

Dec. 19, 1967

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3,359,404

APPARATUS FOR PRODUCING A PICTURE

Filed Feb. 11, 1964

3 Sheets-Sheet 1

Fig. 1

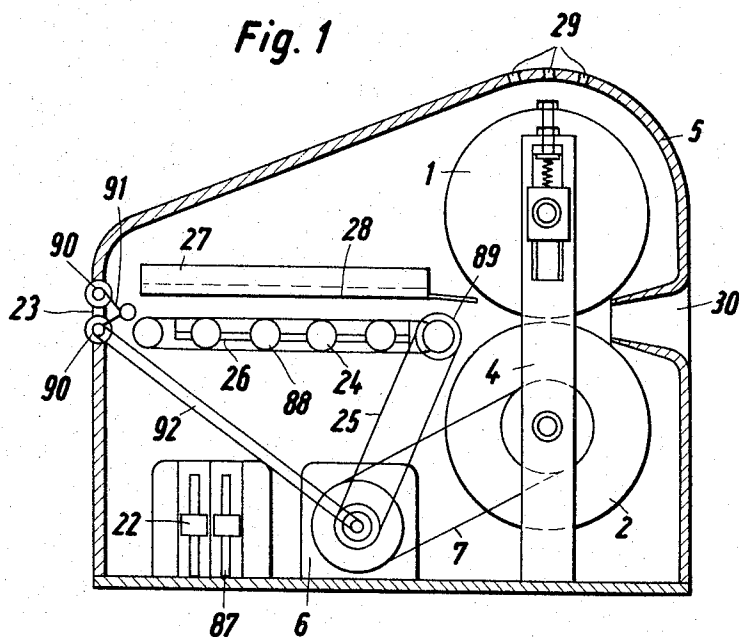
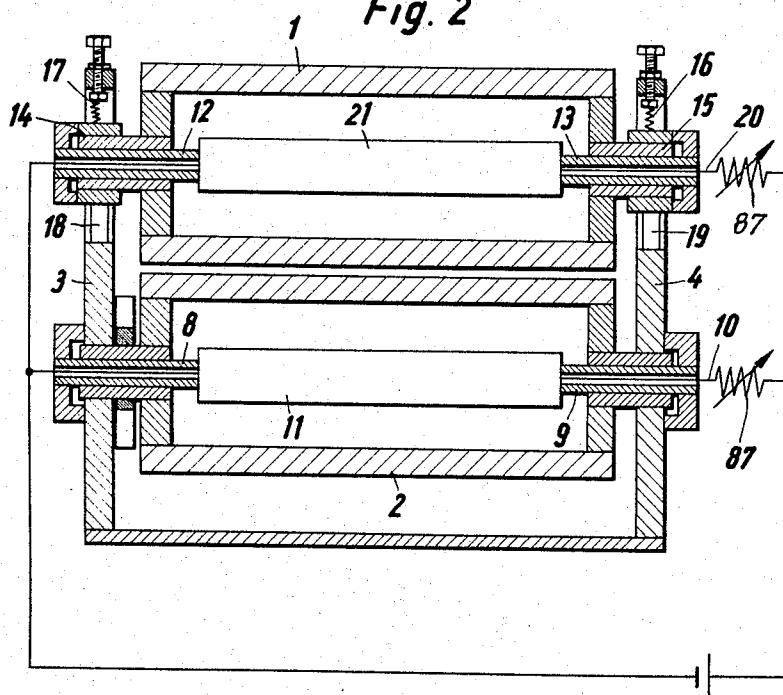


