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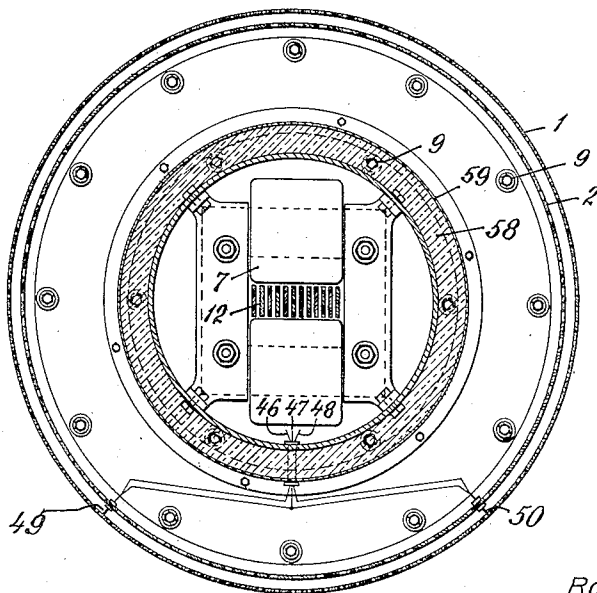
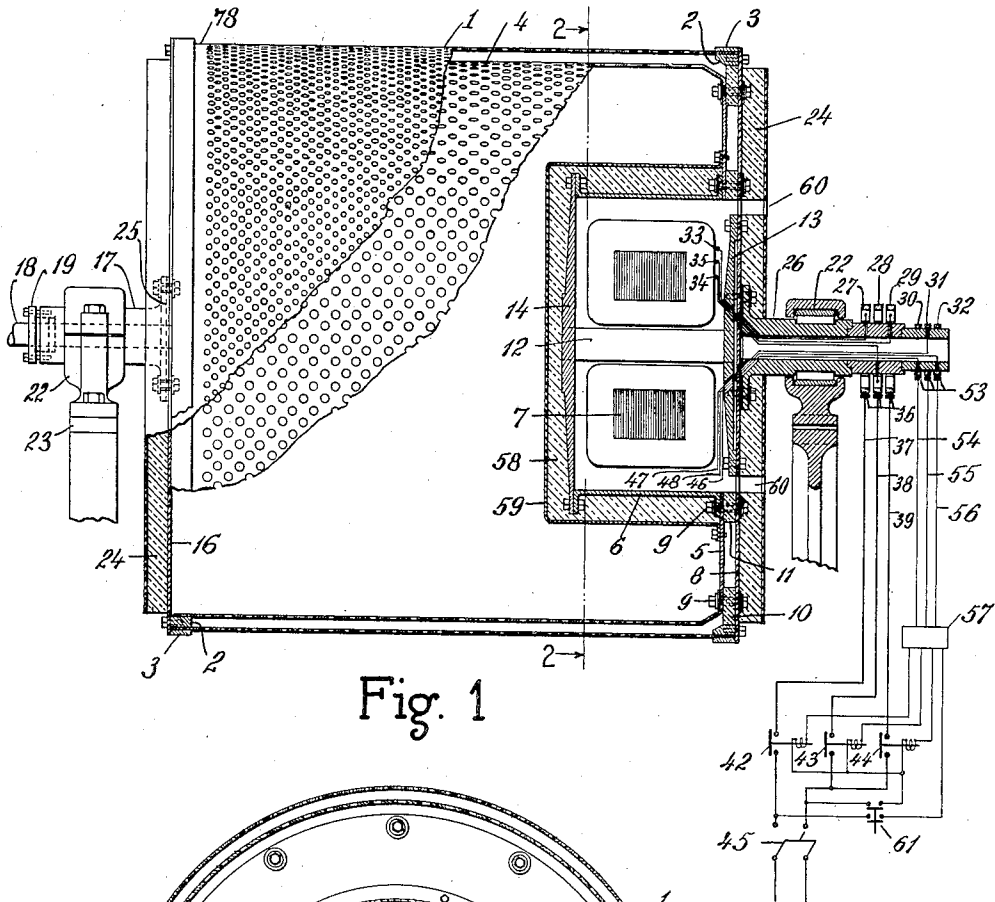
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2,074,455

