Jan. 20, 1970 D. P. DARWIN 3,490,763

MECHANISM FOR FEEDING SHEET MATERIAL

Filed June 15, 1967 3 Sheets-Sheet 1

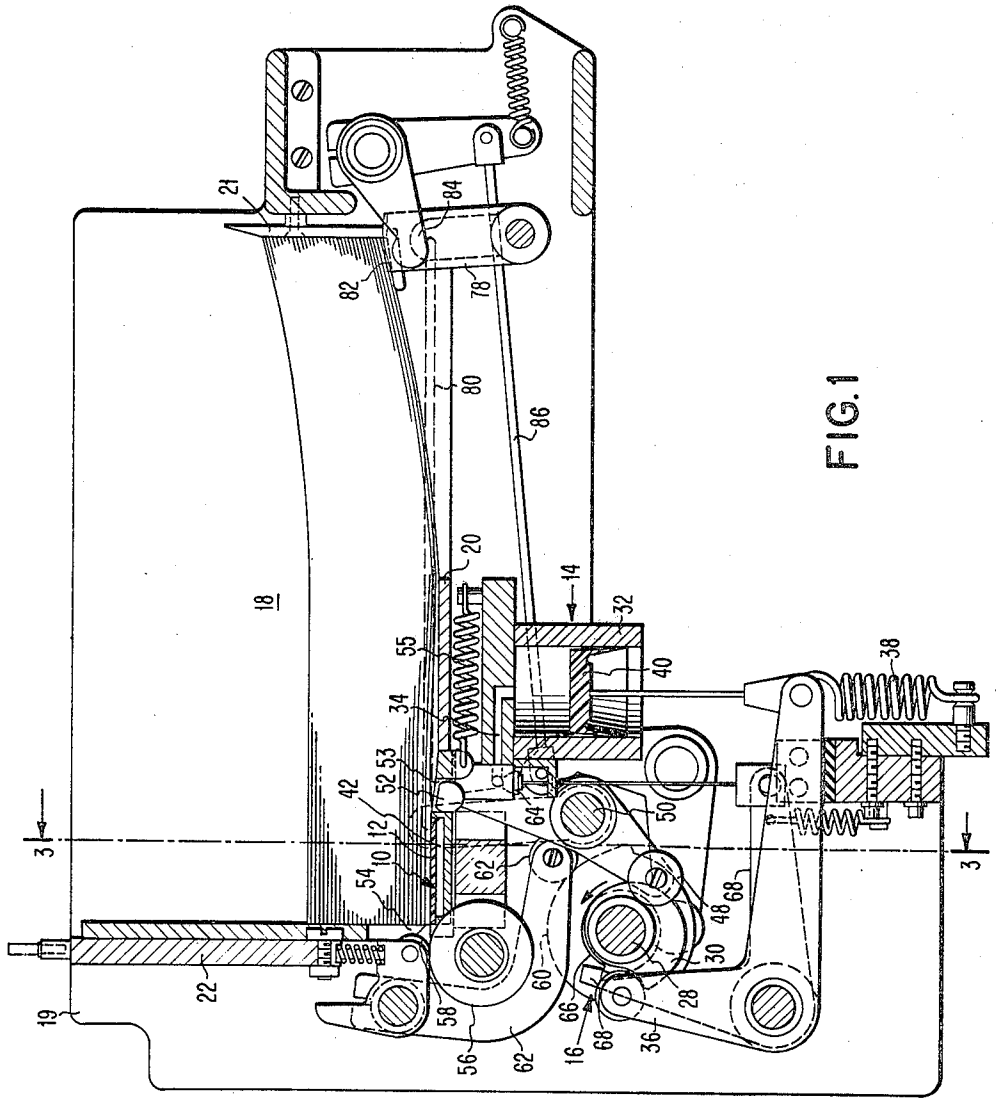

FIG. 1

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MECHANISM FOR FEEDING SHEET MATERIAL

