APPARATUS FOR AUTOMATICALLY CONVEYING SHEETS OF PAPER BY MEANS OF ELECTROSTATIC ADSORPTION

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ABSTRACT
For automatically conveying sheets of paper one after another from the top of a stack of sheets of paper to a predetermined position by taking advantage of the electrostatic adsorption phenomenon, an apparatus comprises sheet of paper carrier means electrostatically charged by charging means, means for supporting said carrier means in parallel opposed relation to the sheet of paper to pick up said sheet of paper under electrostatic force and means for releasing the sheet of paper from said carrier means after the sheet of paper is located in the predetermined position, whereby the sheets of paper can be fed automatically regardless of the thickness of the sheets of paper, the presence or absence of a folded line or wrinkles in the sheets of paper and the type of paper.

14 Claims, 7 Drawing Figures
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BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates to an apparatus for automatically conveying sheets of paper by means of electrostatic adsorption.

2. Description of the Prior Art
Conventional facsimile apparatus, copying machine or printing machines are almost unexceptionally arranged such that sheets of copy paper, recording paper or the like, stacked in a predetermined position, are automatically fed to the apparatus one after another from the top thereof by means of a rubber nail or roller having a large frictional force, which drags the sheet of paper by engaging a portion of the latter.

However, with such arrangement of the conventional apparatus, automatic feeding of the sheet of paper is extremely difficult due to an erroneous operation of the rubber nail or roller which is liable to occur when the quality of the paper is inconsistent or a folded or wrinkled sheet is present in the stack of paper. Therefore, it has been necessary to use sheets of paper of uniform quality or to feed the sheets of paper manually one after another and not automatically where they are inconsistent in quality.

SUMMARY OF THE INVENTION
The object of the present invention is to obviate the above-described drawback of the conventional apparatus, and to make it possible to convey stacked sheets of paper automatically one after another from the top thereof by taking advantage of the electrostatic adsorption phenomenon, i.e. by adsorbing the individual sheet of paper onto electrostatically charged carrier means.

BRIEF DESCRIPTION OF THE DRAWINGS
FIG. 1 is a diagrammatic illustration of an embodiment of the present invention.
FIGS. 2a, 2b, 2c, and 2d are a set of illustrative views diagrammatically showing the operation of the apparatus of FIG. 1.
FIGS. 3 and 4 are diagrammatic illustrations of another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:
Referring first to FIG. 1, there is shown an embodiment of the apparatus according to the present invention, in which reference numeral 1 designates a soft steel drum (hereinafter referred to as drum for simplicity) which rotates with an original sheet lapped thereon. During rotation of the drum 1, the copy sheet is scanned by a light-electricity converter means (not shown), whereby the information on the original is converted into electric signals. Reference numeral 2 designates a thin, tough, transparent plastic film having a thickness of the order of 50 µ and made of polyethylene terephthalate or the like material. The plastic film 2 has one end 3 secured to the drum 1, with the other end being provided with a magnet 5 having a hook 4 at a portion thereof.

Reference numeral 6 designates a drawing member adapted to engage the hook 4 of the magnet 5 provided at one end of the film 2. The drawing member 6 is pulled by traction means while being guided by a guide rail, whereby the hook 4 of the magnet 5 is drawn in the direction of the arrow shown in FIG. 2(b). Reference numeral 7 designates a corona charger which charges the film 2 with static charge when impressed with a high voltage. Reference numeral 8 designates original sheets, for example, for facsimile, stacked on a stacking table 9, and 10 designates a guide plate on which a used original sheet 8 is withdrawn. Reference numeral 11 designates a knife edge-like scraper plate provided at the end of the stacking table 9 adjacent the drum 1 for preventing the original sheet from being again placed on the stacking table 9 after it has been fed onto the drum 1 by the film 2.

