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METHOD AND MEANS FOR AUTOMATIC STITCHING OF NATURAL
AND SYNTHETIC FABRICS
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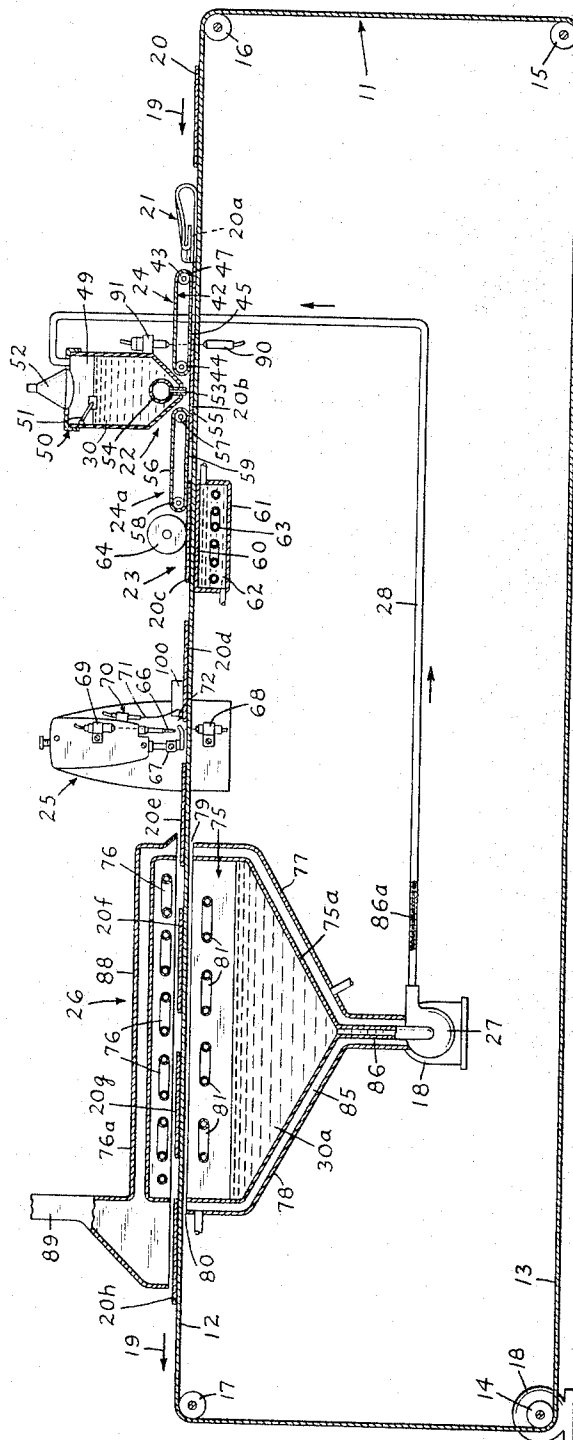


FIG. 1.

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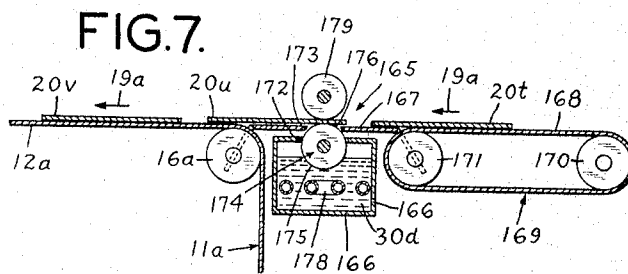
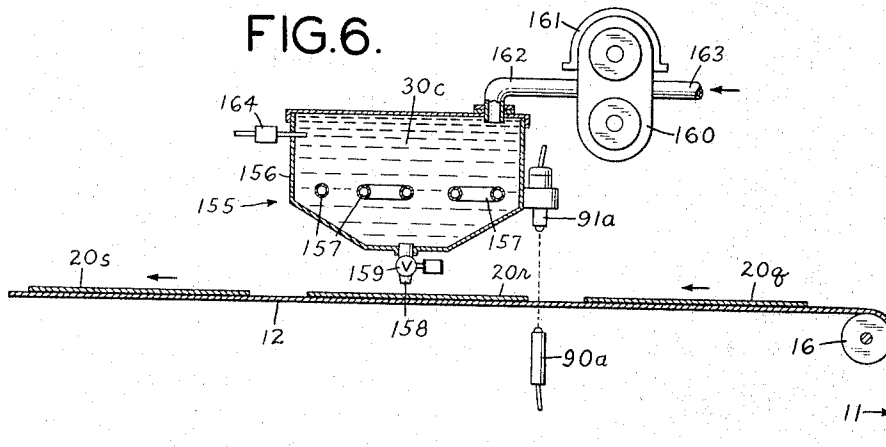
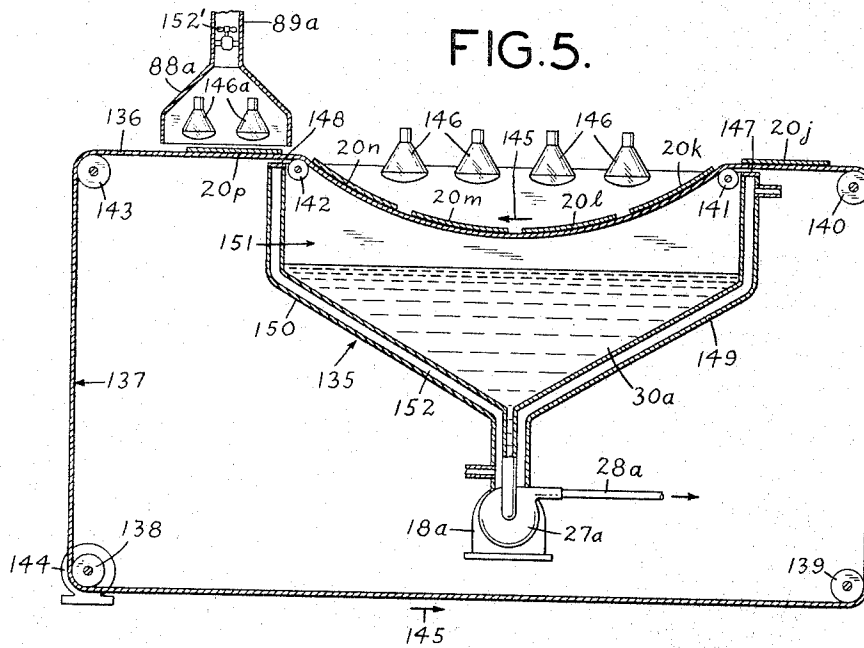
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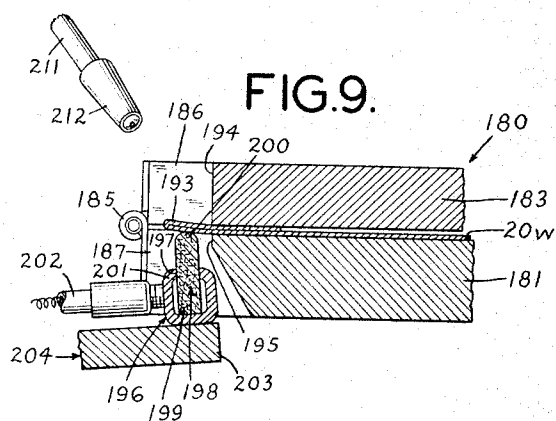
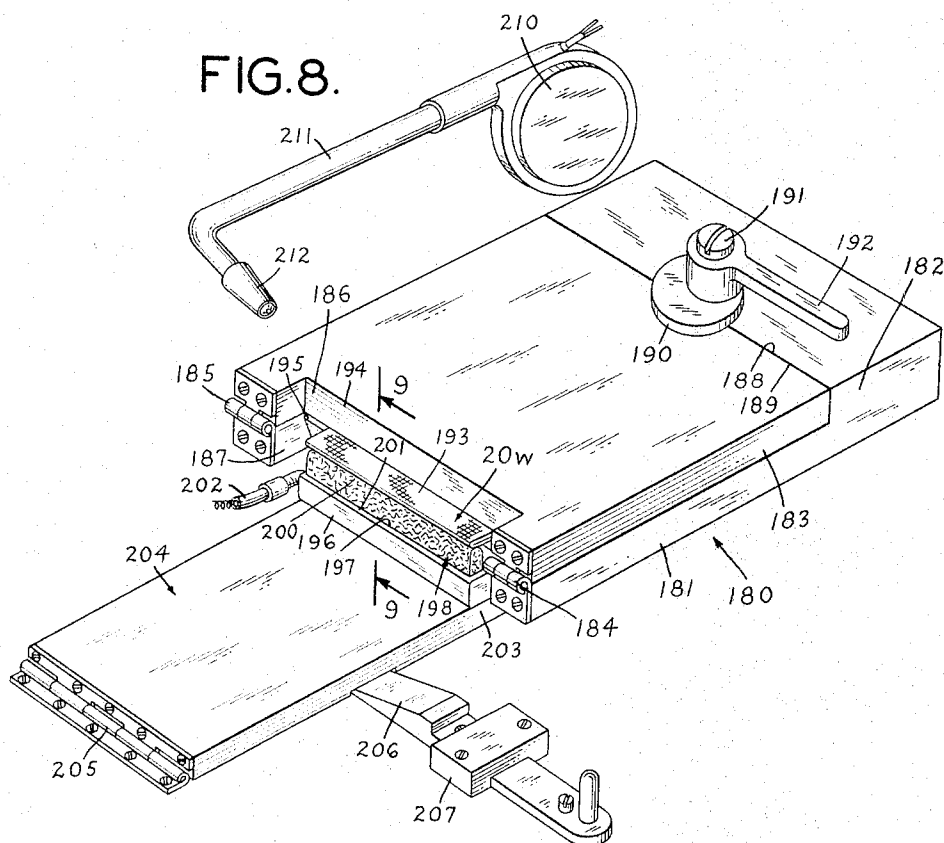
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METHOD AND MEANS FOR AUTOMATIC STITCHING OF NATURAL AND SYN- THETIC FABRICS

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ABSTRACT OF THE DISCLOSURE

Method and apparatus for applying a changeable phase stiffening agent, such as paradichlorobenzene, to a flexible fabric workpiece in liquid phase to impregnate the fabric; changing the impregnated liquid agent in the fabric to solid phase to stiffen the workpiece; performing work on the stiffened workpiece, such as sewing; and thereafter changing the stiffening agent to vapor phase to remove it from the workpiece to restore the fabric to its initial flexible condition.

