

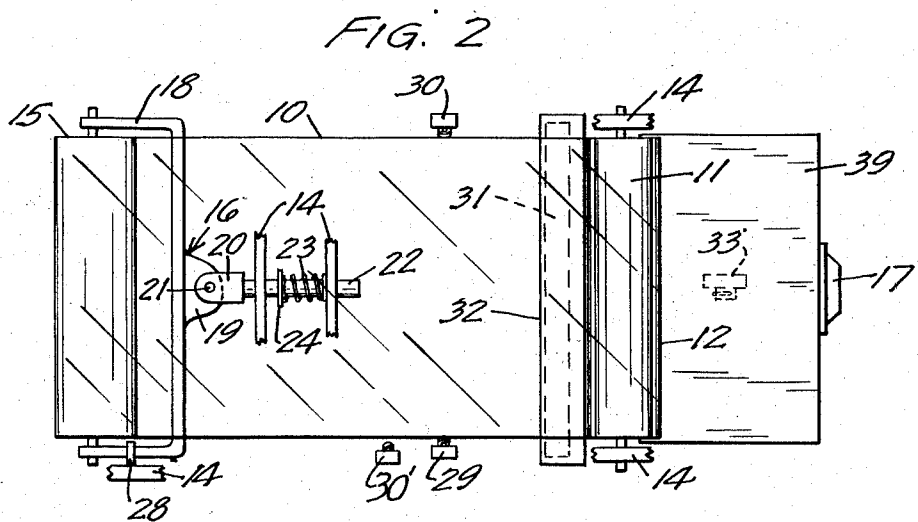
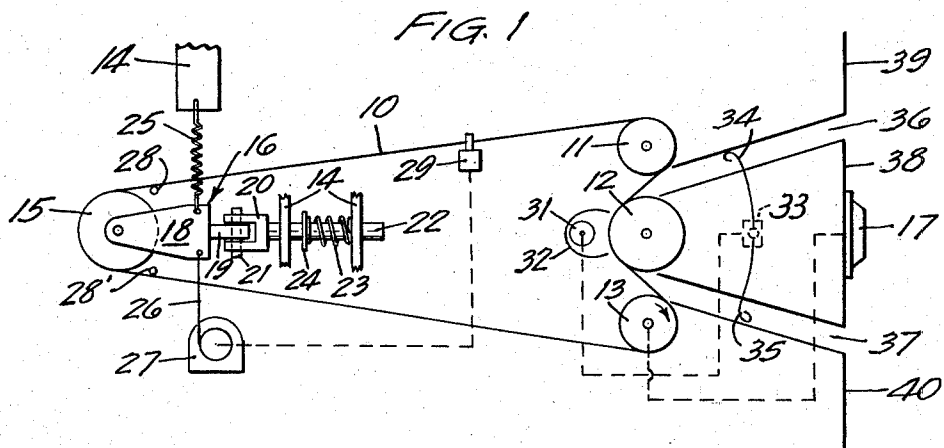
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2,891,165

THERMOCOPYING MACHINE

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1

2,891,165

THERMOCOPYING MACHINE

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This invention relates to the rapid automatic reproduction of graphic originals of the nature of printed or typewritten reports, correspondence, drawings, etc., and has particular reference to apparatus employed therein.

The reproduction of graphic originals by methods involving brief intense irradiation of the original while in heat-conductive pressure-contact with a heat-sensitive copying-paper has been described in Miller application Serial No. 747,338, now Patent No. 2,740,896. Effective apparatus for carrying out such methods is also described therein as well as in Miller application Serial No. 180,617, now Patent No. 2,740,895. The apparatus of the present invention provides for further improvement in the art of thermocopying, and in particular provides means for the rapid copying of graphic originals at high speed and in substantially completely automatic manner to produce copies of improved clarity and contrast.

Typical heat-sensitive copying-papers which have been found to be particularly useful in connection with the apparatus of the present invention have been described in Miller and Clark Patents Nos. 2,663,654-7.

The invention will now be described in terms of the appended drawing, in which:

Figure 1 is a schematic side elevation of a thermocopying device involving the principles of this invention; and

Figure 2 is a schematic plan view of the device of Figure 1.

