COTTON SLASHING

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COTTON SLASHERS

GENERAL CONSTRUCTION

1. Objects of Slashing.—Slashing may be described as including the essential operations of assembling, in parallel order and in the form of a continuous sheet, a desired number of threads, or ends, of warp yarn of equal length to form the warp of a fabric, and of winding the warp thus made on a loom beam. Such a beam, or roll, having suitable heads, is designed to be supported in a loom in such a manner that the warp may be unwound from it during the process of weaving. Slashing also involves the application of a suitable sizing material, or size, to the warp yarn and the drying of the warp after it has been sized. The work is performed on a machine that is known as a slasher, and is in charge of a person who, in most cotton mills, is called an overseer of slashing, or a boss slasher. Operatives of slashers are commonly spoken of as slasher tenders.

The beams filled with warp yarn, as they are received in the slashing department, or slasher room, of the mill from the beam warpers, are usually considerably wider than loom beams. In addition, these beams, which are known as section beams, do not contain a sufficient number of ends to form a warp suitable for the weaving of fabrics of usual constructions. Consequently, it is necessary at the slasher to assemble the ends from a number of section beams into a single sheet of warp that is subsequently wound upon loom beams. The several section beams required to form a warp are supported in a portion of the slasher, known as the creel, in such a manner that they may rotate as the yarn is drawn from them to form the warp. In arranging a number of section beams for the purpose of forming warps for weaving, the total number of ends on the group of section beams mounted in the creel of the slasher should equal the required number of ends in the warps to be formed. Although section beams do not, individually, contain a sufficient number of ends to form a warp of usual requirements, they contain a sufficient length of yarn to enable a number of warps, wound upon several loom beams, to be formed from each set of section beams placed in the creel of the slasher.

Generally, warps contain a number of ends of yarn on each edge of the warp, which are employed as selvage ends in the weaving of a fabric. The object of the selvage ends is to produce firm and secure selvages on each edge of the woven cloth. When the selvage ends are single yarns and when they are of the same counts, or number, as the yarn in the body of the warp, they are usually wound on the section beams in the operation of beam warping. When, however, ply yarns are employed as selvage ends or when yarns of other counts or special characteristics are desired as selvage ends, they are usually drawn from spools that are placed in a special creel conveniently mounted on the slasher.

2. Objects of Sizing.—Single cotton-warp yarns that have merely been spun, spooled, and wound on section beams at the beam warper, are not in a suitable condition to withstand the strain, chafing, and abrasion of the weaving process. In the loom, the ends of the warp are drawn forward through the eyes of the heddles of harnesses that are rapidly moved up and down during weaving, tending alternately to tighten and then to slacken the ends of warp yarn, and, by the insertion of the filling yarn by the shuttle, to form the cloth. In addition, the shuttle chafes the warp yarns as it is thrown through the sheds, or openings made in the warp by the rising and falling of the harnesses. Moreover, the ends of the warp are drawn through the dents, or narrow apertures, of a metallic reed that is constantly moving back and forth at high speed during weaving and that forces the individual threads, or picks, of filling yarn through the warp to the fell, or forming edge, of the cloth being woven.

Although warp yarn contains more turns per inch of twist than filling yarn, it is usually spun from somewhat longer-stapled cotton, and is stronger than filling yarn, the operation of weaving is particularly severe on the warp yarn of a fabric, the harnesses, reed, and shuttle of the loom all tending to chafe, abrade, and break the ends of the warp. Single cotton-warp yarns, therefore, will be subjected to a maximum number of breaks in weaving and cannot be woven satisfactorily if they are not especially treated to withstand the severity of the weaving process. Hence, it is necessary and customary in the slashing of cotton warps to treat the warp yarn with a prepared solution of various suitable ingredients, known as size.

3. The objects to be attained in the pure, or light, sizing of warp yarns, that is, in the application of size only for the purpose of enabling a warp to be woven satisfactorily, may be said, specifically, to be twofold: (1) To cause the sizing solution to penetrate the structure of the yarn to an appreciable extent in order to increase the cohesion of the individual fibers of the yarn and thus increase its strength. (2) To coat and smooth the outer surface of the warp yarn and thus enable the warp to resist the chafing and abrasion that are inevitable during the weaving process. Both of these factors tend to strengthen the warp yarn sufficiently to enable it to pass through the weaving operation without breakage, or at least with a minimum number of breaks.

The sizing of warp yarn during the slashing process also tends, to a considerable extent, to lay fibers, the ends of which may be projecting from the surface of the yarn, close to the surface and parallel to the yarn, and to secure them in that position. This treatment not only increases the strength of the warp yarns, but makes them smoother and more capable of resisting the abrading and chafing tendencies of the loom. In addition, the amount of fly, or loose fibers broken and detached from the yarn, and the friction that is inherent in weaving will be greatly reduced if loose ends of fibers do not project from warp yarns.