This invention relates to a method and means for treating fabrics and the like for sewing on a sewing machine and, more particularly, to a method and means for treating the fabric with a stiffening agent prior to a sewing or stitching operation and subsequent removal of the stiffening agent from the material.

In the textile fabrication industry, and particularly in those segments of the industry wherein sewing or stitching operations are performed, it is desirable in conducting the sewing operations at high speeds and for the purpose of lowering costs and otherwise to perform those operations in efficient manner, to manipulate, position and advance the workpieces automatically to the sewing machine where the sewing or stitching is performed, thus, to eliminate, so far as possible, the personal handling or hand manipulation of the fabric pieces that are to be sewn. However, numerous problems and difficulties are encountered in the automatic handling and sewing of fabric workpieces, where high speed is demanded, due mainly to the inherent extreme flexibility of the fabrics themselves which are to form the workpieces that are to be sewn.

Ordinarily it is desirable, when automatically seaming pieces of cloth one after the other in an automatic or automated system, to position the pieces against an upright guide in order to align each piece in a succession of similar pieces prior to entry into a folding device as the pieces are advanced in aligned relation toward the sewing machine or prior to entry of the successive pieces into the sewing machine. The fabric, if it is in its initial flexible condition, has a tendency to, and frequently does, fold over its edge, or otherwise fold improperly, upon contact with the guides, with the result that many of the pieces in the succession of workpieces being advanced to the sewing machine, are folded in an undesirable or different position, whereas it is necessary for uniform sewing of successive workpieces that each successive piece in the production line of successive pieces, be presented to the sewing machine in the same relative folded shape and position, so that the pieces, after sewing them, will be uniform from piece to piece.

It is one of the principal objects of this invention to overcome the difficulties presented in automatically sewing or otherwise handling successive workpieces formed of initially flexible fabric. This object is accomplished by treating the initially flexible fabric with a stiffening agent to give the workpiece to be sewn, or subjected to other operative steps, a temporary rigidity or stiffness and then advancing the workpieces while in stiffened condition through the sewing machine operation, or through other

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manipulated operations, and thereafter removing the stiffening agent so that the fabric, after being sewn or otherwise worked upon, will be freed of the stiffening agent and then will have its initial flexibility; the stiffening agent being a substance or agent which in liquid form may be applied to the fabric, then its phase changed to solid to stiffen the fabric and permitting the sewing or other manipulation of the fabric while in stiffened condition and thereafter permitting removal from the fabric by changing the solidified substance to vapor phase. Preferably, the substance should be one which will not cause unwanted damage to the fabric; which can be safely used by workmen; which is readily changed from solid to liquid phase at a temperature which will not cause unwanted damage to the fabric when it is applied thereto in its liquid phase; which is readily changed from liquid to solid phase after the liquid is applied and which upon solidification, will stiffen the fabric where it is applied so that the fabric will remain rigid or stiffened to hold its shape during the sewing or other desired operation on the fabric; and which may be readily removed from the fabric by changing its phase from solid to vapor phase, all without the need for additional solvents for the substance at any stage of the operations.

It is desirable that the agent imparting rigidity or stiffness to the fabric to accomplish the object of the invention be one that is readily available at low cost, stable, not harmful to humans or machines and not harmful to fabrics which are in common use, such, for example, as woven, knitted or felted fabrics; fabrics made of natural fibers such as cottons, and fabrics made of synthetic fibers, or mixtures of natural and synthetic fibers and fabrics made of other types of fibers, such as paper. It should be one that is easy to apply, for rendering the fabric sufficiently stiff for uniform sewing operations from piece to piece or for uniform handling from piece to piece in other similar operations and which is easily removed from the fabric. Preferably, it should be one that may be recovered for reuse over and over after serving its function as the fabric stiffening agent.

In addition to providing a method for treating fabric for stiffening it for the sewing operations, other objects of the invention are to provide a method and an automatic system for applying a stiffening agent in its liquid phase to the fabric, subjecting the fabric to conditions which solidify the stiffening agent to render the workpiece stiff, advancing the stiffened workpiece to the sewing machine or other machine for working on the workpiece and then advancing the sewn or worked on piece through suitable apparatus under conditions which cause the stiffening agent to be removed for recovery and reuse.

It has been found that para-dichlorobenzene is admirably suited as a stiffening agent for accomplishing the primary object of the invention. Other organic compounds having similar characteristics may in certain instances be employed. Naphthalene has been used in certain instances to carry out the invention; and also, tetrabutyl alcohol. Mixtures of these substances may be employed. But para-dichlorobenzene has been found to have those characteristics which make it particularly suited for carrying out the invention. Para-dichlorobenzene is hereinafter sometimes referred to as "para-d.c.b."; it being more convenient to use this abbreviated designation than to repeat the full name numerous times.

Para-d.c.b. melts at approximately 127° F. and has a sharp melting point. Its boiling point is approximately 345° F. It can be kept in liquid form (liquid phase) for an extended period by maintaining it in containers under suitable conditions at slightly higher temperature than its melting point. Also it may be maintained for considerable time in its solid phase at room temperature and for an

extended period of time in closed containers. It has a relatively low latent heat of fusion, a relatively low latent heat of vaporization, and relatively low specific heat. It sublimates at 50° F. and above and therefore exerts a vapor pressure of at least one atmosphere at that temperature. At higher temperatures its vapor pressure is considerably higher than one atmosphere. It may be applied in liquid phase to the fabric workpiece by spray, drip or roller means and in some instances, the fabric may be dipped into a body of molten para-d.c.b., although it is likely in most instances that dipping will be less desirable than the other methods of application because the fabric might absorb more of the compound than is needed for the intended purpose. Also, in certain instances, it may be applied in comminuted solid form, heated while on the fabric, to change the solid phase to liquid phase so that it will impregnate the fabric after which it may be cooled to stiffen the fabric for the sewing operation.

In accordance with one manner of practicing the invention, para-d.c.b., in its liquid phase maintained at a temperature above its melting point temperature, for example, about 3° to 5° F. above its melting point, is applied to a piece of fabric. The liquid wicks very quickly, that is, it travels or permeates through the fabric quickly and impregnates it. It is believed that this wicking is brought about by capillary action through the interstices between the threads of the fabric and into pores of the fibers in a manner analogous to the rising of kerosene through the woven wick of a conventional kerosene lamp. Or it may be by absorption or adsorption or a combination of these actions. But whatever be the technical explanation, the fabric treated with the liquid para-d.c.b. becomes impregnated with it and upon being cooled to below its melting point it is changed to solid phase and the fabric becomes quite stiff in the area or areas which are impregnated with the para-d.c.b. If a sufficient amount of the compound in liquid phase is impregnated into the fabric material, and the fabric is then sufficiently cooled, the material may be rendered as rigid as a stiff board. By adjusting the amount of impregnation and the temperature, the stiffness of the fabric may be adjusted to the degree best suited for carrying out the various operations.

Upon cooling the para-d.c.b. in the workpiece sufficiently to change it from liquid phase to its solid phase, the workpiece will retain the conformation that it was placed in prior to the solidification; it being understood that the workpiece is in desired conformed or folded shape and in stiffened conditions when it is advanced to the sewing machine.

After the fabric has been stiffened, the workpiece may be guided very easily against an edge guide as it is advanced to the sewing machine for the sewing operation so that it is an easy matter to guide successive pieces and position them in proper alignment as successive stiffened pieces are presented successively to the sewing machine for sewing so that each workpiece or unit in the production line is uniformly sewn, as it passes through the sewing machine.

Inasmuch as the stiffened fabric, as it is presented to the sewing machine, contains solidified para-d.c.b., or equivalent stiffener having similar characteristics, it may be desirable, in some instances, to heat the sewing machine needle to prevent the para-d.c.b. from adhering to the needle, which of course, is passing through the impregnated fabric as the needle reciprocates to produce successive stitches along the line of stitching. If such heating of the needle is desirable, suitable means may be provided for heating it to avoid interference with the sewing operation which may be caused by the needle contacting the solidified para-d.c.b. In normal sewing operation, at the usual operating speed of a sewing machine commonly used in the industry, the needles generally heat to between 400° and 500° F. which, in normal sewing operations in accordance with the method herein disclosed,

may be sufficient to prevent the para-d.c.b. from collecting on the needle. However, it is nevertheless desirable to provide means for heating the fabric immediately in advance of the sewing machine needle if the line of stitching passes through an area of the fabric where it is impregnated with stiffening agent in solid state, because it is not desirable that the needle punch through the fabric where the solidified stiffener agent is present. Ordinarily, when sewing a piece of cloth, the needle in its reciprocating movement picks and finds its way through the fabric by pushing the fibers aside. If the needle punches through the cloth where it is impregnated with stiffener in solid state, the needle is inhibited from pushing aside the fibers with the result that the fibers are cut. Manifestly, such a result is undesirable. Hence, provision is made whereby the workpieces may be heated, if desired, in advance of the needle of the sewing machine in the line of stitching so that if stiffener agent is present in solid state at that locus, its solid phase may be changed to liquid or vapor phase and removed, if desired, thus to avoid having the needle punch through the stiffener in its solid phase. If such heating be needed, or desired, this may be accomplished by providing a heating means which may be in the form of a heated rod which may be positioned near and in advance of the needle so as to soften the para-d.c.b. impregnated fabric in the line of stitching and, if desired, the para-d.c.b. may be vaporized and removed from the fabric in the line of stitching a little before the needle punches through the fabric. This inhibits unwanted cutting of the fibers by the needle and has the further advantage that it permits the stitches to lie more closely to the cloth and allows the thread which forms the stitches to be pulled up more tightly to form a better and tighter stitch.