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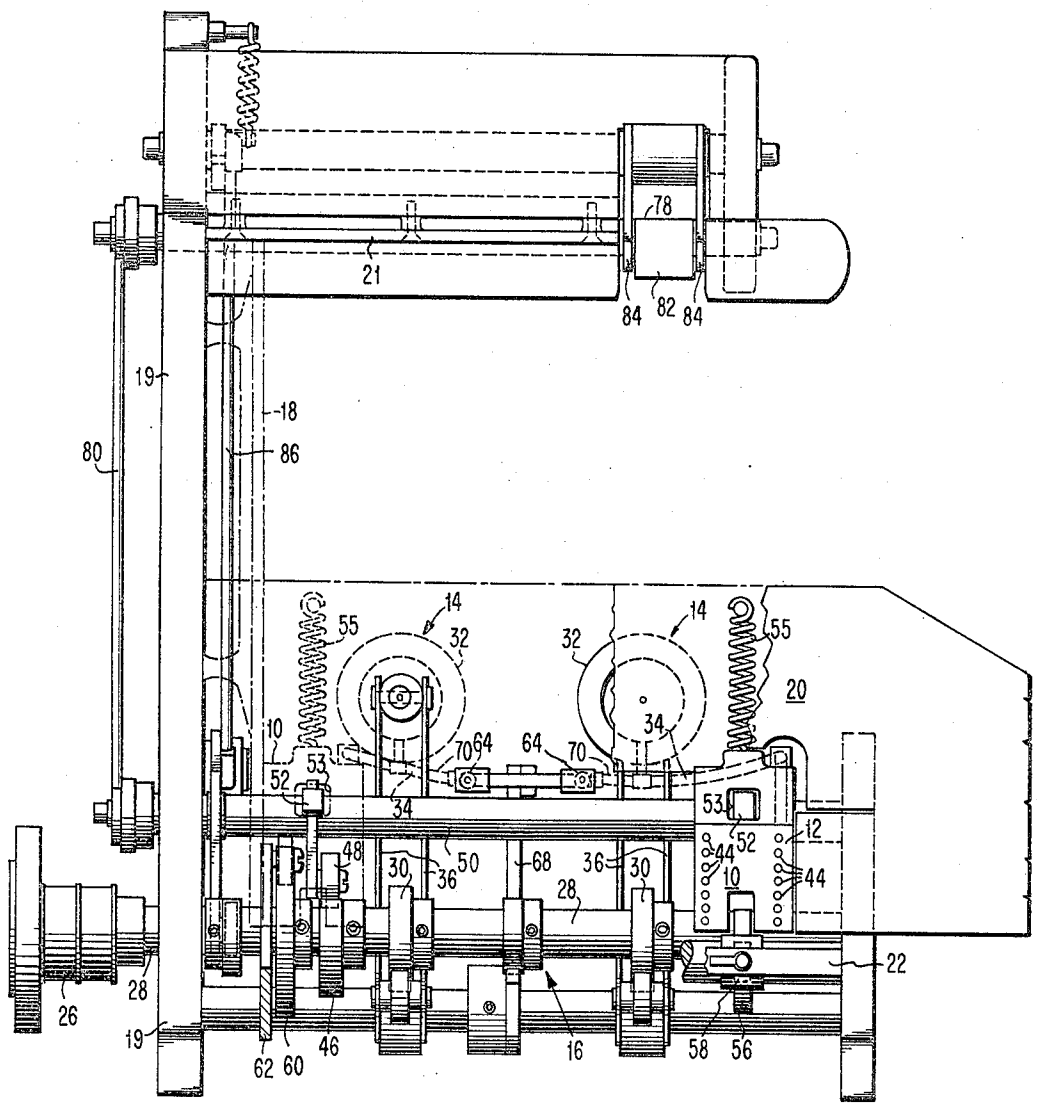

