# COTTON SLASHING

Serial 5473B (PART 2) Edition 1

## SIZING

### SIZING MATERIALS

#### INTRODUCTION

**1. Definitions.**—Sizing is the process of applying to yarns, threads, or textile materials, a film or coating of an adhesive material which, when dry, forms a smooth, hard, but pliable surface that encases the yarns and tends to bind the projecting fibers of the yarn close to the yarn surface. In this manner, the individual fibers of a yarn are bound together by a protective coating, or film, called *size*, which protects them from most harsh and abrasive action, as well as produces an increase in yarn strength.

The purposes for which size is applied to yarn may be generally divided into two classes:

(1) Sizing may be applied solely for the purpose of pure-sizing a yarn. In *pure-sizing*, only a sufficient quantity of size is applied to yarns to permit weaving; that is, sufficient size is applied to strengthen the yarn and to protect it from the chafing action of the harnesses and reeds of a loom as well as from the beating-up of the filling. Yarns intended for fabrics that must be bleached are generally pure-sized because all sizing material is removed from a cloth during bleaching. Also, a cloth must be size-free before it is dyed, for, if size remained on some of the yarns they would not have the same affinity for the dye as those without size and a streaked and spotted dyed cloth would result.

A *light size* is a size mixture that contains a greater amount of sizing agents than is necessary to strengthen a yarn enough to permit weaving, but it does not contain these agents in sufficient quantities to increase the weight of the cloth materially. Such a size is generally classed under the heading of pure sizing. If, however, the weight of the yarn is increased materially, the size is termed medium sizing and may be classified under weighting.

(2) Weighting forms a second classification, which includes medium and heavy sizing. The term *weighting* is used in conjunction with the sizing of yarns when they are sized with the purpose of adding weight to them in addition to furnishing protection to the yarns against the abrasive action of the weaving process. *Medium sizing* is a term often used when a certain amount of weighting material, such as china clay and the like, is added to the size mixture not only to increase the weight of the sized yarn, but also to impart to the yarn a desired quality of feel or sensation of touch. Medium sizing may, in some instances, contain only an excess of ordinary sizing materials and may not contain weighting materials in the size mixture. Then, medium sizing may be used for the purpose of producing a desired feel in the cloth only. Yarns that are medium-sized are seldom used in cloth that is intended to be dyed.

In *heavy sizing*, the sole purpose is generally that of increasing the weight of the yarn by the addition of large quantities of weighting material to the size mixture. However, yarns are seldom sized with this intent except when they are intended to be used in cloths for export, shoe linings, and the like. In such cases, it is generally advisable to apply the size after the cloth has been woven and at the finishing process.

**2. Composition of Sizing.**—Sizing is generally composed of materials that will impart to the size mixture the ability to adhere to the yarn firmly and form a smooth surface, or film, around it. The film formed must be protective in nature so as to resist most of the abrasive action found in a loom, yet it must be flexible so as to prevent cracking and shedding. Besides, the size film should, by binding the fibers of the yarn together, strengthen the yarn slightly. But, aside from possessing these characteristics, the size mixture deposited on the yarn must be easily removed.

The materials composing a size mixture that is suitable for the sizing of cotton yarns may vary slightly in individual mixtures, but essentially the materials used come under the same classifications. Practically all size mixtures are composed basically of an adhesive, that is, a material that attaches itself to the yarn and forms a firm size film. Adhesive materials may be of the nature of starches, as used in cotton sizes, or of a gelatin nature, as applied to rayon yarns. A softening agent must usually be added to the adhesive to counteract the harsh, stiff, but brittle film formed by the adhesive. Thus, the size film formed by the adhesive is made pliable so that the sized yarn may be flexed without danger of rupturing the size film. Also, a gum, or agglutinant, is generally added to the size mixture for the sole purpose of strengthening the size film. Sometimes weighting materials are added, but they are not essential to a size mixture except when it is desired to increase the weight of the sized yarn. Miscellaneous materials are sometimes added to size mixtures, such as antiseptics, dyes, and the like. Antiseptics are usually added to the size mixture to prevent mildew from forming on the sized yarn, and occasionally dyes are added when it is desirable to tint the yarns a color.

### STARCHES

**3. Adhesives.**—The main body, or bulk, of a size mixture must necessarily be of an adhesive nature if the mixture is to be deposited on the warp yarns. The adhesive, however, must be of such a nature that it may be easily removed in cloth finishing operations without damage to the yarn to which it is applied, because certain finishing operations, such as dyeing, cannot be carried out if starch is present. Practically any material possessing these characteristics may be used as a size base. Certain starches are used extensively as adhesives in cotton warp sizing, while gelatin forms an ideal base for rayon warp sizing.

Raw starches, or pearl starches as they are often called, may be divided into three groups according to their agricultural classification; that is, starches are generally obtained from three sources, the seed of a plant, the root of a plant, and the pith of a plant. Some starches that are commonly used in the textile industry and that are derived from seeds, are corn starch, rice starch, and wheat starch. Starches that are obtained from roots are potato starch and tapioca starch. Sago starch is obtained from the pith of a tree.

Starch is generally prepared by grinding the seeds, roots, or piths into a fine flour, which is chemically treated to liberate the starch. The resulting starch is mixed with water and cooked, or boiled, for a period of time, to form a thick but smooth glutinous solution, or paste, which possesses great adhesive qualities and finds extensive use in the sizing process.

4. **Corn Starch.**—Undoubtedly, the most common of all starches used in the textile industry is corn starch, which is obtained from the seed of corn, or maize, as it is often called. Under normal conditions, about 50 per cent of corn consists of starch. The size mixture, when made of corn starch, is of medium consistency, but, when excessive quantities of starch are used, the resulting size film has a tendency to be brittle. However, practically all warp yarns of the coarse and many of the medium counts, say up to 40's, which include the yarns generally used in sheetings and print cloths, are usually sized with corn starch. Then, corn starch is often blended with other kinds of starch, especially if fine counts are to be slashed, to retain some of the desired qualities and characteristics of the starch.

5. **Potato Starch.**—Potato starch, or farina, as it is sometimes called, is obtained from the root, or the tuber, of the potato plant. Ordinarily, the potato will yield about 20 per cent of starch. The usual practice of extracting this starch is to grind the potatoes to a pulp as starch is liberated by the destruction of the cell structure of the tuber. A stream of water directed on the pulp separates the starch from the

pulp and carries it away in suspension. Afterwards, the starch is separated from the water, dried, and purified.

Potato starch, when used as a sizing agent, deposits a smooth, pliable, size film around a yarn. It is used chiefly for sizing the finer counts of yarns, generally those counts above 40's. Because it is slow-congealing, the size has an opportunity to penetrate into the fibers of the yarn and to attach itself firmly to them, thus forming a thin but pliable starch film. Potato starch has a glistening white color that is not possessed by any of the other starches, and, therefore, tends to impart a clear white color to the sized yarns.

**6. Other Starches.**—While corn starch and potato starch are the two kinds widely used for warp sizing, wheat, sago, rice, and tapioca starches are often used, either in their pure form, or, most generally, in combination with certain of the others. Each starch has its own individual characteristics, which distinguishes it from the others. For example, wheat starch produces a very thick adhesive size film, and so is often used when various ingredients, such as weighting materials, are to be attached to the yarns.

Sago, unlike most of the other starches, is obtained from the trunk of certain varieties of palm trees, which are allowed to grow to a height of about 25 to 30 feet. On reaching full growth, the tree is cut and the starch extracted from the trunk with water in about the same manner as potato starch is extracted. Sago produces a very thin and light starch, but one with a strong size film that retains its strength over long periods of time. The starch is adaptable for pure sizing in cases where the greatest amount of strength for the least amount of size is desired. But, as sago starch, when used alone as a sizing material, tends to cut the reeds of the loom, it is not extensively used for the sizing of warp yarns.

**7. Thin-Boiling Starches.**—Thin-boiling, soluble, high-fluidity, or oxidized starches, as they are often called, are sometimes used in the preparation of warp-sizing mixtures. The main advantage in using a thin-boiling starch is that only about 20 minutes is required to prepare a size mixture with it, while about $1\frac{1}{2}$ hours may be required with raw starch. Then, after the thin starch mixture has once reached the proper viscosity, it will remain more stable than one of raw starch, reducing only slightly in size viscosity.

Most soluble starches are made from corn starch, although potato and other starches may be used for them. Starch is added to water and is usually treated with chemical agents that tend to oxidize the starch while it is in a water solution. Careful temperature control is maintained over the cooking of the starch until the desired viscosity is obtained, at which time the solution is neutralized and the starch separated and dried. A size mixture prepared from starch that has been chemically treated will reach a stable size viscosity in one-quarter to one-third of the time normally required when an unoxidized raw starch is used. The reduction in cooking time not only makes possible a saving in the steam required for cooking a size mixture, but also gives assurance that the mixture is cooked thoroughly and the same size viscosity is attained.

While thin-boiling starches are used extensively for preparing size mixtures used in cloth-finishing operations, they may be applied to warp sizing with like advantages. Size mixtures made from raw starches vary in viscosity because starches obtained from raw materials that come from various geographical locations vary slightly in properties. If each of these starches is treated chemically under standardized conditions and the chemical action in each is carried to the same degree, the resulting size solution should show the same viscosity and size characteristics. Thin-boiling starches usually produce more flexible size films than those otherwise obtained and so are suitable for the sizing of fine counts of yarn. However, to produce the same results, a greater amount of thin-boiling starch is required than when raw starch is used in a size mixture.

The term fluidity is generally used in connection with thin-boiling starches. A thin-boiling starch is often referred to as a high-fluidity starch. Then, starches of the thin-boiling variety are often designated as being of a certain degree or number fluidity. For example, a starch may be referred to as a 60-degree fluidity starch. Such a designation is an indication of the viscosity of that starch, but as each starch manufacturer has his own standard on which his fluidity is based, this system may not be used for comparative purposes.

Some mills desire to treat the raw starches chemically themselves, using enzymes for the purpose. Enzymes are substances that are found in plant and in animal life and that, when brought into contact with such a substance as starch, have a chemical action on it but remain inactive themselves. When raw starches are converted into thin-boiling starches at a mill by means of enzymes, great care must be taken to control the process and to obtain the exact weight of each ingredient used, because only a small amount of enzymes is required. Otherwise, the viscosity of the size mixtures will vary.

#### SOFTENING MATERIALS

**8.** Softeners are materials or substances used to overcome some of the harsh and undesirable properties of starches and other ingredients used in size mixtures. Therefore, the term softener applies to any ingredient added to a size mixture for the express purpose of counteracting the hard, harsh, abrasive feel produced by various starches, and of restoring, to a reasonable degree, the original pliability and elasticity of the yarn. Softeners also tend to lubricate a yarn and allow it to slide through various parts of a loom without chafing. Sometimes a sized yarn tends to stick as it passes around the drying cylinders of a slasher, especially when potato starch is used for sizing. Generally, a slight excess of softener in a size mixture will correct this condition and will lubricate the yarns as they pass around the cylinders.

Tallow is used as a softening agent probably more extensively than any other material, the tallow generally being of either beef or mutton derivatives. Chemically, these materials usually consist of various glycerides of stearic, palmitic, and oleic acid. While many mills use tallow purchased in bulk as a softening agent, others prefer to use commercial softeners, which usually have a tallow base and some of which employ glycerin. Glycerin, in itself, is an excellent softener as it possesses the desired softening qualities, is hydroscopic in nature, and thus maintains a high regain in the yarn. But, being slightly antiseptic, glycerin tends to prevent the growth of mildew, which would normally be expected to develop with much moisture present. As a cotton-warp sizing material, glycerin finds very little use, but as a rayon-warp sizing material, it is used extensively.

Caution is required in the use of softeners, only a quantity sufficient to accomplish the desired result in the yarn being permissible. Quantities of softener much in excess of 10 per cent in weight of the starch should never be used because they will tend to weaken the size film to such an extent that sizing will not increase the yarn strength. Soap, also is sometimes added to a size mixture, but this practice should, in most cases, be discouraged because even a small amount of soap will reduce greatly the strength of a size film.

### GUMS AND WEIGHTING MATERIALS

**9. Gums.**—Gums, or agglutinatives, find some use in connection with warp sizing, but their greatest field is in conjunction with cloth-finishing operations. The principal use of a gum in warp sizing is to strengthen and toughen the starch film, and, at the same time, act as an agglutinate for weighting materials when used. Thus, a gum added to a sizing mixture will produce a stronger and tougher size film, which will protect the yarn and enable it to resist the harsh abrasive action of weaving.

Gums used in sizing mixtures may be divided into two classes or groups; those of a dextrine base and those of a pectin base. Gums of a dextrine base are made from starches and may be considered as a converted starch. British gum is included in this classification. Generally, gums of this class find their greatest use in finishing operations because they do not add sufficient increase in strength to a warp size film to warrant their use in sizing.

Pectin gums include such gums as gum tragacanth and gum tragasol, both of which are used extensively in warp sizing.

Gum tragacanth is made from the stem of plants, whereas gum tragasol is obtained from the seed of the locust bean. Pectin gums, however, add sufficient strength to a size film to be of use in warp sizing; therefore, they are used extensively in cotton-warp sizing mixtures. While there are some commercial gum preparations on the market available for use in warp sizing, most of these preparations come under the classification of pectin gums.

**10. Weighting Materials.**—Sometimes it is desired to increase the weight of a cloth, especially if it is to be exported. As such cloths often receive no finishing operations, it is necessary to add the weighting materials at the warp-sizing operation.

China clay, or kaolin as it is often called, is perhaps the most widely used weighting material and is found in natural deposits. A stream of water under great pressure is directed on the deposits so as to carry away the clay in suspension, and then, by various processes of settling and decanting, the final product, pure china clay, is obtained. China clay consists of almost pure hydrated silicate of alumina. It possesses a very fine texture and usually has a flat, dead-white color. The clay has a great affinity for water, that is, it will absorb large quantities of water. Generally, it contains normally about 14 per cent moisture.

Other materials, known as hygroscopic agents, and including such chemicals as sulfate of magnesium, or epsom salts, sulphate of soda, or better known as Glauber or horse salts, chloride of magnesium, and many other metallic salts, also are used for weighting. In each case, these salts have the ability to absorb moisture from the air in large quantities, thus increasing their weight and consequently the weight of the yarn to which they are held by the size film.

**11.** The use of antiseptics is often required in many size mixtures, especially when weighting materials are used, to prevent the formation of mildew, which develops whenever cloth is stored in a damp place. A fiungus, or mold, which is believed to be a bacterial growth, develops from the decomposed size and lives on it. The addition of antiseptics tends to destroy the micro-organisms and the vegetable life in the size on which the fungus grows.

Sometimes coloring matter is added to the size mixture. If the cloth being manufactured is to be finished unbleached, it is of advantage to add a little bluing, or a blue dye, to the size mixture. This will give the sized yarns a bluish cast which, to the eye, will appear to have a greater degree of whiteness than a yarn of a yellowish cast. In many cases, a yarn with yellowish cast will actually have a higher quality, or degree, of whiteness, but, due to optical illusion, a blue-cast yarn will appear to be whiter. Also, when two types of yarns are to be slashed together, for instance, two different-ply yarns with twists in opposite directions, it is advisable to tint, or dye, one of the yarns with a fugitive, or easily removable, dye, an operation most easily accomplished in slashing. Then, the drawing-in girl and the weaver will not encounter much trouble with wrong draws caused by placing the warp ends in the wrong dents and heddles of the loom. Generally, when yarn is slashed in this manner, two size boxes are required at the slasher, the yarn of one twist being run through a box containing a tinted size and the remaining yarn being passed through the regular size box.

### SIZE PROPERTIES

**12. Theory of Size Preparation.**—The elementary theory concerning size cooking most generally accepted is that a starch granule is composed of two distinct parts. An inner part of a granule consists of a substance that is soluble in water, while an outer substance, which encases the soluble material, is insoluble in water and acts as a membrane. A membrane consists of a thin layer of vegetable or animal tissue which permits the passage of water through it under certain conditions. However, if a solution consisting of a soluble substance dissolved in water is used, only water will pass through the membrane and all other materials will be filtered from the solution. In this instance, the inner part of the starch granule is dissolved by the water as it passes through the outer substance or membrane. However, very little cold water can pass through the membrane, but, as the mixture of starch and water is heated, increasing quantities of water are allowed to pass through. As the inner substance is a soluble material, water passing through the membrane will be absorbed by the soluble substance.

The soluble substance will increase in volume as it absorbs the water and will force the outer surface, or membrane, to expand. If this expansion continues until all the water present is absorbed, then the greatest viscosity, or thickness, of the size mixture has been reached, or the maximum gelatinization has been attained. If heat and agitation are continued, the dilated starch granules begin to disrupt. As the outer membrane of the granules bursts, the soluble solution is freed to flow and take the place of the water that it had absorbed. When this condition is encountered, the viscosity of the size mixture tends to decrease until a point is reached where it remains fairly constant. Beyond this point, the addition of heat and agitation will have little effect on the degree of gelatinization. Thus, it is apparent that the percentage of cell ruptures in this instance, governs the size viscosity. The greater the percentage of cell rupture, the less viscose the size. It is easily seen why great care must be exercised to obtain the correct amount of water, the correct degree of heat, and the required amount of agitation for a size mixture of uniform viscosity. A variation in any of these factors will result in a change in the viscosity of the size mixture.

**13. Size Film.**—A size film deposited on warp yarns consists of simply a thin coating of size. The thickness of a film and the depth of its penetration into a yarn structure are controlled, to a certain extent, by the viscosity of the hot size. Then, the strength of a size film may be controlled partially by the addition of gums to a size mixture, while the pliability of a film is regulated by the amount of softener used. A very thin, low-viscosity size penetrates into the yarn structure and surrounds the individual fibers, whereas a thick, heavy, high-viscosity size only forms a heavy protective encasing around a yarn and will not enter the yarn structure appreciably. The advantage of a thin-viscosity size is that it tends to hold, or tie, the individual fibers together and to strengthen a yarn. As heavy viscous size only forms a protective coating, its use is limited to very coarse and fuzzy yarns. Such yarns have many of the individual fibers projecting from their surface, but the fibers must be smoothed and cemented to the yarn surface if the yarns are to be woven efficiently in the loom. Otherwise, the harsh abrasive action on the yarns at the loom as they pass through the heddle eyes of the harnesses, and the action of the reed in beating the filling would cause many of the projecting fibers to be broken and the surface of the warp yarns to be roughened. Small, fine yarns have heavy coatings of thin size applied to them so that the sizing material may penetrate into the yarn structure and strengthen the yarn and at the same time smooth many of the projecting fibers. Increases in yarn-breaking strength of up to 10 per cent may, in many instances, be expected when a warp is properly sized.

### COTTON SIZES

**14. Size Ingredients.**—Cotton warp yarns like most other kinds of yarns intended for the warp of cloth, must be sized. The composition of a size mixture used for slashing cotton yarns may vary slightly from that of the size mixtures employed for sizing other yarns, but the purpose of slashing the yarns remains essentially the same. Cotton yarns, because of their inherent characteristics, require a size that will permit the yarns to be woven into cloth most efficiently and with the minimum of end breakage. Essentially, this is accomplished by a size film that surrounds and strengthens the warp yarns and smooths the fuzz projecting from them.

