Nov. 17, 1964 W. LIMBERGER 3,157,786

THERMOGRAPHIC APPARATUS FOR COPING IMAGES

Filed April 17, 1962 2 Sheets-Sheet 1

FIG. 1

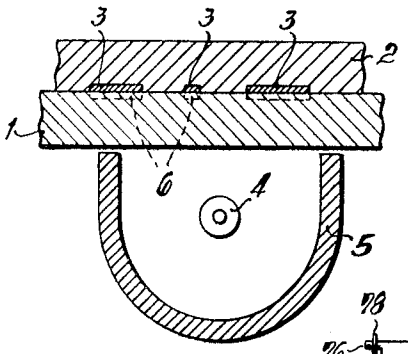


FIG. 2

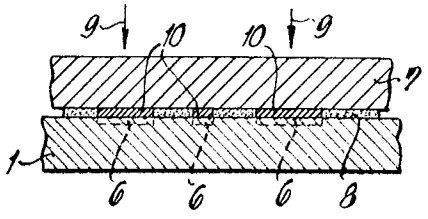


FIG. 7

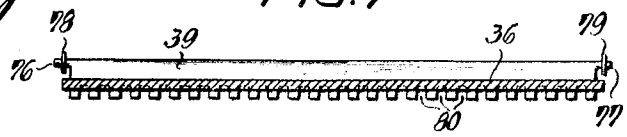
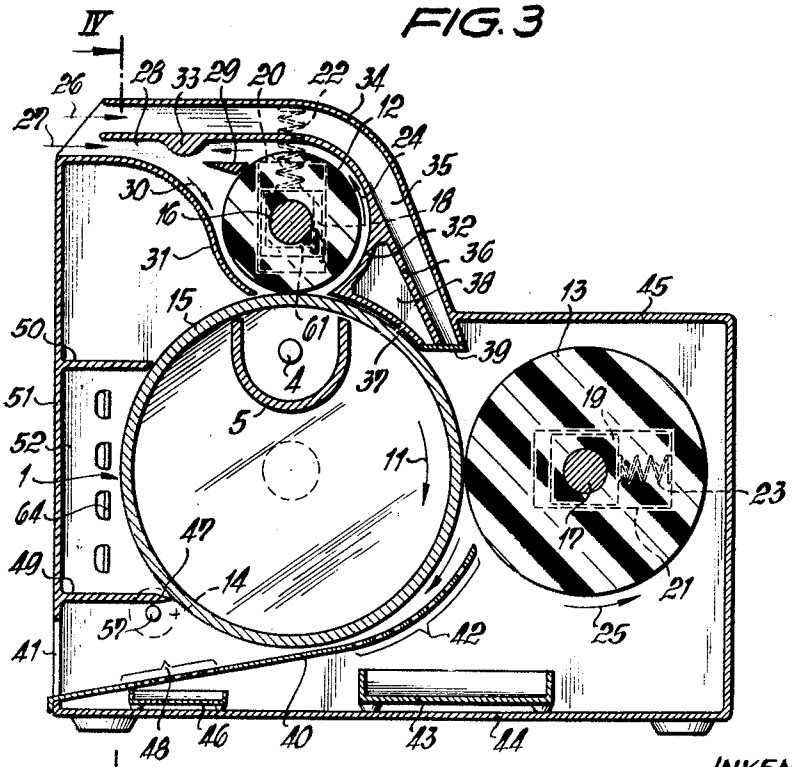