ELECTRIC HEATING AND DRYING ROLL

Filed Feb. 5, 1932

3 Sheets-Sheet 1



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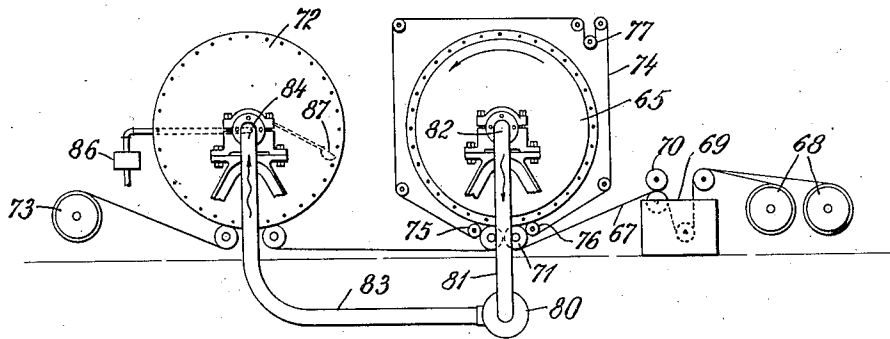


Fig. 3

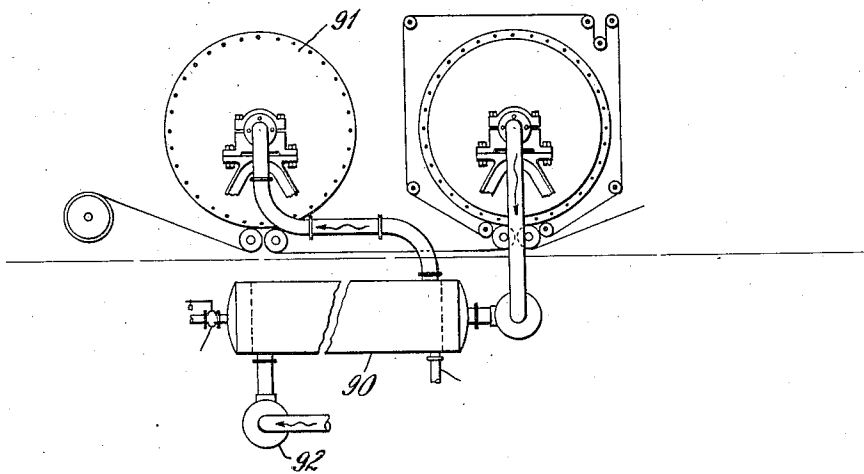


Fig. 4

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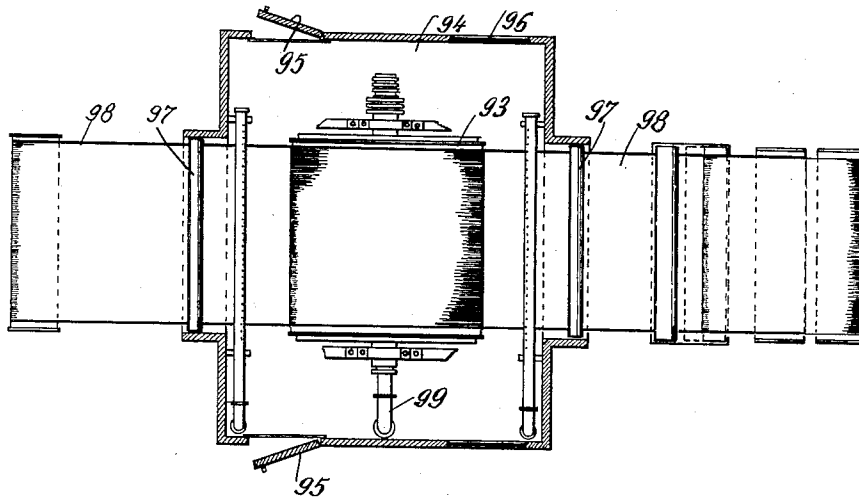


