United States Patent [19]

Clements

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[54] **SPRAYER APPARATUS**

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[52] **U.S. Cl.** **118/600**; 118/324; 118/326; 118/DIG. 7

[51] **Int. Cl.** **B05c 11/16**

[58] **Field of Search** ..... 118/603, 610, 634, 326, 118/24, 302, 324, 600; 55/268, 269; 98/115 SB

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[57] **ABSTRACT**

Sprayer apparatus comprising an enclosure having an article-receiving opening and an article-discharging opening, in which means are provided for preventing the flow of air through the article-receiving opening and in which means are provided for removing entrained particles from the air within the enclosure before discharging the air into the ambient atmosphere.

8 Claims, 5 Drawing Figures

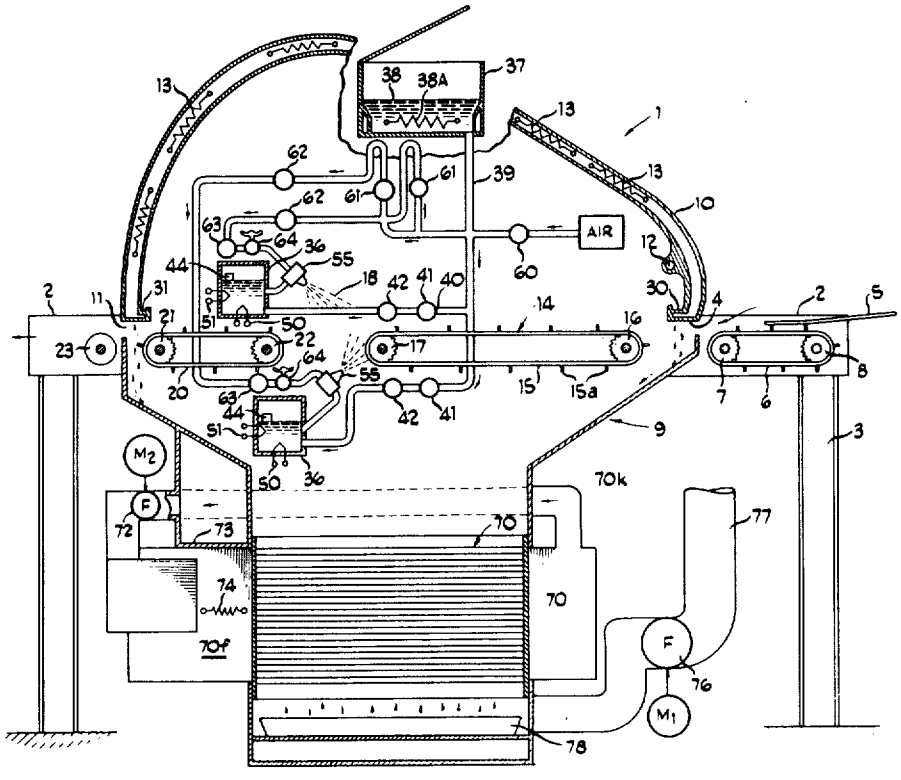
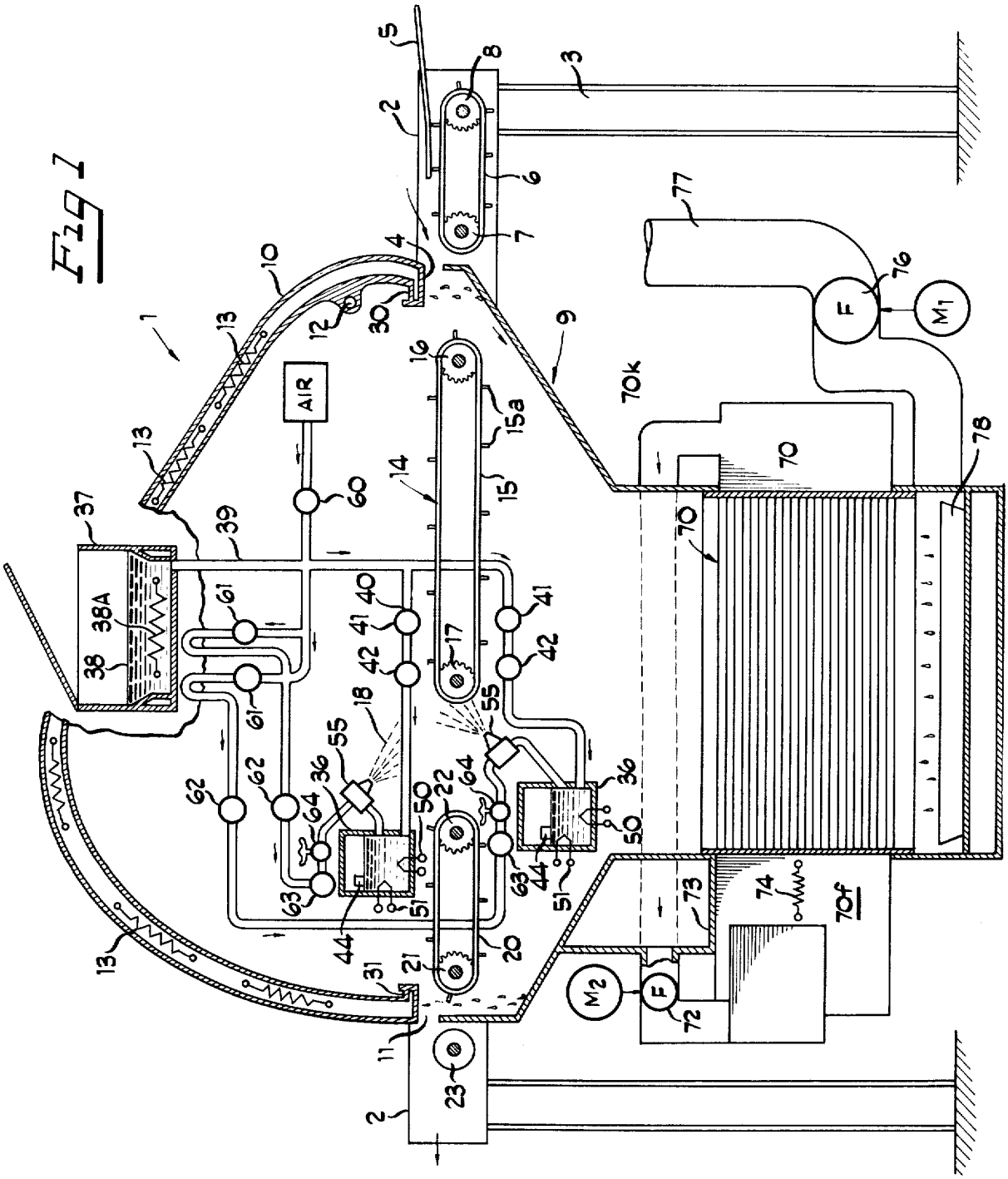


