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(54) Method and apparatus for applying a coating material to sheets

(57) Individual sheets of, for example, paper are coated by feeding the sheets in succession through a coating station (11) in which a primer material and a low adhesion backsize material are applied to opposite sides of the sheets. The sheets are then deposited on a conveyor so that they are overlapped to form a pseudo-web of sheets.

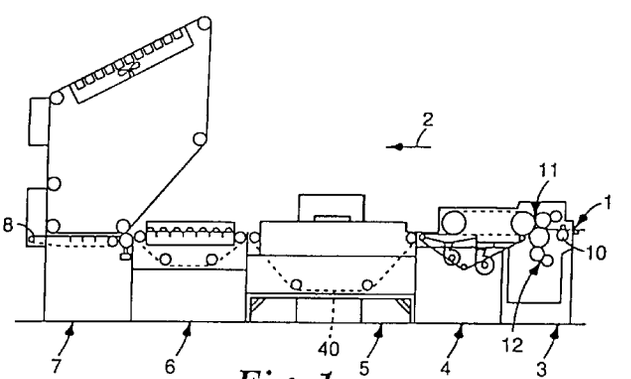

Fig. 1

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Description

Technical Field

The present invention relates to an apparatus and method for applying coating material to both opposing major surfaces of a plurality of individual sheets, for example sheets of paper.

Background of the Invention

It is necessary in certain fields to apply coating material to paper and, in some cases, to apply different coating materials to the two opposing major surfaces of the paper. For example, in the production of so-called repositionable notes it is known to apply a primer material to one side of the paper from which the repositionable notes will be cut and to apply a low adhesion backsize, or release, material to the other side of the paper. The repositionable adhesive is applied to the paper on top of the primer material. Conventionally, for the production of repositionable notes, the various coatings are applied to a web of paper from a roll. The coating materials are dispersed in solvents and coated directly on the paper. The web is dried between coatings and then rewound and the coated roll is subsequently cut into sheets which are used to produce the notes. When the paper web is coated with materials dispersed in an organic solvent and is under tension when the coatings are applied, the tendency of the paper web to curl or wrinkle can be substantially eliminated, otherwise great care is required to balance the paper sheet's expansion during coating.

A process for the production of repositionable notes, in which a release material and a primer material are coated successively on opposite sides of a paper web is described in WO-A-87/05315. In some cases, it is desirable to apply coating material to cut sheets rather than to a web of paper. For example, in the production of repositionable notes it is desirable to have the option of using a stack of preprinted sheets as the supply source, instead of a plain paper web, to extend the flexibility of the production process. In addition, for environmental reasons, there is a desire to move away from the use of materials containing organic solvents in coating processes towards the use of water-based materials. Moreover, many inks are soluble in organic solvents, but insoluble in water. Problems can arise, however, in applying coating materials (and, particularly, water-based coating materials) to individual sheets because the risk that the sheets will curl or wrinkle is greatly increased. Any curling or wrinkling not only spoils the appearance of the sheets but can also make it difficult to apply further coating materials.

Co-pending U.S. Patent Application Serial No. 08/196,490 filed February 15, 1994 entitled"Method"and Apparatus for Applying a Coating Material to a Sheet", discloses apparatus and a method for forming pads of repositionable notes from a stack of uncoated individual paper sheets. The sheets are fed from the stack in an overlapped condition to a coating station in which a continuous layer of a water-based primer material is applied to one major surface of the web-like overlapped sheets and a continuous layer of a water-based low adhesion backsize (LAB) material is applied simultaneously to the other major surface. The overlapped sheets are then dried and fed to a second coating station in which stripes of repositionable adhesive are applied to the web-like overlapped sheets on the surface to which the primer was applied in the first coating station. Thereafter, the sheets are adhered together in a stack and trimmed to form pads of repositionable notes. In that process, curling or wrinkling of the sheets is avoided by applying the primer and LAB coatings simultaneously to both sides of the sheets and then drying both coatings simultaneously.

However, it has been found that existing systems for applying a coating material to sheets, including the aforementioned U.S. Patent Application Serial No. 08/196,490, while having their own utility, are not as effective or efficient as desired in coating some materials onto certain sheet materials. Therefore, an improved method and apparatus for applying a coating material onto sheets is desired.

Summary of the Invention

The present invention provides apparatus for coating both sides of a plurality of sheets, comprising a coating station arranged to receive a succession of sheets and operable to apply coating material to both sides of each sheet as the sheet passes through the station; means for overlapping the sheets whereby the leading edge of one sheet overlies the trailing edge of the preceding sheet; and means for changing the overlap so that the trailing edge of one sheet overlies the leading edge of the succeeding sheet. The sheets may then be fed to a second coating station which is operable to apply a further coating material to one side of the overlapped sheets.

The present invention also provides a method for coating both sides of a plurality of sheets, comprising applying coating material to both sides of each sheet in a succession of sheets; overlapping the coated sheets to form a pseudo-web of sheets in which a leading edge portion of each sheet overlies the trailing edge portion of the preceeding sheet; changing the overlap so that the trailing edge portion of each sheet overlies the leading edge portion of the succeeding sheet; and then applying a further coating material to one side of the pseudo-web of sheets.

Preferably, when both sides of each sheet are being coated, the coating material(s) is/are applied simultaneously to both sides. The coating materials may be a primer material and a low adhesion backsize material. The further coating material may be a repositionable

adhesive.

