Sept. 20, 1960 J. G. SMITH 2,953,371

SHEET FEEDER

Filed Dec. 31, 1957 2 Sheets-Sheet 1

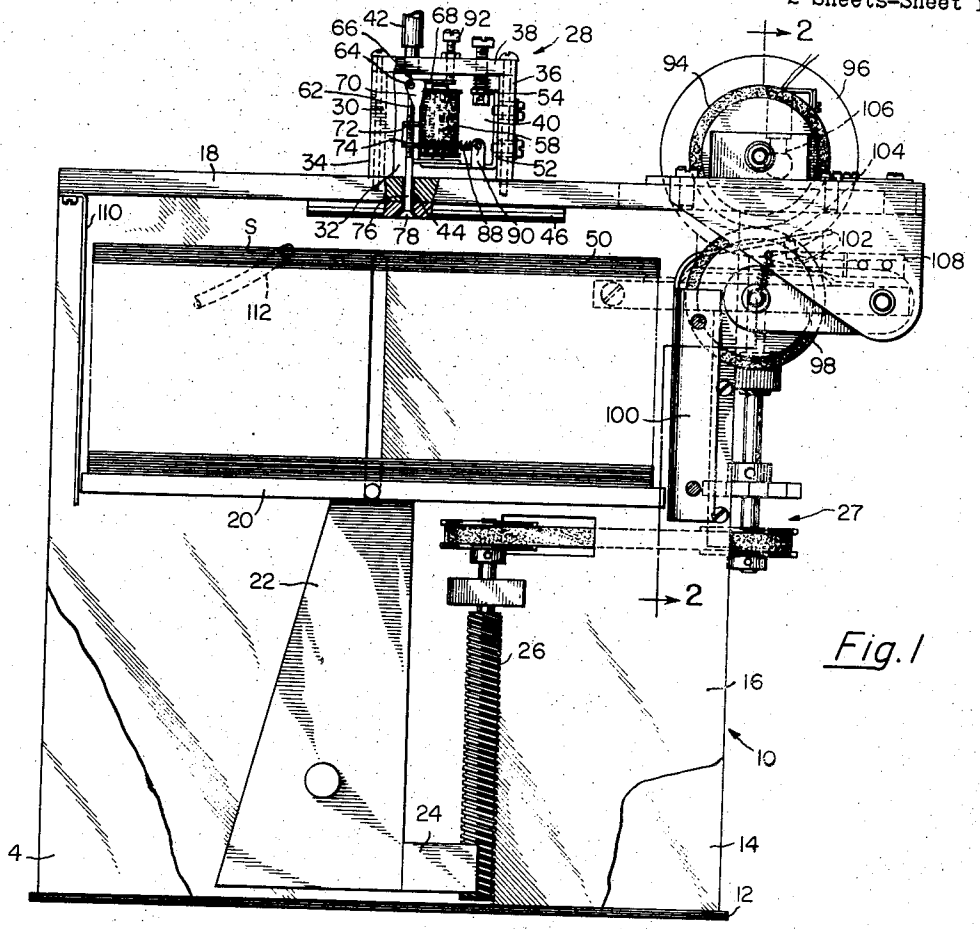

Fig. 1

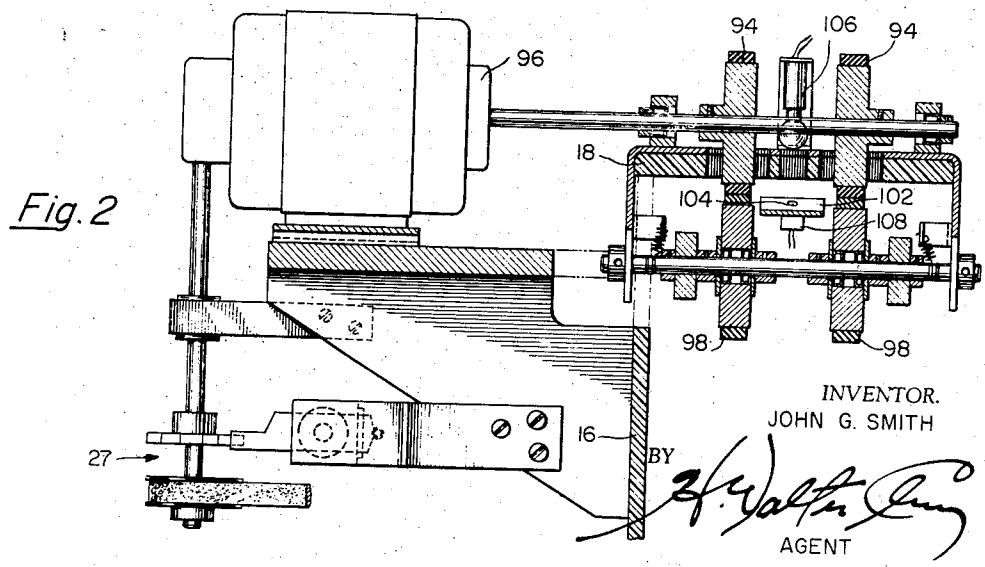