With the apparatus of the invention constructed as described above, when a large number of sheets 8, e.g., original sheets, are stacked on the stacking table 9 in an aligned state and the drawing member 6 is pulled in the direction of the arrow while keeping the corona charger 7 impressed with a plus or minus high D.C. voltage (e.g. of the order of 5 – 6 KV), the drawing member 6 engages the hook 4 of the magnet 5 attached to the drum 1 to pull the same and hence the film 2 is drawn out over the stack of sheets 8 on the stacking table 9 while being charged from one end thereof. In this case, since the drum 1 which is driven by a synchronized motor (not shown), is operatively connected to said motor through a slip connection, e.g., through a friction clutch, it rotates in a direction (of the arrow shown in FIG. 2(a)) opposite to the normal rotating direction (as indicated by the arrow in FIG. 2(b)) while being urged to rotate in the normal direction. Since the film 2 is now charged, the uppermost sheet 8 is attracted onto the film 2. Therefore, when the drawing member 6 is returned in a direction as shown in FIG. 2(b), the drum 1 winds up the film 2 and the sheet 8 attached thereto, while rotating in the normal direction. As the drawing member 6 is returned further forward (to the left as viewed in FIG. 2) as shown in FIG. 2(c), the engagement with the hook 4 of the magnet 5 is released and the drum 1 is set free to rotate. Thus, the information on the original sheet is converted into electric signals by the light-electricity converter means and an auxiliary scanning mechanism (not shown). In this case, since the drum 1 is made of soft steel as stated above, the magnet 5 is attracted onto the drum 1 under the magnetic force when the film 2 is lapped around said drum 1, thereby pressing the free end of the film 2.

When the information on the original sheet has completely been converted into electric signals, the drawing member 6 is again pulled as shown in FIG. 2(d) and brought into engagement with the hook 4, so that the film 2 is drawn out over the stacking table 9 while being charged by the charger 7. In this case, the used original sheet 8' is mechanically peeled from the film 2 by the scraper plate 11 provided at the forward end of the stacking table 9, and discharged to the outside of the apparatus by being guided by the guide plate 10.

The state of the film 2 after it has been fully drawn out and stretched over the stacking table 9, is the same.
as that shown in FIG. 2(a). Therefore, by repeating the above-described operation, the original sheets 8 can automatically be fed onto the drum 1 one after another and automatically be removed therefrom through the guide plate 9, in a positive manner.

Where the process is operated cyclically continuously, the charge remains on the film 2 from one cycle to another, but re-charging of the charged film does not cause any substantial problem. Nevertheless, it is possible to impart a suitable electric conductivity to the film 2 so that the charge will gradually disappear during the period of the scanning and light to electricity conversion process, by reason of the fact that a relating long time is required for said process after the original sheet 8 has been electrostatically attracted onto the film 2 and wound around the drum 1. It is also possible to coat the film 2 with a dielectric, transparent, organic, photoconductive material, such as polyvinylcarbazole or pyrazoline, so that the charge on the film 2 may be dissipated by the light during the light-electricity conversion process, after operating the steps of charging the film 2 and winding the same on the drum 1 in a dark place.

According to the experiment conducted by the present inventor, however, it was not necessary to erase the charge and the used sheet 8' could be removed from the film 2 only by the provision of the scraper plate 11.

Besides the use of the corona charger 7, the adsorption of the sheet 8 onto the film 2 may be attained by a method wherein the film 2 is charged by the rotational friction of a fur adhered to the drum 1, or by a method wherein a high voltage is directly impressed on a transparent metallic film (e.g. a copper iodide film) formed on the film 2 by vacuum evaporation or on a transparent antistatic coating (e.g. Colcoat) formed on said film.

