Development in Sizing Machine

By: Tanveer Malik, P.K.Roy & H.K.Singh

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Abstract

The weaving process depends upon a complexity of factors which include the material characteristics, the sizing ingredients, the sizing operation, and the yarn parameters. In today's environment when loom speeds have increased tenfold from those used in shuttle looms, the modern sizing process is based on various factors: modern control system for reproducible, optimal quality and easy handling. Individual drives and precise measuring systems, pre-wetting technology for a significant reduction in the amount of size and increase in the weaving efficiency, precisely controlled sizing, perfect beams for better weaving results, reproducible size preparation - manually or fully automatically. In this present paper the requirements in the sizing machines, how this can achieve conventionally, and what are the development has been taken place to overcome the difficulties associated with the conventional processes discussed reference with modern machinery.

Introduction

The old adage that sizing is the heart of weaving still holds good today. This statement is all the more important in today's environment when loom speeds have increased tenfold from those used in shuttle looms. The weaving process depends upon a complexity of factors which include the material characteristics, the sizing ingredients, the sizing operation, and the yarn parameters. Slashing tension on yarn during sizing, moisture content drying temperature, slashing machine parameters like slashing speed, size box characteristics, high pressure squeeze rolls, including hardness of rolls, type of sizing method, e.g., single end, cut method, foam method, amount of size, yarn tension, closeness of yarns all the important factors that come into play in deciding the performance of warp yarns during weaving. On the whole, the aim of the textile technologist is to produce ''quality'' fabric economically and efficiently. Here these terms refer to the production of fabrics up to the loom stage. The selection, evaluation, and performance of the warp (yarn/size system) for any specific fabric sett and the loom must be determined in the context of the developments and changes that have occurred in the spinning/winding/warping and the slashing processes. In the past four decades, the weaving industry has been subject to inordinate competition which has primarily come from the fashion (short runs), knitting, and nonwoven segments. The weaving machinery manufacturers answered the pressure of competition by concentrating on the design of looms that offered relatively very high speeds. To meet the demands of the higher productivity on the loom, the machine must be well controlled and improved for the material characteristics and the quality and efficiency of the preceding processes.

Objective of Sizing

The primary purpose of sizing is to produce warp yarns that will weave satisfactorily without suffering any consequential damage due to abrasion with the moving parts of the loom. The other objective, though not very common in modern practice, is to impart special properties to the fabric, such as weight, feel, softness, and handle. However, the aforementioned primary objective is of paramount technical significance. During the process of weaving, warp yarns are subjected to considerable tension together with an abrasive action. A warp yarn, during its passage from the weaver's beam to the fell of the cloth, is subjected to intensive abrasion against the whip roll, drop wires, heddle eyes, adjacent heddles, reed wires, and the picking element,. The intensity of the abrasive action is especially high for heavy sett fabrics. The warp yarns may break during the process of weaving due to the complex mechanical actions consisting of cyclic extension, abrasion, and bending. To prevent warp yarns from excessive breakage under such weaving conditions, the threads are sized to impart better abrasion resistance and to improve yarn strength. The purpose of sizing is to increase the strength and abrasion resistance of the yarn by encapsulating the yarn with a smooth but tough size film. The coating of the size film around the yarn improves the abrasion resistance and protects the weak places in the yarns from the rigorous actions of the moving loom parts. The functions of the sizing operation are

1. To lay in the protruding fibers in the body of the yarn and to cover weak places by encapsulating the yarn by a protective coating of the size film. The thickness of the size film coating should be optimized. Too thick a coating will be susceptible to easy size shed-off on the loom.

2. To increase the strength of the spun warp yarn without affecting its extensibility. This is achieved by allowing the penetration of the size into the yarn. The size in the yarn matrix will tend to bind all the fibers together, as shown in Fig.1. The increase in strength due to sizing is normally expected to be about 10 to 15% with respect to the strength of the unsized yarn. Excessive penetration of the size liquid into the core of the yarn is not desirable because it affects the flexibility of the yarn.

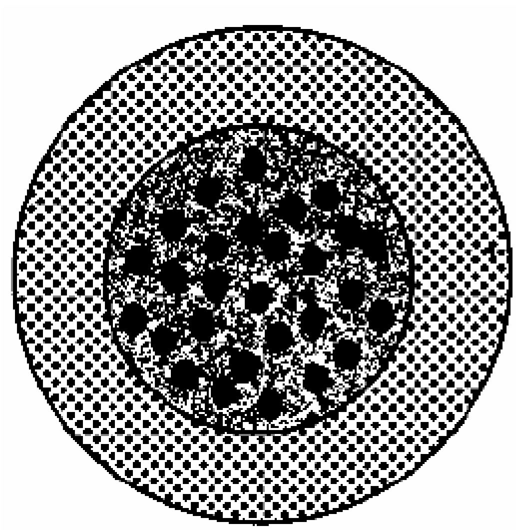

Fig: 1 *Fiber–size binding in a yarn (not to scale).*

3. To make a weaver's beam with the exact number of warp threads ready for weaving.

Sizing Machines

The essential components of a sizing machine to slash spun warp yarns may be categorized as follows:

Zone 1. Creels—unwinding zone
Zone 2. Size boxes—sizing zone
Zone 3. Dring cylindres—dring zone
Zone 4. Bust rods—splitting zone
Zone 5. Head stock—weaver's beam preparation zone
Zone 6. Controls and instrumentations

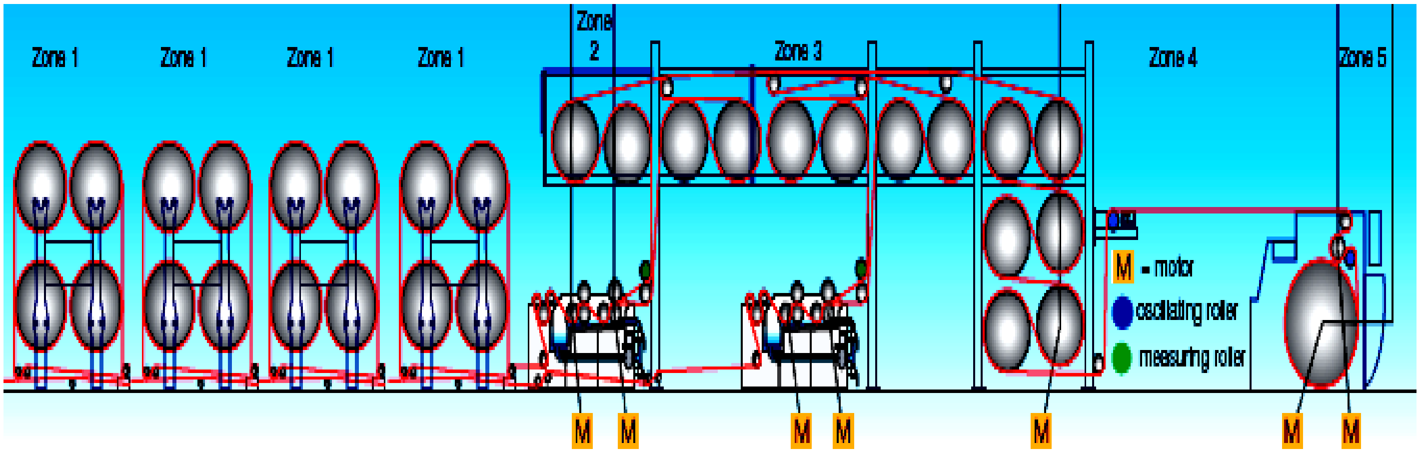

Fig.2 Schematic of sizing operation

Highest warp quality when sizing a modern weaving operation must be uninterrupted, assuring high efficiency, irreproachable quality and low-cost production. The foremost goal of the sizing department is therefore the production of top quality warps. The principle sizing factors influencing weaving efficiency are size pick-up, hairiness and yarn stretch. Through the use of advanced control and regulating technology, these parameters remain constant and optimal. The automatic monitoring of the machine ensures high reproducibility and the highest quality of the sized warps.

