Jan. 4, 1955 P. H. CANNON ET AL 2,698,488

DRYING OF YARN PACKAGES

Filed Jan. 10, 1950 2 Sheets-Sheet 1

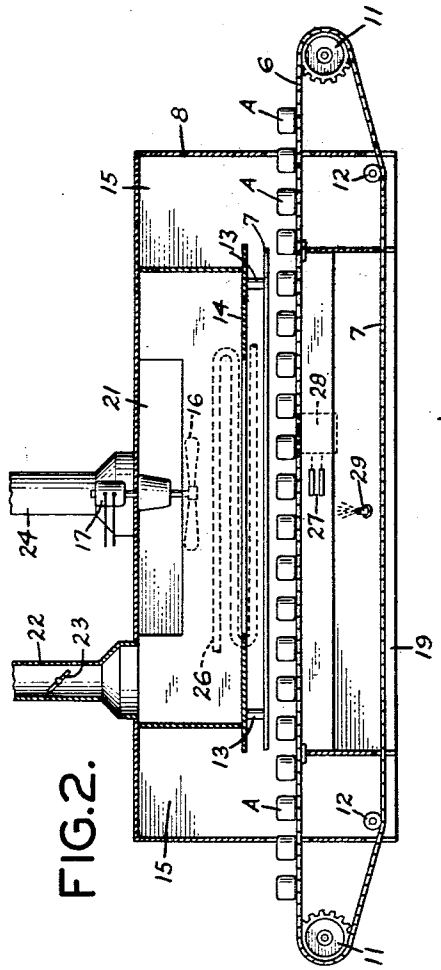


FIG. 2.

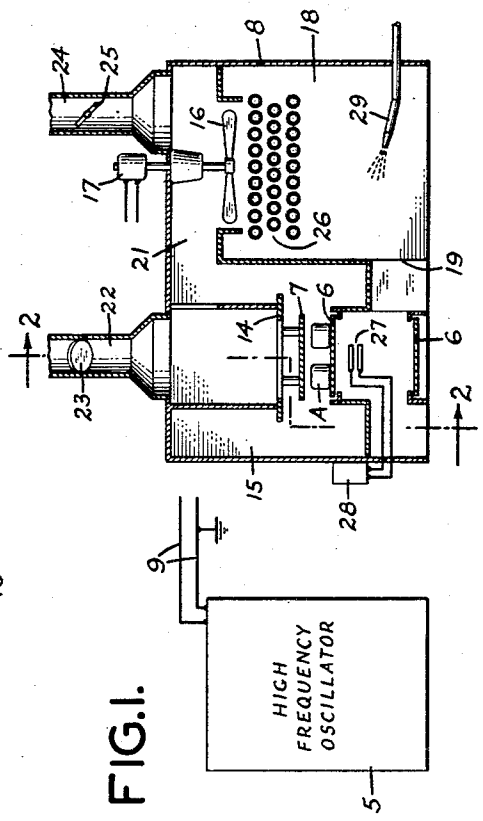


FIG. 1.

INVENTORS.
PAUL H. CANNON
WILLIAM L. LOVE, JR.
BY
ATTORNEY.

