Fusing

When interlinings are sewn in, it can be difficult on parts such as collars to avoid a wrinkling of the interlining inside the collar and pucker around the edge. On large parts such as jacket fronts, the attachment of interlinings by sewing is expensive and requires skill if a high standard is to be achieved. The alternative process that has been developed is that of fusing, whereby the interlining is bonded to the outer fabric by means of a thermoplastic resin.

The fusible interlining consists of a base cloth, which may be similar to that used for a sew-in interlining, and which carries on its surface a thermoplastic adhesive resin, usually in the form of small dots, which will melt when heated to a specific temperature.

ADVANTAGES OF USING FUSIBLE INTERLININGS

- In most cases the use of fusible interlinings shortens manufacturing time with a consequent reduction in direct labour cost.

- There is a reduction in the skill required in many operations involving fusing compared with the sewing in of interlinings and this leads to a reduction in training time.

- It is easier to achieve consistent quality in the lamination process than it is with many of the operations of sewing in of interlinings, especially on modern lightweight fabrics.

- Fusible interlinings provide opportunities for alternative methods of garment construction; in some cases the interlining might be considered as a ‘work aid’.
The process of fusing interlinings to garments must fulfil certain requirements and avoid certain problems if the garment is to have a satisfactory appearance and performance throughout its life.

1- The laminate produced by fusing should show the aesthetic qualities required by the designer in the finished garment. This relates in particular to the stiffness or draping qualities of the garment. It is a matter of trial and error before manufacturing begins. The factors over which the garment manufacturer can exercise choice are the drape of the fusible’s base cloth, and the type and quantity of the fusible resin forming the bond. Other fabric properties that could be affected adversely by the fusing on of interlinings are crease recovery and air permeability.

2- The strength of bond of the laminate must be sufficient to withstand handling during subsequent operations in the garment manufacturing process as well as the flexing that takes place in wear. The bond must resist either the temperature and degree of agitation of a washing and drying cycle, with perhaps subsequent ironing, or the solvents, temperature and agitation of a dry-cleaning process, and in some cases both.

If there is not a complete and even bond over the whole surface of the laminate when first fused, or if delamination takes place at some stage in the garment’s life, it will appear as a ‘bubbling’ in the outer fabric of the garment.

Certain fabrics are particularly difficult to fuse to, notably showerproof rainwear fabrics. Both the showerproof finish on the fabric and its typically smooth, hard surface make a good bond difficult to achieve.
3- Fusing must take place without either strike-through or strike-back occurring. When the softened adhesive resin is pressed into the garment fabric, it is important that it does not go right through to the face side of that fabric, and that it does not go back to the outside of the interlining base cloth. These problems are known as ‘strikethrough’ and ‘strike-back’ respectively. If strike-through occurs it may show on the right side of the garment as a pattern of dots of resin; if it occurs on a garment subject to high temperature ironing such as a shirt collar, it may be picked up on the iron and lead to marking of the garment. If strike-back occurs, it can contaminate parts of the equipment used in the fusing process, and may also adhere to the garment lining during pressing.
4- The fusing process must not cause thermal shrinkage in the outer fabric. Fusing commonly takes place at around 150 °C and at this temperature any fabrics may be subject to thermal shrinkage. If this occurs, it can cause garments to fit together badly during manufacture and be incorrect in size after manufacture. To minimise shrinkage, some fusing presses have a pre-heat zone, set at a lower temperature.

5- A further possible effect of the heat of the fusing process is that of dye sublimation. Fabrics may change colour to a level that is unacceptable, causing a mismatch between the fused and unfused parts of the garment. This phenomenon can sometimes be pronounced. In one company, a polyester fabric was so affected by the fusing process that it was decided to send all the garment pieces through the press, whether or not they required the attachment of a fusible interlining. Only in this way could they avoid shading in the garments.

6- Since the fusing process involves pressure, there is a risk that pile fabrics may be subject to crushing during fusing. Fused and unfused parts of the garment, when sewn together, may have a different appearance.

