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[54] **PNEUMATIC CUT SHEET FEEDER**
4 Claims, 7 Drawing Figs.

[52] **U.S. Cl.**..... **271/11,**
271/26

[51] **Int. Cl.**..... **B65h 5/22**

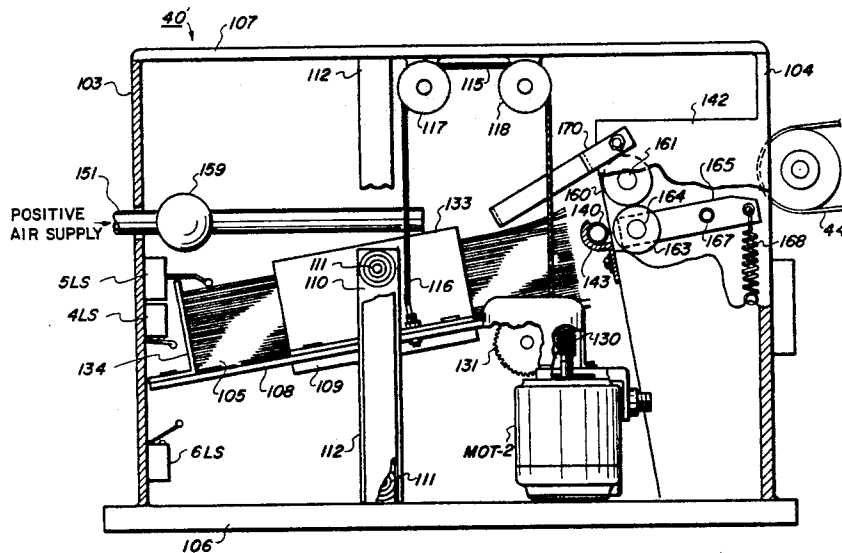
[50] **Field of Search**..... **214/1AB,**
8.5E; 271/5, 11, 26, 28, 30, 74