In one manner of practicing the invention, after the sewing operation, the finished pieces in the succession of pieces, that is, the successive sewn pieces in the production line, are subjected to heat, as the production line proceeds through the system, if it is desired to remove the stiffener agent from the fabric at that time. Or, if desired, the sewn workpieces may be stored under suitable conditions to maintain the stiffener agent impregnated in the fabric in its solid phase for a period of time and removed later, as described in further detail hereinafter. However, in a preferred system, the sewn pieces, as they are passed from the sewing machine operation, are promptly subjected to heat under conditions which cause the stiffener to be removed from the fabric. This may be accomplished by subjecting the impregnated fabric to conditions such that the vapor pressure of the stiffening agent is sufficient to cause the stiffener agent to vaporize and pass out of the fabric. The vaporization or distilling or subliming off of the stiffener agent may be speeded up by heating the fabric and the temperature employed may be as high as desired so long as it does not exceed a temperature at which the fabric would be damaged. It has been found that most cotton fabrics may be heated up to a temperature of 345° F. without harm, and dacrons, rayons and nylons will withstand temperatures up to 290° F. without damage. Vaporization of the para-d.c.b., as stiffener agent, occurs at a suitably fast rate when the impregnated fabric is heated to a temperature within the range of 200° to 345° F., the particular temperature employed being one that the fabric will withstand without damage.

In accordance with a preferred method, the fabric, after the sewing operation, is passed immediately into and through a heating zone which may be in the form of a substantially closed chamber which is contrived to heat the fabric impregnated with the para-d.c.b. The heat causes the para-d.c.b. to become vaporized and it passes off from the fabric in the form of vapor. The vapor is condensed and changed back to liquid phase and collected for reuse, the liquid being transported under suitable conditions back to the applicator device for impregnating

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new workpieces that are to be cooled and passed to the sewing operation in the production line. Thus para-d.c.b. and other compounds having similar characteristics when used as the stiffening agent lend themselves to cycle operation wherein the stiffening agent travels in a cycle in which only its physical condition is changed into solid phase, liquid phase, or vapor phase, but in a chemical sense it is not changed, and no chemical solvent for the stiffening agent is required since it is necessary only to change the phase of the stiffener compound. Suitable apparatus for practicing the invention is described in greater detail later on herein.

Although the novel features which are believed to be characteristic of the invention are pointed out in the annexed claims, the invention itself as to its objects and advantages and the manner in which it may be carried out, may be better understood by reference to the following more detailed description taken in connection with the accompanying drawings forming a part hereof, in which:

FIG. 1 is a view in elevation and primarily diagrammatic illustrating apparatus and system for sewing pieces in a continuous production line, wherein para-dichlorobenzene is used as stiffening agent, the stiffening agent moving in a circuit adapted for cyclic operation;

FIG. 2 is a view in perspective showing a folding device for folding workpieces introduced into the production line;

FIG. 3 is a view in perspective partly broken away of mechanism for moving the workpieces in the production line to the sewing machine and also showing a guide and means for heating the fabric in the area of the stitching line in advance of the sewing machine needle;

FIG. 4 is a view in perspective, partly broken away showing a different form of folding device;

FIG. 5 is a view in elevation, partly diagrammatic to illustrate a modified form of heating arrangement for removing the stiffening agent from the sewn workpieces, by vaporization, condensing it and collecting it in liquid form;

FIG. 6 is a view in elevation, partly diagrammatic, to illustrate a modified form of apparatus for receiving the stiffening agent in liquid form and applying it to the workpieces;

FIG. 7 is a view in elevation, partly diagrammatic, to illustrate a modified form of apparatus for applying stiffener agent in liquid form to the workpieces;

FIG. 8 is a view in perspective, to illustrate another example of apparatus for folding workpieces and applying the stiffener agent in liquid form by means of a porous applicator to limited areas of the workpieces, more particularly to the edge areas; and

FIG. 9 is a view in section on line 9—9 of FIG. 8.

Referring now to the drawings, in which like reference characters indicate similar parts throughout the several figures, the system illustrated in FIG. 1 comprises an endless carrier belt 11 having a horizontally disposed upper run 12, and a lower run 13, the belt 11 being mounted for continuous traveling on rollers 14, 15, 16, 17. Roller 14 is rotated by a prime mover, such as electric motor 18, to drive the carrier belt in the direction of arrow 19. It will be understood that the belts, rollers, and other equipment shown in the drawings are suitably mounted on a frame or other structural members of conventional character (not shown). Various devices and mechanisms are mounted along the upper run 12 of the main carrier belt 11. These devices and mechanisms, as shown in FIG. 1, comprise, in general, a folder 21 for folding workpieces 20 introduced at the head end of the upper run 12 of the main carrier belt 11, an applicator 22 for applying para-d.c.b. 30, in liquid form, to the workpieces; a feeder 24 for feeding the folded workpieces to the applicator; a cooling device 23 for solidifying the para-d.c.b.; a feeder 24a for feeding workpieces from the applicator to the cooling device; a sewing machine 25 for sewing the

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stiffened workpieces, a heating and condensing device 26 for heating the para-d.c.b. carried by the fabric to vaporize it and for condensing and collecting it in liquid form; and a pump 27 and conduit 28 for returning the condensed para-d.c.b. 30a in liquid form to the applicator device 22.

The cloth workpieces 20 are placed in succession on the moving upper run 12 of the main carrier belt at its head end. For convenience of description, these workpieces, as they progress through the system as a production line, are designated 20 (a to h). As the workpiece 20 moves forwardly on the main carrier belt, it is folded in folder 21.

The folder 21, as shown to larger scale in FIG. 2, comprises a thin plate 33 shaped to have an empty portion, forming a funnel-like throat 34 and trailing portion 35. The plate is formed to a shape to provide a tunnel 36 through which the side edge portion 37 of the workpiece 20a passes to produce a folded edge 38 when the workpiece is passed through the folder. The side portion or panel 39 of the workpiece then lies in superimposed fashion on the main panel 40 of the workpiece. The workpiece is thus folded for stitching a seam, for example, through the double thickness of the cloth, along the line indicated by broken line 41. It will be understood, of course, that the workpiece may be otherwise folded and the stitching may be in other lines, as desired, depending on the particular workpieces that are to be stitched, or other work that is to be done in the production line.

The folded piece, now designated 20a, is then moved on the carrier belt into the feeder 24. This feeder, as shown, comprises an endless flexible belt 42, trained over rollers 43, 44, suitably mounted for rotation on a supporting frame (not shown). The lower run 45 of belt 42 is sufficiently close to the upper run 12 of the main carrier belt that when the leading edge 46 of the workpiece enters the bite 47 between the feeder and main carrier belts, the workpiece, now designated 20b, is carried forward and it passes in its folded condition under the applicator 22.

The applicator, as shown in FIG. 1, comprises an enclosed chamber 49 in the form of a supply tank 50 mounted above the upper run 12 of the carrier belt 11. The supply tank maintains an adequate supply of molten para-d.c.b. 30. A float switch 51 controls the liquid level in the tank, as described in further detail later on. Means are provided to supply such heat as is necessary to maintain the temperature of the para-d.c.b. in the tank at any desired temperature above its melting point; to insure that the para-d.c.b. is maintained in its liquid phase and in a condition to obtain the desired wicking. As shown in FIG. 1, the heating means comprises infra-red heating lamps 52. Other heating means may be used to control the temperature of the para-d.c.b. in liquid form in tank 50, such, for example, as hot water or steam coils or electric resistance heaters.

The melting point of para-dichlorobenzene is 53° C. (approximately 127° F.) and the melting point is sharp; the para-d.c.b. at atmospheric pressure being solid at temperatures below 126° F. Ordinarily, it will be satisfactory to maintain the temperature of the liquid para-d.c.b. in tank 50 at about 5° F. above its melting point; but, in any event, it should be maintained at a temperature at which the molten para-d.c.b. will readily wick in the cloth being processed so that a good penetration and impregnation of the cloth is obtained, when the liquid is applied to the workpiece.

As shown in FIG. 1, means connected with the supply 30 of liquid para-d.c.b., in the form of drip nozzle 53 having a control valve 54 in tank 50, are provided for applying the desired quantity of the stiffener agent to the workpieces. Although, for illustrative purposes, only one nozzle and valve is shown, any suitable number arranged in suitable position may be employed so as to impregnate the workpieces in the area or areas that are to be impregnated with the molten para-d.c.b. Means are provided, as

described later on, for automatically controlling the discharge of liquid para-d.c.b. from the supply 30 so that it is applied only while a workpiece is passing under the drip nozzle 53 and the discharge is shut off at times when there is no workpiece under the nozzle. If desired, other means for applying the liquid para-d.c.b. maybe employed such, for example, as spray nozzles or other spray means, or roller means, or daubing means.