7- Where showerproof fabrics are fused, there is a possibility that the presence of a fused interlining in the garment may wick water through the fabric in the fused areas while the unfused areas remain satisfactorily showerproofed. Water-resistant interlinings have been developed for these situations.
THE FUSING PROCESS

The means of fusing are temperature and pressure, applied over a period of time, usually in some kind of specialised fusing press.

In addition to the outer fabric of the garment, three factors determine the properties of the fused laminate:

- base fabric of the interlining
- type of fusible resin
- pattern of application of the resin to the base cloth

Base fabric of the interlining

Base fabrics are available in the woven and non-woven constructions described for sew-in interlinings and also as warp knits. The warp knits are either a lock-knit or weft insert construction.

The most usual fibre is nylon, which gives very soft handle and draping.

Type of fusible resin

Just as there is a range of stitch and seam types to achieve a range of assembly objectives and finishes, so there is a range of resin types to cover a range of laminating requirements. The choice of resin is restricted by limits imposed by the outer fabric, the fusing equipment to be used, the end use requirements, and the precise behaviour of the resins in response to heat.

The particular requirements of resins are as follows:

- The fusing temperature needed must not be so high that it will damage the outer fabric or its colour. The usual maximum is 175 °C, with 150 °C most common.

- The fusing temperature needed must not be so low that the bond is inadequate to withstand garment making. The lower limit is generally 110 °C, although leather may require even lower temperatures.
The resin must provide a bond that is suitably resistant to washing and/or dry-cleaning.

The thermoplastic nature of the resin must be such that adjustment of temperature is sufficient to permit it to penetrate the outer fabric to give a bond, without flowing excessively to give strike-through or strike-back.

The resin must contribute to the achievement of the desired handle of the laminate.

In the majority of end uses, the resin must be white or transparent. It must also have low dye retention properties.

The resin must be harmless in processing and in end use.

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Polyethylene coatings are available in different densities and with different values of a property known as the melt flow index. The value of this index determines the extent to which the resin flows during the fusing operation and the higher its value, i.e. the more easily it flows, the lower will be the subsequent resistance of the laminate to dry-cleaning solvents. The effect of varying the density of the resin is to give a greater resistance to dry-cleaning solvents, and a higher softening point, with increasing density. All the polyethylene resins used in fusible coatings are washable and, in the higher densities, they are both washable and dry-cleanable. They require high bonding pressures on the fusing press. Their main use is in interlinings for shirt collars.

Polypropylene resin is similar in properties to high density polyethylene but reaches its softening point at a higher temperature. This makes it especially suitable for fusing applications where rapid, high temperature drying is part of the garment laundering process. The resin will withstand temperatures at the glue line of 150 °C before delaminating.
**Polyamides** can have a wide range of fusing properties, according to the proportions of the basic ingredients of different nylonls employed as well as the amount of plasticiser added. The objectives are to vary the melting range and lower the softening temperature. Polyamides are used widely in dry-cleanable garments. Polyamides in the higher temperature melting range are generally washable up to 60 °C but in the lower melting ranges they are dry-cleanable only.

**Polyesters** have a similarly wide range of fusing properties as a result of varying the constituents. These resins are used in garments that are dry-cleanable and washable, because polyesters are less water-absorbent than polyamides and therefore resist washing better.

**Polyvinyl chloride (PVC)** is generally printed on to base fabrics as a plasticised paste; the fusing temperature is determined by the amount and type of plasticiser used in its formation. It is both dry-cleanable and washable. It is used commonly in large area applications on coat fronts.

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**Plasticised polyvinyl acetate (PVA)** is normally in the form of a continuous coating for fusing to leather and fur at low pressures and temperatures. It is not dry-cleanable and has limited washability.

A small number of other chemicals have been tried but they are not in widespread use.

**Methods of applying resins to base cloths**

There is further scope for varying the properties of an interlining and its effect on the outer fabric of a garment by varying the application of the resin to the base cloth. The most popular methods used are:

- scatter coating
- dry dot printing
- paste coating
All the methods involve the use of carefully selected particle sizes of the various resins. Scatter coating uses the largest particles, from 150 to 400 microns; dry dot printing uses particles from 80 to 200 microns; and paste coating uses the smallest at 0 to 80 microns (1000 microns equals 1 mm).

