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QUALITY CONTROL IN WINDING, BEAMING AND WEAVING 1/

by

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INTRODUCTION

The main objective of a weaving establishment is to produce fabrics of a specified or better quality, with minimum waste, and at the optimum labour and machine productivities that will maximise profits. Obviously productivity and quality at every stage are governed at the first instance by the quality of yarn supplied, and by the sophistication of the machinery available in the mill. Taking into consideration these two factors, therefore, and keeping in view the realisable prices and acceptability of the fabric being produced, quality standards as well as productivity norms are laid down by the management. The task of the weaving superintendent is, then, to excercise sufficient control over the processes from winding to weaving so as to maintain or improve fabric quality while meeting the production norms.

Now what exactly is meant by quality of fabric? This term obviously denotes many things : weave, drape, feel, texture, strength, durability, wrinkle resistance, dimensional stability etc., on the one hand and freedom from defects on the other. All the former quality attributes are almost completely determined by the design specifications of the fabric : type of fibres used, count and twist of warp and weft yarns, end and pick density, type of weave, type of chemical processes and finishes employed etc. The weaving superintendent has, therefore, to meet the design specifications, inasmuch as they can be controlled by the operations from winding to weaving. Apart from this, his sole preoccupation, as far as quality is concerned, should be to ensure that the fabric is (i) free from yarn faults such as slubs, thick places, foreign matter and thin places, and (ii) free from defects originating at looms or in preparatory processes, such as missing ends, floats, uneven pick density, broken picks, bad selvedges, starting marks, poor cover, bad knots, reediness etc. What then should be his approach for meeting the quality requirement and production norm?

The first point to note is that the quality of fabric and productivity at the loom are determined by the totality of operations from winding to weaving. His approach should, therefore, be to look at each process not in isolation, but in relation to the manner in which it affects subsequent processes, and in particular, the eventual quality of the fabric and productivity at the loom. In this context it is just as well to remember that while preparation and weaving both contribute to fabric quality and loom productivity substantially, the weaving operation contributes by far the greater part to the cost of production. Hence it is obvious that the emphasis in the preparatory processes should be on quality of preparation, to the extent this affects loomshed productivity and fabric quality, rather than on productivity. The weaving superintendent should, therefore, if it be so required for the sake of quality of preparation, bear with lower productivity at the preparatory processes, but he must not compromise with the quality of preparation. On the loom itself the demands of quality and production are sometimes in opposition, and he has to maintain a fine balance between the two conflicting requirements.

The second point is concerned with methods of control. At every process the quality depends mainly on the process parameters employed, condition of machines and work practices. The correct process parameters have to be chosen on the basis of experience and large scale controlled trials; once determined they require only minor adjustments to counter slight fluctuations in the quality of incoming yarn. After optimum process parameters are laid down, quality then becomes largely a function of how well, in actual practice, these process parameters are adhered to, the state of mechanical maintenance of machines, and of the quality of work practices being followed. The weaving superintendent has, therefore, to be extremely vigilant on all these three counts. His approach should be to build into his system of operations and management a regular programme of process control and checks, preventive machine maintenance, and training of workers, rather than depend solely on corrective actions taken after the detection of faults. If this is done, quality will be taken care of to a great extent. Regular measurement of quality and its control by the Statistical Quality Control technique whenever the quality characteristic is measurable and controllable, will then be additional means of ensuring that all is well with the various processes. Sometimes such control will bring out the need for further corrective action that might have otherwise been missed. It is in this sense of comprehensive control - process control, preventive maintenance, improvement of work practices and Statistical Quality Control - that the term Quality Control is used in this paper. Strictly speaking waste control also should form a part of Quality Control, although this aspect has not been discussed in the paper.

In the subsequent sections of the paper the key functions and elements of each process in relation to their effect on eventual fabric quality and loom productivity will be identified, and methods of achieving effective Quality Control at every stage will be discussed. A complete check-list for the Quality

Control Programme in all sections from winding to weaving is given in Appendix-III.

WINDING

The quality of preparation at winding is synonymous with 'optimum' removal of the objectionable 'faults' from yarn and production of 'good' packages. It is worthwhile to define these terms. 'Faults' refer only to those yarn defects which, if not removed at winding, will either show up as a fabric defect, or will almost certainly cause an end break at subsequent processes, particularly at weaving. Ideally, each fault should be removed by a break, and there should be no break in the yarn when there is no fault. In actual practice some faults always escape detection even on the best machines, while many yarn breaks occur without being caused by any fault as defined above. 'Optimum' removal implies that process parameters are so chosen that, while less clearing of yarn faults will increase fabric defects materially and reduce weaving efficiency significantly, greater clearing will not give commensurate benefits in quality of fabric or weaving efficiency, but will, on the other hand, reduce winding productivity substantially. A 'good' package is one which is free from defects, such as stitches, soft nose or base, ribbons and hard rings etc., which are likely to increase yarn waste and breakages at warping, and hence at weaving.

Consideration will now be given to how the Quality Control Programme at winding can help in optimum removal of faults and in the production of good quality package.

REMOVAL OF FAULTS

Faults in yarn are of three types; (i) Thick places such as slubs, thick piecings, foreign matter etc. (ii) Weak places and (iii) Thin places which are not weak. On conventional machines defects of type (i) are removed by the slub-catcher (sometimes also called snick-plate) while defects of type (ii) are removed by the tension in the yarn. These machines are incapable of removing defects of type (iii). Machines equipped with electronic or photoelectric yarn clearers can remove defects of type (iii) also. In developing countries, there are not as yet many electronic or photoelectric yarn clearers in use, and therefore these will not be considered further.

It is important to note that the commonly employed measures of yarn quality do not yield an index of the efficiency of fault removal at winding. The only method of ensuring a satisfactory level of removal of faults is to control the relevant process parameters.

Process Parameters

The two process parameters which govern the removal of faults are the slub-catcher setting and the unwinding tension. The optimum slub-catcher setting will depend on the type of the detector assembly i.e., whether it has fixed blades or an oscillating blade. The actual weights or spring pressures to be employed for obtaining a given level of tension in the yarn will vary according to the design of the machine. The level of tension in the unwinding yarn can be varied on most machines by adjusting tension weights or spring pressures. On the Barber Colman Spooler, direct tensioning arrangements are not provided but the tension level which is dependent mainly on the speed of unwinding can be altered to some extent by adjusting the "detector wire" springs.

Manufacturers of different types of machines no doubt give guide lines regarding optimum slub-catcher settings and tension levels for different counts of yarn. It is the general experience, however, that these recommendations cannot be universally applied. It is essential to conduct large scale controlled trials to set up standards for these two important process parameters appropriate for individual mill conditions. Investigations conducted by ATIRA have shown that for Indian conditions the optimum settings for slub-catchers with fixed blades are around twice the yarn diameter for combed yarns and two and a half times the yarn diameter for carded yarns; for slub-catchers with an oscillating serrated blade the corresponding optimum levels are around four and a half and five times the yarn diameter respectively. The optimum level for average yarn tension, while unwinding from the top and middle position of the bobbin, varies according to the unwinding speed - being around one-tenth of the single thread tensile strength for speeds of the order of 400-600 metres/minute; and around one-seventh of the single thread tensile strength for speeds of the order of 900 - 1000 metres/min. The results of an investigation in an Indian mill illustrating how slub-catcher settings and yarn tension affect winding and weaving performance, and fabric defects are summarised in Table-I.

