Dec. 17, 1940. B. OFFEN 2,225,505

DRYING METHOD AND APPARATUS

Filed April 30, 1937 2 Sheets-Sheet 1

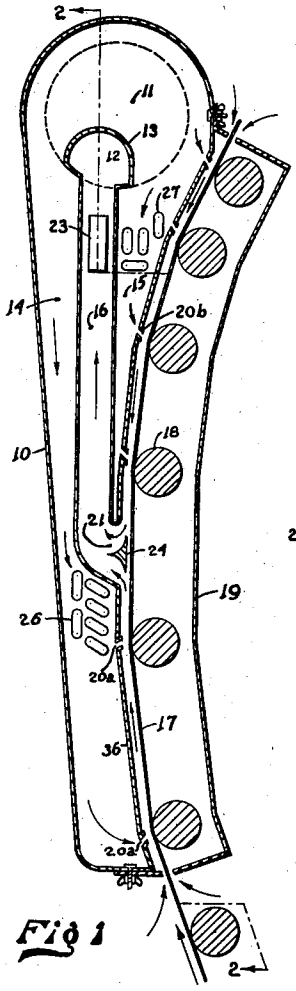


Fig 1

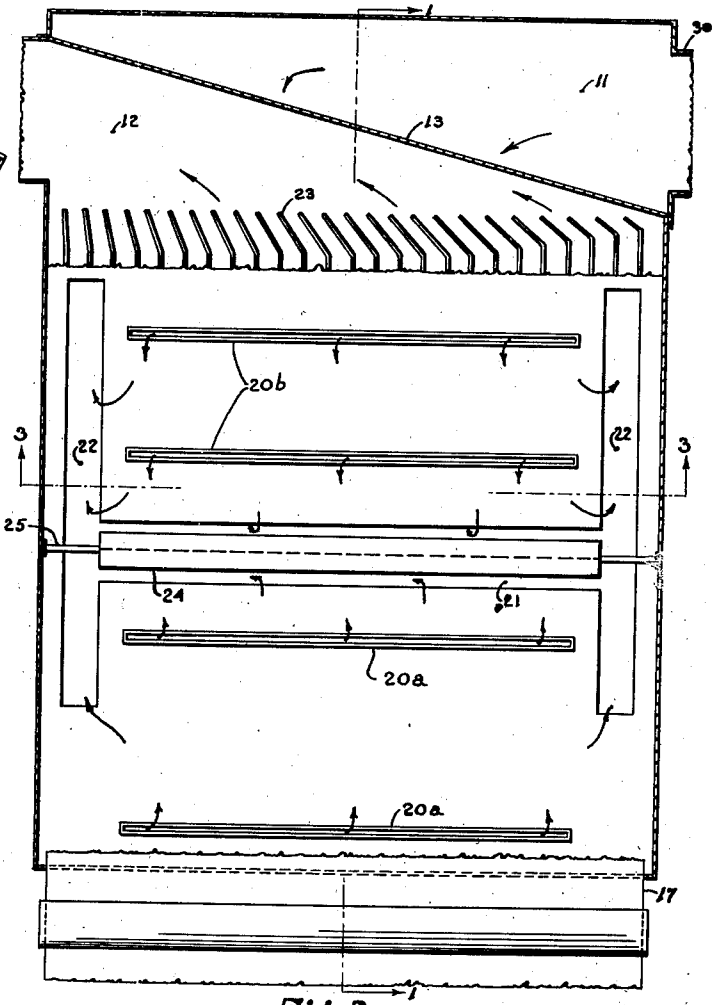


Fig 2

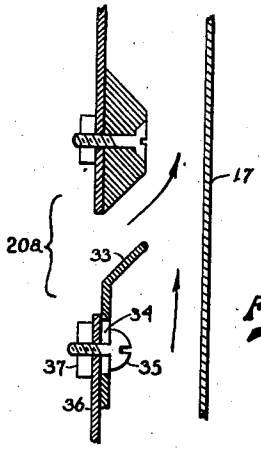


Fig 4

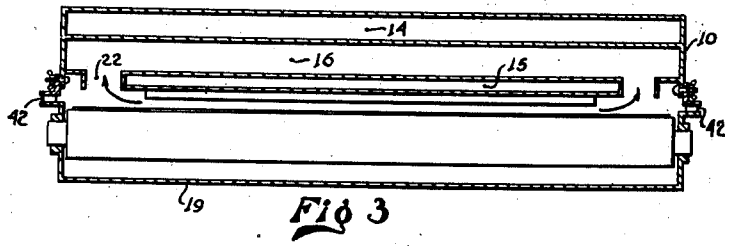


Fig 3

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DRYING METHOD AND APPARATUS

