

[54] **WRAP ADJUST DEVICE FOR CONTROLLING ENGAGEMENT BETWEEN A WEB AND ROLLER IN AN IMAGING SYSTEM**

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[51] Int. Cl. H04n 5/82

[58] Field of Search 346/74 TP, 74 MT, 77 E; 178/6.6 TP; 340/173 TP; 34/110, 152; 165/89, 96; 219/388, 244, 216; 96/1.1

[56]

References Cited

UNITED STATES PATENTS

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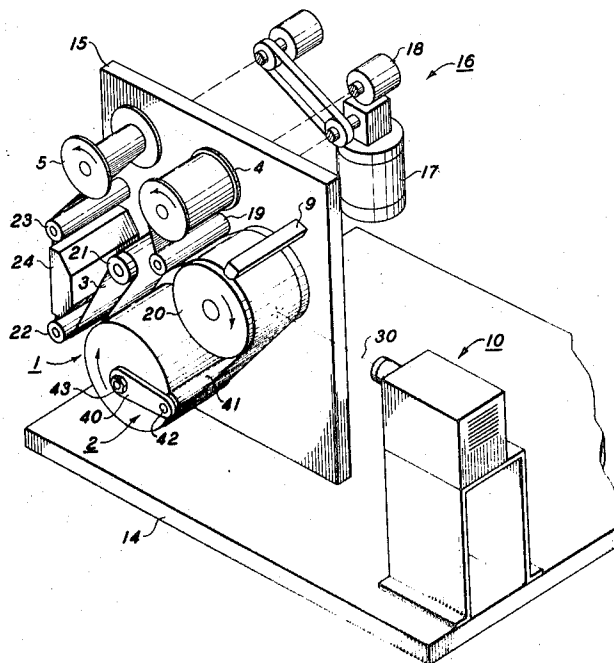
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[57]

ABSTRACT

The temperature of a heat sensitive web is controlled by varying the contact area between the web and a thermo roller having an appropriate thermo energy device coupled to it. A wrap adjust roller is supported for movement along a circular path concentric with the periphery of the thermo roller and varies the surface area contact between web and thermo roller at different locations relative to the thermo roller.