Jan. 4, 1955 P. H. CANNON ET AL 2,698,488

DRYING OF YARN PACKAGES

Filed Jan. 10, 1950 2 Sheets-Sheet 2

FIG.3. RESIDUAL SHRINKAGE CHARACTERISTICS OF VISCOSE CAKE YARN

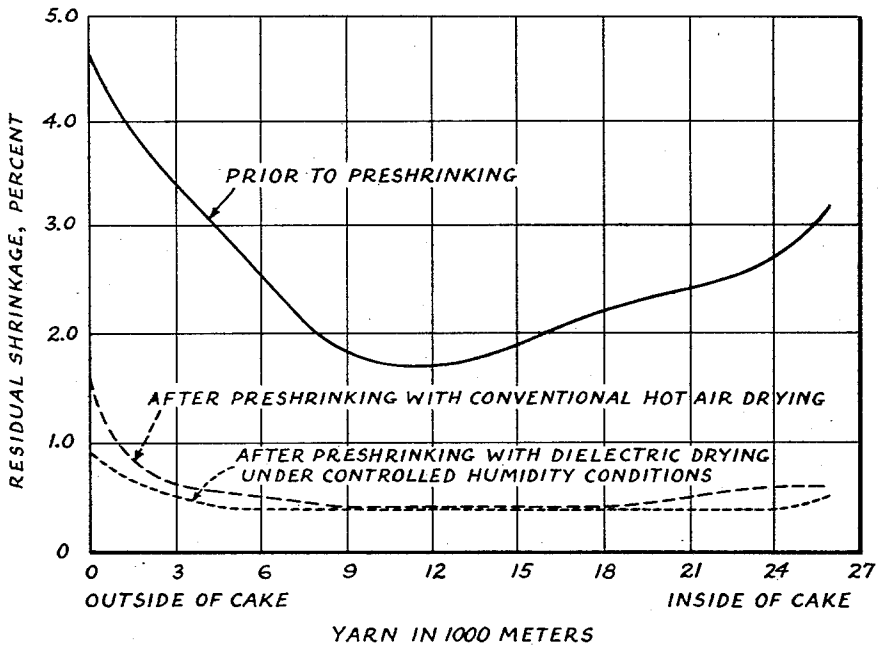
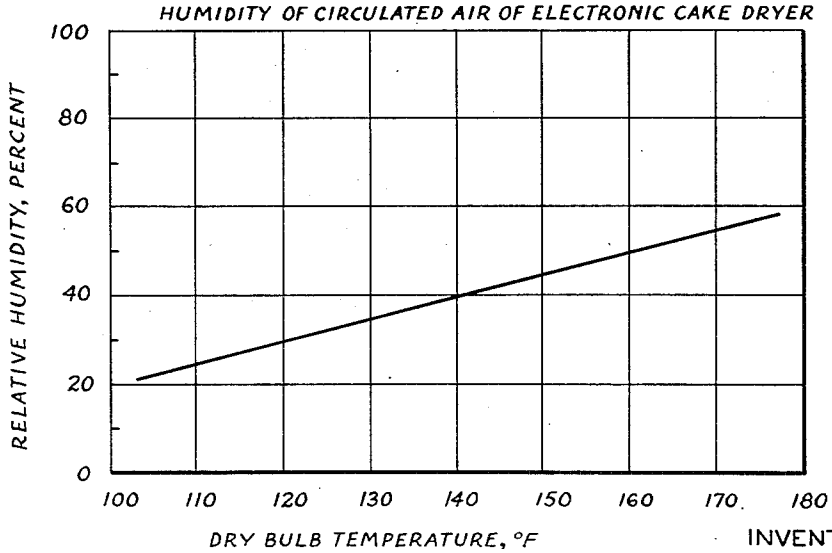


FIG.4. RELATIONSHIP BETWEEN TEMPERATURE AND RELATIVE HUMIDITY OF CIRCULATED AIR OF ELECTRONIC CAKE DRYER



INVENTORS.
PAUL H. CANNON
WILLIAM L. LOVE, JR.
BY
ATTORNEY.

United States Patent Office 2,698,488 Patented Jan. 4, 1955

2,698,488

DRYING OF YARN PACKAGES

Paul H. Cannon and William L. Love, Jr., Rome, Ga., assignors to Celanese Corporation of America, New York, N. Y., a corporation of Delaware

Application January 10, 1950, Serial No. 137,726

1 Claim. (Cl. 34—1)

This invention relates to the drying of yarn packages, and relates more particularly to the drying of cakes of rayon yarn, especially viscose rayon yarn, by subjecting said cakes of rayon yarn to a high frequency electrical field whereby the dried yarn is provided with a low and uniform residual shrinkage.

The primary object of our invention is to provide a novel process for removing the moisture from cakes of yarn under such conditions that the rate of moisture removal from the surface of the said cakes is controlled, whereby there is obtained low and uniform residual shrinkage for the yarn.

Another object of our invention is the provision of a novel drying apparatus for carrying out the foregoing process whereby there is obtained low and uniform residual shrinkage for the yarn.

Other objects and advantages of this invention, together with certain details of construction and combinations of parts, will appear from the following detailed description and accompanying claim.

Heretofore in the manufacture of viscose rayon yarn by the bobbin spinning process, the yarn was dried initially on rigid, cylindrical bobbins. Since this mode of drying did not permit the yarn to shrink uniformly, it was customary to subject the yarn to a subsequent re-wetting and re-drying operation in order to reduce the shrinkage forces so as to approach an extremely low and uniform residual shrinkage throughout each yarn package, residual shrinkage being the amount, in proportion to its original length, by which a dry thread will shrink upon being re-wet and re-dried under conditions permitting it to shrink without restraint. This operation usually consisted of (1) rewinding the yarn into packages known in the art as "cakes," which are unsupported except by their structure and a knitted cloth wrapping, (2) wetting the cakes by soaking in water containing, if desirable, surface active materials, oils, finishes, etc., (3) extracting as much as possible of the liquid from the cakes by the use of a centrifuge, and (4) drying the cakes usually in conventional hot air dryers in which heated air is passed over the cakes.

