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(54) Sheet feeding apparatus

(57) Described herein is a sheet feeding apparatus (70) in which a trailing vacuum plenum (84,92) moves in unison with a guide (78) which engages an edge of a stack (32) to align the sheets thereof. The trailing edge vacuum plenum (84,92) is positioned over the stack (32) to acquire a trailing portion of a sheet. The sheet feeding apparatus (70) includes a leading vacuum plenum (104,106) positioned over the stack (32) to acquire a leading portion of the sheet. A sheet transport (72) advances the sheet acquired by the leading vacuum plenum (104,106) from the stack (32). Fluffer jets (94,96) are employed to inject air between the leading portion and trailing portion of the sheet to assist the sheet transport (72).

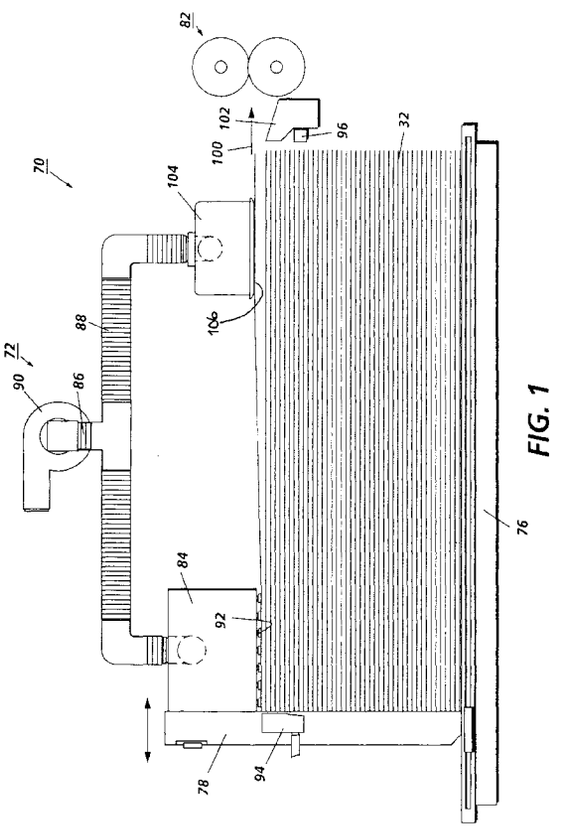

FIG. 1

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Description

This invention relates to an electrophotographic printing machine, and more particularly concerns an apparatus for advancing sheets from a stack to processing stations within the printing machine.

A typical electrophotographic printing machine employs a photoconductive member that is charged to a substantially uniform potential so as to sensitize the surface thereof. The charged portion of the photoconductive member is exposed to a light image of an original document being reproduced. Exposure of the charged photoconductive member selectively dissipates the charge thereon in the irradiated areas to record an electrostatic latent image on the photoconductive member corresponding to the informational areas contained in the original document. After the electrostatic latent image is recorded on the photoconductive member, the latent image is developed by bringing a developer material into contact therewith. Generally, the electrostatic latent image is developed with dry developer material having carrier granules with toner particles adhering triboelectrically thereto. However, a liquid developer material may be used as well. The toner particles are attracted to the latent image forming a visible image on the photoconductive surface. After the electrostatic latent image is developed with the toner, the toner image is transferred to a sheet. The toner image is then heated to permanently fuse it to the sheet.

It is highly desirable to use an electrophotographic printing machine of this type to produce color prints. In order to produce a color, it is frequently necessary to form yellow, magenta and cyan color separations. One skilled in the art will appreciate that the black separation can be made either first or last with respect to the other color separations. In this way, a permanent color print is formed.

In either a monocolor or multicolor printing machine, it is necessary for a sheet feeder to advance cut copy sheets to the processing stations of the printing machine in a rapid, dependable manner. This sheet feeder may be used in a document handling system for advancing original documents to a platen of a copier for subsequent reproduction thereat. Alternatively, this sheet feeder may be used to advance successive sheets to the transfer station of the printing machine in order to receive the monocolor or multicolor toner image from the photoconductive member thereat. These sheet feeders must operate flawlessly to virtually eliminate the risk of damaging the sheets and generate minimum machine shutdowns due to uncorrectable misfeeds or sheet multifeeds.