Fig. 5

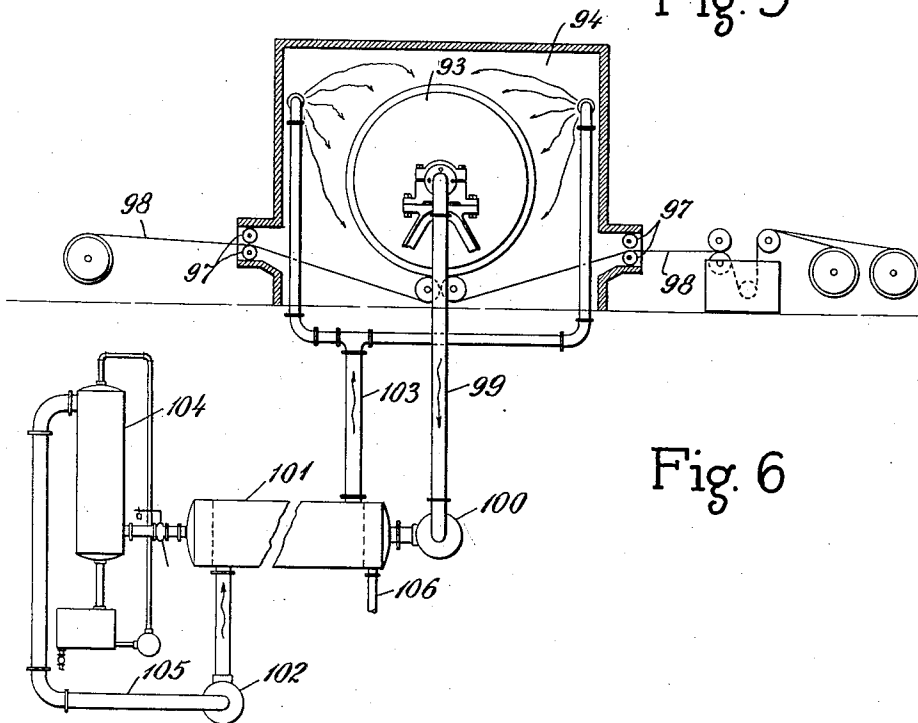


Fig. 6

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2,074,455

ELECTRIC HEATING AND DRYING ROLL

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Application February 5, 1932, Serial No. 591,203

2 Claims. (Cl. 34—4)

This invention relates to an improved method and apparatus for heating and drying and particularly to an improved electrical drying drum or roll and certain cooperating apparatus, and an improved method of heating and drying in which said apparatus may be advantageously used.

Mechanisms commonly employed for heating and drying paper, textiles, and the like usually comprise steam heated drums or rolls rotating at considerable speed, the drying rolls as usually employed for drying paper in large news print paper machines being constructed of cast iron or steel with walls 5 to 8 inches thick, 4 to 6 feet in diameter and up to 20 feet or more in length, weighing up to 6 tons each. 30 to 50 of such rolls are used per machine, and the material to be dried is held firmly in contact with the heated surface by means of webs of canvas or other suitable material.

As such rolls, due to their construction and mechanical limitations, are unable to resist high internal pressure, the steam is usually applied at a relatively low pressure and corresponding temperature, under which conditions the transfer of heat is slow and a relatively long time is required to dry the material to the desired degree. Also, due to the difficulty in efficiently removing the condensed steam from the roll, deposits of dirt and scale form on the inner surfaces, and air is entrained in the drum causing variations in the steam pressure, so that it is difficult to maintain constant and uniform temperature at the heating surface.

Operating at the low temperature available, the vapor is driven from the paper or textile sheet being dried at a temperature only slightly above its condensing point and a considerable part of the vapor is condensed in the outer and cooler layers of the material, making it necessary to re-evaporate the liquid, thus increasing the work required of the drying roll.

