United States Patent [19]

Mooney et al.

[11] **3,748,088**

[45] **July 24, 1973**

[54] **FUSER CONTROL APPARATUS**

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[73] Assignee: **Xerox Corporation,** Stamford, Conn.

[22] Filed: **June 2, 1972**

[21] Appl. No.: **259,282**

[52] **U.S. Cl.** ..... **432/46,** 250/219 FR, 250/219 F, 432/62, 432/60, 432/227, 432/59, 432/45, 219/216

[51] **Int. Cl.** **G01p 3/00,** H05b 3/00

[58] **Field of Search** ..... 432/227, 45, 46, 432/43, 59, 60, 62, 227; 250/219 DR, 219 F, 65 ZE, 65 T; 219/216, 388; 34/1, 48; 118/5, 620, 637, 641, 642, 643

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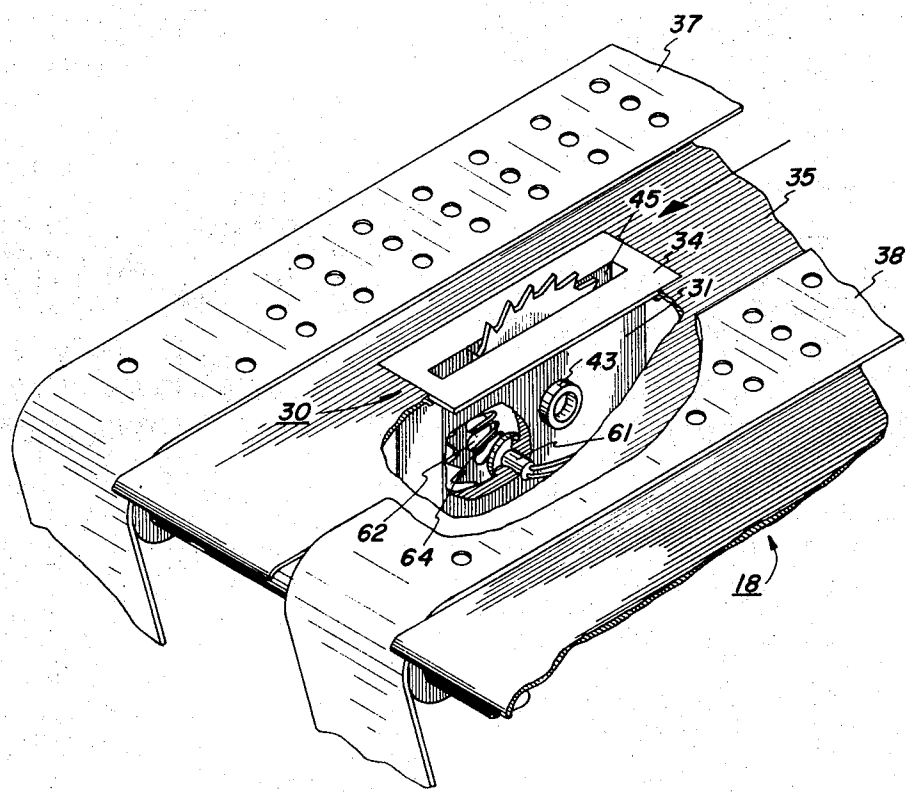
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[57] **ABSTRACT**

Apparatus is herein disclosed for detecting the occurrence of a hazardous condition within a xerographich heat fuser and, in response thereto, for taking appropriate action to prevent the combustion of a copy sheet from occurring within the fusing zone.