7 Claims, 4 Drawing Figures



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SHEET 1 OF 2

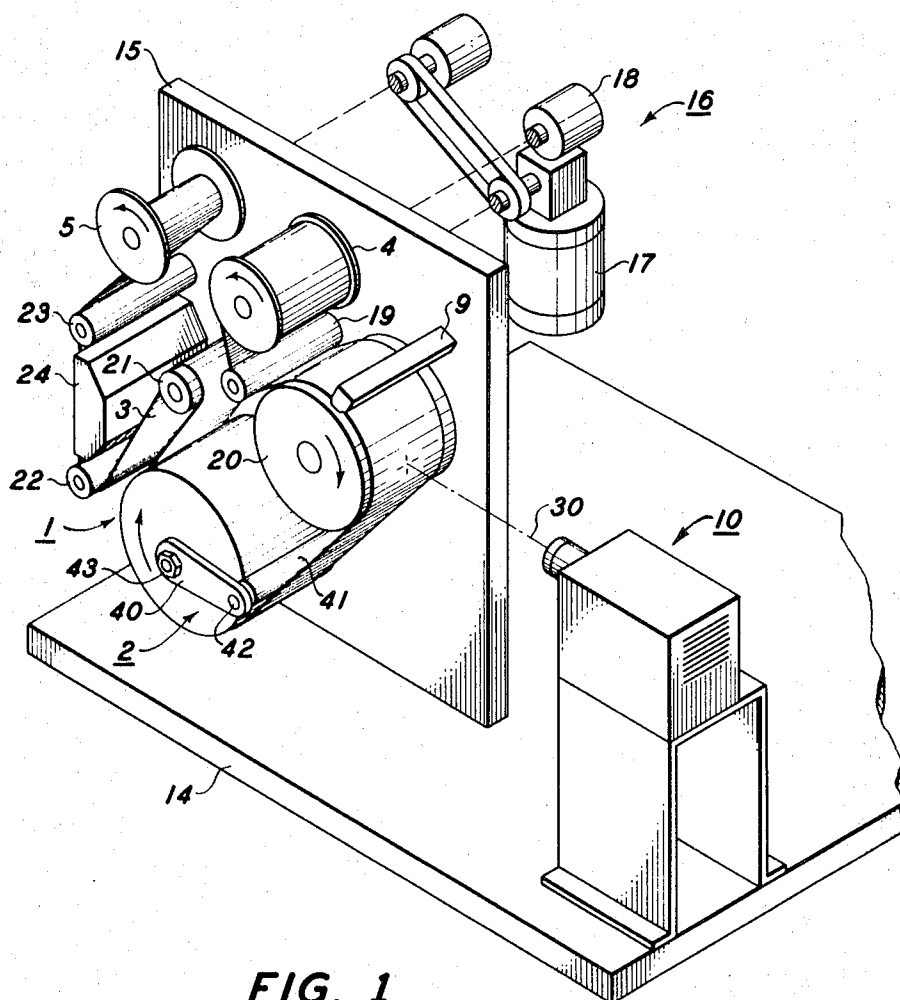


FIG. 1

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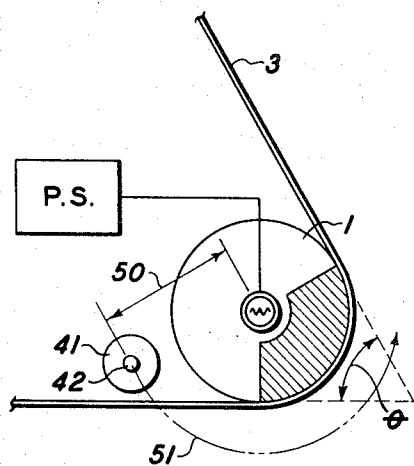


FIG. 2

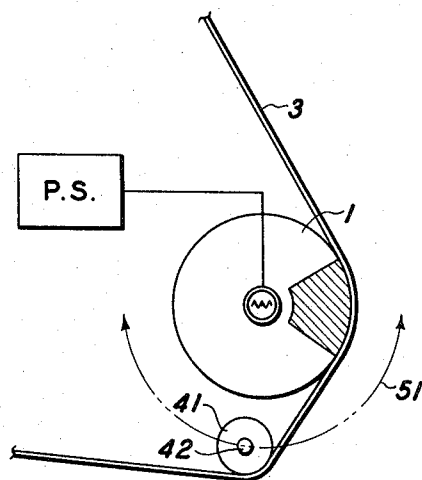


FIG. 3

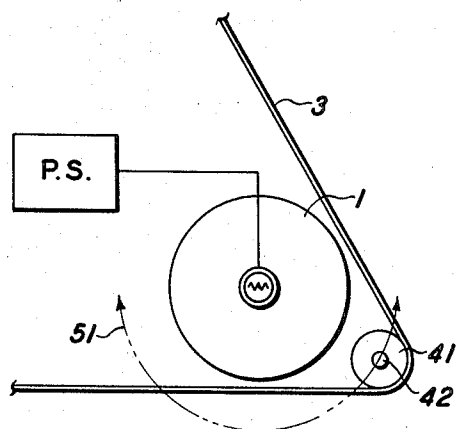


FIG. 4

WRAP ADJUST DEVICE FOR CONTROLLING ENGAGEMENT BETWEEN A WEB AND ROLLER IN AN IMAGING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates generally to imaging systems and more specifically to methods and apparatus for exchanging thermo-energy with a web to control its temperature. The temperature control is used to process a heat sensitive image recording member in web form.

A migration imaging system is disclosed in U.S. Pat. No. 3,520,681 and copending applications Ser. No. 553,837, filed May 31, 1966 now abandoned, 634,757, filed Apr. 25, 1967 now abandoned; and 837,791, filed June 30, 1969 now U.S. Pat. No. 3,580,962 and the disclosures of the foregoing are incorporated herein by reference. Broadly, the above migration imaging system employs an imaging member including image particles and a softenable material. Electric forces associated with certain of the image particles cause the particles to migrate through the softenable material when its mechanical resistance to the migration is reduced. The mechanical resistance of the softenable material is reduced by methods including softening, heating, exposing to solvent vapors or liquids and combinations of the foregoing. The present invention is concerned with heating and cooling the foregoing imaging members and other heat sensitive members in web form.

A migration imaging member in web form may be heated as part of a development step for forming a visible image. The same film is also cooled to lock particles at specified locations within the film. With other heat sensitive materials, heating and cooling may serve some other purpose. The problem in each case is how to control the exchange of energy with a web without raising or lowering the temperature of the web to a level at which the member is structurally and/or functionally damaged.

Accordingly, it is an object of this invention to overcome the above-noted problems and limitations.

Specifically, it is an object of the present invention to devise methods and apparatus for exchanging thermo-energy with the above referenced migration imaging member in web form.