FIG. 2

MECHANISM FOR FEEDING SHEET MATERIAL

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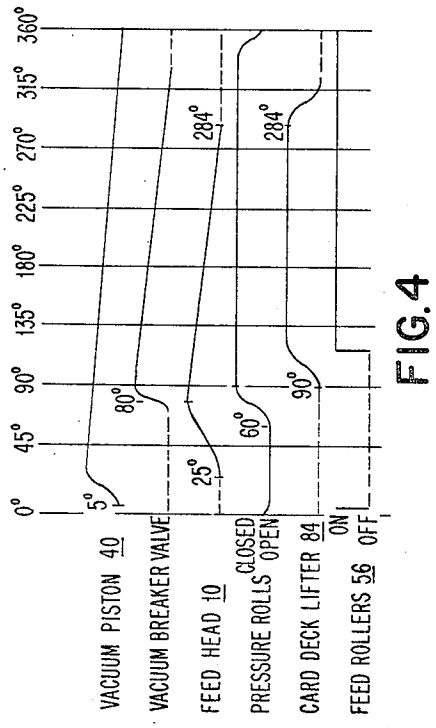

FIG. 4

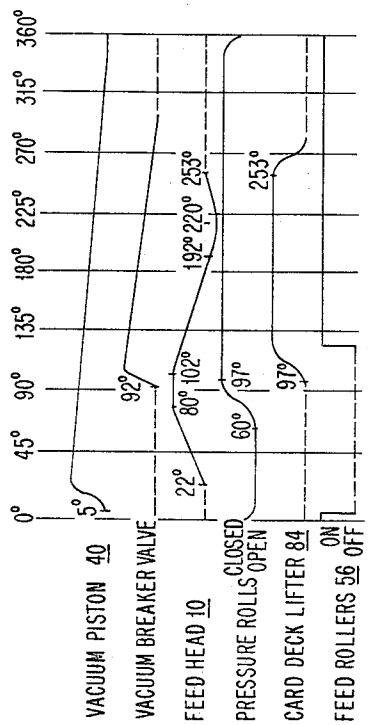

FIG. 5

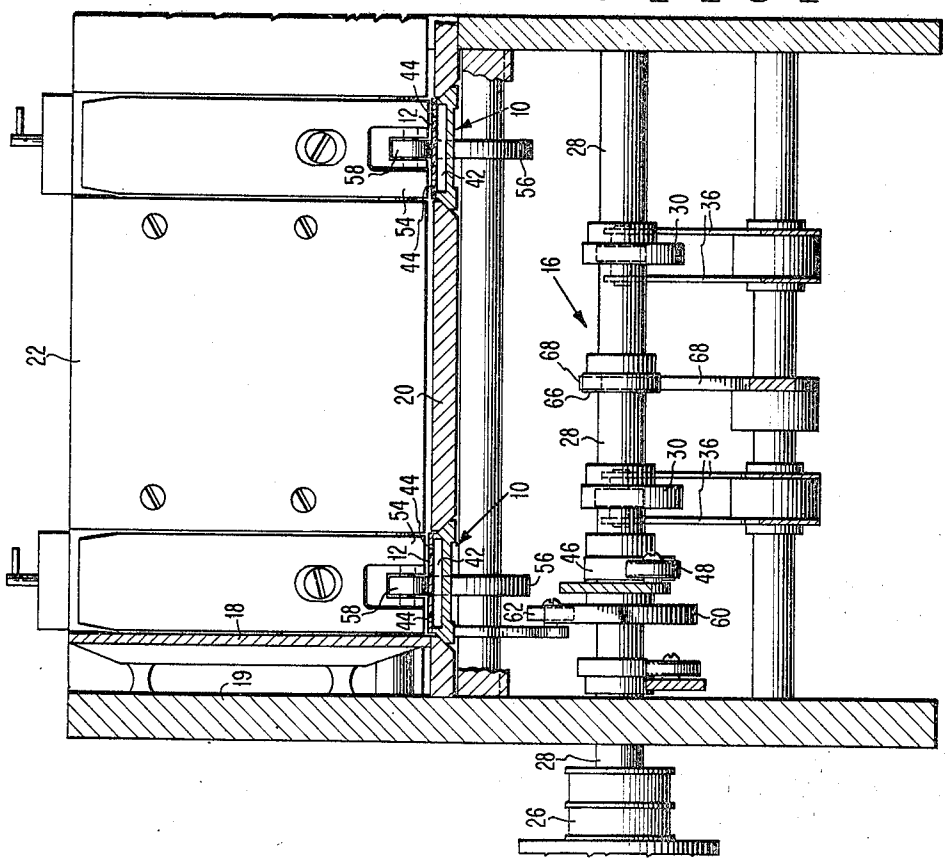

FIG. 3

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MECHANISM FOR FEEDING SHEET MATERIAL