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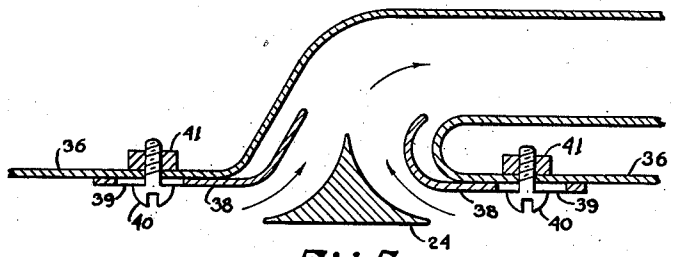


Fig 5

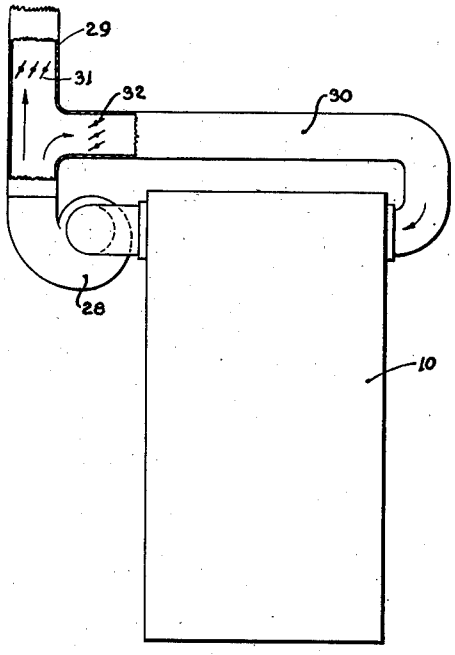


Fig 6

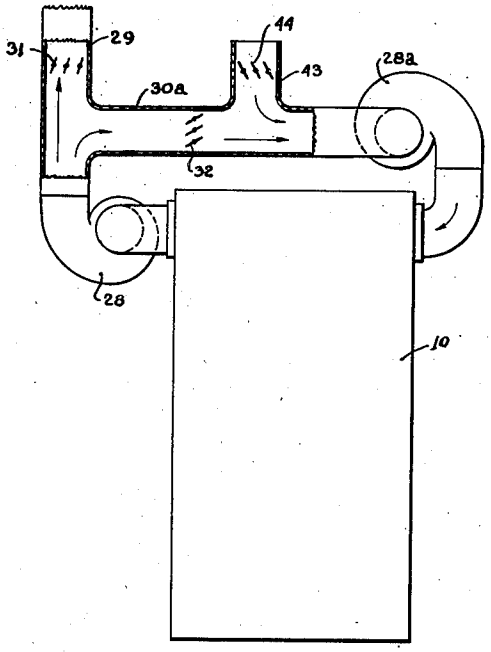


Fig 7

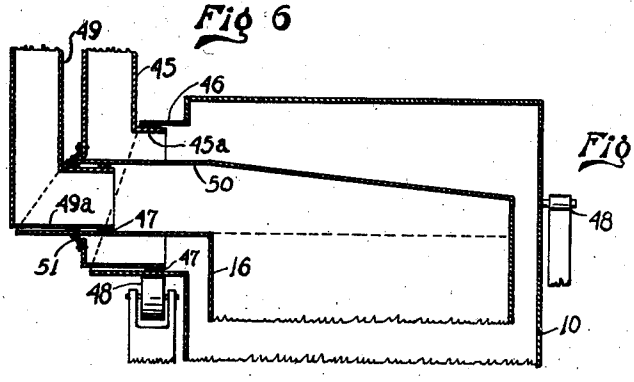


Fig 8

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Patented Dec. 17, 1940 2,225,505

UNITED STATES PATENT OFFICE

2,225,505

DRYING METHOD AND APPARATUS

Bernard Offen, Chicago, Ill.

