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BATCH DIELECTRIC HEATING

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Fig. 1.

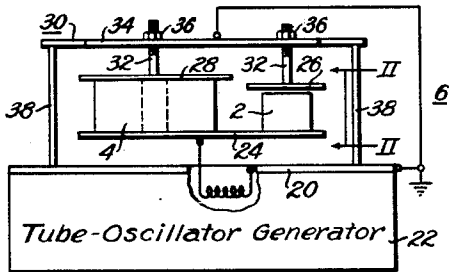


Fig. 2.

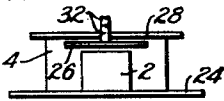


Fig. 3.

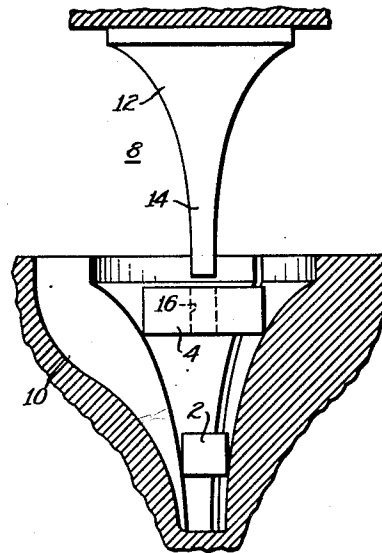
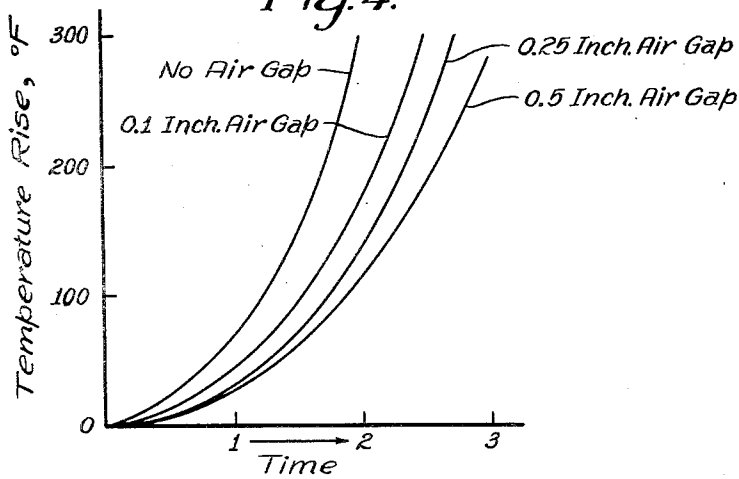


Fig. 4.



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BATCH DIELECTRIC HEATING

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My invention is directed to means and methods for making a molded product from two or more semi-finished pieces which are first given a preliminary heat treatment with dielectric heating equipment.

In some industries, such as for example, in the plastic and rubber fields, a single product is produced from a plurality of pretreated compacts having different sizes, shapes, or other distinguishing physical or chemical characteristics. Such compacts are more commonly known as preforms and a common resinous variety comprises, for example, phenol formaldehyde or urea-aldehyde. A single molding operation on the preforms, under pressure, sometimes with and sometimes without additional heat, is usually sufficient to produce the finished article provided that the preforms have been brought to a proper condition just before the final molding. Generally, the treatment involves bringing the whole of a preform to some uniform temperature which is noticeably above room temperature. Dielectric heating is exceptionally suitable for the treatment because of the rapidity and uniformity with which the preform can be conditioned. However, it is extremely difficult to use a single pair of oppositely charged heating electrodes for simultaneously dielectrically heating a plurality of preforms of different characteristics, especially if the dielectric heating takes place inside a cage provided on the top of a high-frequency tube-oscillator generator, or even in a separate cage or other equipment.

It is an object of my invention to provide a method for making articles of a type described.

It is also an object of my invention to raise the temperature of two or more preforms of different characteristics by substantially the same amount in substantially the same time. Coincident with this object, it is a particular purpose of my invention to simultaneously heat-treat such preforms so that they will be softened to the same extent at the same time.

It is another object of my invention to provide a single apparatus for simultaneously dielectrically heating substances having characteristics which would tend to cause the substances to heat differently when placed together between the same pair of dielectric heating electrodes.

It is a more particular object of my invention to provide a single high-frequency heating equipment which can, in a single operation, raise the temperature of two materials or substances of different characteristics to the same extent.

