Wet finishing

Contemporary wool dyeing and finishing

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Preparation for wet finishing

- Many worsted fabrics are prone to distortion during wet finishing. These distortions, called ‘cockling’ or ‘crows footing’, are caused by the uncontrolled relaxation of tensions introduced into yarns during spinning and weaving.
- Cockling and crows footing give the fabric a wrinkled appearance.
- Once these distortions have appeared in a fabric they cannot easily be removed.

Preparation for wet finishing

- Some fabrics with only low levels of potential yarn distortion can be simply wet relaxed while held flat.
- Fabric may be padded in open width through warm water with a small amount of detergent and then batched in a roll for 1-2 hours before rope processing.
- However, in many cases, at least a moderate amount of permanent flat set must be introduced into fabric before it can be wet finished. This is called pre-setting.

Methods of pre-setting before scouring

- Crabbing or treating fabric in boiling water in open width.
- Wet or dry decatising.

Modern presetting approaches

- Solvent scouring followed by a wet permanent setting process, such as continuous crabbing or by pressure decatising.
- Scouring in water, using an open-width machine, followed by crabbing. Combined scouring and crabbing machines are now available.

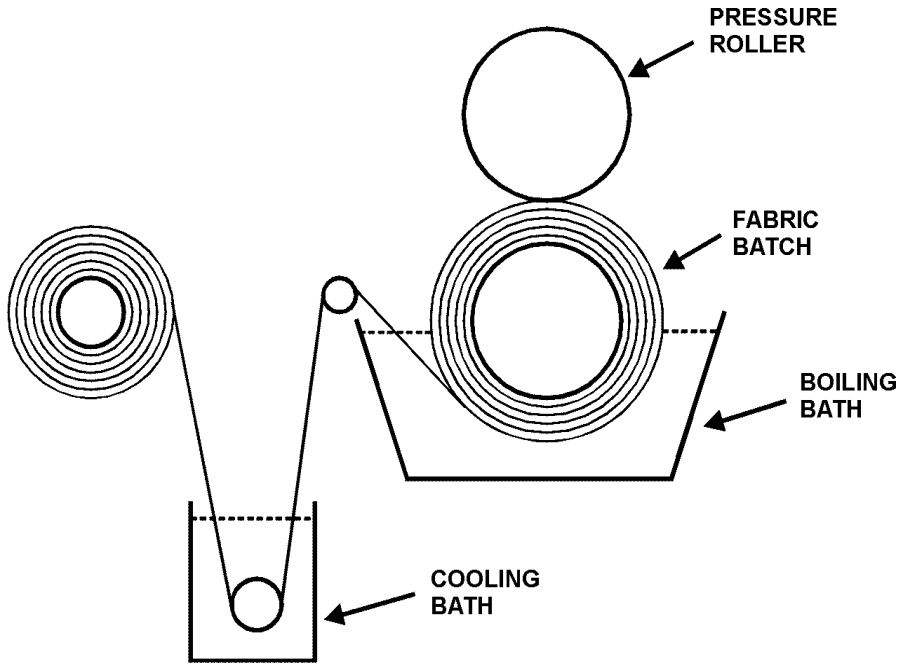
Crabbing

- Crabbing permanently sets fabric while it is flattened and under tension. It may be used to stabilise fabric before it is wet processed in rope form or to remove running marks that may have been introduced during wet rope processing.
- Permanent set introduced during crabbing varies from about 40% to 85%, when measured by the crease angle method.

Crabbing

- In traditional batch crabbing machines, the fabric is first tensioned and compressed by rolling it up on a beam and then treated in boiling water for several minutes before cooling in cold water.
- High levels of permanent set can be imparted. Fabric pH and time are important variables. Permanent set increases with pH so crabbing is often carried out at a pH of 5-7.