Application April 30, 1937, Serial No. 139,831

3 Claims. (Cl. 34—24)

This invention relates to the art of drying, and more particularly, to a novel drying method and apparatus.

This application is a continuation, in part, of the subject matter disclosed in my patents issued subsequent to the filing date hereof, Numbers 2,152,770, 2,123,341 and 2,141,403.

The general object of this invention is to provide an improved method and apparatus for drying web materials, and more particularly for drying such materials as freshly inked paper and the like.

It is an object of the present invention to provide an improved drying apparatus capable of effecting highly efficient drying of printed surfaces and the like, and which uses a relatively small quantity of drying air.

It is another object of the invention to provide a drying apparatus in which relatively high air velocities are maintained at the surface to be dried.

It is another object of the invention to provide a drying apparatus for drying freshly printed surfaces and the like, which is adapted to prevent solvents evaporated from the surfaces from reaching explosive concentrations in the atmosphere within the apparatus.

It is another object of the invention to provide a drying apparatus for drying freshly printed surfaces and the like, in which case hardening of the inks is prevented.

It is another object of the invention to provide a drying apparatus for drying printed surfaces and the like, which is adapted to operate efficiently and safely during both normal operation and during periods when the presses and drying apparatus are being started up. In the past, much difficulty has been encountered in preventing explosions and in avoiding excessive breakage of the paper during this starting up period. The invention overcomes both of these difficulties.

A feature of the invention resides in the novel arrangement of air supply and exhaust ports within a drying hood or the like.

Another feature of the invention resides in a novel method of and apparatus for routing air beneath a drying hood or the like, in contact with a surface to be dried.

Another feature of the invention resides in selectively controlling the temperature of air in different portions of a drying hood or the like, in accordance with requirements of the material to be dried.

Another feature of the invention resides in the provision of novel means for facilitating air flow into the exhaust opening of a drying hood and for preventing the flapping of a material to be dried against said exhaust opening.

Another feature of the invention resides in the provision of a novel method of supplying air to a drying hood and exhausting said air and other air therefrom.

Other objects, features and advantages of the invention will be more apparent from the following descriptiton, to be read in connection with the accompanying drawings, in which

Fig. 1 is an elevational sectional view through a drying apparatus in accordance with the invention, taken on line 1—1 of Fig. 2.

Fig. 2 is an elevational view of the apparatus of Fig. 1, taken on the line 2—2 of Fig. 1.

Fig. 3 is a view taken on the line 3—3 of Fig. 2.

Fig. 4 illustrates on an enlarged scale one of the adjustable air supply nozzles of the apparatus.

Fig. 5 is a sectional view on an enlarged scale illustrating applicant's adjustable exhaust outlet and its associated deflector means.

Fig. 6 is a diagrammatic view in elevation of an air circulating system adapted to be employed in conjunction with the apparatus of Figs. 1–3.

Fig. 7 is a diagrammatic view in elevation illustrating a modified form of air circulating system; and

Fig. 8 diagrammatically represents an alternative duct arrangement.

Referring now to the drawings numeral 10 designates generally a drying hood. Formed in the upper portion of the hood 10 is an air supply chamber 11 and an air exhaust chamber 12, separated by partition 13. Air supply chamber 11 communicates with supply passage 14, leading to the lower part of the hood, and with supply passage 15 leading to the upper part of the hood. Interposed between supply passages 14 and 15 is exhaust passage 16, communicating with exhaust chamber 12.

The freshly inked surface to be dried, 17, is routed upwardly adjacent the hood 10 over rollers 18. Preferably, a sealing member 19 is provided to enclose the rollers in a manner well known in the art. At the face of the lower portion of the hood are provided a plurality of nozzles 20a, preferably in the form of long slots, adapted to discharge air from supply passage 14 against the surface 17. Preferably, the nozzles are arranged to discharge air against the web and in an upward direction. At the face of the upper portion of the hood are provided a plurality of

supply nozzles 20b adapted to discharge air from supply passage 15 against the web and in a downward direction. Thus, nozzles 20a and nozzles 20b both discharge air toward the central portion of the hood.