8 Claims, 4 Drawing Figures



2 Sheets-Sheet 1

FIG. 1

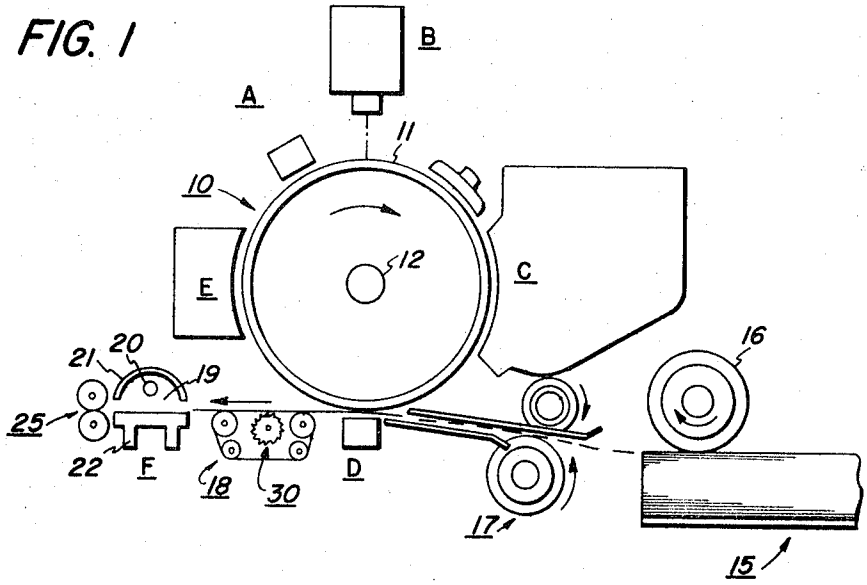


FIG. 2

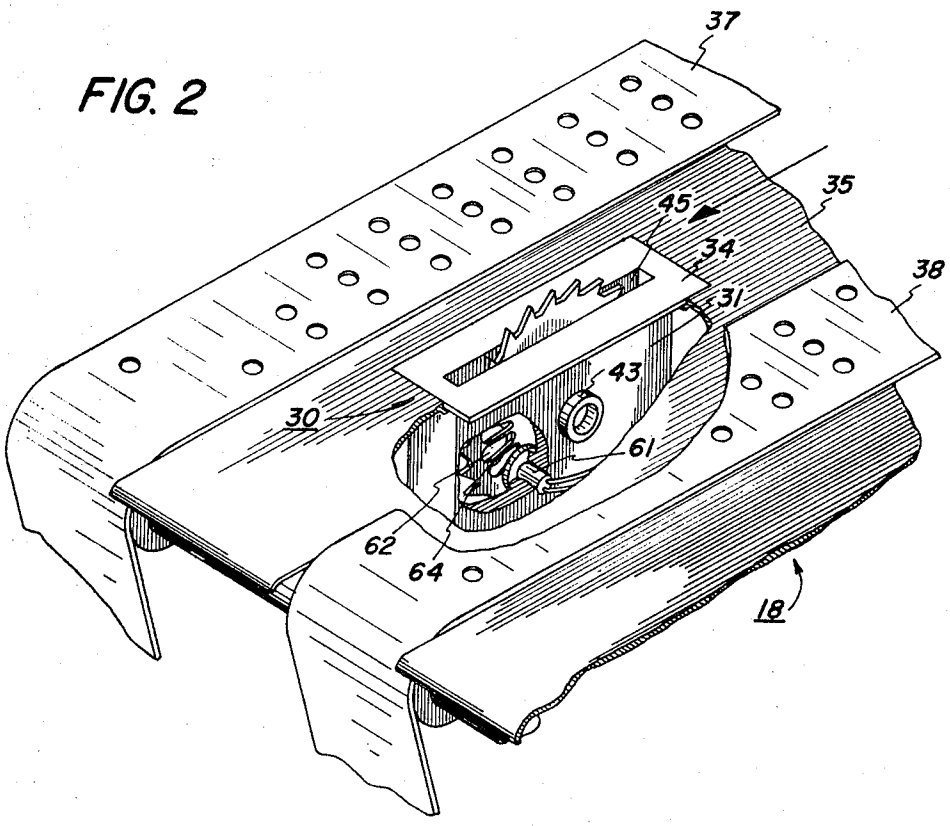


FIG. 3

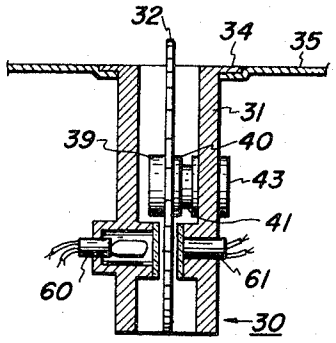
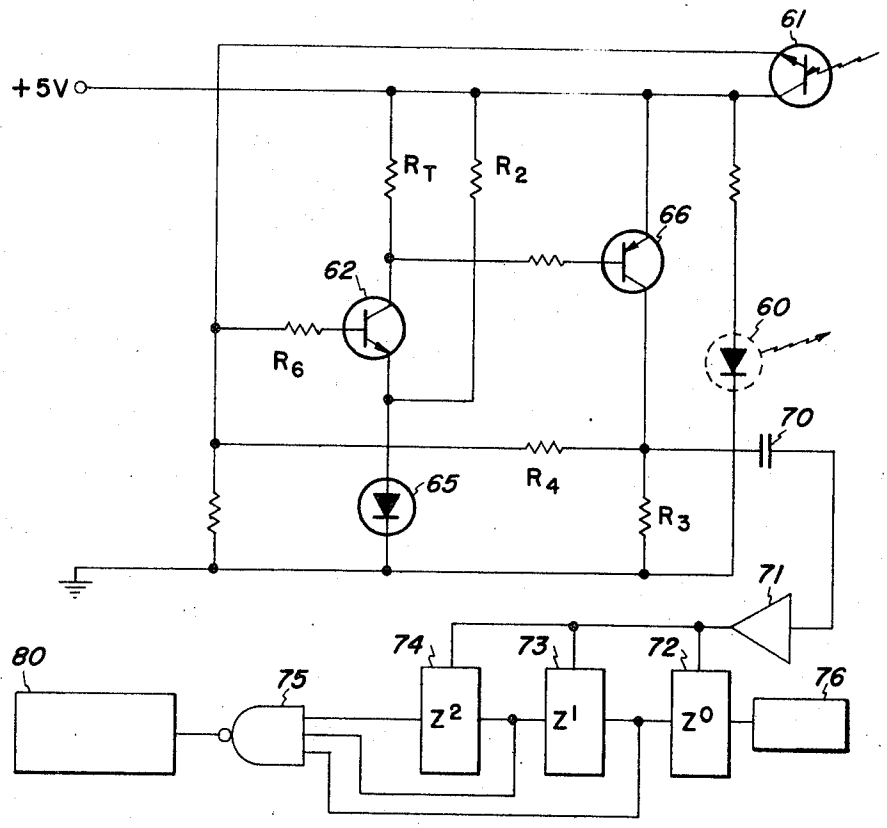

32
34
35
31
39
40
43
41
60
61
30

FIG. 4


61
+5V
R_T
R_2
66
62
60
R_6
70
65
R_4
R_3
71
80
75
74
73
72
76
Z^2
Z^1
Z^0

FUSER CONTROL APPARATUS

This invention relates to a sensor for monitoring the movement of a sheet of final support material, such as paper or the like and, in particular, to a sheet sensor for monitoring the rate at which a final support sheet moves through a xerographic fusing device.

Conventionally, in the art of xerography, a copy of an original is produced by creating a heat fixable toner image of the original upon a sheet of final support material. The copy is then made permanent by heat fixing the toner image to the support material. The most prevalent support material processed in xerography is paper although many other materials, such as acetate or the like, can also be employed. Regardless of the support material involved, the copy sheet material is generally of a combustible nature and subject to being overheated if exposed to a source energy for any prolonged period of time. Overheating results in the copy sheet being disclosed and therefore unsuitable for its intended use and, in extreme cases, leads to fire. For obvious reasons, a fire can be especially hazardous in high speed machines having the capability of delivering a large amount of combustible material into the fusing zone in a short period of time. Early detection and immediate responsive action to this type of situation is essential in this type of high speed copier.

It is therefore an object of this invention to improve fire prevention apparatus in an automatic xerographic machine.

Another object of this invention is to prevent the damaging of a copy sheet during the xerographic heat fusing process.

A further object of this invention is to minimize the dangers of fire within a xerographic fusing system.

Yet another object of this invention is to provide a system capable of sensing a hazardous condition within a xerographic heat fuser and for taking appropriate action to prevent the occurrence of a fire within the fusing zone.

These and other objects of the present invention are attained by means of a sheet motion sensor positioned at the entrance to a xerographic heat fuser that is capable of detecting the velocity at which individual sheets of final support material are moving through the fuser and having the capability of taking preventative action when the velocity of the sheets in process falls at or below a predetermined rate to prevent a fire from occurring within the fusing zone.

For a better understanding of these and other objects of the present invention, reference is had to the following detailed description of the invention to be read in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic illustration of an automatic xerographic reproducing machine employing the fire preventing apparatus of the present invention;

FIG. 2 is a perspective view with portions broken away showing the sheet monitoring sensor employed in the automatic device illustrated in FIG. 1;

FIG. 3 is a sectional front view of the sensor illustrated in FIG. 2 showing the mechanical features of the present invention;

FIG. 4 is an electrical schematic diagram showing the circuitry for sensing a hazardous condition within the fusing zone and for taking appropriate action to prevent a fire from occurring therein.