Fig 1

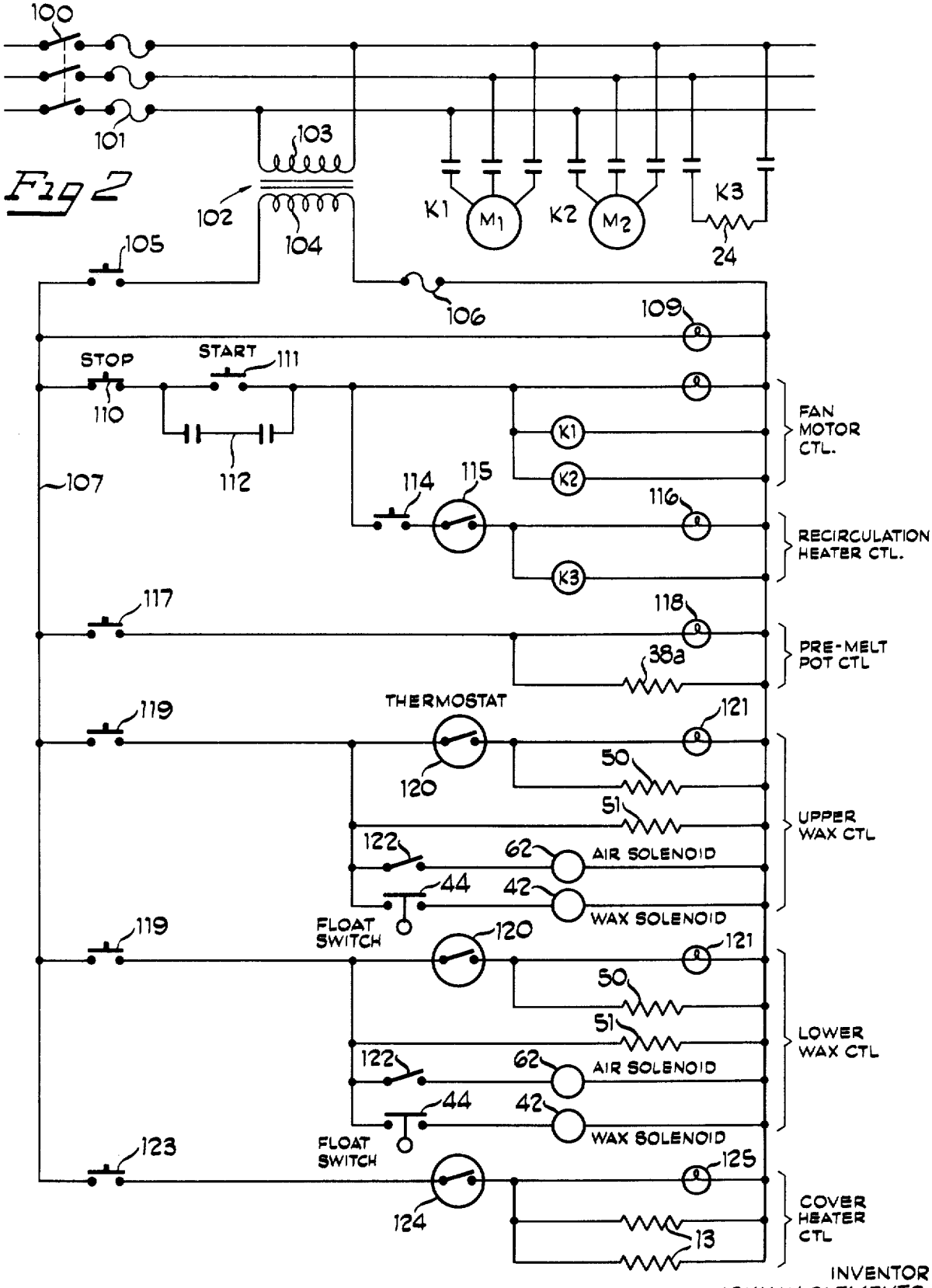


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Fig 2