Fig. 2



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Fig. 3

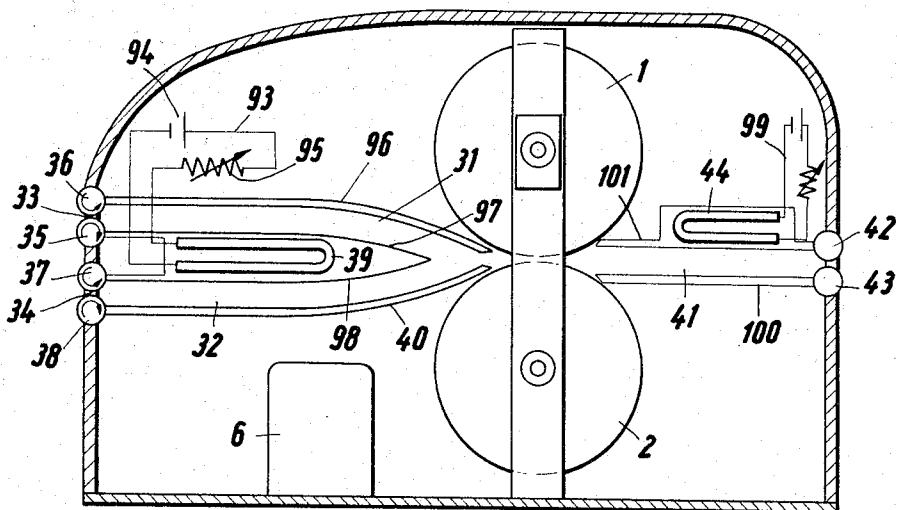
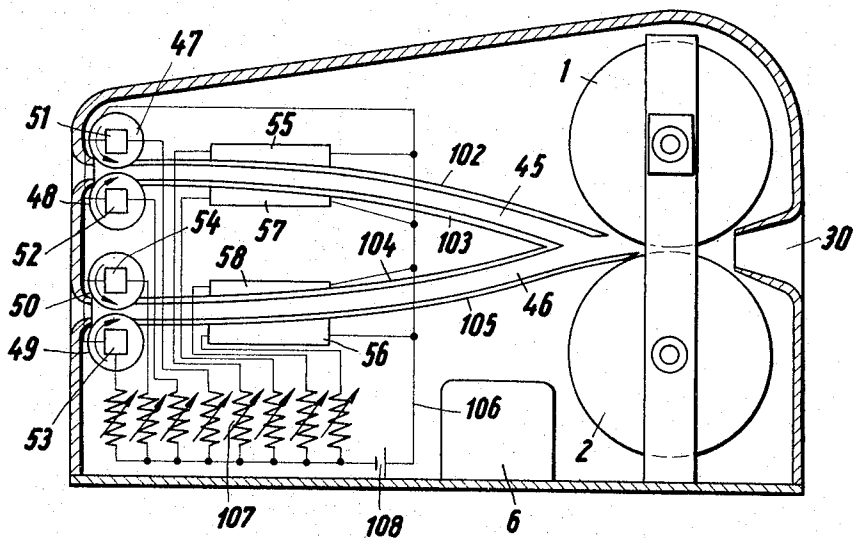


Fig. 4



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Fig. 5

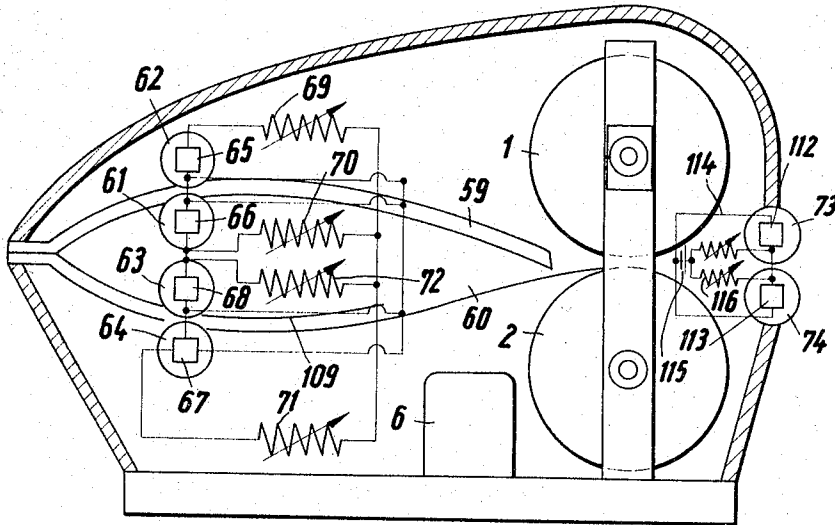
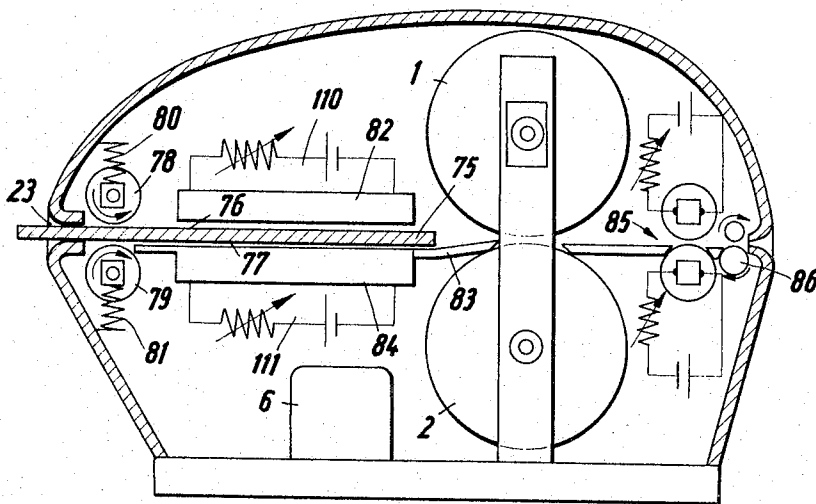