Batch crabbing machine



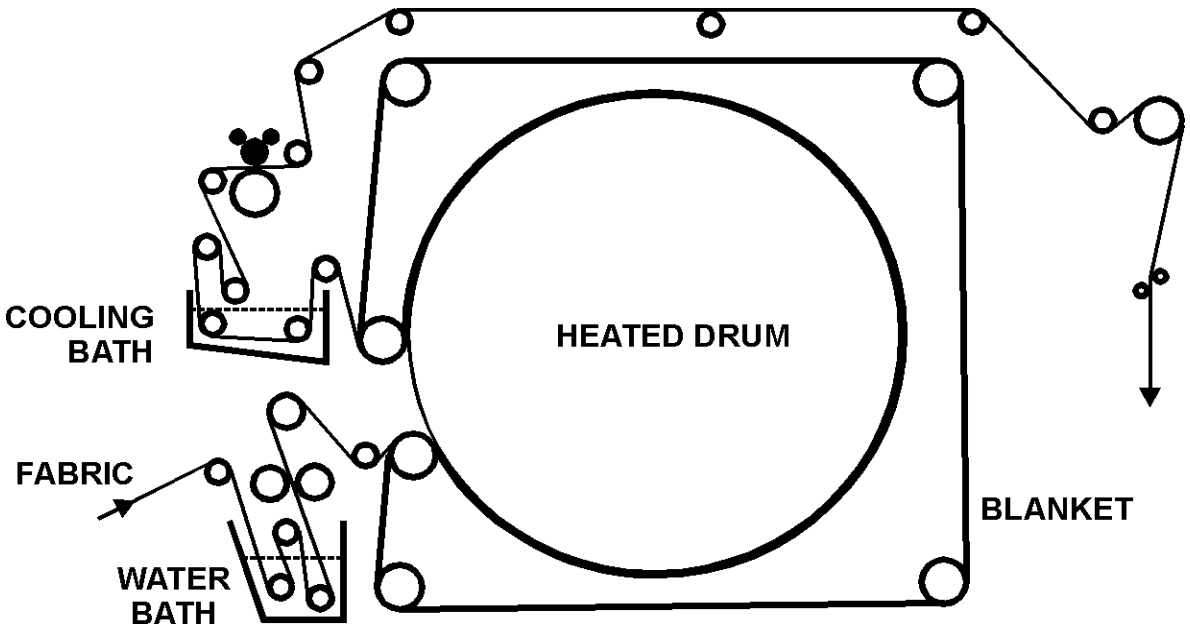
Continuous crabbing

- There are three types of continuous crabbing machines. Two contain a single large drum and the other has a succession of small drums.

Continuous crabbing – single drum

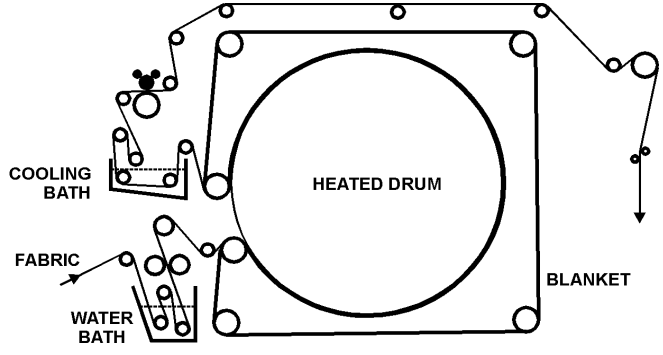
- In one type of single drum machine, fabric is first wet out by padding (fabric is dipped in a bath and squeezed between rollers) and is then held against a rotating drum, at a temperature above 100^{o}C, by an impervious endless blanket (Konticrab, Supercrab [m-tec], Fixwool [Bisio], Multiset [Sperotto Rimar]).

Continuous crabbing – single drum



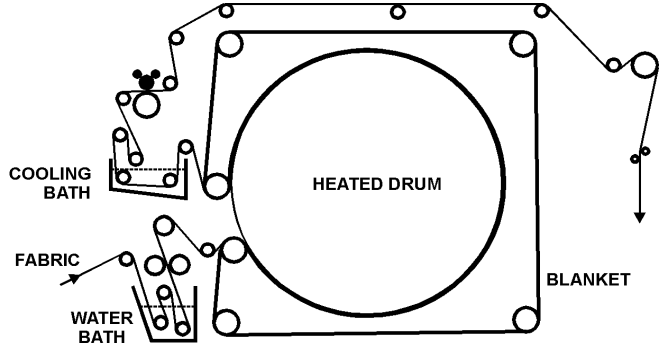
Continuous crabbing – single drum

- Generally, this type of machine is not as effective as a batch crab in introducing permanent set into fabric. This is because the treatment times are too short and the temperature is unlikely to exceed 100^{o}C.
- The impervious blanket cannot effectively seal the fabric against the heated drum even when the blanket tension is high and considerable pressure is applied to the blanket.
- The set imparted is mostly temporary as in an atmospheric decatiser but the fabric is somewhat more compressed and can have a flatter finish.



Continuous crabbing – single drum

- In this type of machine, the rate of permanent setting can be increased by adding a chemical setting agent to the water bath.
- A number of products based on reducing agents are available. Some typical examples are sodium monoethanolamine sulphite (1-3% on mass of fabric), Siroset MS, Siroset FW (Böhme), Ang-Ra 334, Ang-Ra 335 and Ang-Ra 338 (Rotta).
- Colour changes with dyed fabrics may occur but can be avoided by selection of suitable dyes.



