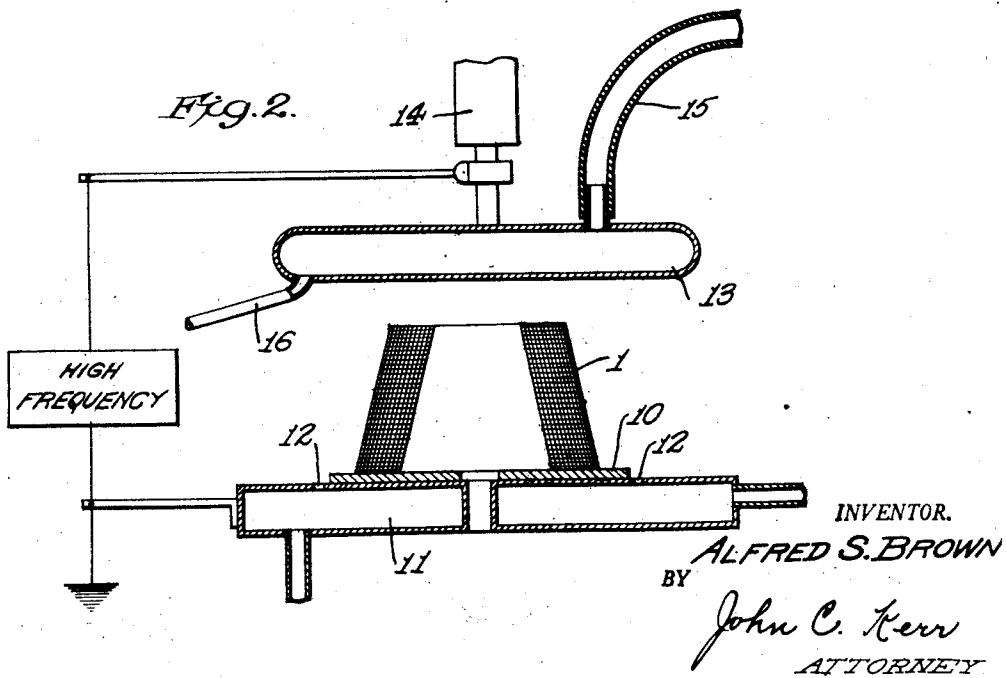
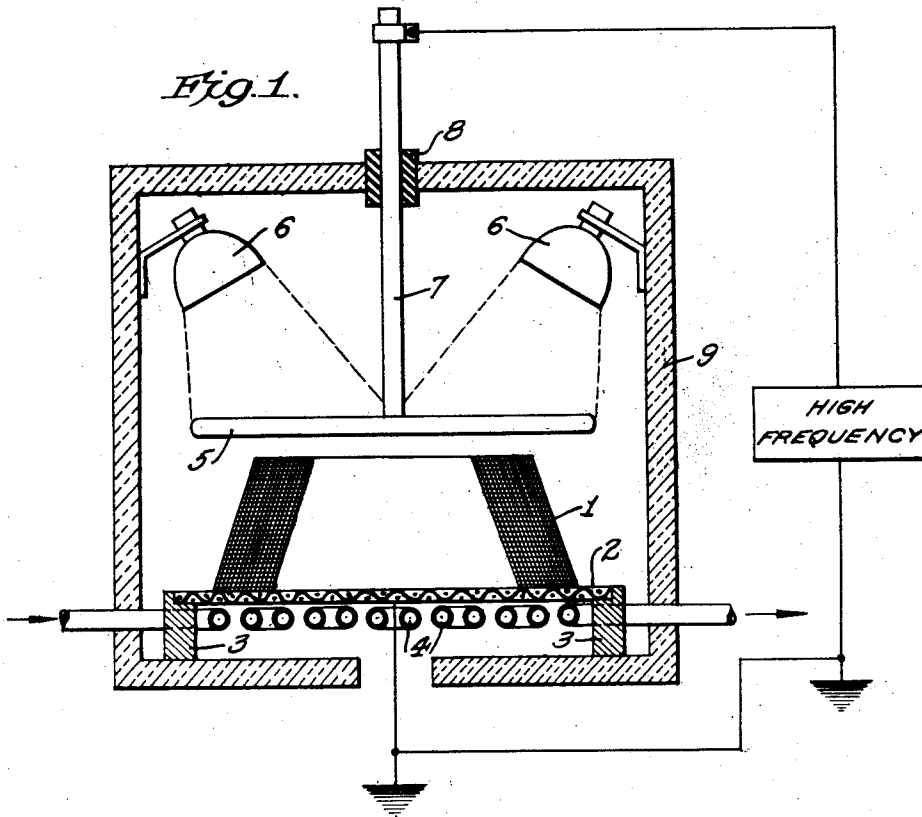


