

June 10, 1958

J. W. MANN ET AL
CONTINUOUS IMMERSION HIGH FREQUENCY HEATING
APPARATUS AND PROCESS
Original Filed April 2, 1951

2,833,640

FIG. 1

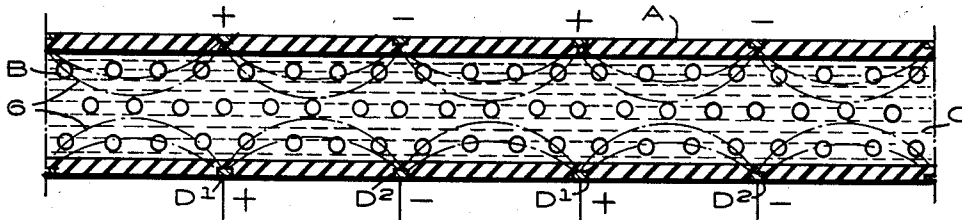
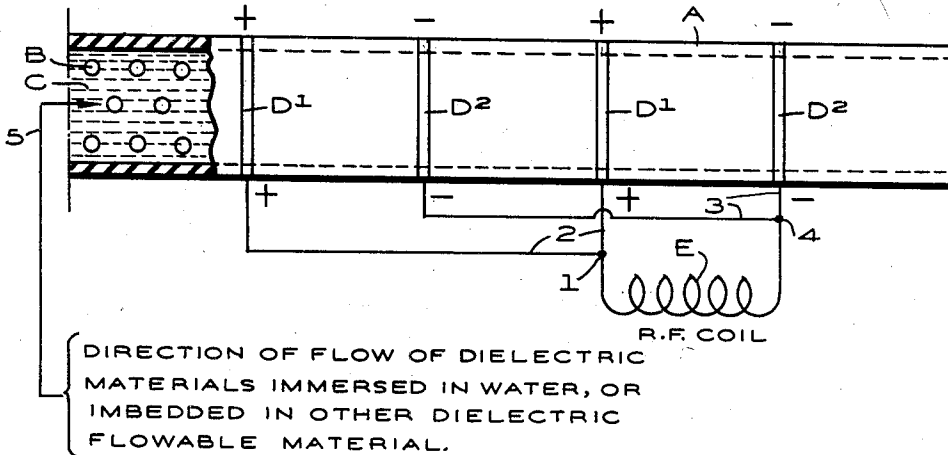


FIG. 2

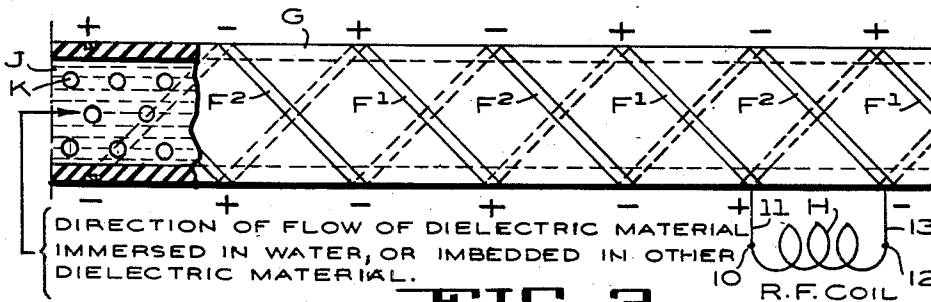


FIG. 3

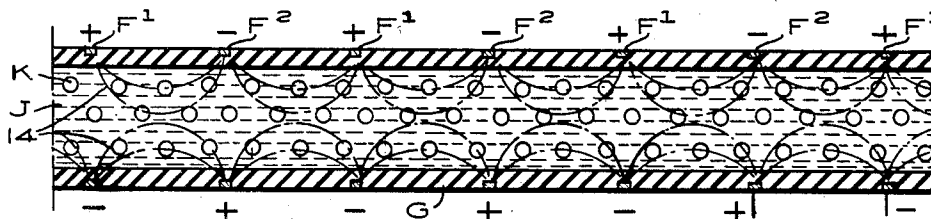


FIG. 4

INVENTORS
JULIUS W. MANN
GEORGE F. RUSSELL
By *Munn & Liddy*
ATTORNEYS

1

2,838,640

CONTINUOUS IMMERSION HIGH FREQUENCY HEATING APPARATUS AND PROCESS

Julius W. Mann and George F. Russell, Tacoma, Wash.