Other objects, features and innovations of my

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invention will be discernible from the following description of a preferred embodiment. The description is to be taken in conjunction with the accompanying drawing, in which:

5 Figure 1 is a schematic elevational view of the dielectric heating equipment having two preforms, of different characteristics, in heat treating position;

Fig. 2 is a partial sectional view along the lines II—II of Fig. 1;

10 Fig. 3 is a vertical sectional view of a molding equipment for molding preforms dielectrically heat-treated in the equipment indicated in Figs. 1 and 2, and

15 Fig. 4 is a graph for explaining operations in accordance with my invention.

In the drawing, I have illustrated a very specific form of my invention, but it is to be understood that my invention is not limited thereto. This specific form of invention comprises a plurality of separate preforms 2 and 4 which are to be pre-treated in a dielectric heating equipment, indicated in its entirety by the reference numeral 6, prior to being molded in a molding equipment, indicated in its entirety by the reference character 8. Preferably, the preforms 2 and 4 are placed in the molding equipment 8 and molded immediately after receiving the preliminary treatment requiring the dielectric heating equipment 6.

20 The molding equipment comprises a stationary lower female mold member 10 and the downwardly movable upper male mold member 12. The lower mold member 10 can be considered as tapered or converging downwardly; and the upper mold member 12 can be considered as tapering downwardly and converging to an almost cylindrical nose 14 at its lower end.

25 The molding equipment illustrated is for making a washing machine agitator having relatively thin radial blades. For molding agitators of this kind, it is desirable to place a treated preform in the narrow or lower part of the lower molding member 10 and a larger treated preform in the upper part, with both preforms resting in the mold cavity. Accordingly, in Fig. 3, the upper treated preform 4 is larger in diameter than the lower treated preform 2, and is provided with an enlarged hole 16 through which the nose 14 of the upper mold member can pass when it moves into the mold cavity.

30 For convenient and satisfactory operation, the preforms are frequently of the same composition and are cylindrical. However, for the described application the preform 2 is not only of lesser

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diameter than the preform 4 but also of lesser height. The difference in height makes it difficult to use a single pair of relatively insulated heating electrodes directly connected to a single source of high-frequency power, for simultaneously heating both of the preforms to the same temperature or condition, and especially in the same time. Obviously, other physical and mechanical characteristics of the preforms could introduce similar difficulties. For example, radical differences in the loss factors of preforms would ordinarily cause one to heat much more rapidly than the other if both were placed in the same electric field such as is present between a single pair of heating electrodes.

In accordance with my invention, I simultaneously treat the different preforms with equipment schematically indicated in Figs. 1 and 2. A table 20 is provided which may, if desired, be the top of a high-frequency generator indicated as a tube-oscillator 22. The table may insulatedly carry a horizontally disposed, planar or flat, rectangular heating electrode 24. Two other heating electrodes 26 and 28 are provided of the same general shape as the insulated heating electrode 24; and a frame 30 supports them horizontally above the heating electrode 24. The heating electrodes 26 and 28 are generally in side-by-side, or edgewise, relation but spaced slightly from each other and not necessarily in the same plane. The combined area of the heating electrodes 26 and 28 is less than the area of the heating electrode 24; and the contour of the latter encompasses the contours of the former as projected thereon.

The metallic frame 30 carries the heating electrodes 26 and 28 so that each can be vertically adjusted. To this end, adjusting means is indicated as comprising metallic screws 32 fastened to the electrodes 26 and 28, and passing through holes in a common support member for electrodes 26 and 28, the support member being in the form of a bar 34 of the framework. These screws receive positioning nuts 36 for individually raising and lowering the electrodes.

The frame 30 raisably rests on uprights 38 carried by the table 20, so that the frame, together with the electrodes 26 and 28, can be repeatedly raised and lowered for successively treating groups of preforms. Positioning means can be provided so that the frame will assume the same operating position whenever it rests on the uprights. Once the distances of the heating electrodes 26 and 28 above the heating electrode 24 are adjusted, the spacings will be same, for practical purposes, for each treating operation.

The tube-oscillator generator 22 is connected across the insulated heating electrode 24 on the one hand, and the heating electrodes 26 and 28 on the other hand. Preferably, an insulated output terminal of the generator is directly connected to the insulated heating electrode 24 and the other output terminal of the generator is grounded, as are the heating electrodes 26 and 28. Consequently, the heating electrodes 26 and 28 are conductively connected together, and each cooperates with the heating electrode 24 to provide a high-frequency electric heating field therebetween. For dielectric heating, frequencies measurable in megacycles are customarily used. Because single input connections are across the electrodes, the voltage across the electrodes 26 and 24, in general, will be the same as that across the electrodes 24 and 26. However, if the spacings between these sets of relatively insulated electrodes are different, the field gradients will be different.