TABLE-I

EFFECT OF SLUB-CATCHER SETTING AND YARN TENSION ON PERFORMANCE AT WINDING, WARPING, & WEAVING

Slub-catcher Settings and Tension Levels at Winding	Yarn Breaks per 100 Bobbins at Winding	Warp Breaks per Loom Hour	Major Defects/100 Metres (Missing ends and Floats)
12/1000" 20 Grammes	38	1.9	3.7
15/1000" 30 Grammes	26	1.4	2.6

Fabric : 30s/30s Counts Warp/Weft ; 112/60 Ends/picks per inch

Once the optimum parameters have been ascertained it now remains to ensure, by routine checking, that these are in force. The Quality Control Programme should therefore, include checking of (i) slub-catcher settings once every shift, (ii) tension weight or spring pressure once a shift, (iii) yarn tension levels once a month, and (iv) winding speeds once a month. While carrying out these checks close attention should be paid to the condition of the slub-catcher and the positioning of the bobbin to ensure that that these do not vitiate the setting of the slub-catcher and the yarn tension level. These two aspects will now be discussed in some detail.

Condition of Slub-Catcher

Correct settings cannot be obtained on defective slub-catchers. On slub-catchers with fixed blades the more common defects are the following : (i) Scissor type opening between blades (ii) Bow shape opening and (iii) The two blades not being in the same vertical plane. These defects are shown in figures 1a, 1b and 1c respectively.

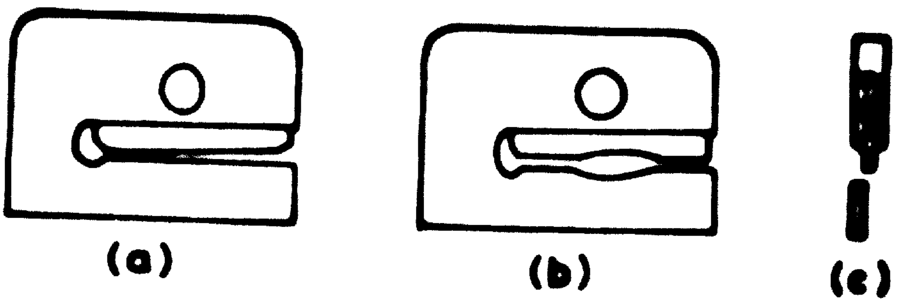

Fig.1 : Defects in Slub-Catchers with Fixed Blades

Defects of types (i) and (iii) are caused by workers tampering with the slub-catcher. Such defects can in general be corrected easily. If this is not possible the slub-catcher should be replaced immediately. Defects of type (ii) are caused by excessive wear of the blades in the portion where the yarn oscillates to and fro. If the total wear of the two blades is more than 2"/1000, new blades should be put in. Excessive wear can be caused if the yarn guides before and after the slub-catcher are not in level with the upper edge of the lower blade, or if the yarn vibrations caused by ballooning during unwinding are not properly damped.

On slub-catchers with an oscillating blade, the desired settings are generally obtained with the help of a specially designed cam, which is calibrated to indicate the setting between the blade and the platform. It has been seen that in course of time this calibration gets disturbed so that the graduations marked on the cam-axis or the 'setting-wrench' do not any more correspond to the actual setting. The following table gives an example.

TABLE-II

VARIABILITY IN ACTUAL SETTINGS ON DIFFERENT SLUB-CATCHERS FOR A NOMINAL SETTING OF 30/1000"

Actual Setting in 1/1000" (Measured by leaf gauge)	Percent of Slub - Catchers		
	Mill-A	Mill-B	Mill-C
20 and below	9	-	-
21 to 27	41	42	9
28 to 32	44	55	81
33 and above	6	3	10

The Quality Control Programme should include a regular check on the calibration of the cams of groups of spindles, in turn, so that every slub-catcher is checked and corrected once in three months. A spare set of a dozen or so slub-catchers should be procured which can replace an existing set of slub-catchers on the machines. The set taken out can then be checked and set right on the tool bench. This set can then replace another set working on the machine and the cycle can thus be completed. This system of maintenance ensures accurate calibration and minimises loss of production. Another point to note is that accumulation of moist fluff in the bearing of the blade shaft hinders free movement of the latter. In that case correct setting on the slub-catcher cannot be ensured. The freedom of movement of the blade shaft should be checked every shift. It is suggested that, at the time of calibration, the slub-catchers should also be cleaned with petrol.

Positioning of the Bobbin

On machines without balloon breakers, the distance between the bobbin tip and the first thread guide greatly influences the manner in which yarn tension increases as unwinding proceeds. Incorrect distances increase the tension particularly towards the latter part of the bobbin, and thus result in unnecessary breaks. Distances which result in minimum tension rise towards the end of the bobbin are approximately given by * $\frac{L + G}{L + 1} = n$, where, L = Bobbin Length in inches, G = Distance of Bobbin Tip from Guide in inches, and n = Any Integer. In using this formula it should be borne in mind that very unfavourable distances are just a little smaller than the optimum.

Another defect in machine setting which increases the peak tensions while unwinding from the bottom of the bobbin, is the improper alignment of the bobbin axis with the first thread guide. Bobbin alignment can be checked easily with the help of a gauge illustrated in the Appendix-I. This alignment should be checked once every month.

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* J.T.I., p.71, Vol.50, No.2, 1959

Incorrect Work Practices

The effectiveness of an otherwise satisfactory Quality Control Programme can be lost to a great extent if incorrect work practices are not curbed. Worker's tampering with gauges has already been mentioned. There should be strict supervision and training of workers to eliminate this practice. A procedure which is helpful in such situations is to confront the workers with the eventual consequences of incorrect work practices : in this case, appearance of big slubs and thick places in the fabric. Removal of faults cannot be considered efficient, if the quality of knot replacing the fault is not satisfactory. This is particularly important for non-automatic winding machines where knotting is done mannually. It is suggested that the workers should be trained in the proper use of mechanical knotters.Where such knotters are in use, the supervisor should keep a regular check on the condition of the shearing blades and the tension jaws of the knotter.

QUALITY OF PACKAGE

Certain machine defects and incorrect work practices result in defective packages. These are discussed below:

Defective Broken-Thread Stop Motion

In course of time the settings of the stop motion may get disturbed. The cone or the cheese will then continue to rest on the drum even after the yarn breaks. The outer layers of the wound package receive severe abrasion and the yarn in these layers may get cut at places or become a potential source of break during subsequent processes. It is a good practice to check stop motions every shift.

