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Wolff et al.

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[54] **COPY MACHINE COOLING AND DRYING SYSTEM**

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[52] **U.S. Cl.** **355/10,** 355/30

[51] **Int. Cl.** **G03g 13/10**

[58] **Field of Search** 355/10, 27, 30

[56] **References Cited**

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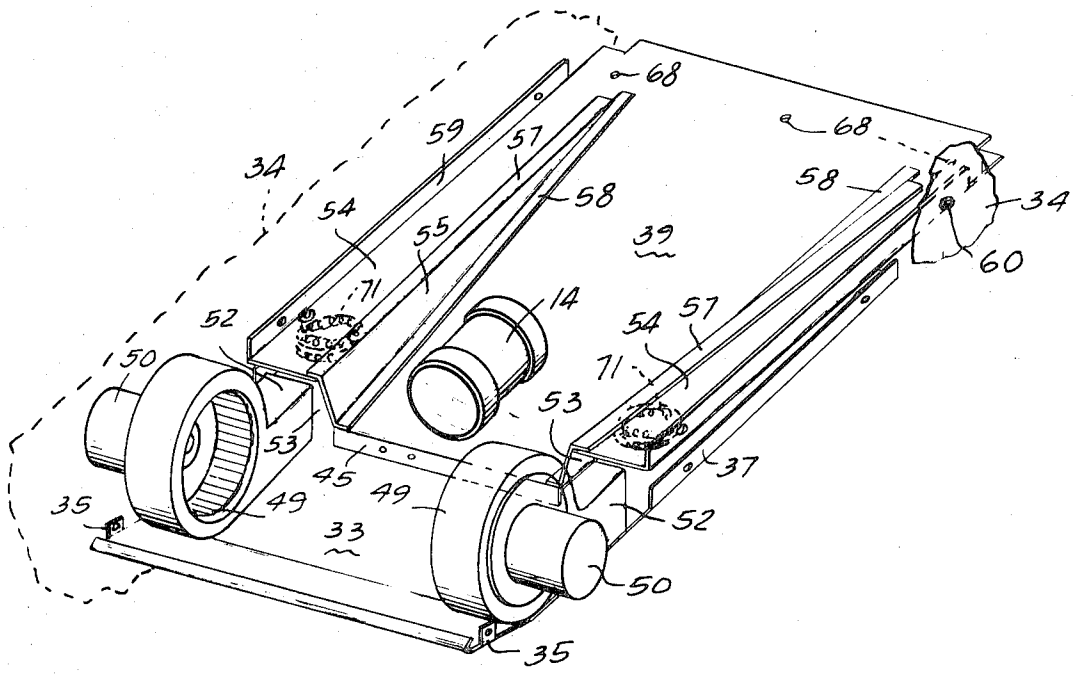
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Assistant Examiner—Michael D. Harris
Attorney—Benjamin H. Sherman et al.

[57] **ABSTRACT**

A copy machine cooling and drying system includes blower means mounted in the scanning chamber of a copy machine and operative to drive air from the chamber into a duct defined along a light tunnel wall and discharging in drying relation onto copy sheets after emergence from liquid developer. A balanced dual blower system is provided. Heretofore wasted tunnel space is utilized in the duct for transferring the air from the blowers to discharge from the duct. Such discharge is through an especially efficient arrangement of distribution ports. At least part of the duct structure provides copy sheet directing means. Start-up booster heating is provided.

