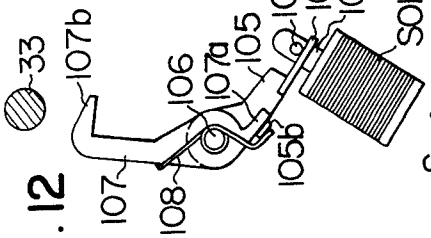


FIG. 12

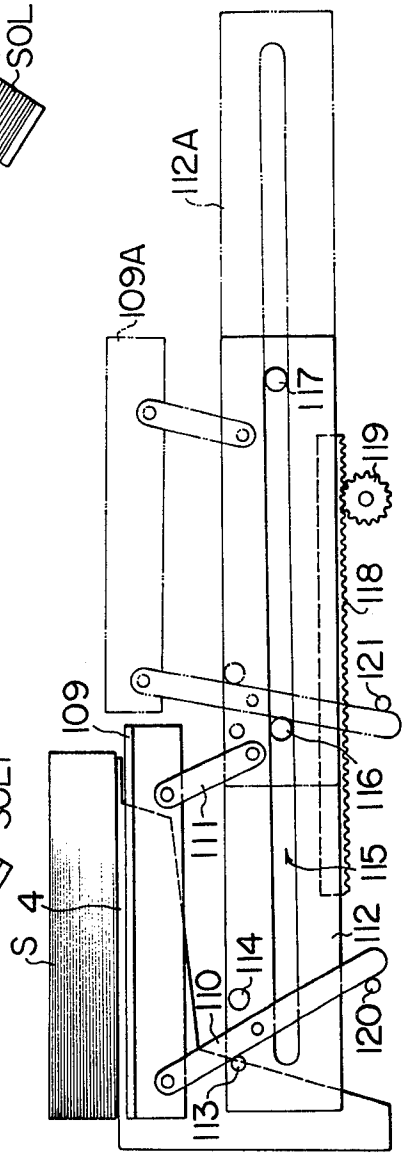


FIG. 14

SHEET FEEDING ASSEMBLY INCLUDING AUTOMATIC STACK REPLACEMENT AND ALIGNING MEANS

BACKGROUND OF THE INVENTION

This invention relates to a sheet feeding apparatus having means for automatically delivering a new stack of sheets to a sheet feed tray when the sheets on the sheet feed tray have all been fed out.

Sheet feed apparatus or devices using sheet feed rollers or sheet feed suction means for automatically feeding out one sheet after another from a stack of sheets resting on a sheet feed tray are effective and being used nowadays to feed copy sheets to duplicating machines, photosensitive sheets to copying apparatus, and magnetic sheets to magnetic recording and transfer printing apparatus.

When such devices are employed, it is necessary to replace the sheets on the sheet feed tray with a new stack of sheets when the former have all been fed out. It has hitherto been customary when all the sheets on the sheet feed tray are exhausted to manually deliver a new stock of sheets to the sheet feed tray, and no effective devices have been developed for automatically delivering a new stack of sheets to a sheet feed tray. Thus, the machine is idle while the operator delivers a new stack of sheets thereto after he notices that the sheets on the sheet feed tray are exhausted. This and other disadvantages have been associated with apparatus requiring automatic replacement of sheets.

SUMMARY OF THE INVENTION

This invention has as its object the provision of a sheet feeding device which has means for automatic replacement of sheets by delivering a new stack of sheets by conveyor means disposed near the sheet feed tray when a stack of sheets resting on the tray has been exhausted by feeding and aligning the new stack on the tray.

According to the invention, there is provided a sheet replacement device adapted to cooperate with a sheet feed device, comprising sheet cconveyor means disposed adjacent to a sheet feed tray of the sheet feed device, means for detecting the absence of sheets on the sheet feed tray and producing a signal indicative thereof, and means responding to the signal and actuating the sheet conveyor means to transfer to the sheet feed tray a new stock of sheets placed on the sheet conveyor means beforehand.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side view of a sheet feeding device constituting one embodiment of the invention;

FIG. **2** is a fragmentary perspective view of one form of a sheet feed tray;

FIG. **3** is a perspective view of a ratchet, holding pawl and pawl disengaging ring, showing their relative positions;

FIG. **4** is a fragmentary perspective view of a sheet feeding device;

FIG. **5** is a side view of sheets and a force applying arm, showing the manner in which streams of air are ejected from the arm;

FIG. **6** is a perspective view of a sheet replacement conveyor device according to the invention, shown in FIG. **1**;

FIG. **7** is a sectional view of a sheet aligning plate and means for moving the sheet aligning plate to an inoperative position, showing the manner in which the plate is mounted;

FIG. **8** is a perspective view of a modification of the means for moving the sheet aligning plate to its inoperative position;

FIG. **9** is a perspective view of a second modification of the means for moving the sheet aligning plate to its inoperative position;

FIG. **10** is a perspective view of a third modification of the means for moving the sheet aligning plate to its inoperative position;

FIG. **11** is a side view of a suction member showing its relation to sheets delivered for replacing the sheets on the tray;

FIG. **12** and FIG. **13** are side views showing the operation of a holding arm to stop pivoting movement of a suction means pick-up lever; and

FIG. **14** is a side view of a sheet feeding device according to the invention using a planar plate type conveyor means.

