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(19)



(54) APPARATUS FOR USE IN PROCESSING SHEETS OR STRIPS OF RECORDING MATERIAL

(71) We, AGFA-GEVAERT, a naamloze vennootschap organised under the laws of Belgium, of Septestraat 27, B 2510 Mortsel, Belgium do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

5 This invention relates to apparatus for use in the application of liquid processing media to sheets or strips of recording material.

10 An important field of use for the invention is apparatus for use in the application of liquid processing media to information-recording materials for the purpose of treating or developing images in or on such material. Thus the invention can be embodied in apparatus for applying liquid processing media to light-sensitive photographic materials, e.g. silver halide materials incorporating silver halide emulsions; and in apparatus for developing electrostatic images by means of a liquid developer or by means of toner material dispersed in a carrier liquid, using electrostatic, electrophoretic or like phenomena.

15 For applying a liquid processing medium to a dielectric or other recording material, e.g. a material in the form of a sheet or strip, it may be desired to run the recording material into contact with the surface of a body of the liquid medium so that one face of the recording material is acted on by the liquid medium. This is a desirable procedure particularly in certain types of developing processing techniques for developing electrostatic images. That procedure has various potential advantages, including that of a well controlled wetting of the latent image-bearing face of the sheet material. There are however practical problems in automating the application of liquid in this way, as is required in processing rooms when successive recording materials have to be quickly

and conveniently treated to make the records available for use within a short space of time. One of these problems is that of ensuring that a proper supply of the treatment medium is always available at the correct surface level at the processing station for contact by one face of the successive sheets or strips of recording material, notwithstanding the take-up of processing medium by the sheets or strips as they pass through such station, and that unwanted depositions of processing liquid on the opposite face of the sheets or strips is avoided or substantially so. The avoidance of such depositions is important, e.g. in some electrographic or electro-ionographic processes because seeping of processing liquid as a consequence of capillary forces onto the top face of the generally transparent recording material would impair the processed record.

According to the present invention, there is provided an apparatus for use in processing sheets or strips of recording material comprising an open-topped trough for holding processing liquid; means for guiding sheets or strips through the apparatus along a path passing over said trough, a pump for pumping liquid upwardly into said trough to cause overflow of liquid therefrom and enable the liquid surface to contact the bottom face of a said sheet or strip as it passes over the trough, and control switch means for said pump, which switch means is arranged so that it operates to switch off the pump automatically in dependence on the arrival of the trailing edge of a said sheet or strip at a predetermined position along said path such that the pumping up of liquid stops before the trailing edge of the sheet or strip reaches the liquid surface.

As will be exemplified later in this specification, electrostatic forces can in certain kinds of processing serve to draw liquid upwardly against the bottom face of a sheet

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or strip disposed over the trough of liquid. This phenomenon may possibly not occur until the whole of the trough of processing liquid is covered by the sheet or strip. In such circumstances liquid will not seep over the leading margin of the sheet or strip even if the pump is in operation while that leading margin is passing over the trough. Consequently it is not essential for an apparatus according to the invention to incorporate switch means which switches on the pumps only after the leading edge of a sheet or strip has completed its travel over the trough. It is permissible for the pump to be normally on but temporarily switched off automatically as the trailing edge of the sheet or strip approaches the liquid. However, as will also be exemplified hereafter apparatus according to the invention may incorporate pump control switch means which is operated to switch on the pump automatically in dependence on the arrival of the leading edge of a sheet or strip at a predetermined position along the aforesaid path, such that the pumping up of liquid is initiated only after that leading edge has travelled too far along that path to be contacted by the liquid.

The term 'strip' as used in this specification does not imply any particular maximum width of material and includes pieces of material which can properly be described as webs.

Apparatus according to the invention may incorporate means for holding sheets or strips against an overlying surface by suction during passage of the sheets or strips through the processing station. Alternatively, means may be provided for supporting sheets or strips only at their side margins so that they sag towards the liquid rising in the trough.

In preferred embodiments of the invention the said trough is one of a plurality of such troughs, disposed in series along the said path for sheet material, and each of the troughs has an associated pump which is automatically operated in dependence on the position or movement of the sheet material so that the pumps associated with the successive troughs are interrupted in sequence or are operated over overlapping periods of time, in synchronism with the advance of a sheet or strip through the apparatus. Such plural-trough apparatus may for example be as claimed in claim 7 or 8 of this specification.

