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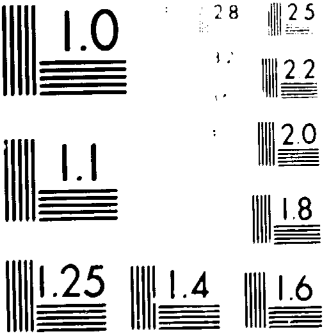
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TEXTILE FINISHING - WET PROCESSING

J. Zartl

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J. Zartl

Contents

WET PROCESSING (FINISHING)

by J. Zartl

1. Introduction

Unlike to cotton or rayon, the synthetic fibres (nylon 6 and 6.6, polyester and polyacrylonitril) already have easy - care criteria. The imparting of special properties to synthetics is described more generally as "finishing".

Synthetic fibre woven and knitted fabrics are usually finished by application of physical processes. Apart from the setting that is unavoidable in the case of polyester and polyamide fabrics, finishing has the object here of imparting special properties to the goods according to the purpose intended and the hence associated requirements of the consumer, or to diminish equally specific disadvantages.

The application of chemicals to synthetic textile materials has now attained considerable importance. The number and reactivity of the functional groups in synthetic fibres is less than in cellulose, so that these chemicals are frequently only deposited on the fibre or they are caused to react, whereby the molecular size is increased. A chemical bond with the substrate is often doubtful.

It is therefore more difficult to attain permanent effects on synthetics than it is with cellulose which frequently undergoes a chemical reaction with the applied products, as in resin finishing. The finish effects obtained on synthetics are more permanent when the chemicals can diffuse into the interior of the fibre and dissolve in the substrate. Hitherto, this was the case only in dyeing and optical brightening, but, more recently, methods based on this principle have been developed to produce permanent finish effects.

The chemicals which are used can be devided into two main groups:

1) Textile Processing Aids.

These are products used in the processing of textile fibres yarns and fabrics prior to dyeing and finishing. They include such things as wetting agents, lubricants, emulsifying agents, antistatic agents and detergents. About this group we have it heard during the preceding lectures.

2) Textile Finishing Agents.

These are applied to scoured (washed) woven or knitted fabrics to impart a particular type of finish. Such agents include water repellants, softeners, stiffeners, "wash wear" resins and others.

My lecture will deal only with the second group, the group of the "wet processing".

2. Washing Processes and Wet Processing

2.1. General Aspects

The "wet processing" begins after the dye has been bonded to the fibre by steaming. The thickenings and the surplus dyes and chemicals must be removed by washing. Concerned are water soluable or unsoluable substances such as pigments or oils.

These processes can be continuous or discontinuous washing-processes with a high speed of the goods, short contact-time and a relativ low bath-ratio.

It appears to be most successful when the washing processes are broken down according to the steps at which a particular particle is to be removed.

Figure 1

" P r e c l e a n i n g " is the first washing process of the untreated goods (raw materials)

" I n t e r m e d i a t e - c l e a n i n g " follows after the bleachingprocesses.

The further " i n t e r m e d i a t e - c l e a n i n g s " are used after the dying and printing process in order to remove nonbonded dyes and chemicals to increase the fastness.
The " P o s t c l e a n i n g " is one of the last steps within the finishing processes with special treatments.
By this process the synthetic resin particle is removed from the surface of the fibres after the application in the finishing.

In the washing of the modern continuous units, the full width washing units, the dwell-times are often only seconds long. Therefore the characteristics of the fibre are important in the determination of the length of time in the wash bath. It is most important that the fibre, fabric or yarn in use shall be rapidly and uniformly wetted. Water may not give a sufficiently rapid and even result and therefore certain products are used to increase the speed of wetting.

The wetting-agents or detergents have many duties:
(wetting, emulsifying, dispersing and soil-supporting-ability)
The substances which are used and whose molecules consist of one hydrophobic and one hydrophilic part are signified by certain properties.

Figure 2

In the wash-bath, the hydrophilic parts are surrounded by watermolecules, while the hydrophobic part attempts to leave the watery medium. By this orientation of the molecules the surface-tension of the water and interfacial-tension between water and textilgood are decreased, whereby the wetting is made possible.

Figure 3

In the washing process, the interfacial-active molecules are orientated to the hydrophobic foreign body, and also the hydrophobic detergent-parts are orientated to the textilgood. In order to make a washing-procedure possible it is necessary that the foreign bodies be eliminated from the textil. This procedure takes place in several places although it should follow spontaneously.

Figure 4

This procedure has the effect, that the foreign bodies on the fibres are pushed together in ball shaped drops in the wash bath. These drops are then washed away by the mechanics and turbulence of the wash-bath. They are at the same time emulsified in the wash-bath. Anionic and Nonionic Agents are used as detergents.

Anionic agent:
Representative compounds are shown on Figure 5.

Nonionic agent:
On Figure 6

In the last twenty years the nonionic agents have proved themselves very useful in textile finishing processes. They have a very good pigment-washing effect. The number of ether-bridges determines the watersolubility, respectively the solubility in oil.

Along with the detergents a certain amount of energy is necessary in removal of the foreign bodies from the substrate. Water itself is a very important factor in the transport of energy. It is supported by the actual mechanics in the form of squeezing, rubbing etc. whereby the result of washing is positively influenced by the raising of the washing temperature.

2.2. Washing Units

One sees that the rinsing of water insoluble materials is an exceptionally complex procedure and that there is no standard description. Experience and the enjoyment in experimentation play an important roll in this procedure as in many other finishing processes. The equipment has a very important influence on the effect of washing. When can choose between two types of washingunits.

The "rope" washing unit and the "full - width" - washing unit.

"R o p e" - washing unit:

The goods run as a rope through the machine and are creased. The goods can therefore not have a high crease-sensibility.

"F u l l - w i d t h " - washing unit:

Puts less stress on the goods since they are not creased in the washing. In order to have a good washing-effect the unit must be of large demention or the mechanical treatment of the goods must be intensified by additional equipment.

Figures 7, 8, 9 show a " r o p e - a - m a t i c "
Possibility exists for different washing and rinsing baths.

The continuous washing-unit was developed from the winch-beck and is supported by an automatic rinsing-equipment.

F u l l - w i d t h - washing unit is shown on Figures 10, 11, 12.

The effect of washing is increased by additional equipment as f. ex. "Turbonators".

Figure 13

2.3. Drainage

After the washing, the textile is mechanically drained and then dried with warm air. Since the drainage is cheaper the the drying, the drainage must be for economical reasons optimized, so that the drying is used as seldom as possible. A good finisher will always try to treat the drained goods further (wet on wet process) and leave the expensive drying process for the very end. Because of the rapidly increasing cost of energy, this wet on wet - treatment is nowadays very important.

In the drainage-process one uses the squeezing-pressure of rollers, the centrifugal power or the suction-air (vacuum) for removing the surplus water.

The principal of a squeezing unit is that the flatly laid textile is drained as it passes between two rubber-rollers.

2.4. Pick up

If we want to "finish" - the material, we "pick-up" in this step a finishing agent on a dry (or wet) fibre or fabric. Usually, this is an impregnation of the fabric in a (aqueos) solution of the finishing agent on the pad.

Figure 14, 15, 16.

The textile is passed through a horizontal bath of finishing agent and then through a pair of pressure rollers, which control the pick-up of agent and, at the same time, ensure complete impregnation with the minimum of solvent.

Furthermore there is the possibility of applying the finishing product to the textil by coating, brushing or spraying.

2.5. Drying

The final drying with warm air must remove the remaining water. The textile should not be overdryed, if natural fibres are present. The drying temperature, the direction of the air and the speed of the air, are all important for economical drying. There have been many new dicoveries in this field in the last twenty years.

Drying machines may be divided into three types,
(a) drying cylinders,
(b) stenters and
(c) hot air stoves.

Drying Cylinders. This equipment consists of a battery of steam heated metal cylinders, the cloth passing from one cylinder to another in contact with the metal surface. The steam pressure used is low. (0,7 At; 115^{o} C) and a range containing 20-30 "cans" or cylinders is common.

Figure 17

Stenter Drying. Stenter driers consist essentially of two parallel endless travelling chains on which are mounted a series of clips or pins which grip the edges of the cloth and carry it into a hot air chamber. The selvedges may be gripped by either clips or pins fixed to the travelling chains. As the cloth is held at the edges only, hot air blasts bring about very rapid drying and water vapour is rapidly removed from the vicinity of the fabric. Since the distance between the chains can be controlled, drying can be carried out at predetermined widths whilst warpways dimensions can be controlled by adjusting the tension of the cloth as it enters the stenter. As the body of the cloth does not make contact with any surface during drying, its appearance is unaltered and the lofty, fuller handling properties of a fabric are maintained. Cloth can be dried at c ntrolled temperatures which may vary between 65 and 220° C. Air cushon dryers do not need clips or pins. The cloth is carried by a special hot-air gui ing.