Highest quality

- Uniformly optimal sizing
- Low hairiness
- Low elongation
- Automatic section tension control
- High reproducibility

High productivity

- Simple attendance
- Automatic monitoring of all parameters
- Comprehensive recipe management

Warp yarns from warping beam placed in a creel are withdrawn and fed to the size box by a feed roll. The yarns are then impregnated in size liquor preheated to a desired application temperature. Then the yarns are passed through a pair of rolls, commonly known as squeeze rolls, to squeeze out excessive size before they are subjected to the drying cylinders of the drying zone. This is necessary to minimize the drying energy required to dry the warp yarns. The yarns wet with size solution are passed over and under the heated drying cylinders to dry the sheet of warp yarns to a desired level. The dried yarn sheet is then passed through a series of bust rods in the splitting zone to separate the yarns. In the final phase, the separated yarns are passed through a guide comb and wound onto a weaver's beam. The following sections will deal with each function and component of the sizing machine separately.

Creels

The creel on a modern slasher is available in several different forms. Basically it must be well built and of robust construction, capable of carrying heavy warper's beams. The primary function of the creel is to allow smooth and steady unwinding of the warp yarn sheet without a side to side swinging of the warper's beam and without entangling two adjacent warp sheets being unwound. Also, the ends from either side of the warper's beam should not touch the beam flanges. To prevent the sideways swinging of the beams and allow a smooth unwinding of the warp sheet, modern creels are equipped with ball bearings to support the end shafts of the warper's beams. This also helps in eliminating unwinding tension variations in the warp sheet. Both fixed and movable (on wheels) types of creels are available. The advantage of the movable creel is that while slashing is in progress from one set of beams, the loading of another set can be done on another stand-by creel, which can be attached to the back of the sizing machine later without loss of much time. Consequently, the next set on the sizing machine can be started with much less down time, thus increasing the slashing efficiency. The major creel types housing multiple beams are

- Over/under
- Equitension
- Inclined
- Vertical stack

Over/Under Creel. In the over/under creel, as the name implies, the warp yarn passes over one beam, under the next beam, again over the next beam, and so on, as shown in Fig.3. This type of creel is most commonly used for slashing spun warp yarns of cotton and synthetic fibers. The threading pattern of warp from the beams in this type of creel varies depending upon the number of size boxes used. For heavy to medium construction fabrics, where two size boxes are used in industrial practice, all top beams in the creel may be threaded over and under and then straight to the first size box, as shown schematically in Fig.4. All bottom beams are threaded over and under and then straight to the second size box, as shown in Fig. 4.

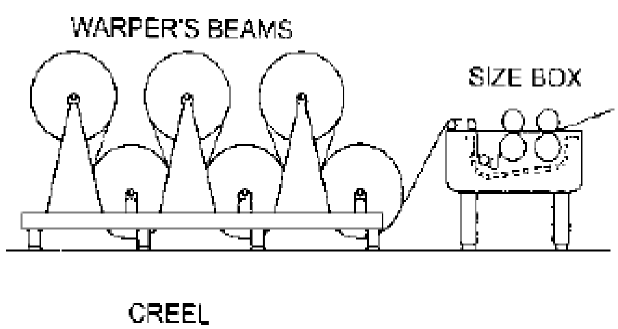

Fig.3 Over/under creel

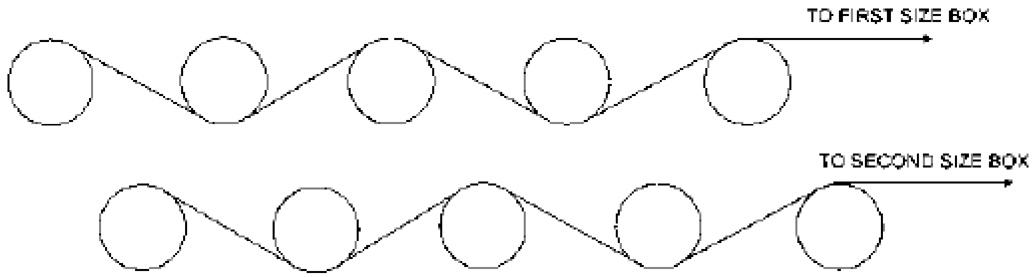

Fig: 4 *Over/under creel for two size boxes.*

Equitension Creel. In this type of creel, the warp sheet is withdrawn from the individual beam and is passed over a guide roll mounted on the creel framework. Thus the yarn sheet from each warper's beam is drawn individually and passed over a guide roll; it then joins the yarn coming from other beams of the top or bottom tier, respectively, and then passes forward directly to the size box, as shown in Fig. 5. This type of creel is more useful for lightweight fabrics of open constructions.

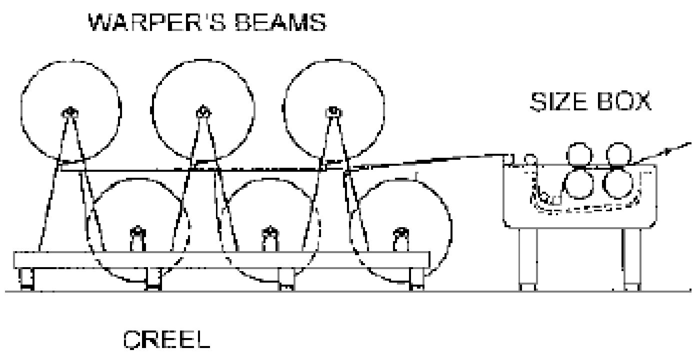

Fig: 5 *Equitension creels.*

Inclined Creel. The inclined creel may be either double tier or single tier. Obviously, the single tier creel requires much greater floor space, and two tier creels are therefore more commonly used in the industry. The double tier inclined creel is commonly used for filament warps. As shown in Fig.6, the inclined creel allows a direct path of the yarn from each beam through the hook reed to the size box.

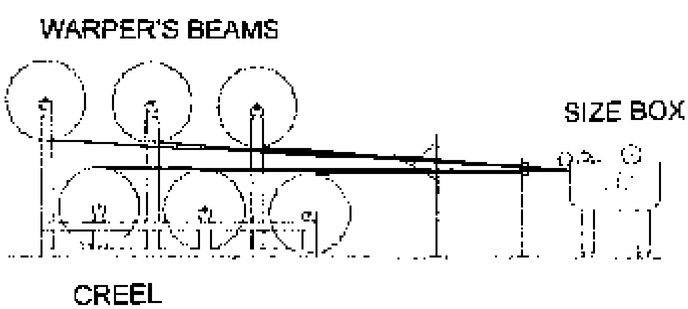

Fig: 6 inclined creels.

Vertical Creel. This type of creel is most suitable where a large number of warper's beams are used. This creel allows the operator easy access to all the warper's beams. The beams are supported on vertical stands in three decks in several modules, as shown in Fig. 7. The passage between each pair of modules allows the operator to easily mend a break or correct a problem in a warp yarn leaving the warper's beam.

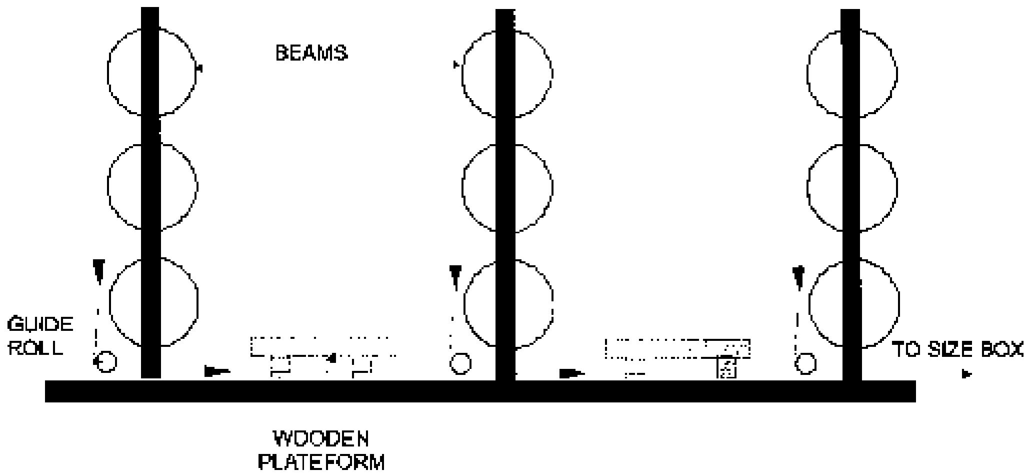

Fig: 7 Vertical creels.