Improper Setting of Winding Spindle with Respect to the Winding Drum

Generally machinery manufacturers provide suitable gauges for setting the winding spindle (on which the wound package is held against the drum) with respect to the drum. If such a gauge is not available it is easy to make one. The actual shape of the gauge will depend on the shape of the drum, the winding spindle and its bracket. A gauge for the Autoconer winding machine is shown in the Appendix-II. The essential thing in this setting is to ensure that the empty package, when mounted on the winding spindle and made to rest against the drum, is completely in contact with the drum; the line of contact between the drum and package should then be parallel to the axis of the drum. If this is not ensured the package will be soft at the nose or base, thereby creating difficulties while unwinding at warping such as slough-off. Such sloughing-off will usually result in yarn break. On occasions the sloughed off layers will escape detection at warping and will cause yarn breaks at weaving.

Non-Alignment of Tension Bracket with the Drum

The last contact point guiding the yarn between the bobbin and the drum should lie in the vertical plane bisecting the traverse. A simple gauge to ensure a correct setting is described in the Appendix-II. If this alignment is not true, rings or stitches are produced on the package. Both these defects are a potential source of break at warping. Soft build at base or nose and rings on the package can also cause shade variations on dyeing.

The alignment of the tension bracket and the winding spindle with the drum should be checked once every month.

Condition of Knotters

Mechanical knotters occasionally tie loose knots which are very likely to slip off at warping. Cones or cheeses with many loose knots will hinder smooth working in warping. To guard against this it is suggested that at least 25 knots be tested from each knotter, in every shift for firmness. Simultaneously the length of tail ends can also be examined. Tail ends should not be longer than 1 cm. Also on automatic winding machines, the frequency of knotter failure should not be allowed to exceed 2%.

Incorrect Work Practices

Workers sometimes release the yarn on to the package so that it falls outside the traverse resulting in a stitch or side wound coils which often cause yarn breaks at warping. The worker should release the knotted yarn to the cone or cheese with a slight tension. Otherwise a snarl may form near the knot and this may cause a break or a stop on the loom. Some workers do not wind (or wind incorrectly) the tail end on a wound package which cannot then be used with advantage in the warping creel as a magazine cone.

WARPING

The objective of warping is to prepare packages of good quality i.e., beams of the correct density which will unwind well at sizing. Removal of yarn faults is not a function of the warping operation. Therefore, yarn breakages at warping should be kept to a minimum. The role of the Quality Control Programme in fulfilling these objectives will now be examined.

MINIMIZING YARN BREAKS DURING WARPING

It is essential to keep yarn breakages at warping to a minimum for two reasons. First, of course, increase in yarn breakage rate will reduce productivity at warping. Secondly, a yarn break at warping is a potential source of break either at sizing or at weaving and may also cause a fabric defect. This is because sometimes a yarn break at warping is not mended properly - that is, instead of knotting the two broken ends together, the worker twirls the end on to a neighbouring thread, leaving a free end in the beam. This will invariably lead to a lapper* at sizing, and a missing end on the weaver's beam. It may also occasionally result in a double end in the fabric. Improper mending of a yarn break at warping may be due to the worker's negligence, particularly if the yarn breakage rate is high. Also, the broken end on the beam is not sometimes traceable because of inefficient braking, and in such cases proper mending cannot be done. Even in cases where the yarn end on the beam is traceable, the worker may not be able to knot the two ends together without crossing of yarns. This again is likely to lead to a lapper at sizing and missing end at weaving. Further, on most warping machines the warper's beam is driven through friction with the driving drum. In order to get a good density of package, the pressure between the drum and the warper's beam has to be kept at a fairly high level. In the event of a break, the warper's beam has to be stopped in a very short time, during which, the drum acting as a brake, abrades the outside layers of yarn on the beam. This is not at all desirable.

With a given quality of yarn and winding preparation, yarn breaks can be minimized by attention to the following factors.

Yarn Tension

There is a systematic and characteristic pattern of variability in the levels of individual yarn tensions near the head-stock. This pattern is governed by

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* Lapper : Accumulation, during sizing, of layers of yarn on the warper's beam, squeeze roller, or any other roller or on the drying cylinder, occasioned by the presence of free ends in the warper's beam or by the occurrence of an end break in sizing itself.

the threading arrangements, that is whether the neighbouring yarns are taken from the same row or the same column of packages in the creel. The average yarn tension during warping should not generally exceed 14 grammes for counts upto 36s, and 8 grammes for counts finer than 60s. The maximum permissible tension levels should be arrived at taking into consideration individual mill conditions. The tension level can be adjusted by a suitable combination of tension weight, wrap of yarn around tension pin, and warping speed. Higher tensions than those recommended above have been seen to increase the end breakage rate at warping. The tension level should be checked once in a month.

Alignment of the Package at the Creel

The alignment of the package at the creel to the first thread guide is the most important factor influencing yarn breakage rate at warping. Table-III illustrates the effect of package alignment on end breaks at warping.

TABLE-III

EFFECT OF POOR PACKAGE ALIGNMENT ON END BREAKS AT WARPING

	Breaks/400 Ends/1000 Metres	
	Mill-A	Mill-B
Poor Alignment	4.2	3.0
Correct Alignment	2.3	1.9

Good alignment requires that the axis of the package when mounted on the creel peg should pass through the point of yarn contact with the first thread guide. For achieving this alignment a gauge similar to that suggested for aligning the bobbins at winding can be used. Even if the alignment is done properly it can get disturbed in a short time if the pegs at the creel holding the cone or cheese are not rigid enough. Improper alignment can be detected by watching the stop motion pins at the head-stock. The pins containing yarns from improperly aligned packages will be 'jumping' far more than the rest of the pins, because of the very large tension fluctuations in yarn from non aligned packages. The alignment of such packages should be corrected during recess every day. A thorough check of the alignment and replacement of defective pegs should be undertaken once every six months. On magazine creels the alignment can be disturbed if the creel-boy does not turn back the creel-peg to its original position after inserting the new cone or cheese. Such defects should be corrected immediately.

Eccentric Guide Rollers

On machines with mechanical stop motion, it is essential to employ several guide rollers, which are positioned very near to one another. Eccentricity in these rollers can introduce short term tension variations of high amplitude leading to a warp break. The guide rollers at warping should be checked for concentricity and made true, if necessary, once every six months. It is also suggested that, if possible, the mechanical stop motion should be replaced by an electrical stop motion. One can then dispense with all guide rollers but one, and thus eliminate the fault described above.

QUALITY OF PACKAGE

The following factors can affect the quality of package.

Condition of Flanges

If the flanges of the warper's beam are not quite perpendicular to the beam axis -- such defects can develop due to poor handling -- the unwinding of yarn from near the beam flanges will not be satisfactory at sizing, which will in turn cause end breaks or sticky ends in the selvedge. The ultimate result will be frequent breaks of selvedge ends at weaving, and consequently poor selvedge in fabric.

The Quality Control Programme should include a regular check on the condition of the flanges. Provision of beam racks for storing full and empty beams, and mechanical handling and transport of beams will be helpful.

Uneven Tensions

Large variations in individual yarn tensions during warping result in an uneven package density across the beam. This, in turn, may cause slack ends, snarls, entanglement and yarn breaks at sizing. Apart from variations in tension weights or in the settings of tension mechanisms, large tension variations between individual yarns are also introduced by accumulation of fluff at the tension device. The tension weights or the settings of the tensioning mechanism should be frequently checked. Use of oscillating fans on the creel, and the cleaning of the creel at every beam fall for magazine creel, and at the running out of the creel for single creel, are suggested for minimizing tension variations caused by accumulation of fluff.