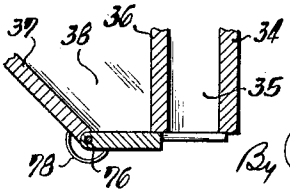
FIG. 3



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FIG. 8



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THERMOGRAPHIC APPARATUS FOR COPING IMAGES

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FIG. 4

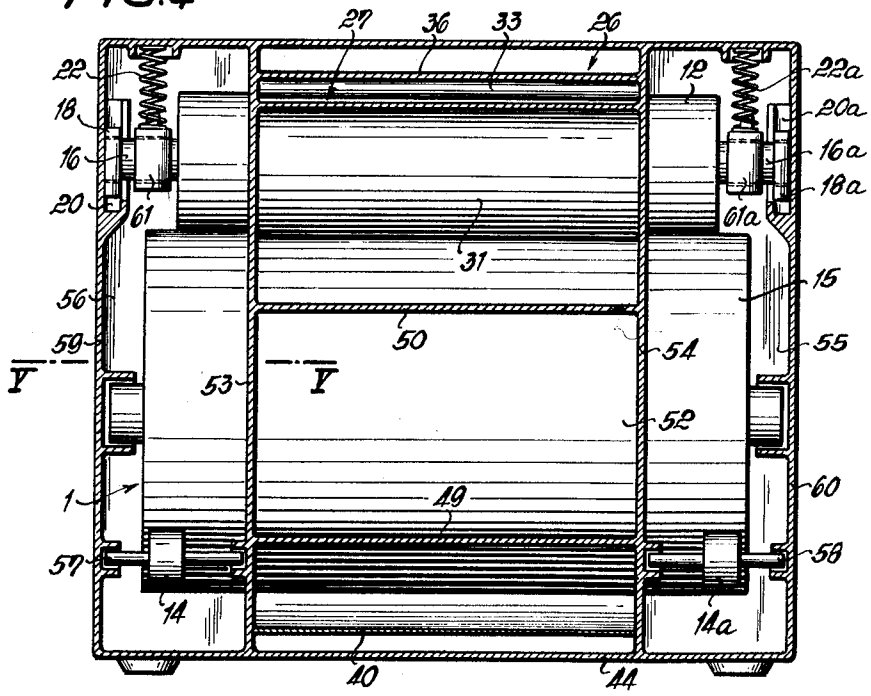


FIG. 5

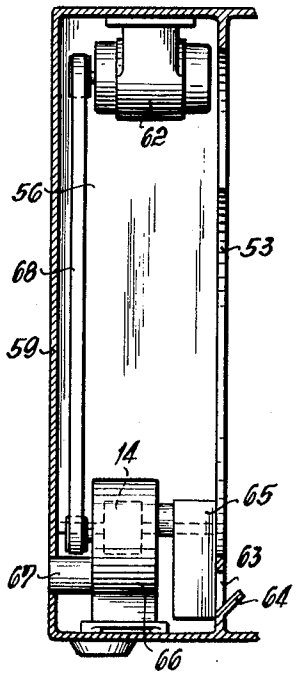
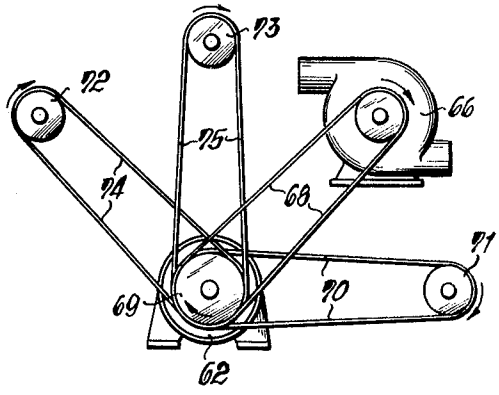


FIG. 6



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United States Patent Office 3,157,786 Patented Nov. 17, 1964

3,157,786

THERMOGRAPHIC APPARATUS FOR COPYING IMAGES

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Filed Apr. 17, 1962, Ser. No. 188,018
Claims priority, application Germany, Apr. 29, 1961, L 38,875
5 Claims. (Cl. 250—65)

This invention relates to a method for dry copying images from an original on a copy sheet, and a device for performing this method in which a source of radiation is employed for producing a locally defined heating.

These known methods and devices require the use of specially composed materials with additives which, during the copying process performed by exerting a pressure upon said original, will effect a decoloration according to the local heating zones. This method is disadvantageous in that special material is required, the characteristics of which being determined by the additives. Besides this such materials are expensive and do not allow second copies to be made.

According to one embodiment the invention starts out from employing in a known manner per se a powdered dyestuff. Such powdered dyestuffs have priorly been used in xerography. According to this method an electrostatic charge dissipation corresponding to the original is produced within a special layer, the electrostatic forces of which exerting a selective force of attraction upon said powder. In this known method it is necessary to fix the powder maintained by the electrostatic forces in a separate annealing device.

This method is disadvantageous because a specially prepared layer must be used for producing the electrostatic latent image, and because a separate additional source of heat must be provided for fixing the powder image. In addition it should be noted that the powdered dyestuff comprises special particles in this known method, for example resinous particles which are being attracted selectively by the electrostatic forces of the latent image, and that particular difficulties arise, because these particles must be distributed evenly over the electrostatic latent picture, and patricles which are not effected by the attractive force must be removed without influencing the arrangement of the other particles.