It has been found from experience that size mixtures intended for the sizing of cotton yarns are preferably composed of starches and tallows as these materials form the best adhesives and softeners. These are not the only substances that are used or that can be used, but, over long periods of time, they have proved the most satisfactory. Then, too, these ingredients lend themselves readily when yarn weighting is desired.

The kind of starches and softeners and the amounts used will vary in different mills because each mill superintendent has his own size formula, which, being based on experience, is generally favored. Also, size mixtures suited for a particular type of yarn under certain conditions may not prove satisfactory in another mill producing the same type of yarn under the identical conditions. The type of cloth for which the yarn is intended, the cloth finishing operations employed, and even the location of the mill all tend to vary the size formula and the ingredients required.

**15. Size Mixtures.**—Size mixtures are varied in composition because they are required to fulfil many different conditions. For example, a size mixture may be required to size a high-twisted, high-count yarn efficiently, while another mixture may be required for a soft, low-twist, low-count yarn. Each yarn is used for an entirely different purpose and must fulfil an entriely different set of requirements. Therefore, the size mixture for each of the yarns must be varied to have characteristics that are suited to each yarn.

Yarn requirements are varied. For example, ply-warp yarn is usually very strong and does not always require the addition of size as a strengthening agent. In such cases, size is usually applied only to lay the fuzz that projects from the yarn and thus prevent shedding of the fuzz at the loom. Then, sometimes it is possible to use ply yarns in warps without slashing them. Generally, a single-warp yarn of medium-yarn counts, intended for the warp of a cloth with a small number of ends per inch, may be woven with the aid of only a small amount of size on the warp. Such a warp possesses a fair degree of strength and does not receive the excessive chafing from the loom which a warp of high-count yarns receive. The warp yarns in a cloth of such construction receive severe chafing from the loom because the cloth requires a large number of picks of filling per inch to be inserted. Therefore, the warp yarns are not drawn forward as rapidly as in a cloth of low-count construction. The increased number of picks per inch cause severe chafing because the reed and the heddles of the loom act on the warp a greater number of times for each inch of cloth woven. A warp, to withstand the strain of weaving under such conditions, must be heavily sized.

Warps containing a large number of ends per inch require that the warp ends be spaced close together; consequently the friction and chafing action on them, caused by the reed passing back and forth as it beats the filling, is much greater than on a warp of comparatively few ends per inch. Then, too, a warp composed of coarse, loosely twisted yarn is subject to fraying because of its lack of strength. Therefore, a warp with yarns of these characteristics requires a heavy coat of sizing for protection. Also, a highly twisted warp yarn, because it has a poor penetration quality, requires a heavier coating of size than a yarn of medium twist. Such a condition is often prevalent with Egyptian yarns, that is, yarns made from Egyptian cotton.

**16.** Size mixtures are varied also because of the purpose for which the finished cloth is intended. A mixture is altered by changing the ratio of ingredients used in it, by varying the kinds of ingredients, or by a combination of the two. When a drastic change is made in the sizing requirements, usually necessitated by a wide variation in yarn counts, the size mixture ingredients are generally varied.

Corn starch, for instance, fulfils most of the requirements as a sizing base for most yarn counts from 30's to 40's. Corn starch, however, has a tendency to form a brittle size film, but the addition of a softening material usually counteracts this tendency. The starch, when corn is used, will show a greater stability of viscosity after gelatinization, that is, it will thin less than a size mixture made from potato or tapioca starch.

Sometimes tapioca or sago starch is substituted for corn starch, especially if corn starch is more expensive than the other starches. Ordinarily, tapioca starch gives a greater degree of penetration into a yarn structure than do most other starches. Sago starch produces a thin, strong, but very harsh size film, which, in many instances, tends to cut the heddles of the harnesses at the loom. Wheat starch is used when a very heavy coating of size is desired on a yarn, especially if the yarns are to be weighted.

Potato starch generally produces the smoothest size film of the thick-boiling, or natural untreated, starches. It maintains a fairly uniform viscosity and is well-suited for sizing the higher counts of yarns. The outstanding advantage of potato starch, which is possessed also by most thin-boiling starches, is that it is very slow to congeal. This characteristic produces a flexible size film about a yarn and allows the yarn to adjust itself to most stresses and strains that might be placed on it during slashing but before the size film congeals. Because potato starch is slow drying, a yarn sized with it tends to stick to the drying cylinders of a slasher, so a softener must be added to the size mixture to lubricate the yarn as it passes around the cylinder.

If the size film about a yarn is hard and brittle, a little softener added to the size mixture will soften and add pliability to it and will impart to it a softer feel to the hand. If, for any reason, the size film is too soft, gum added to the mixture tends to strengthen it. Then, weight may be added to yarn, if desired, by adding weighting materials to a size mixture. However, when weighting materials are added, an antiseptic must be used to prevent the formation of mildew. Sometimes antiseptics are required even when weighting materials have not been used in a size mixture.

**17. Size Formulas.**—A size formula suitable for the sizing of all cotton-warp yarns cannot be formulated because of the multiplicity of the cloth constructions in which these yarns are utilized and because of the variable conditions encountered in the mills. While the same cloth construction may be employed in several mills, one mill may desire to impart to the cloth a soft feel, another may strive for a stiff, crisp effect in the cloth, and a third mill may not care as to the handle of the cloth because all the warp sizing must be removed from the cloth in future finishing operations. In each instance, a different size formula must be employed. Then again, the superintendent in one mill may have made a study of sizing and may utilize it to its greatest advantage, while another may have a wasteful system of preparing size. One mill may deposit large quantities of size on the warps and another may deposit only small quantities. In each instance, a different size formula is employed.

If, however, the fundamental principles of sizing are understood, it is possible for an operative to vary certain ingredients and portions of ingredients of a general size formula to obtain a size mixture possessing the characteristics desired. Certain principles should, in most cases, be judiciously followed: (1) A light size mixture should be applied to most yarns of medium counts, say from about 20's to 40's, when these yarns compose the warp of a cloth of low-count construction, that is, have a small number of ends and picks. (2) If the warp is composed of higher count yarns intended for a cloth of high-count construction, the amount of size deposited on the yarn should be increased proportionally. (3) A still greater percentage of size is required on yarns when they are soft and contain a small number of turns of twist.

The percentage of size deposited on a yarn will vary according to these conditions. However, the normal warp yarn, when sized for low-count construction work, should usually have about 6 to 8 per cent of size deposited on it and, when sized for medium-count construction work, about 8 to 12 per cent of size.

A list of the amounts of starch and softener that ordinarily should be used in preparing size mixtures is given in Table I. To produce a size mixture suitable for the counts of yarns indicated, the materials listed should be added to 100 gallons of water in the amounts stated. In the preparation of these mixtures, the principles of sizing should be considered and the size formula varied accordingly. These formulas are for pure sizing only; that is, only a sufficient quantity of size is used to strengthen the warp enough for the weaving of the yarns.

However, such factors as the number of turns of twist in the yarn to be slashed, the character of the yarns, the fabric for which the yarns are intended, and even the atmospheric and climatic conditions about a mill, all tend to vary the size mixtures given in Table I. Therefore, the correct portions of each

**TABLE I**

**AMOUNTS OF STARCH AND SOFTENER FOR SIZE MIXTURE**

| Counts of Yarn | Light Sley and Pick | | Medium Sley and Pick | | Heavy Sley and Pick | |
|---|---|---|---|---|---|---|
| | Starch Pounds | Softening Pounds | Starch Pounds | Softening Pounds | Starch Pounds | Softening Pounds |
| 10s to 25s | 40 | 5 | 45 | 6 | 50 | 6 |
| 25s to 30s | 30 | 4 | 35 | 5 | 40 | 5 |
| 30s to 40s | 35 | 4 | 40 | 5 | 50 | 6 |
| 40s to 60s | 45 | 5 | 50 | 5 | 65 | 7 |
| 60s to 80s | 50 | 6 | 65 | 7 | 80 | 10 |
| 80s to 100s | 65 | 7 | 80 | 10 | 90 | 12 |

material for the size mixture that is best suited to the conditions existing in each mill can be obtained only by experience and by experimenting. However, it must be remembered that the greater the portion of size added to a mixture in relation to the amount of water used, the stiffer will be the size and the greater will be the percentage that can be attained, and that the more softening materials used, the more pliable and less harsh will be the sized yarn.

A rule sometimes followed to determine the amount of softener required in a size mixture is to use sufficient softening material to equal approximately 10 per cent of the amount of starch. All determinations are considered as pounds of each substance. Sometimes turpentine is added, but only in small quantities for the purpose of cutting the natural oils and waxes in cotton. Usually, turpentine is used only in slashing Egyptian yarns because of their waxy nature, and then, only 1 gill is added to each 100 gallons of water.

**18. Size Preparation.**—Size kettles are equipped with automatic control instruments to permit a more uniform size mixture to be prepared. They allow the mixture to be heated slowly to the gelatinization temperature and to be thoroughly agitated throughout the temperature rise. A gradual temperature rise and slow cooking of a size mixture tend to assure the operative that most of the starch granules will disrupt and completely gelatinize. Small specks, or hard balls, are often formed in the size if its temperature is increased too rapidly because some of the starch gelatinizes and forms a protective coating around those granules that have not gelatinized. These balls, when broken open, will contain pulverized starch. Much trouble is caused in future processing operations if these specks become attached to the yarn at the size box. Trouble will also be encountered with gelatinization if the gum and the softener are added to the mixture before the starch has completely gelatinized. Under such conditions, the newly added ingredients, that is, the gum and the softener, will form a protective coating around the starch granules and prevent them from gelatinizing.

TABLE II

TEMPERATURE AND TIME OF STARCH GELATINIZATION

| Starch | Gelatinization Temperature Degrees F. | Time to Raise to 210° F. Minutes | Time to Raise to 210° F. Minutes |
|---|---|---|---|
| Corn | 168 | 30 | 60 |
| Potato | 150 | 40 | 90 |
| Tapioca | 163 | 30 | 60 |
| Sago | 164 | 30 | 45 |
| Wheat | 176 | 30 | 40 |

Table II has been prepared to show the temperature at which gelatinization of starch takes place, the length of time that should be required to raise a size mixture to 210 degrees F. and thus to assure that complete gelatinization has taken place, and the length of time the size mixture should be cooked. To assure proper control of the cooking of the size, the periods of time listed in Table II should be set on the control disk of the automatic controls that regulate the cooking of the size mixture. However, it should be remembered that these time periods are only approximate and will vary in different mills and under different conditions.

Gelatinization temperature should not be confused with the temperature at which the size commences to become viscous and which is always lower than the gelatinization point, or the point reached when the disruption of the starch granules have been completed.

Some mills consider it good practice to agitate the size mixture for 15 minutes before applying steam. This practice, however, is not necessary when automatic controls are used on the size kettles as these controls will admit steam to the batch for less than 5 minutes at the start and then for periods as short as 6 seconds.

## SLASHER OPERATION

### SLASHING COTTON YARNS

**19. Operations.**—The actual process of slashing yarns is divided into three general groups of operations. The first operation is creeling, or the placing of a set of section beams in the slasher creel and the preparing of the yarns from these beams for slashing.

The second operation is the actual slashing of these yarns. Once the slasher is started, this operation requires little attention except for an occasional broken warp end or a minor adjustment. Many slashers are equipped with automatic control instruments for regulating the temperature of the size in the size box, the level of the size in the size box, the temperature of the drying cylinders, and the like. Slashers so equipped require slight manual control or adjustment after they are once set in operation.

The third operation is doffing, or the removal of the filled loom beam from a slasher. Usually, leases are taken; that is, the warp ends are separated from each other before the loom beam is removed from the slasher.

While these three essential operations are necessary for the slashing of all kinds and types of yarns, certain deviations from the usual practices must be made to cope with situations caused by the use of different yarns in a wide variety of fabrics. For example, the slashing of yarns intended for sheetings might vary slightly in procedure and method of handling from the slashing of warp yarns intended for various woven dress goods due to the greater width and length of the cloth. Yarns intended for cotton crêpe require special handling because the warp is composed of two sets of highly twisted yarns, one having **S** twist, or left-hand twist, and the other **Z** twist, or right-hand twist. In the slashing of colored warps, slight departure from the usual procedure is necessary to keep the colored ends from rolling or changing places.

**20. Creeling.**—Creeling is the operation of removing empty section beams from the creel and replacing them with full section beams from the warper. As section beams, when filled with warp yarn, weigh about 600 pounds, their handling becomes a problem. Hoists running on tracks are employed in practically every mill to facilitate handling. A track is suspended from the ceiling of the slashing room over the creel section of the slasher to the space where the beams from the beam warper are stored previous to slashing. Numerous arrangements are used in connection with the hoist for lifting and holding the section beams. If the beams vary greatly in width, two chains, each having a hook on its free end, generally extend from the lower block of the hoist. Other times, when the beam width is fairly constant, a header may be attached to the lower part of the hoist block, and a long bar with a hook at one end is fastened to each end of the header. Thus, it is necessary only to lower the header over the section beam and slips the hooks around the shafts or gudgeons of the section beam.

Each section beam is lifted into position in the creel. The number of section beams depends on the requirements of the fabric to be woven. The creels furnished with slashers usually accomodate 8 beams, but additional sections, each holding 2 beams, may be added to a creel. Many of the creels used with wide-sheeting slashers hold up to 24 section beams. In case there is a variation in the width of the section beams, the widest beam must be placed in the creel in a position nearest to the size box, the next widest following, and so on. Such an arrangement prevents the yarn from the following beams from running over the beam head, or flanges, of a narrower beam. Where a difference in the number of warp ends wound on the section beams exists but the beams are of the same width, the one having the greatest number of ends should be placed first in the creel next to the size box. If a case should arise in which the section beams vary both as to beam size and number of warp ends contained, the widest beam should be placed first in the creel and should be followed by the next widest beam. After those beams varying in width have been placed in their respective order in the creel, the beams having the greatest number of ends should follow in descending order. The purpose of this arrangement of section beams is to prevent the warp ends that come from beams near the center and rear of the creel, from rubbing, chafing, and being drawn over or against the heads of the beams in the front part of the creel.

**21.** Yarn from each section beam in the creel must be gathered into sheet form and drawn forward to the slasher. The usual method of threading the creel is to draw the sheet of yarn coming from the section beam $a_1$, Fig. 1, forward and down in under the beams $a_2$. As the yarn passes in under the beam $a_2$, the yarn from this beam is united with that from beam $a_1$ and these sheets are passed up and over the beam $a_3$. The yarn from this beam is added to the sheets and the entire group of warp ends passes down and around the beam $a_4$, up and around the beam $a_5$ and down and around the beam $a_6$. As the sheet of warp ends passes around each beam, the ends from each beam are added until the yarn coming from around the beam $a_6$ contains all the ends in the warp. The entire group of warp ends, in sheet form, then passes over the guide rolls $b$, $b_1$ and into the size box.

Sometimes the section beams tend to overrun in the creel, that is, they continue to revolve for a partial number of revolutions after the slasher stops and creates a slack in the sheet of warp yarns. In such instances, it is advisable to pass a rope around the top of the flange of the section beams, a grooved section in the flange often being provided for this purpose. One end of the rope is tied to the frame, while weights are attached to the other end in an effort to provide sufficient friction to prevent the beam from overrunning.

It is customary, in some mills, to start a new set of section beams in the morning and run continuously until they are exhausted. The advantage of this procedure is that, with the exception of periods for doffing the filled loom beams, continuous production is obtained, which results in depositing a more even coating of size about the yarn surface because the size is maintained at a more uniform temperature and viscosity. However, if these operating conditions are to prevail, and it is advantageous to have them, a slasher should be equipped with an individual motor drive to assure continuous operation at all times.

Considerable preparatory work is necessary before a slasher may be set in operation. The creel must be filled and the new yarns from the creel tied to those in the slasher. The size box must be filled and the size brought to operating temperature. Then, the steam to the drying cylinders is turned on and the cylinders are raised to operating temperature. It is advisable, however, to open the steam valve to the cylinders before opening the steam valve to the size box because any condensate in the steam line may be easily removed from these cylinders. If the condensate were to enter the size box, as it would if the valve to the size-box steam coil were first opened, the size would be diluted. While the size mixture and the drying cylinders are being raised to normal operating temperature, the creel is refilled with section beams and the new warp ends are tied to the old ones remaining in the slasher. Generally, the ends in the sheet of warp yarns are divided into a number of sections, usually about eight groups, and the new and old ends are tied. Then, all minor changes and adjustments, such as changing draft gears and the like, should be made before starting the slasher.

**22. Leasing a Warp.**—The purpose of taking leases, or inserting lease bands, is to permit the separation of a sheet of

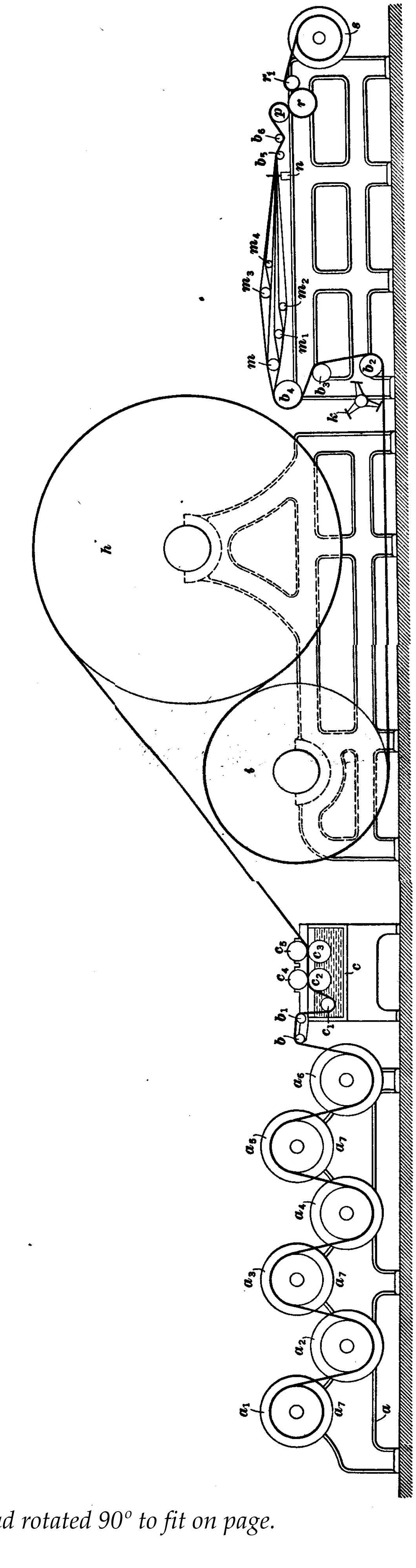

Fig. 1

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*Double-page spread rotated 90° to fit on page.*

warp yarn, as it leaves the drying cylinder of a slasher, into the same division and number of ends of yarn as came from each section beam. Leases are usually taken in a warp preparatory to starting a slasher after a new set of section beams has been inserted in the creel. Then, when a slasher is about to be doffed, or a loom beam is completed, leases are usually taken again, and they are taken frequently throughout the formation of a loom beam if the yarns slashed are of a weak or fine nature. Frequent leasing also tends to prevent the formation of defective loom beams caused by wrong tie-ins. The term tie-in is used to refer to a warp yarn that has been broken during slashing and whose broken end has been tied. Sometimes, when a number of warp ends are broken and are tied at the head end of a slasher, the end of one warp yarn may be tied to the end of another broken warp yarn. In such an instance, the tie-in would cross some of the warp ends, and, when such a loom beam was unwound at a loom during weaving, the crossed ends would be likely to break. Frequent leases, however, tend to prevent misplaced warp ends and crossed tie-ins by keeping the warp ends in the slasher and on the loom beam in their proper order.