Original application April 2, 1951, Serial No. 218,798, now Patent No. 2,761,940, dated September 4, 1956. Divided and this application July 2, 1956, Serial No. 595,449

2 Claims. (Cl. 219—10.41)

The present invention relates to improvements in a continuous immersion high frequency heating apparatus and process. It consists of the combinations, constructions, and arrangement of parts, as hereinafter described and claimed.

This application is a division of our case on an Immersion High Frequency Heating Method, Serial No. 218,798, filed April 2, 1951, now Patent No. 2,761,940. In the parent application just mentioned, we set forth that in the heating of certain dielectrics by a high frequency electric field of force, much damage to material is caused by arcing where a high electrostatic strain exists and/or where the material being heated is of non-uniform thickness, density, size, etc. Claims were drawn to dielectrics to be heated, as being immersed in a liquid dielectric and the liquid dielectric in turn was placed between electrodes which were alternately charged positively and then negatively by a source of high frequency energy such as a vacuum tube electronic generator. The frequencies employed vary from one million to two hundred million cycles per second, the usual range being under thirty million cycles when large masses of material are heated.

The invention in the parent application as well as the present case, is directed to the heating of foods, such as peanuts; the blanching of vegetables, such as carrots; or the heat treating of apples, turnips, etc. When peanuts are placed between electrodes across which a high frequency electric field of force is maintained, there is an extreme tendency for arcing to take place between the electrodes and the dielectric, with the consequent burning of the product. In like manner, when vegetables are blanched with or without an air gap between the vegetables and the electrodes, arcing will generally take place with the resulting ruination of the product. Arcing is therefore a deterrent to rapid blanching. Foods having a high sugar content, such as prunes, raisins and fruits, are particularly subject to heavy arcing tendencies. We have set forth by way of example only a few of the many possible illustrations which could be given.

The principal object of our invention is to heat treat solid dielectric material in the high frequency field while they are immersed in a liquid or flowable dielectric and are suspended in the dielectric as they pass between electrodes so that the arc would have to pass through the liquid or flowable dielectric before it could reach the materials. Two ways for accomplishing this have been disclosed in the parent case.

The present divisional case discloses two additional ways. In our patent on split pole parallel bonding process, Patent No. 2,678,897, issued May 18, 1954, we disclose the fundamentals of applying a high frequency electric field of force to an adhesive line or plane so that the dominant field lines of force parallel the two opposed parallel edges of the said adhesive plane rather than extend across it as disclosed in our patent on radio frequency parallel bonding, Patent No. 2,434,573, issued January 13, 1948. We can use the same principle of split pole high fre-

2

quency heating in the present case for the heat treating of the solid dielectric.

Electrodes of the same instantaneous polarity are placed between electrodes of an opposite instantaneous polarity and arranged along the same side of a liquid or flowable dielectric in which the solid dielectric to be heat treated, is immersed. The result will be the creation of a high frequency electric field of force flowing between oppositely charged electrodes and since the electrodes are preferably arranged along the side of the liquid or flowable dielectric, the dominant field lines of force will parallel the path taken by the flowing dielectric. Therefore, the solid dielectrics immersed in the flowing dielectric will be heat treated.

Different liquids have different specific heats and specific inductive capacities. It has been found desirable to vary the type of liquid dielectric used as the agent which surrounds the solid dielectrics to be heated in order to secure varying heating results from the high frequency field of force in the heated solid dielectrics. Varying the relationship between the specific heats and/or the specific inductive capacity of the liquid dielectric and the solid dielectrics which it surrounds, creates a condition whereby a greater or lesser proportion of high frequency heat effect may be concentrated in the solids being heated. The liquid dielectric between the electrodes of the high frequency generator will be heated in proportion to its specific heat and dielectric loss factor by the high frequency field of force which is employed primarily to heat the solid immersed within it. This is desirable in many cases since the interior of the solid dielectric material will be heated by the effect of the high frequency field of force to a greater degree than will its surface. Reference is made to our patent on a method of heating the interior of plastic preforms, Patent No. 2,642,627, issued June 23, 1953; and our patent on a process of controlling and placing of radio frequency heat in a dielectric, Patent No. 2,599,850, issued June 10, 1952.

It is possible to raise the temperature of the liquid dielectric by external means in addition to that caused by the heating effects of the high frequency electric field of force. This is highly desirable in many cases as for example, the purpose of balancing the natural non-uniform higher internal heat distribution resulting from the sole use of high frequency heating, by the application of external heat to the solid dielectric from its surfaces inwardly due to the elevated temperature of the surrounding liquid dielectric.