Modular back beam unit. The modular concept back beam unit comprises one or more groups of four. These units may be arranged as required. Catwalks between the individual groups ensure safe and convenient access to the warp beams.

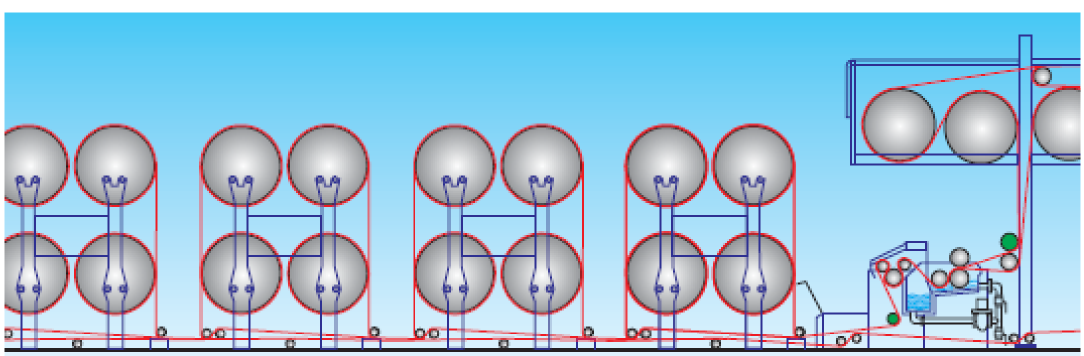

Fig: 8 Modular back beam unit

Warping Beam Braking Systems. These systems are required for preventing the over-running of the beams, especially during the reduction in speed of the slasher at the time of a break or during the doffing of the weaver's beam. Also, the braking device allows control of yarn tension between the size box and the creel during the normal constant speed operation. The most commonly used braking system is the ''rope and belt'' device in which the braking force is applied by means of a rope wrapped around the warper's beam head or by a belt wrapped around a drum or a grooved pulley attached to the beam , as shown in Fig. 9. Usually the drum or grooved pulley containing ball bearings is attached to both ends of the warping beam shaft so as to ensure free rotation during the normal working of the slasher. The braking force is applied by hanging deadweights that must be decreased manually as the beam diameter decreases to maintain a uniform yarn tension from start to finish of the warping beams. The deadweight system is substituted by pneumatic cylinders in the pneumatic braking system. The pneumatic pressure in such cylinders on the individual warping beam can be integrated into a central regulator accessible to the operator. The centralized pneumatic braking system, integrated with the sizing machine drive controller, is very efficient because it applies a higher braking force only when the slasher is decelerated. This prevents the application of excessive tension during the normal working of the slasher. A more precise system is the automatic pneumatic braking system in which a sensor is placed between the creel and the size box for measuring the tension in the whole warp sheet. The desired tension in the warp sheet is pre adjusted by the operator depending upon the yarn type, yarn count, and style of the fabric being produced. The air pressure in the pneumatic cylinders is automatically adjusted in proportion to the tension fluctuations registered during acceleration or deceleration, and also from start to finish of the warper's beams. This system assures a constant unwinding tension of the warp yarns from the warp beams for the entire sizing process, with minimal operator intervention.

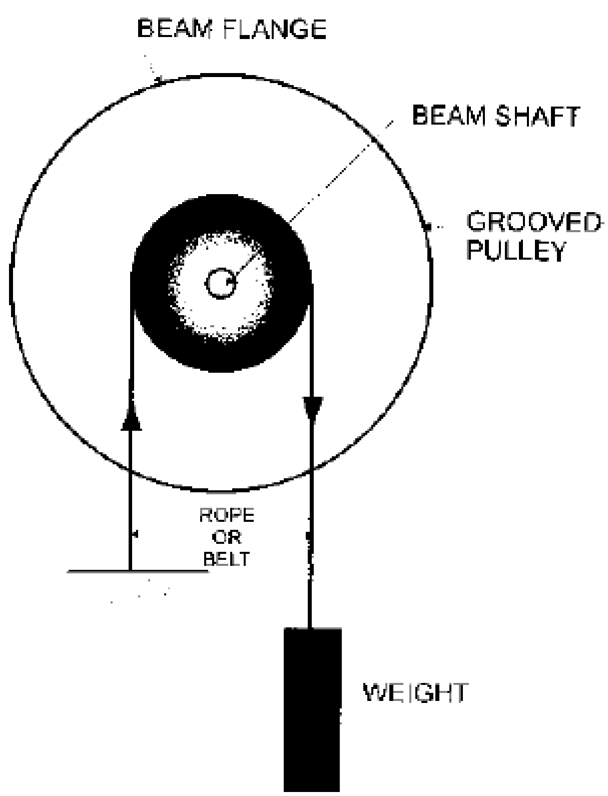

Fig: 9 Rope or belt braking system.

Band brakes ZB. The back beams are mounted in the back beam unit with insertable journals. The unwinding tension is imparted by pneumatically loaded and automatically regulated band brakes. Width adjustments up to 400 mm are possible with the ZB band brake.

Fig: 10 Band brakes ZB

Shoe brakes ZA. The back beams are supported directly on the brake disk ring, rendering insertable journals unnecessary. The unwinding tension is imparted by pneumatically loaded and automatically regulated double shoe brakes. The upper beam supports can be shifted pneumatically, making it easier to mount the bottom beams.

Fig: 11 Shoe brakes ZA

Unwinding device for section warping beams. For mounting section warping beams, pneumatically braked unwinding devices are available for both sides.

Fig: 14 Unwinding devices for section warping beams.

Size Boxes

The size box and all parts that remain in contact with the size solution are made of stainless steel to prevent corrosion. The shape of the size box from the bottom is contoured with no sharp ends. The size liquor in the size box is normally heated by steam supplied through a steam coil placed at the bottom of the size box. The steaming coils placed in the size box should ensure uniform heating of the size liquor in the entire size box. The type and the design of the coil vary depending upon the size box manufacturer. The entry of the high pressure steam in the size box also creates a turbulence which results in the agitation of the size liquor. This is favorable in the case of a starch-based size used for sizing spun yarns because the agitation prevents gelling and scumming of the size near the corners. For filament slashing, a size box with direct heating coils is not desirable as the agitation of the size liquor may disturb the filaments. Also, the bottom of the size box should have an outlet to the effluent disposal system so that the size box can be completely drained when cleaning is required. The configuration of size boxes is quite diverse and they are available in a variety of different forms depending upon the sizing machine manufacturer. However, the basic function of all size boxes is to impregnate the warp sheet in the size liquor at a predetermined application temperature and to squeeze out the excess size liquor before the yarn sheet reaches the drying zone. Most slashers are equipped with a single sizing box having two pairs of squeezing rolls and an immersion roll. Figure 15 shows a typical size box. A sheet of warp yarn is drawn from the warper’s beams and fed to the size box over a pair of guide rolls with a slack rod or tension roll riding on the warp between the two guide rolls. The sheet of yarn is immersed in a size solution by one or two immersion roll(s). The immersion roll is normally movable. It is mounted on the size box with a rack and pinion mechanism so that it can be freely lowered and raised. The amount of size that will be picked up by the yarns will depend upon the depth of the immersion roll and the level of size liquor in the size box. At a given constant size level in the box, the lower the position of the immersion roll, the greater the pick-up of the size by the yarns, as it allows a longer time for the yarns to remain in the size liquor and vice versa. The yarn sheet with wet size on it then passes through one or two pairs of squeezing rolls, as shown in Fig. 15.

