

United States Patent

[11] 3,578,797

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3,256,002	6/1966	Hudson	263/3
3,374,769	3/1968	Carlson	263/3X
3,449,548	6/1969	Adamek et al.	263/6EX
3,452,181	6/1969	Stryjewski	263/6EX
3,464,680	9/1969	Nakamura et al.	263/3

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[54] **FUSING METHOD AND APPARATUS**
9 Claims, 3 Drawing Figs.

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 219/388, 263/6

[51] Int. Cl. **F27b 9/28**

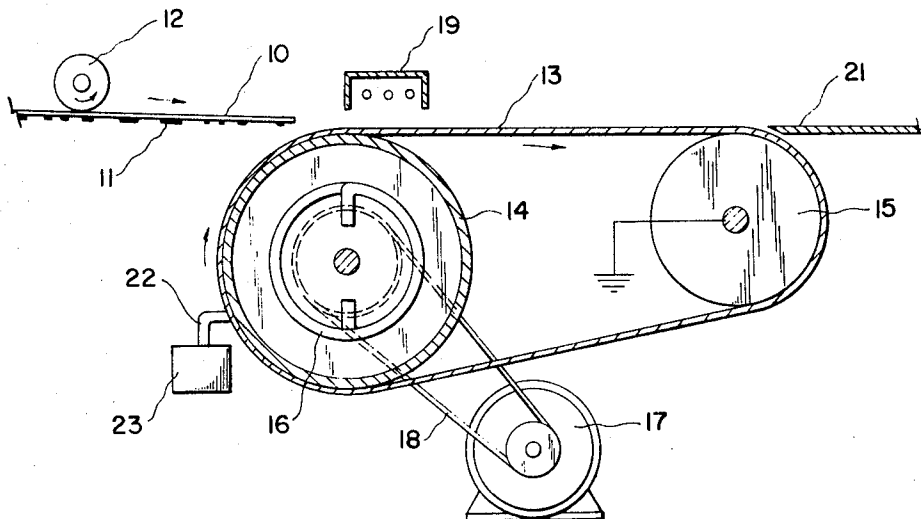
[50] Field of Search. 263/3, 6, 6
 (E); 219/216, 388

[56] **References Cited**

UNITED STATES PATENTS

2,701,765 2/1955 Codichini et al. 263/3

ABSTRACT: A toner image is fused to a receiver sheet without substantial heating of the sheet by placing the sheet, image side down, on an endless heat-conductive web extending around at least two spaced rotatable supports. One or more of these rotatable supports may include a heating element to heat the endless web at or adjacent to the point where the receiver sheet is brought into contact therewith. A corona charger may be used to tack the receiver to the endless web to assure positive contact therebetween.