18 Claims, 4 Drawing Figures



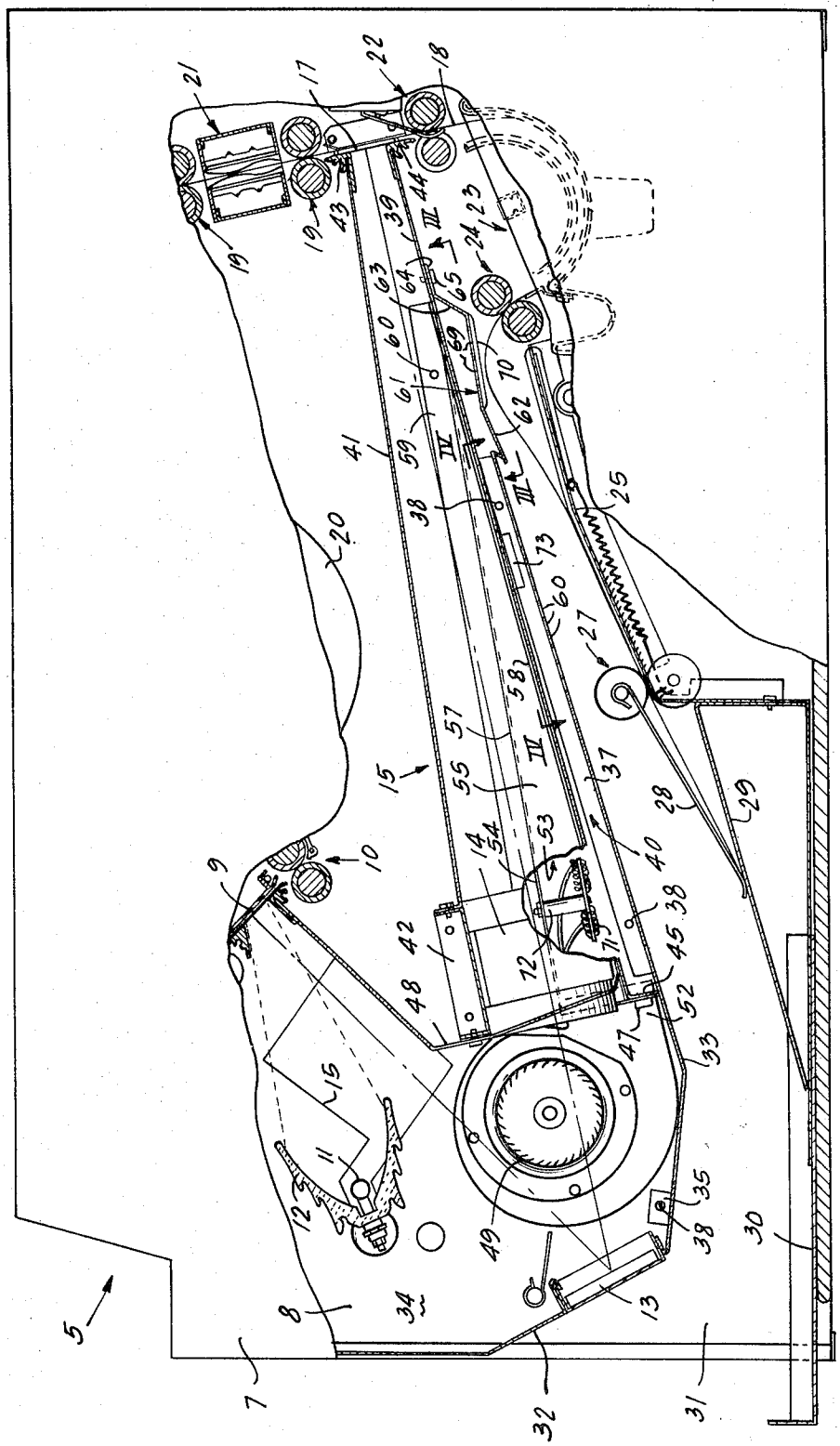


Fig. 1

Fig. 2

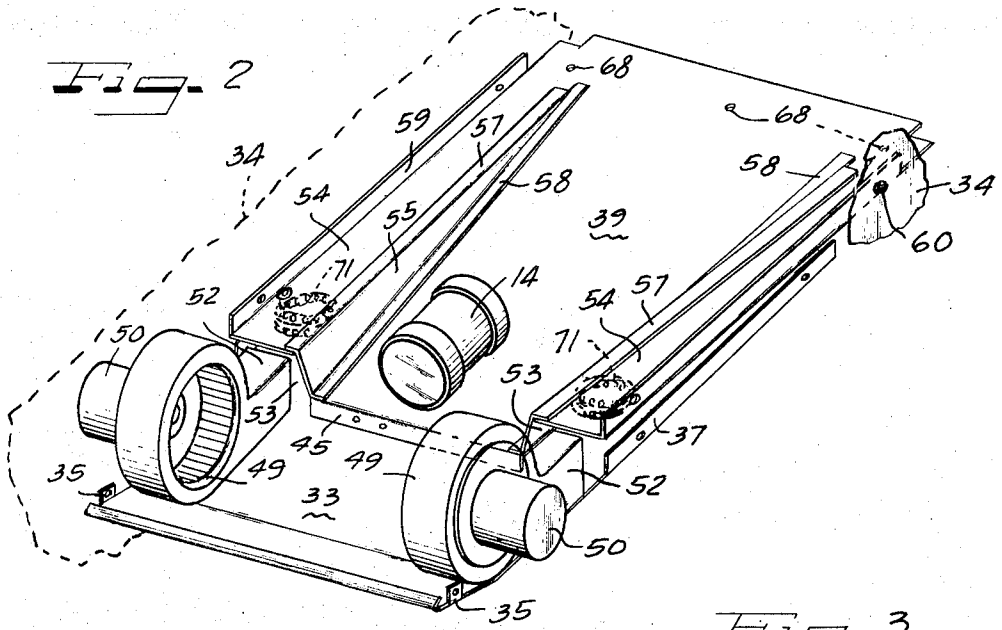
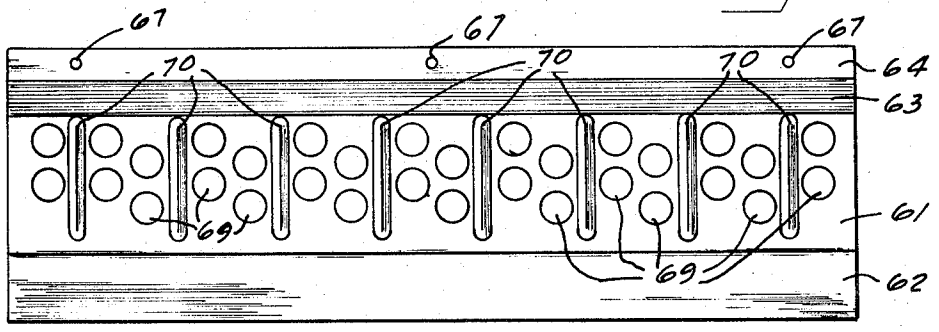


Fig. 3



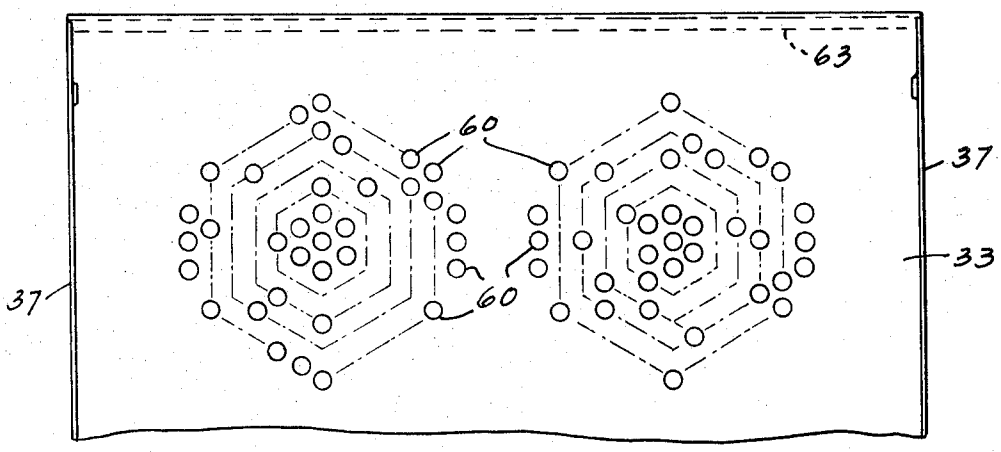


Fig. 4

COPY MACHINE COOLING AND DRYING SYSTEM

This invention relates to copy machine cooling and drying system and is more particularly concerned with an arrangement especially suitable for compact desk model liquid development electrostatic copiers.

