United States Patent [19]

Hakanson

[11] **3,710,755**

[45] **Jan. 16, 1973**

[54] WEB HANDLING APPARATUS

[75] Inventor: **Nils L. Hakanson,** West Springfield, Mass.

[73] Assignee: **The Plastic Coating Corporation,** Hampden County, Mass.

[22] Filed: **April 29, 1970**

[21] Appl. No.: **43,645**

Related U.S. Application Data

[62] Division of Ser. No. 785,993, Dec. 23, 1968, Pat. No. 3,606,123.

[52] **U.S. Cl.** **118/33,** 118/60, 118/65, 118/117, 118/423, 118/428

[51] **Int. Cl.**.....**B05c 11/12**

[58] **Field of Search**.....118/423, 420, 424, 425, 33, 118/34, 6; 95/89 R, 89 A, 94 R; 226/39, 11, 74–76, 108, 111, 86, 37, 195

[56] **References Cited**

UNITED STATES PATENTS

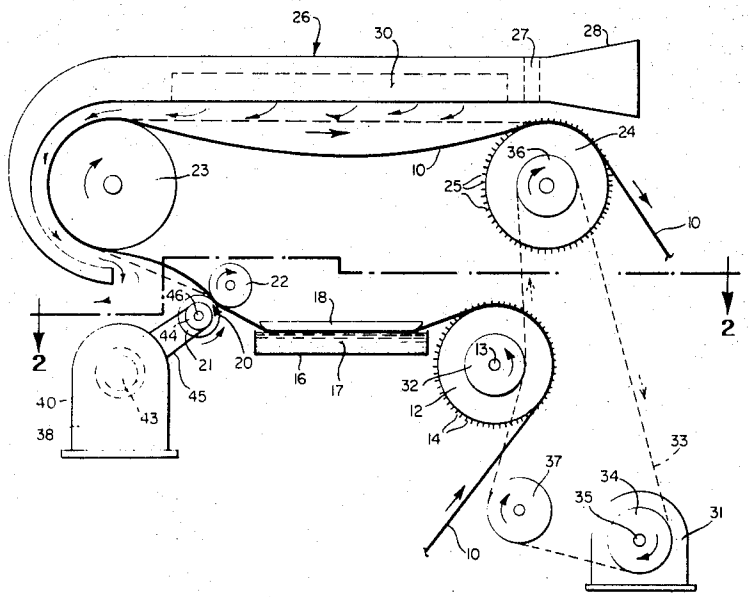
2,699,100	1/1955	Simjian	221/30 X
2,750,921	6/1956	Purdy	118/49 X
2,825,091	3/1958	Burley	118/405 X
2,945,429	7/1960	Grant, Jr.	95/94 R
2,948,209	8/1960	Neidle et al.	95/89 R
3,093,052	6/1963	Burner et al.	95/94 R
3,149,550	9/1964	Lohse et al.	95/89 R
3,263,460	8/1966	Kabelitz et al.	118/119 X
3,264,970	8/1966	Hersh et al.	95/94 R
3,331,301	7/1967	Dieffenbach et al.	95/89 R

Primary Examiner—Morris Kaplan
Attorney—William J. Foley and John W. Kane, Jr.

[57] **ABSTRACT**

Apparatus including a combination of elements enabling a continuous web to be sprocket fed into a pressure nip without creating wrinkles or causing tracking problems of the web, including two parallel spaced-apart moveable series of sprocket pins engaging the web and advancing it at a predetermined speed, two pressure rolls spaced-apart from the series of sprocket pins and forming a pressure nip through which the web passes following its disengagement from the sprocket pins, torque control drive means for driving at least one of the rolls, and speed control means connected to said series of sprocket means so as to maintain tension in the portion of the web running from the sprocket pins to the pressure nip.