Warp Stop Motion

Efficacy of the stop motion on the warping machine determines the ease with which a broken end on the beam can be traced. Brakes of the stop motion should be adjusted so that the yarn wound on the beam after an end break does not exceed the distance between the head stock and creel. If the yarn wound on the beam is more than this, there are chances of the broken end on the beam getting buried under neighbouring threads. Then, not only the worker will take longer time to mend the broken end but he is also likely to mend it incorrectly causing crossed ends in the package. The warp stop motion setting should be checked once every shift.

SIZING

The main objective of sizing is to apply a uniform and smooth protective film of sizing paste on the yarn for added strength and abrasion resistance. This should be done with as small a loss of 'extensibility' of the yarn as possible, that is, the percent elongation at break should not decrease excessively after sizing. At the same time sizing should result in an adequate increase in yarn strength. The sized yarn must have the correct moisture. Furthermore, the sized beam should be firm and should not contain too many crossed or missing ends. The Quality Control Programme at sizing should ensure that the above mentioned objectives are fulfilled. The tensile strength of the sized yarn is governed to a large extent by the size receipe used and the size pick-up level, as well as by the quality of the ingredients used in the receipe. For the present discussion, however, it will be assumed that the correct receipe has been arrived at on the basis of experience and trials and also that the mill laboratory regularly analyses the sizing ingredients to verify that they conform to specifications. Only those aspects of process control proper in the sizing operation itself will therefore be discussed.

YARN EXTENSIBILITY AFTER SIZING

It is not practicable to size the warp without any tension. The tension applied during sizing results in a slight permanent stretch in the yarn with a resultant decrease in extensibility or elongation at break. The greater the stretch, the higher is the loss in yarn extensibility. If the average extensibility of the sized yarn falls below a certain minimum, the less extensible portions in the yarn are liable to break and the weaving performance adversely affected. ATIRA has arrived at the following norms for minimum average yarn extensibility for sized yarns for satisfactory weaving performance under Indian conditions.

Count Group	18s-22s	23s-44s	44s and above
Minimum Average Extensibility %	4.5	4.0	3.3

The extensibility of yarns from each sizing machine should be determined in the laboratory once a week. Day to day control can, however, be excercised by recognizing that the percent increase in the length of yarn noticed after sizing is the measure of the stretch the yarn undergoes during sizing. The extensibility of sized yarns can therefore be kept within satisfactory limits by ensuring that the stretch does not exceed 1.5-2.0%, depending on the extensibility of the unsized yarn. The following table shows typical results of the effect on weaving performance of higher stretch at sizing.

TABLE-IV

EFFECT OF STRETCH AT SIZING ON WEAVING PERFORMANCE
(Fabric: 32s/32s; 96 x 56)

% Stretch at Sizing	Warp Breaks per Hour
1.0	1.8
1.6	1.9
2.0	1.9
2.9	2.7

Very high stretch is generally associated with yarn breaks during sizing, which result in missing and crossed ends in the weaver's beams.

While modern sizing machines are equipped with stretch indicators, on conventional sizing machines stretch can be conveniently measured with the help of two yardage counters, which measure the feed and the delivery rates. In order to control stretch the zone in which the stretch is high should be located.

On conventional sizing machines there are three zones in which stretch can be controlled. These are (i) Creel zone — between last beam and first guide roll in sow box (ii) Drying and splitting zone — between sow box and the drag roller and (iii) Winding zone — between drag roller and the weaver's beam. The stretch should be separately measured in these zones. Stretch should not be allowed to exceed 0.3 to 0.5% in the creel zone, and 1.2 to 1.5% in the drying and splitting zone. The stretch in the winding zone should be practically nil. If creel stretch is high, the braking arrangement at the creel should be checked. While running the machine at high speeds, the sizers have a tendency to over-tighten the brakes on the warping beams lest they overrun when the sizing machine is stopped. The pedestals at the creel should be provided with ball or roller bearings to reduce creel stretch. If guide rollers are employed at the creel they should also run on ball bearings. Bent gudgeon pins of warper's beams should be trued or replaced, since they are instrumental in increasing the creel-stretch substantially. For fine yarns it is desirable to use warper's beams with large barrel diameter, say 8", to keep down the stretch. If the stretch in the drying and splitting zone is high the dynamic balancing of the drying cylinders should be checked and they should be provided with ball bearings. It is desirable to check the dynamic balance once every six months. The circumference of the drag roller, which governs the delivery rate, should be adjusted suitably by removing cloth layers. It is suggested that the last few layers of the drag roller covering should be renewed every week. After renewing the outer layer the stretch should be checked. Winding tension and hence stretch at the winding zone can be easily controlled by the friction clutch drive on conventional machines.

On modern high speed sizing machines there are five zones in which stretch can be controlled : (i) Creel zone (ii) Zone between sow-box and first drying cylinder (iii) Drying zone — between drying cylinders (iv) Splitting zone — from the last drying cylinder to the drag roll and (v) Winding zone. Control is effected by synchronizing the PIV gears.

One of the guide rollers between the drying cylinders and the drag roller is usually mounted on spring loaded bearings. The main purpose of this guide roller is to damp the tension variations. In course of time, compressibility of the spring governing the movement of the guide roller is reduced due to accumulation of fluff in between the coils of the spring. In that case short term variations in warp stretch and consequently in the extensibility of the sized yarn are likely to ensue. It is suggested that the springs should be cleaned thoroughly once every week.

UNIFORMITY OF SIZE PICK-UP

The size pick-up level influences the performance of yarn during weaving. The optimum size pick-up level depends on the type of yarn, and fabric construction. It is, therefore, essential that the optimum average pick-up level should be established by large scale controlled trials. It is ATIRA's experience that with starch recipes, and for warp counts upto 30s, about 10% size pick-up level for light and medium constructions (upto 80 ends/inch in the reed), and 12-13% size pick up level for heavier constructions are adequate. For finer counts about 15% size pick-up level is satisfactory.

The average size pick-up level in yarn varies to some extent from beam to beam. Within a beam the size pick-up level varies considerably at different portions along the length of any yarn. It is important to control the between-beam and the within-beam variations in size pick-up levels within as narrow a range as possible.