In scatter coating, specifically designed scattering heads are used to provide an even scatter under automatic control. The resin is then softened in an oven, pressed on to the base cloth and cooled. This is the cheapest method of making a fusible but the product is neither as uniform nor as flexible as printed coatings.

With dry dot printed coating, the powdered resin fills engraved holes on a roller. The base cloth passes over a heated roller and then against the engraved roller. The powdered resin adheres to the cloth in the form of dots. Oven heating follows the printing operation to ensure permanent adhesion. The temperature and pressure on the two rollers is varied for different resin types. Patterns of dots can vary from 3 to 12 dots per centimetre according to the garment manufacturer’s requirements. Generally, lighter weight garment fabrics require interlinings with smaller dots in higher concentration, while heavier weight fabrics require larger dots in lower concentration to allow good penetration into the fabric surface and give a satisfactory bond.
With *paste coating*, fine resin powders are blended with water and other agents to form a smooth paste and are printed onto the base cloth. Heat removes the water and the dots coalesce into solid resin. This type of coating gives precisely shaped dots and is used to produce the finer dots used in shirt collar fusibles.

Others methods of applying resins to base cloths include preformed systems, where a preformed net is laminated to a base cloth to form precise dot patterns such as are used on top collar fusibles; extrusion laminating, producing a continuous film of polyethylene, also used in shirt collar applications but resulting in a very stiff product; and emulsion coating, for instance by dipping the base cloth into a bath of emulsion, squeezing out excess resin by rolling, and drying in an oven to produce double-sided coatings.

Choice of resin type and method of coating relates to cost, fusing characteristics, suitability for use with particular fusing equipment, durability when washing and dry-cleaning, and particular garment end use.

### MEANS OF FUSING

Fusing equipment must control three factors:

- **temperature**
- **pressure**
- **time**

**Temperature**

This must be high enough to achieve the necessary temperature at the glue line which will change the dry thermoplastic resin into a partially molten state in order that it will flow. For each resin there is a limited range within which the correct level of flow is achieved. Too low a temperature gives poor flow and poor subsequent adhesion. Too high a temperature gives too much flow, resulting in strike-back and strike-through and a reduction of performance in most respects.
Pressure

The equipment must provide enough consistent pressure to ensure intimate contact between interlining and outer cloth over the whole surface of the interlining. This ensures correct transfer of heat to the glue line and correct penetration of resin among the fibres of the outer fabric. Too low a pressure reduces penetration with consequent low adhesion. Too high a pressure provides excessive penetration of resin resulting in strike-back and strike-through.

Time

The equipment must give enough time to allow the temperature and pressure to induce melting of the resin and penetration of the outer fabric in order to produce a satisfactory bond; too much time may result in strike-back and strike-through. It will be appreciated that if a thick fabric and an interlining are put into a heated press in a cool state, it may be several seconds before the resin reaches the required temperature.

FUSING EQUIPMENT

The equipment used for fusing can be divided into:

- specialised fusing presses
- hand irons
- steam presses

Specialised fusing presses

Flat bed fusing press

It consists of two horizontal metal platens between which the fabric and interlining laminate are sandwiched. The top platen is unpadded but the bottom platen has a resilient cover, typically silicone rubber, though it may be a felt pad. Both platens have an outer cover of PTFE, which can be cleaned easily to prevent straining and build-up of resin that would cause garment parts to adhere to the platen.
Heat is provided by electric elements, usually in the top platen only, but sometimes in the bottom as well. The elements provide a uniform temperature over the whole surface.

Flat bed fusing presses. (i) Vertical action. (ii) Scissor action.