The invention enables apparatus to be provided which can work according to a rigorously uniform and reproducible processing cycle. Particular reference is made to apparatus according to the invention which can be used for developing charge patterns produced on a dielectric sheet by the process described in United States Patent 3,774,029 of Eric P. Muntz, Andrew P. Proudian and

Paul B. Scott issued November 20 1972. The process referred to makes use of a sheet of dielectric material onto which a charge build-up occurs during exposure to penetrating radiation while said sheet is kept in an imaging chamber which contains xenon or a gas mixture containing xenon or another high atomic number gas. Charge build-up is the result of the interception of electrons or positive ions by the sheet of dielectric material when the latter contacts or is at least in close proximity to an anode, respectively a cathode, said electrodes being also mounted in said imaging chamber. In order to render the charge pattern on the dielectric sheet visible, extreme care must be taken to avoid contamination of the charge image by friction against guides, frame parts, rollers, etc., because this would result in parasitic charges which would interfere with the charge pattern itself. Bearing in mind that the finished image will serve for diagnostic purposes and that the exposure, in some cases, cannot be repeated, for example when contrast enhancing media are used, interference with the charge pattern itself must be avoided.

Apparatus according to the invention can be used for processing a strip or sheet of recording material which is conveyed over the trough or troughs supported by a carrier sheet or strip which is in contact with the top face of the sheet or strip of recording material. The carrier sheet or strip may be larger than the sheet or strip of recording material and project from the leading and trailing edges thereof. In such circumstances, the pump associated with the trough or each trough will be automatically switched off in dependence on the arrival of the trailing edge of the carrier sheet or strip at a predetermined position such that the pumping up of liquid stops before that trailing edge reaches the liquid surface. Switching on of the pump can of course occur automatically in dependence on arrival of the leading edge of a said carrier sheet or strip at predetermined position.

Certain embodiments of the invention, selected by way of example, will now be described with reference to the accompanying diagrammatic drawings, in which:-

Figure 1 is an isometric view of one form of a sheet material which may be used in combination with the invention.

Figure 2 is an isometric view of an applicator station used in a processing apparatus according to the invention.

Figure 3 is a top view of a transporting mechanism.

Figure 4 is a sectional side view of the transporting mechanism of Figure 3 on line 4-4.

Figure 5 is a cross-sectional view of a processing apparatus according to the invention.

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Figure 6 is an isometric view of the backing electrode of the apparatus of Figure 5.

Figure 7 is a sectional view of the electrode of Figure 6 according to the line 7-7'.

Figure 8 is an isometric view of another embodiment of a transporting mechanism used in a processing apparatus according to the invention.

Figure 9 is a sectional view of a part of another embodiment of the transporting mechanism of Figure 8.

Figure 10 is a sectional view of supplementary expedients used in combination with the transporting mechanism of Figure 9.

Figure 11 is a longitudinal section of a modified embodiment of the applicator station of Figures 2 and 14.

Figure 12 is an isometric view of a switching device serving for regulating the sequential starting and stopping of the pumps.

Figure 13 is a diagrammatic view of an electrical circuit used in combination with the switching device of Figure 12.

Figure 14 is a sectional view of the applicator station of Figure 2 along the line b-b' which is provided with supplementary distributing channels.

As may be seen in Figure 1 a material 10 e.g. a recording material comprises a carrier sheet 11 which supports a recording sheet 12 bearing an electrostatic charge pattern to be developed. In order to avoid unnecessary friction between the recording sheet 12 and machine-parts or rollers during the processing cycle, the carrier sheet 11 has somewhat greater dimensions, so that it may be gripped by means engaging the edges only, such as small rollers, endless belts and the like. In so doing occasional friction occurs only between the concerned parts and the margins of the carrier sheet, so that scratches or static electricity resulting from friction are only transferred to the carrier, whereas no harm to the vulnerable recording sheet occurs. If necessary, the backside of the carrier sheet may be provided with a coating increasing its conductive properties. In the course of the description the combination of the carrier sheet 11 and the recording sheet 12 as well as a recording sheet alone without a carrier, will be referred to as the recording material 10. It will be clear to those skilled in the art that when a recording sheet *solus* is used, its dimensions may be chosen somewhat greater than those of the final image and that the superfluous material may be trimmed off after the processing is completed.

