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HIGH-FREQUENCY HEATING AND COMPRESSION APPARATUS

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Fig. 1.

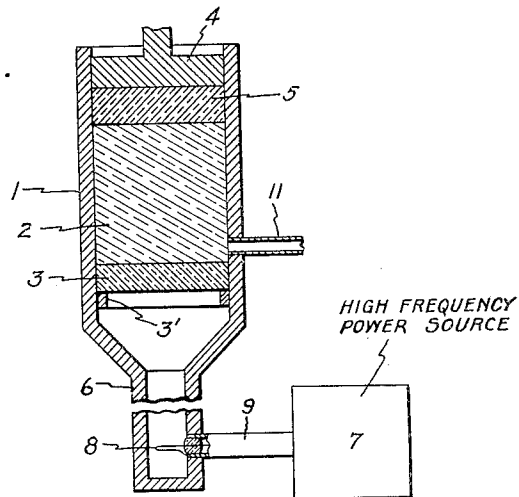


Fig. 2.

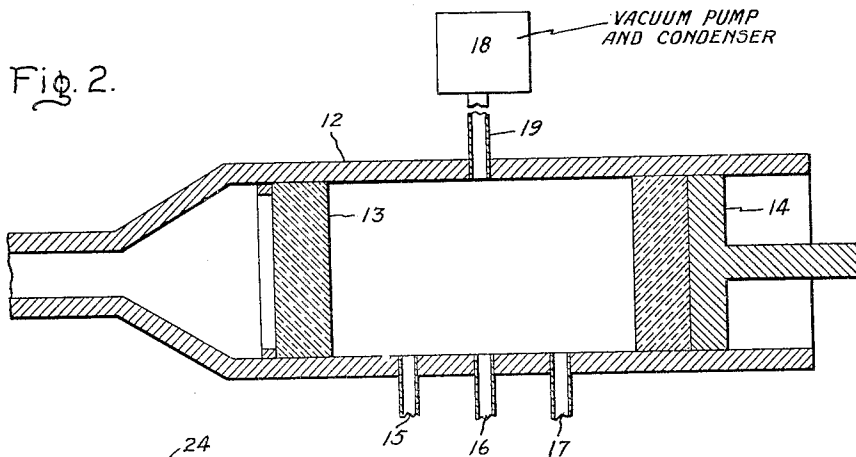
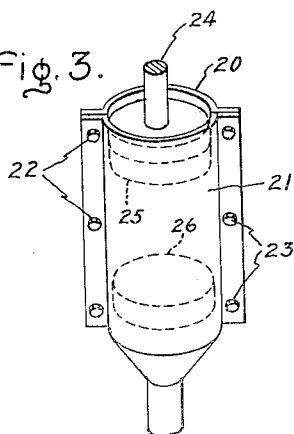


Fig. 3.



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HIGH-FREQUENCY HEATING AND
COMPRESSION APPARATUSEarl C. Hanson, Cleveland, Ohio, and Donald E.
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Our invention relates to high frequency electric heating and compression apparatus, more particularly to heating apparatus utilizing a resonant or nonresonant chamber in which the material is heated, and has for its object simple and reliable apparatus for heating material under pressure.

In carrying out our invention in one form we provide a chamber having walls formed of an electrically conducting material such as copper and of such size as to be tuned to the frequency of the supply source, in which chamber the material is heated and compressed. Our invention is useful in the heating of dielectric organic and inorganic materials including paper, fabrics, food products, synthetic resins, rubber, etc.

The resonant or nonresonant heating chamber may also constitute a mold in which the heated material is compressed into a desired form. For example, an unvulcanized rubber mixture may be heated to vulcanize it and compressed into a desired form in the chamber.

For a more complete understanding of our invention reference should be had to the accompanying drawing Fig. 1 of which is a sectional view of high frequency heating apparatus embodying our invention; Fig. 2 is a view similar to Fig. 1 showing a modified form of our invention, while Fig. 3 is a view in perspective of a modified form of our invention.

We have shown our invention in Fig. 1 as applied to the heating of a plastic material prior to its injection into a molding machine. In this form of our invention we provide a tubular member 1 made of electrically conducting material such as copper for containing a plastic or synthetic resin material 2 to be heated. A fixed end of the chamber is formed by a partition wall 3 secured in place in the tubular member by a flange 3', the wall 3 being made of a suitable dielectric material having a low power factor as compared with the plastic material 2 such as low power factor glass. The opposite end of the heating chamber is formed by a plunger 4 made of copper to which is secured a facing plate 5 made of low power factor glass or other low power loss material, the plunger 4 and plate 5 fitting slidably in the tubular member 1 and being movable therein by suitable means not shown to compress the material 2.

