

Nov. 3, 1964

J. H. BURLEIGH
SHEET-FEEDING DEVICE

3,155,386

Filed July 10, 1962

3 Sheets-Sheet 1

FIG. 1

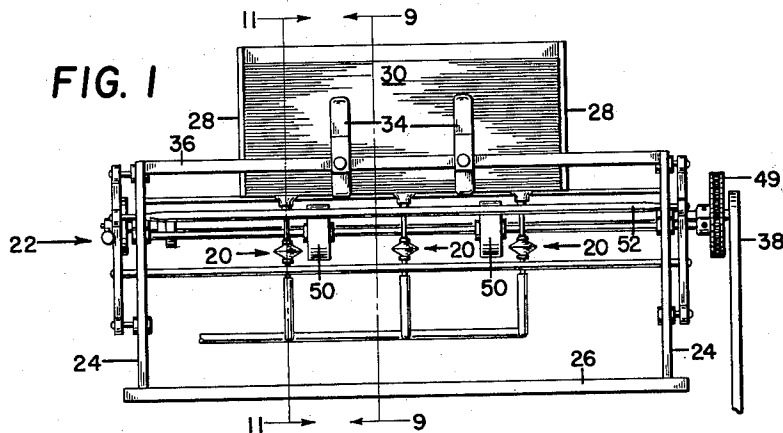


FIG. 2

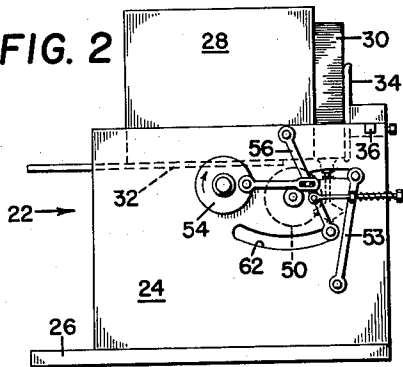


FIG. 3

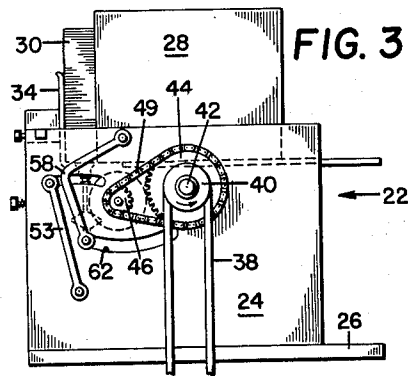


FIG. 4

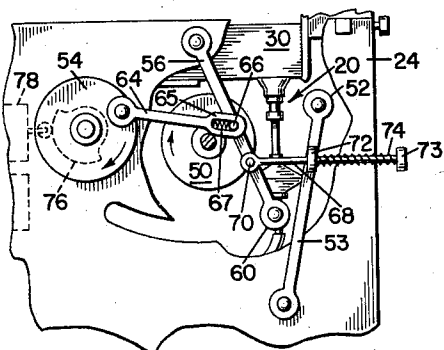
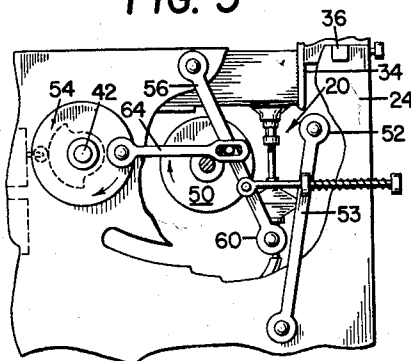