The press manufacturer aims for a standard of control allowing a variation of 5 °C either way from the required temperature over the whole surface area. Pressure is applied by closing the platens together mechanically, hydraulically or pneumatically. The pressure system must be robust, provide accurate closing over a large area, and be free from distortion through heat, wear or mechanical faults. The resilient bottom cover should be changed regularly to avoid pressure problems. Vertical action closure gives more accurate pressure than the scissors action. Fusing time is normally controlled by an automatic timer, whose cycle can be varied to suit different requirements. It is typically of the order of 8–12 seconds.
In the simplest mode of operation, the operator places the garment part face down on the lower platen, places the interlining resin side down on top of it in the correct position, and closes the press. This is slow and time-consuming as the operator can do little that is productive for the duration of the fusing cycle.

These presses do not cover a very large area, often no more than one metre by half a metre, and the number of garment parts that can be fused at one time will depend on their size. Where small parts are being fused, output may be increased by laying them on a sheet of card which is then placed in the press.

Accuracy of positioning of the interlining on the garment part is important, not just for the garment, but for the cleanliness of the press.

Where the whole area of a garment part is being fused, the interlining pattern is normally slightly smaller than the garment pattern so that there is no possibility of the interlining extending over the edge of the garment part.

Variations in the design of these presses can improve productivity, in particular by having a twin-tray system that slides in and out from under the top platen, or a three-station carousel which has two operators at separate loading and unloading stations.
One of the advantages of this type of fusing press is that in the simplest version, their small size and relatively low cost allow their use by the smaller clothing manufacturer. They also tend to reduce fabric shrinkage since the fabric is held under pressure throughout the fusing cycle. A disadvantage is the tendency to crush pile fabrics such as velvet because of the length of time that they are held under pressure.

Continuous fusing systems

These systems operate by passing the garment part, with its interlining placed on it, past a heat source, and either simultaneously or subsequently applying pressure. Heat is provided in one of three ways:

- With direct heating, the conveyor belt carries the components to be fused into direct contact with a heated surface, either a drum or curved plates.

- With indirect heating, the components to be fused are carried through a heated chamber.

- With low temperature, gradient heating, the components are carried through a pre-heating zone. Heating is either direct or indirect. With this approach the temperature reached at the glue line is only just above that required to make the resin a viscous fluid and in some cases fusing takes place satisfactorily with a glue line temperature of only 120 °C. This reduces the possibility of heat shrinkage in the outer fabric and is a feature of some of the most recent fusing presses.
The maintenance of the required temperature is less of a problem inside a fully enclosed, continuously operating press than with a flat bed press, especially with modern electronic temperature controls.

On drum presses, the tension of the conveyor belt presses the components continuously against the heated drum during the complete fusing process. Where conveyor belts carry the components past heating plates (direct) or through a heating chamber (indirect), nip rollers apply pressure to the assembly after heating.

- The pressure time is very small compared to that in flat bed presses and has to be controlled more precisely.
- The loading on the rollers is applied by springs or pneumatically at their ends. Rollers must be maintained parallel, unbowed and free of wear to give even pressure. The rubber covering of the rollers is available in a range of hardnesses. Usually shirt top collar fusing requires the hardest rollers and outerwear fabrics require softer rollers.
- Fusing times depend on the speed of the conveyor belt, which can be adjusted to give various dwell times in the heated zone.
- Companies engaged in high-volume garment production generally use continuous fusing systems, both for the quality of the fusing they give and for the productivity gains.
- Unloading may be by operator at the far end, or by automatic catcher, or the press may divert the fused parts back to the loading station.
Continuous fusing presses generally reduce any problems associated with fusing pile fabrics such as velvet because the duration of pressure on the fabric is short. For the same reason, though, fabrics prone to heat shrinkage are likely to shrink more when fused in a continuous press than when held firmly in a flat bed press.
High frequency fusing

In the fusing presses described so far, heat has been provided by electric heating elements. This limits the number of thicknesses of fabric that can be fused at once because of the time taken for the heat to transfer through the fabric to the resin. The heat may also produce shrinkage and colour changes. If multiple layers of fabric and interlining can be stacked up and fused simultaneously, productivity might be increased.

Over a number of years, attempts have been made to do this by generating the heat by means of high frequency (HF) energy, in the same way as in a microwave cooker. This method offers the possibility of eliminating shrinkage and colour changes.