A continuing problem in liquid development copiers has been sufficiently rapid drying of the copies produced at high speed and relatively short travel distance from the developing station to the receiving station. Although overhead drying air supply directed downwardly against the damp developed copy sheet has been used with some success, prior systems have been less efficient than desired. Although there has been use made of scanning lamp heat to warm the air then directed into drying relation with the damp copy sheets, a serious problem has persisted during start-up before the air in the vicinity of the lamp has been warmed to an efficient degree. Another problem has been that of providing sufficient volume of drying air in a properly applied manner to the damp copy sheets. Yet another problem has resided in that the duct work for conducting the air from source to point of projection toward the damp copy sheets has required excessive headroom or has been sacrified in volumetric capacity to attain compactness in the associated machine.

Accordingly, an important object of the present invention is to overcome the foregoing and other disadvantages, deficiencies, inefficiencies, shortcomings and problems in prior structure and to attain important advantages and improvements as will hereinafter become apparent.

Another object of the invention is to provide a new and improved drying air duct means in a wet development copier.

A further object of the invention is to provide a new and improved light tunnel and air duct structure in a copymaking machine.

Still another object of the invention is to provide an especially efficient drying air distribution and projection arrangement for wet development copymaking machines.

Yet another object of the invention is to improve the volume and distribution of the drying air supply for treating damp copy sheets in a copier.

A yet further object of the invention is to provide an efficient start-up booster heating arrangement for the drying air supply in a damp development copymaking machine.

A still further object of the invention is to provide new and improved means for cooling an electrostatic copier and utilizing the air warmed by the scanning chamber lamp for drying damp copy sheets after wet development.

Other objects, features and advantages of the invention will be readily apparent from the following description of a preferred embodiment thereof, taken in conjunction with the accompanying drawings, although variations and modifications may be effected without departing from the spirit and scope of the novel concepts embodied in the disclosure, and in which:

FIG. 1 is a generally schematic side elevational view of a copymaking machine showing features of the invention;

FIG. 2 is an isometric view showing the air duct system;

FIG. 3 is a fragmentary enlarged plan view taken substantially in the plane of line III—III of FIG. 1; and

FIG. 4 is a fragmentary enlarged plan view taken substantially in the plane of line IV—IV of FIG. 1.

On reference to FIG. 1, a copymaking machine 5 is shown by way of example, more-or-less schematically, and comprises a relatively small, compact desk model electrostatic copier housed within a cabinet 7. Within the cabinet is provided a scanning chamber 8, in this instance in the front upper portion of the cabinet, including means in the upper portion thereof defining a scanning aperture 9 at which a document to be copied is scanned. As shown, the scanning aperture 9 is associated with transport means 10 in this instance comprising a transport system including driven rollers, but this aperture may be of any other desired form such as a full scanning window, a book copier arrangement over which a reciprocating carriage transports the document or other object to be copier, or the like. Whatever the form or disposition of the scanning aperture 9, light produced by a lamp 11 is concentrated by a reflector 12 into the scanning aperture to illuminate the object of which the surface presented at the aperture is to be copied by scanning through an optical system which projects the scanned image onto a copy sheet. Herein this is effected by means of a mirror 13 mounted in the lower front portion of the scanning chamber 8 and which projects the scanned image rearwardly through a lens system 14 located at the front of a light tunnel 15 and extending rearwardly and upwardly to an exposure aperture 17. Copy sheets 18 are transported as by means of driven sets of rollers 19 from a suitable supply such as a stack of cut sheets from a magazine in the upper portion of the cabinet or from a supply roll 20 first through an electrostatic corona discharge device 21 and then across the exposure aperture 17 where the projected image is impressed on the charged sheet surface. From the exposure aperture 17, the exposed copy sheets 18 and transported by means such as rollers 22 through wet developer means, herein comprising a developer tray 23 suitably supplied with liquid and suspended toner. At the discharge side of the developer tray 23, the developed copy sheets 18 are drivingly engaged and squeezed by means such as rollers 24 which advance the damp sheets forwardly over a downwardly and forwardly slanting ramp 25 having at its forward end feed-out roller means 27 which advance the copy sheet on under a pivoted hold-down 28 over a ramp extension 29 which leads to a copy sheet receptacle tray 30 in a receiving space 31 under the exposure chamber 8 and freely accessible at the front of the machine cabinet. Separating the exposure chamber 8 from the receiving space and providing a light barrier is a front panel 32 and a separating panel 33, the latter extending from the lower end of the front panel 32 and rearwardly therefrom spaced above the ramp 25 and the extension 29 and providing a copy paper chute leading to the front of the cabinet. Mounting of the panels 32 and 33 within the cabinet is to and between opposite parallel vertical frame panels 34 (FIGS. 1 and 2), the panel 33, at least, being provided with suitable upstanding side attachment flanges 35 and 37 which are secured as by means of screws 38 to the frame panels 34.

