Dec. 31, 1946. L. HORNBOSTEL 2,413,567

DRIER DRUM HAVING HEAT-EXCHANGE-FLUID SUPPLY AND REMOVAL MEANS

Filed April 10, 1944 2 Sheets-Sheet 1

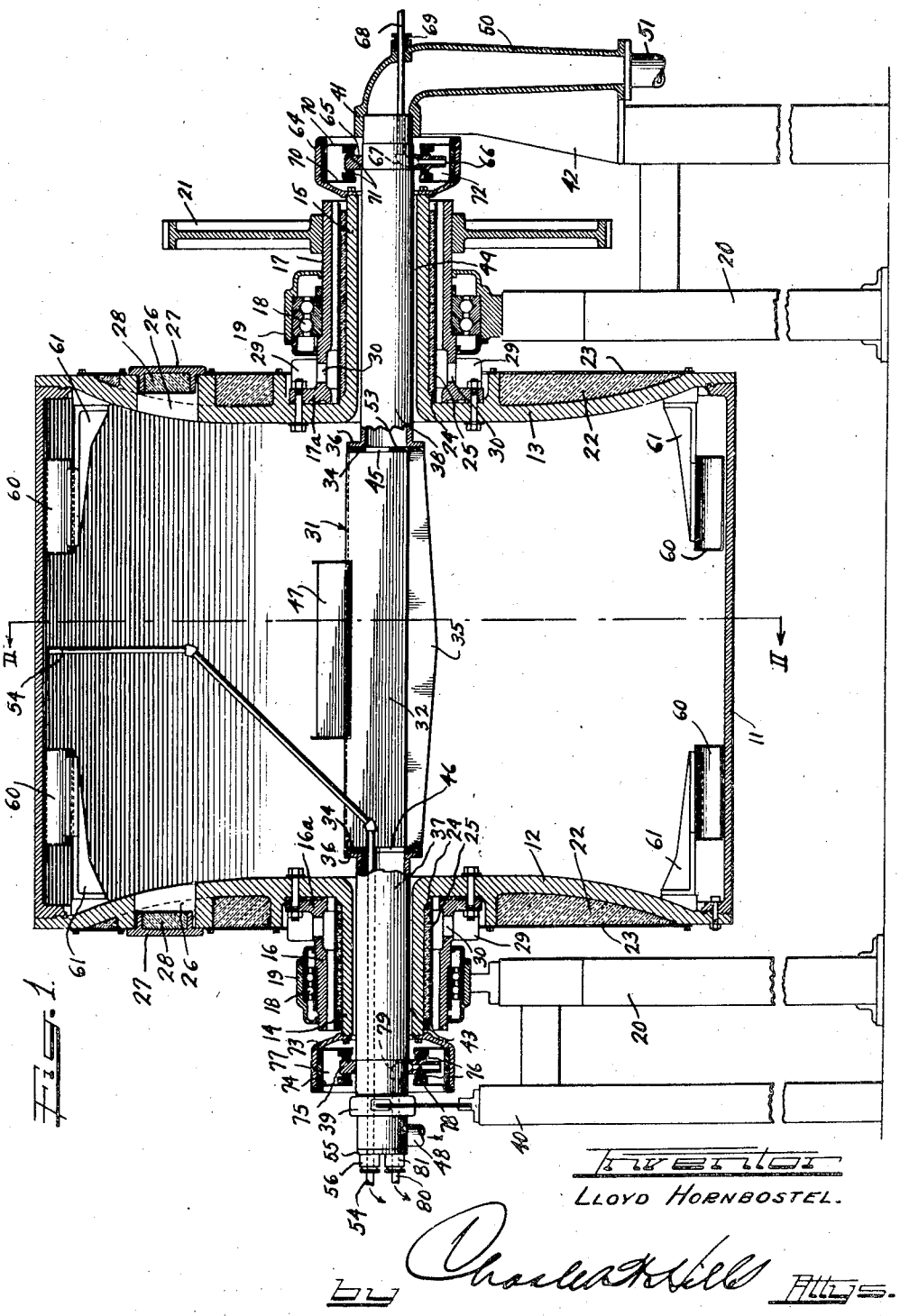


Fig. 1.

