July 4, 1961 MING C. HSU ET AL 2,991,216

METHOD FOR MAKING AND EMBOSSING DECORATIVE ARTICLES

Filed March 26, 1957 2 Sheets-Sheet 1

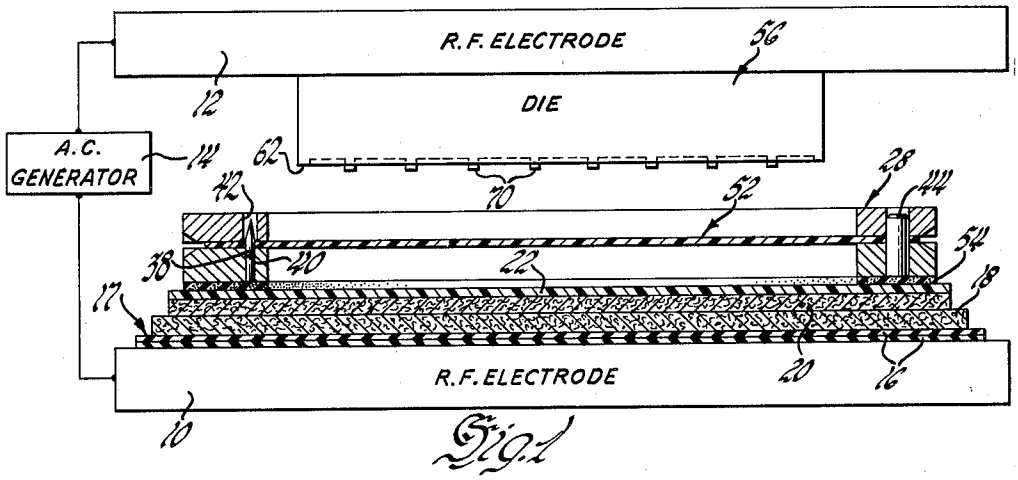


Fig. 1

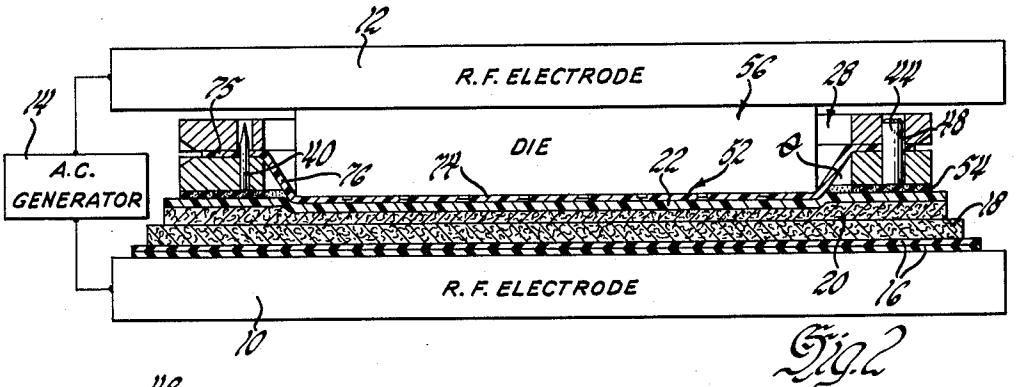


Fig. 2

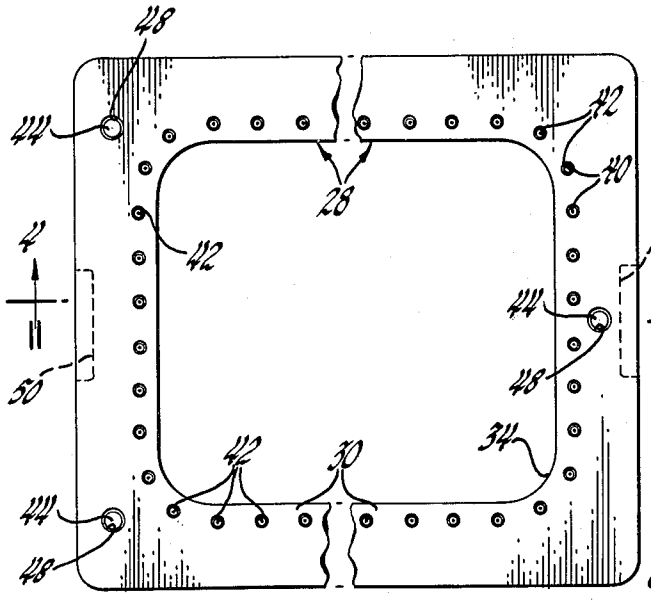


Fig. 3

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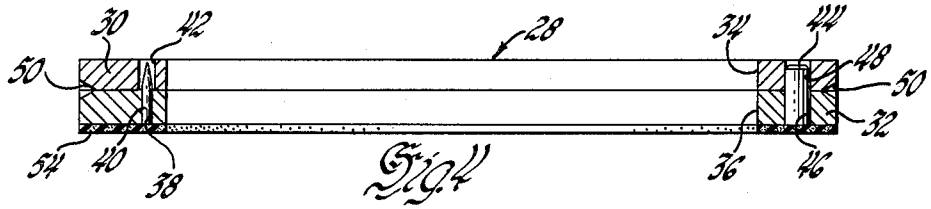