It is in the initial separation of the individual sheets from the stack where the greatest number of problems occur. Since the sheets must be handled gently, but positively, to assure separation without damage, a number of separators have been suggested, such as friction rolls or belts used for fairly positive document feeding in conjunction with a retard belt, pad or roll to prevent multifeeds. Vacuum separators, such as sniffer tubes, rocker-type vacuum rolls or vacuum feed belts have also been utilized. In high speed operation, a vacuum corrugated sheet feeder with an air knife located at the leading edge of the sheet is frequently used. In a system of this type, a vacuum plenum with a plurality of friction belts arranged to run over the vacuum plenum is placed at the top of a stack of sheets in a supply tray. An air knife is located at the leading edge of the stack to inject air between the acquired sheet and the remainder of the stack to separate the acquired sheet, i.e. the top sheet, from the remainder of the stack. After the top sheet is separated, the vacuum pulls the separated sheet up and acquires it. Following acquisition, the belt transport advances the sheet from the stack of sheets. Various types of sheet feeders have been employed heretofore.

US-A-4 451 028 discloses a sheet feeding apparatus with a rear vacuum plenum for acquiring the trailing portion of the sheet. A front vacuum plenum is positioned over the leading portion of the sheet and adapted to acquire the leading portion of the sheet. A sheet transport is associated with the vacuum plenum to advance the acquired sheet in a forward direction. An air knife is located at the trailing edge of the sheet to inject air between the trailing edge of the top sheet of the stack and the remainder of the stack.

In accordance with one aspect of the present invention, there is provided apparatus for advancing sheets from a stack thereof, the apparatus including: a movable guide adapted to be positioned in engagement with an edge of the stack to align the sheets thereof; a trailing vacuum plenum positioned over the stack and adapted to acquire a trailing portion of a sheet; a leading vacuum plenum positioned over the stack and adapted to acquire a leading portion of the sheet; air supply means for injecting air between at least one sheet and the remainder of the stack; and a sheet transport positioned to advance the sheet acquired by the leading vacuum plenum to advance the sheet from the stack; characterised in that the trailing vacuum plenum is associated with the guide to move in unison therewith; and in that the air supply means injects air between at least the trailing portion of the sheet and the stack, and the leading portion of sheet and the stack.

Pursuant to another aspect of the present invention, there is provided a printing machine of a type having a sheet advancing from a stack thereof, the machine including a surface; forming means for forming a visible image on the surface; and transferring means for transferring the visible image from the surface to a sheet, characterised in that the printing machine includes apparatus for advancing sheets from a stack as described above.

Other aspects of the present invention will become apparent as the following description proceeds and upon reference to the drawings, in which:

Figure 1 is an elevational view depicting the sheet feeding apparatus of the present invention; and
Figure 2 is a schematic elevational view showing a multicolor printing machine using the Figure 1 sheet feeding apparatus.

While the present invention will hereinafter be described in connection with a preferred embodiment, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

For a general understanding of the features of the present invention, reference is made to the drawings. In the drawings, like reference numerals have been used throughout to designate identical elements.

Referring initially to Figure 2, there is shown a multicolor electrophotographic printing machine using the sheet feeding apparatus of the present invention. The printing machine employs a photoconductive belt 10 supported by a plurality of rollers or bars 12. Photoconductive belt 10 is arranged in a vertical orientation and advances in the direction of arrow 14. Successive portions of the photoconductive surface of belt 10 advance sequentially to the various processing stations disposed about the path of movement thereof.

Initially, belt 10 passes through charging station 16. At the charging station, a corona generating device (not shown) charges the photoconductive surface of belt 10 to a relatively high, substantially uniform potential. After the photoconductive surface of belt 10 is charged, the charged portion thereof is advanced to the exposure station.

At the exposure station, an imaging beam generated by a raster output scanner (ROS) 20 creates a color separated electrostatic latent image on the photoconductive surface of belt 10. One skilled in the art will appreciate that a laser diode array may be used as well. This color separated electrostatic latent image is developed by developer unit 22.