A secondary object of sizing warps, although not often employed in America, involves the use of sizing materials for the purpose of adding weight to the warp yarns and, hence, to the fabrics woven from such warps. Weighting is accomplished by adding to the size mixture various heavy, inert materials as well as various materials of a hygroscopic nature, that is, substances that have an affinity for moisture and that, therefore, absorb large quantities of water from the size mixture and from the air. By the use of suitable sizing mixtures, it is possible to add as much as 250 per cent to the original weight of warp yarns. The practice of sizing warps with the definite purpose of adding weight to the warp and to the woven cloth is mainly confined to mills that produce cheap fabrics for export to foreign markets where there is a demand for low-priced goods. As the value of a fabric is influenced by its weight, the more weighting material a cloth contains, the lower the price for which it may be profitably sold. This, of course, is true because heavily sized and weighted fabrics of a given number of yards per pound contain a smaller amount of expensive cotton than do fabrics of similar weight that are not so heavily sized.

When weighting by the application of sizing materials is resorted to for the purpose of reducing the cost of a fabric, the practice is also frequently carried on as a finishing operation. In such cases, the cloth is weighted after it has been woven, and the interstices formed by the warp and filling yarns, as well as the yarns themselves, are filled with the weighting material.

4. Types of Slashers.—A typical cotton slasher for the sizing of warp yarn is illustrated in Fig. 1. The slasher consists essentially of four sections: A creel *A* to hold the section beams on which the warp yarn has been wound; a sizing arrangement *B*, which consists of devices designed to apply the size to the yarn; drying equipment *C*, usually consisting of steam-heated cylinders, to dry the yarn; and a headstock *D* to collect the warp ends and wind them upon the loom beam in sheet form and in correct parallel order.