In the drying of paper, textiles, and other sheet material of a finely fibrous structure, where rapid diffusion of moisture from the interior to the surface of the sheet takes place, the rate of drying and evaporating the moisture is limited by the ability of the sheet to discharge the moisture or vapor from the surface into the surrounding air.

Due to the relatively low temperature of the vapors and the low velocity with which they leave the surface, the stationary layer of air surrounding the rolls becomes super-saturated, greatly reducing the amount of moisture or vapor that can be discharged from the material and absorbed by the contacting air.

In usual constructions the vapors discharged from the material pass to and are finally absorbed in the room atmosphere, making it excessively hot and moist or humid, in cold weather causing fog and condensation of the moisture on the walls and ceiling of the drying room.

The steam or vapor discharged from the material contains considerable heat, the latent heat in the vapor comprising approximately 90% of the heat energy required to vaporize the water removed from the material, which in the case of certain papers may equal 2 tons or more of water per ton of dried paper, and which is usually dissipated in the atmosphere, doing no useful work, but on the contrary causing the air to become excessively humid and uncomfortable to work in.

The rate of evaporation of moisture from such a sheet is determined by the temperature and the relative humidity of the air with which it is in contact and is inversely proportional to the thickness of the saturated air film and inversely proportional to the degree of saturation, or of the vapor pressure differential between the air and the material being dried. It is therefore desirable that the moisture laden air be removed continuously and replaced with dry air of greater moisture absorbing capacity thus substantially eliminating the saturated film condition, and that the temperature employed be as high as practical.

The maximum temperature to which the drying surface may be heated is determined by the degree of heat the material it is in contact with may safely withstand. When drying certain starch sized yarns, 160° F. is considered the safe maximum temperature, whereas with certain other materials 250° F. or more may be safely utilized.

The rate of evaporation may also be increased by creating a sufficient current or draft of relatively dry air to continuously absorb and remove the saturated air surrounding the drying surface.

The object of the present invention therefore is to provide a method of rapidly and evenly drying materials in a current of air dispersed so as to aid the drying and to provide a drying surface, usually a roll which may be evenly and uniformly heated to the highest temperature which the material being treated will safely withstand and at the same time provide a means for rapidly and evenly circulating air through the material being dried. Also this invention provides a method and means whereby a partial vacuum may be created about the material as it dries, thus expe-

5 diting the drying and further provides a method and means for removing the vapors which are usually liberated into the room and for recovering a part of the heat energy from these vapors which ordinarily is lost.

10 Broadly, the apparatus of the invention comprises a drying surface, usually a drum or roll having a perforated peripheral surface of conductive material which is heated by the direct passage of electric current therethrough, a means for circulating air through the perforations whereby the material is dried and a means for recovering waste heat from the vapors given off by the material. By drawing the air through the perforations away from the material being dried, a partial vacuum may be created about the material.

20 Important features of the invention are embodied in the construction of the drum which has its conductive surface so arranged that self induction is neutralized and is automatically controlled by a thermostat subjected to the temperature of the surface of the roll.

25 The apparatus of the invention may be constructed in large or small capacities, of simple and rugged construction and arrangement, that will be durable in service and operate efficiently and economically, that may be constructed of materials resistant to the corrosive effect of the substance being treated, that will not burn out or require replacement from over-heating and that can be arranged to operate on any available electric heating current.

35 Additional features and advantages of this invention will appear from the drawings and the following detailed description.

Preferred forms of apparatus embodying the invention are illustrated in the accompanying drawings, in which Figure 1 is a vertical view partly in section of an electrically heated drying roll.

Figure 2 is a vertical sectional view on line 2-2 of Fig. 1.

45 Figure 3 illustrates an arrangement of an electrically heated drying roll with means for creating a reduced pressure at the drying roll surface.

Figure 4 illustrates an arrangement of an electrically heated drying roll with means for supplying a current of moisture absorbing air at the drying roll surface.