Proximate the central portion of the hood there is provided a relatively large exhaust opening 21, communicating with exhaust passage 16. Exhaust opening 21 extends across the face of the hood 10 in a substantially horizontal direction. Air exhaust from the surface of the web is also effected through exhaust openings 22 formed in the face of the hood and communicating with exhaust passage 16. Exhaust openings 22 preferably constitute extensions of exhaust opening 21, and preferably extend downwardly and upwardly therefrom at the sides of the hood. However, it is to be understood that exhaust openings 22 may be otherwise arranged, if desired, and that the exhaust openings 21 and 22 may be discontinuous if desired. Moreover, while the exhaust openings 21 and 22 are shown in the form of relatively wide single slots, it is to be understood that their function may be fulfilled within the purview of the invention by any other formation of exhaust means. Thus, the outlets might comprise a series of narrow slots, a series of independent openings of relatively large or relatively small size, etc., although the illustrated arrangement is preferred, since it offers relatively little static resistance to the flow of air and hence permits operation of the system with a relatively low power consumption. Air exhausted through exhaust openings 21 and 22 and passing through exhaust passage 16 is directed toward the outlet end of exhaust chamber 12 by a series of baffles 23 provided in the upper part of exhaust passage 16. Baffles 23 minimize the formation of eddy currents, reduce the static resistance to air flow, and thus reduce operating costs.

As will be understood, there is a tendency for the web 17 to be drawn toward and into the discharge opening 21, thus tending to interfere with the intended air circulation and tending to injure or break the web. To obviate these occurrences, applicant provides member 24 in the exhaust opening 21. As shown in Fig. 2, member 24 extends substantially completely across the width of the hood in a continuous strip, but it will be apparent to those skilled in the art that the member 24 may be sectionalized without substantial impairment of its function. Member 24 is generally triangular in cross sectional shape, an apex of this triangle being directed into exhaust opening 21. The sides of the member adjacent this apex are curved and thus provide a highly effective baffle means for routing into the exhaust opening 21 air which has been travelling downwardly and upwardly along the face of the hood in contact with the surface to be dried. Triangular member 24 is so mounted, preferably on bars or the like, 25, connecting to the sides of the hood, that its base extends beyond the face of the drying hood. Thus, even if the surface to be dried should tend to be drawn toward the exhaust opening 21, its motion in this direction will be limited by the base of member 24. Thus, the intended air circulation may be maintained at all times free from interruption in this manner, and if the base of member 24 is smoothly finished, the surface to be dried will be uninjured by its contact with this member. In the past, considerable breakage of the web has occurred because of the tendency of the web to be sucked into the exhaust openings. This was especially apt to occur during starting up periods when there is usually a relatively great amount of flapping of the web. However, applicant's arrangement is highly effective in overcoming this very troublesome difficulty.

As the paper or material to be dried is led into the hood, it is quite wet and fumes therefrom are evaporated relatively freely. Thus, in the lower or entering portion of the hood 10 a relatively few nozzles 20a are provided. The function of these nozzles is to stimulate the evaporation of solvents and the like from the surface without causing such rapid drying as would result in case hardening. Heating coils 26, provided in air supply passage 14, may be supplied with heating medium in any desired and well known manner whenever it is desired to increase the temperature of air delivered through nozzles 20a.

After the web to be dried has passed upwardly past the exhaust port 21, some solvents and the like still remain and these, generally speaking, are more difficult to remove than those evaporated in the lower part of the hood. However, the counter-current relation between the air discharged from nozzles 20b and the direction of travel of the surface creates a condition of turbulence and of relatively high air velocity which is very effective in removing these more persistent solvents from the web. Further, to this end, it is generally desired to provide more nozzles 20b than nozzles 20a, although it is to be understood that the invention is not limited to this arrangement. If desired, the temperature of air delivered through nozzles 20b may be increased by supplying to heat coils 27 a heating medium in any desired and well known manner.