For routine estimation of the average size pick-up level of a beam, the beam weighing method is generally used. There are a few points to be kept in mind while using this method. Firstly the method will not give a correct estimate of the size pick-up level, if the tare weights of the weaver's beams are not recorded correctly. Very large apparent variations in size pick-up levels can sometimes be traced to differences between the actual tare weights of the weaver's beams and the nominal weights. Such differences lead to unnecessary adjustments of the size pick-up level. The first requirement to make sure that the beam weighing method is reliable for routine control purposes is, therefore, to check and correct the tare weights at least once a year. The second requirement for the beam weighing method to give a correct estimate of the size pick-up level as determined in the laboratory, is that the moisture regains in the unsized and sized yarns are identical. No doubt the moisture regain in the sized yarn can be maintained very close to a desired level with the help of moisture indicators. In actual practice, however, it may not always be possible, and indeed in most cases, not desirable to maintain the level of moisture regain in the sized yarn the same as that in the unsized yarn. A bias will, therefore, be introduced in the size estimation. But within a day, or over the span of a few days, the moisture regain in the unsized yarn is likely to vary only within very narrow limits. The bias in the size pick-up level obtained by the beam weighing method will, therefore, be constant over such small periods, and in practice small. The moisture regain of the unsized yarn may, however, vary significantly over different seasons, if the humidification in the preparatory section is not properly controlled. Under these circumstances, the bias will no longer be constant in different seasons. This fact should be recognised and allowed for. The last point to be noted is that the warp stretch renders the size pick-up determined by the beam weighing method an underestimate of the actual pick-up. This also needs to be taken into account. A regular check, say once in a fortnight, of the true size pick-up level as estimated by the desizing method in the laboratory, will be helpful towards making such allowances, thereby enabling the beam weighing method to be used with confidence for routine control. With a suitable sampling plan, the laboratory method will also give useful information on the size pick-up variability within a beam.

A careful check on the points discussed below will be helpful in controlling variations in size pick-up level within as well as between beams.

Depth of Immersion Roller in the Size Paste

The depth of the immersion roller in the size paste determines the duration for which the yarn remains immersed in the paste. Any change in this depth will cause a variation in the size pick-up level. The back sizer should be given specific instructions to maintain the depth of the immersion roller in the size paste at the required level, which should be determined on the basis of the size pick-up levels in the preceding beams.

Level of Size Paste in the Sow Box

The level of size paste in the sow box should be maintained at a constant height to ensure a uniform size pick-up level. On machines where level control arrangements are not provided, it will be useful to provide a recirculatory pump. On machines in which neither a level control arrangement nor a recirculatory pump is provided, the back sizer should be very careful to lower the immersion roller as the size paste level goes down.

Movement of Squeezing-Nip

While the sizing roller runs in stationary bearings, the bearings of the squeeze roller are generally free to move up and down. Because of this freedom of movement, the squeeze roller bearings get worn out in course of time. This results in a substantial lateral movement of the squeezing-nip which can introduce short term variations in size pick-up level. Bearings which permit more than 1/16" of a lateral movement should be replaced.

Heating of Paste in Sow Box

On most machines, the size paste is heated directly by steam. The condensed steam should not flow into the sow box. Also the paste temperature should not be allowed to fall below 90°C. While the condensation of steam in the sow box will reduce viscosity and lower size pick-up level, a decrease in temperature will increase viscosity and increase the size pick-up level. It may also result in lump formation and sticky ends, causing end breaks at weaving.

INCREASE IN STRENGTH AFTER SIZING

Sizing of yarn invariably increases the yarn strength. If sizing has been carried out satisfactorily, that is, if size pick-up and penetration of the size paste into the yarn are at correct levels, the tensile strength of the yarn should increase by about 25% for coarse counts (upto 20s), by about 20% for medium counts (upto 40s) and by 16-18% for finer counts. Increase in yarn strength on sizing should be determined in the laboratory once a week along with tests on yarn extensibility. With adequate size pick-up levels, a lower than expected increase in yarn strength indicates an inadequate penetration of the size paste into the yarn Increased penetration can be obtained by employing harder squeezing-nip, lower viscosity, higher temperature of the sizing paste and greater depth of the immersion roller. However, excessive penetration of the paste into the yarn is also to be avoided as it will make the yarn less extensible.

MOISTURE REGAIN IN SIZED YARN

It is important to maintain the correct level of moisture regain in the sized yarn. Generally a regain around 7% is satisfactory. Over-drying results in brittle and harsh yarns while under-drying gives soft and sticky yarns. Modern sizing machines are properly equipped with moisture control devices. Conventional sizing machines should be provided with moisture indicators with the help of which it is relatively easy to maintain the desired level of moisture regain in the sized yarn.

PACKAGE QUALITY

Density of Weaver's Beams

Loosely packed weaver's beams do not work satisfactorily at weaving. The density of weaver's beams is influenced mainly by two factors (i) Effectiveness of the friction clutch or PIV drive, and (ii) Effectiveness of the beam pressing motion. On modern machines, on which PIV drives and hydraulic or pneumatic pressing motions are employed, it is easy to get a satisfactory package density even for beams with large flanges. On conventional sizing machines both the beam driving and the pressing mechanism are not adequate to obtain a satisfactory package density for large flange beams. In such cases provision of a double clutch drive arrangement, and a two-roller pressing motion is called for.

Cut Ends on Beams

On conventional sizing machines, the drag-roller pulls the yarn from the sow box onwards. The pressure between the drag-roller and the two guide rollers bearing on it has to be fairly high to avoid any slippage. Too hard a drag-roller surface may cause cut ends. Such cut ends are a sure cause of loom stop. Use of PIV gears allows greater ease and scope in the adjustment of the hardness of the drag roller surface for eliminating this defect. Sharp edges on pressure rollers can also cause cut ends. The Quality Control Programme should keep a regular check on the condition of the pressure roller. Also the pressure rollers should be polished on lathe once every two months.

WEAVING

As has been pointed out at the very outset the twin responsibilities of the weaving superintendent in respect of fabric quality are : (i) to ensure fabric free from defects, and (ii) to meet the design specifications. The Quality Control Programme in weaving should, therefore, be tailored to aid the weaving superintendent in fulfilling these requirements.

FABRIC DEFECTS

Defects in fabric can be broadly classified into four categories : (i) Those arising from specific defects in preparation such as uncleared yarn faults, long missing ends in weaver's beams, wrong pattern etc. (ii) Defects due to incorrect loom settings such as starting marks, uneven pick density, poor cover etc. (iii) Defects arising from poor work practices such as bad and dirty knots, wrong denting, finger marks etc. (iv) Defects associated with end breaks such as floats, and missing ends caused by delayed mending of warp breaks — it should be noted that end breaks can occur both due to deficiencies in the quality of preparation, such as uncleared faults, poor sizing etc., and due to incorrect loom settings and unsatisfactory loom maintenance.

It is obvious from the above classifications that regular data on the incidence of various types of defects on each loom will be of great help to the weaving superintendent in controlling the number of fabric defects in two ways: firstly in bringing out the relative emphasis to be placed in the preparatory sections and in the loomshed; secondly in locating specific areas of action in loomshed. Data on fabric defects can be obtained by sampling inspection of the fabric produced by each loom. In actual practice, it is desirable to have a 100% inspection of the fabric from each loom. Such inspection makes it possible to mark all major faults which need to be removed before finished packing, and to mend as many minor defects as possible. Information on the incidence and type of fabric defects will enable the weaving superintendent not only to locate specific looms or workers giving poor quality but also to get an indication about the overall quality of preparation. It is to be emphasized that the system of inspection of fabric for locating the source of defects and then taking corrective action should be complementry to, and go hand in hand with, the comprehensive Quality Control Programme designed for preventing the occurrence of fabric defects in the first place. The suggestions discussed for Quality Control in the preparatory sections are meant to ensure the optimum removal from yarn of such faults as are likely to cause fabric defects, and also to minimize the potential for fabric defects likely to be introduced in these sections. It now remains to safeguard that fabric quality is not impaired by the faults solely occuring in weaving. This then forms the key note of quality control in weaving. Consideration will now be given to some of the more important aspects of loom maintenance and settings, and incorrect work-practices, which give rise to defects in the fabric directly, or through increased end breaks.