DESCRIPTION OF THE EMBODIMENTS

The invention will now be described in detail with reference to preferred embodiments thereof.

In FIG. **1**, fixed walls on side plates **1** and **2** (only a portion of side plate **2** is shown) of the machine body are each formed at a lower central portion with vertically oriented slots **3**. The slot **3** formed in the side wall **1** has fitted therein rollers **5** and **6** attached to one leg **4**a of a sheet feed tray **4** (See FIG. **2**), while the slot **3** (not shown) formed in the side wall **2** has fitted therein rollers **7** and **8** (shown in FIG. **2**) attached to another leg **4***b* of the tray **4**. The leg **4***a* has attached to its front side a rack **9** with which a pinion **10** is maintained in meshing engagement. Firmly secured to a portion of a pinion shaft **11** supporting the pinion **10** which is disposed outwardly of side plate **1** is a ratchet wheel **12** with which a drive or feed pawl **13** and a holding or check pawl **14** are maintained in pressing engagement by the biasing forces of springs **15** and **16** respectively each having one end secured to the shaft **11**.

The feed pawl **13** is pivotally supported by one arm portion of a pawl lever **18** through a shaft **17** while the check pawl **14** is pivotally supported by the side plate **1** through a shaft **19**. Fixed to the end of the other arm portion of the lever **18** is a pin **20** which engages in a fork **12**a formed at the end of one arm of a linkage member or lever **21** and pivotally connected to the side plate **1** through a shaft **22**, so that a roller **23** supported at the end of the other arm portion of the lever **21** is urged against a cam **24**. An engaging portion **18**a is formed at one arm portion of the lever **18** on which the feed pawl **13** is pivotally supported. A locking arm **25** is urged toward in locking engagement at a locking portion **25***a* with the engaging portion **18***a* to prevent pivotal movement of the lever **18** when the uppermost sheet of a stack of sheets on the sheet supply tray **4** is disposed at a level at which feeding of the sheets can be effected. The locking arm **25** is pivotally supported by the side plate **1** through a shaft **25***b* and urged to move upwardly by the biasing force of a spring **26**.

A spring **27** connected at one end to a pin **27***a* fixed to the side plate **1** is connected at the other end to the lever **21** to urge the roller **23** into pressing engagement with the cam **24**. However, when the lever **18** is locked by the locking arm **25** as aforementioned, the roller **23** is held away from the cam **24**.

When the lever **18** is locked by the locking arm **25**, the ratchet wheel **12** is locked by the check pawl **14** while the feed pawl **13** is only maintained in engagement with the ratchet wheel **12**, so that the pinion **10** is also locked in position to maintain the sheet feed tray **4** in position.

An operating lever **28** is pivotally supported by the shaft **22** supporting the lever **21**. A spring **29** connected at one end to the pin **27***a* is connected at the other end to the operating lever **28** to urge a roller **30** rotatably supported at the end of one arm portion into engagement with an operating cam **31**. A connector link **32** is pivotally connected at one end to the end of other arm portion of the lever **28** through a pin **33** and at the other end to the end of one arm portion of a pick-up lever **34** through a pin **35**. The lever **34** is pivoted about a shaft **36** rotatably supported by the side plates **1** and **2** and has arms **37** and **38** (See FIG. **4**) secured at their bases to portions of the shaft **36** disposed inwardly of the side plates **1** and **2** respectively.

In FIG. **4**, a rotary tubular shaft **39** is rotatably supported by the lower ends of the arms **37** and **38** and has secured to one end thereof on the side plate **1** side the base of an arm **40** having at its bottom end a roller **41** rotatably supported by a shaft **41**a and received in a guide slot **43** formed in the side plate **1** (FIG. **1**).

Referring to FIG. **4** again, the tubular shaft **39** has connected thereto a plurality of tubular arms **44, 45, 46** and **47** having secured to their lower ends suction members **48, 49, 50** and **51** and stoppers **52, 53, 54** and **55** respectively which serve concurrently as members for precluding feeding of two sheets at a time.