Brief Description of the Drawings

Embodiments of the invention will be described, by way of example, with reference to the accompanying drawings, wherein like structure is referred to by like numerals in the several views, and in which:

Figure 1 is a schematic side view of apparatus which includes a coating station, in accordance with the invention;
Figure 2 is a schematic top view of the apparatus shown in Figure 1;
Figure 3 is a view of a coating station forming part of the apparatus shown in Figure 1;
Figure 4 is a view similar to Figure 3 showing part of the coating station in greater detail;
Figure 5 shows a coating material supply system for the coating station of Figs. 3 and 4;
Figure 6 is a diagrammatic side view of part of an adhesive coating station at the downstream end of the apparatus shown in Figure 1 with an alternative coating section;
Figure 7 is a diagrammatic side view of a modified version of the apparatus shown in Figure 1 with an alternative guiding section; and
Figure 8 is an enlarged partial view of part of Figure 4.

Detailed Description of the Invention

The apparatus shown schematically in Figure 1 and 2 is specifically for use in the production of repositionable notes from sheets of any suitable substrate material, example, paper, polymeric film or foils, such as metallic foils and, in particular, for the application to individual sheets of a primer material, a low adhesion backsize (LAB) material, and a repositionable adhesive so that the sheets can subsequently be used to form repositionable notes. In the following description, it will be assumed that the sheets (which may be pre-printed) are of paper. The paper may be any suitable paper, such as the paper utilized to construct the Post-it® brand repositionable notes available from Minnesota Mining and Manufacturing Company ("3M") of St. Paul, Minnesota. In the following description, it will be assumed, unless otherwise noted, that the sheets (which may be pre-printed) are of paper.

The apparatus has a paper path entry 1 which receives a succession of paper sheets (not shown) from any suitable source, for example a stack. From the paper path entry 1, the sheets travel in the direction indicated by the arrow 2 through a double coating station 3, a sheet overlapping station 4, a dryer 5, a sheet guiding section 6. Conveniently, the apparatus may be used in conjunction with an adhesive coating station 7. The coating station 7 may be any quitable coating station, but the present invention is most conveniently used in conjunction with the coating station disclosed in co-pending United States patent application filed of even date herewtih, entitled "Method and Apparatus for Applying a Coating Material to Sheets", and commonly assigned to the Assignee of the present invention, and the contents of that co-pending application are incorporated herein by reference. Alternatively, the output of the present invention may be stored, such as in stacked form and independently and subsequently coated with a separate coating station. The control and synchronization of the drives of the various stations may be performed by a central electronic control unit (not shown), for example a Siemens PLC 135.

Individual sheets arrive one after another at the paper path entry 1 of the apparatus and are fed by a nip roll pair 10 into the double coating station 3 (shown in greater detail in FIGs. 3 and 4). It is one of the advantages of the present invention, as compared to other arrangements, such as in the above identified co-pending U.S. Patent Application Serial No. 08.196,490 filed February 15, 1994 entitled "Method and Apparatus for Applying a Coating Material to a Sheet", that the sheets are fed into the coating station in a non-overlapped condition. This exposes all, or a substantial portion, of both major surfaces of the sheets to coating by the LAB and the primer. Further, handling of the sheets is more convenient, since the "pseudo-web" is of uniform thickness.

The sheets are preferably all of the same size, for example A2, and weight, for example 70 gsm. The paper may be of any convenient weight, including, but not limited to papers having a weight between 45 grams per square meter (gsm) and 90 gsm. The double coating station 3 comprises an upper coating station 11 and a lower coating station 12 located, respectively above and below the paper path. As the sheets pass through the double coating station the upper station 11 applies a coating of primer material to one side of each sheet and the lower station 12 simultaneously applies a coating of LAB material to the other side of each sheet. In one embodiment of the present invention, the primer material and the LAB material are coated over substantially both major surfaces of the sheets. Typically, mechanical means are used to grip and advance the sheets through the apparatus, preventing the primer and LAB to be coated over the entire major surfaces of the sheets.

Paper is commonly formed by accumulating paper fibers on a wire mesh or screen and compressing the accumulated fibers between the screen and a "felt" or cloth layer opposite the screen layer. This produces paper having a "wire" side and a "felt" side. It has also been found advantages to convey the sheets S through the apparatus of the present invention with the "wire" side presented for coating of the release material and the "felt" side presented for coating of the primer and ultimately for coating of the adhesive.

The primer material may, for example, be a water-based solution of an organic binding agent and a

cleaved mineral pigment. More specifically, the primer material may be obtained by mixing approximately 3-7% by weight of the binding agent MOWIOL (Trade Mark) available from Hoechst AG, Frankfurt/Main, Germany and approximately 3-8% by weight of the pigment AEROSIL (Trade Mark) available from Degussa AG, Frankfurt/Main, Germany with approximately 90% by weight of water.

The LAB material may be any suitable material, including, but limited to, acrylate co-polymers, silicone materials, urethanes, and fluoro polymers. For example, the LAB may be a water-based solution of the material described in co-pending United States patent applicaiton Serial No. 08/040,876, filed March 31, 1994 and commonly assigned to the Assignee of the present invention, the contents of which are incorporated herein by reference. The solution comprising typically from about 5% to about 10% solid material. Other LAB materials that may be employed with the present invention include those disclosed in United States Patent Nos. 5,202,190 and 5,032,460.

