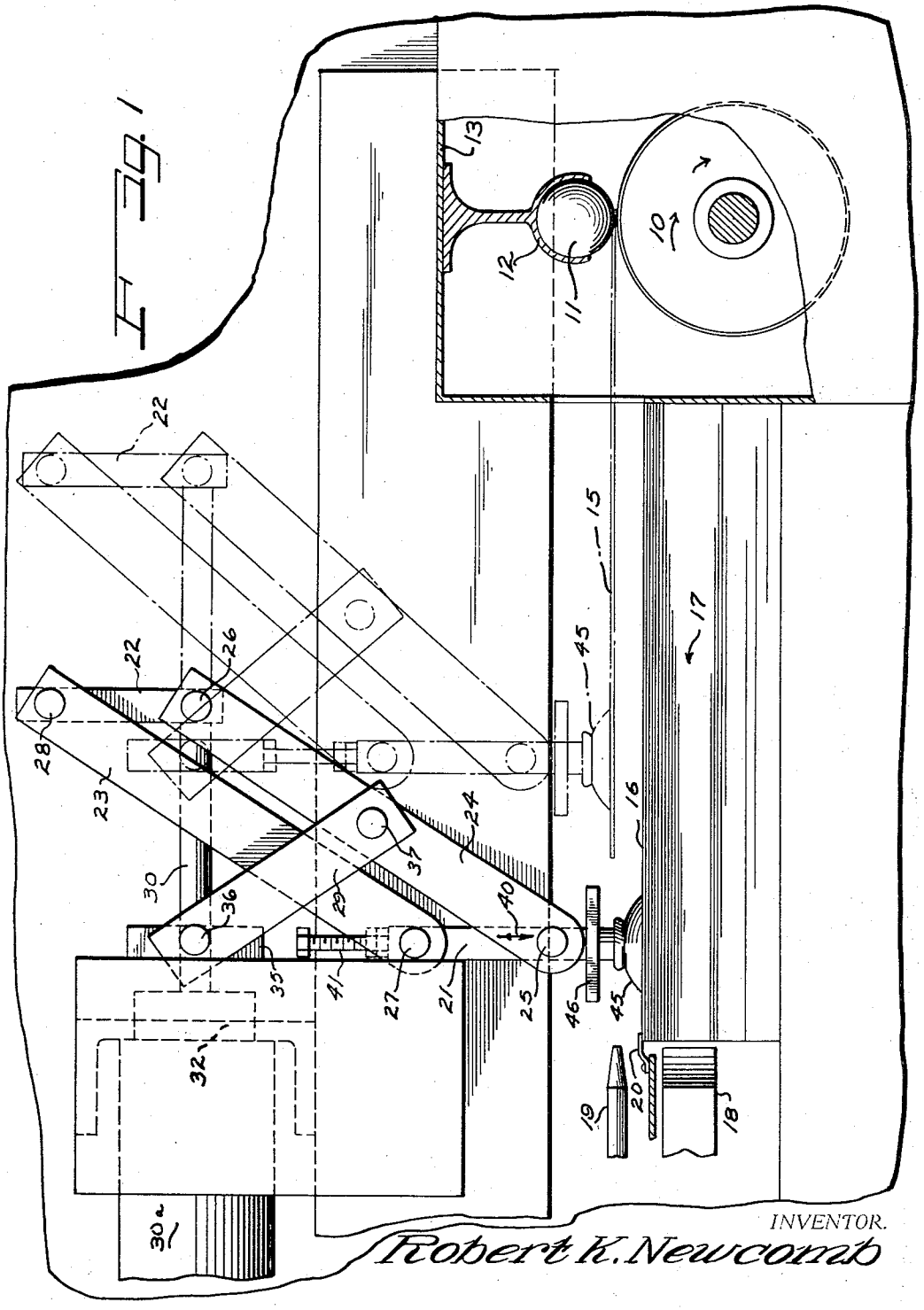
Feb. 27, 1968 R. K. NEWCOMB 3,370,845

SHEET FEEDING APPARATUS

Filed Sept. 7, 1965 3 Sheets-Sheet 1