Hot Air Stoves. The simplest form of hot air stove consists of a chamber carrying rollers along the top and bottom. The cloth runs up and down the stove over the rollers, and is dried by circulating hot air which is usually heated by closed steam coils. There is little contact between the cloth and any surface (merely the rollers surfaces) and so flattening effect of can drying is not obtained. There is no weft tension device, and usually some stretching results from the tensioned condition of the cloth as it passes over the rollers.

Figure 18 shows the entrance section of a stenter.

Figure 19 gives a survey of the stenter-dryer.

There are also other drying-systems such as over heated steam or direct contact-warmth, infrared-lighting, but these systems are not so universally applicable.

2.6. Curing or Baking

For satisfactory working, a machine is required which will operate continuously at temperatures as high as 150 - 160° C. Lower temperatures can be used depending on the type of finish and time of baking and dry heating is, of course, essential. The most common baking machine consists essentially of a simple hot air stove carrying rollers top and bottom over which the cloth passes. The necessary heat is supplied by high pressure steam, gas burners, non-glow electric heating elements, or a combination of these. In such a drying and curing unit, the drying time at 110-140° C is 30 seconds and the corresponding curing-temperature of 170-185° C for 30 seconds. The desired rate of production in such a flush-curing-process is 18 m/sec., if the stenter has a length of 18 m.

Figure 20

2.7. Mechanical Finishing

It must be remembered that in many cases the application of finishing agents is only a contribution to the final finish. Apart from the mechanical effect produced by different drying machines, e.g. cans and stenters, the finish produced on a fabric can be considerably modified by mechanical treatment. However, apart from the thin, highly lustrous finish given by calendering, there are many machines used in the finishing trade which are employed to produce the final effect. Scheinering machines are used to give more durable and less "highly polished " lustre than is obtained by calendering. In addition hydraulic presses, embossing machines, raising machines and many others play a very important part in finishing. Whilst many of these machines are long established they can be used with advantage along with finishing agents, as for example in the production of durable glazed and durable embossed effects.

3. Finishing of Synthetic Fibres

More recently, woven and knitted fibre fabrics have increasingly been finished by the application of chemicals. Such are:

3.1. Filling and Stiffening Finishes

A stiffening finish is often required for certain polyamide and polyester materials, such as those used for collar interlinings, petticoats, lacework, tulle, or trouser abrasion tapes. Methylol-ureas adhere very well to the smooth surface of the polyamide fibre and impart a stiffening effect. At the same time, they reduce the slipperiness of the smooth polyamide fabric. Too rough a surface, which can cause "chalking", can be satisfactorily prevented by using of an anionic silicat or specific non-ionic oxyalkylation-product as a smoothing agent.

During the last few years, synthetic knitgoods have increased very much in importance. Texturized polyester, polyamide and acrylic fibre materials are used mainly in the garment industry, where a finish that improves the wearing properties of these inherently easy-care materials is demanded. In the majority of cases, depending on the nature of the material, effects such as greater fullness or resilience are sought. For instance, the application of film-forming acrylate dispersions gives a fuller material.

3.2. Softening Finishes

Softening agents are intended to impart a pleasant handle and smoothness to the treated material. At the same time, a great majority of these products also modify the fullness of the handle.

There are no objective scales for assessing the handle of a fabric. This situation has led to a multiplicity of ratings for designating the handle. In the case of softening agents, the main criterion is the actual softness, as opposed to stiffness, and the surface smoothness, that is, low friction characteristics.

Another criterion is the elasticity (suppleness) of a fabric when subjected to elongation and compression. Although there are instruments for testing this property, it is customary to assess it by hand.

There has been no lack of attempts to devise a suitable method of test for obtaining objective and reproducible numerical values so as to provide genuine comparisons. Up to now, however no satisfactory solution has been found.

In many cases, synthetic materials are required to have a soft handle. Various softening agents are available, depending on the desired handle and on the material. Generally, the nonionic softening agents (polyethers) are used in conjunction with N-methylol compounds. These products can be used on a wide variety of cloths, and they are highly compatible with other products in finishing baths. A silk-like, scroopy handle can be achieved.

A great number of products of varying efficiency are marketed by different firms for use as softening agents. The choice of any particular agent will depend, of course, not only on the effect sought, but also on the price and efficiency of the agents available.

3.3. Hydrophilic Finishes

As is well-known, synthetic fibres and filaments possess relatively little water absorbance. The polyamides take up about 5% water and thus behave more favourably than polyesters with only 0,5% equilibrium moisture. However, when polyamide underwear comes into direct contact with the skin, it can become very uncomfortable. To improve this situation, such textiles should be given a hydrophilic finish.

In general, products based on modified polyamides, are used for this purpose. These products do not make water-repellent textiles more absorbent, but they do reduce the cohesion of the water so that it spreads itself out over a larger area and thus evaporates more rapidly. This makes the wearing of such materials more pleasant.

3.4. Water Proofing and Water Repellent Finishing

Water resistant textiles can be grouped into two broad classes, namely the water impervious coated (Water Proof) type in which the interstices between the yarns are completely filled up and the so-called water repellent type in which porosity and air permeability of the fabric are preserved.

In this first group fall rubber and plastic coated fabrics which are made by applying a succession of very thin films in the form of a soft, suitably compounded dough, and afterwards heating to cure the coating. An alternative method of manufacture is to bond two layers of fabric with a rubber adhesive. The fabrics employed in these processes are usually composed of cotton and more recently also polyester.

Fabrics of the leathercloth type can be classified with rubber coated fabrics and find many applications as water impermeable finishes. Leathercloths are made by coating a cotton or synthetic fibre non-woven base fabric with a oil of the linseed oil class; polyvinyl chloride, acrylic or polyurethane; these coatings when dried are converted to tough pliable films. Such coatings are used for boots, garments, upholsteries and for the big blowable tents.

"Water-repellent" finishes are those which resist surface wetting by water, but which do not impair the air porosity of the fabric. Water under pressure, water vapour and air can pass through the cloth.

The properties exhibited by water-repellent finishes which make them of value of prevention of water clinging to the surface of the fabric and delaying wetting of the surface. These are due to surface tension effects, i.e. to surface forces at the fabric-water interface. This surface tension effect acts as a barrier which gradually loses its effectiveness on continued contact of the fabric with water, the time taken to arrive at the stage where water penetrates and wets the fabric being dependent upon the nature of the surface finish, the fibre from which the fabric is made, the fabric structure and the presence of any contaminants (e.g. dirt picked up during use).

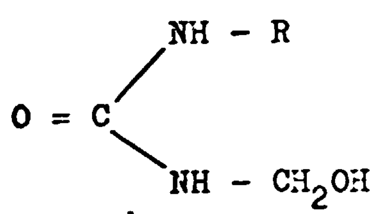
A variety of methods is available for rendering textiles water-repellent, the methods having as their basis the application of waxes, fatty bodies of metallic salts, or a combination of these substances.

The application of paraffin wax alone imparts only moderate water repellency unless relatively high quantities of wax are used. This is of course undesirable in the case of clothing fabrics because of the greasy handle which results and the ease with which the treated fabrics pick up dirt. However, it is noteworthy that if the fabric is first treated with an aluminium salt, an excellent finish can be obtained by the subsequent use of relatively small amounts of wax. The modern types of aqueous paraffin wax emulsions have excellent stability. When suitably diluted with water and used in conjunction with aluminium salts in one bath give highly effective results. The final drying temperature should be about 120°C if best results are to be obtained.

All the water repellent finishes produced by the use of wax have little or no resistance to washing and dry cleaning. All the finishes based on paraffin wax and allied fatty bodies are virtually destroyed if the fabrics to which they have been applied, are washed or dry cleaned. Many people who have had raincoats dry cleaned will substantiate this. The inclusion of zirconium salts as metal components results significant advantages as compared with products containing aluminium salts.

Resin-forming or reactive water-repellent agents have remarkable wash resistance. Research has shown that a combination of water-repellent compounds with crosslinking agents markedly improves the water-repellent effect on cellulosic fibres as a result of simultaneous reduction of swelling. Trials were then carried out to use as water-repellent finishing agents N-methylol compounds substituted with higher alkyl residues. Of the commercially available products of this group, those based on methylol melamines or methylol ureas with higher fatty acid substituents have established themselves in the textile industry.