In addition to its chamber separatiang and light shielding function, the panel 33 is constructed and arranged to serve as an important part of an air duct system for cooling the illumination and scanning chamber

8 and drying the devloped copy sheets 18 after they leave the developer tray 23. To this end, the plate 33, which serves as a roof for the copy sheet exit chute, cooperates with the bottom wall of the light tunnel 15 provided by a plate 39 to define an air duct system 40 leading to adjacent terminating adjacdent the feed-out rollers 24 at the developer station. In a desirable arrangement, the bottom panel 39 of the light tunnel cooperates with a top panel 41, both of the panels being of a width to extend fully between the vertical frame panels 34. At its forward end the top panel 41 is supported on a transverse frame bracket bar 42 which also supports the lens assembly 14. At its rear end the panel 15 is supported by a transverse bracket bar 43 which also serves as the upper side of the exposure aperture. Similarly, the rear end of the bottom tunnel panel 39 is supported by a transverse bracket bar 44 which serves as the bottom edge of the exposure aperture. At its front end portion, the panel 39 underlies the lens assembly 14 and has a downturned spacer and attachment flange 45 which defines a shallow air duct gap spaced relationship to the underlying panel 33 and is secured as by means of screws 47 to the lower end portion of a rear closure panel 48 for the light chamber 8 extending from the scanning aperture 9 to the panel 33, with a suitable opening therein to accommodate light beam access from the mirror 13 to the lens system 14.

For large volume cooling air circulation through the chamber 8 and correspondingly large volume drying air delivery to the air duct system 40, blower means are mounted in the lower part of the chamber 8, desirably comprising a pair of squirrel cage blowers 49 respectively mounted one on each of the frame panels 34 and each driven by a respective motor 50, with the intake opening from each of the blower housings exposed to the interior of the chamber 8 so that the air which is drawn into the respective blowers will circulate past the lamp 11 as for example through air entry openings 51 in the frame panels 34 generally aligned with the portion of the chamber 8 where the greatest heat is generated in the operation of the lamp 11. Thereby large volume of air is drawn into the chamber 8 in the operation of the blowers 49 not only through the openings 51 but other openings such as in the vicinity of the exposure aperture 9, etc., for cooling circulation through the chamber 8, with exhaust from the blowers 49 being into the drying air duct system 40.

In order to accommodate respective exhaust nozzles 52 from the blowers 49, and to assist in directing the air for most efficient application to the damp copy sheets for drying the same, while maintaining the utmost compactness of structure, means are provided forming respective air duct lead-in passages 53 along the opposite sides of the tunnel 15 and communicating with the respective discharge nozzles. In a simple, economical and efficient construction, each of the lead-in passages is desirably formed in the tunnel lower panel 39. Accordingly, this panel is desirably constructed from a sheet metal plate which has respective opposite side marginal portions partially severed along longitudial lines from the front end of the panel to adjacent but spaced from the rear end of the panel and providing a passage roof 54 offset by bending the same up from the main plane of the panel along the line of the rear end juncture thereof with the panel body sufficiently to accommodate the height of the associated nozzle 52 as well as being of a width to accommodate the width of the nozzle. To close the inner sides of the passages 53 from the inside of the light tunnel 15, respective elongated triangular closure plates 55 are mounted between the inner edges of the marginal sections 54 and the adjacent edges of the body of the panel 39 from which severed, angular longitudinal outwardly projecting respective attachment flanges 57 on the offset enclosure plates being attached to the sections 54 and inwardly angular respective longitudinal attachment flanges 58 on the plates being fixedly secured to the body of the panel 39. Along their longitudinal outer edges, the offset panel sections 54 are provided with respective attachment flanges 59 secured as by means of screws 60 to the contiguous frame panel 34.