During the passage of a workpiece, under the drip nozzle 53, the workpiece being now designated 20b in the succession of workpieces, liquid para-d.c.b. drips through nozzles, such as nozzle 53, to the workpiece in the area or areas where impregnation is wanted. In the example being described, it is particularly important to impregnate the workpiece at the overlying panel 37 to insure a stiffening of the folded edge and in such fashion that both thicknesses of the work, i.e., the underlying panel 40 and overlying panel 37, are impregnated so that when the workpiece is cooled to solidify the para-d.c.b., the workpiece will be rendered rigid or stiff. When processing some kinds of work, it may be advantageous to fold the workpiece after application of the liquid para-d.c.b. and prior to cooling it. This may be done, if desired.

After the workpiece has been impregnated at the applicator station 22, it is in folded condition and enters the bite 55 of the feeder device 24a which comprises an endless flexible belt 56 trained over rollers 57, 58 mounted for rotation on suitable frame supporting members (not shown); the lower run 59 of the belt being close enough to the upper run 12 of the main carrier belt so that when the leading edge of the workpiece enters the bite 55, the workpiece, in folded condition, is carried forward on the main carrier belt. The workpiece, now designated 20c, passes on the conveyor belt over a cooler or chill plate 60 where the para-d.c.b. is changed to solid phase.

The melting point of para-d.c.b. is less than a degree F. higher than 127° F., and it will solidify at a temperature of 126° F. because it has a sharp melting point, and does not go through a wide plastic temperature range before it reaches its freezing point. Moreover, the latent heat of fusion of para-d.c.b. is relatively low and the amount of heat required to be removed from liquid para-d.c.b. when near its freezing point in order to change it to its solid phase is relatively low. Hence, the chill plate may readily be kept sufficiently cool to change the para-d.c.b. to its solid form. As shown, the plate 60, preferably made of a good heat conductor metal, is supported on and forms the top wall of a liquid cooled tank 61; the liquid 62 in the tank being in contact with the cooler plate 60. Heat from the cooler plate 60 entering the cooling liquid 62, which may be water or any other suitable cooling medium, is carried away by circulating a cooling medium or other suitable medium, maintained at desired cooling temperature, through coils 63; the temperature being maintained sufficiently low to quickly solidify the para-d.c.b. in the workpieces passing over cooling plate 60. Enough heat must be carried away to insure solidification of the para-d.c.b. in the workpieces in the time required for a workpiece to pass through the cooler device 23. In order to insure movement of the workpiece over the cooler plate in close contact with it and also to maintain the workpiece, in as close contact as possible, a pressure roller 64 mounted for rotation engages the workpiece, now designated 20c, to urge the workpiece in as close contact as possible with the cooler plate. This roller 64 may, if desired, be designed for circulating cooler medium therethrough if more cooling of the workpiece is desired.

The workpiece, now designated 20d, after it passes from the cooling station 23, is carried in its folded and stiffened condition on the main conveyor belt to the sewing machine 25. The sewing machine, driven by an electric motor, shown conventionally in FIG. 1, comprises the usual head, reciprocating needle 66, presser foot 67 and other elements required for stitching. The workpiece is introduced to the stitching mechanism in such fashion that

the workpiece, where the line of stitching is to be made, is outside the edges of the belt or in such manner that the belt will not interfere with the stitching operation. The sewing machine is equipped with means for starting and stopping its operation in response to movement of the workpiece 20d through the sewing machine station. Such means are known. See, for example, Kosrow U.S. Patent No. 3,116,705. As shown in FIG. 1, a beam of light from a light source 68 below the path of travel of the workpieces, is cast upon a photoelectric cell 69, positioned above said path. The photoelectric cell is connected in a suitable circuit with relays in known manner to control the operation of the sewing machine. When the light beam is interrupted, as by the passage of the workpiece through the path of the light beam, the sewing machine is caused to operate to stitch the workpiece and after passage of the workpiece from the sewing machine, the light beam striking the photoelectric cell 69 is restored and the sewing machine is stopped in response to restoration of the light beam. If desired, the sewing machine may be provided with a thread cutting device, such devices being known in the art. (See, for example, Kosrow U.S. Patent No. 3,116,705.)

Mounted on the sewing machine is a heater device 70 in the form of an electrically heated rod 71 mounted adjacent to the sewing machine needle 66, and having a portion 72 at its extremity which is positioned close to or in contact with the upper surface of the workpiece 20d, and in the line of stitching to be made by the sewing machine. In those instances in which the line of stitching will be in an area of the workpiece, which is impregnated with solidified para-d.c.b., the heating device will function to change the phase of the solid para-d.c.b. to soften it to liquid, or, if desired, to vaporize it in a confined area along the stitching line. This has the important advantage of eliminating the need to reciprocate the needle through solidified para-d.c.b. and the needle, in its stitching operation, will more easily punch through the fabric. And it has the further advantage of reducing to a minimum the cutting of the fibers of the fabric. Furthermore, this elimination of solid para-d.c.b. in the fabric in the line of stitching permits the sewing thread to be drawn up tighter to avoid a loose stitch and to make a tight and better stitch.

After sewing the stiffened workpiece, now designated 20e, containing para-d.c.b. in its solid phase, it is carried on the conveyor through a heating zone for removal from the workpiece of the para-d.c.b., by changing it to its vapor phase. As shown in FIG. 1, the apparatus for doing this comprises a substantially closed chamber 75 in which are positioned heater devices 76 and the apparatus is so designed that the vapor formed by evaporation or sublimation of the solid para-d.c.b. is condensed to liquid form 30a, for recovery and reuse.

The chamber 75 is bounded by a top wall 76a and jacketed side walls 77, 78 through which a cooling medium is circulated. The top run 12 of the carrier belt passes through an entry opening or port 79 and an exit opening or port 80 in the side walls of the heating and condensing chamber 75. Mounted above the conveyor belt and adjacent to it is coil 76, through which a heating medium, such as steam, is circulated. If desired, electric heaters or other suitable heating means may be employed. Mounted below the belt is a cooling coil 81 through which cooling water or other suitable cooling mediums are circulated. The temperature of the heating coil 76 is maintained sufficiently high to cause the solid para-d.c.b. in the workpieces, now designated 20f, 20g, to vaporize or sublime at a rate to remove the para-d.c.b. from the workpieces by the time they pass through the exit port 80.

The sewn workpieces, now designated 20h, are carried on the belt in succession from the heating zone and removed from the belt for such further operations as may be desired, and the fabric is in its initial flexible condition, freed of para-d.c.b. except perhaps for an insignificant

residual amount which may linger for a while and then become dissipated.

Referring again to the heating and condensing apparatus 26, the chamber 75 is provided with a hood 88 connected to a vent stack 89. This is desirable to remove excess vapor or fumes which may escape from the system and carry them away for dissipation into the outside atmosphere. Although the vapor which may escape is not dangerous, it is desirable to avoid an unnecessary amount of vapors or fumes in the work area. The portion of the chamber 75 below the conveyor belt is kept cool enough to cause the para-d.c.b. vapors, generated by heating the workpieces, to be condensed to liquid form. Para-d.c.b. vapor has a vapor density greater than the ambient air. Being heavier than air the para-d.c.b. vapor leaving or driven off from the workpieces 20f, 20g flows downwardly where it enters the space cooled by coils 81 and is condensed to its liquid form. The condensed liquid 30a is collected in the bottom portion 75a of the chamber 75. Condensation is aided by the vapors contacting the surface of the liquid para-d.c.b. 30a. The walls of this bottom portion are maintained at a temperature which will be cool enough to condense para-d.c.b. vapor but warm enough to maintain the collected para-d.c.b. 30a in its liquid phase, a little higher than its melting point, so that it may be pumped back to the applicator tank 50. Any suitable heating medium, for example, water, may be circulated through the jacket 85 which surrounds the condenser portion 75a of the chamber 75. It will ordinarily be satisfactory to maintain the temperature of the liquid 30a at about 5° F. above the melting point of the para-d.c.b.

The walls of the lower portion of chamber 75 converge and terminate in a conduit 86, connected to the suction side of a suitable pump, such as rotary pump 27, which is driven by an electric motor 18. The discharge side of the pump is connected to an insulated conduit 28 which may, if desired, be provided with an electrical resistance heater coil 86a or other suitable heating means to maintain para-d.c.b. in liquid form as it is pumped through conduit 28. The conduit 28 is connected to applicator tank 50 so that the liquid para-d.c.b. 30a may be pumped from the condenser chamber 75a and return to the applicator 22 for reuse.

It is desirable to heat the workpieces as they pass through the heating zone of chamber 75 as high as possible in order to evaporate the para-d.c.b. therefrom as rapidly as possible, bearing in mind, however, that the temperature should not be higher than the fabric can withstand without damage to it. Of course, the fabric will move through the heating chamber at a controlled speed. Hence the speed of the movement of the workpieces and the temperature in the heating zone above the conveyor belt are adjusted with respect to both; the adjustment being made so that the temperature is maintained at a point preferably within the range of 200° F. and 345° F. and the speed which permits complete removal of the para-d.c.b. from the fabric while it passes through the heating zone. Cotton fabrics can withstand a temperature up to 345° F. without damage whereas synthetic fabrics, such as dacrons, rayons and nylons, may not withstand a temperature higher than about 290° F. without harm.