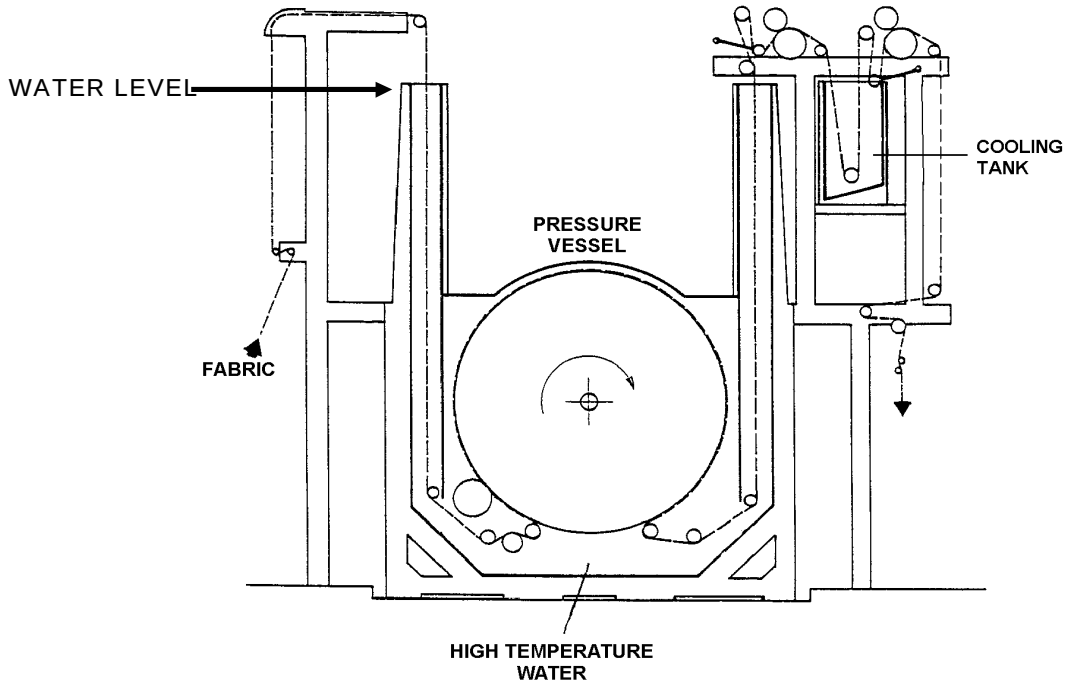
Two types of continuous crabbing machines

Continuous crabbing – multi-drum

- In machines with a series of drums, fabric passes around the drums (or rollers) under controlled tension. The drums have a diameter of about one metre and are immersed in hot water, just below the boil.
- The total treatment time of the fabric is about one to two minutes.
- Fabric speeds are about 10 to 20 metres per minute and a machine may have five or more drums.
- This type of machine was developed in Japan around 40 years ago.

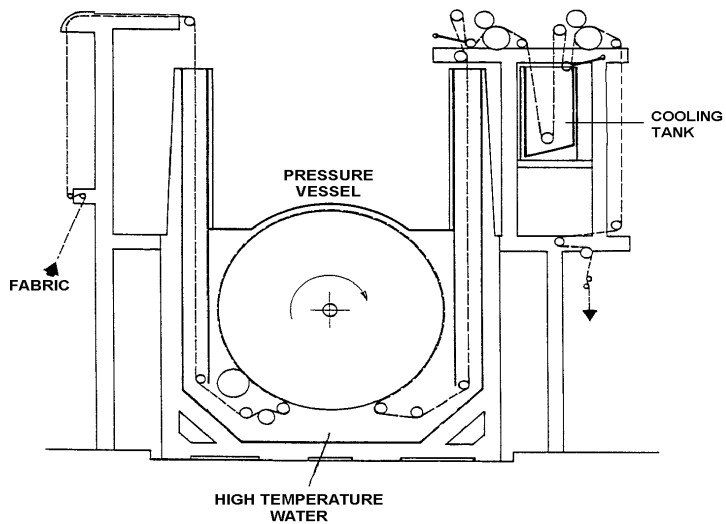
Continuous crabbing – single drum

In this type of single drum machine, the Conticrab (MAT), the fabric is treated with water above 100°C in open-width.



Conticrab (MAT)

- A unique principle is exploited to avoid the use of complicated sealing systems.
- The pressure of hydrostatic columns of water in the fabric inlet and outlet is used to raise the temperature of the water in the bottom of the machine above 100ºC.
- Fabric is treated in the fully-flooded chamber containing superheated water while it is held under tension against large diameter drum.
- A level of about 40% permanent set is typically achieved and this is adequate for pre-setting many fabrics.



Scouring

- Scouring cleans fabric by removing processing lubricants, oil stains, unfixed dye and dirt.
- In woollen finishing routines, scouring is often the first finishing process but in worsted finishing it may follow a setting operation to avoid cockling and crowsfooting of the fabric, as already mentioned.

Scouring

- Finishers often expect fabric to be developed while it is being scoured. During development, parts of fibres migrate out of the yarns to form a light fuzz on the fabric surface. Development of wool fabrics is the first stage of felting or milling.

The aims of development are:

- to soften the handle of the fabric - sometimes referred to as ‘bursting’ of the yarns
- to increase the cover of the fabric
- to promote even felting if the fabric is to be subsequently milled.

Scouring

- Scouring is usually carried out in water, but solvents can also be used in specially designed machines.
- The common principle of scouring machines is to impregnate fabric with scour liquor containing a cleaning agent and then remove it after a short contact time.
- Multiple cycles of impregnation and removal of scouring and rinse liquors are usually employed. The more efficient the liquor exchange, the faster the cleaning and rinsing processes.