Referring now to the drawings, there is shown for the purposes of explanation an automatic xerographic reproducing machine incorporating the improved fire prevention mechanism of the present invention. The copying machine illustrated in FIG. 1 employs an image recording drum like member **10**, the outer periphery of which is coated with a suitable photoconductive material **11** that is well known and used in the art for recording a latent electrostatic image of an original to be reproduced. The drum, which is suitably journaled within the machine frame by means of a shaft **12**, rotates in the direction indicated to bring the image retaining surface thereon past a plurality of xerographic processing stations. Suitable drive means (not shown) are provided to both power and coordinate the motion of the various cooperating machine components to produce a faithful rendition of the original input scene information which is subsequently recorded upon a sheet of final support material such as paper or the like.

Since the practice of xerography is well known in the art, the various processing stations for producing a copy of an original are herein represented in FIG. 1 as blocks A–E. At station A, an electrostatic charge is placed uniformly over the surface of the photoconductive drum preparatory to imaging. The charged drum is then moved through an exposure station B wherein a flowing light image of the original to be reproduced is created and used to illuminate the drum surface. As a result, the charge on the drum is selectively dissipated in the light exposed regions to record the original input scene information in the form of a latent electrostatic image. Next, in the direction of drum rotation, the image bearing plate surface is transported through a developing station C wherein the toner material is applied to the charged surface rendering the latent image visible. The developed image is then brought into contact with a sheet of final support material, such as paper or the like, within a transfer station D and the toner image transferred from the photoconductive plate surface to the contacting side of the support sheet. Finally, within a cleaning station E, the residual toner particles that remain behind on the drum surface after the transfer operation are removed thus placing the photoconductive plate in a condition to be once again reused in the recording process.

It is herein contemplated that the sheets of final support material processed in this automatic xerographic reproducing device will be stored within the machine by means of a removable paper cassette **15**. It is further contemplated that the automatic reproducing machine will have the capability of accepting and processing copying sheets of various lengths, the length of the copy sheet, of course, being dictated by the size of the original input scene information recorded on the photoconductive drum. In operation the individual sheets of support material are separated from the stack and forwarded into the transfer station in synchronous moving relationship with a developed image on the photoconductive drum surface by means of a pair of cooperating feed rollers **16** and a sheet registering device **17**.

Upon the completion of the transfer operation, the image bearing support sheet is forwarded into a radiant heat fusing station F via a conventional vacuum belt transport system **18**. The radiant fusing station basically consists of a radiant source energy, such as an infrared quartz lamp, mounted within a reflector **21**

which serves to focus the radiant energy towards a stationary platen **22** located within a fuser cavity **19.** The radiant lamp and the associated reflector extend transversely across the fusing cavity to span the intended path of travel of a copy sheet forwarded therethrough. In operation, the leading edge of a copy sheet being advanced along vacuum transport **18** is pushed through the fusing cavity in sliding contact with the upper surface of the platen **22** and guides the sheet into cooperating pinch rollers **25.** The peripheral speed of the pinch rollers is coordinated with that of the vacuum belt transport to prevent the sheet from buckling as it is being drawn over the platen surface. As the trailing edge of the copy sheet clears the vacuum transport, the sheet forwarding function is taken over by the pinch rollers which serve to pull the trailing edge of the sheet through the fuser and advance the fused copy into a storage tray (not shown).

Referring now more specifically to FIGS. **2** through **4** there is illustrated an electromechanical device for sensing the velocity of a copy sheet as the copy sheet moves through a xerographic fusing cavity and for taking fire preventative action when the sheet velocity approaches a danger level. The motion sensing apparatus, generally referenced **30,** is mounted within the vacuum transport system **18** (FIG. **1**) close to the entrance to the fusing station F. The sensing unit basically consists of a housing **31** and an encoder disc or motion sensing wheel **32.** As illustrated in FIG. **2,** the housing **31** is provided with an upper, horizontally extending, flange **34** which rests in contact with a stationary guide plate **35** describing a portion of the upper run of the vacuum transport system. The main body of the housing **31** extends downwardly from the horizontal flange **34** and is contained substantially within the transport system. The housing is mounted in a stationary position between two moving vacuum transport belts **37** and **38** whereby a sheet being forwarded into the fuser cavity by the belts will be caused to move in close proximity with the upper flange portion thereof.