The heating effect is different for different polymers, and many fibres are not affected at all. The fusible adhesive material heats up much faster than either the interlining base fabric or the garment fabric. This results in bonding at the glue line without excessive heat being generated in the fabric.

Multiple plies of garment and interlining can be stacked up to 70 mm high, and since the heating effect is not dependent on its distance from a heat source, the adhesive at each joint should be raised to the same temperature.

Less pressure is needed than with conventional fusing presses. The time required to generate the heat depends on the capacity of the high frequency unit and the weight of the load to be fused. For a typical 30 kW unit, operating times of 1–3 minutes may be achieved for loads of 5–20 kg.

The difficulty that arises with this method of fusing is that the press must be set to allow for the particular natural or man-made materials being used, the weight and thickness of those materials, and their moisture content. This has not been found easy, especially in the case of the moisture content. If incorrect estimates are made, the press may overfuse and bond the whole stack together, or underfuse and produce a poor bond on each garment part.
**Hand iron**

Only those interlinings that can be fused at relatively low temperatures, low pressures and in relatively short times are suitable for fusing by hand iron. There are a number of difficulties:

- The operator cannot know the temperature at the glue line and cannot apply pressure uniformly.
- The operator estimates the time subjectively.
- Only small parts can be fused with any degree of success, and then only by pressing the iron for a fixed time on to the fusible, covering the area step by step and using steam to help the heat transfer.

In this situation, garment parts may appear to be satisfactorily fused initially but deficiencies will show up as delamination during wearing or cleaning of the garment.

When the iron is used merely to position an interlining part or tape temporarily, to be followed by pressing on a steam press, fusing conditions are more satisfactory. This is common in menswear where additional, reinforcing, fusible tapes are often added during the construction of a jacket, in positions such as pockets, vents and hems.

The garment is placed on a shaped press (described in the next chapter), the interlining sections are positioned using the hand iron, and the press is closed to effect complete fusing. On jacket hems, a slotted interlining tape is often used; once this is fused on, the iron can be further used to press up the hem along the line of slots before further sewing.
Steam press

In this case fusing takes place on presses of the type used for intermediate and final pressing of made up garments. Temperature at the glue line is achieved by steam from the head of the press. The resins that fuse most successfully on a steam press are polyvinyl acetate and the lower melting range of polyamides, but fusing is not as effective as when using a dedicated press.

A specialised use of a steam press for fusing is in the positioning and initial attaching of fusible shoulder pads in men’s jackets.

Methods of fusing

All the descriptions of the fusing process that have been included so far have represented it as a single piece of interlining, laid resin side down, on a single piece of garment fabric, laid right side down. This is referred to as single fusing, and is the safest in the sense that it is easiest to set the press conditions to achieve the correct temperature at the glue line. Several other configurations are possible, both in terms of the presentation of the parts to the fusing press, and in the parts that are included in the garment. Some of the variations will now be described; illustrating them will demonstrate some of the methods of garment construction that involve fusible interlinings. The main variations are:

- reverse fusing
- sandwich fusing
- double fusing
- block fusing (HF fusing)
**Reverse fusing**
In this method the outer fabric lies on top of the fusible. It is sometimes used in fusing shirt and blouse collars. On flat bed presses with elements only in the top platen, it is necessary to adjust temperature settings. Since the interlining part is normally slightly smaller than the garment part, accurate positioning may be difficult.

**Sandwich fusing**
This is effectively carried out only on a horizontal continuous press where heat is applied both from above and below. Two pairs of components, forming two laminates, are fused together, with the two outer fabrics on the outside of the sandwich (of four layers) and the two interlinings on the inside. With correct temperature settings, the glue line temperature may be achieved in both laminates, but the potential for strike-back occurring and causing all the layers to adhere together is considerable. A small amount of fusing time will be saved but preparation will take longer and the quality of the results may be unsatisfactory.

**Double fusing**
This is the fusing of two sorts of interlining to the outer fabric in one operation. It is most commonly used in shirt collars and men’s jacket fronts.