In the present description, which is related to the processing of materials used in the method according to United States Patent 3,774,029, already mentioned hereinbefore, it will be taken into account that the recording material 10 is processed

with its recording layer in downward direction.

In Figure 2 is illustrated an applicator station 13 used in the processing apparatus according to the invention. It comprises a troughlike structure 14 which is provided at about 2 millimeters from its upper edges with a plate 15 of a porous material. Preferably, a sintered metal such as sintered copper is used for such plate. The plate has a spongelike appearance and its thickness may range between 2 and 10 millimeters. Processing liquid is pressed or pumped through the pipe 16 provided near the bottom of the trough, said pipe having a plurality of openings 17, 18 drilled in it, the axes of which form an angle of about 45 degrees with respect to the water level. In this way, processing liquid may gradually rise in the trough 14, and is forced through the plate 15 of porous material. By the fact that the pores of the latter are purely arbitrarily arranged, no preferential flow is built-up, so that a homogenous and stable layer of processing liquid is obtained at the top of the trough. The quality of the flow of liquid reaching the charge bearing surface of the material to be processed may be enhanced by providing a plurality of upstanding ridges or ledges 110 (Figure 14), causing the processing liquid to flow in the space between said elements. In this way small irregularities in the structure of the porous member giving rise to a less uniform flow of processing liquid may be easily compensated. The amount of processing liquid which is not consumed during processing flows over the edges of the trough and returns back to a container (not shown) for recycling. A certain part of the liquid of the layer will be taken away by the charge pattern of the recording material to be processed when such material is moved over the trough in contact with the layer of processing liquid.

For high quality processing cycle the processing liquid should be deposited onto the material to be processed in the form of a uniform layer. A possible cause of imperfect deposition may be found in the bending of the recording material, especially when large sized formats are used. In medical radiography such formats may attain a width of, say 40 to 50 cm, so that already a considerable bending of the material may be observed if no measures are taken to prevent it. In processing apparatus, intended for treating silver halide materials, this problem does not occur due to the fact that, in general, rollers which support the material over its full width are used the bending of which is almost zero due to the favourable ratio between their moment of inertia and their width.

For reasons described hereinbefore, the

most convenient way of transporting the material 10 is by engaging it at its side edges with the help of two pairs of endless belts, or by a plurality of pairs of small transporting rollers situated at the same location as the endless belts.

Figures 3 and 4 present a transporting mechanism which is capable of providing a high degree of tautness and flatness to the material 10. Two pairs of endless belts (shown are only the belts 19, 20 and 25) engage the material 10 at its side edges.

The endless belts may be tensioned for example by means of a pressure roller 28 (Figure 4) by urging the latter to the belt in the sense indicated by the arrow. In this way the tensioning of the belts 19, 25 and of the other pair of belts may be adjusted at will. It will be appreciated by those skilled in the art that tensioning of the belts may be carried out by other means than pressure rollers. The endless belts are supported by roller pairs 21, 22-23, 24-26, 27-28, 49 (see also Figures 8 and 9). The lines of motion of belts 19 and 25 slightly diverge from those of the other set of endless belts in that they form a small angle α with each other. In Figure 3 this angle α has been exaggerated. In practice, said angle amounts only to 1 or 2 degrees. In this manner the recording material 10 is kept taut. In practice, only one pair of endless belts (in Figure 3 the belt 20, and the underlying one) has to be aligned at an inclination to the direction in which the recording material should travel.

If the tension of the pair of endless belts which run parallel with the sheet transport direction is made somewhat greater than the tension of the inclined belts, the latter will slip on the margins of the recording material which they engaged. In this way the material is neither stretched nor submitted to excessive lateral forces. In practice, the pressure exerted by the pair of endless belts (19 and 25) which are parallel with the transport direction is adjusted to 1.7 kg/sq.cm whereas the pressure exerted by the inclined pair is adjusted to about 1.2 kg/sq.cm.

It will be appreciated that if opposed sets of small rollers are used which engage the side margins of the material 10, instead of two pairs of endless belts, one set of rollers can be arranged along an inclined path in the same way as the inclined belts.

Figure 5 is a diagrammatic representation of the complete processing device 30 applied for processing the recording material 10.

The said material is introduced at the right side of the device in the bite of the endless belts 19 and 25. First, its back is uniformly wetted with the help of the wick 39 which is soaked with, for example, a water/alcohol mixture. The conductivity of the layer occasionally provided at the back-

side of the recording material 10, can thereby be increased. In this way, also a good contact between the back of the recording material 10 and a backing plate 34, the latter serving as a grounded development electrode, is obtained.