FIG. 5



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3 Sheets-Sheet 2

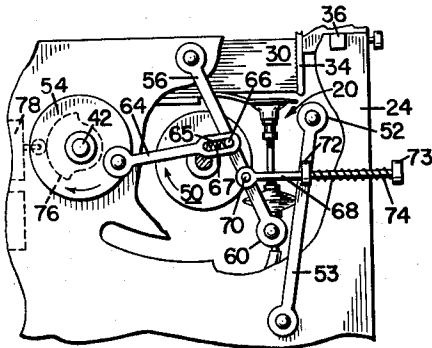


FIG. 6

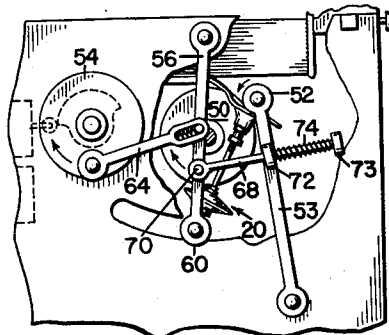


FIG. 7

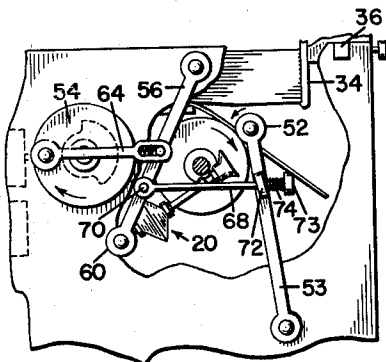


FIG. 8

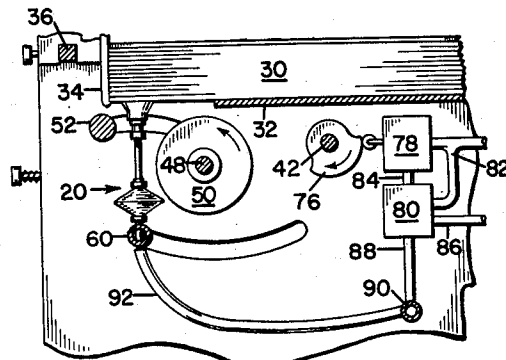


FIG. 9

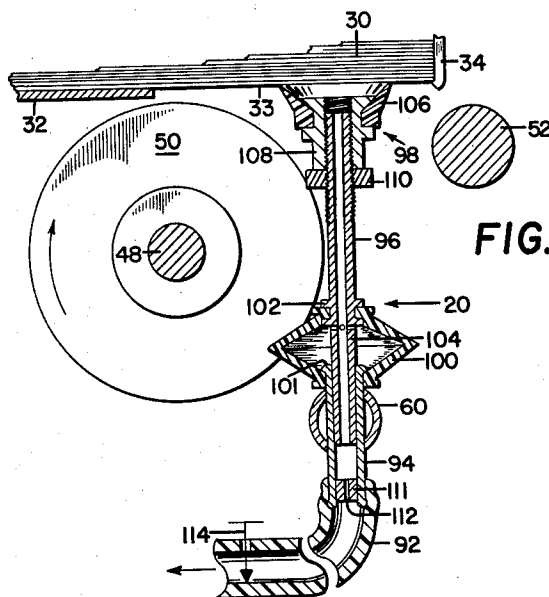


FIG. 10

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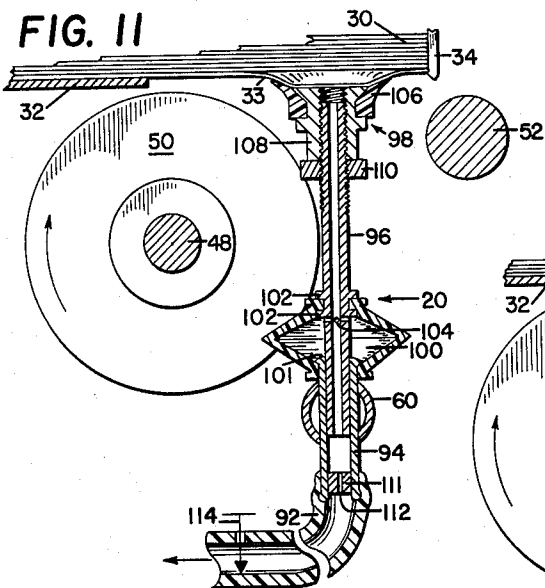
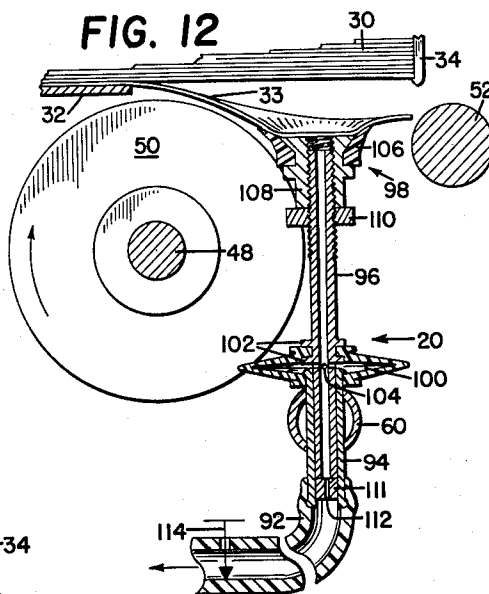
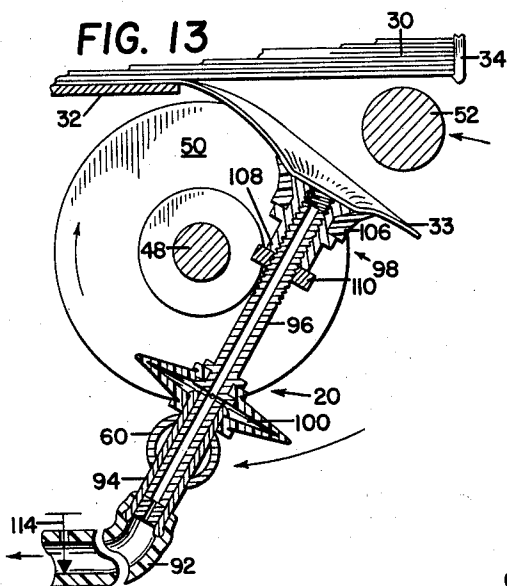
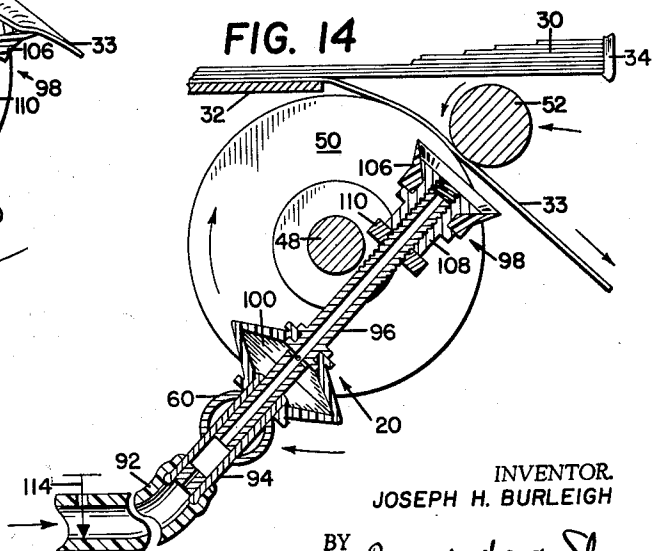
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Filed July 10, 1962

