

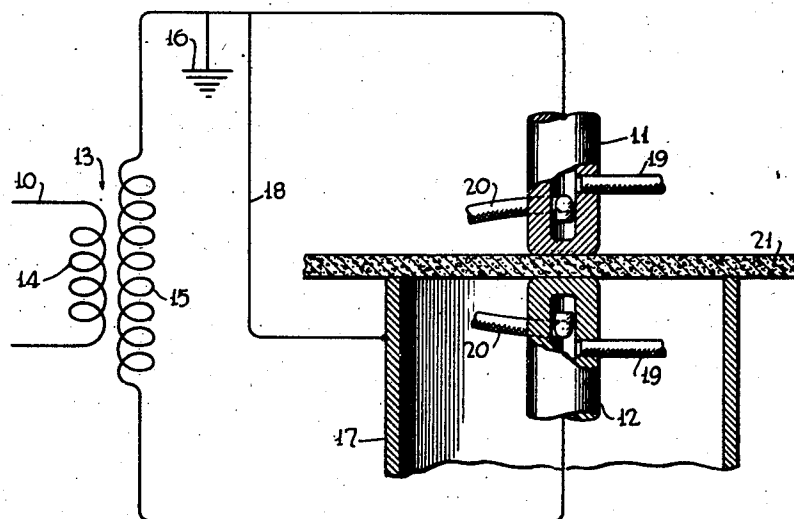
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HEAT TREATMENT OF PLASTICS

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HEAT TREATMENT OF PLASTICS

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1 Claim. (Cl. 18—48)

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This invention relates in general to plastics, and more particularly to means for heat treating a thermo-setting plastic material, so as to fix the form but not to heat-set the material permanently in an infusible state.

In my co-pending application, Serial No. 415,342, filed October 17, 1941, I have described a method and apparatus for heating plastics, so as to make possible a juncture between separate layers of similar material without the interposition of a binder, the described invention having special utility with thermoplastics. In the present application one of the principal objects of the invention is to provide means for heating a thermo-setting plastic, so as to bring about, at will, partial or complete polymerization in the same physical unit. Another object is to provide means for heating a single body of plastic material in such a manner as to cause confinement of heat produced in sections intermediate the surfaces of the material. Still another object is to combine pressure on plastic material with high frequency and high potential voltages in such manner as to utilize the alternating stresses introduced in the material for heating purposes. An important object also is to provide a method for plastic article manufacture in which the parts are first partially polymerized separately and later, on assembly, completely polymerized. Other objects of the invention will appear as the description of the invention proceeds, reference being made to the accompanying drawing, in which the figure illustrates diagrammatically one means of effectuating the objects of the invention.

As shown in the figure a source of high frequency alternating or oscillating voltage 10 is applied to the electrodes 11 and 12 through the transformer 13, having a primary 14, and a secondary 15. The transformer 13 is merely a diagrammatic showing as previously indicated of a device for increasing the potential of the alternating current to values approaching the breakdown potential of the plastic. Such potentials vary, of course, with the plastic employed, breakdown voltages for phenol-formaldehyde compound varying from 400 to 500 volts per-mil for uniform electric field conditions. The frequency of the oscillating voltage should be preferably in ranges exceeding 20 megacycles, though somewhat lower frequencies may be used but ranges in excess of 40 megacycles are particularly pertinent to this invention. The importance of high potential and high frequency appears from the fact that the heating developed in the work is proportional to the volt-ampere rating of the capaci-

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tance between the heating electrodes multiplied with the dielectric loss factor of the material. The volt-ampere rating is directly proportional to the frequency effective in the capacitance between electrodes and to the voltage applied to the electrodes. The loss factor is a material characteristic and is equal to the power factor of the material multiplied by its dielectric constant. Inasmuch as voltage is limited by breakdown, heating of the material can be best increased by increase of frequency.

Because of the high potentials utilized, it has been found desirable to ground one of the electrodes as 11, as indicated at 16 and use is also made of a protective shield 17 consisting of metal drum which surrounds the electrode 12 and is likewise grounded through the connections 18.

Electrodes 11 and 12 are shown as being similarly constructed, each including a flat ended metal member centrally hollowed to receive a cooling fluid. Inlet and outlet pipes 19 and 20 are employed for the transfer of coolant. The purpose of the coolant is to confine the heat induced by the electric field variation to areas within the material surfaces, where desired. By maintaining the surfaces intact during the heating period the later assembly of the parts is facilitated.

The workpiece is indicated by the numeral 21 and is illustrated as a flat plate of plastic which may have been previously molded to retain the shape as in a preform and which is adapted to lie over the protective shield 17 and between the electrodes 11 and 12. Sufficient pressure is applied through the electrodes to insure good electrode thermal contacts and to maintain the surfaces at the electrodes below the fusion temperature. The complete polymerization of the portion of the piece which is not subject to further processing may be accomplished simultaneously. This plastic being of the thermo-setting type may be completely or partially polymerized and the degree of polymerization is determined by the temperature-time relationship and therefore to the amount and rate of energy input at the electrodes. Consequently it appears that on application of electrical energy to the electrodes, the plastic material between these electrodes is subjected to heating stresses of the high frequency alternations to an extent as may be determined by the operator. The surface or surfaces which are to be subsequently processed are kept cool by the cool electrodes while the central or uncooled portion is heated through a polymerization cycle.

The desirability of variation of polymerization

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arises from the fact that in many articles of manufacture it is advantageous that the article be completely polymerized as to the main body thereof, but that particular sections, such as those, for example, related to the points of attachment to similar bodies, be partially polymerized, so that a processing manufacturer to whom the articles are shipped may subsequently, as desired, complete the heating step and thus not only effect a bond between connecting sections as described in my co-pending application hereinabove referred to, but also bring about a full polymerization of the partially polymerized areas and thus obtain a full polymerization of the entire article. It thus appears that the apparatus lends itself particularly to the treatment of a single physical unit or body, so as to produce variable states of polymerization of the single unit, so that the bodies may be fabricated or otherwise assembled into the final unit at different times and utilizing successive heat treatments to fully develop the thermo-setting characteristics of the plastic.

The field of thermo-setting plastics is well known and includes, for example, the synthetic resins such as phenol and urea formaldehyde, phenol furfural and the melamine formaldehydes. Variation in the place or area of polymerization

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may be made by movement of the plastic sheet between the electrodes; however, it is apparent that the same result may be secured by utilizing ordinary mechanical means for shifting the electrodes with reference to stationary plastics; or the electrodes may be enlarged or elongated or formed as long rollers or co-acting roller discs, depending on the type of workpiece or the manufacturing problem involved. Variations in the cooling means may also be made provided equivalent results are obtained.

Other modifications of the invention as described may be apparent to those skilled in the art, the scope of the invention being determined by the claim hereto appended.

What is claimed is:

The method of heat treating a thermo-setting plastic which comprises subjecting different parts of the plastic to alternating electrical stresses of diverse values, the stresses to which one part is subjected being sufficient to produce polymerization of the plastic and the stresses to which another part is subjected being insufficient to produce polymerization whereby separate parts of the plastic are partially and completely polymerized.

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