Fig. 2

INVENTOR.
JOHN G. SMITH
BY
AGENT

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Fig. 3

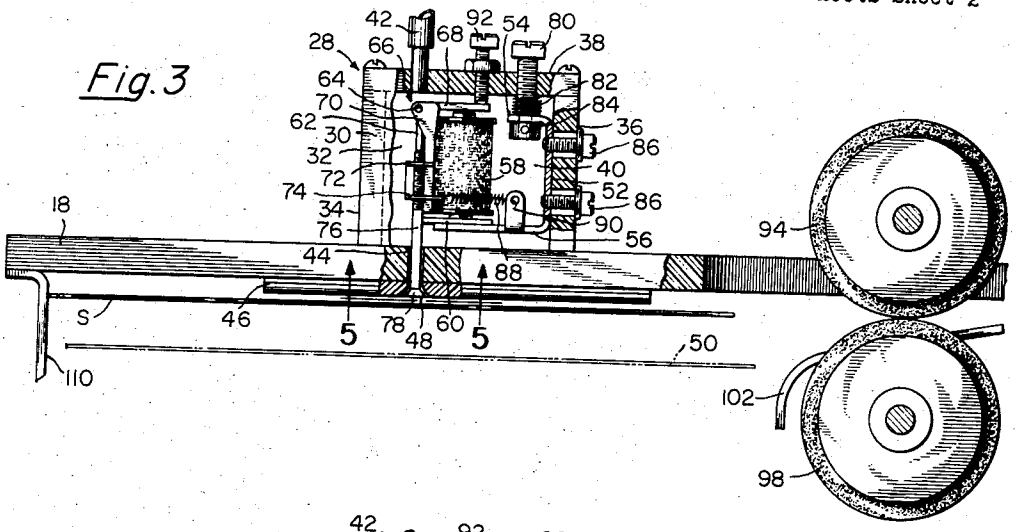
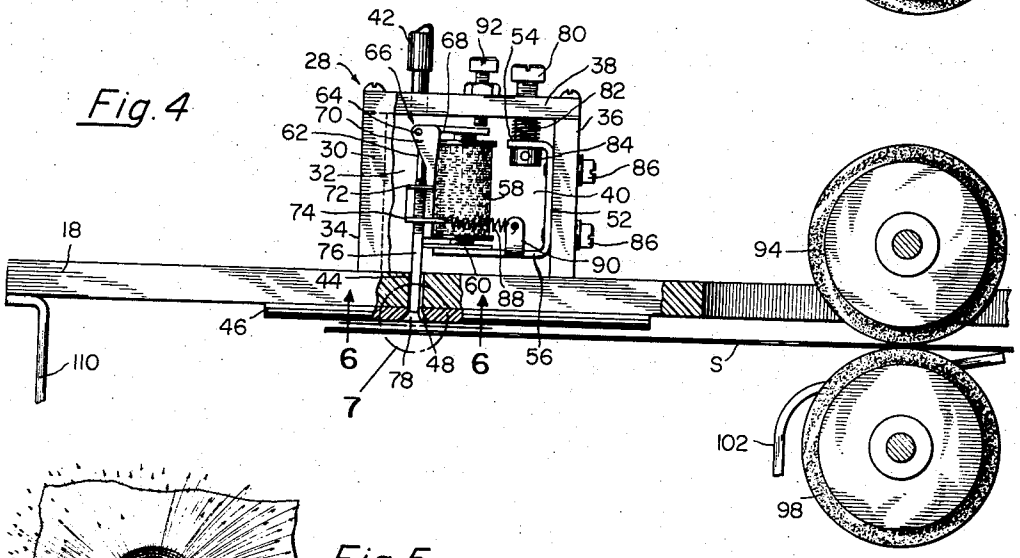