The foregoing so-called "preshrinking" treatment, although it materially relieved the shrinkage forces, did not shrink the yarn located at the outer surface of the cake to the desired extent in relation to the remainder of the cake. This resulted in a greater residual shrinkage for the yarn located at and near the outside of the cake than obtained throughout the remainder of the cake. This non-uniformity was caused mainly by the fact that the outer layers of the yarn dried quickly while the remainder of the cake was still swollen and wet. As a result, the outer yarn did not have space in which to shrink and thus the degree of shrinkage was retarded. Because of this non-uniformity of residual shrinkage, the yarn is unsuitable for certain fabric constructions in which the variable shrinkage produces faults known as "tight ends," "shiners," etc. In order to overcome these faults, various methods have been employed, including (1) segregation of the outer yarn containing the undesirable residual shrinkage from the desirable yarn by winding off and discarding the yarn having excessively high residual shrinkage, (2) high humidity controlled drying in which the cakes are dried very slowly by the use of air having a high moisture content so that the rate of evaporation of the moisture from the surface of the cake approaches the rate of movement of the moisture to the surface of

the cake, (3) drying of the cake from the inner surface of the cylindrical yarn package by covering the outer surface of the cake with an impermeable membrane, (4) combination of high humidity and inside drying, (5) reversing the position of the yarn in the cake by a rewinding or re-drawing operation so that the outer yarn of the initial cake is positioned at the inner part of the second cake and then subjecting the cake to a second preshrinking treatment, and (6) re-wetting only the outer layers of the initially preshrunk cake and then re-drying. All of these aforementioned methods as well as others not mentioned are subject to criticisms because of unreliability or because of the added expense relating to labor, floor space, capital investment, or damage to yarn.

More recently another method has become available which offers a convenient, fast, reliable means of producing a low and uniform residual shrinkage. This method involves the drying of the centrifuged-wet cakes by radio frequency power. In this process, the cake is subjected to an electrostatic field, alternating at a frequency in the range of five to thirty megacycles. This method, generally known as dielectric heating, possesses the advantage, lacking in other methods, of heating the yarn uniformly throughout the yarn cake. This unique feature of dielectric heating is due to the fact that the heat is generated within the yarn itself by reason of dielectric losses. It is because of this feature that viscose cakes can be dried in less than one per cent of the time required by conventional methods. Whereas hot air drying of one-pound cakes may take from 30 to 120 hours, depending on the method involved, dielectric drying of the same size cakes may be accomplished in as little as 15 to 30 minutes. Normally, arrangements are provided whereby the cakes are passed continuously through the high frequency field on a conveyor. Because of these factors, dielectric drying possesses advantages with respect to smaller floor space requirements, smaller inventory of yarn in process, and less auxiliary processing equipment. Thus, our invention contemplates the drying of yarn cakes by dielectric heating under precisely controlled temperature and humidity conditions. Thus, in accordance with our invention, the yarn cakes are passed through a high frequency electrostatic field in a cabinet through which air is circulated and to which water vapor may be supplied. The air circulating about the yarn cakes carries away the water vapor developed by the dielectric heat acting upon the water-wet dried cakes. However, the capacity of the circulated air to pick up moisture is limited in order to prevent the flow of air about the cakes from removing the moisture from the surface of the cakes at a faster rate than the moisture is expelled from the interior of the cakes. This is effected by controlling the relative humidity within the cabinet, by supplying thereto additional water vapor, such as steam, when necessary for humidity control.

It has been found that the relative humidity and air velocity are directly related to their effect upon residual shrinkage, that is, in obtaining desirable shrinkage it is necessary to increase the relative humidity as the air velocity is increased. It has also been found that the drying of yarn cakes may be economically and efficiently effected at a relative humidity of 75%, or less, operating at a dry bulb-temperature of 130 to 170° F. and when employing an air velocity of 50 to 100 feet per minute. It is believed that the very low air velocity employed during the drying period results in the immediate surface of the cake being incased in an envelope of water vapor expelled by the dielectric heating of the yarn. The slow movement of the air is sufficient to carry away the moisture driven out of the cake but, combined with the low capacity of circulated air for pick-up of additional moisture, it may not disturb to any great extent the moisture vapor conditions immediately adjacent to the cake surfaces. We have found that the best results are obtained by employing an air velocity of 75 feet per minute and a relative humidity of 50%, giving a ratio of 1.5:1, the dry bulb-temperature being 140° F.