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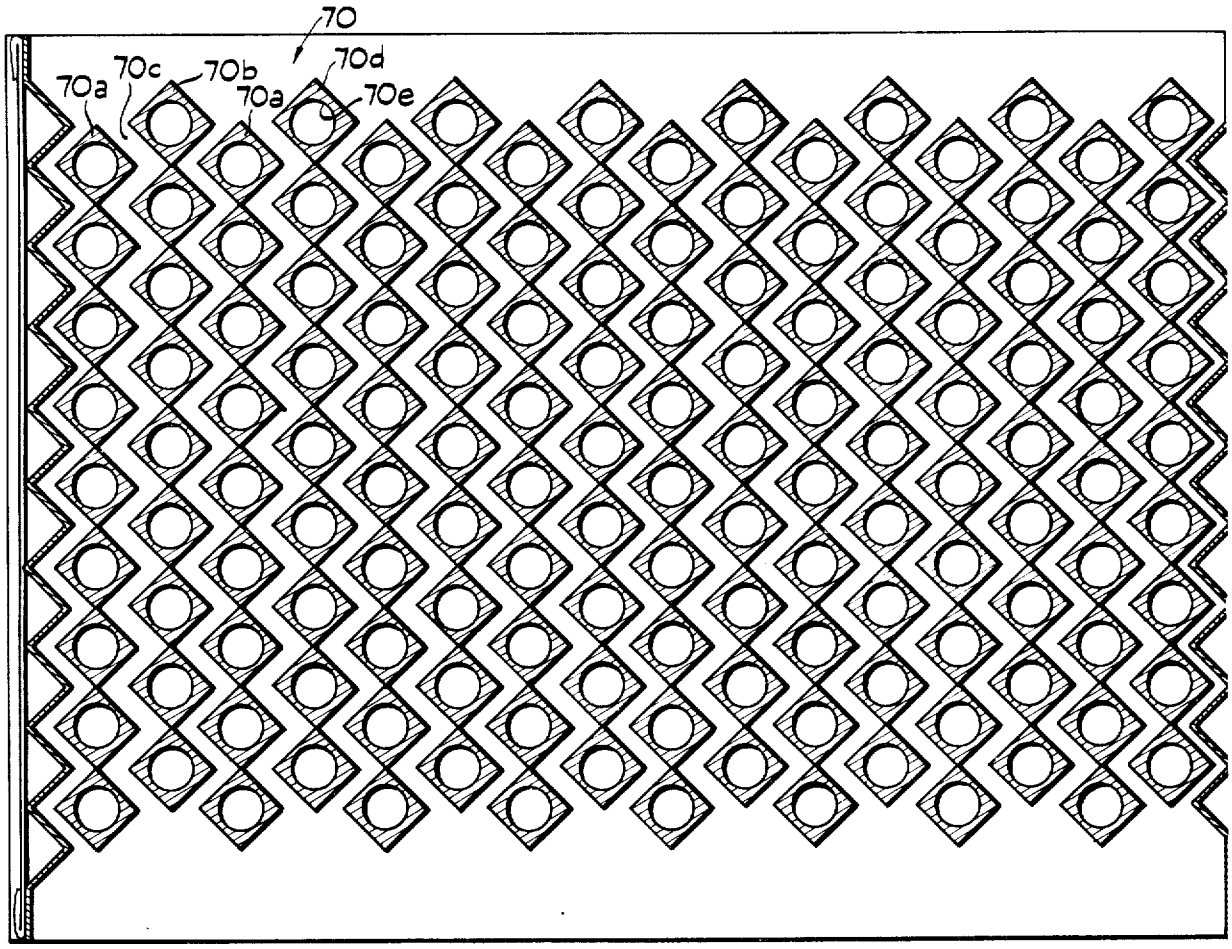