Fig. 1



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SHEET FEEDING APPARATUS

Filed Sept. 7, 1965 3 Sheets-Sheet 2

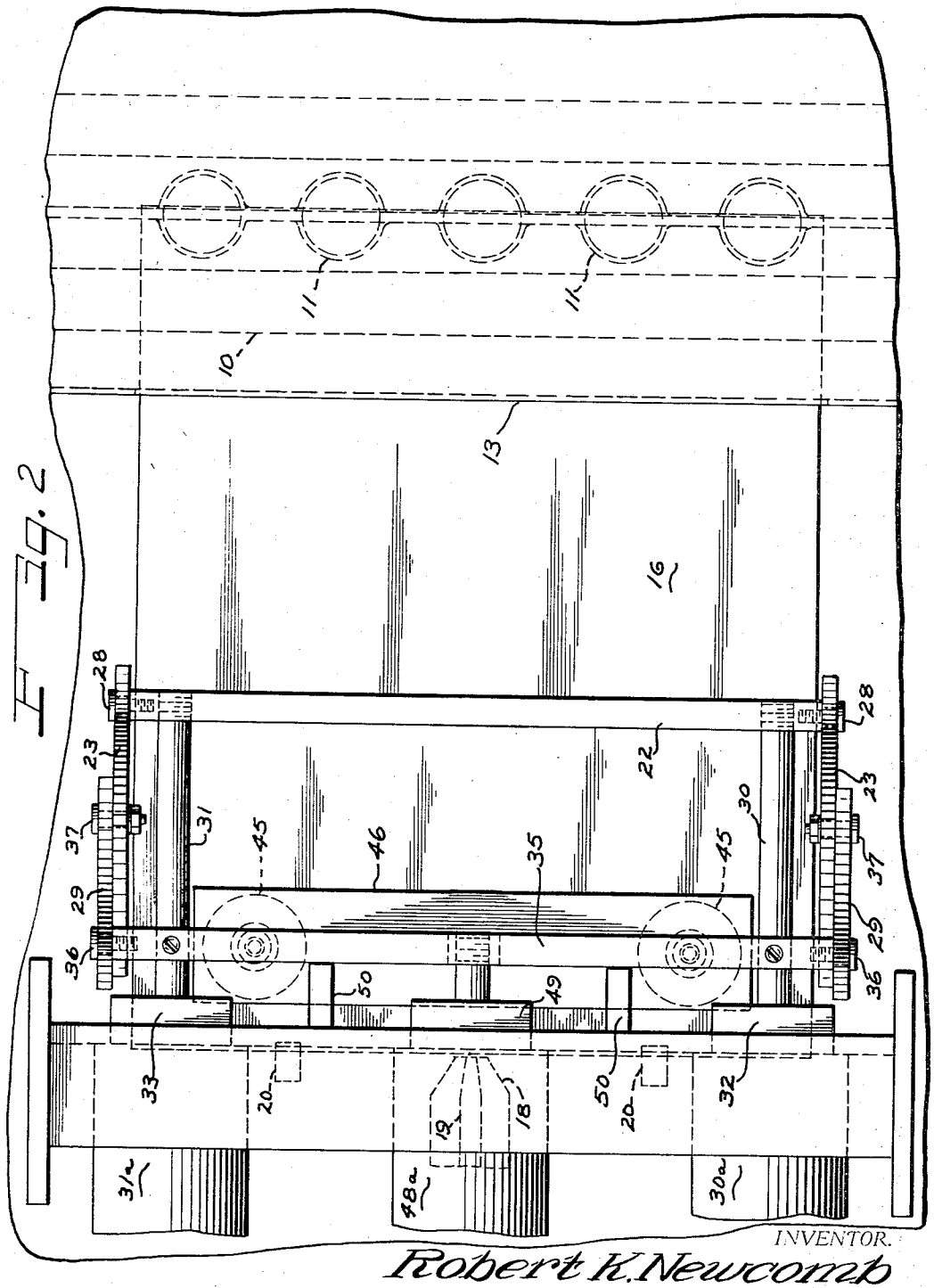

FIG. 2

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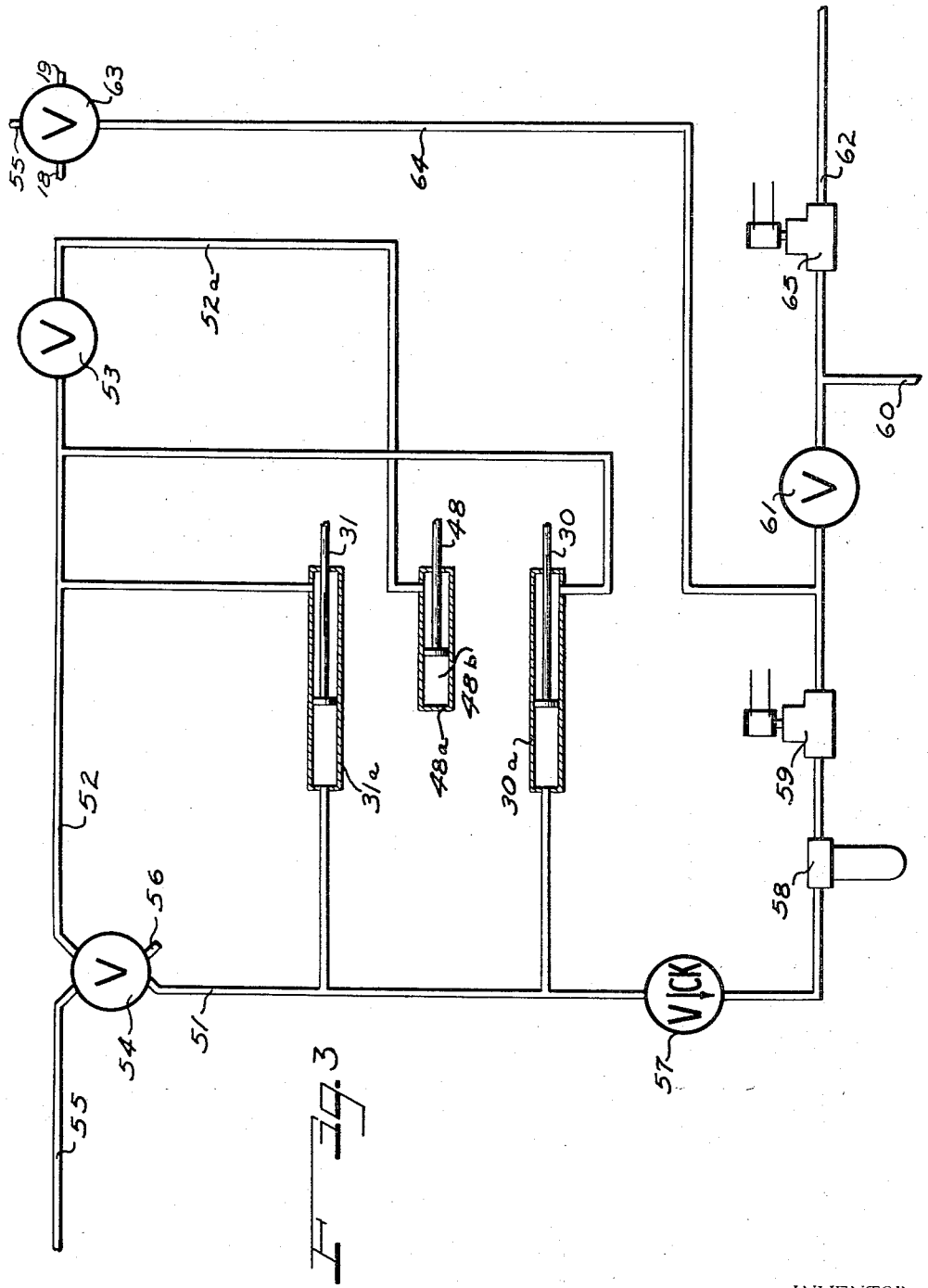

