United States Patent

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[72] Inventors **Hugh Ross;**
Franklin E. Parke, both of Pittsburgh, Pa.

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[73] Assignee **Ropak Manufacturing Co.**
Pittsburgh, Pa.

[54] **MAGNETIC CONVEYOR**
12 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** ..... **271/12,** 271/63 A
[51] **Int. Cl.** **B65h 5/06**
[50] **Field of Search** 271/26, 18.1, 74.1, 11, 12; 294/64, 65; 198/41

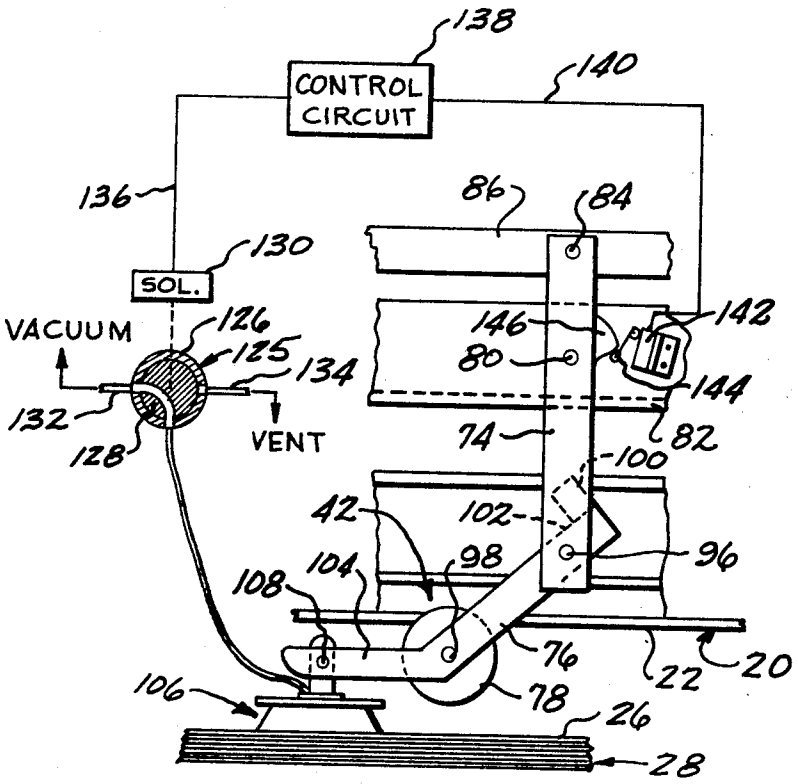
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Primary Examiner—Harvey C. Hornsby
Assistant Examiner—W. Scott Carson
Attorney—Brown, Murray, Flick & Peckham

ABSTRACT: Mechanism for picking up a magnetically permeable sheet from a stack of such sheets and for transferring the sheet to a magnetic conveyor comprising a pickup arm that has both magnetic roller means and readily releasable suction cup means. Suction cup means grasp a sheet, preferably while magnetic roller means are not in contact with the sheet so that double sheeting is safely avoided, and then, by pivoting the pickup means, the sheet is contacted and held by magnetic roller means on the pickup arm, with the vacuum in the suction cup means then being released, before there is any motion of the sheet on a magnetic conveying belt so that tearing of the suction cup means and possible marking of the sheets are safely avoided.