Fig. 6



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APPARATUS FOR PRODUCING A PICTURE

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10 Claims. (Cl. 219-216)

ABSTRACT OF THE DISCLOSURE

Reproduction apparatus for the diffusion-transfer of an image to a copy-receiving sheet from a thermally-activatable latent-image-carrying reproducing sheet having an emulsion layer containing a heat-activatable substance adopted to release a diffusion medium, comprising a housing, inlet means and outlet means in said housing respectively for receiving the reproducing sheet and discharging the reproducing and copy-receiving sheets, means intermediate the inlet means and the outlet means for providing a transport path for the reproducing sheet, a pair of drums disposed on opposite sides of said transport path and rotatable in engagement with the reproducing and copy-receiving sheets passing therebetween; spring means resiliently bearing on at least one of the drums for pressing them into line engagement, means for setting the minimum gap between the drums; heating means along the path between the drums and the inlet means and including a heated surface adapted to heat the emulsion layer upon confronting same for thermally activating the substance to at least partially release the medium prior to the passage of the sheets between the drums, and means for passing said copy-receiving sheet and the reproducing sheet concurrently between the drums.

The present invention relates to an apparatus for manufacturing a picture by means of an exposed photographic silver-halide layer in conjunction with a receiving layer, wherein these layers are subjected in mutual contact to a line pressing, and contain the substances necessary for the development and fixing, as well as layer formers and substances, or wherein the materials of each layer contain substances which form, when heated, media for triggering off and completing silver-salt diffusion reproduction transfer, development and fixing.

Hitherto, silver-salt diffusion methods applying heat have been carried out only in laboratories, for example, by heating the material under a heating plate. It is also known in the art to use photographic-emulsion layers which, or the carrier of which, form an electric conductor through which a heating current is passed in order to heat the material from the inside.

It has already been proposed to provide roller passes for the heating of emulsion carriers, wherein the individual rollers may be heated to different degrees. It has also been proposed to bias the rollers carrying out a line pressing of the material so that the rollers are resiliently urged one against the other. In addition, the rollers are guided towards an adjustable minimum gap so as to prevent damage to the emulsion layers during the application of line-pressing pressure.

It is an object of the invention to improve the known methods for manufacturing pictures by means of a transfer of substances between different layers under heating.

It is a further object of the invention to provide a simply constructed apparatus for a particularly efficient development of photographic material under the application of heat.

It is a further object of the invention to provide an arrangement wherein more than one application of heat is effected in correlation with the applications of pressure,

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whereby the effects on the material are improved compared with known arrangements.

According to the method of the invention, the heat is applied at least partly to one material either prior to the line pressing of both layers, or during the processing of two materials.

The invention is based on the fact that, for example, in the preferred application using the silver-salt-diffusion method, a photographic silver-halide layer on a carrier, for example an impregnated paper substrate, and is processed together with a positive layer arranged on the same carrier so that the layer is in the same material, wherein the substances necessary for effecting the reactions are present in the material, or else positive and negative layers are processed which are always located on an emulsion carrier.