Hereinbefore, the principle behind the present invention has been explained with reference to FIGS. 1 and 2. In the practical operation of the apparatus, there arises such a problem that the second one from the top of the stack of original sheets is wound on the drum 1 together with the uppermost one due to the frictional force or the pneumatic attraction acting between said sheets, or the stack of the aligned sheets is collapsed, in the process of absorbing the uppermost sheet onto the film 2 and winding the same on the drum 1. In order to avoid such a problem, the stacking table 9 is held in a lowered position until the film 2 is drawn out over the stack of the sheet 8, is moved upwardly after the film 2 has been charged and completely drawn out, and is again lowered slowly after the uppermost sheet has been absorbed on the film 2, and thereafter the film 2 is wound on the drum 1, whereby a more positive feeding operation can be obtained.

Although the apparatus of the invention has been described with reference to an embodiment wherein the sheet 8 is lapped on the drum 1, another embodiment of the apparatus will be described hereunder with reference to FIGS. 3 and 4, wherein the sheet is handled in a planar shape. Referring to FIG. 3, reference numeral 21 designates sheets of paper stacked on a stacking table 22 which is secured to one end of a lever 23. Reference numeral 24 designates a pivot pin on which the lever 23 is pivotably mounted, and to the other end of the lever 23 is connected an iron core 26 which is attracted by a solenoid 25. A spring 27 is anchored to the aforesaid one end of the lever 23, by which the stacking table 22 is held in a lowered position in the de-energized state of the solenoid 25. Reference numeral 28 designates a belt consisting of a tough plastic film (e.g. a polyethylene terephthalate film having a thickness of the order of 50 – 100 μ) and engaged around rollers 29, 29' in an endless state. The belt 28 is disposed above the stack of paper 21, with the lower length thereof extending in spaced parallel relation to the latter, and is driven by the roller 29. Reference numeral 30 designates chargers for charging the belt 28, which are arranged inside of said belt 28 along the lower length thereof in opposed relation thereto. Reference numeral 31 designates a charge eraser for erasing the static charge, imparted to the belt 28 by the chargers 30, therefrom by neutralizing the same, said charge eraser being a device substantially similar to the chargers 30. Reference numeral 32 designates a machine, e.g. a facsimile apparatus, in which the sheet of paper 21 is to be mounted, and the belt 28 and the facsimile apparatus 32 is associated with each other by a slide plate 33. Reference numeral 34 designates a guide plate provided above the slide plate 33, with one end thereof closely spaced from the belt 28. The guide plate serves to peel the sheet of paper 21 from the belt 28 and simultaneously to guide the sheet of paper introduced into the facsimile apparatus while sliding on the slide plate 33.

Reference numeral 35 designates a scanning light-electricity converter of the facsimile apparatus 32, and below the scanning light-electricity converter 35 are provided a conveyer belt 37, engaged around rollers 36, 36', and press rollers 38 for pressing the sheet of paper 21 against said conveyer belt. A receptacle 39 is provided at the forward end of the conveyer belt 37 for receiving a used sheet of paper.

In the apparatus of the invention constructed as described above, when a large number of sheets of paper 21 are stacked on the stacking table 22 in an aligned state and the solenoid 25 is energized by a current supplied thereto, the iron core 26 is attracted by the electromagnetic force of said solenoid 25 as shown in FIG. 4, causing the lever 23 to make a pivotal movement about the pivot pin 24 against the biasing force of the spring 27 connected to one end thereof. Therefore, the stacking table 22 is elevated by the lever 23 and the uppermost one of the sheets of paper 21, stacked on said stacking table 22, is brought into contact with the endless belt 28.