Inventor
LLOYD HORNBOSTEL.

By Charles R. Wells Attys.

Dec. 31, 1946. L. HORNBOSTEL 2,413,567

DRIER DRUM HAVING HEAT-EXCHANGE-FLUID SUPPLY AND REMOVAL MEANS

Filed April 10, 1944 2 Sheets-Sheet 2

Fig. 3.

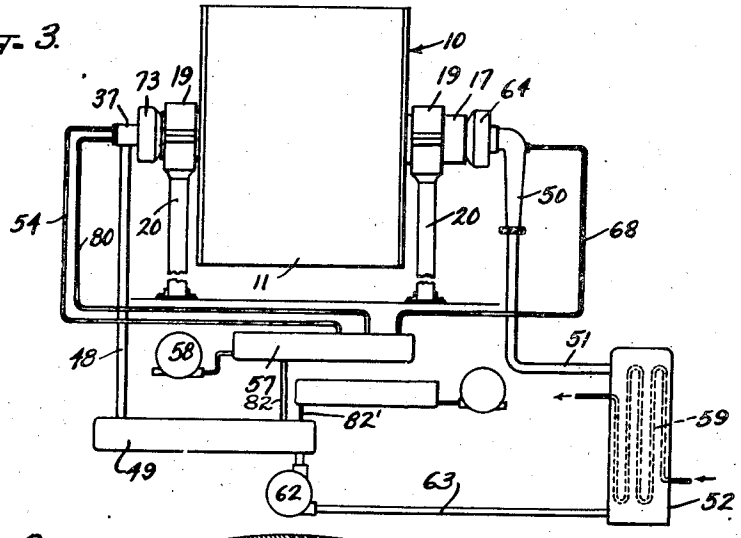
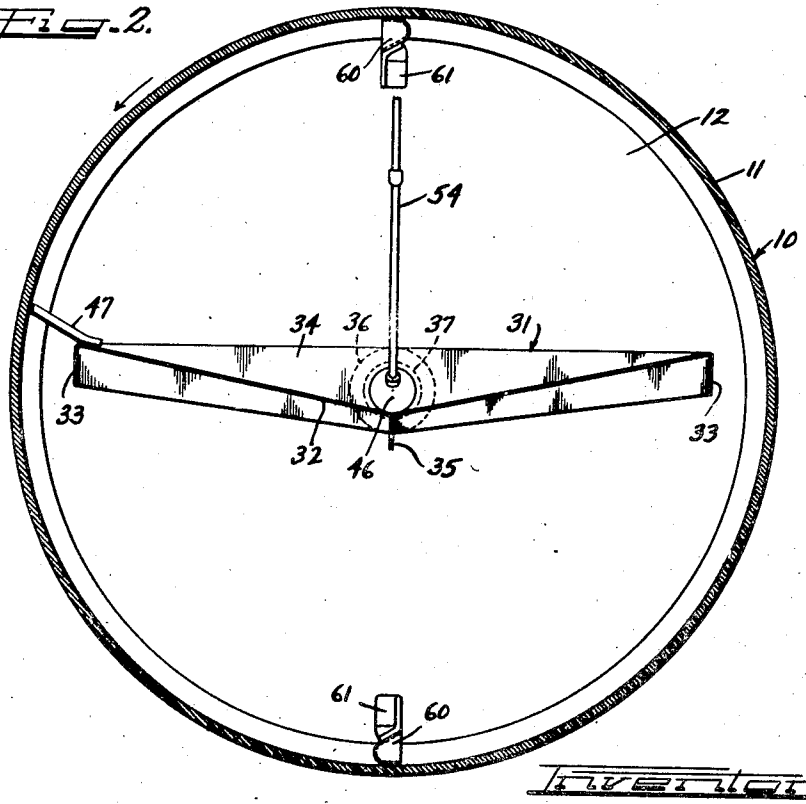


Fig. 2.



Inventor
LLOYD HORNBOSTEL.

By Charles K. Hill Attys.