Developer unit 22 deposits black toner particles on the electrostatic latent image. In this way, a black toner powder image is formed on the photoconductive surface of belt 10. After the black toner powder image has been developed on the photoconductive surface of belt 10, belt 10 continues to advance in the direction of arrow 14 to a recharge station.

At the recharge station, a corona generating device 56 recharges the photoconductive surface to a relatively high, substantially uniform potential.

After recharging, a different imaging beam 18_Y from ROS 20 selectively dissipates the charge to record another partial electrostatic latent image on the photoconductive surface of belt 10 corresponding to the regions to be developed with yellow toner particles. This partial electrostatic latent image is now advanced to the next successive developer unit 50.

Developer unit 50 deposits yellow toner particles on the photoconductive surface of belt 10 to form a yellow toner powder image thereon. After the electrostatic latent image has been developed with the yellow toner, belt 10 advances in the direction of arrow 14 to the next recharge station.

At this recharge station, a corona generating device 58 charges the photoconductive surface of belt 10 to a relatively high, substantially uniform potential.

After recharging, another imaging beam 18_M from ROS 20 selectively discharges the charge on the photoconductive surface to record a partial electrostatic latent image for development with magenta toner particles.

After this latent image is recorded on the photoconductive surface, belt 10 advances the latent image to the magenta developer unit 52. Magenta developer unit 52 deposits magenta toner particles on the latent image. These toner particles may be in partially superimposed registration with the previously formed yellow toner powder image. After the magenta toner powder image is formed on the photoconductive surface of belt 10, belt 10 advances to the next recharge station.

At this recharge station, corona generator 60 recharges the photoconductive surface of belt 10 to a relatively high, substantially uniform potential.

After recharging, another imaging beam 18_C from ROS 20 selectively discharges those portions of the charged photoconductive surface which are to be developed with cyan toner particles. The latent image to be developed with cyan toner particles is advanced to cyan developer unit 54.

Cyan developer unit 54 deposits cyan particles on the latent image recorded on the photoconductive surface of belt 10. These cyan toner particles form a cyan toner powder image which may be partially or totally in superimposed registration with the previously formed yellow and magenta toner powder images. In this way, a multicolor toner powder is formed on the photoconductive surface of belt 10.

Thereafter, belt 10 advances the multicolor toner powder image to transfer station 24.

At transfer station 24, a sheet of support material, e.g. paper, is advanced from stack 32 by sheet feeding apparatus 70. Sheet feeding apparatus 70 includes a trail vacuum plenum 84, a lead vacuum plenum 104 and sheet feeding plate 106. Stack 32 is supported by tray 76. A trail edge guide 78 is mounted movable on tray 76. Trail edge guide 78 engages the trailing edge of the stack of sheets to align the sheets of stack 32. Trail vacuum plenum 84 is mounted on guide 78 and moves in unison therewith. One skilled in the art will appreciate that trail vacuum plenum 84 may be associated with guide 78 to move in unison therewith. For example, trail vacuum plenum 84 may be coupled to guide 78 by belts or gears to move in unison therewith. Tray 76 is mounted on an elevator system (not shown) and adapted to move in a vertical direction so as to position the topmost sheet

of stack 32 adjacent the trailing vacuum plenum 84 and the lead vacuum plenum 104 and feeding plate 106. Sheet feeding apparatus 70 will be described hereinafter in greater detail with reference to Figure 1.

With continued reference to Figure 2, the topmost sheet is advanced by forwarding rollers 82 to transfer station 24. At transfer station 24, a corona generating device sprays ions onto the backside of the sheet. This attracts the developed multicolor image from the photoconductive surface of belt 10 to the sheet. A vacuum transport (not shown) moves the sheet in the direction of arrow 36 to fusing station 38.

Fusing station 38 includes fuser roll 40 and a backup roll 42. The backup roll 42 is resiliently urged into engagement with the fuser roll 40 to form a nip through which the sheet passes. In the fusing operation, the toner particles coalesce with one another and bond to the sheet in image configuration forming a multicolor image thereon. After fusing, the finished sheet is discharged to a finishing station 44 where the sheets are compiled and formed into sets which may be bound to one another. These sets are advanced to a catch tray 46 for subsequent removal therefrom by the printing machine operator.