As shown in FIG. **1**, the operating cam **31** is secured to the shaft **24***a* which rotates in the direction of an arrow at a constant rate together with the cam **24**. As the cam **31** rotates, the lever **28** rocks and its movement is transmitted through connector link **32** and lever **34** to the shaft **36** and the arms **37** and **38**. As arms **37** and **38** rock, the tubular shaft **39** moves in reciprocating motion along an arc centered on the shaft **36**, and the arm **40** also moves generally up and down. The roller **41** at the lower end of the arm **40** moves in the guide slot **43**, so that the arm **40** reciprocates generally along the guide slot **43**.

At this time, the tubular arms **44, 45, 46** and **47** move in the same manner as the arm **40**, so that the suction members **48, 49, 50** and **51** repeatedly move from their initial position shown in FIG. **1** along a path similar to the path of movement of the roller **41** in reciprocating leftward downward movement and rightward upward movement. All the suction members **48, 49, 50** and **51** are brought into engagement with the uppermost sheet S1 (See FIG. **4**) of the stack of sheets S on the sheet feed tray **4** at the end of the leftward downward movement. Air is drawn by suction from a suction pump (not shown) through a pipe **56** connected to the other end of the shaft **39** to attract the sheet S1 to the suction members **48, 49, 50** and **51**, which are then moved upward and rightward as aforementioned to feed the sheet S1 to feed-out means or delivery rollers **57** and **58** (See FIG. **1**) disposed anterior to the sheet feed tray **4**. As the sheet S1 is fed to the delivery rollers **57** and **58**, the suction operation is interrupted so that the sheet S1 is released from engagement with the suction members **48, 49, 50** and **51** and nipped by the delivery rollers **57** and **58** to be fed out of the device to another machine (not shown). A spring **42** is connected at one end to the side plate **1** and at the other end to the shaft **41***a* supporting the roller **41** to facilitate the operation of the arm **40**, tubular shaft **44** and suction members **48, 49, 50** and **51**.

When the top of the stack of sheets S on the sheet feed tray **4** (See FIG. **4**) is at a sufficient height, the suction members can smoothly perform the sheet feed operation as aforementioned. However, as the height of the stack of sheet S is reduced, the range of downward movement of the suction members increases and consequently the angle of rocking movement of the lever **34** increases. Threadably connected to the end of the other arm portion of the lever **34** is a presser **59** which is engagable with a pressed member **25***c* disposed at the central portion of the locking arm **25**. When the angle of rocking movement of the lever **34** increases, the presser **59** bears against the pressed member **25***c* to move locking arm **25** downwardly.

Downward movement of the locking arm **25** results in its locking portion **25***a* being released from engagement with the lever **18** to thereby allow pivotal movement of the latter. Thus, the lever **18** is free to be operated by the cam **24** through the lever **21** and begins to pivot about the shaft **11**. Pivotal movement of lever **18** moves the feed pawl **13** in reciprocating motion so as to intermittently move the ratchet wheel **12** in the direction of an arrow in FIG. **1**. Rotation of the ratchet wheel **12** is transmitted through the shaft **11** to the pinion **10** which moves the rack **9** upwardly. Upward movement of the rack **9** results in the sheet feed tray **4** also moving upwardly. Thus, the height of the stack of sheets S on the sheet feed tray **4** increases and facilitates the sheet feeding operation. It is to be noted that when the height of the stack of sheets S increases, the range of movement of the suction members **48, 49, 50** and **51** is reduced and the angle of rocking movement of the lever **34** is reduced. This results in the locking arm **25** moving upwardly, so that its locking portion **25***a* limits the pivotal movement of the engaging portion **18***a* of the lever **18**.

The sheets S on the sheet feed tray **4** (See FIG. **4**) are successively fed as aforementioned. When the sheets S are exhausted, a pressure switch SW for detecting the absence of sheets S on the sheet feed tray **4** provided through the surface of the tray **4** as shown in FIG. **2** is closed and feeds a signal to a release solenoid SOL1 provided at the lower central portion of the side plate **1** as shown in FIG. **1**. An actuator of a conveyor switch **61** is disposed through a notch **60** formed through the sheet feed tray **4** as shown in FIG. **2**. When the force applied by the sheets S to the switch SW is released, the switch SW is closed and produces a signal for delivering a new stack of sheets to the sheet feed tray **4**.