Another object of the instant invention is to protect a heat sensitive web from being heated or cooled to temperatures that are structurally or functionally unsuitable.

Yet another object of the invention is to effect rapid engagement and disengagement of a thermo-energy element with a web member.

Still another object of this invention is to control the surface area over which thermo-energy is exchanged with a web.

Even a further object of the instant invention is to contact a web with a thermo-energy device while the web is moving and to break the contact when the web is stationary.

These and other objects of the present invention are realized with novel web handling methods and apparatus. Thermo-energy is exchanged with a web member by passing the web over a thermo roller coupled to a thermo-energy device. A first heat exchange occurs while the web is in contact with the thermo

roller and a second heat exchange is made when the web is separated from the roller. The engagement and separation of the web and thermo roller is accomplished with a wrap adjust device. The wrap adjust device includes a wrap roller journaled in pivot arms that are rotatably supported about the rotation axis of the thermo roller. The wrap roller moves around the periphery of the thermo roller along a coincident circular path. The position of the wrap roller relative to the thermo roller determines whether the web is in contact with the thermo roller and the amount of surface area contact between them.

DESCRIPTION OF THE DRAWINGS

Other objects and features of the instant invention will be apparent from a further reading and from the drawings which are:

FIG. 1 is a schematic perspective view of an imaging system including web handling methods and apparatus according to the present invention.

FIGS. 2-4 are schematic side elevation views of a web passed over wrap and thermo rollers with the wrap roller at a different position in each figure illustrating different areas of contact between the thermo roller and web including no contact.

DESCRIPTION

The migration imaging system of FIG. 1 employs a thermo roller 1 and wrap adjust device 2 for controlling the temperature of web 3. Web 3 is a migration imaging structure including a conductive substrate and a migration layer composed of image particles and softenable material. The web is threaded through the machine between the supply 4 and take-up reel 5. Images are formed with the web as it is wound between the two reels by steps including: depositing electrostatic charge on the free or outer surface of the web as it travels past corotron 9; exposing the charged web to electromagnetic radiation (for example, a flying light spot) as it travels past exposure means 10; and developing the charged and exposed web as it moves past the thermo roller by reducing the mechanical resistance of the web softenable material to migration by the image particles. The reduction in mechanical resistance may be effected by several methods including the presently concerned method of heating the softenable material.

The charging and exposing steps give rise to a latent electrical image which is rendered visible by development at the thermo roller. Solvent vapor and/or liquids may be used in addition to the heat. The heating reduces the mechanical resistance of the web by softening it. The image particles associated with the latent electrical image migrate in depth through the developed softenable material thereby creating positive and negative images from the migrated and non-migrated particles. Process parameters such as charge levels, polarities and/or materials are controllable such that the exposed or the non-exposed particles are the image particles that migrate. For details in regard to the migration image process, the reader is directed to the initially referenced Patent and Patent Applications. These references also include disclosures relating to washing away the softenable material and to splitting a softenable material to separate migrated and non-migrated particles.

Thermoplastic deformation imaging processes and structures such as disclosed in U.S. Pat. Nos. 3,055,006; 3,196,011; and 3,113,179 are examples of other systems to which the present invention is applicable and the disclosures thereof are incorporated herein by reference. Briefly, the processes involve deforming the surface of a thermoplastic material with electric fields associated with charge deposited on the surface of the thermoplastic. Heating and/or exposing to a solvent enables the thermoplastic to deform under the influence of the charge. When the thermoplastic is placed on a photoconductor, the process step can include charging, exposing and developing as with the migration imaging process. The difference between the processes include those involved in the developing step. In one developing step, particles migrate and in the other a surface deforms.

Heating and/or cooling web members is desirable in systems other than the foregoing. For example, a silver halide motion picture film requires cooling to protect the resin material of the film from heat generated by lamps used to project the film images. In addition, the manufacture of web members may include a step wherein heat is applied to or subtracted from a web for diverse purposes. The present invention finds use in all such web systems, processes and/or apparatus.

Turning now to FIG. 1, horizontal and vertical frame plates 14 and 15 support the various system components. The drive mechanism 16 is illustrated in an exploded position adjacent the vertical frame plate on which it is carried. The drive mechanism includes the electric motor 17 drivingly coupled to the take-up reel 5 and the drag brake or clutch 18 coupled to supply reel 4. The motor coupled to the take-up reel pulls the web 3 from the supply reel against the bias force provided by the drag brake to maintain tension in the web whether it is moving or at rest. The web is threaded under the first idle roller 19 and over the image roller 20. From the image roller, the web is threaded: around the thermo roller 1 and wrap adjust device 2; over the exit idle roller 21; across the display idle rollers 22 and 23 and viewing screen 24; and onto the take-up reel 5. As mentioned earlier, the web is charged as it passes corotron 9, exposed as it traversed means 10 and developed as it passes the thermo roller 1.