For the structure of the backing plate 34, which will be further referred to as electrode 34, reference is also made to figures 6 and 7. As may be seen, it is provided with a plurality of grooves 51 to 56, which are provided with holes 59 through which air may be sucked.

Referring again to Figure 5 it may be seen that the recording material 10 during its travel through the apparatus passes with its charge bearing layer above a plurality of troughs 13 to which processing liquid under relatively high pressure is fed with the help of pumps 32 so that the processing liquid flows over the edges of each trough after having formed a liquid layer a few millimeters high above the top of each trough. As already explained, the presence of a sintered metal plate in each trough, whether or not combined with upstanding ridges helps to promote uniform flow of liquid into that layer so that processing faults such as streaks which frequently occur with previously known apparatus are completely prevented.

Each applicator station 13 is continuously supplied with processing liquid from a container 31 by means of an associated pump 32, whereby a layer of said liquid is formed. This layer is contacted by the recording material 10, passing over the applicator station, whereby part of the processing liquid is retained by the surface of the recording material 10. The residual processing liquid which is not taken away flows into the collecting vessel 33 and is recycled to the container 31 for re-use.

After processing, the material 10 has to be dried quickly. Therefore, a combination is provided composed of a corona device 40, infrared dryers 41 and a blower 42 which directs heated air onto the wet surface of recording material 10. In the embodiment shown air is heated by heating element 43, which may be in the form of wire resistances, a tube system containing heated oil or any other heating device known in the art. The DC corona device 40 is based on the phenomenon of the 'electric wind' for repelling the residual liquid which would adhere to the surface of the image side of the recording material and such liquid layer may be decreased from 30 to 7 microns. The other expedients positively dry the still wet image.

If desired, the last processing trough 13 may be connected via its associated pump to a supply of liquid in which no toner particles are present, so forming a station which may be compared with the rinsing station in clas-

sical photographic processing machines. In so doing excessive toner which does not adhere to image parts and which is still present in the uniform layer of liquid may easily be washed away, so that the risk of fog formation is greatly reduced. A cutting mechanism (not shown) may be provided after the drying station(s) in order to trim off the edges of the dried processed material in the case that no carrier sheet was used.

The pumps 32, associated with the plurality of applicator stations 13 are sequentially energized with energizing depends on the position taken by the recording material 10 at a given moment. The electrode 34 is provided with holes 59 to which a suitable source or sources of vacuum 36 may be connected via conduits 35. The sources of vacuum 36 are permanently energized, so that in the absence of the material 10, no substantial air pressure drop in the conduits 35 occurs. Once, however, the leading edge of the recording material 10 is masking the openings, a substantial air pressure drop is created in said conduits 35, whereinafter a pressure-sensitive microswitch 37 starts to energize its associated pump 32. As a consequence, the direct projected of processing liquid 31 in the holes 59 and further into conduits 35 is avoided, the recording material 10 is kept taut, and the conductivity enhancing liquid on the backside is evaporated to a great extent at the same time. As may be derived from Figure 6, the canals 51 to 56 extend transversely with respect to the width of the electrode 34 and are in the form of grooves (see also Figure 7) provided in a metal plate 50, the latter having preferably highly conductive properties. A cover plate 58 (drawn in dotted in Figure 6) guarantees an airtight sealing.

Apparatus as just described is suitable for processing advanced technology materials.

If such sophisticated processing is not needed, apparatus of much simpler form can be used. Simplification can be effected by using means alternative to the relatively complicated vacuum circuitry for removing the layer of conductivity enhancing liquid.

An example of such a simplification is represented in Figure 8. The apparatus here shown comprises a sheet or strip transporting mechanism 60 is built up by the roller pairs 21, 22 and 26, 27 at one side and the roller pairs 23, 24 and 48, 49 at the other side. These four roller pairs support the endless belts 19, 25 20 and 47 respectively.

As may be derived from Figure 8, the upper endless belts serve as support for at least one sheet 61 of porous material. The term 'porous' must be understood to include fully porous materials and materials which are porous at only one side. This sheet of porous material 61 is attached to the endless belts 19 and 20 with the help of straps 62, 63

made of rubber or other elastic material to allow for the divergence of the lines of motion of the opposed pairs of belts.