One skilled in the art will appreciate that while the multicolor developed image has been disclosed as being transferred to a sheet of support material, e.g. paper, it may be transferred to an intermediate member, such a belt or drum, and then, subsequently transferred and fused to the sheet of support material. Furthermore, while toner powder images and toner particles have been disclosed herein, one skilled in the art will appreciate that a liquid developer material may also be used.

Invariably, after the multicolor toner powder image has been transferred to the sheet, residual toner particles remain adhering to the photoconductive surface of belt 10. These residual toner particles are removed therefrom by cleaning station 48. After cleaning the photoconductive surface of belt 10, the cycle is repeated for the next successive print.

Turning now to Figure 1, there is shown the details of sheet feeding apparatus 70. Sheet feeding apparatus 70 may be installed adjacent to the exposure platen of a conventional printing machine for feeding of documents to the platen for copying. Alternatively, as shown in Figure 2, the sheet feeding apparatus may be mounted at the beginning of the sheet path for advancing cut sheets to the transfer station of the printing machine. In either case, the sheet feeding apparatus illustrated is merely one example of a sheet feeder which may be used according to the present invention. Sheet feeding apparatus 70 is provided with a sheet stack supporting tray 76 which may be raised and lowered through electrical power screws by a motor (not shown) from a base support platform (also not shown). The motor is activated to move the sheet stack support tray 76 vertically upward by a stack height sensor (not shown) when the level of the sheet relative to the sensor falls beneath a predetermined level. The motor is inactivated by the stack height sensor when the level of the sheets relative to the sensor is above the predetermined level. The stack height sensor may be located at the rear or at a side of the stack of sheets to sense a height level. In this way, the level of the top sheet of the stack of sheets may be maintained within narrow limits to assure proper sheet separation, acquisition and feeding. The sheet feeding apparatus has both a leading and a trailing vacuum plenum arrangement to perform separation functions. The leading vacuum plenum 104 and the trailing vacuum plenum 84 are supplied with low air pressure through conduit system 72 by vacuum pump 90. Pump 90 is connected to conduit 86 which, in turn, is connected to conduit 88. Conduit 88 is connected to vacuum plenums 84 and 104. When pump 90 is actuated, air is pulled from both the leading and trailing vacuum plenums through the pump 90 to an exhaust (not shown). A valve (not shown) is placed in the portion of air conduit 88 supplying the leading vacuum plenum 104. The leading vacuum plenum 104 has associated therewith a slide plate transport assembly 106 for advancing the top sheet in the stack from the remainder of the stack. The surface 92 of trailing vacuum plenum 84 adjacent the topmost sheet is made from low friction material to reduce the friction between the trailing vacuum plenum 84 and the topmost sheet. Trailing vacuum plenum 84 is mounted on guide 78. Guide 78 is mounted movably on tray 76. Guide 78 is moved into position in contact with the trailing edge of the stack 32 of sheets to align the sheets thereof. In this way, as guide 78 moves with respect to tray 76, trailing vacuum plenum 84 moves in unison therewith. This permits different sizes of stacks of sheets to be supported by tray 76 with the trailing vacuum plenum 84 properly positioned relative to the trailing portion of the uppermost sheet of the stack 32.

Rear fluffer jets 94 are mounted on guide 78 to move in unison therewith as well. The rear fluffer jets 94 have at least two nozzles (not shown) directed to the rear or trailing edge of the top sheet in the stack 32 of sheets to be fed. The rear fluffer jets serve to direct a blast of air at the trailing edge of the sheets to separate the trailing portion of several sheets from the remainder of the stack by inserting a volume of air therebetween. Leading fluffer jets 96 and air knife 102 direct a blast of air at the leading edge of the sheets to separate the leading portion of several sheets from the remainder of the stack by inserting a volume of air therebetween. This facilitates acquisition of the topmost sheet by plenum 104.