The main object of this invention is to provide a method for dry copying images from an original, in which a normal sheet of paper may be used for making the copy, and in which in addition the production of the image is accomplished without special measures for shaking-off a developing powder from the paper sheet.

Another object of the invention is to provide a device for performing the method which is simple in construction and easy to operate.

According to the invention the problem involved is solved in that a heat dissipation, corresponding to the image of the original, is produced in an areal heat storage body, and that this heat dissipation and an intermediate substance reacting to heat is brought into contacting pressure engagement with a sheet, preferably of paper, whereby this substance will react in accordance with the heat dissipation and produce in the zones of reaction an image on the sheet of paper.

By using the heat method for producing a selective heat dissipation the invention provides an indirect heat dissipation causing no reaction when generated, but is used to produce an image on a normal copying sheet, preferably made of paper.

If the copy material and an original are superposed in areal engagement, zones of increased temperature may be

produced, for example by directing a heat radiation by means of an infrared radiator through the copy material, which radiation is absorbed in the black zones of the original and converted into heat. This is known.

Preferably the heat reactive substance is a meltable powder which, according to an advantageous embodiment of the invention, is characterized in that no foreign particles besides the pigment particles are required. In this connection it should be noted however that the invention also includes the use of a powder including, or consisting of a dyestuff, for example a meltable artificial resin on the base of polystyrol, and if required with an addition of nigrosine.

According to another embodiment of the invention a first heat reactive substance is used which, upon heating, will react with a second substance applied to the receiving sheet. This second substance may be provided on the receiving sheet, or, for example, may also be a volatilizing substance which, before the powder is applied, is applied to or sprayed on the receiving sheet, whereby the advantage of using a normal sheet of paper is maintained.

An advantageous embodiment of the invention provides that the heat storage body is cooled before inducing the heat dissipation.

According to a preferred embodiment of the invention an original is brought into surface contacting engagement with the heat storage body and is exposed during the contacting period to a source of radiation, whereupon the heat storage body is moved towards a contact pressure element, while simultaneously the original is removed from the heat storage body, the heat reactive substance is applied between the heat storage body and the receiving sheet, and this sheet is passed through the contact pressure element, whereby the reaction of the heat reactive substance according to the heat dissipation is accomplished.

The device according to the invention for dry copying image from an original on a copy sheet comprises within a common housing heat storage means, cooling means selectively acting upon said heat storage means, a source of radiation controlled to act upon said heat storage means subsequently to the action of said cooling means, first contact pressure means arranged with respect to said source of radiation in such a manner that a sheet-like original fed to said first contact pressure means is pressed against said heat storage means in that zone in which said source of radiation is effective, second contact pressure means arranged to press a sheet against said heat storage means, and means for feeding a heat reactive substance to said sheet pressed by said second contact pressure means against said heat storage means.

It is to be noted that the copying device according to one embodiment of the invention merely requires a single contact pressure element if, for example, a plate-like heat storage body, corresponding to the size of the original, is used, above which a corresponding contact pressure plate is arranged. In this the original may be placed on the heat storage plate and urged against it, during which period the source of radiation is switched on. After releasing the contact pressure plate the original is exchanged against a receiving sheet, preferably a sheet of paper, after either the heat storage plate, or that side of the sheet facing the heat storage plate has been covered with heat reactive substance or pigment powder. Thereupon the contact pressure plate is urged a second time against the arrangement, whereby the heat reactive substance or pigment powder is reacting in the increasedly heated zones of the heat storage plate, so that, for example by melting the heat reactive substance and adhering to the sheet, the copy of the image of the original is produced.

Preferably the device according to the invention comprises a hollow cylindrical body forming said heat stor-

age means, means rotatably supporting said heat storage means within said housing, said first and said second contact pressure means being formed by a first and a second roller, means rotatably supporting said first and said second roller within said housing in contacting, rotating engagement with said heat storage means, means for driving at least one of said rollers transmitting its rotation by said contacting engagement to said heat storage means which in turn is transmitting the rotation to the other roller, said radiation source being arranged within said heat storage means located opposite the engagement zone of said first roller, the arrangement around said heat storage means being such that in the direction of rotation first said cooling means become effective, then said first roller and said source of radiation, then said means for feeding said heat reactive substance, and finally said second roller.