Fig. 4

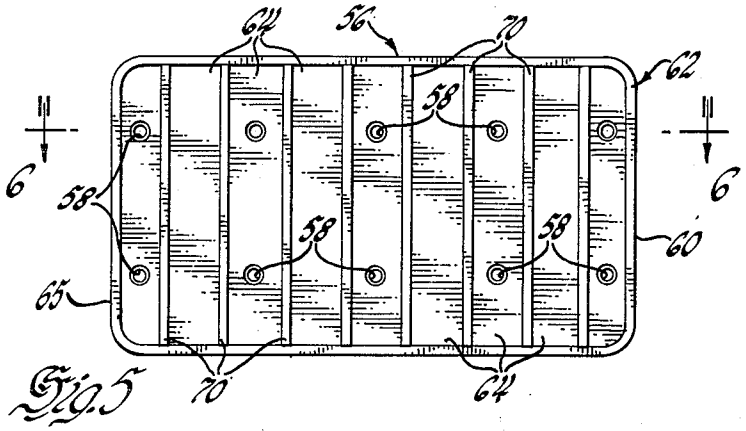


Fig. 5

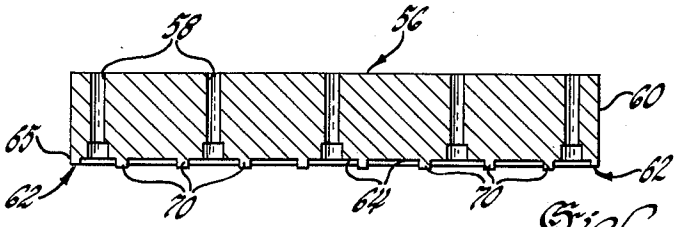


Fig. 6

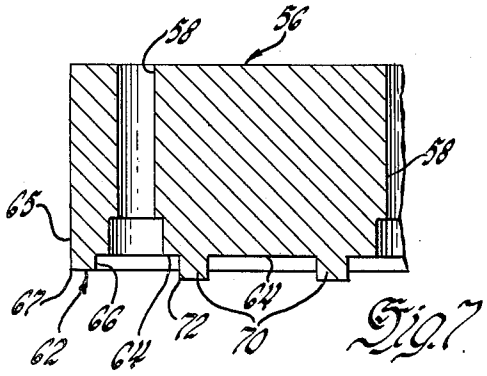


Fig. 7

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METHOD FOR MAKING AND EMBOSSING DECORATIVE ARTICLES

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Filed Mar. 26, 1957, Ser. No. 648,654
15 Claims. (Cl. 154—125)

This invention relates to a method and apparatus for making and embossing decorative articles and more particularly to a continuous method for making and embossing inlaid 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 planes is operative 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.

This invention utilizes the property of dielectric materials to become heated when subjected to an alternating current of radio frequency to provide a method for making and embossing inlaid decorative articles by means of dielectric heating, and, in its preferred embodiment, provides a continuous method for cutting a finite portion from a sheet of thermoplastic material and embossing the finite portion on a trim assembly by means of dielectric heating.

In the preferred embodiment of the invention, a holder for the sheet of thermoplastic material includes a pair of releasable members having openings therethrough which are aligned when the members are assembled. The sheet of thermoplastic material is secured in place between the members so as to be held taut across the openings therethrough.

One of the members of the holder is provided with a facing of resilient material.

The heating of the sheet of thermoplastic material and also the trim assembly is provided by a dielectric heating press. Such presses are commonly known and used and, therefore, the details of the press are unimportant to an understanding of the invention. However, it will be understood that the press generally includes a lower or stationary press electrode and an upper or movable press electrode having a die secured thereto of the desired size or shape of the finite portion to be cut from the sheet of thermoplastic material and subsequently embossed on the trim assembly.

The trim assembly is supported on the lower electrode of the press. Although the subject method may be used with various types of trim assemblies, as will be hereinafter set forth, it is preferred that all of the trim assemblies include an outer sheet of thermoplastic material which may be provided with one or more backing or other layers as desired. The holder for the sheet of thermoplastic material is supported upon the outer sheet of thermoplastic material of the trim assembly, with the facing of resilient material of the holder in engagement therewith.

When the holder has been positioned on the outer sheet of thermoplastic material of the trim assembly, the upper press electrode is moved downwardly until the die engages the portion of the sheet of thermoplastic material held taut across the opening of the holder. Thereafter, as the die continues to be lowered, it will depress a finite portion of the sheet of thermoplastic material out of the plane thereof under tension and move this finite portion into engagement with the outer sheet of thermoplastic material of the trim assembly. During this forcing of the finite portion out of the plane of the sheet of thermoplastic material, the resilient facing of the holder will be partially compressed. An alternating current of radio frequency is then impressed across the upper and lower electrodes of the press. Since the electric field will concentrate around the edge of the die, the concentration of the field between the die and the lower electrode will be greatest immediately adjacent the periphery of the die. Thus, a relatively narrow continuous area of the thermoplastic material immediately adjacent the die will become heated to the highest temperature to cause this narrow area to be softened. The tension in the sheet of thermoplastic material will thereupon cause the finite portion of the material to become cleanly separated along the relatively narrow area of highest temperature. The separation of the finite portion will also allow the resilient facing of the holder to shift the frame upwardly and remove the remainder of the sheet of thermoplastic material away from the finite portion and die face. Thus, the finite portion is cut from the remainder of the thermoplastic sheet solely by means of dielectric heating.