Oct. 7, 1947.

A. S. BROWN
METHOD AND APPARATUS FOR DRYING YARN
PACKAGES IN AN ELECTROSTATIC FIELD
Filed Dec. 30, 1944

2,428,615

2 Sheets-Sheet 1

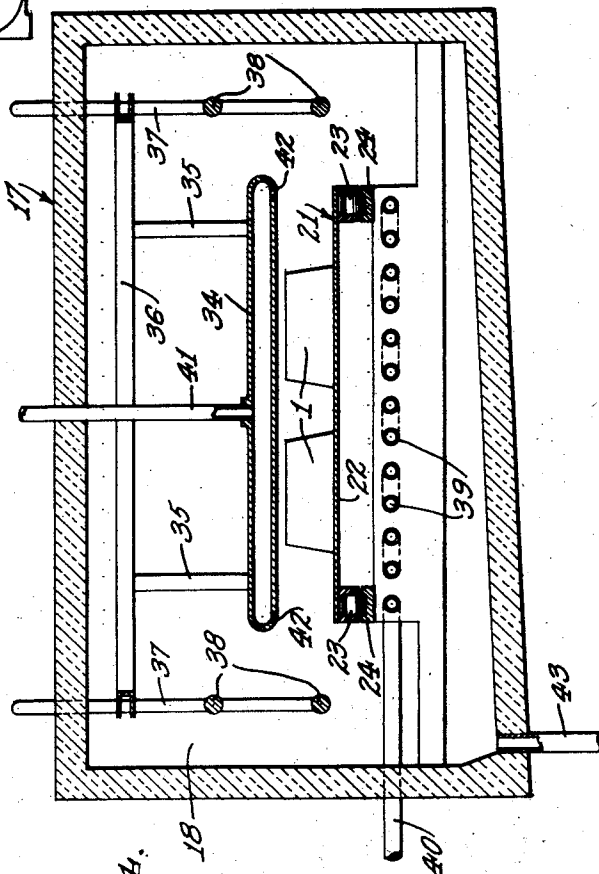
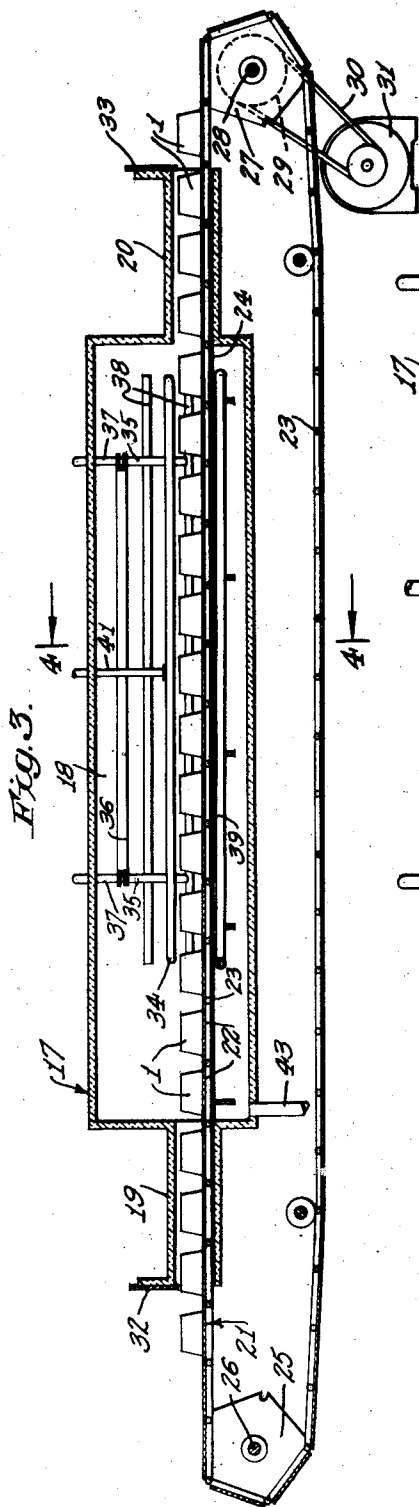