Fig. 3

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SHEET FEEDING APPARATUS

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11 Claims. (Cl. 271—26)

ABSTRACT OF THE DISCLOSURE

A sheet feeding mechanism for transporting the top sheet of a stack of sheets from a first position to a laterally removed position, including air means for separating the topmost sheet from the remainder of the stack and a mechanical linkage device moving a sheet lifting suction cup vertically and then horizontally, and conversely to successively feed sheets from the stack.

The present invention relates to apparatus for feeding sheet material and is, more particularly, concerned with the provision of a new and improved apparatus for transporting sheet materials from a stack to the inlet mechanism of a sheet processing apparatus.

In the handling of sheet materials, such as, for example, paper, it has been considered necessary to provide means for transferring a single sheet of the material from a stack of identical sheets, to processing apparatus, such as for example a printing press or the like. It has been found over the years that paper is a particularly difficult material to successfully uniformly feed on a sheet by sheet basis. In situations where the passage of more than one sheet by the feeding mechanism is cause for rejecting the processed sheet, the inconvenience and expense of an inaccurate feeding mechanism becomes extremely great. Accordingly, apparatus for successfully feeding one, and one only, sheet at a time from a stack of sheets has assumed great importance. While I am, of course, aware that sheet feeding devices of various sorts and descriptions have been constructed and sold in the prior art, the feeding system of the present invention is extremely simple in construction and operation, employs relatively inexpensive components, and is essentially fool-proof in operation.

In accordance with the principles of the present invention, a sheet feeding mechanism is provided for lifting a sheet from a stack of sheets, positively separatng the sheet from the sheets therebelow, and advancng the forward edge of the sheet into guide rollers or other inlet sheet controlling means. In effecting this, the top sheet of the stack is lifted adjacent its rearmost edge by a plurality of suction cups. Upon the initial vertical motion of the rear of the sheet of paper, a positive air blast is provided beneath the sheet for separating sheets immediately below the top sheet from the top sheet. Immediately following the vertical lifting of the rearmost edge of the sheet, and the application of an air blast which acts to suspend the sheet in mid-air, the suction cups are moved forwardly toward the inlet mechanism depositing the forward edge of the sheet into the inlet rolls or the like. Accordingly, the sheet-moving suction cups are provided with a progressive vertical and then forward mechanical movement, during which movement the application of an air blast to the sheet is likewise controlled. This combination motion is successfully achieved in accordance with the principles of the present invention in a relatively inexpensive, completely reliable manner.

In order to provide satisfactory suction cup motion along a rather complex path without the application of complicated mechanical equipment, I have provided a combination reciprocal and parallelogram linkage. Reciprocal motor means is provided for initially moving the forward edge of a parallelogram in a generally horizontal plane in a manner such that the trailing edge of the parallelogram is vertically moved. Additional motor means is provided for physically moving both the forward and trailing edges of the parallelogram in a horizontal plane to provide a subsequent substantially horizontal movement. These mechanical motions, coupled with a control for the application of air under pressure, and vacuum, have provided a unique sheet feed system.

It is, accordingly, an object of the present invention to provide a simplified sheet feed system.

Still a further object of my invention is to provide an improved system for separating the topmost sheet of material from a stack of such sheets and delivering such topmost sheet only to another apparatus.

A feature of the invention resides in the provision of a parallelogram linkage actuatable as a whole and in part by simple means.

Another feature of the present invention is the utilization of simple time-delay means in air pressure lines for providing a vertical lifting and laterally sideways combination feed motion.

