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Hodgett et al.

[11] **3,878,619**

[45] **Apr. 22, 1975**

[54] **DRYING OF WOOL SLIVERS**

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[73] Assignee: **The Electricity Council,** London, England

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[21] Appl. No.: **300,551**

[30] **Foreign Application Priority Data**

Oct. 25, 1971 United Kingdom 49531/71

[52] **U.S. Cl.** **34/1;** 34/49; 34/55

[51] **Int. Cl.** **F26b 3/32**

[58] **Field of Search** 34/1, 49, 159, 161, 55; 219/10.61, 10.67, 10.81

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Primary Examiner—Charles J. Myhre
Assistant Examiner—Paul Devinsky

[57] **ABSTRACT**

Textile fibers, for example wool slivers, are dried by passing them through a series of co-axial loop electrodes energized at a radio frequency preferably above 10 MHz to effect dielectric heating, successive electrodes along the path being at opposite polarity. The material is carried on an aportioned endless belt of resin-bonded glass fibre material. Simultaneously a stream of hot air is directed over or through the fibre material. Sensing means at the fibre outlet sense the moisture content and control the radio frequency power. A fibre break detection at the film entry switches off the radio frequency power in the event of a fibre break and also reduces the speed of traverse so that the material in the apparatus is dried by the hot air.