Release means comprising a pawl disengaging ring **62** provided with projections **62***a* and **62***b* for releasing the pawls **13** and **14** from engagement with the ratchet wheel **12** is rotatably supported by the shaft **11** which supports the ratchet wheel **12**. A spring **63** is connected at one end to a pin **63***a* fixed to the end surface of the ring **62** and to the lever shaft **19** as shown in FIG. **1** to urge the ring **62** to rotate rightwardly about the shaft **11**. When there are sheets S on the sheet feed tray **4**, a projection **62***c* of the ring **62** is in engagement with the shaft **19** and the pawl disengaging projections **62***a* and **62***b* are disposed in positions in which the projections **62***a* and **62***b* are spaced from the feed pawl **13** and check pawl **14** respectively. The pawl disengaging ring

62 has another projection 62*d* which is connected to the solenoid SOL1 which is energized upon closing of the sheet detection switch SW and moves the pawl disengaging ring 62 counterclockwise about the shaft 11 against the biasing force of the spring 63. Counterclockwise movement of the pawl disengaging ring 62 about the shaft 11 results in the pawl disengaging projections 62*a* and 62*b* moving the feed pawl 13 and the check pawl 14 upwardly away from the teeth of the ratchet wheel 12 as shown in FIG. 3 with reference to the check pawl 14. Thus, the pawls 13 and 14 are released from engagement with the teeth of ratchet wheel 12.

When the feed pawl 13 and check pawl 14 are released from engagement with the teeth of ratchet wheel 12, no restriction is placed on the movement of the pinion 10 which allows downward movement of the sheet feed tray 4 and rack 9 by gravitational force.

The role played by a rotary solenoid SOL2 will now be described. The side plate 1 has a lower rightward portion as shown in FIG. 4, with a tilting sheet aligning plate 64 and pressure applying arm supporting plate 65 being mounted thereon. As shown in FIG. 4 and FIG. 7, the sheet aligning plate 64 is loosely mounted at its base to the side plate 1 by a plurality of bolt 66 and nut 67 combinations. A plate spring 68 is interposed between the base of the plate 64 and the side plate 1 so that the upper portion of the plate 64 tilts inwardly toward the stack of sheets S on the sheet feed tray 4 and strongly urges the sheets S against the side plate 2 to thereby align the side edges of the sheets S as shown in FIG. 4. The sheet aligning plate 64 has a rightward portion which is bent outwardly so as not to interfere with the delivery of a new stack of sheets So (See FIG. 6) to the tray 4 as subsequently to be described.

The support plate 65 is secured at its base to the side plate 1 by three screws 69. A tubular rotary shaft 70 is rotatably supported at one end by the upper portion of support plate 65 and at the other end by the side plate 2. As shown in FIG. 1, a gear 71 is mounted on an end portion of the tubular shaft 70 which is disposed outwardly of the side plate 2 and maintained in meshing engagement with a gear 72 of the rotary solenoid SOL2 mounted on the side plate 2. As shown in FIG. 4, pressure applying arms 73, 74 and 75 are fixed to the tubular shaft 70 and maintained in pressing engagment with the rear edges of the sheets S to align the rear edges thereof when the rotary solenoid SOL2 is not energized or when there are sheets S on the sheet feed tray 4. The pressure applying arms are each formed with a plurality of air ejection orifices or openings 73*a* as shown with reference to the pressure applying arm 73 in FIG. 5, and receive a supply of air from a blower (not shown) through a pipe 71' connected to the tubular shaft 70 at its end near the support plate 65, so that air is blown against the rear edges of the sheets S to prevent adhesion of the sheets. This is conducive to prevention of two sheets being fed at one time by the suction members.

A collar 76 is mounted on the tubular shaft 70 at its end near the support plate 65 and has secured thereto a sheet aligning plate actuating arm or pin 77 which is disposed in a position corresponding to the position at which a relief member 78 is provided on the right shoulder of the plate 64 (See FIG. 7).

When the sheets S on the sheet feed tray 4 are exhausted, the switch 61 closes to produce a signal to deliver a new stack of sheets to the sheet feed tray 4. This signal energizes the rotary solenoid SOL2 which angularly rotates the tubular shaft 70 counterclockwise through about 50° to move the pressure applying arms 73, 74 and 75 to a position in which they are clear of the path of movement of the sheets So (See FIG. 1). At the same time, the pin 77 moves to a dash-and-dot line position 77A shown in FIG. 7 in which the pin 77 presses against an inclined edge 78*a* of the relief member 78 so as to move the sheet aligning plate 64 to a dash-and-dot line position 64A in which the plate 64 is inoperative and does not interfere with the movement of the sheets So onto the tray 4.

FIG. 8 shows another form of means for moving the sheet aligning plate 64 to its inoperative position. As shown, the pin 77' is fixed to one end surface of the collar 76' and the relief member 78' is formed integrally with the sheet aligning plate 64 and has the inclined edge 78'*a* which is positioned conjugate to the pin 77'. FIG. 9 shows another form of means for moving the sheet aligning plate 64 to its inoperative position in which a relief arm 79 formed with an inclined surface 79*a* is secured to the tubular shaft 70 so that the arm 79 alone can move the sheet aligning plate 64 to its inoperative position. FIG. 10 shows still another form of means for moving the sheet aligning plate 64 to its inoperative position in which the relief member 78'' similar to the one described with reference to FIG. 8 is moved by a pin 77'' similar to that shown in FIG. 4. It is to be understood that any means as desired may be used for moving the sheet aligning plate 64 to its inoperative position in the present invention.