During the processing of two materials heat is preferably applied to the material prior to the line pressing and the material may give up larger quantities of a medium for diffusion, such as water.

According to a further preferred embodiment the heat is applied directly to the emulsion side of a sheet of reproduction material. This offers a substantial advantage compared with known pressing rollers between which the materials are passed with the emulsions in contact, because these can apply the heat to the layers only through the carriers. This not only increases the duration of the heating until the required reactions occur, but requires also much more heat to be applied and necessitates the use of a more heat-resistant emulsion carrier than with the method according to the invention, in which the emulsion layers are heated directly. The application of heat from the emulsion side has also further advantages in the case of certain materials, i.e. where the carrier has applied thereto in superimposed relationship several different layers, namely the actual reaction layer and one or more further layers with one or more substances for effecting individual reaction between these layers and with the reaction layer. By arranging these layers in a suitable manner, the application of heat according to the invention prior to the line pressing may have a beneficial effect on the course of the reaction.

According to a special embodiment of the invention, the heat is applied exclusively prior to the line pressing, that is to say, work is carried out with a cold pair of press rollers. In conjunction with the above-described advantages of an application of heat according to the invention there results a new and unexpected solution in that the substances in the individual emulsions or materials are individually transformed into their reactive conditions while the layers are then subjected under contact pressure to a line pressing in order to carry out the diffusion.

According to another preferred embodiment, preheating is effected at a lower temperature than that of the materials during line pressing. In this method, materials are preferably used containing an additive which gives up stored moisture at higher temperatures than other substances forming constituents of the materials. Also here, the development and, where required, the fixing is timed conveniently so that, for example, the additives are present in layers containing reactive substances which are transformed into their reactive condition conveniently later than other reactive substances (for example, during the line pressing), and arranged, for example, in a layer former liberating water, such as water of crystallization, at the temperatures used for the preheating.

The present invention also comprises an embodiment, in which both materials are heated before the line pressing. Moreover, according to a preferred embodiment, the preheating and the heating prior to the line pressing are effected under simultaneous application of pressure on

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to the layers, for example, in the form of a line pressure.

The apparatus according to the invention has a pair of rollers, at least one of said rollers being biased in the direction towards the other roller, one of the said rollers being driven directly or indirectly, and wherein there is provided at least one delivery track leading to the gap between this pair of rollers, with a heating unit located in this delivery track. Obviously, at least the parts of the equipment in which heat is applied are equipped with an insulating housing, possibly containing vents, while the remaining parts are preferably force ventilated.

According to a further preferred embodiment, there are provided two delivery tracks which join upstream of the roller gap, and at least one heating device in one of the delivery tracks. In a special construction, these two delivery tracks need not be thermally separated one from the other and the heating device is conveniently located between the tracks and supplies heat to both of them. In yet another embodiment, the heating device is divided into two units, each in one of the delivery tracks which are conveniently formed in sections in the shape of a cone.

It follows from the preceding statements that a special embodiment will comprise heating units located laterally of the delivery track or tracks wherein the layers on the material sheets passing through the said delivery tracks face these heating units during their passage.

According to a further embodiment of the invention, the pair of rollers contains a heating device in order to apply heat to the materials during the line pressing.

The heating device and/or devices may preferably have the form of heat radiators; in another preferred embodiment, they comprise each a pressure roller so that the heating prior to the line pressing is effected under the application of pressure.

This pressure roller, which may be heated, may be one roller of a pair of pressure rollers or may collaborate with a guide surface which may also be heated and forming part of the delivery track.

Further advantages of the invention will become apparent from the following description, given, by way of example, with reference to the accompanying drawing, showing diagrammatically embodiments of the invention, and in which:

FIG. 1 is a cross-sectional side elevation of one embodiment of the invention;

FIG. 2 is a cross-section along the line II—II of FIG. 1 and explains the arrangement of press rollers;

FIG. 3 is a side elevation of another embodiment of the invention;

FIG. 4 is a side elevation of yet another embodiment of the invention;

FIG. 5 is a side elevation of yet another embodiment of the invention; and

FIG. 6 is a side elevation of yet another embodiment of the invention.