50 Figures 5 and 6 illustrate another arrangement of the apparatus with means for utilizing the heat contained in the vapor discharged from the drying roll surface.

55 It will be understood that this invention is not limited to the uses or arrangements shown in the drawings but that they may be readily modified within the scope of the invention to provide an efficient external or internal rotary type of heater for the heating, drying, evaporating, roasting and calcining of various materials and for many other useful applications in industrial process operations.

60 The heater roll illustrated in Figures 1 and 2 while generally applicable to the heating and drying of a moving web of paper, textile, or the like, is primarily designed for and will be described in connection with its use in a slasher for drying sized yarns.

70 It comprises a perforated outer shell 1 of Monel, chrome nickel alloy or other metal having suitable electrical resistance and mechanical characteristics, welded to and firmly supported by expansion rings 2 and 3. A perforated inner shell 4 of copper or other relatively low resistance metal

is provided, one end being supported by and welded to the ring 2, and the other end being connected to a copper plate conductor 5, the inner edge of which connects to a copper cylinder 6 forming a part of the electric circuit and the support for a heating transformer 7. An end plate 8 of copper is connected to expansion rings 2 and 3 and supports the copper plate conductor 5, from which it is electrically insulated by means of insulated bolts 9 and insulating members 10 and 11.

The heating transformer 7 is of the step down type providing a relatively low secondary voltage, the secondary winding comprising copper bus bars 12 connected to an outer terminal plate 13 and an inner terminal plate 14. The terminal plate 14 connects to the end of cylinder 6 and the terminal plate 13 connects to the end plate 8.

20 An end plate 16 of steel or other suitable metal is provided and bolted or otherwise connected in a steam tight manner to the expansion rings 2-3 and a hollow trunnion 17 is connected to the end plate and provided with a vapor outlet 18 and a packing gland 19, communicating with the interior of the heating roll.

25 Roller bearings 22 are provided, supported by a frame 23 and serve to rotatably support the heating roll. Heat insulation 24 is provided to reduce the loss of heat by radiation from the surface of end plates 8-16. Suitable electrical insulation 25 is also provided to insulate the end of the drying drum from the trunnion 17 and supporting frame 23.

35 A hollow trunnion or shaft 26 is provided, fastened to end conducting plate 8 and provided with electric heating current collector rings 27-28-29 and temperature control collector rings 30-31-32. Collector ring 27 connects by means of wire 33 to one end of the primary winding of step down heating transformer 7, the other end being connected by wire 34 to collector ring 28. Collector ring 29 connects by means of wire 35 to a transformer tap by means of which the electric current may be applied to but a portion of the full transformer winding. Collector rings 27-28-29 connect by means of brushes 36 and wires 37-38-39 and through magnetic switches 42-43-44 and main control switch 45 to a suitable source of alternating electric current.

40 Temperature control collector rings 30-31 connect by means of wires 46-47 to thermocouple 49 in contact with the outer heating shell 1.

50 Collector rings 31-32 connect by means of wires 47-48 to thermocouple 50 which is likewise connected to the outer shell and acts as a safety device to disconnect the electric heating current in the event that through any cause whatsoever the main temperature control devices should become inoperative and permit the surface of the outer shell to become heated to too great a degree, thereby acting to prevent injury to the material being heated and to the drying roll itself.

65 Brushes 53 in contact with collector rings 30-31-32 connect by means of wires 54-55-56 to pyrometer controller 57 which acts by means of magnetic switches 42-43-44 to regulate the electric heating current supplied the outer shell 1 by varying the voltage of the heating current delivered by means of step-down transformer 7, thus automatically maintaining the temperature of the outer shell at a substantially uniform selected degree of heat.

Heat insulation 58 supported by moisture-

tight metal casing 59 is provided, to reduce the flow of heat from the interior of the roll to the transformer enclosure. Ventilating openings 60 are provided, to create a circulation of air for cooling purposes around transformer 7. If desired, vanes or blades may be provided at openings 60 so that when the roll is rotating an induced air current may be caused to circulate through the transformer enclosure.