Fig. 4



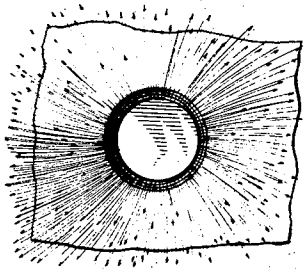


Fig. 5

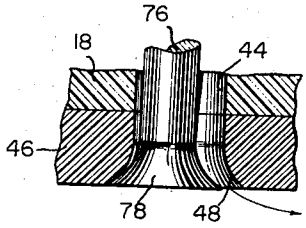


Fig. 7

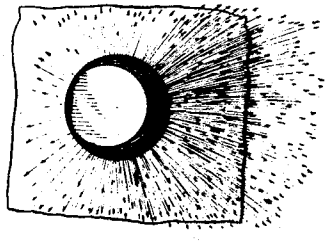


Fig. 6

INVENTOR.
JOHN G. SMITH

BY

AGENT

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SHEET FEEDER

John G. Smith, Philadelphia, Pa., assignor to Burroughs Corporation, Detroit, Mich., a corporation of Michigan

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13 Claims. (Cl. 271—26)

This invention relates generally to sheet feeding and more particularly to means for separating a sheet of material from a support or a stack of such sheets and feeding it away from the support or stack to a predetermined position.

In some instances, prior art devices utilize suction means as part of apparatus for feeding sheets one at a time from a stack of sheets. Such devices are subject to certain limitations. For example, in feeding perforated sheet material such as punched cards or thin porous paper material, the suction is often transmitted through the perforations or pores of the material to the next succeeding sheet with the result that two or more sheets are fed at the same time. Suction devices are also limited in certain respects in feeding sheets of material from a stack having a mixed assortment of sheets of different sizes such as, for example, a stack of bank checks. In such case, design of the ports in the suction device is limited to the common area of the checks to assure that no part is uncovered or partially uncovered when a check is engaged and that no loss in suction results.

An object of the present invention is to provide a sheet feeding device of improved design which will avoid the above limitations.

Another object of the invention is to provide a sheet feeder for feeding sheets one at a time from a stack of sheets with a minimum of friction and without abrasion of the sheet surfaces.

A further object of the present invention is to provide instrumentalities for separating a sheet of material from a supporting surface or from a stack of sheets by altering the atmospheric pressure on one side of the sheet to create a pressure differential between the two sides thereof.

A still further object is to provide such instrumentalities which will separate a sheet from a sheet support or a stack of sheets and feed it away from the support or stack without making contact with the separated sheet.

These and other objectives will be revealed more clearly in the following detailed description of a specific apparatus embodying the principles of the invention when read in conjunction with the accompanying drawings in which:

Fig. 1 is an elevation of a sheet feeder utilizing form of the invention;

Fig. 2 is a section taken on line 2—2 of Fig. 1;

Fig. 3 shows a portion of the apparatus of Fig. 1 on an enlarged scale and illustrates a position of a sheet after its separation from the sheet stack;

Fig. 4 is a view similar to Fig. 3 and illustrating a sheet separated from the stack and fed into the grip of withdrawal feed rolls;

Fig. 5 is a view on an enlarged scale taken in the direction of arrows 5—5 of Fig. 3 and illustrating also the flow of a fluid under pressure;

Fig. 6 is a view taken on an enlarged scale taken in the direction of arrows 6—6 of Fig. 4 and showing also the flow of a fluid under pressure; and

Fig. 7 is an enlarged view of an encircled section 7 of Fig. 4.

The illustrated form of the invention is shown in a sheet feeder (Fig. 1) comprising an open box frame indicated generally at 10 having a base plate 12, a front plate 14, a rear plate 16 spaced from and similar to front plate 14, and a top plate 18 extending rightwardly beyond plates 14 and 16. Plates 14 and 16 are secured to base plate 12 while top plate 18 is secured to plates 14 and 16. Plates 14, 16 and 18 are shown to be of a transparent material, however, this is not critical but illustrative only, as is also the case with other transparent parts hereinafter described.

Within frame 10 between plates 14 and 16 is a sheet support or stack table 20 secured to an arm 22 having at its lower end a half-nut 24 engaging a stack elevating screw 26 which may be operated in any well-known manner by stack advance mechanism 27 which in this disclosure forms no part of the present invention and need not be further described.