Anti-Crack Motion

One of the more objectionable fabric defects is starting marks, which can be either a crack or a 'thick place'. Mostly starting marks are caused by faulty setting of the anticrack motion. In the event of a loom stop,if the catch-pawl of the take-up motion releases too many teeth of the take-up wheel, a thick place will be formed. If on the other hand, the catch-pawl does not release any teeth or releases less number of teeth than required, a crack will be formed. Starting marks can also be produced if the stop-rod collars,swing-rail bearing, and crank arm bearings are loose or worn out. If the weaver leaves the loom with the shed open on the eve of a stop day, a starting mark will generally be produced on restarting the loom. The anti-crack motion on a loom should be checked and set at every beam fall. The condition of stop rod,crank are bearings, and swing rail bearings should also be checked at every beam fall.

Back-rest Setting and Timing of Shedding

The height of the back rest in relation to the cloth fell and the timing of shedding significantly influence the cloth cover. For satisfactory cover,particularly of fabrics of heavy constructions, the back rest should be set about $1\frac{1}{2}$" higher than the cloth fell. If the cloth cover is still unsatisfactory,early shedding (upto 10°) should be employed. Other factors responsible for inferior fabric cover are improperly designed tappets and top rollers, worn-out tappets and loose shed connections. All these lead to jerky shedding and consequently to a reppy appearance of the fabric face. Cover of the fabric should be checked by taking occasional snap rounds in the loomshed. While gaiting a new beam the condition of tappets and back rest settings should be checked.

Settings of Battery Scissors

The main function of the battery scissors is to hold and cut-off the yarn from the pirn which has just run out and is about to be replaced by a new pirn. The efficiency of the battery scissors largely determines the incidence of double picks at the time of pirn change. This is because the yarn from the old pirn, if not removed, will also be laid into the shed at the next pick, thus causing full or a partial double pick. The battery scissors should be properly set at every beam fall. Their setting should be checked once every shift and if found unsatisfactory should be corrected.

Settings of Temple Cutters

The main function of the temple cutters is to shear off the yarn between the battery knob and the fabric selvedge. If these yarns are not sheared off, 'lashing-in' will generally occur, that is, these protruding yarns will get woven into the fabric during the subsequent weaving cycle. The temple cutters should be reset at every beam fall. The setting should be checked during every shift.

Feeler Motion and Battery Settings

The efficiency of feeler motion and the accuracy of the pirn transfer mechanism are very important as they affect the incidence of double picks, shuttle traps, broken picks, pirn breakages, etc. at the time of pirn transfer. Faulty pirn transfer mechanisms, thus, not only lead to poor quality but also affect productivity at the loom, and increase the consumption of shuttles and pirns. Battery settings and feeler motion settings should be set with the help of gauges at every beam fall. Feeler motion setting should be checked once a shift.

Let-off Motion and Take-up Motion Settings

Variation in pick-density and weft bars are mainly caused by faulty let-off or take-up motions. Fabric cover, end breakage rate at weaving and hence incidence of missing ends and floats, grey fabric dimensions, warp and weft crimp and hence feel and handle of the grey fabric are all significantly influenced by overall level of warp tension which in turn is determined by the settings of let-off motion. The let-off motion settings should be adjusted at every beam fall in accordance with the fabric construction to be woven from the warp of incoming beam. Condition of take up motion gears and pawls should be checked at every beam fall. Blunt pawls or ratchets with blunt teeth which are likely to slip off should be replaced.

Setting and Cleanliness of Front Box Plate

The accuracy of the front box-plate setting is one of the factors that determine the efficiency of the pirn transfer mechanism, the rebounding of the shuttle, and the incidence of shuttle traps. The box-plate settings should be checked at every beam fall. It is important to keep the front plate free from dirt and fluff, as otherwise the weft trapped between the shuttle and the plate may get twisted and cause snarls in the fabric. Such snarls characteristically occur, on plain as well as automatic looms, in a narrow band situated at an almost constant distance from the selvedge farther from the starting handle. Use of split front box-plate and of centre threading shuttle greatly reduces the incidence of such snarls.

Warp Stop Motion

Unsatisfactory maintenance of the warp-stop motion is the most important single factor leading to occurrence of missing ends and floats in the fabric. On some looms the warp stop motion as a whole may not function properly, while on some others one or more rows of the warp-stop motion may be defunct. The common causes of unsatisfactory working of the warp stop motion are bent serrated bars, accumulation of fluff in the serrated bars, faulty electrical connections, and bent drop pins. Occasionally the worker may also tamper with the motion, if the weaver's beam has too many crossed, sticky or slack ends. The warp stop motion on each loom should be set at every beam fall, and also checked once during the running of the beam. Each row of warp stop motion should be checked at three places along its width.

Plain looms are not generally equipped with warp-stop motion. It has been seen that, under Indian conditions, missing ends and floats on such looms account for about 70% of the major defects in fabric. It is therefore recommended that such looms should be provided with warp-stop motions at least for heavy constructions, to minimize the incidence of floats and missing ends. The following example illustrates the effectiveness of warp-stop motion in controlling these fabric defects on plain loom.

TABLE-V

EFFECT OF WARP STOP MOTION ON FABRIC DEFECTS

Fabric Construction	Defects per 100 Metres			
	Without Warp Stop Motion		With Warp Stop Motion	
	M	F	M	F
28s/36s ; 88 x 60	8.0	6.9	2.1	1.4
32s/36s ; 108 x 60	8.8	4.2	2.2	1.6

M == Missing Ends F == Floats

Loom Factors Leading to Increased End Breaks & Fabric Defects

Fabric defects such as floats and missing ends which are caused by delayed mending of a warp break are influenced by the warp breakage rate during weaving. This is particularly true on plain looms without warp-stop motion. Even on automatic looms with well maintained warp stop motions such defects can occur if the broken end gets entangled with a neighbouring end. There are a number of loom factors which need to be checked if warp breakage rate increases on particular looms.

Faults in shedding such as too large or too small a shed, jerky sheddings, lower shed line pressing against the race board, and too late or too early shedding, can increase warp breaks significantly. The average level of warp tension has also an important effect on the breakage rate — there is generally an optimum level for a given type of fabric being woven on a given type of loom. Reeds with higher air space, 60 to 65% as against the conventional 50 to 50% have been seen to reduce warp breaks significantly. Frayed shuttle walls and loose and dented shuttle tips, poor condition of the heald eyes and reed wire also increase warp breaks.