The upper coating station 11 comprises a metering roller 13 and a coating roller 14, located above the path of the sheets of paper throught he double coating station. The coating roller 14 cooperates with a coating drum 16 of the lower coating station 12 which also comprises a metering roller 17 and a transfer roller 18, all located below the paper path through the double coating station. The coating drum 16 has a cut-out portion 9 of rectangular cross-section (shown in greater detail in Figure 8) which contains a conventional sheet gripper 9A (shown closed in Figure 8) for grasping sheets from the feed nip 10. In addition, the drum is covered, around less than half its circumference, with a blanket 20 (not shown in Fig. 8) whereby, as described below, the coating roller 14 and coating drum 16 form a coating nip only when the blanket is located directly adjacent the coating roller 14. As described below, the upper coating station 11 provides substantially full surface roll coating of primer material on the upper surface of the sheets, and the lower coating station 12 provides substantially full surface roll coating of LAB material on the lower surface of the sheets. In each case, the portions engaged with the grippers (as described herein) are not coated.

In the upper coating station, a trough 15 for the printer material is formed by the surfaces of the metering and coating rollers 13, 14 adjacent the nip between the rollers and on the upper side thereof together with two opposed end walls (not shown) which engage in grooves (not shown) adjacent the ends of the rollers. As the rollers 13, 14 rotate, the primer material forms a film on the coating roller 14 and is transferred to a sheet passing underneath the roller.

The thickness of the primer film on the coating roller 14, and hence the amount of primer coated onto a sheet, is dependent on the viscosity of the primer and on the pressure between the metering and coating rollers 13, 14 and, for a given primer, can be adjusted by moving the metering roller towards or away from the coating roller thereby adjusting the pressure between the rollers. The trough 15 is supplied with primer by nozzles 60 (see also Figure 5) which receive the primer from a tank 61 by means of a pump 62. The trough 15 also has overflow outlets 63 through which excess primer is returned to the tank.

In the lower coating station 12, a trough 19 for LAB material is similarly formed between the metering roller 17 and the transfer roller 18. As in the upper station, the coating material forms a film on the transfer roller, the thickness of which can be adjusted by moving the metering roller 17 towards or away from the transfer roller 18, thereby controlling the amount of LAB material that passes from the transfer roller to the blanket covering 20 on the coating drum 16 (but not on to the remainder of the drum, which the transfer roller 18 does not contact).

In a similar manner to the trough 15 in the upper coating station 11, the trough 19 is supplied with LAB material by respective nozzles 60A (see also Figure 5) which receive the LAB material from a respective tank 61A by means of a pump 62A. The trough 19 has overflow outlets 63A through which excess LAB material is returned to the tank 61A. As the blanket covers part of the drum 16 moves around adjacent the coating roller 14 of the upper station, a sheet that is incoming from the feed nip 10 of the double coating station 3 will be picked-up by the gripper 9A in the drum and carried through the coating nip between the roller 14 and the blanket 20 on the drum 16 and, as the sheet passes through the nip, it will be coated on one side with the LAB material. Sheet strippers (not shown) are located on the downstream sides of the coating roller and the coating drum to ensure that sheets do not wrap around either the roller or the drum but are fed out to the overlapping station 4. The next sheet from the feed roll nip 10 will be picked up and carried between the coating roller and the coating drum when the blanket covering once again moves around adjacent the roller 14.

It will be appreciated that the coating in the double coating station 3 is discontinuous because it occurs only when the blanket covering 20 on the coating drum 16 is adjacent the coating roller 14 (i.e. when a sheet is passing through the coating nip). A typical coating weight for the LAB material on the sheets is from about 0.5 gsm to about 12.0 gsm and the coating weight of the primer material would be matched to that to ensure that the coated sheets remain flat. Because the primer and the LAB materials are applied to the paper sheets simultaneously in the coating station and are preferably selected to have appropriately selected characteristics, such as viscosity, % solids, coating weights, the risk that the sheets will curl or wrinkle is substantially eliminated.

The blanket covering 20 on the coating drum 16 can be of any suitable type, for example a DuPont "CYRELL" polyurethane blanket available from E.I. DuPont Demours of Wilmington, Delaware.

On the exit side of the coating nip 14, 16, in the sheet overlapping station 4 a gripper unit 27 is positioned to take sheets as they emerge from the coating nip and deposit them on a conveyor 30 (not shown in Figure 4). The gripper unit 27, which is conventional, comprises sheet grippers 28 carried on an endless chain 29 the movement of which is synchronized with the sheet feed so that a gripper 28 is positioned to receive each sheet that leaves the coating nip. A blower 31, located below the paper path on the exit side of the coating nip, provides a cushion of air to support the sheet as they are being carried by the sheet grippers 28 The blower 31 incorporates a heater (not shown) which serves to dry the LAB coating on the sheet to some extent, to prevent the sheets from sticking to the conveyor The conveyor 30 is run at a slower speed than the chain 29 of the gripper unit so that each sheet is deposited on the conveyor with the leading edge of the sheet lying on top of the trailing edge of the preceding sheet, forming a pseudo-web of sheets Typically, the extent of the overlap is from about 1 centimeter (cm) to about 2 cm The conveyor 30 is a vacuum conveyor connected to a source 32 of low pressure so that the sheets are positively held on the conveyor and the overlapped relationship between them is maintained.

