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PROCESS FOR IMPARTING CREASES

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FIG. 2

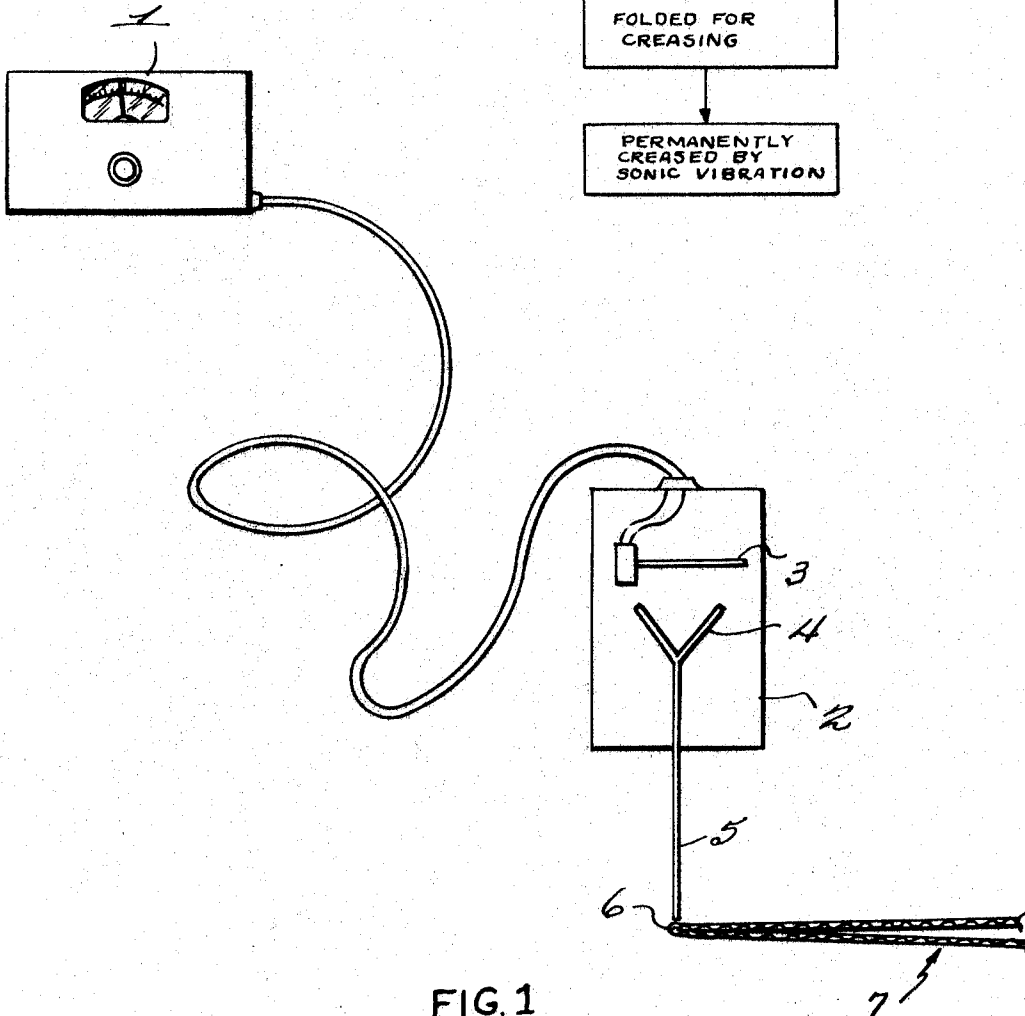
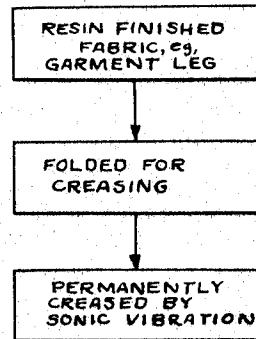


FIG. 1

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PROCESS FOR IMPARTING CREASES

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The present invention relates to a method for imparting permanent creases to textiles, plastics or other materials.