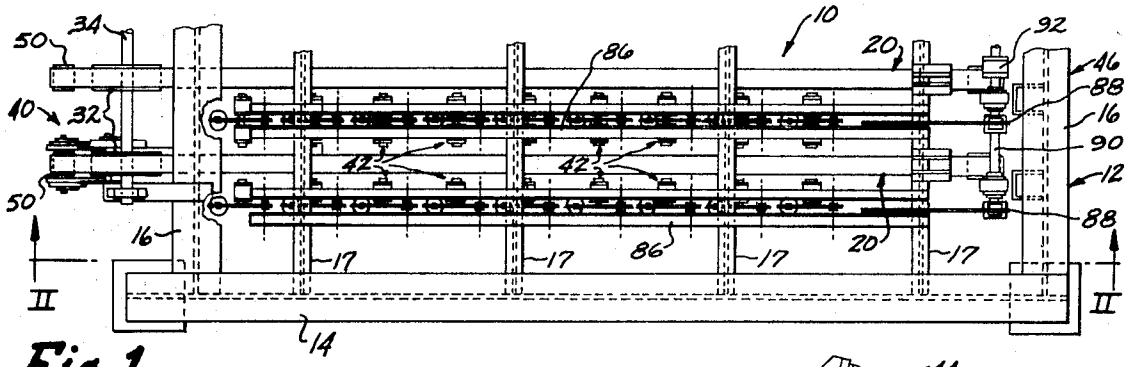


Fig. 1

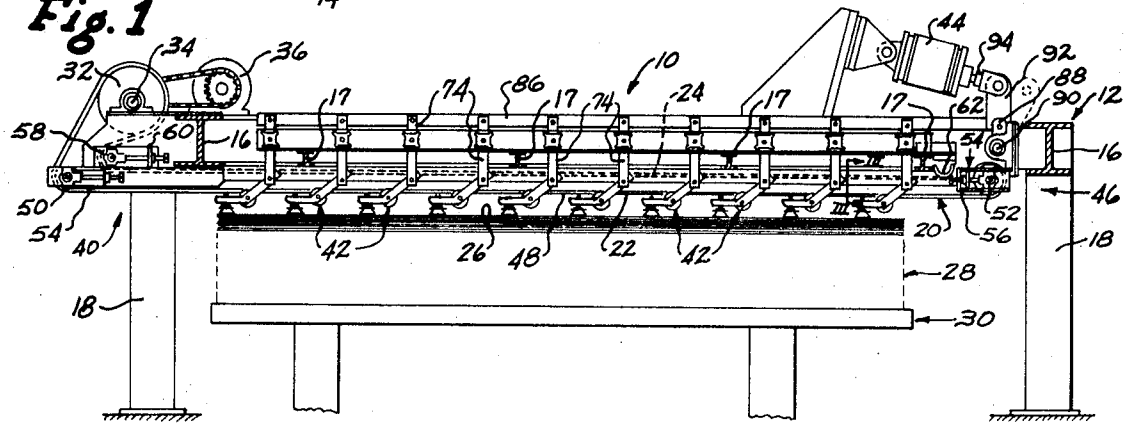


Fig. 2

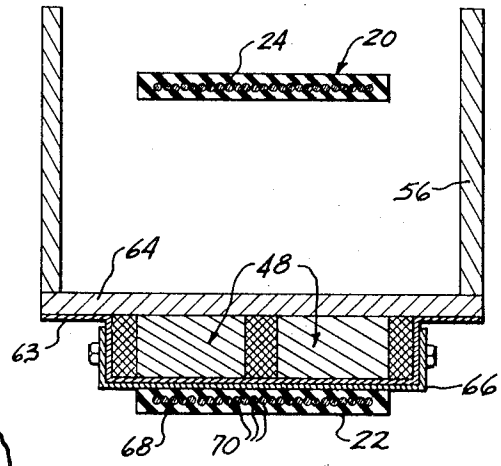


Fig. 3

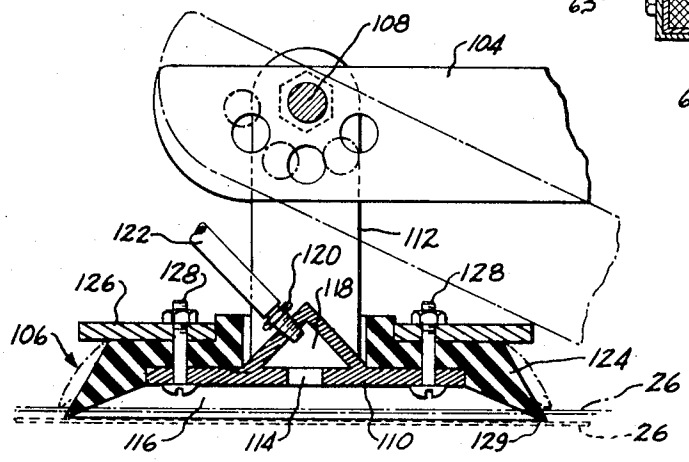


Fig. 4

INVENTORS.
HUGH ROSS
FRANKLIN E. PARKE
BY.
Murray & Linklaer
ATTORNEYS

Fig. 5C

Fig. 5B

Fig. 5A

Fig. 6

INVENTORS.
HUGH ROSS
FRANKLIN E. PARKE
BY
Murray & Linkhauer
ATTORNEYS

MAGNETIC CONVEYOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to magnetic conveyors for conveying single sheets of paramagnetic material such as steel sheets, and more particularly, to improvements in the construction and operation of such conveyors.

2. Description of the Prior Art

From our earlier filed copending application, Ser. No. 604,443, filed Dec. 23, 1966, (now U.S. Pat. No. 3,425,688, issued Feb. 7, 1969) it is known to use a sheet transfer means that comprises a plurality of arms, arranged for movement in unison and each containing a roller of magnetic material supported for free rotation on a shaft. Although for many purposes such an arrangement serves satisfactorily, it will also be seen that such apparatus will not, for example, reliably handle a series of sheets of paramagnetic material that differ, one from another, substantially in gage. There is the possibility, when the sheets are thin, that two will be picked up at once, and the other possibility, where the top sheet is thick, that it will not be picked up at all or will be moved slightly and immediately dropped, partly because of the need to limit the strength of the magnetic field surrounding the magnetic rollers rather carefully in order to avoid double sheeting.

It is also known, in the handling of steel sheet, to cause a single sheet to be picked up by the action of multiple suction cups that are provided with means for releasing the vacuum therein. A difficulty with such means has been that the timing of such release of vacuum must be carefully controlled. If it occurs too soon, unwanted premature dropping of the sheet occurs. If it occurs too late, i.e., after movement of the sheet in the direction of conveying has started, tearing or undue wear of the suction cups and possible marking of the sheets result.