3 Sheets-Sheet 3



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3,155,386

SHEET-FEEDING DEVICE

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Filed July 10, 1962, Ser. No. 208,749

4 Claims. (Cl. 271-26)

This invention relates to sheet-feeding devices, and more particularly to sheet-feeding devices having suction cups for engaging and separating one sheet or a group of sheets from a stack of sheets.

It is common practice in sheet-feeding devices to bring a suction cup into engagement with the outermost sheet of a stack of sheets, leave the suction cup in contact with the sheet for a short interval of time and by suitable mechanical means move the suction cup and, hopefully, the sheet which it has contacted away from the stack of sheets so that thereafter the sheet may be completely removed from the stack by other means and transferred by suitable means to some other part of the machine, as well understood in the art.

It is well known that when feeding single sheets of paper, the paper is usually sufficiently porous that the vacuum pressure built up in the feeding mechanism often passes or leaks through the sheet of paper in contact with the suction cup and causes more than the desired number of sheets to be attracted and held by the suction cup. This produces what is known as a "double." However, if the feeding device is adjusted so as to reduce or possibly eliminate doubles, the suction cup will then often fail to securely grip the outermost sheet, so that when the cup is moved away from the stack of sheets it does not carry the desired sheet with it, and this causes what is known as a "miss" or "skip" in the operation of the machine.

Consequently, one object of my invention is to provide a sheet-handling device which not only eliminates "doubles," but also eliminates "skips" or "misses" and which will consistently and uniformly remove the desired number of sheets per cycle of operation from a stack of sheets.

Another object of my invention is to provide a device of the above character which has positive means for moving the suction cup or gripping head and the attached sheet out of contact with the remaining sheets prior to the time that the pressure in the sheet-handling device builds up to the point where it would attract a second or third sheet, thereby preventing "doubles" or unwanted multiple feeding.

Another object of my invention is to provide a device having the above advantages in which the means for initially moving the suction cup or gripping head is actuated in response to the action of the suction cup or gripping head contacting and gripping the sheet of material to be removed, so that the means for moving the suction cup will not operate until the sheet is properly gripped by the suction cup. Thus, my device is self-compensating and as a result will operate satisfactorily with materials having a wide range of weight and porosity.

A further object of my invention is to provide a sheet-feeding device which may be used to remove the sheets from the bottom of a stack of sheets, or may be used with equal facility to remove the sheets from the top or from the side of a stack of sheets.

Still a further object is to provide a device of the above nature which is reliable and consistent in operation and which will run for extended periods of time with little or no attention or adjustments required by the operator and which utilizes a minimum number of parts which may be readily and easily manufactured and assembled.

To these and other ends the invention resides in certain improvements and combinations of parts, all as will be hereinafter more fully described, the novel features being pointed out in the claims at the end of the specification.

In the drawings:

FIG. 1 is a front elevational view of a machine having a sheet-feeding device embodying the present invention;

FIG. 2 is a side elevational view of the above machine as seen from the left in FIG. 1;

FIG. 3 is a side elevational view of the above machine as seen from the right in FIG. 1;

FIGS. 4, 5, 6, 7 and 8 are enlarged fragmentary side elevational views showing the operating mechanism of FIG. 2 in different positions during a portion of the operating cycle of the machine;

FIG. 9 is an enlarged fragmentary sectional elevational view along the line 9-9 in FIG. 1;

FIGS. 10, 11, 12 and 13 are sectional elevational views substantially along the line 11-11 in FIG. 1 on an enlarged scale and showing the details of an improved sheet-feeding device during a portion of the cycle of operation thereof, said figures corresponding substantially with FIGS 4-7, respectively, and

FIG. 14 is a sectional elevational view similar to FIGS. 10-13 showing the position of the sheet-feeding device immediately after the release of the paper and prior to its movement to its position shown in FIG. 8.