Means are provided for automatically maintaining a desired amount of liquid para-d.c.b. in the applicator tank 50. When the liquid level in tank 50 is lowered a predetermined amount, the electric float switch 51, which is connected through an electrical circuit with suitable switches and relays arranged in a manner well known, is adjusted so that when the liquid level falls to a predetermined point the float switch functions to supply electric power to operate motor 28 to pump more liquid into the tank, and when the liquid in tank 50 rises to a predetermined level, the float switch 51 functions to cut off the power supply to motor 18 and stop it, and hence the flow of liquid para-d.c.b. from chamber 75a to tank 50 is stopped.

The pressure in tank 50 is maintained within such range as will maintain the para-d.c.b. in liquid phase at the temperature employed.

As mentioned in the foregoing, means are provided for automatically opening and closing the applicator valve 54, see FIG. 1) so that liquid para-d.c.b. is dipped through applicator nozzle 53 (or a plurality of nozzles if additional ones are needed) on to the workpieces only at such times as a workpiece is passing under the drip nozzle. The means, as shown in FIG. 1, comprising a light source 90, positioned below the path of travel of the workpieces 20 as they are carried on the conveyor belt, which casts a beam of light through said path of travel on to a photoelectric cell positioned above the upper run 12 of the conveyor belt. When a workpiece travels across the path of the light beam, the beam is interrupted and the light beam to the photo electric cell is restored after the workpiece travels beyond the path of the light beam. The photocell is connected in a suitable circuit with relays in known manner to operate a solenoid valve. The valve 54, shown conventionally in FIG. 1, is a solenoid operated valve and is operated in response to the action of the light sensitive photoelectric cell in known manner, to open the valve 54 when the light beam from light source 90 to photoelectric cell 91 is interrupted and to close the valve when the light beam to the cell is restored. The mechanism is adjusted so that para-d.c.b. flows on to a workpiece only when a workpiece is passing under the drip nozzle 53.

In certain kinds of work an edge guide is desirable for proper alignment of the successive workpieces passing to the sewing machine. An edge guide 100 is illustrated in FIG. 3, which may be mounted along the upper run 12 of the conveyor belt in advance of and adjacent to the sewing machine 25, together with an endless feed belt 101 trained over rollers 102, 103, mounted for rotation on suitable frame members (not shown). The lower run 104 of the feed belt, is close enough to the main conveyor belt 12 to engage the workpiece as it passes through the sewing machine station. The edge guide comprises a plate 105 adjustably secured to a suitable table 107 carried on a supporting frame (not shown). The plate 105 has an upstanding guide rail or flange 106 which the workpiece 20d engages in its forward movement, to properly align the workpiece so that the stitching will be made along a stitch line 41 which is in a predetermined location. The plate 105 has slots 108, 109, through which threaded set screws 110 extend, thus providing means whereby the guide flange 106 may be adjusted to any position toward and away from the conveyor belt for locating the stitch line, as desired. A heater, in the form of an electrically heated rod 112 which is mounted on a bracket 113, secured to a plate 114, is provided. This plate has a slot 115 through which threaded set screws 116 extend into bracket 107, thus providing means for adjusting the position of the heater rod 112 so that its bent terminal end portion 117 will be close to, or engage, the workpiece at the stitch line 41. The rod is so adjusted that the heat emitted therefrom will heat the para-d.c.b. in the workpiece along the stitch line and just in advance of the needle, so that the stiffener agent (para-d.c.b.) will be softened or, if desired, evaporated off along the stitch line. Thus when the workpiece passes under reciprocating needle 66, the needle does not have to penetrate or punch through solidified para-d.c.b. This has the advantages, as mentioned above, of avoiding undue cutting of the fibers of the fabric by the needle and permits the sewing thread to be pulled up close to the fabric to avoid loose stitches and it also makes for tighter stitches.

Another type of operation that may be performed with in the contemplation of the invention is illustrated in FIG. 4. In this operation two pieces may be held together in overlapped relation for purposes of making a lap seam. Before applying the liquified para-d.c.b. from the applicator, such, for example, as applicator 22 (see FIG. 1), or other suitable applicator, the two pieces of fabric 120,

121 that are to be sewn together in lap seam fashion are passed through a forming guide 122 which comprises a right hand plate 123 having an offset guide passageway 124 formed by a panel 125 of the plate folded back on itself and a left hand plate 126 having a guide passageway 127 formed by a panel 128 of the plate folded back on itself; the guide passages being superimposed one above the other. Fabric piece 120 is passed through guide passage 124 with its side edge 129 engaging its curved side wall and fabric piece 121 is passed simultaneously through guide passage 127 with its side edge 130 engaging its curved side wall, so that the two fabric pieces emerge aligned with their edge portions overlapped. The plates may be arranged to provide an overlap of any desirable width. The fabric pieces in overlapped condition and aligned position are then passed through the applicator station where liquid para-d.c.b. may be applied in successive narrow areas of desirable length, to impregnate the two thicknesses of the overlapped panels of the fabric, such, for example, as the area 131 indicated by broken lines. The application of the liquid para-d.c.b. may be in a continuous line along the entire length of the overlapped fabric pieces, or the line of impregnation may be interrupted to form spots of impregnated para-d.c.b. which penetrate both thicknesses of the fabric. The impregnated fabric pieces in conformed position are then passed from the applicator device through the cooling device and the para-d.c.b. is frozen. That is, it is changed from liquid to solid phase and the two fabric pieces are then "welded" together and passed to the sewing machine operation, as described above in connection with FIGS. 1 and 3. After the sewing operation, where the two fabric pieces are sewn together along a predetermined stitch line, the sewn unit is then passed through the heating zone for changing the para-d.c.b. from solid to vapor phase for removal of the para-d.c.b. from the fabric and the vapor is condensed for reuse as above described. It will now be seen that the method of the invention lends itself to various ways of applying the para-d.c.b. in its liquid phase, including one which is akin or analogous to spot welding.

A modified form of arrangement for heating workpieces containing para-d.c.b. for removing it therefrom and recovering it in liquid form is illustrated in FIG. 5. Such an apparatus may be used in place of the heating and condensing apparatus 26 disclosed in the system illustrated in FIG. 1; or it may be used as a separate piece of apparatus for removing para-d.c.b. from workpieces that have, for example, been previously sewn and the sewn pieces stored for a time under conditions which maintain the para-d.c.b. in solidified form. It may be pointed out here that fabric, which has been stiffened by impregnating it with liquid para-d.c.b. and changing the para-d.c.b. to solid phase, may be stored in closed containers or confined chambers and thereby the para-d.c.b. may be maintained in its solid phase in the fabric at ordinary room temperature. This may be done by providing an excess or an added amount of crystalline para-d.c.b. in the closed or substantially closed container because the nature of evaporation of the para-d.c.b. is such that as the molecules of the para-d.c.b. leave the surface of the solid phase, the ambient space around it becomes saturated with molecules of vaporous para-d.c.b., and at any given temperature, conditions are attained ultimately in which the number of molecules escaping from the solid phase is balanced by the number of molecules returning to the surface of the solid phase. Assuming the container will withstand the vapor pressure of the para-d.c.b. at the storage temperature, the impregnated fabric will retain the para-d.c.b. in solid phase.

The arrangement illustrated in FIG. 5 for removing solidified para-d.c.b. from the workpieces comprises a jacketed tank 135 mounted under the upper run 136 of an endless carrier belt 137 trained over roller 138, 139, 140, 141, 142, 143 mounted for rotation; roller 138 being rotated by a motor 144 to drive the carrier belt in the di-

rection of arrow 145. It will be understood that the illustration is somewhat diagrammatic and suitable means such as a sprocket chain and driven sprocket gear, known in the art, may be connected with the carrier belt for driving it. The workpieces 20j, which have been sewn and which contain the para-d.c.b. in solid phase, are carried on the upper run 136 of the carrier belt and are passed under a gang of electric heating lamps 146, such as infrared heating lamps, and the workpieces (now designated 20k to n) are heated by radiant heat rays from the lamps, the workpieces being heated sufficiently to sublime or evaporate the para-d.c.b. from the fabric. It will be observed that the path of the carrier belt under the lamps, is located below the top edges 147, 148 of the walls 149, 150 of the jacketed tank 135. As mentioned before, the vapor density of the para-d.c.b. is greater than the ambient atmospheric air so the para-d.c.b., removed or driven off as vapor from the workpieces, flows downwardly and is condensed in the condenser chamber 151 provided by the downwardly converging jacketed walls 149, 150. These walls are maintained at a temperature which will condense the para-d.c.b. vapor to liquid phase and maintain the condensed liquid 30a a few degrees, say about 3° to 5° F., above its melting point. Water or other suitable heat exchange medium is circulated through the jacket 152 of the condenser tank. As the para-d.c.b. in vapor phase flows downwardly, it comes in contact with the surface of the liquid para-d.c.b. and is changed to its liquid phase. A heated rotary pump 27a, driven by a motor 18a, is connected to the tank in the same manner as described in connection with the system illustrated in FIG. 1 and the liquid may be pumped through an insulated, heated discharge pipe 28a by the heated pump 27a in similar manner as in that system or to storage, if desired.

As the workpieces are carried from the heating zone 145, they pass under a hood 88a connected to a stack 89a to carry fumes outside the building which houses the work area. Additional heating lamps 146a are mounted under the hood 88a to drive off any significant amount of residual para-d.c.b. that may be present in the workpieces, now designated 20p. An exhaust fan 152', may be provided, if desired, to insure sufficient draft to carry any fumes up and out of the stack.