The finite portion remains in engagement with the outer sheet of the trim assembly after the cutting operation and the electric field passing between the die and the lower press electrode will subsequently emboss the finite portion on the trim assembly. Since the remainder of the sheet of thermoplastic material which was cut has been moved out of engagement with the finite portion and the trim assembly by means of the resilient facing of the holder, there is no chance that the remainder of the sheet of thermoplastic material will in any way interfere with this embossing operation. Thereafter, the press may be opened and the holder removed. The finished trim assembly may then be removed and will comprise a trim assembly having an outer sheet of thermoplastic material provided with an insert which is embossed thereon. Thus, this invention provides a continuous method for cutting a finite portion from a sheet of thermoplastic material and embossing the finite portion on a trim assembly by means of dielectric heating.

The primary object of this invention is to provide an improved method for making and embossing inlaid decorative articles. Another object of this invention is to provide a method for cutting finite portions from thermoplastic material and securing the portions on trim assemblies by means of dielectric heating to make inlaid dec-

orative articles. A more specific object of this invention is to provide a continuous method for cutting a finite portion from a sheet of thermoplastic material and embossing this portion on a sheet of thermoplastic material of a trim assembly by means of dielectric heating to make an inlaid and embossed decorative article.

These and other objects of this invention will be readily apparent from the following specification and drawings, in which:

FIGURE 1 is a schematic view of a dielectric press having the sheet of thermoplastic material positioned therein prior to the cutting operation;

FIGURE 2 it a view similar to FIGURE 1 and showing the press and sheet of thermoplastic material during the cutting operation;

FIGURE 3 is a view of the holder for the sheet of thermoplastic material;

FIGURE 4 is a sectional view taken on the plane indicated by line 4—4 of FIGURE 3;

FIGURE 5 is a view of the die;

FIGURE 6 is a sectional view taken on the plane indicated by line 6—6 of FIGURE 5; and

FIGURE 7 is an enlarged view of a portion of FIGURE 6.

Before proceeding with a further description, it will be understood that the subject method may either be used to cut finite portions from sheets of thermoplastic material without any further operation on the finite portion or may be used to cut the finite portion and then emboss the finite portion on a trim assembly in a continuous operation.

Although this invention is herein disclosed and claimed in conjunction with a continuous operation for making inlaid and embossed decorative articles, reference may be had to applicants' co-pending application, Serial No. 648,673, filed March 26, 1957, and assigned to the assignee of the present invention, for a further disclosure of the cutting operation which is claimed therein.

Referring now to FIGURE 1 of the drawings, a dielectric heating press of common type includes a lower or stationary press electrode **10** and an upper or movable press electrode **12** which is movable toward and away from the lower press electrode by suitable operating means. An alternating current generator **14** is connected in series with the upper and lower press electrodes in order to impress an alternating current of radio frequency therebetween. One or more buffer sheets **16** of silicone rubber or butyl rubber are laid on the lower press electrode in order to prevent arcing between the upper and lower electrodes when the press is closed and also to provide a resilient support for a trim assembly **17** to insure equal pressure of the die on all areas of the trim assembly engaged thereby. As previously mentioned, the subject invention will be described in conjunction with a continuous operation whereby a finite portion is cut from a sheet of thermoplastic material and then embossed on a trim assembly.

Although one particular trim assembly **17** will now be described it will be understood that other trim assemblies may be used with equal success as hereinafter set forth.

The trim assembly **17** includes a backing **18** which is supported by the sheets **16** on the press electrode **10**. The backing may be cardboard or Kraft board or may be of other rigid, semi-rigid, or flexible material as desired. Immediately adjacent the backing, a layer of riser material **20** is provided. This riser material may be hair or wool padding which has been impregnated with a thermoplastic material in fiber or powdered form. A sheet **22** of trim material is then laid upon the layer of riser material. The trim material may be any thermoplastic material such as vinyl chloride, vinylidene chloride, either supported or unsupported, other plastics or synthetics formed into flexible sheets, or leather, etc.

As previously mentioned, other trim assemblies may be used with equal success, but it is preferred that the trim assembly include an outer sheet of thermoplastic material. Excellent results have been obtained with a trim assembly of the type disclosed in application Serial No. 538,914, filed October 6, 1955, Dusina et al., and assigned to the assignee of the present invention. The trim assembly disclosed in this application includes an outer sheet thermoplastic material and a backing of sponge rubber. During the embossing operation, portions of the thermoplastic sheet and the sponge rubber are depressed and are fused together by means of dielectric heating. Excellent results have also been obtained from a trim assembly which comprises only a sheet **22** of 16 gauge thermoplastic material provided with a fabric backing, without any backing or other intermediate layers between the sheet **22** and the buffer sheets **16**. Thus, although a particular trim assembly **17** has been disclosed and described herein, it is obvious that other trim assemblies may be used as long as the trim assembly includes the outer sheet of thermoplastic material, which may be supported or unsupported as desired.