The plates 3 and 5 serve to position the material 2 in the chamber 1 relative to the end walls of the chamber for effective heating by the electric and magnetic fields in the chamber.

Electric power at a suitable high frequency is

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supplied to the chamber 1 by means of a tubular wave guide 6 joined with and closing the lower end of the chamber to which in turn high frequency power is supplied from an electronic oscillator supply source 7 by means of a magnetic coupling loop or hairpin device 8. The device 8 is electrically connected to the source 7 by a coaxial line 9. By means of the coupling device 8 high frequency oscillating magnetic and electric fields are set up in the chamber by means of which heat is generated in the material 2. The device 8 is preferably located about one-half wave length from the lower end of the wave guide. It will be observed that the partition 3 forms a space for the power coupling device 8 between the partition and the lower end wall of the chamber.

In order to provide for the propagation of electric waves in the wave guide and chamber and energy oscillation back and forth from electric to magnetic fields at the frequency of the supply source, the diameters of the wave guide and the chamber are selected to have a predetermined relation to the wave length of the supply frequency, i. e., 0.585 wave length or greater. For example, with a frequency of 2000 megacycles and wave length of 15 centimeters the inside diameter of the wave guide 6 is at least 8.775 centimeters while the diameter of the chamber 1 is much greater in order to contain the desired amount of material 2.

In the operation of the heater of Fig. 1 the plastic material 2 is put into the chamber 1 after first removing the plunger 4 and plate 5. The plunger and plate are then inserted and a suitable pressure applied. When the plastic material is heated to the desired extent it becomes liquid enough to flow out of the spout 11 which feeds the material, for example to a molding machine, not shown. The movement of the plunger may decrease the rate of heating and if desired the frequency of the supply source can be changed to restore generation of heat.

In Fig. 2 we have shown a modified form of our invention for use in the processing of food products by combined heat and pressure. This heating apparatus comprises a cylindrical member 12 forming a resonant or nonresonant heating chamber with a fixed low-loss glass wall or other low-loss material 13 at one end and a plunger 14 in the other end, these parts being similar in construction to the corresponding parts of Fig. 1 and power coupling means being provided between the wall 13 and the left-hand end of the chamber as shown in Fig. 1. A plu-

ality of apertures 15, 16, and 17 are provided in the lower wall of the chamber for the escape of liquids pressed out of the food products in the chamber.

In the operation of this form of our invention the plunger 14 is moved inward by the application of a predetermined force thereto while the food products in the chamber are heated to a predetermined temperature and maintained at that temperature to facilitate the compression of the products and their drying. Vapors given off by the products may be removed by a vacuum pump and condenser 18 connected to the chamber by a pipe 19.

We contemplate that by means of the apparatus disclosed in Fig. 2 compressed and dehydrated food pellets may be made. Also juices and oils may be extracted from the compressed products such as grapes, sugar beets, oranges, cotton seeds, peanuts, fish, etc.

In the modified form of our invention shown in Fig. 3 a heating chamber similar to that disclosed in Fig. 1 is provided but adapted to form a compression mold for forming articles from various materials such as thermal setting synthetic resins and for vulcanizing and forming rubber articles. In this case the heating chamber is formed in at least two parts which can be separated to remove the formed and heat treated article. As shown, the heating chamber is formed by two semi-cylindrical parts 20 and 21 suitably detachably secured together as by bolts 22 and 23, although preferably quickly detachable means is provided for securing the parts together.

In the form of Fig. 3, as in the form of Figs. 1 and 2, the plunger 24 is depressed as the material in the chamber is heated and cured. After the completion of the heat treating and forming operation the chamber is opened by separating the parts 20 and 21 for the removal of the molded and cured article. It will be understood that the internal configuration of the parts 20 and 21 and of the low-loss glass (or other low-loss material) end parts 25 and 26 is such as to give the desired shape of the molded part. It will be understood that power coupling means as shown in Fig. 1 is provided between the wall 26 and the lower end of the chamber.

Obviously, when the heating chamber is filled with material, tuning of the chamber with the supply source will be broad and a resonant condition may not exist.