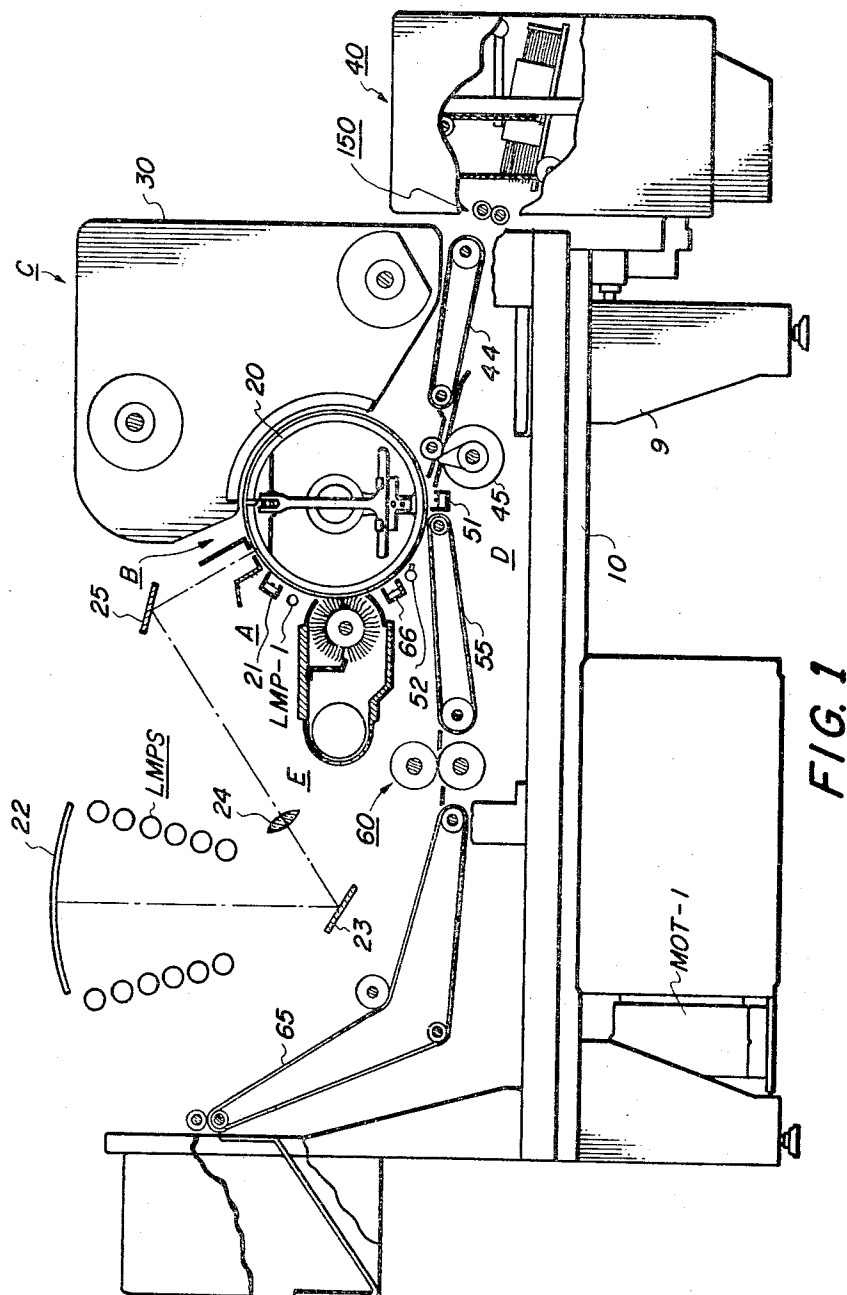
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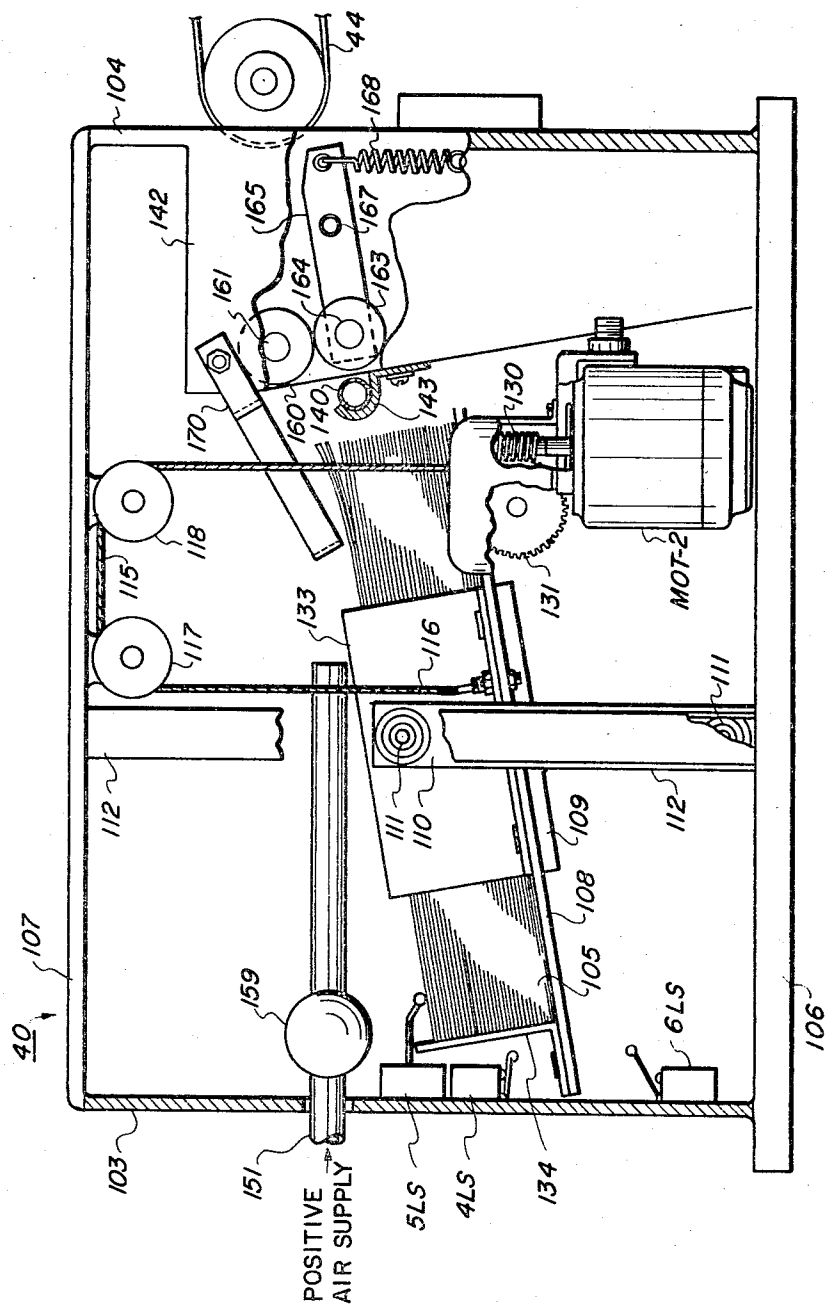
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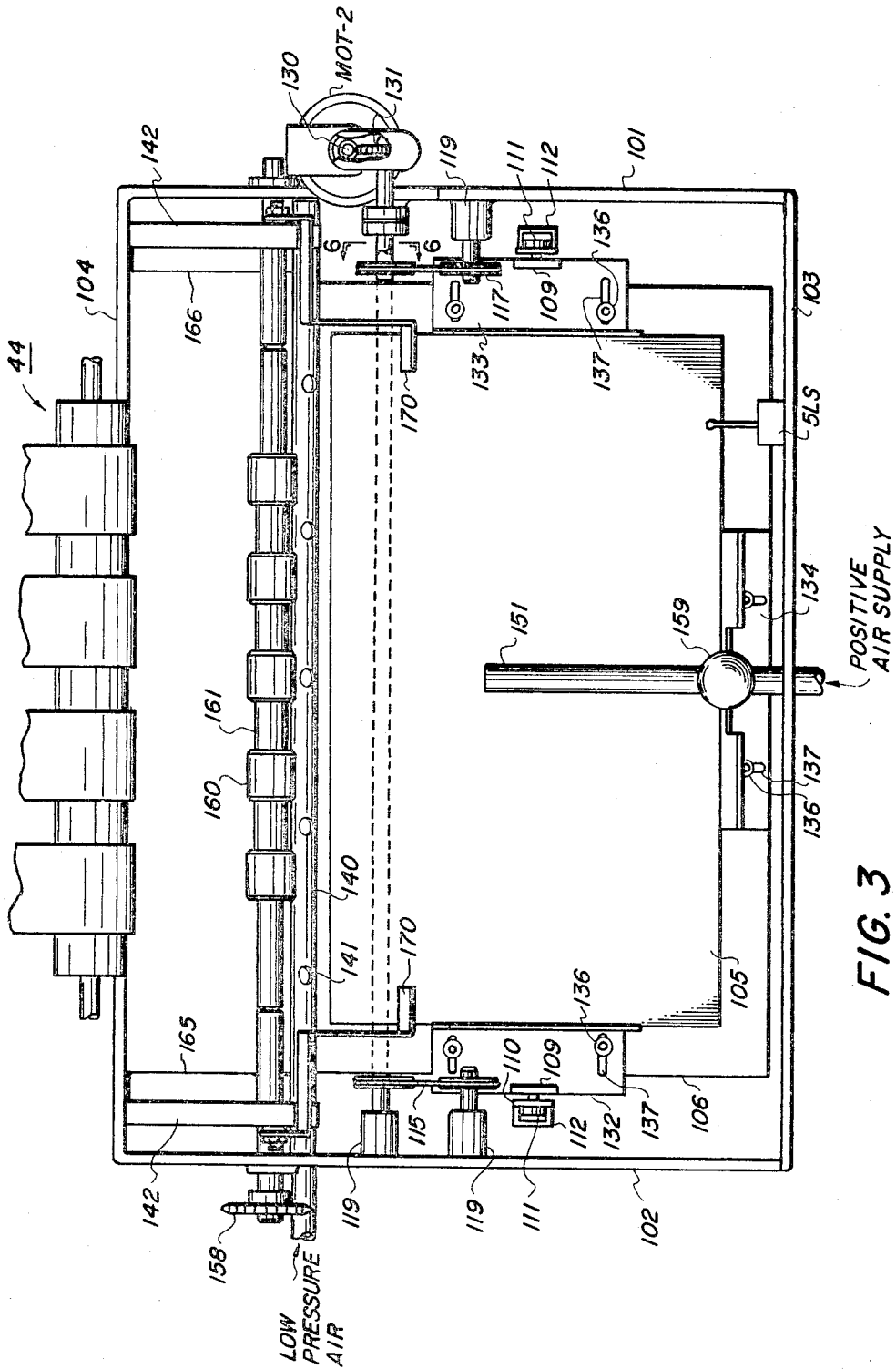
ABSTRACT: Apparatus for removing the topmost sheet from a stack of support material by supporting said topmost sheet on an aeriform cushion and passing a jet of aeriform fluid over the top of said sheet at a velocity sufficient to cause said sheet to be lifted and forwarded into the nip of continually driving feed rolls. The jet of aeriform fluid is periodically pulsed to forward said sheets at a desired rate.