The heating coils 26 and 27 may be manually or thermostatically controlled. Further, the heating coils are preferably individually controlled. This is of particular advantage where it is required to dry inks or varnishes or the like, which tend to become tacky or sticky at temperatures above normal room temperatures. In such applications, only the heating coil 26 will be supplied with heating medium. Thus, most of the drying will be effected in the lower portion of the hood with relatively high temperature air. The remainder of the drying will be effected in the upper part of the hood with air approximately room temperature. Thus, the web as it is delivered from the hood will be at approximately room temperature and the inks or varnishes thereon will be firmly set. On the other hand, in drying materials which have a relatively great tendency to case harden, it may be preferred to supply heating medium to the coils 27 only, and not to the heating coils 26. Thus, the web will be subjected first to drying air having a relatively low temperature and then, after it has been dried to a substantial degree, will be subjected to drying air having a higher temperature to complete the drying process without at any time causing case hardening of or on the surface of the web.

As disclosed by applicant, in his copending application Serial No. 6,453, filed January 14, 1935, the outward leaking into the drying room atmosphere of gases and fumes from the hood may be avoided by withdrawing from the hood a greater volume of air than is supplied thereto by the fan supply system. This difference in air volumes is made up by the inward leakage of room air into the drying hood, this inward leakage providing an effective check against the

outward leakage of gases and fumes which tend to be carried out into the drying room atmosphere due to the skin friction of the fast-moving web. In the present invention, applicant provides an improvement over this formerly disclosed concept, and utilizes the intaken room air in substantial quantities to augment the drying action of the air supplied to the hood from supply chamber 11.

As shown in Fig. 6, fan 28 is adapted to withdraw air from exhaust chamber 12. Part of this withdrawn air is exhausted to the outdoor atmosphere through exhaust passage 29 and a portion of this withdrawn air is returned to supply chamber 11 through duct 30. The proportions of air exhausted to the outdoor atmosphere and recirculated to the drying hood 10 are controlled by dampers 31 in the exhaust connection 29 and dampers 32 in the recirculating duct 30. Thus, it will be seen that the air which is intaken within the hood from the ambient atmosphere of the drying room is substantially equal in amount to that exhausted to the outdoor atmosphere through exhaust connection 29. By suitable regulation of the dampers 31 and 32, the concentration of fumes within the drying hood may at all times be kept below an explosive range by admixture with freshly-intaken room air. It will be understood that such use of the drying room atmosphere is made possible only by the provision of the exhaust opening at the central portion of the hood; with the exhaust openings on either side of the air supply openings, the dilution of the evaporated fumes which the present invention makes possible, would not take place. Furthermore, the centrally located exhaust port 21 insures that during the starting up period of operation, the air intaken at the ends of the hood will travel toward the center thereof, avoiding the development of any "pockets" or dead areas, effectively ventilating the entire hood, and sweeping away the evaporated fumes.

Applicant has found that the drying of freshly printed surfaces and other webs is most effectively brought about by the use of high pressure, high velocity drying air. The present invention makes possible the maximum utilization of the pressure and velocity of the drying air supplied to the hood. This is accomplished by positioning the face of the hood relatively close to the surface to be dried. Thus, the air discharged from the air supply nozzles impinges against the surface to be dried before its velocity and pressure are dissipated, and this air is held in close contact at high velocity with the surface to be dried. Exhaust openings 22, extending in a vertical direction at the sides of the hood, provide for relieving from under the hood air which has contacted with the web and accomplished its drying function. Thus, it is not necessary that the space between the face of the hood and the web need carry to the central exhaust port all of the air which has been used in drying the web, but only a portion thereof. Hence, this arrangement of the supply and exhaust ports permits the face of the drying hood and the web to be much closer together than in conventional drying hoods heretofore known. Since the air discharged from the air supply nozzles of the hood is highly effective in drying the web, applicant's invention makes it possible to achieve highly satisfactory drying with smaller air volumes and lower air pressures than in former practice.

In operating the system shown in Figs. 1, 2, 3 and 6, the exhaust fan 28 is started up at the same time as the printing press or other equipment with which the drying hood is used. During this starting-up period, the web is run rather slowly; hence the evaporation of fumes therefrom within the hood proceeds at a relatively slow rate. Accordingly, during this period the dampers 32 are closed and the dampers 31 are set so that fan 28 draws within the hood sufficient air to maintain therewithin the dilution of evaporated fumes well below the explosive range. As the rate of travel of the web increases, of course, the dampers 31 and 32 are readjusted so that a portion of the withdrawn air is exhausted to the outdoor atmosphere and another portion is recirculated to the drying hood through duct 30.

