

[54] **COPYING METHOD AND APPARATUS
WITH MEANS TO EFFECT VISIBLE RAY
IMAGING AND INFRARED RAY
TRANSFIXING OR FUSING**

3,623,869 11/1971 Allard 250/316

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[22] Filed: **Jan. 2, 1974**

[21] Appl. No.: **430,279**

[52] U.S. Cl. **250/319; 250/316; 355/3 DD**

[51] Int. Cl.² **G03C 5/16**

[58] Field of Search 250/316, 317, 318, 319;
101/470, DIG. 13; 355/3 DD, 16, 110

[56] **References Cited**

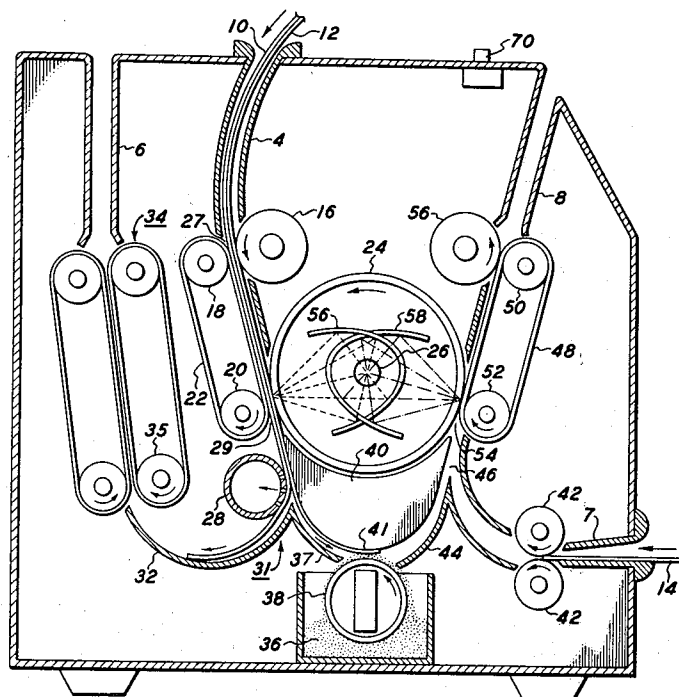
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[57] **ABSTRACT**

To improve the quality of the copies produced by a thermographic copier which relies on a tungsten lamp to thermally expose a heat sensitive member to an original which has some areas which absorb principally infra-red energy and others which absorb principally visible energy, a substantial portion of the infra-red energy emitted by the lamp is filtered out during the exposure process to thereby obtain a better balance between the infra-red energy and the visible energy. Toner particles containing materials which are absorptive in the infra-red and visible spectrums are then applied to the sheet sensitive member to develop the image, and the developed image is thereafter fused on the heat sensitive member or transfixed onto a separate copy sheet under the influence of radiation from the same lamp but at a higher infra-red energy level.