A very large number of end breaks at weaving occurs due to yarn to yarn abrasion and entanglements. Use of variable heald staggering technique, which staggers the crossing of the warp threads forming top and bottom shed line, reduces such entanglements and abrasion and hence warp breaks significantly. Some typical results, obtained in member mills of AIIRA, which illustrates the usefulness of the staggering technique in reducing end breaks in weaving are summarised in Table-VI

TABLE-VI

EFFECT OF STAGGERING ON ENDS BREAKS AND FABRIC DEFECTS

Fabric Particulars	End Breaks per Loom Hour and Defects* per 100 Metres			
	With Staggering		Without Staggering	
	End Breaks	Defects	End Breaks	Defects
30s/34s Count 104/56 Ends/Picks per Inch	1.2	2.2	1.6	3.0
36s/38s Count 120/74 Ends/Picks per Inch	0.9	1.6	1.2	2.0
30s/34s Count 112/56 Ends/Picks per Inch	1.1	2.0	2.0	3.9

* Major defects consisting of missing ends and floats only

Incorrect Work Practices

Incorrect work practices can lead to many fabric defects. Production of defect free fabric depends to a very large extent on the quality consciousness of the workers. It has been mentioned earlier that in Indian mills as much as 70% of the total defects in fabrics manufactured on plain looms without warp-stop motion are made up of missing ends and floats. While these fabric defects cannot be entirely eliminated on such looms, in most cases, their incidence can be greatly reduced if the weavers are alert and careful. Oil stains, finger marks, big or dirty knots, wrongly drawn ends, wrong pattern etc. mostly arise from incorrect work practices. Systematic supervision and training of workers coupled with incentives for better quality are helpful in reducing the incidence of such defects.

A method of supervision which has been seen to be very effective is that the supervisor should inspect the fabric on each loom once a day, and affix his signature on the portion examined. All the looms can be suitably divided amongst different supervisors in the three shifts. While signing the cloth, the supervisor should see that the defects due to incorrect work practices, if any, are corrected immediately or brought to the worker's notice. Fabric defects due to loom faults should be brought to the notice of the maintenance supervisor.

DESIGN SPECIFICATIONS

Non-conformity of fabric to design specifications can render even a defect - free fabric sub-standard. Assuming the counts of warp and weft yarn supplied are according to specifications, routine control then needs to be exercised on weave, end and pick density, cloth width, and piece length.

Correctness of the weave on each loom, particularly for dobby, drop box and Jacquard designs should be checked for every newly gaited beam. During daily cloth inspection rounds in the loomshed, the weaving supervisor should make sure that the weave pattern continues to conform to specifications. On looms weaving difficult designs, it will be useful to keep a fabric sample with four full repeats of the weave. This will make checking of weave pattern easy.

The first step towards ensuring that the fabric dimensions and the end and pick densities are as per specification is to determine the reed count, reed space and tape length correctly. Past experience of the mill should be a good guide for determining the correct reed space and tape length for any specified fabric. If these have been determined correctly, and if a correct pick wheel has been inserted in the take-up motion, then the fabric dimensions and the thread density in the fabric will generally remain within tolerance limits. Variations in these specifications, if any, should then be traced to variations in the warp tension level, or differences in actual and nominal reed count. To ensure that the fabric dimensions and the density of ends and picks are maintained according to specifications, it is suggested that these should be checked at least once on every loom after mounting a new beam. It will be desirable to take these observations after weaving five yards or so when the weaving conditions have got stabilised.

ACKNOWLEDGEMENT

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SUGGESTED READING

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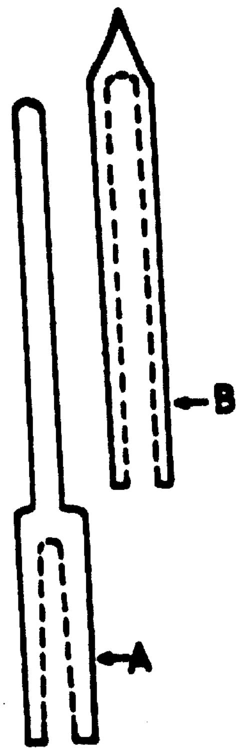
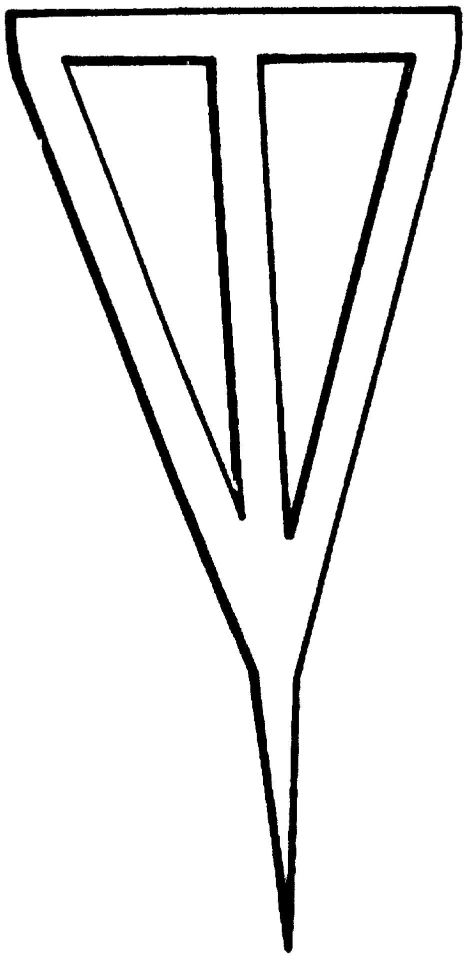
APPENDIX-I



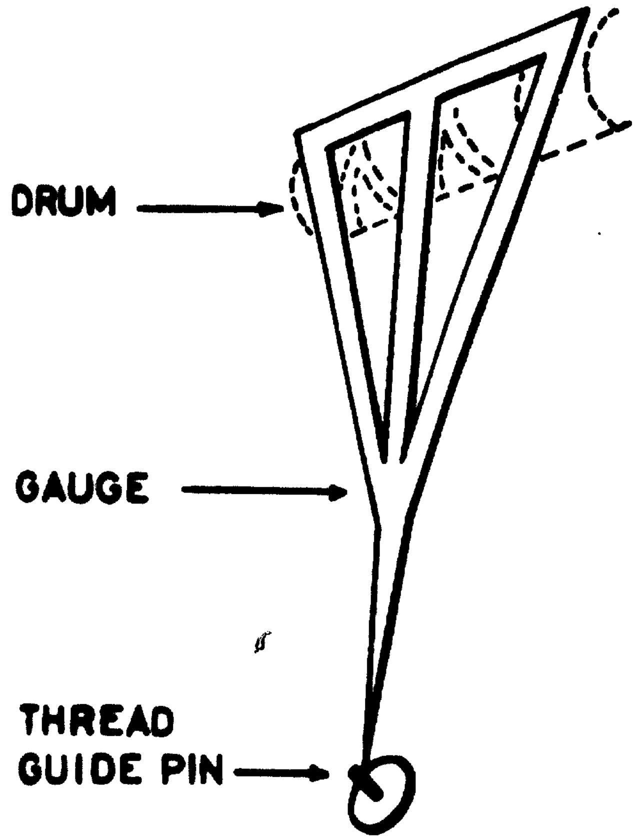
GAUGE FOR CORRECTING ALIGNMENT OF BOBBIN

The gauge for alignment of bobbin consists of two parts - Stud A and Cap B. The base of the stud has a suitable recess so that it can be mounted on the bobbin skewer. The Cap B fits snugly on the upper part of the stud and can slide up and down easily. When required the cap can be fixed in any position on the stud with the help of a set-screw not shown in the figure. This permits easy adjustment of the total length of the gauge. For obtaining correct bobbin alignment the gauge - stud and cap together - should be mounted on the bobbin skewer. The cap should be moved upwards so that the tip of the cap touches the thread guide. The skewer, should then be turned around suitably so that the tip of the Cap touches the contact point of the yarn with the thread guide. The bobbin skewer should then be secured in position firmly.