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Int. Cl. B65h 29/24, 1/06
U.S. Cl. 271—32 4 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for selectively feeding sheets along a feed path one at a time from the bottom of a stack of sheets comprising a vacuum feed head mounted adjacent to the leading edge of the sheets, a high-friction material covering the feed head, means for selectively applying to the feed head a vacuum which works through the high-friction material to pull the bottom sheet closely adjacent to the feed head and means synchronized with the vacuum applying means for moving the feed head along the feed path to shear the bottom sheet from the stack.

BACKGROUND OF THE INVENTION

This invention relates to a mechanism for feeding sheet material and more particularly to mechanism for feeding sheets one at a time from the bottom of a stack.

This invention is particularly applicable for use in an input/output machine operating with a data processing system wherein different size sheets are fed into the input/output machine. Precision feeding of record cards is accomplished by prior art devices such as picker knives, but these devices are not suitable for feeding sheets due to the size and flexibility of the sheets. Sheet feeding mechanisms are available for feeding sheets at high rates which usually utilize some form of vacuum assist in feeding. However, these mechanisms do not produce the shear force necessary to feed sheets reliably from the bottom of a stack of sheets. The shear force cannot be increased by an increase in the vacuum force since it has been found that higher vacuum levels are effective through several sheets due to the porous nature of the sheets and, thus, tend to hold these sheets together and actually increase the shear force necessary to feed the sheets. It is a primary object of this invention to provide an improved sheet feeding apparatus wherein sheets of different sizes and thicknesses can be fed from the bottom of a stack with the same precision and reliability as record card feeding apparatus.

It is another object of this invention to provide sheet feeding apparatus for selectively feeding a single sheet from the bottom of a stack.

It is a further object of this invention to provide a sheet feeding apparatus suitable for feeding a single sheet in a precise position synchronized with the operation of the associated processing machine.

SUMMARY OF THE INVENTION

According to the invention, apparatus is provided for selectively feeding sheet materials one at a time along a predetermined path from the bottom of a stack by means of a vacuum selectively applied to a vacuum feed head covered by a high-friction material so that the vacuum pulls the sheet to the feed head and driving means synchronized with the vacuum applying means is actuated to move the vacuum feed head along the predetermined path as the form is held firmly to the high-friction material and moved along the path to feed the bottom sheet from the stack.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a side view, with some parts cut away, of the sheet feeding apparatus embodying the invention.

FIGURE 2 is a top view of the sheet feeding means shown in FIGURE 1.

FIGURE 3 is a section view of the sheet feeding apparatus taken along the line 3—3 of FIGURE 1.

FIGURE 4 is a cam timing diagram showing the relative times at which the components of the mechanism are actuated.

FIGURE 5 is a cam timing diagram of another embodiment of the invention.

Referring to the drawings, there is shown a sheet feeding device for selectively feeding sheet material, one at a time, along a predetermined path from the bottom of the stack of sheets. Sheets are placed in hopper **18** with one edge aligned along side member **19** and another edge aligned along front member **22**. Associated with bottom member **20** of the hopper is a vacuum feed head **10** mounted adjacent to the leading edge of the sheet. A cover **12** of high-friction material is fixedly mounted to cover the feed head. A vacuum applying means **14** is coupled for selectively applying a vacuum to the feed head and a control means **16** is actuable to move the vacuum feed head in synchronism with the vacuum applying means so that the sheet is firmly held to the vacuum feed head and is moved along the predetermined path as the vacuum feed head moves.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the embodiment of the sheet feeding mechanism shown in the drawings, hopper **18** comprises a bottom member **20** disposed at substantially right angles to the front member **22**. The sheets are placed in hopper **18** so that the leading edges of the sheets are aligned along front member **22** of the hopper and a path is provided to feed the bottom sheet in the stack out of the hopper to a utilization device. The motive force to drive the components of the sheet feeding mechanism is supplied by a suitable motor (not shown) and the motor is coupled through a selectively operable clutch **26** to drive a feeding control means **16**. Feeding control means **16** comprises a plurality of cams and associated follower mechanism to provide the precision positioning of the sheet relative to the other components of the input/output machine and these components are described in detail below.