A voltage is impressed on the chargers 30 at this time, so that the lower length of the endless belt 28, opposed by said chargers 30, is charged and the uppermost sheet of paper 21 is electrostatically adsorbed on the belt 28. Thereafter, the current supply to the solenoid 25 is interrupted and the stacking table 22 is lowered. The current supply to the chargers 30 is also interrupted at the same time but the sheet of paper 21, electrostatically adsorbed on the belt 28, is retained thereon. The rollers 29, 29' are rotated under such condition, to drive the belt 28. When the charged portion of the belt 28 passes below the charge eraser 31, the charge on the belt 28 is neutralized and the sheet of paper 21 is gradually released from the belt, from the
forward end thereof and slides down on the slide plate 33 into an inlet opening of the facsimile apparatus. In this case, the current supply to the charge eraser 31 need not be interrupted intermittently but can be continued throughout the period of operation of the apparatus. When the rear end of the sheet of paper 21 has passed below the charge eraser 31, the sheet of paper 21 is completely released from the belt 28 and fed into the facsimile apparatus 32, through the slide plate 33. In the facsimile apparatus 32, the sheet of paper 21 is transported by the conveyor belt 37 and the press rollers 38. During this period, the information on the sheet of paper 21 is converted into electric signals by the scanning light-electricity converter 35. The used sheet of paper 21 is discharged through an outlet opening of the facsimile apparatus and received in the receptacle 39.

By repeating the above-described operation, the sheets of paper 21 stacked on the stacking table 22 are successively individually adsorbed on the belt 28, introduced into the facsimile apparatus 32 and received in the receptacle 39 after use.

In the embodiment described above, the facsimile apparatus 32 may be eliminated by providing the scanning light-electricity converter 35 beneath the endless belt 28 and intermediary between the chargers 30 and the charge eraser 31, so as to convert the information on the sheet of paper into an electric signal during the period from the time when said sheet of paper is charged by said chargers 30 to the time when the charge on the sheet of paper is erased by said charge eraser 31.

It is also to be understood that the sheet of paper 21 may be released from the belt 28 mechanically by the upper end of the guide plate 34, as in the preceding embodiment, instead of providing the charge eraser 31.

Although the apparatus of the present invention has been described and illustrated herein with particular reference to the case wherein it is used with the transmitter of a facsimile apparatus, it will be obvious to those skilled in the art that the apparatus can similarly be used with the receiver of the facsimile apparatus, a copying machine or a printing machine. For instance, where the sheets of paper are photosensitive papers, such as photographic films or printing papers, printing is possible through the transparent film 2 and, therefore, these photosensitive papers can be automatically fed by the apparatus of this invention, simply by replacing the sheets of paper with the photosensitive papers. The apparatus of the invention can also be effectively used for the automatic mounting and demounting and automatic feeding of recording papers.

Furthermore, the apparatus of the invention can be used with a recording system of the type wherein an electric signal is converted into an electromagnetic vibration to thereby apply a pressure to record on a single sheet of pressure-sensitive paper, only by arranging such that the magnet 5 and the hook 4 provided thereon are located inwardly of the surface of the drum 1. In this case, the film 2 need not be transparent.

With the apparatus of the invention, as described hereinbefore, sheets of paper are individually handled by being electrostatically adsorbed over the entire surface thereof. Therefore, the operation is more reliable than that of the conventional apparatus wherein sheets of paper are pulled or rubbed at a portion by mechanical means, and automatic feeding or automatic mounting and demounting of sheets of paper can be achieved satisfactorily, with no fear of erroneous operation, even if the sheets of paper to be handled include sheets of paper of different qualities, or folded or ruptured sheets of paper.

I claim:

1. An apparatus for automatically conveying sheets of paper, one at a time, from one predetermined position in a stack containing a plurality of sheets stacked one on top of the other to another predetermined position spaced from said stack; said apparatus comprising: flexible film means including an endless belt engaged around spaced belt rollers, charging means for electrostatically charging said film means, first moving means including means for rotatably driving at least one of said belt rollers for moving the film means to a first predetermined position where a planar surface of the film means is located parallel to and adjacent to a sheet at the top of said stack, at least a portion of the film means having been electrostatically charged by said charging means such that the sheet is electrostatically adsorbed to the film at least when the film is in said first position, second moving means for moving the film means and adsorbed sheet from the first position to a second predetermined position spaced from said stack, releasing means for releasing said sheet from said film means after the film means and adsorbed sheet have been moved from the first position, and stack conveying means for intermittently positioning the stack in a position adjacent the endless belt, wherein said stack conveying means includes a pivotal lever, biasing means, and a solenoid means, said stack being supported at one portion of the lever which is normally biased downwardly by said biasing means, said solenoid means being operably connected to another portion of said lever for raising the one portion, said solenoid means including means to position the stack adjacent the belt when a sheet is to be transferred to the belt from the stack.