In operation, tray 76 is elevated by power screws and advances the topmost sheet to the sheet feeding level. Vacuum pump 90 is activated and continuously exhaust air from conduits from 86 and 88. The portion of conduit 88 connected to plenum 104 is periodically closed by a valve (not shown) therein. In addition, the rear fluffer jets 94, leading fluffer jets 96 and air knife 102 are activated to inject air between the top sheets and the remainder of the stack 32. This serves to sep-

arate the top sheets from the remainder of the stack 32. When separated, the trailing portion of the top sheet is acquired by the trailing vacuum plenum 92. With the valve (not shown) in conduit 88 open, the front of the topmost sheet is acquired by leading vacuum plenum 104. Slide plate assembly 106 is energized and the top sheet, which has been acquired by the vacuum plenums, is driven forward in the direction of arrow 100 from stack 32. Surface 92 of rear plenum 84 has a low coefficient of friction. In contrast, slide plate assembly 106 include a slide plates having a high coefficient of friction. In this way, the frictional driving force exerted on the leading portion of the sheet by the vacuum and by the slide plate transport assembly 106 is greater than the drag exerted on the rear portion of the sheet by the trailing vacuum plenum 84. In operation, the rear fluffer jets 94, leading fluffer jets 96, air knife 102 and rear vacuum plenum 84 are constantly energized, while the leading vacuum plenum 104 and slide plate transport assembly 106 are pulsed for each sheet that is fed to insure an intercopy gap between the sheets being fed and to avoid the possibility of sheets shingling. Further details of this type of system are discussed in US-A- 4 451 028.

In recapitulation, it is clear that the present invention is directed to a sheet feeding apparatus wherein a trailing vacuum plenum, positioned over a stack of sheets, is adapted to acquire a trailing portion of the uppermost sheet of the stack. The trailing vacuum plenum is associated with a movable guide. The movable guide aligns the sheets of the stack. In this way, the guide and trailing vacuum plenum move in unison with one another. A leading vacuum plenum, positioned over the stack, is adapted to acquire the leading portion of the sheet. A sheet transport advances the sheet acquired by the leading vacuum plenum. The sheet is advanced from the stack to a processing station in the printing machine. The processing station, may be a transfer station when cut sheets are being advanced by the sheet feeder for receiving information thereon, or a document handler for advancing sheets to the exposure platen of a copier.

It is, therefore, apparent that there has been provided in accordance with the present invention, a sheet feeding apparatus which fully satisfies the aims and advantages hereinbefore set forth. While this invention has been described in conjunction with a specific embodiment thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art.

Claims

1. Apparatus (70) for advancing sheets from a stack (32) thereof, the apparatus including:

   a movable guide (78) adapted to be positioned in engagement with an edge of the stack (32) to align the sheets thereof;

   a trailing vacuum plenum (84,92) positioned over the stack (32) and adapted to acquire a trailing portion of a sheet;

   a leading vacuum plenum (104,106) positioned over the stack (32) and adapted to acquire a leading portion of the sheet;

   air supply means (94,96,102) for injecting air between at least one sheet and the remainder of the stack (32); and

   a sheet transport (72) positioned to advance the sheet acquired by the leading vacuum plenum (104,106) to advance the sheet from the stack (32);

   characterised in that the trailing vacuum plenum (84,92) is associated with the guide (78) to move in unison therewith; and in that the air supply means (94,96,102) injects air between at least the trailing portion of the sheet and the stack (32), and the leading portion of sheet and the stack (32).

2. Apparatus according to claim 1, wherein the air supply (94,96,102) includes a rear fluffer jet (94) mounted on the guide (78) which injects air between the trailing portion of the sheet and the stack (32), a leading fluffer jet (96), and an air knife (102) mounted stationarily which inject air between the leading portion of the sheet and the stack (32).

3. An apparatus according to claim 1 or 2, wherein the sheet transport (72) is operatively associated with the leading vacuum plenum (104,106).

4. An apparatus according to any one of claims 1 to 3, further including a tray (76) for supporting the stack (32).

5. An apparatus according to claim 4, wherein the movable guide (78) includes a planar member mounted movably on the tray (76) so as to be positioned in engagement with the trailing edge of the stack (32).

6. A printing machine of a type having a sheet advancing from a stack thereof, the machine including a surface; forming means for forming a visible image on the surface; and transferring means for transferring the visible image from the surface to a sheet, characterised in that the printing machine includes apparatus for advancing sheets from a stack (32) according to any one of claims 1 to 5.