As heretofore mentioned, the liquid para-d.c.b. may be applied to the workpieces by spraying. FIG. 6 illustrates an applicator device 155 for spraying liquid para-d.c.b. on to the workpieces 20 (q to s). This applicator may be used instead of the applicator illustrated in FIG. 1. An enclosed tank 156 contains a supply 30c of liquid para-d.c.b. under pressure and maintained at a temperature a few degrees higher than the melting point of the para-d.c.b., by suitable heating means, such as heater coils 157 through which a heat exchange medium at suitable temperature is circulated. A spray nozzle 158, openable and closeable, by means of a solenoid valve 159 is connected to the spray nozzle, communicates with the liquid supply 30c. The spray nozzle is located above the upper run 12 of main conveyor 11. Only one spray nozzle 158 is shown but additional controlled spray nozzles, positioned to spray liquid para-d.c.b. over any desired area or areas of the workpieces, may be employed. Means for automatically opening and closing valve 159 are provided. A source of light 90a is positioned below the upper run 12 of the carrier belt. It casts a beam of light upon photoelectric cell 91a. These devices are connected into an electrical circuit with relays and switches in known manner with the solenoid valve 159 and the arrangement is such that liquid para-d.c.b. is sprayed through nozzle 158 only at such times as a workpiece is passing under the spray nozzle.

When a workpiece 20q passes through the path of the light beam to interrupt it, the solenoid valve 158 is caused to open to spray para-d.c.b. through the nozzle on the workpiece. When the workpiece passes beyond the nozzle, the light beam is restored and the solenoid valve is caused

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to close, thereby shutting off the spray. A suitable pump, such as gear pump 160, driven by an electric motor 161, and having a discharge conduit 162 connected to the closed tank 156, and having its suction conduit 163 connected to a source of liquid para-d.c.b. such as liquid 30a in tank 75a, or other source, maintains a substantially constant and suitable pressure on the liquid in tank 156. A desired pressure is automatically maintained in the tank, for example, by means of a pressure responsive switch 164 connected to be responsive to change in pressure of the liquid 30c in the tank. The pressure responsive switch 164 is connected to an electrical circuit with relays and other necessary elements, in known manner, to start and stop the motor 161 in response to change in pressure in tank 156. The pressure responsive switch 164 is set to maintain such pressure in the tank as is required to obtain in proper spray from applicator nozzle 158. When the pressure in tank 156 drops below a preset pressure, the switch is operated to cause the motor 161 to operate to produce more pressure and when the preset pressure is reached, the switch operates to stop motor 161. After the para-d.c.b. is sprayed on to the workpieces, they are carried on the main conveyor, to the cooling device, and the para-d.c.b. is then changed to its solid phase and thereafter the workpieces are sewn and processed as previously described.

Also, the liquid para-d.c.b. may be applied to the workpieces by roller means. Such means 165 are illustrated in FIG. 7. A tank 166, in which is maintained liquid para-d.c.b. 30d at constant level, is positioned under a stationary table 167, the surface of which lies in the same horizontal plane as the upper run 168 of an endless feeder belt 169, the latter being trained over rollers 170 and 171, one of which is a driven roller. A slot 172 is provided in the upper wall of tank 166 and a slot 173 is provided in the table 167. A driven applicator roll 174 is mounted for rotation so that the lower segment 175 of the cylindrical surface of the roll dips into the liquid para-d.c.b. and the upper segment 176 of the roll extends through the slots 172 and 173, so that the cylindrical surface of the roll is at, or slightly above, the plane of the surface of the table 167. A driven presser feeder roll 179, mounted for rotation above the roll 174, with its lower cylindrical surface located in such manner that a workpiece introduced into the bite of the rolls 174 and 179 is moved between the rolls in the direction of arrows 19a. Upon rotation of applicator roll 174, a film of liquid para-d.c.b. of substantial thickness is picked up on the surface of the roll and the liquid para-d.c.b. is transferred on to the workpiece, now designated 20u, as it passes over and in contact with, applicator roll 174; the pressure roll 179 serving to feed the workpiece forward and assuring good impregnation of the para-d.c.b. into the fabric of the workpiece. Impregnated workpieces 20v, discharged from table 167, are passed on the upper run 12a of a carrier belt 11a, to be carried to a cooling device for changing the liquid para-d.c.b. to solid phase, after which the workpiece may be sewn, handled and processed as described in the foregoing. The carrier belt is trained over suitable rollers, one of which 16a is shown in FIG. 7, and the upper run 12a of the carrier belt is positioned in the plane of the table 167. Suitable means, such as heater coils 178 in tank 166, are provided for maintaining the para-d.c.b. 30d in liquid form at the desired temperature.

As mentioned previously herein, the para-d.c.b. may be applied by a daubing method whereby liquid para-d.c.b. is daubed on the workpiece by means of a porous applicator, such as a porous felt or other similar porous material. One example of an arrangement for applying para-d.c.b. by daubing is illustrated in FIGS. 8 and 9. A device of this general character is useful in preparing workpieces, such as shirt pockets that are to be sewn on shirts, and the like. This shows a device 180 for folding a piece of fabric so as to expose an edge of the folded cloth to which is applied liquid para-d.c.b. by means of a porous applicator made of felt. It comprises a base plate 181

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having an upstanding shoulder portion 182, a top plate 183 hinged by means of hinges 184, 185 at their end edges. These plates serve as presser and chill plates as described later on. The upper and lower plates have cut out portions 186 and 187, respectively, one above the other. When the upper plate 183 is swung on hinges 184, 185 to closed position, as shown in FIG. 8, the outer edge 188 of the upper plate lies adjacent the edge 189 of the shoulder 182 of the lower plate. A cam disc 190 is pivotally mounted on a stud pin 191 threaded into the shoulder portion 182 of the bottom plate. Fixed to the pivoted cam 190 is a handle 192 pivoted at its inner end on the pivot provided by the stud pin 191. When the handle 192 is turned to the position, as shown in FIG. 8, the cam disc 190 engages the top surface of the upper plate 183 and applies a force on the upper presser plate toward the lower plate 181. When the handle is turned 180° the cam disc 190 is rotated so that it does not lie over the upper plate, then the upper plate may be swung on hinges 184, 185 and lifted up. A folded workpiece 20w is placed on the lower plate when the upper plate is in its upward or lifted position with the folded edge portion 193 of the workpiece 20w extending beyond the edges 194, 195 of the upper and lower chill plates 183, 181. The upper plate is then swung on the hinges 184, 185 to closed position and clamped by turning cam disc 190 and the workpiece 20w is thus clamped in and held in pressed condition with the folded edge portion 193 exposed at the cut out portions 186, 187 at the hinged end of the chill plates.

Mounted below the upper chill plate and within the cut out portion is a heated elongated trough 196, having a slot opening 197 along its upper wall. A porous felt dauber 198 fits into the slot 197 with a snug fit, with its lower portion 199 extending into the trough and its upper portion 200 extending above the top wall 201 of the trough. A heated conduit 202 communicates with the interior space of the trough 196. The conduit 202 is connected with a source of liquid para-d.c.b. and it is passed through the conduit into the trough in the space surrounding the lower portion 199 of the dauber felt 198. Liquid para-d.c.b. saturates the dauber, so that when the dauber is caused to engage the exposed folded edge portion 193 of the workpiece 20w, the liquid is transferred to the fabric of the workpiece by wicking action and the folded edge portion of the workpiece is impregnated with the liquid. The chill plates will cause liquid flowing in the fabric toward the chill plates to be sufficiently cooled to set up a solidified barrier or dam to prevent the liquid from working its way or working into the main body portion of the workpiece lying between the chill plates.

The trough 196 is mounted on means for lifting it, together with the dauber, so that the dauber engages the exposed folded edge portion 193 of the workpiece and for lowering it out of contact with the workpiece and to permit opening and closing of the chill plates 183, 181. As shown in FIG. 8, the trough 196 is mounted on the outer end 203 of a mounting plate 204 which is hinged at its opposite end to a hinge 205 fixed to a suitable support. A wedge member 206 is mounted to be slidably reciprocated in a guide 207 thus to move the wedge inwardly under the trough mounting plate 204 and to move it outwardly to retract it. When the wedge 206 is moved inwardly under the mounting plate 204, the mounting plate is swung upwardly about the hinge 205, thus lifting the dauber 198 into engagement with the folded edge portion 193 of the work, thereby to apply liquid para-d.c.b. to it, as illustrated in FIG. 9. Upon retraction of the wedge 206, the dauber is lowered away from the folded edge portion 193.

Means are provided to cool the para-d.c.b. impregnated in the folded edge portion 193, to change it to solid phase. The cooling may be done by a flow upon the workpiece of cooled air or water mist or other gaseous medium or even water, if desired. As illustrated

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in FIG. 8, a blower 210 is provided to force cooled air through conduit 211 having a nozzle or jet 212 to divert the flow of cooling medium on to the workpiece at the place where it is desired to freeze the para-d.c.b.

Although various ways of cooling the liquid para-d.c.b. to change its phase to solid have been illustrated, the foregoing disclosure will suggest other ways, such as the use of solid carbon dioxide, refrigerated air or other gaseous media. Also, as suggested previously, the para-d.c.b. may be applied in solid comminuted form, to desired areas, of the workpieces then being heated under conditions to melt it so that it will wick in the fabric after which it may be cooled to render it in solid phase and then the workpieces may be sewn and processed as described in the foregoing.