When the feed pawl 13 and check pawl 14 are released from engagment with the teeth of the ratchet wheel 12 by the pawl disengaging ring 62, the sheet feed tray 4 on which no sheets S rest moves downwardly while rollers 5 and 6 move in the slot 3 and the rack 9 and pinion 10 are maintained in meshing engagement with each other, until the roller 5 abuts against the lower edge of the slot 3. Thus, the tray 4 is disposed in its lowermost or bottom position as shown in FIG. 6.

A pair of endless cog or conveyor belts 80 and 81 are mounted below the lowermost position of the sheet feed tray 4 and astraddle the tray 4 as shown in FIG. 6. The belt 80 rides over a pair of gears 82 and 83 while the belt 81 rides over gears 84 and 85. The upper run of each belt has a length of about 2.5 times as great as the length of the tray 4. A stack of new reserve sheets can be placed on the rear portion of the upper run at any time desired. The gears 82 and 84 are fixed to a shaft 86 rotatably supported by the side plates 1 and 2 while the gears 83 and 85 are fixed to a shaft 87 rotatably supported by the side plates 1 and 2. The shaft 87 is slidably received in horizontally oriented slots 88 (only one is shown) formed through the in side plates 1 and 2 to allow lengthwise adjustment of the side plates 1 and 2 as shown in FIG. 1. The position of the shaft 87 can be adjusted by a screw 90 mounted on a rear plate 89 of the machine body so that the belts 80 and 81 can be tensioned or loosened as desired.

A sheet support roller 91 is fixed to the central portion of the shaft 87 and interposed between the rollers 83 and 85. Another sheet support roller 92 fixed to a shaft 93 rotatably support by the side plates 1 and 2 is disposed beneath the front portion of the reserve sheets

So and aligned with the support roller **91** between the belts **80** and **81.**

On the other hand, a gear **94** is secured to the shaft **86** and maintained in meshing engagement with a gear **97** secured to a drive shaft **96** of a motor **95.**

A sheet feed tray downward movement detection switch **99** having an actuator **98** disposed in the slot **3** formed in the side plate **1** is mounted near the slot **3.** The switch **99** is adapted to be closed when the sheet feed tray **4** moves downwardly and its roller **5** pushes the actuator **98,** so that the motor **95** is energized. Upon actuation of the motor **95,** the gears **82** and **84** are driven through the gears **97** and **94** and the belts **80** and **81** begin to move in the direction of an arrow *a* in FIG. **6.** Thus, the reserve sheets So resting on the rear portion of the belts **80** and **81** are transferred to the sheet feed tray **4** as a fresh supply of sheets.

Support plates **100** are secured to the side plates **1** and **2** respectively and disposed in positions in which they are side by side with belts (only one support plate **100** secured to the side plate **2** is shown in FIG. **1**) to aid the belts **80** and **81** in supporting the sheets So. Auxiliary plates **101** and **102** each having a rear marginal portion bent downwardly are connected to opposite sides of the front end portion of sheet feed tray **4.** The sheet feed tray **4** has a width smaller than the width of the sheets So to facilitate transfer of the sheets *So* thereto from the belts **80** and **81.** Because of this, when the sheets *so* (shown in dash-and-dot lines in FIG. **2**) tend to sag or curve downwardly at opposite sides, the operation of moving the new stack of sheets *So* to the tray **4** will be performed satisfactorily due to the provision of the auxiliary plates **101** and **102.**

In FIG. **1,** an arm **105** has an engaging portion **105***a* which engages with a pin **104** secured to an actuator **103** of the solenoid SOL**1.** The arm **105** is pivotally supported by the side plate **1** through a shaft **106** having an arm **107** fitted thereon. As seen more clearly in FIGS. **12** and **13** spring **108** mounted on the arm **106** is connected at one end to the arm **105** and at the other end to the arm **107.** The arm **107** has an abutting portion **107***a* which is positioned against an engaging portion **105***b* of the arm **105.** The arm **107** has a folding portion **107***b* conjugate to the pin **33** connected to the lever **28** which is spaced apart from the pin **33** when the solenoid SOL**1** is not energized.