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UNITED STATES PATENT OFFICE

2,428,615

METHOD AND APPARATUS FOR DRYING
YARN PACKAGES IN AN ELECTROSTATIC
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Application December 30, 1944, Serial No. 570,601

8 Claims. (Cl. 34—1)

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This invention relates to the drying of yarn packages, and is particularly described in its application to the removal of water from packages of viscose rayon yarn, although it is applicable to the removal of liquids from other materials also.

In the manufacture of rayon yarn by the pot or bobbin systems the drying of the yarn packages has long been an important problem. Most methods of drying such yarn packages use air to carry off the water vapor, usually heating this air to a temperature approximating 150° F. Other methods use vacuum drying in an effort to remove the water readily at a lower temperature. In general, however, the energy required to vaporize water from the yarn package has been supplied by substantially thermal conductive means, with the result that the package dries more quickly in some regions, usually the surfaces, than in others. Consequently yarns from these different regions of the package differ in textile characteristics.

High frequency electrical fields are capable of heating a package substantially uniformly throughout the mass of such a package when suitable conditions are imposed. The general idea of heating a yarn package by high frequency electric power has been known for a long time and is, per se, no part of the present invention. However, methods are known also which involve non-uniform heating of the yarn package. Also some methods use costly vacuum systems for boiling water at a relatively low temperature.

Pertinent scientific literature has stated that viscose rayon yarn is weakened by drying at elevated temperatures and at high relative humidities in the surrounding atmosphere; and it is probable that certain prior art methods for drying yarns at lower temperatures were based upon this belief. I was, therefore, surprised to find that viscose rayon yarn dried at a temperature of about 212° F. in an atmosphere that is substantially water vapor is at least as strong as yarn dried by current manufacturing methods. Furthermore, I have found that if water is removed at about 212° F. from a yarn package maintained in an atmosphere that is substantially water vapor, and the energy needed to remove the water is supplied by high frequency power, a dried package characterized by exceptional uniformity of yarn textile quality is produced. In addition, I have found that these drying conditions may be accomplished with relatively simple equipment and in a surprisingly economical manner.

A principal object of this invention is the pro-

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vision of a method for drying yarn packages uniformly with respect to textile quality.

A further object of this invention is the provision of an economical method for drying yarn packages with high frequency electric power.

Another object of the present invention is to provide apparatus by which the methods hereinabove generally referred to may be carried out in an efficient manner.

A further and more specific object of the present invention is to provide apparatus for the drying of yarn packages including viscose rayon yarn in a uniform manner, so as to retain the high quality textile characteristics of the yarn.

A further object of the present invention is to provide apparatus of a substantially continuous type by which yarn packages may be dried, utilizing the principles of the present invention as to method and in a commercial manner, that is, for the drying of a large number of yarn packages.

Other and more detailed objects of the present invention will become apparent from the following specification and appended claims, when taken in connection with the accompanying drawings, in which:

Figure 1 is an elevation, partly in section, of an apparatus for practicing this invention;

Fig. 2 is an elevation, partly in section, of a preferred embodiment of this invention;

Fig. 3 is a view principally in longitudinal section, of apparatus for applying this invention to the continuous drying of yarn packages; and

Fig. 4 is a transverse sectional view of the apparatus of Fig. 3, taken on the line 4—4 thereof.