The device of Figures 1 and 2 includes a flexible carrier belt 10 supported on a series of revolving drums 11, 12, 13, directly supported by the frame 14, and a fourth drum 15, adjustably mounted in a support 16 which is also supported by the frame 14. The lower drum 13 is driven by propulsion means, not shown, which is controllable through control dial 17 as indicated schematically in Figure 1.

The adjustable support 16 for the drum 15 consists of a main clevis 18 having a tongue 19 fitting within a smaller clevis 20 and held in place by a pin 21 acting as a center of rotation for the main clevis 18 carrying the drum 15. The smaller clevis 20 is supported on a shaft 22 rotatably and slidably mounted on the frame 14 and urged in the direction of the drum 15 by means of a compression spring 23 disposed between an element of the frame 14 and a stop 24 affixed to the shaft 22.

To one end of the main clevis 18 there is attached a tension spring 25, affixed at its other end to the frame 14, and a cord 26, the other end of which attaches to the pulley of a constant-torque motor 27, all as indicated in Figure 1. For convenience, the spring, cord, and motor are omitted from Figure 2. A pair of stops 28, 28', mounted on the frame 14 limit the movement of the end member of the clevis 18. Switch 29 is positioned adjacent the edge of the flexible belt 10 and controls the operation of the motor 27, as indicated schematically in Figure 1. Switches 30 and 30' are limiting switches

2

for stopping the machine in the event the belt 10 becomes jammed or out of control.

A tubular line-filament lamp 31 disposed within an open elliptical reflector 32 is located parallel to the central drum 12, with the open face of the reflector closely adjacent the surface of the drum. The filament of the lamp 31 is located along one of the focal lines of the elliptically cross-sectioned reflector, the position of the other focal line falling just in front of the surface of the drum 12. The lamp is actuated by a switch 33, as indicated schematically in Figure 1. Contact levers 34 and 35, attached to the switch 33, cross an entrance channel 36 and an exit channel 37 respectively, the channels being formed between frame members 38, 39 and 40 as indicated.

The operation of the device is as follows:

With the roller 13 actuated and the belt 10 in motion, the printed or typewritten page of which a copy is desired is placed in contact with a suitable heat-sensitive copying-paper and the composite is fed into the machine through the entrance channel 36. Contact of the sheet material with the contact lever 34 actuates the switch 33 and the lamp 31. It will be observed that the lamp is thus actuated and brought to full operating temperature before the sheet material reaches a position of irradiation. The sheets are drawn between the belt 10 and the drum 12 and in front of the lamp assembly, where they are strongly and briefly irradiated while being held firmly and smoothly together under pressure-contact. The sheets then pass out through channel 37, meanwhile contacting the contact lever 35 and thereby continuing actuation of the lamp 31 until the papers have passed completely beyond the point of exposure. The path of travel between contacts 34 and 35 is no greater than the length of the sheets fed through the machine. The composite of original and reproduction is removed from the exit channel 37 and the sheets then separated.

The radiant energy provided by the lamp 31 and concentrated at the surface of the composite of original and copying-paper by the reflector 32 is differentially absorbed at the printed surface of the original to provide a differential heat pattern corresponding to the printed message. This heat pattern then develops a reproduction of the original message in the heat-sensitive copying-paper with which it is in contact.

The heat-sensitive copying-paper may be placed in contact with the side of the printed original opposite that on which the printed message to be copied appears, and the printed surface is then faced toward the lamp 31. This "back-printing" process requires that the heat-pattern developed at the printed surface be transmitted through the paper of the printed original to reach the heat-sensitive copying-paper and there develop the copy. Hence the process is most effective with thin and rather highly heat-conductive originals, such as typewritten correspondence on office letterhead or other high grade moderate weight paper.

The printed original may alternatively be placed beneath the heat-sensitive copying-paper, with the printed surface in contact with the back surface of the latter. The composite is passed through the machine with the face side of the copying-paper toward the source of radiation. In this "front-printing" process the copying-paper must be capable of transmitting the radiation, which then is transmitted directly to the printed surface of the original where the heat-pattern is developed which results in the formation of a reproduction in the heat-sensitive copying-paper.