An N-methylol urea substituted with higher fatty acid substituents has the following constitution:

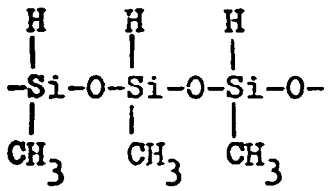


R = fatty acid residue, e.g., $C_{17}H_{35}$ -CO-

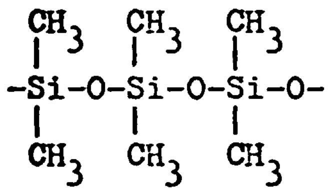
Products of this type impart to textiles of native cellulose, regenerated cellulose or their blends with synthetic fibres an excellent water-repellent effect with very good resistance to washing. If these products are combined with N-methylol compounds, the water repellency and the wash resistance improve still further.

Finishes with silicone compounds have become very significant. Silicones can be used for water repellent finishing of all types of fibres; and they offer, in addition to superior values of water repellency, the important advantage of imparting a smooth, "silicone" handle.

Practically all commercial silicone water-repellent agents contain polymerized siloxanes, i.e., hydrogenmethyl polysiloxane or dimethyl polysiloxane or blends of both types in aqueous emulsion.



Hydrogenmethyl polysiloxane



Dimethyl polysiloxane

The emulsions also often contain zirconium salts; sometimes zirconium or tin salts are also added to the liquor. Addition of zirconium salts has the purpose of suitably arranging the methyl groups of the siloxane molecules on the substrate to produce an optimum water-repellent effect; the tin salts promote further crosslinkage. Excellent results have been obtained by crosslinking hydrogenmethyl polysiloxane with epoxy resins in place of metal salts, because these often impair the rub fastness of disperse-dyed shades.

3.5. Oil-repellent Finishing

Although this type of finish is expected to have a relatively extensive field, it is not yet very popular in practice. The reasons may be those connected with the costs involved.

Oil-repellent finishing should not be considered alone, because, generally speaking, it is carried out in combination with water-repellent finishing and possibly resin finishing.

It is used primarily on upholstery material, covers, lining materials, basic fabric for convertible roofs in the automotive industry, tablecloths, outerwear, and textiles for military use.

The products used for oil-repellent finishing are compounds that contain flourinated hydrocarbon chains in their molecules, e.g., Scotchgard FC 203 (3M Company) and Zepel B (DuPont).

Reactive, resin forming water-repellent agents can be used successfully with special perflour compounds for combined water- and oil-repellent finishes. This process is becoming more popular, particularly for soil- and stain-repellent finishes on outerwear. It has been found that a resin-forming water-repellent agent not only produces a good water-repellent effect but also improves the oil- and fat-repellent effect of perfluorine compounds.

3.6. Anti-Pilling Finishes

Pilling is an unpleasant phenomenon associated with spun yarn fabrics, especially when they contain synthetics. Fibres are released from the yarn by bending and abrasion, and they combine together at the surface of the material to form knots known as "pills". These little knots contain fibres that are still partially embedded in the yarn, so that they are secured to the surface of the fabric. Resin-finishing fundamentally reduces pilling, but, in addition there are also the anti-pilling synthetic resin dispersions (polyacrylates) that have proved highly satisfactory; their wash fastness is improved by the presence of crosslinking agents.

3.7. Anti-Picking and Anti-Snagging Finishes

With synthetic textiles and especially with knitgoods, the abrasion experienced during use can cause individual filaments to work themselves out of the yarn and veil over the knit pattern as a kind of pile of varying density (cf. Figure 21, left). The term "picking" is used for this effect, which produces a fluffy, unattractive appearance on the garment. Even less pleasant is the drawing out of filaments or yarn loops onto the surface of materials made of filament yarns, when the garment catches on pointes or rough objects (cf. Figure 22). Such drawing out of threads is known as "snagging" and it can soon rake the garment worthless. Picking and snagging arise all the more quickly, the more open the weave and the bulkier the yarns. Knit goods made of texturized filament yarns are therefore the most exposed to the danger of picking and snagging.

Thus, the finisher is faced with the task of "cementing" the fibres within the yarn with a finish so that the dragging out of fibres or filaments is made more difficult, but the handle of the goods must not suffer thereby. This can be achieved particularly well with special polyacrylate dispersions.

3.8. Antistatic Finish

All synthetic fibres, have a tendency to accumulate electrostatic charges. These electrostatic charges cause difficulties during processing of such textiles and also during their use, and hence an antistatic finish is usually required. Static charges are largely dependent on humidity. For this reason, an antistatic finish of cellulosic/synthetic fibre blends is always beneficial when the humidity is low, whereas under high humidity conditions, such a finish may sometimes be unnecessary.

Synthetic fibres are given an antistatic textile processing aid or spin finish already during their manufacture. This finish, however, dissolves partial in subsequent wet treatments. An antistatic finish is therefore important during or after further processing in order to facilitate garment manufacturing and to improve the wearing properties of the garment.

In view of the large variety of antistatic agents on the market, it is difficult for the finisher to select a product suitable for his particular article. Available are cationic, nonionic and anionic products.

It must be considered that almost all of these products influence the handle of the goods and also sometimes that their effect has only limited wash resistance.

Permanent antistatic agents are based on the physical principle of thermosoling under conditiones similar to those for dyes. This group also has a good soil-release action, which is equally as permanent as the anitstatic effect.

3.9. Antistatics and Soiling

The tendency of synthetic fibres to soil is often a result of static charges on the fibre. Dust has approximately the same amounts of positively charges and negatively charged particles. A positively charged fibre will therefore attract negatively charged dust particles. The object of antistatic finishing is to impart to the fibrous material properties that make it electrically neutral. If this is achieved, the soiling tendency is reduced. Some antistatic finishing agents, however, produce a tacky film, to which soil adheres despite the good antistatic effect obtained. Thus, soil adheres to the finished fabric more than it does to the unfinished. Products that give the material stiffness and smoothness prevent deposition of soil more efficiently than antistatic finishing agents that produce a softening effect. Soiling is reduced by antistatic finishing agents that produce a non-tacky film, although the handle may become somewhat scroopy.

4. The Finishing of Fibres Blended with Synthetic Fibres

4.1. General Information

The arrival of the synthetic fibres provided the textile industry with some new fibre materials with remarkably good properties. Fibres of different types were blended to provide combinations of properties that no one kind of fibre can exhibit. Blends of cellulosic and synthetic fibres were particularly successful. While water absorbance and the ability to transport moisture characterize cellulosic fibres as regards wear comfort and low electrostatic charge, the synthetic fibres improve the durability and the easycare properties of materials. This possibility of combining certain properties is, indeed the basis of quite a number of well-known fibre blends, but blends of polyester with natural and regenerated cellulosic fibres enjoy particular popularity.

In the case of white goods, the finishing of synthetic/cellulosic fibre blends generally proceeds in two steps in order to impart optimum easy-care properties to both components. First of all, the synthetic fibre is heat-set, whereupon the cellulosic fibre is resin finished. If the flash curing process is used, and the temperature is sufficiently high, heat-setting and crosslinking can be carried out in one step. This procedure has proved particularly useful with knitgoods.

4.2. Resin-Finishing of Cellulosic/Polyester Fibre Blends

In principle, there are two fundamentally different methods of finishing cellulose with chemicals. The first method consists of depositing a low-molecular-weight chemical by polycondensation in the form of a high-molecular-weight elastic synthetic resin on the fibre. This involves no formation, or hardly any formation, of bonds between the resin and the fibre. The second method uses a chemical that does not undergo polycondensation. This chemical is made to react with the cellulose, resulting in its modification. In this reaction, the reactive groups of the crosslinking agent form crosslinkages with the hydroxyl groups of the cellulose, with formation of stable atomic bonds between different cellulose molecules. The term "resin finishing" is, therefore, not quite correct in this case, although it is often used to cover both methods of finishing. In fact, though, both kinds of reaction may occur together. The resin-finishing chemicals can be subdivided into "self-crosslinking agents" and "reactant types", depending on which of the two reactions predominates in the condensation reaction.

Crosslinking of cellulose restricts the possibility of the chain molecules being displaced. The highly valued properties, such as crease recovery and dimensional stability, are improved according to the degree of crosslinking. At the same time, the extensibility of the fibre is diminished to a greater or lesser degree. This becomes evident in the fibres becoming somewhat more brittle with a consequent loss in abrasion resistance, tensile strength, and tearing strength, again to a varying degree.

Because of its different morphological structure regenerated cellulose does not behave quite like natural cellulosic fibres towards resin finishing.

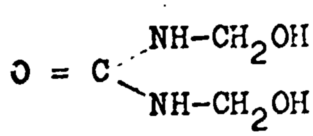
Compared with cotton, the regenerated fibre has a considerably higher water retention, and this is diminished by the finish, so that the relatively lower wet fastness is improved thereby. The reduction in the tensile and tearing strength is also lower than with cotton. The residual shrinkage and the abrasion resistance of crease-resist finished regenerated cellulosic textiles are the most important criteria of their usage properties.