In operation, the heating mechanism functions as follows: Upon closing push button switch 61, the drum being cold, pyrometer 57 acts to close magnetic switches 42—43 causing the electric current to flow by way of wires 37—38 to collector rings 27—28 and to step down heating transformer 7 connecting to the end and to partial winding tap of the transformer, thereby causing the maximum low voltage heating current to flow in the secondary windings, passing by way of terminal plate 14, to cylinder 6, to end plate 5, to inner shell 4, all of which being of relatively low resistance metal and of large cross section, creates but slight drop in voltage, thence by way of end rings 2—3 to outer shell 1 comprising the high resistance heating element, the end of outer shell 1 being connected to end rings 2—3 throughout its entire edge the electric current flows in a uniform manner therethrough and generates heat uniformly over its entire surface the current then passing by way of end rings 2—3 to end conductor plate 8, to transformer terminal plate 13, thereby completing the electric circuit.

The outer shell 1 being heated to the selected degree of heat, thermo-couple 49 by means of pyrometer 57, acts to open magnetic switch 43 and close magnetic switch 44, thereby connecting the electric current to the outer ends of the primary winding of transformer 7 and causing less current to flow through the heating circuit and less heat to be generated in outer shell 1.

The heating current then supplied the heating element is preferably that required to supply radiation loss and to maintain the surface of the roll at the desired temperature under conditions requiring the minimum amount of heat.

In the event the surface of shell 1 shall become heated to too great a degree from any cause whatsoever, thermo-couple 50 connecting by means of collector ring 32 to pyrometer 57 will then act to open magnetic switch 42, thereby interrupting the flow of heating current to the heating element and prevent injury to the apparatus or material being heated.

Due to the relatively small amount of heat storage capacity in the heating element, the temperature of the element or outer shell 1 responds practically instantaneously to any change in the heating current and it is thus possible to maintain the roll surface very close to the desired temperature, and the roll surface may be raised to any desired temperature very quickly. As an example, using a 6' diameter slasher drum 6' wide with an electric heating capacity of 75 kw., the roll surface temperature is maintained within a variation of $1\frac{1}{2}^{\circ}$ Fahr. with a heat requirement or load variation of approximately 75% and it is raised from a room temperature of 60° to an operating temperature of 242° F. within a period of four minutes. A steam heated slasher drum under the same condition had a temperature variation of 20° and required 40 minutes to become heated to the operating temperature.

It will also be observed that the direction of flow of the electric heating current is such that

it passes through the end conductors 5 and 8 and the outer shell 1 and inner shell 4 in opposite directions, the electric current conducting members being relatively close together whereby the effects of the magnetic field set up by the flow of electric current in one conductor, for instance, the inner shell 1, is opposite in direction to that set up by the current flowing in the outer shell 4, thereby substantially neutralizing the effects of self-induction and permitting the apparatus to operate at a desirable high power factor and efficiency.

The perforations in the metal shells 1 and 4 may be of any desired size or shape, either round, rectangular or otherwise, as best suited to the mechanical or other requirements. Preferably the shape, size and location of the openings comprising the perforations should be such as to present a relatively uniform cross section of area of metal to the flow of the electric heating current. While in the preferred arrangement a perforated metal shell is described, a metallic sheet or screen composed of wires of any desired degree of fineness, of suitable cross section and material through which the electric heating current may be passed in the manner described may be used, or alternatively, a metallic perforated sheet as described can be used and a fine mesh wire screen stretched tightly over it, the electric heating current passing both through the relatively thick perforated shell and the thin wire mesh, the electric heating current dividing in the ratio of the relative electrical resistance of the two conducting sheets. As a further variant, a porous material with high liquid diffusibility, such as felt or cloth may be used over the perforated sheet, particularly where the nature of the material being dried is of a plastic nature and may be affected by the mechanical impression of the edges of the openings comprising the perforations in the outer shell 1. This permits the production of a fine or smooth finish or surface on the material being dried.