SUMMARY OF THE INVENTION

In accordance with the invention, the above-indicated problems are overcome by using a pickup means that comprises a plurality of arms arranged along the lower reach of a magnetic conveyor, with each of the arms having both magnetic roller means and pivotally mounted releasable suction cup means. The suction cup means grasps a single sheet from a stack of sheets, and then, by pivotal movement of the arms, the sheet is brought into contact with the magnetic rollers mounted therein. Vacuum in the suction cup means is safely released, before any movement of the sheet in the direction of the conveying begins. In this way, the problem of tearing of the suction cup means is reliably avoided, and double sheeting is made unlikely or impossible, because of the distance between the magnetic rollers and the sheet at the time that it is picked up by the suction cup means.

In accordance with a preferred aspect of the invention, control means associated with the arms of the pickup means and actuated by angular, pivotal movement thereof, are used to time accurately the release of vacuum in the suction cup means. This contributes further to the reliable operation of the system.

DESCRIPTION OF THE DRAWINGS

The objects and advantages of the present invention will become apparent from the foregoing and following detailed description thereof, with reference to the accompanying drawings, in which:

FIG. 1 is a fragmentary plan view of the present magnetic conveyor;

FIG. 2 is a cross-sectional view taken substantially along the line II–II of FIG. 1;

FIG. 3 is an enlarged cross-sectional view taken along the line III–III of FIG. 2;

FIG. 4 is a cross-sectional view of one form of suction cup means used in the practice of the invention;

FIGS. 5A, 5B and 5C are views illustrating the action of a pickup means in accordance with the present invention; and

FIG. 6 is a cross-sectional view of an alternative form of suction cup means used in accordance with the invention.