Examples of the substances which may be processed by means of the method of the invention include the silver salt diffusion method. It is known in this method to add to the reaction layers substances which, when heated beyond their melting point, form the medium necessary for the diffusion. To this end an alkali-metal-salt melt may be provided, and in particular crystalline sodium acetate is provided as the substance giving up water.

In principle, salts containing water of crystallization may be provided, which have a low melting point and a water-release point which is not too high, so that when the substances are heated to temperatures of the order of, say, 80 or 90° C., other substances provided for the development and fixing may dissolve causing the development and fixing of an exposed photographic layer in a liquid phase.

An example of the receiving or positive material, having in this instance several layers, follows: The receiving material has two layers, one containing a fixing agent and silver seeds (nuclei), and the other a metal-salt melt and alkali. Conveniently, the second layer contains poly-

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vinyl alcohol as layer former. This layer contains also preferably polyvinyl alcohol in addition to alkali and bi- and trivalent alcohols, preferably glycerine or glycol.

By way of example, the following composition may be given:

Initially a first layer consisting of an emulsion having the following composition:

Distilled water	-----ml--	100
Gelatin	-----g--	9
Sodium acetate, crystallized	-----g--	20
Silver nitrate	-----g--	0.1
Sodium thiosulphate, crystallized	-----g--	3.0

is applied to a sheet of barite paper.

On this first layer, after it has dried, a second layer is supplied having the following composition:

Polyvinyl alcohol	-----g--	10
Distilled water	-----ml--	50
Glycerin	-----ml--	15
Sodium acetate, crystallized	-----g--	5.0
Sodium carbonate, sicc.	-----g--	2.0

The polyvinyl alcohol had a saponification number of 20±, 15 mg./KOH/g. and a degree of hydrolysis of 97.5–99.5 and a viscosity of 28±4 cp. in a 4% aqueous solution at 20° C.

The negative material was a conventional sheet of material, such as are commercially available for the silver salt diffusion method. This sheet contains developing substances and is combined after the exposure of a pattern with the receiving layer of the positive material and processed according to the description of the invention under application of heat and pressure.

There is also the possibility of arranging the light-sensitive layer of the negative material and the receiving layer of the positive material on one layer carrier. To this end, the composition mentioned above in the second place may be used as receiving layer with the modification that double the amount of sodium acetate is used with only half the amount of sodium carbonate; one gram of sicc. potassium metabisulphate is added. The receiving layer contains an irreversible polyvinyl alcohol matrix which includes the fixing agents and the developer alkali necessary for the reaction. To this layer substances are added which act as reducing agents and which ensure a high residual moisture (bi- and trivalent alcohols, such as glycerine and glycol). Preferably, a further additive is an alkaline metal salt known as melting agent, and known also in its application as softener of polyvinyl alcohol, e.g., sodium acetate.

To this reaction layer a photographic silver halide emulsion is applied, containing in addition to developer substances also further additives, such as dehaizing agents, stabilizers and additives capable of forming compounds with alkali of low solubility.

The apparatus according to the invention has generally a pair of rollers 1, 2 for carrying out the line pressing of both layers and is shown more clearly in FIGURES 1 and 2. The rollers 1, 2 are journaled in two posts 3, 4 mounted within a housing 5. This housing 5 contains also the terminal and driving unit 6 for the heating devices disposed in the apparatus, such as, for example, heating coils or radiators, and driven parts, such as the roller 2 or other rollers provided in modified embodiments of the invention. The roller 2 is connected through a transmission 7 with the driving unit 6.

The roller 2 is received rotatably in stub shafts 8, 9 in the posts 3, 4. The said stub shaft 9 may be a quill shaft containing the leads 10 for a heating element 11 located in the hollow roller 2. The supply lead 10 or the connecting unit 6 contains an adjusting member 37 (variable resistor) for controlling the current supplied to the heating element. The adjusting element 37 serves also for the switching on and off of the heating element 11.

The roller 1 is mounted by means of stub shafts 12, 13 in the same posts, but in movable bearing blocks 14, 15 which are each affected by a pressure spring 16, 17. These bearing means are guided in oblong slots of the posts. In order to adjust a gap, the movement of the bearing blocks may be limited by adjustable means, such as spacer inserts 18, 19, located under the bearing blocks 14, 15.

