

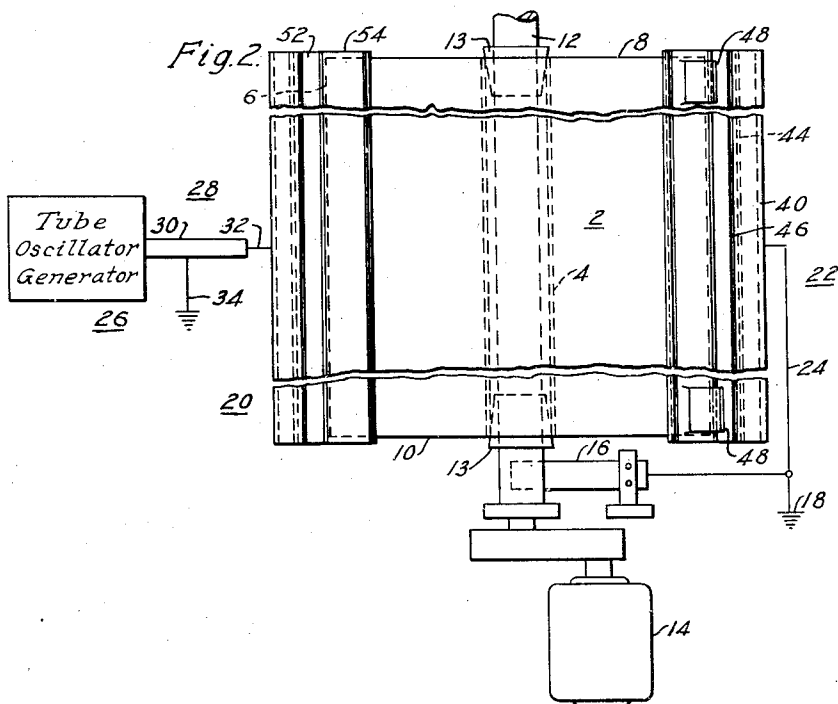
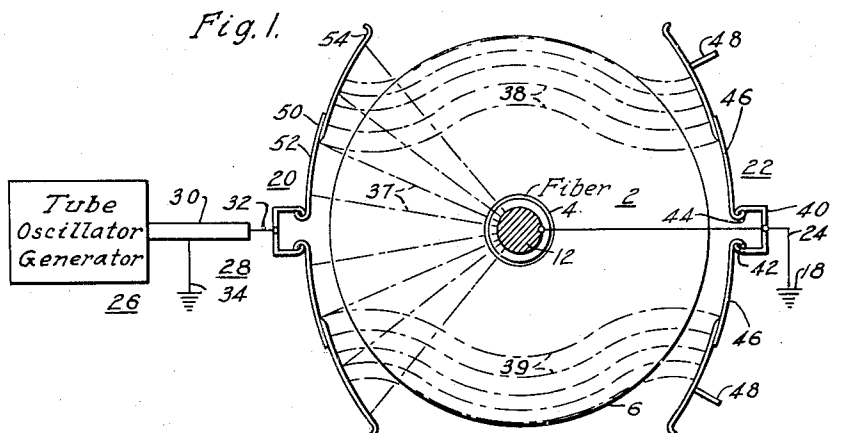
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HIGH-FREQUENCY DIELECTRIC HEATING APPARATUS

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HIGH-FREQUENCY DIELECTRIC HEATING
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This invention generally relates to dielectric heating, but is more particularly directed to improved means and methods for dielectrically heating long cylindrical shapes of dielectric material such, for example, and not in limitation, as large rolls of paper stock.

It is an object of my invention to provide means for controllably heating long cylindrical dielectric material in an elongated electric field having field lines transverse to the length, or axial, direction of the material.

It is a primary object of my invention to provide a means through which dielectric material in the shape of rolls or the equivalent can be uniformly dielectrically heat-treated.

It is a specific object of my invention to provide a dielectric heating means for uniformly heating long, thick rolls of paper.

A further object of my invention is to practicably dielectrically heat rotating rolls of dielectric material, using axially arranged electrodes, one of which may form a core of the roll or be associated with a shaft for rotating the roll; this central electrode being at ground potential so that problems of insulating it are avoided.