12 Claims, 12 Drawing Figures

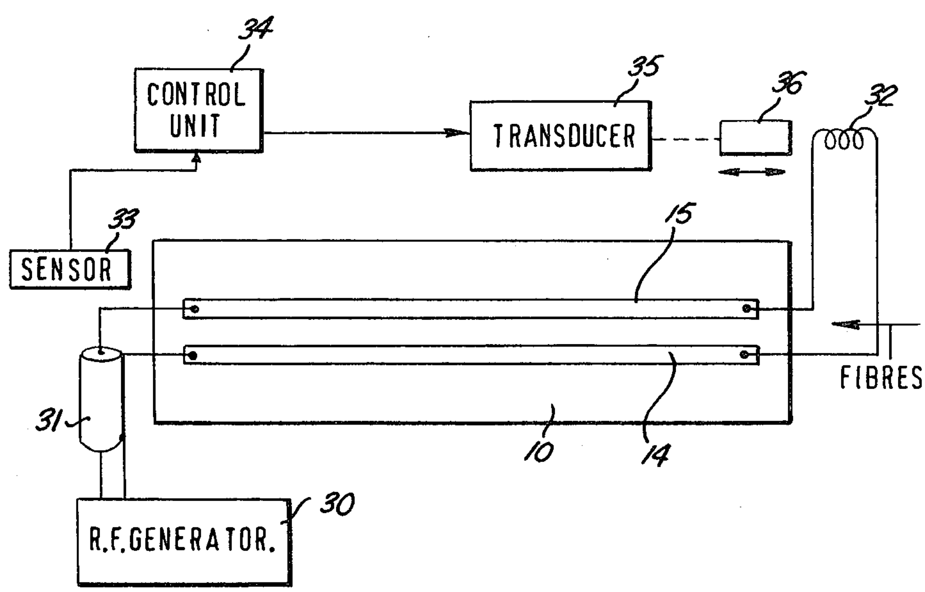


FIG. 1

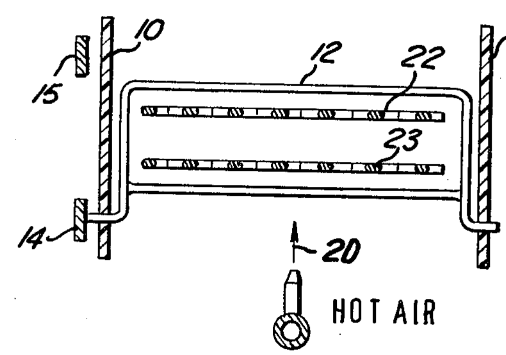


FIG. 2

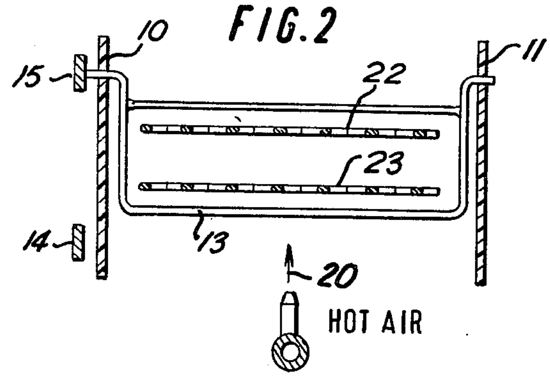