Figure 3 illustrates an arrangement of apparatus for drying sized yarns with means for creating a reduced pressure or partial vacuum at and for quickly removing the vapors from the evaporating surface as they are formed. It also illustrates means for utilizing the heat in the vapors in the performance of useful work.

As shown in Figure 3, an electrically heated drying roll 65 of the type described in Figure 1, is arranged for drying sized yarns. The yarn 67 is supplied on reels 68 from which it passes through size tank 69 where it is saturated with a suitable sizing compound, the excess amount of size being removed by means of squeeze roll 70, passing thence by means of guide rolls 71 to the electrically heated drying roll 65, thence to a steam heated drying roll 72 of the usual design, and passing finally, dried to the desired degree, to finished stock reel 73.

The drying rolls may be driven by any usual means, preferably the finished stock reel is driven by means of belt or gears not shown and causes the drying rolls to rotate by means of the tension thus created in the yarns. If desired other means of driving the mechanism may be employed, such as gears arranged to drive each drying roll or any other suitable or conventional means.

A web 74 of canvas or felt is held in close contact with the yarn 67 on the drying roll 65 by means of guide rolls 75—76 and tension rolls 77, and acts to prevent or to reduce the amount of air drawn into drying roll 65 through the perfo-

rations on its surface. The guide rolls 75 being closely spaced act as a seal and substantially prevent air being drawn in at the bottom where the yarn enters and leaves the roll surface.

5 The canvas web 74 is of sufficient width to project over the selvage 78 or solid portion of the perforated sheet, forming the outer surface of the drying roll 65.

10 Blower 80 is provided, with its suction connected by means of heat insulated duct 81 to vapor outlet 82 of roll 65, acting to create a reduced pressure within the roll, withdrawing the vapor and after compression causing it to flow by means of heat insulated duct 83 to inlet 84 of steam heated roll 72, where it is condensed by heat exchange with the yarn in contact with its outer drying surface, heating and causing the remaining moisture in the yarn to vaporize. The water of condensation is removed from the steam heated drum 72 by the usual syphon and bucket 87, being discharged through a hollow trunnion to trap 86.

15 By condensing the vapors discharged by the material on the electrically heated roll 65 in the steam heated roll 72, the latent heat contained in the vapors is utilized to heat and further dry the yarn on the steam drum, and a large portion of the heat which would otherwise be dissipated in the air from the electrically heated drum surface is recovered, thereby greatly reducing the total amount of heat that would be otherwise required for drying the yarn.

20 Figure 4 illustrates another arrangement of drying rolls also having means for supplying dry air under pressure at the evaporating surface and means for utilizing the heat contained in the vapors discharged from the electrically heated roll. As shown, the arrangement is similar to that illustrated in Fig. 3 except that the vapors discharged from the electrically heated roll are passed through the air heater 90 and the steam or vapor condensed by heat exchange, thereby heating the air which is caused to pass into a second perforated drying roll 91 by means of a blower 92, the heated air passing through the perforations in the shell of the drier roll 91 and through the relatively porous material being dried, thereby removing the moisture in a rapid and efficient manner.

25 The surface of the drum or dryer roll 91 may if desired, be provided with a single perforated outer shell, the entire heat required for drying or evaporating being obtained by the heated dry air circulating therethrough, or it may be further heated by electric current utilizing a drying roll of the type described in Figures 1 and 2.

30 Figures 5 and 6 illustrate still another arrangement of the apparatus. As shown, drying roll 93 of the type disclosed in Figures 1 and 2 is placed in a substantially air tight heat insulated enclosure 94 provided with doors 95 and one or more windows 96 through which its operation may be observed. Sealing means, as rolls 97 or other suitable mechanism to prevent leakage of air, are provided to conduct the yarn 98 into and out of enclosure 94.