At their rear ends, the duct passages 53 terminate in the plane of the panel 39 generally vertically above the feed-out rollers 24. As a result of the diminishing cross sectional flow area of the passageways 53 from their inlet ends at the discharge nozzles 52 to the rear ends of the passageways, and by having the area of the duct system 40 which provides a relatively flattened plenum chamber of gradually diminishing cross sectional flow area from the front end toward the rear end, the progressive restriction causes gradual increase in air pressure for efficient drying discharge onto the damp copy sheets passing thereunder in the copy sheet delivery passageway chute over the ramp 25.

To implement and improve distribution and direction of the thus pressurized air from the blowers 49 onto the copy sheets, the rear end portion of the duct panel 33 is provided with an efficient pattern of air distribution and delivery ports 60. For best results, due to the relative concentration of air in this area from the two delivery passages 53, the ports 60 are provided in two identical, balanced relation groups of perforations each of which groups covers a similar area, in relatively transversely spaced relation, of the panel 33 overlying the ramp 25. For example, where the total width of the panel 33 is about 12½ inches, each of the groups perforations, arranged in generally pentagonal shape may extend a little over 4 inches in any direction with a uniform number of the perforations such as 194 holes one-quarter inch in diameter in each group with the perforations uniformly distributed in each group.

By preference the duct plate 33 extends short of the total length of duct desired, and a combination duct terminal and deflector plate 61 provided of a width to extend fully between the frame panels 34 and of a length to underlap the rear end of the panel 33 and to extend into overlying relation to the feed-out rollers 24. In a desirable configuration, the plate 61 has a front end lip flange 62 which engages against an underturned reinforcing flange along the rear edge of the panel 33. Rearwardly from the lip flange 62 the plate 61 is maintained in spaced relation to the underface of the tunnel panel 39 by means of an offsetting flange 63 joining an attachment flange 64 along the rear margin of the plate. Attachment of the flange 64 to the panel 39 is by means of screws 65 extending through screw holes 67 in the flange and tapped into corresponding screw holes 68 in the panel 39. Through this arrangement, the plate 61 provides a rearward extension of the plenum and duct passages 53 provided between the panels 33 and 39 and also serves as a rear closure for the plenum. In addition, the plate 61 provides an extension of the drying air delivery and distribution port system from the delivery duct system, being for this purpose pro-

vided in that area thereof between the flanges 62 and 63 with a pattern of a plurality of port perforations 69. For example, there may be 32 of the holes 69 of about one-half inch in diameter, located in desirable groups along the width of the perforated area, in a uniformly balanced relationship and located to issue the air downwardly against the damp, developed copy sheets as they are advanced from the rollers 24, and with the juncture of the offsetting flange 63 with the perforated body of the plate relatively close to the upper of the rollers 24 so that the rollers provide, in effect, a barrier, together with the imperforate offsetting flange 63, against rearward travel of the drying air, thus protecting the developer tray against evaporating effect of such air, and taking advantage of the air for its intended purpose, namely drying the copy sheets efficiently and rapidly.

In addition to its air distribution function, the plenum terminal and air distribution plate 61 conveniently serves as a copy sheet deflector toward which the copy sheets are directed by the rollers 24 in a generally upward and forward direction and from which the sheets then turn downwardly and forwardly to the ramp 25 and onward into the nip of the rollers 27. To avoid closing of the ports 69 and to prevent any tendency for adherence of damp or wet copy sheets to the deflector surface of the plate 61, the plate is provided with a plurality of longitudinally extending downwardly projecting deflector ribs 70 desirably uniformly spaced across the body of the plate between groups of the perforations 69. Beyond the forward ends of the ribs 70, if the leading end of a copy sheet has not already turned downwardly toward the ramp 25, the front end flange 62 serves a further deflecting function and for this purpose is desirably turned obliquely generally downwardly and forwardly, and by the spaced relation of the forward end of the flange from the adjacent portion of the panel 33 positively deflects the leading end of the copy sheet away from the panel 33 and toward the ramp 25.