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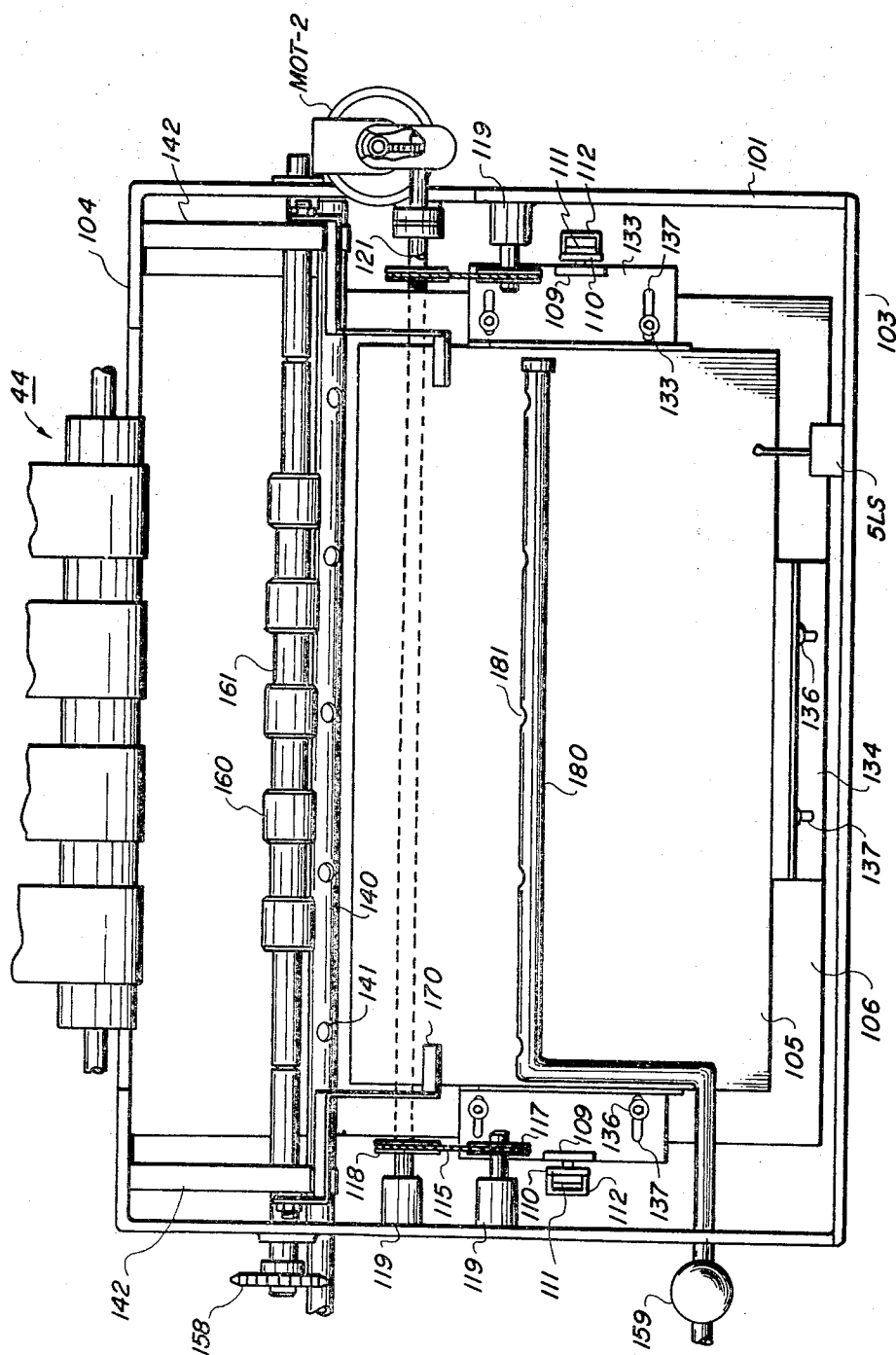