Referring now to the accompanying drawings, I have shown in Fig. 1, a form of the present invention intended for the drying of one yarn package at a time by the use of high frequency electric energy and including the establishment of a high frequency field in which the yarn package is located, so that heat energy will be substantially uniformly generated throughout the yarn package. I have further provided means by which the yarn package will be substantially enclosed by a protecting atmosphere of the vapor of the liquid being evaporated therefrom, which, in the usual case, will be water. There is further provided means by which the electrodes will be maintained at temperatures at least as high as the boiling temperature of the liquid being evaporated from the yarn package, or in the case of water, at least 212° F., the liquid being evaporated preferably at substantially atmospheric pressure.

In Fig. 1, a yarn package 1 is supported on a

metal screen 2 which, in turn, is supported by a framework 3, the screen 2 comprising one electrode in a high frequency circuit and being preferably grounded as indicated. The screen 2 is preferably maintained at a temperature of at least about 212° F. by a heating coil 4, which is heated by steam or some other suitable heating fluid. An upper electrode 5 in the high frequency circuit is shown spaced above the yarn package 1, although I sometimes prefer to rest this electrode on the yarn package. The electrode 5 is preferably maintained at a temperature of about 212° F. or somewhat higher by one or more heating means, here shown as lamps 6. The electrode 5 is connected to the high frequency circuit by a lead 7 which is supported by a high voltage insulator 8. The entire cake-electrode assembly is preferably enclosed in a housing 9, which is preferably constructed of suitable insulating material.

Any suitable means such as those commercially available, may be used for generating high frequency electric energy, or transforming such energy as may be received from a conventional power supply line into desired high frequency electric energy. This means is not here illustrated in detail, but is diagrammatically indicated by the box shown in Fig. 1, containing the legend "High frequency."

In Fig. 2, I have shown another and what I now consider to be a preferred form of my invention as applied to the drying of yarn packages. In this figure the yarn package 1 is shown supported on an annular disk 10 which rests on a hollow electrode 11, this electrode preferably being adjustable in a vertical direction by any suitable means (not shown). The disk 10 is preferably made of some suitable metal, such as stainless steel or aluminum, although it may be constructed of suitable non-metallic materials, in which case the selected material should preferably have a low electrical loss factor at the high frequencies and high temperatures contemplated in this invention. The disk 10 may sometimes be omitted when drying certain types of yarn packages. The hollow electrode 11 is preferably maintained at a temperature of about 212° F. or slightly higher by passing through it any suitable heating medium. I prefer to operate the electrode 11 at substantially ground potential, although this is not necessary if suitable insulating supports are provided. When the electrode 11 is heated by steam supplied at a pressure somewhat above atmospheric, the upper surface of this electrode may be provided with a number of small holes 12 located adjacent to the periphery of the disk 10. A cloud of steam is thus blown from these holes, enveloping the yarn package during the drying operation.

An upper electrode 13 is shown supported from a high voltage insulator 14 in vertically spaced relationship with the yarn package 1. The electrode 13 is of hollow construction and is preferably maintained at a temperature of about 212° F. or higher by passing therethrough any suitable heating medium, which may be supplied through one or more connections 15 preferably constructed of suitable glass or rubber tubing. When the heating medium is circulated through the electrode 13, other connections (not shown) similar to the connections 15, are provided for completing the circulation system. When the electrode 13 is heated by low pressure steam, means shown at 16 may be provided to drain any condensate from within the electrode 13. The means 16 may

be of some suitable material, such as glass, having a low electrical loss factor. The means 16 is here shown as a conduit serving to carry any drops of water away from the yarn package 1, although I have found a simple hole to serve this purpose adequately if the hole is located a short distance away from the yarn package.

The observed effects of this invention may be explained by the following theoretical considerations, although I do not wish to be limited to any particular theory. The heating effect of high frequency power appears to be closely related to the wetness of the material between the electrodes. Hence, the uniformity with which a package may be thus dried is dependent upon the accuracy with which electrical energy is caused to evaporate liquid in all regions of the yarn package and at any instant in the drying period. If some other mechanism, such as a stream of air or an evacuation system, is simultaneously supplied, thus removing water vapor differentially to a greater extent from the generally outer surfaces of the package, a non-uniformity in the drying of the several regions of the package is introduced.