The encoder disc **32** is supported between two hubs, **39** and **40** upon a shaft **41** and the shaft, in turn, journaled for rotation within the housing upon a bearing provided within bearing cap **43.** The encoder disc is arranged to freely rotate through the aperture **45** provided in the upper surface of the housing **31.** The outer periphery of the disc is provided with a saw tooth-like surface which, in operation, extends upwardly slightly beyond the surface of the moving vacuum transport belts **37** and **38.** As a result, the saw tooth surface is caused to ride in contact with a sheet of final support material being forwarded by the belt into the fuser cavity. Sufficient vacuum is pulled by the vacuum system to hold the copy sheet in friction driving contact with the disc so that the moving sheet translates a rotational motion to the disc that is proportional to the rate at which the sheet is moving into and through the fusing cavity **19.** That is, the angular velocity of rotation of the disc is indicative of the rate at which a copy sheet is moving into and/or through the xerographic fusing cavity.

The rotating disc is employed to encode the sheet motion by making and breaking an optical link established between two optically coupled elements **60, 61.** The resulting signal is then electrically differentiated to obtain a true velocity signal which is then compared to a predetermined theoretical paper velocity. Any significant negative aborations from a theoretical velocity will cause the radiant energy source as well as the moving machine components to be shut down thus preventing the sheets in process from being damaged and the unwanted deliverance of more sheets into the danger area.

The two optically coupled elements consist of a photoemitting diode **60** and a phototransducer **61.** The two elements are secured within the side walls of the housing **31** so that the photodiode can optically communicate with the phototransducer. As can be seen more clearly in FIGS. **2** and **3** the encoder disc **32** is positioned between the two optical elements so that as the wheel is driven in the direction indicated by a copy sheet tracking thereover, the disc is caused to rotate at some angular velocity through the optical link created between the two cooperating elements. A series of equally spaced uniform clear apertures **62** are formed in the wheel; the apertures passing through the two side faces of the disc. Each aperture is separated by uniform congruent spokes **64.** As the disc rotates, the optical link between the two cooperating elements is periodically made by the passage of an aperture and then broken by the passage of a spoke. The rate at which the link is periodically broken is thus indicative of the velocity of a sheet in process.

It is known that for any given support material there exists a certain fuser access period within which the sheet can safely remain within the fusing cavity. This access time, of course, can be controlled by regulating the rate at which the sheet is moved through the cavity. When the copy sheet rate falls below this predetermined velocity, as for example, upon the occurrence of a sheet jam or the like, there is, of course, the danger of the sheet being scorched or, even worse, ignited. The apparatus of the present invention has the capability of sensing a drop-off in the support material velocity and possesses the further capability of instituting appropriate safety measures long before a fire can occur.

As the motion sensing disc **32** is rotated by a copy sheet entering the fuser cavity, the radiation emitted by the light emitting diode **60** is periodically chopped by the spokes **64** of the disc. As a result, the phototransducer **61** is caused to conduct periodically, that is, only those periods of the light chopping cycle when the transducer is actually irradiated by the output of the photoemitting diode. When the phototransducer **61** goes conductive, the conduction of the phototransducer causes a voltage to be dropped across resistor R_7. As a result, a signal of about 3.5 volts is felt at the base of transistor **62** causing the transistor to conduct at this time.

A voltage reference device is electrically connected to the emitter side of transistor **62** and, in conjunction with resistor R_2, functions to set the threshold potential of the transistor at a level to reduce electrical noise sensitivity. The stabilized output of transistor **62** is applied to the base of a second transistor **66** which also conducts during those periods when the photodetector is irradiated. A current feedback network consisting of R_4, R_3 and R_6 provides positive hysteresis which prevents circuit oscillation during the conduction of transistor **66.**

Conduction of transistor **66** causes a voltage of about 5 volts to be developed over resistor R_3 which is applied to a capacitor **70.** The capacitor **70** and amplifier **71** combine to generate a discrete trigger pulse for each

light chopping cycle of the encoder disc. The amplified trigger signal is applied to the reset line of a register made up of three flip-flops **72, 73** and **74,** which are arranged to accept a 7-bit count.