10 Claims, 2 Drawing Figures



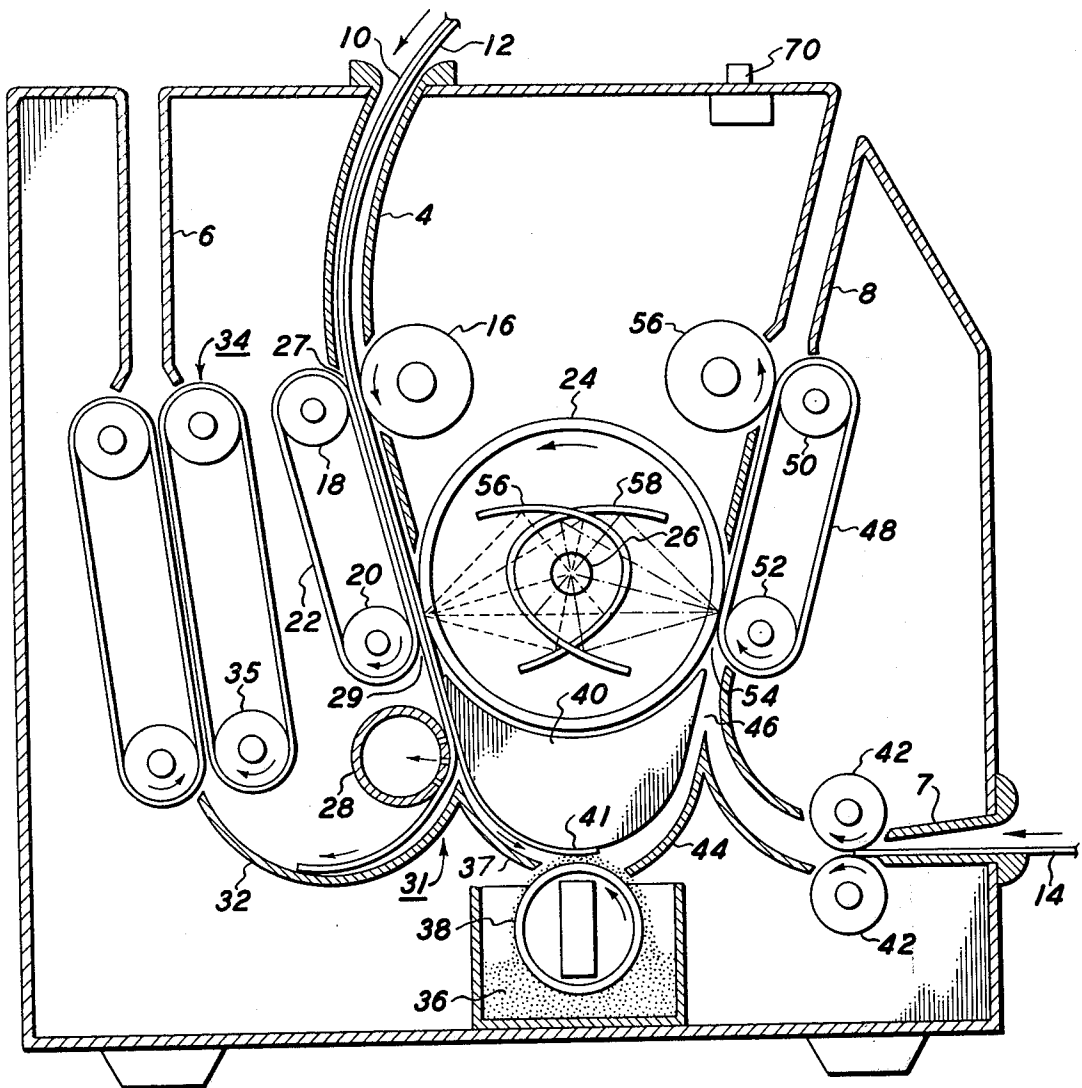


FIG. 1

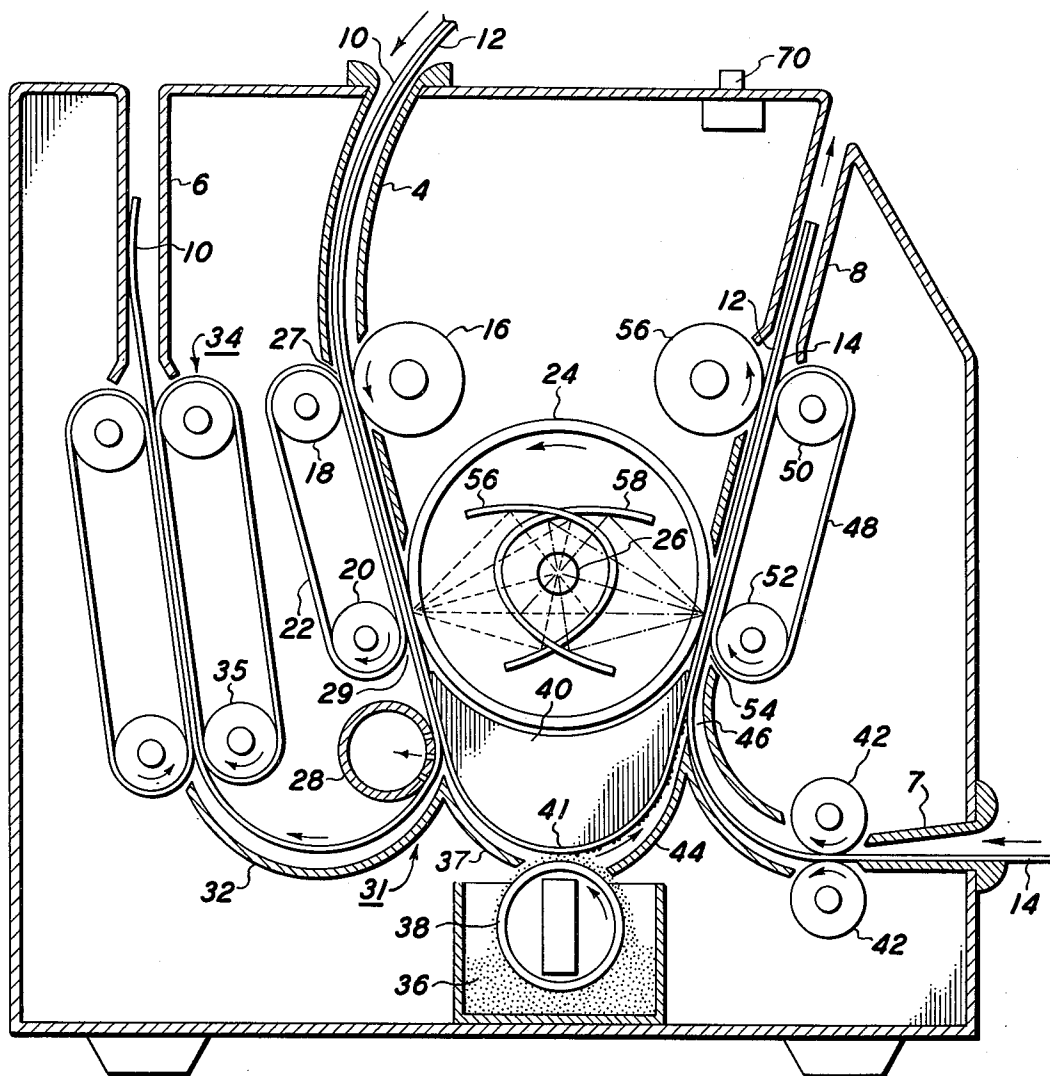


FIG. 2

COPYING METHOD AND APPARATUS WITH MEANS TO EFFECT VISIBLE RAY IMAGING AND INFRARED RAY TRANSFIXING OR FUSING

DESCRIPTION OF THE INVENTION

In most thermographic copying systems there is a tungsten lamp for heating an original member which is held in contact with a heat sensitive member thereby imparting a thermal image to the heat sensitive member. It has been found that such systems encounter problems in making copies of images which absorb mostly (at least 90 percent) in the visible spectrum when they appear on an original either alone or along with infra-red absorbing images. An example of such an image is a signed, typewritten letter wherein (1) the type is of infra-red absorbing carbon black while (2) the signature is written in an ink which principally absorbs radiation in the visible spectrum such as a black or blue ball point or felt pen. The root of the problem is that a tungsten lamp emits much more energy in the infra-red range than in the visible range. For instance, a tungsten lamp operating at 2,500° Kelvin has about 95 percent of its energy in the infra-red spectrum and about 5 percent of its energy in the visible spectrum. A tungsten lamp heated to 3300° Kelvin has about 85 percent of its energy in the infra-red spectrum and about 15 percent of its energy in the visible spectrum. Thus the amount of heat or energy absorbed by an infra-red absorbing image from the tungsten lamp will be much greater than that absorbed by a visible ray absorbing image. If the visible spectrum absorbing image absorbs sufficient energy for thermal imaging, then the infra-red absorbing image usually absorbs too much energy with the result that it overheats, thereby preceding a "ballooning" effect on the heat sensitive sheet. The term "ballooning" refers to a thermal image increasing in size due to excessive heat being transferred to the heat sensitive member. In short, ballooning results in distorted characters and in many cases even overlapping of characters. Similarly, if the original image absorbs visible energy but little, if any, infra-red energy then the background areas of the original may absorb sufficient infra-red energy to activate the heat sensitive member in the background areas, thereby causing a loss of definition between the image and background areas. But if a sufficient amount of infra-red energy is filtered out so the ratio of infra-red energy to visible energy emanating from the lamp is better balanced, the amount of heat absorbed by an infra-red absorbing image or background on an original as compared to an image absorbing mostly in the visible spectrum is also better balanced. For instance, the ratio of energy (infra-red and visible) can be reduced to the extent which will allow sufficient heat to be absorbed by the inks on an original which absorb mostly in the visible spectrum for reproduction thereof while still retaining sharp characters in the reproduction of the carbon black images on the same original and without the background absorbing an undue amount of infra-red energy. Thus, this will allow reproduction of a broader range of colored images on an original.