12 Claims, 2 Drawing Figures



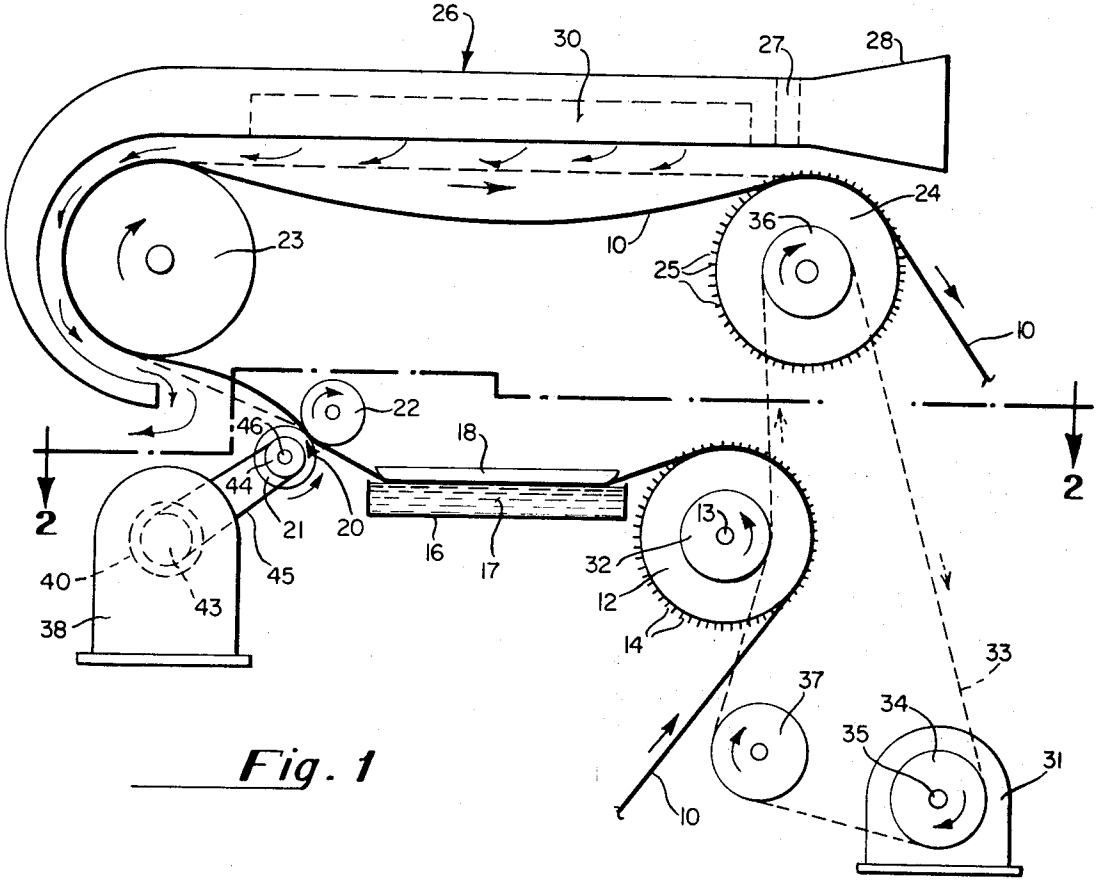


Fig. 1

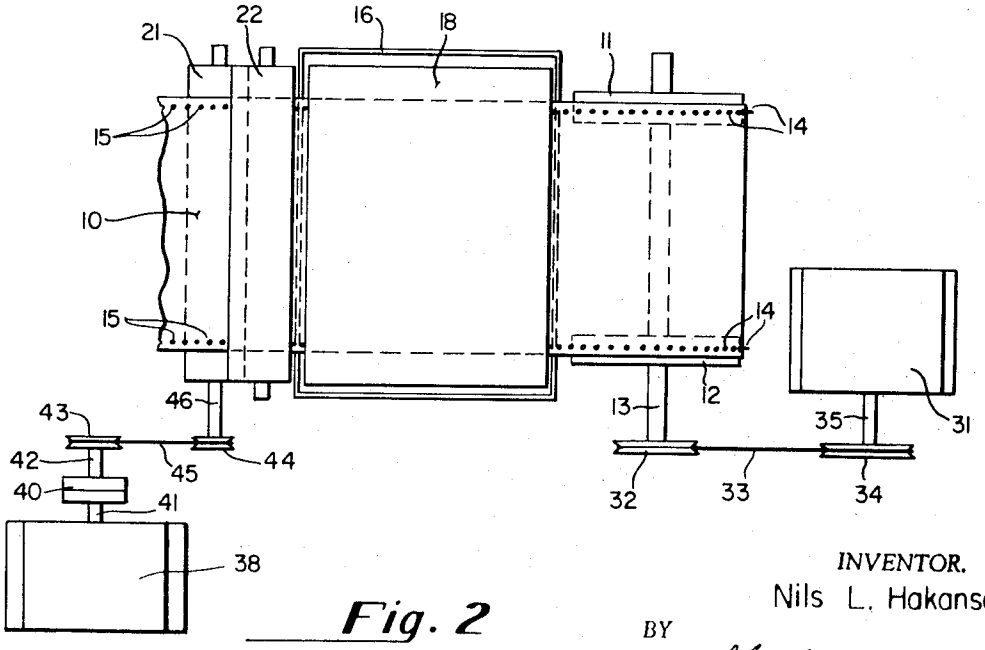


Fig. 2

INVENTOR.
Nils L. Hakanson

BY

Stanton T. Kelley
ATTORNEY.

WEB HANDLING APPARATUS

This application is a division of U.S. patent application, Ser. No. 785,993, filed Dec. 23, 1968, and now U.S. Pat. No. 3,606,123.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to web handling apparatus and, more particularly, to apparatus including a combination of elements enabling a continuous web to be sprocket fed into a pressure nip, such apparatus being particularly advantageous for use in high speed electrophotographic copying apparatus.

2. Brief Description of the Prior Art

In the past, continuous webs have been sprocket fed in many instances where the web was to be treated, handled or utilized in various ways. It is also well-known to pass a web through a pressure nip for purposes of treating the web in various ways, such as for calendering the web as in a papermaking operation or wiping or doctoring the web such as by squeegee rolls following a coating operation.

However, when sprocket feeding of the web is combined with treatment of the same web by a pressure nip where the sprocket fed web is passed through the pressure nip at substantial speed in a continuous operation, serious problems arise. These problems are generally of two types but they may well be related to one another. Thus the web received by the pressure nip and gripped in line contact transversely across it tends to wander off its straight course and becomes misaligned, that is, it fails to track accurately. This is believed to be due to the fact that the sprockets contacting each side edge do not feed the web at the precise same speed due to dimensional differences in the web and in the size and spacing of the sprocket holes therethrough. Attempts to correct this condition and to retrack the web by contact with the edges thereof tend to result in degradation of the edges of the web which is generally of a weak nature such as paper. Therefore, it is important to prevent this failure to track at the outset or to find another means for correcting it.

In addition, the web tends to be degraded in the pressure nip after some time, as by the formation of longitudinally aligned wrinkles in the web which generally are unsatisfactory in any process but are of particular disadvantage in an electro-photographic copying process where the web being fed through the nip comprises a recording element containing an electrostatic image thereon which is being developed to render it visible. Such wrinkles are believed to be caused by transverse forces in the web stemming from the misalignment or failure to track properly.

It is a principal objective of the present invention to provide apparatus including a combination of elements which enable a continuous web to be sprocket fed into a pressure nip without degradation of the web and without the formation of wrinkles or folds therein.

It is an additional object of the present invention to provide such apparatus including developer means adapted to apply liquid developer to the web which is a recording element having an electrostatic image thereon so as to render the electrostatic image visible, and wherein the pressure nip is utilized to remove excess liquid developer from the surface of the recording element.