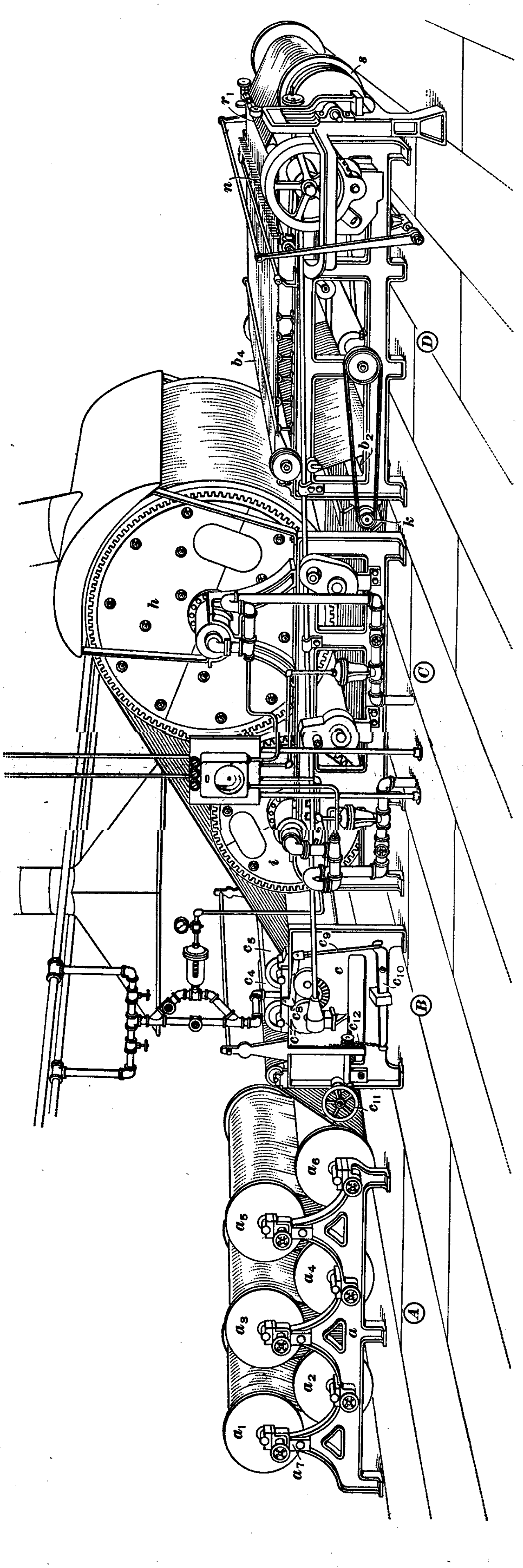

Fig. 1

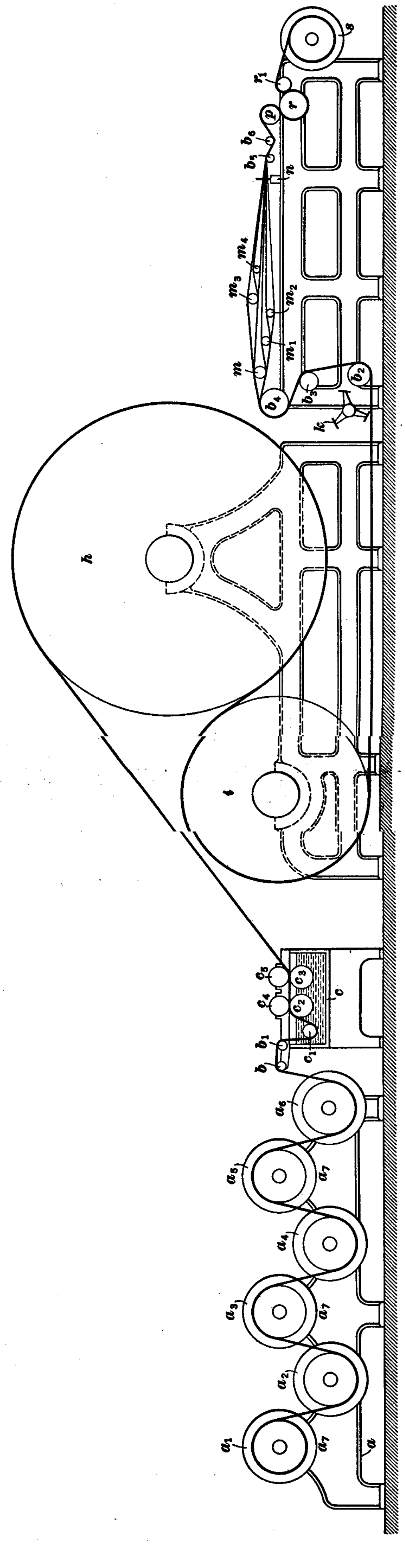

Fig. 2

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The purposes of the slasher may be briefly stated as follows: (1) To assemble in sheet form the desired number of ends of yarn required for the formation of a warp suitable for weaving. (2) To pass this sheet of yarn through a suitable size mixture to strengthen and smooth the warp yarn for the weaving process. (3) To dry the sized warp in such a manner as not to injure the yarn and as to prevent the individual yarns from adhering to each other. Also, the drying process must not be so severe as to cause the removal of the hygroscopic moisture contained in the cotton fibers of the yarn. (4) To wind the sheet of sized and dried warp yarns on a loom beam in a form suitable for the operation of weaving.

To accomplish these purposes, there are two general types of slashers, namely, the cylinder slasher, of which Fig. 1 is a typical example, and the hot-air slasher. In the cylinder slasher, the sheet of sized warp yarns is dried by being passed partly around a steam-heated cylinder or cylinders, but in the hot-air slasher, which is frequently called a dresser, the warp is dried by being passed several times through an enclosed, heated chamber. This chamber is usually heated by coils of steam pipes arranged in several banks. At the present time the hot-air type of machine is rarely, if ever, employed for slashing cotton warps, but is used to a considerable extent in the preparation of woolen and worsted warps.

The cylinder type of slasher is of practically universal acceptance in the preparation of cotton warps, and is of several different kinds. The single-cylinder slasher accomplishes the drying of the yarn by passing the sheet of warp partly around a single large drying cylinder that is usually 7 feet in diameter. This slasher is well adapted to mills that have a limited amount of floor space and for cases where the rapid drying of the sized warp is not of paramount importance. The two-cylinder slasher, of which Fig. 1 shows a typical example, is very similar to the single-cylinder machine but differs essentially in possessing a drying cylinder 5 feet in diameter in addition to the usual 7-foot cylinder. This slasher, therefore, has an additional drying capacity and, hence, is capable of greater production than a single-cylinder slasher, since the production of a slasher is largely governed by the speed with which the sized yarn may be satisfactorily dried.

A four-cylinder slasher having drying cylinders about 5 feet in diameter is sometimes used. The added drying surface presented by this type of slasher has made yarn speeds of up to 100 yards per minute possible. The use of such a slasher, of course, is suited only to mills capable of handling large amounts of yarn for the warps of fabrics of standard construction, such as print cloths, sheetings, industrial fabrics, and the like. While other types of slashers, having drying cylinders that vary in size and number, are sometimes employed for slashing cotton warps, the two-cylinder slasher having one 7-foot cylinder and one 5 foot cylinder may be considered to be the standard type of machine employed in cotton mills.

Special types of cylinder slashers have been developed for slashing rayon warps. Some of these slashers contain three drying cylinders about 5 feet in diameter. Others are made with three, five, or seven smaller drying cylinders, each about 2 feet in diameter. Some of these multicylinder slashers are arranged for the preparation of warps in accordance with typical cotton-mill practice, and others are with silk-mill practice.

5. Importance of Good Slashing.—The efficiency of the slashing operation determines, to a marked degree, the efficiency with which the weaving operation may be performed. Slashing, when properly carried out, should result in a definite increase in the tensile strength of warp yarn. In some instances, a loosely twisted, weak yarn must be used for the warp and, unless strength is imparted to it by sizing, it is certain to cause much trouble. Sizing also tends to lay the fuzz, or fibers projecting from the surface of a yarn, and enables the yarn to be drawn easily through the drop wires of the warp stop motion, the heddles of the harnesses, and the reed. Unless properly sized, much of the fuzz will, in most instances, roughen and shed because of the harsh chafing action of the shedding motion of the loom. Again, a sufficient quantity of size may have been deposited on the yarn, but the sizing material may be lacking in adhesive qualities. In such instances, a large percentage of the size will be scraped or peeled from the warp yarn during the weaving process, leaving the yarn unprotected. The sizing material and fuzz shed by the yarn soon covers much of the operating mechanism of the loom and offers problems in cleaning the loom and keeping it in ideal mechanical condition.

