Dec. 17, 1940. P. ERBY 2,225,166

WEB DRYING APPARATUS

Filed Oct. 6, 1938 2 Sheets-Sheet 1

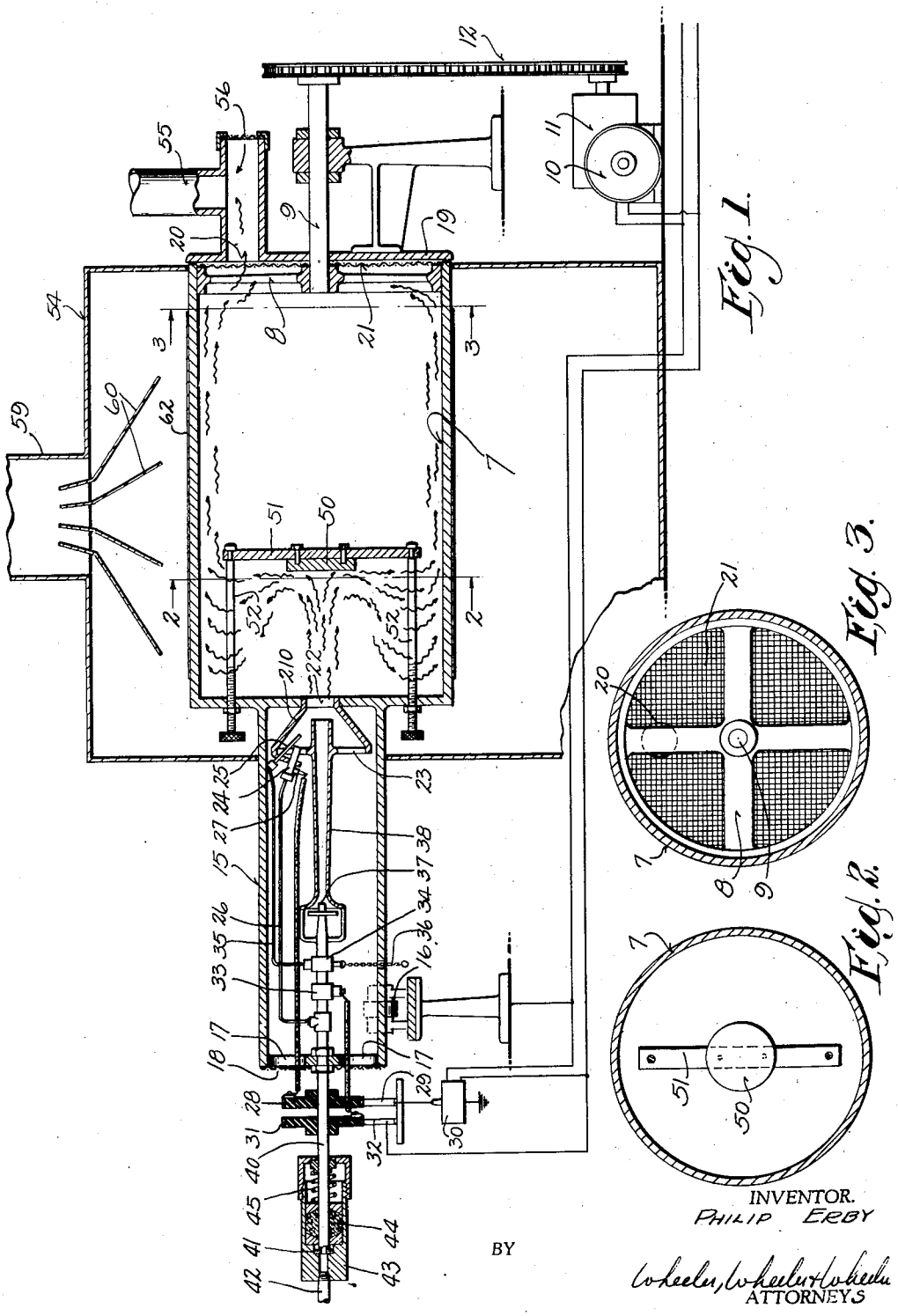

Fig. 1.