2. An apparatus according to claim 1, characterized in that the charging means are located between the belt rollers within the space surrounded by the endless belt.

3. An apparatus according to claim 1, characterized in that said releasing means comprises discharging means for discharging the electrostatic charge on the belt, said discharging means being located adjacent the path of the belt in a position closer to the second predetermined position than is the charging means.

4. An apparatus according to claim 3, characterized in that said discharging means is located between the belt rollers within the space surrounded by the endless belt.

5. An apparatus according to claim 1, characterized in that the releasing means includes a rigid guide plate arranged adjacent the belt roller positioned closest to said predetermined second position.

6. An apparatus according to claim 1, characterized in that said releasing means includes means for introducing the sheet to a conveyor system in a facsimile apparatus.
7. An apparatus for automatically conveying sheets of papers, one at a time, from one predetermined position in a stack containing a plurality of sheets stacked one on top of the other to another predetermined position spaced from said stack; said apparatus comprising:
flexible film means,
charging means for electrostatically charging said film means,
first moving means for moving the film means to a first predetermined position where a planar surface of the film means is located parallel to and adjacent to a sheet at the top of said stack, at least a portion of the film means having been electrostatically charged by said charging means such that the sheet is electrostatically adsorbed to the film at least when the film is in said first position,
second moving means for moving the film means and adsorbed sheet from the first position to a second predetermined position spaced from said first stack, and
releasing means for releasing said sheet from said film means after the film means and adsorbed sheet have been moved from the first position,
wherein said flexible film means comprises a film of predetermined length having one end fixed to a rotatable drum, said drum and film being so arranged that the sheet of paper is positioned between the film and the surface of the drum while being transferred to the second position.

8. An apparatus according to claim 7, wherein said flexible film means comprises a film of predetermined length having one end fixed to a rotatable drum, said drum and film being so arranged that the sheet of paper is positioned between the film and the surface of the drum while being transferred to the second position.

9. An apparatus according to claim 8, characterized in that said film is initially positioned in lapping engagement around said drum, the first moving means including means for unwinding a portion of said film from the drum and positioning said portion over said stack at which time the top sheet is electrostatically adsorbed to the film, said second moving means including means for rotating the drum and thereby wind the film and the adsorbed sheet positioned radially inwardly of the film onto the surface of the drum, said releasing means including means for releasing said sheet from the film while the first moving means is unwinding the film preliminarily to obtaining another sheet.

10. An apparatus according to claim 9, characterized in that said film has a film hook at the end opposite the end fixed to the drum, and in that said first moving means includes a hook releasably engageable with said film hook.

11. An apparatus according to claim 10, characterized in that said drum includes ferromagnetic materials, and in that said film has a permanent magnet adjacent said film hook for attaching the end of the film to the drum when the film hook is out of engagement with the film hook of the moving means, whereby the sheet of paper is held in position against the drum during the time the respective hooks are released from one another.

12. An apparatus according to claim 9, characterized in that said releasing means includes a rigid plate member positioned adjacent the film path near the place on the circumference of the drum where the film starts winding onto the drum such that when the film is unwound from the drum the sheet is deflected away from the film by said plate member.

13. An apparatus according to claim 9, characterized in that said film means is treated so that the electrostatic charge is dissipated in the presence of light.

14. An apparatus according to claim 8, characterized in that said drum is constructed so as to be positionable with respect to light-electricity converter means so that the sheet can be scanned by the converter means while the sheet is on the drum.

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