At the output end of the conveyor 30, the sheets pass over an air knife 33 which is arranged to reverse the direction in which the sheets are overlapped. The air knife 33 is arranged to direct a current of air at the sheets so that the trailing edge of each sheet is moved out from underneath the leading edge of the succeeding sheet and deposited instead on top of that leading edge. Instead of using an air knife 33 to change the direction of overlap of the sheets, an equivalent mechanical arrangement could be employed, for example an arrangement similar to that described in GB-A-2 166 717.

The double coating station 3 together with the sheet overlapping station 4 may be based on the "GUILA SPEED GS GS 8000" coater available from Billhöfer Maschinenfabrik GmbH of Nürnberg, Germany.

Returning to Figure 1, the pseudo-web of sheets now moves out of the sheet overlapping station 4 and into the dryer 5 in which moisture is removed from the primer and LAB coatings. The dryer 5 is preferably a radio-frequency dryer, for example a particularly adapted version of the Model No. SP 890 GF"C" -AG manufactured by Proctor Strayfield Ltd. of Berkshire, England. The dryer 5 is provided with a control unit (not shown) which adjusts the power of the dryer in accordance with the line speed of the apparatus. That control unit may, for example, be a Siemens PLC 55 95U interconnected with the central electronic control unit of the whole apparatus. The overlapped sheets move through the dryer 5 continuously on an endless belt 40 and are dried to attenuate the tendency of the sheets to curl but which ensures that they emerge substantially dry. The use of a radio-frequency dryer is not essential and the overlapped sheets could, instead, be dried using infrared heating or hot air. Alternatively, the endless belt 40 could be heated to dry the sheets. However, radio-frequency drying is preferred for its simplicity and lower energy consumption.

Downstream of the dryer 5, the overlapped sheets move through the guiding section 6 in which they are side registered and aligned with each other in preparation for advancement to further processing stations, such the adhesive coating station 7, previously identified as the subject of a co-pending United States patent application filed of even date herewith, entitled "Method and Apparatus for Applying a Coating Material to Sheets", and commonly assigned to the Assignee of the present invention. As described in the above indicated co-pending application, the overlapped sheets pass through a transfer nip 50 (see also Fig. 6) where they contact an endless transfer belt 51 to which an adhesive coating has previously been applied in the form of a plurality of stripes extending longitudinally of the belt. The adhesive may be a pressure-sensitive adhesive, preferably a repositionable microsphere pressure-sensitive adhesive, for example as described in U.S. Patent No. 4,495,318 to Howard, or U.S. Patent No. 3,691,140 to Silver. Adhesives for use with the present invention also includes film-forming materials known in the art, including those containing organic solvents.

At the transfer nip 50, the adhesive is transferred in continuous stripes to the pseudo-web of overlapped sheets on the surface to which primer was applied in the double coating station 3. The adhesive-coated sheets are then pulled away from the transfer belt 51 at a vacuum roller 52 (shown in Figure 6) the interior of which is connected to a source of low pressure. The removal of the sheets from the transfer belt 51 is facilitated by the direction in which the sheets overlap (i.e. by the fact that the air knife 33 has caused the leading edge of each sheet to underlap the trailing edge of the preceding sheet). Following removal from the transfer belt 51, the sheets are held to a vacuum belt 53 which passes around the roller 52 and carries the sheets (still overlapped) out of the adhesive coating station 7 to the sheet exit 8 of the apparatus. The sheets may then be stacked and trimmed to form pads of repositionable notes, for example those available under the trademark "Post-it"® available from the Minnesota Mining and Manufacturing Company ("3M") of St. Paul, Minnesota.

Although the above description refers to the sheets as being paper, they could (as already mentioned) be formed of other materials, for example polymeric films or metallic foils, as previously described. When the sheets are paper, they are preferably fed through the apparatus with the "machine direction" of the paper sheets aligned with the machine process direction; in that way, the tendency of the sheets to curl or wrinkle can be further attenuated.

Papers of different weights and textures can be used if desired. For example, although the above

description refers to a sheet size of A2, the described apparatus is readily adaptable to handle sheets of A4 size. Likewise, although the above description refers to sheets of weight 70 gsm, the apparatus could also handle sheets of a higher weight (e.g. 90 gsm) and sheets of a lower weight (e.g. 70 gsm and possibly even as low as 45 gsm).

If the sheets supplied to the double coating station 3 are pre-printed, the above-described method results in the LAB coating material being applied over the printed matter on the sheets. The LAB coating then serves to protect the printed matter, especially against removal by the adhesive on an adjacent sheet when the sheets are subsequently stacked and cut to form pads of repositionable notes. The protection offered by the LAB coating enables the use of stronger adhesives on printed notes to be considered. Of course, the sheets maybe printed on after the double coating station 3, whether or not pre-printed, using any conventional printing operation.

Although it is advantageous for the primer and LAB coating to be applied to the sheets simultaneously in the double coating station 3 as described above, that is not essential. However, the simultaneous application of the coatings is preferred, particularly when the coating materials are water-based, since it assists in maintaining the sheets in a flat condition.

Apparatus in which the primer and LAB coatings are not applied simultaneously is illustrated in Fig. 7. In that apparatus, the primer coating station 11 is located prior to the LAB coating station 12 and, consequently, the coating roller 14 of the upper station 11 and the coating drum of the lower station 12 both require a respective counter-pressure roller 14A, 16A. In each coating station, the arrangement for supplying coating material to the coating roller/drum also differs from that shown in Fig. 1 in that, in each case, the metering roller 13, 17 dips into a respective tank 13A, 17A of coating material and applies the coating material to a respective transfer roller which, in turn, applies the coating material to the coating roller/drum 14, 16. The remainder of the apparatus shown in Fig. 7 (comprising the overlapping station 4, the dryer 5, the guiding section 6 and the adhesive transfer station 7) is effectively as described above with reference to Fig. 1.