According to the invention the storage drum is made of a material having a low heat conductivity and a high high heat storage characteristic and a surface which is rejecting the heat reactive substance.

An especially advantageous feature of the invention must be seen in the fact that only one slot is required for introducing and dispensing the original into and out of the device. In this the inlet slots for the receiving sheet and the original are arranged one above the other, and the guide path for the original is extending around the first contact pressure roller joining the inlet portion again.

According to the invention a supply container for the heat reactive substance, preferably a dyestuff, may be arranged above the nip between the heat storage drum and the second contact pressure roller for the receiving sheet opening between the guide channel for this sheet and the heat storage drum. This opening may be provided with closing means operable in dependence on the passage of a sheet, preferably by the sheet itself. The closing means may, for example, be formed by a flap controlled by an abutment lever effecting the closing or opening of the outlet flap of the container. Preferably the outlet flap is acted upon by spring means, and is formed itself with an abutment extending into the guide channel for the receiving sheet, the flap being disposed below a partition wall between the container and the guide channel, which wall is forming an abutment for the outlet flap. Preferably the outlet flap is provided with dispersion openings which are closed when the flap abuts the partition wall.

According to the invention paper or cardboard as well as artificial resin or glass may be used for making the heat storage drum. It is important that the heat storage drum has a surface which has a low heat conductivity but a high heat storage capacity.

Additional means may be provided, comprising a stripping device constantly effecting a cleaning action of the rotating heat storage drum. This stripping device may be formed by a scraper or a brush.

Further features and advantages will become apparent as the description of several embodiments of the subject matter of this invention, illustrated in the accompanying drawings proceeds, it being understood, however, that the embodiments are described by way of example only, since alterations are possible for those skilled in the art, without departing from the scope of the invention.

In the drawings:

FIG. 1 is a partial sectional side view illustrating how the heat dissipation is induced;

FIG. 2 is a partial sectional side view of the heat storage means with a receiving sheet illustrating the method of copying an image;

FIG. 3 is a sectional side view of a preferred embodiment of the device according to the invention;

FIG. 4 is a sectional view taken along the line IV—IV of FIG. 3;

FIG. 5 is a sectional top view of the left hand chamber of the device taken along line V—V of FIG. 4;

FIG. 6 is a diagrammatic view of the drive arrangement for the various elements of the device shown in FIGS. 3, 4, and 5;

FIG. 7 is a detail top view of the container closing flap according to FIG. 3;

FIG. 8 is an enlarged partial sectional side view of the closing flap according to FIG. 7 including the pivotal arrangement and the abutment means for actuating the flap.

Now referring to the drawings it will be seen in FIGS. 1 and 2 that the heat storage element is generally denominated with the reference numeral **1**. FIG. 1 shows an original **2** placed on the heat storage element **1** in such a way that the image, parts of which being denominated with the reference numeral **3**, is facing the heat storage element **1**. On that side of the heat storage element disposed remote of the original **2** a source of radiation **4**, for example a heat radiator, or an infrared radiator, is provided, arranged within a reflector **5** serving to direct the rays to the heat storage element **1**. The rays pass the heat storage element **1**. The colored areas **3** of the original **2** will absorb the rays and convert them into heat, whereby corresponding strongly heated zones **6** are induced below the colored areas **3** of the original **2**. Since the heat storage element has practically no, or merely a very low heat conductivity, the heat concentration at the zones **6** is maintained at least during a limited period of time sufficient to carry through the method.

After the original has been removed a receiving sheet **7** is placed on the heat storage element **1** with a heat reactive substance, followingly called pigment powder **8**, disposed between the receiving sheet **7** and the heat storage element **1**. The receiving sheet **7** is urged against the heat storage element, as illustrated by the arrows **9** in FIG. 12. By means of this the pigment powder **8** is strongly heated over the heated zones **6** to such an extent that the pigment powder **8** will melt or dissolve in the zones and adhere to the facing side of the receiving sheet, whereby an image coresponding to the heated zones **6** is produced.

After the receiving sheet **7** is removed from the heat storage element **1** the molten pigment powder **8** adheres to the receiving sheet **7** in the areas **10**, while outside of these areas the pigment powder **8** may be shaken off, or may be removed in any other suitable manner.