Patented Dec. 31, 1946

2,413,567

UNITED STATES PATENT OFFICE

2,413,567

DRIER DRUM HAVING HEAT-EXCHANGE-FLUID SUPPLY AND REMOVAL MEANS

Lloyd Hornbostel, Beloit, Wis., assignor to Beloit Iron Works, Beloit, Wis., a corporation of Wisconsin

Application April 10, 1944, Serial No. 530,373

6 Claims. (Cl. 34—124)

1

This invention relates to a rotatable drum structure that is heated with a vaporized material that boils at high temperatures. More particularly this invention relates to a drier drum for a paper making machine and to means for heating the drying surface of the drum with a high temperature boiling material that has been transformed into a vapor by subjecting the material to high pressure or superheated steam in a chamber that is located outside the drum.

This application is a continuation-in-part of my copending application Serial No. 480,054, filed March 22, 1943, entitled "Drier drum," now Patent No. 2,365,271.

While this invention has been disclosed herein as embodied in the drier drum of a paper making machine, it is not intended to in any way limit the structure to this type of drum since the improvements are equally applicable to many types of drums in the other arts.

Heretofore, in order to attain a rapid drying capacity for a drier drum in certain types of paper making and other machines wherein a single drum of large size is employed, it has been the practice to use high pressure steam in the drum as the heat transfer medium therefor, but this has required a thickening of the drum wall in order to withstand such internal high pressure to which the drum is subjected. This thick wall structure results in a decrease in the heat transfer through the wall to the paper sheet or other web thereon, and the heavier wall also places a higher load upon the drum actuating devices thereby requiring an increased power to rotate the drum.

The present improvements aim to overcome the conditions above mentioned by providing a high pressure steam boiler exterior to the drum for heating and vaporizing a high boiling point material, and then transferring this vaporized material which is at a relatively low pressure, to the interior of the drum to transfer heat to the surface thereof. The products of condensation of this vaporized material that accumulate on the walls of the drum are removed and are returned to the high pressure steam boiler for reheating, revaporizing and recirculating it. By using a high boiling point heat transfer liquid material the steam boiler may be charged with high pressure steam at a temperature up to around 850 pounds per square inch pressure to heat and transform the liquid high boiling heat transfer material into a vapor that is characterized by its high temperature as well as its low pressure which will be only slightly above atmospheric pressure. As a result thereof, the drum structure

2

may be made comparatively light since it is not subjected to high internal pressure.

In carrying out this invention it is contemplated to use a high boiling point material such as that commercially known as "Dowtherm" which is a eutectic mixture of diphenyl and diphenyl oxide. This material is a relatively inert, colorless and non-corrosive liquid that is stable up to 725° C. and has a boiling point of 258° C. with a heat vaporization of 123 B. t. u. per pound at its boiling point.

It is one of the principal objects of this invention to simplify the construction of a drier drum such as contemplated herein and to improve the efficiency, operation and dependability of such drier drum.

Another principal object of this invention resides in the provision of a high pressure boiler heating unit wherein the heat transfer medium is heated and vaporized at a location outside the drum to be heated, and then discharging such vaporized medium into the drum through a trunnion thereof to bring this hot vaporized material into heat exchange relation with the drum wall. The invention also contemplates the condensing of the vaporized heating medium upon the walls of the drum to be removed therefrom into a stationary tray or basket that is disposed axially of the drum, and then conveying the condensate out of the drum for returning it again to the high pressure boiler unit for revaporization and recirculation.

Another object of the invention aims to utilize super-heated or high-pressure steam to heat and vaporize a high boiling point heat transfer liquid for charging a drier drum of a paper making machine whereby the drum is maintained at a desirable high degree of temperature without subjecting the drum to a high internal pressure.

It is a further object of the invention to provide means for removing or exhausting air that may accumulate within the upper segment of the drum thereby preventing the formation of an air pocket that might interfere with or prevent uniform heating of the drum surface upon which the paper is carried.

Another object of the invention is to provide a dipper device coacting with but spaced from the inner surface of the drum, said dipper being adapted to scoop up the condensate material from the drum surface and deposit it into a tray or basket within the drum. Scraper means are mounted on the tray or basket to terminate closely adjacent the drum wall to sweep the interior surface of the drum at a position between the lines of travel of a pair of spaced dippers. Spacing of the

dippers and scraper from the drum surface permits the heating material to contact all of the cylindrical part of the drum thereby preventing formation of zones on the cylinder which are at different temperatures than the rest of the cylinder.