FIG. 3

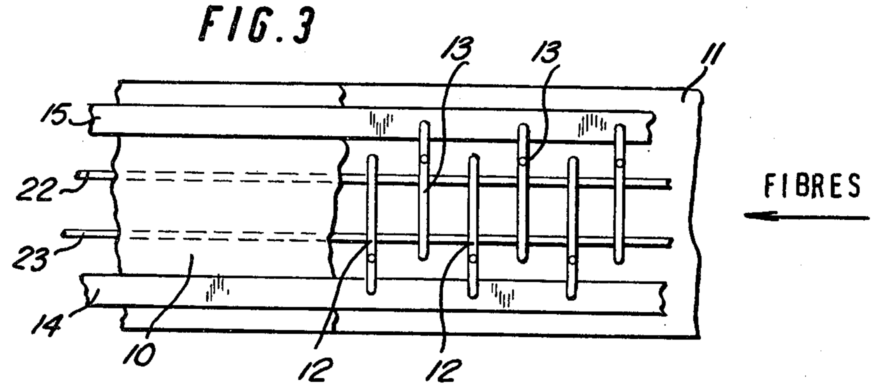


FIG. 4

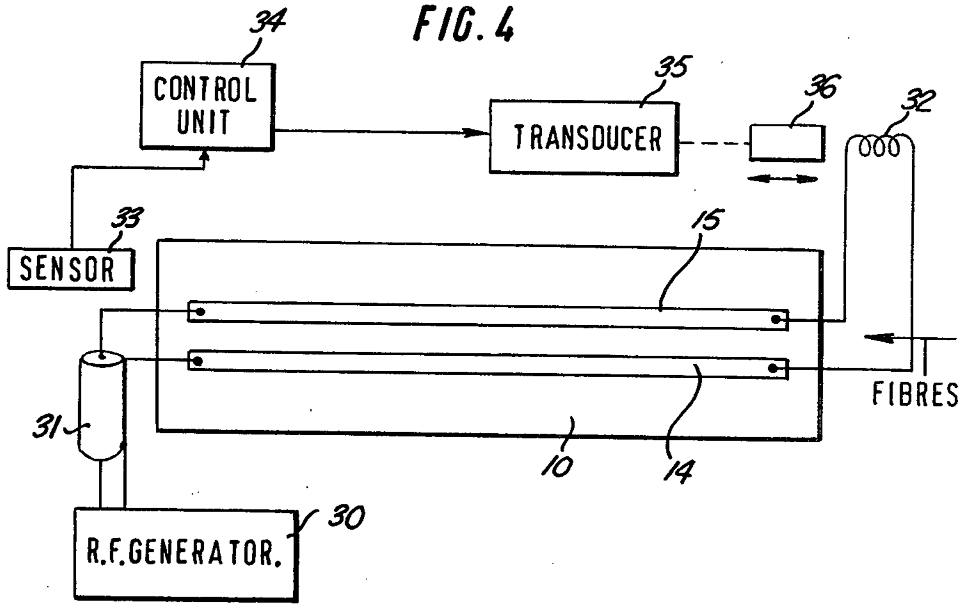
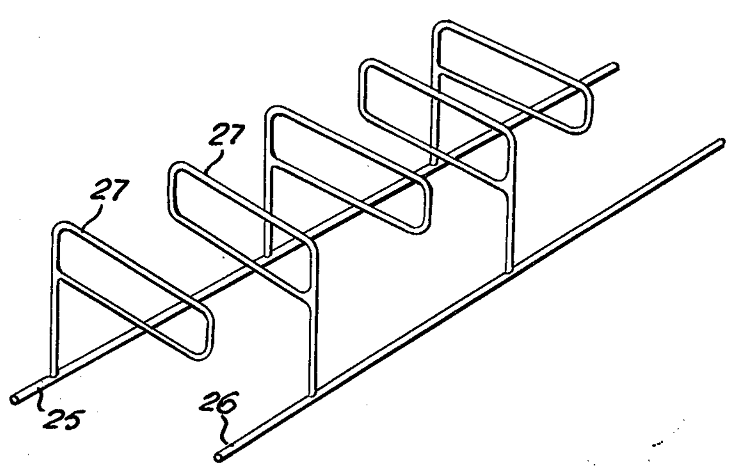