In the embodiment of the invention shown in the drawings, two vacuum feed heads **10** are slidably mounted in a spaced-apart manner in bottom member **20** of hopper **18** and positioned to engage the leading edge of the bottom sheet in the hopper. Directly opposite each of the feed heads are mounted throat knives **54**, and the throat knives are spaced from heads **10** by substantially the thickness of the sheet to be fed. This spacing provides an exit from hopper **18** aligned to pass only the bottom sheet. Since it is desired to feed sheets having different thicknesses such as standard sheets of paper, ledger cards, record cards, and postal cards, the throat knives are adjustable relatives to the feed heads to permit manual selection of the form thickness by the operator.

Referring to FIGURE 4, it can be seen that the first step in feeding a sheet provided by the feeding control means is to actuate the vacuum producing means. After the vacuum has attracted the sheet to the feed head, the next step provided by the control cams is a forward movement of the feed heads. Since the vacuum holds the sheet in intimate contact with the high-friction surface

of the feed head, the bottom sheet is sheared from the pack and moved along the feed path without damage. The vacuum to the feed heads is interrupted at the end of the forward movement of the feed heads **10** and a pressure roll is then moved closely adjacent to the clutched feed-roll which drives the sheet the remainder of the distance from the hopper and to the utilization station. The feed head is returned to its initial or feed ready position under control of the cam. The return movement of feed heads **10** is timed so that the high-friction material is covered by the sheet being fed during the entire return movement. Because of this timing, the second sheet from the bottom of the stack is not fed in a backward direction due to contact with the high-friction material covering as the vacuum feed head is returned.

In the embodiment of the sheet feeding apparatus shown in the drawings, the feeding control means **16** is powered by a motor. The motor is running continuously when power is on for the machine, and when it is desired to feed a sheet a suitable control signal such as a FEED A SHEET signal from the associated processing machine is sent to selectively actuate a feed clutch **26**. The actuation of clutch **26** couples the motor to drive main cam shaft **28** for one cycle. A plurality of cams are mounted on shaft **28** to provide the control for various components of the feeding apparatus in synchronism with the other components of the feeding apparatus. The sheets are disposed in hopper **18** so that the leading edge of the sheet is over a vacuum feed head. When shaft **28** is running, cam **30** controls a means for applying vacuum to the feeding apparatus. In the embodiment shown, the means for applying vacuum to the apparatus comprises a cylinder **32** which is coupled by pipe **34** to the vacuum feed head **10**. At the selected point in the cycle (see FIGURE 4), cam follower member **36** engages a sharp fall on cam **30** and under the force of spring **38** causes the plunger member **40** to be lowered, thereby creating a vacuum in the cylinder which is coupled to the feed head **10** by means of pipe **34**. The vacuum feed head comprises an enclosure **42** which has an opening coupled to pipe **34** at one point and has a planar cover member **12**. Cover member **12** is made from a high-friction material and the vacuum feed head is mounted for back-and-forth movement relative to the leading edge of the sheet so that when vacuum is applied to the vacuum feed head, the bottom sheet in the stack is drawn to the high-friction material and the sheet is then fed along the feed path as the feed head is moved, due to the frictional engagement with the cover member producing a greater shear force than the frictional force between the bottom sheet and the adjacent sheet and the hopper bottom plate.