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By means of the equipment described, the preforms 2 and 4, of different characteristics, can be treated under controlled conditions. For example, they can be simultaneously heated to the same temperature, or can be brought to treated condition at substantially the same moment, or both. This facilitates quickly placing the required preforms in molding equipment in proper condition for undelayed molding.

In operation, the preform which requires the longest heating or treatment, say the preform 4, is placed between a pair of relatively insulated heating electrodes, say 24 and 28. The time to bring this preform to its treated condition can be ascertained. The other preform 2 is placed between the other set of relatively insulated heating electrodes 24 and 26. If the time for treating this preform 2 while the electrodes 24 and 26 are directly at its top and bottom surfaces is not the same as that for treating the preform 4, in other words, the treating time is less, the treating time can be controlled or equalized by introducing an air gap between the heating electrode 26 and the top surface of the preform 2.

The effect of providing a variable air gap will be better understood with the reference to Fig. 4. The abscissae represent units of time and the ordinates represent the rise in temperature, in degrees Fahrenheit, of a preform as it is dielectrically heated between variably-spaced heating electrodes, the preform being originally at ordinary room temperature. Suppose a preform is to be raised in temperature 200° F. by means of a high-frequency electric field having no air gap between the preform and the heating electrodes. According to Fig. 4, this could be done in about 1.7 units of time. If an air gap of .1 inch is introduced between the top of the preform and the upper heating electrode, such as the heating electrode 26, the treating time is increased to about 2.2 time units. With increasing air gaps, the time for properly treating this same preform until its temperature is raised 200° F. is progressively increased. Accordingly, assuming Fig. 4 applicable, should the larger preform 4, which must be heated for the longer time, require about 2½ units of time to increase its temperature by an amount of 200° F., then the equipment should be adjusted so that the air gap above the preform 2 is about .4 inch in order for its temperature to increase to the same extent in the same time.

A family of curves such as shown in Fig. 4 can obviously be obtained for each preform that is to be treated in the dielectric heating equipment indicated schematically in Figs. 1 and 2. Such curves permit the most expeditious way of treating the preforms to be scientifically ascertained. However, it is obvious that ordinary experimentation of the "cut and try" type can yield the same results. Obviously, if the heating temperatures are substantially alike, the ordinates of Fig. 4 may represent final temperatures instead of rises in temperature. Similar curves can be obtained for other equipment based on the teachings of my invention since obviously the electrodes need not be of the same shape, but can be of different shapes and sizes.

While I have described my invention in a preferred practical application, it is obvious that its teachings are subject to more general application and that the equipment is subject to wide modifications which embody the principles and teachings disclosed herein.

I claim as my invention:

1. Dielectric heating equipment comprising, a

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plurality of substantially edgewise spaced, upper heating electrodes, a relatively insulated, flat lower heating electrode, means for conductively connecting the electrodes of said plurality of upper heating electrodes, supporting means for supporting said plurality of upper heating electrodes at a distance from a face of said insulated heating electrode for providing a work-receiving space between each of said plurality of upper heating electrodes and said insulated heating electrode, said supporting means comprising a common support member for said plurality of upper heating electrodes, said support member being movable with said plurality of upper heating electrodes carried thereby in a direction from said lower heating electrode so as to provide greater accessibility to said work-receiving spaces, and individual adjusting means carried by said support member for separately adjusting said distance between each of said upper heating electrodes and said insulated lower electrode.

2. For the simultaneous dielectric heat treatment of a plurality of workpieces, the combination of, at least a first heating electrode, a second heating electrode and a third heating electrode, said second and third heating electrodes being at substantially the same electrical potential, the second and third heating electrodes being commonly positioned in the same direction away from the first heating electrode and respectively in a cooperative heating relationship to the first heating electrode, means for individually preadjusting the relative spacing between said second and first heating electrodes, and means for individually preadjusting the relative spacing between said third and first heating electrodes.

3. For use in the simultaneous dielectric heating of at least a first and second workpiece, the combination of at least a first conductive surface

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having a first electrical potential, and a second and a third conductive surface having a second electrical potential, said second conductive surface being positioned with respect to said first conductive surface to accommodate said first workpiece, said third conductive surface being positioned respecting said first conductive surface to accommodate said second workpiece, said second and third conductive surfaces being commonly positioned in the same direction away from the first conductive surface, means for independently preadjusting the relative position of said second conductive surface with respect to said first conductive surface, and means for independently preadjusting the relative position of said third conductive surface with respect to said first conductive surface.

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