The present invention has now been described with respect to several embodiments thereof. It will be apparent to those skilled in the art that many changes may be made in the embodiments described without departing from the spirit and scope of the invention. Thus, the scope of the present invention should not be limited to the structures and processes described herein, but rather by the language of the claims, and the equivalents thereof.

Claims

1. Apparatus for applying water-based coating material to both sides of a plurality of sheet members, the apparatus comprising :

   (a) a conveyor for conveying the sheet members sequentially along a sheet path
   (b) a dual coating station positioned to receive the sheet members sequentially from the conveyor, the dual coating station comprising first and second coating stations located on opposite sides of the sheet path through the dual coating station, each of which first and second coating stations comprises a respective source of water based coating material and a respective coating member positioned to contact the sheet members at a point along the sheet path to apply coating material from the respective source to the respective side of each sheet member ;
   (c) an overlapping conveyor arranged to receive sheet members from the dual coating station and movable at such a speed that the leading edge portion of each sheet member leaving the dual coating station is deposited on the trailing edge portion of the preceding sheet member on the conveyor thereby forming a pseudo-web of overlapping sheet members ;
   (d) an air knife positioned to direct a current of air at the overlapped sheets to change the relative positions thereof in the pseudo-web whereby the trailing edge portion of each sheet members overlies the leading edge portion of the succeeding sheet member ; and
   (e) a dryer in the sheet path for removing water from the coating material applied to the sheet members in the dual coating station.

2. The apparatus of claim 1, further including :

   (f) a further coating station comprising a source of water-based coating material, and a coating member positioned to contact the pseudo-web of overlapping sheet members at a point along the sheet path to apply coating material from the respective source to one side of the pseudo-web of overlapping sheet members.

3. Apparatus as claimed in claim 1, in which the coating members in the first and second coating stations of the dual coating station comprise coating rollers disposed in opposed relationship on opposite sides of the sheet path to form a coating nip whereby coating material is applied simultaneously to both sides of a sheet member passing through the coating nip.

4. Apparatus as claimed in claim 3, including a covering member over part of the circumference of one of the coating rollers whereby the coating nip is

formed only when that part of the roller is located adjacent the other coating roller.

5. Apparatus as claimed in claim 4, in which the said one of the coating rollers includes a sheet gripper for pulling each sheet member through the coating nip.

6. Apparatus as claimed in claim 5, including a further sheet gripper downstream of the dual coating station for removing each sheet member from the dual coating station and depositing the sheet member on the overlapping conveyor.

7. Apparatus as claimed in claim 1, including a blower positioned to provide a cushion of air to support the sheet members as they are being removed from the dual coating station.

8. Apparatus as claimed in claim 7, in which the blower includes a heater for partially drying the sheets on the side that is then deposited on the overlapping conveyor.

9. Apparatus as claimed in claim 1, in which the dryer comprises a conveyor which is non-reactive to radio-frequency radiation and is arranged to convey the overlopped sheet member along part of the sheet path, and a source of radio-frequency radiation directed to the water-based coating material on the sheet members.

10. Apparatus as claimed in claim 2, further including an aligning station located in the sheet path to align the overlapping sheet members before they enter the further coating station.

11. Apparatus as claimed in claim 2, in which the coating member in the further coating station comprises a transfer belt having a transfer surface positioned to contact the overlapping sheet members at a point along the sheet path.