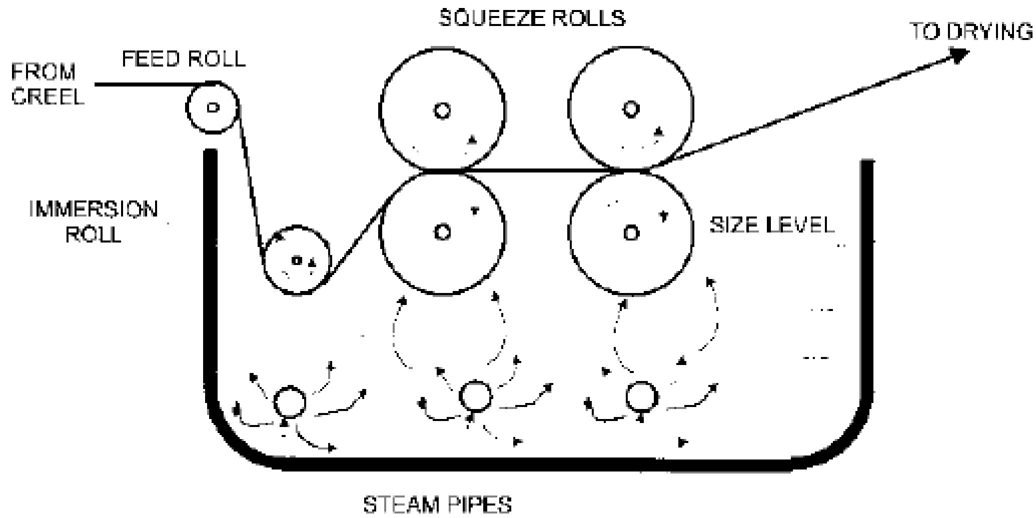

Fig: 15 Schematics of size box.

The purpose of the ***squeeze rolls*** is to remove the excess size liquid from the yarns. For filament yarn sizing a single squeeze size box is usually used; however, in case of spun cotton and synthetic yarns where higher size add on is required, double squeeze size boxes are normally preferred. The bottom roll in a pair of squeeze rolls is made up of stainless steel and the top roll is made from cast iron material covered with rubber. The top roll is usually under pressure in addition to its own weight of around 180 to 250 kg. The pressure is usually applied by compressed air operating on pneumatic cylinders or pneumatic diaphragms. In modern slashers, the trend is to use a high squeezing pressure to save energy in drying and to make it possible to use higher concentrations of the size liquor to obtain the predetermined size add on. In high pressure squeezing, the squeeze roll loading is up to approximately 9000 kg (20,000 lb), which is about 15 times the loading used in a conventional size box. In high pressure squeezing, the quantity of water evaporating during the drying process will be lower, thereby allowing not only savings in drying energy, but also an increase in sizing machine productivity. The drawback of the high pressure squeezing is that the top squeeze rolls deflect or bend when loaded at such high pressure. This results in a nip size variation across the width of the roll, as shown in Fig. 16. An uneven nip zone width causes a variation of squeezing pressure across the roll width, resulting in variation in size add-on from the selvedge to the center of the warp sheet. For narrow size boxes (1.4-m width of yarn sheet) West Point Co. research has found that the variation in size add-on due to top roll bending is not significant. Nevertheless, in the case of wider size boxes corrective action incorporating ‘‘crowned’’ squeeze rolls should be used to obtain a uniform nip width. A crowned squeeze roll is produced by grinding the rubber cover top roll to a slightly larger diameter in the center than at the ends. This compensates for the possible bending of the top roll while under high pressure and provides a reasonably uniform nip width and squeezing pressure across the entire width of the roll.

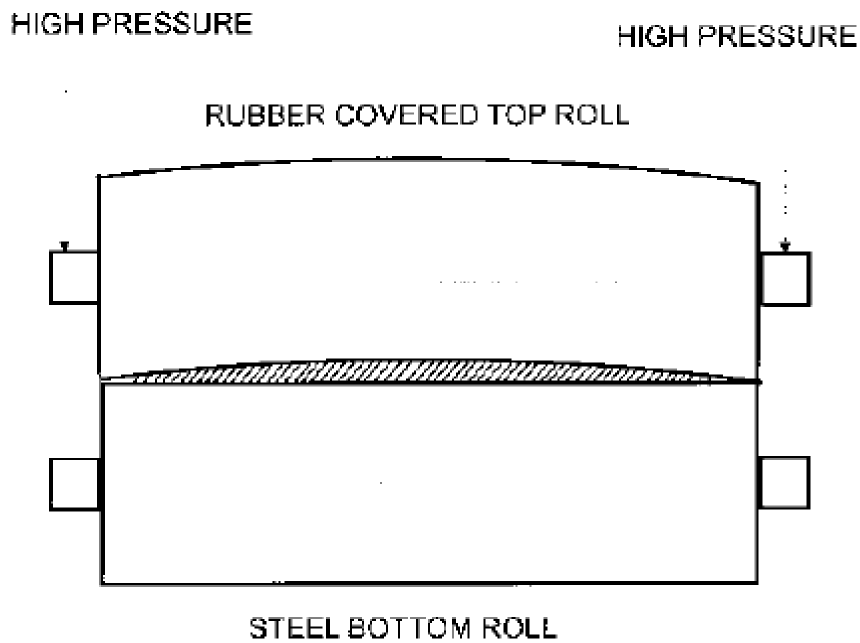

Fig: 16 Schematics showing nip deformation in high pressure squeezing

Uniform sizing over warp width and length. The sizing of warps demands an absolutely uniform squeeze pressure application over the entire warp width. Only in this way is it possible to guarantee a uniform size pick-up from the centre and the edges. Required for this is a special squeeze roller with a mathematically defined flexing characteristic. Simultaneously the application of the pneumatic squeeze pressure with air-cushion cylinders is indispensable. Small steps for the squeeze pressure regulation can only be achieved by a system with no friction losses. The programmability of the squeeze pressure curve, independent of crawl or production speed, ensures a uniform size pick-up.

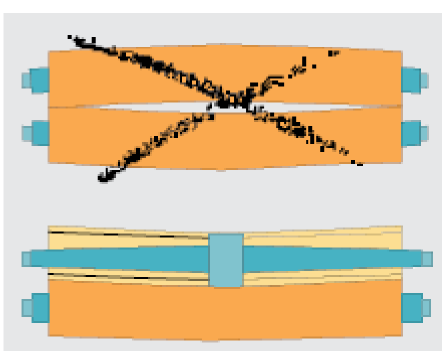

Fig: 17 *Uniform sizing over warp width and length*

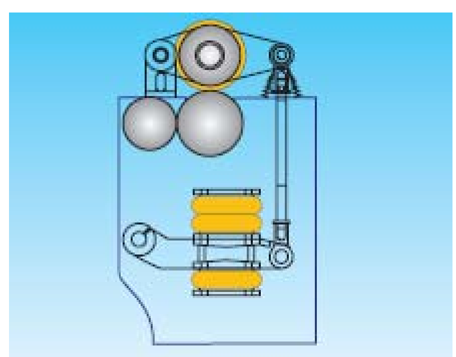

Fig: 18 compressed air operating on pneumatic cylinders or pneumatic diaphragms

Structured squeeze roller. The inlaid glass beads on the roller surface provide a special structure which is maintained throughout the roller life. The structured surface prevents the sticking of the threads and results in reduced hairiness.