Lease strings are inserted with the aid of a lease rod, which is as long as or longer than the section beams contained in the creel of the slasher. A cord or a piece of warp yarn that is to be used as the lease string is doubled and wrapped around one end of the rod. While the slasher is running at slow speed, the lease rod containing the string is inserted by the slasher tender between the warp sheets coming from two section beams, and the rod is immediately withdrawn, leaving the lease string between the two sheets of warp yarn.

The first lease string is placed between the yarns from the section beams $a_1$, $a_2$, Fig. 1. The lease string may be placed in position, in this instance, by simply holding the lease rod over the warp yarn between the section beams $a_1$, $a_2$. The lease string is released and falls between the section beam $a_2$ and the sheet of yarn from the section beam $a_1$ at the point where this sheet of yarn comes in contact with the section beam $a_2$. The lease rod is then withdrawn and another lease string wrapped around it. The next lease string is inserted between the yarns coming from under the section beam $a_2$ and the section beam $a_3$. In this case, the lease rod must be inserted up under the yarns so that the lease string actually separates the yarns coming from the section beams $a_1$, $a_3$. Next, a lease string is placed on top of the yarns from the section beam $a_2$ as it passes over the top of the section beam $a_3$. The lease string thus separates the yarns from the section beams $a_2$, $a_4$. As the entire group of warp ends are brought forward, they pass under the section beam $a_4$, and the yarns from this section beam will form the top yarn sheet. A lease string placed under the warp ends as they pass over the section beam $a_5$ separates the yarns coming from the section beam $a_3$, which is on the bottom of the sheet of warp ends, from the yarns coming from the section beam $a_5$. The entire group of warp ends now pass down and around the section beam $a_6$, and a lease string is inserted from the top to separate the yarns coming from the section beams $a_4$ and $a_6$.

The group of warp yarns now pass to the size box in sheet form in the following order: The yarns from the section beam $a_6$ are on top of the group and those from the section beams $a_4$, $a_2$, $a_1$, $a_3$, $a_5$ follow in this order. When the lease strings reach the size box, the slasher is stopped so as to fold over the top of the yarn sheet the long lease strings projecting beyond the sheet of warp ends. This precaution is taken to prevent the lease strings from becoming entangled in the size rolls and being withdrawn. When the lease strings reach the head end of the slasher, the slasher is stopped and split rods are inserted in place of the lease strings.

**23. Striking Comb.**—The slasher is set in operation at slow speed, and, when the first lease string is between the creel and the size box, a striking comb is inserted into the warp between the size-box guide rolls and the creel. A striking comb consists of a number of metal teeth, about 2 inches long, held in a base. Usually, the same number of teeth are contained in the comb as there are teeth in the slasher comb at the headstock. The comb is moved slightly laterally, and a distinguishing mark, generally a colored streak, is made on the sheet of yarn at its center. As the sheet of yarn passes through the size box, the groups of yarn created by the striking comb will be sized in tape-like formation, each group containing the number of ends desired in each dent at the slasher comb. When the first lease string reaches the striking comb, the comb is removed to permit the passage of the lease strings through the size box.

As the warp yarns travel forward slowly, care should be exercised to keep the warp in the center of the slasher by watching the mark made at the center of the yarn sheet at the size box. The tape of yarn carrying the center mark should be placed at the center of the slasher comb and each tape placed in sequence in each dent of the slasher comb.

Ordinarily, the distance between the teeth in the slasher comb varies over a wide range because it is adjustable as to width, 7 to 11 dents per inch being normally used. The number of dents per inch, however, depends on such factors as the counts of yarn, the cloth construction, the number of ends in the warp slashed, and the like. The usual procedure, in most instances, is to place one warp end from each section beam in a dent. For instance, if there are 4 section beams, there would be 4 ends in a dent, but under no circumstances are more than two ends from the same beam placed in the same dent. However, in the estimation of many mill men, not over 6 ends should be placed in a dent. If the number of ends in a dent exceeds this number greatly, it is claimed that the warp ends will tend to roll, entangle, and eventually break, thus producing a loom beam of inferior quality. The placing of the ends in the dents of a slasher comb in the manner described creates a thorough separation of warp ends, breaks up any size formation existing between a number of ends, and tends to keep them in their proper position. Whenever a striking comb is used to facilitate placing the warp ends in the correct dents of the slasher comb, it should be used before the lease bands reach the size box, and the tapes of ends should be placed in the dents before the split rods are inserted.

**24. Inserting Split Rods.**—Split rods must be substituted for lease strings as the strings appear at the headstock of a slasher. A split rod is a smooth, flat rod with rounded corners and is slightly longer than the width of the slasher. Brackets are provided to hold these rods between the guide roll $b_4$, Fig. 1, and the slasher comb *n*. Each bracket is attached to the side rail of the slasher framework and may be adjusted as to height. As the first lease string reaches this section of the slasher, one operative on each side of the slasher takes hold of the string and gently moves it back and forth to break the size formation, at the same time lifting it slightly to form a shed through which one of the operatives passes a split rod. The rod is then placed in the brackets provided to hold it. The first split rod inserted is the rod *m*, which separates the warp yarns coming from the section beams $a_1$, $a_2$. The split rod *m* is in reality the main split rod because it divides not only the sheets of yarn from the section beams $a_1$ and $a_2$ but also the warp into two distinct sections. The upper section consists of yarn passing over the top of the main split rod and coming from the bottom tier of the section beams $a_2$, $a_4$, $a_6$, while the lower section of warp yarns consists of yarn from the top tier of section beams $a_1$, $a_3$, $a_5$. The remaining lease strings are likewise replaced by the split rods $m_1$, $m_2$, $m_3$, $m_4$. Regardless of the number of section beams used to compose the warp, generally one less split rod will be required than there are section beams.

Whenever ply selvage yarns are used in a warp, they should be separated from the other yarns that compose the main body of the warp. Generally, two extra split rods are used for this purpose. These rods not only split and separate the selvage yarns from the main body of warp yarns, but tend to keep the warp running straight and the ends from twisting. One rod is often placed between the small drying cylinder *i*, and the guide roll $b_2$ in the headstock; that is, it is placed just back of the fan *k*. The other split rod is placed a little forward and above the main split rod *m*. With the split rods in this position, the ply selvage yarns pass above the regular warp yarns.

**25. Operating a Slasher.**—The temperature and the level of the size in the size box should be checked before commencing actual slasher operation. Unless the size level and size temperature are maintained constant by automatic control instruments, great care must be taken to see that they do not vary. The position of the immersion roll should be adjusted because this roll governs the time the yarn remains in contact with the size and, consequently, the amount of size absorbed by the yarn. Whenever a size box is heated by having steam injected into the size from open or perforated steam pipes, care must be taken to regulate the period of time the size remains in the box. Steam injected into a size box condenses in the size and gradually reduces the concentration, or viscosity, of the size mixture. In turn, this reduction of viscosity will change the amount of size deposited on the yarn and also vary the penetrability of the size. When fresh size is added to a mixture, the size viscosity of which differs from that in the size box, the amount of size deposited on the yarn will then vary constantly. At the completion of a day's work, however, all size remaining in the size box should be drained and discarded and the size box thoroughly washed with warm water.

The temperature of the drying cylinders also should receive careful attention before starting a slasher, and, unless automatically controlled, should be checked frequently. The cylinders should be run with as low a steam pressure as possible, and under no circumstances should this pressure exceed 15 pounds. Better slashing is produced by running a slasher slowly and utilizing a low steam pressure. A steam pressure of about 8 pounds produces a medium cylinder temperature in most instances.

The drying cylinders should always be kept clean. Yarn may, in some instances, be prevented from sticking to new cylinders by rubbing tallow over the surface of the hot cylinders. Oftentimes this treatment is advisable on old cylinders when an insufficient amount of softener is used in the size mixture and yarn stickage results. At the completion of each day's work, the slasher cylinders should be washed, or rubbed down, with hot water to remove all traces of size that may have adhered to their surfaces.

The slasher should always be started at low speed and run until it is operating smoothly. Then it may be shifted to a higher speed. Section beams require careful attention in case of end breakage. Breakage is often detected by the lapping of an end around a section beam. In such a case, the lap should be cut off and the end passed forward with the warp. The slasher should run at low speed while broken ends are being replaced. Unless a slasher is equipped with some means of automatically closing the steam valve to the drying cylinders while it is running at low speed, the slasher operative must close the valve to prevent the yarn from scorching.

The cut marker, which can cause much annoyance to the weaver, is another point that should receive attention. Care should be exercised so that too much dye is not placed on the dye pulley of the marker or the cut marker hammer does not remain in contact with the yarn for too great a period of time. Otherwise, the coloring matter will soak through two or three layers of yarn as the loom beam is formed and make it difficult for the weaver to determine where the cut should end.

**26. Doffing.**—The operation of removing the filled loom beam from the head end of a slasher and replacing it with an empty one is known as doffing. In mills weaving plain or heavy standard fabrics, it is customary to overrun the yarns in slashing; that is, the loom beam is filled with yarn to a level of about an inch above the flange heads. The yarn is then tapered gradually, or the ends are made conical by slowly contracting or reducing the distance between the teeth of the slasher comb. A much greater amount of yarn is thus contained and wound firmly on a loom beam. If, for example, the yarn required for winding 15 loom beams can be placed on 13 loom beams, a saving is made not only in loom beams, but in the expense of drawing-in the warps preparatory to instillation in the loom. Then, the looms will operate for a longer period of time before requiring a new warp, thus increasing both loom efficiency and loom production. This practice cannot be applied in mills weaving fine or fancy fabrics as the difference in the width of the warp caused by the contraction of the slasher comb will change the construction of the cloth.

A lease is taken, in most instances, before a slasher is stopped and the filled loom beam doffed. A lease taken when the loom beam is completed tends to hold the warp ends in their proper order and facilitate in preparing the loom beam for instillation in a loom.

Numerous methods of doffing looms may be used. However, one method that has proved satisfactory is to use gum tape to hold the warp ends in position and in correct order on the loom beam. It is essential that all warp ends be in correct order on a loom beam if warp tying-in machinery is to be used in later operations. Two rows of gummed tape extending the width of the warp are applied to it, and, the warp yarns are cut between the two rows of tape. An empty loom beam replaces the filled one, and the tape containing the warp ends is pulled down and around the empty loom beam. To fasten the warp yarns securely to the loom beam, a wooden stick is laid over the yarn and driven into the slot running the length of the loom-beam barrel. Sometimes, however, the warp yarns are simply wrapped around the bare loom beam instead of being held by a stick. Before the newly started loom beam may be operated at high speed, the slasher comb is adjusted so that the new warp will fit the loom beam; that is, the width of the warp is adjusted so as to equal and fill the space between the heads of the loom beam.

Sometimes, a comb instead of tape is used to hold the warp ends in place. However, this is an older practice and, in many instances, does not meet the conditions required in some mills. When a comb is used, it is slipped through the warp after the lease has been taken and the comb cap is tied in place to prevent the warp ends from dropping out of the dents of the comb. The warp yarns are cut, and those ends projecting from the comb are divided into a number of groups and tied to prevent the warp ends from being pulled through the comb.

Full beams are often removed from the head end of a slasher by means of a hoist, which eliminates much heavy lifting ordinarily required of the operative. Before the new loom beam may be started, several adjustments should be made. Usually, the weight on the starting lever of the friction drive is so adjusted as to produce a firm and even loom beam. The width of the warp wound on the loom beam is then adjusted by the slasher comb so that the warp ends will fit snugly against the loom-beam heads. All adjustments that tend to produce a firm, well-rounded loom beam should be made because soft beams will cause broken ends and much trouble at the loom.

## SLASHING YARNS FOR SHEETING WARPS

**27. Loom-Beam Requirements.**—Cotton warp yarns that are intended for use in the production of sheeting cloth often require slightly different handling procedure in slashing and necessitate slight slasher alterations. Sheetings are woven in widths varying up to 120 inches at the loom, but the width of the average slasher is about 60 inches. Many times, two loom beams, each about 60 inches in width, are used in wide sheeting looms to form a warp 120 inches wide. In such cases, warps may be prepared and slashed on the ordinary cotton slasher without slasher alterations being required.

**28. Slasher Construction.**—When wide loom beams are to be slashed, that is, loom beams about 120 inches in width, several distinct types of slashers may be employed. One type of slasher that has been used occasionally to slash wide loom beams consists of a large drying cylinder that acts in conjunction with a hot-air chamber. Two size boxes are usually employed so as to increase slasher production, the sheet of warp yarn being divided at the creel into two groups and each group passing through its own size box. Thus, superior size penetration of the yarn is obtained, and this permits higher slasher speeds than possible when only one size box is utilized. The warp yarns, still divided, pass through a hot-air chamber that is heated by steam pipes. The yarns are united as they pass around a large drying cylinder located beyond the hot-air chamber, and are finally dried.

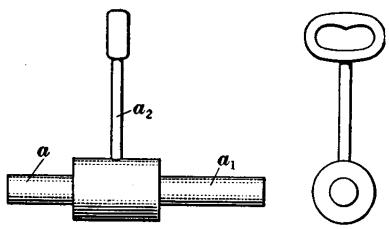
The most common type of slasher used for the slashing of yarns intended for sheeting warps is a two-cylinder cotton slasher to which slight changes have been made. It is common practice to utilize two size boxes, as employed in the sheeting slasher mentioned previously, so as to increase slasher production. The standard-size drying cylinders are used on this slasher, and carrying rolls are incorporated to provide added drying surface. Carrying rolls are simply small rolls placed in proximity to the drying cylinders and in such a position as to hold the yarn passing around the drying cylinder in contact with it for a greater portion of its circumference.

The warp yarns slashed in such a slasher are divided and pass through the two size boxes in individual sheets; then they are joined at the first carrier roll and pass around the drying cylinders as a single sheet. On leaving the drying cylinders, the yarn enters the head section of the slasher which has been designed to accommodate a special headstock installed to hold the wide loom beams. The new headstock at the front of the slasher is made about 17 feet wide at the friction drive end, and the head section from this point gradually tapers to the width of the drying cylinders in a distance of from 12 to 20 feet, depending on the number of split rods contained in this section. A 17-foot space provides ample accommodations for the large loom beam, which generally measures about 120 inches between flanges.

The large loom beams used for such warps are built with gear teeth cut into the flanges at both ends. The teeth on these flanges are used in connection with the geared let-off motion employed on sheeting looms. It is of advantage to have both loom beam flanges cut with gear teeth, for, regardless of the manner in which the loom beam is inserted in a slasher, it will always unwind correctly at the loom. Otherwise, care must be taken in inserting the loom beam in the headstock of a slasher because, if the geared flange end is placed on the wrong side of the headstock, the loom beam will unwind backwards when placed in a loom.

**29. Slasher Practice.**—Sheeting looms are often built to accommodate two regular-size loom beams so as to form the warp in a wide sheeting loom. Thus, the slashing of warps is possible with regular cotton-slashing equipment. In such loom beams, one flange head has gear teeth cut in it while the other flange consists of a plain disk about $\frac{3}{8}$ inch in thickness. When the beams are placed in the loom, the two plain flanges are together at the center and the geared flanges are on each end of the loom. The teeth on these flanges mesh with those of the let-off motion.

An iron rod extends through the hollow center of each beam to support it in the loom. Thus, instead of a shaft, or arbor, extending from either end of the beam, a hole runs through its center and necessitates the use of arbors, as shown in Fig. 2, view (*a*), to hold the beam in position at the slasher. View (*b*) is a side view showing the hollow center. One arbor is required at each end of a loom beam. The short end of the arbor *a*, view (*a*), is inserted in a hole in the friction shaft plate of the friction drive, while the end $a_1$ fits into the hole in the barrel, or end, of the loom beam. The handle $a_2$ provides an easy means of handling the loom beam while it is either inside or outside of the headstock of a slasher.



(*a*) FIG. 2 (*b*)

When loom beams are equipped with shafts, or arbors, built into the loom-beam barrel to support them at the slasher, a dog, or arm, is setscrewed to the shaft. A stud extending from the friction plate of the friction drive comes in contact with the dog. Thus, as the friction plate revolves, carrying with it the stud in contact with the dog, the loom beam is rotated. In cases where the loom beams used are of the hollow-barrel type, or depend on a long shaft passed through the beam for support in a loom, the extended stud on the friction plate is adjusted in length until it is brought against an edge of one of the ribs on the loom beam flange and so provides a means of turning the beam. Whenever two loom beams are used to form a single warp at a loom, one-half of the beams required must be slashed with the geared flange next to the friction drive, and the others with the plain flange next to the friction drive. When the plain ends or flanges are on the friction-drive side, a hole slightly in excess of the diameter of the extended stud is often drilled a short distance into the flange. By extending, or adjusting, the stud, it will fit in this hole and provide a means of rotating the loom beam as the friction plate revolves. It is necessary to place the loom beams in the slasher in the manner described because the geared end of each of the two beams at the loom must be on the outside. The geared head then meshes with the geared let-off motion, and, unless one beam from each of the two groups made at the slasher is used, yarn from one beam will unwind from over the loom beam while yarn from the other beam will unwind from under the beam.

When ply yarn is used as selvage ends, it is usually advisable, when making a long loom beam, to distribute the selvage ends evenly with the yarn so as to cover about one-third of the center section of the beam. Running the selvage ends and yarn in this way subjects them less to stretch and thus reduces, to a considerable extent, breakage of the single-end warp yarns. However, in slashing a warp to be run from two beams at a loom, it should be remembered that only one-half the number of selvage ends required are placed on each loom beam and that these ends are always on the side next to the geared flange.

A cut marker finds little use in slashing sheeting warps as the length of most sheeting woven is measured in hundred yards. Then, the same amount of weight used on the friction drive and beam presser while slashing one loom beam must be used for all loom beams. Generally, the weights are set in one position and are so maintained throughout the slashing of an entire set of section beams. Otherwise, the loom beams will vary in diameter and in yarn tension, factors that will often produce uneven cloth. Defects of this nature are almost impossible to detect until after the cloth has been woven and has been unrolled for inspection.