The improvement in easy-care properties and the lowering of the strength values are always linked together, particularly with cotton.

A further possibility lies in compensating for the loss in strength of the cotton in finishing by blending with synthetic fibres. Resin-finished cotton/polyester fibre fabrics are therefore acquiring a steadily increasing significance.

An important way of limiting the losses in strength and abrasion resistance is to apply chemicals that counteract the lowering of the elasticity of the fibre without, however, adversely influencing the finish effect. Almost every resin-finishing recipe contains such additives.

As a staple fibre, polyester is used predominantly in textiles as a blend with other types of fibres. In mixtures with cellulosic fibres, the preferred percentage of the polyester component is either 50 or 65-70. Urea formaldehyde products e.g. Dimethylol urea (DMU)



or reactant types e.g. Dimethylol-dihydroxy-ethylene urea (DMDHEU)

$CH_2.OH$

$O = C$ — $N - CH.OH$

$N - CH.OH$

CH_2-OH

can be used for imparting an easy-care finish to the cellulosic fibre component, depending on the type of material, the blend ratio, and the handle desired.

Conventional finishing with the dry-curing process involves the following operations:

-padding,
-drying (to a specified residual moisture content),
-curing, and
-if necessary, an afterwash and aftertreatment.

In resin finishing these blends, the more sensitive partner, the cellulosic fibre component, is weakened. As regards the tensile and tear strength, this is actually of no great significance, since these losses can be compensated for by the polyester component. The same applies to abrasion resistance in the case of white or solid-shade materials. However, with bicolour fabrics, resin finishing must be carried out with great discretion and controlled by the use of additives so that no change in shade arises with the abrasion of the resin-finished cellulosic fibre. In order to keep the losses in abrasion resistance of the cellulosic fibre component as low as possible, it is recommended that in resin finishing these blends, additions should be made of polyethylene dispersions, or acrylic dispersions, or certain surface smoothers.

4.3. Finishing of Wool Blend Fabrics

The most popular wool blends on the market are:

wool/polyester 45:55, wool/polyacrylonitrile 45:55, wool/polyamide 50:50, and wool/rayon staple 70:30.

To improve resilience and residual shrinkage of Wool/Rayon Staple 70:30 blend fabrics it is appriorate to finish the spun rayon component with urea-formaldehyd condensations products, such as Dimethylol urea (DMU).

Blend fabrics consisting of wool and synthetic fibres are inherently easy-care fabrics. In general, such materials are not treated with N-methylol compounds.

However, in many cases, it is desired to impart more firmness and fullness to these fabrics. Selected plastics dispersions or solutions, such as polyacrylate or polyvinyl propionate, can be used as finishing agent.

Modified Methylol-urea too, can be used with wool/polyacrylonitrile blend fabrics to impart a full handle and some firmness.

Silicones or circonium salt-containing paraffin wax emulsiones are available for giving water-repellent finishes to wool/synthetic fibres blend fabrics.

4.4. Soil-Release Finishing

Blends containing synthetic fibres have to be washed at relatively low temperatures because synthetic fibres become plastic in hot water. Compared with the good cleansing effect obtained on cotton by washing at the boil, that obtained in a milder wash at 30-60° C is relatively poor.

This fact, together with the special behaviour of synthetic fibres towards soil, made it necessary to develop a finish that facilitates good cleansing of the easy-care textiles also under milder wash conditions. This required the study of the types of soil and the soil-repellent properties of special finishes.

Special finishes which prevent soiling or facilitate cleansing are explained in Figure 23.

The term stain repellency is the term given to a finish which prevents soil from entering the fabric bond. This type of finish is principally of hydrophobic nature.

Soil-release is the term that is given to a type of finish with hydrophilic nature, which does not prevent soil from entering the fabric but facilitates removal of soil during washing. This is obtained by products with special functional groups that facilitate removal of the soil particles from the fabric to the wash liquor.

The term anti-soil redeposition denotes a finish that prevents redeposition of the soil which has already been dissolved or dispersed in the wash liquor. In this case, the detergents and the finishing chemicals must develop a synergetic effect. Anti-soil redeposition is an important prerequisite for an effective soil-release finish.

The object of soil-release finishing is to improve the removability of soil particles in washing at relatively low temperatures. The effect should be as wash permanent as possible. For this reason, it is advisable to use a combination of reactant crosslinking agent and soil-release product. The finishing recipe should contain:

(a) Crosslinking agent (N-methylol compounds)
(b) Soil-release chemical (Polyacrylate)
(c) Selected resin-finishing additives, which do not impair the soil-release properties
(d) Catalyst
(e) Bath stabilizer

Impregnate on the pad, dry as usual, and cure under the specific conditions recommended for the crosslinking agent used.

It is advisable to calender and/or sanforize after the curing operation in order to correct the handle.

Generally speaking, preliminary trials are always advisable, because the type of substrate and the fabric construction are liable to influence the soil-release properties.

The effect that can be achieved and the wash permanence of a soil-release finish are shown in tests.

5. "One-bath Pigment Dyeing" and Finishing

The priviously described processes can be combined and used according to the desire for the individual fabrics (materials), whereby for economical reasons it is necessary to work wet on wet-process and dry only at the very end.

Processes such as the one-bath dyeing with pigment-dyes and simultaneous finishing are then the desired target of each finishing plant.

Pigment dyeing and finishing with pigment dyes and methylolurea resins can be carried out in one bath and at the same time. The method offers the economical advantages of a continuous process, including savings in labour, machine and energy costs, no afterwash, etc. It produces dyeings with very good wash, light, and rub fastness, even in pale shades, and a soft handle. A further advantage of the process is that it permits solid shades to be dyed with dyes of only one class on cotton and spun rayon fabrics, on polyester/cellulosic fibre blends, and purely synthetic fabrics.

The sequence of operations is only: Pad - dry - cure.

Figure 24

An essential condition for good evenness and good fastness properties is that the goods have good absoprtivity. They must, therefore, be desized and pretreated suitably. When the blend contains synthetic fibres, it is advisable to heat-set the synthetic fibre if this is no done simultaneously in curing the crosslinking agent.

Liquor pick-up: as low as possible. After padding is followed by drying at 100-120^{o} C and curing for 5 minutes at 150^{o} C.

Summary

A revue is given of the finishing processes after the dyeing and printing, such as washing, draining, and drying, and application of the finishing-materials.

A discussion concerning the possibilities in finishing the synthetic fibres and blends with natural fibres. Examples are filling and stiffening, softening, hydrophilic, hydrophobic, antipilling, antistatic-finishing, resin-finishing and soil-release finishing. The profitableness of the wet on wet process and the simultaneous dyeing and finishing is mentioned.

Washingprocesses of the different processing-steps.

Precleaning

of the raw materials or untreated goods
washing out of size
grease
preperation a. o.

Intermediate cleaning

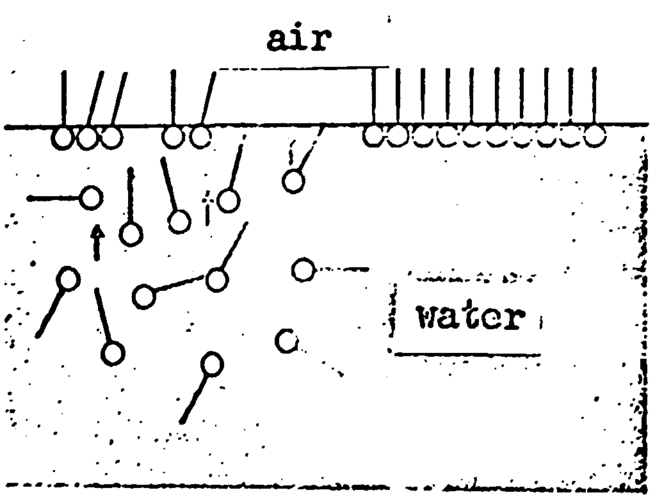
for example: after a bleaching process
washing out of decomposition products
and surplus chemicals

after dying and printing processes
washing out of nonbonded parts of dyes
pigments
carrier
reducing agents
thickener of the print past a. o.