A ***double squeeze*** size box with twin rolls is also used for slashing light and heavy warp sett spun yarns. The twin immersion rolls allow both sides of the yarns to be exposed to the size mixture, thus ensuring uniform coating and penetration of the size liquor. Both squeeze rolls are equipped with independent loading and lifting controls. This provides flexibility to the slashing operator in using either one or both rolls depending upon the requirement. A size box having double roller, double immersion with high pressure squeezing, as shown in Fig. 19, is also used. In such a size box, one set of immersion and squeeze rolls is followed by another set of immersion and squeeze rolls. A recent development is the Equi-Squeeze Size Box, shown in Fig. 20. In this system the top squeeze roll position is adjustable. A unique bracket and loading system allows the positioning of the roll to the rear 15 or 30 degrees off the top center position, as shown in Fig. 20. By moving the roll to the rear, the adherence of yarns to the roll as they leave the squeezing nip is minimized.

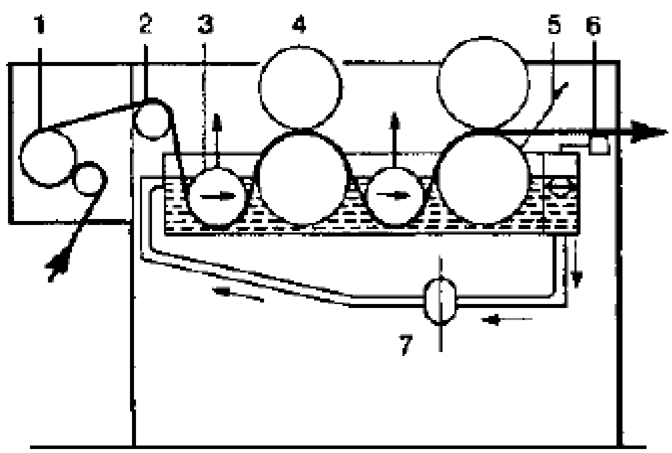

Fig.19 *Schematic of double squeeze rollers, double immersion with high pressure squeezing.*

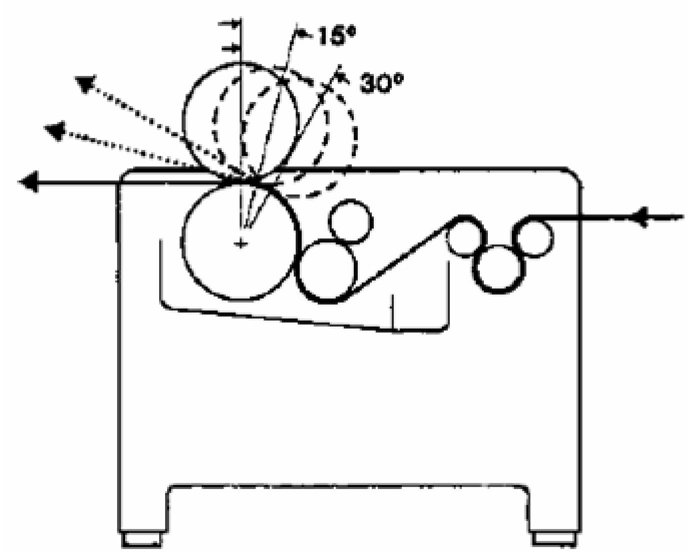

Fig. 20 Equisqueeze size box.

Liquor consumption. The liquor level in the size box is measured with a maintenance-free sensor, unsusceptible to contamination and regulated to the specified level. This measurement serves to measure liquor consumption and calculate the actual size pick-up.

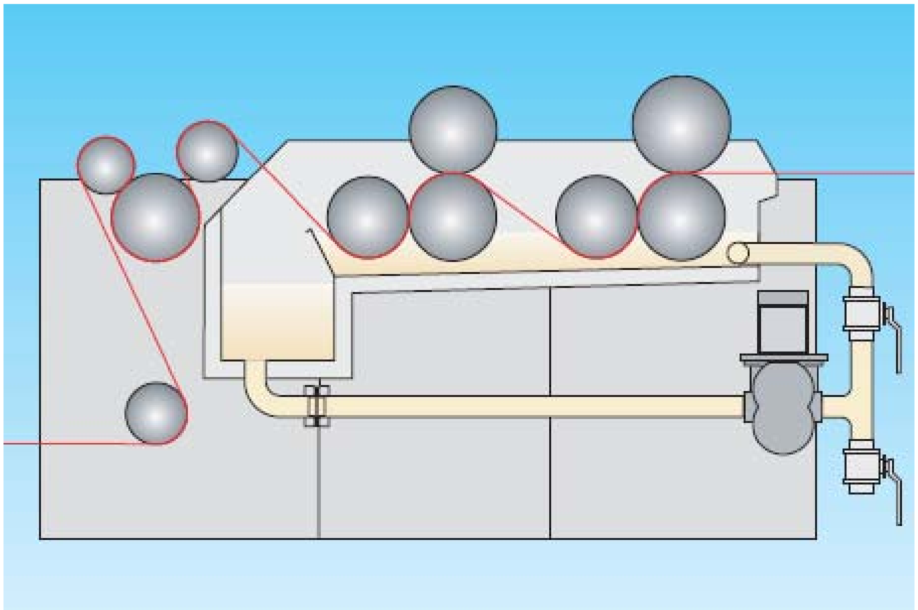

Fig. 21 Modern size box

Size box heating. Two heating systems are matched optimally to one another. The indirect heating in the double bottom compensates the heat loss by radiation and the direct steam heating responds quickly and effectively. High circulation and low liquor level ensure an homogeneous liquor.

True wet splitting. With a high yarn density in the size box, there is less dust and less warp yarn hairiness when working with true wet splitting. A basic prerequisite for this is the large dimensioned, steam heated deflection rollers.

Fig. 22 Wet Splitting Rollers

Drying Cylinders

There are two principal types of drying methods used, namely,

1. Cylinder, or can, dryers
2. Hot air, or convection, dryers

Cylinder Dryers. These are most widely used as they are the most energy efficient. The cans or cylinders are about 75 cm in diameter and are used in a multiple unit containing a series of five, seven, nine, or eleven cylinders, usually arranged in two tiers to save floor space. The maximal working pressure of steam in these cylinders is about 4.92 kg/cm2 (70 psi). The cylinders are made of stainless steel. These cylinders are mounted on ball bearings and driven positively by a chain and sprocket. This eliminates undue tensioning of the yarns while they are dried. The cylinders are also coated with nonstick coating, e.g. Teflon, for preventing the size and yarns from sticking while the warp is partially dried. Usually the first three cylinders from the front are coated with Teflon in any sizing machine containing five, seven, and nine cylinder systems. For an eleven-cylinder drying system, usually the first four cylinders are coated with Teflon. In the case of filament sizing, usually all cylinders are coated with Teflon. The cylinders in a drying section are usually arranged either horizontally or vertically. The horizontal system is generally used because it allows easy access to the cylinders for threading and mending a break, whereas the vertical system is useful in cases where floor space is limited and when more cylinders are required because a greater number of size boxes are used. The horizontal system of drying cylinders usually consists of seven, nine, or eleven cylinders, depending upon whether one or two size boxes are used. The number of drying cylinders required in a typical slasher will be decided by the density of the warp and the slashing speed that is used. For a higher number of warps and faster slashing speeds, a greater number of drying cylinders will be required. With faster slashing operation, the time available for the warp yarns to be dried will be less, and therefore a high heat transfer rate is required. On a multi cylinder machine, in practice, it is desirable to increase the drying temperature during the first phases of drying and to decrease it during the final phases. However, too high of a drying temperature is detrimental to the quality of the sized warp and also too much penetration of size will take place. Typically the temperature range from 80 to 105°C is used in practice.