On the upper surface of top plate 18 is secured a transparent box-like enclosure 28 comprising a front wall 30 (partially broken away) a rear wall 32, left and right side walls 34 and 36 respectively and a top cover plate 38. Cover plate 38 is provided with an aperture for admitting fluid into the inside or fluid chamber 40 of enclosure 28 by means of a hose 42 leading from a source of fluid supply, not shown. Fluid chamber 40 communicates with an aperture 44 extending through top plate 18 and an orifice plate 46 secured to the top plate and lying, preferably, in a horizontal plane, the aperture terminating in a bell-shaped orifice 48 (see also Fig. 7) so that fluid may be discharged from fluid chamber 40 across the top sheet of a stack 50 in a manner to be hereinafter described.

On the inside face of right side wall 36 (Fig. 3) is secured a mounting bracket 52 having a leftwardly extending lug 54 at its top and a longer leftwardly extending arm 56 at its bottom. Secured to arm 56 is an electromagnet 58 and an angle bracket 60 having its vertical leg 62 provided with a pivot pin 64 for pivotally mounting an L-shaped armature 66 having a horizontal arm 68 and a depending arm 70, the arm 70 being formed with forwardly projecting ears 72, 74 having threaded holes therein for receiving the threaded shank end of a circular deflector bell 76 having its lower portion disposed within aperture 44 and flared orifice 48 and having its lower end 78 formed preferably bell-shaped to conform substantially with the shape of orifice 48. Mounting bracket 52 and the elements mounted thereon may be adjusted vertically within fluid chamber 40 by means of a screw 80 threadedly engaging top cover plate 38 and passing through a helical compression spring 82 and lug 54 to threadedly engage a collar 84 secured on the end of the screw. Threading screw 80 outwardly of plate 38 will move bracket 52 upwardly while threading it inwardly will cause the bracket to be moved downwardly under the biasing action of helical spring 82. Bracket 52 is secured in its adjusted position to right side wall 36 by means of clamping screws 86 passing trough enlarged holes in the side wall and engaging tapped holes in the bracket.

Armature 66 is biased in a counterclockwise direction about pivot pin 64 by a spring 88, one end of which engages ear 74 of the armature and the other end engages an upturned lug 90 on bracket arm 56. An adjustable stop screw 92 threadedly engaging top cover plate 38 is set to limit the counterclockwise movement of armature 66 and also establishes the normal or rest position of deflector bell 76 within aperture 44 and orifice 48.

At the right or feed-off end of the sheet feeder are mounted withdrawal feed rolls for feeding the sheets away from the stack comprising drive rolls 94 (Fig. 2) driven by a motor 96 and idler pressure rolls 98 spring-pressed against the drive rolls. Secured to plates 14 and 16 (Fig. 1) is a bracket 100 having its upper portion reduced to form a guide plate 102 extending upwardly and rightwardly between the withdrawal feed rolls. Adjacent the rightward end of guide plate 102 and slightly rightward of the contact point of the drive rolls 94 and idler rolls 98 is an aperture 104 (see also Fig. 2) in guide plate 102 for admitting rays from a source of radiation such as lamp 106 mounted above the guide plate to a radiation sensitive means such as a phototransistor element 108 mounted on the underside of guide plate 102.

In operation, a stack of sheets 50 is placed on the stack table 20 and a stream of high velocity fluid of proper volume, preferably air, is supplied through hose 42 to fluid chamber 40. The air flows from the fluid chamber through aperture 44 and orifice 48 and is caused to flow in radially opposite directions with respect to aperture 44 across the entire upper surface of the top sheet S of the stack by means of orifice 48 and the bell-shaped end 78 of deflector bell 76, as depicted by the arrows shown in Fig. 5. As the stream of high velocity air passes across sheet S between the sheet and orifice plate 46 a drop in pressure results therebetween so that atmospheric pressure on the underside of the sheet is greater than the resultant pressure on the top of the sheet, thereby causing the sheet to separate from the stack and rise toward the orifice plate. The sheet will continue to rise until it reaches a point at which the pressures on both surfaces of the sheet are in balance, which will be some spaced distance away from the orifice plate. The sheet will thus be held in suspension, or, in other words, held on an "air bearing" beneath the orifice plate until it is fed away in a manner presently to be described.