At cold start-up of the machine, only cold air will be initially derived from the scanning chamber 8 by way of the blowers 49, resulting in slow and possibly inadequate drying of the first produced copy sheets. Accordingly, until sufficient heat has been generated by operation of the lamp 11 to raise the air temperature sufficiently for efficient drying, means are provided for heating the air downstream from the blowers, in the duct passages 53, and also serving for booster heating should the lamp-generated temperature drop below a desirable degree. To this end, small resistance heaters 71 (FIGS. 1 and 2) are mounted in the front, larger portions of the passages 53 just behind the nozzles 52. These heaters may be of the kind commonly used in hairdryers capable of very rapid warm-up, being of low cost, and of modest power consumption. By having one of the heaters 71 suspended as by means of a bracket 72 from the associated passage roof panel portion 54 and located adjacent to and substantially centered relative to the adjacent blower nozzle 52, extremely efficient heating of the drying air driven into and through the duct system is attained immediately on start-up of the machine so that by the time the copy sheet has travelled through its delivery path, exposure zone and the developer tray 23 and emerges from between the feed-out rollers 24, the air issuing from the ports 60 and 69 has reached a satisfactory drying temperature. Then, as the illumination lamp heat builds up and is added to the heat produced by the heater 71, and the temperature of the drying air reaches the maximimum degree considered safe for the purpose, the heaters 71 are deenergized by operation of any preferred form of thermally actuated switch 73 located at a suitable point downstream from the heaters and desirably in the delivery port area of the duct system. It will be understood, of course, that the electrical resistance heaters 71 and the control thermal switch 73 which may be a conventional thermostatic switch, will be connected in an electrical operating circuit for the machine, which circuit includes the motors 50 for the blower fans 49, the electrical illuminating lamp 11, the corona discharge device 21 and all other operating and control devices for the machine including drive motor for the conveyor roller systems, liquid toner pump where desired, and the like, and including suitable control switches.

It will be understood that variations and modifications may be effected without departing from the spirit and scope of the novel concepts of this invention.

We claim as our invention:

1. In a copymaking machine including a chamber providing a document scanning zone and having an illumination lamp therein, an exposure zone, means for transporting copy sheets through said exposure zone, an optical system for translating a scanned image from the scanning zone to a copy sheet in the exposure zone, and liquid development means for the exposed copy sheets:

means for guiding the developed copy sheets from said development means to receiving means;

a structure providing a tunnel through which the optical system translates the image between said zones;

said tunnel structure including enclosure panel means facing in spaced relation toward said guiding means;

air duct panel means located between said enclosure panel means and said guiding means and facing toward said guiding means and with said enclosure panel means defining an air duct system;

said air duct system including a shallow plenum duct area with a major portion of said tunnel enclosure panel means;

blower means mounted in said scanning chamber;

a lead-in passageway along one side of the tunnel;

said passageway being of substantial cross sectional flow area at an end near said chamber and at said end communicating with said blower to receive air from within said chamber impelled by said blower into the passageway;

said passageway opening along its length into said plenum duct area and delivering the air from the passageway into the plenum duct area; and

said duct panel means in said plenum duct area having means for directing air from the plenum duct area toward said guiding means for drying copy sheets after the sheets leave said development means in movement along said guiding means.

2. A copymaking machine according to claim 1, including a second passageway along an opposite side of said tunnel and also communicating in air delivering relation along its length with said plenum duct area, and another blower in said chamber drawing air from within the chamber and discharging into said another passageway for delivery of the air through said another passageway into the plenum duct chamber in addition

to the air from said passageway along said one side of the tunnel.

3. A copymaking machine according to claim 1, including start-up heating means in said duct system, and means for controlling said heating means to maintain proper heat level in the drying air correlated with the heat generated by said lamp in the air drawn by said blower means from within said scanning zone chamber.

4. A copymaking machine according to claim 1, including a cabinet having said document scanning zone chamber in the forward upper portion thereof, means enabling air circulation into said chamber for cooling said scanning zone by operation of said blower means, said blower means comprising a blower having its intake within said chamber and provided with a discharge nozzle delivering into said passageway said duct panel means underlying said tunnel panel means and including a portion providing closure for the bottom of said chamber spaced above a copy sheet receptacle, and means below said duct panel means providing a developed sheet delivery chute extending from said development means to said receptacle.