Postcleaning

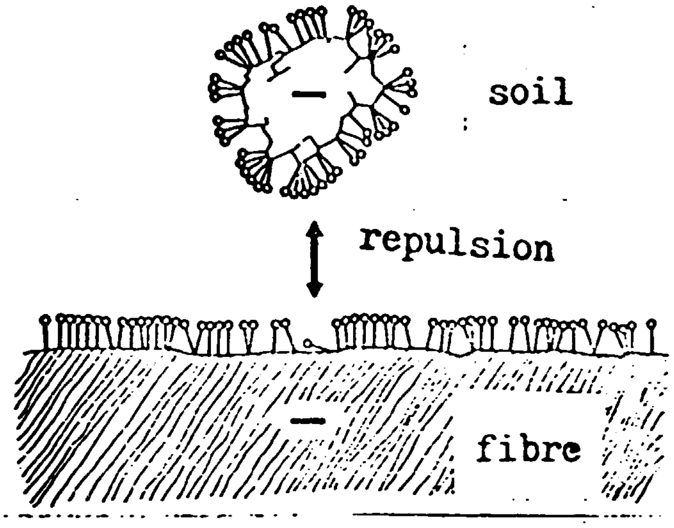
after special treatments (f.e. resin finishing)
washing out of the resinparts which are not bonded,
which are sitting on the surface of the fibres

Figure 1



Oriented adsorption of tensidmclecules on the surfacc

Figure 2



Removing of pigmentsoil

Figure 3

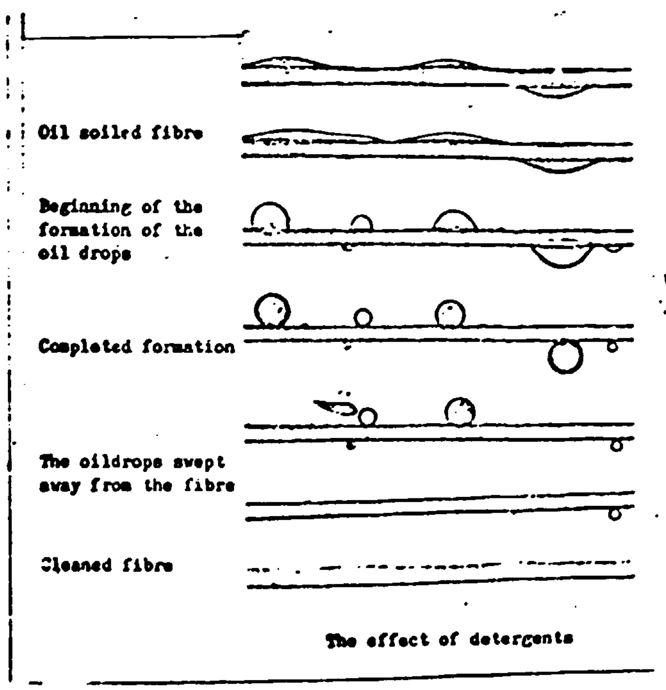


Figure 4

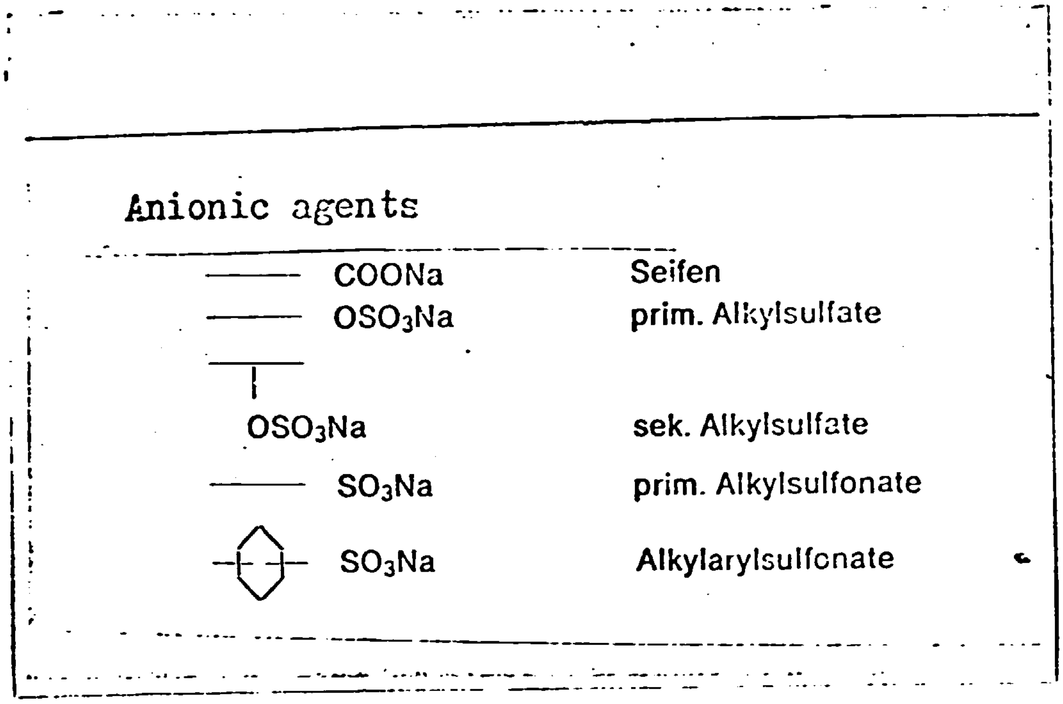


Figure 5

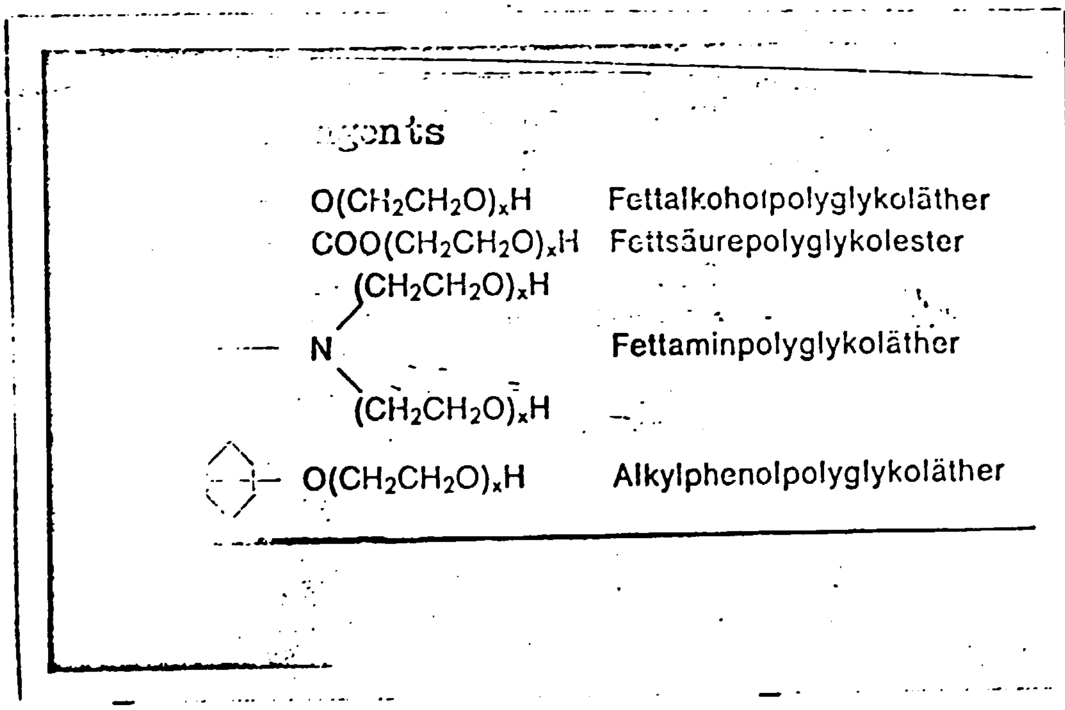
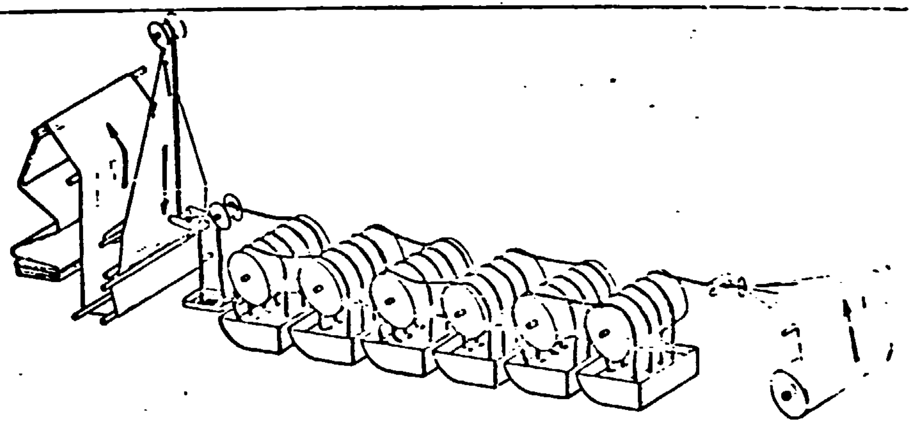
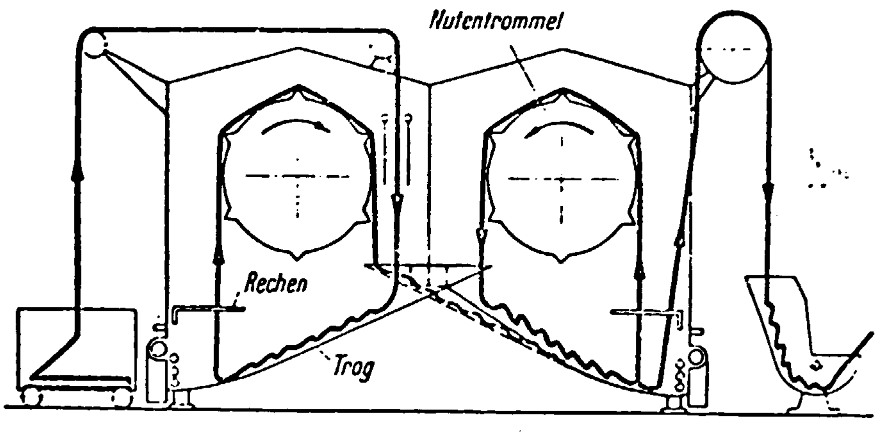