GENERAL DESCRIPTION

Referring now to FIGS. 1 and 2, a magnetic conveyor 10 is illustrated which comprises a horizontal, generally rectangular frame 12 including longitudinal frame members 14, end frame members 16, and intermediate frame members 17. The frame 12 is supported on columns 18, which may be of any desired height. The frame 12 supports a number of movable belts 20, each having a lower reach 22 and an upper reach 24. The belts 20 are spaced apart across the width of the frame 12 and operate in unison to convey a single sheet 26 of paramagnetic material, such as steel sheet.

A stack 28 of the sheets 26 is positioned below and spaced from the lower reach 22. The stack 28 rests on a lift table 30 of the type which may be raised incrementally from time to time to position the uppermost sheet of the stack 28 at an appropriate level relative to the conveyor 10. The lift table 30 is conventional in the art and does not require additional description.

The movable belts 20 are frictionally engaged with drive pulleys 32 carried on a common shaft 34. Motor means 36 supported on the frame 12 is drivingly connected to the common shaft 34 by a drive chain 38. If desired, a transmission (not shown) may be interposed between the motor means 36 and the drive chain 38 to effect a change in the speed of the movable belts 20. In operation, the drive pulleys 32 rotate in a clockwise direction, whereby the lower reaches 22 move from right to left of FIG. 2, and such that single sheets are conveyed toward and beyond a forward end 40 of the frame 12.

The present magnetic conveyor 10 also includes a plurality of magnetic transfer means 42 which cooperate to transfer the single sheet 26 from the stack 28 into engagement with the lower reach 22, whereupon the single sheet 26 is conveyed toward and past the forward end 40 of the frame 12, to further processing. As best shown in FIG. 1, a row of magnetic transfer means 42 is provided on opposite sides of each of the movable belts 20. As will be more fully described, the magnetic transfer means 42 are operated, in unison, by a pneumatic cylinder 44 (FIG. 2) mounted at the rear end 46 of the frame 12.

As will also be more fully described, the position of each of the magnetic transfer means 42 relative to the lower reach 22 may be changed. Furthermore, one or more of the magnetic transfer means 42 may be repositioned such that they are incapable of attracting the single sheet 26. The overall arrangement is such that any number of the transfer means 42 may be employed to transfer the single sheet 26 from the stack 28 to the lower reach 22. In this connection, it should be evident that when a heavy gage sheet 26 is to be transferred, more of the magnetic transfer means 42 will be required to transfer the same as compared to the number of magnetic transfer means 42 required to transfer a single sheet of lighter gage.

Double sheeting (picking up two sheets rather than one) can also be prevented by the use of a smaller number of magnetic transfer means 42. Double sheeting occurs when the top sheet is saturated with magnetic flux lines and there remains additional attractive power which also attracts the second sheet. A decrease in the number of magnetic transfer means 42 decreases the additional attractive power to a value below that required to raise the second sheet. In the practice of the present invention, however, there will seldom be any occasion to decrease the number of magnetic transfer units 42 used for this reason, inasmuch as the single sheet 26 is, in each case, raised by means of suction cup means, to be hereinafter described, with the magnetic roller means of the transfer means 42 being, at the time that the suction cup means comes into engagement with the sheet 26, positioned relatively distant from the sheet 26, so as to be incapable of in most in-

stances of attracting the single sheet **26**, and far less likely of attracting two such sheets, as occurs when the problem of double sheeting is encountered.

In accordance with a preferred manner of practicing the present invention, the magnetic transfer unit is made to contain a roller that would, if it were brought into contact with the top sheet of a stack of sheets, raise two or more sheets. This provides additional magnetic strength to insure against premature dropping or other unwanted disengagement between the sheet and the magnetic transfer means. Such strong magnetic forces cannot be used, because of the double sheeting problem, in devices of the kind wherein magnetic force from a permanent magnet is used for the initial lifting of a top sheet from a stack of sheets of paramagnetic material.