### SLASHING COTTON CREPE YARNS

**30. Variations in Slashing.**—The slashing of cotton crêpe yarns differs greatly from the slashing of plain yarns because of several inherent reasons caused, to a considerable extent, by the yarn and fabric construction employed in cotton crêpe fabrics. One of the distinguishing features of a cotton crêpe is the use of two highly-twisted warp yarns, each yarn having twist in a direction opposite to that of the other. For instance, one yarn may be composed of a yarn having **S**, or left twist, while the other yarn will have **Z**, or right twist. Although these yarns are of the same counts, the same number of turns of twist per inch, and the like, they may be distinguished from one another only if inspected rather closely before they are slashed. After sizing, most of the distinguishing features are obviated, and minute inspection is often required for differentiation. Often, by tinting or coloring one of the yarns with a fugitive dye during slashing, this disadvantage is overcome. A fugitive dye, when used, may be easily removed during later processes after the cloth has been woven. The drawing-in operator and the weaver are thus allowed to differentiate between the two yarns and maintain the definite arrangement of warp ends as specified by the design of the fabric.

Another source of trouble encountered in slashing crêpe yarns, due to the great amount of twist in the yarns, is the easiness with which these yarns roll and become entangled, especially if they are wet. Yokes, that is, boards with V-shaped notches, are used to divide the warp into a number of groups of ribbons to prevent the ends from rolling. Generally, this method has been found applicable for warps containing up to 3,000 ends. For warps containing a greater number of ends, usually two separate sheets of yarn are run; however, the yarns in each sheet must contain yarns with twist in the same direction and each sheet must be kept separate by carrier rolls.

**31. Slasher Alterations.**—Numerous changes of varying magnitude may be made on cotton slashers to permit them to slash cotton crêpe yarns successfully. One group of possible alterations, not extensive in magnitude but accomplishing the slashing of cotton crêpe yarns with the least amount of trouble, is described.

While the regular section-beam creel, as used with most cotton slashers, can be used successfully, better results can be obtained by constructing a new creel of 3″×4″ angle iron and pipe standards. The angle iron forms the two lateral surfaces on which the adjustable bearing holders are bolted at such a distance apart that a space of about 1 inch exists between consecutive section-beam flanges. The pipe standards are used to form the legs, or supports, of the creel and are of sufficient length to raise the rear, or that part of the creel farthest from the size box, to a much greater height than the front of the creel. The yarn can then be drawn from each beam in the creel without coming in contact with the yarn of the other beams.

A slasher altered to slash cotton crêpe yarns is illustrated diagrammatically in Fig. 3. The creel holding the section beams is inclined, and the section beams $a$, $a_1$, $a_2$, holding regular twist yarn, are grouped together, and the beams $a_3$, $a_4$, $a_5$, having reverse twist yarn, are likewise grouped together. The warp yarn from the beams containing the regular twist yarns passes over the guide roll $b$, through the yoke $c$, and into the size box. The reverse twist yarns are gathered and passed over the guide roll $b_1$, through

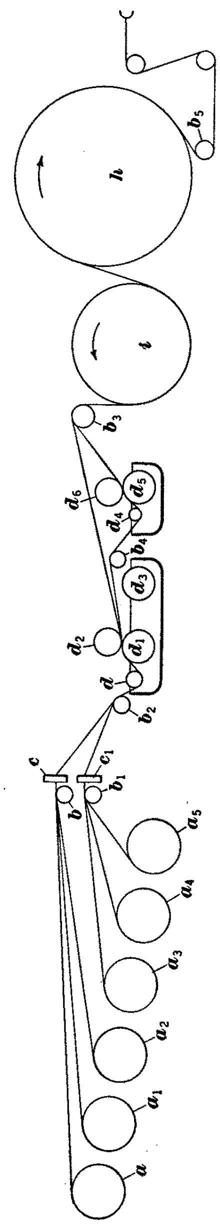



FIG. 3

the yoke $c_1$, and unite with the regular twist yarn at the guide roll $b_2$, from where they pass into the size box.

The yoke $c$, also illustrated in Fig. 4, is supported in an adjustable stand a little forward and above the first section beam in the creel nearest the size box. A set of saw-tooth projections $c_2$ are cut in the yoke. The projections, or teeth, are about 6 inches high with a curved root of $1\frac{1}{2}$-inch radius. The first recession is cut about $7\frac{1}{2}$ inches from the left side. Seven recessions are then cut, leaving 6 teeth, or projections, and a blank space of about 12 inches on the right side of the yoke. The finished yoke is placed in the adjustable stand and the guide roll $b$, Fig. 3, is placed close to it but at such a height that the top of the roll is a little above the root of the recesses in the yoke. As the yarn passes over the guide roll, the yoke at the front of it will split or divide the sheet of yarn into

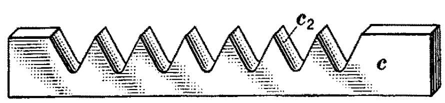



Fig. 4

ribbons. The distance that the ribbons of yarn extend into the recesses between the teeth on the yoke will govern the distance apart the ribbons are held from each other, and this distance may be varied by either raising or lowering the yoke.

Another yoke $c_1$ is placed directly below the yoke $c$ and divides the yarns from the section beams $a_3$, $a_4$, $a_5$, which contain reverse twist. The two yokes are constructed alike, but in the adjustable stands the yoke $c_1$ is placed under the yoke $c$. However, the yoke $c_1$ is placed in such a position that the blank space of about $7\frac{1}{2}$ inches from the end on the lower yoke will come under the 12-inch blank space of the top yoke. Thus, the ribbons from the group of section beams containing different twists run alternately instead of being superimposed, one ribbon on the other, at the drying cylinder. A guide roll $b_1$ is placed to the rear of the lower yoke $c_1$ and in the same relative position to it as the guide roll $b$ is to the yoke $c$.

The ribbons of yarn from each yoke meet at the guide roll $b_2$ at the size box and pass in sheet form around it and then into the size box and around the immersion roll $d$. At the size box, however, the second, or finisher, squeeze roll is removed, and a small size box is placed between the main size box and the small drying cylinder to hold a fugitive dye to tint certain of the yarns. The secondary size box contains an immersion roll and a size, or dye, roll that acts in conjunction with a squeeze roll. The ribbons of yarn absorb size as they pass around the immersion roll $d$ of the first size box. Then, they pass through the size and squeeze rolls $d_1$, $d_2$. The size roll $d_3$ is not used in this instance and its squeeze roll is removed. The purpose of the rolls $d_1$, $d_2$ is to force the size into the structure of the yarn and at the same time remove, or cut, the excess size from the surface of the yarn. The yarns are again separated into two groups of ribbons. The ribbons that contain the regular twist yarn pass directly to the carrier roll $b_3$, which is placed next to the small drying cylinder. The other group of yarn passes over the guide roll $b_4$ and under the immersion roll $d_4$, which is held in a dye solution. The guide roll $b_4$ is set in such a position as to prevent the yarn from coming in contact with the sides of the size box. The yarn absorbs the dye as it passes under the immersion roll and to the dye and squeeze rolls $d_5$, $d_6$. Thence it passes around the carrier roll $b_3$, where the two sheets of yarns are united. A light fugitive dye is always used in the secondary size box, that is, a dye that can be easily removed by soaping the cloth in the finishing operations. A soaper, as used in finishing, is simply a long continuous washer containing a soap solution through which the cloth is passed to be cleaned and freed from all traces of the fugitive dye. Actually, the dye is about the same as that used in the cut marker of a slasher but different in color.

**32.** A divided size box is another form that may be used for slashing cotton crêpe yarns, it being similar to that sometimes employed for slashing rayon. The size box may be divided by placing a partition $d_7$, Fig. 5, between the two size rolls $d_1$ and $d_3$. The first section of the size box $d_8$ is used for sizing the crêpe yarns, while the second section $d_9$ is used for tinting. In this case, the yarn passes around the guide roll $b_2$

and under the immersion roll $d$ in the size mixture. It continues on through the nip of the size and squeeze roll $d_1$, $d_2$ as usual, but here the two groups of warp ribbons are divided. The group of ribbons containing the regular twist yarns passes over the guide roll $b_6$, which keeps the yarn from coming in contact with the rolls of the size box that are used in conjunction with tinting. The yarns then pass to the carrier roll $b_3$, which is next to the small drying cylinder $i$. The yarns containing the reverse twist pass from the squeeze rolls of the size box to between the nip of the dye roll $d_3$ and the squeeze roll $d_6$. The dye roll rotates in a fugitive dye solution and carries the coloring matter to the yarn where it is forced into

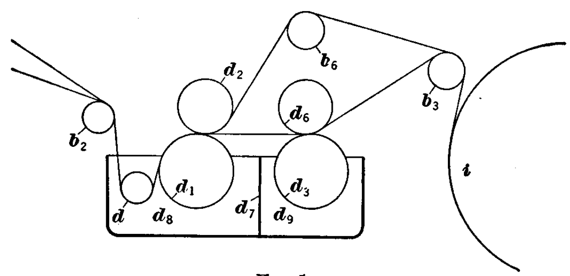



FIG. 5

the yarn by the squeeze roll. These ribbons of yarn likewise pass to the carrier roll $b_3$ and join those ribbons of yarn containing regular twist so as to form a wide sheet of warp yarn. The dye squeeze roll $d_6$ is covered with cloth in the same manner as a squeeze roll in the size box of the ordinary slasher. A suitable covering consists of about 20 yards of 16-ounce burlap to form a blanket and 2 or 3 yards of a light-construction cloth to form the surface of the roll.

As a precautionary measure, sometimes adopted to prevent the crêpe yarns from rolling in the slasher, the yarns are passed directly from the size box to the small drying cylinder instead of around the large drying cylinder, to lessen the distance the yarns are uncontrolled by rolls after they leave the size box. The direction of normal rotation of both drying cylinders, in this case, remains the same. The carrier roll $b_3$, Fig. 3, is placed well toward the top of the small cylinder $i$

so that the yarns will obtain the maximum drying area by practically encircling the cylinder. The yarns pass down around the small cylinder and up and over the large drying cylinder *h*. Another carrying roll $b_5$ is placed beneath the large drying cylinder likewise to obtain the maximum area of drying surface and to bring the yarn in line with the regular guide rolls of the slasher around which the warp must pass to reach the headstock. Whenever the yarn is run to the small drying cylinder first, the temperature of this small cylinder must be changed to equal the temperature ordinarily maintained by the large cylinder. Sometimes trouble is experienced by the formation of caking; that is, size will be left in cake form on the drying cylinders and on the yarns. At close inspection, it will be found that the caking is usually coming from the tinted yarns. In such cases, the amount of size added to the fugitive dye bath should be reduced and the temperature of the dye bath raised.

**33. Leasing.**—The warp must be leased after a new set of section beams is placed in the creel. Otherwise, it would be difficult to insert the split rods at the headstock so as to effect a thorough separation of all warp ends. The slasher should be operated at low speed throughout the leasing operation so that the lease strings may be placed a distance of about 2 feet apart.

The first lease string is inserted between the group of warp ribbons coming from the section beams containing regular twist and reverse twist. A string is placed between the two groups or sheets of ribbons at a point between the small drying cylinder and the yokes. The ends of the lease string are turned in and allowed to pass forward. The next lease string is placed at the creel between the warp yarns coming from the section beams *a*, $a_1$, Fig. 3. The string is slackened as it approaches the guide rolls and yokes so that it may be lifted over the saw-tooth projections. Great care must be taken not to lift the yarn at the bottom of the recesses, or teeth, out of the yoke. After passing the yoke, the lease string is made tight, and its ends are folded over onto the warp and allowed to pass forward. Lease strings are next placed between the sheets of yarn coming from the beams $a_3$, $a_4$, from the beams $a_1$, $a_2$, and from the beams $a_4$, $a_5$, the same procedure being followed as previously. The slasher is stopped as the lease strings arrive at the head end, and split rods are substituted for the strings so as to provide a thorough separation of the warp ends coming from the various section beams.

## SLASHING COLORED WARP YARNS

**34. Colored Warps.**—Loom beams are often required, especially if varied colored yarns are being woven at a loom, to contain more than one color of yarn. Many fabrics, such as fancy dress goods, fancy shirting materials, ginghams, and the like, require warp yarns of several colors, and these yarns must be arranged on a loom beam in a definite order. If yarn of only two colors is required for a warp and these yarns are evenly divided in number, practically no difficulty will be encountered in slashing such a warp. The yarns of each color are wound separately on individual section beams, and placed in the creel of a slasher. A lease is taken to keep the colors separated while they are slashed and until they reach the comb. At the comb, they are combined to produce the correct sequence, as desired, of colored yarns on the loom beam.

However, most colored warps contain more than two colored yarns and the yarns are seldom divided in such a manner as to have an equal number of ends of each color. The procedure in slashing such warps is involved. Practically every warp slashed varies as to the number of different colors, the number of yarns of each color, the arrangement of the yarns, and the like, and must be treated according to its own requirements. Only certain broad principles and procedures may be applied to the slashing of all warps, but from them the problems besetting the slashing of each individual warp may usually be solved.

**35. Principles of Slashing Colored Warps.**—The principles employed in preparing and slashing most colored warps are illustrated in the three basic operations of slashing. First, a suitable section beam is prepared at a beam warper by winding on a section beam a definite number of ends of warp yarn from spools, cones, or cheeses, these being placed on that beam in a definite order if the yarns are of different color. Also, the yardage of yarn wound on all section beams is alike.

Second, the section beams are arranged and placed in the creel of a slasher so that the sheet of warp yarn coming from each section beam is in correct order. For example, if section beams are used and some of these beams contain yarn of a different color, all yarns of the same color should be grouped together as they leave the creel of a slasher. Also, if the section beams vary in width or in number of warp ends contained, they should be arranged in the creel accordingly.

Third, the slashed ends of yarn must be so placed in the comb of a slasher that they are wound on the loom beam with the color sequence of yarns that is desired in the warp of the fabric being woven. Also, the colored warp ends are arranged so that there will be a minimum number of warp ends crossed at the loom.

Supplementary information concerning the colored warp to be made at the slasher is sometimes given to the slasher overseer by the designer. But usually the designer simply gives to the slasher overseer an arrangement of the colored warp ends as they appear in the cloth, known as the designer's draft, and whatever information the designer deems necessary. From this material, the slasher overseer must figure out whatever information is needed to make a slasher draft, which is, in reality, a draft of the order of warp ends in the slasher comb.

**36.** Colored warps are prepared and slashed in many different ways, each method having its advantages. One method may be best suited for use in a certain mill because of the warping and slashing equipment possessed by that mill or because of the peculiar problems encountered in slashing the warps in the mill. One method of slashing a colored warp, which is generally applicable to most colored warps, is illustrated.

The designer, for instance, has a piece of cloth that is to be duplicated. After the cloth has been dissected and analyzed, it is found to be composed of warp yarns of four different colors, namely, dark blue, white, light blue, and tan. These colored yarns appear in the warp in the order listed in Fig. 6.

ORDER OF WARP ENDS IN PATTERN

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dark Blue | 2 | | | | | | 2 | | | 4 | | | 2 | | | | | | 2 | =12 |
| White | | 6 | | | | 6 | | | 2 | | 2 | | | 6 | | | | 6 | | =28 |
| Light Blue | | | 6 | | 6 | | | | | | | | | | 6 | | 6 | | | =24 |
| Tan | | | | 4 | | | | 4 | | | | 4 | | | | 4 | | | | =16 |
| | Total number of ends in pattern | | | | | | | | | | | | | | | | | | | =80 |

FIG. 6

The gingham warp, as drafted above, is 72 sley, that is, there are 72 warp ends to every inch of the cloth, and, as the cloth is 36 inches in width, excluding selvages, there will be $72\times 36=2{,}592$ ends in the warp. There are 16 ends of white-ply selvage yarns placed on each side of the cloth, making a total of 32 selvage ends. As there are 80 ends to a pattern and 2,592 ends in the warp, there will be $2{,}592\div 80=32\frac{32}{80}$ patterns in the warp, or 32 complete patterns and 32 ends left over. The portion of the pattern left over and consisting of 32 ends must be divided in some manner so that, when this portion appears in the woven cloth, it will not make the entire design of the cloth appear unbalanced and as if a portion of it had been cut off or removed.

**37. Designer's Draft.**—From these data and the order shown in Fig. 6, the designer prepares a designer's draft, which, as previously explained, is simply a layout showing the order in which the colored warp yarns and the warp pattern appear in the fabric throughout its entire width.

First, the warp pattern shown in Fig. 6 is balanced in the warp of the intended cloth. The pattern repeats itself 32 times and 32 additional ends remain. These 32 ends are divided, preferably into two groups of 16 ends each, and a group is placed next to each of the selvages. The layout should have a symmetrical appearance. A rule often used to balance and determine the order of warp ends to be placed next to each of the selvages in a warp pattern is as follows:

**Rule.**—*Find the center of any symmetrical part of a complete pattern and count a number of ends each side equal to one-half the number of ends in the incomplete pattern.*

One-half of the incomplete pattern, counted as described in this rule, is placed on the left side of the cloth next to the selvage, and the other half of the pattern is placed on the right side of the cloth next to the selvage yarns on that side. Thus, the pattern will appear in the warp as centered and well-

ILLUSTRATION OF DESIGNER'S DRAFT

| | |
|---|---|
| | 6 white |
| | 2 dark blue |
| | 4 tan |
| | 2 white |
| | 2 dark blue |
| ⎧ | 2 dark blue |
| ⎪ | 6 white |
| ⎪ | 6 light blue |
| ⎪ | 4 tan |
| ⎪ | 6 light blue |
| ⎪ | 6 white |
| ⎪ | 2 dark blue |
| ⎪ | 4 tan |
| ⎪ | 2 white |
| 32 times ⎨ | 4 dark blue |
| ⎪ | 2 white |
| ⎪ | 4 tan |
| ⎪ | 2 dark blue |
| ⎪ | 6 white |
| ⎪ | 6 light blue |
| ⎪ | 4 tan |
| ⎪ | 6 light blue |
| ⎪ | 6 white |
| ⎩ | 2 dark blue |
| | 2 dark blue |
| | 2 white |
| | 4 tan |
| | 2 dark blue |
| | 6 white |

balanced. When balancing a pattern in the warp of a fabric, this rule should be applied in such a manner as to have the white yarns, if used in the pattern, next to the selvage yarns on either side of the fabric. A division of this kind always gives the woven fabric a more pleasing appearance than if a dark-colored yarn was placed next to the white selvage ends.

Applying the rule to the pattern draft, as illustrated in Fig. 6, a center of symmetry that meets all requirements appears at the center of the draft, that is, this point, which is listed as 4 dark-blue ends, is 32 ends from each side. The designer's draft for the warp pattern in Fig. 6 would appear as shown on the preceding page.

Such a draft is generally given to the slasher overseer with such pertinent information about the yarns, the selvages, and the like as he must know to determine the number of section beams required and to lay out his draft.