Fig 3

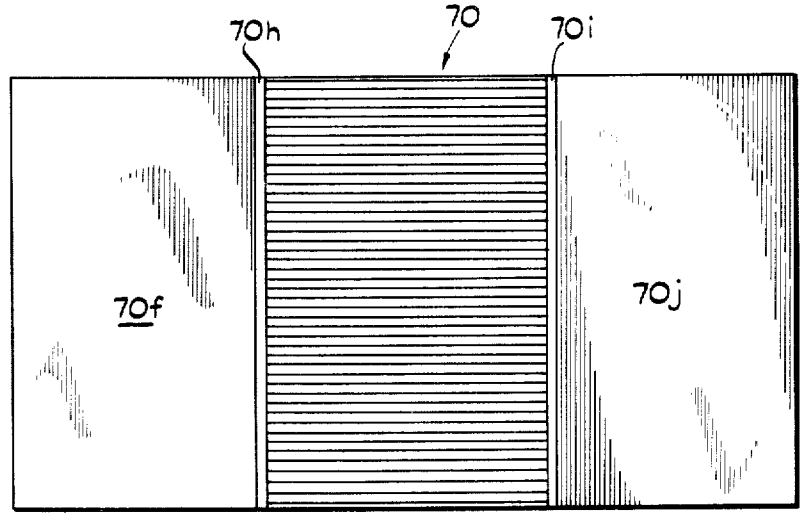
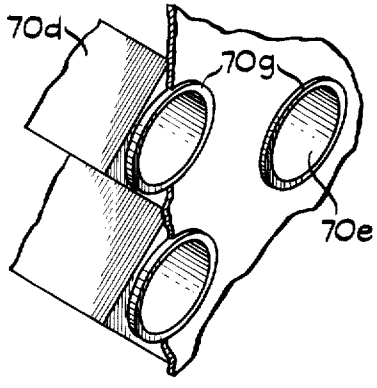


Fig 4

Fig 5



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SPRAYER APPARATUS

SUMMARY

This invention relates to sprayer apparatus and more particularly to apparatus for spraying a continuous web of sheet material, such as metal or the like, with a coating of normally solid liquid material such as wax or the like.

Apparatus has heretofore been devised for spraying melted normally solid liquid coatings on a wide variety of continuous webs of sheet material for various purposes. A principal disadvantage of the prior art devices has been pollution of the ambient atmosphere with deposits of condensed solid particles as well as contamination of maze-type filters. In addition, the spray condensate has a tendency to deposit on raw stock with the result that further processing may be carried out only with difficulty. Also, in prior apparatus there is a tendency for the spray heads to malfunction because of clogging due to the premature change in state of the material to be sprayed.

In some prior art devices attempts have been made to maintain the material to be sprayed in liquid condition until the spraying operation is effected. These efforts have included the provision of heated spray heads, etc. but in none of these devices has the problem of dripping and spoilage of feed stock been accomplished.

Accordingly, a principal object of the invention is to provide sprayer apparatus in which substantially all of the entrained particles of material sprayed is recovered, and in which the apparatus is constructed and arranged to preclude inadvertent condensation of the sprayed material.

Another object of the invention is to provide sprayer apparatus in accordance with the preceding object wherein efficient and effective means are provided to induce the flow of ambient air into the enclosure through the inlet and outlet openings thus to preclude the flow of air having entrained particles therefrom.

Another object of the invention is to provide sprayer apparatus in accordance with the preceding objects wherein a novel heat exchanger is provided to remove entrained particles from the air within the enclosure before discharged therefrom.