On rotation of the endless belts care must be taken to maintain exact synchronism between the motion of the belts carrying the porous material 61 and the motion of the recording material 10 to be processed. The wet top face of the latter material contacts the porous material and in the meantime contacts a grounded metal strip 64 serving as backing electrode during development.

Due to the fact that porous material 61 contacts the wet top face of the recording material 10 that side of the material is made sufficiently conductive for optimum development of the charge pattern at the bottom face of the material. A major part of the wetting liquid may be sucked up once the recording material leaves the developing station and prior to its complete drying. The porous material 61 itself has sufficient time to dry during its inactive period. If necessary, drying of the latter itself may be accelerated by means of a blower (not shown). It will be appreciated, that the porous material itself may be in the form of an endless belt if desired.

The synchronism between the motion of the recording material 10 to be processed and the porous material 61 may be obtained by means sufficiently known in the art of electronic and/or pneumatic logic and which need no further explanation.

For reasons of convenience, the metallic strip 64 too, may be substituted by an endless belt conductor.

Embodiments of the porous material 61 may be either in the form of a sheet of fabric onto which a layer of rubber or a high polymeric material is coated or in the form of a sheet of fabric alone.

Another embodiment of a transport medium which is illustrated in Figures 9 and 10 makes use of a porous material which is built-up as a kind of 'Venetian blind'. Small strips of a sintered material analogous in structure to the porous material used in the troughs in Figure 5 may be employed for this purpose.

So, a plurality of strips 66 to 72 are used which, when positioned in close parallel relationship with the recording material 10 to be processed, serve firstly as a conductive backing electrode and then as carriers for the excess conductivity enhancing liquid taken up during processing. Thereafter they pass in front of a corresponding plurality of suction-pipes 73 to 78 each of which is connected to a suitable blower not shown. In this way the liquid becomes evaporated and the strips are ready for re-use in a subsequent processing cycle. The result is the same as when using a porous material made of fabric but the reliability of the apparatus

is better due to the higher mechanical resistance and the anti-corrosive qualities of the sintered metal strips.

In a simplified embodiment of an apparatus wherein there is no vacuum system for keeping the recording material completely flat, the said material will bend as indicated in an exaggerated way at 80 in Figure 11. This figure is a vertical longitudinal sectional view of a processing station comprising a trough as already described with reference to Figure 2, but wherein the porous plate 15 has a curvature corresponding with the transverse curvature assumed by the recording material. In this way a homogenous bead of liquid of constant thickness is still formed notwithstanding the sagging of the recording material. If ridge strips 110 (see Figure 14) are employed in association with the porous plate, those strips are formed with a corresponding curvature.

If the recording material is allowed to sag as described with reference to Figure 11, the leading edge of the recording materials may not sag into contact with the liquid layer as that leading edge moves over the trough. Sagging of the recording material into contact with the liquid is most likely to occur as the recording material moves into a position in which it covers the whole area of the trough and the associated liquid layer. At that moment in the processing cycle there is a mutual attraction between the recording material and the liquid due to electrostatic phenomena and the recording material sags and contacts the layer of processing liquid and remains adherent thereto due to surface tension effects. In this way the surface of the recording material may be uniformly wetted and processing is carried out easily. The bending of the recording material at its trailing edge, however, may be the cause that, when passing over an applicator station, developing liquid creeps over said edge and wets the backside. Indeed, the still bent recording material has not yet been released by the liquid, so that, temporarily, the level of processing liquid is at a higher position than the rear edge of the recording material.

As a consequence thereof, a special step has to be taken in order to prevent this undesired phenomenon. In Figures 12 and 13 are shown a switching device and an electric circuitry by means of which that can be done.

Figure 12 represents a mechanism 81 fixedly mounted on a shaft bearing the roller 23 over which runs the endless belt 20, forming part of the transporting mechanism. This shaft carries an electromagnetic friction clutch 82, which may drive a shaft 83 carrying a plurality of cams 84 to 88. If desired, the electromagnetic friction clutch 82 may be linked with the shaft 83 by means of a gear box (not shown).