FIG. 4

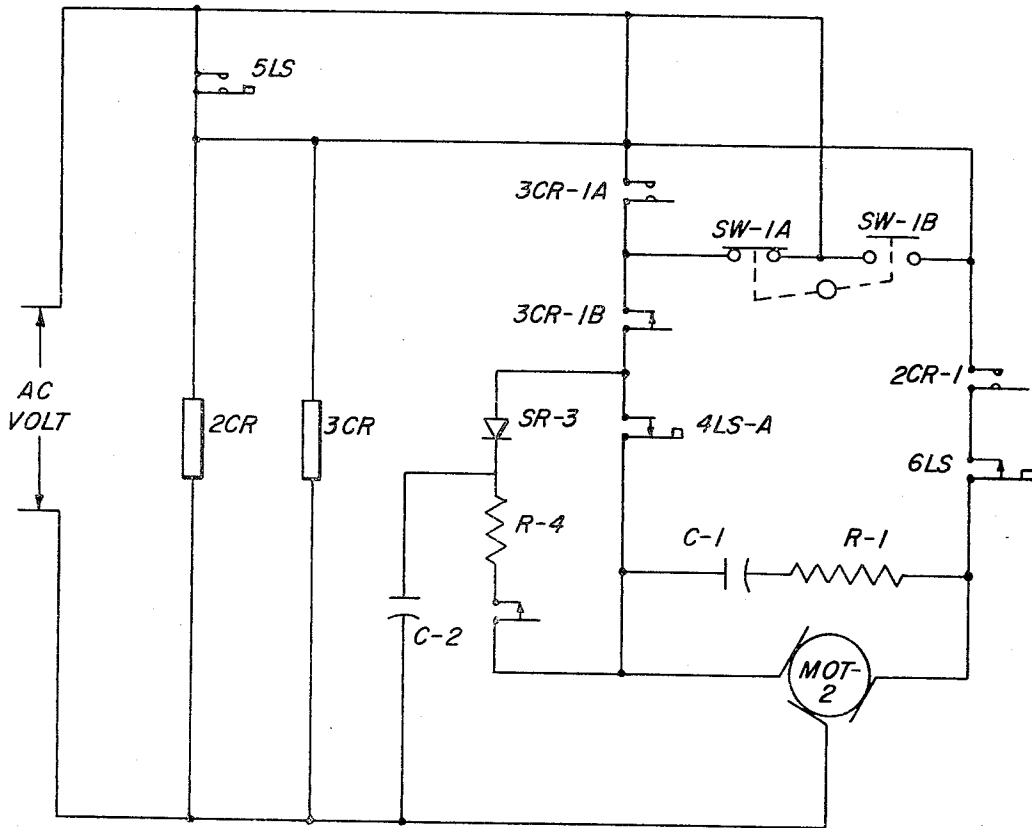


FIG. 5

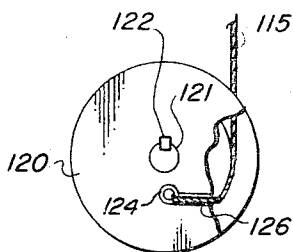


FIG. 6

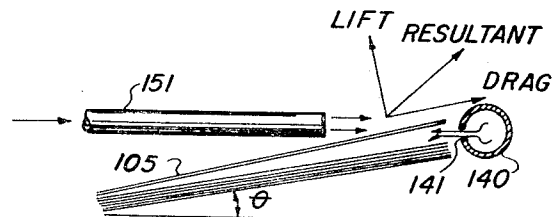


FIG. 7

PNEUMATIC CUT SHEET FEEDER

This invention relates in general to xerographic or other copy apparatus and, in particular, to apparatus for feeding cut sheets of material from the top of a stack.

While not limited to such use, this invention is especially useful in xerographic reproducing apparatus as disclosed in U.S. Pat. No. 3,301,126 issued to R. F. Osborne et al. Machines of this type include processing stations relating to the basic xerographic steps as originally disclosed by C. F. Carlson in U.S. Pat. No. 2,297,691 as well as material-feeding apparatus having a bin for receiving a stack of cut sheets of support material, as for example paper, upon which a xerographic image is to be placed, a vertically movable platform for leveling said stack; and means to forward a sheet from the stack to the xerographic processing station.

