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DIELECTRIC EMBOSSING
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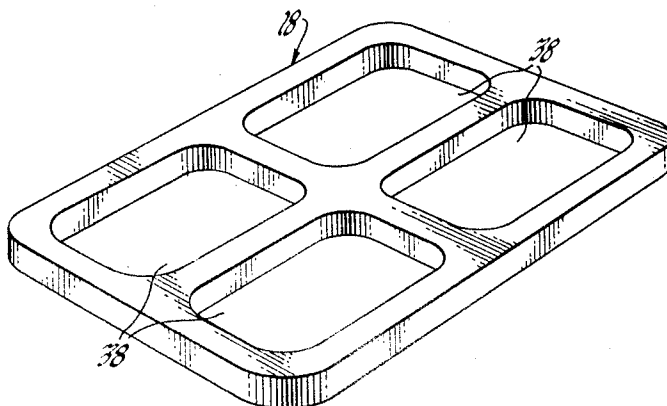
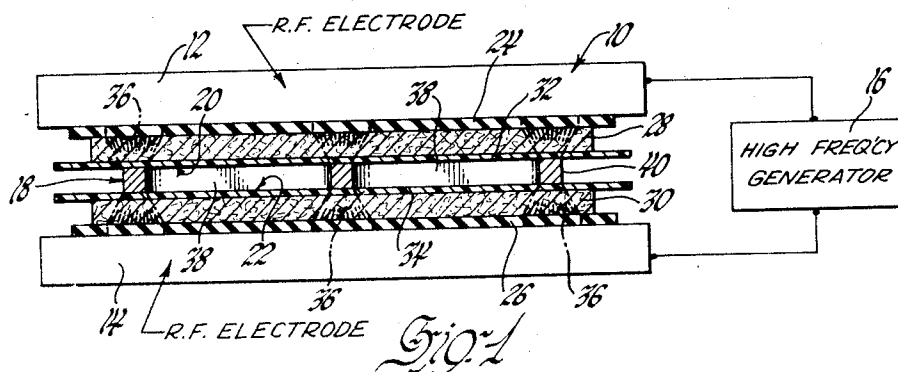


Fig. 2

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DIELECTRIC EMBOSSING

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This invention relates to a method for making and embossing decorative articles and more particularly to a continuous method for making and embossing decorative articles by means of dielectric heating.

Dielectric heating is a selective heating process whereby heat can be developed within an electrical insulating or dielectric material. Since the dielectric material is one which also does not normally conduct any appreciable amount of electrical current, dielectric heating does not result from the resistance of the material to current flow but rather from the frictional heating caused by the forced back and forth rotating movement of the molecules of the material. The force that produces the heating will be uniform throughout the material if the material has a uniform molecular arrangement and if the electrical field strength is uniform.

When the dielectric material is placed in an electrical field such as exists between two plates or electrodes having a voltage impressed across them whereby one of the plates is positive and the other is negative, the molecules of the dielectric material appear to stretch out and elongate themselves so that one end of the molecule has a positive charge which points toward the electrode with the negative charge and the other end of the molecule has a negative charge which points toward the electrode with the positive charge.

If the charge between the plates is reversed so that the positive plate now becomes negative and vice versa, the molecules will rotate to realign themselves. Thus, if an alternating current of radio frequency is impressed across the electrodes, the electrodes will continually change their charge and the molecules of the dielectric material will be forced to rotate back and forth as the electrodes change their charge. As the molecules of the dielectric material rotate back and forth, heat will be developed within the dielectric material, although the electrodes will not become heated except by conduction from the heated dielectric material if they are in contact therewith.

The present invention relates to a unique method and apparatus which permits the simultaneous embossment of a plurality of thermoplastic trim materials with the use of a single die. With the particular embossment process illustrated, the articles to be embossed in general include a foundation board or backing member to which riser material such as foam rubber, felt or paper waste material is bonded and overlying which is a thermoplastic trim material secured to the riser material through the use of any suitable cement.

In the present invention a pair of such prefabricated articles to be embossed are mounted in a way that the trim materials are face to face but interposed between which materials is a floating die member having identical die faces on either side thereof. Thereafter the sandwich of the articles to be embossed along with the floating die member are disposed between the electrodes of a dielectric press whereby a high frequency current is passed be-

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tween the electrodes and at the same time pressure is applied thereby identically embossing both articles.