It is also to be noted that the sheets **26** of the stack **28** may be of any desired length, their length being determined, of course, by the overall distance between the endmost transfer means **42**.

The present magnetic conveyor **10** also includes elongated magnetic means **48**, one positioned above each of the lower reaches **22** and supported by the frame **12**.

MOVABLE BELTS 20

Referring now to FIGS. **2** and **3**, the lower reach **22** of each of the movable belts **20** extends between end idlers **50**, **52**. Each of the end idlers **50**, **52** has associated therewith takeup means **54** carried on a U-shaped frame **56**, best illustrated in FIG. **2**. The lower reach **22** extends around the end idler **50** up over the drive pulley **32** and thence around an intermediate idler pulley **58** also adjustably supported on takeup means **60**. The upper reach **24** extends from the intermediate idler **58** beneath a second intermediate idler **62** and then around the end idler **52**. The several takeup means **54**, **60** are employed to take up any initial slack in the belt **20** to permit adjusting the idler rollers **50**, **52** and **58**, such that the movable belt **20** runs true, i.e., does not wobble from side to side.

Each of the movable belts **20** is magnetically susceptible, whereby the lower reach **22** is attracted by the magnet means **48** and prevented from sagging below the frame **12**. As can be seen in FIG. **3**, the magnet means **48** is carried on a U-shaped support plate **63**, which is mounted to a plate **64** forming a part of the U-shaped frame **56**. A wear plate **66**, secured to the magnet means **48**, is engaged by the lower reach **22** and thus a relatively smooth surface which minimizes frictional heat generated by the passage of the lower reach **22**.

As stated above, the movable belt **20** is magnetically susceptible and preferably comprises an endless strip of resilient material **68** having metal stands **70** embedded therein, extending longitudinally thereof and being susceptible to magnetization by the magnet means **48**.

MAGNETIC TRANSFER MEANS 42

Referring now to FIGS. **4**, **5A**, **5B** and **5C**, the magnetic transfer means **42** comprises, in general, a first arm segment **74**, a second arm segment **76**, and magnetic roller means **78**. The first arm segment **74** is pivotally supported on journals **80** for arcuate movement substantially parallel with the direction of belt travel. The first arm segment **74** is pivotable through an angle, as can be seen from the FIGS. **5A**, **5B** and **5C**. The journals **80** are secured to spaced angle members **82** that, in turn, are supported on the intermediate lateral frame members **17**. The first arm segment **74** extends upwardly between spaced angle members and is connected to the journals **80** by means of a shaft. Although not limited thereto, the magnetic roller means **78** preferably comprise those rollers described, illustrated and claimed in our U.S. Pat. No. 3,224,757.

The upper end of the first arm segment **74** is pivotally connected as at **84**, to an actuator arm **86**, which is operated by the pneumatic cylinder **44** (FIG. **2**). Referring now to FIGS. **1** and **2**, the actuator arm **86** is connected to all of the magnetic transfer means **42**. The actuator arm **86** extends rearwardly of the frame **12** and is pivotally connected to a lever arm **88** secured to a shaft **90**. The shaft **90** is, in turn, connected to a main lever arm **92**, which is pivotally connected to a piston rod **94** of the pneumatic cylinder **44**. In FIG. **2**, the main lever arm **92** and all of the first arm segments **74** are shown in a generally vertical position. When the cylinder **44** is actuated, the main lever arm **92** is rotated to the dashed outline position, whereupon the actuator arms **86** are moved rearwardly, causing all of the arm segments **74** to be pivoted about the journals **80** to an inclined position as shown in FIG. **5C** and in dash-dot outline in FIG. **4**. Deactivation of the pneumatic cylinder **44**, of course, causes the main lever arm **92** and all of the first arm segments **74** to return to their generally vertical position.