In addition, it is possible in some instances to remove para-d.c.b. from the fabric workpieces after the sewing operation by a wicking method, particularly in situations in which the fabric of the workpieces is quite porous. The workpieces containing the para-d.c.b. may be passed between two traveling heated endless belts made of a material in which the interstices or pores therein provide a high capillary attraction for the liquid para-d.c.b. so that when the para-d.c.b. is heated a little above its melting point by the belts and squeezed therebetween, this will cause the liquid para-d.c.b. to wick off from the workpieces on or into the traveling belt. It is possible to remove approximately 90% of the para-d.c.b. by this method. The para-d.c.b. deposited on the belts may be reclaimed by causing them to travel through a zone of higher temperature whereby to vaporize the para-d.c.b., the vapor being recoverable by condensation.

In addition to the various ways of carrying out the numerous steps performed in practicing the invention as described in the foregoing for illustrative purposes, it is within the contemplation of the invention to take two workpieces to be sewn together, place them one on top of the other, apply the para-d.c.b. in liquid phase in selected areas and press both pieces together and then cool. Both pieces are thereby solidified or "welded" together and may be maintained in that condition until after the sewing operation after which the stiffener may be removed and, if desired, recovered for reuse.

It is also contemplated within the scope of the invention that para-d.c.b. may be applied to a piece of fabric and, while it is in molten condition, the cloth folded and cooled. Also, a piece of fabric may be stiffened with the para-d.c.b. in solid phase, a hot wire or other suitable heater device applied to the fabric along a straight line, and the fabric then folded at the line made in the fabric by the hot wire. Several pieces of cloth may be temporarily joined together by means of spot welding or line welding of the para-d.c.b. The para-d.c.b. may also be applied to prematched plies of cloth, the cloth folded in any desired shape or in any desired number of folds and caused to hold their preformed shape during the stitching or sewing operation.

The foregoing preferred embodiments of the invention have been described particularly in connection with the use of para-d.c.b. as the stiffening agent but, as has been previously stated, other substances having similar characteristics may be used. As illustrative of other substances that have been used in carrying out the method contemplated by the invention, naphthalene and tetra-butyl alcohol may be mentioned. Naphthalene has a melting point approximately 122° F. and a boiling point approximately 424° F. Hence, in applying this stiffener in liquid phase to fabric the temperature must be maintained at least a few degrees higher than its melting point and the workpiece cooled sufficiently to change the naphthalene from liquid to solid phase for stiffening the fabric which may then be sewn as described in the foregoing. And after the sewing operation, the stiffener may be removed by heating it to change the naphthalene to vapor which may

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be condensed and recovered for reuse. However, naphthalene, because of some of its characteristics, is not as well suited for carrying out the inventions, as is para-d.c.b. Amongst other things, naphthalene vapor is considered to be toxic and special precaution to avoid its toxic effect upon the workmen must be taken. Para-dichlorobenzene vapors are considered to be harmless to persons under normal conditions. (Farmer's Bulletin 1246, revised January 1940, U.S. Dept. of Agriculture.) Tetra-butyl alcohol may also be used in practicing the method of the invention. It has a melting point approximately 79° F. and a boiling point 185° F. so the temperatures at which the various steps are conducted must be adjusted accordingly. It is not as desirable for use as a fabric stiffener for purposes of the invention as is para-d.c.b. For one thing, it may be necessary to adjust the temperature of the work area by refrigeration to below what is usual room temperature in hot weather because tetra-butyl alcohol has a melting point of 79° F. Also, particular precautions may be necessary because of the explosive nature and the inebriating character of its vapor.

If used in the claims, and as used herein, it will be understood that the term "downstream" means the direction of travel of the conveyor; that is, the direction of travel of the upper run 12 of the conveyor belt 11; i.e., in the direction of arrows 19; and "upstream" means the opposite direction.

It will be seen from the foregoing that the stiffening agent suitable for practicing the invention should be a substance which, at the temperatures employed, will not be damaging to the fabric to be sewn. It should have a melting point which is not so high that the fabric would be damaged when it is applied in liquid form and it should be a substance which develops a vapor pressure considerably higher than one atmosphere at temperatures below a temperature which would be damaging to the fabric because this facilitates subliming off or evaporating the substance from the fabric, after the fabric has been sewn, in order to restore the fabric to its initial flexible condition. And preferably the substance should be one which has a melting point higher than room temperature to avoid the necessity of cooling or refrigerating the work area. In order to have a frame of reference, normal room temperature may be taken to be 68° F.

It is also within the contemplation of the invention to apply the method disclosed herein to systems which provide folding and pressing devices for prefolding pockets, cuffs, collars and other workpieces which are to be sewn and become a part or parts of completed garments. Instead of using steam or heat to press folded portions, as is common practice with those known prefolding or pressing devices, the method herein disclosed may be used. The stiffening agent, for example, para-dichlorobenzene, may be applied in liquid phase simply and quickly to the folded edge portions of the workpieces, such as pockets, cuffs, collars, and the like, when placed in the folding machine or device so that the liquid impregnates the folded edge portions. Then the impregnated portions are subjected to a cooling step to cool the liquid to below its melting point to change the stiffening agent to its solid phase thereby stiffening the fabric whereby the folded portions are maintained in fixed, flat, stiffened condition, and the thus stiffened workpieces will maintain a fixed folded condition for the subsequent sewing operations; whereas, when using the conventional pressing and folding machines or devices which depend on steam or heat pressing, the folds have a tendency to open, requiring the workman or operator to use particular care in attaching and sewing the workpieces to the garment. By use of the method of the present invention, the folds of the workpieces may be maintained in stiffened condition without tendency to open during handling and thus the sewing of the workpieces to the garment in proper position is much simplified. And subsequently the

fabric may be restored to its initial flexible condition as disclosed herein.

The terms and expressions which have been employed herein are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. A method of preparing a workpiece of initially flexible fabric to stiffen it and manipulating the workpiece for performing work on it in stiffened condition and thereafter restoring the fabric to flexible condition which comprises supplying an organic stiffening agent having a melting point at a temperature which does not damage the fabric, applying said agent in its liquid phase to said fabric to impregnate it with said liquid, changing said agent in the fabric to its solid phase by cooling it to below its melting point, thereby to stiffen the impregnated fabric, then performing work on the stiffened fabric, and thereafter subjecting the impregnated fabric to a temperature below that which damages the fabric but sufficiently high and under conditions to change the stiffening agent to vapor phase without damage to said fabric thereby to remove the stiffening agent and restore the fabric to its initial flexible condition.

2. A method of preparing a workpiece of initially flexible fabric to stiffen it and performing work on it in stiffened condition and thereafter restoring the fabric to flexible condition which comprises providing a supply of an organic stiffening agent having a melting point at a temperature which does not damage the fabric and which has a vapor pressure greater than one atmosphere when heated to a temperature up to but not exceeding a temperature damaging to the fabric, applying said agent in its liquid phase to said fabric to impregnate it with said liquid, changing said agent in the fabric to its solid phase by cooling it to below its melting point, thereby to stiffen the impregnated fabric, then performing work on the stiffened fabric, and thereafter subjecting the impregnated fabric to a temperature below that which damages the fabric but sufficiently high and under conditions to change the stiffening agent to vapor phase without damage to said fabric thereby to remove the stiffening agent and restore the fabric to its initial flexible condition.

3. A method of preparing a workpiece of initially flexible fabric by stiffening it, then sewing it in stiffened condition and thereafter restoring the fabric to flexible condition which comprises providing a supply of an organic substance harmless to the fabric which has a solid, a liquid and a vapor phase and which has a melting point at a temperature above normal room temperature and which can be caused to develop a vapor pressure greater than one atmosphere at a temperature below the temperature at which the fabric would be damaged, applying said substance in its liquid phase to said fabric to impregnate it with said substance in its liquid phase, changing the substance in said fabric from its liquid to its solid phase by cooling it to below its melting point, thereby to stiffen said fabric, sewing the stiffened fabric and thereafter subjecting the fabric to a temperature sufficiently high to cause said substance to be changed to its vapor phase but at a temperature below that which would damage the fabric thereby to remove said substance from said fabric and restore it to its initial flexible condition.

4. A method according to claim 3 which includes heating the substance in the workpiece after it is sewn to a temperature substantially higher than its melting point but lower than its boiling point thereby to remove said substance from said workpiece as vapor, and condensing the vapor to liquid form for reuse.

5. A method of preparing a workpiece of initially flexible fabric to stiffen it and sewing it in stiffened condition and thereafter restoring the fabric to flexible condition which comprises applying para-dichlorobenzene to said fabric and causing said para-dichlorobenzene to wick in said fabric in its liquid phase, changing said liquid para-dichlorobenzene in said fabric from its liquid to its solid phase by cooling it to below its melting point, thereby to stiffen the impregnated fabric, sewing the stiffened fabric, and thereafter subjecting the fabric containing the para-dichlorobenzene to conditions to change the para-dichlorobenzene to vapor phase without damage to said fabric thereby to remove the para-dichlorobenzene and restore the fabric to its initial flexible condition.

6. A method according to claim 5 in which said workpiece is folded prior to application of said liquid para-dichlorobenzene to form, at least two plies of fabric, and said liquid para-dichlorobenzene is applied in an area where there are at least two plies of fabric, prior to cooling the para-dichlorobenzene.

7. A method of preparing a workpiece of initially flexible fabric to stiffen it and sewing it in stiffened condition and thereafter restoring the fabric to flexible condition which comprises applying para-dichlorobenzene in its liquid form to a selected area of the workpiece and causing said para-dichlorobenzene to wick in liquid form solid phase, and thereafter removing the para-dichlorobenzene wicked in said area sufficiently to change said liquid para-dichlorobenzene to its solid phase, sewing the workpiece while the para-dichlorobenzene is maintained in solid phase, and thereafter removing the para-dichlorobenzene from said workpiece by subjecting it to conditions which heat the para-dichlorobenzene sufficiently to change it to vapor phase, thereby to remove the para-dichlorobenzene and restore the fabric to its initial flexible condition.