Pleats, creases, folds, hems, etc., (all hereinafter broadly referred to herein as "creases" for convenience), are conventionally imparted to textiles by heat and pressure means such as laundry presses, where the heat is supplied by steam or electricity. The success of these methods depends on externally applied heat and high mechanical pressures obtained by placing the press on the area to be creased. Times of several seconds or minutes are involved, depending on the material being creased, notably its receptivity to pressing, its weight or thickness, heat transfer properties, sensitivity to heat, and other factors.

In these conventional creasing systems, it is evident that the externally supplied heat must be conducted from the outside layers of the material being creased to the inside layers, and therefore the outside must be heated to a higher degree so that the inner layer will receive the heat required to soften the fibers and allow the crease to be formed. The entire surface of the garment or article is, therefore, exposed to the full heat of the press and some fibers, such as nylon, may be degraded and discolored by this intense external heat source. Many dyes are changed in hue or sublimed away from the fabric due to the high external heat.

An additional disadvantage of the above-noted prior procedures for creasing is discomfort to the press operator. Additionally, since the steam or electric heat radiates around the press easily, there is always the potential of injury due to contact with the hot press surfaces. Furthermore, the mechanical pressure necessary to obtain rapid external heat transfer and a sharp crease are in most cases very high and this can cause impressions or "show through" of seams, pocketing, waistbands, buttons, zippers, etc., onto the flat areas where such impressions are highly undesirable. Another disadvantage is that some fibers, such as acrylics, tend to "glaze" or shine due to external heat and pressure in conventional presses and this effect can occur all over the entire pressed area of the garment which has been exposed to the heat.

In view of the foregoing, the principal object of the present invention is to provide a method for obtaining permanent creases in textiles or other materials whereby the above-noted prior art disadvantages are obviated. Other objects will also be apparent from the following detailed description of the invention.

Broadly stated, the objects of the invention are realized by using vibrations in the sonic or ultrasonic frequency range to impart the desired creases. It is an advantage of the present method that highly effective results are obtained using frequencies which are above the normal hearing level, typically 20-40 kilocycles per second, although higher or lower frequencies could be employed in special cases.

It is to be appreciated that the use of ultrasonic vibrations or heating as contemplated herein is different from dielectric heating. Both of these techniques involve the use of high frequencies although the dielectric technique operates at much higher frequency levels, (e.g. radio frequencies in the order of millions of cycles per second).

Both ultrasonic and dielectric heating have previously been used in textile applications, notably in "welding" operations, such as bonding, laminating, joining or seam-

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ing without sewing and sealing, e.g. hosiery toe closing. Other specific uses have included welds of various patterns and designs, welds on knitted fabrics, cutting of shapes, and joining ends together.

For present purposes, ultrasonic heating is essential and offers a number of unique advantages over dielectric heating or other types of high frequency operations. For example, the ultrasonic method requires no electrodes or shielding and, as noted above, it is highly effective herein with relatively low frequencies in the range of 20-40 kilocycles per second. Furthermore, the use of ultrasonic heating herein is also completely safe and comfortable for the operator and there is an exceptionally high energy conversion (up to 93%) resulting in excellent operating efficiency and little loss of heat to the surroundings under efficient operating conditions. Then too, ultrasonic heating employs no moving parts which require constant repair.

In contrast to ultrasonic heating, dielectric heating has the disadvantage that the rate of heating varies with the temperature of the thermoplastic polymer or other material being heated. Nylon 66, for example, absorbs radio frequency power (millions of cycles per second) more quickly the higher its temperature. Therefore, uneven heating could result and an uncontrollable melting or fusion could also result. Additionally, the rate of heating in the dielectric process depends on the voltage stress applied, frequency of the generator, and most importantly on the physical properties of the material being treated as measured in terms of dielectric constant and dielectric loss factor. The dielectric constant is a measure of the amount of high frequency current that can be carried under certain conditions while the loss factor denotes the amount of heat generated under certain conditions. The success of dielectric heating, therefore, depends on these two critical factors.