Returning now to FIGS. **5A**, **5B** and **5C**, the second arm segment **76** is pivotally connected at **96** to the first arm segment **74**. The magnetic roller **78** is rotatable on a shaft **98** which, in turn, is secured to the lower end of the second arm segment **76**. The first arm segment **74** carries an eccentric cam member **100**, which is engageable with an upper surface **102** of the second arm segment **76** to maintain the second arm segment **76** at a preselected angular position relative to the first arm segment **74**. As can be seen in FIGS. **5A**, **5B** and **5C**, the second arm segment **76** is angled relative to the first arm segment and extends forwardly thereof in the direction of belt travel. If desired, the cam member **100** may be made rotatable about a bolt passing through the first arm segment **74** and secured in an adjusted position with respect thereto by a wing nut or the like.

As explained above, the magnetic transfer means **42** are arranged such that the single sheet magnetically supported by the magnetic roller **78** is accelerated in the direction of belt travel so as to minimize marking of the sheet when engaged by the moving belt. The magnetic transfer means **42** is also arranged such that the sheet is moved parallel to and with the lower reach at a speed greater than the speed at which the sheet is moved upwardly into engagement with the lower reach **22**.

Referring to FIG. **5A**, it will be seen that the second arm segment **76** of the transfer means **42** has a portion **104** that extends at an angle with respect to the remainder of the arm **76**, and a releasable suction cup means, indicated generally at **106**, is connected to the portion **104**, as by a pivot **108**.

Referring now to FIG. **4**, which shows one particular form of suction cup means **106**, there is shown a structure comprising a member **110** having arms **112** rising centrally thereof that contain suitable openings for registering with the pivot **108**. The member **110** further contains an opening **114**, whereby pressure or partial vacuum in the space **116** is communicated to a chamber **118**, and thence via a fitting **120** and line **122** to other parts of the apparatus, as will be hereinafter described. Fitted over the member **110** is a suction cup **124** of rubber or other suitable flexible material. Suction cup **124** is secured to the member **110** by means of a washer member **126** and suitable bolts **128**.

Also shown in FIG. **4** in dotted lines is the position of a sheet **26** of magnetic material to be taken up by the suction cup means **106**. Initially, the pressure in the spaces **116** and **118** is substantially atmospheric, and the rim **129** of the suction cup **124** is brought into contact with the sheet **26**. Then a partial vacuum is drawn on the line **122**, and the suction cup **124** is then drawn into the position indicated in dash-dot lines, so that the sheet **26** is raised into the position indicated in dash-dot lines. FIG. **4** may also be interpreted as showing in dash-dot lines the suction cup means **124** compressed against the sheet **26**, at which time a vacuum is drawn in the space **118** and the means **124** is moved apart from the stack of sheets **26** on the table **30**, so that the suction cup means **124** begins to support the weight of the sheet **26**, which is then in the position indicated by the dashed lines. The creation of a partial vacuum in the space **118** may be effected in any of the variety of ways, one of which is indicated schematically in FIGS. **5A**, **5B** and **5C**, to which reference is now made.

In this embodiment, the line **122** is connected to a valve **125** comprising a casing **126** and a valve member **128**. The valve

member **128** is operatively connected to a solenoid **130**, and the valve **125** has operative connections to a source of vacuum as at **132** and to a vent as at **134**. The solenoid **130** is connected by a line **136** to a control circuit **138**, which communicates also by a line **140** with a microswitch **142** having a lever **144** and operated by a cam **146** on the first arm segment **74**.

The mode of operation is as follows. The actuator arm **86** is operated by means of the cylinder **44** to bring the arm segments **74**, **76** into the position shown in FIG. **5A**, and this moves the lever **144** of the microswitch **142** into the position shown, so that by the operation of the control circuit **138**, the valve **125** is caused to connect the line **122** to the source of vacuum **132**. At the same time, the portion **104** of the second arm segment **76** is moved to a substantially horizontal position, and the suction cup means **106** is brought into contact with the sheet **26**. Thus, by operation of the vacuum means, the suction cup **124** is partially evacuated and the sheet **26** is lifted, as explained above in connection with FIG. **4**. At this time, the magnetic roller **78** is out of contact with the sheet **26**, so that there is no chance of the occurrence of double sheeting as a result of the action of the magnetic roller **78**.