Any suitable material may be used for cover member **12** of high-friction material which is mounted to cover the vacuum feed head. The cover must have sufficient openings for the vacuum to engage the sheet to a closely abutting position without having openings large enough that the sheets are deformed by the vacuum. One suitable material is a vitreously bonded abrasive material commonly used for grinding wheels. The coefficient of friction of the material is quite high and the porous nature of the material permits the vacuum to act through the pores to attract the bottom sheet to the feeding pads. Another suitable material for the cover of the feed head is a polyurethane rubber. Since this material is not porous, a plurality of spaced apart small holes **44** (see FIG. 2) are provided in the material so that the vacuum pulls the sheet into contact with the feed head. While the coefficient of friction of this material is not as great as the grinding wheel material, this material provides sufficient shear force and sufficient stiffness to operate in the embodiment shown in FIGURE 1. In this embodiment a polyurethane rubber having a surface durometer hardness of about 50 to 90 was found suitable. In the embodiment shown in FIGURE 1, the hopper is disposed at an angle of approximately 60 degrees to the vertical to lessen the pull-out force on the bottom sheet. It can be seen that a hopper in which the sheets are stacked horizontally has a maximum pull-out force whereas a hopper wherein the sheets are disposed vertically has a considerably lower pull-out force requirement. Since it is a requirement of the input/output machine that sheets be loaded into the hopper at any time without stopping the machine, the hopper must be capable of having sheets added in their normal disposition while the machine is running. For this reason, the sheets are disposed at the greatest angle from the horizontal which does not require a follower member or weight to feed sheets from a stack, whether one sheet or a complete stack is present, one at a time from the bottom of the stack.

The movement of feed head **10** is controlled by a cam **46** on shaft **28** which is engaged by follower member **48**. Follower member **48** is pinned to shaft **50** and an arm **52** which is pinned to shaft **50** fits in a slot **53** in the trailing edge of feed head **10** to move the feed head responsive to the contour of cam **46** against the force of spring **55**. The sheet next to the bottom sheet is prevented from moving along with the bottom sheet by a throat knife **54** which is mounted in the front wall **22** of hopper **18** and adjusted so that the space between throat knife **54** and feed head **10** is greater than the thickness of one sheet being fed, but less than the thickness of two of the sheets. A set of feedrolls **56** is spaced a short distance along the card path in front of the feed head. At the properly timed point in the cycle (see FIGURE 4), a pressure roll **58** is lowered to force the sheet into engagement with feedroll **56**. Just after the pressure rolls are lowered, the clutch driving feedrolls **56** is tripped from a cam on shaft **28**. Feedrolls **56** then feed the sheet to its utilization station. Pressure roll **58** is controlled by cam **60** through follower member **62**. When the sheet has progressed to the point at which the sheet is to be driven by the feedrolls, it is desired to release the vacuum from feed head **10**. This is accomplished by a vacuum breaker valve **64** which is controlled by cam **66** in conjunction with follower member **68**. Vacuum breaker valve **64** is coupled through pipe **70** to vacuum feed head **10** and valve **64** functions to couple pipe **70** to atmospheric pressure, thereby releasing the vacuum in feed head **10**. During the remainder of the cycle as the sheet is being fed from the hopper by means of feedrolls **56**, the feed head **10** is being restored to its feed-ready position. The restore of feed head **10** takes place while the trailing edge of the sheet covers the high-friction material so that there is no tendency to feed the second sheet in the stack in a backward direction as the feed head is restored. In some cases it may be desirable to reduce the friction on the bottom sheet in the stack to as great a degree as possible. In such cases, the rear of the deck is supported on a member **78** which moves in synchronism with feed head **10** by means of link **80**. This member **78** has a high-friction face **82** to further enhance its ability to drive the sheet in contact with it. After feed head **10** and member **78** have completed, by pull rod **86**, their forward motion and before feedrolls **56** start driving the sheet further, a lifter member **84** is operated to raise the rear of the deck from the high-friction material **82** on the face of member **78**, thus eliminating the tendency to drag the new bottom sheet backwards during the restoration of member **78**.