It is therefore an object of this invention to produce a thermal images from original images, which contain images absorbing mostly in the visible spectrum, by utilizing a tungsten lamp and filtering out a substantial part of the infra-red energy emanating therefrom

thereby achieving a more balanced ratio of infra-red energy to visible energy, whereby images absorbing mostly in the visible range will absorb enough energy to form a thermal image on the heat sensitive sheet, without any infra-red absorbing image becoming too hot to form a corresponding distorted heat image on the thermal sensitive sheet or the background areas of the original becoming too hot to melt the heat sensitive sheet in corresponding areas to affect the image definition.

Another object of the invention is to utilize a tungsten lamp in the aforementioned manner to reproduce thermal images from original images formed from non-carbon black or blue inks.

After a heat image is formed on the heat sensitive member, it is developed with infra-red and visible absorbing developer materials which will utilize the total available energy emanated by the tungsten lamp to either fuse the same to the heat sensitive material or to transfix (transfer and fuse) the same to a copy sheet.

It is a further object of this invention to utilize the same tungsten lamp for reproducing an original image by effecting a heat image thereof on a heat sensitive member utilizing a significantly reduced energy ratio of infra-red to visible and for fusing a developed image onto the heat sensitive member or effecting transfixing of a developed image from the heat sensitive member to a copy sheet utilizing a substantially increased amount of infra-red energy compared to the infra-red energy utilized during the imaging function.

Other objects of the invention will become apparent from the following description with reference to the drawing wherein:

FIG. 1 is a schematic view of a copying machine showing an original and a heat sensitive member passing through an imaging and transfixing or fusing station; and

FIG. 2 is a schematic view similar to FIG. 1 only showing a developed heat sensitive member and a copy medium being passed through the machine to effect transfer of the developed image to the copy medium.

Referring to the drawings, the copying apparatus therein has four sets of guide moldings 4, 6, 7 and 8, the outer ends of each opening into the outer surface of the copying apparatus. The molding 4 serves as an inlet guide for a sandwich of an original sheet 10 and a heat sensitive sheet 12. The molding 6 serves as an outlet guide for the original sheet 10, and the molding 7 serves as an inlet guide for a copy sheet 14. The mold 8 serves as an outlet guide for a sandwich of the heat sensitive sheet 12 and the copy sheet 14.

The heat sensitive sheet 12, which may be considered for practical purposed to be transparent to infra-red energy comprises a support and a heat sensitive coating. For example, the support may be paper or an organic film, such as a polyester film, cellulose acetate or triacetate film coated with a delayed tack adhesive which is normally hard and non-tacky at room temperature, but which, upon being activated by heat to a tacky condition and subsequently cooled to room temperature, thereafter remains tacky for considerable periods of time varying from at least 30 seconds to several days or more depending upon the particular composition involved. Such delayed tack coatings are well known and can be a mixture of discrete particles of resin, such as indene resin or esterified resin and discrete particles of crystalline plasticizer such as diphenyl or N-cyclohexyl

paratoluene sulfonamide. The particles are bound together into the supporting film by a binder, such as styrene-butadiene copolymer. Generally speaking, the crystalline plasticizer component of the mixture is in excess of the resin component.

An idler roll 16 and a conveyor mechanism comprising a drive roll 18, an idler roll 20 and a conveyor belt 22 are located at the inner end of the guide 10. A rotatably driven, radiation transparent, quartz cylinder 24 is arranged on the frame of the copying apparatus to rotate in opposite directions, and located within the cylinder 24 is a tungsten lamp 26. The idler roll 16 is arranged to contact the belt 22 to provide a nip 27 therebetween for receiving and forwarding the sandwich of the original sheet 10 and the heat sensitive sheet 12. The cylinder 24 is arranged to contact the belt 22 at the idler roll 20 to form a nip 29 whereby a slight pressure between the cylinder 24 and the roll 20 is created to effect a slight pressure on a sandwich passing therebetween. Located downstream of the idler roll 20 is a vacuum source 28 which serves to separate the original from the heat sensitive member. A guide member 31 has a portion 32 located and shaped to guide the original sheet 10 to a conveyor mechanism 34, driven by a drive roll 35, which grabs the original sheet and conveys the original sheet through the guide 6 out of the machine.

A portion 37 of the member 31 directs the heat sensitive member to a developer station which comprises a housing containing ferromagnetic toner particles 36 and a magnetic brush 38.