The actuator arm **86** is then moved to the right, to cause the arm segments **74** and **76** to assume the position shown in FIG. **5B**. This raises the sheet **26** and brings it into contact with the magnetic roller **78**. At the same time, the lever **144** of the microswitch **142** is depressed by the action of the cam **146** on the first arm segment **74**, causing the control circuit **138** to operate the valve **125**, i.e., by rotating the valve member **128** by 90° counterclockwise, so that the line **122** is now connected to the vent **134**. This causes release of the partial vacuum in the suction cup means **106**. This is done neither too soon, since the sheet is now being held by the magnetic roller **78**, nor too late, since the partial vacuum in the suction cup means is completely released before any conveying of the sheet **26** by the remainder of the magnetic conveyor means is done. Thus, both premature dropping and tearing of the suction cup means are safely avoided.

Then, by further motion of the actuator arm **86**, the second arm segment **76** is brought into the position shown in FIG. **5C**, with the result that the sheet **26** is brought into contact with the lower reach **22** of the magnetic conveyor means. As can be seen, the suction cup means **106** is, at this time, safely out of contact with the sheet **26**.

Although the connection **134** mentioned above has been described as a vent, it is also within the scope of the invention to provide in place thereof a source of pressure, such as a connection to a tank of compressed air. Moreover, other electrical or pneumatic control schemes will suggest themselves to persons of ordinary skill in the art as equivalents for that described above.

Referring to FIG. **6**, there is shown an alternative embodiment of suction cup means, designated **106'**. The embodiment shown in FIG. **6** is generally similar to that shown in FIG. **4**, except that partial vacuum in the space **116'** is created to release without the use of an external force of vacuum. Instead, there is provided for the space **118'** a valve **150** that comprises a tubular portion **152**, a cap **154**, and a plunger **156** having a head **158** in sealing engagement with the opening **160** and urged there against by means of a compression spring **162**. An opening **164** provides for release of pressure in the bore in which the compression spring **162** is contained. Depressing the suction cup **124** against a sheet of magnetic material to be moved causes the head **158** of the plunger **156** to be moved away from the opening **160**, as a result of pressure buildup in the space **118'**, and when the pressure so created is released, the spring **162** forces the head **158** into engagement with the opening **160**, so that, as the lifting of a sheet begins, there is a partial vacuum in the spaces **116'** and **118'**, and the sheet is thus secured to the suction cup means **106'**. When release of the partial vacuum thus created is desired, the plunger **156** is pulled, to disengage the head **158** from the opening **160**. This may be done manually or by any of a variety of suitable mechanical means, such as will suggest themselves to persons of ordinary skill in the art.

Although in the particular embodiment described above, the transfer means **42** move, when bringing a conveyed sheet into contact with the lower reaches **22** of the belts **20**, in such a way as to give acceleration to the sheet, thereby more nearly matching its speed with that of the belts **20** and thus tending to reduce the likelihood of marking of the sheet when it comes into contact with the moving belt, it is also possible, when the avoidance of marking of the sheet is not an important consideration, to use apparatus wherein the sheet is moved oppositely to the direction of travel of the lower reaches **22** of the belts **20**. When this can be done, there may be a further advantage. The arclike motion of the arm of the transfer means **42** will tend to move the sheet immediately below the one being picked up backward, i.e., opposite to the direction of travel of the lower reaches **22**. If the transfer means **42** are so located and operated that the forward end of the sheet being conveyed is brought into contact with the belts **20** while at the same time the trailing end of the sheet rests upon the sheet below, the sheet so being handled will then cause the sheet immediately below it in the stack to be moved forward again, and by proper control of the two motions, it is possible to keep the stack from which the sheets are being taken substantially square.