Gentle yarn treatment during drying. The shrinkage behavior of the yarns on the drier is very diverse. Driving the cylinders by the warp has proved to be the gentlest way of compensating shrinkage. The special suspension and bearings of the cylinders permits an acceleration of the drying cylinder with minimum expenditure. The cylinders at the entry of the drier are able to compensate the residual shrinkage of the yarns. The other cylinders have a fixed drive.

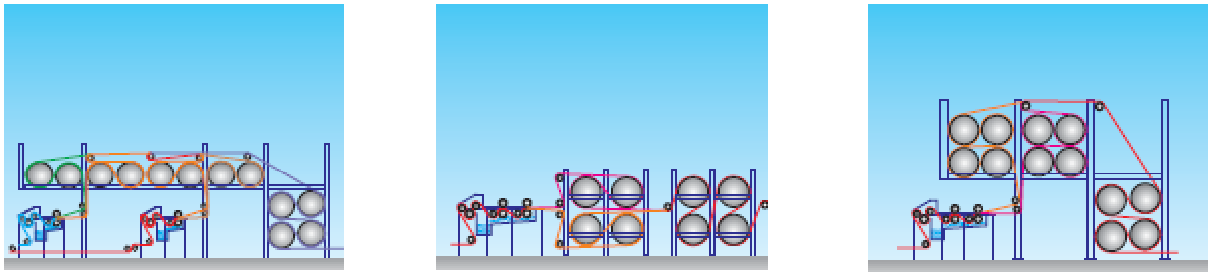

Fig: 23 Different Drying Configurations

Temperature and residual moisture control. The desired cylinder temperature is programmed in individual control groups via the size recipe. The process control regulates the steam supply to the set point value. The residual moisture, measured at the drier exit is automatically regulated by adjusting the speed.

Convection Drying. In this system, hot air is used as a drying medium instead of the steam used in cylinder drying. The heated air is passed through the drying chamber. The warp yarn through its passage in the drying chamber comes into contact with the heated air circulation, as shown in Fig. 24. The air is heated either by electric coil or steam. The advantage of the hot air convection drying system is that the whole yarn surface is subjected to a uniform drying temperature in contrast to cylinder drying where only a part of the yarn surface is in contact with a hot cylinder. The surface of the yarn in contact with the hot cylinder is likely to be over dried. Cylinder drying is therefore expected to result in uneven drying, with a resultant uneven distribution and migration of size in the yarn. Modern multiple-cylinder drying systems overcome this drawback by subjecting both the top and bottom sides of the yarns to drying by allowing the yarns to pass over and below the hot cylinders, resulting in progressive and uniform drying.

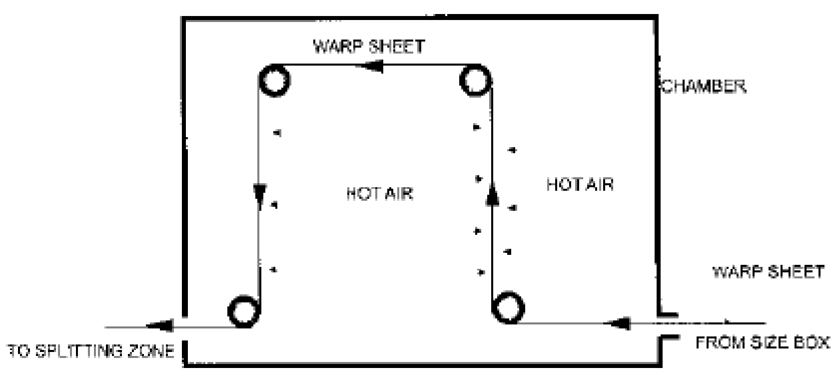

Fig. 24 Schematic of convection dryer.

Infrared and Microwave Drying. Other forms of drying methods, though not yet widely used in practice for sizing, are infrared drying and microwave drying systems. These systems aim to conserve energy through the efficient and cost-effective use of drying energy to replace conventional steam-based conductive drying. Infrared drying energy can be sourced either electrically or from gas. In an electric system, a series of infrared lamps with reflectors are mounted above and/or below the warp yarn sheet to be dried. The cost of electricitybased infrared drying is usually higher than that of conventional steam-based conductive drying. Gas-based infrared energy can be achieved by heating refractory materials to incandescence. This drying energy is similar to hot air drying based on the convection principle. The heat produced due to the combustion of gases is also circulated. The yarn can be passed through a number of infrared-radiating gas burners for drying.

Advantages in comparison to conventional drying systems

- Reduction of the drying time from hours to minutes
- fully continuous process
- gentle material treatment
- No separation of products with different bulk densities
- high efficiency, reduced energy consumption
- no additional drying aids required
- easy handling and installation

Microwave radiation is an inexpensive form of energy generation widely used in many industrial practices. Microwave energy can be obtained easily without causing pollution and therefore receives attention for the drying of textiles where large amounts of energy are consumed. The major problem of the conventional form of microwave energy radiation is the lack of uniform heating, resulting in randomly occurring hotspots which cause overheating in some areas and under heating in others. This problem has been corrected recently by the introduction of appropriately designed ‘‘waveguides’’ systems where microwave energy is transmitted back and forth across the material. This improvement in uniformity of distribution in microwave radiation has opened up new opportunities for its use in textile drying applications. Industrial microwave systems designed for specific purposes are now available which can be retrofitted to the existing conventional fossil fuel burning ovens or drying chambers that can be used as pre- or post-dryers. The use of microwave drying in sizing is in an early stage of development and has yet to replace the conventional drying methods based on conduction and convection.

Dry Splitting

The function of the lease rods in the splitting zone is to separate the individual yarns which are stuck together because of the drying of the size film in the drying section. To achieve this, a series of lease or bust rods, with one large diameter busting rod, are used, as shown in Fig. 25. The lease rods are generally chromium-plated hollow cylindrical bars flattened at both ends to be placed firmly in the brackets. The number of lease rods used is determined by the number of warper’s beams being used in the creel. The yarn sheet emerging from the drying section is divided into two sections by one large lease rod, as shown in Fig. 25, and each section is further subdivided into two subsections by successive lease rods. The pattern of dividing by lease rods in the splitting section is usually kept similar to the pattern of combining the sheet in the unwinding section, which helps in maintaining the order of the warp sheet, thus facilitating the subsequent drawing-in operation. Also, the leasing-in of the sized yarns to the weaver’s beam is facilitated by inserting leases in the top few layers of the warp. Even under normal operating conditions, the splitting zone imposes tension in the warp by offering resistance to the forward movement of the dried warp sheet. However, under stable running conditions, the tension imposed on the warp sheet is not affected significantly.

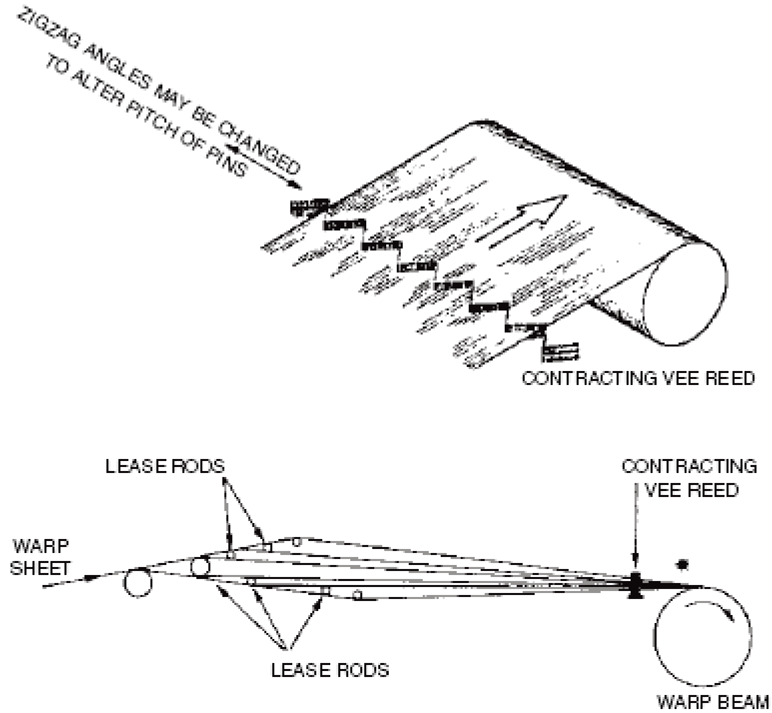

Fig. 25 Schematics of splitting zone.