SUMMARY OF THE INVENTION

The invention is a combination of apparatus which includes two parallel spaced-apart moveable series of pins. The pins in each series are uniformly spaced-apart from one another and are arranged so that their axes lie in the same plane. The pins are adapted to engage a continuous web which has holes disposed along each elongate side margin thereof and spaced inwardly therefrom. The holes are uniformly spaced apart from one another by a sufficient distance to enable successive holes in each respective side of the web to receive successive pins in each respective parallel spaced-apart movable series of pins, so that the web is advanced upon movement of the pins.

Speed control means are operably connected to the two series of pins and are adapted to regulate the movement of the pins and, correspondingly, the rate of advance of the web to a predetermined speed. Two rotatably mounted rolls are disposed in parallel contacting relationship at a position spaced from the two series of pins. The rolls are adapted to receive the web following its disengagement from the two series of pins and are arranged to form a pressure nip through which the web passes. Drive means are operably connected to at least one of the rotatably mounted rolls. The drive means are adapted to apply a torque to the roll sufficient to maintain tension in the portion of the web running from the rotatable means to the pressure nip.

In a preferred embodiment, the two series of pins are carried by rotatable means for movement about an axis, the pins projecting radially outward from the rotatable means. The rotatable means in one form comprise two spaced-apart sprocket wheels mounted for rotation about a common axis, and the pins comprise sprocket pins extending radially outward from the sprocket wheels. The drive means preferably comprise a drive motor operably connected to at least one of the rotatably mounted rolls through a torque control clutch, the torque control clutch being adapted to apply a predetermined amount of torque to the roll.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of a preferred form of apparatus of the invention showing some portions in section, and

FIG. 2 is a top view of a portion of the apparatus shown in FIG. 1 taken along line 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates one form of apparatus which utilizes the apparatus of the invention to advantage. Thus, the apparatus shown in FIG. 1 is adapted to develop a latent electrostatic image carried on one surface of a photoelectrostatic recording element, and includes means for applying a liquid developer to the surface of the recording element carrying the electrostatic image thereon so as to render that image visible. It also includes means to remove excess liquid developer from the surface of the recording element and means for drying the recording element. The apparatus of the invention is incorporated therein for the purpose of advancing the recording element through the developing apparatus and for maintaining a portion of the recording element in tension during development of the electrostatic image thereon.

Looking now at FIGS. 1 and 2, a recording element 10, which in other applications may be another type of web made of material such as paper, fabric, plastic or the like, is fed into engagement with a pair of axially spaced-apart sprocket wheels 11 and 12. The sprocket wheels 11 and 12 are mounted for rotation about an axis and are fixedly attached to a shaft 13. Each of the sprocket wheels 11 and 12 carries a row or series of pins or projections 14 thereon about the rotational axis of the shaft 13. The pins 14 are uniformly circumferentially spaced-apart from one another about each of the sprocket wheels 11 and 12 for a short distance depending to some extent upon the form of the recording element 10. Of course, the sprocket wheels 11 and 12 and shaft 13 might be replaced by a roll having two axially spaced-apart rows of pins corresponding in shape and position to those shown in FIGS. 1 and 2. A further alternative is belt or chain elements connected to wheels, which chain elements contain pins corresponding to those shown in FIG. 1. Regardless of whether the sprocket wheels and shaft, the belts, or a rotatable roll are utilized, a rotatable means is provided carrying pins 14 for revolution or movement about an axis.

The nature of the recording element 10 is more clearly shown in FIG. 2. The recording element 10 comprises a base sheet which is generally paper but which may also be fabric, plastic or the like, the base sheet having a photoconductive layer thereon which in most instances comprises a homogeneous mixture of a film-forming resin containing photo-conductor particles. The film-forming resin may be, for example, silicone resin, polyvinyl chloride resin, polyethylene, phenolic resins, polyester resin, methacrylate resin, polystyrene resin, styrenated alkyd resins, or vinylacetate-vinylchloride copolymer resin. The preferred photo-conductor is zinc oxide such as, for example, the photoconductive zinc oxide sold by the New Jersey Zinc Company as Florence Green Seal 8. The photo-conductor particles can be any known photoconductor such as the oxides of zinc, antimony, aluminum bismuth, cadmium, mercury, molybdenum and lead; the iodides, selenides, sulphides or tellurides of these metals; selenium, arsenic trisulfide, lead chromate and cadmium arsenide. It is also contemplated that various types of organic photo-conductors might be used. These materials have been recently developed and are well-known to those skilled in photo-sensitive resins.