5. A copymaking machine according to claim 4, wherein said duct panel means include a combination duct end closure and copy sheet deflector having perforations therein through which air is discharged initially onto the developed copy sheets on leaving the development means and cooperating with a rear end portion of a main panel to deflect developed copy sheets downwardly therefrom.

6. A copymaking machine according to claim 4, wherein said blower means comprise a pair of blowers which are located at respectively opposite sides in the lower portion of said scanning zone chamber, said optical system including a lens assembly centrally located at the chameber end of said tunnel and with the image path extending centrally through the tunnel to said exposure zone which is located at an opposite end of the tunnel, said tunnel panel means including a central portion underlying said optical image path and respective passage formations upwardly offset relative to said central portion and defining with said duct panel means said passageway longitudinally along one side of the tunnel and a second passageway longitudinally along an opposite side of said tunnel communicating with a duct plenum space between said central portion and said duct panel means, said blowers respectively discharging into chamber ends of said passageways.

7. A copymaking machine according to claim 6, wherein said passage formations progressively diminsh in cross sectional flow area from said chamber ends thereof to adjacent said discharge means.

8. A copymaking machine according to claim 6, including start-up heating means in each of said passages.

9. A copymaking machine according to claim 8, said heaters comprising electrical resistance heaters mounted in the path of discharge from the blower nozzles and adjacent thereto, and thermal switch means in said duct system for controlling said heaters.

10. In a copymaking machine including a chamber providing a document scanning zone, an exposure zone spaced from said scanning zone, means for transporting a copy sheet through said exposure zone, an optical system for translating scanned images from said scanning zone to copy sheet in said exposure zone, liquid development means for exposed copy sheets, and means for transporting the developed copy sheets from said development means;

a tunnel structure through which the optical means translates the iamge between said zones including an enclosure panel;

panel means located between and facing toward both said transporting means and said enclosure panel and defining an air duct system with said enclosure panel and including means for directing drying air toward said transporting means onto the developed copy sheets as transported from the development means;

said air duct system including passages at each side of said tunnel structure leading to a common plenum between said passages at said air directing means; and

respective blowers discharging into said passages.

11. A copymaking machine according to claim 10, said enclosure panel having side marginal portions thereof partially separated along longitudinal lines, and spacer and closure plate means secured to and between the severed edges and offsetting said marginal portions to define enclosure panel portions of the passages of larger cross sectional flow area at inlet ends into which the blowers discharge, said passages progressively diminshing in cross sectional flow area from said inlet ends to said air directing means.

12. A copymaking machine according to claim 11, including respective rapid warmup resistance heaters mounted in said passages adjacent to the inlet ends, and thermally responsive means in said passages downstream from said inlet ends for controlling said heaters.

13. A copymaking machine according to claim 10, said panel means including respective multi-aperture ported plate areas generally aligned with said passages and providing at least a portion of said air directing means.

14. A copymaking machine according to claim 13, including additional plate area in downstream relation to said ported areas and having a pattern of air direction apertures supplemental to the ported areas.

15. A copymaking machine according to claim 14, said downstream plate area including means for deflecting the copy sheets from said development means past said air directing means.

16. In a copymaking machine including document scanning and copy sheet exposing means with a light tunnel structure operatively connecting the scanning and exposure means, liquid development means for exposed copy sheets, and means for transporting the developed copy sheets from said development means;

said tunnel structure including an enclosure panel extending therealong and spaced from said transporting means;

air motivating means; and

panel means located between said enclosure panel and said transporting means and defining with said panel an air duct system into which said air motivating means drives air;

said panel means including means for directing air toward said transporting means in drying relation to copy sheets leaving said development means; and

said air directing means including successive spaced areas of air directing ports.

17. A copymaking machine according to claim 16, wherein the downstream area has ports which are larger than the ports in the upstream area.

18. A copymaking machine according to claim 16, wherein said panel means defining the duct with the tunnel enclosure panel comprise a principal panel having an edge adjacent to said developing means, and a combination duct closing sheet deflecting and air directing means plate attached to said tunnel panel and lappingly engaging said edge, said plate having air directing ports therein and also having spacer ribs between said ports to limit contact of copy sheets therewith.

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