Head Stock

The head stock is a take-up unit supporting the weaver's beam and necessary drive gears. The drive equipment imparts necessary beaming tension for compact and straight winding of the warp yarn on the weaver's beam. The configuration of the head stock is available in a variety of widths and styles. The width of the head stock is determined by the width of the weaver's beam and the number of weaver's beams being wound side by side. Usually head stocks are available which allow winding on a single beam, two beams side by side, and two beams positioned vertically or half beams run in center. Double beam head ends with vertical arrangement are primarily used for towel, gauze, and leno warps, which contain so few warps that winding on only one beam may either lead to the warp being over dried or else the full drying efficiency of the cylinder surfaces not being used a typical head stock is shown in Fig. 26. Irrespective of the configuration, the head stock is equipped with a positively driven roll, commonly known as the delivery roll or draw roll. The cork and rubber covered draw roll is placed between two heavy chrome-plated nip rolls, as shown in Fig. 27, to assure that the yarn sheet being drawn is wrapped well around the draw roll. The delivery roll moves at a constant speed for any sizing machine, and the speed of the weaver's beam is adjusted to impart the necessary winding tension. This poses a problem of driving the weaver's beam at a constant tension from start to finish of the beam, because the surface speed of the beam keeps increasing as the diameter of the beam increases, and consequently the winding tension also increases. This requires that the driving arrangement of the weaver's beam must incorporate a proportional reduction in the rotational speed of the weaver's beam to assure winding at a constant surface speed. On most modern sizing machines this is automatically controlled. Depending upon the type of arrangement used, the head stock driving system may be grouped as controlled tension beam drive, DC multi motor drive, or digital drive the arrangement and the principle used vary from machine to machine and the techniques employed by various manufacturers differ considerably, although the objectives remain the same.

Fig: 26 Head end of a sizing machine.

Controlled Tension Beam Drive. This system is the most accurate; is reliable, easy, and inexpensive to maintain; and is used widely. The drive is purely mechanical and utilizes a pneumatically loaded clutch to transfer the input torque to a positive infinitely variable (PIV) speed variator. In this system, the position of the pulleys in transmission is adjusted by comparing the revolutions of the clutch input shaft to the output shaft. With the increasing beam diameter the torque required to drive the beam also increases; however, the revolution of the beam should decrease to keep the surface speed constant, so the slippage across the clutch should be increased. This will lead to a reduction in the clutch output speed at the constant input speed. The automatic adjustment of speed and torque thus continues until the beam is full. While placing the new empty beam, the operator is required to reset the system to the proper ratio of barrel to full beam diameter. In this type of system, normally a single DC motor drive is used for the whole sizing machine.

The special arrangement of rollers in the 3-roller set prevents threads from slipping through and keeps the thread tension constant in the dry split section when changing beams.

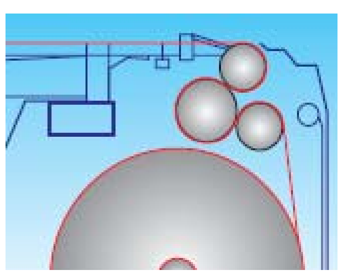

Fig. 27 Side view of a typical head stock.

Multimotor Drive. This system uses two DC motors, one for driving all components of the sizing machine, except the beam, and the other exclusively for driving the beam. The motor driving the beam provides constant winding tension as the beam diameter increases. This system is very simple mechanically but very complicated electrically. This system does not require resetting before beginning the new beam .

Digital Drive. This system comprises an electrical analog to the mechanical line shaft drive. The components of the sizing machine such as head end, dryer section and size box, etc., are driven by an individual motor. The digital system used for regulating the speed is most accurate.

Perfect beam surface. Speed-dependent, steplessly adjustable comb traversing, a hold-down bar, which prevents twisted thread groups, and the pressing devices all ensure a uniform surface and a compact, cylindrical package build.

Controls and Instrumentation

There are a variety of controls available on modern sizing machines. The essential functions of all these controls are to provide optimal quality of warp at a minimal cost. The controls usually act on the basis of information provided by the particular sensors placed on the machine. Figure 29 is a sketch of a typical two–size box slasher with locations of various sensors and controls.

Programming the machine. The easy to follow visualization and recipe management, in which all the machine and textile parameters are stored, permit fast and simple programming.

Sizing monitoring. The sizing process is automatically monitored. All set points are specified with upper and lower tolerance limits. Deviations from the programmed value are displayed at once and instructions for their rectification are explained in the language of the operator.

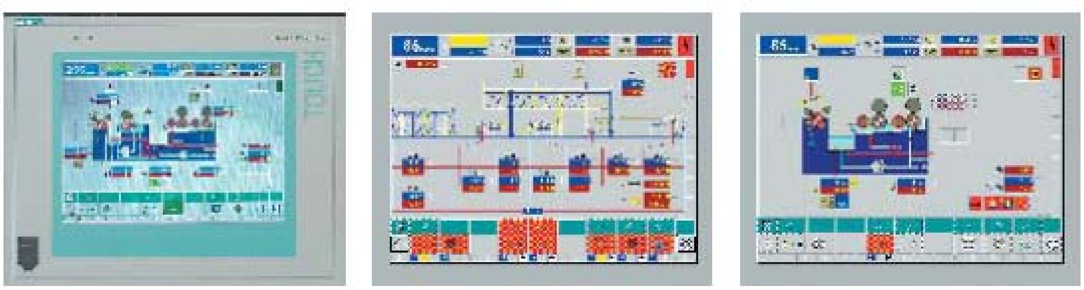

Fig: 28 Checking and monitoring the sizing process

Automatic tension control. In the direction of the yarn path, from the creel to the weaver’s beam at the head stock, controls are placed to monitor tension and effectively regulate the speed of the sizing machine. The controls are placed in the creel to maintain uniform unwinding of the warp beams in the creel, in the size box for a smooth drive of the dry feed rolls, in the drying section to drive cylinders, and in the head stock to drive the weaver's beam.

Automatic size box level regulator, with a warning indicator for low size level or verflow.

Electronic stretch indicators and controllers with digital display for yarn elongation. Excessive yarn elongation (stretch) resulting from the applied tension is detrimental to the quality performance of the warp during weaving. The loss in elongation results in an increase in warp breaks on the loom. Surface speed sensors, mechanical or electronic, in direct contact with the warp sheet are placed from the creel to the front roll in each zone. The automatic controls adjust the size box roll speeds to maintain a constant stretch.