A yarn that is unprotected or unstrengthened by sizing is subjected to frequent breakage in the loom. As a result, much of the weaver's time is required in piecing broken ends, and loom production is reduced greatly. Besides, unsized yarn produces a cloth of inferior quality, which may have to be classed as a second because of an excessive number of defects.

6. Value of Automatic Slasher Controls.—Good slashing depends, to a marked degree, on the maintenance of a uniform level of the size in the size box of the slasher, a uniform temperature of the size, a correct and uniform temperature of the drying cylinders, and the constant use of the same size formula and size-cooking procedure. Manual control of these features always introduces numerous variables, which are practically impossible to overcome because of the human element. Automatic slasher control has been developed to replace human control, thus reducing variation in these factors to a point where they are negligible.

Automatic control of slashing, in the strict sense of the word, usually conveys the thought of automatic regulation, or control, of the level and the temperature of the size and the temperature of the drying cylinders. Actually, to obtain the full benefits offered by automatic control in slashing, such as increased production, less end breakage in weaving, and a saving in cotton by reducing the amount of warp shedding, automatic control should be extended to include size cooking, or preparation.

The majority of defects caused in slashing may be traced, either directly or indirectly, to improper temperature control. For example, constant temperature regulation of the size at the size box is practically impossible when hand controls are employed. A temperature variation of 20 degrees may exist at the size box when hand controls are used, while automatic control at this point reduces this temperature variation to 2 degrees. Size tends to become pasty when its temperature is below 190° F. and thin and watery when heated above 200° F. Within this 10-degree range, the size viscosity remains fairly stable, but above or below these temperatures it fluctuates rapidly. Therefore, the necessity for automatic temperature control of the size is readily seen.

Improper drying of the sized yarn at the slasher always results in difficulties in handling the warps in the weave room. The yarn will mildew if removed from the slasher in a damp condition, while it will become harsh and brittle if dried too long or at a temperature high enough to scorch and tender it. Also, too much drying removes the hygroscopic moisture of the cotton fiber, which is necessary for ideal weaving conditions and the maintenance of maximum yarn strength. Automatic temperature controls are often used on the drying cylinders of a slasher instead of hand controls to maintain uniform drying conditions. When such controls are correctly adjusted, the same degree of drying is maintained and the same amount of moisture is left in the yarn regardless of the slasher speed.

Automatic slasher control cannot correct a poor size mixture caused by the use of an unsuitable size formula. The careful selection of the ingredients used in preparing the size can prevent such a mixture. However, control can be exercised over the cooking and preparing of the size mixture. The time and temperature of the cooking operation generally control the degree of gelatinization, which in turn governs the viscosity of the size. Size viscosity, in turn, influences the penetration of the size into the structure of the warp yarns during slashing. Only slight changes in heat application are necessary to bring about a change in size characteristics; therefore, exacting control of the size temperature and the period of size cooking will influence greatly the degree of success with which a warp is sized. Automatic controls, when applied to regulating the time period and the temperature variation of size cooking, will, in most cases, permit exact duplication of successive size mixtures. This duplication cannot, in most cases, be performed through manual control because of variations caused by the human element.

TWO-CYLINDER HIGH-SPEED SLASHER

INTRODUCTION

7. The modern two-cylinder high-speed cotton slasher varies only slightly from its predecessors. The early types of two-cylinder slashers consisted of practically the same units, namely, a creel for holding the section beams of yarn to be slashed, a metal-lined, wooden, or cast-iron size box, two drying cylinders, one 7 feet and the other 5 feet in diameter and both driven by the pull of the yarn passing around them, and a head-stock section for taking leases and winding the warp yarns in parallel order on a loom beam.

Slashers, however, like other textile machines, have undergone improvements, which have made it possible for warps to be slashed better and at higher speeds. These changes in slasher construction have been made gradually; they do not represent radical departures from established practice. Therefore, the creel and the size box now used on many slashers are substantially the same as those employed in earlier machines, although movable creels are sometimes utilized with slashers to reduce the amount of time required for creeling. A unit, known as a stretch control, also has been added to some slashers for the purpose of maintaining a greater degree of control over yarn stretch, especially when rayon is being slashed. Most slashers also utilize some method of positively driving the drying cylinders to reduce yarn strain to a minimum. Slight changes have been made in the headstock of the slasher, although most of these are of minor importance.

8. Passage of Yarn.—A diagrammatic view of a two-cylinder high-speed slasher is illustrated in Fig. 2. The yarn has been wound previously in parallel order on section beams, which are supported in a creel *a*. The warp ends from each section beam are grouped and drawn forward, being passed around the section beams a_1, a_2, a_3, a_4, a_5, a_6 over the guide rolls b, b_1, and into the size box c. The sheet of yarn is immersed in the size by partially encircling an immersion roll c_1 in the size box, which is beneath the surface of the size, and then passes between the size and the squeeze rolls c_2, c_4 and c_3, c_5. The squeeze rolls tend to press some of the size into the yarn and, at the same time, they remove the surplus size from its surface. The wet yarn then encounters a large steam-heated drying cylinder h and a smaller cylinder i, from where it passes beneath the fan k and around the guide rolls b_2, b_3, b_4. The fan cools the yarn as it comes from the hot drying cylinders and, to a certain extent, tends to eliminate any size formation that may exist between the sized warp ends. The warp is split into as many sections, or divisions, by the split rods m, m_1, m_2, m_3, m_4 as there are section beams in the creel. The warp then passes through an expansion comb n, which regulates its width, and is finally wound on the loom beam s after passing between tension bars b_5, b_6, around a measuring roll p and drag roll r, and over a guide roll r_1.