Scouring agents for use in water

- Soaps
- Anionic detergents
- Nonionic detergents
- Amphoteric surfactants

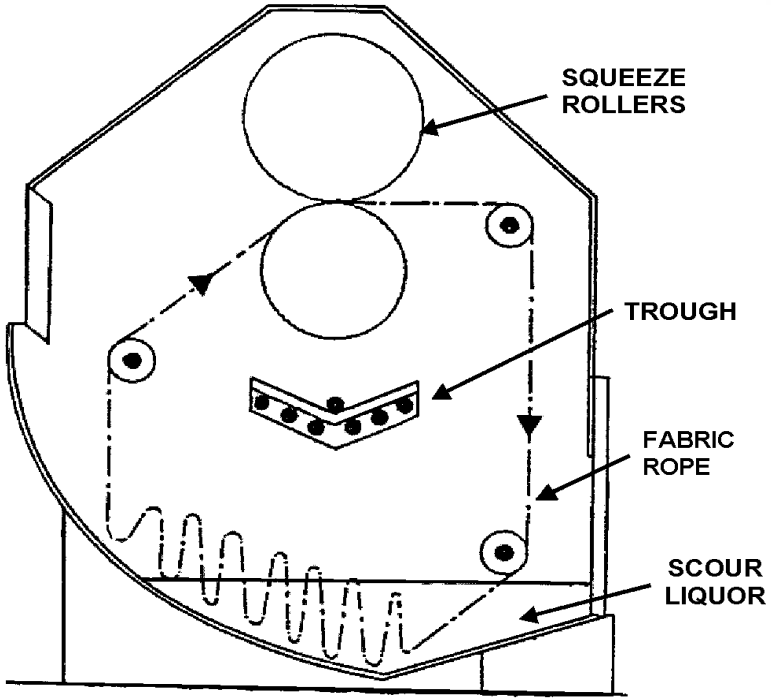
Scouring

- All scouring agents have the potential to interfere with dyeing processes. Rinsing may not always totally remove some scouring agents before the fabrics are dyed.
- Compatibility of scouring and dyeing processes should always be checked whenever changes are made to the auxiliaries used in either process.

Batch rope scouring

- Fabric in rope form is either immersed in, or sprayed with, scour liquor in the bottom of the machine. The fabric is then drawn upwards and passes through a pair of squeeze rollers.
- Expressed liquor is collected in the trough under the rollers and is either discarded or returned to the bottom of the machine. Fabric is circulated as a continuous rope at speeds of up to 100 metres per minute.

A dolly scour



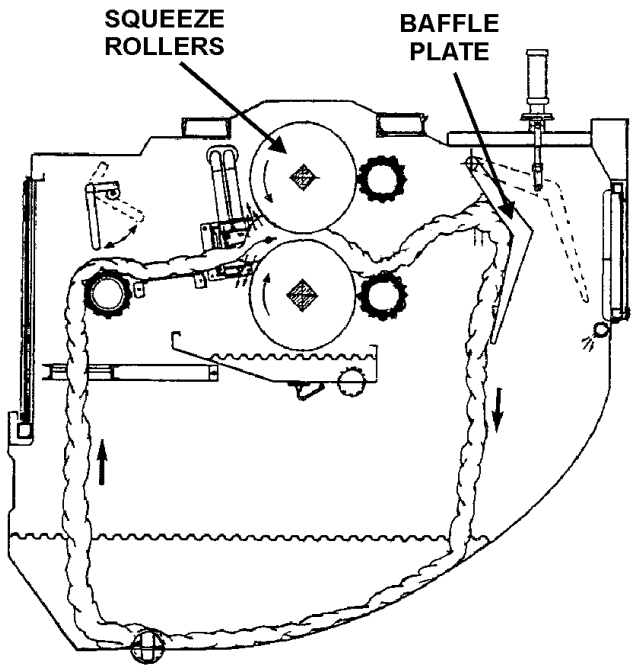
Continuous rope scouring

- Continuous rope scouring machines have been developed to reduce the time delays associated with loading and unloading conventional batch machines.
- The operating principles are similar to batch machinery, except that the fabric rope travels along a spiral path through the machine by means of special loading and guidance systems.

