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3,131,302

THERMOPRINTING BY PRE-HEATING ORIGINAL IMAGE

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FIG. 1

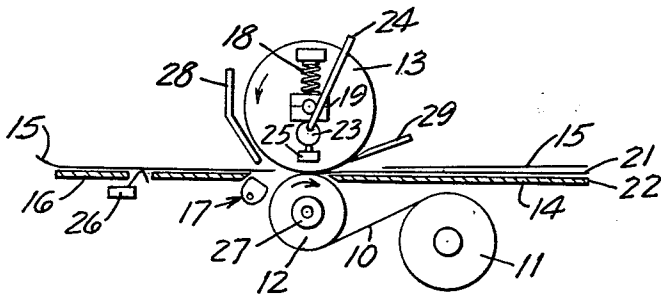


FIG. 2

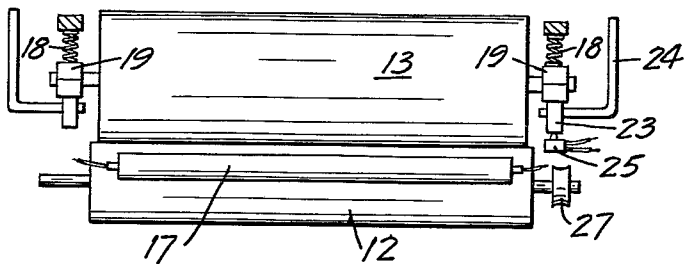
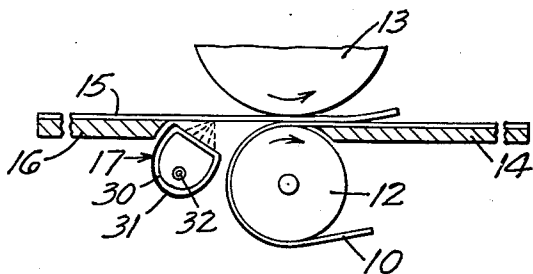


FIG. 3



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THERMOGRAPHIC BY PRE-HEATING ORIGINAL IMAGE

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This invention relates to the thermographic reproduction of differentially radiation-absorptive graphic originals, and in particular to apparatus and method useful in the front-printing of such originals on heat-sensitive copy-paper which may or may not be transmissive of the radiation employed.

In conventional thermographic front-printing procedures, the graphic original, which may be of printed or typewritten correspondence, pencil sketches or drawings, pages of printed books or magazines, printed forms, etc., is briefly irradiated with intense radiation applied through a radiation-transmissive heat-sensitive copy-sheet held in heat-conductive pressure-contact with the printed or other graphic surface of which a reproduction is desired. Front-printing makes possible the reproduction of originals printed on a wide variety of substrates, including heavy opaque paper or board as well as thin and comparatively readily heat-conductive substrates. However the front-printing processes as heretofore applied have been restricted to radiation-transmissive copy-papers.

The apparatus of the present invention permits the thermographic reproduction of differentially radiation-absorptive originals by a front-printing procedure on copy-paper which may or may not be transmissive of the radiation employed. A high unit pressure is provided at the area of pressure contact between copy-paper and original, thereby permitting the effective copying of excessively creased or folded originals. The copying operation is necessarily rapid, the copies being produced at a high rate of speed, and consequently is efficient and economical.

These and other advantages are obtained, in accordance with the principles of the present invention, by briefly applying intense radiant energy directly to the printed or equivalent surface of the graphic original, and then immediately pressing the irradiated surface into close heat-conductive contact with the heat-sensitive copy-sheet. It is found, surprisingly, that the heat-pattern imparted to the differentially radiation-absorptive original is of sufficient intensity and duration to cause a visible change to occur in the heat-sensitive layer pressed thereagainst while still causing no degradation of the original. The radiation does not contact the copy-paper, which therefore may be partially or completely opaque thereto.

In the accompanying drawing:

FIGURE 1 is a schematic representation of illustrative thermographic copying apparatus of the present invention shown in side elevation;

FIGURE 2 is a schematic representation of a front elevation of the same machine; and

FIGURE 3 illustrates in greater detail the general area of irradiation from FIGURE 1.

In making a reproduction of a printed original, heat-sensitive copy-paper 10 from a stock roll 11 is drawn around a drive roll 12 and beneath a driven pressure

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roll 13 to a supporting shelf 14. A graphic original 15 is moved along a supply table 16 and into the nip area between the two rolls 12 and 13. The printed surface of the graphic original 15 is toward the table 16. As the original 15 approaches the nip area it is irradiated on the printed surface by radiation from a lamp 17, the radiation being focused at the surface along a narrow path parallel to the axes of the two rolls. The irradiated portion of the original then promptly enters the nip between the rolls and comes into pressure-contact with the copy-paper 10, pressure being supplied by springs 18 pressing against journals 19 of roll 13. Alternatively, the roll 13 may be spring-supported out of contact with roll 12, being forced into pressure-contact by means of suitably positioned cams; but the structure illustrated permits passage of originals of different thicknesses at substantially constant pressure and is preferred.