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**Quality control in fusing**

**Temperature control**
It is necessary to calibrate fusing presses before operating them, in order to relate actual glue line temperatures to thermostat settings. The glue line temperatures required for fusing will always be lower than the thermostat temperatures displayed owing to the insulating effect of press cladding, interlining and outer fabric. A further factor is the heat required to remove the regain, the natural moisture contained within materials, which is a variable factor. If the machine is not fitted with a sensor, two methods of checking temperature are available:
A portable *pyrometer* is a device consisting of a long wire probe that can be inserted into a press, between plies of interlining and fabric; the pyrometer shows on a dial the temperature achieved after a certain time of closing of the press. It can be used only on a flat bed press and should be calibrated itself using heat sources with known temperatures, e.g. boiling water.

A *thermopaper* consists of a narrow strip with a series of heat-sensitive areas. Each section along the thermopaper is marked with a temperature and it changes from white to black if that temperature is reached while it is in the press.

Whether the press is being calibrated initially, or is in use for fusing, it must be allowed sufficient time to reach its working temperature after switching on.

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**Pressure control**

Adequate and even pressure over the whole area of a fusing press is essential, and although there will probably be a dial showing the pressure in the compressed air line supplying the press, this does not provide a very good indication of the actual pressure on the platens. In practice, only the evenness of the pressure can be measured. The method uses strips of paper in different ways according to the type of press. For example, with *continuous presses*, provided access can be gained to the rollers in the press, strips of paper can be passed through the press which is stopped when they are partially through the rollers. Pulling out the strips by hand will show if there is any bowing in the rollers. The most important check, however, is whether the desired bond strength is achieved, and this laboratory test should be carried out as a matter of routine.
Time control

In the calibration of a press, the representation of time on the press controls
must be related to the actual time of fusing, i.e. the time of press closure for
a flat bed press or the time of heating in a continuous press. It should not be
assumed that the time in seconds given on a dial is what is actually
happening. Both types of press can be checked with a stop watch.

In the course of checking the temperature on each type of press, the time
cycle required for the desired temperature to be reached will be discovered.
This will change for different fabrics and interlinings, as with thicker fabrics
more time will be needed for the heat to penetrate to the glue line. When a
garment is designed, and the interlining is selected, checks should be made
to establish the fusing conditions, which must be specified for production.

Garment quality control

• Bond strength
For each new style of garment, a figure must be established as the
required standard. Tests for peel bond strength should be carried out at
least twice each day during the production run of the style, the figures
recorded, and action taken to investigate the cause if inadequate
strengths are discovered.

• Heat shrinkage and colour change

• Cleanliness of the press and surrounding area
Pressing

The purpose of pressing

- Presenting the fabric for retail
- Making creases
- Moulding the garment to the contour of the body
- Preparing garments for further sewing

The term ‘underpressing’ is reserved for pressing operations on partly constructed garments, while top-, off- or final pressing is used for completed garments, the actual term varying according to the sector of the industry.

The means of pressing are heat, moisture (usually as steam) and pressure, singly or in combination. Equally important, after the application of heat and moisture, is the application of vacuum, which sucks ambient air through the garment as it lies on the buck (the lower part of a press) or pressing table. This dries out residual moisture from the garment (and the buck cladding) rapidly and ensures that the set imparted by pressing is retained.

Steaming of garments on a press without the head of the press locked closed produces garment temperatures just short of 100 °C and it is only by locking the press head closed for at least ten seconds and adding further steam that the required temperatures of around 130 °C can be achieved.

A concern of the garment manufacturer, especially one using woollen fabrics, is the possibility of excessive shrinkage during pressing, resulting from relaxation of tensions from inadequate setting during fabric finishing. Some manufacturers carry out their own shrinkage operation before spreading and cutting, usually by a form of steam blowing or decatising, but occasionally by immersion in cold water with a wetting agent followed by air drying at room temperature.
PRESSING EQUIPMENT AND METHODS

Iron

The industrial version of the hand-iron is usually part of an ironing station, and offers the same facilities as the domestic one but commonly uses a floor-standing boiler to provide copious amounts of steam and this is fed into the iron through a high-pressure hose. The iron is often suspended from a cantilever arm using a counterbalance spring, to ease the drudgery of wielding the iron over extended periods of time. This also allows the iron to be heavier when required; industrial irons generally weigh between 1.0 and 2.5 kg.