CREEL CONSTRUCTION

9. Stationary Creel.—The stationary slasher creel, as illustrated in Figs. 1 and 2, consists of a cast-iron framework a constructed in such a manner as to support a number of section beams. The creel, when used in connection with the slashing of cotton yarns, is usually built to support the section beams in two tiers, the same number of beams being accommodated in each tier. Each section beam is supported in the creel by an adjustable bearing. The bearings for the upper-tier beams are fastened to the top of the creel uprights a_7, while those for the lower-tier beams are likewise attached to a lower section of the creel. The bearings are constructed in such a manner that they may be moved either towards the center of the creel or outward by simply turning a handwheel. In this manner, the creel may be adjusted to accommodate section beams of varying widths.

The individual requirements of a mill usually govern the length and the capacity of the slasher creel. Some mills, such as those manufacturing wide sheetings, require creels capable of holding as many as 24-section beams. Other mills may need only 4- or 6-section beams to meet their requirements. Generally, a creel holding 6- or 8-section beams meets the requirements of most mills. If, however, a creel with a greater capacity is desired, it may be ordered in increments of two, that is, the next larger creel would have a capacity of two more section beams.

10. Movable Creel.—Another type of creel, and one that is often used in connection with a high-speed slasher, is known as a movable, or double, creel. This really consists of two creels, both of unusually substantial construction and both mounted on wheels that run on the same track. The track is laid at right angles to the direction of yarn travel in the slasher and at the rear of the size box, or stretch control unit if one is used, and extends a considerable distance each side of the slasher. One creel will, at all times, be at the back of the slasher in a normal position for slashing, while the other creel will be at one side. Thus, warp yarn in sheet form is drawn from the creel in the normal position and slashed in the usual manner. When the yarn in this creel is exhausted, the creel is unlocked and moved to one side, and the other creel, which has been filled while the slasher was operating, moved into the place of the one exhausted.

The movable type of creel possesses definite advantages for a mill that operates on standard work without making changes in its size formula. For example, a mill producing sheeting or print cloth would come under this classification, as would also one making only one or two types of industrial fabrics exclusively. Creels of this type will permit such a mill to employ unskilled help to fill the empty creel and to lease, or separate, the warp ends while the slasher is slashing yarns from the other creel. Then, when it is necessary to replenish the yarn in the slasher, this creel may be moved into position and the ends twisted in. A great saving in time is made and, hence, the period during which the slasher is stopped is reduced greatly.

11. Creeling Ply Yarns.—Ply or other special yarns are used extensively for selvages in many fabric constructions, therefore it is necessary in most instances to wind these yarns in their proper positions on the loom beam. Several methods of creeling ply or other selvage yarns are used in the slasher room. For example, one method often used is as follows:

The total number of selvage ends required is usually split, that is, half of them are run on one side of a section beam and the rest on the other side. The beam is placed in the creel with the other section beams, but it is usually placed in the lower tier of the creel next to the size box. Selvage ends placed on a section beam located in this position will form the top sheet of the yarn as it passes from the creel to the size box, and thus may be separated easily from the rest of the yarn. Special rolls should be supported from the slasher hood over the size box so that the selvage ends may be guided directly from the section beam on which they are wound to the nip of the last set of size and squeeze rolls, where the selvage yarn again unites with the yarns that have passed through the size solution. The selvage yarns pass around the drying cylinders and through the comb with the other warp yarns. These selvage ends are placed in their correct positions at the comb so as to be wound on each side of the loom beam.

Often special creels are constructed at the rear of the regular slasher creel for the purpose of holding spools of yarn to be used as selvages. This system of creeling has several disadvantages: first, it is difficult to notice when a selvage end has run out because these ends must pass the entire length of the slasher creel; second, the special creels are often in the way during the creeling of the section beams.

Another method of creeling selvage yarns, which eliminates the disadvantages enumerated, is to have a creel suspended from the hood, or bonnet, over the size box. A creel of this type is shown in Fig. 3. The creel a_8 consists of a simple wooden frame. Two vertical members divide the frame into three parts, and notches are cut at equal intervals in the vertical members and sides. The notches act as retainers for holding the skewers, or pins, which pass through the spools of yarn and support them. A guide rod a_9 is fastened and held to the front of the creel by brackets. Three groups of pins, each group containing a number of pins equal to one in excess of the number of spools held in each vertical division, project from the guide rod. Each pin group is located directly in front of a division of the creel a_8 and is used to keep the yarn drawn from the spools separated.