The toner particles comprise thermoplastic particles pigmented with carbon black or other infra-red absorbing dyes or pigments and mixed with iron oxide particles. Preferably, the toner particles will absorb both in the infra-red and visible spectrums. The magnetic developer brush 38 is rotatably mounted on the housing and is so located to have a portion thereof rotatable through the toner particles 36 and another portion in engagement with the heat sensitive member 12 to develop the same. A guide member 40 is located opposite the magnetic developer brush 38 and has a portion 41 spaced from the outer surface of the developer brush 38 approximately a distance corresponding to the thickness of the heat sensitive member 12 to ensure engagement of the toner particles 36 with the heat sensitive member to develop the image thereon as the heat sensitive member passes the developer station.

Located within the copy guide 7 are a pair of nip rolls 42 which are located to grip the leading edge of the copy sheet 14 upon insertion thereof into the guide 7. Also, there is a guide 44 positioned to direct the developed heat sensitive sheet 12 and the copy sheet 14 into a common passage 46 and to a conveyor mechanism comprising a belt 48 which is trained around a drive roll 50 and an idler roll 52. The cylinder 24 engages the belt 48 at the idler roll 52 to form a nip 54 therebetween into which the copy sheet 14 and the developed heat sensitive sheet are fed. At the proper time, the nip rolls 42 forward the copy sheet 14 into the common passage 46 where the leading edges of the heat sensitive sheet 12 and the copy sheet 14 become aligned and form a sandwich which is conveyed to the nip 54 between the cylinder 24 and the belt 48 past the lamp 26. An idler roll 56 engages the belt 48 at idler roll 50 and coacts with the belt 48 to move the copy sheet 14 and

the heat sensitive member 12 sandwich into the outlet guide molding 8 and out of the machine.

The lamp 26 is surrounded by a pair of filter-reflectors 56 and 58. The reflector 56 comprises a radiation transparent material such as quartz and is coated with an infra-red energy reflecting dichroic filter, and the reflector 58 comprises a radiation transparent material such as quartz and is coated with a visible energy reflecting dichroic filter. Such dichroic filters are well known and can be designed to perform a function depending upon the results desired as well as conditions involved to carry out this invention, the filter 56 should be designed so that it reflects substantially all visible energy while passing or filtering out sufficient infra-red energy to modify the ratio of infra-red energy to visible energy incident on the heat sensitive sheet 12 such that images absorbing mostly (at least 90 percent) in the visible range will absorb enough energy to form a corresponding heat image on the heat sensitive sheet without any infra-red absorbing image becoming so hot that the thermal image thereof on the heat sensitive is distorted and also without background areas of the original becoming so hot that background areas of the heat sensitive sheet are activated. It should be recognized that a given available ratio of infrared energy to visible energy can result in an energy absorption ratio of carbon black to non-carbon ink (black or blue) which is substantially lower than the energy absorption ratio of carbon black to other non-carbon inks. This means that a non-carbon black or blue ink can be copied much easier and produce much better copies than other non-carbon inks. This, however, would cover most originals with signatures since either blue or black ink is utilized for signatures. Obviously, the lamp must be emanating sufficient visible energy to effect a heat image by the mostly visible absorbing images. A tungsten lamp operating at 3,300° Kelvin is usually sufficient for imaging. As will be seen, the filter coated reflector 56 is shaped to focus the energy reflect thereby to the point of contact between the belt 22 and the cylinder 24.

The reflector 58, on the other hand, is shaped to focus the energy reflected therefrom toward the point of contact between the belt 48 and cylinder 2. The coating thereon preferably passes or filters out visible energy while reflecting substantially all of the infra-red energy.

A motor (not shown) is operably connected to drive the drive rolls 18, 35 and 50, the cylinder 24 and the magnetic brush 38. This same motor also is connected to a vacuum supply source providing vacuum to separator 28. A separate motor (not shown) is operably connected to the nip rolls 42 for driving the same. The motors are operated by a control (not shown) which operates the machine as follows:

Referring to FIG. 1, the heat sensitive sheet 12 and an original sheet 10, bearing an image absorbing mostly in the visible spectrum, together with another image for absorbing infra-red energy absorbing image thereon, are placed together and then inserted as a sandwich into the guide passage 4 and into the nip 27 between the rolls 16 and 18. A copy sheet 14 is inserted into guide 7 and into the nip formed by rolls 42. A switch 70 is actuated to start the control mechanism whereupon the conveyor belt 22 and the idler roll 16 grab the leading edge of the sandwich and move the same to the nip 27 between the cylinder 24 and the belt 22. At this time, the lamp 26 is energized and the sandwich is ex-

posed thereto as it travels therepast to create a tacky image on the heat sensitive member 12 corresponding to the image on the original sheet. The sandwich is moved downstream where the original and the heat sensitive sheet are separated by the vacuum source 28. The original 10 continues around the guide 32 to the conveyor mechanism 34 and out of the machine through the guide 6 while the heat sensitive member continues to the developer station whereby the magnetic brush 38 dusts the tacky image with toner particles 36 to develop the same.