Still another feature of the present invention is to provide a sheet feed mechanism automatically operable to provide efficient sheet pickup over a wide range of sheet pile height with a minimum of expense.

Still other and further objects and features of the present invention will at once become apparent to those skilled in the art from a consideration of the attached drawings and specification wherein one embodiment of my invention is shown by way of illustration only, and wherein:

FIGURE 1 is side-elevational view of a sheet feed mechanism constructed in accordance with the principles of the present invention:

FIGURE 2 is a plan view of the apparatus illustrated in FIGURE 1; and

FIGURE 3 is a diagrammatic illustration of the pneumatic and vacuum system employed in the apparatus of the present invention.

As shown on the drawings:

The sheet feed apparatus construction may readily be seen from a consideration of FIGURES 1 and 2. As there shown, a rotating feed roll **10** is rotatable in a clockwise direction as viewed in FIGURE 1 to pull sheets fed from the left thereof into machinery at the right. A plurality of spherical balls **11** are carried in ball sockets **12** secured to the frame **13** supporting the roll **10**. The balls **11** rest upon the sheet **15** as it passes between the roll **10** and the balls **11**. The balls **11** act to hold the sheet against the roll **10** and, accordingly, to provide a substantially positive grip contact between the sheet **15** and the pull roll **10**. It will, of course, be apparent to those skilled in the art that any number of different apparatus inlet feed mechanisms may be employed with the sheet feed apparatus of the present invention. The fundamental requirement is, only, that mechanism be provided, as in the case shown, for gripping a sheet as it is moved horizontally toward the feeding rolls, and moving the sheet to an internal process station of the machine. The embodiment illustrated has proven acceptable for feed purposes and, further, is particularly well adapted to the mechanical sheet feeding mechanism about to be described.

It is desired that the apparatus be constructed to feed the topmost sheet **16** of material, such as for example paper, from a stack of such sheet materials indicated at **17**. The stack **17** is kept substantially peripherally confined in an even stack. Air from a source under pressure is directed against the side of the stack **17** by way of air jets **18** and **19** the purpose of which will be more fully set forth below. Additionally, a relatively light

weight readily overpowered spring **20** is provided for maintaining the top sheet **16** properly in position on the stack **17** until selected. It will be noted that the spring **20** is preferably relatively soft and flexible and is not intended as a device for strongly gripping the top sheet **16**. Instead, it is intended only that a relatively small amount of holding force be applied to the top sheet **16** in a manner readily overpowered upon the application of means for removing the top sheet.

Apparatus for moving the top sheet **16** from the pile **17** is provided in accordance with the present invention. This apparatus comprises a pair of longitudinally, substantially vertically extending cross-pieces, or wall members **21** and **22**. The members **21** and **22** are connected to each other by parallelogram links **23** and **24** which are connected to the cross-pieces **21** and **22** by means of pivots **25**, **26**, **27** and **28**. As a result of the utilization of cross-pieces **21** and **22** with parallelogram links **23** and **24**, relative movement between the pieces **21** and **22** is controlled such that they remain substantially vertical at all times. Cross-piece **22** is reciprocably mounted in horizontal plane by way of a pair of reciprocal motor shafts **30**, **31** supported in sliding bearings **32** and **33** respectively. The shafts **30** and **31** pass slidably through a generally vertically disposed plate **35**. The plate **35** is connected to links **24** by way of a pair of links **29** pivotally connected at pivots **36** to plate **35** and pivots **37** to links **24**.