Upon actuation of the solenoid SOL**1,** the arms **105** and **107** rotate clockwise as a unit about the shaft **106** under the influence of the spring **108,** thereby bringing the holding portion **107***b* of the arm **107** into the path of movement of the pin **33** (See FIG. **12**). The pin **33** which moves up and down in slaved relation to the lever **28** rocking in slaved relation to the cam **31** is locked by the holding portion **107***b* when it moves lower than the holding portion **107***b* coming into the path of movement of the former. As a result, rocking of the lever **28** is prevented, thereby preventing movement of the lever **34,** arms **37, 38** and suction members **48, 49, 50** and **51.** The suction members are thereby held in their upper positions. This is conducive to prevention of the suction members from interfering with the delivery of the sheets S to the sheet feed tray **4.**

When the new stack of sheets So is delivered to the sheet feed tray **4,** the detection switch SW is opened and the solenoid SOL**1** and rotary solenoid SOL**2** are de-energized, so that all the parts of the sheet feed device are restored to their normal positions and sheet feed operation is restored.

It will be appreciated that the invention permits a new stack of sheets to be delivered automatically to the sheet feed tray **4** when the sheets on the tray **4** are exhausted, if a new stack is placed on the conveyor at an opportune time. The invention has been described as a machine in which the sheet feed tray is automatically moved downward. It is to be understood, however, that the invention can also be embodied as a machine of the type in which the sheet feed tray is manually moved downwardly.

In the embodiment shown and described above, endless belts are employed as a conveyor. The conveyor using endless belts may be replaced by a conveyor using a planar plate as shown in FIG. **14.**

In FIG. **14,** a planar plate on frame type conveyor **109** has a pair of elongated links **110** pivotally connected at their upper ends to the front end portion of the conveyor **109** at opposite sides, and a pair of short links **111** pivotally connected at their upper ends to the rear end portion of the conveyor **109** at opposite sides, the two pairs of links **110** and **111** being disposed parallel to each other. The links **110** and **111** are pivotally connected at their lower ends to a movable bed **112.** Two pins **113** and **114** are fixed to each of the opposite sides of the movable bed **112** and disposed at opposite sides of each elongated link **110** to limit the range of pivotal movement of the links **110.**

The movable bed **112** is formed with a slot **115** in each opposite side thereof which receives therein pins **116** and **117** secured at opposite ends to immovable members (not shown) for supporting the movable bed **112** for sliding motion and limiting the range of movement thereof. Secured to the underside of the bed **112** is a rack **118** which is maintained in meshing engagement with a pinion **119.**

Actuating pins **120** and **121** are provided below the front end portion and rear end portion of the bed **112** respectively and secured to immovable members for causing the elongated links **110** to change their directions of inclination. By the aforementioned arrangement of links and pins, the planar plate type conveyor **109** is disposed at a level which is below the level of the upper surface of sheet feed tray **4** when the movable bed **112** has moved to its most forward position or end of travel and disposed at a level which is above the level of the upper surface of the sheet feed tray **4** when the movable bed **112** has moved to its most rearward position. The rearward positions of the planar plate type conveyor **109** and movable bed **112** are shown in dash-and-dot lines as **109A** and **112A** respectively.

The pinion **119** is driven by a motor (not shown) for rotation in forward and reverse directions. The planar plate type conveyor **109** shifts to the lower position when moving forwardly and to the upper position when moving rearwardly, so that transfer of the reserve sheets to the sheet feed tray **4** can be readily effected.

In the present invention, a conveyor of any type as desired can be used, and the position in which the conveyor is disposed may be selected as desired so long as it is near the sheet feed tray **4.** The sheet feed tray **4** need not be moved up and down as described above but may be disposed in end-to-end relationship to the conveyor. If this is the case, the sheet replacement device according to the invention is constructed as shown in FIG. **6** and the motor **95** is controlled directly by the

sheet absence detection switch SW. In place of the suction members, rollers may be used as means for feeding one sheet after another. For moving the sheet feed tray 4 up and down, any other known means may be used in place of the means shown and described herein.

What is claimed is:

1. In a sheet feeding apparatus having a tray supporting a first stack of sheets and a feeding mechanism for removing sheets from the stack on the tray and feeding the sheets out of the apparatus one at a time, the improvement comprising:

elevating means for continuously raising the tray from a bottom position as the feeding mechanism feeds out the sheets so that the successive top sheets of the first stack are maintained substantially at a predetermined height and for lowering the tray to the bottom position when the last sheet has been fed out;

sensing means disposed at the tray for sensing when the last sheet of the first stack has been fed out by the feeding mechanism and for generating a signal indicative thereof;

conveyor means arranged adjacent to the tray for supporting a second stack of sheets, and being responsive to said signal to move the second stack of sheets to the tray to be fed out; and

alignment means for urging and aligning side edges and rearward edges of the stack of sheets on the tray, and being responsive to said signal to clear the path of movement of the second stack of sheets while they are being moved to the tray.