The preferred embodiment of the present invention, herein disclosed by way of illustration, comprises a device shown generally at 20 (FIGS. 1, 4 and 10) for feeding or removing a predetermined number of sheets of paper or other similar material per cycle of operation from a stack of sheets. While I have shown my invention in a sheet-feeding device as applied to a bottom-feed machine shown generally at 22 (FIGS. 1, 2 and 3), wherein the feeding device is brought into engagement with the lowermost sheet of a stack of sheets, somewhat in the manner of the bottom-feeding mechanism shown in the patent to De Back, No. 2,742,285, it will be understood that my sheet-feeding device may also be applied to a top-feeding mechanism such as shown in the patent to Baker et al., No. 2,341,521.

Consequently, for the purposes of illustration only, I have shown my sheet-feeding device as applied to a bottom-feeding machine wherein the sheet-feeding device is moved downwardly in substantially an arcuate path as shown in FIGS. 4-8 and 10-14. Machine 22 comprises a pair of side plates 24 (FIG. 1) which are mounted on a bottom plate or frame 26. A magazine or hopper 28 is located centrally of the machine and is adapted to hold a substantially vertical stack of sheets 30. Magazine 28 has a bottom plate 32 which preferably extends for the full width of the magazine and extends from the rear toward the front thereof. However, plate 32 (FIGS. 2 and 9) terminates short of the front edge of the magazine, so as to allow room for my improved sheet-feeding device to move upwardly into contact with the lowermost sheet 33 (FIGS. 10-14) of the stack of sheets in the magazine. A pair of adjustable supporting brackets 34 (FIGS. 1, 5 and 9) are slidably mounted on a transversely extending rod 36 and are adapted for supporting the front edge of the stack of sheets, as shown in FIG. 9.

All of the moving parts of machine 22, including the movement of sheet-feeding devices 20, may conveniently be driven from a common source of power. Thus, the shaft of an electric motor (not shown) may be operatively connected by means of a belt 38 (FIG. 3) with a pulley 40 which in turn is mounted on one end of a shaft 42 which extends transversely through the machine and is mounted in suitable bearings or bushings (not shown) in side plates 24. Shaft 42 is provided adjacent the right

end thereof, as shown in FIGS. 1 and 3, with a sprocket 44 which is connected to a smaller sprocket 46 on a roller shaft 48 by a chain 49. Roller shaft 48 extends parallel to shaft 42 and is preferably supported in end plates 24 by suitable bearing or bushing means (not shown). Shaft 48 carries a pair of feed rollers 50 (FIG. 1) which are driven in a clockwise direction as viewed in FIG. 2 and which will be turning at a higher rate of speed than shaft 42 as a result of the difference in size between sprockets 44 and 46, as seen in FIG. 3.

Machine 22 is preferably provided with a movable feed roller 52 (FIGS. 1 and 4) which is mounted on a pair of arms 53 (FIGS. 2 and 3) which are pivotally mounted on sides 24. Roller 52 is intermittently brought into engagement with rollers 50 for feeding therebetween the sheet of material which has previously been drawn between the rollers by the action of my improved sheet-feeding devices, somewhat in the same manner as shown in the patent to De Back. The means for operating my sheet-feeding devices and movable feed roller 52 can be best seen in FIGS. 2-8.

The means for moving feeding devices 20 comprises a crank 54 located on the left end of shaft 42 and a pair of swinging arms 56 (FIG. 4) and 58 (FIG. 3) which are pivotally mounted at the upper ends thereof on end plates 24. Arms 56 and 58 are connected at their lower ends to a transversely extending tubular member 60 (FIG. 1) which has feeding devices 20 mounted thereon by means hereafter described. End plates 24 are preferably formed with arcuate slots 62 (FIGS. 2 and 3) which allow arms 56 and 58 to move member 60 in an arcuate path from its position shown in FIGS. 2 and 4 to its position shown in FIG. 8 and back to its initial position during the operation of the machine. Arm 56 is preferably connected to crank 54 by means of a connecting link or rod 64 which, as shown in FIG. 4, is formed with a slot adjacent the right-hand or forward end thereof for engagement with an upstanding boss 66 on arm 56. Rod 64 is provided with a slot 65 in order to provide a dwell period for the feeding devices as crank 54 moves from its position shown in FIG. 4 through its position shown in FIG. 5 to its position shown in FIG. 6, as hereafter more fully described. Slot 65 is also provided with a light coil spring 67 (FIG. 4) and it is evident that the rotation of crank 54 will cause arm 56 to move from its position shown in FIG. 4 to its position shown in FIG. 8 and back to its position shown in FIG. 4 during each cycle of operation of the machine.

As mentioned earlier, feed roller 52 is caused to move into and out of contact with feed rollers 50. The means for accomplishing this movement comprises a rod 68 (FIG. 4) which is mounted at one end thereof on a boss 70 on arm 56 and which slidably engages a projecting portion 72 (FIG. 4) on arm 53 at the left end of the machine. Rod 68 has a stop collar 73 at the right-hand or free end thereof and is connected to portion 72 by means of a coil spring 74, whereby the reciprocatory movement of rod 68 will reciprocate arms 53 and move roller 52 toward and away from feed rollers 50 as can be seen from an inspection of FIGS. 4-8.