The stub shaft 15 is again formed by a quill shaft, containing the supply leads 20 for a heating element 21. Adjusting elements 87 (variable resistors) are provided in the connecting and driving unit 6 so that not only can the heating elements 11 and 21 be adjusted to various temperatures, but also only one heating element in one roller need be switched on.

A delivery track forms a transport path which leads from an inlet slot 23 of the housing to the roller gap. In the embodiment shown, the lower limit of this track is formed by an endless conveyor belt 24 supported by rollers and driven from the unit 6 through a transmission 25. The rollers 88 for this conveyor belt are mounted in the side walls of the housing or frame, parallel to the plane of the drawing, or in frame walls which are parallel to the posts 3, 4. These walls are not shown in detail. The transmission 25 co-operates with a driving gear 89. The conveyor belt may be perforated, and a heating device, such as a heat radiator may be mounted under its upper run, as shown at 26. The guide surface 27 of the guide track, forming the upper limit of the delivery track, is associated with a downwardly directed heating device 28, for example, a radiator. Naturally, an apparatus equipped with only one of these heating devices also falls within the scope of the present invention. The said guide surface 27 is also mounted in the frame walls extending parallel to the plane of the drawing.

In addition, a so-called heat lock may be arranged within the zone of the inlet opening 23; the heat lock can include a pair of rollers 90 affected by a weak contact pressure and driven synchronously to the transporting member 24 and to the pair of rollers 1, 2, so that heat is prevented from escaping towards the operating side of the appliance and a desirable, weak, preparatory line pressure may be exerted.

In FIG. 1, the rollers of the roller pair 90 are adjustably mounted in the left frame wall and biased by means of a spring 91, urging the said rollers towards each other.

Conveniently, the heat is removed by vents 29. The delivery slot 30 of the housing 5 is located downstream of the pair of rollers 1, 2. However, an additional heating station, such as a flat heating element, may be mounted downstream of the pair of rollers.

In the following description of modified embodiments, parts which correspond to those shown in FIGURES 1 and 2 are marked with the same reference numerals; the features described in conjunction with FIGURES 1 and 2 are also referred to although not all details are reproduced in the subsequent figures.

According to FIG. 3, the pair of rollers 1, 2 is associated with two guide tracks 31, 32. While the FIG. 1 embodiment shows an arrangement for one material, carrying both the negative and the positive layers, the FIG. 3 embodiment is adapted for processing two separate and distinct materials, one carrying the positive and the other the negative layer.

The guide tracks have adjacent inlets 33, 34 and in spaced relationship therefrom a roller pair each with roller 35, 36 and 37, 38, adapted to serve as transporting means and heat baffle in the arrangement comprising a heating unit 39, or else as preheating arrangement, in which at least one roller of each set of rollers, namely preferably the adjacently mounted rollers 35, 37 are equipped with heating elements, for example, as described in conjunction with rollers 1 and 2. The rollers 35 through 38 are driven and revolve in the direction indicated by the arrows.

The rollers 36 through 38 are rotatably mounted in the left housing wall. The drive is taken from the transmission as shown in FIG. 1 for the rollers 90.

The heating device 39 is connected into a circuit 93 with a power source 94 and an adjusting element 95. These parts may also be located in the connecting unit 6.

On their remote sides, the guide tracks 31, 32 are defined by the guide members 40 and 96, mounted in walls parallel to the plane of the drawing. The facing sides are equipped with guide elements 97, 98 which are permeable to heat radiation and consist, for example, of perforated plastic, wire mesh, or the like.

Between the guide tracks 31, 32, a heating device, equipped for example with heat radiators, may be so located that it is effective upwardly and downwardly, i.e. affecting both guide tracks 31, 32 so that the layers are heated before they reach the rollers 1, 2.

The apparatus according to FIG. 3 shows also a construction for carrying out a two-stage heating, namely once with the application of pressure by the rollers 35 through 38 and once without the application of pressure by the heating device 39 prior to the line pressing between the rollers 1, 2, during which a third application of heat may be effected if desired.

Conveniently, the guide tracks are so arranged that the materials are brought together on the lower guide face 40 of the delivery track 32 and run from there to the gap between the rollers 1 and 2.