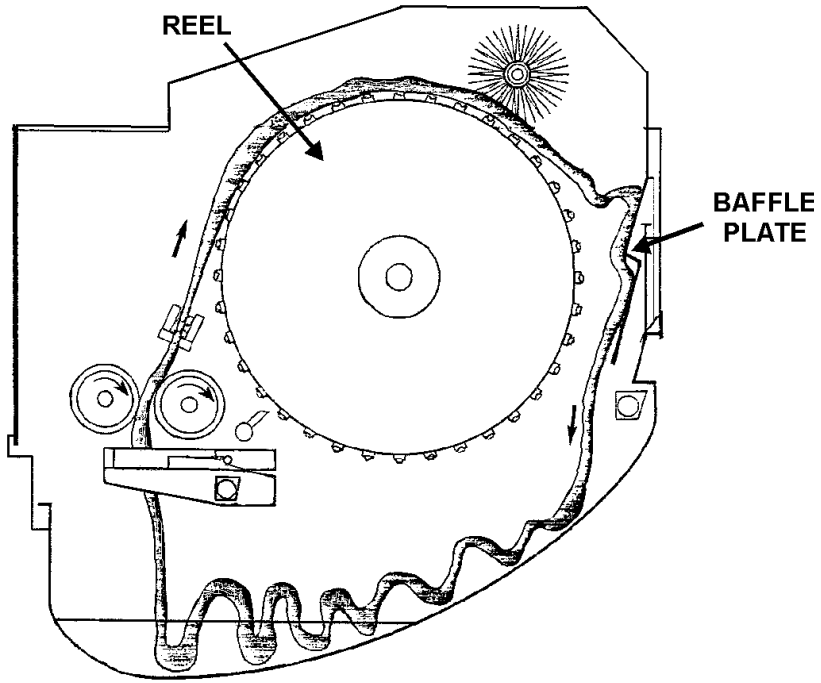
High-speed rope scouring

- Modern high speed scouring machines can be operated at fabric speeds up to about 600 metres per minute.
- In addition to their scouring action, many have provision for fabric development or light milling.
- Many machines resemble conventional scours but the processing speeds are greater.
- In addition, fabric can be subjected to extra mechanical action when it is thrown against a baffle at the back of the machine by its own momentum.

Flexirapid high speed scour



m-tec high speed scour



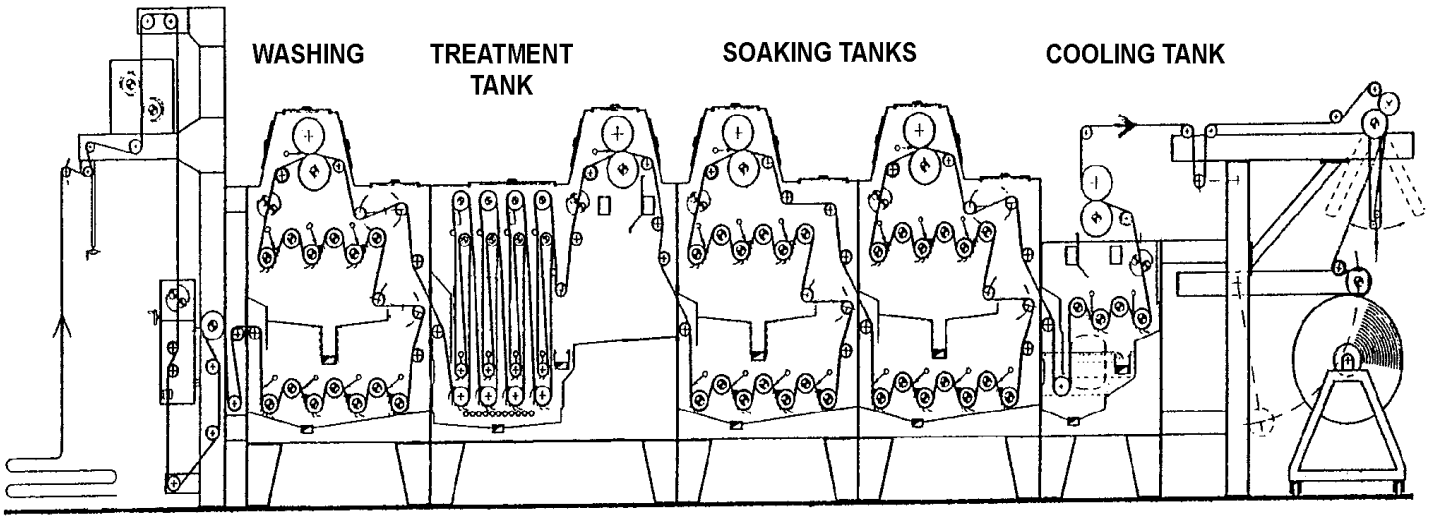
Batch open width scour

- Fabric can be scoured in open width and circulated as an endless loop in a batch machine.
- This has the advantage that permanent creasing of the fabric can be avoided.
- A number of different types of machines have been made, mainly by Hemmer.

Continuous open-width scouring

- Usually a number of modular units are run in series to achieve the required scouring action.
- There are two general types of machines.
- One uses dips, squeezes and sprays to obtain liquor interchange. A typical example is the Lavanova range (CIMI).

Lavanova open-width continuous scouring machine



Solvent scouring

- Continuous open-width solvent scouring machines that use a chlorinated hydrocarbon solvents such as perchlorethylene are available.
- This type of method is very efficient for removing oily substances, such as processing lubricants, and some types of solid contaminants.
- However, if significant quantities of water-soluble materials (such as sizes) need to be removed, aqueous scouring must also be used.

Milling

- Milling is sometimes also called fulling or felting. During milling, fibres migrate out of yarns and become entangled within the fabric structure.
- Untreated wool fibres are covered with overlapping scale cells that all point in the same direction and this greatly facilitates entanglement when fibres move.
- Milling produces thickening and shrinkage and is a feature of many woollen fabrics.

Fabrics are milled for the following reasons:

- to increase fabric strength
- to obtain finishes with very high cover in which the weave structure of the fabric is partly or completely hidden
- to reduce air permeability
- to increase mass per unit area
- as a preliminary process to raising the fabric.