By the present method of embossing a plurality of articles, essentially twice as many articles may be embossed with the same amount of time and power being expended as was formerly necessary to merely emboss one such article. It is apparent that such a process results in a considerable cost reduction in the manufacture of such articles.

Additionally, it is an object of the present invention to provide a unique embossing process in which the quality of the articles being embossed is greatly enhanced by the double embossing die which results in a further savings in cost due to the lower rate of imperfect part rejections. The improved quality of embossed articles is realized due to the floating die being constructed in a way to reduce the tendency of blistering in the thermoplastic trim materials. To this end, pockets are formed in the die which entrap air and which confined air has its pressure raised during dielectric heating process to counteract internal vapor pressures which otherwise tend to cause blistering.

The details as well as other objects and advantages will be apparent from a perusal of the detailed description which follows.

In the drawings:

Figure 1 shows a dielectric press embodying the subject invention; and

Figure 2 is an isometric view of the floating die.

Referring to the drawings, there is schematically shown a dielectric press 10 having upper and lower platens 12 and 14 connected in series with a high frequency generator 16. Such dielectric presses are, in general, well known and it is unnecessary to specifically show or describe the functioning of the same. It will suffice to note that in general one of the platens, for instance 14, is generally fixed whereas platen 12 is movable, by any satisfactory hydraulic, pneumatic or electric means, toward the fixed platen.

In the past it has been the practice to form an embossing service on one of the platens while supporting the material or article to be embossed upon the other platen and thereafter moving the platens together causing the embossing member to engage one such article to create the desired configuration thereon. In the present instance, platens 12 and 14 are flat having no embossing services formed thereon. In the present apparatus and process the die or embossing member 18 is not fixed or otherwise connected to either of the platens but instead floats therebetween in the manner to be hereinafter considered.

While it is possible to emboss many types of articles by the present process and apparatus, for the purposes of illustration the typical type article or articles to be embossed will be considered. In this instance the unembossed articles 20 and 22 are identical and include backing sheets 24—26 by which is meant to include flexible materials such as fabrics formed of cotton, wool, rayon, glass fibers, synthetic fibers, etc. paper, leather, etc. as well as rigid and semi-rigid materials such as composition board, fiberboard, paper laminates, synthetic sheets and metals. Next, sheeted or pre-formed riser material 28—30 is suitably bonded to the backing sheets 24—26 by any bonding agent which is unaffected by the dielectric heating process involved as well as one which is chemically inert with respect to the materials used in the article to be embossed. The riser material may be of sponge rubber as set forth in copending application Serial No. 538,914 Dusina et al., filed October 6, 1955, and assigned to applicant's assignee. In that case the term "sponge rubber" was meant to specify a soft cellular sponge-like material which exhibits highly resilient prop-

erties and quickly recovers its shape and form when deforming pressure is removed therefrom. Such materials may be formed of natural rubber, various synthetic materials, as for example butyl rubber, the vinyl chloride resins, neoprene, isocyanate resins, etc. and mixtures of natural rubber and/or such synthetic materials. Likewise such riser material may be formed of non-rubberous materials such as a "felt" or paper waste product as described in copending application Serial No. 688,853 Spieles, filed October 8, 1957, and assigned to applicant's assignee. Generically speaking such riser material may be formed of any substance which in general has some resilience and which is capable of taking a permanent set when heat and pressure are applied thereto as will occur during the operation of a dielectric press.

Next trim materials 32-34 are applied to the respective riser pads and bonded thereto by a suitable cement. By trim material it is intended to include such substances such as leather, plastic material, i.e. vinyl chloride, vinylidene chloride and other similar synthetics formed into flexible sheets with finishes simulating leather, woven fabrics, etc., and cloth materials formed of woven fibers of the natural, synthetic and glass type.