The maintenance of an atmosphere of water vapor substantially completely surrounding the package being dried is believed to prevent the evaporation of surface liquid at a rate faster than that in the interior portions of the package. Furthermore, I believe that it is important to minimize the loss or gain of heat by thermal conduction and radiation from and to the package, to relate quantitatively the dissipation of electrical energy and the evaporation of liquid. I have found that a wet ring tends to be left at the region of contact between the yarn package and its support unless the lower electrode is heated to a temperature of about 212° F. or slightly higher, and that such a wet ring is removable only with difficulty.

Spacing of the upper electrode 13 from the yarn package 1, results in desired structural simplifications. It also appears to be of considerable technical importance in producing uniform heating in the package, probably because the spacing contemplated by this invention is large as compared with the dimensional irregularities usually present in such yarn packages. I generally use a spacing of about half an inch, although this dimension is not critical. I have also successfully used spacings of up to about three inches.

Maintenance of the upper electrode at a temperature of about 212° F. or somewhat higher may be of critical importance in preventing condensation of moisture on the lower side of this electrode. If drops of water fall from this electrode onto the yarn package, they often cause arcing, which may shut down the high frequency generator or burn the yarn package. Such drops also may carry dirt and result in the formation of stains on the yarn package. Furthermore, if a substantial amount of liquid is returned to the package through such condensation, there may result a wet ring about the top of the package. The removal of such a ring is not only costly, but also detrimental to the objects of this invention as explained above.

The effect of the substantially water vapor atmosphere on the strength and extensibility characteristics of the yarn is difficult to explain. It may be that the deterioration described in the literature aforesaid was largely due to oxidation; and that such oxidation is prevented by the sub-

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stantial displacement of air by water vapor at and adjacent to the surfaces of the yarn package. It may be simply a reflection of the uniformity with which the yarn package is dried, and the consequent prevention of localized strains.

I have found that yarn from packages dried according to the present invention is exceptionally relaxed and uniform. If a measured length of such yarn is wetted and redried under a tension of only a few milligrams per denier, the final length will exceed the original length irrespective of the particular region of the package from which the yarn sample may have been selected. Furthermore, the length increases observed in such tests will generally vary by only 0.3% to 0.4% of the original sample lengths. In addition, yarn dried according to the present invention has a tenacity and an extensibility at least as high as yarn dried by warm air, and may even be significantly better.

The present invention also provides relatively simple means for drying yarn packages with high frequency power, thus making practical the very fast drying of such packages. For example, the benefits of this invention are realized even when the packages are dried at a rate one hundred to two hundred times as fast as obtained in equipment using only warm air to dry the yarn.

I have also found that, according to the practice of the present invention, drying of the yarn package may readily be terminated at a selected residual moisture content of, say, for example, about eight percent, with the result that the subsequent conditioning of this package is materially facilitated.

While the present invention has been described in terms of the removal of water from a yarn package, it is contemplated that many of its novel features are applicable to the evaporation of other liquids. In such other applications it is necessary only that the electrical loss factor of the system be high enough to permit the generation of adequate heat. The system will operate at substantially the normal boiling point of the liquid being evaporated and the vapor of this liquid will substantially enclose the material being dried. If the vapor could be ignited by an accidental arc, air should be excluded from the drying chamber.

I also contemplate that vapors emitted in the drying chamber of this invention may be recovered by any suitable means. If the vapor is steam, it will often be desirable to recover this heat in a suitable condensing system, thus obtaining a supply of hot water. Normally, some air will gain access to the drying chamber and will pass into the recovery system, this warm and humid air being of use in air conditioning if the dryer installation is very large.