Variations between graphic originals, or between types of heat-sensitive copying-papers, or in ambient temperatures, or in line voltages, or other variations require that the rate of passage of the papers past the source of

irradiation be controllable. The machine is therefore equipped with speed control means, indicated in Figure 1 as a manual control member 17 through which the speed of the drive roll 13 and therefore of the belt 10 may be varied as required. Variation in the rate is necessary as the ambient temperature at the surface of roll 12 varies during continued or intermittent operation of the machine; but with any given type of copy and of copying-paper, and with a suitably designed source of radiant energy, the extent of the necessary variation may be minimized.

Control of the ambient temperature is also effected by the circulation of cooling air past the radiation assembly, by blower means not shown.

The belt 10 is maintained in its path around the several rollers by means here shown to comprise the adjustable mounting assembly 16 supporting the roller 15, in combination with intermittent adjusting means provided by the switch 29 and the motor 27 and spring 25. The switch alternatively actuates and deactuates the constant-torque motor 27 as the belt is urged from one side to the other. Actuation of the motor applies tension through cord 26 and, by rotating the assembly about the axis of the shaft 22, lowers the end of the clevis 18 against the stop 28', where it is maintained against the force of the spring 25 as long as actuation of the motor continues. The resulting tilting of the clevis 18 and therefore of the roll 15 causes the belt 10 to progress sideways against the direction of the tilt as it is drawn around the several rolls of the assembly. This action eventually deactuates the motor 27 and permits the spring 25 to tilt the clevis 18 in the reverse direction until the end of the clevis contacts the stop 28. The moving belt then progresses in the reverse direction, and the cycle is repeated.

Since the belt 10 is substantially inextensible under the tension provided, it is necessary that the roller 15 be capable of motion about the pivot 21 as it is tilted from side to side, in order that uniform tension from side to side of the belt 10 may be maintained and wrinkling be avoided. Tension is provided by the compression spring 23, as indicated in the drawing.

Limit switches 30 and 30' permit weaving by the belt within the limits indicated but are designed to shut off all power in the event the belt is pulled too far off course through some failure in, or abuse of, the machine.

Since the transparent belt 10 is itself strongly irradiated during the copying procedure, it must be substantially completely non-absorptive of the radiation employed. It must also be highly heat-resistant as well as resistant to stretching under the conditions existing in the machine. It has been found that continuous belts of polytetrafluoroethylene or similar inert polymeric materials are highly suitable for this application. Such belts are preferably formed by extrusion of the polymeric material in the form of a tube, from which segments may be removed in the form of the desired splice-free continuous belt. Open fabric such as silk boltingcloth is likewise useful but splice areas in belts made of such material provide discontinuities which cause irregularities in the copy, and the edges of such belts are likely to prove insufficiently rigid for continued effective activation of the control switches.

It will be appreciated from the foregoing that the success of the duplicating process as here described depends on the formation at the printed surface, and transmission to the heat-sensitive surface, of a heat-pattern at a temperature level sufficient to cause a visible change in the heat-sensitive copying-paper. Careful insulation of the composite of original and copying-paper so as to avoid all loss of heat from the composite has heretofore been thought to be essential in providing for successful reproduction of graphic originals by such processes. Surprisingly, it has now been found that the composite may in fact be held in close contact with a highly heat-conductive surface, such as the roller 12 when constructed of

polished steel or aluminum, during irradiation and copy formation, with the production of copies having even greater clarity and contrast than were previously obtainable. It is found, for example, that any slight darkening of background areas which might occur with the completely insulated composite is entirely eliminated. Apparently the heat-conductive metal roll may take up a sufficient quantity of heat from those areas to maintain the temperature of the copying-paper well below the point required to produce even the beginning of a color change. At the same time, the intense irradiation provides an abundance of heat at the heat-absorptive inked message areas, and causes a rise in temperature at such areas to a degree sufficient to provide complete visible change in the copying-paper. It is believed that the ink itself assists in this temperature rise by acting as a non-conductor of heat. But regardless of theory, observation has shown that improved reproductions are in many cases obtained by employing a heat-conductive roll 13 rather than a roll having a heat-insulated surface. However a roller having reduced heat conductivity, such as a plastic-covered or jacketed metal roller, is useful under some conditions.