After a sheet has been thus separated from the stack and a feed is called for, magnet 58 is energized, thereby attracting arm 68 of armature 66 and rocking the armature clockwise about pivot pin 64 to position deflector bell 76 leftwardly in aperture 44 and orifice 48, as seen in Fig. 7 whereby a larger quantity of air flows from the rightward side of orifice 48 than, from the leftward side as depicted in Fig. 6 while maintaining a pressure differential between the two surfaces of the sheet, and causing the separated top sheet S to move rightwardly in the direction of the larger flow of air and into the nip of withdrawal feed rolls 94 and 98 (Fig. 4). Guide plate 102 directs the sheet into the feed rolls.

When the leading edge of the sheet passes through the feed rolls it passes over aperture 104 in guide plate 102 thereby cutting off the rays of light of lamp 106 from the phototransistor element 108 so that by suitable circuitry and electrical components, not shown, magnet 58 is de-energized and armature 66 is returned to its normal or rest position under the biasing action of spring 88. As the fed sheet passes beyond the vicinity of orifice plate 46 and sheet stack 50, the next succeeding sheet will immediately separate from the stack under the action of the continuously flowing high velocity air and be held in an upward position on an air bearing as explained heretobefore until another feed is called for. In this connection, it should be mentioned that while deflecting bell 76 may be adjusted for its normal or rest position in concentric relation with aperture 44 and orifice 48 it is preferable, as shown more clearly in Fig. 5, to adjust the deflecting bell so that it is slightly rightward within the aperture and orifice. This will cause a slightly larger quantity of air to flow leftwardly from the orifice and thereby urge the separated sheet against a stop plate 110 (Fig. 3) where it will be held until a feed is called for. In this manner, a sheet which is held upwardly in a separated position for any appreciable time before being fed into the withdrawal feed rolls will remain against the stop plate, and any tendency to drift toward the feed rolls and possibly cause a premature or misfeed, as might be encountered if the deflecting bell were set concentrically within the aperture and orifice, is thus avoided.

As the fed sheet passes beyond the grip of the feed rolls and the trailing edge of the sheet passes over aperture 104, rays of light are again admitted through the aperture from lamp 106 to phototransistor element 108 causing magnet 58 again to be energized whereby armature 66 is rocked clockwise and the next succeeding separated sheet is fed rightwardly to the withdrawal feed rolls as explained above.

To aid in separating the sheets one at a time from the top of the stack it is preferable to use an auxiliary air stream to preliminarily separate the upper layers of sheets one from another. For this purpose there is provided a hose 112 (Fig. 1) leading from a source of air supply, not shown, and positioned adjacent the top layers of sheets at one side of the stack, shown illustratively at the rear side of the stack, so that air flows therefrom substantially in the planes of the uppermost sheets in the stack.

From the foregoing description of a specific embodiment of the invention, it will be apparent that the invention is an improvement over the vacuum or suction type feeders in that perforated as well as porous sheets of material may be separated one at a time from a stack of sheets more efficiently, particularly since the lifting force of the present invention is effective across the entire area of a sheet as compared to the limited area of the suction orifice in a vacuum feeder; and furthermore, the invention provides a low-friction feeder for feeding sheets one at a time from a support or stack of sheets and without any abrasion of the sheet surfaces.

While there has been described a specific sheet feeding apparatus incorporating the principles of the present invention, it will be apparent to those skilled in the art that the invention may be constructed in various forms. Accordingly, it is to be understood that the invention as herein shown and described is to be taken as a preferred embodiment thereof, and that various changes in size, shape and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

What is claimed is:

1. In a sheet feeding apparatus for feeding sheets one at a time from a stack of sheets, means to conduct fluid at a predetermined volumetric rate, means to direct said fluid across the top sheet of said stack in radially opposite directions, said fluid moving at a velocity to create a lower pressure on the top surface of said sheet than the atmospheric pressure on the bottom surface of said sheet whereby said sheet is caused to separate from said stack and rise toward said directing means, means to increase the volume of flow of said fluid in a given direction while maintaining a pressure differential between said sheet surfaces whereby said sheet is fed away from said stack, and means in the path of the fed sheet and actuated thereby to return the volume flow to said radially opposite directions.