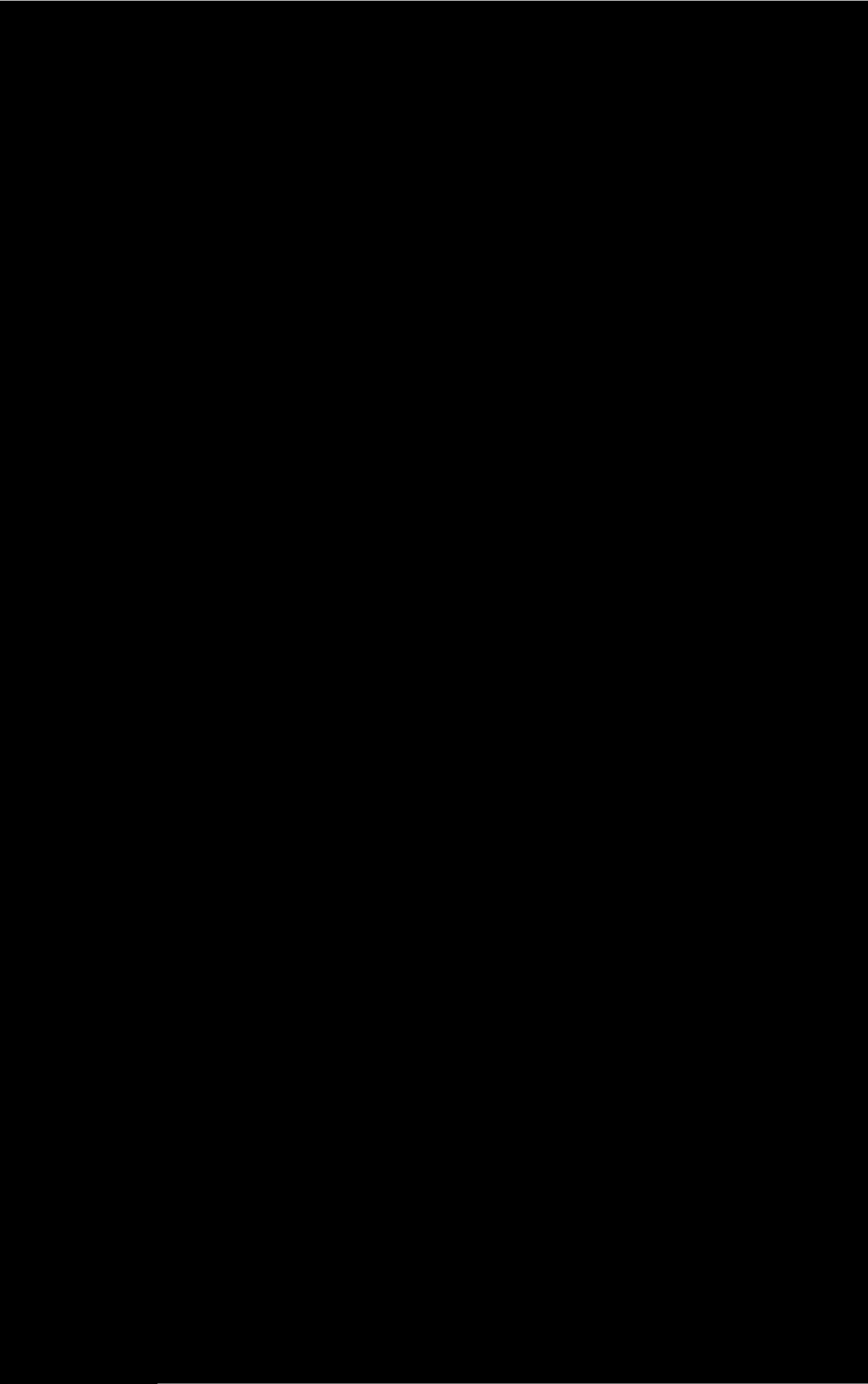
Referring now to Figs. 3 and 4 I have shown in somewhat diagrammatic form, an apparatus for the carrying out of the method above outlined on a large number of yarn packages which are moved progressively and preferably continuously through an elongate drying oven upon an endless conveyor, so that a large production of dried yarn packages may be obtained. The same principles as to method, and more or less similar apparatus, are employed as have been particularly described in relation to Figs. 1 and 2. The same advantages are to be gained with the additional advantage of high production operation

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such as is necessary when operating on a commercial scale.