Referring to FIG. 2, the developed heat sensitive sheet 12 continues beyond the developer station and onto the guide 44 whereupon the control system actuates the nip rolls 42 to bring the leading edges of the copy sheet 14 and the heat sensitive sheet 12 into aligned engagement to form a sandwich which enters the nip 54 and is moved past the lamp 26 by the belt 48 allowing the sandwich to be heated by infra-red radiation until a substantial portion of the toner particles become transfixed (transferred and fixed) to the copy sheet to provide a reproduction of the original image. This transfer occurs due to the pressure between the sheets effected by the pressure contact between the roll 52 and cylinder 24 combined with a corresponding proper temperature. The sandwich is driven out of the machine through the guide 8. The control system has a cam system which is turned off the motors and the lamp 26 after the trailing edge of the heat sensitive sheet, copy sheet sandwich is passed between the belt 48 and the idler roll 54. The operator of the machine then removes the sandwich from the machine and separates the copy sheet 14 from the heat sensitive sheet 12 to obtain his copy of the original.

Rather than transfer the developed image, the developed image may be fused onto the intermediate. In this instance, the belt 48 may comprise a material to which melted toner particles will not stick. Alternatively, a release sheet could be substituted for the copy sheet 14 with a heat sensitive sheet, release sheet sandwich being fed past the lamp 26. In this case, the release sheet will be of a material to which the toner particles will not stick.

Rather than inserting a copy sheet into a slot in the machine, an automatic paper feeder could be provided.

The control system and the components thereof for operating the machine in the manner described are all well known and well within the grasp of one having ordinary skill in the art and therefore have not been shown.

What is claimed is:

1. A method for using a radiant source which emits substantially more infra-red radiation than visible radiation in thermographically copying an original bearing an image which is principally absorbtive to visible radiation; said method comprising the steps of
 bringing said original into engagement with a heat sensitive member to form a sandwich,
 exposing said sandwich to radiation from said source to thermally impart said image to said heat sensitive member,

and filtering out a predetermined part of the infra-red radiation emitted from said source while exposing said sandwich, with said filtered out part being selected to prevent excessive heating of infra-red absorbtive areas of said original.

2. The method of claim 1 wherein at least 90 percent of the radiation absorbed by said image is visible radiation.

3. The method of claim 2 further comprising the steps of developing the image on the heat sensitive member with an infra-red absorbing material, and exposing the developed image to a substantially higher level of infra-red radiation from said source than was utilized while exposing said sandwich.

4. The method as recited in claim 3 wherein the developed image is fused to the heat sensitive sheet when exposed to said radiation.

5. The method as recited in claim 3 wherein the developed image is transferred from the heat sensitive sheet and fixed to a copy member when exposed to said radiation.

6. The method as recited in claim 3 wherein the exposure of a portion of the developed image to said radiation is simultaneous with the exposure of a trailing portion of said sandwich.

7. A thermographic copier comprising the combination of

a radiant source which emits substantially more infra-red radiation than visible radiation,

an imaging station, and

means including dichroic filter for focusing radiation from said source onto said imaging station, said filter being selected to prevent a predetermined part of the infra-red radiation emitted by said source from reaching said imaging station without materially attenuating the visible radiation.

8. The thermographic copier of claim 7 wherein said radiant source is a tungsten lamp.

9. A thermographic copier comprising the combination of

a radiant source which emits substantially more infra-red radiation than visible radiation,

an imaging station where images carried by an original are thermally imparted to a heat sensitive member,

a fixing station where developed images on said heat sensitive member are fused,

a first reflector having a dichroic filter-type surface coating for focusing radiation from said source to said imaging station while filtering out at least a part of the infra-red radiation, and

a second reflector having a different dichroic filter-type surface coating for focusing radiation from said source to said imaging station while filtering out at least a part of the visible radiation;

said first and second filters being positioned to surround said radiant source.

10. The thermographic copier of claim 9 wherein said source is a tungsten lamp.

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