Additional objects, aims and advantages of the invention such as contemplated herein will be apparent to persons skilled in the art after the construction and operation of the drier drum is understood from the within description.

It is preferred to accomplish the numerous objects of this invention and to practice the same in substantially the manner hereinafter fully described and as more particularly pointed out in the claims. Reference is now made to the accompanying drawings that form a part thereof.

Figure 1 is a vertical longitudinal section through the axis of a drier drum structure showing the instrumentalities of this invention incorporated therein;

Figure 2 is a vertical transverse section of the drier drum taken along the plane of line II—II on Figure 1; and

Figure 3 is a diagrammatic view illustrating the manner of vaporizing and circulating the heat transfer material, the evacuation of condensate liquid from the drum, and the other instrumentalities of the present invention.

The drawings are to be understood as being more or less of a schematic character for the purpose of disclosing a typical or preferred form of the improvements contemplated herein.

The drier drum according to the invention is designated as a whole by reference numeral **10**, and is shown to comprise a cylindrical wall **11** having end walls or heads **12** and **13** that preferably bulge inward as shown in Figure 1. The web or sheet of paper to be dried is received upon and usually travels with the outer surface of the cylindrical wall **11**. The end walls or heads are provided with axially disposed hollow hubs **14** and **15**, respectively.

The trunnions of the drum comprise tubular members **16** and **17**, respectively, that have flanged end portions **16***a* and **17***a*, respectively, and are bolted to the end walls or heads **12** and **13** in surrounding relation with respect to the hubs **14** and **15** but spaced therefrom. The trunnions **16** and **17** are rotatably mounted in anti-friction bearings **18** carried in journal housings **19** that are supported upon the upper portions of pedestals **20**. The drum is rotated by means of a large gear **21** that is secured to the trunnion **17** and actuated by any suitable prime mover.

The end walls or heads **12** and **13** of the drum are exteriorly covered with insulating material **22** that is held in place and protected by means of retainer plates **23**. The hollow hubs **14** and **15** of the end walls or heads are sheathed with insulating material **24** that is held in place by cylindrical retainers **25**. Suitable access openings **26** are provided in convenient portions of the heads **12** and **13**, and these openings are closed by caps or covers **27** that are lined with insulating material **28**. Cooling fins **29** project from the flanges **16***a* and **17***a* of the trunnions and between these fins the trunnions are provided with apertures **30** that permit coolant air to enter the trunnions to circulate between them and the insulated hubs **14** and **15** of the heads of the drum. The cylindrical wall **11** of the drum is an effective heat transfer metal that is adapted to retain its shape during the repeated heating and cooling thereof that takes place between the operating and the shut-down periods of the machine. By reason of the above mentional insulating arrangement and the cooling of the hub, the cylinder **11** will be the only heat radiating surface of the drum and it therefore may be made of a relatively thin metal because it is not subjected to internal high pressure due to the use of a heat transfer material that vaporizes at a high boiling point.

A comparatively shallow tray or basket **31** is disposed within the drum and it is of a width to extend across the diameter of the drum in the manner shown in Figure 2 to space its ends from the inner surface of the drum.

The tray has a trough-shaped bottom portion **32** the outer portions of which are down-turned as at **33**, and its edges are connected to suitable end walls **34**. A depending rib **35** extends along the lower portion of the tray bottom wall to reinforce and strengthen the tray structure. The end walls **34** of the tray are suitably secured to annular flanges **36** upon the inner ends of tubular members **37** and **38** that freely pass through the hubs **14** and **15** of the respective heads **12** and **13** of the drum so that their other ends project beyond the ends of said hubs as shown in Figure 1.

The outer end portion of the tubular member **37** is fixedly mounted in a support **39** on a pedestal **40**, and the outer end of the other tubular member **38** is fixedly mounted in a support **41** upon a pedestal **42** that is located beyond the driving gear **21**. The supports **39** and **41** grip the tubes **37** and **38** to support them in spaced relation to the hubs **14** and **15** that rotate free thereof. This arrangement provides a fixed exterior support for the tray or basket **31** that is within the drum and it also provides annular passageways **43** and **44** in the clearances between the trunnions and the tubes.