Referring now more particularly to the drawings, there is shown an elongate drying chamber generally indicated at 17, enclosing a path of travel for the yarn packages, this chamber having an enlarged central portion 18 and relatively constricted entrance and exit yarn ports, which may have the form of end portions 19 and 20, respectively, at the ends of the path. The yarn packages 1, to be dried, are carried through the chamber 17 by an endless conveyor generally indicated at 21, which is shown as being made up of a plurality of panels 22, preferably of metallic construction, so that this conveyor may serve as the lower electrode in addition to its function as a conveying means. Suitable wheels or rollers 23 are provided to minimize friction in the movement of the conveyor, these rollers being arranged to travel along tracks shown at 24, so as to predetermine the path of the conveyor, at least through the chamber 17. Adjacent to the entrance end of the chamber 17 the conveyor 21 passes around a pair of idler sprocket members 25 mounted on a shaft 26, these sprocket members being shown as five-sided members, so as to accommodate the particular type of conveyor employed. Somewhat similar sprocket members 27 are fixedly mounted adjacent to the exit end of the chamber 17 on a shaft 28, which also carries fixed thereto a suitable driving wheel 29 driven by a flexible belt or sprocket chain 30 from a driving means here shown conventionally as a motor 31. While I have shown a direct drive from a motor and contemplate a continuous movement of the conveyor through the drying chamber, I also contemplate that in its broader aspects, the invention is applicable to apparatus wherein a conveying means is moved intermittently through a drying chamber having, for example, doors at the entrance and exit ends of the chamber which may be closed during the dwell periods of the conveyor and opened, possibly automatically, only when the conveyor is to move along another step in its movement. Furthermore, while I have shown a direct drive from a motor 31 to the shaft 28, I also contemplate that any speed varying means such as a conventional "Reeves Drive" may be interposed in the drive between any suitable prime mover and the means which are per se used for driving the conveyor.

At the entrance and exit ends of the drying chamber the yarn ports are preferably constricted both vertically and laterally as shown, to provide only enough space to permit the introduction and removal of yarn packages, while minimizing any inflow of air currents such as might interfere with the operations taking place within the device, including particularly the maintenance around each yarn package of an atmosphere substantially vapor of the liquid being evaporated therefrom as has been described more in detail in connection with Figs. 1 and 2. As above set forth, I contemplate the possibility of an intermittently moved conveyor and the provision of doors as shown diagrammatically at 32 and 33 for the entrance and exit ends respectively, which doors would normally be closed during the periods when the conveyor is not moving yarn packages into or out of the drying chamber. In either case however, i. e. with open ports or intermittently closing doors at the ports, the ports will ensure the maintenance within the chamber of a pressure substantially equal to the pressure of the atmosphere outside the chamber.



plant in which the device of my invention may be located.

While I have shown and described but a few embodiments of my invention and set forth in detail certain methods to be performed in accordance therewith, I contemplate that both the apparatus and method phases of this invention may be varied as will occur to those skilled in the art and within the scope of the appended claims, which are to be construed validly as broadly as the state of the art permits.

What is claimed is:

1. The method of evaporating a substantially aqueous liquid from a rayon yarn package, comprising the steps of positioning and supporting said yarn package between spaced electrodes in a substantially closed chamber, applying to said electrodes high frequency electric energy to generate heat within said yarn package to maintain the vapor pressure of said liquid of the package higher than the vapor pressure of the atmosphere surrounding the package and evaporate the liquid at substantially the boiling point thereof, and at least substantially as early as said high frequency electric energy is applied to the package subjecting the package to, and thereafter maintaining in said chamber in at least the immediate neighborhood of and substantially surrounding said yarn package, an atmosphere of substantially aqueous vapor at substantially atmospheric pressure.

2. The method according to claim 1 with the additional step of supplying aqueous vapor from an external source to the inside of said chamber surrounding said yarn package so as to maintain an envelope of such vapor about said yarn package during the evaporation of the liquid therefrom.

3. The method of evaporating water from a rayon yarn package at substantially atmospheric pressure, comprising the steps of positioning and supporting the yarn package between spaced electrodes in a substantially closed chamber, applying high frequency electric energy to said electrodes to generate heat within said yarn package to maintain the vapor pressure of the water of the package higher than the vapor pressure of the atmosphere surrounding the package and evaporate water from the package at substantially 212° F., and at least as early as the high frequency energy of the electrodes is applied to the package subjecting the package to an atmosphere of substantially water vapor in said chamber and thereafter maintaining said atmosphere at least immediately and substantially surrounding said yarn package during the evaporation of water therefrom.