The apparatus for carrying out our invention comprises a metal cabinet, provided with thermal insulation, which houses the electrodes for producing the electrostatic field.

The electrodes are supplied with power, through a concentric transmission line, from a high frequency oscillator located outside of the dryer cabinet. The electrodes may be of any suitable type, one preferably being in the form of an endless type conveyor belt at ground potential. The other electrode may be a plate supported in the dryer cabinet in such a manner that it is spaced a suitable distance from the conveyor belt to permit of the passage of the cakes carried on said conveyor belt.

The electrodes are preferably perforated for the purpose of allowing the passage of air and moisture therethrough. Means are provided for circulating air through the conveyor belt and about the yarn cakes to carry away the water vapor expelled from the heated yarn cakes, thus preventing condensation of the water vapor on the electrodes which would cause arcing to the yarn cakes with consequent damage thereto. Preferably, a portion of the air is recirculated and a smaller portion is exhausted from the dryer cabinet, the exhausted portion replaced by air drawn into the dryer cabinet from the atmosphere. In order to maintain the air at the desired elevated temperature, it is necessary to heat the air by means other than the high frequency power, for example, by means of steam coils. The temperature of the air should be such that condensation of the moisture is prevented. Control of air temperature and humidity is provided by wet and dry bulbs placed at a suitable position in the dryer cabinet and connected to suitable automatic control mechanism. A steam jet is provided to supply automatically to the circulated air the required amount of steam for the humidity control.

It is of the utmost importance that the flow of air about the cakes as they pass through the dryer should not be at such a rate as to remove the moisture at a faster rate than it is expelled from the interior of the cakes, otherwise the residual shrinkage results would not be within the desired range, primarily because the yarn located at the immediate outside of the cake would not shrink sufficiently. Thus, notwithstanding the fact that the cake is heated uniformly throughout in the high frequency electrostatic field, the pick-up of moisture from the surface of the cake must be controlled in order that the outside layers of yarn be allowed to shrink satisfactorily. To this end, our invention contemplates, by the use of controlled relative humidity as well as air velocity, the limiting of the capacity of the circulated air to pick-up moisture.

In the drawings wherein a preferred embodiment of the apparatus employed in accordance with our invention is shown,

Fig. 1 is a schematic view, in vertical cross-section, of the yarn cake dryer embodying our invention,

Fig. 2 is a cross-sectional view taken along line 2—2 in Fig. 1,

Fig. 3 is a series of curves showing the residual shrinkage characteristics of viscose cake yarn, and

Fig. 4 is a curve showing the relationship between temperature and relative humidity of the circulated air obtained in our electronic cake dryer.

Like reference numerals indicate like parts throughout the several views of the drawings.

Referring now to the drawings, and particularly Figs. 1 and 2, there is shown schematically an apparatus for electronically drying yarn cakes consisting essentially of a dryer cabinet and a radio frequency generator. The radio frequency generator is substantially of the type manufactured and sold by the Radio Corporation of America in various power and frequency ratings. Since the electrical arrangement employed in such a yarn cake dryer does not form part of our invention, we have omitted the electrical connections from the high frequency oscillator **5** to the electrodes **6** and **7**.

Essentially, the yarn cake dryer comprises a cabinet **8** having metal walls, although other suitable material may be employed, normally provided with thermal insulation. The electrodes **6** and **7** which produce the electrostatic fields are located within the cabinet **8** and are supplied with power through a concentric transmission line **9** from the high frequency oscillator **5** located, as shown, outside of the dryer cabinet **8**.

The electrode **6** comprises an endless metallic belt at ground potential which is trained about sprocket wheels **11** at least one of which is positively rotated to supply movement to said endless belt. Idler roller **12** are provided to maintain the endless belt **6** in substantially taut

condition. The electrode **7** is supported by insulators **13** which are mounted on the lower cross-member of a supporting frame **14** positioned in compartment **15** within the cabinet **8** above the electrostatic field generated by the electrodes **6** and **7**. The electrode **7** is spaced a suitable distance above the electrode **6**, which acts as the conveyor of the yarn cakes A through the dryer cabinet **8**, to permit of the passage of the yarn cakes resting on said endless belt conveyor. The electrodes are preferably perforated to allow the passage therethrough of air and moisture circulating within the cabinet.

To circulate the air in the cabinet **8**, there is suitably mounted within the cabinet a fan **16** which is caused to be rotated at any desired speed by a motor **17**. The air is forced by fan **16** to pass downward through a chamber **18** in the cabinet **8**, through an opening **19** in said chamber, and then up through the perforations in the endless belt electrode-conveyor, whereby the air circulates about the yarn cakes on the conveyor. In this manner, the water vapor expelled from the yarn cakes by the electronic heating thereof is carried away, thus preventing condensation of the water vapor on the electrodes **6** and **7** which would cause arcing to the yarn cakes with consequent damage to them.