Material such as polyvinyl chloride, nylon, cellulose acetate, and polyvinylidene chloride have high dielectric loss factors, and are very suitable for dielectric applications. Acrylics and polyesters have fair dielectric loss factors and may be effectively processed with dielectric heating but cellulose triacetate, rayon, polypropylene, and polyethylene have much lower dielectric loss factors, and consequently respond poorly or not at all to the dielectric process. The greater the unheatable nature of the polymer, the more it resists heating by high frequency dielectric methods.

The foregoing discussion points up further advantages of the present method in that the success of imparting heat to the material being creased using ultrasonic vibrations for heating is not limited to the dielectric properties of the material since no current or electrodes are used. Thus, for example, polyethylene and polypropylene, on which radio frequency dielectric process have little, if any effect, respond extremely well to the present ultrasonic process.

Conventional means for obtaining ultrasonic vibrations may be used herein. Such means generally comprise a generator which produces a high frequency signal, the latter being fed to a sonic converter which includes a transducer for providing mechanical energy in response to the applied electrical high frequency signal. This transducer may be of the electrostrictive or magnetostrictive type. The magnetostrictive type comprises a vibrating nickel core within a coil, while the electrostrictive transducer, which is preferred, utilizes polarized ceramic blocks, e.g. lead zirconate titanate.

The ultrasonic vibrations from the transducer are transmitted to a horn which concentrates and intensifies the energy. The vibrations emitted from the horn travel to a suitable tip or probe, which contacts the material to be heated. High speed agitation or flexing of the tip causes intense localized heating in the object contacted. The tip

itself is not heated but where there are two or more fibers, yarns or layers of material in contact, heat is generated due to friction of the molecules against one another. Thus, it is possible for a single fiber to be heated internally by molecular agitation and friction. The vibrational energy is, therefore, transmitted to the interface of the contacting surfaces. Thus, two layers of fabric, for example, are heated at the point or area of contact at the inner faces of the layers or between fibers. In other words, the heat is not transmitted from the outside to the inside, as in conventional pressing operations which use an external heat source but is generated from the inside touching surfaces to the outside.

As will be recognized, the tip or probe which is used to contact the textile or other material for the purpose of creasing according to the invention may be varied as to geometry and intensity to fit special applications. The horn of the apparatus employed controls the acceleration and displacement of the tip. If the acceleration is increased, the force of the tip is decreased. Different types of horns are known in the art and any of these may be used herein. For example, a "step horn" may be used to provide maximum acceleration and displacement. This type horn requires the application of light pressure to accomplish heating and creasing. Catenoidal and exponential type horns require more pressure but have more force and less acceleration for specific uses.

The invention is applicable to a wide variety of materials in various different forms where permanent creasing is desired. The most important application of the invention is in the creasing of textiles, particularly fabrics (woven, knitted or nonwoven), although other textile forms, such as yarns and fibers; plastics and like materials may be processed in the manner described. The textiles or other materials so processed preferably comprise thermoplastic polymers, e.g. nylon, acrylics, polyesters and acetates. These materials may be used singly or in admixture with each other or with other fibers. By means of the present method, textiles or other products comprising thermoplastic polymers may be readily softened and made to take the new creased shape with essentially no pressure or at least very little pressure on the material being creased. This elimination of the high pressures previously considered necessary for imparting creases constitutes an important advantage over conventional creasing methods.

Materials which of themselves are not thermoplastic may be coated or mixed with thermoplastic polymers which can be softened to impart the desired creased shape to the whole material. Additionally, non-thermoplastic materials may be coated with thermosetting, crosslinkable type products or reactant finishes which are cross-linked, cured or otherwise reacted by the heat generated from the ultrasonic vibrations in order to effect the desired permanent creasing. The application of a polymerizable or crosslinkable resin or reactant to celluloses to impart wash/wear properties and permanent creases is an example of this embodiment of the invention.