If, however, the number of selvage ends desired in the warp is in excess of the capacity of the creel, the selvage ends may be doubled on the spools; that is, two ends of selvage yarns may be wound on a spool, thus doubling the creel capacity. When this method of creeling is used, two selvage ends will pass between each two pins of the guide rack.

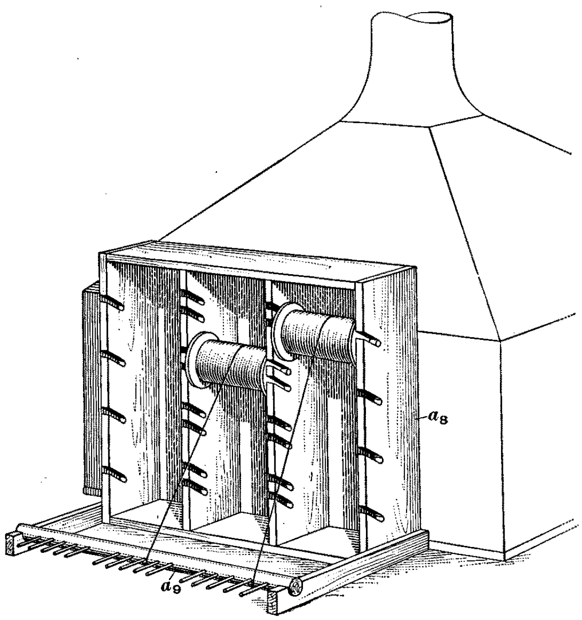

FIG. 3

The selvage yarn passes between the pins of the guide rack and through a reed supported from the under side of the hood. A reed consists of a large number of thin metal strips, usually referred to as splits, held close together in a frame in such a manner that a definite space exists between each two of them. Thus, each warp end passing through the spaces, or dents, is held in an exact position in relation to other warp ends. The reed tends to keep the selvage yarns running in their correct position in regard to the sheet of warp yarn being sized. The yarns pass directly from the reed to the size rolls where they unite with the sheet of regular warp yarns.

Ply or other heavy selvage yarns are seldom immersed in a size solution for several reasons. First, such yarns are strong and do not require sizing to increase their strength. Consequently, the addition of a great amount of size to them only tends to make them stiff, harsh to handle, and brittle. Second, these yarns are often heavier than those used to form the warp of a cloth. If the same amount of size were deposited on them as on the warp yarns, a greater drying period would be required to dry the selvage yarns thoroughly. Consequently, the warp yarns would be overdried and subjected to scorching, or the ply yarns would be underdried and subject to mildew.

STRETCH-CONTROL CONSTRUCTION

12. Most high-speed slashers employ some form of yarn-stretch control. As its name implies, a stretch-control unit consists of a device designed to regulate and control the tension placed on the warp yarns as they are drawn from the creel. High yarn speeds, encountered in many slashers, place a great strain on the yarns as they are drawn from the creel. Usually the yarn tension thus created is unequal, and, in many cases, results in poor sizing. The effect of uneven tension is especially noticeable in the sizing of rayon warps, where unequal tension and abnormal yarn strain often cause shiners and other defects in the woven cloth.

A form of stretch control, often found on high-speed slashers, consists of a framework for holding an iron roll, commonly known as a drag roll, at the rear of the size box. The drag roll is about 9 inches in diameter and has two small guide rolls located in such a position as to hold the sheet of warp yarns passing around the drag roll in contact with it for about four-fifths of its circumference. The unit is positively driven from the side shaft by an extension shaft, which is attached to the side shaft at the size box and extends to the stretch-control unit. Through a suitable gearing arrangement, the side shaft imparts motion to the drag roll, the speed of which may be changed in relation to the speed of the size rolls by means of change gears. Thus, the yarn passes from the creel around the drag roll, and is fed to the size rolls at a predetermined rate of speed.

SIZE-BOX CONSTRUCTION

13. Size Boxes.—The purpose of the size box is to hold the size mixture that is applied to the warp yarns, and to contain suitable mechanism to assist in applying this mixture to the yarns. The size box used with most high-speed slashers is constructed with a cast-iron framework, the framework being cast in several pieces and bolted together. The box proper is lined with sheet copper, which is sometimes tinned, especially if

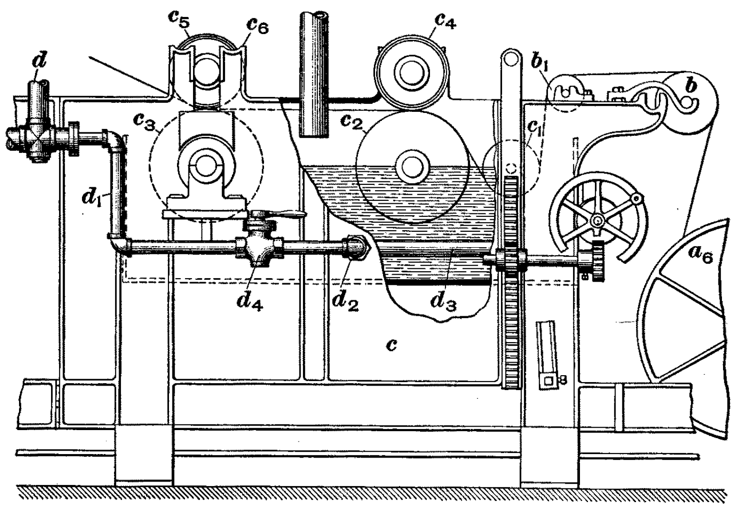

FIG. 4

it is to be used for rayon sizes. Some of the old-type size boxes that are still in use have a cast-iron frame that supports a wooden size box. In some instances, the wooden box is lined with a suitable material, while in other cases, the size is held in the unlined wooden box.