Figure 6



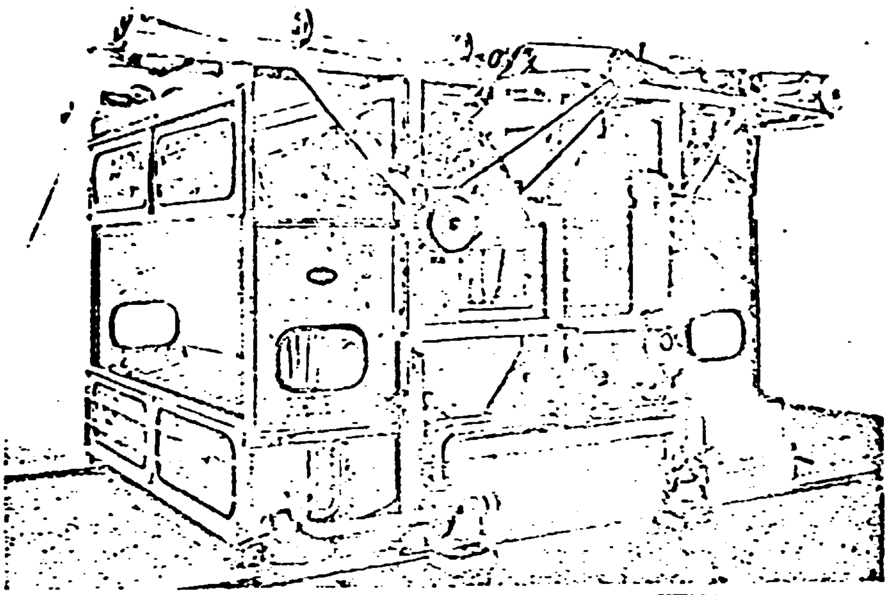
Rope-o-matic washing unit. The way of the good.

Figure 7



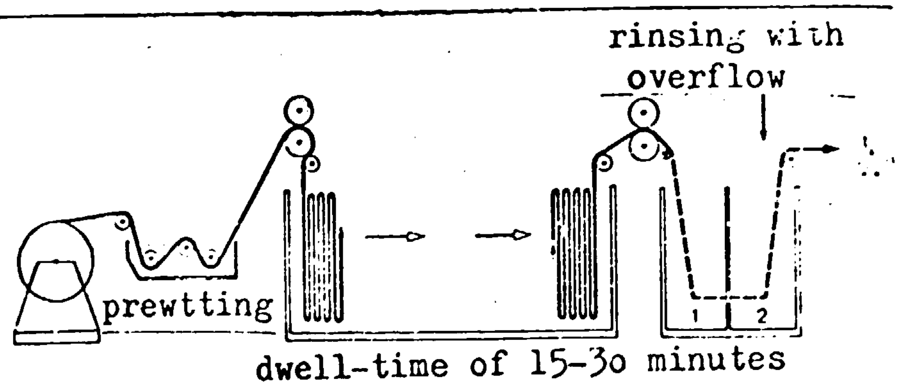
"Niagara" - rope-o-matic washing unit

Figure 8



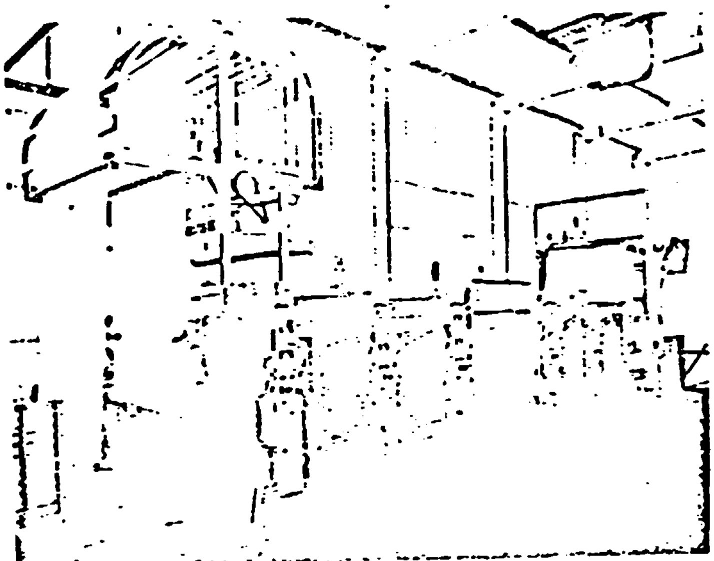
"Niagara" - rope-o-matic washing unit

Figure 9



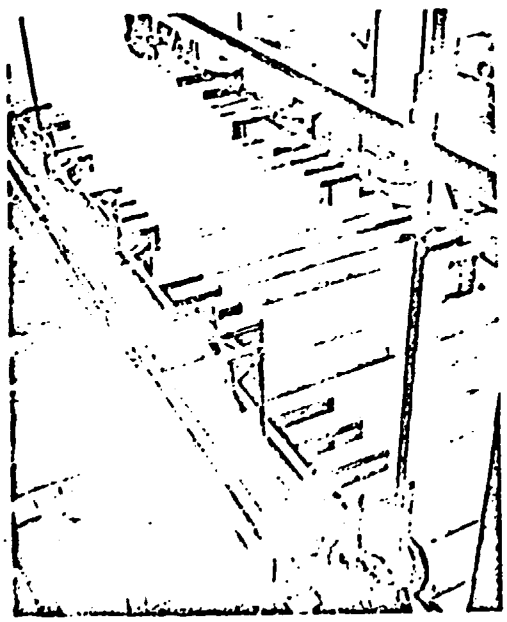
continuous dwell-time process

Figure 10



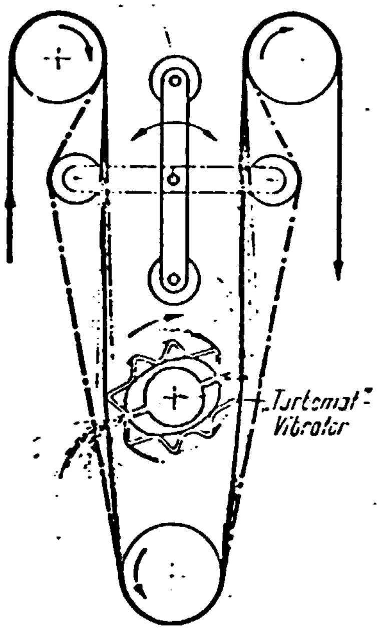
Counter current full-width washing plant with 4 washing- and 1 passage-soap sections.