The surface of the recording element 10 which is photoconductive is the surface containing the electrostatic image to be developed and will be referred to throughout this application as the "front surface." The opposite surface of the recording element will be referred to throughout this application as the "back surface."

The recording element 10 has a plurality of uniformly spaced openings or holes 15 extending through it along each of its longitudinal side margins. These openings or holes 15 are generally from about one-eighth inch to about one-fourth inch in diameter and are generally spaced inwardly from the side margins by a distance of from about one-fourth inch to about one-half inch. The holes 15 are spaced-apart along the recording element 10 by a distance of about three-fourths inch. These holes 13 permit the edges of the recording element to be engaged by the pins 14 on sprocket wheels 11 and 12 so that the element 10 can be swiftly and accurately moved through the handling and treatment apparatus shown in FIGS. 1 and 2. Obviously, the dimensions and spacing of these openings 15 may vary quite widely from one recording element to another depending on the feeding system utilized and the type of web being fed.

In any event, the recording element or web 10 is engaged on each side by insertion of successive pins 14 in successive holes 15, so that the speed of movement of the element or web 10 is controlled by pressure of the pins 14 against the edges of the holes 15. The pins 14 are of a height which permits them to engage the web 10 at one point and to disengage it at another point without tearing the web 10 in the process. The spacing of the pins 14 may be the same as the spacing of the holes 15 or may be equal to the spacing of some multiple of holes 15 so that, for example, only every other hole 15 in the series is penetrated by a pin 14.

Development of the electrostatic image on the front surface of the recording element 10 by the liquid developer may be accomplished in any one of a number of ways. However, in any event the liquid developer is applied to the recording element 10 in a manner such that the back surface of the recording element 10, that is, the surface not containing the electrostatic image, is not contacted to any substantial extent by the liquid developer. Thus the developer may be applied while the front surface of the recording element 10 is facing downwardly and while any perforations or holes 15 in the element 10 are closed by a backing surface against which the back surface of the recording element 10 is pressed by tension in the portion thereof exposed to the developer. Preferably, only the front surface of the recording element 10 is immersed in the liquid developer. Alternatively, the liquid developer might be sprayed onto the front surface of the recording element 10.

In the embodiment shown in FIG. 1, a tank 16 containing a supply of liquid developer 17 is disposed along the path of the recording element 10. A backing member 18 is disposed above the recording element 10 and is arranged to guide the recording element 10 over the tank 16 so that its lower surface, that is, its front surface containing the electrostatic image thereon, is immersed in the liquid developer 17 and coated with the liquid developer 17. Preferably tension is maintained in the stretch of the recording element 10 extending through the developing apparatus so as to press the back surface of the recording element 10 against the lower surface of the backing member 18. This is accomplished by the apparatus of the invention in a manner described below. This ensures that the back surface of the recording element 10 is firmly pressed against the lower surface of the backing member 18, thereby preventing wetting of this back surface with the liquid developer 17 due to flow around the sides thereof and through the holes 15.

The liquid developer 17 may comprise any one of the conventional types of toner materials utilized which generally comprise pigment particles carried in a carrier solution, each of the pigment particles being of a nature enabling it to receive a triboelectric charge thereon of a predetermined polarity so that it tends to

gravitate toward a charged image portion of the recording element **10** so as to develop that image and render it visible. Such liquid developers are well-known to those skilled in the art of photocopying processes of the electrostatic type.

In addition, as the recording element **10** emerges from the developing apparatus, it is fed through a squeegee nip **20** formed by two rotatably mounted rolls **21** and **22**. These rotatably mounted rolls **21** and **22** are disposed in parallel contacting relationship with one another and serve to remove excess liquid developer **17** from the lower or front surface of the recording element **10** as it passes through the squeegee nip **20** formed by the rolls **21** and **22**.