Referring particularly to FIGURES 3 and 4 of the drawings, the frame or holder **28** for the sheet of thermoplastic material to be cut will now be described. The holder generally comprises upper and lower members **30** and **32**, respectively, which are provided with central openings **34** and **36** in alignment with each other when the holders are in assembled relationship as shown. A number of openings **38**, which may be equally spaced or otherwise are provided around the opening **36** in the lower member **32**. A needle **40** is forced within each of the openings **38** and extends upwardly from the lower member **32**. The needles are preferably formed with uniform conical points, as shown, to prevent tearing of the sheet of thermoplastic material, when assembled therewith as will be described. When the members **30** and **32** are assembled, the conical points of the needles are received within openings **42** in the upper member **30**, with the number of openings **42** being equal to the number of openings **38**, although the openings **40** are larger. Thus, it may be seen that the upper and lower members may be assembled by positioning the needles **40** of the lower member **32** within the openings **42** of the upper member and then moving the members together to align the openings **34** and **36**.

In order to accurately assemble the members, three studs **44** are fixedly secured within openings **46** in the lower member **32** and are received within openings **48** in the upper member which are of substantially the size of the studs. It will be noted that the studs are unequally positioned so that it is impossible to assembly the upper and lower members in the wrong manner. In order to provide a means for separating the members, portions **50** of opposing side edges of the upper and lower members are cut out to provide finger grips.

When the upper and lower members are disassembled, a sheet **52** of thermoplastic material is forced over the conical points of the needles **40** in the lower member so that the sheet of thermoplastic material is tautly held across the opening **36** of the lower member. Thereafter, the upper member **30** is assembled with the lower member so that the sheet of thermoplastic material is tautly held across the aligned openings **34** and **36** of the members. Since the sheet of thermoplastic material is under tension during the cutting operation, it is preferred that the needles **40** have uniform conical points to prevent tearing of the sheet when under tension.

It is preferred that the sheet of thermoplastic material be unsupported, i.e., have no fabric or other backing. Excellent results have been obtained with sheets of vinyl chloride and vinylidene chloride of sixteen gauge, although other gauges of the material or of other materials may be used. However, it is preferred that all be in sheet form. The sheet may be of any known thermoplastic material, such as vinyl chloride, vinylidene chlor-

ide, etc., and may be tooled or otherwise provided with a decorative surface. The sheets may also be of any color desired.

It will be noted that the lower member **32** of frame **28** is provided with a continuous facing **54** of resilient material secured to its free surface. This resilient material may either be foam rubber, polyurethane foam, or sponge silicone rubber, with the latter two materials being preferred over the former material. The purpose of the facing **54** will be hereinafter discussed. After the sheet of thermoplastic material **52** has been assembled within the frame or holder, the holder is then positioned on the sheet **22** of trim material, with the facing **54** of resilient material on the lower member of the holder in engagement therewith. Thus, the sheet **52** of thermoplastic material is positioned in a horizontal plane generally parallel to the plane of the lower press electrode and sheet **22**.

A die **56** is secured in a suitable manner to the upper or movable press electrode **12**. Referring now to Figures 5 and 6, one or more openings **58** may be provided in the die to receive bolts which may be threaded into the electrode to rigidly secure the die in place. The die generally comprises a block of thermally conductive metal, such as steel, bronze, brass or copper, or other material. The outer periphery of the die generally comprises a continuous vertical wall **60** which defines the size or shape of the finite portion to be cut from the sheet **52** of thermoplastic material.

A continuous rib **62** provided at the juncture of wall **60** with the flat or horizontal base wall **64** of the die controls the cutting of the finite portion from the sheet **52** of material and also acts to provide an embossing line around the periphery of the finite portion when the finite portion is embossed on the trim assembly **17**. It is preferable that the rib **62** be integral with the material of the die although it may be formed separate and secured thereto in a suitable manner if so desired. It is also preferable that the outer wall **65** of the rib **62** be coplanar with or a continuation of the vertical wall **60** of the die and that the inner wall **66** thereof be generally parallel to the outer wall. The radius of the outer edge **67** of rib **62** controls the electrical field around the outer edge of the die to cause selective heating of the sheet **52** of thermoplastic material in a relatively narrow area immediately adjacent the outer edge of the die as will be described. Although the radius is not critical, it is preferable that it be from .005 to .010 inch.

If additional embossing lines are desired within the periphery of the finite portion, one or more embossing ribs **70**, equally spaced or otherwise, may be provided within the continuous rib **62** as shown in Figure 5. As indicated in Figure 1 of the drawings, the ribs **70** extend outwardly from the base wall **64** of the die a greater distance than does the rib **62**. Although the disparity in extent is somewhat exaggerated in Figure 1, it is preferred that the embossing ribs extend outwardly further from wall **64** of the die from .010 to .060 inch more than does the rib **62**. In addition, it is also preferred that the edges **72** of ribs **70** be formed on a .03125 inch radius, as compared to a radius of .005 to .010 inch for the edge **67** of rib **62**. The reason for this arrangement of the extent and radius of the ribs **70** and **62** will be hereinafter described.

When the trim assembly and the holder **28** with its sheet **52** of thermoplastic material have been positioned within the press, as shown in Figure 1, the upper or movable press electrode **12** is moved downwardly until the die **56** engages the sheet **52** of thermoplastic material within the openings **34** and **36** of the holder and depresses a finite portion **74** thereof out of the horizontal plane of the material and into engagement with the sheet **22** of thermoplastic material, as shown particularly in Figure 2. This finite portion **74** lies in a horizontal plane and is generally of the shape of the outer periphery of the die **56** as defined by the wall **60** thereof and the outer wall **65** of rib **62**. The portion **74** is joined to the remainder portion **75** of the sheet **52** in a horizontal plane by a continuous intermediate portion **76** which is angular to the horizontal plane of the finite portion **74** and to the horizontal plane of the remainder portion **75** of the thermoplastic sheet **52**. It will also be noted that when the die **56** engages the sheet **52** to depress the finite portion **74**, the force of the die causes the resilient facing **54** on the lower member **32** of the holder to become partially compressed.