The illustration in FIGS. 1 and 2 are extremely enlarged, since the receiving sheet **7** is practically a common sheet of paper.

FIG. 3 shows an advantageous device for making copies in the aforedescribed maner.

Within a housing **45** the heat storage element **1**, which is formed by a cylindrical drum, is arranged. This drum is journalled within the housing **45**, in a manner to be described yet, to rotate in the direction indicated by the arrow **11**. The drum may, for example, be rotatably journalled between a first contact pressure roller **12** for the original **2**, a second contact pressure roller **13** for the receiving sheet **7**, and guide rollers **14** which latter are arranged in the extended angle bisector of the angle included between lines passing through the center of the drum **15** and the axis of the first and the second contact pressure roller **12** and **13**. The guide rollers **14** are disposed one at each end of the drum **15** outside of the working surface for making copies, i.e. in the illustration according to FIG. 3 behind lateral partition walls each having an opening through which the drum extends. The guide rollers **14** may be journalled in the housing unyieldingly, since the contact pressure rollers **12** and **13** are preferably resiliently urged towards the center of the heat storage drum **15**. For this purpose the shafts **16**, **17** of the contact pressure rollers **12**, **13** may, for example, be journalled in bearing blocks **18**, **19** having parallel side

surfaces guided in slots 20, 21 of the housing walls. These bearing blocks 18, 19 are acted upon by pre-tensioned springs 22, 23 urging them into contacting engagement against the heat storage drum 15.

The contact pressure rollers 12 and 13 may, for example, be made of plastic material, rubber, or the like material, which is somewhat elastic. The rollers are rotating synchronously, i.e. with equal circumferential speed, in a direction indicated by the arrows 24 and 25, and may be driven, except an embodiment is preferred, in which they are taken along in dependence on the rotation of a driven heat storage drum 15.

Inside of the heat storage drum 15 the source of radiation 4 is disposed within the reflector 5 opposite the first contact pressure roller 12.

At the top of the housing 45 two inlet slots 26 and 27 are provided one above the other, the upper one serving for the introduction of the receiving sheet 7 and the lower one for the original. The subsequent guide channed section 28 for the original bifurcates at the guide element 29. The channel extending in the direction of the arrow 30 is defined by the guide element 31 and the first contact pressure roller 12, and leads to the heat storage drum 15, and thence between the roller 12 and a guide element 32 concentrically encompassing the roller 12 back to the channel section 28. The guide element 32 simultaneously forms the partition wall between the inlet slots 26, 27, a projection being formed behind the lower inlet slot 27 for the original preventing an original, when introduced, to be moved above the guide element 29.

From the inlet slot 26 a guide channel for the receiving sheet 7, defined by the outer housing wall 34 and the guide element 32, extends and terminates approximately above the nip between the second contact pressure roller 13 and the heat storage drum 15. This channel is defined at the side facing the drum 15 by a guide surface 36 which together with a section of the planar guide element 32 and a wall section 37 extending substantially concentrically around the drum 15 defines a chamber 38 serving as a supply container for the pigment powder. This container has an opening slot adjacent the outlet of the guide channel 35, which opening slot is closed by a flap 39 which has projections extending across the outlet of the guide channel 35 and which is adapted to be opened.

Below the contacting zone between the drum 15 and the second contact pressure roller 13 a guide element 40 is arranged which extends from the second contact pressure roller, from which its end is spaced a little, around the lower part of the heat storage drum 15 to the lower edge of an outlet slot 41 provided in the housing wall. The guide element 41 is perforated over the section 42, or is formed grate-like, or provided with slots, whereby pigment powder dropping down from the nip between the heat storage drum 15 and the second contact pressure roller 13 may be gathered in a container 43 which is resting on the bottom plate 44 of the housing 45 and may, for example, be removed through a slot in one of the side walls.

Another container 46 is removably arranged on the bottom plate 44. This container is disposed below a stripper 47, which may be formed by a resilient strip or brush resiliently engaging the outer circumference of the heat storage drum 15. Any pigment powder adhering to the heat storage drum 15 will be removed by this stripper 47. The guide element 40 is also perforated or slotted in the zone 48 with a wire-like grating so that the removed pigment powder may drop into the container 46.