The corotron includes a thin conductive wire coupled to a high electrical potential source. The web substrate is conductive and is coupled to a suitable potential, e.g. ground, through the image roller 20. The image roller is a conductive roller electrically coupled to ground, for example, to ground the web. The potential difference between the web substrate and corotron wire yields a flow of ions and other charged particles between them. Consequently, the outer surface of the web is charged to a high potential by the ions and other charged particles deposited on its surface.

The exposure mechanism is illustrated schematically as a moving pencil of electromagnetic radiation 30 that sweeps across the width of the web. This pencil of light can be generated by any suitable means including a beam of light reflected from the mirror surface of a galvanometer. The intensity of the light beam can be modulated by suitable means such as a transparency positioned in its path. The light beam may be that generated at the face of a cathode ray tube. Alternately,

the exposure means can include a line or slit exposure wherein a line of light replaces the pencil of light 30.

The thermo-roller includes a relatively large diameter roller having an appropriate heating (or cooling in another system) element within its volume. Examples of suitable thermo energy elements include: an electrical resistance heater; and infra-red lamp; hot or cold liquid coils; and hot or cold vapor coils. The object is to exchange thermo energy between the web and the periphery of the thermo roller. Most conveniently, the thermo roller periphery is heated or cooled by conduction through the walls of the roller. How the walls are heated is not particularly important since this may be a matter of design convenience. For example, radiation and/or convection may be the principal means for heating the inside walls of the roller. However, this invention is not limited to the methods of heating or cooling since the invention may be practiced even when the thermo-roller is a hollow glass cylinder having an infra-red lamp within its volume. The primary requirement for this invention is to provide a web location at which a highly efficient heat transfer occurs. This location is the periphery of the thermo-roller and the wrap adjust device cooperates to control web temperature by varying the contact area between the web and thermo roller.

The wrap adjust device includes two pivot arms journaled at opposite ends of the thermo roller about its axis. Member 40 is one of the pivot arms and is typical of the other positioned at the hidden (as viewed in FIG. 1) end of the thermo-roller. A wrap adjust roller 41 is journaled near the free ends of the pivot arms by suitable bearings, bearing 42 being typical. A lock nut 43 is coupled to the axle of the thermo roller and abuts against pivot arm 40 to hold it against rotation. When the lock nut is loosened, the pivot arms are rotated to vary the location of the wrap adjust roller relative to the thermo roller. With this scheme, the wrap roller can be positioned at an infinite number of locations on a circular path around the thermo roller. The clearance between the peripheries of the wrap adjust and thermo rollers is selected to be sufficiently great to prevent contact between the web and thermo roller at least at one position of the wrap roller. The function of web separation is discussed in more detail below.

The lock nut 43 is representative of one of many mechanisms for controlling the position of the wrap adjust roller relative to the periphery of the thermo roller. In more sophisticated systems, the lock nut is replaced by a stepping motor or other position control device. The position control device is operated automatically in response to the movement of the web. An example, is an electrical motor coupled to the pivot arms that is energized to rotate in a first direction a fixed number of angular degrees when the motor 17 coupled to the take-up reel 5 is started and a fixed number of angular degrees in the opposite direction when motor 17 is stopped. Switching apparatus capable of such operation is well known. The described apparatus causes the web to be pulled into contact with the periphery of the thermo roller when the web moves and to be pulled out-of-contact with the thermo roller when the web stops.

FIGS. 2-4 depict the operation of the wrap adjust device except the pivot arms are deleted for clarity of presentation. The angle theta is the angle by which the web 3 is diverted when passed around the thermo roller while out of contact with the wrap adjust roller 41. The angle theta also defines the maximum contact area between the thermo roller and web. The larger the angle theta, the greater the amount of heat exchange occurs between the web and thermo roller because of the greater period of time in which heat is exchanged.