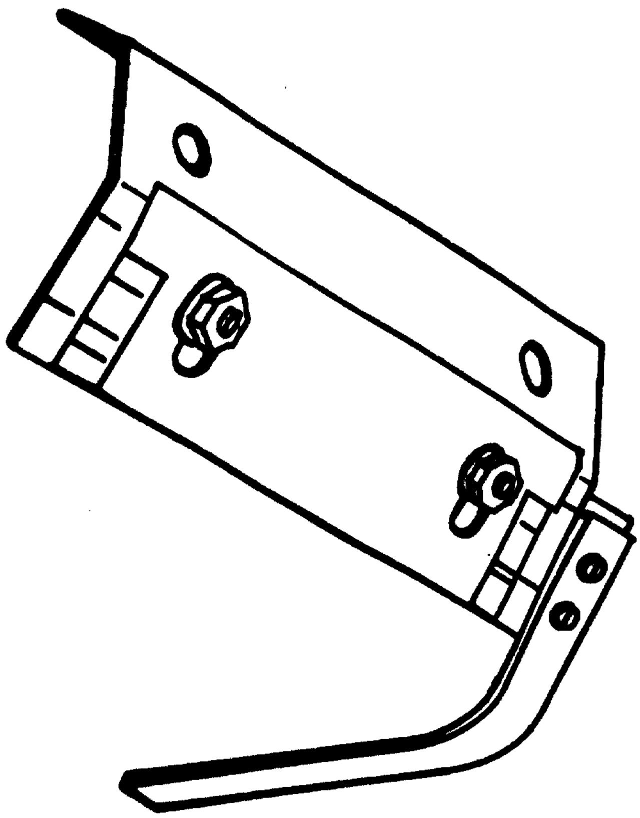
APPENDIX-II



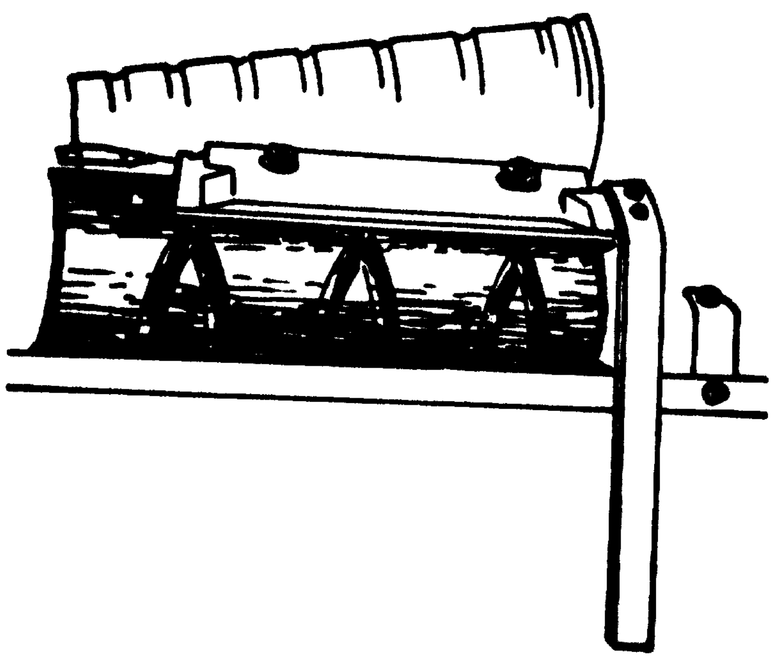
Gauge for Aligning the
Tension Bracket with
the Winding Drum



Gauge shown in Position
while carrying out the
alignment



Gauge for aligning the Winding Spindle with the Winding Drum



Gauge shown in Position While Carrying out the Alignment

APPENDIX-III

CHECK LIST FOR QUALITY CONTROL PROGRAMME

Section	Item	Frequency of Routine Inspection and Correction	Frequency of routine Setting and Adjustment
WINDING	Slub Catcher Setting	Once every shift	At count change
	Tension Weight or Spring Pressure	Once every shift	At count change
	Tension Level	Once every month	—
	Machine Speed	—	Once every month
	Alignment of Bobbin	Regularly	Once every month
	Alignment of Winding Spindles with Drum	—	Once in six months
	Alignment of Tension Bracket with Drum	—	Once in six months
	Testing of Knots	Once every shift	—
	Movement of Blade Shaft	Once every shift	Once in three months
	Caliberation of Slub-Catcher	—	Once in three months
	Stop Motion	Once every shift	—
WARPING	Tension Weights and Tension Mechanism	Regularly	At count change
	Tension Level	—	Once every month
	Alignment of Package at Creel	Regularly	Once in six months
	Concentricity of guide rollers	—	Once in six months
	Condition of Beam Flanges	Regularly	Regularly
	Stop Motion	Once a shift	Regularly

Section	Item	Frequency of Routine Inspection and Correction	Frequency of Routine Setting and Adjustment
SIZING	Tape Length	Once for every new set	—
	Drag Roller Covering	During the week, if worn out	Once every week
	Stretch on Conventional Sizing Machines	Every time drag roller covering is changed	—
	Stretch on Modern Sizing Machines	Regularly	Regularly
	Extensibility of Sized Yarns	Once every week	—
	Increase in Tensile Strength after Sizing	Once every week	—
	Spring ~t Guide Roller Bearing	Regularly	Once every week
	Size Pick-up by Desizing Method	—	Once in two weeks
	Dynamic Balancing of Drying Cylinders	—	Once in Six months
	Stamping Tare Weight on Warper's and Weaver's Beams	—	Once every year
WEAVING	Battery Scissors	Once every shift	At every beam fall
	Temple Cutters	Once every shift	At every beam fall
	Feeler Motion	Once every shift	At every beam fall
	Battery Setting	—	At every beam fall
	Back-rest Setting	Regularly	At every beam fall
	Let off & Take-up Motion	—	At every beam fall
	Settings of Box-plate, Reed Alignment, Stop Rod	—	At every beam fall
	Anticrack Motion	Regularly	At every beam fall
	Warp Stop Motion	Once during running of the beam	At every beam fall
	End and Pick Density	—	Once after gaiting new beams
	Weave	—	-do-
	Reed-Space and Cloth Width	—	-do-
	Damage Inspection on the Loom	Once every shift	—

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