35 The vapors discharged from the heated yarn 98 are removed from the drying roll as before described under Figure 1, and pass by means of heat insulated duct 99 and exhaust fan 100 through air heater 101 of a usual and conventional type wherein the vapors are condensed, causing the air which is also circulated through the heater by means of blower 102 to become heated, the hot dry air then passing by means of

insulated duct 103 to enclosure 94 where by reason of the air pressure in the enclosure and the reduced pressure or vacuum within the drying roll 93, the air passes between and through the web of yarn and the perforations in the shell of roll 93, carrying the vapors discharged from the surface of yarn 98 with it, and causing the yarn to be dried in a rapid and efficient manner.

40 The mixture of air and vapor passes through the air heater 101, where the vapor is condensed, the air passing to air drier 104 comprising a mechanism utilizing a cold water spray to cool and remove the entrained moisture from the air, discharging it in a relatively dry condition which then passes by means of duct 105 to blower 102, thence through air heater 101 and recycled through the heating and evaporating system as before described.

45 Air heater 101 is provided with drain 106 for removing the hot water resulting from the vapor condensation, the heat of which may be utilized for many useful purposes about the plant, for instance, for heating the size tanks and similar operations.

50 By the above method of operation, a high degree of economy is attained by reason of the recycling and the recovery of the waste heat from the initial evaporation, and less electricity is required to carry on the operation. The only heat loss is that resulting from the unused heat discharged in the water of condensation, that due to surface radiation and the sensible heat contained in the finished material. By reuse of the air in the system, two important results are effected, first, the assurance of a constant supply of dry air independent of atmospheric conditions and humidity, and second, the elimination of the high and excessive humidity usually present in such drying rooms, caused by discharging the vapors or steam directly into the room atmosphere.

55 While a single phase alternating electric current is shown in the drawings and described, any suitable or available source of electric heating current may be employed, either direct or single or polyphase alternating, and while the step down heating transformer is shown mounted within and rotating with the heated roll, it may readily be placed external to the roll and the electric heating current supplied the heating element by means of the collector rings.

60 The invention may readily take other forms in which the heating surface may be in the form of flat or curved plates of any desired dimensions suitable for use in drying such materials as thick sheets of felt, fiber board and the like, that it may be desirable to dry in a flat form, as in a press, where a plurality of such flat heater plate assemblies may be employed in a manner similar to the conventional hydraulic press arrangement, or the heater plates may be shaped in various desired forms to act as a mold to suitably support the material to be heated or dried.

65 Thermostatic means subjected to the temperature of the heated surface operable to control the supply of electric heating current to the apparatus is shown in the drawings. Alternatively, the controlling mechanism may be subjected to the influence of the temperature, moisture, or other desired condition of the material discharged from the apparatus, or a combination of such methods may be utilized in a manner well known to the art, to suitably control the input of the electric heating energy to the apparatus.

70 While the invention has been described partic-

ularily with reference to heating rotating rolls for drying webs of paper or textiles, using an outer heating surface, it is obvious that alternatively the inner surface or both the inner and outer surfaces may be heated and the roll may be used to treat or evaporate liquids from chemicals or similar material, either in the form of a slurry or paste applied directly to the heating surface, or carried by means of webs or belts of cloth or other material, or this roll may be readily employed as an efficient internal rotary heater or roaster.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

15 1. A drying apparatus comprising a rotatable cylinder having a perforated heating surface of high resistance metal adapted to support a material to be dried, a second perforated cylinder concentric with the first cylinder and electrically

connected at one end thereto, means for causing an alternating heating current to pass uniformly through said cylinders in opposite directions to heat the surface of the first cylinder, and means for circulating a current of air through the perforations in said surfaces. 5

2. An electrically heated rotatable cylinder comprising a perforated heating surface of high resistance metal adapted to support a material to be heated, means for causing an electric current to pass uniformly through said metallic surface to heat the same, and a pair of thermostatic means subject to the temperature of points spaced approximately 90° on said metallic surface, said means cooperating to regulate the flow of the electric current through said metallic surface in accordance with variations in the average of the temperatures at said points. 10 15

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