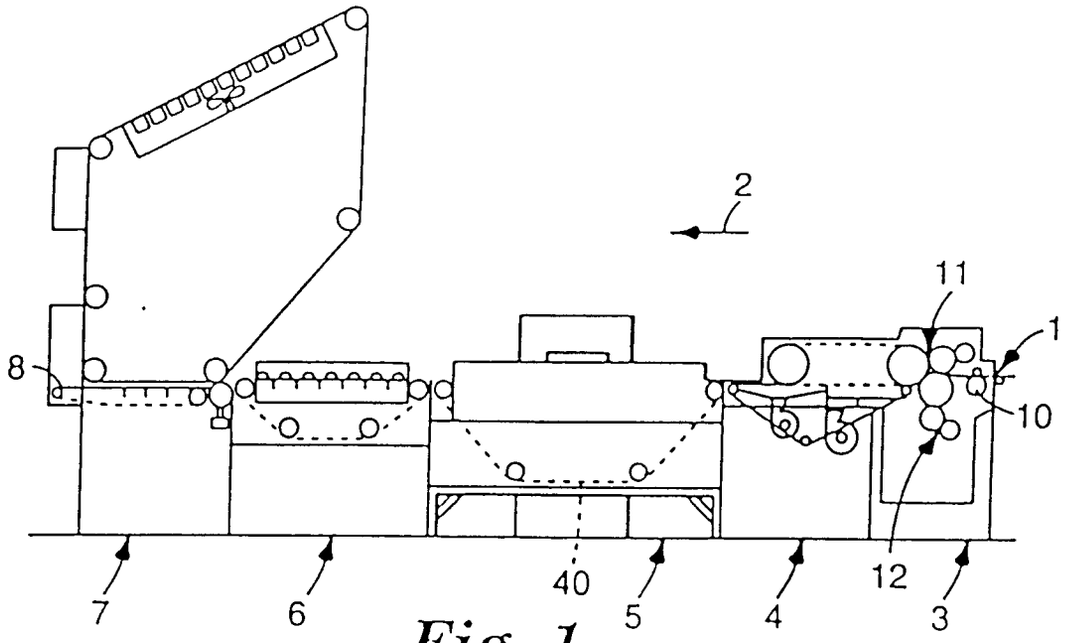

Fig. 1

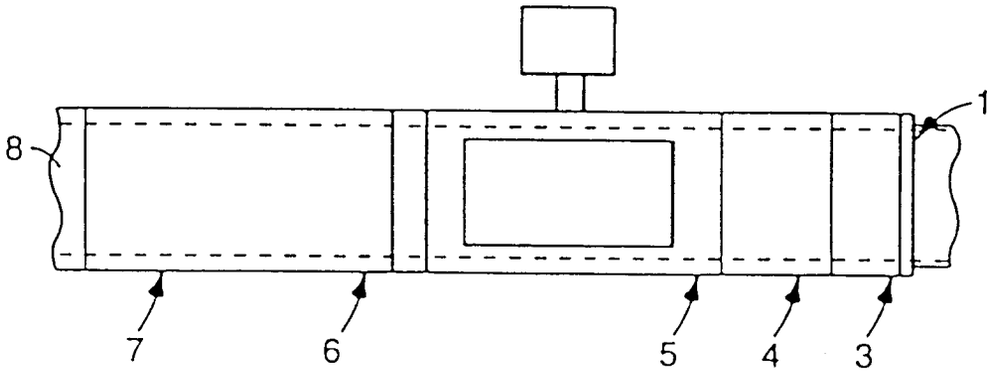

Fig. 2

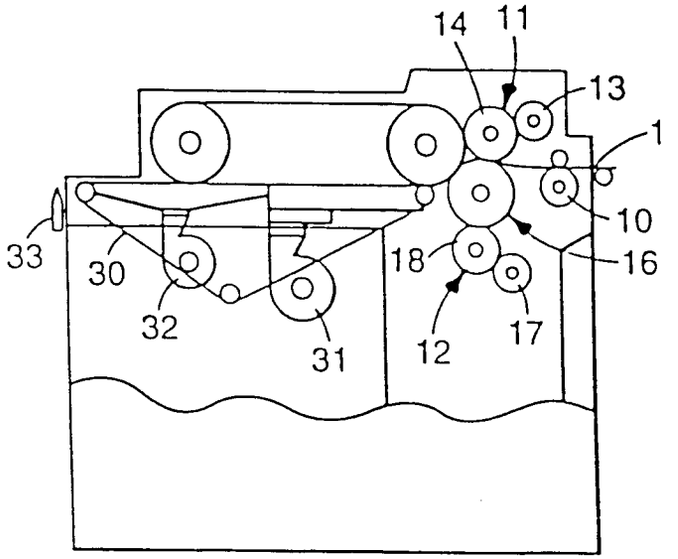