The time involved for heating the textile or other material by ultrasonic vibrations according to the present method can be varied but, in any event, the treatment is extremely fast, the most effective time for any particular situation depending on other factors such as the material involved and the power of the generator employed. Exposures of a second or less (e.g. one tenth of a second) are usually sufficient to impart durable creases in any given area although longer times (e.g. 2-3 seconds) may be employed if necessary or desired. No external heat source is needed and no undesirable heat is radiated around the ultrasonic transducer or otherwise.

The present method may be carried out in batch or continuous fashion. All that it is necessary to do is to fold the material into contacting layers as desired to give the crease and then subject the same to ultrasonic vibrations as described until the crease is fixed. In this

connection, it is important to note that the contacting layers are not welded together, the power and duration of treatment being adjusted to avoid this. It will also be appreciated that the treatment may be limited to a very small area of the material being processed. For example, in the case of a garment, the tip need contact only an area of about $\frac{1}{4}$ - $\frac{3}{8}$ " around the pleates, creases, cuffs, seams, hems, etc. (all of which are generically embraced by the references to the "crease" elsewhere herein for the sake of convenience, as noted above). This limited area of exposure very effectively avoids or minimizes degradation of polymer or fabric, glazing and dye color changes. Only the precise area to be heated and the precise amount of energy required is necessary for successful permanency and since the whole garment is not pressed, the problem of "show through" or impressions of pocketing, zippers, buttons, etc., encountered with conventional procedures is avoided.

The invention is illustrated, but not limited, by the following examples wherein, in each instance, the desired ultrasonic effect was obtained by means of the well known "Sonifier" model S-75 (Branson Instruments, Inc.). This apparatus consists of a fully transistorized generator, a hand held sonic converter housing a "Sonogen Z" ceramic piezoelectric transducer, a step type horn, and a flat, circular $\frac{1}{2}$ " O.D. tip. The power of the unit is 75 watts. Power is controlled by numbered settings. The settings 6 and 7 (representing various powers in the range of 20 kilocycles per second) were used in the following examples:

Example 1

A standard size 33 trouser leg was cut and sewn from a fully resin finished (urea- and melamine-formaldehyde resin types) woven and cured fabric comprising an acrylic/rayon/acetate flannel. The leg consisted of the area between the crotch seam and the cuff. The front and back creases were imparted by moving the tip of the ultrasonic horn (at setting 6) over the crease with very light pressure (about 15-20 p.s.i.) at a very rapid rate (about 0.15-0.3 feet per second) sufficient to cause the fibers to soften and reform in the new configuration. The area of contact with the tip was only approximately one half to $\frac{3}{4}$ of the area of the tip which had a diameter of $\frac{1}{2}$ inch. Therefore, only about $\frac{3}{8}$ " of the fabric was exposed along the crease. As a result, there was no show-through of the seam onto the flat area of the garment as would normally be seen in the center of the trouser leg.

The fabric was then washed five times in a conventional washing machine at about 105° F. with detergent. After this severe washing, the leg showed excellent crease retention and surface appearance. This shows the surprising durability of a crease imparted by the ultrasonic technique. This example also illustrates that thermoplastic acrylic and acetate polymers can be shaped by this process, and that a fiber such as rayon, which is not thermoplastic, but which is intimately blended with thermoplastics, can also be caused to take a new shape. It also shows that a fiber such as rayon which has been cross-linked in the flat state with a fully cured wash/wear resin can be made to assume the new configuration. This was apparently due to the presence of thermoplastic fibers and/or changes in the resin itself which could cause reformation of crosslinks with the new configuration.

The acrylic was not glazed or degraded, neither was there any color difference between the area heated with the ultrasonic vibrations and the untreated area.

The resin formula used to treat the fabric before creasing according to the invention was as follows:

- 5.5% of melamine-formaldehyde resin (about 40% solids)
- 2% of a magnesium chloride catalyst solution (about 30% solids)
- 50% of a urea-formaldehyde resin (about 25% solids)
- 1.6% of an amine hydrochloride catalyst (about 35% solids)

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10% of various softeners, dye fixatives, wetting agents, etc.