**38. Section Beams.**—The total number of warp ends required in the warp of the cloth and the number of warp ends of each color must be determined before figuring the number of section beams required in the creel of the slasher. The slasher overseer, by referring to the designer's draft, finds that the is about to be removed from the wraper.

| | |
|---|---|
| 912 | white ends |
| 768 | light-blue ends |
| 520 | tan ends |
| 392 | dark-blue ends |
| 2,592 | total number of ends in warp |

The number of warp ends placed on a section beam should, in most cases, approach the maximum number of ends it is possible to place on a section beam, but, at the same time, should be such as to fill a number of section beams practically to capacity. In this instance, it is advisable to use 6 section beams and to have each beam contain approximately 450 ends. However, if the section beams used are of such capacity as to hold less than 450 ends or if the warper creels are of a smaller capacity, a greater number of section beams must be used. By using 6 section beams, it is possible to have 5 beams of solid color and one beam, commonly known as a pattern beam, containing yarn of two colors. The white yarns, 912 in number, are placed on 2 section beams. Likewise, the 768 ends of light-blue yarn are placed on 2 section beams. The 520 ends of tan yarn are divided, part of them forming one solid section beam of tan and the remainder placed on the pattern beam along with the 392 ends of dark-blue yarn. Dividing the colored yarns in this manner is only one of the many varied combinations that may be used. The grouping of these yarns on their respective section beams is illustrated in the accompanying list:

2 beams, each of 456 ends of white yarn
2 beams, each of 384 ends of light-blue yarn
1 beam, each of 456 ends of tan yarn
1 beam of 456 ends (392 ends of dark-blue yarn and 64 ends of tan yarn)

6 beams

The preparation of section beams of solid color will give little trouble to the warp-preparation department, but, for the preparation of pattern beams, that is, the beams combining the dark-blue and the tan yarns, instructions must be given by the slasher overseer.

**39. Pattern Beam.**—When warps contain yarns of different colors and there is of one color not enough to fill a section beam, the yarns are combined on a pattern beam. Thus, a pattern beam contains yarns of different colors or characteristics arranged on a section beam in a definite order. The order of these yarns and their number should, however, be the same as those of the same color which appear in the designer's draft. Also, the number of repeats and the arrangement of yarns on the pattern beam should be similar to those of the pattern in the warp of the fabric. While this method of arranging colored yarns on a pattern beam should, in most instances, be followed, there are times when it is neither possible nor practical to follow this procedure.

The order of the dark-blue and the tan warp ends on the pattern beam for the design in Fig. 6 must be specified by the slasher overseer. The arrangement of these warp ends is such as to facilitate the counting of the pattern in the comb of the slasher. The principles involved in the construction of a pattern beam for such a pattern have been adhered to as closely as possible.

The pattern beam, in this instance, must contain 64 tan ends and 392 dark-blue ends. One possible arrangement of colored yarns on the pattern beam is to divide the different colored ends into a pattern that repeats 32 times because this number of repeats of the pattern is contained in the warp of the fabric. Thus, each pattern of the pattern beam will contain 2 tan yarns and 12 dark-blue yarns. This combination of yarns will repeat 32 times and there will be 8 dark-blue ends left over. The arrangement of the colored ends in this repeat of the pattern should be the same as these ends appear in the designer's draft. However, not a sufficient number of tan-yarn ends are contained in a repeat of the pattern on the pattern beam to permit the same grouping of tan ends. Therefore, by using the following pattern draft for the colored ends on the pattern beam, a division of colored ends is obtained.

| | |
|---|---|
| | 4 dark blue |
| 32 times | 4 dark blue<br>1 tan<br>4 dark blue<br>1 tan<br>4 dark blue |
| | 4 dark blue |

This division of the colored ends is about as similar to the order of arrangement in the designer's draft as it is possible to obtain. The 8 remaining ends of dark-blue yarn are divided, and half of them are placed at each end of the pattern beam so as to balance the yarn pattern. However, when the yarns combined on the pattern beam are all the yarns of that color appearing in the warp, the order of ends taken in the pattern beam should, in most instances, be the same as appear in the designer's draft.

Whenever a pattern beam is made in the warping department, regardless of the manner of making or the order of the colored yarns on the beam, a lease string must be inserted to separate the colored yarns, this usually being done to permit separation of the yarns at the slasher. About 10 yards of lease string is inserted between the varied colored yarns as the pattern beam is about to be removed from the warper.

**40. Ends Per Dent.**—The number of warp ends placed in a dent at a slasher comb is determined usually by the number of section beams placed in the creel of the slasher. Generally, one warp end from each section beam should be placed in a dent; therefore, if 6 section beams are used, the warp should be placed 6 ends to the dent at the slasher comb.

The number of warp ends per dent, it is claimed by some mill men, should not exceed 6. If a greater number than this is used, the ends are crowded in the dents and tend to roll and become entangled. In such instances, it is usually advisable to replace the present slasher comb with one that contains a greater number of dents and to place only a few warp ends in each dent. No rule can be given to determine the maximum number of warp ends that may be placed in a dent, as numerous factors must be considered, such as the number of section beams to be used, the counts of the yarn, the type of yarn, that is, whether the yarn is twisted highly, whether cotton or rayon yarns are to be used, and the like. Therefore, the number of warp ends to be placed in a dent of a slasher comb is a matter of judgment on the part of the slasher overseer.

**41. Slasher Draft.**—The slasher draft, that is, a draft showing the arrangement of the colored warp ends in the comb of a slasher, is usually made by the slasher overseer. In addition, the slasher draft shows the arrangement of these ends on the loom beam, because the purpose of the comb is to guide the warp yarn on the loom beam in correct order.

The slasher overseer obtains much of the necessary data for constructing the slasher draft from the designer's draft. Knowing the number of colored yarns as they appear in the pattern, the number of selvage ends used, and the number of ends to be placed in a dent, the slasher overseer lays out the slasher draft as shown in the accompanying illustration. In

| | Dent | Ends |
|---|---|---|
| | 1st dent — | 4 selvage |
| | 2nd dent — | 4 selvage |
| | 3rd dent — | 4 selvage |
| | 4th dent — | 4 selvage |
| | 5th dent — | 6 white |
| | 6th dent — | 2 dark blue<br>4 tan |
| | 7th dent — | 2 white<br>2 dark blue |
| 32 times | 1st dent — | 2 dark blue<br>4 white |
| | 2nd dent — | 2 white<br>4 light blue |
| | 3rd dent — | 2 light blue<br>4 tan |
| | 4th dent — | 6 light blue |
| | 5th dent — | 6 white |
| | 6th dent — | 2 dark blue<br>4 tan |
| | 7th dent — | 2 white<br>4 dark blue |
| | 8th dent — | 2 white<br>4 tan |
| | 9th dent — | 2 dark blue<br>4 white |
| | 10th dent — | 2 white<br>4 light blue |
| | 11th dent — | 2 light blue<br>4 tan |
| | 12th dent — | 6 light blue |
| | 13th dent — | 6 white<br>2 dark blue |
| | 1st dent — | 2 dark blue<br>2 white |
| | 2nd dent — | 4 tan<br>2 dark blue |
| | 3rd dent — | 6 white |
| | 4th dent — | 4 selvage |
| | 5th dent — | 4 selvage |
| | 6th dent — | 4 selvage |
| | 7th dent — | 4 selvage |

this instance, the selvage ends are placed 4 to a dent and the warp ends 6 to a dent.

The slasher overseer always counts the order of warp ends from the designer's draft by beginning at the bottom of the draft. It is necessary to follow this order because the slasher attendant that places the warp yarns in the slasher comb begins at the right side of the comb and works toward the left, while the designer's draft is usually made to read from the left to the right. Otherwise, the warp pattern would be laid in the slasher comb and placed on the loom beam in reverse.

The selvage ends are placed 16 in number on each side of the fabric. As these are composed of ply yarns and are larger than those yarns used for the body of the warp, they are placed 4 to a dent. The first 4 dents will contain selvage ends only. Commencing at the bottom of the designer's draft, it is observed that 6 white ends appear first. These 6 white ends are placed in the 5th dent because the warp pattern is placed 6 ends to a dent in the slasher comb. The 6th dent has 2 dark-blue ends and 4 tan ends. In the 7th dent, the 4 remaining ends of the balancing pattern are placed. Because the pattern in the fabric repeats 32 times, it is advisable to keep the ends of this pattern arranged so that, for each repeat of it, the same corresponding warp ends always appear in the same dent. Thus, the pattern, after it has been placed in the slasher comb, may be checked easily.

**42. Creeling.**—The arrangements of section beams in a slasher creel, when colored warps are slashed, is of utmost importance. The same general principles employed in regard to section-beam widths and number of ends on a beam when creeling a warp of one color still apply to multicolored warps. However, some exceptions are made. A pattern beam is always placed in the lower tier next to the size box and its yarn of each color is treated as if it came from a separate beam. A beam in this position has its sheet of yarn forming the top yarn-sheet of the entire group of warp ends. Therefore, the multicolored yarns from this beam may be observed more closely, especially when a certain color effect is desired in the warp of a fabric and is to be created by only a few yarns. The observance of these yarns, if they do not form the top sheet of warp ends, will be difficult, and broken warp ends may pass unnoticed.

The section beams that contain yarns of a solid color are so placed that the yarns of one color will appear together as the warp ends pass from the creel. Then, sometimes a warp contains yarns of about the same color but of different shades. In such instances, the yarns may be difficult to distinguish and yarn of another color is so creeled that it divides these sheets of similar-colored yarn. Unless the yarns of similar color are divided, difficulty may be encountered in distinguishing these yarns as the warp pattern is placed in the slasher comb.

The section beams that are to form the warp are creeled in a slasher in the following order, as shown diagrammatically

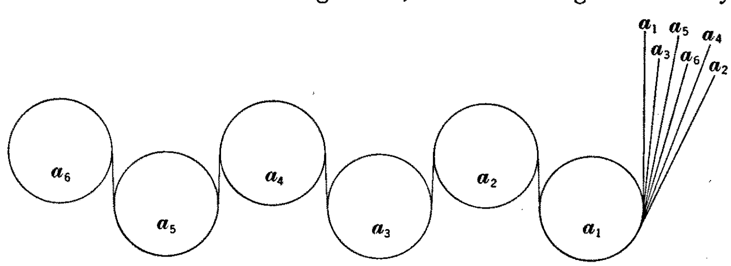



FIG. 7

in Fig. 7. The section beam $a_1$ contains the dark-blue and tan yarns and is placed in the lower tier next to the size box of the slasher. The beam $a_2$ of the top tier has light-blue yarn, the beam $a_3$ has tan yarn, the beam $a_4$ light-blue yarn, and the beam $a_5$, $a_6$ have white yarn. Therefore, the colored yarn is grouped as follows:

| | |
|---|---|
| dark-blue and tan yarn combining on beam | $a_1$ |
| tan yarn on section beam | $a_3$ |
| light-blue yarn on section beams | $a_2$, $a_4$ |
| white yarn on section beams | $a_5$, $a_6$ |

The yarn ends on the last section beam $a_6$ in the creel are grouped in sheet form by the slasher attendant and drawn down and around the next section beam $a_5$, the yarns from the latter beam being united with the others. The group of warp ends are likewise passed up and over the section beam $a_4$, down and around the section beam $a_3$, and so on. As the group of warp ends passes around each section beam, the warp yarns on that beam are united with the group, the yarns from every section beam helping to compose the yarn sheet. The sheet, or group of warp ends, is then threaded through the size box of the slasher.

**43.** The sheet of warp ends at the size box is composed of warp ends from each section beam but in layers of yarn of different colors. The object of placing the section beams in the creel in the order shown in Fig. 7 is to have the yarn sheets from each section beam appear at the size box in a certain position in the group of warp ends. The colored ends from the section beams appear at the size box in the following order of yarn sheets, the first sheet listed appearing at the top of the group:

yarn sheet from section beam $a_1$ of dark-blue and tan yarns
yarn sheet from section beam $a_3$ of tan yarns
yarn sheet from section beam $a_5$, $a_6$ of white yarns
yarn sheet from section beam $a_4$, $a_2$ of light-blue yarns

The 32 white, ply selvage yarns, in this instance, are creeled in a special creel supported from the hood over the size box. This creel has a capacity of 12 spools, so, if two ends are wound on a spool, only 24 selvage ends are accommodated. Creels of this style, however, are often constructed to hold a greater number of spools, 16 spools, in this instance, being placed in each side of the creel. If the creel does not hold this number, two ends of ply yarn may be wound on a spool, and then only 8 spools would be required on each side. The other side of the creel is likewise filled, and the ply selvage yarns are drawn through the pins at the bottom of the creel to keep them in proper order. The yarns are drawn directly to the nip of the last set of size and squeeze rolls, where they unite with the warp yarns. These selvage yarns should be placed to the side of the warp yarns so that they will be in the correct position to be placed in the slasher comb with the rest of the warp yarn.

**44. Split Rods.**—The warp ends gathered in sheet form at the size box of the slasher are drawn forward by the slasher attendants and threaded through the slasher without size.

The warp must then be leased, as described in Art. 22. Lease strings are placed between the yarn sheets from each section beam and the yarns are drawn forward until the lease strings reach the head of the slasher, at which point the lease strings are removed and the split rods inserted in their place.

Split rods are placed at the head end of the slasher so as to divide the slashed sheets of colored warp yarns into the same grouping of color and number of ends as is maintained in each section beam at the slasher creel. Split rods also facilitate in taking a lease in the warp ends while slashing and help to locate crossed warp ends.

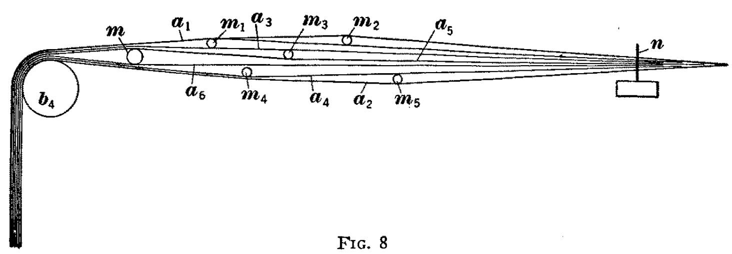



FIG. 8

The rule generally used to determine the number of split rods required by a warp states that one less split rod than there are section beams is usually necessary. However, when a section beam contains yarns of two or more colors, as does a pattern beam, each sheet of colored yarn on that beam is considered as coming from a separate section beam. For example, if this rule was to be followed, the warp, as creeled in Fig. 7, would require 6 split rods to separate the various sheets of colored yarns.

A main split rod *m*, Fig. 8, is inserted as the first lease string; that is, the lease string placed between the yarn sheets from the section beams $a_5$, $a_6$ appears at the head of the slasher. The main split rod divides the warp from the guide roll $b_4$ into two sheets. The yarns from the section beams in the lower tier of the slasher pass over the top of the main split rod, while the yarns from the section beams in the top tier pass beneath this split rod. The split rod $m_1$ is inserted to replace the lease string that divides the yarn from the section beams $a_1$,

$a_3$. The section beam $a_1$ contains a combination of dark-blue and tan yarns, so the split rod $m_2$ is inserted in place of the lease string placed in the warp of section beam at the warper to separate the two colored yarns on this beam. The lease string that divides the warp yarns from the section beams $a_3$, $a_5$ is removed and the split rod $m_3$ inserted in its place. Likewise, the split rod $m_4$ divides the sheet of warp yarns from the beams $a_6$, $a_4$, while the split rod $m_5$ separates those yarns from the section beams $a_4$, $a_2$.

**45. Counting-In Pattern.**—The process of placing the warp ends in the various dents of a slasher comb is commonly known as counting-in. The warp ends are placed in the slasher comb in the order in which they are to be wound on the loom beam. The arrangement of the colored warp ends in the slasher comb is usually made by the slasher overseer and is so specified in the slasher draft; therefore, it is a simple matter for the slasher attendant to follow the slasher-draft outline in placing warp ends in the comb.

The slasher, or expansion, comb, as used on various slashers, often differs in construction. For example, the slasher comb, used in connection with the counting-in of the warp pattern, consists of 440 dents, which are composed of twenty-two, 20-tooth segments. According to the slasher draft, 7 dents are required for the selvage yarns and for the balancing of the warp pattern on one side, therefore, a total of 14 dents would be required to balance both sides. The main pattern shown in the slasher draft requires 13 dents for one repeat and, as there are 32 repeats of the pattern, it will require $13 \times 32 = 416$ dents, plus 14 dents, or a total of 430 dents. The comb contains 440 ends, thus 10 surplus dents are left, these being divided and 5 left empty on each side of the comb.

The slasher attendant usually places the warp ends in the slasher comb, commencing at the right side and working to the left. The warp yarns at the right side of the comb are pushed toward the left for a distance of about 25 dents by the slasher attendant as the comb is turned into the warp yarns. Thus, ample hand room is provided for the slasher attendant to work between that part of the sheet of warp yarns to be counted and that portion of the sheet already placed in the dents. The first 5 dents are not used, but 4 selvage ends are placed in each of the 6th, 7th, 8th, and 9th dents of the comb. In reality, only the first four dents of the slasher draft have thus far been counted-in. The 5th dent of the slasher draft contains 6 white yarns, so these yarns are placed in the 10th dent of the comb next to the selvage yarns. The tan and dark-blue ends of the 6th dent in the slasher draft are placed in the 11th dent of the comb, but the 12th comb dent has only the 2 white and the 2 dark-blue ends that are listed for the 7th dent of the slasher draft. These ends compose the last of those in the balancing pattern. Two additional ends are not taken from the main warp pattern because the removal of these ends would prevent the same colored ends from appearing in the corresponding dent in a repeat of the pattern.

The 13th dent of the comb contains those ends of color listed as the first dent in the repeat pattern. The colored warp ends in the other dents of the pattern are likewise placed in the comb dents, as indicated in the slasher draft. However, 8 warp ends are listed in the slasher draft for the 13th dent. By maintaining the same number of ends per dent as listed in the slasher draft, it is possible to count-in the pattern with little difficulty. After a repeat is counted-in, the number of dents required for the pattern should be counted. Thus, it is possible to discover a mistake, if one has been made, before the entire warp of the fabric is counted-in. The pattern of 13 dents is repeated 32 times and then the other half of the balancing pattern is counted-in as listed in the slasher draft.

With the warp placed in the comb dents correctly, it is necessary only to turn on the steam to heat the drying cylinders of the slasher and fill the size box before operating the slasher. It is good practice not to size the warp colored yarns before counting-in because the yarns sometimes tend to stick together if sized.

**46. Leasing.**—Leases are taken as a loom beam nears completion so as to create a thorough separation of warp ends of varying color. By separating the warp ends at this point, it is much easier for the drawing-in girl to find the desired colored warp end during the drawing-in process at the loom.

A cap is usually placed over the slasher comb as the loom beam nears completion so as to prevent the warp ends from being pulled out of the right dent during leasing. The slasher is shifted to slow speed. A rod about $\frac{1}{2}$ inch in diameter is passed through the shed formed by the split rod $m_2$, Fig. 8. By moving this rod forward to the comb *n*, a similar shed is formed on the other side of the comb. A flat leasing stick about 1 inch wide, $\frac{1}{8}$ inch thick, and extending about 15 inches beyond the width of the warp, is inserted in the newly formed shed on the loom-beam side of the comb. As this stick is withdrawn, a lease string that had been attached to the end of the leasing stick is left in the warp. The round rod that created the shed is likewise removed and next inserted in the shed formed by the split rod $m_3$. Another shed is formed at the comb and a lease string likewise inserted. Again, the same procedure is followed at the split rod $m_4$. The three lease strings just inserted now divide the dark-blue, the tan, the white, and the light-blue yarn from one another.