Fig. 3

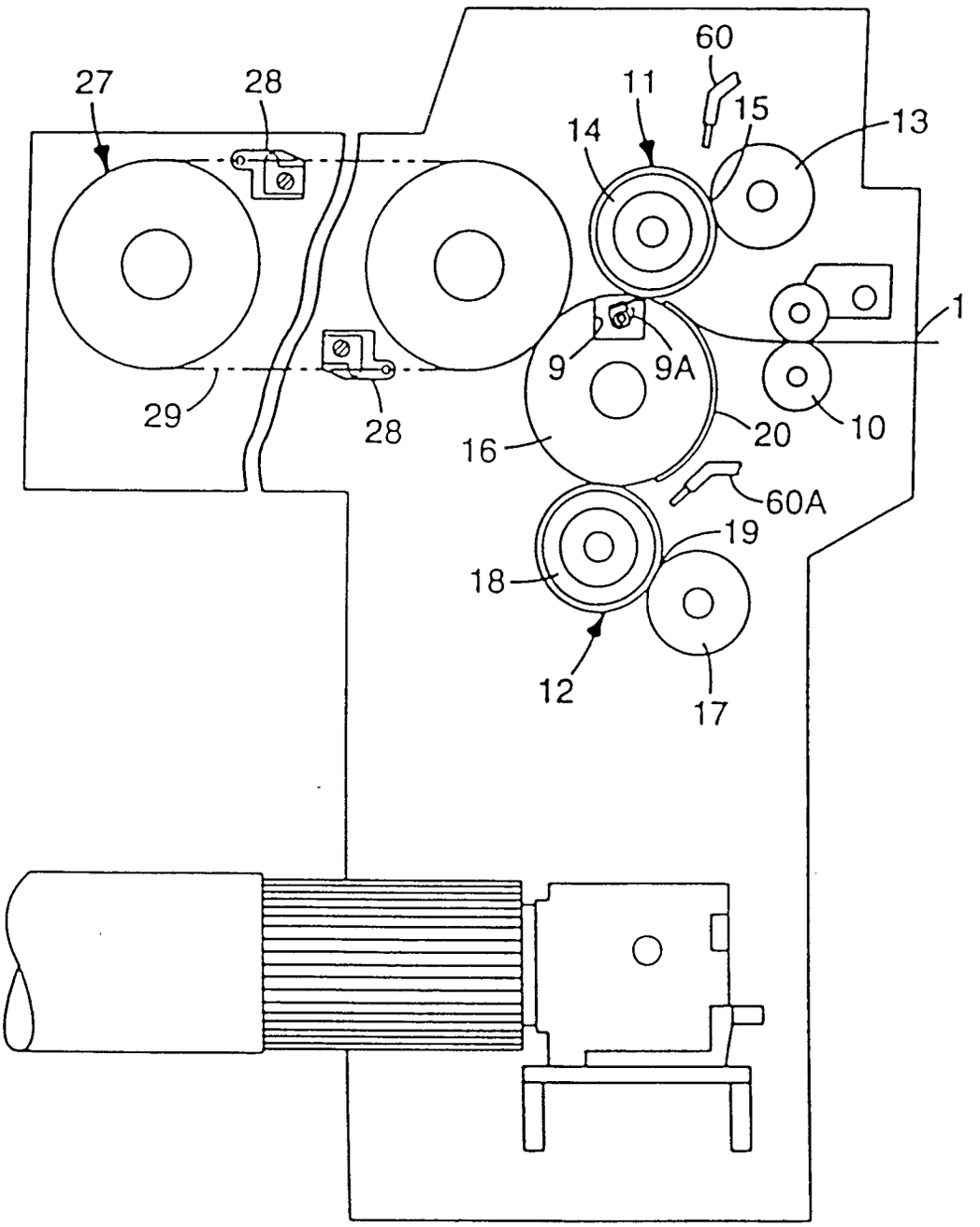

Fig. 4

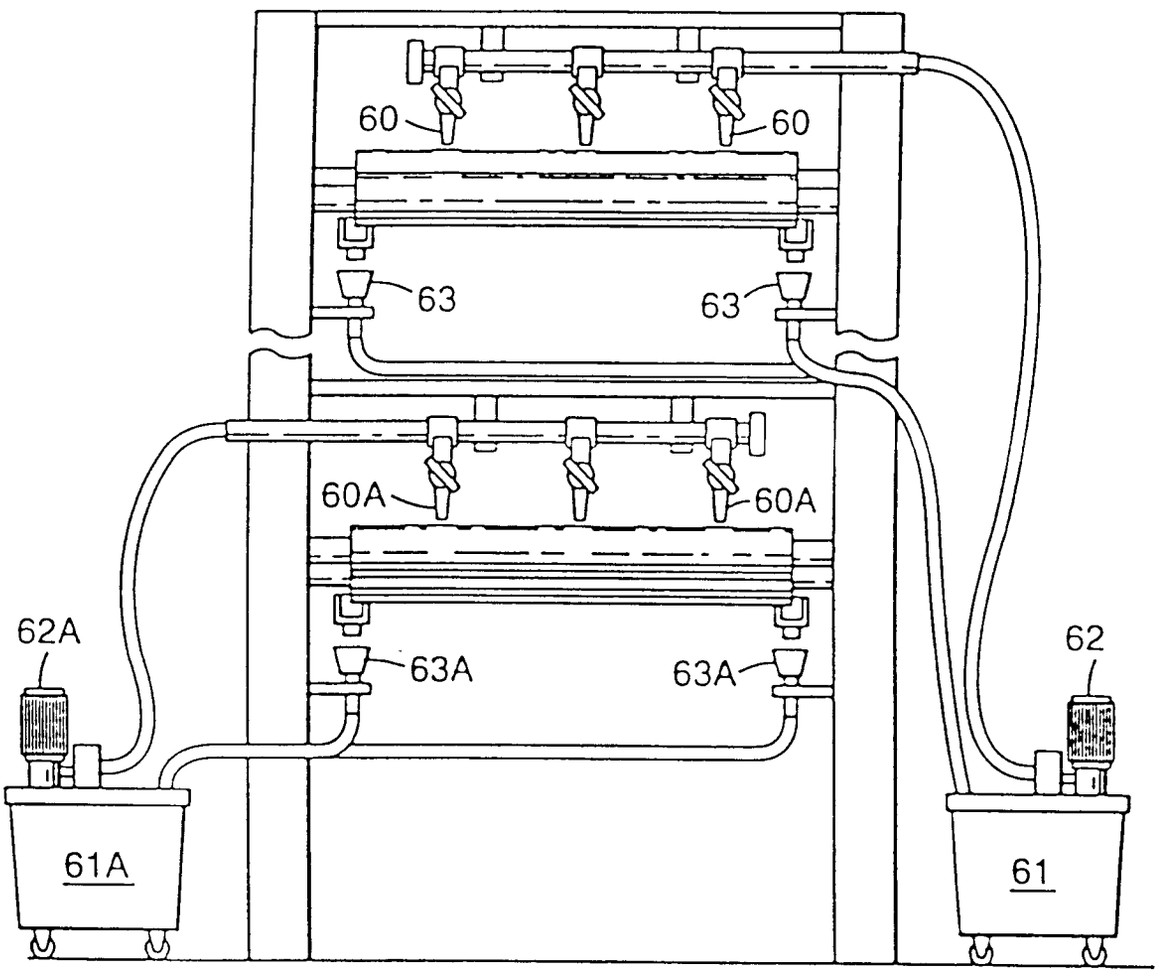

Fig. 5