Other objects and advantages of the present invention will become apparent as the description proceeds with reference to the accompanying drawings wherein:

FIG. 1 is a diagrammatic, elevational view, partly in section, of sprayer apparatus made in accordance with the present invention;

FIG. 2 is a schematic diagram of the control system for the sprayer apparatus of FIG. 1;

FIG. 3 is an enlarged sectional view of the heat exchanger forming a part of the sprayer apparatus of FIG. 1;

FIG. 4 is a plan view, on reduced scale, of the heat exchanger assembly of FIG. 3; and

FIG. 5 is a greatly enlarged fragmentary view in perspective of a detail of the heat exchanger of FIG. 3.

Referring now to the drawings, and more particularly to FIG. 1, the system includes a controlled enclosure 1 supported on a frame which includes side rails 2, only one of the pair being shown, and legs 3 secured at the free ends of the side rails. Enclosure 1 includes a base section 9 and a heated cover 10 which are so fitted as to seal the enclosure except for a feed slot 4 and a discharge slot 11. Cover 10 is connected to the frame by

means of a pivot bar 12 so that it may be elevated to expose the interior of the enclosure. Opening of the cover is preferably controlled by a pair of air cylinders, not shown. The feed slot is arranged to receive sheets 5 to be treated which are transported to slot 4 with the aid of a parallel array of chain carriers 6, each driven by a sprocket 7 and entrained over an idler sprocket 8. Arranged inside the enclosure to receive the delivered sheets is a parallel array of chain carriers 14, which in a typical embodiment may be four in number. Each chain carrier includes a link chain 15 having orthogonal fingers 15*a* connected to certain links of the chain. These fingers form the only contact with the sheets 5 received via feed slot 4 and as a consequence, smearing, which is otherwise encountered due to wax deposits formed on the sheet transporting mechanisms, is minimized. Each chain carrier includes a drive sprocket 16 and an idler sprocket 17. All drive sprockets are fixed to a common drive shaft while all idlers are mounted on a common idler shaft, the shafts being journaled in bearings (not shown) mounted in side rails 2.

Feed carriers 14 transport the sheet materials to be waxed to the spray system indicated generally at 18 after which they are picked up by a discharge chain carrier comprising a plurality of link chains 20 each driven by a drive sprocket 21 and cooperating idler sprocket 22. The discharge chain carrier is similar in construction and mounting to the feed chain carrier 14.

As the treated sheets are discharged from discharge slot 11 by the action of the discharge chain carrier, they are picked up and urged forward by a plurality of rollers 23 driven by a common shaft which is journaled in the side rails 2. Rollers 23, drive sprockets 21, 16 and 7 have their respective common shafts extending through one of the side rails 2 where they are driven from an electrical motor (not shown).

In order to prevent wax drippings from spoiling the treated sheets, cover 10 is contoured such that wax condensing thereon is forced to flow either towards the feed end or discharge end of the cover where it is collected in eaves 30 or 31. These eaves are inclined downwardly from the center line thereof to the outer extremities. These outer extremities extend beyond the edges of the feed and discharge slots, and hence, beyond the sides of the sheets 5. Accordingly, if there is dripping from the ends of the eaves, the wax does not touch the sheets but rather falls unobstructed to the inclined end portions of base section 9. For additional control over this action, the cover 10 includes flexible cable type heaters 13 therein which are thermostatically controlled for operation in the range of 150° F. to 175° F. The temperature is adjusted to permit the proper flow of the condensate without causing dripping action until the condensate is collected in the eaves 30 and 31. Temperature conditions are also established such that the drops of wax leaving the eaves are large enough to prevent their absorption in the circulating atmosphere.

The spray system 18 includes an upper distributor and a lower distributor. Each distributor includes a liquid reservoir or wax bar 36 which extends the width of the machine, i.e., at right angles to the line of feed and supplies the liquid for spraying. Each reservoir has one end extending out through the side of the enclosure 1 so that access thereto is provided for drainage without opening cover 10.

Reservoirs **36** are fed from a main hopper or reservoir **37** having therein a pre-melt pot **38.** The hopper is preferably large enough to accommodate a full day's supply of wax and is located outside enclosure **1.** Pre-melt pot **38** includes an electric heater **38A** for melting the wax, this heater being designed to maintain an appropriate temperature, e.g., of about 250° F. As it is melted, the wax is gravity fed via an outlet conduit **39** to a pair of branch feed conduits **40,** one for each of the wax distributors. Manually operated valves **41** followed by solenoid actuated, normally closed, valves **42** are located in branch lines **40.** From the outlet of each valve **42** there is a connection to the respective reservoir **36.**

Each valve **42** is controlled by an electrical system illustrated in FIG. **2** which includes a float **44,** connected to an associated float switch which is actuated when the wax level in the associated reservoir falls below a predetermined level. When the minimum wax level is approached, the switch actuates the respective solenoid **42** to thereby replenish the wax supply.