With the above mechanical linkage arrangement, it will be seen that if the cross-piece **22** is moved toward the right as viewed in FIGURE 1 when cross-piece **21** is in some manner restrained against movement toward the right, then the parallelogram linkage will require that the cross-piece **21** entirely move generally vertically in the direction of arrow **40**. Upward movement of the cross-piece **21** is terminated by contact of vertically extending adjusting screws **41** which contact the bottom of plate **35**. Continued movement of the cross-piece **22** toward the right requires, at this point, that the plate **35** and the cross-piece **21** move toward the right. This movement is permitted by the slide bearings **32**, **33** with the result that the parts assume the dot-dash line position in FIGURE 1. The result is, accordingly, that suction cups **45** carried by cross-piece **46** secured to the cross-piece **21** are moved first upwardly and then to the right toward the feed pull roll **10** carrying a selected sheet **15** into the nip between the roll **10** and the balls **11**. Upon completion of this motion, fluid power is applied in the opposite direction to the piston rods **30**, **31** tending to move cross-piece **22** toward the left as viewed in FIGURE 1. Simultaneously fluid power is applied to the plate **35** by means of piston rod **48** slidably carried in sleeve bearing **49** and secured to plate **35**. In view of this simultaneous motion of the rods **30**, **31** and **48**, cross-pieces **21** and **22** simultaneously move toward the left, causing the suction cups **45** to move toward the left without initially being lowered. Upon interception of the cross-piece **21** and the plate **35**, however, by vertical abutments **50**, further left-hand movement of cross-piece **21** and plate **35** is prevented. Accordingly, the parallelogram links **23**, **24** and the pivoted link **29** cause vertically downward sliding motion of the wall **21**, upon continued left-hand movement of the rods **30**, **31**. Accordingly, the suction cups **45** drop vertically downwardly until they contact the top of the pile of sheets **17**. In this connection it will be observed that continued downward movement of cross-piece **21** is limited only by the fact that such continued movement will cause pallelogram links **23**, **24** ultimately to contact each other and lock against further movement. When this locking ocurs, further movement of cups **45** downwardly cannot occur. This downward position controls the maximum depth of reach of the suction cups **45** and hence, the lowest permissible top of the stack **17**.

Energization of the piston rods **30**, **31** and **48** to accomplish the motions above described is provided, in a preferred embodiment of the invention, in a manner illustrated in diagrammatic form in FIGURE 3. As there shown, piston rods **30**, **31** and **48** are actuated, respectively, by pneumatic motors **30***a*, **31***a* and **48***a*, respectively. As illustrated, motors **30***a* and **31***a* are two-way motors which move the piston rods **30**, **31** toward the right upon the application of positive air under pressure to line **51**, coupled with simultaneously exhaustion of air via line **52**. Conversely, movement of the piston rods **30**, **31** toward the left is accomplished by the pressurization of line **52** and the depressurization of line **51**. Movement of piston rod **48** to the left is accomplished by pressurization of **52** coupled with venting of the chamber **48***b* to atmosphere.

As above described, it is desired that the piston rod **48** move toward the right with resistance so that it, in effect, trails the movement of piston rods **30**, **31**. This is accomplished by providing a restriction in line **52**, as at **53**, in the form of a valve which permits flow of pressurized air to motor **48***a* via conduit **52***a* without restriction but permits retrograde movement of the air from the motor **48***a* via conduit **52** and valve **53** only by way of a restriction in valve **53**. Accordingly, motion of the rod **48** is delayed, thereby causing cross-piece **21** to rise vertically prior to any right-hand or horizontal movement thereof, all as above described. It may be observed that restraint of the rod **48** in its movement toward the right may similarly be accomplished by providing a restrictive vent to the chamber **48***b* permitting the ingress of air into the chamber **48***b* only at a slow rate while providing unrestricted egress.

Valve **54** comprises a four-way valve of conventional form, such as for example a valve commonly marketed under the trade name "Humphrey Four-Way Valve." Such a valve is capable of conventional electrical control to connect an air pressure source **55** selectively to conduits **51** and **52** while simultaneously venting the unselected conduit to a low pressure exhaust or sump **56**. Thus, when valve **54** acts to connect source **55** to conduit **51**, it simultaneously vents conduit **52** to atmosphere via line **56** and, conversely, when valve **54** connects source **55** to conduit **52**, it vents conduit **51** to atmosphere via conduit **56**. As a result of the above arrangement, the mechanical movements of the suction cups **45** are controlled in the manner described.