The stripper 47 may, for example, be arranged adjacent the upper edge of the outlet slot 41 forming a partition wall 49. Spaced from this partition wall 49 there is a second partition wall 50 provided which, together with the section 51 of the outer housing wall forms a cooling chamber 52, within which a low temperature is maintained, for example by directing a stream of cool air into it, thereby cooling the surface of the heat storage drum 1 to an even, low temperature.

FIG. 4 shows that the operating chamber in the middle of the device shown in FIG. 3 in a sectional view which is defined by lateral partition walls 53 and 54 forming outer lateral chambers 55 and 56 serving to accommodate bearings and drive elements. The heat storage drum 15 extends for example through apertures in the partition walls 53 and 54 and is supported at its lower section by the guide rollers 14 and 14*a*, the shafts of which being journalled on one side in the partition wall 53 and the side wall 59, and on the other side in the partition wall 54 and the side wall 60.

As shown in the upper part of FIG. 4 the first contact pressure roller 12 is also extended into the lateral chambers 55 and 56 its shaft 16 being journalled in the slots 20, or 20*a* respectively, of the side walls 59, 60 of the housing 45, the springs 22 and 22*a* being provided between the top wall of the housing 45 and bearing blocks 67 and 67*a*. The second contact pressure roller 13 is journalled correspondingly.

The drive is shown by way of example in FIG. 5, in which the heat storage drum 15 is not illustrated, but merely the guide roller 14 and the drive motor 62. It will be noted that the partition wall has apertures 63 formed therein (see FIG. 3 also) which are covered by baffle surfaces 64 serving to direct a stream of cold air passing through the aperture to the heat storage drum 15. The apertures 63 are interconnected by a manifold 65 arranged within the lateral chamber. A ventilator 66 is discharging into the manifold 65. The intake 67 of the ventilator 66 may, for example, be extended outwardly through the side wall 59 of the housing 45. The ventilator 66 is driven by the motor 62, for example via a transmission 68. The drive motor 62 drives the shaft 57 of the guide roller 14 via a corresponding transmission with a different drive ratio. This shaft 57, for example, may be formed integrally with the shaft of the guide roller 14*a*, provided it extends above the partition wall 49, whereby in this manner the drive of the heat storage drum 15 may be accomplished.

It is understood that electrical connection means such as transformers, rectifiers, and the like for the radiator 4 may be arranged within the lateral chamber 56, or also in the lateral chamber 55. The radiator 4 is also mounted on the partition walls 53 and 54, which are also serving to support the reflector 5.

The arrangement of the drive is shown in FIG. 6. The drive motor 62 has a shaft 69 which may, for example, carry several pulleys for achieving different drive ratios. The transmission 68 drives the ventilator 66, another transmission 70 drives the pulley 71 on a shaft. The pulleys 72 and 73 are mounted on the shafts 17 and 16, and are driven by endless helical springs or so called garter springs. These drives are elastic, thereby preventing influence of the pressure action of the contact pressure rollers 12, 13.

One example of an embodiment of the container closing flap 39 is shown in the FIGS. 7 and 8. The flap 39 may, for example, be supported by pivot pins 76 and 77 rotatably journalled in the partition walls 53 and 54. Springs 78 and 79 are acting on the pivot pins 76 and 77, thereby urging the flap 39 against the guide surface 36. The lower edge of the guide surface 36 is shown, for example, in hatched lines in FIG. 7.

The portion of the flap 39 extending below the guide surface 36 is provided with narrowly spaced slots 80 open towards the side of the guide channel. If the flap is pressed against the guide surface 36 the inner ends of the slots are closed with respect to the chamber 38. If the flap is rotated clockwise, as viewed in FIG. 3, pigment powder can trickle out of the chamber 38 through the slots 80 and fall into the nip formed between the heat storage drum 15 and the second contact pressure roller 13. In this the shape of the slots allows to control the

amount of pigment powder dispensed out of the container **38**.