As described in the aforementioned copending applications, it is desirable to provide a controlled amount of moisture in the riser material. The moisture serves several functions including facilitating the flow of electricity through the dielectric materials as well as to facilitate and sharpen the embossment by creating a vapor pressure on the trim material not engaged by the floating die 18. In general the range of moisture content is between 2 to 7% by weight of the riser material. It has likewise been found that a moisture content of from 4 to 5% is an optimum value under substantially all operating conditions such as are set forth hereinafter.

While the controlled quantity of moisture may be added directly to the riser material 28-30, it has been found more desirable to combine this function with the provision of the cement which bonds the trim material to the riser material. Accordingly, while substantially any cement or adhesive compatible with the materials of the trim assemblies 20 and 22 may be used, it is preferred to employ a latex-rubber cement in order to simultaneously introduce the desired amount of moisture into the sponge rubber. After extended development work to determine the best method for introducing the moisture, the following procedure was adopted: the back of the trim material 32-34 is spray coated with a 60% solids latex emulsion at the same time that the surface of the riser material 28-30 upon which the trim material is to be assembled is roll coated with a 30% solids latex emulsion. The concentrations of the emulsions are stated in terms of weight percentage. The trim and the riser materials are then assembled.

The next step in the process is to place the floating die member 18 upon the trim material 34 of trim assembly 22 followed by inverting and placing assembly 20 on die 18 so that trim material 32 and 34 are disposed face to face. While it would be possible to utilize a floating die member 18 having different embossing configurations on each of the faces thereof, it is the intent in the subject process to utilize such a die having identically embossed faces. In this way identical pairs of embossed articles may be made during each cycle of the press 10. It is, of course, also possible to construct the die in a manner to produce identically embossed articles except that they may be left and right-handed which, for example, is the case when such process is used to make a set of door panels for an automobile interior trim. For reasons which will be subsequently considered in greater detail, the die member 18 includes a plurality of openings or pockets 38.

The next step in the process is to move the upper or movable platen 12 downwardly toward the lower platen 14 at the same time causing the high frequency generator

16 to pass current through the electrode-platens and dielectric materials to suitably emboss the articles 20 and 22.

It has been found that a very satisfactory embossed pattern is obtained on the articles 20 and 22 by applying a pressure of from about 200 to 800 p.s.i., a pressure of about 500 p.s.i. being suitable in substantially all instances. Embossing pressure serves two functions, that of obtaining adequate bond strength as well as imparting good definition to the embossed design.

The dielectric embossing cycle comprises two phases from the time standpoint, the length of time during which dielectric heating takes place (the heat cycle) and the length of time that pressure is maintained on the embossed assembly after the heating is accomplished (hold or soak time). The thermal efficiency of the dielectric heating process is improved as the heat cycle is decreased since the thermal efficiency is a function of the heat loss per unit of time, loss of heat taking place by conduction through the materials of the trim assembly to the embossing die and flat surfaced electrodes of the press. While it will vary from material to material it has been found in the case of foam rubber, for example, that a heat cycle of from 6 to 60 seconds and a hold time of up to 10 seconds was satisfactory. However, from the standpoint of maximum efficiency, it is preferred to use a heat cycle of from about 12 to 25 seconds, about an 18 second heating cycle being suitable in most instances along with a hold time of 1 to 2 seconds. The peak temperature reached during the heat cycle is from about 275 to 350° F., a temperature of about 325° F. being typical.

While the heat generated within a dielectric material is dependent upon the voltage across the material, varying as a square of the voltage, the limiting factor on the voltage is, of course, the dielectric strength of the materials being embossed as well as the corona discharge effect which causes arcing along the surface of the material. It has been found that a voltage of from 600 to 1200 volts across the trim assembly is satisfactory, the preferred voltage being of about 1,000 volts. Similarly, the higher the frequency used the more the heat developed. The practical range of frequencies used is, however, between 8 and 20 megacycles. With the present arrangement 14 megacycles is preferred. The lines 36 are symbolic of the electric field extant during dielectric heating.

With regard to the floating die 18, particularly as seen in Figure 2, it will be appreciated that the particular configuration or pattern as therein shown is merely illustrative and may assume any shape desired. The die itself may be made of any easily machinable metal which is electrically conductive. While it is preferable that the die material also be thermally conductive this factor is not absolutely necessary. As a practical matter it has been found that a die made of brass is satisfactory in view of its easily machinable character.