With the advent of new xerographic processing techniques and materials, it is feasible to produce xerographic copy at an extremely high rate in machines similar to the one described above. However, supplying cut blanks of support material at these extremely high rates has become increasingly more difficult. The trend heretofore has been towards more and more complex apparatus to perform this function. Apparatus of various configurations employing drag pads, gripper bars, snubbers, guide plates, moving suction feet and the like are known in the art. However, because of the complexity of these devices they are by their very nature space consuming and highly susceptible to breakdowns. It should be further noted, that in many of these devices the interrelationship of moving parts limits the paper feeding speeds that are attainable. That is, the dynamic forces created by the interrelated movement of parts is such as to limit the paper-feeding rates that can be attained.

It is therefore an object of the present invention to improve xerographic reproducing apparatus.

Another object of this invention is to improve apparatus for feeding cut sheets of material from a stack.

A further object of this invention is to eliminate complex moving apparatus from high speed paper-feeding apparatus.

A still further object of this invention is to provide apparatus which will rapidly feed a single sheet of cut material from the top of a stack of said material.

Another object of this invention is to reduce the size of high speed sheet-feeding apparatus.

Yet another object of this invention is to improve paper-feeding apparatus for use in office copying machines.

These and other objects of the present invention are attained by means of a xerographic apparatus, and adjustable table for supporting a stack of support material in said apparatus, fluffing means to support at least the top sheet in said stack upon a cushion of aeriform fluid, cooperating feed rolls adapted to engage a sheet of support material and forward said material to subsequent processing stations, and aeriform fluid means to lift and forward the top sheet in said stack into the cooperating rolls.

For a better understanding of the invention as well as other objects and further features thereof reference is had to the following detailed description to be read in conjunction with the accompanying drawings wherein:

FIG. 1 illustrates schematically a xerographic apparatus using a sheet-feed mechanism constructed in accordance with the present invention;

FIG. 2 is a front view of the preferred embodiment of the sheet-feeding mechanism of the present invention with portions broken away to show internal operations of the apparatus;

FIG. 3 is a top view of the sheet-feed mechanism of the preferred embodiment of the present invention shown in FIG. 2.

FIG. 4 is a top view of another embodiment containing the features of the present invention.

FIG. 5 is a schematic illustration of the paper-feeding elevator circuitry.

FIG. 6 is a partial section showing the table elevating pulley of the present invention taken along line 6-6 in FIG. 3.

FIG. 7 is a diagram showing the vectorial forces exerted on a moving stream of aeriform fluid on the topmost sheet in the present invention.

As shown schematically in FIG. 1, the automatic xerographic reproducing apparatus comprises a xerographic plate 20 which includes a photoconductive layer of light receiving surface on a conductive backing and formed in the shape of a drum, the drum being mounted on a shaft which is journaled in a frame to rotate in the direction indicated by the arrow to cause the drum surface sequentially to pass a plurality of xerographic processing stations.

For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the drum surface may be described functionally as follows:

a charging station, at which a uniform electrostatic charge is deposited on the photoconductive drum surface;

an exposure station, at which a light or radiation pattern of the original to be reproduced is projected onto the drum surface thereby dissipating the charge on the drum in the exposed areas to form a latent electrostatic image of the copy to be reproduced;

a developing station, at which the xerographic developing material, herein referred to as toner, having an electrostatic charge opposite to the charge of the latent image on the drum is cascaded over the drum surface whereby the toner particles adhere to the electrostatic latent image to form a xerographic powder image in configuration to the original to be reproduced;

a transfer station, at which the xerographic powder image is electrostatically transferred from the drum surface to the final support material, and;

a cleaning and discharge station, at which the drum surface is brushed to remove residual toner particles found thereon after image transfer and at which the drum surface is exposed to a light source to effect substantially complete discharge of residual electrostatic charges found thereon.

The charging station, indicated by reference character A, is arranged to include a corona charging device 21 which includes a corona discharge area of one or more corona discharge electrodes that extend transversely across the drum surface and are energized from a high potential source (not shown) and which are substantially enclosed within a shielding member.

Next subsequent thereto in the path of motion of the drum is exposure station B. An optical scanning or projection system is provided to project a flowing image onto the surface of the drum from a stationary platen 22. The original is illuminated uniformly by a bank of lamps LMPS arranged on opposite sides of the platen. Scanning of the document on the stationary platen is accomplished by means of a mirror assembly which is oscillated relative to the platen in timed relation to the movement of the xerographic drum.

The mirror assembly includes an object mirror 23, a lens element 24 and an image mirror 25 which are arranged to reflect the image of the original document onto the xerographic drum through a slot in a fixed light shield 26 positioned adjacent to the drum surface.

Adjacent to the exposure station is a developing station C in which there is positioned a developer apparatus 30 including a casting or housing having a lower or sump portion for accumulating developer material. A bucket-type conveyor is used to transport the developer material to the upper part of the housing where it is cascaded by means of a hopper chute of over the xerographic drum surface to effect development as heretofore described. A toner dispenser is used to accurately meter toner to the developing material as toner particles are consumed during the xerographic developing process.

Positioned next adjacent to the developing station is the image transfer station D which includes a sheet feeding arrangement adapted to feed sheets of support material, such as paper or the like, successively to the xerographic drum in coordination with the presentation of the developed image onto the drum surface at the transfer station.

The sheet-feeding mechanism includes a sheet-feeding device 40 adapted to feed the top sheet of a stack to cooperating rolls which, in turn, cooperate with the belts of paper transport 44 to convey the sheets to a sheet registration device 45 positioned adjacent to the drum. The sheet registration device arrests and aligns each individual sheet of material and then in timed relation to the movement of the drum advances the sheet material into contact therewith in registration with the powder image.