7. A printing machine according to claim 6, wherein the surface includes a photoconductive surface.

8. A printing machine according to claim 6, wherein the surface includes an intermediate surface.

9. A printing machine according to claim 8, further including a photoconductive surface; and developing means for developing a visible image on the photoconductive surface, the forming means transferring the visible image from the photoconductive surface to the intermediate surface.

10. A printing machine according to claim 6, further including reproducing means for reproducing indicia on the sheet, the sheet transport advancing the sheet to the reproducing means.

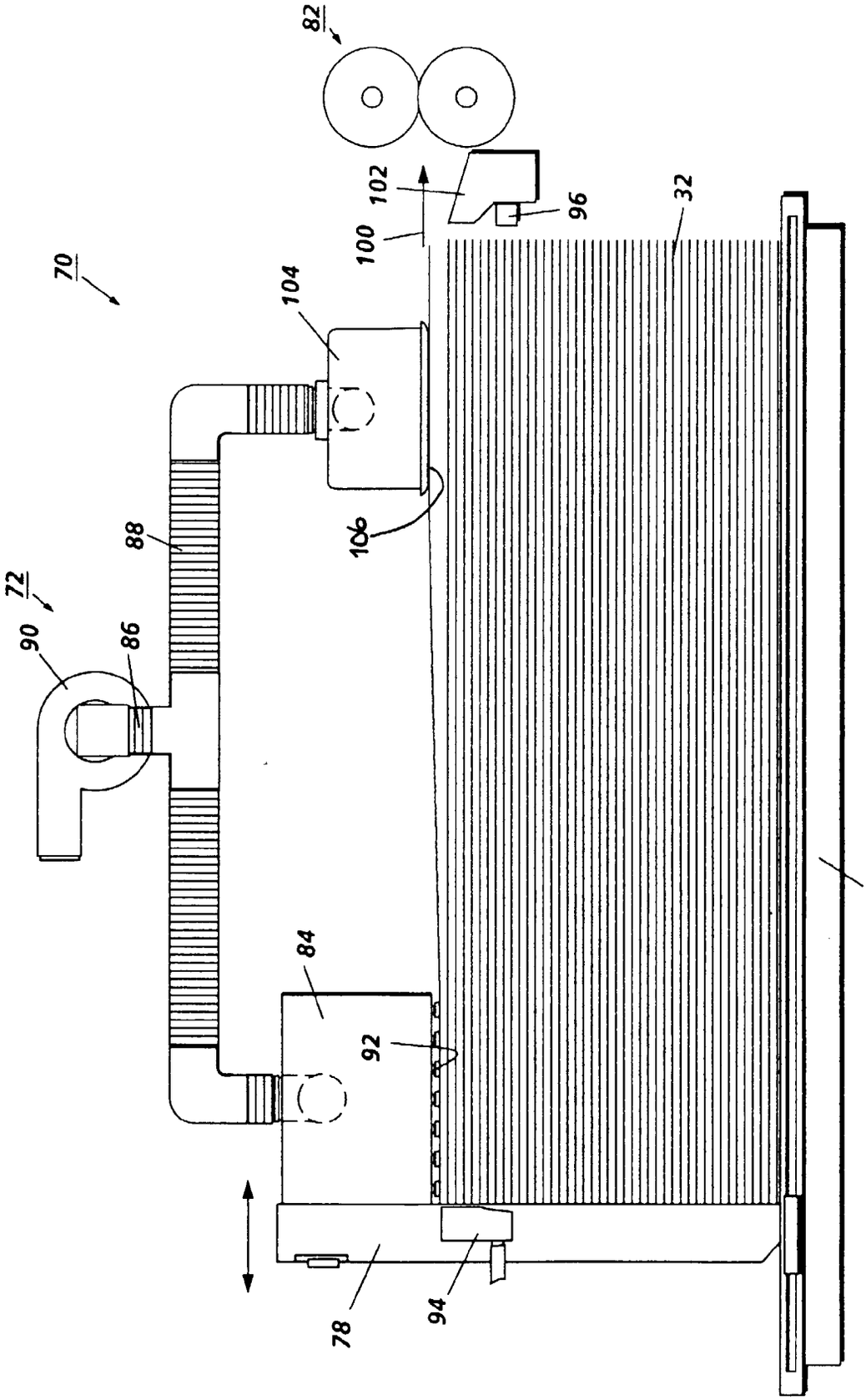

FIG. 1

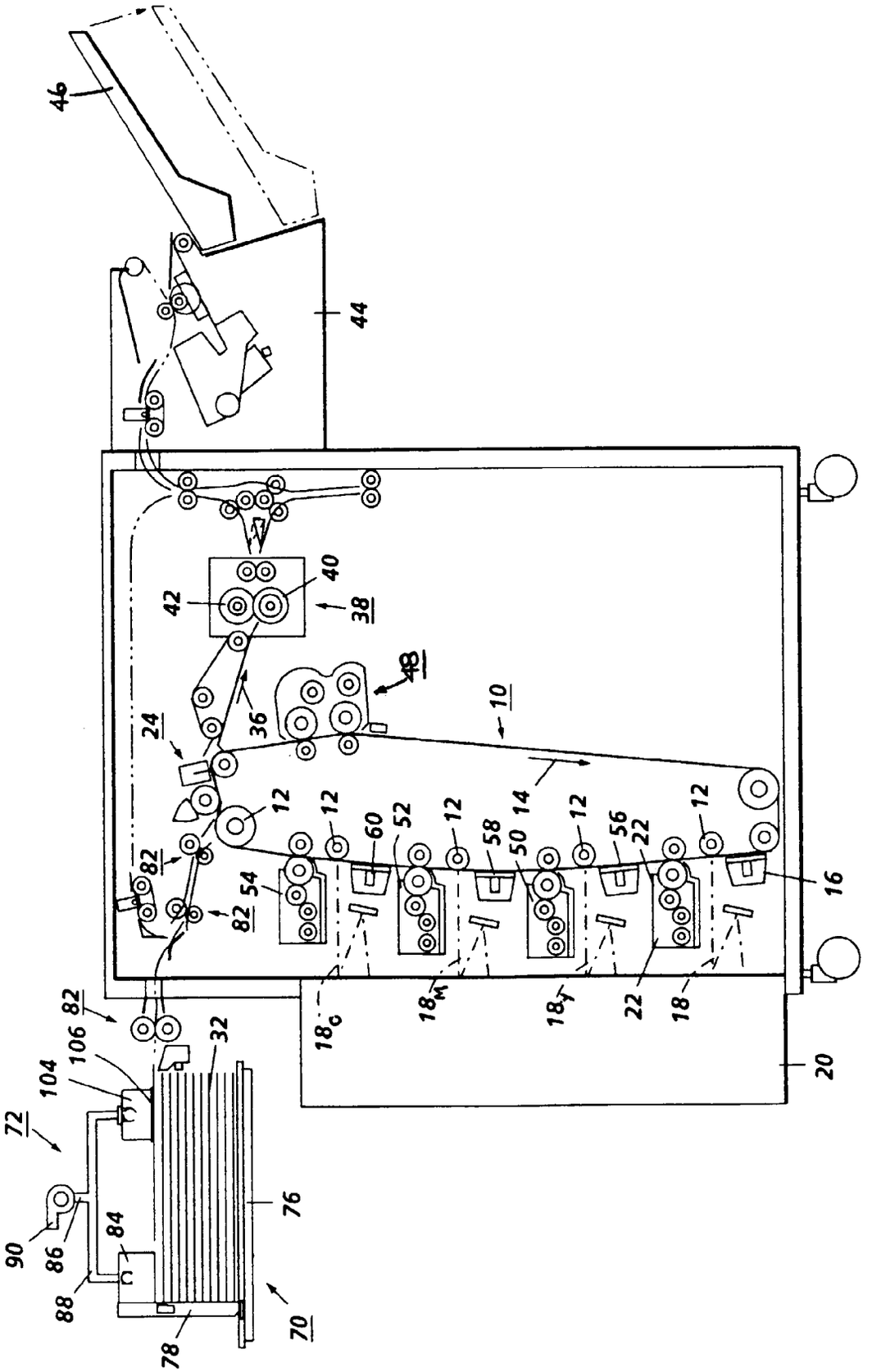
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FIG. 2