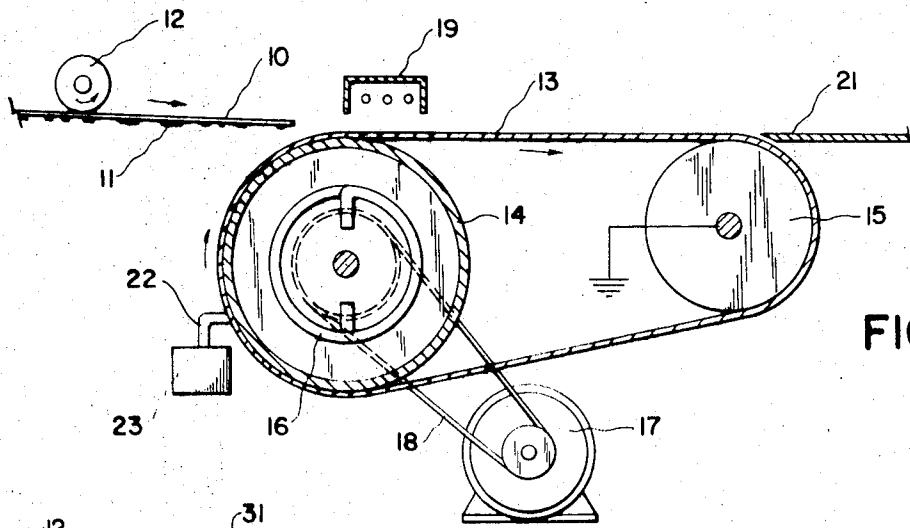


FIG. 1

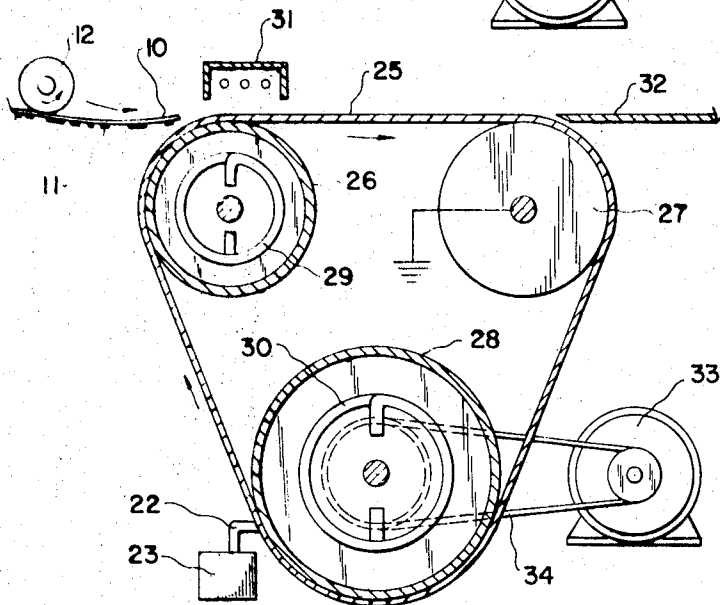


FIG. 2

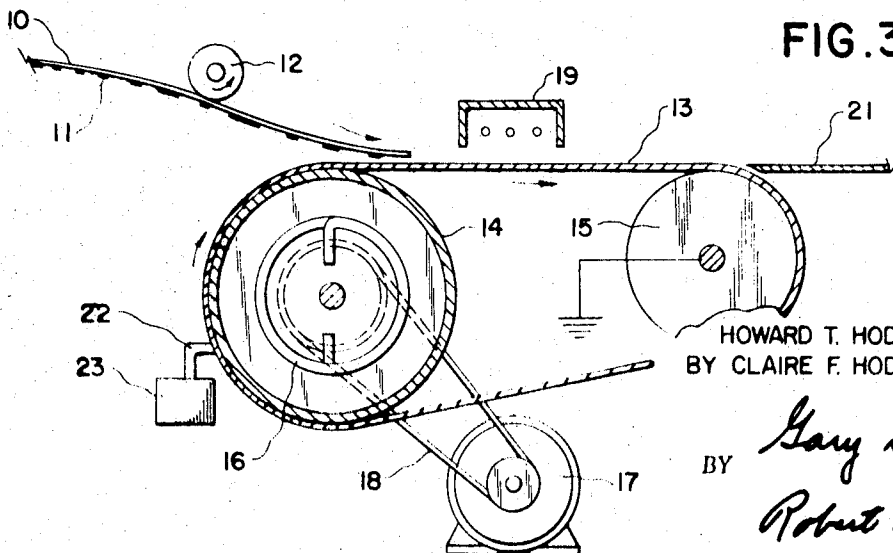


FIG. 3

HOWARD T. HODGES, DECEASED,
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FUSING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method and apparatus for fusing a toner image to a receiver and more particularly to a method and device wherein a heat-conductive web is used to provide a substantial time period over which the toner image is fused.

2. Description of the Prior Art

In a conventional electrophotographic process an electrostatic image is formed by exposing a photoconductive material to a pattern of radiation, and this electrostatic image is either developed on the photoconductive material, which serves as a receiver, or is transferred to a receiver after development. The toner image is then securely affixed to the receiver to form a permanent image. To accomplish this, the toner material is usually heated to its melting point so that it flows into the fibers of the receiver sheet and when the image is cooled, it is tightly bound to the receiver.

Various methods of fusing the toner have been suggested. The toner may be heated by an infrared heat source or it may be affixed to a receiver by passing the receiver through a pair of pressure rollers. Another way of fusing the image is to pass the receiver over a heated drum or roller. Also, pressure and heat may be applied simultaneously to a toner image to fuse it. Each of these prior art methods, have certain disadvantages. Either the power required to heat the toner to a sufficiently high temperature is excessive or the pressures required to cause fusing are very great. In the case of roller or pressure fusing, the nip between the rolls is necessarily small. Therefore, at high feed-through rates, very high roller temperatures are required because of the short contact time. Also, separation of the receiver from the roller must necessarily be made when the toner is at a low viscosity state since the contact time is so short. This can result in toner sticking to the roller and offsetting on subsequent portions of the receiver or on another receiver subsequently fed through the rollers. On the other hand, if the toner material is not heated sufficiently the image will not be properly fused.

SUMMARY OF THE INVENTION

In accordance with the present invention, an endless heat-conductive web is driven along a closed path. A receiver, bearing the toner image, is placed face down on the web at or adjacent to a source of heat which heats the conductive web. The web, in turn, heats the toner image to its melting point so that it is fused to the receiver. The image on the receiver remains in contact with the heat conductive web for a substantial period of time as the web moves along its path of travel. Since the receiver need not be heated clear through to melt the toner, the image is fused with less energy than would otherwise be required. Also, because the receiver remains in contact with the web for a substantial period of time, the toner, after melting, has a chance to cool, thereby reaching a relatively high viscosity so that the tendency of toner to stick to the belt when the receiver is stripped therefrom is lessened. Thus, offsetting of toner onto the web is lessened. Conveniently, an offset preventing material such as silicone oil may be applied, as by a wick means, to the web to further lessen offsetting onto the next receiver. Also, the receiver may be clamped or tacked to the web by applying an electrostatic charge to the back surface of the receiver so that the latter is electrostatically attracted to the web.