Other objects, features, innovations, combinations and methods attributable to my invention will be discernible from the following description of an embodiment at present preferred, which is to be taken in connection with the accompanying schematic drawing, in which:

Figure 1 is a sectional view of apparatus in accordance with my invention showing in a general, but not necessarily accurate way, the electric field lines produced in the apparatus; and

Fig. 2 is a horizontal plan view thereof perpendicular to the section plane of Fig. 1.

Referring to the drawing, the material to be heat-treated is shown as a roll 2 of paper which is solidly spirally wrapped on an inner fiber core 4, and has an outer surface 6 and ends 8 and 10; the roll being elongated in the direction of its axis so that it cannot be conveniently or practicably dielectrically heated by electrodes parallel to its ends 8 and 10. The roll 2 is supported for rotation on a metal mandrel or shaft 12, being fixed thereto in any suitable manner as for example by wedging means 13. The shaft 12 extends beyond the ends 8 and 10 of the paper roll 2, and has one end geared to an electric motor 14 which, when energized, causes the roll to rotate about its axis. The rotation may be either clockwise or counterclockwise with respect to Fig. 1. The shaft 12 constitutes an electrode means, and may be grounded in any manner through its supporting

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bearings, but it is shown as grounded through a brush 16 which presses on the shaft and is connected to ground, indicated at 18.

Radially outward from the roll 2, I provide an axially extending electrode means 20 and an axially extending electrode means 22 along opposite sides of the paper roll 2.

The electrode means 20 and 22 are circumferentially spaced from each other and relatively insulated. In the particular embodiment being described, each of the electrode means 20 and 22 spans about 90 degrees or somewhat more of the surface 6 of the paper roll 2. The electrode means 20 is insulated from the shaft 12, while the electrode means 22 is connected, in this embodiment, through a conductor 24, so as to be at the same potential as the shaft.

For providing the electric fields necessary for heating the paper roll 2 as it is rotated by the motor 14, I provide a tube-oscillator generator 26 delivering power to a coaxial output cable 28 comprising an outer conductor 30, and an inner insulated conductor 32. The former is grounded as indicated at 34, and the latter is connected to the electrode means 20 so that the last is at a high frequency potential with respect to the shaft 12 and the electrode means 22.

When the tube oscillator generator 26 is operating at radio or high frequency, an electric field is established having a component between the metal shaft 12, functioning as a central electrode, and the electrode means 20. This field portion extends radially through a sector of the paper roll 2, as indicated by field lines 37. Electric field components are also established which extend between the electrode means 20 and the electrode means 22. In effect, two fields are formed which pass directly through the paper roll 2 on opposite sides thereof, one of these fields being represented by 38 and the other by 39. In general, it may be said that the intensity of the electric fields 38 and 39 in the outer part of the paper roll 2, nearer the surface 6, is much greater than it is at the inner periphery of the roll, near the fiber core 4. For want of a better term, I call the fields 38 and 39 outer fields, by this also meaning that the fields are more intense at the outer portions of the roll, and have field-lines which generally pass transversely through the material. By controlling the curvature and position of the electrode means 20 and 22, the outer fields and their intensities in the material 2 can be altered. However, the radial electric field is necessarily of greater intensity near the inner periphery of the paper roll than it is near the outer

surface 6. By suitably adjusting the radial and outer field components it is possible to improve the uniformity with which the paper roll will increase in temperature throughout as it is heated.

In order to provide for ready adjustability of the fields, the electrode means 20 and 22 are preferably made in a plurality of sections permitting both radial and circumferential adjustment. Thus in Fig. 1 the electrode means 22 comprises a fixed metal U-shaped member 40 having turned edges 42 at the ends of its legs. Interlinked with each of the curved edges 42 is a curved edge 44 of a curved metal electrode section 46 having any suitable adjustable supporting means 48 by means of which the electrode section 46 can be swung toward or away from the surface 6. The electrode means 20 is similarly constructed except that its outer electrode sections 50 are formed of two slidably engaging portions 52 and 54 for permitting adjustment of the circumferential extent of the electrode means. It should, of course, be understood that I have shown the electrode means in a simplified manner; but they can take any form or shape which permits their radial and circumferential positions with respect to the surface 6 to be changed, either along their full lengths or breadths or along parts thereof.

The strength of the radial field at the fiber core 4 can also be controlled by selecting a suitable diameter for the shaft 12. However, I am not limited to the use of the shaft, which rotates the roll, as the central electrode. Obviously, many other expedients suggest themselves as a boundary for the electric field at the inner periphery or near the inner periphery of the paper roll 2.