Fig. 3.

Fig. 2.

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WEB DRYING APPARATUS

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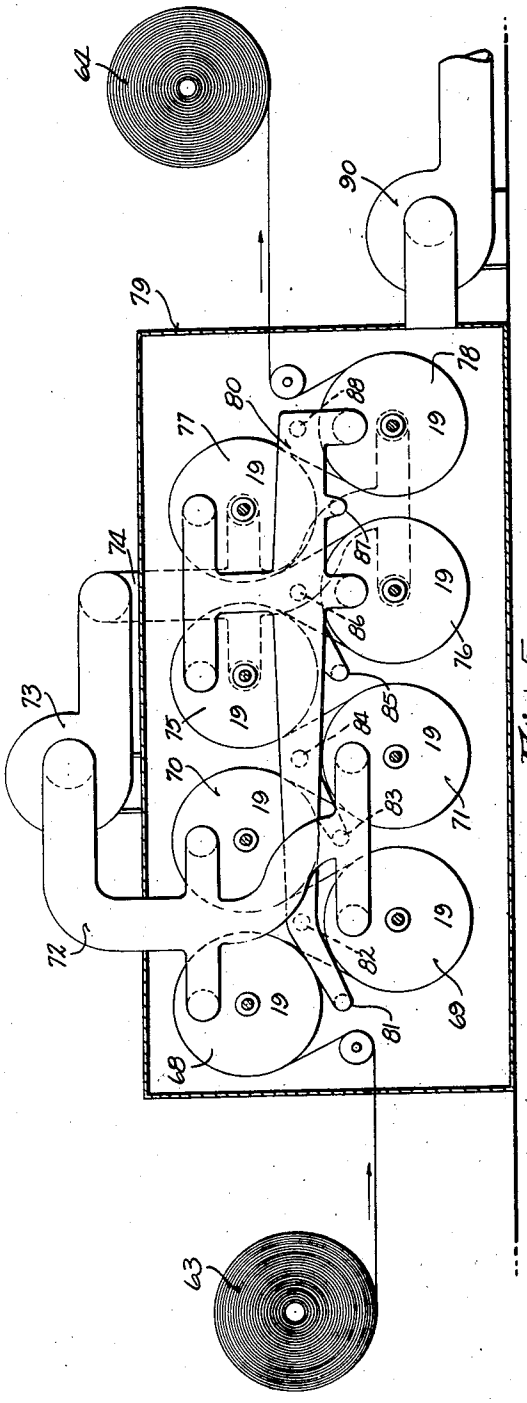

Fig. 5.

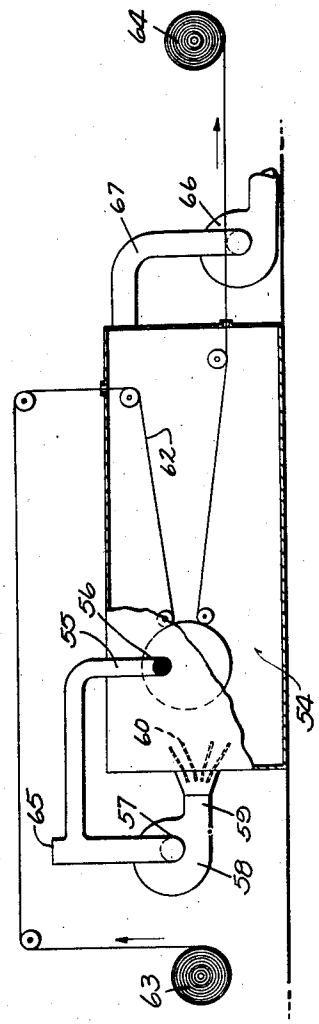

Fig. 4.

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WEB DRYING APPARATUS

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Application October 6, 1938, Serial No. 233,565

9 Claims. (Cl. 34—48)

This invention relates to improvements in web drying apparatus.

It is the primary object of the invention to provide a simplified means for ensuring the speedy drying of a web of paper or the like. It is a further purpose of the invention to provide means whereby a drum, over which the web to be dried is passed, can be thoroughly and adequately heated from the interior by gases which have not yet been used to pick up moisture from the web, whereby the heat imparted to the drum is the high temperature heat of such gases before the gas temperature is reduced by evaporation, the same gases being later recirculated about the exterior of the drum in direct contact with the web to pick up the moisture driven from the web by the heat.

It is my further purpose to provide a complete burner and safety control mechanism rotatable with the drum about which the web to be dehydrated is passing.

Other objects will be apparent from the following disclosure.

I have shown not only a single drum but a multiple drum arrangement embodying my invention and arranged in each instance to utilize hot gases, preferably products of combustion, without burning the web to be dried.

In the drawings:

Fig. 1 is a view in longitudinal section of apparatus comprising a single drum and embodying my invention.

Figs. 2 and 3 are respectively detail views in cross section taken on the section lines 2—2 and 3—3 of Fig. 1.

Fig. 4 is a diagrammatic view showing partially in end elevation and partially in section, the arrangements for moving the gaseous material and the web to be dried through such apparatus as illustrated in Fig. 1.

Fig. 5 is a diagrammatic view taken in transverse section through the casing and showing an end elevation, a set of drying rolls, and gaseous conduits constituting a multiple drum apparatus embodying the invention.

Like parts are identified by the same reference characters throughout the several views.

The heat to be used is preferably generated in the first instance directly within the drum to be heated. In Fig. 1 I have shown a gas burner installation which is particularly satisfactory for the purposes of the invention. The web to be dried is fastened over the roll or drum 7, one end of which is carried by spider 8 from a shaft 9 driven from motor 10 through the speed reducer 11 and chain 12.

The other end of the drum has a tubular extension 15 of reduced diameter which is carried on supporting rollers such as those shown at 16. The air inlet ports at 17 within the tubular drum extensions 15 are covered by the screen 18 to prevent fire propagation beyond the confines of the drum. The larger end of the drum, adjacent the spider 8, is provided with a stationary closure at 19 having an opening 20 through which the products of combustion are removed from the drum. Spider 8 carries a screen 21 rotatable with the drum and the spider across the opening at 20 to prevent flame propagation beyond this end of the drum.

The gas burner comprises a series of concentric nozzles through which gas and air in proper proportions are admitted to the drum. The largest nozzle 210 is a frusto-conical fitting carried by the admission end of drum 7 surrounding the admission port 22 which is provided in such fitting. The larger end of the fitting is open at 23 to admit the secondary air. Into the opening projects the pilot burner 24 and thermostat 25 which, being of generally conventional construction, are not described in detail. The pilot light 24 is supplied with gas through the branch pipe 26, the gas being ignited by a spark plug 27 supplied with current through slip ring 28 and brush 29 from the spark coil diagrammatically illustrated at 30. Another slip ring 31 and brush 32 supply current to a conventional solenoid valve 33, the brush being so connected to the main motor circuit as to cut off the gas flow when the motor is not in operation, and to open the burner for gas flow when the motor is in operation.

A secondary gas valve at 34 is likewise of conventional form and arranged to be latched open by a detent (not shown) which is controlled by the thermostat 25 through the line 35. The valve may be cocked open manually by the chain 36 when the pilot light is in operation to keep the thermostat hot, but if the pilot light at burner 24 is extinguished the thermostat 25 cools and trips the detent to allow the valve at 34 to close, thus cutting off the gas from the valve nozzle 37.

The gas nozzle 37 directs the gas through a Venturi tube at 38. Primary air enters around the gas nozzle and flows through the Venturi tube entraining secondary air at the nozzle 210 to maintain combustion at the point where the mixed gas and air are ignited by the pilot burner 24 and projected into the drum 7.

The gas supplied to nozzle 37 enters through pipe 40 which provides mechanical support for the slip rings 28 and 31, being fixedly mounted in the tubular drum extension 15 at the inlet end thereof. The gas pipe 40 is provided with a flanged head 41 swiveled to the gas main 42, such main being provided with a casing 43 in which packing 44 is confined under pressure of spring 45 to permit the pipe 40 to rotate with the drum in respect of the relatively stationary supply main 42.

It is not important which pipe carries the chambered head or casing 43, nor what specific means is used to restrict the pipes against undue separation, but it is desirable that some freedom of axial motion be provided for in addition to relative rotation. The flange 41 has for this purpose substantial clearance from the packing gland element which closes its recess in casing 43.

Directly in the path of the flame projected into the drum from the gas burner is a refractory baffle 50 carried by a transversely extending support 51 to which the adjusting screws 52 are swiveled. These screws are threaded into the end of the drum to adjust the baffle to and from the burner so that the exact point may readily be found at which the flame will be caused to travel through the drum in a manner to heat its surfaces uniformly. The approximate path of the flame is indicated by lines drawn from the burner to the baffle and through the drum in Fig. 1. The flame traverses the inner periphery of the drum closely adhering to the inner peripheral surfaces to give up the heat of the incandescent gases directly to the metal of the drum, thereby highly heating the web which is traversing the drum.

The type of burner illustrated is one which requires a rapid circulation of air through the burner to maintain the flame. Although means hereinafter to be described is provided for maintaining a partial vacuum within the casing 54, it is preferred that an additional air circulating means be provided to draw gases directly from the drum. The reason for using the additional air circulator is to avoid the extinguishing of the flame which might follow if a workman should open a door in casing 54 for the purpose of gaining access to the web while the burner was in operation. Otherwise the intervening blower might be omitted.

From the drum opening 20 in the stationary drum unit 19 leads pipe 55 which may be provided with a screened auxiliary inlet at 56. Pipe 55 goes to the inlet or eye portion 57 of the intermediate blower 58 above referred to (Fig. 4) and this intermediate blower discharges into the casing 54 through pipe 59 over the set of baffles 60 which distribute the flow of gas over the web 62 which is passing through the casing between the parent roll 63 and the rewind roll 64.

The gases resulting from combustion of the burner have lost some of their heat through direct contact with the interior of the drum. Additional heat has been given to the extra air admitted at 56 and 65, but such gases have not yet come into contact with any moisture and consequently are extremely dry at the time they flow over the web on the surface of the drum. Evaporation is therefore rapid and it may be facilitated by the fact that the exhaust blower 66 which withdraws the gases and vapors from the casing through pipe 67 preferably maintains the interior of the casing under partial vacuum. In other words, the capacity of blower 66 preferably exceeds the capacity of the intermediate blower 58 to enhance the rapidity of the vaporization of the moisture from the web.

In the arrangement shown in Fig. 5 the web passing from the parent roll 63 to the rewind roll 64 passes over two series of rolls. Each of the first four rolls encountered by the web at 68, 69, 70 and 71 is identical with roll 7, each being heated by its own separate burner. The gases emerging from the stationary heads 19 of these first four rolls are collected in the pipe 72 through its several branches, and led to the intake eye of the intermediate blower 73. By this blower the collected gases are again distributed through pipe 74 and its branches to the input ends of the rolls 75, 76, 77 and 78, these being the next rolls encountered by the web as it traverses casing 79. Thus far the hot gases have not yet come in contact with the web to carry off the moisture therefrom. From the stationary heads 19 of rolls 75, 76, 77 and 78, however, the hot gases are collected in a manifold 80 and discharged through the ports 81, 82, 83, 84, 85, 86, 87, and 88, each of such ports being arranged to direct the hot gases into the bight between two successive flights of the web where the web passes about the respective rolls in opposite directions. Hence the distribution of the hot gases is such as to assist in taking off the moisture from the web, and the gases are then withdrawn from casing 79 through the suction blower 90 which, as above explained, preferably keeps the entire interior of the casing 79 normally under partial vacuum.

It will be understood that while the web may be of any material, and while the liquid to be vaporized therefrom may constitute a liquid other than water, I have noted the problem of paper drying as a means of illustrating the invention. For the evaporation of water from a paper web the organization herein disclosed has been found to have particular utility. Notwithstanding the intense heat applied to the interior of the drum, the motion of the paper over the drum may be so rapid and the rate of extraction of water therefrom be so high as to keep the paper sufficiently cool to prevent it from scorching. The problem of uniformity in drying has been solved by the mechanism herein disclosed, and by employing two separate blowers disposed in the system in the manner indicated I am able to maintain the burner in operation and to maintain flow through the system in the desired manner.

The drum extension may be of any desired dimensions, and is shown as an example of one convenient means for providing a restricted air passage about and through the burner to the interior of the drum while supporting the burner largely externally of that portion of the drum on which the web is carried, so that the flame can be uniformly distributed on the web carrying surfaces.

By means of the invention the distribution of heat and the controls herein provided protect the web against damage notwithstanding the extremely high temperatures and direct heat which are used. As an example of such temperatures it may be stated that for 80 lb. wall paper the drum temperature is preferably about 850° F. and the surface or peripheral speed is approximately 350 feet per minute. This enables the web tc be dried with much greater efficiency than has heretofore been possible in the use of steam. It is

because of these high temperatures that it is important to cut off the flow of gas instantly when the current to the operating motor is cut off so that by the time the drum comes to rest it will have been substantially cooled.

It will be noted that the gases circulated over the surface of the web are virtually free of oxygen, thus enabling much higher temperatures to be used than would be possible if air or other oxygen-containing gases were used. Moreover, because of this fact, it is possible to dry on this and other similar apparatus webs containing highly inflammable and explosive gases and also materials which, in the presence of oxygen, would suffer changes of color.

For example, highly colored wall papers are dried with utmost rapidity at temperatures which, in the presence of oxygen, would result in changes in the color of the dyes and pigments used. Also, webs of cloth containing naphtha can be safely passed over a drying roll and subjected to high temperature gases in accordance with this invention and thus dried almost immediately without having the naphtha reach the air of the plant in which the drying operation is conducted. The gases reaching the fabric are so completely free of oxygen due to the fact that they are products of combustion, as to eliminate any possibility of explosion. Heretofore products containing naphtha have been dried by festooning them over long series of rollers and the problem of ridding the plant of the naphtha vapors has involved a frequent exchange of all of the air in the establishment with consequent enormous heating bills during cold seasons.

I claim:

1. Web drying apparatus of the character described, including in combination a drum mounted for rotation, means for passing web-like material peripherally over said drum, means for projecting an open flame longitudinally of the interior of the drum, conduit means leading from the interior of the drum and having a discharge portion arranged to deliver gases into contact with the material externally of the drum, and power driven means associated with said conduit means for drawing heated gases from the drum and maintaining a partial vacuum therein and propelling such gases into contact with said material, and a foraminous element in the path of such gases comprising means for preventing flame propagation from the interior of the drum to the gases contacting said material.

2. In a web drying apparatus of the described class, the combination with a drum having a web supporting periphery, means for maintaining combustion within the drum, gaseous conduit means leading from the drum interior to a point adjacent the web supporting periphery thereof, and propelling means associated with said conduit means for drawing heated gases from the drum interior and dispelling said gases adjacent the web supporting periphery.

3. In a machine for drying webs of paper and the like including a housing, a series of drums in said housing and means for feeding the web successively over peripheral surfaces of said drums, at least one of said drums being provided with a burner at one end and an outlet at the other end, baffle means within the drum provided with the burner for distributing flame and products of combustion from said burner along its interior surfaces, means for propelling the heated gases from the drum outlet into the housing, and means for preventing flame from being so circulated, whereby the peripheral wall of the drum may be kept at a high temperature and the gases discharged therefrom utilized to provide a moisture absorbing atmosphere in contact with the web.

4. Web drying apparatus of the character described including a rotatably mounted cylindrical drum provided at each end with an aperture, a tubular housing surrounding the aperture at one end and having disposed therein a burner of the Bunsen type positioned to project flame through the aperture longitudinally of the drum, baffle means disposed within said drum in the path of the projected flame and adapted to distribute the flame and heated gases along the interior surface of the drum wall, said baffle being adjustable in an axial direction, a housing enclosing said drum and provided with inlet and outlet apertures, a conduit leading from the aperture in the drum end wall opposite the burner to said housing inlet and having disposed therein means for drawing heated gases from the interior of the drum and circulating them through the housing, and means for passing moisture containing webs through said housing and arcuately over a portion of said drum whereby the dry heat from the flame within the drum and the hot gases within the housing co-act to vaporize the moisture carried by said web.

5. In a web drying apparatus, the combination with a web supporting drum and means supporting the drum for rotation, said drum having a tubular extension at one end, of a burner mounted in said extension and adapted to deliver flame and products of combustion into said drum, burner control mechanism including a pilot burner mounted in said extension, electrical means for igniting said pilot burner, electrical feeding connections for said control mechanism including slip rings rotatable with said tubular extension and having brushes acting thereon, and means for supplying fuel to said burner during drum rotation.

6. In a web drying apparatus of the character described, the combination with a drum mounted for rotation and having a peripheral web supporting portion, and a centrally apertured end wall, a frusto-conical housing positioned exteriorly of said drum adjacent said end wall aperture and axially provided in its larger end with a spider, a flaring tube aligned with the end wall aperture and having its larger end supported by the spider and provided adjacent its smaller end with air admission ports, a jet tube aligned with the smaller end of the first mentioned tube to direct fuel thereto for the carburetion of primary air admitted through said ports and the carburetion of secondary air admitted to said spider, a supply pipe in operative connection with said jet tube, and means for withdrawing gases from said drum whereby to aspirate primary and secondary air currents into said drum for the proper combustion of fuel supply.

7. A device of the character described, comprising the combination with a rotatable drum provided at one end with a supporting shaft and spider, and a drum head provided with an outlet, power means for exhausting gases from said drum through said outlet, the end of said drum remote from said outlet being provided with a tubular bearing extension provided with bearing support in which said drum and extension are rotatable and said extension having an inlet port, a burner provided with fuel and air supply connections for directing flame into said drum through said inlet, and a baffle disposed within the burner end of the

drum in the path of flame projected by said burner, whereby to distribute the burner heat over the drum walls.

8. In an apparatus for drying continuous webs of paper and the like, the combination with a drum and means for guiding the continuous web thereover at substantial rates of speed, of a combustion burner within the drum for heating the drum, a casing in which said drum operates, means for discharging the products of combustion from the drum into the casing whereby to produce a substantially oxygen-free atmosphere therein, and means for exhausting gases from the casing at a rate exceeding the rate at which they are delivered thereto, whereby a web traversing said drum derives heat from the drum and from the atmosphere of said casing while subjected to partial vacuum adapted to enhance the rate of moisture evaporation from said web, whereby to cool said web below the temperatures to which it would be subject at atmospheric pressure and to evaporate moisture from the web at a lower temperature than that which would be required to produce like evaporation at atmospheric pressure, and whereby the high speed of web travel, the relatively oxygen-free atmosphere in which the web is dried, the relatively high rate of evaporation from the web, and the cooling effect produced by such evaporation all combine to enable the web to be dried rapidly and without discoloring oxidation or ignition.

9. In an apparatus for drying webs of paper and the like, the combination with a suitable housing, of a web supporting drum therein, means for maintaining combustion at one end of the drum and passing the products of combustion therethrough and delivering the same into the housing exterior to the drum and in contact with the web, and suction means for maintaining a partial vacuum in the portion of the housing through which the web passes to prevent excessive heat tending to discolor the web or cause the same to ignite.

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