The angle theta also defines the minimum dimension for the pivot radius 50 which is the distances between the axes of rotation of the wrap adjust and thermo rollers. When the radius 50 is sufficient to position the wrap adjust roller near the apex of angle 50, a minimum contact occurs between the web and thermo roller. Making the radius 50 even larger to position the wrap roller to the right of the apex of angle theta, as in FIG. 4, results in complete separation between the web and thermo roller. The drag brake 18 coupled to the supply reel keeps the web taut when the wrap roller is positioned at either the home position shown in FIG. 2 or the apex position shown in FIG. 4.

If the thermo roller is heated (versus cooled), the temperature of the web is raised when roller 41 is at the home position. The web temperature is lowered by the ambient air when the wrap roller is located at the apex position. The surface contact can be varied between the two extremes by locating the wrap roller at intermediate positions such as illustrated in FIG. 3.

The angle theta is selected for the needs of a particular system and may be varied from zero degrees to 180°. In the event that theta is zero degrees, the web is wrapped half way around the thermo roller and the radius of the wrap roller must be greater than the radius of the thermo roller to obtain complete separation between the web and thermo roller. The apex position in this case is at infinity. When theta is 180°, the contact between the web is substantially a line at the tangent point between the web and thermo roller. The wrap roller separates the two when positioned at the apex of angle theta, in this case the tangent point. Alternately, the wrap roller is positioned on the other side of the web. In this case, there is minimum surface contact when the wrap roller is at the apex or tangent point and the contact area is increased when the roller is moved to another position. Since the web is between the wrap and thermo roller, the wrap roller pulls the web into greater contact with the thermo roller when moved from the apex position.

Other variations and embodiments of this invention will be apparent to those skilled in the art from the present description and drawings.

What is claimed is:

1. A method of controlling the temperature of a heat sensitive web, including a migration imaging member comprising imaging particles and a softenable material, comprising

depositing electrostatic charge on said web and exposing said web to electromagnetic radiation in image configuration to create an electrical latent image which develops by imagewise migration of image particles as a result of the contact of said web with a thermo roller having a thermo energy source including means for heating the thermo roller, coupled to it;

wrapping said web about the thermo roller thus diverting the direction of the web;

supporting a wrap adjust roller for movement along at least a portion of circular path around the periphery of the thermo roller;

moving the said wrap adjust roller between at least two positions on said circular path for varying the surface area contact between the web and the thermo roller.

2. A method of controlling the temperature of a heat sensitive web, including a thermoplastic deformation member including a thermoplastic insulating layer and a photoconductive layer, comprising:

depositing electrostatic charge on said web and exposing said web to electromagnetic radiation in image configuration to create an electrical latent image which develops by imagewise deforming said insulating layer as a result of the contact of said web with a thermo roller having a thermo energy source, including means for heating the thermo roller;

wrapping said web about the thermo roller thus diverting the direction of the web;

supporting a wrap adjust roller for movement along at least a portion of a circular path around the periphery of the thermo roller;

moving said wrap adjust roller between at least two positions on said circular path for varying the surface area contact between the web and thermo roller.

3. Imaging apparatus comprising:

a. means for advancing a member comprising a web through a predetermined path;

b. charging means positioned along said path adapted to charge said member;

c. exposure means positioned along said path adapted to expose the member to an image configuration of electromagnetic radiation to create an electrical latent image in said member;

d. development means comprising a thermo roller positioned along said path adapted to have the member wrapped around a portion of its periphery to effect heat exchange between the member and said thermo roller;

e. a wrap adjust roller supported for movement along a circular path around the periphery of said thermo roller for varying the surface area contact between the member and said thermo roller.

4. Imaging apparatus comprising

supply and take up reels for supporting a heat developable imaging web,

an imaging roller positioned adjacent said web between the supply and take up reels for electrically coupling a potential source to a conductive substrate of said web,

a corotron for generating electrostatic charge for deposition onto said web as it passes the imaging roller,

exposure means for exposing a charged web to electromagnetic radiation,

a thermo roller positioned to have said web wrapped around a portion of its periphery for heating the web for image development and

a wrap adjust roller supported for movement along a circular path around the periphery of said thermo roller for varying the surface area contact between the web and thermo roller.

5. Apparatus according to claim 4 wherein said exposure means is adapted for exposing a charged web to an image configuration of electromagnetic radiation.

6. The apparatus of claim 4 further including position control means coupled to said wrap adjust roller for moving the wrap adjust roller between various positions along said circular path.

7. The apparatus of claim 6 wherein said position

control device includes switching means for moving said wrap adjust roller to a position causing contact between the web and thermo roller when the web is moving between the supply and take up reels and to a position for separating the web from the thermo roller when the web is at rest.

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