34
CONTROL UNIT
35
TRANSDUCER
36
32
33
SENSOR
15
31
FIBRES
10
14
R.F.GENERATOR.
30

FIG. 5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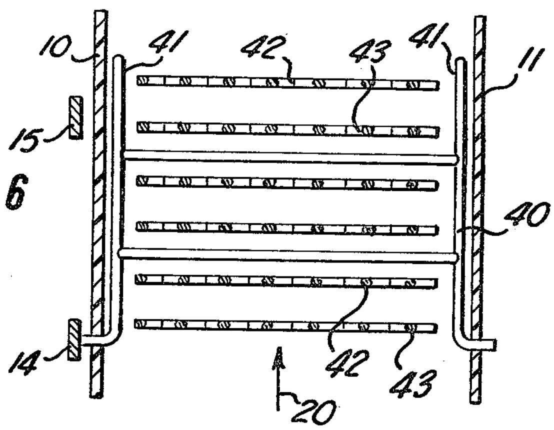


FIG. 6

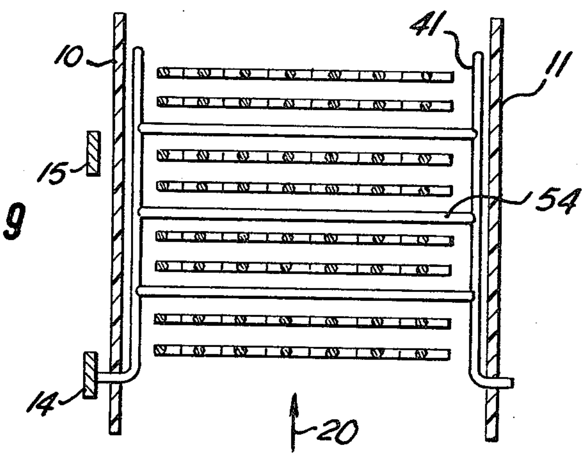


FIG. 9

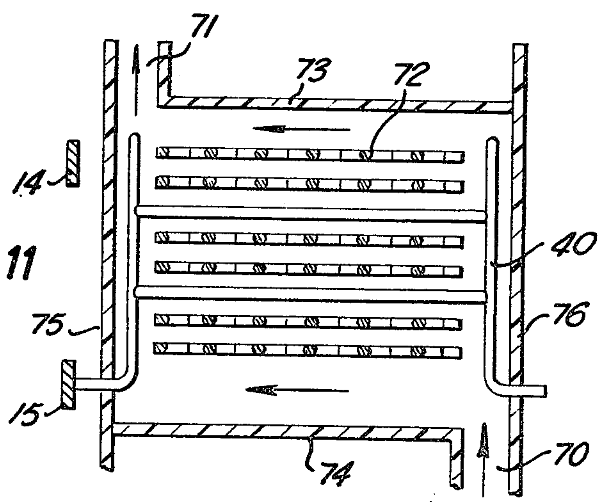


FIG. 11

FIG. 7

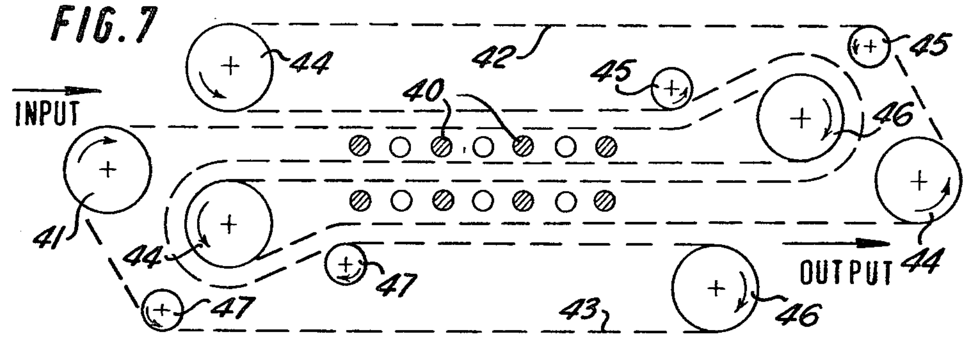


FIG. 8

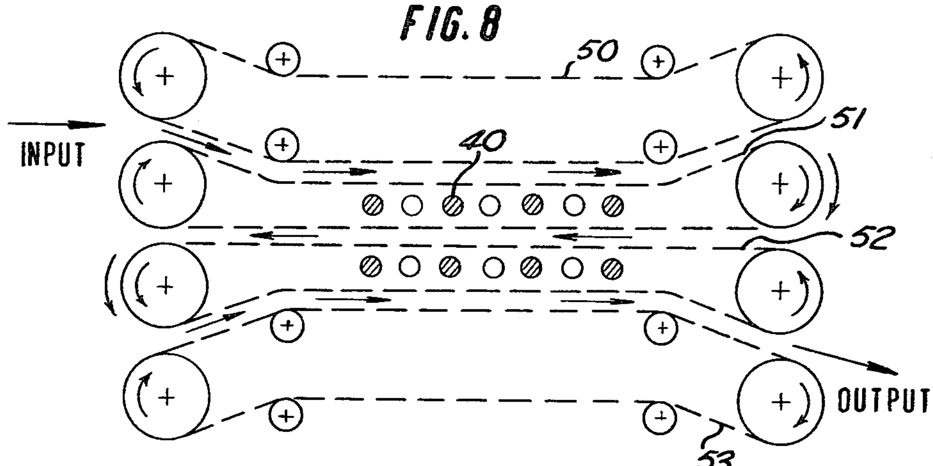


FIG. 10

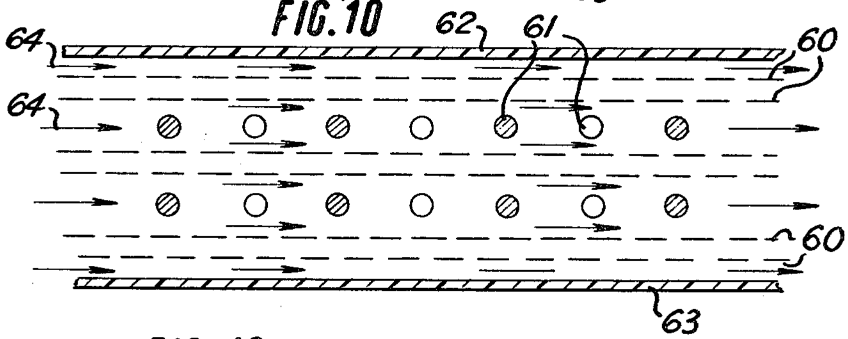
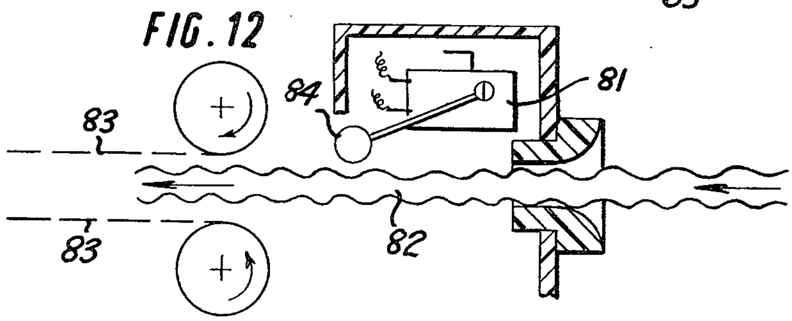