Industrial steam irons may be fitted with a hard or soft brush to assist in crease removal, and they also have options for the fitting of Teflon or non-shine sole-plates. Irons are also available in a selection of shapes for specialised tasks; ranging from wide, heavy irons for removing and re-positioning creases and for pressing winter coats to small, narrow irons for flattening open seams on shirt sleeves.

There is a range of workplaces available for ironing. Modern tables have a supply of vacuum to hold the garment in position and dry and set it after ironing. The flat table can be fitted with swivel arms, which present bucks of varied shapes to allow the laying of sleeves, shoulders and collars without distortion or the danger of creasing.
Dress board ironing station with both air suction and blowing. The unit is shown with a swivel arm and sleeve buck; it also has a cantilever iron support gantry.

Steam press (Hoffmann press)

The Hoffmann press is valuable in industrial clothing manufacture because it can process garments very quickly; it uses very hot dry steam, high pressure and swift cooling. In order to avoid damage to the textile fabric, it is very important to control the timing of each stage accurately.
Press for jacket shoulders and collars.
Pressing without pressure

The tunnel finisher

Steam finishing using a tunnel process is based around a continuous conveyor to which garments on hangers are attached. The conveyor first draws the garments through flexible entrance curtains into a steam cabinet. Once inside, the garments are exposed to low-pressure steam. Hot air may be mixed with the steam to adjust the humidity; however, as the environment is unpressurised, it is not possible to provide steam in excess of 100 °C. Dry, superheated steam from a pressurised generating source inevitably suffers adiabatic cooling as it expands into a cabinet that is at atmospheric pressure. The damp steam that results relaxes the textile fibres, but offers only a limited capability to remove creasing, as the temperature is not particularly high and the only tension on the fabric is that due to gravity.

After exposure to damp steam, the conveyor transports the garments into a drying area where warm air is blown through the garments, primarily to remove moisture and to inhibit the development of mildew. In order to improve the capacity for crease removal, turbulence is commonly introduced into the air flow to help shake out the creasing from woven fabrics. Some tunnel finishers are capable of processing 3000 garments per hour using synchronised conveyor loading and it is optimised for energy efficiency. The dried garments often proceed directly to a bagging machine that wraps them in a clear plastic film, still on their hangers.
The steam-air (dolly) finisher

Steam-air finishing is specifically intended for use with completed garments. This category of finishing equipment comprises either a metal dummy (mesh space-frame) shaped appropriately to support a knitted garment which is placed over this former in preparation for processing. Alternatively, for clothing made from woven fabric, a partly inflated porous cloth bag may be provided onto which a shirt or jacket may be placed ready for finishing. Similarly, two long thin bags may be used for pressing casual trousers such as chinos or jeans, where creases are not required.
The operator locates an item of knitwear on the former (or a woven item on the dolly bag), and it follows by injection of steam into the former. (If a dolly bag is being used, the bag will inflate until its expanded size is constrained by the garment mounted on it).

The steaming cycle lasts for around 10 s, depending on the type of material being used and on the temperature and quality of the steam. At the end of this cycle, hot air is blown through the finisher in place of the steam, hence the garment is dried to preclude the occurrence of mildew. A third cycle, that of cold air ensures that the textile material has been set before being subjected to the stresses and strains of the removal process. The whole process extends over about 30 s.

It may be noted that clamps are usually applied to button bands to prevent distortion of the tensioned fabric around the buttons. For very delicate fabrics, a non-stretch woven cover may be placed over both the garment and the dolly bag to prevent excessive straining of the material as it is inflated.
The Veit TwinStar shirt press utilises heated external shaping plates in conjunction with an internal air bag which inflates to apply even pressure to the garment.