Machine 22 is also provided with suitable cam-actuated air valve means which connect sheet-feeding devices 20 either with a source of vacuum pressure such as that supplied by a known vacuum pump (not shown) or to the atmosphere, in accordance with the operational cycle of the machine, as well understood in the art. For this purpose, crank shaft 42 carries a cam 70 (FIG. 9) which engages a roller or cam follower on an air-operated relay 78 which in turn actuates air valve 80. Relay 78 and air valve 80 are connected to a common source of vacuum pressure through a suitable conduit 82 and are interconnected by a second conduit 84 by means of which relay 78 actuates valve 80. Valve 80 has connected thereto a conduit 86 which is open to the atmosphere and a conduit 88 which terminates in a manifold 90. Manifold

90 is connected to devices 20 by suitable flexible conduit means 92, and it will be readily understood that depending upon the position of air valve 80, manifold 90 and thus devices 20 are either connected to a source of vacuum pressure through conduits 88 and 82 or are connected to the atmosphere through conduits 88 and 86. Cam 76 is preferably of the desired shape and extent so that air relay 78 and thus air valve 80 are closed and opened at the desired times during the operation of the machine, as well understood in the art.

As mentioned above, my improved sheet-feeding devices 20 are preferably mounted on tubular member 60 which is caused to move in an arcuate path by crank 54, rod 64 and arms 56 and 58. Since devices 20 are preferably identical to one another, a description of one device will apply to all. As shown in FIGS. 10 through 14, device 20 comprises a first tubular member 94 which is fixedly secured in position on member 60. Member 94 is connected at its lower end to a suitable length of flexible conduit 92 and its upper end extends slightly above member 60. A second tubular member 96 is slidably mounted in member 94 and is capable of telescopic movement therewith. Member 96 carries at the upper end thereof a gripping head shown generally at 98 and as hereafter described. Member 96 is mounted on member 94 and is caused to move relative thereto by the action of a collapsible chamber or bellows 100.

Chamber 100 preferably comprises a pair of flexible vacuum or suction cups which are cemented together at the larger ends thereof to form a chamber which is essentially diamond-shaped in cross section as shown in FIGS. 10 and 11. The lower end of chamber 100 is mounted on tubular member 94 and is air sealed thereto by means of a flange 101 (FIG. 11) while the upper end of the chamber is attached to member 96 by a pair of spaced collars 102 which firmly hold the chamber in airtight engagement with member 96 and which insure that any vertical movement of the chamber will be transmitted to member 96. Member 96 is preferably formed with a plurality of small holes or apertures 104 which are preferably positioned just below the lower one of collars 102. Apertures 104 create a path of communication for air flow between the inside of chamber 100 and tube 96.

Gripping head 98 preferably comprises a flexible suction cup 106 which is mounted on a rigid hollow center member 108. Member 108 is formed with a vertically extending opening therethrough which is internally threaded whereby member 108 may be threadedly attached to the upper threaded end of tubular member 96. A stop or lock nut 110 is positioned below body member 108 and it will be seen that the position of gripping head 98 may be readily changed relative to chamber 100 and member 60 by merely loosening lock nut 110 and then threading member 108 upwardly or downwardly on member 96 until the gripping head is at the desired position, at which point nut 110 is tightened against the lower portion of member 108 to hold the same securely in the desired position on member 96.

The upper end of body member 108 extends well into cup 106 and forms a rigid center portion therefor, which serves two functions. First, it prevents the paper from being drawn so far into the cup that it is dented or wrinkled. Second, it prevents the side walls of the cup from curling or rolling inwardly when the cup is brought into contact with a sheet of paper thereby insuring that the cup will have a certain minimum effective diameter which will remain uniform throughout the operation of the device. That is, I have found with conventional flexible suction cups such as those made of rubber, neoprene or the like, the paper not only is often drawn too far into the cup, but the edges of the cup tend to roll or fold under, so that the cup does not have the same effective area from cycle to cycle. I have further found that with the use of a rigid center member in suction cup 106 I am able to use a cup having a thin or feathered edge

rather than the conventional cup having a reinforced or rolled edge portion which has heretofore been used on various vacuum feeding devices. Of course, I prefer to use a cup having a feathered edge because of the increased ease with which the mouth of the cup can be sealed by a sheet of paper or other similar material and because of the increased reliability resulting therefrom.