Simultaneously with the pneumatic actuation of the suction cups **45**, vacuum and air under positive pressure are selectively applied to the cups. During the time that conduit **51** is pressurized and the rods **30**, **31** are being moved toward the right, air under pressure is permitted to pass one-way check valve **57** and line filter **58** to a solenoid valve **59**. Valve **59** is maintained in a closed condition until the suction cups reach their right-hand position and the top sheet of paper or the like is well within the feed mechanism **10**, **11**. At such time, a switch, not shown, which is preferably position-responsive, for example to the position of cross-piece **22** into its right-hand condition shown in FIGURE 1, is closed to open valve **59**. Upon energization of valve **59**, air under pressure is applied to suction cups **45** via conduit **60** and valve **61**. Upon pressurization of conduit **52**, however, and movement of the rods **30**, **31** toward the left, with resultant movement of cross-piece **22** toward the left, the position-responsive switch controlling solenoid is actuated to close valve **59** by deenergizing its control solenoid and to energize solenoid valve **65** to connect a source of vacuum **62** to the suction cups by way of conduit **60**.

In addition to the alternate positive air pressure and vacuum applied to the suction cups **45**, air under pressure selectively flows through jets **18** and **19**. Jet **19** provides a flow of pressurized air toward the right which blows beneath and floats selected sheet **15** after it has been lifted from the top of the stack **17**. This blowing air effectively separates any sheets that have remained

attached to the top sheet held to the suction cups **45** by vacuum. Jet **18** provides a vertical fan of air against the left-hand edge of the stack **17** aiding in keeping the sheets riffled for easy separation. In actual practice, air is selectively directed from jets **18**, **19** under the control of an air piloted valve **63** which directs air from a source **55** to jets **18** or **19** depending upon the air pressure in conduit **64**. Thus, during pressurization of the cups **45** by positive pressure in line **51**, the bottom jets **18** are activated. Upon connection of the cups **45** to a source of vacuum via conduit **62**, however, the pressure in conduit **64** drops connecting jets **19** to the source of air under pressure **55** to provide a separating jet for floating the top sheet away from the remainder of the stack while the sheet is gripped by the suction cups **45**. Valve **61** comprises a one-way restriction in the conduit **60** permitting a rapid build-up of pressure in the line **64** upon the application of pressure to the suction cups via line **51** and relatively slowly releasing such air under pressure by way of the suction cups **45**. At the same time, the application of vacuum to the line **64** is rendered gradual by the restriction valve **61**.

It will thus be seen that I have developed a very simple mechanical linkage actuated by power motors movable only in the horizontal direction, to provide both horizontal and vertical movements of the top sheet of a stack of sheet material. Movement of the top sheet is automatically effected and complete separation of the sheet from the stack is automatically positively accomplished by means of an air jet. I have found that the system above described has provided an extremely inexpensive and yet highly efficient automatic feed for sheet material, particularly of paper sheet material. I am, of course, aware that variations and modifications may be made without departing from the scope of the novel concepts of the present invention and it is, accordingly, my intention that the scope of the invention be limited solely by that of the hereinafter appended claims.

I claim as my invention:

1. In combination in a sheet feed mechanism for transferring a sheet from a first position to a laterally and vertically spaced second position, a suction cup, means applying a vacuum to said cup, horizontally movable motor means, mechanical linkage means connected to said cup and said motor means initially lifting said cup from a position in contact with said sheet in its first position and then moving said cup laterally toward said second position, and means applying air under pressure to said suction cup to release said sheet, said linkage means comprising a first member carrying said suction cup, a second member vertically and laterally spaced from said first member in the direction of said second position, rigid link means pivotally connecting said first and second members, pivot means pivotally connected to and supporting said link means between its pivot connections with said first and second members, reciprocal means connecting said horizontally movable motor means with said second member, and means controlling the position of said pivot means to control movement of said first member.