Milling

- Milling of fabric is achieved by intermittently moving, compressing and squeezing the fabric in various ways.
- The milling rate depends on the mechanical action of the machine and on the physical properties of the fibres and the fabric, such as fibre diameter, yarn twist and weave construction.
- Almost all modern milling machines combine scouring with development and milling.

Milling

- It is usual to facilitate milling by the use of soaps or detergents in the milling liquor.
- These are designed to act as lubricants and in some cases are claimed to prevent creases and crack marks.
- Specific agents claimed to prevent creases and running marks in all wet processes may also be used.

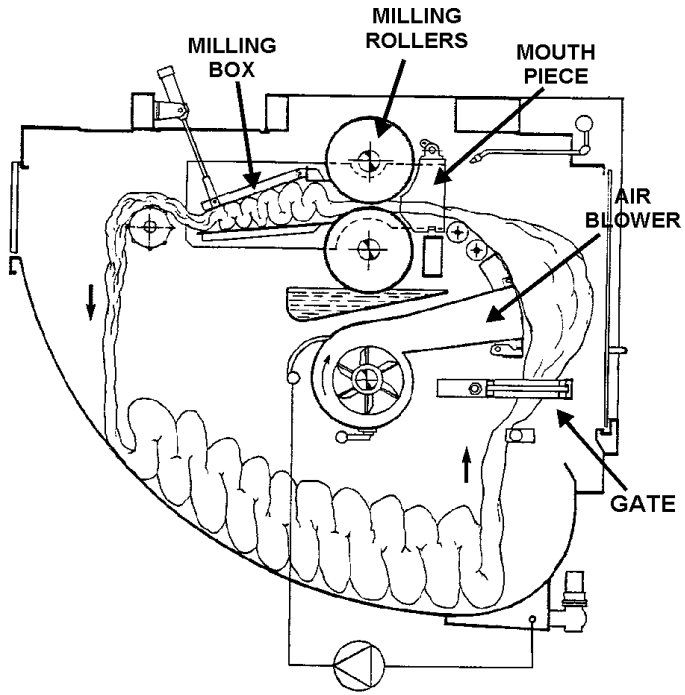
Milling

- Running marks can occur when wet fabric in rope form is subject to mechanical action (e.g. during scouring and milling).
- These marks are apparently caused by increased felting at the edges of creases in the fabric rope.
- Fabrics which consistently exhibit running marks should be permanently set in open width before rope scouring and/or milling.

Machines available for milling are:

- rotary milling machines
- combined scour/milling machines
- stocks.

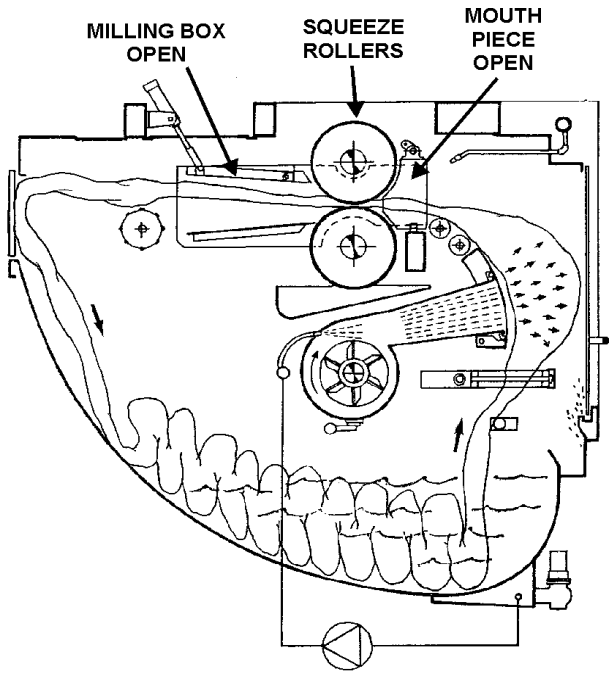
Rotary milling machines



Combined scouring and milling machines

- Combined scouring and milling machines resemble conventional milling machines but can be operated in a number of modes.
- During scouring, only the rollers are used to squeeze the fabric with light pressure.
- Some machines are fitted with a baffle plate to facilitate fabric development during scouring, when operated at high speed mode.

Tobomat 4 seasons (MAT)