Figure 11



Way of the goods in a full-width washing unit

Figure 12



Effect of a "Turbinator

Figure 13

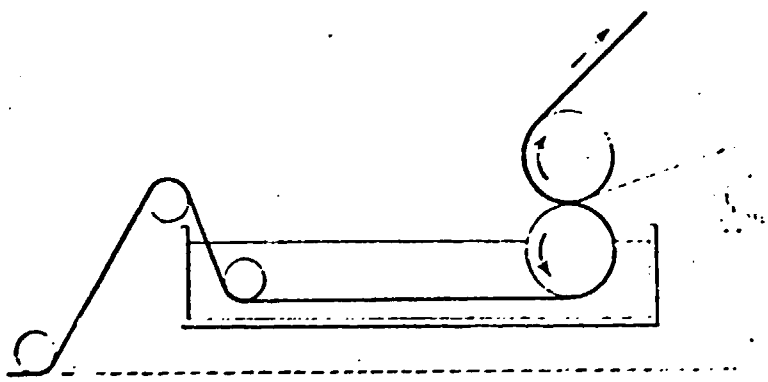
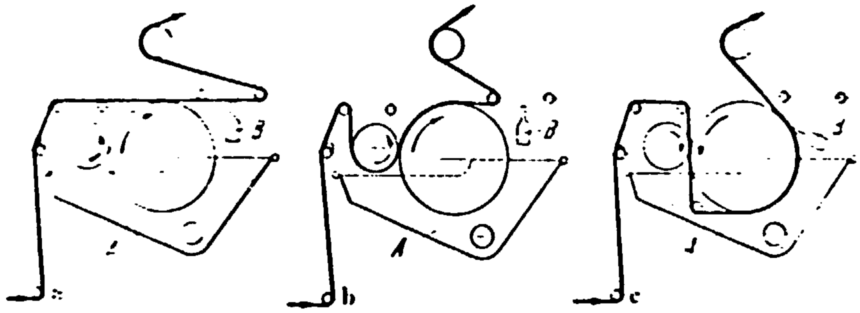


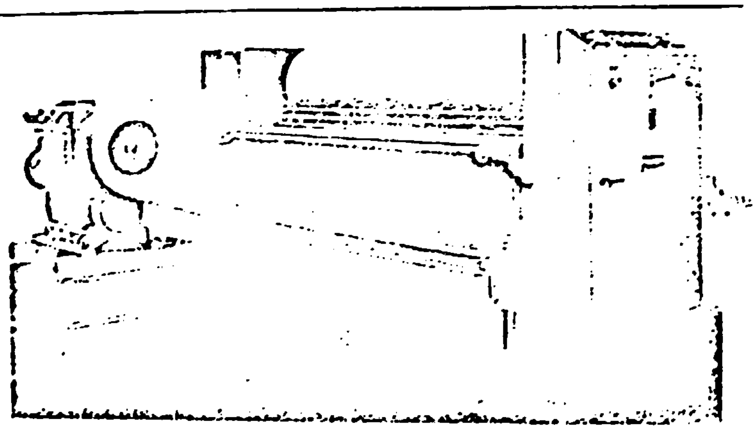
FIG. 18. "Dip-Pressure" Treatment

Figure 14



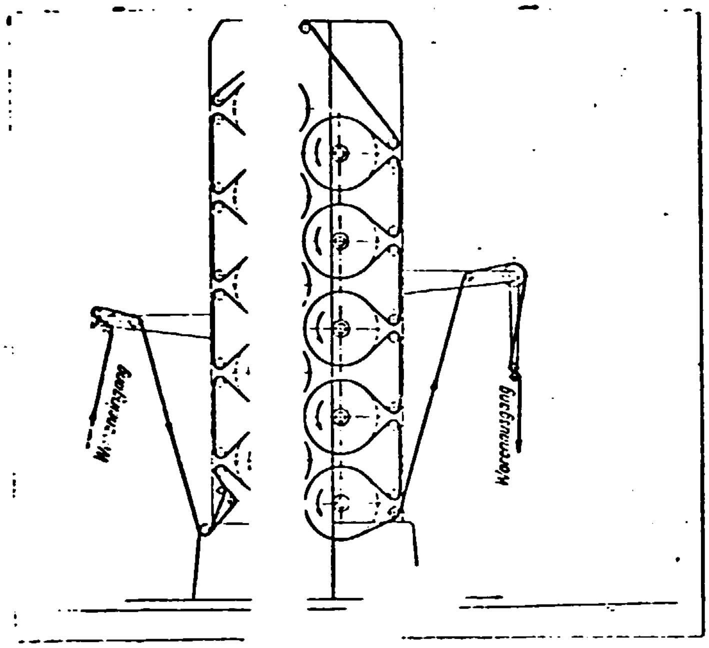
Possibility of the guidance of the textile

Figure 15



3-rolls padder

Figure 16



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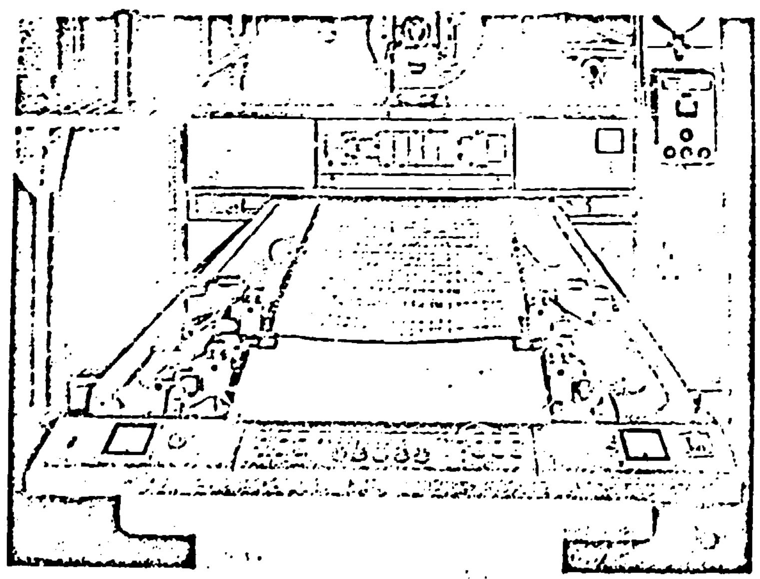