Remainder water.

and the curing conditions which were used involved heating at 305° F. for about six minutes.

Example 2

A resin treated and cured fabric containing an intimate blend of 65% polyester and 35% rayon was treated at setting 6 as in Example 1, and washed accordingly. Excellent retention of the pressed-in crease and general surface appearance were obtained. This example illustrates that polyesters respond well to the ultrasonic method, and again that non-thermoplastic polymers blended with the thermoplastics are caused to reform into the new shape. The resin used on this fabric was as follows:

3.7% of a melamine-formaldehyde resin (about 60% solids)

3.7% of another melamine-formaldehyde resin (about 40% solids)

2.7% of a magnesium chloride catalyst solution (about 30% solids)

8% of various softeners, dye fixatives, wetting agents, etc. Remainder water.

and the cure was carried out by heating at about 305° F., for six minutes.

Example 3

Two fabrics, one containing 50% polyester/50% cotton and another 65% polyester/35% cotton were treated by the continuous, aqueous formaldehyde process described in the copending application, Ser. No. 156,859. This process crosslinks the cellulosic portion of the fabric. Both fabrics were washed to remove some of the unreacted products. Then both were treated with a 1.0% solids solution of zinc nitrate catalyst and dried at 270° F. The fabrics were then treated with ultrasonics and laundered as in Example 1. Both showed excellent crease retention and surface appearance after five launderings.

This example shows that fabrics containing cotton crosslinked in the wet, flat state can be caused to change configuration by either or both of the mechanisms explained in Example 1. The presence of zinc nitrate catalyst can cause further reaction of the hemi acetals present in the formaldehyde crosslinked cellulose. This reaction promotes further crosslinking in the dry, creased state by the heat generated from the ultrasonic energy.

The formaldehyde process referred to in this example involved padding the fabric with 87.7% water + 12% formaldehyde (anhydrous) + 0.3% hydrochloric acid (anhydrous), and passing it into the following bath for 31 seconds at 70-78° C.:

	Percent
Formaldehyde (anhydrous) -----	10.3
Hydrochloric acid (anhydrous) -----	0.26
Calcium chloride (anhydrous) -----	35.0
Water -----	Remainder

Example 4

A fabric containing rayon, acetate and nylon fibers and having a conventional wash/wear resin formula which had been fully cured and crosslinked was treated with ultrasonics and washed as in Example 1. The fabric was treated in an oven at 325° F. for 10 minutes to set the flat areas of the garment. A very sharp crease and excellent surface appearance resulted after five launderings.

This example shows that blends of nylon, rayon and acetate can be treated and formed into a crease by this process, and again that a non-thermoplastic rayon may be molded into a new shape and held by the thermoplastic nylon and acetate. The Example also illustrates that a conventionally cured and crosslinked resin can be made to further cure and/or reform in the presence of thermo-

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plastics and non-thermoplastics by the action of ultrasonic energy. This contributes materially to the overall excellent results.

The conventional wash/wear formula referred to above comprised the following:

78% of a urea-formaldehyde resin (about 25% solids)

1.7% of an amine hydrochloride catalyst (about 35% solids)

7.5% of a methylated urea-formaldehyde resin (about 60% solids)

7.2% of softeners, dye fixatives, wetting agents, etc.

Remainder water.

Curing and crosslinking, prior to processing according to the invention, were effected by heating at 305° F. for 6 minutes.

Example 5

A 100% cotton fabric was treated with the following:

6.4% of a uron type resin (about 48% solids)

1.4% of a mixed catalyst of zinc nitrate and magnesium chloride (about 40% solids)

1.8% softeners

Remainder water.

Curing was effected by heating for 1 minute at 350° F. and the fabric was then treated under the same formaldehyde crosslinking process as in Example 3, with the same washing treatment, catalyst application, etc. The crease was imparted at setting 6 on the ultrasonic machine. After treatment with the ultrasonic energy, the fabric was placed in an oven at 325° F. for 10 minutes in order to cure the flat areas of the garment. After five washings, the pressed-in crease remained.

