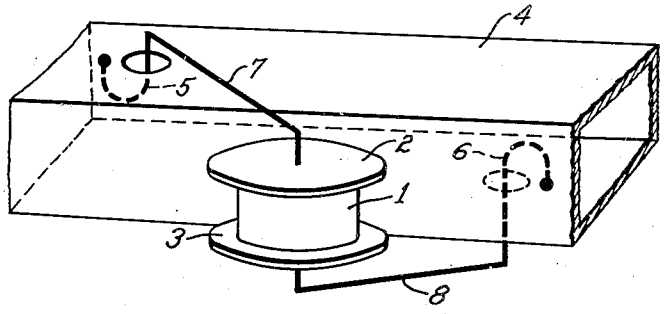
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APPARATUS FOR MICROWAVE HEATING OF DIELECTRIC MATERIALS

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WITNESSES:

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APPARATUS FOR MICROWAVE HEATING OF DIELECTRIC MATERIALS

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1

This invention relates to microwave heating, and has particular relation to apparatus for heating dielectric material with electric energy at frequencies in the microwave region. In heating dielectric material with conventional high-frequency apparatus, difficulty is encountered in providing a sufficiently fast heating rate. It has been suggested that heating might be accomplished at a very rapid rate with the use of electric energy at microwave frequencies. Difficulty is encountered in such an arrangement in providing a uniform field to give uniform heating because of uneven field distribution in a hollow body resonator.

It is, accordingly, an object of my invention to provide new and improved apparatus for heating a dielectric material.

Another object of my invention is to provide novel apparatus for heating a dielectric material with electric energy at microwave frequencies.

Still another object of my invention is to provide novel apparatus for heating a dielectric material uniformly and rapidly with electric energy at frequencies at the microwave region.

In accordance with my invention, the dielectric material is to be placed between a pair of electrodes which are coupled to a hollow body resonator, or wave guide, to receive energy therefrom. By this arrangement, uniform and rapid heating may be accomplished.

The features of my invention which are believed to be novel are set forth with more particularity in the accompanying claims. The invention itself, together with additonal objects and advantages thereof, may be better understood from the following description of a specific embodiment, when read in connection with the accompanying drawing, in which the single figure is a diagrammatic illustration of a preferred embodiment of my invention.

As shown in the drawing, a dielectric material 1 is positioned between a pair of spaced electrodes 2 and 3. The electrodes 2 and 3 are coupled to a hollow body 4 adapted to have high-frequency electromagnetic oscillations established therein. The hollow body 4 may be a suitable wave guide, or cavity resonator, into which energy is introduced from any suitable high-frequency source.

The electrodes 2 and 3 form energy-transferring means to transfer energy from the hollow body 4 to the material 1. The electrodes are coupled to the guide at spacially and electrically spaced points, preferably by means of suitable coupling loops 5 and 6. The points of coupling are electrically spaced by n half-wave lengths of

2

the oscillations for which the body is designed, where n is a whole number, preferably by one-half wave length. With such spacing, it is evident that the maximum difference is obtained between the two coupling points. Thus, with maximum current in the coupling loop 5 at any particular instant, there is also a maximum current of opposite polarity at the coupling loop 6.

The electrode 2 is connected to the coupling loop 5 by a conductive lead 7, while electrode 3 is connected to coupling loop 6 by a conductive lead 8. These leads 7 and 8 are preferably an odd quarter wave length long. Consequently, with a maximum current at the coupling loops 5 and 6, maximum voltage difference appears between electrodes 2 and 3.

It is then apparent that an alternating voltage of high frequency appears between electrodes 2 and 3. As a result, a high-frequency electric field is established between these electrodes for heating the material.

Although I have shown and described a preferred embodiment of my invention, I am aware that many modifications thereof may be made without departing from the spirit of the invention. I do not intend therefore to limit my invention to the specific embodiment disclosed since I have also disclosed a manner of taking energy from a wave-guide in which the energy is introduced and is conducted, the energy being withdrawn through the coaction of two points spaced along the wave-guide.

I claim as my invention:

1. Apparatus for use in heating a dielectric material comprising, in combination, a hollow body adapted to have high-frequency electromagnetic oscillations established therein, a pair of spaced electrodes externally of said hollow body and positioned to receive the material therebetween, coupling devices at a plurality of spacially and electrically spaced points of said hollow body for taking electrical energy from said hollow body, and conductor means from said coupling devices to said electrodes for delivering said energy to said electrodes.

2. Apparatus as set forth in claim 1 wherein said points are electrically spaced by a multiple of one half wave length of the oscillation for which the body is designed.

3. Apparatus as set forth in claim 1 wherein said conductor means comprises a separate conductive lead for each electrode having a length approximately equal to an odd number of quarter wave lengths of the oscillation for which said hollow body is designed.

4. Apparatus for heating a dielectric material comprising, in combination, a hollow envelope comprising a wave-guide adapted to have high-frequency electromagnetic oscillatory wave energy introduced therein and to conduct such energy therealong, a pair of spaced electrodes externally of said envelope and positioned to receive the material therebetween for heat-treatment, means electrically coupling said electrodes to said wave-guide, comprising coupling devices at spacially and electrically spaced points of said wave-guide, adapted to be excited by said energy, and comprising conductors from said coupling devices to said spaced electrodes, whereby to establish a field between the electrodes to heat the material.

5. Apparatus as set forth in claim 4, but characterized further by said points being located along said wave-guide so as to be electrically spaced by a multiple of one-half wave length of the oscillations of said wave.

6. Apparatus as set forth in claim 5, but characterized further by said coupling devices comprising magnetic loop couplers, and said conductors having a length approximately equal to an odd number of quarter-wave lengths of the oscillations of said energy.

7. Apparatus for high-frequency heating of material, comprising, in combination, a hollow envelope comprising a wave-guide adapted to have high-frequency electromagnetic oscillatory wave energy established therein, and to conduct such energy therealong, energy-transferring means externally of said envelope for delivering electrical energy to said material, energy-absorbing coupling devices at spacially and electrically spaced points of said wave-guide, for taking

energy from said wave-guide, conductor means extending from said coupling devices to said energy-transferring means for conducting the energy taken from the wave-guide by said coupling devices to said energy-transferring means.

8. Apparatus as set forth in claim 7, but characterized further by said coupling devices comprising magnetic loop couplers, and said conductor means comprising conductors, each having a length approximately equal to an odd number of quarter-wave lengths of the oscillations of said energy.

9. Apparatus as set forth in claim 7, but characterized further by said points being located along said wave-guide so as to be electrically spaced by a multiple of one-half wave length of the oscillations of said wave.

10. Apparatus as set forth in claim 9, but characterized further by said coupling devices comprising magnetic loop couplers, and said conductor means comprising conductors, each having a length approximately equal to an odd number of quarter-wave lengths of the oscillations of said energy.

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