For purposes of this specification, the bacteria or germs in a liquid suspension will be regarded as the solid portion of the intermixture of solids and liquids. In other words, the solid dielectrics in a liquid may comprise the bacteria or germs in that liquid or micro-organisms therein. Enzymes could be considered as solid dielectrics. Certain types of liquids are capable of ionization and such liquids may be pasteurized by radio frequency lines of force passing therethrough. Where purification by radio frequency pasteurization is desired, the term solid dielectrics may be anything carried by the liquid.

Other objects and advantages will appear as the specification proceeds. The novel features will be set forth in the claims hereunto appended.

Drawing

For a better understanding of the invention, reference should be had to the accompanying drawing, forming part of this application, in which:

Figure 1 is a diagrammatic view in which the dielectric to be heated is immersed in a liquid or flowable dielectric that is caused to flow past oppositely charged ring-shaped electrodes so arranged that the radio frequency dominant

lines of force will pass into and parallel the path taken by the flowing dielectric;

Figure 2 is a longitudinal section of the tubular member illustrated in Figure 1, and indicates the path taken by the radio frequency dominant lines of force as they flow between oppositely charged ring-shaped electrodes;

Figure 3 is a diagrammatic view somewhat the same as Figure 1, but where the oppositely charged electrodes are arranged in the form of helices that extend along the tubular member; and

Figure 4 is a longitudinal section of the tubular member illustrated in Figure 3, and indicates the path taken by the radio frequency dominant lines of force as they flow in the same direction as the liquid dielectric.

While we have shown only the preferred forms of our invention, it should be understood that various changes or modifications may be made within the scope of the appended claims without departing from the spirit and scope of the invention.

Description

In carrying out our process, we illustrate in Figures 1 to 4, inclusive, the arrangement of the electrodes so that the dominant radio frequency lines of force will move through the liquid dielectric in paths that will parallel substantially the wall of the container or tube. Where the dielectric is moved through a tubular member, the dominant radio frequency lines of force will parallel the fluid flow.

Referring to Figure 1, we show a tube A partly in section, through which solid dielectrics B are passed while suspended in a fluid or flowable dielectric C. We mount ring-shaped electrodes D¹ and D² on the tube A and space them apart a predetermined distance. The rings D¹ alternate with the rings D² and any desired number may be used and they may be spaced from each other at any desired distance. The rings D¹ are connected to the left hand end 1 of a radio frequency coil E, by wires 2, while the rings D² are connected to the right hand end 4 of the coil E by wires 3. Figure 2 shows the tube A in section as being made from insulating material.

We have indicated in both Figures 1 and 2, the flow of the fluid dielectric C through the tube in which the solid dielectrics B are suspended. The arrow 5 in Figure 1 shows the direction of fluid and solids flow. We have further indicated in Figure 2, the paths taken by the dominant radio frequency lines of force, see the arcuate dot-dash lines 6 in this figure. It will be seen that the radio frequency lines of force pass between the oppositely charged ring electrodes D¹ and D². Of course the electrodes change their polarity at the same rate as the radio frequency of the inductance coil E. The paths of the dominant radio frequency lines of force will substantially parallel the flow of the liquid dielectric C and the solid dielectrics B through the tube A.

Although the paths taken by the dominant high frequency field lines of force extend parallel to the flow of the dielectrics B and C through the tube A and between the ring electrodes D¹ and D² when energized, the area covered by these field lines of force will equal the cross sectional area occupied by the two dielectrics; or, in other words, will equal the cross sectional area of the tube interior. The radio frequency generator used, not shown, of which the induction coil E is a part, is preferably the one disclosed and claimed in our patent on a single standing wave radio circuit, No. 2,506,158, issued May 2, 1950.

The novel arrangement of the ring-shaped electrodes D¹ and D² in Figures 1 and 2, results in a greatly reduced radiation of spurious harmonics and signal strength on the fundamental wave. The entire radio frequency field is so confined within the bounds of the tubular member A, that radiation outside of the tube is greatly reduced. Although Figure 2 shows the dominant

radio frequency lines of force as extending apparently between diametrically opposed portions of the same ring, in actual practice, the entire inner surfaces of the rings throughout their circumference will radiate the radio frequency lines of force. The spacing of the ring electrodes D¹ from the electrodes D² can be varied to suit the type of heat concentration desired. Usually the spacing between adjacent electrodes is equal to the inner diameter of the tube A. Other factors which need consideration are the power applied to the electrodes, the speed of travel of the materials B and C in the tube, the types of dielectrics being heated, and other variables.