While as described in copending application Serial No. 538,914, it is desirable to provide sufficient water within the riser material to create steam because of the better embossment definition realized thereby, such steam, if uncontrolled, also creates the problem of blistering of the trim material. In general the problem of controlling the quantities of steam is determined by limiting the quantity of moisture added by the latex rubber cement, supra. While quantitatively controlling moisture content limits blistering, this control is somewhat imprecise and blistering can nonetheless occur. Trim materials such as genuine leather and the plastics have particular propensities for blistering and/or hardening or drying out under the influence of the internally confined vapor pressures. The blistering will occur only in the unconfined surfaces, e.g. not engaged by die 18, of the trim materials. By constructing the die 18 with pockets or chambers 38, air is trapped therewithin and as the dielectric heating takes place this air is also heated and creates a counterpressure

which acts upon the unconfined trim material surfaces preventing the latter from blistering. In thus constructing the die member 18 in conjunction with the controlled quantity of moisture provided within the riser material, the problem of blistering is substantially entirely eliminated in the present embossing method.

While the precise configuration of the die pockets 38 will in general conform to the desired embossing pattern and will not affect the above described anti-blistering function, it has been found that the smaller the volume of each pocket the more effective is the entrapped air pressure in preventing blistering. Accordingly, the thickness or height 40 of the die 18 should be maintained as small as possible consistent with non-interfering relationship between the respective trim materials on the articles 20 and 22 which project within the pockets 38.

While the precise value of entrapped air pressure is not specified there are certain general observations to be made with respect thereto. First, the air pressure will be less than the die pressure exerted on thermoplastic material 32—34 insuring embossment of the material under the die. Secondly, it is desirable that there be a pressure differential between the air pressure and the vapor pressure within the assemblies 20 and 22. In other words, the vapor pressure should exceed the air pressure sufficiently to insure a good definition of the embossed pattern and yet not be great enough to cause blistering. Again it is possible to establish these general relationships by controlling the size of pockets 38 and the moisture content in assemblies 20 and 22.

It is important to note that pockets 38 are preferably formed completely through die 18 opening into the opposite embossing faces thereof. This construction is less expensive, when identical die faces are desired, in that the die configuration can be formed on both faces during a single cutting operation. This construction also results in a thinner die section and common pockets 38 within which the air pressure will act simultaneously on the thermoplastic trim material 32—34 of assemblies 20 and 22.

An additional advantage of the floating die arrangement resides in the ability of such an arrangement to compensate for limited amounts of misalignment between the platens 12 and 14 or certain misalignments or variations in thickness between the respective assemblies 20 and 22. In other words, if there is a relatively high spot either on a platen or in one of the assemblies when the platens are brought together the die 18, since not fixed, may make an adjustment whereby the pressures exerted by the press 10 tend to be equalized across the surfaces to be embossed.

As already suggested, various applications may be made of the method and apparatus described within the intended

scope of the present invention as set forth in the herein-appended claims.

I claim:

1. In a process for dielectrically embossing articles each of which includes a sheet of porous material containing cement plus moisture and having a thermoplastic trim surface thereon, the steps of mounting a first such article on an electrode with the thermoplastic trim material remote from the electrode, placing a die member on said thermoplastic material, inverting a second such article and placing the same on said die, moving a second electrode into engagement with said second article, applying sufficient pressure to compress said articles against the opposite faces of said die while entrapping a volume of air between the die and the opposed thermoplastic surfaces of said articles, and simultaneously dielectrically heating said articles whereby in each of said articles said thermoplastic material is embossed with the pattern formed on said die.

2. In a process for dielectrically embossing articles each of which includes a sheet of porous material containing cement plus moisture and having a thermoplastic trim surface thereon, the steps of mounting a pair of said articles between electrodes with the thermoplastic trim surfaces in facing relation, interposing a die member having an opening therein between said surfaces, entrapping a volume of air in said die opening between said surfaces, applying sufficient pressure to at least one of said electrodes to compress said articles against the opposite faces of said die, and simultaneously dielectrically heating said articles whereby in each of said articles said thermoplastic material is embossed with the pattern formed on said die.

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