The operation of my improved sheet-feeding device can be best understood from a comparison of FIGS. 10-14. FIG. 10 shows the device in its position at the moment of contact with the lowermost sheet 33 of a stack of sheets 30. Device 20 is brought into this position by the action of crank 54, rod 64, arms 56 and 58 which are in their positions substantially as shown in FIG. 4. At this time and as shown in FIG. 4, air relay 78 and air valve 80 are closed and conduit 92 is connected to a source of vacuum pressure so that the air in conduit 92 is flowing in the direction of the arrow in FIG. 10. This flow of air continues until the lowermost sheet seals the upper open end of suction cup 106. Thereafter, the air is evacuated from tube 96 and, as a result of holes 104, from the inside of chamber 100. This evacuation of chamber 100 continues so long as conduit 92 is connected to a source of vacuum and the upper end of suction cup 106 is sealed by means of sheet 33. As the vacuum builds up within chamber 100, the atmospheric pressure acting on the outside of the chamber causes the chamber to collapse and move from its position shown in FIG. 11 to its position shown in FIG. 12. This collapsing movement of chamber 100 imparts a rapid downward movement to tubular member 96 and causes the same to further telescope within member 94, as can be seen from an inspection of FIGS. 11 and 12. This movement also quickly moves the lowermost sheet 33 in a downward direction away from the next-succeeding sheet, so that any continued build-up of vacuum pressure within member 96 and suction cup 106 will not carry through sheet 33 and cause secondary attraction between suction cup 106 and the next-succeeding sheet in the stack of sheets.

The above initial movement of suction cup 106 results from the collapse of chamber 100 and occurs while devices 20 are substantially stationary or in a period of dwell which occurs when the actuating parts are moving from their positions shown in FIG. 4 through their positions shown in FIG. 5 to their positions shown in FIG. 6. There is a similar period of dwell at the lower end of the movement of devices 20 when the parts are approximately in their positions shown in FIG. 8.

As crank 54 continues rotating in a clockwise direction from its position shown in FIG. 6 to its position shown in FIG. 7, rod 64 swings arm 56 in a clockwise direction and carries member 60 and feeding devices 20 to substantially their positions shown in FIGS. 7 and 13. It will be noted that air valve 80 is still in its "on" position whereby conduit 92 is connected to the source of vacuum pressure. This continued application of vacuum pressure causes suction cup 106 to continue to firmly grip sheet 33 and causes chamber 100 to remain in its collapsed position shown in FIG. 13. As crank 54 moves further in a clockwise direction from its position shown in FIG. 7, cam 76 releases air relay 78 which in turn causes air valve 80 to move to its "off" position, thereby connecting conduit 92 to the atmosphere. This release of vacuum pressure in conduit 92 causes suction cup 106 to release its grip on sheet 33 and allows chamber 100 to return to its normal erect position due to the natural resiliency of the material of which the chamber is made, as shown in FIG. 14.

During the movement of feeding device 20 from its position shown in FIG. 12 to its position shown in FIG. 13, crank 54 rotates from approximately its position shown in FIG. 6 to approximately its position shown in FIG. 7 and rods 64 and 68, together with arm 56, move arms 53 and feed roller 52 from their positions shown in FIG. 6 to their positions shown in FIG. 7 at which

time roller 52 is brought into close relationship with rollers 50 and would contact rollers 50 if it were not for sheet 33 which is lying therebetween. Roller 52 contacts sheet 33 with sufficient force to hold the sheet firmly against feed rollers 50 which, as a result of their rotation in a clockwise direction (as viewed in FIGS. 4-8, 13 and 14), cause sheet 33 to be pulled out of the bottom of hopper 28.

As the operating parts continue to move from their positions shown in FIG. 7 through their positions shown in FIG. 8, spring 74 is compressed and as can be seen from the drawings, this provides a period of dwell for rollers 52 and insures that rollers 52 and 50 will contact the opposite sides of sheet 33 for a sufficient length of time to completely remove the sheet from the hopper. Continued rotation of the parts from their positions shown in FIG. 8 will bring them to their positions shown in FIG. 4 for the beginning of another cycle of operation.

Devices 20 are preferably moved in an arcuate path so as to limit the relative movement between suction cup 106 and sheet 33 as devices 20 move from their positions shown in FIG. 10 to their positions shown in FIGS. 13 and 14. However, as mentioned earlier, while this arcuate movement is preferable, devices 20 may be moved in a straight-line path or in a combination of a straight line and arcuate path, as desired.

I have found that in order to secure the proper feeding of a single sheet from a stack of sheets, it is necessary to construct the feeding device in such a way that chamber 100 will not collapse until suction cup 106 has been sealed by lowermost sheet 33. Of course, until lowermost sheet 33 seals cup 106, there is substantially no vacuum in tubular member 96, chamber 100 or cup 106. As soon as the mouth of cup is sealed by lowermost sheet 33, the build-up of vacuum pressure within device 20 continues and causes the collapse of chamber 100. However, I have found that it is necessary to slow down the build-up of vacuum pressure within each of devices 20 in order to afford sufficient time for chamber 100 to collapse before the vacuum pressure becomes so great that it seeps through the lowermost sheet and attracts the next sheet, thereby causing a double feed. To this end, I preferably provide the lower end of each of tubular members 94 with a plug 111 having an orifice 112 (FIG. 10) which will restrict the build-up of vacuum pressure within my device and which in combination with the other elements thereof will insure a proper operation of the device. In addition, I preferably provide each of conduits 92 with a suitable adjustable valve such as the needle valve shown schematically at 114 (FIG. 10) for regulating the flow of air therethrough.