Following the squeegee rolls **21** and **22** the recording element **10** is entrained over a heated rotatably mounted roll **23**. In this manner, heat is transmitted through the back surface of the recording element **10** and serves to heat liquid developer **17** on the front surface thereof and to promote volatilization of volatile portions of the liquid developer **17**. The heated roll **23** may be heated electrically as by the resistance elements (not shown) beneath its surface or through the circulation of heated fluid such as steam therethrough. It is preferable that the heater roll **23** be mounted for free rotation but it may also be driven. In some instances it might be stationary with the recording element **10** sliding over it. After leaving the heated roll **23**, the recording element **10** is suspended over a short span and entrained over a subsequent pair of spaced apart sprocket wheels **24** having pins or projections **25** thereon, whereupon the drying of the liquid developer **17** is substantially complete and the recording element **10** or similar type web may be subsequently processed as by folding, stacking, severing, collating or any other desired process.

A drying hood, indicated generally by reference number **26**, is employed for circulating gas over the front surface of the recording element **10** during the time the recording element **10** is in contact with the heated roll **23** and is suspended between the heated roll **23** and the pins **25** on sprocket wheels **24**. The drying hood **26** is spaced in close relationship to the front surface of the recording element **10**, that is, from about one-half to about 4 inches from the front surface of the recording element **10**. Gas such as air at ambient temperature is fed into the downstream end of the hood **26** and is then emitted onto the front surface of the recording element **10** and generally directed along a flow path countercurrent to the direction of movement of the recording element **10** with a primary emission point being in the area between the end of the hood **26** adjacent the heated roll **23** and the squeegee rolls **21** and **22**. Of course, portions of the gas are emitted along the sides of the hood **26** between the hood **26** and the recording element **10**. The gases containing the volatile portions of the liquid developer **17** are collected in the apparatus and withdrawn from the apparatus through ducts (not shown).

The gases may enter the hood **26** under pressure or may be drawn into it as by a motor driven fan **27** positioned as shown at the inlet end **28** of the hood **26**. It is preferred that the gases be heated prior to their circulation over the front surface of the recording element **10**. This is conveniently accomplished by employing a plurality of heating means **30** such as electrical heating elements along the bottom of the hood **26** in the portion disposed over the suspended portion of the recording element **10**. In this manner, the gases entering the hood **26** are forced to pass these heating means **30** prior to being emitted into contact with the front surface of the recording element **10** and the heat contained in these gases further assists in the volatilizing of the volatile portions of the liquid developer. These heating means **30** also serve to radiate heat onto the front surface of the recording element **10**, thereby further assisting in the drying thereof.

In accordance with the invention, it has been found that tracking problems and degradation of a recording element **10**, passing through a squeegee nip **20** from sprocket wheels **11** and **12** which are connected to a means governing their speed, can be avoided if one of the squeegee rolls **21** and **22** is connected to a drive means for maintaining tension in the web **10** running from the sprocket wheels **11** and **12** to the squeegee nip **20**. The movement of the pins **14** carried on the sprocket wheels **11** and **12** is regulated and, correspondingly, regulates the rate of advance of the web at a predetermined speed.

This is accomplished in the embodiment shown by operably connecting a drive motor **31** to a pulley **32** on the end of the shaft **13** by means of a belt **33** running around a pulley **34** carried on the end of a shaft **35** connected to the motor **31**. The belt **33** also passes around a pulley **36** of the same diameter as the pulley **32** so as to drive the sprocket wheels **24** at the same speed of the sprocket wheels **11** and **12**. A guide roll **37** is employed for tensioning the belt **33**. The drive motor **31** may be arranged to operate at a predetermined speed which may be fixed or adjustable as desired.