While I have described my invention briefly so that it may be understood, it is obvious that it is subject to side modification and its teachings can be incorporated in different ways.

I claim as my invention:

1. Apparatus for dielectrically heating cylindrical dielectric material, comprising, in structural combination, a central electrode means, a first outer plate-type electrode means radially spaced and insulated from said central electrode means; a second outer plate-type electrode means radially spaced from said central electrode means and circumferentially spaced and insulated from the first outer electrode means, and energizing means connected to said electrode means for establishing an alternating radially-directed electric field between said central electrode means and said first outer electrode means, and for establishing an alternating outer electric field on each of the opposite sides of said central electrode means, extending between said first and second outer electrode means.

2. Apparatus for dielectrically heating cylindrical dielectric material, comprising, in structural combination, a central electrode means, a first outer electrode means radially spaced and insulated from said central electrode means, a second outer electrode means radially spaced from said central electrode means and circumferentially spaced and insulated from the first outer electrode means, energizing means for establishing an alternating radially-directed electric field between said central electrode means and said first outer electrode means, and for establishing an alternating outer electric field on each side of said central electrode means, extending between said first and second outer electrode means, and means for rotating said material, said central

electrode means and said second outer electrode means being grounded.

3. Apparatus for dielectrically heating elongated cylindrical dielectric material having a central axis, comprising, in structural combination, an electrode means centrally of the material, a first curved plate-type electrode radially spaced from said central electrode means, a second curved plate-type electrode radially spaced from said central electrode means and circumferentially spaced from said first curved electrode, at least one of said pair of curved electrodes extending circumferentially on both sides of a plane including said axis and the curved electrodes, means connected for applying a high frequency voltage between said central electrode means and said first curved electrode, means connected for applying a high frequency voltage between said first and second curved electrodes whereby to establish radial and outer alternating electric fields in said material, and means for rotating said material about said central electrode means and in the space between said central electrode means and said curved electrodes.

4. In apparatus for heating an annular article of dielectric material, the combination of a first electrode, a second electrode spaced therefrom whereby said electrodes are adapted to receive said article therebetween with its axis parallel to said electrodes, a third electrode within said article, said first and third electrodes being electrically connected to each other for maintenance thereof at the same potential, and means for coupling said electrodes to a source of high frequency electrical energy for producing between said second electrode and each of said first and third electrodes a high frequency electric field for generating heat in said article.

5. In apparatus for heating elongated dielectric material wound on an electroconductive core to constitute an annular package, the combination of a pair of electrodes arranged in opposed, spaced relation to each other for the reception of said package therebetween with the axis of said core parallel to said electrodes, means electrically connecting said core to one of said pair of electrodes whereby said core and said one electrode are maintained at the same electrical potential, and means for coupling said electrodes and said core to a source of high frequency electrical energy for producing between the other of said pair of electrodes and each of said core and said one electrode a high frequency electric field for generating heat in said material.

6. In apparatus for heating an annular article of dielectric material, the combination of a pair of electrodes disposed to receive said article therebetween with the axis of said article parallel to said electrodes, a third electrode within said article cooperatively related to said pair of electrodes, and means for maintaining said third electrode and one of said pair of electrodes at the same electrical potential.

7. In apparatus for heating an annular article of dielectric material, the combination of a pair of electrodes arranged in opposed, spaced relation to each other for the reception of said article therebetween with its axis parallel to said electrodes, and a third electrode within said article cooperatively related to said pair of electrodes, said third electrode being electrically connected to one of said pair of electrodes for maintaining said one electrode and said third electrode at the same potential.

8. Apparatus according to claim 4 characterized

by the addition of means for rotating said article substantially on its axis.

9. Apparatus for dielectrically heating elongated dielectric material having a central axis, comprising, in structural combination, an electrode means centrally of the material, additional electrode means radially spaced from said central electrode means, said additional electrode means comprising an insulated first curved portion and a second curved portion, said central electrode means and said curved portions extending longitudinally, one of said curved portions having a concave face facing said axis which is circumferentially less than 180°, and lies on both sides of a plane which includes said axis and passes through both of said curved portions, the last said curved portion having axially directed edges circumferentially spaced from corresponding edges of the other of said curved portions, and means for applying a high frequency voltage between said in-

ulated curved portion and said central electrode means, and between said first and second curved portions.

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