A strip heater **50** extends along the bottom of each reservoir **36** and is thermostatically controlled to maintain a proper wax viscosity within the respective reservoir. Typical temperatures are in the range 250° F. to 350° F. In order to insure prompt response from the level controlling floats, each reservoir also includes a separately energized cartridge heater **51** located in the reservoir beneath the respective float. This arrangement insures that the wax immediately beneath the float will be melted rapidly when operation is initiated thereby insuring cut-off of the reservoir supply when the liquid wax reaches its appropriate level.

The float switch is preferably of the type in which a float operated linkage displaces a magnetic element relative to a switch comprising a pair of contacts sealed in a glass ampule. The contacts include a ferrous element which responds to the magnet to close the switch.

Each reservoir also includes a thermometer bulb (not shown) connected to a suitable temperature indicator for monitoring temperature conditions within each reservoir and a thermostatic switch forming part of the control system shown in FIG. **2.**

Distributed along the length of each reservoir in side-by-side relation are a plurality of spray heads **55** of the syphon type. These heads each have a liquid wax inlet connected to the wax reservoir and an air pressure or pneumatic inlet connected to a pneumatic system described hereinafter. The heads **55** are perferably of the type disclosed in U.S. Pat. Nos. 2,943,795 and 2,817,600, issued to J. G. Yahnke on July 5, 1960 and Dec. 24, 1957, respectively. Each head includes a central orifice forming the wax outlet, this orifice being surrounded by an annular air discharge opening which acts to syphon and atomize the liquid wax supplied to each head. As shown in the aforesaid patents, each head also includes a pair of diametrically opposed air jets having outlets canted towards the axis of the main orifice to increase the dispersion of the spray.

The pneumatic system for supplying air under pressure to each head includes an input filter **60** in the line from the air pressure source. The output of filter **60** is divided into two branches, each branch including a pressure regulator **61** adjustable from outside enclosure **1.** In a typical installation, pressure at the input to the pressure regulators is in the range from 75 to 125 p.s.i. The pressure regulators **61** are each adjustable to yield the desired low pressure output. the value of which depends upon the number of spray heads **55** which are in operation and the quantity of wax being dispensed.

As each air pressure line leaves its respective regulator **61,** it is routed through a pre-heating arrangement including a series of coils adjacent pre-melt pot **38.** Thereafter, the branches are connected to respective normally closed solenoid valves **62.** Actuation of the solenoid opens the valve thereby causing operation of the respective wax distributor. The output of each solenoid valve is connected to a respective manifold **63** which has a plurality of spaced outlets, one for each spray head **55.** In each line from the manifold to the spray head is a petcock **64** which, when closed, disables the respective spray heads, thus permitting selection of the number of heads required for a particular job. Further description of the spray systems will be found in the aforesaid patents.

According to the present invention, means are provided for recovering substantially all of the sprayed material for reuse. By this arrangement also, air exhausted to the atmosphere is free of pollution. To this end, there is provided a novel heat exchanger **70** which is positioned to receive drippings from the sloping surfaces of the base of the enclosure and to maintain the entrained particles of sprayed material in vaporous condition. Referring now to FIG. **3,** the heat exchanger of the invention includes a first series of vertically disposed baffles **70***a* and an alternate series of baffles **70***b*, the latter series being vertically offset with respect to the former series so as to form a plurality of substantially vertically extending tortuous paths **70***c*. Each of the baffles of the series **70***a* and **70***b* are identical and comprises an elongate tube **70***d*, of metal such as aluminum or the like, and has a central opening **70***e*. The opening **70***e* is of sufficient diameter to permit the flow of a requisite quantity of warming air, while leaving a substantial mass of metal as a heat sink. Hot air from a plenum chamber **70***f* is blown through the openings **70***e* by a blower **72** driven by a motor **M2.** The air is heated by a bank of electric resistance heaters **74** within the chamber **70***f*. After passage through the openings **70***e*, and after removal of some of the heat by the wax drippings and entrained particles the air is returned to the intake of the blower **72** for recirculation. It will be appreciated that the heat from the secondary air maintains the baffles at a steady temperature high enough to render all wax particles liquid.