FIG. 3 shows a further configuration according to which a third guide track 41 is connected to the pair of rollers 1, 2, terminating in a pair of conveyor rollers 42, 43 in front of the delivery slot of the apparatus and in which a further heating device 44 effects the after-heating of the superimposed materials after the line pressing. Such an additional heating device may also be provided with all types of apparatus hereinafter described.

The said heating device 44 is connected in a circuit 99 with a power source and an adjusting member. The pair of conveyor rollers 42, 43 is mounted rotatably in the right housing wall. The guide track 41 is defined at the bottom by the guide element 100 and at the top by the guide element 101, open at least in part towards the heating element 44 and mounted in the side walls of the housing.

FIG. 4 shows two separate guide tracks 45, 46 upstream of the pair of rollers 1, 2 which run together in front of the roller gap 1, 2 each equipped with a pair of conveyor and/or heating rollers 47, 48 and 49, 50, having the construction described in conjunction with the rollers 35 through 38 in FIG. 3. The guide elements 102, 103, 104, 105, defining the guide tracks 45, 46 are mounted in the side walls parallel to the plane of the drawing. They are permeable to heat radiation at least within the zone of the heating elements, such as, for example, through perforations, in the manner hereinbefore described. The rollers 47 through 50 are driven in the sense indicated by the arrows, as mentioned in FIG. 1 in conjunction with roller 90. The possible heating element arrangements are indicated at 51, 52, 53, 54, and connected with a terminal and driving unit 6 in the same manner as the elements 11 and 21.

A circuit is shown at 106, indicating the connecting lead, the arrangement of adjusting elements 107 and a power source 108.

A heating arrangement 55, 56 is located along each guide track on the mutually facing sides of these tracks, having for example the form of a heat radiator. However, additional heating arrangements 57, 58 on opposite sides of the guide tracks 45, 46, or only these latter arrangements fall also within the scope of the invention.

Moreover, the invention relates also to an embodiment in which one guide track, say 46, is free from heating elements, or has only a single heating element corresponding to the rollers 49, 50, while the other guide track, for example track 45, has heating elements 55, 57

and/or a heatable pair of rollers 47, 48. The guide track 45 may also be equipped with only a single heating arrangement 55 or 57, conveniently 55. This embodiment makes it possible to preheat only the negative or the positive in a certain manner, for example, in several stages, possibly under pressure, while the other sheet of material is applied without preheating (or with another preheating) to the cold or hot line pressing between the rollers 1 and 2.

FIG. 5 shows an embodiment with two delivery tracks 59, 60 upstream of the pair of rollers 1, 2, each having only one pair of conveyor or heating rollers 61, 62 and 63, 64. The rollers 61 through 64 are located rotatably in the housing walls parallel to the plane of the drawing. These side walls also carry the guide members which define the guide tracks 59, 60 towards the top and bottom and the construction of which is as described hereinbefore. The rollers are equipped with heating elements 65 through 68 and revolve in the direction of the arrows. The guide track 60 shows that the guide tracks need not be equipped with guide elements 109 extending over their entire length, in order to define the delivery. The guide elements may also be perforated, especially those located inside the housing of the apparatus.

The adjusting elements 69 through 72 for the independent switching or adjustment of the heating elements 65 through 68 are shown with reference to the heating elements 65 through 68.

In FIG. 5, a second contact pressure and conveyor roller pair 73, 74 is provided downstream of the roller pair 1, 2 and may be heatable and driven in the same manner as this pair 1, 2, making possible an after-heating under pressure. The heating elements in the roller 73, 74 are shown at 112, 113. The circuit 114, the elements of which may be connected in the terminal unit 6, comprises a power source 115, and adjusting means 116.

FIG. 6 shows a device with a pair of rollers 1, 2 and with two guide tracks 76, 77 divided centrally by a guide member 75. This guide member is mounted on the side walls and extends into the inlet slot 23. Downstream thereof, there may be heatable conveyor rollers 78, 79 mounted in the side walls, driven in the direction indicated by the arrows and biased by springs 80, 81 towards the guide element 75. The rollers are so guided, for example by means of the mounting described in conjunction with the roller 1 above, that they keep a minimum gap relative to the guide element 75 which is smaller than the thickness of the material supplied thereto.