4. The method of evaporating a substantially aqueous liquid from a rayon yarn package at substantially the boiling temperature of said liquid at atmospheric pressure, comprising the steps of positioning and supporting said yarn package between substantially plane, parallel, spaced electrodes in a substantially closed chamber, applying high frequency electric energy to said electrodes to generate heat substantially uniformly within said yarn package to maintain the vapor pressure of said liquid of the package higher than the vapor pressure of the atmosphere surrounding the package, and at least substantially as early as the package is subjected to said electric energy subjecting the package to an atmosphere consisting substantially of aqueous vapor and thereafter maintaining an

atmosphere substantially of aqueous vapor at substantially atmospheric pressure in said chamber at least immediately and substantially surrounding said yarn package.

5. The method of continuously drying rayon yarn packages, comprising the steps of substantially continuously passing such yarn packages along a predetermined path through a substantially closed chamber and at least a predetermined portion of which path in said chamber is between spaced electrodes, maintaining a substantially uniform electric field on each of the yarn packages during its passage along said portion of the path by impressing high frequency electric energy onto said electrodes, and thereby maintaining the vapor pressure of the water of said packages higher than the aqueous vapor pressure of the atmosphere surrounding the packages and vaporizing water of the packages at substantially the boiling point thereof at atmospheric pressure, and at least substantially as early as each package is subjected to said field subjecting the respective package to an atmosphere consisting of substantially water vapor at substantially atmospheric pressure, and thereafter maintaining an atmosphere consisting substantially of water vapor at substantially atmospheric pressure in said chamber substantially around each of said packages during at least its passage through the portion of its path that is within such electric field.

6. Apparatus for evaporating a substantially aqueous liquid from a rayon yarn package at substantially atmospheric pressure, comprising a substantially closed chamber open to the atmosphere so as to insure the maintenance of substantially atmospheric pressure therein, a generator for generating high frequency electric energy, a pair of spaced electrodes in said chamber receiving energy from said generator to establish a substantially uniform electric field in the yarn package for heating said yarn package and the aqueous liquid therein substantially to the boiling point of such liquid at atmospheric pressure and maintaining the vapor pressure of the aqueous liquid of a package higher than the pressure of the aqueous vapor of the atmosphere within the chamber, means for maintaining said electrodes at a temperature at least as high as that of the boiling point of said liquid at substantially atmospheric pressure, means for supporting said package in said field in said chamber and means for maintaining in said chamber, independently of a particular package being treated, an atmosphere substantially vapor of the liquid being evaporated in at least the immediate neighborhood of and substantially surrounding said package.

7. Apparatus for evaporating water from a yarn package at substantially atmospheric pressure, comprising a generator for generating high frequency electric energy, a hollow lower electrode above which a yarn package is adapted to be supported, means for supplying low pressure steam to the interior of said lower electrode to maintain it at a temperature at least 212° F., a series of holes in the upper portion of said lower electrode so positioned as to conduct steam from the interior thereof to the region around said yarn package so as to establish and maintain an atmosphere of steam surrounding the yarn package during the drying thereof, an upper electrode located at substantially a predetermined distance above a yarn package positioned as

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aforesaid, means for heating said upper electrode to maintain it at a temperature at least 212° F., and means for supplying high frequency electric energy from said generating means to said electrodes to establish an electric field therebetween. 5

8. Apparatus for evaporating water from a yarn package at substantially atmospheric pressure, comprising a generator for generating high frequency electric energy, a hollow lower electrode serving as a support for a yarn package, a hollow upper electrode substantially parallel with said lower electrode and spaced above a yarn package supported on said lower electrode by substantially a predetermined distance, means for supplying low pressure steam to the hollow interior portions of said electrodes, an annular series of holes in the upper wall of said lower electrode surrounding a yarn package thereon for the flow of steam from the interior of said lower electrode to the region about said yarn package and thereby for establishing and maintaining an atmosphere consisting substantially of steam in the vicinity of and substantially surrounding a yarn package on said lower electrode, and means for supplying high frequency electric

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energy from said generating means to said electrodes to establish an electric field therebetween.
ALFRED S. BROWN.

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