As shown in FIG. **4,** the output of each flip-flop is applied to a NAND gate **75.** The register is periodically interrogated within a predetermined time period, and starts to accumulate bits from a 60 hertz source supplied by a real time clock **76.** Under normal operating conditions, that is, when a sheet of final support material is passing through the fuser at or above the prescribed paper feeding velocity, less than 7 bits of information is accepted by the register prior to the register being cleared. As a consequence, no shutdown signal is generated. On the other hand, when the velocity of the sheet in process falls below the predetermined rate, the register will acquire 7 bits of information and the NAND gate will decode a machine interrupt. As a consequence, the NAND gate causes a shutdown signal to be generated which is then forwarded to the machine control logic **80** telling the logic that a jam condition has occurred. In response to the jam signal, the logic system is programmed to immediately shut down the infrared source of radiation in the fuser and to shut down the other machine processing functions thereby substantially eliminating the danger of fire in the fuser and the danger of paper jams occurring throughout the various processing stations.

While this invention has been described with reference to the structure herein disclosed, it is not confined to the details as set forth and this application is intended to cover any modifications or changes that may come within the scope of the following claims.

What is claimed is:

1. Apparatus for sensing the velocity of a sheet of final support material during the heat fusing of a xerographic image thereto including:

transport means for moving the sheet past a source of heat energy at a predetermined velocity whereby the xerographic image on said sheet is fused and the sheet remains undamaged;

an encoder disk positioned at the sheet entrance to the fusing zone and being arranged to be rotated by contacting a sheet passing therethrough;

optical means operatively associated with said encoder disk for generating a signal indicative of the sensed sheet velocity;

means for comparing the sensed sheet velocity to said predetermined velocity; and

means responsive to said last mentioned means to inactivate said source of energy when said sensed sheet velocity falls below said predetermined velocity.

2. The apparatus of claim **1** wherein said means to compare the sheet rate to said predetermined rate consists of

electrical means for differentiating the encoded signal to obtain a true sheet velocity output, and

clock means for comparing the true sheet velocity signal with a predetermined output velocity signal.

3. The apparatus of claim **2** wherein said encoder disk has a serrated outer periphery and wherein said disk has a series of equally distant spaced apertures therein and a series of congruent opaque areas between said apertures, and wherein said optical means comprises cooperating optical elements positioned on either side of said disk so that opaque disk areas interrupt the optical communication between the elements to generate a periodic signal.

4. Apparatus for sensing the velocity of a sheet of final support material during the heat fusing of a xerographic image thereto including:

transport means for moving the sheet past a source of heat energy at a predetermined velocity whereby the xerographic image on said sheet is fused and the sheet remains undamaged;

means for sensing and encoding the velocity of the sheet as it moves through the fusing zone;

electrical means for differentiating the encoded signal to obtain a true sheet velocity signal;

clock means for comparing the true sheet velocity signal with a predetermined velocity signal; and

means responsive to said last mentioned means to inactivate said souce of energy when the true sheet velocity signal fals below said predetermined velocity signal.

5. The apparatus of claim **4** wherein said encoder disk has a serrated outer periphery, and wherein said disk has a series of equally distant spaced apertures therein and a series of congruent opaque areas between said apertures, and wherein said optical means comprises cooperating optical elements positioned on either side of said disk so that opaque disk areas interrupt the optical communication between the elements to generate a periodic signal.

6. Apparatus for preventing the destruction of a sheet of final support material during the heat fusing of a xerographic image thereto including:

a radiant source of energy arranged to concentrate its output within a fusing zone;

transport means for moving the image bearing sheet of final support material through said fusing zone in thermal communication with said energy source at a predetermined velocity sufficient to fix the images thereon and being insufficient to damage such support sheet;

an encoder disk positioned at the sheet entrance to the fusing zone and being arranged to be rotated by contacting a sheet passing therethrough;

optical means operatively associated with said encoder disk for generating a signal indicative of the sensed sheet velocity;

comparator means for comparing the sensed sheet velocity to said predetermined velocity; and

means responsive to said comparator means to inactivate the radiant source of energy when the true sheet velocity falls below said predetermined velocity.

7. The apparatus of claim **6** wherein said encoder disk has a serrated outer periphery, and wherein said disk has a series of equally distant spaced apertures therein and a series of congruent opaque areas between said apertures, and wherein said optical means comprises cooperating optical elements positioned on either side of said disk so that opaque disk areas interrupt the optical communication between the elements to generate a periodic signal.

8. The apparatus of claim **7** wherein said inactivation means is further operable to inactivate said transport means.

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