The warp yarns in sheet form pass from the creel, or the stretch control if one is used, over the guide rolls b, b_1, Fig. 4, and under the immersion roll c_1, from where they are threaded between the size roll c_2 and the squeeze roll c_4, through another set of size and squeeze rolls c_3, c_5, and to the large drying cylinder.

The immersion roll c_1 is held in a rack that may be raised or lowered by turning a handwheel, which, through a gear train, raises or lowers the rack. The warp yarn passes beneath the immersion roll, the height of which may be so adjusted as to maintain the same size level on the immersion roll at all times and thus obtain a uniform size penetration in the warp. The two 9-inch bottom copper size rolls c_2, c_3 are supported in fixed bearings, which are secured to the size box a little above its center. These two size rolls are positively driven, receiving their motion from the side shaft.

The squeeze rolls c_4, c_5 are usually 6-inch iron rolls covered with several yards of slasher cloth for the purpose of pressing or removing from the yarn the surplus size absorbed by it as it passes through the size bath. The squeeze rolls rest on the size rolls and are driven by frictional contact. Vertical slots are cut in the size box above the squeeze-roll bearings to allow the operative to remove the squeeze rolls and place them on the stands c_6. Generally, it is advisable to remove the squeeze rolls and place them on the stands if the slasher is stopped for a long period of time. The stands c_6 are simply projections built as a part of the framework beside the squeeze roll bearings and are of sufficient height to hold the squeeze rolls from contact with the size rolls, thus preventing injury to the squeeze-roll covering.

Some slashers incorporate a system of mechanical roll-weighting, a method that is sometimes employed being illustrated in Fig. 1. A yoke c_7 is connected to the bearings of the squeeze rolls c_4, c_5 in such a manner that pressure is applied to the rolls by the lever c_8 working through the rod c_9 and the weight lever c_{10}. A weight may be adjusted as to position on the weight lever arm to regulate the pressure applied to the squeeze rolls. When it is desired to remove the pressure applied to the squeeze rolls, or when the slasher is to be stopped for a long period of time, the rolls may be lifted from contact with the size rolls by means of the handwheel c_{11}. The handwheel, when turned, winds a chain c_{12} around a drum, which the handwheel causes to revolve. The shortening of the chain, which is attached to one end of the lever arm c_{10}, will cause the mechanical linkage to lift the yoke c_7 and consequently the squeeze rolls c_4, c_5.

14. Steam Connections.—The size mixture, contained in the size box and used to size the individual ends of the warp, must be held at a constant temperature. Steam is used for heating purposes, but in varied ways. For instance, enclosed steam coils are sometimes used to heat the size mixture, but generally a perforated steam coil is utilized. Both steam coils consist of a long length of pipe, or tubing, sometimes bent in the shape of a coil. Steam is passed through the pipe to heat it and the size in contact with it. However, the perforated steam coil is practically the same as the enclosed steam coil, except that many small holes are drilled in the coil. The steam, under pressure in the steam coil, is forced through these perforations into the size mixture, and, as the steam rises, it tends to agitate the size and keep it in motion. However, the perforated steam coil has one disadvantage in that some of the steam blown into the size mixture through the perforations in the steam coil tend to condense and form water in the size mixture. The slight amount of condensation of steam, and hence the thinning of the size mixture, however, is not sufficient to counteract the distinct advantage offered by the perforated steam coil of constantly agitating the size mixture and thus preventing it from settling.

The steam connections required for heating the size in a size box equipped with a perforated steam coil are illustrated in Fig. 4. The main steam pipe d directs the steam to the size box through the branch pipe line d_1, which enters the size box near its bottom at point d_2. The pipe d_1 extends across the size box, while at each end of it two branches extend from the pipe, each running around the size box parallel to it so as to form the perforated steam coil d_3. A valve d_4 is placed in the steam line to control the steam flow. The resulting steam coil is rectangular in shape and is slightly smaller than the bottom of the size container. The pipe d_1, which extends across the box, actually divides the large rectangular coil into two smaller ones. Small holes, or perforations, in the steam coil point towards the bottom of the box at an angle of 30 degrees from the horizon. The holes are spaced about 4 inches apart, a row of holes being placed on each side of the pipe and staggered so that two holes will not come opposite each other.

15. Squeeze Rolls.—The squeeze rolls c_4, c_5, Fig. 4, are iron rolls that are covered with cloth. The object of covering these rolls is to form an absorbent blanket around the squeeze rolls and thus enable the size to penetrate the warp yarn uniformly. At the same time, the blanket tends to remove all of the surplus size from the yarn so that it may be drawn through the size box by the rolls without slippage. The cloth used to cover these rolls is termed slasher cloth and is of special construction. A woolen cloth weighing about 12 to 16 ounces per yard is generally used for this purpose.