FIG. 12



DRYING OF WOOL SLIVERS

This invention relates to a method of and apparatus for drying of textile fibres. The invention is applicable to the drying of natural or synthetic fibres or mixtures thereof in loose, sliver or hank form.

The invention is applicable, for example, to the drying of wool slivers

After wool has been washed and carded and formed into slivers, it is the practice to wash it again, this step being known as back-washing, before it is spun. Heretofore the drying of the slivers after back-washing has been commonly effected using hot air flowing through holes in a steam heated drum. This drying operation is very slow resulting in large quantities of slivers accumulating for drying before they can be further processed. It is an object of the present invention to provide an improved method and apparatus for the drying of wool slivers.

According to this invention, textile fibres are dried by passing the fibres through a radio frequency field to effect dielectric heating and simultaneously or subsequently a stream of hot air is directed at the fibres. With this technique, it is possible to effect the drying of the fibres as a continuous operation without having to store the fibres in a drying apparatus.

According to one form of the invention, a method of drying textile fibres comprises the steps of passing the fibres through a succession of electrodes energised alternately at oppostie polarities with a radio frequency alternating supply at a frequency above 1 MHz and preferably above 10 MHz to effect dielectric heating and simultaneously and/or subsequently subjecting the fibres to a transverse hot air stream to remove the water vapour. Preferably the hot air stream is passed through the fibres simultaneously with the dielectric heating, the hot air stream being arranged to force the fibres against an apertured guide or support means of low loss dielectric material which holds the fibres in position when passing through the electrodes. The support means may comprise a moving apertured belt e.g. a mesh belt, the fibres being blown by the air stream onto the belt. Conveniently the air stream is either directed downwardly to blow the fibres downwardly onto the belt or upwardly to hold the fibres against the undersurface of the belt. Preferably however apertured belts are provided both above and below the fibres.

The method described above is particularly applicable to the drying of slivers, e.g. wool slivers. The slivers are passed through the electrodes which thus provide "stray field" dielectric heating with the field direction parallel to the surface of the slivers and coinciding with both the principal fibre orientation and the direction of movement of the sliver. It is thus possible to produce a high field strength in the material and hence to obtain high power coupling enabling high speed drying to be achieved.

The invention furthermore includes with its scope apparatus for drying textile fibres consisting of one or more drying sections, each drying section comprising a plurality of electrodes each extending around the fibre path, the electrodes being spaced along the fibre path, radio frequency supply means for energising the electrodes at a frequency above 1 MHz and preferably above 10 MHz with alternate electrodes of opposite polarity, means for directing a stream of hot air transversely through the fibres and support means for holding the fibres as they are traversed through the drying section or sections. The aforementioned support means preferably comprises an apertured or perforated belt of low dielectric loss material which is moved through the electrode system with the fibres. Preferably the air stream is directed to force the fibres onto the surface of the belt; the air stream may be upwardly to force the fibres onto the underside of the belt or downwardly to force the fibres down onto the belt. Most conveniently however two belts are provided one above and one below the fibres.

Each belt is conveniently of open mesh construction of a low dielectric loss material such as resin-bonded glass fibre material. The electrodes are preferably made as loops which extend around the belt or belts and fibres. Each electrode for example may be formed of a circular section rod or tube shaped to form a loop preferably a closed loop. Conveniently the loop is a flat loop with straight horizontal top and bottom portions joined by end portions which may be curved.