Referring further to Figure 13, it may be derived that the electromagnetic friction clutch 82 is actuated by the closing of a microswitch 89. Said microswitch 89 is located at the beginning of the first applicator station and serves to detect the passage of the leading edge of the recording material. Upon closing of the microswitch 89, the coupling between the electromagnetic friction clutch 82 and the cam bearing shaft 83 is performed and the latter starts to rotate. The cams 84 and 88 serve to open or to close a corresponding plurality of switches 91 to 95, preferably microswitches, the mobile contact of which serving as cam followers for the cams 84 to 88. When the cut away portion of a cam is contacted by a cam follower, the corresponding switch will open, as is shown for switches 94 and 95.

The switches 91 to 95 are series-connected with the motors 95-100 of the pumps 101 to 105, so that the opening of a switch de-energizes the pump associated therewith. In operation, the pumps 101 to 105 pump processing liquid to the applicator stations 13 so that upon de-energizing a pump, the supply of processing liquid is automatically interrupted. The structure of the cams 84 to 88 and the rotation of the shaft 83 are so designed that opening of a switch 91 to 95 occurs at the moment that the trailing edge of the material to be processed is just above the applicator station fed by the pump associated with said switch.

With the help of an arrangement as described hereinbefore, cutting off the supply will occur in sequence until the cam follower contacting the last cam resets its associated switch in closed position. Another switch (not represented) which may be located in a downstream section of the apparatus and which takes care of the 'HOLD'-condition of the clutch during processing, provides for the de-energizing of the clutch 82 after the trailing edge of the material sheet has passed the last applicator station. At that moment, all pumps are again pumping and the processing station is ready for receiving another sheet or web of recording material to be processed. The processed material is then subjected to a rinsing and drying process, whereinafter the excess of material in the vicinity of its four edges maybe trimmed off. As this last treatment may be carried out by means which are sufficiently known in the art, it has not been illustrated.

It will also be clear that the regulation of the sequential de-energizing of the pumps may be carried out with other means than an electromagnetic clutch with a cam-bearing shaft. If desired, a fully electronic hardware device may be used for this purpose.

WHAT WE CLAIM IS:-

1. An apparatus for use in processing

is better due to the higher mechanical resistance and the anti-corrosive qualities of the sintered metal strips.

5 In a simplified embodiment of an apparatus wherein there is no vacuum system for keeping the recording material completely flat, the said material will bend as indicated in an exaggerated way at 80 in Figure 11. This figure is a vertical longitudinal sectional view of a processing station comprising a trough as already described with reference to Figure 2, but wherein the porous plate 15 has a curvature corresponding with the transverse curvature assumed by the recording material. In this way a homogenous bead of liquid of constant thickness is still formed notwithstanding the sagging of the recording material. If ridge strips 110 (see Figure 14) are employed in association with the porous plate, those strips are formed with a corresponding curvature.

10 If the recording material is allowed to sag as described with reference to Figure 11, the leading edge of the recording materials may not sag into contact with the liquid layer as that leading edge moves over the trough. Sagging of the recording material into contact with the liquid is most likely to occur as the recording material moves into a position in which it covers the whole area of the trough and the associated liquid layer. At that moment in the processing cycle there is a mutual attraction between the recording material and the liquid due to electrostatic phenomena and the recording material sags and contacts the layer of processing liquid and remains adherent thereto due to surface tension effects. In this way the surface of the recording material may be uniformly wetted and processing is carried out easily. The bending of the recording material at its trailing edge, however, may be the cause that, when passing over an applicator station, developing liquid creeps over said edge and wets the backside. Indeed, the still bent recording material has not yet been released by the liquid, so that, temporarily, the level of processing liquid is at a higher position than the rear edge of the recording material.

15 As a consequence thereof, a special step has to be taken in order to prevent this undesired phenomenon. In Figures 12 and 13 are shown a switching device and an electric circuitry by means of which that can be done.

20 Figure 12 represents a mechanism 81 fixedly mounted on a shaft bearing the roller 23 over which runs the endless belt 20, forming part of the transporting mechanism. This shaft carries an electromagnetic friction clutch 82, which may drive a shaft 83 carrying a plurality of cams 84 to 88. If desired, the electromagnetic friction clutch 82 may be linked with the shaft 83 by means of a gear box (not shown).

Referring further to Figure 13, it may be derived that the electromagnetic friction clutch 82 is actuated by the closing of a microswitch 89. Said microswitch 89 is located at the beginning of the first applicator station and serves to detect the passage of the leading edge of the recording material. Upon closing of the microswitch 89, the coupling between the electromagnetic friction clutch 82 and the cam bearing shaft 83 is performed and the latter starts to rotate. The cams 84 and 88 serve to open or to close a corresponding plurality of switches 91 to 95, preferably microswitches, the mobile contact of which serving as cam followers for the cams 84 to 88. When the cut away portion of a cam is contacted by a cam follower, the corresponding switch will open, as is shown for switches 94 and 95.