A major cause of damage in sheets fed from the bottom of the stack is damage caused by the second sheet from the bottom of the stack being accelerated into the throat knife. To prevent this type of sheet damage, an alternate embodiment of the invention may be used. This embodiment comprises different timing of the components of the machine as shown in FIGURE 5. In this embodiment of the sheet feeding mechanism, the feed heads **10** are retracted beyond the normal feed position while the bottom sheet in the hopper covers the high-friction material. The feed heads are then restored to feed position

at a time when the feeding of the bottom sheet has progressed to the point at which the bottom sheet begins to uncover the high-friction material. The restore of the feed head to feed position thus imparts a frictional force on the second sheet from the bottom of the stack timed to move the sheet adjacent to the throat knife. However, since the bottom sheet has not left the throat, the second sheet is not fed past the picker knife. This operation insures that the bottom sheet in the hopper is always properly aligned adjacent to the throat knife so that the leading edges of the sheets are not damaged by being accelerated into the throat knife.

The embodiment of the invention which has been shown and described permits sheets of various lengths to be fed from the hopper without adjustment of any of the components. This is possible because of the spaced-apart relationship of the vacuum pistons and the independence of the vacuum source in the two cylinders. In apparatus operating from a vacuum pump wherein two openings for the vacuum are provided, there is a possibility that the opening of one of the openings to the atmosphere will reduce the vacuum level to the point that the feed will not be reliable.

The apparatus described can also be adapted to feed sheets of different widths by properly aligning the leading edge of the sheet adjacent to the throat knife. One simple way to accomplish this purpose is to make the back wall **21** of the hopper adjustable. In this embodiment of the apparatus, the deck lifter could not be utilized unless this mechanism is designed also to be adjustable relative to the front wall of the hopper.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in the form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A sheet feeding device for selectively feeding cut forms one at a time along a predetermined path from the bottom of a stack of forms comprising:

a vacuum feed head slidably mounted adjacent to the leading edge of said form;

a cover of high-friction material fixedly mounted to cover said feed head;

means for selectively applying a vacuum to said feed head;

means synchronized with said vacuum applying means to move said vacuum feed head from an original position along the predetermined path whereby said form is held firmly to said material and is moved along the predetermined path as the vacuum feed head moves;

pusher means having a high friction surface;

means for moving said pusher means in synchronism with said means for moving said vacuum feed head to assist in shearing the bottom sheet from the stack;

means for removing said vacuum to said feed head after a predetermined time; and

means for restoring said feed head to its original position after said predetermined time.

2. The sheet feeding device according to claim **1** further comprising a pack lifter member and means for actuating said pack lifter member in synchronism with said means to restore said feed head to prevent feeding the next to bottom sheet in a reverse direction.

3. A sheet feeding device for selectively feeding cut forms one at a time along a predetermined path from the bottom of a stack of forms comprising:

a vacuum feed head slidably mounted adjacent to the leading edge of said form;

a cover of high-friction material fixedly mounted to cover said feed head;

means for selectively applying a vacuum to said feed head;

means synchronized with said vacuum applying means to move said vacuum feed head from an original position along the predetermined path whereby said form is held firmly to said material and is moved along the predetermined path as the vacuum feed head moves;

means for removing said vacuum to said feed head after a predetermined time;

means for restoring said feed head to its original position after said predetermined time;

a pack lifter member; and

means for actuating said pack lifter member in synchronism with said means for restoring said feed head to prevent feeding the next to bottom sheet in a reverse direction.

4. The method of feeding sheets one at a time along a feed path from the bottom of a stack comprising:

placing the sheets adjacent to a feed head having a high-friction cover member,

applying a vacuum to said feed head to pull said bottom sheets closely adjacent to said cover member,

moving said feed head along said feed path to shear said bottom sheet from the stack and partially remove said bottom sheet,

exhausting the vacuum in said feed head,

feeding said bottom sheet the remainder of the way from said stack, and

returning said feed head path the feed ready position prior to the time the trailing edge of the bottom sheet moves past said feed head, and moving said feed head to the feed ready position while said bottom sheet partially uncovers said feed head so that the next to bottom sheet is urged in a feeding direction.

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EDWARD A. SROKA, Primary Examiner

U.S. Cl. X.R.

271—44

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,490,763 Dated Jan. 20, 1970

Inventor(s) D. P. Darwin

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In Col. 6, line 40, the word "path" should read --past--.

SIGNED AND
SEALED
JUN 23 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents