Dec. 1, 1925. 1,563,461

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HIGH TEMPERATURE RADIANT DRYING SYSTEM

Filed Nov. 26, 1923 3 Sheets-Sheet 1

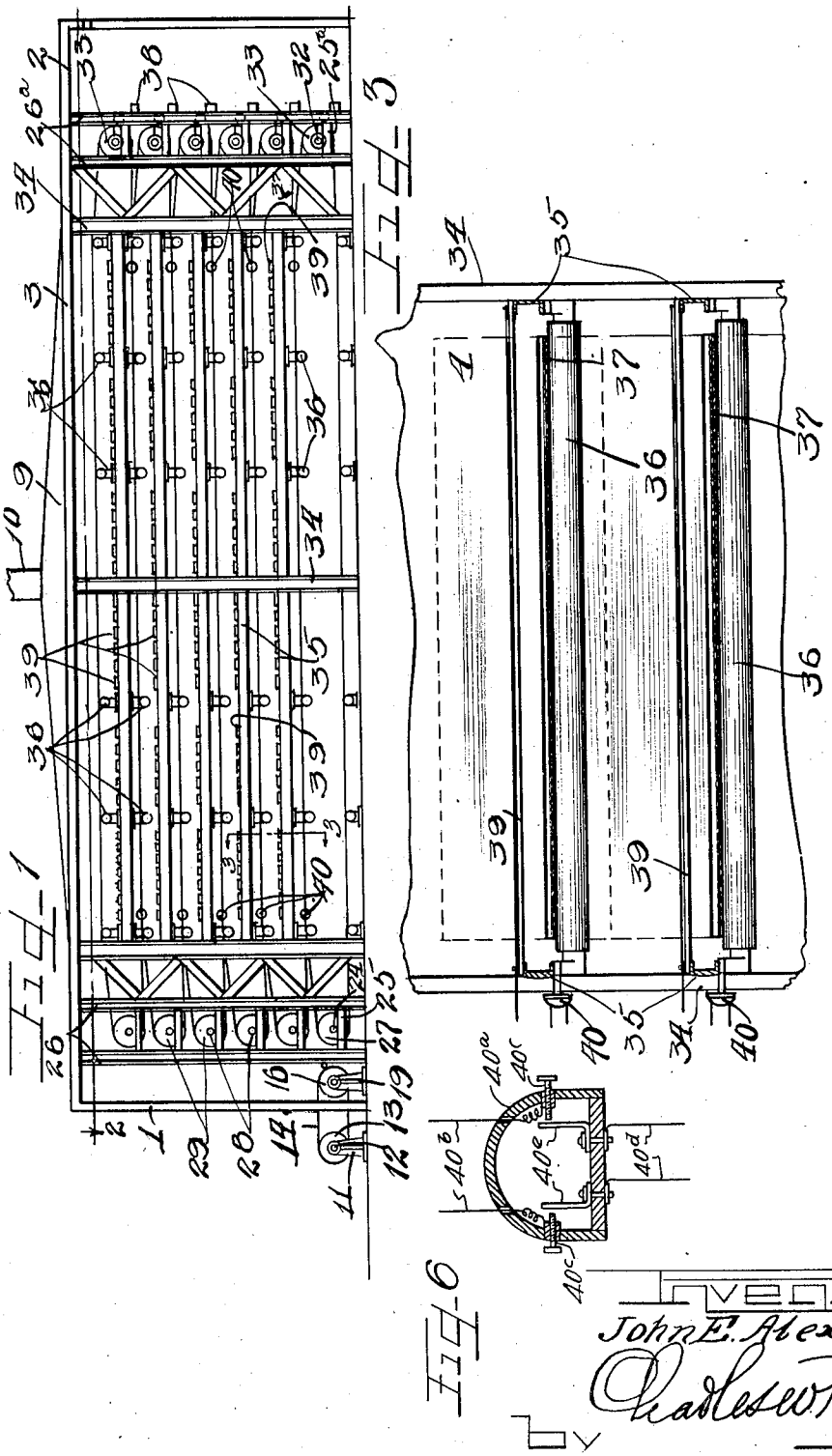


Fig. 1

Fig. 3

Fig. 6

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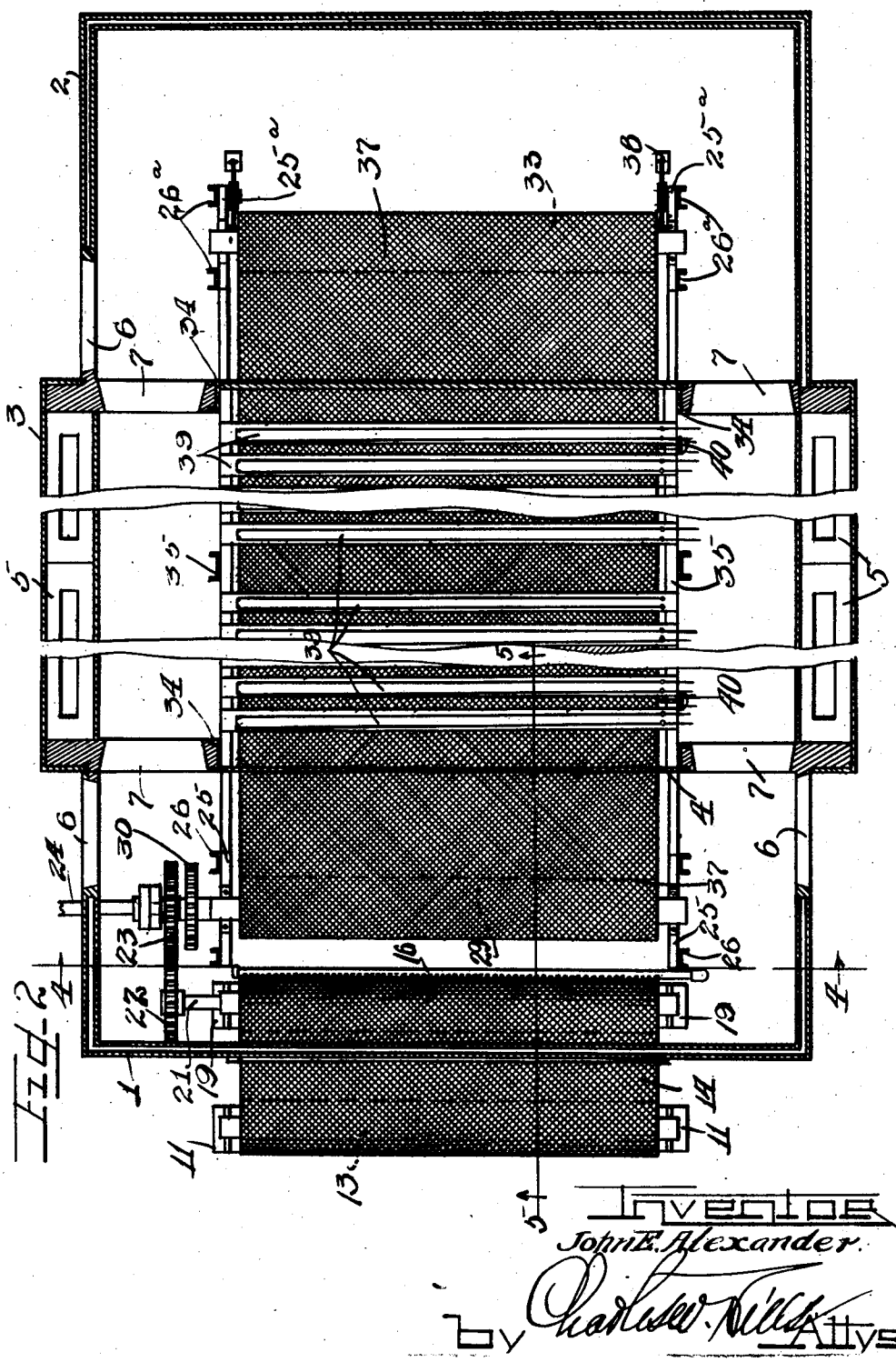


Fig. 2

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Fig. 4

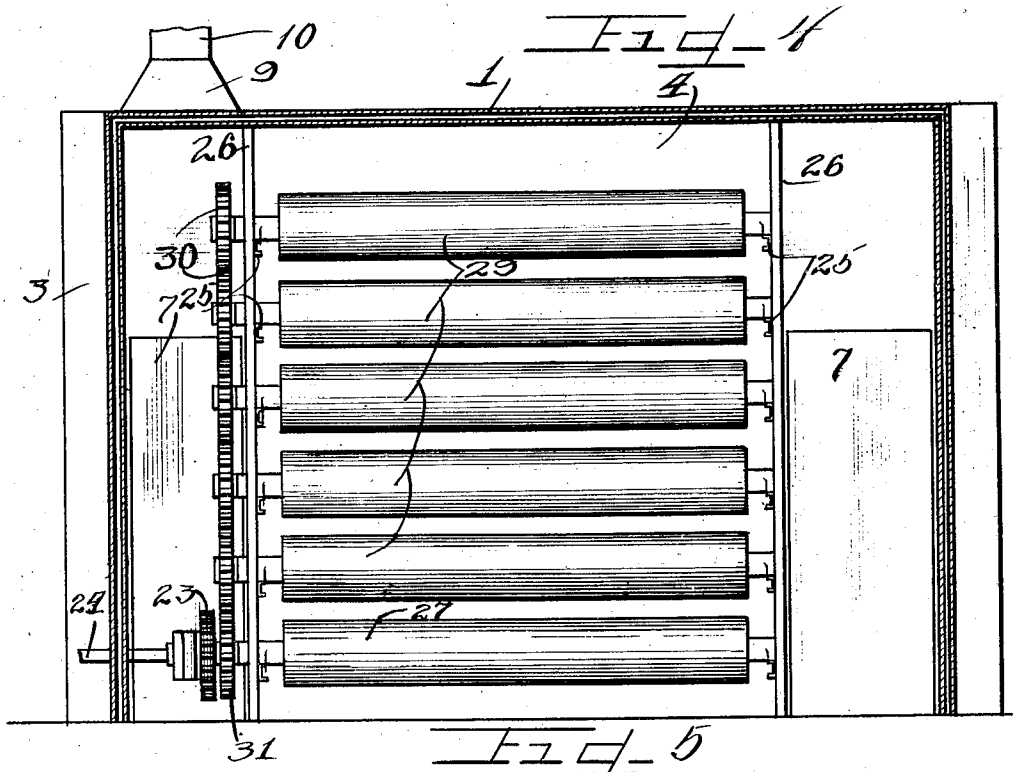
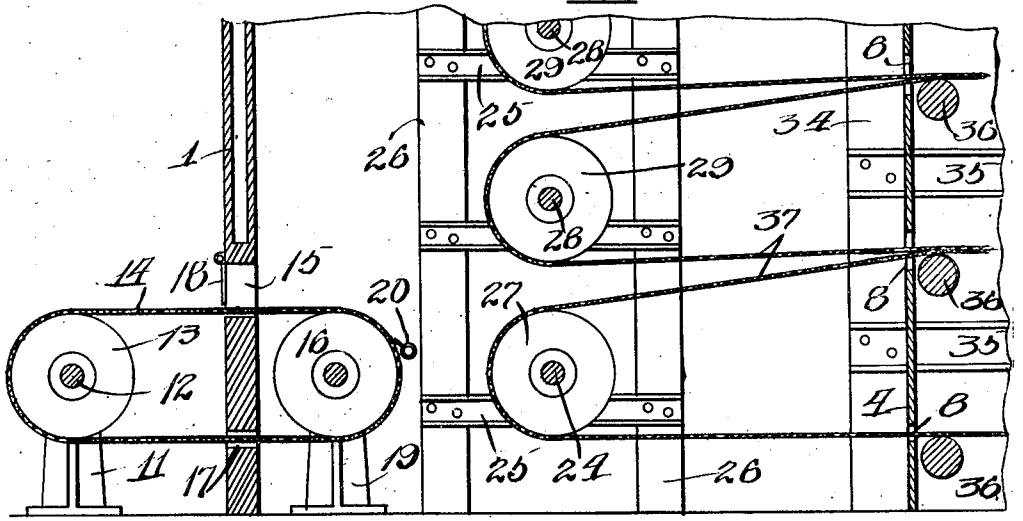


Fig. 5



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UNITED STATES PATENT OFFICE.

JOHN E. ALEXANDER, OF PORT EDWARDS, WISCONSIN.

HIGH-TEMPERATURE RADIANT-DRYING SYSTEM.

Application filed November 26, 1923. Serial No. 676,913.

To all whom it may concern:

Be it known that I, JOHN E. ALEXANDER, a citizen of the United States, and a resident of the city of Port Edwards, in the county of Wood and State of Wisconsin, have invented certain new and useful Improvements in a High-Temperature Radiant-Drying System; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, and to the numerals of reference marked thereon, which form a part of this specification.

In the conventional types of paper drying machines at present extensively in use, a great deal of difficulty and loss is encountered in that the paper sheet fabric, wet or other material being dried is often burnt or scorched, due to the fact that the fibers on one side of the web come into direct contact with the heated surfaces of the drying rolls or cylinders, while the fibers on the other side of the web remain moist. It often happens that when higher drying temperatures are used one or both surfaces of the web become encrusted and seared, thereby preventing proper evaporation of the moisture. With the arrangement of a series of drying cylinders at present in use the drying machines are enormous in size and require an extremely large amount of floor space as well as being expensive, on account of the large amount of material required in the construction of the machine. In air circulating systems certain limitations are present in that a given amount of air can only carry away only a given amount of moisture, regardless of the rapidity with which heat is applied. The excessive weight of the drying cylinders in the present types of machines requires a great driving force applied through extensive gearing which is noisy in operation and requires frequent replacement of parts. It is with a view of overcoming the above mentioned defect in paper drying machines and to realize greater economies and efficiencies that the present invention has been developed.

This invention relates more particularly to an improved type of paper drying machine wherein the use of heavy and large drying cylinders or drums and the use of felt belts is eliminated, thereby permitting a machine to be produced which will occupy a comparatively small amount of floor space, require less material in its construction and less power to operate, thus affording a machine of reduced cost and increased efficiency.

It is an object of this invention to provide a paper drying machine of reduced weight, size and cost, requiring a relatively small amount of driving power without requiring the overcoming of an excessive starting torque.

It is also an object of the invention to provide a paper drying machine wherein the use of air as a circulating medium is eliminated.

It is a further object of the invention to provide a machine wherein the danger of burning or scorching the paper is eliminated by providing wire mesh or some other type of metallic or fabric conveyors for conducting a web to be dried through the machine through the fields of radiation of thermostatically controlled heaters without bringing the web into direct contact with said heaters.

It is furthermore an object of this invention to provide a paper drying machine wherein the conducted web to be dried is surrounded by a gaseous medium which will consistently dry the web of paper all the way through.

Still another object of the invention is to provide a paper drying machine provided with electric or other types of heaters which are thermostatically controlled and so arranged that the heat can be rapidly applied and concentrated in selected areas to evaporate the moisture from the paper to evenly dry the same.

Another object of the invention is to provide a paper drying machine in which there will be practically no escape of hot gases from the machine since the pressure within the drier is maintained slightly lower than atmospheric by the use of a small exhaust fan on the discharge side of a condenser which will only have to take care of any air which may become entrained in the system, and which will act to draw out the gases so that the escape of said gases into the room containing the machine will be reduced to a minimum.

A further object of the invention is the constructing of a paper drying machine wherein the heat losses from the unit are exceedingly small so that the atmosphere

in the room is substantially normal so that it will not be uncomfortable to work in the room in the vicinity of the machine.

It is also an object of this invention to provide a paper drying machine wherein the material to be dried is not brought into contact with hot metallic surfaces and is not conducted between heated drying rolls and dryer felts, but is carried on meshed conveyors permitting the heated gaseous medium within the machine to surround and permeate through the material to uniformly dry the same throughout.

It is an important object of this invention to provide a paper drying machine of improved construction requiring comparatively small quantities of material for construction, reduced floor space, reduced driving force, and wherein the degree of heating and drying may be readily and automatically controlled at different levels and points in the machine for the purpose of removing the moisture from the sheet in the quantities desired along the path of travel of the sheet, depending upon the material being dried and the adjustment of the heater controls.

Other and further important objects of this invention will be apparent from the disclosures in the specification and accompanying drawings.

This invention (in a preferred form) is illustrated in the drawings and hereinafter more fully described.

On the drawings:

Figure 1 is a side elevation of a paper drying machine with one side removed, and embodying the principles of this invention.

Figure 2 is a horizontal section of the machine partly broken away and taken on line 2—2 of Figure 1.

Figure 3 is an enlarged fragmentary detail section taken on line 3—3 of Figure 1.

Figure 4 is a transverse sectional view taken on line 4—4 of Figure 2.

Figure 5 is a fragmentary detail section taken on line 5—5 of Figure 2.

Figure 6 is a detailed section with parts in elevation illustrating a form of adjustable thermostat used with the drying apparatus of this invention.

As shown on the drawings:

The machine comprises a casing or housing consisting of end sections 1 and 2, and an intermediate or middle section 3 divided from the end sections by transverse walls or partitions 4. The walls of the housing end section 1 and 2 are of double construction having non-conducting air spaces therebetween. The side walls of the middle housing section 3 are built up of hollow non-conducting tile 5 or some other suitable heat insulating material. Doors 6 are provided in the housing end sections 1 and 2, while the walls 4 are constructed with doors 7 to permit access to the interior of the middle chamber from the end sections. The walls 4 are provided with horizontal slots 8 (Figure 5) for a purpose hereinafter described. The top of the housing intermediate section 3 is provided with a longitudinal opening along one side and said opening is closed by a hood 9 having an outlet or exhaust pipe 10 connected therewith for the purpose of taking off the water vapor and gases resulting from the drying process.

Mounted on the exterior of the entrance end of the housing section 1 are a pair of pedestals or supports 11 having journalled thereon the gudgeons 12 of an exterior roller 13 around which an endless wire mesh or fabric feed conveyor 14 is trained. The feed conveyor 14 passes into the end section 1 through a slot 15 and after passing around an inner roller 16 passes out of the section through a lower slot 17 in the end wall of said section. The upper entrance slot 15 is partially closed by means of a pivoted flap or apron 18. The inner roller 16 has the gudgeons thereof journalled in bearings formed on the top of a second pair of pedestals or supports 19 mounted upon the floor within the entrance end section 1 of the machine housing. A wet paper or fabric web to be dried is fed onto the upper span of the feed conveyor 14, and is thus conveyed into the housing end section 1 through the slot 15 and is loosened or separated from said feed conveyor by means of currents of air blown from an apertured air pressure pipe 20 (Figure 5).

One of the gudgeons 21 of the inner roller 16 projects through its supporting bearing and has a gear 22 fixed on the end thereof in mesh with a gear 23 mounted on a driving shaft 24. The driving shaft 24 projects out of the housing end section 1 and is connected with any suitable source of driving power, such as a motor or the like.

The shaft 24 is journalled in bearings mounted on the lower cross bars 25 secured to frame uprights 26 rigidly mounted within the housing section 1. A roller 27 is engaged on the shaft 24 on a level with the rollers 13 and 16. A plurality of pairs of cross bars 25 are secured to the uprights 26 at different levels and support the shafts 28 of a plurality of rollers 29. Fixed on one end of each of the roller shafts 28 is a gear 30. The gears 30 mesh with one another and receive a drive from a gear 31 on the lower shaft 24.

A pair of frames or racks are also mounted in the outlet end section 2 with each of said frames comprising uprights 26^a and cross bars 25^a. A plurality of shafts 32 are rotatably supported on the cross bars 25^a and have rollers 33 mounted thereon at levels corresponding to the level of the rollers 29 and 27 respectively.

Rigidly mounted within the intermediate

housing section 3 are a plurality of upright vertical members 34, to which a plurality of horizontal members 35 are secured. Journalled on the frames within the intermediate housing section 3 are a plurality of vertical transverse rows of guide rolls 36. The guide rolls 36 are arranged to lie in different horizontal planes so that the upper level of each set of the rolls in each horizontal plane is positioned above the upper level of the respective sets of end rollers 29 and 33 and the lower set of the end rollers 27 and 33. The lower set of rolls 36 are positioned with the upper level thereof in the plane of the lower level of the roller 27 and the lowermost roller 33. The remaining sets of rolls 36 are positioned with the upper levels thereof slightly above the lower levels of the respective sets of end rollers 29 and 33.

Engaged around each horizontal set of end rollers 29 and 33 and around the lower set of rollers 27 and 33, is an endless wire mesh or fabric belt or conveyor 37. The lower lap of the lowermost belt 37 runs over the lowermost set of guide rolls 36, and when leaving the roller 27 passes upwardly in an inclined plane to pass over the second set of guide rolls 36 and then downwardly in an inclined plane back around the lowermost roller 33. The wire mesh or fabric belts 37 from each of the rollers 29 pass upwardly to the planes of the respective guide rolls 36 as clearly illustrated in Figure 5. This arrangement of the belts over the end rollers and the intermediate guide rolls serves to hold the belts properly tensioned. To further afford a means of tensioning the belts 37 the rollers 33 are supported on slidable supports having depending counter weights 38 connected therewith by cables which run over suitable idler pulleys 38^a (Fig. 2) and which act to pull the rollers 33 outwardly, thereby tensioning the belts.

The belts 37 are provided at different elevations for the purpose of conducting a paper or fabric web upwardly in a circuitous path through the end chambers and through the intermediate heated chamber of the machine housing, and out through the upper end of the end housing section 2. If desired, the paper or fabric web may enter the top section of dryer and may be conducted downwardly in a circuitous path, passing out of the lower portion of the housing.

The intermediate housing section 3 is electrically heated by means of a plurality of horizontal layers of electric heating units 39 which are supported transversely in the section 3 by the horizontal members 35 (Figure 3) and are adapted to produce relatively high temperatures. With this arrangement one horizontal set of electric heating units 39 is positioned between the upper and lower laps of each belt 37 and out of contact therewith. The electric units 39 are connected with any suitable source of electrical energy with the electric units at each level connected with adjustable thermostats 40 at each end of the intermediate housing section 3, so that the heating units at each level may be automatically controlled by the thermostats whereby different relatively higher temperatures may be maintained at different levels in the housing section 3, depending upon the particular adjustment at which the thermostats are set. Figure 6 shows one form of adjustable thermostat which is suitable for this purpose. In this construction the reference numeral 40^a represents a suitable supporting casing and 40^b designates lead-in conductors which are electrically connected to adjustable screw contacts 40^c. Outgoing conductors 40^d are connected to members 40^e of thermostatic metal which are adapted to contact the adjustable contacts 40^c at certain temperatures and to move away from said contacts when such temperatures are exceeded. This operation is, of course, controllable by the position of the screw contacts 40^c. It will, of course, be understood that any commercial form of adjustable thermostats might be used in lieu of those shown and described herein.

The operation is as follows:

A material to be dried such as a wet paper or fabric web is delivered to the wire mesh or fabric feed belt 14, and is conveyed into the drying machine through the inlet slot 15 when the machine is in operation driven from the shaft 24. The rollers 13 and 16 receiving their drive through the meshing gears 22 and 23. The various rollers 27 and 29 are rotated from the drive gear 31 and the meshing gears 30, thereby causing the wire mesh or fabric belts 37 to rotate and pass over the guide rolls 36 and the respective rollers 33.

The wet web delivered to the belt 14 is conveyed into the end housing section 1 through the slot 15, and as the web starts to pass around the roller 16 the air blasts from the air pipe 20 (Figure 5), blowing under the web, act to separate the web from the belt 14 and permits the loosened web to be conducted over onto the inclined portion of the upper lap of the lowermost wire mesh belt 37 and then between said upper lap of the lowermost belt and the lower lap of the belt immediately thereabove. The wet web is thus conveyed between two wire mesh or fabric belts through one of the openings 8 into the intermediate heated chamber of the housing section 3, then out into the end section 2 and back into section 3 upwardly in a circuitous path below and above the various sets of electrical heating units 39 and finally out of the upper end of the end section 2. If desired, the path of travel of the material to be dried may be reversed.

During the passage of the wet web through the machine, the various heaters 39 act to remove the moisture from the web through the wire mesh or fabric belts by means of a heated gaseous medium within the section 3, which permeates through the web to uniformly dry the same all the way through. The temperature of the interior of the housing is maintained at or in excess of the vaporizing temperature of water and this gaseous medium consists of superheated vapor such as superheated steam emanating from the material which is being dried and since there are no air inlets of any substantial area leading into the casing, air is excluded therefrom by the pressure of the heated gaseous medium or steam and there is no air in the chamber during the drying operation. The web, when being dried by the heat from the heating units, cannot be burned or scorched, inasmuch as the temperature of the wet web in the section 3 cannot rise above 212° at atmospheric pressure. As soon as any particles of moisture in the web reaches a temperature higher than 212° it is turned into steam and removed through the hood 9 and the exhaust pipe 10. (Figure 4.)

The paper web is thus uniformly dried without the use of air as a circulating medium and without any danger of being burnt, seared or scorched. Since air is not used as a circulating medium, the rapidity with which the moisture can be evaporated from the web is practically unlimited and depends primarily upon the rapidity with which the heat can be applied and concentrated. The heat is applied by the electric or any other suitable heating units, which are governed by the respective thermostats which may be set so that the greatest heat may be applied to the portions of the web containing the most moisture. The setting of the thermostats permits different temperatures to be maintained in different locations within the machine housing, so that the temperature applied at the drier portions of the web need not be as great as the temperatures applied at the wet portions of the web at the entrance end of the heated drying chamber. The heating and drying of the web can be readily controlled automatically in different sections of the machine, and the temperature gradient can be arranged to produce the most efficient and economical results.

In view of the fact that the pressure within the housing is somewhat below atmospheric and the amount of air entering the drier is relatively small compared to the total gases handled, there will be no hot gases escaping from the heater itself since whatever gas movement there may be will be from the outside toward the interior of the drier. Employees working around the drier will not be subjected to injury from the escaping gases and from the intense heat which ordinarily surrounds driers.

I am aware that numerous details of construction may be varied through a wide range without departing from the principles of this invention, and I therefore do not purpose limiting the patent granted otherwise than necessitated by the prior art.

I claim as my invention:

1. A material drying machine comprising a housing substantially closed to the entrance of air, foraminous conveyors therein for conducting a material to be dried through a circuitous path in said housing, heating units within said housing adapted to uniformly dry said material during its passage through the housing, and means connected with said heating units for automatically controlling the same to regulate the temperatures in different parts of the housing.

2. In a machine for drying paper or similar material, a substantially closed chamber from which incoming air is excluded during the drying operation, means for conveying the material to be dried through said chamber and high temperature heating elements in the chamber for maintaining the temperature therein substantially at or in excess of the vaporizing temperature of water so as to first vaporize the water in the paper or similar materials and then to heat the water or other substance so vaporized and maintain it at or above its vaporizing temperature during the drying operation until it is discharged or withdrawn from the chamber.

3. In a machine for drying paper or similar material, a substantially closed chamber from which incoming air is excluded during the drying operation, means for conveying the material to be dried through said chamber and high temperature heating elements in the chamber for maintaining the temperature therein in excess of the vaporizing temperature of water so as to first vaporize the water in the paper or similar materials and then to heat the water or other substance so vaporized and maintain it above its vaporizing temperature during the drying operation until it is discharged or withdrawn from the chamber.

4. In a drying machine the combination with a housing, of heating units therein, and means for automatically controlling said units for the purpose of obtaining gradient temperatures in said housing.

5. In a drying machine the combination with a drying housing, of heating units therein, and adjustable thermostatic mechanisms in different parts of the housing connected with the various heating units for obtaining gradient temperatures in said housing.

6. A drying machine comprising a hous-

ing having slotted partitions therein dividing the housing into an intermediate section and end sections, conveyors extending from the end sections through said intermediate sections, heaters in said intermediate section, and adjustable thermostatic means in said intermediate section for automatically governing said heaters.

7. A drying machine comprising a housing, slotted walls in said housing dividing the same into end sections and an intermediate section, doors in the housing to afford access to said end sections, doors in said walls to afford access from the end sections to said intermediate section, conveyors in the housing operating through said slotted walls for conducting a material to be dried through the end sections and through the intermediate section, heating units in said intermediate unit, and thermostatic mechanisms connected with said heating units for automatically governing the same.

8. A drying machine comprising an insulated housing, slotted partitions therein dividing the housing into end sections and an intermediate section, and foraminous conveyors in said housing traveling through said slotted walls for conducting a material to be dried alternately through the end sections and said intermediate section.

9. A drying machine comprising an insulated housing, slotted walls therein dividing the housing into end sections and an intermediate section, foraminous conveyors in said housing operating in said end sections and through said intermediate section, heaters in said intermediate section, automatic controls for said heaters, and a gas and vapor relief and exhaust connected with the intermediate section.

10. A drying machine comprising a housing divided into end sections and an intermediate section, a gas and vapor relief connected with the intermediate section for maintaining the pressure within the housing slightly below atmospheric pressure, heaters in said intermediate sections, conveyors in said housing operating through the intermediate section to conduct a material to be dried between said heaters, and controls for said heaters at different levels in said intermediate section for automatically obtaining gradient temperatures within said intermediate section.

11. The method of drying paper or similar material comprising subjecting the same in a chamber from which air is substantially excluded to the drying action of superheated vapor emanating from the material itself.

12. The method of drying paper or similar material comprising conveying the material through a substantially closed chamber from which a circulation of incoming air is substantially excluded during the drying operation and maintaining the temperature in said casing in excess of the vaporizing temperature of water so as to first vaporize the water in the paper or similar materials to be dried and to heat the water or other substance so vaporized and maintain it at or above its vaporizing temperature during the drying operation until it is discharged or withdrawn from the chamber.

13. The method of drying a material by conducting the same through a circuitous path in a housing, wherein air is not a circulating medium and wherein graduated temperatures are automatically maintained.

In testimony whereof I have hereunto subscribed my name.

JOHN E. ALEXANDER.