The distance through which the holder **28** moves downwardly upon compression of the resilient facing **54** is less than the distance between the planes of the remainder portion **75** and the finite portion **74** so that the finite portion **74**, the intermediate portion **76**, and the remainder portion **75**, from its attachment to the needles **40** to its juncture with the intermediate portion **76**, are placed in tension. In the arrangement shown, the lower member **32** of the holder is .25 inch thick and the resilient facing **54** of the lower member is also .25 inch thick when free. When the die **56** engages the sheet **52** of thermoplastic material with a pressure, preferably from 100 to 500 lbs. per square inch, the facing **54** will be compressed approximately 50%.

The above dimensions together with the distance between the wall **60** of die **56** and the walls of the openings **34** and **36** of holder **28** further control the angle θ, theta, which the intermediate portion **76** makes with the horizontal plane of portion **74**. This angle preferably should fall between **30** and **55** degrees as will be hereinafter described. If the distance between the wall **60** of the die and the walls of openings **34** and **36** is .375 inch and the other dimensions remain as outlined above, the angle theta will be approximately 45 degrees.

When the die **56** has been moved into engagement with the sheet **52** of thermoplastic material, as shown in Figure 2 of the drawings, an alternating current of radio frequency is impressed across the upper and lower electrodes **12** and **10**, respectively. The voltage may be between 1,200 and 4,000 volts, and the frequency between 1 and 100 megacycles. It is intended that the A.C. generator **14**, which is in series with the electrodes, be capable of generating a field within this voltage range and frequency range.

Since an electric field tends to concentrate at sharp corners or edges, the field will tend to concentrate around the periphery of the die **56**, particularly at the edge **67** of the rib **62** thereof, in order to pass from this edge to the lower electrode **10**. It will be remembered that the radius of the edge **67** of rib **62** is smaller than the radius of the edges **72** of the embossing ribs **70**. This difference in radius is desirable in order to reduce the intensity of the electric field between the edges **72** of the ribs **70** and the lower electrode **10** so as to prevent any cutting of the finite portion within its boundary.

As the electric field passes between the edge **67** of rib **62** and the lower electrode **10**, the greatest concentration of the field will be immediately adjacent the edge **67** so that a relatively narrow area of the intermediate portion **76** immediately adjacent the edge **67** will be heated to the highest temperature. This relatively narrow area will be spaced approximately 10 to 15 thousandths of an inch from the edge **67** of the rib **62** and the temperature range in the area will be from 150° F. to 300° F. It is intended that the softening temperature of the sheet **52** of the thermoplastic material be within this range so that the relatively narrow area of the intermediate portion **76** will be softened more than any other area but will not be burned or charred. As the relatively narrow area in the intermediate portion **76** becomes softened, the tension between the finite portion **74** of the sheet and the intermediate portion **76** will cause the finite portion **74** to be separated from the remainder of the sheet. This separation is clean along a continuous line without any ragged edges being left on either the finite portion or on the inter-

mediate portion 76. When the finite portion 74 becomes separated, the resilient facing 54 on the lower member 32 of holder 28 causes the holder to move slightly upwardly to remove the intermediate portion 76 away from the finite portion and the sheet 22 of thermoplastic material of the trim assembly 17.

Thereafter, as the die 56 continues to hold the finite portion against the sheet 22 of the trim assembly, the electric field passing between the die and the lower electrode 10 will cause a softening of the finite portion and sheet 22 along embossing lines defined by the rib 62 and the ribs 70 to fuse the finite portion to the sheet 22 of thermoplastic material along these lines. However, intermediate the lines, there is no fusing between the finite portion and the sheet 22 of thermoplastic material.

It will be remembered that the layer 20 of padding between the sheet 22 of thermoplastic material and the backing 18 of the trim assembly is provided with thermoplastic material in either powdered or fiber form. The electric field passing between the die and the lower electrode 10 will also heat this thermoplastic material within the layer 20 so that the thermoplastic material softens and flows to fuse the sheet 22 to the backing 18 through the layer of padding 20. Again, this fusing will be along lines defined by the ribs 62 and 70 with no fusing taking place intermediate these lines.

As perviously mentioned, other types of trim assemblies 17 may be used. If a trim assembly of the type which includes an outer sheet 22 of thermoplastic trim material and the backing of vulcanized sponge rubber is used, then the finite portion will be embossed on the sheet 22 along embossing lines defined by the ribs 62 and 70 with these embossing lines being depressed within the sponge rubber backing and with the backing being fused along the embossing lines as is fully set forth in application Serial No. 538,914, hereinbefore mentioned. If the trim assembly includes only the outer sheet 22 of the thermoplastic material, then the finite portion and the sheet 22 will be embossed along the embossing lines defined by the ribs 62 and 70.