As mentioned, it is necessary to insure proper sealing between suction cup 106 and lowermost sheet 33 before the collapse of chamber 100, and it is further necessary to achieve the collapse of chamber 100 before the vacuum pressure in cup 106 becomes so great that it creates secondary attraction and draws a second or third sheet out of the hopper. Perhaps my invention may be best understood from the following example. I have found that when handling conventional paper ranging in weight from 13 to 28 pounds or multiple sheets as a 16-sheet signature, secondary attraction will occur at approximately one pound of pressure for the 13-pound paper, at approximately two pounds for the 20-pound paper, and at approximately three pounds for the 28-pound paper. With the signature there is no appreciable secondary attraction at pressures as high as eight pounds. Thus, if a device is to be capable of handling single sheets of any of the above papers, as well as signatures, suction cup 106 must first grip the lowermost sheet and collapsible chamber 100 must thereafter collapse, all prior to the pressure within the device reaching one pound per square inch of vacuum pressure. Preferably, I prefer to construct the device so that the above steps will occur when the vacuum pressure is between 25% and 75% of that necessary to cause secondary attraction. Chamber 100 is col-

lapsed by the pressure of the atmosphere acting on the outside acting against the air pressure within the chamber and the natural resiliency of the chamber. However, before the effective area of collapsible chamber 100 can be determined, it is necessary to determine the force needed to collapse the chamber plus the force needed to bend the lowermost sheet downwardly from the hopper. The first force, which I call Force C will, as mentioned above, depend upon the resiliency of chamber 100 and the amount of friction between tubular members 96 and 94 and in the present illustration, using suction cups having a nominal diameter of $\frac{3}{4}$ inch, is approximately ten ounces. The force required to bend the lowermost sheet of paper, which I call Force V, is the total of the force required to bend a sheet of paper against its natural resiliency plus the force required to overcome the friction created by supporting members 34. Of course, the friction may be varied by varying the lateral position of supports 34 which respect to one another. However, I have found that with the supports positioned approximately as shown in FIG. 1, Force V is approximately $\frac{1}{2}$ ounce for 13-pound paper, two ounces for 20-pound paper, three ounces for 28-pound paper and four ounces for a 16-page signature. Since area equals force divided by pressure, the effective area A of collapsible chamber 100 can be determined by the following formula:

$$A = \frac{C + V}{P}$$

Substituting the above values for C and V and having determined that we wish to have chamber 100 collapse when pressure P reaches approximately ten ounces, it appears that for 20-pound paper the effective area A of chamber 100 must be 1.2 square inches.

$$A = \frac{C + V}{P} = \frac{10 + 2}{10} = 1.2 \text{ sq. in.}$$

Suction cup 106 must have sufficient area to provide enough force, prior to the pressure reaching ten ounces, to insure proper attraction between the suction cup and lowermost sheet 33. If it is assumed that the vacuum cup is to firmly grip the lowermost sheet at a pressure of four ounces, the effective area of the vacuum cup may be determined from the following formula, wherein A' equals the effective area of the vacuum cup, V, as above, equals the force in ounces required to bend one sheet downwardly and pull it below supports 34 and P' equals the pressure within cup 106:

$$A' = \frac{V}{P'} = \frac{2}{4} = 0.50 \text{ square inch}$$

With an area of 0.50 square inch cup 106 will exert 5.0 ounces of force when the pressure in cup 106 reaches ten ounces per square inch. It is obvious that cup 106 may have an effective area greater than 0.50 square inch, and its maximum area is limited primarily to a size which will not interfere with the proper operation of the other parts of the machine.

Thus, with the above area and with the above values for C, V, P, and P', it will be seen that when the vacuum pressure within cup 106 reaches four ounces, the cup will securely grip lowermost sheet 33, as in FIG. 11, and will continue to grip the same as the vacuum pressure increases. When the vacuum pressure reaches approximately ten ounces, chamber 100 will collapse, moving the parts from their positions shown in FIG. 11 to their positions shown in FIG. 12. Since this movement has separated the lowermost sheet from the next-succeeding sheet, a further build up of vacuum pressure within the device will not cause secondary attraction with the next-succeeding sheet in the stack of sheets and the device will operate to remove only a single sheet from the hopper. It will be seen that lowermost sheet 33 is partially moved out of engagement with only ten ounces of pressure and this is well below the pressure of one pound at which secondary attraction will occur

with 13-pound paper. Of course, this is also well below the pressure at which secondary attraction will occur with 20- or 28-pound papers. As a result, my devices will feed one sheet at a time of paper ranging from 13- to 28-pound paper and will also feed one signature per cycle of operation.