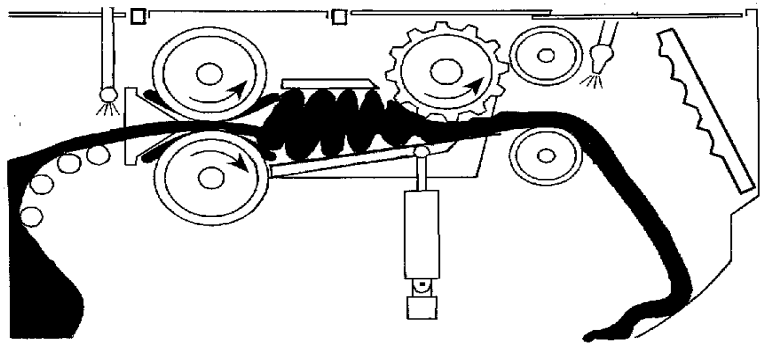


Combined scouring and milling machines

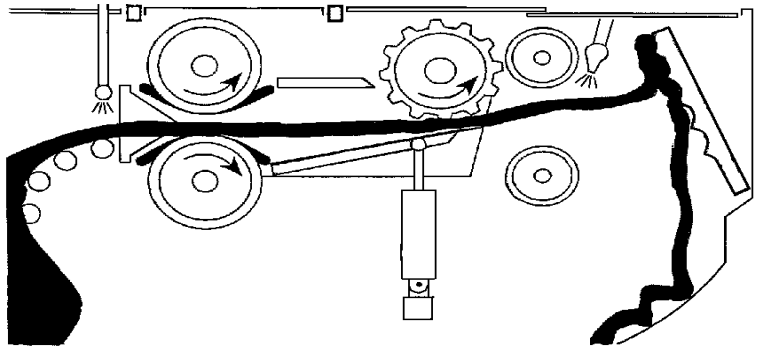
- A number of modifications on the basic design are incorporated in some modern machines.
- For example, in the Folatex machines (CIMI), part of the top lid of the milling box has been replaced with a fluted roller) and the Futura machine (Famit) has two small-diameter top rollers and a moveable baffle plate.

The working section of a Folatex (CIMI) machine in scouring and the milling modes

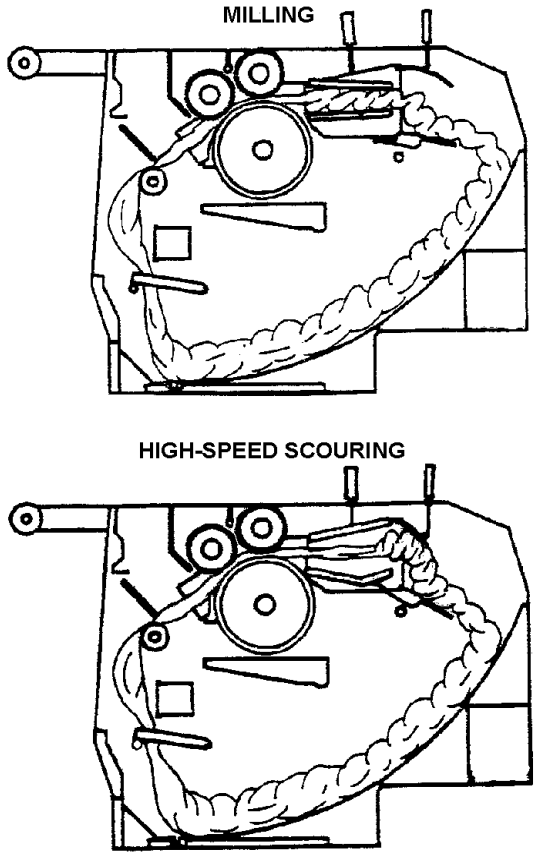
MILLING



HIGH-SPEED SCOURING



Futura machine (Famit) with two small-diameter top rollers and a moveable baffle plate.



Milling stocks

- Milling stocks are batch machines in which wet fabric is beaten with wooden hammers while it lies in a specially shaped trough.
- This type of machine is now rarely used, but can give a soft handle to knitted fabrics, particularly those made from blends of angora and wool.
- Milling with stocks was formerly used to obscure faults such as running marks and rig marks in woollen fabrics.

Bagging of fabrics

- Fabrics are bagged by sewing the selvages together to make a tube.
- During circulation of bagged fabric in a machine, an air pocket, or balloon, forms in the tube.
- This promotes refolding of the cloth so that individual folds are not fixed in a single position.
- This action reduces the opportunity for running marks to become established.

Bagging of fabrics

- Some fabrics need to be bagged for all rope processing processes, including dyeing, if running marks are to be avoided.
- As discussed, running marks seem to be caused by increased felting at the crease edges of wet fabric rope during scouring, milling and dyeing.
- In the case of alkaline scouring and dyeing, the marks can be caused by permanent setting of the creases.
- When running marks occur they can be very difficult to remove.