The transfer of the xerographic powder image from the drum surface to the sheet of support material is affected by means of a corona transfer device 51 which is located at or immediately after the line of contact between the support material and the rotating drum. Immediately subsequent to the image transfer station there is positioned stripping apparatus or pick off mechanism 52 for removing individual sheets of support material from the drum surface. A pulsator is adapted to force jets of pressurized aeriform fluid through orifices into contact with the surface of the drum slightly in advance to the support material from the drum surface to strip the leading edge thereof from the drum surface and to direct the support material onto an endless belt conveyor 55 whereby the sheet material is carried to a fixing device 60. At the transfer fixing device, the transferred xerographic powder image on the support material is permanently affixed thereto by means of heat. After fusing the reproduction is discharged from the apparatus at any suitable point for collection external of the apparatus by means of conveyor 65.

The next and final station in the device is a drum cleaning station E having positioned therein a preclean corotron 66, a drum cleaning brush 70 adapted to remove powder remaining on the drum after transfer and a discharge lamp LMP-1 adapted to flood the xerographic drum with light to cause dissipation of any residual electrostatic charge found thereon.

Suitable means are provided to drive the drum, rotating mirror and sheet-feed mechanisms at predetermined rates, and also to effect operation of the bucket-type conveyor and toner dispenser mechanism and other operating mechanisms. The various components are driven by means of main drive motor MOT-1 positioned beneath frame 10.

There is provided a frame for supporting the various components herein described, the frame being formed by a base plate 10 supported on legs 9. Vertical outboard and inboard plates are secured to the base plate 10 in space relation to each other so as to rotatably support xerographic drum 20 therebetween.

It is believed that the foregoing description is sufficient for the purposes of this application to show the general operation of these xerographic reproducing apparatus using a sheet feed mechanism constructed in accordance with the present invention. For further details concerning the specific construction of the xerographic apparatus shown herein, reference is made to the previously mentioned patent application issued in the name of Robert F. Osborne et al.

The sheet mechanism 40 used to separate the uppermost sheet on the stack one at a time from the top of said stack and to feed the sheets to paper transport 44 is shown in this preferred embodiment as an integral part of the reproducing apparatus. However, it should be clear that the subject matter of the present invention may be formed as a separate unit being adapted to connect to the frame of the reproducing apparatus.

Referring now to FIG. 2, 3 and 7 there is shown a front bearing plate 101 and a rear bearing plate 102 connected together and maintained in space relation to each other by means of two side plate 103 and 104, respectively, so as to form the four walls of sheet-feeding mechanism 40. The walls are securely mounted upon a base plate 106 as for example by welding and a cover plate 107 affixed thereto to enclose the sheet feeding mechanism. A stack or pile of cut sheets of support material, indicated as 105, is supported on a movable table 108 supported between the bearing plate 101 and 102. The table has dependent sides 109 extending downward from table 108 and

to which are secured a pair of extension arms 110 carrying a pair of rollers 111. The rollers are adapted to ride in guide channels 112 secured to the base plate as for instance by welding. The table 108 is movable and guided in a vertical direction by means of the rollers moving in guide channels 112.

The table 108 is supported from a pair of cables 115 by means of connectors 116 which are secured to the side of the table. The cables pass over idler pulley 117 and 118, rotatably mounted in the bearing blocks 119, provided, and the opposite end of the cable is securely pinned to pulley 120. The pulley 120 is in turn securely affixed to the table raising and lowering drive shaft 121 by pin 122 (FIG. 6). It should be noted that in FIG. 6 the pulley end of the cable has affixed thereto a bead 124. The bead and cable are passed through the slotted hole 126 provided in pulley 120 so that the cable rotates with the shaft 121 to raise or lower table 108.

Pulleys 120 are fixed to opposite ends of shaft 121. Shaft 121, journaled for rotation in bearing frames 101 and 102 is driven by means of index motor MOT-2 acting through a worm and worm gear assembly. Driving power to raise and lower table is supplied through worm 130 mounted on the drive shaft of index motor MOT-2. Worm 130 acts through worm gear 131 pinned to shaft 121 to rotate the shaft in the desired or programmed direction.

The index motor MOT-2 is electrically connected to a source of power and its operation is programmed by a series of switches, limit switch 4LS, down switch 6LS, manual index switch SW-1 and a low paper limit switch 5LS, shown schematically in the wiring diagram and further described hereinafter. The down limit switch 6LS is secured to the side plate 103 in position to be actuated by the table as the table reaches its lowermost or bottom position. Index limit switch 4LS and low paper limit switch 5LS are mounted in tandem on side plate 103. The index limit switch 4LS is arranged to be actuated by the uppermost sheet in the stack and functions to maintain the stack at a constant predetermined level. The low paper limit switch 5LS is adapted to be actuated by the table when the table reaches an elevation at which the paper supply is exceedingly low. The interrelation of the switches to program the movement of the table will be described in greater detail below. During continued operation of the sheet feed mechanism, the sheet stack is periodically indexed to raise the stack to a level so that the uppermost sheet is continually in a position to be forwarded to subsequent sheet forwarding rolls 150. A stack of cut support material is aligned on the table by means of adjustable aligning members which includes two side aligning members 132 and 133 and trailing edge aligning member 134. The bases of the various members are secured to the table by means of screws 137. Slotted holes 136 are provided in the base portion of each aligning member and the member adapted to slide in the plane of the base so as to accommodate the appropriate size sheets.