We have illustrated the instantaneous charges on the electrodes as positive and negative, but it should be understood that this condition would be effected in only one charged state when the ring electrodes of opposite charges as illustrated in Figures 1 and 2, are connected in turn to opposite sides of a double ender source of high frequency alternating current, with the charges as shown, reversed at the next instant. It should be borne in mind that a high frequency source of alternating current using a single ender output may as well be employed. In this event, one set of the charged rings would be grounded and the other set would alternate between positive and negative on alternate instants of radio frequency change. Whatever the source of high frequency energy, therefore, if it is delivered through a single radio frequency hot electrode network or set, working against another set of electrodes acting as ground; or if delivered through dual sets of electrodes, both radio frequency hot and alternately charged with relation to each other or other method of delivery, the principles are essentially the same.

In Figures 3 and 4, we show a slightly different arrangement of electrodes from that illustrated in Figures 1 and 2. We provide the helical-shaped electrodes F¹ and F², and these spiral about the outer surface of a tubular member G. The helical electrodes F¹ and F² are arranged with the coils of one being disposed midway between the coils of the other. The electrode helix F¹ is connected to an end 10 of an induction coil H by means of a wire 11, while the electrode helix F² is connected to the other end 12 of the coil H by a wire 13. The coil H is similar to the coil E shown in Figure 1 and is electrically connected to a radio frequency generator (not shown) in the same manner as explained for coil E.

The helical electrodes F¹ and F² are oppositely charged and the radio frequency current flowing through the coil H will change the polarity of the electrodes as rapidly as the frequency of the radio waves passing through the coils. Figure 4 is a longitudinal section through the tube G and illustrates the spacing of the coils of the helical electrode F¹, midway between the coils of the helical electrode F². The fluid or flowable dielectric J is also illustrated as flowing through the tube G and carrying the solid dielectrics K that are immersed therein. The radio frequency lines of force are indicated by the arcuate dot-dash lines 14 in Fig. 4 as flowing between adjacent coils of the two helical electrodes F¹ and F², and the path of flow parallels the flow of the two dielectrics J and K through the tube G. The dielectrics J and K will be heat treated in the same manner as explained for the dielectrics B and C in Figures 1 and 2.

It should be understood that the continuous flow process disclosed in Figures 1 to 4 inclusive, will be changed to a batch process for heating solid or liquid dielectrics by merely closing an end of the tubes A or G and standing the members in a vertical position with the open end uppermost. The continuous or batch process is contemplated for either one of the two different forms disclosed.

In the various forms of process illustrated, the liquid dielectric may have a specific heat lower or higher than the specific heat of the solid dielectrics immersed therein. Again, the specific heat of the liquid dielectrics may approximate the specific heat of the solid dielectrics. It is further possible to have the specific inductive capacity

5

of the liquid dielectrics lower than that of the solid dielectrics or approximately the specific inductive capacity of the solid dielectrics.

We claim:

1. The herein described method of heating solid dielectrics by the penetration of radio frequency lines of force which comprises the steps of: immersing solid dielectrics in a liquid dielectric; flowing both dielectrics in a confined path; establishing a radio frequency field having dominant lines of force that move in paths that penetrate the liquid dielectric and extend generally lengthwise of the liquid flow for heat-treating the solid dielectrics through which the lines of force pass, while maintaining the liquid dielectric in surrounding relation to the solid dielectrics to thereby prevent any arcing among the solid dielectrics.

2. An apparatus for heat-treating solid dielectrics by a radio frequency field and comprising: a conduit having a liquid dielectric disposed therein and flowable there-through; said liquid dielectric constituting a carrier medium for solid dielectrics; and means operable to estab-

6

lish a radio frequency field having dominant lines of force that move in paths that penetrate the liquid and solid dielectrics, and extend generally lengthwise of the conduit for heat-treating the solid dielectrics and the liquid dielectric, whereby the solid dielectrics are heated internally by the radio frequency lines of force and are heated externally by contact with the liquid dielectric; the liquid dielectric surrounding the solid dielectrics to prevent any arcing among the solid dielectrics.

References Cited in the file of this patent

UNITED STATES PATENTS

2,397,615	Mittelmann	Apr. 2, 1946
2,415,025	Grell et al.	Jan. 28, 1947
2,492,187	Rusca	Dec. 27, 1949
2,503,779	Story	Apr. 11, 1950
2,508,365	Bierwirth	May 23, 1950

FOREIGN PATENTS

605,589	Great Britain	July 27, 1958
---------	---------------	---------------