8. A method according to claim 7 in which the para-dichlorobenzene removed as vapor from said workpiece is cooled and changed to its liquid phase for reuse.

9. A method according to claim 8 in which the liquid para-dichlorobenzene is applied to a succession of moving workpieces in a production line and the para-dichlorobenzene is removed in vapor form from said succession of workpieces after the sewing operation, the vapor condensed to liquid form and collected and the collected liquid reused by applying it to initially flexible workpieces in said production line in cyclic fashion.

10. A method according to claim 9 in which the liquid para-dichlorobenzene is applied to said workpieces in the succession of said workpieces in said production line by dripping it on to the workpieces in selected areas of said workpieces.

11. A method according to claim 9 in which said para-dichlorobenzene is applied to said workpieces in a plurality of separate areas on each of the workpieces.

12. A method according to claim 9 in which said sewing is performed by a power driven sewing machine having a reciprocating needle, and the solidified para-dichlorobenzene in said workpieces is heated in a narrow area slightly in advance of the needle, thereby to soften said para-dichlorobenzene in said workpieces in the line of stitching.

13. A method according to claim 9 in which said sewing is performed by a power driven sewing machine having a reciprocating needle and the para-dichlorobenzene in said workpieces is heated sufficiently in a narrow area slightly in advance of said needle to vaporize the para-dichlorobenzene in the line of stitching and thereby remove it from said succession of moving workpieces in the line of stitching prior to the sewing of the workpieces.

14. A method according to claim 7 in which the liquid para-dichlorobenzene is applied to the workpiece by dripping it on to the workpiece.

15. A method according to claim 7 in which the liquid para-dichlorobenzene applied to the workpiece is applied by rolling it on to the workpiece from a cylindrical roll.

16. A method according to claim 7 in which liquid para-dichlorobenzene is applied to the workpiece by daubing said liquid on to the workpiece in a selected area.

17. A method of treating a workpiece of initially flexible material to stiffen it and performing work on said workpiece in stiffen condition and thereafter restoring the material to its initial flexible condition which comprises applying para-dichlorobenzene to said material and causing said para-dichlorobenzene to wick in said material in its liquid phase and thereby impregnate it with said liquid para-dichlorobenzene, changing said liquid para-dichlorobenzene in said material to its solid phase by cooling it to below its melting point thereby to stiffen the impregnated material, thereafter performing work on said material while in stiffened condition, and after said work is performed on said stiffened material subjecting the material containing the para-dichlorobenzene to conditions which change the para-dichlorobenzene to vapor phase without damage to said material thereby to remove the para-dichlorobenzene and restore the material to its initial flexible condition.

18. Apparatus for automatically sewing fabric workpieces in a production line of successive workpieces which comprises a travelling conveyor means for moving a succession of workpieces in a fixed path of travel, an applicator means mounted adjacent said path for applying a stiffener agent in liquid phase form for impregnating with said liquid the workpieces moved in succession by said conveyor in said path, a cooling means adjacent said path of travel for cooling the impregnated workpieces moved in said path in succession by said conveyor means for changing the stiffener agent from its liquid to its solid phase thereby to stiffen said workpieces, a power driven sewing machine mounted adjacent said path for sewing said workpieces in stiffened condition while said workpieces are moved by said conveyor means in said path and stiffener agent removing means to remove the stiffener agent from the sewn workpieces by vaporization of the stiffener agent.

19. Apparatus according to claim 18 in which said applicator means comprises a chamber in which to maintain a supply of stiffener agent in its liquid phase, discharge means connected to said chamber and positioned above and adjacent to said path in which said workpieces travel in succession, heat supplying means associated with said chamber for maintaining the stiffener agent therein in liquid form at a predetermined temperature above its melting point, and control means operative to control discharge of liquid from said discharge means on to workpieces moving in said path under said discharge means.

20. Apparatus according to claim 19 in which said control means comprises a solenoid valve operative to open and close said discharge means in response to action of a photoelectric cell mounted on one side of said path, said cell in turn being operative in response to interruption and restoration of a light beam cast upon said cell by a light source positioned on the other side of said path of travel of said workpieces.

21. Apparatus according to claim 19 in which said discharge means comprises nozzle means connected to said chamber for dripping stiffener agent in liquid form on to workpieces moving in said path of travel.

22. Apparatus according to claim 18 in which said applicator means comprises a liquid supply chamber maintaining a supply of stiffener agent in liquid form mounted beneath the path of travel of said workpieces, an applicator roll having a cylindrical peripheral surface, said roll being mounted for rotation with a lower portion of its peripheral surface rotatable beneath the surface of the liquid supply and its upper portion in contact with workpieces moving in said path.

23. Apparatus according to claim 18 in which said cooling means comprises a cooling plate made of heat conductor material mounted adjacent the path of travel of said workpieces over which said workpieces pass for transferring heat from said workpieces to cool the stiffener agent therein to a temperature below its melting point and means to carry away the transferred heat from said plate.

24. Apparatus according to claim 18 in which said sewing machine has at least one reciprocating needle and which apparatus has a heater element mounted adjacent said needle and positioned to heat the stiffener agent on said workpiece in its path of travel in advance of said needle.

25. Apparatus according to claim 18 in which said stiffener agent removal means comprises a heater device mounted to supply a heat zone through which said workpieces pass in their movement in said path of travel to change said stiffener agent to vapor phase.

26. Apparatus according to claim 23 which includes condenser means for condensing said vapor to liquid phase, and a collector chamber in which said condensed liquid is collected.

27. Apparatus according to claim 26 which includes a conduit connected to said collector chamber and to said applicator means, and pump means for transporting the stiffener agent in liquid form from said collector chamber to said applicator means.

28. Apparatus according to claim 27 in which said applicator means includes a supply chamber for temporarily holding a supply of the stiffener agent in liquid form and control means connected with said supply chamber operative in response to a change of liquid level in said chamber to maintain a predetermined supply of stiffener agent in said supply chamber.

29. Apparatus according to claim 27 in which said applicator means includes a supply chamber for temporarily holding a supply of the stiffener agent in liquid form and pressure responsive control means connected to said supply chamber operative in response to change in pressure in said supply chamber for maintaining a predetermined pressure on the liquid in said supply chamber.

30. Apparatus according to claim 18 in which said travelling conveyor means comprises an endless belt trained over rotatable rollers having a run which travels in said fixed path and said applicator means, said cooler means and said sewing machine is mounted adjacent the path of travel of said run and which apparatus includes heating, cooling and condensing devices which heating device has a heating zone through which said sewn workpieces pass, and heating means in said zone, to heat the stiffener agent in said pieces sufficiently to remove said stiffener agent from said pieces in vapor state, and which condensing device has a chamber in which to collect said agent in its liquid phase and cooling means in said chamber to cause said stiffener agent removed from said pieces in vapor state to be condensed to liquid phase.

31. In a system having means for applying a stiffener agent for stiffening initially flexible fabric, a sewing machine for sewing the stiffened fabric and means thereafter removing the stiffening agent and restoring the fabric to its flexible condition, a device for preparing a workpiece to be sewn and stiffening the workpiece along a folded edge, which comprises a base plate, a pressing and clamping plate hinged at one end to said base plate permitting opening and closing of said plates with the folded edge portion of the workpiece extending beyond the edges of said plates, a trough mounted adjacent said end of the base plate, a porous dauber element mounted in said trough, means supplying liquid stiffening agent to said trough, and means to move said trough from its normal position to cause said dauber element to engage the folded edge portion of the workpiece when said workpiece is clamped between said plates and to move said trough back to normal position so that said dauber element is not

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in engagement with said folded edge portion and means for supplying a cooling fluid to said folded edge portion.

32. In a system wherein a workpiece of initially flexible fabric is treated with a stiffening agent which is applied to the fabric in liquid phase, cooled to change the agent to solid phase to stiffen the fabric, the stiffened fabric then worked on, and the fabric then subjected to conditions to change the agent to vapor phase to remove it from the fabric to restore it to its initially flexible condition, a pressing and chill plate device which comprises a pair of cooperating plates movable toward each other to closed position and away from each other to open position and between which the fabric work piece may be pressed with at least one folded edge portion extending beyond the confines of said pair of plates when said plates are moved to closed position, thereby exposing said folded edge portion; means for applying said agent in liquid phase to said exposed folded edge portion to impregnate said folded edge portion with said liquid; means mounted adjacent said plates supplying cooling medium to said

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exposed edge portion for solidifying the liquid agent in said exposed portion by cooling it to below its melting point thereby to stiffen the impregnated fabric; said device, when said plates are moved to open position, permitting removal therefrom of said workpiece with its folded edge portion in stiffened condition.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,329,116

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John G. Attwood et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 9, line 46, for "thereform" read -- therefrom --; line 66, for "ciscuit" read -- circuit --; column 10, line 6, for "dipped" read -- dripped --; column 12, line 24, for "smelting" read -- melting --; line 37, for "cnneted" read -- connected --; column 17, line 70, for "substaance" read -- substance --; line 71, for "meling" read -- melting --; column 18, line 27, strike out "solid phase, and thereafter removing" and insert instead -- in said fabric in said area, cooling --; lines 29 and 33, for "para-dichlorobenzen", each occurrence, read -- para-dichlorobenzene --; lines 31 and 32, for "para-chlorobenzene", each occurrence, read -- para-dichlorobenzene --.

Signed and sealed this 13th day of August 1968.

(SEAL)
Attest:

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