2. In combination in a sheet feed mechanism for transferring a sheet from a first position to a laterally and vertically spaced second position, a suction cup, means applying a source of vacuum to said cup, first and second horizontally movable motor means, and mechanical linkage means interconnected to said cup and said motor means initially lifting said cup from a position in contact with said sheet in its first position and then moving said cup laterally toward said second position, and means applying air under pressure to said suction cup adjacent said second position, said mechanical linkage means comprising a first member connected to said suction cup, a second member positioned vertically and laterally spaced from said first member in the direction of said second position, means connecting said first horizontally movable motor means to said second member for actuation of said second member in opposite directions to and from said first and second positions respectively, a third member horizontally slidable and positioned immediately above said first member, a first link pivotally connected to said second member and said first member, a second rigid link means pivotally connected to said third member and to said first link whereby movement of said second member toward said second position causes first member to move vertically upwardly into contact with said third member and further movement of said second member toward said second position causes said third member to move toward said second position therewith, said third member being connected for actuation in the direction from said second position to said first position by said second motor means.

3. In combination in a sheet feed mechanism for transferring a sheet from a first position to a laterally and vertically spaced second position, a suction cup, means applying a source of vacuum to said cup, first and second horizontally movable motor means, and mechanical linkage means interconnected to said cup and said motor means initially lifting said cup from a position in contact with said sheet in its first position and then moving said cup laterally toward said second position, and means releasing the vacuum from said suction cup adjacent said second position, said mechanical linkage means comprising a first member connected to said suction cup, a second member in the direction of said second position, means connecting said first horizontally movable motor means to said second member for actuation of said second member in opposite directions to and from said first and second positions respectively, a third member horizontally slidable and positioned immediately above said first member, a first link pivotally connected to said second member and said first member, a second rigid link means pivotally connected to said third member and to said first link whereby movement of said second member toward siad second position causes the first member to move vertically upwardly into contact with said third member and further movement of said second member toward said second position causes said third member to move toward said second position therewith, said third member being connected for actuation in the direction from said second position to said first position by said second motor means, and a third rigid link connecting said first and second members at points spaced substantially equally from the respective points of connection of said first link with said first and second members whereby said first and second members and said first and third links comprise substantially a parallelogram requiring movement of said first and second members in an upright condition.

4. The construction in accordance with claim **2** wherein the length of said second link equals substantially one-half the length of said first link and is pivotally connected at the mid-point of said first link.

5. The construction in accordance with claim **3** wherein the length of said second link equals substantially one-half the length of said first link and is pivotally connected at the mid-point of said first link.

6. The construction of claim **2** wherein means is provided retarding movement of said third member toward said second position whereby said third member moves toward said second position under the influence of said first motor means and said linkage.

7. The construction of claim **3** wherein means is provided retarding movement of said third member toward said second position whereby said third member moves toward said second position under the influence of said first motor means and said linkage.

8. Apparatus constructed in accordance with the provisions of claim **6** including control means providing energization of said first and second motor means from said second position toward said first position simultaneously.

9. Sheet feed apparatus constructed in accordance with the provisions of claim 6 wherein abutment means are positioned to intercept said first member upon movement of said first member to said first position from said second position and prevent further movement of said first member in that direction causing vertically downward movement of said suction cup.

10. The construction in accordance with claim 2 including four-way valve means for directing air under pressure to said first movable motor means to move said second member toward said second position and alternatively to energize said first and second motor means to move said first and second members toward said first position.

11. The construction in accordance with claim 10 including position-responsive switch means for actuating said four-way valve in response to the position of said second member to alternately move said second member from said first position to said second position and vice versa.

References Cited

UNITED STATES PATENTS

949,850	2/1910	Smith.	
2,566,175	8/1951	Danielsson	271—26
2,812,061	11/1957	Pfister	271—26 X
3,079,147	2/1963	Childs	271—26
3,199,863	8/1965	Muller	271—26

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