The tray end wall **34** that is secured to the tube **38** has an aperture **45** at least the major portion of which is disposed above the axis of said tube, and the other end wall **34** of the tray that is secured to the tube **37** has an opening **46** therein that is preferably co-extensive with the interior bore of the tube **37**. A scraper or doctor **47** projects from the mid-portion of a margin of the tray into close proximity to the inner surface of the drum for the purpose of directing condensate swept by it from the drum into the tray. The liquid is drawn off the tray through the large aperture **46** and flows through the tubular member **37**. At its outer end the tubular member **37** communicates with a drain-pipe **48** that conveys the condensate to an accumulator or tank **49**.

The outer end of the tubular member **38** communicates with a nozzle **50** on the support **42** that receives the heat transfer material in a vaporized form at relatively low pressure from a conduit **51** that leads thereto from a vapor chest or boiler **52**. This vaporized material is discharged into the drum through the aperture **45** in the tray end wall. The lower portion of the end wall below the aperture **45** provides a dam **53** that prevents the flow of liquid from the tray into the tubular member **38** through which the vapor passes.

For the purpose of evacuating air from the upper portion of the drum to prevent formation of an air pocket therein, a suitable air exhaust pipe **54** is disposed in the cylinder with its upper open end adjacent the top segment of the drum as shown in Figure 1. This pipe extends down into the tray and then through the tubular member **37** and out of the end thereof through a cap or closure plate **55** that is suitably secured to the

outer end of said tubular member 37. The air exhaust pipe 54 passes through a seal gland 56 on the closure cap 55 and then leads to a condenser 57 with which a suction pump 58 communicates for sucking the air through the pipe 54.

A heat exchanger consisting of a boiler or vapor chest 52 comprises a closed shell that surrounds a coil 59 in which super-heated or high-pressure steam is circulated from any suitable source. The heat transfer material in a liquid form is contained in the shell where it surrounds the coill 59. The temperature of the heat transfer material is thus raised above its high boiling point to vaporize it, and this vapor leaves the boiler shell through a feed pipe 51 that conveys the vaporized material to the nozzle 50 for discharging it into the drum through the tube 38 and the opening 45 in the end wall of the tray.

The condensate that accumulates in a film upon the interior surface of the drum is removed therefrom by the scraper or doctor 47 and flows into the tray or basket 31. Suitable concave or pocket-shaped dippers 60 are carried by brackets 61 that project inward from the heads 12 and 13 of the drum and are disposed with their lip portions close to the inside surface of the drum to scoop up the condensate liquid that forms a puddle in the bottom or lower segment of the drum during its rotation. The scoops or dippers travel with the drum and they are arranged preferably in pairs at diametrically opposite portions of the drum, and being in non-contacting relation to the inner surface of the cylinder 11 they do not interfere with the heating of the drum surface. The dippers of each pair are spaced apart a distance that permits them to clear the end edges of the scraper 47 when the drum is operating. These dippers 60 are adapted to spill the condensate liquid into the tray or basket 31 after they have traveled above the horizontal plane of said tray. The superficial area of the tray is sufficient to receive any drip of the condensate that may gravitate from or be thrown off during rotation of the drum. The liquid of condensation passes out of the tray through the large aperture 46 in its end wall and flows into tubular member 37 from which it is removed by the drain-pipe 48 that discharges into the accumulator 49. From the accumulator the condensate liquid is returned to the steam chest or boiler by means of a fluid pump 62 and a return pipe 63. This arrangement is effective for the recirculation and the revaporization of the heat transfer material.

An annular seal casing 64 is carried by the end face of the hub 15 to rotate with the drum in surrounding relation to the end portion of the stationary tubular member 38. Within this casing the tubular member 38 has an annular collar 65 secured to it that has a radial bore 66 alined with a hole in this tubular member. An elbow coupling 67 is threaded into the hole to establish communication between the radial bore and a suction pipe 68 that extends out of the supported end of the tubular member 38 and through a gland 69 in the wall of the nozzle 50 and thence to the condenser 57. A pair of spaced diaphragm rings 70 are carried by the inner surface of seal casing 64 and extend inwardly toward and past the outer face of the collar 65 on tubular member 38 where they are provided with seal rings 71 that slidably engage or oppose the side face of said collar to bear against them in sealing relation. The spacing of these diaphragm rings 70 provides between them an annular sealed chamber 72 with which the radial bore 66 of collar 65 is in communication, so that the said chamber may be evacuated by suction pipe 68 in response to the action of the vacuum pump 58. As shown in Figure 3, the condenser 57 is in advance of the vacuum pump 58 for condensing any vapor that may pass through suction pipe 68.