In one embodiment, the endless web extends around two spaced rotatable supports, one of which contains a heating element for heating the web. The receiver is fed with the image side toward the web so that it comes in contact with the web at the heat source. Spaced above the heat source is a corona discharge device for applying an electrostatic charge to the back of the receiver so that it is electrostatically attracted to the web. In another embodiment, the endless web extends around three rotatable supports providing a shorter path over which the receiver is in contact with the web, which

may be desirable for some space requirements. Also, because the fusing area is relatively short, it is necessary that the web be raised to the fusing temperature by the time the receiver contacts it. To assure this, the belt may be preheated by a second heating element. In a third embodiment the web extends around a pair of spaced rotatable supports and the receiver is fed into contact with the web downstream from the heat source where the web is not at its maximum temperature to prevent any possibility of igniting the receiver should the web stop moving, due to a malfunction, while the receiver is in contact therewith.

Additional novel features of this invention will become apparent from the description which follows, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatical side elevation, partly in section, showing a preferred embodiment of the invention wherein a receiver is brought into contact with a heat-conductive web at a heat source for the latter; and

FIG. 2 is a view, similar to FIG. 1, but showing another preferred embodiment of the invention in which the path of contact between the receiver and the web is relatively short; and

FIG. 3 is a third alternative embodiment wherein the receiver is brought into contact with the heat-conductive web downstream from the heat source.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A toner image is formed and placed on a receiver, such as by any conventional method known in electrophotography. In accordance with this invention, a receiver sheet 10, having a toner image 11 thereon, is fed by drive means, such as roller 12 face down so that image 11 will be brought into direct contact with an endless heat-conductive web 13 to fuse the image to the receiver. Web 13 extends around a pair of spaced, rotatably mounted rollers 14 and 15, as shown. Conveniently, roller 14 is made of a heat-conductive material and is provided with a heating element 16 therein which heats the roller 14 in turn heating heat conductive web 13. The web is driven, as by motor 17 through a belt 18. Because of the heat-conductive property of web 13, it serves as a heat source, having a decreasing temperature gradient in the direction of travel, for fusing a toner image to a receiver brought into contact therewith.

Advantageously, receiver 10 is brought into contact with web 13 directly above heating element 16 and may be tacked or clamped thereto by a corona discharge device 19 so that image 11 is held in intimate contact with web 13. Because rollers 14 and 15 are spaced apart a substantial distance, the receiver remains in contact with web 13 for a substantial period of time to assure that the toner image melts and fuses as completely as possible to the receiver. With the toner side toward the heated belt, only the toner and the surface of the receiver where the fusing action is needed is heated without requiring that the receiver be heated all the way through. This saves heat energy and allows faster feed-through than devices wherein the receiver is heated from the back side, since actual physical contact and low thermal conductivity of conventional receiver material normally would prevent or retard sufficient heating. However, in the present instance the low conductivity of the receiver becomes an asset because it tends to minimize heat transfer through the paper and retains heat at the image where it can be utilized. Also, the toner has sufficient time to flow into the fibers of the receiver and to cool so that as it is at a relatively high viscosity by the time it is stripped from belt 13 at roller 15, as by a stripper finger 21. Roller 15 may be grounded, as shown, to dissipate the electrostatic charge on the belt so that the receiver may more easily be stripped from the receiver. Although the only force serving to hold the receiver against the web is due to the electrostatic forces created by corona charger 19, the added contact time more

than compensates for this lack of pressure to absorb toner into the receiver material.

Since the belt is cooled by the sump effect of the receiver, a downward temperature gradient in the direction of belt travel exists on the belt between the rollers. Thus, after application of maximum heat at the input to the fusing device, toner flow time at reducing temperature is provided as the receiver progresses toward roller 15. This reducing temperature along the direction of travel provides higher toner viscosity at the strip point which results in an optimum toner-to-paper bond which provides cleaner stripping of toner from the belt. By adjustment of the distance between the rollers, the belt tightness and the heating arrangement, the temperature gradient can be controlled for optimum transfer taking into account the temperature versus viscosity characteristic of a preferred toner. Also, toner may be prevented from sticking to belt 13 by application of an offset-preventing material such as silicon oil applied as by means of a wick 22 from a supply 23.