As will be understood, such adjustment of dampers 31 and 32 will depend upon the type of volatile matter to be handled, because substances which tend to be explosive will necessitate a greater exhaust to the outdoor atmosphere and lesser recirculation to the hood, while substances which have a lesser tendency to be explosive permit more air to be recirculated through the hood and require that less air be exhausted to the outdoor atmosphere. In practice, it has been found expedient to recirculate between 25% and 75% of the total air drawn from the hood, depending upon the explosive tendencies and other characteristics of the material to be dried. The balance of the air circulated in contact with the material to be dried is intaken within the hood from the drying room atmosphere through the openings formed at the extremities of the hood through which the web enters and leaves.

Fig. 4 illustrates on an enlarged scale one of the nozzles used for discharging air against the web The nozzle comprises two parts, at least one of which is adjustably carried on the wall of the hood. As illustrated, for example, the lower member 33 of one of the nozzles 20*a* is provided with a slot 34, through which extends a screw 35, which extends through the face 36 of the hood and carries a holding nut 37. By loosening the screw 35, the member 33 may be moved into any desired position, thus to control the discharge area and hence discharge velocity of the nozzle 20*a*.

Similarly, the area of the exhaust opening 21 may be controlled, as shown in Fig. 5. Adjustable plates 38 are provided with slots 39 through which extend screws 40. Screws 40 extend through the face 36 of the hood and are retained in place by nuts 41. By adjusting the position of the plates 38, the exhaust area of exhaust opening 21, and hence the exhaust velocity, may be desirably controlled.

To prevent air leakage between the hood 10 and the sealing member 19, applicant provides seals 42, preferably formed of rubber, felt, or similar material. These seals are held in compression between suitable flanges of the drying hood and the sealing member. If desired, these flanges may be made adjustable so as to insure a substantially air-tight connection.

In Fig. 7 is illustrated an alternative air routing arrangement which is particularly intended for use where small quantities of high pressure drying air are to be used. As illustrated, fan 28 withdraws air from the hood 10 and exhausts a portion of this air to the outdoor atmosphere through duct 29. Another portion of this air is delivered through duct 30*a* to fan 28*a*, which delivers air at relatively high pressure to the supply chamber 11. Fan 28*a* is adapted to intake not

only air from duct 30a but also air from the outdoor atmosphere or the drying room atmosphere through duct 43 connected to duct 30a. Dampers 32 and 44 control the proportions of recirculated air and fresh air intaken by the fan 28a and delivered to the hood 10.

While in this description applicant has referred to the air intaken at the ends of the hood as room air, it will be apparent that outside air may be used in this way if desired.

If desired, the apparatus described herein may be operated in such manner that the air withdrawn through exhaust passage 16 is several times greater in volume than the air supplied through nozzles 20a and 20b. The difference in air volume will be made up by a relatively great volume of air intaken within the hood at the extremities thereof, as above explained. In such case, the air so intaken will accomplish the major portion of the solvent absorption effected beneath the hood. The air supplied through nozzles 20a and 20b is air having a relatively high pressure discharged against the web at relatively high velocity. Thus, after the air intaken within the hood at the ends thereof has been in contact with the web for a short interval of time, the web will be subjected to an impacting discharge of high pressure air which will break up the film of drying air formed at the surface of the web and penetrate into the pores of the web surface. This action will have the effect of bringing into intimate contact with the web surface other air having a low vapor concentration which had not previously contacted therewith and of sweeping away the air which has absorbed solvent fumes given off by the web. The repetition of this process as the web passes each of the air supply nozzles, and the relatively great turbulence which obtains within the hood, insure highly effective and rapid drying of the web surface. Moreover, since such operation involves the handling of less air than was formerly required, such operation effects a considerable reduction in power requirements of the drying system. As described above, the heaters 26 and 27 may be selectively controlled or, if desired, they may be completely eliminated, since the greatest part of the drying is done by air intaken within the hood ends whose temperature has not been changed. Thus, this arrangement provides for the further reduction of operating costs by eliminating the necessity for preheating most or all of the air used for drying purposes, as has been general practice in the past. While applicant does not limit himself to any particular ratio of air volumes, the system as thus described may be so operated that the volume of air intaken within the hood ends is five or six times greater than the volume of air supplied through the nozzles 20a and 20b. The introduction of such relatively large volumes of air at the hood ends maintains the concentration of solvent fumes and vapors within the hood at all times well below the explosive range. Although recirculation to the hood of air withdrawn therefrom, as above described, may be employed, such recirculation may be dispensed with if desired.