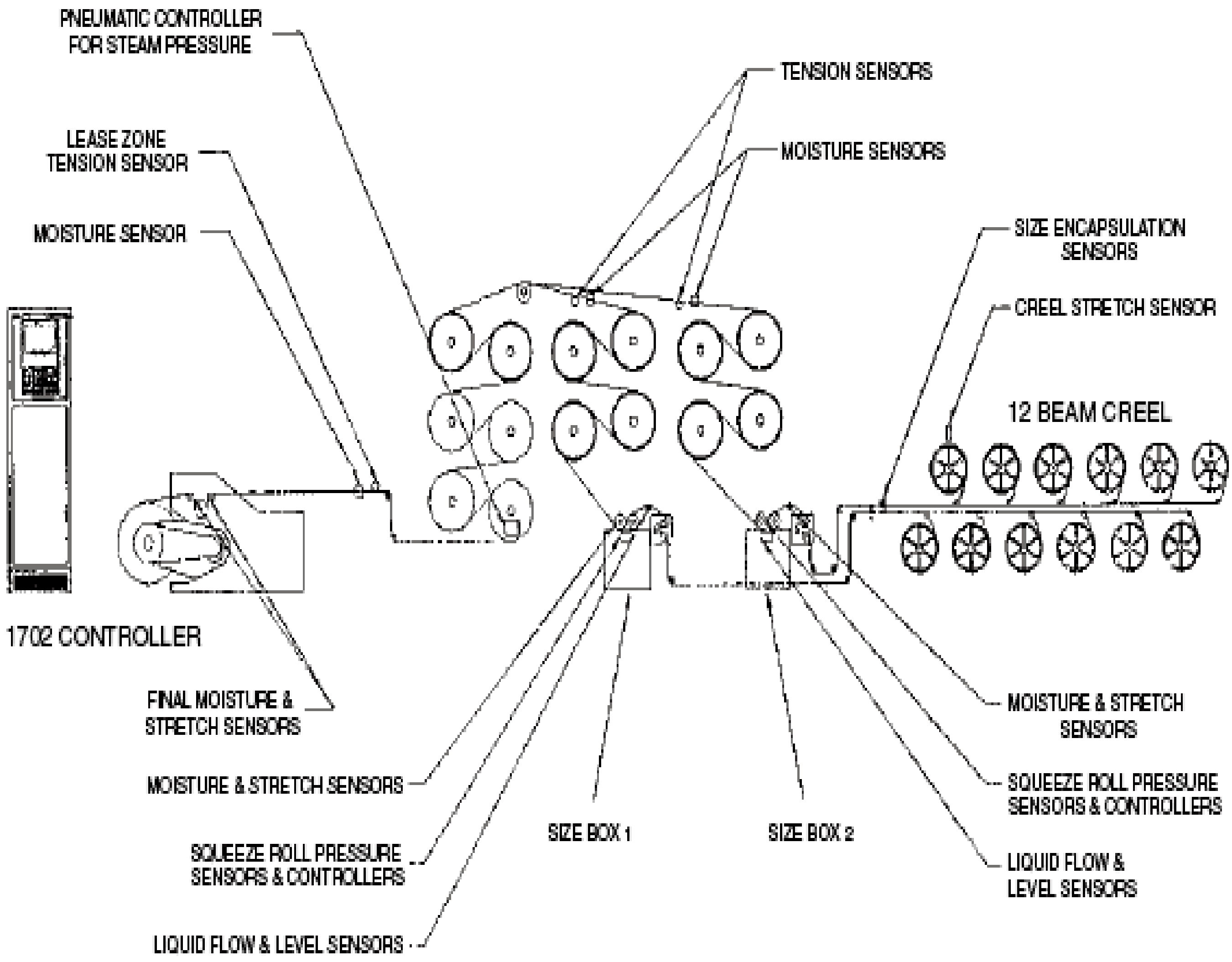

Fig. 29 Sensors and controls on a typical two–size box slasher

Electronic moisture detectors, used to regulate the slashing speed automatically or steam pressure in the drying cylinders.

Steam pressure controllers in the cylinders which may be interfaced to drive the controller to reduce the steam pressure during the slow or creep speed operation.

Temperature controls for the drying cylinders which can be used for maintaining accurate temperature and effective condensate removal.

Squeeze roll pressure release system designed to decrease the squeezing pressure when operating the machine at creep speed or maintaining proportional pressure with respect to the operating speed of the sizing machine.

Size liquor filtration and circulation system designed to filter out yarn waste and fibers (wild yarns and short fibers) found in the sizing system.

Creel braking systems to decelerate the warper's beams effectively, thereby preventing over-run and maintaining the unwinding tension at a constant speed operation.

Microprocessor controls interfaced to a computer for effective management of the operating variables of the sizing machine.

Wet pick-up measurement and size add-on control. In this device, microwave energy which is absorbed by water is used to continuously measure the wet pick-up immediately after the yarn sheet leaves the size box. The on-line refract meter monitors the size solids in the size mix. The size add-on, which is the product of the wet pick-up and size solids in the size mixture, is automatically calculated by the microprocessor. The corrections in the size add on is made by automatically adjusting the squeeze roll pressure to keep the add-on practically constant throughout the sizing operation.

On-line size encapsulation measurement. Size encapsulation is the measure that defines the degree of reduction of the yarn hairiness due to sizing. One on-line yarn hairiness sensor is placed on the unsized and the other on the sized yarn sheet. The difference between the two, expressed as percentage, is the measure of size encapsulation.

Pre Wetting

Prewetting technology. Impregnating the warp with hot water whilst at the same time washing it has demonstrated its ability to yield better surface sizing of the threads. Adhesion between size and yarn is enhanced, hairiness is reduced and maximum thread breaking strength increased.

Savings

- *Size savings of up to 50%*
- *Improved weaving characteristics*
- *Lower effluent treatment costs*

High productivity

- *Optimal weaving efficiency*
- *Greater flexibility due to fast and simple changeover*
- *Fewer warp beam changes thanks to increased warp lengths*

Savings. Prewetting significantly reduces the degree of sizing, cutting size costs considerably. Additionally, the reduced hairiness cuts down thread breaks during weaving, resulting in increased efficiency.

Drawing-in. As with any sizing process, with pre wetting too, the thread tension must be reduced in comparison to the draw-off tension from the back beam creel on immersion in the liquor. The lower tension permits simpler absorption of the liquor and reduces elongation. Through the powered drawing-in, the thread tension can be individually selected on immersion in the hot water, therefore reduced in each case.

High degree of flexibility. Through the special execution of this multifunctional sizing box, rapid and simple adaptation to article diversity is no longer a problem. Depending on article and requirement, the first compartment can be used for pre wetting with water or filled with liquor as a sizing compartment. The different processes can be pre selected at the PC or saved in the recipe management.

Prewetting zone. The warp is immersed into the water bath by the lower squeezer roller. A first press roller presses the air from the yarn sheet and achieves the washing effect. On leaving the squeezer, the warp is again sprayed with hot water by a spraying unit. The second wetting is achieved through this sprinkling and in the gap of the press roller, after which the warp runs through the high-pressure squeezer.

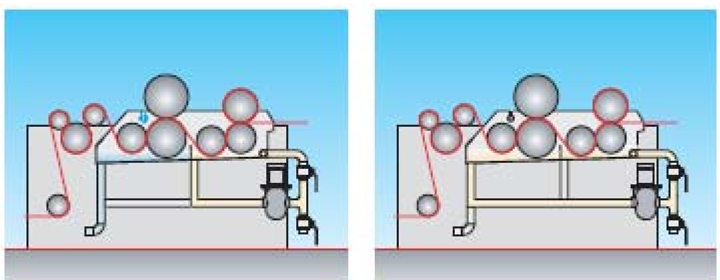

Fig: 30 *Multi-functional sizing box TKV With this combination Benninger has combined proven sizing technology with the advantages of pre wetting. This concept offers the additional possibility of using this unit as a conventional sizing box with double squeezer.*

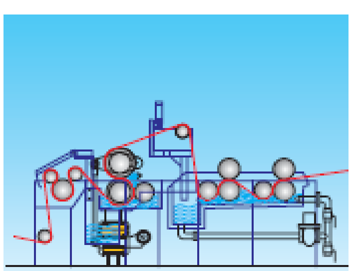

Fig: 31 KVD warp drawing-in, pre wetting zone, sizing box with two immersions and two squeezes

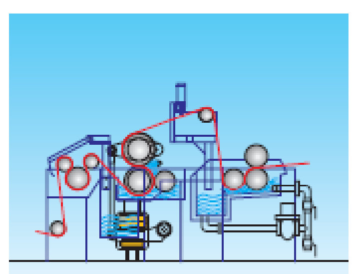

Fig: 32 KVE warp drawing-in, pre wetting zone, sizing box with an immersion roller and a squeezer

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