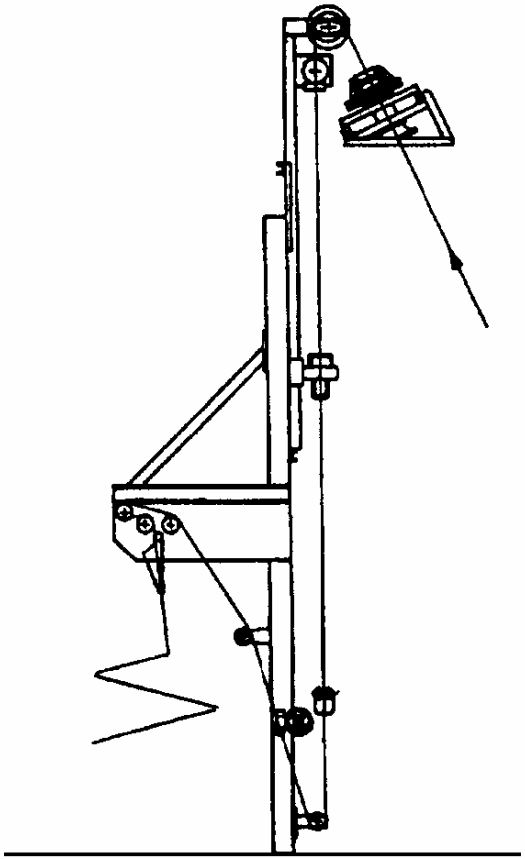
Bagging of fabrics

- Bagging is also used with fabrics that tend to roll up at the selvages; this can be a problem with some twills and gaberdines.
- Many modern scouring, milling and dyeing machines are fitted with air blowing systems to open and reform fabric ropes during the fabric circulation. (See, for example, the Tubomat 4 seasons machine from MAT). This may eliminate the need for bagging of fabric in some cases.

Scutching

- Scutching machines are used to convert fabric from rope form to open-width.
- In machines commonly used for wool, the rope of fabric is drawn over an elevated narrow reel and a sensor detects the twist in the rope as it is drawn upwards.
- An untwisting device, driven by the twist sensor, rotates the fabric to remove the twist before it passes over the reel.

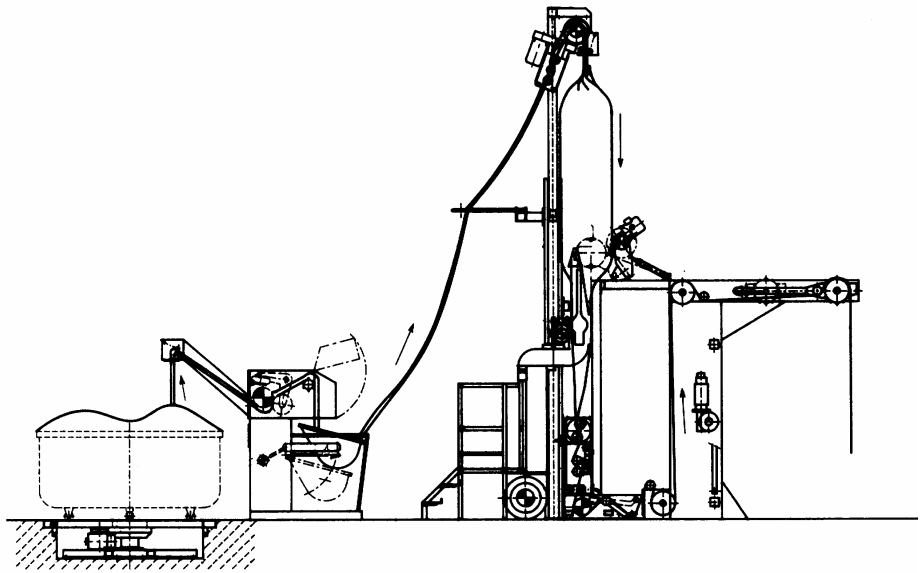
A scutching machine (G Durrant & Sons)



Scutching

- The fabric then passes downwards through opening rollers and guides before being cuttled or rolled up.
- Scutching is mainly carried out on wet fabric after scouring, milling or dyeing.
- To prevent extensible fabrics from being stretched, it is desirable to reduce their mass by squeezing out excess water with a mangle or centrifuge before scutching; some scutchers incorporate suitable mangles.

Combined scutching and slitting machine for tubular knits (Bianco)



Carbonising

- The purpose of carbonising is to remove vegetable contamination such as grass seeds and seed husks from fabric.
- This is achieved by treating the fabric with acid to convert the cellulose in the vegetable matter to hydrocellulose which can be crushed and mechanically removed from the fabric.

Carbonising

- In the worsted system, it is sometimes necessary to carbonise fabrics to improve their quality if small amounts of vegetable matter remain in the wool after combing.
- In the woollen system, vegetable matter is usually carbonised immediately after loose wool scouring, so piece carbonising is used only with relatively clean wools that have not been already carbonised.

Three basic steps in piece carbonising

- Impregnation with acid.
- Drying, baking and crushing.
- Washing and neutralising.

Piece dyeing

- The changes in fabric properties that occur during piece dyeing are as large as those that occur in other wet finishing processes.
- Significant levels of permanent set are introduced into fabric during piece dyeing.
- The most important consequences of piece dyeing are permanent setting of the relaxed (wet) dimensions of the fabric and an increase in the hygral expansion.

Piece dyeing

- It is not unusual for hygral expansion to increase by up to a factor of three, and values as high as 12% can be obtained with piece-dyed gaberdine fabrics.
- Control of hygral expansion in wet finishing is discussed in more detail later. The relaxed (wet) dimensions of any fabric become permanently set at the ambient wet dimensions in the machine. Particularly in rope dyeing machines, there is no effective way of controlling these dimensions.

Piece dyeing using the Basolan AS process

- The best way of restricting permanent setting during dyeing, and limiting the increase in hygral expansion in particular, is to incorporate the Basolan AS Process (BASF) in the dyeing.
- This process involves the addition of anti-setting chemical assistants to the dyebath, with few other changes to existing dyeing processes.
- This process is described in the lectures on dyeing methods.