Entrance section of a stenter

Figure 18

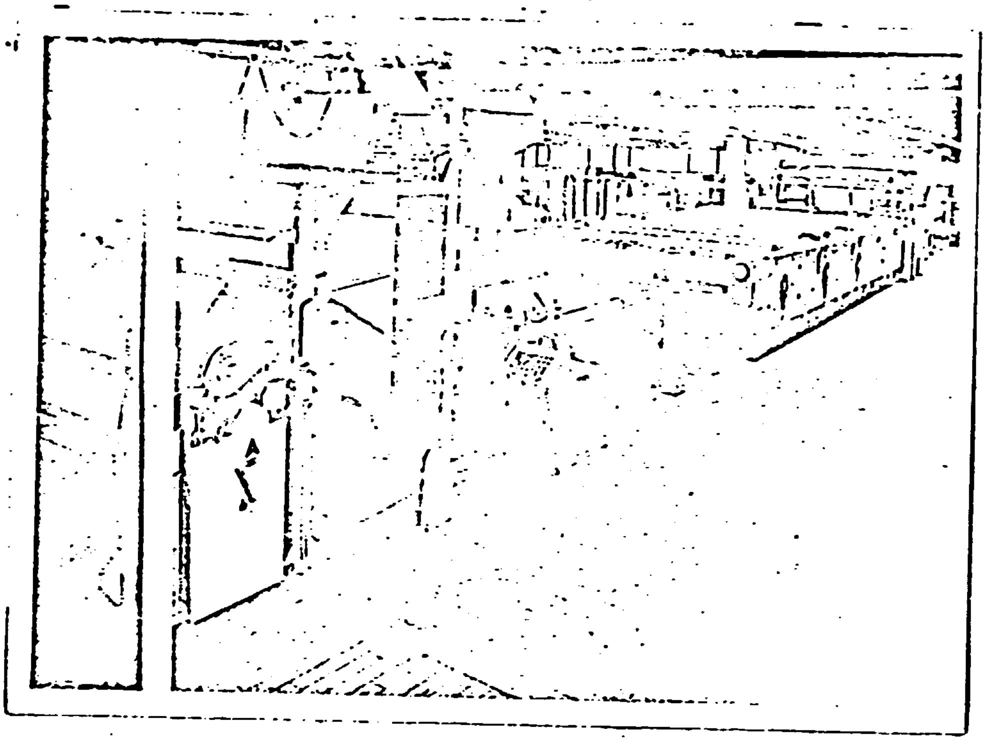


Figure 19

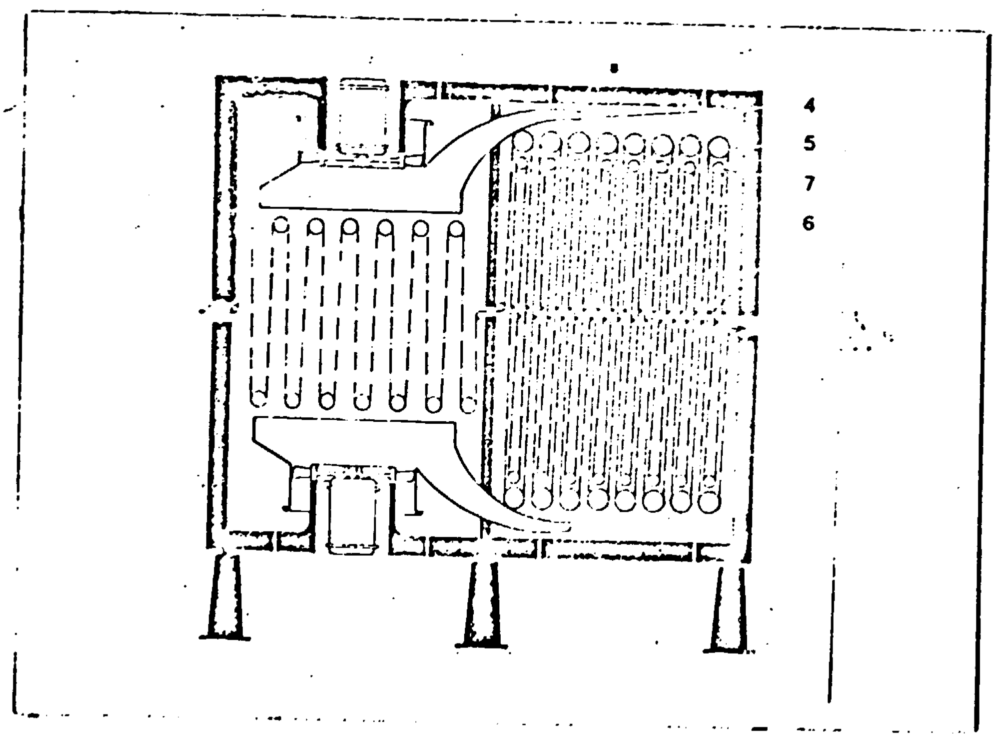


Figure 20

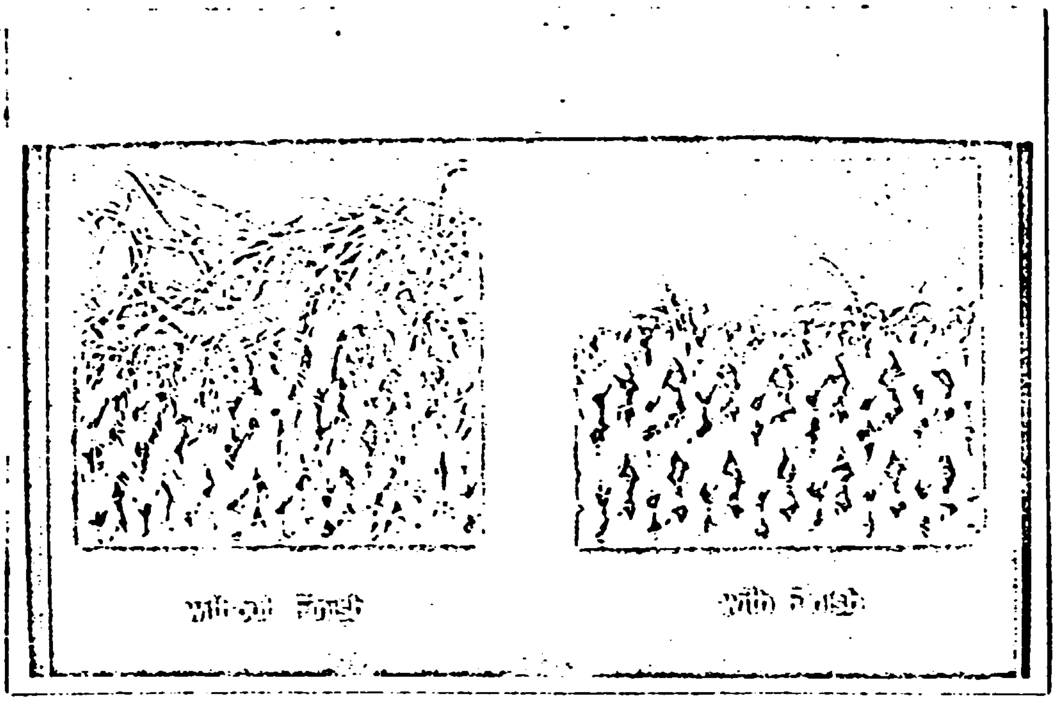


Figure 21

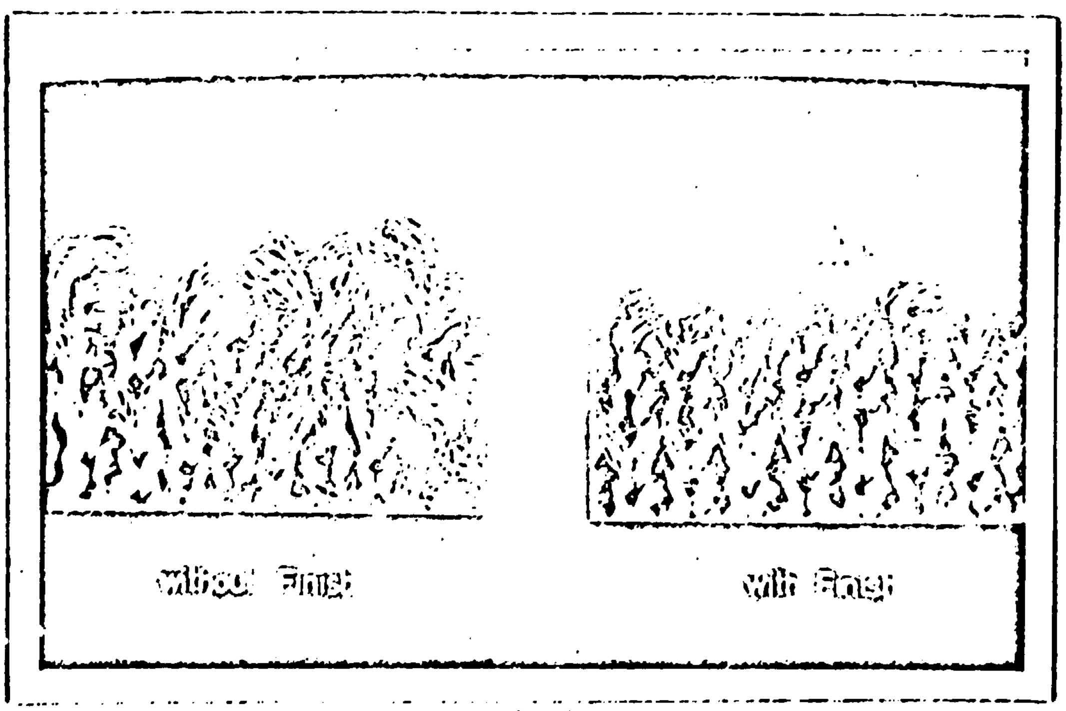
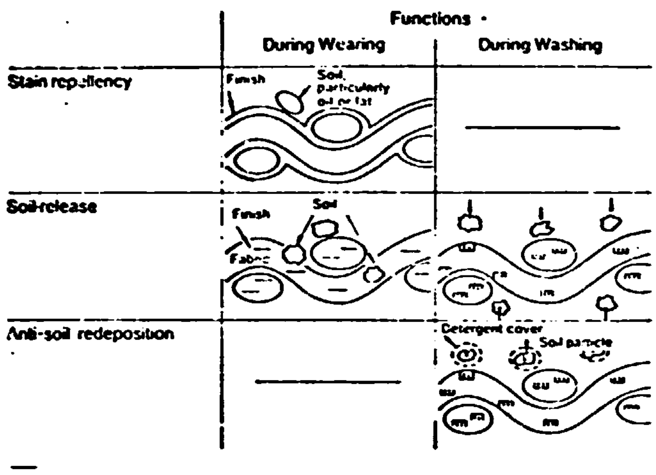


Figure 22



Effect of anti-soil finishing

Figure 23

Procedure of combined dyeing and finishing: top row with soluble dyes, bottom row with pigment dyes

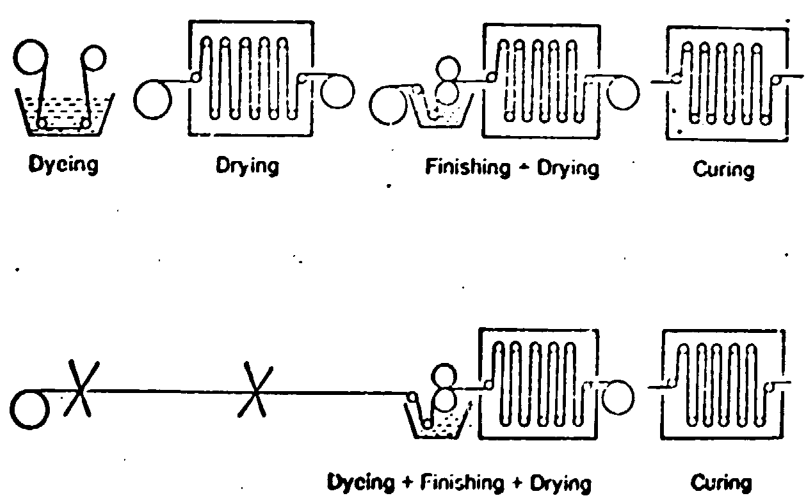


Figure 24