After being thus copied, the graphic original 15 is recovered on the shelf 14, and the reproduction 21 is separated from the continuous stock of copy-paper 10, e.g. by tearing against a suitable cutting edge 22 on the shelf 14.

On completion of a copy, the roll 13 is raised out of contact with the roll 12 by means of cams 23 operated by lever arms 24, thus releasing the tension in the strip of copy-paper 10 and preventing further unwinding thereof from the stock roll 11. At the same time the lamp switch 25 is opened, thus extinguishing the lamp 17. These operations may be performed by hand, or may be accomplished by suitable automatic controls operated through a switch 26 which is actuated by the insertion of the graphic original 15. Suitable relays, time delay controls and the like will be understood to be included where necessary for automatic operation.

The drive roll 12 is driven through the pulley 27 or other suitable connecting linkage, by a motor, not shown, which may also suitably be automatically actuated on the closing of switch 26 or may be permitted to operate continuously while the machine is in use. Suitable fans or other control devices for limiting or controlling the ambient temperature within the machine may be included with the drive motor if desired. Speed control devices may also be included, to permit the operator to compensate for variations in lamp performance, printed original, or copy-paper.

A shield 28 and blade 29 are preferably provided to assist in guiding and in removing the graphic original, but are not essential and may be omitted. The extended free edge of the blade 29 may replace edge 22 as a cutting edge for removal of segments of the heat-printed copy. The shield 28 may form with the table 16 a feeding slot through which the original 15 is automatically fed by suitable fingers or rolls where automatic operation is preferred, thus to assure effective actuation of the switch 26.

In FIGURE 3 the lamp 17 is shown to consist of a transparent evacuated housing 30 having a truncated substantially elliptical cross-section, provided over the curved exterior with a reflective coating 31 and having an extended coiled filament 32 arranged along the enclosed focus of the ellipse. Radiation supplied by the lamp unit is concentrated on the printed surface of the graphic original 15 at the external focus of the ellipse and along a narrow path parallel to the axes of the rolls 12 and 13,

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as illustrated. Immediately after being thus irradiated, the original 15 is brought into heat-conductive pressure-contact with the copy-paper 10 between the opposing surfaces of rolls 12 and 13. With the high intensity radiation provided, and at the high speed of advance imparted to the composite of original and copy-paper by the drive roll 12, the heat from the irradiated absorptive image areas of the graphic original is effectively utilized in causing a visible change to occur within the heat-sensitive layer of the copy-paper so that a direct reproduction of the absorptive image areas is produced.

The roll 12 may be a metal roll, in which case the pressure roll 13 is preferably of soft rubbery material; or the compositions of the two rolls may be reversed, the pressure roll 13 being of metal or other rigid material and the drive roll 12 then being resiliently compressible. The former structure is preferred, since the surface of the drive roll at the nip between the rolls then remains fixed with respect to the position of the table 16 and shelf 14.

With the table 16 in the position shown in FIGURE 1, and as further illustrated in FIGURE 3, it will be observed that the graphic original 15 is freely suspended along the area of irradiation. Such a configuration provides maximum insulation against loss of heat from the irradiated surface, and is desirable with some radiation sources. Where radiation of sufficiently high intensity is available, the graphic original may be in direct contact with the surface of the roll 13 at the line of irradiation, the roll in such instances preferably being a heat-conductive metal roll. For such arrangement the surface of the roll 13 should preferably be highly polished and nonabsorptive of the radiation.

Control of ambient temperature within the apparatus may be accomplished by the use of fans or the like as already noted. In some instances, and particularly where the heat-sensitive copy-paper has a relatively high conversion temperature, improved copying conditions may be provided by maintaining one or both of the rolls 12 and 13 at a constant elevated temperature just below the reaction temperature of the copy-sheet, for example with suitably controlled internal electrical heating elements.

The pressure supplied through the roll 13 by the springs 18 is sufficient to cause significant deformation of the compressible roll. The pressure is also sufficient to ensure fully effective heat-conductive relationship between the graphic original 15 and the copy-paper 10 within the pressure area. Due to the narrowness of this area, the pressure is fully effective even though the original has previously been creased or folded, so that the creases or folds or other irregularities are in effect ironed out, and a smooth contact is maintained.