As previously stated, the pressure of the die 56 on the finite portion is from 100 to 500 lbs. per square inch. This pressure continues through the cutting operation and the subsequent embossing operation of the finite portion on the trim assembly. The electric field remains for a period of from 1 to 20 seconds, with a normal heating cycle being about 10 seconds. However, the electric field between the die and the lower electrode is turned off before the upper electrode 12 and the die 56 are moved out of engagement with the finite portion after the embossing operation. It is preferred that the die 56 remain in engagement with the finite portion for a period of from 2 to 10 seconds after the heating cycle in order to quench the finite portion and sheet 22 along the embossing lines. When the electrode 12 and the die 56 have moved out of engagement with the finite portion 74 after the embossing operation, the frame 28 is removed and the entire assembly is then removed from the press. The finished assembly will then include the backing 18, the intermediate layer 20, and the sheet 22 of thermoplastic material which will be provided with an insert defined by the finite portion 74, with each of these materials being secured together along embossing lines to define a pattern which is defined by the rib pattern of the die 56. If desired, the finite portion 74 and the outer layer 22 of thermoplastic material may be of different colors to provide a more pleasing appearance to the finished assembly.

It will be remembered that the ribs 70 extend further from the base wall 64 of the die than does the rib 62. By so locating the ribs with respect to each other, the ribs 70 will provide the major engagement between the die and the finite portion during the cutting operation while the rib 62 will only slightly engage the finite portion. As previously mentioned, the die 56 is not heated in any manner except by conduction. By having the ribs 70 extend further than rib 62, the ribs 70 will quench the thermoplastic material at their areas of engagement therewith to a much greater degree than rib 62 at its area of engagement with tne material, so that this quenching together with the difference in radius between the edges 72 of the ribs 70 and the edge 67 of the rib 62 will prevent any cutting of the finite portion within its peripheral edge during the cutting operation of the finite portion from the sheet 52.

It will be noted, however, that the ribs 70 do not necessarily have to extend further outwardly from the base wall 64 of the die than does rib 62 in all instances. The discrepancy in extent of the ribs is controlled primarily by the thickness of the sheet 22 of trim material. If the thickness is large, in the range of 1/64 inch to 1/16 inch, then it is preferable that ribs 70 be of a greater extent than rib 62. However, as the thickness decreases the discrepancy in extent becomes less critical and the ribs 62 and 70 may either be of the same extent or ribs 70 may be of greater extent. Thus, the discrepancy in extent varies with particular trim materials.

It will also be noted that the differences in radii of the edges of ribs 62 and 70 may not be necessary in instances. Again, this will depend on the particular trim assembly and in certain instances the radii of the edges of the ribs 70 may be the same as the radius of the edge 67 of rib 62.

It will also be remembered that the angle theta between the intermediate portion 76 and the horizontal plane of the finite portion 74 should fall between 30 and 55 degrees, and will be 45 degrees in the particular arrangement shown in the drawings. If this angle were zero degrees, then the efficiency of the electric field would be maximum since there would be no engagement between the rib 62 and the sheet 52 of thermoplastic material 52, the only engagement being between the ribs 70 and the sheet of thermoplastic material. Thus, without any engagement between the rib 62 and the sheet 52 of thermoplastic material, the rib 62 could not in any manner quench the thermoplastic material to draw heat away from the material at the relatively narrow area of highest temperature immediately adjacent the rib. Likewise, if the angle theta were 90 degrees, the efficiency of the electric field would be minimum since the area of greatest heating would then be in engagement with the die so as to be quenched while it is heated. Thus, the preferred range between 30 and 55 degrees is a compromise between maximum and minimum efficiency. Within this range, the sheet 52 of thermoplastic material will be in engagement with the outer edge 67 of rib 62, although the relatively narrow area of greatest heating of the sheet will be out of engagement with the rib. However, since the distance between the edge 67 and the area of greatest heating is relatively small, there will be some quenching of this narrow area by rib 62 and the die 56. However, this quenching does not reduce the efficiency of the electric field to a point where it will prevent the field from cutting the finite portion from the sheet 52 of thermoplastic material.

When the method for cutting the finite portion from a sheet of thermoplastic material is used in conjunction with a subsequent embossing operation to provide a continuous operation, it is preferable that the finite portion 74 be held in engagement with the sheet 22 of the trim assembly during the cutting operation so that the finite portion, when cut, is accurately positioned in place with respect to the trim assembly. This engagement of the finite portion and sheet 22 also decreases the time required for the cutting operation since the sheet 22 is being heated in the area of rib 62 at the same time as the portion 76 of the sheet 52 is heated in the same area. Thus, heat will be transferred by conduction from the sheet 22 to the sheet 52 to the area of highest temperature to decrease the time required for cutting. It will also necessarily follow that the time required for the embossing operation will be decreased since the periphery of the finite portion 74

and the sheet 22 in the area of rib 62 will already be softened.

If the method is used only for cutting finite portions from sheets of thermoplastic material, it is not necessary that the finite portion 74 be held in engagement with any other material during the cutting operation. Thus, when the die 56 is moved into engagement with the sheet 52 of thermoplastic material to depress the finite portion 74 thereof, the portion 74 may be spaced from the buffer sheets 16 during the cutting operation. Either manner of cutting the finite portion 74 from the sheet 52 of thermoplastic material may be used with equal success if there is no subsequent embossing operation. Of course, if the method of this invention is used only for cutting finite portions from sheets of thermoplastic material, there is no need for providing any of the ribs 70 or otherwise, since only the rib 62 is needed.