25 The switches 91 to 95 are series-connected with the motors 95-100 of the pumps 101 to 105, so that the opening of a switch de-energizes the pump associated therewith. In operation, the pumps 101 to 105 pump processing liquid to the applicator stations 13 so that upon de-energizing a pump, the supply of processing liquid is automatically interrupted. The structure of the cams 84 to 88 and the rotation of the shaft 83 are so designed that opening of a switch 91 to 95 occurs at the moment that the trailing edge of the material to be processed is just above the applicator station fed by the pump associated with said switch.

30 With the help of an arrangement as described hereinbefore, cutting off the supply will occur in sequence until the cam follower contacting the last cam resets its associated switch in closed position. Another switch (not represented) which may be located in a downstream section of the apparatus and which takes care of the 'HOLD'-condition of the clutch during processing, provides for the de-energizing of the clutch 82 after the trailing edge of the material sheet has passed the last applicator station. At that moment, all pumps are again pumping and the processing station is ready for receiving another sheet or web of recording material to be processed. The processed material is then subjected to a rinsing and drying process, whereinafter the excess of material in the vicinity of its four edges maybe trimmed off. As this last treatment may be carried out by means which are sufficiently known in the art, it has not been illustrated.

35 It will also be clear that the regulation of the sequential de-energizing of the pumps may be carried out with other means than an electromagnetic clutch with a cam-bearing shaft. If desired, a fully electronic hardware device may be used for this purpose.

WHAT WE CLAIM IS:-

1. An apparatus for use in processing





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5 sheets or strips of recording material comprising an open-topped trough for holding processing liquid, means for guiding sheets or strips through the apparatus along a path passing over said trough, a pump for pumping liquid upwardly into said trough to cause overflow of liquid therefrom and enable the liquid surface to contact the bottom face of a said sheet or strip as it passes over the trough, and control switch means for said pump, which switch means is arranged so that it operates to switch off the pump automatically in dependence on the arrival of the trailing edge of a said sheet or strip at a predetermined position along said path such that the pumping up of liquid stops before the trailing edge of the sheet or strip reaches the liquid surface.

10 2. Apparatus according to claim 1, wherein the control switch means is arranged so that it operates to switch on the pump automatically in dependence on the arrival of the leading edge of a said sheet or strip at a predetermined position along said path such that the pumping up of liquid is initiated only after the leading edge of the sheet or strip has travelled too far along said path to be contacted by the liquid.

15 3. Apparatus according to claim 1 or 2, wherein there is a flow distributor in said trough for promoting uniformity of upward liquid flow over the whole plan area thereof.

20 4. Apparatus according to any preceding claims, wherein there is air aspirating means for holding a said sheet or strip against an overlying surface during passage of the sheet or strip over the trough.

25 5. Apparatus according to claim 4, wherein said pump control switch is arranged so that it is actuated by pressure changes in said aspirating means caused by movement of a said sheet or strip into a predetermined position.

30 6. Apparatus according to any of the preceding claims, wherein the said trough is one of a plurality of such troughs disposed in series along the said sheet or strip path, and each of the troughs has an associated pump and control switch means therefor which is arranged to switch off that pump automatically in dependence on the arrival of the trailing edge of a sheet or strip at a predetermined position along said path such that the pumping up of liquid from that trough stops before that trailing edge reaches the liquid surface associated with that trough.

35 7. Apparatus according to claim 6, wherein there is a liquid reservoir common to the plurality of troughs, the pumps being arranged to pump liquid upwardly from that reservoir into the troughs, and means for collecting residual processing liquid overflowing from the troughs.

40 8. Apparatus according to claim 6 or 7,

70 wherein the control switch means for each pump is arranged so that it operates to switch on that pump automatically in dependence on the arrival of the leading edge of a said sheet or strip at a predetermined position along said path such that the pumping up of liquid from that trough is initiated only after the leading edge of the sheet or strip has travelled too far along said path to be contacted by the liquid pumped upwardly in that trough.