The slasher is stopped as the lease strings approach the loom beam, that is, after passing around the drag roll. The first lease string inserted, and that which separates the dark-blue from the tan yarns is raised, and a stick about 2 inches wide and $\frac{3}{16}$ inch thick is inserted. The stick is turned, thus forming a shed between the dark-blue and the tan yarns, and a capped comb is inserted in the resulting shed. A capped comb is a comb base carrying teeth a few inches high, over which a cap, similar to the base, is slipped to hold the yarns in the comb in their respective dents. The cap of the comb is removed, but left in the shed, and the comb is turned upward to penetrate the sheet of dark-blue yarns. Another comb cap is fitted over the comb teeth and tied securely to the comb. The dark-blue warp ends are now held in the comb in correct order. The comb and lease string are moved as close as possible to the loom beam to provide room for inserting the other combs. The stick is removed and inserted in the shed formed by lifting the second lease string, which divides the tan yarns from the white yarns. Two combs are inserted in the shed thus formed. One of the combs is turned upward to penetrate the tan warp ends. The cap that was left in the shed above is fitted over the comb that passes through the tan ends and is bound securely to the comb. The comb and lease string are likewise moved close to the loom beam. The remaining comb is turned downward to pass through the white warp after a shed has been formed by inserting the stick where the third lease string divides the white from the light-blue yarn. The cap from the comb inserted in this lower shed is placed over the comb that contains the white yarns. The remaining comb is passed through the light-blue yarns and likewise capped. All of the combs are tied together and the warp yarns wound once around the loom beam before the yarn is severed. In this manner, a thorough separation of warp ends is maintained on the loom beam.

There are a great many different ways and methods of handling and slashing colored warp yarns. Ordinarily, the method just described will enable an attendant to slash most colored warps with a minimum loss of time because the leases can usually be taken in less than 2 minutes. However, combs are not always inserted in the warp at leasing. A practice sometimes followed consists of using gum tape in place of combs. The lease strings are inserted in the warp in the same manner, but, when the lease strings reach a point between the guide roll and the loom beam, they are moved toward the loom beam as far as possible so as to make a division or separation of the colored warp ends. Gum tape is applied to each sheet of colored warp ends to hold the ends in place. This method, in the estimation of some mill men, creates a considerable amount of yarn waste in other processes of handling the loom beam.

**47.** Colored warps are often slashed on slashers that have movable creels. In such instances, one creel is recreeled with section beams while the slasher is slashing yarns drawn from the second creel. Those yarns contained in the creel of the slasher that is not in use are leased and counted-in while in the creel; that is, a movable drawing-in stand is moved to the front of the creel and the yarns are counted-in and leases taken. Thus, considerable time is saved by making these operations unnecessary as a new set of section beams is required by the slasher. Then, when first starting a slasher, it is necessary only to tie the warp to a tape threaded through the slasher and draw the new warp through, insert the lease rods at the head end of the slasher to replace the lease strings, and place the ends in the comb of the slasher.

### DRAWING-IN AND REEDING

**48. Operation.**—The warp yarn, as it is slashed at the slasher, is wound firmly on a loom beam. However, before the warp is placed in the loom, it is customary to pass the warp through a preliminary operation known as drawing-in and reeding. This operation consists of drawing the individual ends of warp yarn through various groups of heddles held in the harnesses of the loom. Each heddle has a small eye, or hole, through which the warp end is drawn. Then, when these harnesses, which vary from 2 to 36 in number, are placed in a loom and are raised or lowered, a shed is formed, thus permitting the weaving of cloth. It has been found that the manual process of drawing-in the warp, as it is often called, is best accomplished outside of the loom, although on occasions it may be performed in the loom. Usually, the drawing-in operation may be classed as an operation preliminary to weaving and supplementary to slashing.

**49. Harnesses.**—The harnesses used in a loom may be divided into two classes, depending on the type of heddles they contain, namely, those having heddles made of wire, or steel and those having heddles made of cotton or twine.

Harnesses usually consist of a wooden framework similar to that illustration in Fig. 9, view (*a*), while the heddles that are held or supported in a harness appear like the steel one shown in enlarged size in view (*b*). Two steel heddle bars $a_1$ pass through hooks at the top and bottom of the framework for support. Stretcher hooks and nuts are used at one end for fastening the heddle bars in place, and, as they may be removed easily, they allow additional heddles to be added to or removed from the harnesses as required.

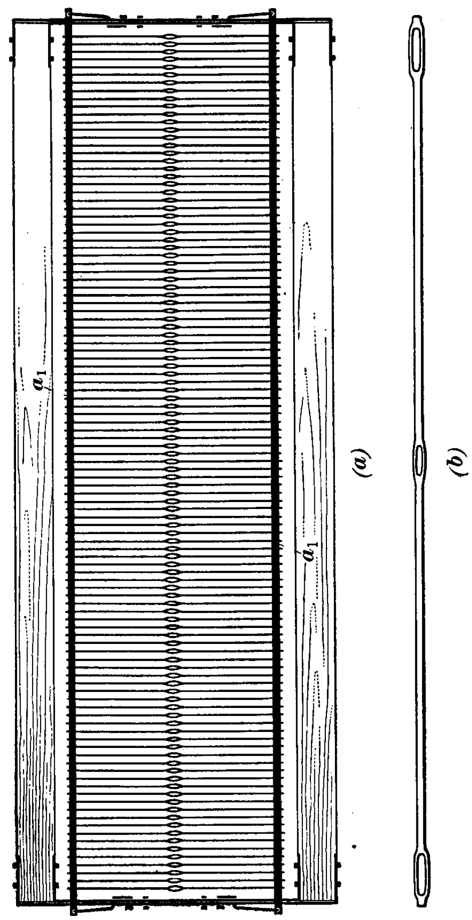



Fig. 9

The heddle illustrated in view (*b*) is formed from a flat piece of steel. The heddle eye, which is at the center of the heddle, is about $\frac{1}{4}$ inch long, its length usually depending on the counts of yarn and the type and construction of the fabric being woven. The holes at the top and bottom of the heddle are so placed as to allow the heddle to slide freely on the heddle bars. Heddles made by twisting wire into the desired shape are occasionally used, but this form of heddle has prac-

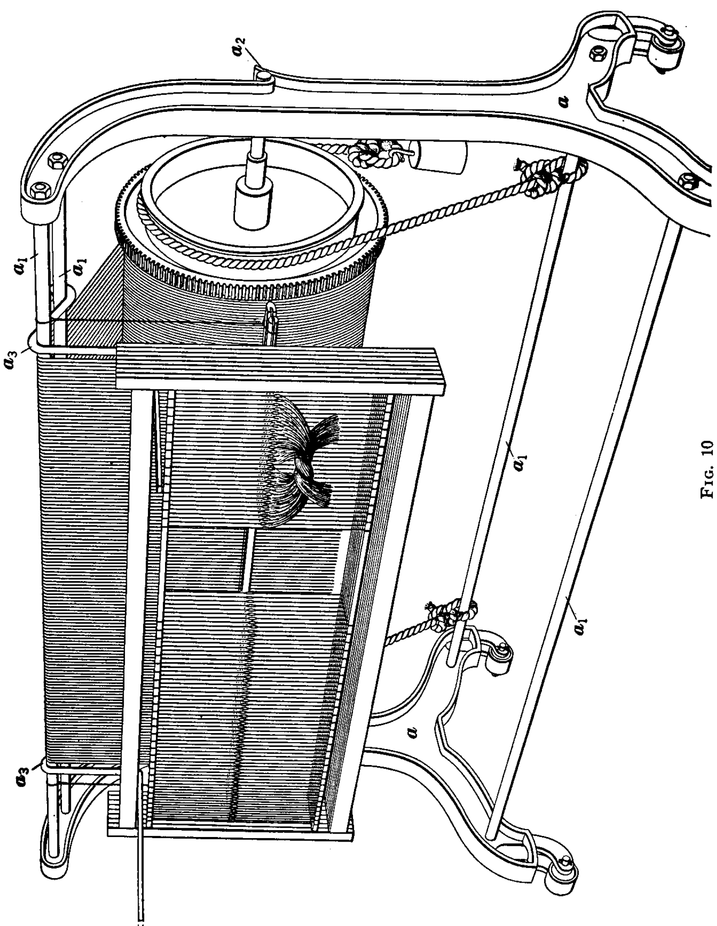



FIG. 10

tically been replaced by the flat steel heddle, which is generally considered to be superior.

The cotton, or twine, heddles, which were used largely in the production of plain cotton cloths, were formed by knitting threads together in such a manner as to form three loops, one at each end of the heddle and the other in the center to form the eye. As heddles must withstand a great amount of friction, those made of twine were sized and varnished to produce a smooth, hard, but pliable surface. However, unless care is taken in varnishing the twine, the eyes may become swollen and even closed. Also, trouble is encountered because the heddles are either too stiff or too sticky and cause excessive wear. As these heddles are mounted in the harnesses on wooden rods, they cannot be added or discarded at will, as in the case of wire or steel heddles. Thus, because of these disadvantages, heddles of this type have gradually been replaced by steel heddles.

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | 8 | | | | 8 | 8th Harness |
| | | | | | | | | | | 7 | | | | 7 | | 7th Harness |
| | | | | | | | | | 6 | | | | 6 | | | 6th Harness |
| | | | | | | | | 5 | | | | 5 | | | | 5th Harness |
| | | | 4 | | | | 4 | | | | | | | | | 4th Harness |
| | | 3 | | | | 3 | | | | | | | | | | 3rd Harness |
| | 2 | | | | 2 | | | | | | | | | | | 2nd Harness |
| 1 | | | | 1 | | | | | | | | | | | | 1st Harness |

Fig. 11

**50. Drawing-In.**—The operation of drawing-in may best be accomplished in what is known as a drawing-in frame. Such a frame is illustrated in Fig. 10 with a loom beam in position and part of a warp drawn through the harnesses. The frame consists of two castings *a* mounted on casters and supported or held in place by means of the connecting rods $a_1$. The loom beam is supported in the rests $a_2$, and a rope is tied around one of the connecting rods and thrown over the loom-beam head. A weight is attached to the other end of the rope to prevent the beam from rotating. A supporting bracket $a_3$ is passed over the upper top connecting rods in such a manner that the bracket projects in front of the frame and acts as a support for the harnesses.

The warp ends are drawn through the harnesses in a definite order of arrangement. The arrangement varies as to the kind of weave used and is represented by the harness draft, one of which is illustrated in Fig. 11. The design, in this instance, repeats on 16 ends and requires 8 harnesses. Each horizontal row of the draft represents one harness, while each vertical row represents one end of warp. The operator starts at the right side of the warp and, consequently, the right side of the harness draft. Following the draft in Fig. 11, the operator passes the drawing-in hook through the first heddle eye of the eighth harness and draws the first end of warp through. The drawing-in hook is made of a thin metal blade attached to a handle and having a slot at the end of the hook to catch the thread and draw it through the heddle eye as the hook is withdrawn through the eye.

The hook is passed through the heddle eye of the seventh harness and the next warp end is drawn through. The warp ends are drawn in consecutive order so as to avoid crossed ends. The comb inserted in the warp before doffing the loom beam, or the thread lease, if taken, helps to keep the warp ends in order during drawing-in. The warp ends, in consecutive order, are drawn through the heddle eyes of the sixth, fifth, and eighth harnesses. The seventh, sixth, fifth, and fourth harnesses likewise have ends drawn through them. The third, second, first, and then the fourth, third, second, and first harnesses are drawn next in order. A complete repeat of the pattern has now been made. This order of drawing-in is repeated until all of the warp ends have been drawn-in. After a large group of ends have been drawn through the harnesses, they are divided into two bunches and tied in front of the heddles in a half-knot, as shown in Fig. 10, to prevent them from being pulled out accidentally.

**51. Reeding.**—The warp ends are next drawn through the reed. The operation of reeding may be accomplished with the warp either in the loom or out of it. Usually, it can be performed more easily in the drawing-in frame. A reed consists of a rectangular frame with a large number of metal splits, or strips, of flat steel held vertically and at a specified distance apart in the frame. The number of spaces per inch created by the splits is known as the dents per inch, and is governed by the type and the construction of the fabric being woven. For example, a warp may be reeded 2 ends to the dent, when 2 ends of warp would be drawn through each dent or space between splits, or 4 ends to the dent, when 4 ends would be drawn through each dent in consecutive order.

A reed hook, that is, a hook similar to that used for drawing-in but heavier in construction, is passed through the first dent, and the required number of warp ends, as desired in a dent, are passed over the hook and pulled through the reed. This process is continued until all the warp ends have been reeded. The ends are likewise knotted before the reed to prevent them from pulling out. Then, the warp is ready to be placed in the loom.

**52. Twisting-In.**—Frequently, the new warp placed in the loom is of the same pattern, the same yarn counts, and the same number of ends as the previous warp in the loom, especially in mills weaving cloths of standard construction. In such cases, much time and labor may be saved by twisting-in the warp, that is, by twisting the ends of the old and the new warp together.

When the warps are to be twisted-in, the new loom beam is placed in an improvised or a portable stand back of the loom and parallel to it. One end from the warp in the loom and one end corresponding to it in the new warp are laid together in the right hand, and, with the left hand, the two ends are first twisted to remove the twist in the yarn, and then are bent back and twisted together. Each end in the old and the corresponding end in the new warp are twisted together in like manner. The operatives generally apply a mixture of whiting and oil to their fingers to prevent the threads from cutting them and to make a firmer binding between the two ends. While twisting-in does not provide a method of joining the ends securely enough to permit operation of the loom, the binding is sufficient, however, to permit the new warp to be drawn carefully through the harnesses and the reed by hand.

## SLASHER CALCULATIONS

### SLASHER CONTROL

**53. Importance of Slasher Calculations.**—Slashing is an important operation, one that governs, to a marked degree, the ease and success with which a cloth is woven in a weave room. Several hours' operation of a slasher will, in most instances, provide enough loom beams to keep a number of looms operating for several weeks. Therefore, the slasher room should receive great consideration. The finished product, that is, the woven cloth, can be of no higher quality than the quality of the slashed warp yarns going into it. But, even with control instruments on slashers for the purpose of increasing the uniformity with which each lot of warp yarn is slashed, the benefits accrued through the use of these instruments will not be fully realized unless a close check over them is maintained.

Calculations offer a method of obtaining a quick and fairly accurate check on a slasher as to both its performance as a whole and the work of the individual slasher units. Most calculations, when used to check slasher operation, will tend to check the operation of the unit at maximum efficiency and will generally apply whether it is a two-cylinder cotton slasher or a cotton slasher that has been rebuilt for slashing rayon. Calculations can be derived to apply to slashers whether they are single 7-foot cylinder models or the two-cylinder type. The basic principles used in the calculations will remain the same, although the constants and some factors used may vary for different slashers.

**54. Production.**—One of the simplest calculations, and perhaps the most useful one in connection with slasher operation is that concerning production. In all production calculations, the allowances for stops due to creeling, doffing, twisting-in, or, in fact, for any purpose, must be considered if accurate results are to be obtained. These allowances are usually included in one broad term, namely, slasher efficiency. Usually, the efficiency of a slasher will depend on the type and

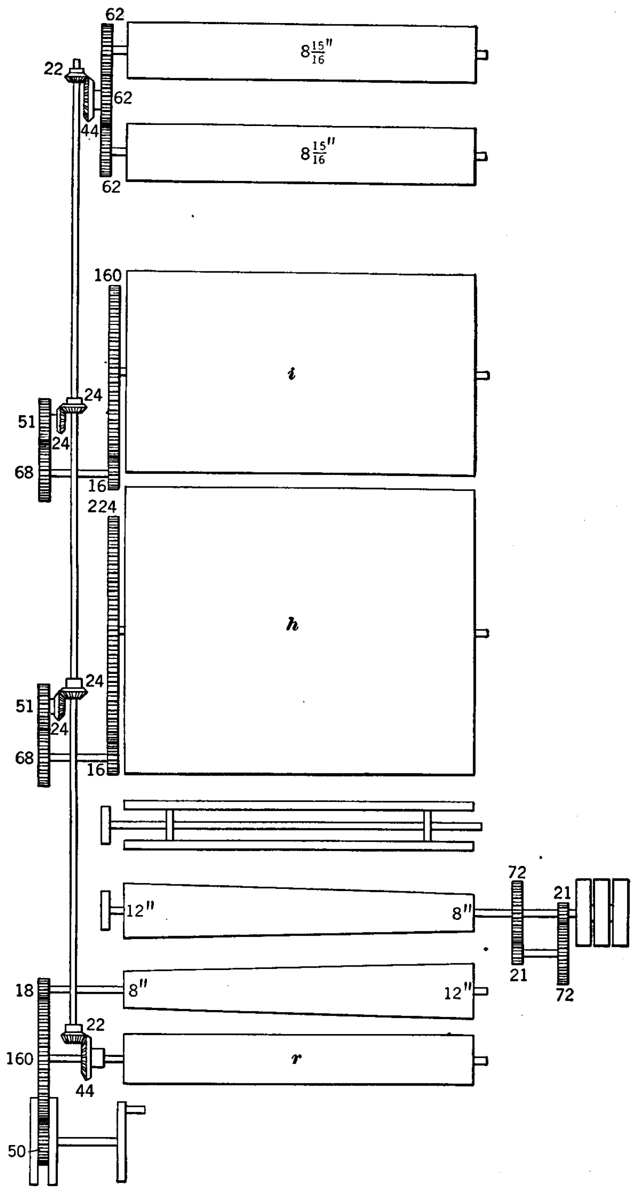

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FIG. 12

the class of the yarn being slashed and on the skill of the operative. A slasher will generally be stopped about 35 per cent of the time, or have an efficiency of 65 per cent if a warp of ordinary composition is being slashed, but a good slasher attendant should be able to reduce the unproductive time to about 25 per cent. The figure given for average slasher efficiency will, however, vary according to the type of yarn being slashed, whether the yarn is weak or is twisted highly, the number of ends in the warp, the number of times the slasher must be slowed while broken ends are being tied-in, and the like.

Production calculations are usually based on the speed of the drag roll because all yarn slashed must pass around this roll. Actually, this roll not only feeds the yarn to the loom beam but tends to drag the yarn through the slasher in conjunction with the size rolls. Thus, under all circumstances, the gearing between the drag roll and the size rolls should always be arranged so that the drag roll takes up the same amount of yarn that the size rolls pass forward. The purpose of gearing in this way is to eliminate practically all strain and tension on the warp yarns and to avoid unnecessary yarn stretch. Some manufacturers use a drag roll of smaller diameter than the size roll, but the two rolls are geared as though both were of the same diameter. Cloth is wound around the drag roll to form an absorptive blanket and build the roll to the same diameter as the size roll, as well as to provide a means of regulating the yarn tension. When a slasher is geared in this manner, the drag roll must be built up with cloth until it is of a diameter of approximately 10 inches. The amount of cloth added to an iron drag roll $8\frac{15}{16}$ inches in diameter generally provides enough tension to keep the yarn passing through the slasher taut. All calculations involving the drag-roll diameter will, therefore, be treated as though the roll were of a 10-inch diameter.