With the system described, employing a metal roller 12, a radiation source capable of providing exceedingly high intensity radiant energy is required. A specific system which has been found useful includes a General Electric Co. "T-3" lamp. This energy source consists of a linear coiled filament supported on suitable spacers along the axis of a clear quartz tube having an external diameter of $\frac{3}{8}$ inch. The coiled filament is 0.042 inch in diameter and 10 inches in length, and draws 1350 watts at 280 volts to provide a color temperature of about 2800° K. The lamp is located with the filament at one focal point of the cross-section of an elliptical reflector having a major axis of 0.8436 inch and a minor axis of 0.7556 inch, and placed as shown in the drawing. There is provided an intensity of irradiation sufficient, in the apparatus described and with a copying-paper sensitive to temperatures in the neighborhood of 90–100° C., to provide a clear and distinct reproduction of an entire 11-inch typewritten sheet within as little as two seconds.

While other systems of belt guiding are known, the system employing a reciprocating universal mounting for a control drum as herein described and illustrated is found to have a number of advantages. Crowning of the rollers is avoided, hence the length of the belt may be constant across its entire width. The slight reciprocating side-to-side motion prevents localized wear on the belt such as might otherwise be caused by surface irregularities on the rollers. Exactitude of alignment of the several rollers is less critical than would otherwise be the case.

There is thus provided a thermocopying machine capable of rapidly and almost entirely automatically providing exceptionally clear and distinct thermocopies, on heat-sensitive copying-paper, of graphic originals such as typewritten manuscript.

What is claimed is as follows:

1. A thermocopying machine for the rapid automatic reproduction of graphic originals on heat-sensitive copying-paper by methods herein described, comprising, in combination: a source of intense radiation; heat-conductive means for advancing a composite of graphic original and heat-sensitive copying-paper under intimate pressure-contact past said source and comprising a roller member and a dimensionally stable heat-resistant continuous belt member having high transmissivity for said radiation; means for maintaining said belt in substantial alignment with said roller; means for controlling the rate of advance of said composite past said radiation source; and means for actuating said radiation source during passage of said composite past said source.

2. A thermocopying machine for the rapid automatic reproduction of graphic originals on heat-sensitive copying-paper by methods herein described, comprising, in combination: a line source of intense radiation; heat-con-

5

ductive means for advancing a composite of graphic original and heat-sensitive copying-paper under intimate pressure-contact past said source and comprising a heat-conductive metal roller member and a dimensionally stable heat-resistant continuous homogeneous belt member having high transmissivity for said radiation; means for maintaining said belt in substantial alignment with said roller; means for controlling the rate of advance of said composite past said radiation source; and means for actuating said radiation source during passage of said composite past said source.

3. In a thermocopying machine for making copies of improved clarity and contrast on heat-sensitive copying-paper from graphic originals having image areas highly absorptive of heat-producing radiation and background areas poorly absorptive of said radiation by a process involving irradiating said original with said radiation while in intimate heat-conductive pressure-contact with said heat-sensitive copying-paper as a composite, the improvement comprising, in combination, means for conducting heat from said composite during irradiation, and means for irradiating said original at sufficiently high intensity and for sufficiently short time to bring the areas of said copying-paper corresponding to said image areas to full copying temperature despite conduction of heat therefrom, while heating the remaining areas, corresponding to said background areas, to a degree insufficient, in view of the conduction of heat therefrom, to cause any observable visible change in said remaining areas.

4. A thermocopying machine as described in claim 1

6

and in which the heat-conductive advancing means comprises a smooth metal roller contacting one external surface of said composite and an inert fluorocarbon polymer continuous belt member contacting the other external surface of said composite.

5. The method of making copies of improved clarity and contrast on heat-sensitive copying-paper from graphic originals having image areas highly absorptive of heat-producing radiation and background areas poorly absorptive of said radiation, said method comprising assembling a composite of said copying-paper and said original in intimate heat-conductive pressure-contact in position for irradiation and with at least one surface of said composite in heat-conductive contact with means for conducting heat from said composite, and irradiating said original at sufficiently high intensity and for sufficiently short time to heat the areas of said copying-paper corresponding to said image areas to full copying temperature despite conduction of heat therefrom by said conducting means, while heating the remaining areas, corresponding to said background areas, to an extent insufficient, in view of the conduction of heat therefrom by said conducting means, to cause any observable visible change in said remaining areas.

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