The outer end face of the other drum hub 16 carries a seal casing 73 the surface of which has diaphragm rings 74 secured to it that extend inwardly toward the adjacent end portion of tubular member 37 upon each side of a collar 75 secured to said tubular member 37. Seal rings 76 are secured to the diaphragm rings 74 in contacting relation to the side faces of the collar against which they are adapted to slide to effect a seal therebetween. This arrangement provides a sealed annular chamber 77 between the diaphragm rings 74 and surrounding the adjacent portion of the tubular member 37. A radial bore 78 is made in the collar 75 that opens into chamber 77 and is registered with a hole in the adjacent portion of the tubular member 37. An elbow coupling 79 has an end threaded into the hole to establish communication between the annular chamber 77 and a suction pipe 80 that is screwed into the other end of the coupling 79. The suction pipe 80 passes through a gland 81 in the closure plate or cap 55 at the end face of the tubular member 37 and leads to the condenser 57 that is located in advance of the vacuum pump 58 in the same manner as before described with respect to the suction pipe 68.

The action of the vacuum pump 58 is to establish a vacuum in the annular chamber 72 in the seal casing 64 carried at the end of trunnion 15, and also a vacuum in the annular chamber 77 in the seal casing 73 carried at the end of trunnion 14.

The interiors of the seal casings 64 and 73 next to the ends of the respective trunnions, are in communication with the interior of the drum through the annular passageways 43 and 44 that are provided by the clearances between the trunnions and the telescoped adjacent tubular members that carry the tray 31. By means of this arrangement, any vaporized heat transfer material that may seep past the seal rings 71 and 76, due to an increase of pressure in the drum above the desired pressure, will be sucked out of the respective chambers 72 and 77 through the suction pipes 68 and 80 and delivered to the condenser 57. Condensate liquid matter will flow from the condenser into the accumulator 49 through a pipe 82 and the volatile, non-condensibles will be drawn off by the vacuum pump 58 and discharged into the atmosphere. A similar condenser 57' and pump 58' are provided in communication with the accumulator 49 through the pipe 82' so as to remove volatile non-condensibles from the fluid circuit including the accumulator and boiler. This arrangement provides a blow-off for the drum and is effective to clear the drum of abnormal pressure and to discharge the non-condensible matter at a location remote to the paper making machine.

This invention provides a drier drum construction that is heated with a low pressure hot vapor that is produced outside the drum by subjecting a high boiling material in a boiler to heat transfer from high pressure or superheated steam. There is a closed fluid circuit in which the drum and the boiler are interposed, with one side of the fluid circuit constituting a drain leading from the drum to the boiler, and the other side of said

fluid circuit providing the means whereby the vaporized high boiling material is delivered to the drum. This arrangement effects the continuous revaporization and recirculation of the high boiling heat exchange material. It also provides for the heating of the drum with a low pressure vapor slightly above atmospheric pressure but having the temperature of high pressure steam, without subjecting the walls of the drum to undesirably high internal pressures.

I claim as my invention:

1. In a drier drum assembly the combination of a rotatable cylinder; a closed fluid circuit, in which said cylinder is interposed, for passing vaporized heat transfer material into the cylinder to heat the same, one side of said fluid circuit constituting a drain for said cylinder; a stationarily supported tray within said cylinder with scraper means attached thereto and extending into close proximity with the inner surface of said cylinder adapted to collect condensate from the inner surface of said cylinder and deliver the condensate to the drain side of said fluid circuit; means including dipper means supported within said cylinder and rotatable therewith for collecting condensate from the surface of the cylinder for delivery to said tray; a heat exchanger exterior to said cylinder comprising a housing interposed in said fluid circuit to receive condensate from the drain side of said fluid circuit; high boiling low vapor pressure material in said housing; and means for passing high pressure steam through said housing in heat exchange relation to the high boiling material to vaporize the material for delivery to the other side of said fluid circuit; said heat exchanger and said fluid circuit constituting means whereby the high boiling material is continuously revaporized and recirculated through said cylinder.