The release of pressure, by raising the roll 13 at the conclusion of the copying cycle, permits the continuously rotating drive roll 12 to slip against the surface of the copy-sheet in contact therewith and thus avoids the feeding of further quantities of copy-paper between copying cycles. Where necessary, suitable light braking action may be applied to the stock roll 11, by means not shown, further to prevent such wasteful feeding of the copy-paper. For the same reason, it is preferred that the drive roll 12 be constructed of polished metal or other smooth surface having a low frictional drag against the surface of the copy-paper.

The specific dimensions of the apparatus are not critical. For example, thermographic copying has successfully been accomplished in apparatus constructed generally as described in which the roll 12 was about one inch in diameter while the roll 13 was varied from about one inch to about three inches in diameter. The lamp 17, formed as described from a tube not more than about $\frac{3}{4}$ inch maximum cross-sectional dimension, provides a highly satisfactory concentration of radiation; but much larger lamp and reflector systems, up to maximum cross-sectional reflector dimensions of 4-5 inches, have likewise been shown to be useful although requiring additional

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shield members to minimize heating of components adjacent the irradiation zone. Lamps about 10 inches in length permit effective reproduction of the usual $8\frac{1}{2}$ inch width office correspondence, and may require about 1000-2000 watts to provide the necessary intensity of radiation.

What is claimed is as follows:

1. In a thermographic copying machine for reproducing a differentially radiation-absorptive imaged paper graphic original on a heat-sensitive copy-paper, the combination of: means for directly, briefly and intensely progressively irradiating the entire unobstructed imaged surface of said original to provide thereon a heat-pattern corresponding to the graphic pattern thereof; means for promptly thereafter placing said irradiated surface in contact with the surface of a visibly heat-sensitive copy-paper; and means for briefly pressing said surfaces together in mutually heat-conductive pressure-contact.
2. Apparatus suitable for use in the reproduction of differentially radiation-absorptive imaged paper graphic originals on visibly heat-sensitive copy-paper non-transmissive of said radiation by front-printing thermographic reproduction processes, said apparatus comprising a pair of pressure-rolls, means for rapidly passing said original and said copy-paper between said pressure-rolls in mutually heat-conductive pressure-contact, and means for briefly intensely and directly progressively irradiating the entire unobstructed imaged surface of said original immediately prior to said pressure-contact.
3. Apparatus suitable for use in the reproduction of differentially radiation-absorptive imaged paper graphic originals on heat-sensitive copy-paper non-transmissive of said radiation by front-printing thermographic reproduction processes, said apparatus comprising: a smooth-surfaced rigid drive roll; a resiliently compressible pressure roll; means for placing said pressure roll alternately into and out of aligned pressure-contact with said drive roll; a source of visibly heat-sensitive copy-paper in continuous strip form advancing under moderate tension around a portion of the periphery of said drive roll and between said drive roll and said pressure roll; guide means for directing said graphic original into the nip between said drive and pressure rolls and with its imaged surface in heat-conductive contact with said copy-paper, said guide means terminating short of said nip area; and focusing lamp means for irradiating the entire unobstructed imaged surface of said graphic original between said guide means and said nip area with high intensity radiation.
4. Apparatus suitable for use in the reproduction of differentially radiation-absorptive imaged paper graphic originals on heat-sensitive copy-paper non-transmissive of said radiation by front-printing thermographic reproduction processes, said apparatus comprising a pair of pressure-rolls, means for separately advancing said imaged original and said copy-paper into the nip area of said pressure-rolls and into mutual pressure-contact, lamp means for progressively briefly directly irradiating the unobstructed imaged side of said original just prior to said pressure-contact with high intensity radiation, means for separating said pressure-rolls on passage therebetween of said original, and switch means associated with said separating means for extinguishing said lamp means concurrently with separation of said rolls.
5. Method of making a thermographic reproduction of a differentially radiation-absorptive imaged paper graphic original comprising progressively briefly directly irradiating the unobstructed imaged side of said original with intense radiation to provide thereon a heat-pattern corresponding to the graphic pattern thereof, and then promptly placing the irradiated side of said original in mutually heat-conductive pressure-contact with a heat-sensitive copy-paper.
6. Method of making a thermographic reproduction of a differentially radiation-absorptive imaged paper graphic original which comprises progressively briefly directly

irradiating the unobstructed imaged side of said original with intense radiation to impart thereto a heat-pattern corresponding to the graphic pattern thereof, and then promptly advancing the irradiated original into mutually heat-conductive pressure-contact with a heat-sensitive copy-paper between rapidly rotating pressure-rolls.

7. The method of claim 6 in which at least the pressure-roll in contact with the heat-sensitive copy-paper is maintained at an elevated temperature slightly lower than the temperature at which the copy-paper is rapidly visibly changed.

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