2. The apparatus according to claim 1, in which said alignment means comprises:

a vertically disposed fixed plate arranged outward of and parallel to one side of said conveyor means;

a generally vertically disposed tilting plate arranged outward of and parallel to the other side of said conveyor means, said tilting plate being tiltably mounted at its bottom edge;

biasing means for urging said tilting plate to tilt inward toward said conveyor means to urge and align the sheets against said fixed plate;

solenoid controlled arm means for normally urging the sheets toward the tray and disengaging them from said tilting plate; and

a pressure switch disposed at the tray and sensitive to the weight of the sheets on the tray, said pressure switch being arranged to actuate said arm means when the last sheet of the first stack has been fed out and the weight of the sheets on said pressure switch is thereby zero to move said arm means to a position so that the second stack of sheets will clear said arm means while being fed to the tray and said arm will engage with said tilting plate to tilt said tilting plate outwardly away from said conveyor means against the force of said biasing means to prevent said tilting plate from impeding the movement of the second stack of sheets to the tray, said pressure switch de-actuating said arm means when the second stack of sheets contacts the tray due to the weight of the sheets.

3. The apparatus according to claim 2, in which said arm means comprises:

a rotary shaft arranged above and transverse to said conveyor means;

arms fixed to said rotary shaft arranged to normally engage with the edges of the sheets to urge the sheets toward the tray;

an actuating arm fixed to said rotary shaft arranged to normally disengage from said tilting plate; and

a rotary solenoid arranged to normally rotate said rotary shaft so that said arms engage with the sheets and said actuating arm disengages from said tilting plate and to be actuated by said pressure switch to rotate said rotary shaft so that said arms are moved to a position of disengagement from the sheets and said actuating arm engages with said tilting plate to tilt said tilting plate outward away from said conveyor means.

4. The combination according to claim 3, in which said arms are hollow, and communicate with a source of pressurized air through a passageway formed through said rotary shaft, said arms being further formed with orifices facing the sheets when in engagement therewith so that pressurised air is blown against the rear edges of the sheets to prevent adhesion of the sheets.

5. The combination according to claim 1, in which said conveyor means comprises a pair of motor driven endless conveyor belts straddling the tray and supporting the second stack of sheets, said sensing means being connected to the motor to control the same and the upper surfaces of said conveyor belts being at approximately the same height as the tray when the tray is in the bottom position.

6. The combination according to claim 1, in which said conveyor means comprises:

a motor driven bed movable to and away from the tray;

a horizontally disposed frame supporting the second stack of sheets;

a pair of parallel links pivotally connected to said bed and said frame to support said frame, said links being pivotal in a vertical plane parallel to the direction of movement of said bed; and

fixed actuating pins engagable with one of said links near the ends of travel of said bed;

the motor of said motor driven bed being controlled by said sensing means;

whereby said bed is normally at its end of travel farthest from the tray with said one of said links engaged with one of said actuating pins to rotate said link to a position to move said frame to a height above the tray when the tray is in the bottom position;

the motor of said motor driven bed is actuated by the signal from said sensing means to move said bed toward the tray;

said one of said links disengages from said one of said actuating pins and engages with another of said actuating pins to rotate to a position to move said frame to straddle the tray at a height below the tray and thereby place the second stack of sheets on the tray; and

the motor of said bed is actuated by the absence of the signal from said sensing means as the tray is raised by said elevating means to move said bed away from the tray so that said one of said links disengages from said another of said actuating pins and again engages with said one of said actuating pins to move said frame to the height above the tray when the tray is in the bottom position.

7. A sheet feeding apparatus comprising, in combination:
a horizontally disposed, vertically movable tray adapted to support a first stack of sheets;
a pick-up lever pivotal about a fixed point;
suction members carried by the pick-up lever engagable with the top sheet of the first stack;
feed-out means for taking sheets from the suction members and feeding the sheets out of the apparatus;
a vertically disposed rack fixed to the tray;
a pinion shaft carrying a pinion engaging with the rack;
a ratchet fixed to the pinion shaft parallel to the pinion;
a drive pawl and a holding pawl operatively engaging with the ratchet;
a pawl lever fixed to the pinion shaft and carrying the drive pawl;
cams rotated by a prime mover;
first and second linkages connecting the cams to the pick-up lever and the pawl lever respectively so that the pick-up lever is urged to rock and cause the suction members to pick up the sheets from the first stack one sheet at a time and pass the sheets to the feed-out means, and the pawl lever is also urged to rock and urge the pawl to rotate the ratchet and thereby the pinion to cause the rack and the tray to move upward to maintain the top of the first stack at substantially a predetermined height as the sheets are being fed out;
release means for normally urging the pawl lever and the second linkage to disengage from the cams, the release means being de-actuated by the pick-up lever when the height of the top of the first stack drops below the predetermined height;
a release solenoid arranged to disengage the drive and holding pawls from the ratchet when actuated;
a pressure switch provided to the tray arranged to actuate the release solenoid when the last sheet of the first stack is lifted off the tray by the suction members whereby the tray drops down to a bottom position;
conveyor means supporting a second stack of sheets and adapted to straddle the tray;
sensing means arranged to be actuated by the tray when the tray reaches the bottom position to generate a signal to actuate the conveyor means to move the second stack to the tray; and
alignment means for aligning the stack of sheets on the tray, said alignment means being responsive to said signal to clear the path of movement of the second stack of sheets while being moved to the tray.