In some installations space limitations may require that the duct supplying air to and exhausting air from the hood 10 be connected to the hood on one side only. And in some cases while there may be ample room for providing duct connections on both sides of the hood, as illustrated in Figs. 6 and 7, it may be desired to keep all the duct connections on one side of the hood in order to provide an unobstructed working area on the other side of the hood. This follows the general practice in installing presses and the like, in conjunction with which applicant's hood is adapted to be used, where all of the control connections are, to the greatest extent possible, kept on one side of the apparatus in order to provide a free working space on the other side.

Fig. 8 diagrammatically represents a modification of the invention in which the supply and exhaust connections to the hood are connected to one side thereof. As shown, air supply duct 45 is provided with an angular extension 45a extending within collar 46 projecting from the hood 10. Felt strips or the like, 47, are provided to constitute an air seal between section 45a of the supply duct and the extension 46. Thus, while the hood 10, and hence extension 46, may be rotated about supports 48, and while duct 45 may remain stationary, there will occur no leakage between the air circulating system and the ambient atmosphere. Similarly, extension 49a of exhaust duct 49 extends through the outside of duct 45 and within extension 50 of the exhaust passage 16 of the hood. Felt strips or the like, are provided between extension 49a and extension 50 to constitute an air seal, and a felt strip or the like, 51, is provided to seal the opening between extension 50 and the opening formed in the side of duct 45.

Since many changes may be made in the invention without departing from the scope thereof, it is intended that the foregoing description and accompanying drawings shall be regarded as illustrative only, applicant limiting himself only as indicated in the accompanying claims.

I claim:

1. The method of drying a freshly printed web or the like, which consists in passing the web through an enclosed space, discharging against the web within said space a relatively small first volume of air at relatively high velocity, withdrawing a relatively large second volume of air from the atmosphere surrounding said enclosed space and passing said second volume of air along said web, and withdrawing from said enclosed space said first-mentioned and said last-mentioned air, said high velocity air being discharged against portions of said web along which said second volume of air is passing, whereby said last-mentioned air is effective to accomplish a substantial portion of the drying of said web while said first-mentioned air is effective to inhibit the formation of film of relatively saturated air which tends to overlie said web.

2. In an apparatus of the character described, a drying hood, means for passing beneath said hood a web to be dried, air discharge outlet means in one end portion of the hood adapted to discharge air against said web, other air discharge outlet means in the other end portion of the hood and adapted to discharge air against said web, air exhaust means in said hood between said first-mentioned and said last-mentioned air discharge outlet means adapted to withdraw from the web, after it has contacted therewith, air from said first-mentioned and said last-mentioned air discharge outlet means, said last-mentioned air discharge outlet means having a greater total delivery area than said first-mentioned air discharge outlet means, and means in combination with said last-mentioned discharge outlet means discharging therethrough and against said web a greater volume of air than is discharged through said first-mentioned air discharge outlet means, said last-mentioned air outlet means being positioned

beyond said first-mentioned discharge outlet means in the direction of web travel.

3. In an apparatus of the character described, a drying hood having a substantially sheet-like face, means for passing beneath the hood and proximate the face thereof a web to be dried, first air discharge outlet means, second air discharge outlet means, exhaust port means, said exhaust port means being generally H-shaped in arrangement and being formed in the face of the hood, said first and second discharge outlet means being positioned on opposite sides of the exhaust port means comprising the crossbar of said H formation, said web-passing means being adapted to pass said web proximate said first discharge outlet means, then proximate the exhaust port means comprising the crossbar of said H formation, and then proximate said second discharge outlet means, the side-leg portions of said H-shaped exhaust port means extending in the direction of web travel and being respectively located proximate the sides of said hood.

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