2. A drier drum comprising a cylinder; hollow trunnions for supporting and journaling said cylinder for rotation; a tray disposed diametrically across the interior of said cylinder for receiving condensate from the inner surface thereof; stationary hollow supports extending through the trunnions into the cylinder for maintaining the tray in fixed relation within said cylinder, one of said supports adapted to drain condensate from said tray; means for discharging heating vapor through the other of said supports to charge said cylinder with said vapor; scraper means projecting from said tray into close relation with the interior surface of said cylinder for removing condensate from said interior surface and for discharging the condensate into said tray; and dipper means mounted in said cylinder adjacent the ends thereof and rotatable therewith for collecting condensate of the vapor from the inner surface of the cylinder for discharge to said tray.

3. In a drier drum assembly the combination of a cylinder; hollow trunnions for supporting and journaling said cylinder for rotation; a tray disposed in said cylinder for receiving condensate from the inner surface thereof; hollow stationary supports extending through the trunnions into said cylinder for maintaining said tray in fixed relation within said cylinder, one of said supports adapted to drain the condensate from said tray; the other of said supports providing communication with the interior of said cylinder; means including dipper means supported within said cylinder and rotatable therewith for collecting condensate of the vapor from the surface of said cylinder for delivery to said tray; a heat exchanger exterior to said cylinder comprising a casing containing high boiling material, and a high pressure steam coil in said casing positioned to be submerged in the material to vaporize the same; and a conduit establishing communication between said casing and said other tray support for charging the cylinder with the vaporized material.

4. A drier drum comprising a cylinder; a closed fluid circuit in which said cylinder is disposed, hollow trunnions for supporting and journaling said cylinder for rotation; a tray in said cylinder for receiving condensate from the inner surface thereof; stationary hollow supports extending through the trunnions into said cylinder for maintaining the tray in fixed relation within said cylinder, said supports communicating with the interior of said cylinder and one of said supports adapted to drain said tray; means including dipper means supported within said cylinder and rotatable therewith for collecting condensate of the vapor from the surface of said cylinder for delivery to said tray; means exterior to said cylinder for subjecting heat transfer material to high pressure steam to vaporize the material; means for delivering the vaporized material through the other of said supports for charging the cylinder with said vaporized material; an exhaust pipe extending inside said cylinder and having an inlet adjacent the top thereof; a pump for removing vapor from the inside of said cylinder through said exhaust pipe; a condenser for condensing the removed vapor; and means for returning the condensed vapor to said fluid circuit.

5. In a drier drum assembly the combination of a cylinder having end heads; hollow trunnions projecting from said heads for supporting and journaling said cylinder for rotation; a tray disposed diametrically across the interior of said cylinder for receiving condensate from the inner surface thereof; stationary hollow supports extending through the trunnions into the cylinder for maintaining the tray in fixed relation within said cylinder, one of said supports adapted to drain condensate from said tray; means for discharging heating vapor through the other of said supports to charge said cylinder with vapor; and dippers carried by said heads in non-contacting relation to the inner surface of the cylinder for removing condensate from said inner surface and depositing the condensate in said tray.

6. In a drier drum assembly the combination of a cylinder; hollow trunnions for supporting and journaling said cylinder for rotation; a tray disposed diametrically across the interior of said cylinder for receiving condensate from the inner surface thereof; means including dipper means supported within said cylinder and rotatable therewith for collecting condensate of the vapor from the surface of said cylinder for delivery to said tray; apertured end walls for said tray, stationary hollow supports extending through said trunnions into the cylinder for maintaining the tray in fixed relation within said cylinder, one of said supports adapted to drain condensate from said tray through one of the apertured end walls, and means for discharging heating vapor through the other of said supports and the other apertured end wall to charge the cylinder with vapor, the said other end wall having its aperture so adapted that the solid portion of said wall provides a dam beneath its aperture to prevent flow of liquid from the tray into the adjacent hollow support.

LLOYD HORNBOSTEL.