This example shows that a crosslinking and/or reforming reaction can be made to take place in a completely nonthermoplastic cotton structure. It further shows that catalytic reaction of many types of reactants designed for imparting wash/wear and permanent creases can be made to occur. In addition, the example shows that a finisher of the fabric may apply catalysts and reactants to a fabric before a garment is made, and the reaction caused to take place after garment manufacture by ultrasonic means in those areas of the garment desired.

Example 6

A pleated skirt (2" pleats all around) was made from the same 65% polyester/35% cotton fabric as used in Example 3. One half of this garment was pressed with a conventional laundry press (electric hot-head type) and another portion was treated with the ultrasonic vibrations (setting 7). A portion was left unpressed for comparison. After laundering, the pleats imparted by the ultrasonic method compared favorably with those pressed by the hot-head press method. This indicates excellent pleat retention during laundering, and also indicates that permanent pleats can be successfully imparted by the ultrasonic method.

Example 7

A trouser leg was made from a 65% polyester/35% cotton fabric. The garment was reversed, the inside seams were pressed out flat at setting 7 with the ultrasonic method. The garment was reversed to normal position, the creases and cuffs were pressed the same way. This illustrates that several areas of a garment may be creased by the ultrasonic method.

An arrangement suitable for use herein is diagrammatically shown in the accompanying drawing wherein the numerals 1, 2, 3, 4, and 5 represent, respectively, the generator, the sonic converter, the transducer, horn and tip. As shown, the tip 5 is adapted to contact and move rapidly over the folded portion 6 of fabric 7 to provide the desired creasing effect.

It will be appreciated that various modifications may be made in the invention described herein. For example,

the method may be adapted to an automatic continuous jig or clamp arrangement for high speed production of creased products. Additionally, it will be recognized from the foregoing that the invention may be applied to textiles which have been previously treated (e.g. by means of pad-dry or pad-dry-cure processes) with methylolated amino products, such as methylolated ureas, melamines, triazines, triazones and urons and/or other fiber reactants, in order to impart permanent creases. Partial or complete curing may be effected before the ultrasonic treatment. Thus, for example, the fabric may be padded with a methylolated material or other fiber reactant, dried only or dried and partially cured, followed by garment manufacture and completion of the cure simultaneous with the creasing operation using ultrasonic heating. To this end, a latent or otherwise suitable catalyst may be applied to the fabric along with the reactant or separately therefrom, the ultrasonic treatment serving to release the catalyst and/or otherwise functioning to complete the curing or thermosetting with the creasing operation. Other modifications will also be evident from the foregoing description of the invention, the scope of which is defined in the following claims wherein:

We claim:

1. A method of imparting a permanent crease to a textile fabric comprising thermoplastic fibers which comprises folding said fabric to form a crease and subjecting the thus folded material to sonic vibrations having a frequency in the range of 20-40 kilocycles per second whereby said crease is made permanent, the vibrations being applied at a power level and for a duration of time sufficient to cause heating of the material without fusing and welding of the superposed layers.

2. The method of claim 1 wherein said textile fabric comprises a cellulosic fiber.

3. The method of claim 2 wherein said textile fabric is treated with a resin before fabric is treated with a member selected from the group consisting of textile reactants and textile resins before said fabric is subjected to said sonic vibrations.

4. The method of claim 3 wherein said resin is cured simultaneously with the creasing operation using said sonic vibrations.

5. A method of imparting a permanent crease to a woven textile material which includes a thermoplastic constituent which comprises folding the material into two superposed layers to form a crease and applying a sonically vibrating instrumentality to the thus folded material at the area of the crease to heat the area of the crease by the dissipation of sonic energy whereby said crease is made permanent, the vibrations being applied at a power level and for a duration of time sufficient to cause heating of the material without fusing and welding of the superposed layers.

6. A method of imparting a permanent crease to a material as set forth in claim 5 wherein said instrumentality is applied to an outer surface of said crease.

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