2. In a sheet feeding apparatus for feeding sheets one at a time from a stack of sheets, means to conduct fluid at a predetermined volumetric rate, means to direct said fluid across the top sheet of said stack in radially opposite directions, said fluid moving at a velocity to create a lower pressure on the top surface of said sheet than the atmospheric pressure on the bottom surface of said sheet whereby said sheet is caused to separate from said stack and rise toward said directing means, means for directing a stream of fluid in the planes of the uppermost sheets in said stack to aid in said separation, means to increase the volume of flow of said fluid in a given direction while maintaining a pressure differential between said sheet surfaces whereby said sheet is fed away from said stack,

and means in the path of the fed sheet and actuated thereby to return the volume flow to said radially opposite directions.

3. In a sheet feeding apparatus for feeding sheets one at a time from a stack of sheets, orifice means adjacent the top of said stack, a fluid chamber communicating with said orifice means, means to conduct fluid at a predetermined volumetric rate into said chamber and through said orifice means to the upper surface of the top sheet of said stack, said fluid moving at a velocity to create a lower pressure on said surface than the atmospheric pressure on the bottom surface of said sheet, means for directing the flow of fluid through the orifice means, and control means in the path of sheet feeding and actuated by a moving sheet to effect alternate changes in said directing means whereby alternate changes in fluid flow volume and direction will cause sheets to be fed successively in spaced relation from said stack.

4. In a sheet feeding apparatus for feeding sheets one at a time from a stack of sheets, orifice means adjacent the top of said stack, a fluid chamber communicating with said orifice means, means to conduct fluid at a predetermined volumetric rate into said chamber and through said orifice means to the upper surface of the top sheet of said stack, said fluid moving at a velocity to create a lower pressure on said surface than the atmospheric pressure on the bottom surface of said sheet, means for directing the flow of fluid through the orifice means, auxiliary means for partial separation of the upper sheets of said stack, and control means in the path of sheet feeding and actuated by a moving sheet to effect alternate changes in said directing means whereby alternate changes in fluid flow volume and direction will cause sheets to be fed successively in spaced relation from said stack.

5. In a sheet feeding apparatus according to claim 4 wherein the fluid flow directing means is a deflector element disposed within the orifice means.

6. In a sheet feeding apparatus according to claim 4 wherein the fluid flow directing means is an element with an actuator portion disposed within said fluid chamber and a deflector portion disposed within said orifice means.

7. In a sheet feeding apparatus according to claim 5 wherein said deflector element and orifice means are complementally bell-shaped to direct said fluid across said sheet in radially opposite directions.

8. In a sheet feeding apparatus according to claim 5 and including electromagnetic means under control of said control means for operating said deflector element.

9. In a sheet feeding apparatus according to claim 4 wherein said control means includes means responsive to radiation.

10. In a sheet feeding apparatus for feeding sheets one at a time from a stack of sheets, means to conduct fluid at a predetermined volumetric rate, means to direct said fluid across the top sheet of said stack in radially opposite directions, said fluid moving at a velocity to create a lower pressure on the top surface of said sheet than the atmospheric pressure on the bottom surface of said sheet whereby said sheet is caused to separate from said stack and rise toward said directing means, and means to increase the volume of flow of said fluid in a given direction while maintaining a pressure differential between said sheet surfaces whereby said sheet is fed away from said stack.

11. In a sheet feeder, means to conduct fluid at a predetermined volumetric rate, and means within said conducting means to direct said fluid in radially opposite directions across a surface of a sheet, said fluid moving at a velocity to produce a lower pressure on said surface than the atmospheric pressure on the opposite surface of said sheet to move the sheet toward said directing means.

12. In a sheet feeder, means to conduct fluid at a predetermined volumetric rate, means including an element having a surface lying in a plane parallel to the plane of a sheet to be moved to direct said fluid in radially opposite directions across a surface of a sheet, said fluid moving at a velocity to produce a lower pressure on said surface than the atmospheric pressure on the opposite surface of said sheet to move the sheet toward and perpendicular to said first-mentioned plane, and means to change the volume of flow of said fluid in a given direction while maintaining a pressure differential between said surfaces to move the sheet laterally away from said fluid directing means.

13. In a sheet feeding apparatus for feeding sheets one at a time from a stack of sheets, means to conduct fluid at a predetermined volumetric rate, means to direct said fluid in radially opposite directions across the top sheet of said stack, said fluid moving at a velocity to produce a lower pressure on the top surface of said sheet than the atmospheric pressure on the bottom surface thereof, and means to direct a stream of fluid in the planes of the uppermost sheets in said stack to partially separate said sheets one from another.

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