After circulating about the yarn cakes the air, now containing water vapor, passes into compartment **15**. A portion of this air passes through an opening **21** into chamber **18** and is recirculated, and a smaller portion is exhausted through a stack **22** communicating with compartment **15** and provided with a damper **23**. The portion of the air which is exhausted is replaced by fresh air drawn through stack **24** communicating with cabinet **8** and having therein a damper **25**.

Since even with the movement of the air about the electronically heated yarn cake, it is necessary, for the proper functioning of the apparatus to dry the yarn cakes adequately and to insure against condensation, to heat the air by means of energy other than high frequency electrical power. To this end there is provided in the chamber **18** a coil **26** through which steam from any suitable source, not shown, is passed. The temperature of the air should be at least 120° F. and preferably 140° F.

Provision is made for the control of air temperature and humidity by mounting wet and dry bulbs **27** in the vicinity of the yarn cake conveyor **6**, and a recording temperature and humidity controller instrument **28** on the outside of cabinet **8**. For automatically supplying water vapor to the circulated air, when required for humidity control, a steam jet **29** is mounted in chamber **18** and is connected to a suitable source of supply (not shown).

In operation, the yarn cake dryer described above permits of the satisfactory drying of the yarn cakes with residual shrinkage results within the desired range due to the fact that the use of controlled relative humidity regulates the removal of moisture from the surface of the yarn cakes by limiting the capacity of the circulated air to pick up the moisture. That the use of controlled humidity, in combination with electronic drying, advantageously influences the residual shrinkage values is evidenced in Fig. 3 where there is shown a typical residual shrinkage curve (the lowest of the curves shown in said figure) for yarn cakes dried with radio frequency power under optimum conditions of temperature and relative humidity, i. e., with the circulated air at a dry bulb-temperature of 140° F. and a relative humidity of 50%, the other two curves showing the residual shrinkage characteristics of the yarn cakes prior to preshrinking and after preshrinking with conventional hot air drying. A typical residual shrinkage curve for yarn cakes dried with radio frequency power but without the use of controlled air conditions to assure the optimum rate of moisture removal from the surface of the yarn cakes, is impossible because of the erratic residual shrinkage results obtained from yarn cake to yarn cake and from test to test under such conditions.

Inasmuch as the moisture capacity of the air varies directly as the temperature of the air, it is necessary to employ higher relative humidities as high temperatures are employed in order that the moisture pick-up, by the air, from the surface of the yarn cake being dried be restricted. We have found that optimum conditions are attained when the relative humidity is at or above a line defined by the coordinates (in Fig. 4), (1) relative

humidity of 35% at a temperature of 130° F. and (2) relative humidity of 55% at 170° F.

Whereas no upper limit of relative humidity is essential from the standpoint of shrinkage, we have found that it is usually impractical to operate satisfactorily, because of the problem of condensation and subsequent arcing, with a relative humidity in excess of 75% at the temperatures normally employed in the drying operation. Within the range of relative humidities employed in accordance with our invention, satisfactory residual shrinkage has been obtained with the temperature of the circulated air within the range of 130 to 170° F. However, the temperature of 130° F. is close to the borderline of faulty operation with respect to condensation, and the temperature of 170° F. is higher than that necessary to prevent condensation and is, therefore, uneconomical.

It is to be understood that the foregoing detailed description is merely given by way of illustration and that many variations may be made therein without departing from the spirit of our invention.

Having described our invention, what we desire to secure by Letters Patent is:

In a process for drying yarn packages wherein moisture-containing packages of yarn are passed through a high frequency electrical field, the steps of passing air through said high frequency electrical field to remove moisture expelled from said packages of yarn, removing a part of the moisture-containing air, and replacing the latter with air drawn from the atmosphere, the improvement which comprises effecting the drying in an atmosphere wherein the relative humidity is maintained at 50% and the temperature at 140° F., and air is passed over the yarn packages being dried at a velocity of 75 feet per minute.

References Cited in the file of this patent

UNITED STATES PATENTS

1,550,422	Braemer	Aug. 18, 1925
2,231,457	Stephen	Feb. 11, 1941
2,263,681	Hart	Nov. 25, 1941
2,408,434	Mann et al.	Oct. 1, 1946
2,428,615	Brown	Oct. 7, 1947
2,485,609	Koster et al.	Oct. 25, 1949