In drying slivers, if more than one sliver is to be dried, the various slivers are preferably arranged side by side, each electrode being made of a horizontal width slightly greater than the total width of the slivers. The vertical internal dimension of each electrode is preferably made slightly larger than the height of one sliver together with the belt or belts.

The hot air stream may be directed onto the fibres after passing through the electrode system of a drying section but is preferably directed onto the fibres whilst they are passing through the electrode systems.

In the following description reference will be made to the accompanying drawings, in which:

FIG. **1** is a diagrammatic transverse section through a drying section of a combined dielectric and forced convection drier for wool slivers showing only a single electrode;

FIG. **2** is a diagrammatic section similar to FIG. **1** but showing a different electrode;

FIG. **3** is a part side elevation of the apparatus of FIG. **1** and **2** partly in section along a vertical central plane;

FIG. **4** is a diagram illustrating the electrical arrangement of the apparatus of FIGS. **1** to **3**;

FIG. **5** is a perspective view illustrating an alternative construction of electrode system;

FIG. **6** illustrates a modified electrode system;

FIG. **7** and **8** illustrate multipass constructions;

FIG. **9** shows another multipass construction;

FIGS. **10** and **11** show further air flow arrangements, and

FIG. **12** illustrates a broken sliver detector.

Referring to FIGS. **1** to **3** the apparatus has two low-loss dielectric side walls **10, 11** formed for example of glass bonded mica. These side walls lie in vertical planes and extend horizontally and between them are arranged a series of loop electrodes, each loop electrode lying in a vertical plane transversely to the plane of the walls, the loops being spaced apart along the length of the apparatus. All the loops are co-axial but alternate loops are inverted as seen in FIGS. **1** and **2** where one loop electrode **12** is shown in FIG. **1**, this loop being adjacent to inverted loops such as the loop electrode **13** of FIG. **2**. Two flat strip bus bars **14, 15** are arranged outside the wall **10**, the electrodes **12** being connected to bus bar **14** and the electrodes **13** to bus bar **15**.

Each electrode is formed of a circular section rod or tube of a suitable metal such as non-magnetic stainless steel and is shaped to form a flat loop with straight top and bottom portions and rounded, e.g. semi-circular side portion joined to the top and bottom portions. The electrode loops are supported in the side walls **10, 11** and are spaced sufficiently far apart to avoid dielectric breakdown between them.

A number of slivers of wool are traversed at a uniform rate side by side through the loops of the electrode system. The internal horizontal dimension of each loop is made slightly larger than the total width of the number of slivers to be dried whilst the vertical dimension is slightly larger than the height of one sliver.

Hot air is directed upwardly through the electrode system as indicated by the arrow **20.** The slivers are supported and guided by a pair of open mesh or perforated belts **22, 23** formed of low dielectric loss material, for example resin bonded glass fibre material. These belts **22, 23** are made slightly narrower than the internal horizontal dimension of the electrodes **12, 13.** The belt **22** forms an upper support for the slivers **21** which are forced against this belt **22** by the upwardly directed stream of hot air. Thus the wool is blown onto the belt **22** and is transported thereby through the electrode of the drying section. The lower belt **23** forms a guide and prevents the slivers falling downwardly e.g. if the air supply should fail.

It would alternatively be possible to direct the air flow downwardly so that the wool slivers **31** are held down on a lower belt of open mesh or perforated material having a low dielectric constant which belt passes through the electrodes at the bottom of the loops. In this case the upper belt would be unnecessary.

An alternative construction of electrode system is illustrated in FIG. **5** with bus bars **25, 26** one on each side of the apparatus below the lower belt. In this arrangement the electrodes **27** are supported each by one of the two bus bars, the electrodes being arranged alternately as before.