Above the delivery track 76 there may be mounted and fixed to the frame a heating arrangement 82, for example, a source of radiation, while the guide element 83, defining the lower side of the delivery track 77 and leading to the gap between the rollers 1, 2 may be equipped with a heating arrangement 84 having the form of an upwardly radiating radiator. The heating devices 82, 84 are individually operable and adjustable. Also the said heating arrangement 84 is mounted to the side walls of the frame. The drawing shows the circuits between the electrical elements 110, 111.

FIG. 6 shows an after-heating arrangement 85, similar in construction to the after-heating stations in FIGS. 3 and 5, combining, for example, the characteristic features of these devices and not described in further detail.

It should also be pointed out that the downstream end of an after-heating device may be equipped with a separating device 86 of known construction, such as with pivoting segments or with a pair of separating rollers so that the positive of the developed and fixed picture is delivered independently of the negative which remains in the apparatus.

The invention is not limited to the embodiments described hereinbefore by way of example and comprises particularly also various combinations of the feature disclosed hereinbefore with reference to various drawings.

Having thus fully disclosed my invention, what I claim and desire to secure by Letters Patent is:

1. A reproduction apparatus for the diffusion-transfer of an image to a copy-receiving sheet from a thermally-activatable latent-image-carrying reproducing sheet having an emulsion layer containing a heat-activatable substance adapted to release a diffusion medium, comprising a housing; inlet means and outlet means in said housing respectively for receiving said reproducing sheet and discharging said reproducing and copy-receiving sheets; means intermediate said inlet means and said outlet means for providing a transport path for said reproducing sheet for the reproducing sheet and a transport path for said copy-receiving sheet; a pair of drums disposed on opposite sides of said transport path and rotatable in engagement with the reproducing and copy-receiving sheets passing therebetween; spring means resiliently bearing on at least one of said drums for pressing them into line engagement; means for setting the minimum gap between said drums; heating means along said path for said reproducing sheet between said drums and said inlet means and including a heated surface adapted to heat said emulsion layer upon confronting same for thermally activating said substance to at least partially release said medium prior to the passage of said sheets between said drums; and means for passing said copy-receiving sheet and said reproducing sheet concurrently between said drums.

2. An apparatus as defined in claim 1 wherein said inlet means includes a pair of feed rollers, said apparatus further comprising common drive means for concurrently displacing said feed rollers and said drums at the identical peripheral speed, said heating means including a resistive heating body lying along said surface, and adjustable circuit means for controlling the temperature of said surface, said heating means being disposed at least in part laterally of said transport path of said reproducing sheet and transferring heat to said reproducing sheet in a nonpressed condition thereof.

3. An apparatus as defined in claim 2 wherein said heating means includes a plurality of heated rollers directly ahead of said inlet means.

4. An apparatus as defined in claim 2 wherein said means providing said transport path of said reproducing sheet includes a plurality of guide elements defining between said inlet means and said drums a pair of separate branches merging at said drums for said reproducing sheet and said copy-receiving sheet, respectively, said heating means being included in said elements.

5. An apparatus as defined in claim 4 wherein said heating means is positioned between said branches.

6. An apparatus as defined in claim 2 wherein said heating means is provided at least in part in said feed rollers.

7. An apparatus as defined in claim 2 wherein said transport path of said reproducing sheet is defined at least in part by a plate extending between said inlet means and said drums, said inlet means having slots for delivering said sheets to opposite sides of said plate, said feed rollers advancing the respective sheets along the respective sides of said plate for convergence of said sheets at said drums, said heating means including heated members closely spaced from said opposite sides of said plate.

8. An apparatus as defined in claim 1, further comprising feed rollers downstream of said drums between said drums and said outlet means, and further heating means between said drums and said outlet means.

9. An apparatus as defined in claim 8 wherein said further heating means is included in said feed rollers.

10. An apparatus as defined in claim 1 wherein said means for setting the minimum gap between said drums includes a pair of journal blocks rotatably supporting at least one of said drums, guide means in said housing slidably receiving said blocks for movement of said one drum toward the other of said drums, and spacer means interchangeably positionable in said guide means for

retaining said one drum in a selected position relatively
to the other drum.

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