Circulation of air within the enclosure is afforded by a blower **76** driven by a motor **M1.** The blower **76** is of sufficient capacity to effect a relatively low air pressure within the enclosure so that air with entrained particles cannot flow from the enclosure through the article entrance and exit openings. Liquid wax is collected in a pan **78** while air from the enclosure is exhausted through a stack **77.**

Referring now to FIG. **5,** each of the baffles **70***d* has at each end thereof an outwardly extending annular boss **70***g* which is received in registering openings of partitions **70***h* and **70***i*. The partition **70***h* separates the chamber **70***f* from the heat exchanger **70**; the partition **70***i* separates the heat exchanger **70** from receiving chamber **70***j*. Communiucation Communication afforded between the chamber **70***j* and the intake of the blower **72** by means of a conduit **70***k*, see FIG. **1.**

The electrical control system is shown in FIG. **2** wherein like reference numerals are applied to compo-

nents also appearing in FIG. 1. The control system is energized from a three-phase line through a three contact switch 100 and a set of fuses 101 located in the individual lines. Fan motors M1 and M2 are coupled to the three phase line via the normally open contacts of relays K1 and K2 respectively. Heater 74 associated with the exhaust heat exchanger is energized from the three phase lines via normally open contacts of a relay K3.

The remainder of the control circuits are energized through a transformer 102 having a primary winding 103 connected between two lines of the three phase supply. The secondary winding 104 of the transformer is connected between a pair of conductors 107 and 108, via a main control switch 105 and a fuse 106 in series with lines 107 and 108 respectively. A lamp bulb 109 connected directly between conductors 107 and 108 indicates when the control circuits are energized.

The energizing coils for relays K1 and K2 are connected in parallel with one another and in series with a normally closed, momentary contact, stop switch 110 and a normally open, momentary contact, start switch 111. Normally open contacts of relays K1 and K2 are connected in series in a holding circuit 112 bypassing the contacts of switch 111. Thus, when switch 111 is closed momentarily relays K1 and K2 are energized to close their associated contacts to thereby energize motors M1 and M2. Energization of relays K1 and K2 also, closes the contacts in holding circuit 112 so that the relays will remain energized after momentary contact switch 111 is released. Actuation of switch 110 momentarily deenergizes relays K1 and K2 and opens holding circuit 112. Lamp bulb 113 is connected in parallel with the energizing coils of relays K1 and K2 to indicate when the motor circuits are energized.

The control circuits for the recirculation heater 74 are also completed through switches 110 and 111. More specifically, a path is completed from switch 111 to conductor 108 via a normally open switch 114, the contacts of a thermostat 115 and the energizing coil of a relay K3. Thermostat 115 is located within heater box 73 (FIG. 1) and is operative to control the temperature therein. Thus, when switch 114 is closed, the thermostat 115 energizes relay K3 which in turn closes the associated contacts to energize heater 74 when the temperature falls below a predetermined value determined by the thermostat. A lamp bulb 116 is connected in parallel with the energizing coil of relay K3 to indicate when heater 74 is energized.

The heater control circuit for pre-melt pot 38 includes heater 38A connected in series with a switch 117 between conductors 107 and 108. The purpose of the pre-melt pot is simply to convert the wax into a liquid form and since the temperature for accomplishing this is not particularly critical, thermostatic control is not required. Thus, whenever switch 117 is closed heater 38A is energized and lamp bulb 118 connected in parallel with the heater indicates this condition.

Switch 119 controls energization of the control circuits for the upper wax unit. Switch 119 is connected between conductors 107 and 108 in series with the contacts of a thermostat 120 and heater 50 located in the upper wax reservoir 36. Thermostat 120 is located to sense the temperature within the reservoir and closes the associated contacts to energize heater 50 whenever the temperature falls below a predetermined value. Lamp blub 121 is connected in parallel with heater 50 to indicate when the heater is energized. Heater 51 is located in the vicinity of float 44 within the wax reservoir and is connected in parallel with the thermostatic switch contacts. Thus, heater 51 is energized to melt the wax in the vicinity of the float as soon as switch 119 is closed. Switch 119 is also connected to conductor 108 through two parallel paths, one of these paths including a switch 122 in series with the energizing coil for air solenoid 62, and the other parallel path including the contacts of float switch 44 and the energizing coil of wax solenoid 42. Accordingly, when switch 119 is closed the air solenoid can be energized selectively by closing switch 122 from an external control panel. Also, when switch 119 is closed, float switch 44 closes its associated contacts to energize wax solenoid 42 whenever the liquid wax level is reservoir 36 falls below a predetermined level. Actuation of the wax solenoid permits the flow of wax into the reservoir to thereby replenish the supply. The control circuits for the lower wax unit are essentially the same therefore like reference numerals are employed.