While we have shown a particular embodiment of our invention it will be understood of course that we do not wish to be limited thereto since many modifications may be made and we therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States, is:

1. High frequency electric heating and compression apparatus comprising an electronic oscillator generator for supplying high frequency power, walls made of electrically conducting material forming a heating and compression chamber closed at one end, power transmission means connecting said generator with said chamber including power coupling means extending through one of said walls into said chamber for producing high frequency oscillating fields in said chamber for the generation of heat in a material to be heated in said chamber, a partition wall of dielectric material extending across said chamber

adjacent said one wall thereby to provide a space for said power coupling means between said partition wall and said one wall, said partition wall being made of a material having a low power factor as compared with the material to be heated, and pressure applying means made of electrically conducting material closing the other end of said chamber operable to compress the material in said chamber.

2. High frequency electric heating and compression apparatus comprising an electronic oscillator generator for supplying high frequency power, walls made of electrically conducting material forming a heating and compression chamber closed at one end by an end wall, power transmission means connecting said generator with said chamber including power coupling means extending through said end wall into said chamber for producing high frequency oscillating fields in said chamber for the generation of heat in a material to be heated in said chamber, a partition wall of dielectric material extending across said chamber adjacent said end wall thereby to provide a space for said power coupling means between said partition wall and said end wall, said partition wall being made of a material having a low power factor as compared with the material to be heated, and a plunger made of electrically conducting material in the other end of said chamber movable to compress the material in said chamber against said partition wall.

3. High frequency electric heating and compression apparatus comprising an electronic oscillator generator for supplying high frequency power, a tubular member of electrically conducting material forming a heating and compression chamber having a diameter at least as great as .585 times the wave length of said generator, an electrically conducting end wall closing one end of said tubular member, power transmission means connecting said generator with said chamber including power coupling means extending through said end wall for producing high frequency oscillating magnetic and electric fields in said chamber for the generation of heat in a material to be heated in said chamber, a partition wall of dielectric material extending across said chamber adjacent said end wall thereby to provide a space for said power coupling means between said partition wall and said end wall, said partition wall being made of a material having a low power factor as compared with the material to be heated, and a plunger made of electrically conducting material closing the other end of said chamber movable to compress the material in said chamber against said partition wall.

4. A combined electric heater and mold for heating and forming dielectric materials comprising an electronic oscillator generator for supplying high frequency power, walls made of electrically conducting material forming a heating and mold chamber closed at one end by an end wall, power transmission means connecting said generator with said chamber including power coupling means extending through said end wall into said chamber for producing high frequency oscillating fields in said chamber for the generation of heat in a dielectric material in said chamber, a partition wall of dielectric material extending across said chamber adjacent said end wall thereby to provide a space for said power coupling means between said partition wall and said end wall, said partition wall being made of a material having a low power factor as compared with the dielectric material to be heated, and a plunger

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er made of electrically conducting material closing the other end of said chamber movable to compress the dielectric material in said chamber against said partition wall thereby to form the material.

5. A combined electric heater and feeding device for plastic dielectric materials comprising an electronic oscillation generator for supplying high frequency power, walls made of electrically conducting material forming a heating and compression chamber closed at one end, power transmission means connecting said generator with said chamber including power coupling means extending through one of said walls into said chamber, a partition wall of dielectric material extending across said chamber adjacent said one wall thereby to provide a space for said power coupling means between said partition wall and said one wall, said partition wall being made of a material having a low power factor as compared with the dielectric material to be heated, pressure applying means made of electrically conducting material closing the other end of said chamber, operable to compress the dielectric material in said chamber, and a spout connected to said chamber through which the heated dielectric material can be forced by said pressure applying means after it has been heated to liquefy it.

6. A combined electric heater and feeding device for plastic dielectric materials comprising an electronic oscillation generator for supplying high frequency power, walls made of electrically conducting material forming a heating chamber closed at one end by an end wall, power transmission means connecting said generator with said chamber including power coupling means extending through said end wall into said chamber, a partition wall of dielectric material extending across said chamber adjacent said end

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5 wall thereby to provide a space for said power coupling means between said partition wall and said end wall, said partition wall being made of a material having a low power factor as compared with the dielectric material to be heated, a plunger made of electrically conducting material closing the other end of said chamber movable to compress the dielectric material in said chamber against said partition wall, and a spout connected to said chamber adjacent said partition wall through which the heated dielectric material can be forced by movement of said plunger after it has been heated to liquefy it.

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