An alternative embodiment is illustrated in FIG. 2 which finds utility where space requirements limit the amount of contact time. In this case, an endless heat-conductive web 25 extends around three spaced rollers 26, 27, and 28. Conveniently, rollers 26 and 28 are made of heat-conductive material and are provided with heating elements 29 and 30 respectively. Thus, the web may be preheated by roller 28 and brought to its optimum temperature by roller 26 just as receiver 10 is fed against web 25. Receiver 10 will be held against web 25 due to electrostatic forces created by corona-discharge element 31 with toner image 11 being fused to the receiver over the relatively short path between rollers 26 and 27 whereupon the receiver will be stripped from web 25 by stripper finger 32 at roller 27, which roller may be grounded. The endless web may be driven by a motor 33 through belt 34 extending to roller 28.

In the embodiment of FIG. 3, the elements are all arranged exactly as in FIG. 1 except that corona-discharge element 19 is moved downstream from roller 14 and receiver 10 is fed into contact with web 13 at a point downstream from roller 14. In this way, the ceiling temperature of the receiver is limited by the finite heat energy stored in web 13 as it passes roller 14. Thus, the temperature may be adjusted so that it is below the ignition temperature of the receiver at the point where the receiver comes in contact with the belt so that the receiver will not burn even if the web should stop with the paper in contact therewith due to a malfunction.

From the foregoing, the advantages of the present invention are readily apparent. A fusing device has been provided wherein a minimum amount of heat and pressure is required for fusing. This is accomplished by feeding a receiver with the image side against a heat-conductive web which heats only the toner and the portion of the receiver adjacent thereto thereby reducing the amount of energy necessary to fuse the image. In addition, because of the sump effect of the receiver, a downward temperature gradient exists, in the direction of web travel so that the toner reaches a relatively high viscosity level by the time the receiver is stripped from the web. This assures better fusing and reduces the possibility of offset of toner material onto the web. In an alternative embodiment a plurality of heat sources may be provided to assure that the web is at optimum temperature whereby a shorter fusing path may be provided. In a further alternative embodiment, the receiver is fed into contact with the web downstream from the heat source so that the receiver will not burn even if the web is stopped with the receiver in contact therewith.

Although the heating elements have been illustrated as being located in the rollers, it will be understood that heating of the web may be accomplished by any other methods as would occur to one skilled in the art. Also pressure rollers could be used in combination with a heated belt to insure fus-

ing.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

I claim:

1. A fusing device for heating a toner image to a fusing temperature on a receiver sheet, said device comprising:
 - an endless heat-conductive web movable along a path;
 - drive means for moving said web along said path;
 - at least one heat source means for heating said web to said fusing temperature;
 - means for stripping said receiver from said web at a point along said path downstream from said heat source means; and
 - means for feeding said toner image on said receiver sheet into contact with said web to fuse said image to said sheet, said receiver acting as a sump to cool said image to a relatively high viscosity before said receiver reaches said stripping means.
2. A fusing device, as claimed in claim 1, said device further comprising:
 - means for urging said receiver sheet against said web to provide intimate contact between said toner image and said web.
3. A fusing device, as claimed in claim 2, wherein said urging means includes:
 - a corona-discharge device for causing electrostatic attraction between said receiver and said web.
4. A fusing device, as claimed in claim 1, wherein said feeding means feeds said receiver sheet onto said web at said heat source means.
5. A fusing device, as claimed in claim 1, wherein said feeding means feeds said receiver sheet onto said web downstream from said heat source.
6. A fusing device, as claimed in claim 1, further including:
 - means for applying an offset-preventing material to said web to minimize offset of said toner image onto said web.
7. A fixing device, as claimed in claim 1, wherein said heat source means includes at least two heating elements spaced along said path for heating said web.
8. A fusing device for fixing a toner image to a receiver sheet, said device comprising:
 - an endless heat-conductive web movable along a path;
 - at least two spaced rotatable supports for said web;
 - drive means for moving said web along said path;
 - a heating element in at least one of said supports for heating said web, said web having a decreasing temperature gradient in the direction of movement of said web;
 - feed means for feeding said receiver sheet into intimate contact with said web with said toner image facing said web;
 - a corona discharge means for electrostatically urging said receiver sheet against said web to assure intimate contact between said toner image and said web, to melt said toner image so that it is fused to said receiver; and
 - means for stripping said receiver from said web after fusing, said receiver serving as a sump to cool said toner image after fusing so that it reaches a relatively high viscosity prior to stripping.
9. A method of fusing a toner image to a receiver comprising the steps of:
 - positioning said receiver with said toner image in direct contact with a source of heat having a temperature sufficient to cause said toner image to become a viscous fluid;
 - decreasing said temperature while said receiver is in contact with said source to increase the viscosity of said toner image so that it adheres to said receiver; and
 - separating said receiver from said heat source.