Referring to FIG. **4,** a radio frequency generator **30** is connected by a low inductance co-axial transmission line **31** to the bus bars **14, 15** at the centre of the electrode system. Variable shunt inductors **32** are connected between the bus bars at the ends thereof from the co-axial feed **31.** For simplicity in the FIG. however only one inductor **32** is shown. In the simplest form the inductor might be adjusted manually to control the power fed into the electrodes. In the construction shown in FIG. **4** however, automatic control is provided. A sensor **33** is provided consisting of a transducer responsive to some property, such as electrical resistance, of the slivers leaving the drier, which is dependent on the regain (i.e. the moisture content on a dry weight basis) of the fibres. The electrical signal from the sensor **33** is fed to a control unit **34** which, by means of a transducer **35,** effects mechanical movement of a movable element **36** of the inductor **32.**

A complete dryer may consist of one or more drying sections, each having an electrode system and a wool handling system.

With the arrangement described above, drying is achieved by the combination of dielectric heating of the wool whilst it is between the electrodes and convective heating from the hot air stream. The stream of hot air also removes the water vapour produced during the drying. The air can be heated either wholly or partially

by waste heat from the radio frequency generator **30.** The electrode system produces stray field dielectric heating, that is to say the field direction is parallel to the surface of the wool and is arranged to coincide with the principal fibre orientation and the direction of movement of the wool. Although the wool slivers form what would normally be considered as a relatively thick load for a stray field electrode dielectric heating system, the above described construction of the electrode system with the closed loops and its combination with the wool transportation system and the hot air system gives sufficient drying of wool slivers passing at high speeds through the system. The smoothly curved ends of the electrodes enable the wool slivers to be retained within the electrode system without the need for any side walls thereby minimising the problem of dielectric breakdown between electrodes which would be caused by the resultant field intensification if side walls were provided. The slivers are placed side by side in passing through the drier so that the maximum surface area is presented to the air stream to maximise convection heating and moisture removal. Placing the slivers side by side also avoids slippage between slivers; each of the slivers is in contact with the moving belt and is carried at the speed thereof. The electrodes are placed sufficiently far apart to avoid dielectric breakdown between them but near enough to obtain a high field strength in the wool and thereby high power coupling enabling high speed drying to be achieved.

Although the apparatus has been described more specifically for the drying of wool slivers, it may be used for natural, man-made, or synthetic fibres or blends or combinations thereof. The fibres may be in loose, sliver or hank form and may be dyed or undyed.

As shown in FIG. **6,** use may be made of the stray field above and below the loop electrodes. The sliver can be passed above the electrodes, between them and below them. In FIG. **6,** the electrodes **40** are extended upwardly at **41** (compared with the electrodes **12** of FIG.**1**) so as to form a guide for the sliver at the top. Similarly the electrodes **13** of FIG. **2** would be extended downwardly.

Preferably the slivers are passed in succession above, through and below the electrodes (or vice versa) as shown in FIG. **7.** This FIG. shows two endless belts **42,** 43 between which the sliver is sandwiched. Belt **42** runs over drive rollers **44** and guide rollers **45** while belt **43** runs over drive rollers **46** and guide rollers **47.** An alternative arrangement is shown in FIG. **8** using 4 belts **50,** 51, 52, 53.

As seen in FIG. **9,** more than three passes may be obtained by adding one or more cross bars **54** across the loop electrodes.

Because of the low dielectric constant of the wool sliver at the RF frequencies there is little increase in capacitance of the applicator system. For materials which have a very low dielectric loss factor at RF frequencies, such as some dyed wool slivers, the field strength required to dry the sliver in a reasonably long single pass system would be too high for practical purposes. Using n passes enables the drying length to be effectively increased n times without any extra length on the machine itself so that the field strength can be reduced by a factor of n for the same power.

In a multipass system, the airflow may more conveniently be longitudinal or lateral. FIG. **10** illustrates longitudinal flow. In this construction the belts are shown at **60** and electrodes at **61**. Upper and lower walls **62** and **63**, respectively, of glass bonded mica are provided as well as the side walls **10, 11**. The airflow is indicated by the arrows **64**.

Lateral airflow is illustrated in Figure **11**, the air inlet being at **70** and air outlet at **71**, the air passing laterally between the belts **72**. The duct has upper and lower walls **73, 74** and side walls **75, 76**.