75 9. Apparatus according to any preceding claim, wherein the means for guiding sheets or strips through the apparatus comprises two opposed pairs of endless belts disposed for engaging opposed margins of a sheet or strip.

80 10. Apparatus according to claim 9, wherein the lines of motion of the opposed pairs of endless belts slightly diverge from each other in the direction of sheet or strip conveyance.

85 11. Apparatus according to claim 9, wherein the line of motion of one of the pairs of endless belts is parallel with the direction in which sheets or strips should travel over the trough(s).

90 12. Apparatus according to claim 11, wherein the mutual contact pressure of the belts whose line of motion is parallel with the direction in which sheets or strips should travel over the trough(s) exceeds the mutual contact pressure of the belts of the other pair.

95 13. Apparatus according to any of claims 9 to 12, wherein there is means for wetting the top surface of a said sheet or strip prior to its passage over the trough(s), an electrode shrip for contacting such top surface during its said passage, and a liquid-absorbing member which is connected with the upper belts of said opposed pairs of belts so that such absorbing member contacts such top surface of a sheet or strip.

100 14. Apparatus according to claim 13, wherein said absorbing member has a tissue-like structure.

105 15. Apparatus according to claim 13, wherein said absorbing member comprises a body of sintered material and there is suction means operative to draw off liquid from such member.

110 16. Apparatus according to any preceding claim, wherein the or each trough has a rectangular top opening and a porous liquid flow distributor is present in that trough at a position above the bottom thereof and such that the top surface of such member is a little below the top of the trough, said member extending over the whole plan interior area of the trough.

115 17. Apparatus according to claim 16, wherein the or each liquid flow distributor is a substantially rigid member.

120 18. Apparatus according to claim 16 or 130

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- 17, wherein the or each flow distributor is made of sintered copper.
19. Apparatus according to any of claims 16 to 18, in which the top surface of the or each flow distributor is parallel with the plane occupied by a said sheet or strip as it passes over the associated trough.
20. Apparatus according to any of claims 16 to 19, wherein the or each flow distributor has a plurality of equally spaced upstanding ridges
21. Apparatus according to any preceding claim, wherein electrode means is provided for contacting the top surface of a said sheet or strip during its passage over the trough(s).
22. Apparatus according to claim 21, wherein said electrode means comprises a metallic strip.
23. Apparatus according to claim 21, wherein said electrode means comprises a metallic plate.
24. Apparatus according to claim 23, in which there is a said metallic plate which is provided with one or more rows of holes extending transversely of the sheet or strip path and located above the or a said trough, and wherein means is provided for exerting suction forces on a said sheet or strip via said holes.
25. Apparatus according to claim 24, wherein the or each pump has control switch means arranged for automatically switching on that pump responsive to the arrival of the leading edge of a said sheet or strip at a position in which it covers a said row of holes.
26. Apparatus according to claim 25, wherein there is a plurality of troughs each having as associated pump, and a said metallic plate which extends over the troughs and has a said row of holes over each trough, and wherein there is a plurality of vacuum-sensitive pump switches responsive to the passage of a said sheet or strip across said rows of holes, said switches being arranged to start the pumps one after the other in succession as the leading edge of said sheet or strip moves across the successive rows of holes and to stop the pumps in succession as the sheet or strip moves from beneath the successive rows of holes.
27. Apparatus according to any of claims 1 to 23, wherein there is a plurality of said troughs each having an associated pump and wherein there is first switch means responsive to the passage of the leading edge of a sheet or strip over the first trough, a clutch actuated by such first switch means, a shaft which is driven via such clutch and on which a plurality of cams are located, and further switch means for the pumps of the other troughs, said further switch means being actuatable by said cams to cause operation of the pumps in correct timed relationship to the travel of the sheet or strip over the successive troughs.
28. Apparatus according to claim 27, wherein said clutch is secured to a shaft driving an endless belt serving for transporting sheets or strips over the troughs.
29. Apparatus according to any preceding claim, wherein means is provided for uniformly wetting the top surface of a said strip or sheet prior to its arrival at the or a said trough.
30. Apparatus according to any preceding claim, wherein means is provided for drying the sheets or strips after passing over said trough(s).
31. Apparatus according to claim 30, wherein said drying means comprise a corona generating device, infrared sources and a blower which directs drying air over or through electrical heating elements.
32. Apparatus for use in processing sheets or strips of recording material substantially as herein described with reference to the accompanying drawings.
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