Another drive motor **38** is operably connected to the roll **21** by means of a torque control clutch **40** connected to the motor shaft **41**, the shaft **42** extending from the opposite side of the torque control clutch **40** having a pulley wheel **43** rotatably connected to a pulley wheel **44** on the end of the shaft **46** of roll **21** by means of a belt **45**. The motor **38** serves to impart a biasing torque through the torque control clutch **40** to the roll **21** so as to impart substantially constant tension to the portion of the web **10** running from the sprocket wheels **11** and **12** to the pressure or squeegee nip **20** through the developer means.

With this arrangement, it has been found that any differential tensions existing momentarily in opposite sides of the recording element **10**, due perhaps to dimensional differences in the material comprising the web **10** or due to differences accumulated by manufacturing tolerances in the spacing of holes **15** along the sides thereof or due to other factors, are eliminated and that the web **10** runs true and in alignment through the pressure nip **20** without degradation thereof or wrinkles appearing therein. Thus, all of the materials from which web **10** is comprised tend to permit small dimensional changes under light tension, especially in the instance of paper. This is promoted, of course, by exposure of one surface of the web **10** to a liquid as by the toning of the front surface of the recording element **10** with liquid developer **17** in the tank **16**. It is a practical impossibility to prevent some differential tensions from occurring since changes in dimensions occur after crea-

tion of the holes **15** in the web **10**. In addition it is difficult to create the holes **15** on precisely uniform spacings. All of these small differences become accumulative in the manufacturing process and in the handling process over a period of time and, without compensation, cause serious problems.

Although the reasons for the success of the apparatus of the invention are not fully understood, it is believed that these tensions are eliminated by dimensional changes of the material comprising the recording element **10** itself in response to the tension applied to the recording element as it travels from the sprocket wheels **11** and **12** and the pressure nip **20**. It is believed that as the web **10** moves toward one end of the pressure nip **20** the tension in the side of the web **10** adjacent that end increases. The web **10** elongates slightly along that side in response to that increased tension, thereby equalizing the length of each side of the web **10** which must pass through the nip **20**. It is believed that this causes the web **10** to stay in alignment. The fact that it runs in alignment prevents transverse or lateral tensions from being created and thus prevents the formation of longitudinal folds or wrinkles in the web **10**. These lateral tensions, previously experienced when the recording element **10** was not tensioned, are believed to result from folding over or wrinkling of the web **10** when failure to track and resultant misalignment become quite pronounced. In high speed processing and web handling apparatus of the nature of that described, in which the web runs at a speed of up to 200 feet per minute or even higher, any slight problem or tendency for the web **10** to become misaligned becomes pronounced and intolerable over a very short period of time. The torque control clutch **40** may be any type of conventional form of torque control clutch in which the clutch has two engageable elements and can be adjusted to permit slip therebetween when a predetermined torque is applied through the clutch **40**. For example, the clutch **40** might be of the type manufactured under the trade name of Magtrol hysteresis clutch by Magtrol, Buffalo, N. Y.

From the above it can be seen that the invention provides apparatus including a combination of elements enabling a continuous web to be sprocket fed into a pressure nip without creating wrinkles or causing tracking problems. In that regard, the apparatus is highly advantageous for use in electrophotographic copying apparatus in which a continuous recording element containing a latent electrostatic image on one surface thereof is to be rapidly fed through a developing station and a drying station in which the latent electrostatic image is developed to render it visible and the recording element is dried to permit subsequent handling thereof.

From the above, it can be seen that many changes and modifications can be made in the apparatus described without departing from the spirit and scope of the invention, for example, various types of means for applying tension in the portion of the recording element **10** running from the sprocket wheels **11** and **12** to the pressure nip **20** might be provided. For example, the sprocket wheels **11** and **12** might be connected to a braking mechanism for applying a braking or drag torque thereto against which the drive motor **38** would operate. Such a device would of course be substituted for the belt **33** and the drive motor **31**. In addition, the recording element **10** might be pulled through the apparatus shown in FIG. **1** as by a drive connected to the sprocket wheels **24** in which the recording element **10** would then follow the dotted line path in tension rather than the solid line path indicated in FIG. **1**. Moreover, a torque motor may be substituted for both the drive motor **38** and torque control clutch **40** in order to supply the requisite tension control to the recording element **10**. In view of these and other possible changes and modifications, the invention is not intended to be limited to the particular embodiments described herein.