A gearing diagram of a typical two-cylinder slasher is illustrated in Fig. 12. The slasher is driven through a pair of cones with driving diameters varying from 8 to 12 inches and they, in turn, drive the drag roll *r*. A side shaft, driven by the drag roll, in turn drives the large drying cylinder *h* and the small drying cylinder *i*. Also, the two $8\frac{15}{16}$-inch size rolls are driven from the side shaft. If a stretch control is added to a slasher, this unit is driven by the size rolls. However, when a stretch-control unit is used, the drag roll of this unit is often taken as a basis of slasher calculations instead of the drag roll of the headstock on the ordinary slasher.

**Rule.**—*To find the slasher production in pounds per hour; multiply the circumference of the drag roll by the revolutions per minute of the drag roll, the result by the number of ends in the warp, and that result by 60. Divide the product obtained by the product of the yarn counts multiplied by 840, and by 36.*

EXAMPLE 1.—(*a*) If the 10-inch drag roll on a slasher makes 40 revolutions per minute and the creel holds 10 beams, each containing 420 ends of 30's yarn, what will be the production for one hour, the slasher operating at 70 per cent efficiency?

(*b*) What will it be if the size and moisture added during slashing is 10 per cent?

SOLUTION.—(*a*) By applying the preceding rule, the production will be

$$\frac{10\times 3.1416\times 40\times 10\times 420\times 60\times .70}{36\times 840\times 30}=244.35 \text{ lb. per hr. Ans.}$$

(*b*) With 10 per cent size and moisture added, the production will be $244.35\times 1.10=268.79$ lb. per hr. Ans.

**55. Production Constant.**—Many times it is desirable to find the slasher production without long and involved calculations. In some cases, production formulas may be reduced or simplified to such an extent that the calculations may be done mentally by the operator. A production constant is obtained by substituting in the production formula values that do not change or vary when different counts of yarn are slashed. The other factors, which vary under different conditions, are considered as 1, that is, the drag roll is considered as making one revolution per minute and the warp consists of one end of number one counts yarn. In solving such a problem, a value is obtained which is called the production constant. By considering all variables in the production formula as having a value of 1, any value, depending on the problem given, may be substituted in place of 1 and, in conjunction with the production constant, the production formula may be solved.

**Rule.**—*To find the production constant, consider the revolutions of the drag roll, the number of ends in the warp, and the yarn count, each as having the value of 1, and substitute these as in the production formula and solve.*

EXAMPLE 1.—Find the production content for the slasher shown in Fig. 12, using the data given in Example 1 (*a*), Art. 54.

SOLUTION.—According to the preceding rule, the production constant is

$$\frac{10 \times 3.1416 \times 1 \times 1 \times 60 \times .70}{36 \times 840 \times 1} = .04363. \text{ Ans.}$$

EXAMPLE 2.—Using the production constant found in Example 1, find the production of the slasher, using the data given in Example 1 (*a*), Art. 54.

SOLUTION.—According to the rule in Art. 54, the production

$$= \frac{.04363 \times \text{r.p.m. of drag roll} \times \text{ends}}{\text{counts}} = \frac{.04363 \times 40 \times 10 \times 420}{30} = 244.33 \text{ lb. per hr. Ans.}$$

**56.** A slasher operative often has no way of determining the drag-roll speed, or he may find it inconvenient to obtain this information. The drag-roll speed, or the speed of some other part of a slasher whose linear velocity is equivalent to that of the warp being slashed, must be known in production calculations. With these data known, a method of finding the production without knowing the actual drag-roll speed may be evolved. One method of making these calculations is to use as a known value the speed of the driving pulley. Knowing the driving-pulley speed, the drag-roll speed is determined by figuring through the gear train; then the rest of the calculations for finding slasher production are the same as illustrated previously. A slasher gear train usually contains two cones, one a driven and the other a driver cone with a cone belt connecting them. The cones introduce a variable element as different speeds will be produced with the cone belt in different positions. Thus, several calculations are necessary to obtain a production constant.

The procedure usually followed in such instances is first to calculate the production constant with the cone belt on the small end of the driving cone. The same calculation is again repeated, but the belt is considered as being on the large end of the driving cone. These calculations give the production constant for the two extreme ranges of position of the cone belt. But, as the slasher is very seldom run under either of these conditions, a more practical form of constant must be found. By determining the difference between the two constants, the range over which the constant varies, due to the travel of the cone belt laterally, is obtained. Dividing this result by the length of the cones gives a factor or a constant for each inch of cone length. Therefore, if the belt is located 4 inches from the small end of the driving cone, the factor just found multiplied by 4, and this product added to the constant found for the small end of the cone gives the production constant for the slasher with the cone belt in that position. In case the cone belt is 4 inches from the large end of the driving cone, the product found should be subtracted from the constant obtained when the cone belt is at the large end of the cone. The correction, or variation in production, constant may be broken up into smaller units than the inch by considering that the cone belt is usually moved by means of a handwheel, and a given number of turns of the handwheel are required to move the belt a distance of 1 inch laterally.

EXAMPLE 1.—(*a*) Find the production constant for the slasher shown in Fig. 12 when the cone driving belt is on the small end of the driving cone. (*b*) Find the production constant when the cone driving belt is on the large end of the driving cone. (*c*) Determine the variation in production constant for each turn of the handwheel that moves the cone belt if 4 turns of the handwheel are required to move the cone belt 1 inch and the driving cone is 44 inches long.

*Note.*—It is common practice to substitute the letter $E$ for slasher efficiency in many problems involving production-constant calculations so that the production constant may apply to a slasher regardless of the efficiency at which it is operating. In the final solution of such a problem, the efficiency of the slasher is substituted for the letter $E$ in the production constant.

Solution.—(*a*) According to the rule in Art. 55, the production constant with the cone belt on the small end of the driving cone is $\frac{1\times 8\times 18\times 10\times 3.1416\times 60\times 1\times E}{12\times 160\times 36\times 840\times 1}=.004675E$. Ans.

(*b*) The production constant with the cone belt on the large end of the driving cone is found according to the rule in Art. 55. $\frac{1\times 12\times 18\times 10\times 3.1416\times 60\times 1\times E}{8\times 160\times 36\times 840\times 1}=.010519E$. Ans.

(*c*) The variation in production constant for each turn of the handwheel is found by obtaining the difference, in production constants, between the large and small ends of the driving cone and dividing this difference by the number of turns required to move the cone belt the length of the driving cone. $.010519E-.004675E=.005844E$ variation in production constants. $\frac{.005844E}{44\times 4}=.0000332E$ variation in production constant for one turn of handwheel. Ans.

Example 2.—Using the constants found in Example 1, what will be the production of a slasher having 10 beams of 420 ends, each of 30's counts in the creel? The driving pulley makes 350 revolutions per minute and the cone belt is 90 turns of the handwheel from the small end of the driving cone. The machine operates at 70 per cent efficiency.

Solution.—By using the production constants found in example 1, the slasher production constant is found by multiplying the number of turns of the handwheel by the variation in the production constant for one turn of the handwheel and adding the product to the production constant with the cone driving belt on the small end of the driving cone. $.004675E+(90\times .0000332E)=.007663E$ production constant. Then, by applying the rule in Art. 55 and substituting the 70% efficiency in place of the $E$, $\frac{.007663\times .70\times 350\times 10\times 420}{30}=262.84$ lb. per hr. Ans.

**57. Yarn Speed Without Automatic Controls.**—The speed of yarn passing through all slashers, and this includes those equipped with automatic-control instruments as well as those not so equipped, must be well controlled and regulated. Then, too great a yarn speed will not allow the sized yarns to remain in contact with the drying cylinders over as long a period of time as is required to dry the yarns thoroughly. If the yarn speed is too slow, on the other hand, scorched or burnt yarns will result. The yarn counts being run and the number of ends in the warp being processed have a very important bearing on yarn speed. As the yarn counts increase up to a certain point, the yarn speed increases, but as the number of ends in the warp increases, the yarn speed will decrease. Also, the amount of moisture to be left in the sized yarns is influenced by the yarn speed.

Several constants have been derived for use in determining the correct yarn speed in slashers not equipped with automatic controls. The constants take into consideration many of the factors involved in calculating yarn speeds. Thus, the constants apply to the average range of counts provided the yarns are being slashed under normal operating conditions and are to be moderately sized. Yarns used in the construction of the general range of standard cloth goods would be included in this classification, such as those used for sheetings, print cloths, percales, and the like. In each case, however, the speeds found are such as to leave approximately 6 per cent of moisture in the yarns sized.

The yarn speed of a two-cylinder slasher without automatic control and slashing yarns to be used in a low-count, medium-sley goods and to leave about 8 per cent of size on the yarn and about 6 per cent of moisture, may be found by the following rule:

**Rule I.**—*Multiply the constant 3,536 by the yarn counts and divide the resulting product by the number of ends in the warp.*

EXAMPLE 1.—Find the yarn speed of a slasher running 2,800 ends of 20's warp, 8 per cent size being left to the yarn.

SOLUTION.—By applying the preceding rule, the speed of the slasher will be $\frac{3{,}536\times 20}{2{,}800}=25.26$ yd. per min. Ans.

If carrying rolls are used on the slasher, that is, if several extra rolls are placed around the cylinder in such a manner as to increase the area of contact that the yarn makes with the drying cylinder, the constant will be changed to 4,530.

The speed of yarn passing through a slasher, especially yarn suitable for the medium and better grades of sheeting, and all other yarns intended for a medium-count cloth of about 80 to

124 picks per inch and with about 12 per cent of size being deposited on the yarn, may be found by applying the following rule:

**Rule II.**—*Multiply the constant 3,360 by the yarn counts and divide the resulting product by the number of ends in the warp.*

EXAMPLE 2.—At what speed should a slasher be operated, having 4,350 ends of 40's yarn, so that the warp may be used in a fabric of medium construction?

SOLUTION.—By applying Rule II, the slasher should be operated at

$$\frac{3{,}360 \times 40}{4{,}350} = 30.89 \text{ yd. per min. Ans.}$$

When carrying rolls are used, the constant will be changed to 3,718.

The yarn speed of a slasher that is slashing yarns of high counts and requiring about 18 per cent of size to be deposited on the yarn may be found by the following rule:

**Rule III.**—*Multiply the constants 3,300 by the yarn counts and divide the resulting product by the number of ends in the warp.*

EXAMPLE 3.—Find the yarn speed of a slasher that is slashing 60's yarn and depositing about 18 per cent of size on the yarn, the warp containing 6,200 ends.

SOLUTION.—The speed of the slasher is obtained by applying rule III.

$$\frac{3{,}300 \times 60}{6{,}200} = 31.94 \text{ yd. per min. Ans.}$$

If carrier rolls are used, the constant should be changed to 4,145.

In each of these three rules, it should be noted that all the constants given apply to finding the yarn speed when certain stipulated conditions are maintained. Such factors as a change in the dryness of the yarn, that is, the amount of moisture remaining in the yarn, will change the value of the constants. Also, a change in many other factors may change the value of the constants. In each case, the correct change to be made in the constant depends on the actual mill conditions and practices. Therefore, in many instances, it may be necessary to derive constants to meet the conditions of slashing in an individual mill.

**58. Yarn Speed With Automatic Controls.**—Automatic controls, when applied to slashers, eliminate a large number of variable conditions which are ordinarily met in slashing, such as, variation in size level, size-box temperature, and cylinder temperatures. However, automatic controls do not attempt to regulate yarn speed on most slashers. Therefore, one variable factor that must be regulated manually is that of yarn speed, because, after the slasher has once been started, the size-box temperature and the cylinder temperatures will be maintained constant, regardless of slasher speed. Yarn-speed calculations on a slasher equipped with automatic controls are of a complex nature because they are dependent on size-box and drying-cylinder temperatures and on drying-surface areas. Also, variable factors, such as the yarn counts being slashed, the amount of size to be added to the yarn, the amount of moisture to be left in the warp yarns, and the like, must be considered in yarn-speed calculations. However, the conditions existing in individual mills are different, and consequently the yarn-speed calculations in these mills will not be alike, nor will the results be the same. Thus, it is difficult to state calculations and constants to be used in yarn-speed calculations that can be used in all mills.

An attempt is made in Table III to show the variations in yarn speed when different yarn counts are slashed and the suitable range of drying-cylinder temperatures that should be used in each instance. The slasher, to which these yarn-speed calculations refer is a $7' \times 5'$ two-cylinder cotton slasher that is equipped with automatic size-level control, size-box temperature control, and drying-cylinder temperature controls. The calculations are based on the assumption that 6 per cent of moisture is to remain in the warp yarns. The calculations shown should be considered as approximate results only and should not be applied to other slashers because of the variable conditions existing in different mills. However, the values shown in

Table III indicate the general range of cylinder temperatures and yarn speeds desirable to be maintained in a two-cylinder slasher of the type described when slashing cotton yarns of the approximate weight given.

**TABLE III**

**YARN-SPEED AND CYLINDER-TEMPERATURE CALCULATIONS**

| Weight of Warp | Temperature | | Yarn Speed in Yards per Minute | | | |
|---|---|---|---|---|---|---|
| Ounces per Running Yard | Large Cylinder | Small Cylinder | 20's | 30's | 42's | 50's |
| 1.0 | 202.6 | 216.6 | 20.4 | 26.1 | 39.8 | 44.6 |
| 1.1 | 204.3 | 218.3 | 21.3 | 26.5 | 39.0 | 43.4 |
| 1.2 | 206.0 | 220.0 | 21.5 | 26.3 | 37.7 | 41.7 |
| 1.3 | 207.6 | 221.6 | 21.5 | 26.0 | 36.5 | 40.2 |
| 1.4 | 209.3 | 223.3 | 21.6 | 25.7 | 35.5 | 38.9 |
| 1.5 | 211.0 | 225.0 | 21.6 | 25.5 | 34.6 | 37.8 |
| 1.6 | 212.6 | 226.6 | 21.6 | 25.2 | 33.8 | 36.8 |
| 1.7 | 214.3 | 228.3 | 21.6 | 25.0 | 33.1 | 35.9 |
| 1.8 | 216.0 | 230.0 | 21.7 | 24.9 | 32.5 | 35.2 |
| 1.9 | 217.6 | 231.6 | 21.7 | 24.7 | 31.9 | 34.5 |
| 2.0 | 219.3 | 233.3 | 21.7 | 24.6 | 31.4 | 33.8 |
| 2.1 | 221.0 | 235.0 | 21.7 | 24.4 | 31.0 | 33.3 |
| 2.2 | 222.6 | 236.6 | 21.5 | 24.1 | 30.3 | 32.5 |
| 2.3 | 224.3 | 238.3 | 21.3 | 23.7 | 29.7 | 31.8 |
| 2.4 | 226.0 | 240.0 | 21.0 | 23.4 | 29.1 | 31.1 |
| 2.5 | 227.6 | 241.6 | 20.7 | 23.1 | 28.5 | 30.5 |
| 2.6 | 229.3 | 243.3 | 20.4 | 22.6 | 27.9 | 29.9 |
| 2.7 | 231.0 | 245.0 | 20.1 | 22.2 | 27.3 | 29.1 |
| 2.8 | 232.6 | 246.6 | 19.8 | 21.9 | 26.8 | 28.5 |
| 2.9 | 234.3 | 248.3 | 19.5 | 21.5 | 26.2 | 27.9 |
| 3.0 | 236.0 | 250.0 | 19.3 | 21.2 | 25.8 | 27.4 |
| 3.2 | 239.3 | 253.3 | 18.8 | 20.6 | 24.9 | 26.4 |
| 3.4 | 242.6 | 256.6 | 18.4 | 20.1 | 24.1 | 25.6 |
| 3.6 | 246.0 | 260.0 | 18.2 | 19.8 | 23.6 | 24.9 |
| 3.8 | 249.3 | 263.3 | 18.2 | 19.8 | 23.4 | 24.6 |

EXAMPLE.—Find the yarn speed in a slasher when 4,200 ends of 50's yarn comprise the warp.

SOLUTION.—The weight of the warps will be $\frac{4{,}200 \times 16}{840 \times 50} = 1.6$ oz. per running yard.

Follow the first column of Table III down until the weight 1.6 oz. is reached, and then run horizontally from 1.6 oz to the last column marked 50's, where the yarn speed in yd. per min. will be found to be 36.8. Ans.

**59. Control of Yarn Speed.**—The speed at which the warp yarn passes through slashers, and this includes both those slashers equipped with automatic controls and those without it, should, under most conditions, be maintained at about the speed previously determined, that is, provided the variable factors taken into consideration in the calculations are maintained constant in actual practice. Usually, it is difficult for an operative to determine yarn speed in a cone-driven slasher unless the slasher is equipped with some form of a speed indicator. Sometimes yarn speed may be determined in gear-driven slashers, when not so equipped with speed indicators, by making what is known as a production table. In a production table, the drag-roll speeds, and consequently the yarn speeds, are calculated for various change gears. A table is then made which shows the yarn speed and drag-roll speed obtained with each change gear.

A speed scale is sometimes traced on the girt, or framework, of cone-driven slashers underneath the slasher comb, and a pointer is attached to the shifting fork to indicate the speed. In other words, the yarn speed obtained when the cone belt is directly under any point along the girt of the slasher is indicated by a pointer on the shifting fork, which points to a number on the speed scale marked on the girt.

A similar method of obtaining the speed of the yarns passing through a slasher, regardless of the position of the driving belt on the cones, is accomplished by constructing what is known as a speed cone. A speed cone is a long board, the length of the cone, that is fastened to the framework of the slasher above the cone. The board is painted black and has a white line running horizontally its full width so as to divide it into two equal parts, and ten vertical white lines drawn to divide the board into eleven equal, vertical spaces. In the upper eleven divisions is placed the drag-roll speed that is obtained when the cone belt is under each division, and in the eleven lower divisions is placed the speed of the yarn calculated from the drag-roll speed. The speed values, in yards per minute, are calculated for each division, the cone belt being considered as in the center of each division. After the necessary calculations have been made, the results are tabulated in their proper divisions. Thus, to obtain the speed of the slasher, it is necessary for an operator only to glance at the position of the cone belt and read the yarn speed marked in the division above the belt.

**60. Cylinder Temperatures.**—The control over the correct cylinder temperature and the maintenance of it are of utmost importance in the operation of a slasher. Any variation in speed with which the yarn passes through a slasher varies the period of time the yarn remains in contact with the hot drying cylinders, and consequently changes the amount of moisture remaining in the yarn. As has been previously stated, the amount of moisture contained by a yarn determines, to a marked degree, the ease with which the warp will run during the weaving process. Ordinarily, it is desired to have the slashed yarns contain 6 to 7 per cent of moisture. Thus, careful control over drying must be maintained in regards to both cylinder temperatures and yarn speed if the desired moisture content is to be maintained in the slashed yarn.