The sheet-separating mechanism for separating the top sheet from the stack includes a manifold 140 having a series of apertures 141 machined therein the manifold is operatively connected to a source of aeriform fluid which is maintained at a predetermined positive pressure. The manifold is secured to two extension arms 142 of frame plate 104 by means of a plurality of C-type clamps 143 (FIG. 2). The manifold is arranged so that the apertures are positioned in close proximity to the leading edge of the uppermost sheet on the stack. The apertures direct a continual flow of aeriform fluid under pressure towards the leading edge of the topmost sheets whereby at least the uppermost sheet in the stack is loosened or fanned away from the remaining sheets and more or less supported on a cushion of air. It has been determined that a continuous flow of high volume air positive pressure, less than 1 pound per square inch, directed under the leading edge of the uppermost sheet provides a cushion upon which the sheet can be readily and easily transported.

The uppermost sheet on the stack is forwarded to continually drive feed rolls, generally referred to as 150, by means

of a blast of aeriform fluid across the top of the uppermost sheet. As shown in FIG. 3, exhaust tube 151 directs a stream of aeriform fluid across the back surface of the topmost sheet on stack 105. The tube is arranged so that the center line of the tube is substantially perpendicular to the leading edge of the stack such that a stream of air issued therefrom acts normally to the leading edge of the top sheet towards the cooperating feed rolls 150.

When a body is immersed in a fluid, such as air, and the fluid caused to travel at a greater velocity over the top surface of the body than over the lower surface of said body, such as air over the top of a flat sheet of paper, the fluid exerts a resultant force on the body. As shown in the FIG. 7, this resultant force is basically resolved from two main components; one component being called resistance or drag and the other component being called lift. The drag on a flat sheet is a result of skin friction which builds up tangential or shear stresses in a relatively thin boundary layer between the fluid and the body. The skin friction acts on the moving fluid to retard the fluids' velocity to near zero at the interface between the body and the fluid. Shear forces are developed in this boundary layer as adjacent layers of fluid in the boundary layer over each other at different velocities. The end result of the total shear forces is a vectorial force represented as drag in FIG. 7.

Furthermore, when a body is immersed in a fluid, such as paper in air as shown in FIG. 7, and the fluid caused to move over the top of the body at a greater velocity than the fluid over the lower surface, the body tends to lift. Application of the basic energy equation shows the fluid pressure is inversely proportional to velocity and therefore the pressure on the lower surface must be greater than on the upper surface as air is blown over the top of the body. The pressure difference causes a lifting effect on the body.

In operation, the exhaust tube 151 is positioned to direct a stream of air at the center forward position of the top sheet on stack 105. The uppermost sheet is being supported on a cushion of relatively still air. In the preferred embodiment, the stack is supported by the table at an angle with the horizontally exhausted jet of air from exhaust tube 151. This angling of the sheet in relation to the jet to increase the resultant force acting on the flat sheet much in the same manner as changing the angle of attack of an aircraft's wing. The jetted air stream tends to push the topmost sheet, which is supported on a cushion of air, upwardly and forwardly toward cooperating rolls 160 and 163 (FIG. 2).

Air under pressure is delivered periodically to the exhaust tube by activating solenoid valve 159. The air acts on the paper for a period of time at least long enough to deliver the leading edge of the paper into the nip of forwarding rolls 150. It should be clear to one skilled in the art that the actuation of the solenoid valve can be programmed in conjunction with the xerographic steps whereby a sheet of material is forwarded in timed relation to said process.

Drive roll 160 are pinned to shaft 161 and the shaft rotatably supported in bearing blocks 162 which are mounted in bearing plates 101 and 102. One end of the shaft 161 terminates in a sprocket 158 which is adapted to be chain driven from the main motor MOT-1 (FIG. 1). Canted rolls 163 which cooperate with upper driving rolls 160, are rotatably mounted on shaft 164 and the shaft secured against rotation between extended support members 142. The lower rolls are canted at an angle in the plane of the paper to prevent the paper from buckling and to smooth the sheet out so it can be properly forwarded to conveyor 44. Arms 165 and 166 are pivotally mounted in extended supports 142 by means of pivot pin 167. Torsion spring 168 (FIG. 2) exerts a downward pressure on the extreme end of arm 165 causing the idler rolls at the opposite end of the arm to be forced into driving contact with driving rolls 160.

Also mounted on extended support members 142 are two elevation guides 170 which limit the height to which the uppermost sheet can be dynamically lifted by the air blast.

Although the path of travel of the paper sheet between the top of the stack and the cooperating forwarding rolls is not substantial, it is found that the lift of the forwardly moving paper may be such as to carry the sheet above the horizontal center line of top roll 160, in which case the paper sheet will not be engaged in the forwarding rolls. The elevation guides are arranged to contact the upwardly moving sheet of support material at the proper height so that the paper is fed into the nip of the rolls.

By the same token if the topmost sheet in the stack is too low the sheet will not be lifted into the nip of the rolls. The top of the uppermost sheet in the stack is maintained at a known working level by the programmed paper elevator. Referring now to FIG. 5, there is shown a schematic illustration of the paper feeder elevator or index motor circuitry. The circuit includes an index motor MOT-2 which is controlled by paper feeder up index limit switch 5LS actuated by the top sheet on the stack as previously described. With the "up" contact switch SW-6A of the index switch in a closed position, a circuit is partly completed through normally closed contact 3CR-1B of relay circuit 3-CR. The only break in this circuit being the contact of normally closed 4LS-A of index limit switch 4LS. As sheets are fed from the stack, the position of the uppermost sheet will drop sufficiently to actuate switch 4LS thereby closing contact 4LS-A to energize the index motor MOT-2 so as to raise the stack until the uppermost sheet once again makes limit switch 4LS. This cycle of operation continues during normal operation of the machine.