What is claimed is:

1. In combination, apparatus comprising:

two parallel spaced-apart movable series of pins, said pins in each series being uniformly spaced apart from one another and arranged so that their axes lie in the same plane, said pins being adapted to engage a continuous web comprising a recording element containing a latent electrostatic image on one surface thereof, said web having holes disposed along each side margin thereof and spaced inwardly from each side edge thereof, said holes being uniformly spaced-apart from one another by a sufficient distance to enable holes in each respective side of said web to receive successive pins in each respective parallel spaced-apart movable series of pins, whereby said web is advanced upon movement of said pins,

speed control means operably connected to said two series of pins and adapted to regulate the movement of said pins and, correspondingly, the rate of advance of said web to a predetermined speed,

two rotatably mounted rolls disposed in parallel contacting relationship at a position spaced from said two series of pins, said rolls being adapted to receive said web following its disengagement from said two series of pins and being arranged to form a pressure nip through which said web passes,

drive means operably connected to at least one of said rotatably mounted rolls, said drive means being adapted to apply a torque to said roll sufficient to maintain tension in the portion of said web running from said two series of pins to said pressure nip, and

developer means adapted to apply liquid developer to successive transverse portions of said one surface of said recording element moving in tension between said two series of pins and said pressure nip so as to render visible the latent electrostatic image thereon.

2. Apparatus according to claim **1**, wherein said developer means comprises a tank containing a supply of liquid developer and means for guiding said recording element over the tank in a manner such that only the lower surface of said recording element is immersed in said liquid developer.

3. Apparatus according to claim **1**, wherein said pressure rolls are adapted to remove excess liquid developer from the surface of said recording element.

4. Apparatus according to claim **1**, wherein said two series of pins are carried by rotatable means for movement about an axis, said pins projecting radially outward from said rotatable means.

5. Apparatus according to claim 4, wherein said rotatable means comprise a rotatably mounted roll.

6. Apparatus according to claim 4, wherein said rotatable means comprise two spaced-apart sprocket wheels mounted for rotation about a common axis, and said pins comprise sprocket pins extending radially outward from said sprocket wheels.

7. Apparatus according to claim 1, wherein said speed control means comprise braking means operably connected to said two series of pins and adapted to apply a controlled amount of drag to said two series of pins so as to counteract force imparted to said two series of pins by said drive means through the portion of said web which is maintained in tension.

8. Apparatus according to claim 1, wherein said speed control means comprise a constant speed drive motor operably connected to said two series of pins and adapted to move said two series of pins at a fixed predetermined speed.

9. Apparatus according to claim 1, wherein said drive means are adapted to apply a biasing torque to at least one of said rotatably mounted rolls so that a predetermined tension is maintained in the portion of said web running from said two series of pins to said pressure nip.

10. Apparatus according to claim 1, wherein said drive means comprise a drive motor operably connected to at least one of said rotatably mounted rolls through a torque control clutch, said torque control clutch being adapted to apply a predetermined amount of torque to said roll so that a predetermined tension is maintained in the portion of said web running from said two series of pins to said pressure nip.

11. Apparatus according to claim 1, including two additional parallel spaced-apart movable series of pins, disposed along the path of said continuous web following its emergence from said pressure nip, said series of pins being adapted to advance said web to a remote position.

12. Apparatus according to claim 11, wherein the pins in each of said two additional series of pins are uniformly spaced apart from one another and arranged so that their axes lie in the same plane, said pins being adapted to engage a continuous web, said web having holes disposed along each side margin thereof and spaced inwardly from each side edge thereof, said holes being uniformly spaced-apart from one another by a sufficient distance to enable successive holes in each respective side of said web to receive successive pins in each respective parallel spaced-apart movable series of pins, whereby said web is advanced upon movement of said pins.

* * * * *