With reference to FIG. 3 the device functions in the following manner:

The original is introduced through the slot **27** with the image facing downwardly, and simultaneously a receiving sheet of paper is introduced through the slot **26**. The length of the path from the slot **26** through the guide channel **35** to the contacting spot between the heat storage drum **15** and the second contact pressure roller **13** is equal to the length of the path, corresponding to the arrow **30**, from the slot **27**, past the first contact pressure roller **12** to the contacting spot between the heat storage drum **15** and the second contact pressure roller **13**. The source of radiation **4** may, for example, be switched on in dependence on the introduction of the sheets. When the original is passed between the heat storage drum **15** and the first contact pressure roller **12** a local heat dissipation is introduced on the heat storage drum **15**, as has been described in connection with FIG. 1. In this the original and the heat storage drum **15** continue rotating, and the original is returned to the slot **27**, while the heat storage drum **15** with its heat dissipation is moving towards the second contact pressure roller **13**. The paper sheet introduced through the slot **26** abuts with its leading edge projections formed on the flap **39** and extending across the mouth of the guide channel **35**, whereby the flap **39** is opened and pigment powder allowed to trickle out of the container **38** through the slots **80** of the flap **39** and fall into the nip formed between the heat storage drum **15** and the second contact pressure roller **13**. The leading edge of the receiving sheet of paper simultaneously reaches the contacting line between that zone of heat dissipation on the heat storage drum **15** which corresponds to the leading edge of the original. The pigment powder covering the heated zones of the heat storage drum **15** is molten and absorbed by the surface of the paper sheet which, according to a preferred embodiment is absorbing, whereby the copied image will be produced on this surface. The thus treated sheet of paper passes along the guide element **40** and out of the outlet slot **41**. Pigment powder which, due to the missing of heated zones, has not been molten after the sheet of paper has passed the second contact pressure roller **13** drops into the container **43**. If pigment powder should adhere to the surface of the heat storage drum **15** it is removed by the stripper **47** and drops into the container **46**. The heated zones are cooled when passing the chamber **52**, whereby an evenly cooled surface reduced to a low temperature is obtained on the heat storage drum **15**, before this section of the surface reaches the zone of radiation **4** again.

A certain absorbing capacity of the receiving sheet of paper is very advantageous in order to keep the smooth, and preferably hard, surface of the drum as clean as possible.

What is claimed:

1. In an apparatus for producing dry copies from an original on a copying sheet comprising, in combination, mounting means, a thermal image-retaining transfer and heat storage cylinder rotatably supported on said mounting means, said cylinder having an upper portion, heat radiating means mounted within said cylinder, said radiating means irradiating said cylinder upper portion, first roller pressing means rotatably supported on said mounting means at a location outside of said cylinder and in such a manner that said pressing means resiliently engages said upper portion of said cylinder which is irradiated by said heating radiating means, second roller pressing means rotatably supported on said mounting means at a location outside of said cylinder spaced in the direction of rotation relative to said first pressing means and resiliently engaging said cylinder, a first feed channel having an inlet and an outlet, said outlet being adjacent said cylinder in the peripheral zone thereof between said first and said second pressing means and extending toward said second pressing means, storage means defined within said mounting means intermediate said cylinder and said first channel outlet and having an outlet opening disposed adjacent the outlet of said first channel and intermediate said first channel outlet and said cylinder, closure means selectively opening and closing said storage means outlet opening, spring means biasing said closure means toward its closed position, actuating means defined on said closure means extending into the outlet of said first channel and operable by a copying sheet being advanced through said first channel so as to open said closure means during the passage of said sheet, a second feed channel having an inlet for feeding an original intermediate said first pressing means and said cylinder, and drive means driving said cylinder.

2. In a device as in claim 1 wherein said first and said second pressing means engage said cylinder at locations spaced approximately 90° on the periphery of said cylinder.

3. In a device as in claim 1 wherein cooling means are mounted on said mounting means associated with said cylinder at a location of its circumference prior to said first pressing means relative to the direction of cylinder rotation.

4. In a device as in claim 1 wherein the inlet of said second channel is adjacent the inlet of said first channel, said second channel encompassing said first pressing means in a loop-like manner whereby an original introduced into said second channel is transported around said first pressing means and is dispensed through the inlet of said second channel, the length of the path from the inlet of said second channel to the zone of engagement between said first pressing means and said cylinder and from this zone of engagement along the cylinder circumference to said second pressing means being substantially equal to the length of the copying sheet path from the inlet of said first channel to the zone of engagement between said cylinder and said second pressing means.

5. In a device as in claim 1 wherein an outlet opening is defined in said mounting means, a guide element leading to said mounting means outlet opening and extending from said outlet opening around the lower portion of the circumference of said cylinder in spaced relation thereto to below the zone of engagement between said cylinder and said second pressing means, and perforations defined in said guide element.

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