The cable type heaters within the cover 10 are connected in series with contacts of a thermostat 124 and a control switch 123. The thermostat is suitably located within enclosure 1 near cover 10 to close the contacts and energize heaters 13 whenever the temperature drops below a predetermined value. A lamp bulb 125 is connected in parallel with heaters 113 to indicate energization thereof.

While only one illustrative embodiment of the invention has been described in full detail, it should be obvious to those skilled in the art that there are numerous variations within the scope of this invention. It is particularly pointed out that although the illustrative embodiment is described as a wax sprayer, this unit can also be used to spray other liquids such as vinyl and phenolic resins. The invention is more particularly defined in the appended claims.

I claim:

1. Apparatus for spray coating articles comprising an enclosure having article feed and discharge openings and an exhaust opening, means for removing air-suspended particles from the air within said enclosure, said means comprising means for effecting a positive circulation within said enclosure so that ambient air is drawn into said enclosure through said feed and discharge openings said dispelled through said discharge opening, said last-named means including a plenum chamber, an exhaust chamber, a heat exchange chamber interposed between said plenum chamber and said exhaust chamber, a first perforate partition dividing said plenum chamber and said heat exchange chamber, a second perforate partition separating said heat exchange chamber from said exhaust chamber, a plurality of baffles extending between said first partition and said second partition, each of said baffles being of rectangular cross-section and being disposed to form a plurality of tortuous paths for air having particles entrained therein, each of said baffles having an opening therein in register with aligned openings in said first and second partitions so that heated air may flow from said plenum chamber through said openings to said exhaust chamber to maintain in liquid condition the entrained particles in the air flowing through said tortuous paths.

2. Apparatus in accordance with claim 1 wherein said baffles are disposed in said heat exchange chamber in

alternate series, the baffles of one series being offset with respect to said second series to provide said tortuous paths.

3. Apparatus in accordance with claim **2** wherein each of said baffles has at each end thereof an annular boss sealingly received in one of the openings of the associated partition.

4. A hot liquid wax spraying system comprising a plurality of wax sprayheads, a wax supply system therefor, means for transporting sheets to be treated through the region covered by said wax sprayheads, and a controlled enclosure for said wax spraying system comprising a base having a collecting section therein disposed to collect spurious wax, a cover connected to said base in sealing relationship therewith except for feed and discharge openings for said sheets, means for heating said cover, said cover being heated thereby and shaped to direct spurious wax deposits to flow to said collecting section in said base without contacting the sheets to be treated, heat exchanger means in said collecting section, means for heating said heat exchanger, and means for drawing air into said enclosure and for exhausting said air and spurious wax in said enclosure through said heated exchanger to an outlet, said heat exchanger being oriented and heated such that wax in said collecting section separates from said exhausted air.

5. Apparatus as defined in claim **4** in which said transporting means include point contact means for minimizing spurious transfer of wax from said transporting means to said sheets.

6. Apparatus as defined in claim **4** in which said exchanger heating means are positioned to also heat said enclosure.

7. Apparatus for spray coating articles comprising an enclosure having article feed and discharge openings and an exhaust opening, means for removing air-suspended particles from the air within said enclosure, said means comprising means for effecting a positive circulation within said enclosure so that ambient air is drawn into said enclosure through said feed and discharge openings, and dispelled through said exhaust opening, said last-named means including a passage, a heat exchanger positioned within said passage, said heat exchanger having a plurality of tortuous paths each including a plurality of angularly oppsitely disposed heating surfaces, whereby all of the particle-laden air is passed through said heat exchanger prior to passing through said discharge opening, said heat exchanger being of the air-to-air type and including a heating chamber and fan means for circulating air through said heating chamber and the spaces between said paths.

8. Apparatus for spray coating articles comprising an enclosure having article feed and discharge openings and an exhaust opening, means for removing air-suspended particles from the air within said enclosure, said means comprising means for effecting a positive circulation within said enclosure so that ambient air is drawn into said enclosure through said feed and discharge openings, and dispelled through said exhaust opening, said last-named means including a passage, a heat exchanger positioned within said passage, said heat exchanger having a plurality of tortuous paths each including a plurality of angularly oppositely disposed heated surfaces, whereby all of the particle-laden air is passed through said heat exchanger prior to passing through said discharge opening, said enclosure being contoured to direct spurious liquid collected thereon to the region of said heat exchanger.

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