8. A sheet feeding apparatus according to claim 7, further comprising holding means actuated by said release solenoid for maintaining the suction members in an upper position while the second stack is being moved to the tray.

9. A sheet feeding apparatus according to claim 7, in which said alignment means comprises:
a vertically disposed fixed plate arranged outward of and parallel to one side of said conveyor means;
a generally vertically disposed tilting plate arranged outward of and parallel to the other side of said conveyor means, said tilting plate being tiltably mounted at its bottom edge;
biasing means for urging said tilting plate to tilt inward toward said conveyor means to urge and align the sheets against said fixed plate;
solenoid controlled arm means for normally urging the sheets toward the tray and for disengaging them from said tilting plate; and
a conveyor pressure switch disposed at the tray and sensitive to the weight of the sheets on the tray, said conveyor pressure switch being arranged to actuate said arm means when the last sheet of the first stack has been fed out and the weight of the sheets on said conveyor pressure switch is thereby zero to move said arm means to a position so that the second stack of sheets will clear said arm means while being fed to the tray and said arm will engage with said tilting plate to tilt said tilting plate outwardly away from said conveyor means against the force of said biasing means to prevent said tilting plate from impeding the movement of the second stack of sheets to the tray, said conveyor pressure switch de-actuating said arm means when the second stack of sheets contacts the tray due to the weight of the sheets.

10. A sheet feeding apparatus according to claim 9, in which said arm means comprises:
a rotary shaft arranged above and transverse to said conveyor means;
arms fixed to said rotary shaft arranged to normally engage with the edges of the sheets to urge the sheets toward the tray;
an actuating arm fixed to said rotary shaft arranged to normally disengage from said tilting plate; and
a rotary solenoid arranged to normally rotate said rotary shaft so that said arms engage with the sheets and said actuating arm disengages from said tilting plate and to be actuated by said conveyor pressure switch to rotate said rotary shaft so that said arms are moved to a position of disengagement from the sheets and said actuating arm engages with said tilting plate to tilt said tilting plate outward away from said conveyor means.

11. A sheet feeding apparatus according to claim 10, in which said arms are hollow, and communicate with a source of pressurized air through a passageway formed through said rotary shaft, said arms being further formed with orifices facing the sheets when in engagement therewith so that pressurized air is blown against the rear edges of the sheets to prevent adhesion of the sheets.

12. A sheet feeding apparatus according to claim 7, in which said conveyor means comprises a pair of motor driven endless conveyor belts straddling the tray and supporting the second stack of sheets, said sensing means being connected to the motor to control the same and the upper surfaces of said conveyor belts being at approximately the same height as the tray when the tray is in the bottom position.

13. A sheet feeding apparatus according to claim 7, in which said conveyor means comprises:
a motor driven bed movable to and away from the tray;
a horizontally disposed frame supporting the second stack of sheets;
a pair of parallel links pivotally connected to said bed and said frame to support said frame, said links being pivotal in a vertical plane parallel to the direction of movement of said bed; and

fixed actuating pins engageable with one of said links near the ends of travel of said bed;

the motor of said motor driven bed being controlled by said sensing means;

whereby said bed is normally at its end of travel farthest from the tray with said one of said links engaged with one of said actuating pins to rotate said link to a position to move said frame to a height above the tray when the tray is in the bottom position;

the motor of said motor driven bed is actuated by the signal from said sensing means to move said bed toward the tray;

said one of said links disengages from said one of said actuating pins and engages with another of said actuating pins to rotate to a position to move said frame to straddle the tray at a height below the tray and thereby place the second stack of sheets on the tray; and

the motor of said bed is actuated by the absence of the signal from said sensing means as the tray is raised by said elevating means to move said bed away from the tray so that said one of said links disengages from said another of said actuating pins and again engages with said one of said actuating pins to move said frame to the height above the tray when the tray is in the bottom position.

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