While we have shown and described herein certain embodiments of our invention, we intend to cover as well any change or modification therein which may be made without departing from its spirit and scope.

We claim as our invention:

1. Apparatus for lifting a single sheet of paramagnetic material from a stack of such sheets, said apparatus comprising an arm having an upper end pivotally connected to a member above said stack and carrying releasable suction cup means and magnetic roller means at its lower end, said suction cup means being pivotally connected to said arm at its lower end, said arm being so constructed and arranged that said suction cup means may be brought into contact with said sheet while said magnetic roller means remains out of contact with said sheet, and that said magnetic roller means may be brought into contact with said sheet before release of partial vacuum in said suction cup means but after disengagement of said single sheet from said stack of sheets.

2. Apparatus as defined in claim **1** including a magnetic belt conveyor above said stack of sheets and to which said sheets are conveyed by said magnetic roller means, characterized in that said apparatus comprises means for releasing a partial vacuum in said suction cup means before said sheet is brought into contact with said conveyor.

3. Apparatus as defined in claim **2**, further characterized in that said magnetic conveyor is nonsagging, said magnetic conveyor comprising a magnet extending substantially throughout the length thereof and a belt containing magnetic material enclosed in flexible material.

4. Apparatus as defined in claim **2**, further characterized in that said arm comprises first and second arm segments, said first and second arm segments having means for maintaining a predetermined angular relationship between said segments, said first arm segment being pivotally connected to said magnetic conveyor, said second arm segment having first and second portions meeting in an obtuse angle, said magnetic roller means being positioned in the vicinity of the junction of said first and second portions and said suction cup means being pivotally connected to said second portion in the vicinity of the end of said second portion remote from said first arm segment.

5. Apparatus as defined in claim **4**, characterized in that said suction cup means comprises a valve containing an opening, a plunger member having a head adapted to register with and close said opening, and spring-biasing means for urging said head against said opening, said plunger means further having means for withdrawing said head from said opening to permit release of partial vacuum within said suction cup means.

6. Apparatus as defined in claim 4, further characterized in that said suction cup means comprises a suction cup adapted to be brought into contact with a sheet to be raised by said suction cup means, a line communicating with the interior space of said suction cup and with a source of vacuum, and a valve within said line for causing said line to communicate with gas at least atmospheric pressure.

7,. Apparatus as defined in claim 6, further characterized in that said apparatus further comprises a solenoid operatively connected with said valve, a cam on said first arm segment of said arm, and means operated by said cam for causing said solenoid to operate said valve to effect release of pressure in said suction cup means when said arm is moved to a preselected angular position.

8. A method for lifting a single sheet of paramagnetic material from a stack of such sheets, said method comprising

moving into contact with said sheet through an arcuate path of travel a transfer means comprising a suction cup means and a magnetic roller means mounted on a pivoted arm, said suction cup means coming initially into contact with said sheet while said magnetic roller means remains out of contact with said sheet,

initiating action of said suction cup means to create therein a partial vacuum by means of which said sheet is held to said transfer means,

thereafter bringing into contact said magnetic roller means and said sheet so that the weight of said sheet is supported by said magnetic roller means, and

releasing the partial vacuum in said suction cup means.

9. A method as defined in claim 8, characterized in that said step of initiating partial vacuum in said suction cup means is done by communicating vacuum with space within said suction cup means from an external source of vacuum.

10 A method as defined in claim 8, characterized in that said step of initiating vacuum within said suction cup means is done by forcing air from said suction cup means through a valved opening.

11. A method as defined in claim 8, said method further serving to convey said sheet to a reach of a magnetic conveyor, said method comprising the further step of

moving said transfer means to a position such that said sheet supported by said magnetic roller means is brought into contact with a belt comprising said reach of said conveyor.

12. A method as defined in claim 11, further characterized in that, while bringing said sheet into contact with said conveyor, said suction cup means is removed from contact with said sheet.