I have found that without a suitable restriction in the device or in conduit 92, the vacuum pressure will build up so rapidly that although chamber 100 will collapse at only ten ounces' pressure, the pressure will reach a value sufficient to cause secondary attraction due to the time required to overcome the inertia of chamber 100 and collapse the same. However, with the proper restriction, such as orifice 112 which in the present instance has a diameter of 0.052 inch, with needle valve 114 set to provide an aperture of from 0.010 to 0.100 inch and with a maximum vacuum pressure between 15 to 25 in. Hg the above device will consistently operate to remove only a single sheet or signature from magazine 28 per cycle of operation.

Vacuum cup 106 is preferably threadedly positioned on cup 92 so as to firmly contact the lowermost sheet in the hopper without, however, engaging it with sufficient force to collapse or partially collapse chamber 100. Preferably, the open end of cup 106 just contacts the lowermost sheet, but there is sufficient resiliency in the rim or lip portion of the cup that should a sheet be lower than normal, the cup will merely open outwardly slightly to accommodate the sheet. If the sheet is slightly too high, I have found that the flow of air through cup 106 will be sufficient to draw the lowermost sheet down into position where it will securely seal the open end of the suction cup. Thereafter, the vacuum pressure builds up as mentioned before, and the device will operate in the described manner.

Thus, it will be seen that my invention accomplishes its desired results and provides a highly reliable and efficient sheet-feeding device which will operate through a wide range of materials and which will consistently remove only a single sheet from the hopper without doubles or skips. In addition, my device may be used with machines having top, bottom or side feed and it will operate for extremely long periods of time in a highly reliable and dependable fashion. My device is self-compensating in that chamber 100 which introduces the first movement of the suction cup will not collapse and cause this movement until the suction cup has securely gripped the lowermost sheet of paper and if for any reason the cup does not grip the paper, then the chamber will not collapse. However, my device will operate with papers of different stiffnesses and porosity since although a stiffer paper will require more force to bend it downwardly past adjustable supports 34, suction cup 106 may be readily provided with sufficient area to provide the desired force for even the stiffest papers, while operating at a pressure lower than the pressure at which chamber 100 will collapse which in turn is lower than the pressure at which secondary attraction will occur.

It will thus be seen that the invention accomplishes its objects and while it has been herein disclosed by reference to the details of a preferred embodiment, it is to be understood that such disclosure is intended in an illustrative, rather than a limiting sense, as it is contemplated that various modifications in the construction and arrangement of the parts will readily occur to those skilled in the art, within the spirit of the invention and scope of the appended claims.

I claim:

1. In a sheet-feeding device for removing sheets successively from a stack of sheets in a repetitive cycle of operations, a system comprising:
 - a flexible fluid conduit;
 - control means for connecting said conduit alternately to an evacuation means and to the atmosphere during a cycle of operation of the device;
 - a first tubular member communicating with said conduit and extending therefrom;

a second tubular member communicating with said first tubular member and that is mounted for sliding, telescoping movement relative thereto, with one of said members sliding within the other;

a resilient hollow body that is collapsible upon evacuation thereof but that is normally extended and resiliently self-sustaining in its extended state, and that is formed with two opposed openings, one of which is sealed about an end portion of one of said members and the other of which is sealed about a portion intermediate the ends of the other of said members, said body being disposed to hold said members in a predetermined, partly telescoped position in its normal condition; a gripping head having at least one suction mouth, and that is disposed at the free end of said second tubular member, with its suction mouth in communication with the bore of said second tubular member, for gripping the surface of a sheet on which it is engaged, upon evacuation of said second tubular member;

one of said members being formed in its wall with at least one opening that is disposed to provide communication between the bore thereof and the interior of said body;

the evacuable relationship between the suction mouth of said gripping head and said opening being such that the body is not evacuated until the mouth is sealed by the surface of a sheet that is gripped by said gripping head, and such that the body is evacuated and collapsed before the gripping head can grip more than one sheet;

said opening being disposed to maintain communication between the bore of the member in which it is formed and the interior of said body in all of the positions of said members during said cycle, and

means coupled to one of said members for moving said members as a unit from a first, sheet gripping position to a second, sheet release position and back again,

during each cycle of operation, while maintaining said first member in communication with said conduit.

2. A system that is constructed in accordance with claim 1, wherein:

said last-named means comprises transport means coupled to said first member for moving said first member to said first position, in which said gripping head is disposed to engage the surface of a sheet for making a pickup;

means operative thereafter for operating said control means to permit the evacuation of said system to begin, to permit the sequential gripping of the surface of a sheet and subsequent collapse of said body;

said transport means being operative thereafter for moving said first member, body, second member, gripping member, and gripped sheet, together, to said second position, from which said gripped sheet can be dispensed from said system; and

means operative thereafter for operating said control means to place the conduit in communication with the atmosphere;

said transport means being operative thereafter for returning said members to said first position, for a repetition of the cycle.

3. A system that is constructed in accordance with claim 1 wherein said second member is disposed within said first member.

4. A system that is constructed in accordance with claim 1, including an adjustable control valve that is mounted in said conduit to provide controllable communication between said system and the atmosphere, to permit control over the rate of evacuation of said system.

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