It will also be noted that the method of this invention can be used with equal success to merely cut a piece of thermoplastic material into two pieces, whether in sheet form or otherwise. Thus, if a sheet of thermoplastic material is to be cut into two pieces opposite portions of the sheet to either side of the cut line may be fixed within a suitable holder with the edge portions of the sheet transverse to the cut line being free. Thereafter, a die having a rib can engage the sheet at the cut line, with the rib extending beyond the free edge portions of the sheet. Since the cut line and engagement of the rib with the sheet will be transverse to the tension in the sheet, the sheet will be cut as hereinbefore set forth. Thus, this invention broadly encompasses the cutting of thermoplastic trim materials by means of dielectric heating.

Thus, this invention provides an improved method for cutting finite portions from sheets of thermoplastic material and embossing the finite portions on trim assemblies by means of dielectric heating. The finite portions may be of any size or shape and will have a sharp and well-defined peripheral edge which is not ragged in any manner. Although various types of trim assemblies may be used, it is preferable that each such trim assembly include an outer sheet 22 of thermoplastic material which may be supported or unsupported as desired.

The subject method is entirely different from mechanical cutting and subsequent embossing processes since it does not depend on a sharp blade or other member engaging and entering the thermoplastic material to thereby provide the required separation prior to the subsequent embossing operation. In such other processes, the sheet 52 of thermoplastic material is placed directly on the sheet 22 in surface to surface contacting relationship therewith. When the die has embossed a portion of sheet 52 corresponding to the finite portion 74 on the sheet 22, the remainder of the sheet 52 is then stripped off along the embossing line. Thus, such other methods are not continuous and also do not depend solely on dielectric heating to not only provide the embossing operation but also the cutting operation.

Although the die 56 has been shown of a particular shape with regard to the shape of the rib 62, other dies of other shapes may be used with equal success whether the dies are symmetrical or asymmetrical. However, it is preferable in all instances that the shape of the openings 34 and 36 in the holder 28 be of the same shape as the shape of the die although larger. By so arranging the openings 34 and 36 with respect to the die equal tension is provided around the periphery of the finite portion 74 so that the finite portion will separate as a unit in one simultaneous step rather than in a series of discontinuous steps. In addition, it is not necessary that any ribs 70 or otherwise be provided within the continuous rib 62 or otherwise of the die since the rib 62 will act in and of itself to not only cut a finite portion from a sheet of thermoplastic material but also to emboss this finite portion on the trim assembly 17 and to secure various layers of trim assembly to each other and to the finite portion along an embossing line. If the trim assembly includes only the sheet 22 of thermoplastic material, then the finite portion and the sheet 22 will be secured only to each other.

We claim:

1. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a sheet of heat softenable material over the base sheet, holding a portion of the heat softenable sheet of the size of the insert in engagement with the base sheet, applying tension between the portion of the sheet in engagement with the base sheet and the remainder of the sheet, applying high frequency energy to the sheet of heat softenable material at the periphery of the portion in engagement with the base sheet to thereby soften the sheet in this area and allow the tension in the sheet of heat softenable material to separate therefrom the portion in engagement with the base sheet, and thereafter securing the portion separated from the heat softenable sheet to the base sheet.

2. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a sheet of heat softenable material over the base sheet, holding a portion of the heat softenable sheet of the size of the insert in engagement with the base sheet, applying tension between the portion of the sheet in engagement with the base sheet and the remainder of the sheet, applying high frequency energy to the sheet of heat softenable material in the area of the periphery of the portion in engagement with the base sheet to thereby soften the sheet in this area and allow the tension in the sheet of heat softenable material to separate from the sheet the portion thereof in engagement with the base sheet, and thereafter applying pressure to the heat softened area of the separated portion to secure the separated portion on the base sheet.

3. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a sheet of the heat softenable material over the base sheet, holding a portion of the heat softenable sheet of the size of the insert in engagement with the base sheet, applying tension between the portion of the sheet in engagement with the base sheet and the remainder of the sheet, applying high frequency energy to the sheet of heat softenable material in the area of the periphery of the portion in engagement with the base sheet to thereby soften the sheet in this area and allow the tension in the sheet of heat softenable material to separate therefrom the portion in engagement with the base sheet, and thereafter continuing to hold the heat softened area of the portion separated from the heat softenable sheet in engagement with the base sheet to secure the separated portion thereto.

4. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a sheet of thermoplastic material in spaced relationship to a base sheet, applying pressure to a portion of the thermoplastic sheet of the size of the insert to displace this portion into engagement with the base sheet under tension, applying high frequency energy to the sheet of thermoplastic material in the area of the periphery of the displaced portion to thereby soften the sheet of thermoplastic material in this area and allow the tension in the sheet to separate the displaced portion therefrom, and applying pressure to the heat softened area of the displaced portion to secure the displaced portion to the base sheet.

5. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a sheet of thermoplastic material in spaced relationship to a base sheet, applying pressure to a portion of the thermoplastic sheet of the size of the insert to displace this portion into engagement with the base sheet under tension, applying high frequency energy to the sheet of thermoplastic material in the area of the periphery of the displaced portion to thereby soften the sheet

of thermoplastic material in this area and allow the tension in the sheet to separate the displaced portion therefrom, and securing the displaced portion to the base sheet.

6. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a sheet of thermoplastic material over a base sheet, holding a finite portion of the sheet of thermoplastic material under pressure in engagement with the base sheet, maintaining the remainder of the sheet of thermoplastic material under tension, applying high frequency energy to the sheet of thermoplastic material in a relatively narrow area at the boundary of the finite portion thereof to soften the sheet in this area and allow separation of the finite portion from the remainder of the sheet by means of the tension therebetween, and securing the heat softened area of the finite portion to the base sheet.

7. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a sheet of thermoplastic material over a base sheet, holding a finite portion of the sheet of thermoplastic material under pressure in engagement with the base sheet, maintaining the remainder of the sheet of thermoplastic material under tension, applying high frequency energy to the sheet of thermoplastic material in a relatively narrow area at the boundary of the finite portion thereof to soften the sheet in this area and allow separation of the finite portion from the remainder of the sheet by means of the tension therebetween, and continuing the application of pressure on the heat softened area of the finite portion to secure the finite portion to the base sheet.

8. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a pair of sheets of thermoplastic material in spaced relationship to each other, applying pressure to a finite portion of one of the sheets to displace this portion into engagement with the other sheet under tension, applying high frequency energy to each of the sheets in a relatively narrow area immediately adjacent the periphery of the finite portion of the one sheet to thereby soften each of the sheets in this area and allow separation of the finite portion of the one sheet from the remainder of the one sheet by means of the tension therebetween, and continuing the application of pressure after separation to fuse the heat softened areas of the finite portion and the other sheet of thermoplastic material.

9. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a sheet of thermoplastic material in spaced relationship to a base sheet, positioning the sheets between a pair of electrodes, displacing a finite portion of the sheet of thermoplastic material into engagement with the base sheet under tension, applying high frequency energy to the electrodes to generate a field therebetween, concentrating the field in a relatively narrow continuous area immediately adjacent the periphery of the finite portion to thereby soften the sheet of thermoplastic material in this area and allow separation of the finite portion from the remainder of the sheet by means of the tension therein, and continuing the application of pressure in the heat softened area of the finite portion to secure the finite portion on the base sheet.

10. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a pair of sheets of thermoplastic material in spaced relationship to each other between a pair of electrodes, applying pressure to a finite portion of one of the sheets to displace this portion into engagement with the other sheet under tension, applying high frequency energy to the electrodes to generate a field therebetween, concentrating the field in a relatively narrow continuous area immediately adjacent the periphery of the finite portion of the one sheet to thereby soften each of the sheets in this area and allow separation of the finite portion from the remainder of the one sheet by means of the tension therein, and continuing the application of pressure to secure the finite portion to the other sheet of thermoplastic material.

11. A method for making a decorative article having a base sheet provided with an insert comprising, resiliently supporting a sheet of thermoplastic material on the base sheet in spaced relationship thereto, applying pressure to a finite portion of the sheet of thermoplastic material to displace this portion into engagement with the base sheet under tension and partially compress the resilient supporting means of the sheet of thermoplastic material, applying high frequency energy to the sheet of thermoplastic material in a relatively narrow continuous area immediately adjacent the finite portion thereof to thereby soften the sheet in this area and allow separation of the finite portion from the remainder of the sheet by means of the tension and the resilient support, and applying pressure to the heat softened area of the finite portion to secure the finite portion to the base sheet.

12. A method for making a decorative article having a base sheet provided with an insert comprising, positioning a sheet of thermoplastic material in spaced relationship to the base sheet, applying pressure to the sheet of thermoplastic material along a relatively narrow continuous area thereof defining a finite portion to thereby displace this finite portion into engagement with the base sheet under tension, applying high frequency energy to the sheet of thermoplastic material adjacent the relatively narrow area thereof to thereby soften the sheet in this area and allow separation of the finite portion from the remainder of the sheet by means of the tension therein, and continuing the application of pressure to secure the heat softened area of the finite portion to the base sheet.

13. Dielectric apparatus for bonding a layer of flexible heat-fusible material to a base layer of material and for forming an embossed pattern therein comprising an electrode having a surface adapted to receive the base layer of material and an opposed electrode shaped as a die with raised embossing surfaces and a continuous rib about its periphery, said electrodes being connected in series to a source of high frequency electrical energy, means for holding tautly a sheet of flexible heat-fusible material between, and in spaced relationship to said die and the base layer of material on said first mentioned electrode, and means for moving said electrodes toward each other so that said die presses a portion of said sheet into contact with said layer of base material to bond said portion to said base layer and form an embossed pattern therein and so that said portion separates from the remaining portions of said sheet at the periphery of said embossing die.

14. Dielectric apparatus for bonding a layer of flexible heat-fusible material to a base layer of material and for forming an embossed pattern therein comprising a bottom electrode having a surface adapted to receive the base layer of material and an upper electrode shaped as a die with raised embossing surfaces and a continuous rib about its periphery, said electrodes being connected in series to a source of high frequency electrical energy, a frame for holding tautly a sheet of flexible heat-fusible material between, and in spaced relationship to said die and the layer of base material on said bottom electrode, and means for moving said electrodes toward each other so that said die presses a portion of said sheet into contact with said base layer to bond said portion to said base layer and form an embossed pattern therein and so that said portion separates from the remaining portions of said sheet at the periphery of said embossing die.

15. Dielectric apparatus as defined in claim 14 and wherein said frame comprises upper and lower matched frame members adapted to clamp the sheet of flexible heat-fusible material therebetween, one of said members having a series of needles adapted to extent through said sheet of material and the other of said members having

a series of openings for mating engagement with said needles.

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