Another point requiring careful consideration is the maintenance of a temperature differential between the two drying cylinders in accordance with the accepted practice. The usual practice is to establish a differential of about 14 degrees between the large and the small drying cylinder; that is, the small cylinder is held at a temperature 14 degrees in excess of that of the large cylinder. Therefore, by knowing the temperature of one cylinder, the temperature of the other cylinder may be readily found.

Calculations have been made, based on actual practice, for determining the cylinder temperatures under normal operating conditions. In most cases, however, these calculations have proved to be too complex and involved for practical purposes. The cylinder temperatures normally maintained, based on 6 per cent of moisture being left in the yarn, have been derived and are listed in Table III. The first column of the table contains the weight of the warp in ounces per running yard, and this value is usually given in most calculations. The second and third columns contain the cylinder temperatures for the large and small cylinders respectively. Knowing the weight of the warp being slashed, to find the cylinder temperature it is necessary only to follow across the line on which this value occurs. Even if the warp weight is not given, the correct temperatures may be determined by calculating the warp weight, provided the yarn counts and the number of warp ends are known. Then, by finding the corresponding value given in the first column of the table and following across the line, the temperatures may be easily found.

However, the values given in Table III are approximate values only. Other factors aside from yarn counts, the number of ends in the warp, the amount of moisture to remain in the yarn, the yarn speed, and the like tend to vary the values. For example, the size temperature, the amount of twist in the yarn, the depth of the immersion roll, the squeeze-roll pressures used, and the like all tend to change the cylinder temperatures. Therefore, the figures given in Table III should be used for comparative purposes and only as a general indication of the correct cylinder temperature because the temperature will usually vary in different mills, regardless of whether they are slashing the same counts and the same types of yarns or different counts and types.

**61. Size-Box Temperatures.**—Table IV has been prepared to show the approximate relationship that should exist between the yarn counts and the size-box temperature when slashing a medium range of yarn counts. In preparing such a table, variable factors must be considered. For example, fine yarns generally require a heavier coating, or greater percentage, of size to strengthen the yarns and protect them from the abrasive action of the heddles and the reeds in the weaving process. Also as the size temperature is increased, the degree of size penetrability into the yarn structure is increased. Advantage is taken of this fact in maintaining a much higher size temperature for fine yarns so as to allow the size to penetrate more fully into the fiber structure of the yarn and securely bind the fibers together.

However, as with all other tables concerning size-box temperature, cylinder temperatures, yarn speed, and the like, this table is for comparative purposes only. Therefore, it is advisable to derive a set of values for size-box temperatures in each mill based on the operating conditions found in that mill. Thus, the values given in Table IV may vary in different mills if ideal operating conditions are to be maintained because of the way the size formulas, yarn counts, yarn speeds, and the like vary in different mills.

TABLE IV

SIZE-BOX TEMEPRATURES OF VARIOUS YARN COUNTS

| Yarn Counts | Size-Box Temperature Degrees F. |
|---|---|
| 10 | 182.3 |
| 14 | 184.0 |
| 18 | 185.7 |
| 22 | 187.4 |
| 26 | 189.1 |
| 30 | 190.8 |
| 34 | 192.5 |
| 38 | 194.2 |
| 42 | 195.9 |
| 46 | 197.5 |
| 50 | 199.1 |
| 54 | 200.8 |
| 58 | 202.5 |
| 62 | 204.2 |

**62. Moisture Content.**—The moisture content of slashed yarns should be checked at definite intervals during slashing. Too great an amount of moisture often causes mildew to form on the yarns, while the removal of too much moisture will produce tendered, overdried, and baked yarns. Accurate moisture determination of warp yarns usually requires the use of a fully equipped laboratory and hours of tedious, painstaking work.

First, a sample of yarn is taken from the warp as it leaves the slasher and is weighed. Then it is placed in a drying oven. Periodic weighings are made until the sample ceases to lose weight, when the bone-dry weight, is obtained. From the initial weight to the bone-dry weight, the percentage of moisture in the yarn may be easily calculated.

As most mills are not equipped to make these intricate moisture determinations, a rule has been developed, based on laboratory tests, to enable an operative to make most moisture determinations quickly, easily, and fairly accurately.

**Rule.**—*To find the percentage of moisture in slashed yarns, add the weight of the yarn after slashing, the average drying temperature of the large cylinder, the average drying temperature of the small cylinder, the average size-box temperature, and the speed of the yarn in yards per minute. Divide the resulting sum by 100 to obtain the moisture content of the yarn in percentage.*

EXAMPLE.—Find the percentage of moisture remaining in the warp yarns slashed if the weight of the yarn after slashing is 141 pounds, the large cylinder is held at 224 degrees, the small cylinder at 238 degrees, the size-box temperature is held at 186 degrees, and the yarn speed is 29 yards per minute.

SOLUTION.—According to the preceding rule, $\frac{141+224+238+186+29}{100}$ $=8.2$ per cent of moisture. Ans.

Sudden atmospheric changes often vary the amount of moisture remaining in a yarn. Because of these sudden changes, the moisture content of a yarn slashed should be checked frequently. A method used by many slasher attendants to obtain a rough check on the moisture content is to touch the yarn often. This check is best accomplished by placing the back of the hand in contact with the yarn between the drag roll and the loom beam. The yarn will feel warm if too dry, and damp if too wet. Whenever the yarn produces a cool sensation, it indicates that the correct amount of moisture is being left in the warp. With a little practice, an operative should soon become expert in quickly checking the moisture content with an amazing degree of accuracy. However, it is not always advisable to determine the moisture content of warps by touching the yarn. If a slasher attendant's hand is slightly soiled, the warp also will be soiled where his hand comes in contact with it. Such conditions must be watched closely, especially when rayon yarns are slashed because such hand marks are apt to show on rayon cloth during dyeing, even though they were not noticed in the warp slashed.

**63. Amount of Size Deposited on Yarns.**—The amount of size and moisture absorbed by a yarn during the slashing process is spoken of as the amount of increase in weight. Actually, this increase in weight should be divided into two components, that is, into a solid content made up of size and into the moisture content consisting of water. Yarns, before they are slashed, contain varying amounts of moisture that is absorbed from the air. Slashing, besides adding the solid content to the yarns in the form of size, also adds moisture. Therefore, by subtracting the initial amount of moisture, or that before sizing, from the final amount, or that after sizing, as found in Art. 62, the increase in moisture content is determined. Knowing the increase in moisture and the increase in weight of the warp caused by sizing, the solid content, or the amount of size added, is found by subtracting the increase in moisture from the increase in weight of the warp. In making this determination in a laboratory, small lengths of yarn and delicate laboratory scales are used.

Constants have been derived to be used in connection with the following rule in obtaining the percentage of increase in the weight of yarns. The use of this rule gives a rough check on the size content and usually eliminates the necessity of costly laboratory equipment for making this determination. Because the conditions encountered in slashing warp yarns vary in different mills, even when slashing the same counts of yarns, it may be necessary to vary the constants that correspond to the percentage values used in determining the increase in weight of the yarns so as to correspond with the conditions existing in each mill.

**Rule I.**—*To find the increase constant, multiply the counts of the yarn by the area of contact of the drying cylinders, multiply the result by 840, and divide the product by the product of the number of ends in the warp, multiplied by the yarn speed in yards per minute.*

The area of contact, or the area of drying surface with which the yarn comes in contact as it passes around the cylinders in a two-cylinder slasher, is approximately 120 square feet. If the slasher is equipped with carrying rolls, this area of contact is increased to about 151 square feet. After obtaining the value of the constant as indicated in Rule I, the percentage corresponding to the constant found in Table V represents

TABLE V

PER CENT WEIGHT—INCREASE CONSTANTS

| Per Cent of Increase in Yarn Weight | Constant |
|---|---|
| 5 | 28.0 |
| 7½ | 28.5 |
| 10 | 29.0 |
| 12½ | 29.5 |
| 15 | 30.0 |
| 17½ | 30.5 |

the percentage of increase in weight of the yarn sized. Great care should be taken in using this table, as it applies only to those slashers not equipped with automatic control instruments.

**Rule II.**—*The percentage of size added is found by subtracting the percentage of moisture added to the yarn during slashing from the per cent of increase in yarn weight.*

Example.—Find the percentage of size added to 141 pounds of warp yarn if 2,400 ends of 20's yarns, having an initial moisture content of 6 per cent, are slashed in a non-automatic slasher. The yarn speed is maintained at 29 yards per minute, the large-cylinder temperature at 224 degrees, the small-cylinder temperature at 238 degrees, and the size-box temperature at 186 degrees.

SOLUTION.—Apply Rule I, Art. 62.

$$\frac{141+224+238+186+29}{100}=8.2 \text{ per cent of moisture.}$$

Apply Rule I, Art. 63. $\frac{20\times120\times840}{2{,}400\times29}=29$ constant

According to Table V, a 29 constant equals 10 per cent increase in yarn weight.

Apply Rule II, Art. 63. 8.2−6.0=2.2 per cent of moisture added by slashing. 10.0−2.2=7.8 per cent of size added. Ans.

**64. Horsepower Required.**—It often becomes necessary to know the approximate horsepower required to drive a slasher. Necessity of knowing power requirements sometimes arises in cases where slasher rooms are being planned or revamped. The power required to drive the slasher and that consumed by the shafting must be determined, in such cases, before the correct size motors may be specified or ordered.

The horsepower required to drive a two-cylinder slasher with a single size box, including shafting, may be found by the following rule.

**Rule.**—*Add the net weight of the yarn to be slashed to the weight of the empty section beams and multiply the resulting sum by .000063; then add 2.44 to the resulting product.*

EXAMPLE.—Find the horsepower required to drive a slasher, including shafting, if the set consists of 10 beams of 420 ends each of 30's yarns. The net weight of the yarn on each beam is 495 pounds and the total weight of the empty beams is 1,850 pounds.

SOLUTION.—The application of the foregoing rule results in the following calculations:

10×495=4,950 lb., net weight of yarn
4,950+1,850=6,800 lb.
6,800×.000063=.430290 or .43
.43+2.44=2.87 hp. Ans.

When a slasher is designed to slash cotton crêpe and requires the use of two size boxes, the constant .000063 is changed to .000025 and the other constant 2.44 is changed to 2.75. Otherwise, Rule I will be applied in the same way as illustrated in the example given.

ADJUSTMENTS

**65. Weighting of Section Beams.**—All slasher adjustments should be made with great care so as to eliminate excessive yarn stretch. Some stretch will, however, be encountered by the yarn between the section beams and the size box because the section beams weigh, when filled with yarn, about 600 pounds and depend solely on yarn pull for their rotation. The section-beam arbors are held in the creel in ball bearings or roller bearings to eliminate, as much as possible, all friction. It is possible, by using these antifriction bearings, to start a section beam rotating with only a few pounds of initial force. Because of the great weight of a section beam and the momentum created by its rotation, it will continue to rotate for a short period of time, and consequently will deliver variable lengths of yarn at the creel, after the slasher is stopped unless an external force or friction is applied to retard its rotation. The earlier slashers were sometimes equipped with what was known as a rise roll to absorb the excess yarn delivered and to prevent it from kinking and entangling. The device consists of a roll held in a rack and counterweighted so that it always tends to rise. The yarn passes over the top of the roll and, as long as it is under a slight tension, the roll is held down. Whenever the yarn becomes slack, due to its overrunning the section beams, the roll tends to rise and take up the slack in the yarn.

Most slashers employ a cone drive to provide a quick and easy means of altering slasher speeds. Such slashers make use of a heavy fan to act as a balance wheel, or flywheel, and store momentum. When the shipper handle of a slasher is moved to the off-position, the slasher continues to operate, processing several yards of cloth before it gradually stops. The momentum of the fan, which acts as a balance wheel, makes this action possible. If, however, a slasher is gear-driven, a flywheel is usually employed also. Thus, a slasher continues to operate over the period of time the section beams overrun and feed the excess yarn into the slasher until the slasher and section beams stop as a unit. In this manner, the necessity of a rise roll is eliminated. However, in slashing some types of yarns, the weight of the section beams and the yarn speeds may be such as to cause the yarns to overrun slightly, regardless of what precautions are taken. Under such conditions, a rope is often attached to the creel framework and passed around the head of the section beams. A small weight of several pounds attached to the free end of the rope is usually sufficient to prevent the yarn from overrunning. Another method frequently used to produce the same results is that of substituting a spring for the weight at one end of the rope and then attaching the spring to the floor. The force created by the tension of the spring takes the place of the small weight.

**66. Weighting Squeeze Rolls.**—The weighting of squeeze rolls on a slasher influences greatly the proper size penetration secured. Unless sufficient weight is applied to the squeeze rolls during sizing, the size will not be forced into the structure of the yarn so as to bind the individual fibers together and increase the strength of the yarn. Then, if the weight used on the squeeze rolls is too great, much size that should be left in the yarn structure will be forced from it. In eliminating difficulties caused by improper squeeze-roll weighting, it has been found advisable, a great many times, to use a light squeeze roll to which weights may be added or removed. In this way, the roll will not be too heavy for sizing light warps nor too light for sizing heavy warps.

Various methods of weighting squeeze rolls are often employed. Sometimes screw pressure is used, while in other instances lever weighting may be employed. In cases where no provision is made for obtaining pressure, a weight suspended from a leather strap that fits over the end of the squeeze-roll shaft on each side may be used. Another method that has proved satisfactory involves the use of a lever having attached to it a hardwood block that acts as a bearing surface on the squeeze-roll shaft. Notches in which to place a weight are made along the top side of the lever, and the resulting force on the squeeze roll produced by the weight, when placed in each notch, should be marked on the lever under the notch. When the slasher is not in operation, the weights should be removed.

The following rule may be used to find the proper weight to be placed on the yarn, or, in other words, the total weight of the squeeze roll for producing satisfactory results in slashing.

**Rule.**—*Multiply the square root of the weight of a 1-yard length of warp by 1,000.*

EXAMPLE.—Find the proper weight of the squeeze rolls for a set consisting of 4,720 ends of 38's yarn.

SOLUTION.—By applying the foregoing rule, the weight is found as follows:

$$\frac{4{,}720}{840 \times 38} = .1479 \text{ lb. per yd. of warp}$$

$$\sqrt{.1479} = .3845$$

$$.3845 \times 1{,}000 = 384.5 \text{ lb. Ans.}$$

Another factor to be considered in regard to weighting squeeze rolls is the matter of stretch occurring between the front and the rear set of size and squeeze rolls. The size rolls are positively driven and, if one roll is larger than the other, the yarn either will be stretched or will run slack. If the first roll, or the roll nearest the creel, is found to be smaller than the finisher roll, stretch will occur. In many cases, however, it is preferable to have a slight amount of stretch in place of slack. Under such conditions, yarn slack is often caused by using a finisher size roll of smaller diameter. Slack in a yarn sheet has a tendency to cause the yarn to roll and the ends to entangle with one another. As a result, the yarn often breaks at the split rods. In such a case, the first size roll and the finisher roll should be reversed so as to produce a slight yarn stretch instead of yarn slack.

**67. Drag-Roll Adjusting.**—The size of the drag roll used in a slasher, and as specified by different slasher builders, often varies as to roll diameter. Some builders recommend a drag roll of the same diameter as the size roll, and in such cases both rolls have the same speed. Other builders employ a drag roll of a smaller diameter than that of the size roll. Regardless of the roll sizes, both are usually geared to have the same number of revolutions per minute. If the size roll has the greater diameter, and consequently the greater circumference, it will deliver the greater amount of yarn. The variation in roll diameter is usually made intentionally to provide a means of adjusting the tension, or stretch, of the warp yarn. The drag roll, in such a case, is lapped with cloth to build, or increase, the roll diameter until it equals or slightly exceeds the diameter of the size roll. The drag roll will, therefore, absorb all of the yarn delivered by the size roll, and in addition provide enough tension on the yarn to cause the drying cylinders to rotate, provided they are not gear-driven. Yarn tension should, therefore, be regulated so as to keep the sheet of yarn between the drying cylinders and the drag roll just taut enough to cause the yarns not to sag more than about $\frac{1}{4}$ inch. If the yarn is too taut, excess yarn stretch will result. The tautness, or tension placed on the yarn, may thus be regulated by either adding or removing several layers of cloth from around the drag roll.

Tension is easily perceivable when warps of light sley and high counts are slashed, while it is usually rather difficult to determine when heavy-sley warps are slashed. One method of determining excess tension, when using geared cylinders, is to watch the sheet of yarn as it passes over the cylinders. If the yarn has a tendency to creep on the cylinder or tends to operate the cylinder-drive release motion, the tension is excessive. Another method is to watch the yarn as it passes the split rods. If the sheet of warp yarn starts to split at a distance of about 3 inches in front of the first split rod, the correct amount of tension is being applied. But, if the distance of splitting exceeds 3 inches, several layers of cloth should be removed from the drag roll to correct the defect of excess tension. This method of determining the tension, however, does not apply if the warp is split, or opened, between the size box and the drying cylinders by means of an opening rod.

**68. Cut Marker.**—It is often necessary to change the number of yards or the distance between which the cut marks are placed on a warp. The distance between marks, commonly called a cut, is varied for numerous reasons. For example, it may be desired to weave a longer length of cloth before severing the finished, or woven, piece of cloth from the warp.

Also, the cloth shrinkage may vary, making it necessary to have the woven piece longer so that the finished cloth will shrink to the desired length.

The cut markers used on some of the older slashers are so constructed and geared that considerable mathematical work is required to determine the correct size change gear necessary to produce a cut of the desired length. However, by using some gear in the gear train other than the gear on the end of the measuring roll as a change gear, cut-marker calculations are greatly simplified. In some instances, it is possible to gear a cut marker so that the number of teeth on the change gear will indicate and equal the number of yards of yarn in a cut. Thus, if a 60-tooth change gear is used, the cut would be 60 yards in length. A cut marker, geared in this way, and employed on many slashers, eliminates practically all cut-marker calculations. However, when a cut-marker is not so geared, the cut-marker constant is often utilized. The cut-marker constant is a number, usually derived by the slasher manufacturer, into which the cut length desired is divided so as to obtain the size change gear necessary on the marker. If, for example, the constant for a certain slasher is 1,800, and a 60-yard cut is desired, then $1{,}800 \div 60 = 30$-tooth change gear required.

A cut-marker constant may, in some instances, not be known. If, however, it is known that a certain size change gear will produce a cut of a known length, then the size change gear, or the length of cut desired in any specific instance, may be easily calculated. For example, if it is known that a 45-tooth change gear will produce a cut 40 yards in length, then the size change gear required to produce a cut of any length may be obtained by multiplying the known gear tooth by the known yardage, the product being the constant for that cut marker. Then, this constant may be used in the same way as explained for the known constant. However, if it is desired to find the yardage of yarn in a cut produced by a known change gear, the constant should be divided by the number of teeth on the change gear. Thus, if the constant is 1,800 and it is desired to find the yardage of yarn in a cut when a 32-tooth gear is used, then $1{,}800 \div 32 = 56.25$ yards of yarn to a cut.