If the supply of paper is nearly exhausted, the low paper limit switch 5LS is actuated closing its contact which completes a circuit to energize relays 2CR and 3CR. As this occurs, contact 3CR-1A closes and contacts 3CR-1B opens to establish a holding circuit to relays 2CR and 3CR through the closed "up" contact switch SW-6A and contact 3CR-1A. At this time, contact 2CR-1 also closes and provides power to the "down" circuitry of the elevator motor through the down limit switch 6LS, which is normally closed switch. The motor is now in a condition to lower the paper tray. The tray continues to be lowered until limit switch 6LS is actuated thereby breaking the down circuit.

The operator now loads additional paper into the paper tray and then presses the up button SW-1A to momentarily open the contact to break the circuit to relay 2CR and 3CR. The low paper limit switch now opens as the paper tray is lowered. At this time, the up index limit switch 4LS again takes over control of the motor until the upper sheet on the stack is again moved out of contact with switch 4LS to once again open its contact stopping the upward progress of the paper tray at a predetermined height so that the uppermost sheet in the stack is in operative relation with continually rotating paper feed rolls.

The purpose of rectifier SR-3, normally closed contact 4LS-B and capacitor C-7 is to provide a holding torque on motor MOT-2 when it is not operating. The capacitor C-1 and resistor R-2 are part of the circuit for the motor itself. The motor MOT-2 is preferably a synchronous motor adapted to be electrically connected for reversible rotation.

Referring now to FIG. 4, there is shown another embodiment of the instant invention in which a high pressure manifold 180 is extended laterally across the uppermost sheet in the stack. The manifold is provided with a series of ports 181 arranged to act at various points on the back side of the topmost sheet to cause said sheet to be lifted and forwarded into cooperating rolls 160 and 163. It is quite feasible that the paper feeder of the instant invention be adapted for use in copying devices to feed relatively large sheets of paper as for example large engineering drawings where the use of a single exhaust means would be impractical to properly forward large sheets. Aeriform fluid is periodically supplied to manifold 180 by actuating solenoid valve 159 at the desired rate. The air exhausted from ports 181 not only provides the forces needed to lift and forward the sheets but also acts to move the sheets uniformly along the path of travel into the nip of the pinch

rolls 160 and 163 so that very little buckling of the paper is produced.

It should be noted that the use of conventional snubbers, grippers or suction feet have been eliminated in the instant invention and that a continuously rotating, relatively simple, pinch roll assembly provides the only mechanically moving means for transporting the sheets. It has been found that sheets of 8½ inches × 11 inches paper mounted on table inclined at approximately 10° with the horizontal can be forwarded at rates in excess of 12 inches per second by subjecting the back of the sheets to a single stream of air about or less than 15 p.s.i. pressure issuing from a .250 inches diameter exhaust tube when the sheet is supported on a cushion of air.

While this invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth and this application is intended to cover such modifications or changes as may come within the purpose of the improvements or the scope of the following claims.

I claim:

1. In a xerographic reproducing machine, apparatus to feed cut sheets of support material seriatim from a stack to said xerographic machine, the combination including:

a frame;

a cooperating pair of feed rolls journaled for rotation in said frame;

drive means to continually drive said cooperating pair of feed rolls;

means to support a stack of cut sheets of support material in said frame and being adapted to position the leading edge of the uppermost sheet in said stack adjacent to said cooperating feed rolls;

elevating means operatively connected to said support means and being adapted to raise and lower said stack;

switching means being operable by the uppermost sheet in said stack to prevent further elevation of said stack when

said sheet is in operative relation with said feed rolls; aerating means positioned in cooperative relation to the prepositioned stack to introduce a controlled flow of aeriform fluid against the leading edge of the stack to create an air cushion such that at least the uppermost sheet on said stack will be fanned and separated from said stack;

exhaust means being arranged to direct a stream of aeriform fluid across the top of the uppermost sheet in said stack so that said stream moves substantially normal to and towards the leading edge of said sheet;

means to supply aeriform fluid to said exhaust means whereby said exhaust means delivers a stream of fluid at a velocity to move said sheet upwardly and forwardly towards said cooperating feed rolls;

guide means positioned above the uppermost sheet in said stack and being arranged to direct the uppermost sheet in said stack into said feed rolls as the sheet moves upwardly and forwardly toward said rolls; and

further means to pulse said air delivery means so that sheets in said stack are delivered seriatim to said pinch rolls in predetermined timed relation.

2. The apparatus of claim 1 having a plurality of exhausted means being adapted to direct a series of substantially parallel streams of fluid across the top surface of said uppermost sheet to lift and forward said sheet into said cooperating feed rolls.

3. The apparatus of claim 2 wherein said aerating means is arranged to produce an air cushion of approximately 1 pound per square in positive pressure.

4. The apparatus of claim 1 wherein said stream of aeriform fluid is directed over the top of the stack by means of an exhaust tube having an inside diameter of 0.250 inches and said fluid being delivered at a positive pressure of approximately 15 p.s.i.

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