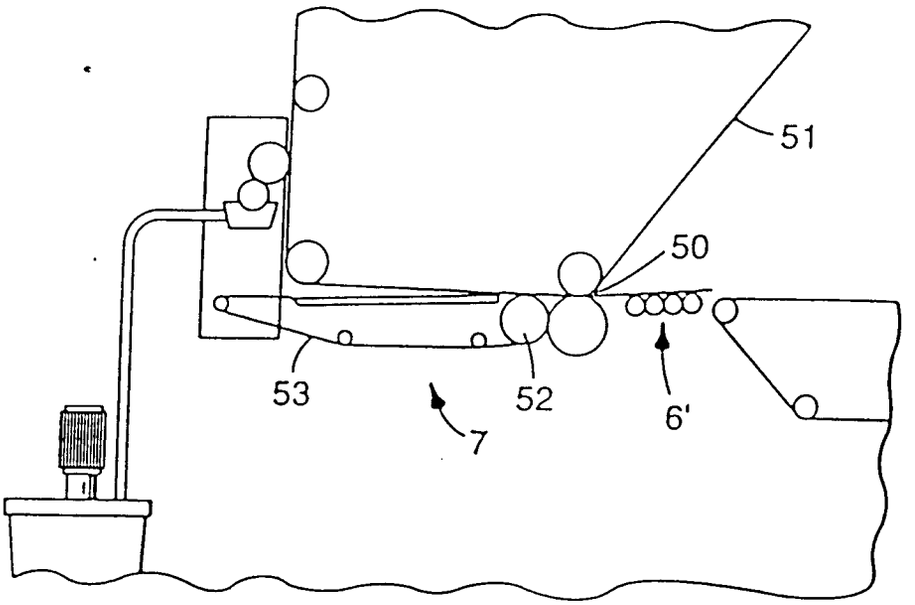

Fig. 6

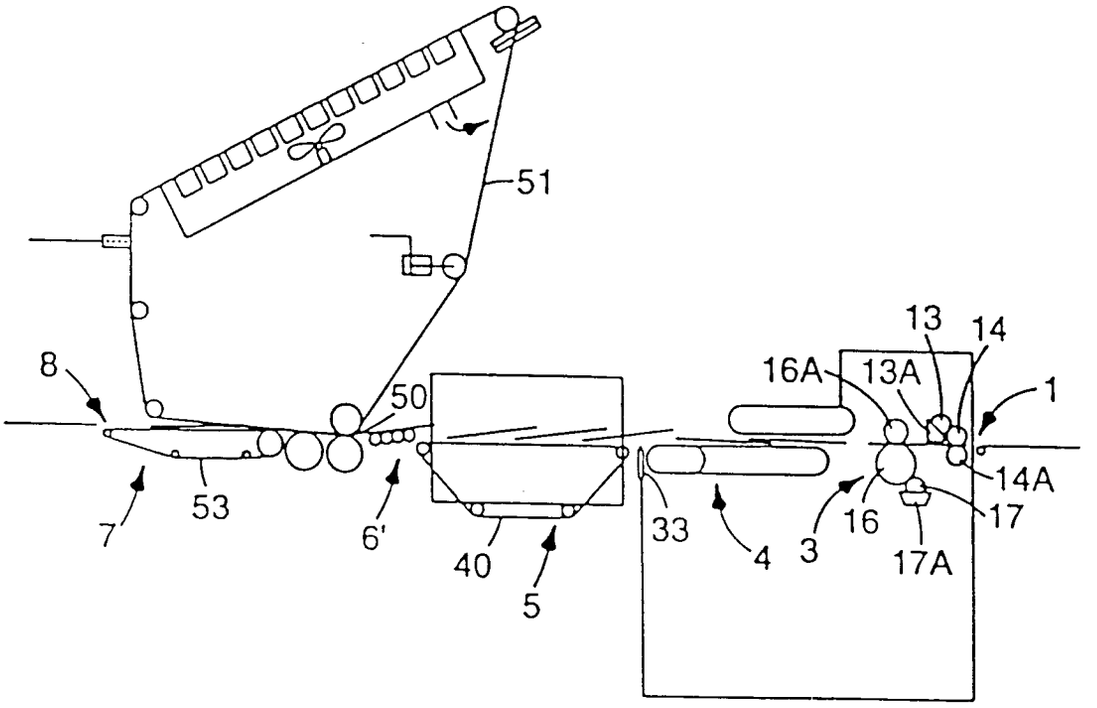

Fig. 7

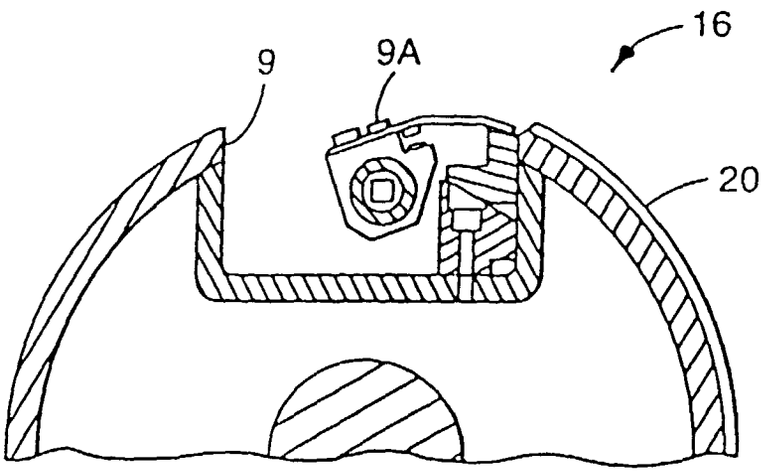

Fig. 8