As shown in Figure **12**, a microswitch **81** at the sliver inlet is operated by a dancing roller **84** which rests on the sliver **82** before it passes between the belts **83** to switch off the radio frequency power if any one sliver breaks. The microswitch also operates a speed control system so that the dryer reduces to a speed at which the remaining slivers can continue to be dried by the hot air only until such time as the broken sliver is retreaded or a new sliver threaded into the machine..

We Claim:

1. Apparatus for drying textile fibres consisting of at least one drying section, the drying section comprising a plurality of electrodes each extending around the fibre path, a pair of bus bars to which said electrodes are connected, radio frequency supply means arranged for energising said bus bars at one end thereof at a frequency above 1 MHz, said bus bars being each connected to alternate electrodes so that alternate electrodes are of opposite polarity, an adjustable inductance connected across said bus bars at said other end, means for traversing the fibres along said path, means for directing a stream of hot air traversely through the fibres, support means for holding the fibres as they are traversed through the drying section, moisture content sensing means providing an electrical signal representative of the moisture content of the fibres leaving the apparatus, and control means responsive to said electrical signal operable to control said adjustable inductance to regulate the power applied to said electrodes.

2. Apparatus for drying textile fibres consisting of at least one drying section, the drying section comprising a plurality of electrodes each extending around the fibre path, radio frequency supply means arranged for energizing the electrodes at a frequency above 1 MHz with alternate electrodes of opposite polarity, means for traversing the fibres along said path from a fibre entry end, means for directing a stream of hot air transversely through the fibres, support means for holding the fibres as they are traversed through the drying section, fibre material sensing means at the drying section fibre entry, said sensing means being arranged for producing a control signal indicating the absence of fibre, and means responsive to said control signal operative to switch off the radio frequency supply means and to reduce the speed of traverse of the fibres along said path.

3. Apparatus for drying textile fibres consisting of at least one drying section, the drying section comprising a plurality of loop electrodes arranged co-axially with their axis horizontal, radio frequency supply means arranged for energising the electrodes at a frequency above 1MHz with alternate electrodes of opposite polarity, a multipass transport system for carrying said fibres along a path and comprising at least one aperture belt of low dielectric loss material and having three passes extending horizontally below, through and above the electrodes, means surrounding said electrodes and transport system defining an air passageway, means for directing a stream of hot air through said air passageway, fibre material sensing means at the drying section fibre entry, said sensing means being arranged for producing a control signal indicating the absence of fibre, and means responsive to said control signal operative to switch off the radio frequency supply means and to reduce the speed of traverse of the fibres along said path.

4. Apparatus as claimed in claim **3** wherein said means surrounding said electrodes and transport system include side walls of dielectric material to form an air flow duct.

5. Apparatus as claimed in claim **3** wherein the radio frequency supply means is arranged for energising the electrodes at a frequency above 10MHz.

6. Apparatus as claimed in claim **3** wherein the air stream is directed upwardly to force the fibres against the underside of a belt.

7. Apparatus as claimed in claim **3** wherein apertured belts are provided both above and blow the fibres.

8. Apparatus as claimed in claim **3** wherein said means for directing a stream of hot air is arranged to direct the air stream longitudinally along the fibre path.

9. Apparatus as claimed in claim **3** wherein said means for directing a stream of hot air is arranged to direct the air stream laterally across the fibre path.

10. Apparatus as claimed in claim **3** wherein the belt material is a resin-bonded glass fibres material.

11. Apparatus as claimed in claim **3** and having fibre material sensing means at the drying section fibre entry, said sensing means being arranged for producing a control signal indicating the absence of fibre, and means responsive to said control signal arranged to switch off the radio frequency supply means.

12. Apparatus according to claim **3** including moisture content sensing means providing an elecrical signal representative of the moisture content of fibres leaving the apparatus, and control means responsive to said electrical signal operable to regulate the power applied to said electrodes.

* * * * *