A method sometimes employed to cover squeeze rolls is as follows: The outer surface of the squeeze roll is roughened. A rough cut taken across the roll surface by drawing a file across it is usually sufficient if the surface is not already rough. A coating of undiluted white-lead paint is applied to the roll surface to act as a binding agent between the roll and the cloth. About 3 yards of a good strong cloth is rolled on the roll and white lead is applied to the end of the cloth for about 4 inches to seal it. Generally, the roll is allowed to stand from several hours to overnight after the white lead and the cloth are applied. Two pieces of 16-ounce burlap, equal in width to the length of the roll and about 7 yards in length, are soaked in cold water overnight, the purpose being to shrink the burlap. Usually, this method of shrinking is preferred to having the burlap shrunk on the roll. If, however, the squeeze roll is to be recovered while a set of warp ends is in the slasher, those yarns remaining in the slasher should be removed. The drive to the cylinder is uncoupled to prevent cylinder rotation. The squeeze roll is allowed to rest on the size roll. The slasher is started and run at slow speed. One piece of burlap is wound around the squeeze roll while the size roll is in motion by guiding the burlap on the squeeze roll at a point close to the previous lap. The second piece of burlap is attached to the squeeze roll by tucking about a yard of it under the first piece of burlap, previously applied, so as to form a lap. The burlap, when wound on the roll with the slasher in motion, almost always produces a better squeeze-roll covering than is possible to obtain by hand winding. Slasher cloth should never be substituted for the burlap because, regardless of the cost of the slasher cloth, it will not serve the purpose as efficiently.

The finisher, or second squeeze roll, is likewise covered. First, 3 yards of a strong, heavy cloth is applied to the finisher roll in the same manner as the front roll is covered. But, in this case, only one 5-yard piece of burlap is wrapped around the roll. The roll, however, is then covered with two pieces of slasher cloth, each piece varying in length from 2 to 6 yards. The object of using two slasher cloths on the finisher roll is to season one of the cloths. Thus, when one of the slasher cloths becomes unfit for further service, a new cloth is ready to replace it. The new slasher cloth is always placed next to the burlap and the older cloth on the outside because the older cloth will remove the surplus size from the yarns much better. A well-seasoned slasher cloth may be easily recognized by its brown color.

When it is necessary to cover the finisher roll with a seasoned slasher cloth, a new cloth may be partially seasoned by lapping it around the first roll and allowing it to remain for several days. In this manner, the cloth will be stretched and seasoned so that, when it is used on the finisher roll, it will remove size efficiently. When a seasoned cloth is not available, a cloth of light construction wound several turns around the slasher cloth and allowed to remain for several days, or until the squeeze roll does not slip, will, in most cases, take the place of a seasoned slasher cloth.

16. The efficiency of the squeeze roll may be easily determined by watching carefully the condition of the yarn emerging from the size box. When the sheet of yarn passing from the size box has wet streaks and spots, it is a sign that the squeeze rolls are not removing the size efficiently. A yarn passing through a slasher in such condition will not dry well, and hard size will appear in spots throughout the yarn. Ordinarily, a slasher cloth will serve efficiently for 2 to 4 weeks before replacement is required. The period of operation depends on numerous factors, such as the quality of the slasher cloth, whether the woolen yarns used in its construction are dyed or not, the speed at which the slasher is operated, the size viscosity, and the like. The slasher cloth, when removed, should be well washed and soaked to remove as much of the hard size as possible and to restore to the cloth some of its original pliability.

The washing of slasher blankets is an important factor in the operation and the management of a slasher room. Size is absorbed by the slasher blankets. After a period of time, the amount absorbed reaches a point where the blankets become hard and stiff and cease to function efficiently. Before the blankets may again be used, the size must be removed. Generally they are soaked and washed in boiling water. Care should be taken not to permit live steam to be applied to the water while the blankets are soaking because of the damaging effect steam has on them. While slasher blankets are continually washed to remove the size that has impregnated the yarns and the interstices of the fabric, the burlap should never be removed for washing.

AUTOMATIC SIZE CONTROL

17. Automatic control, or regulation, at the size box usually implies automatic temperature control over the size and automatic regulation of the height of the size in the size box. The necessity for automatic temperature control at the size box has been explained, but, in addition to temperature regulation, the size level at the size box also must be controlled if the full benefits of automatic controls are to be obtained. A size level that is constantly fluctuating, as in the case of manual regulation of the size level, will produce uneven yarn sizing. A variation in size level changes the percentage of size deposited on the yarn by varying the depth the yarn is immersed in the size mixture.

18. Size-Box Temperature Control.—The object of a size-box temperature control, as has been stated, is to maintain a uniform size temperature at the size box. This is generally accomplished by placing in the steam line to the size-box steam coil a valve that may be opened or closed by air pressure. Thus, the steam may be admitted or stopped from entering the steam coil and heating the size mixture. A thermostat or a similar

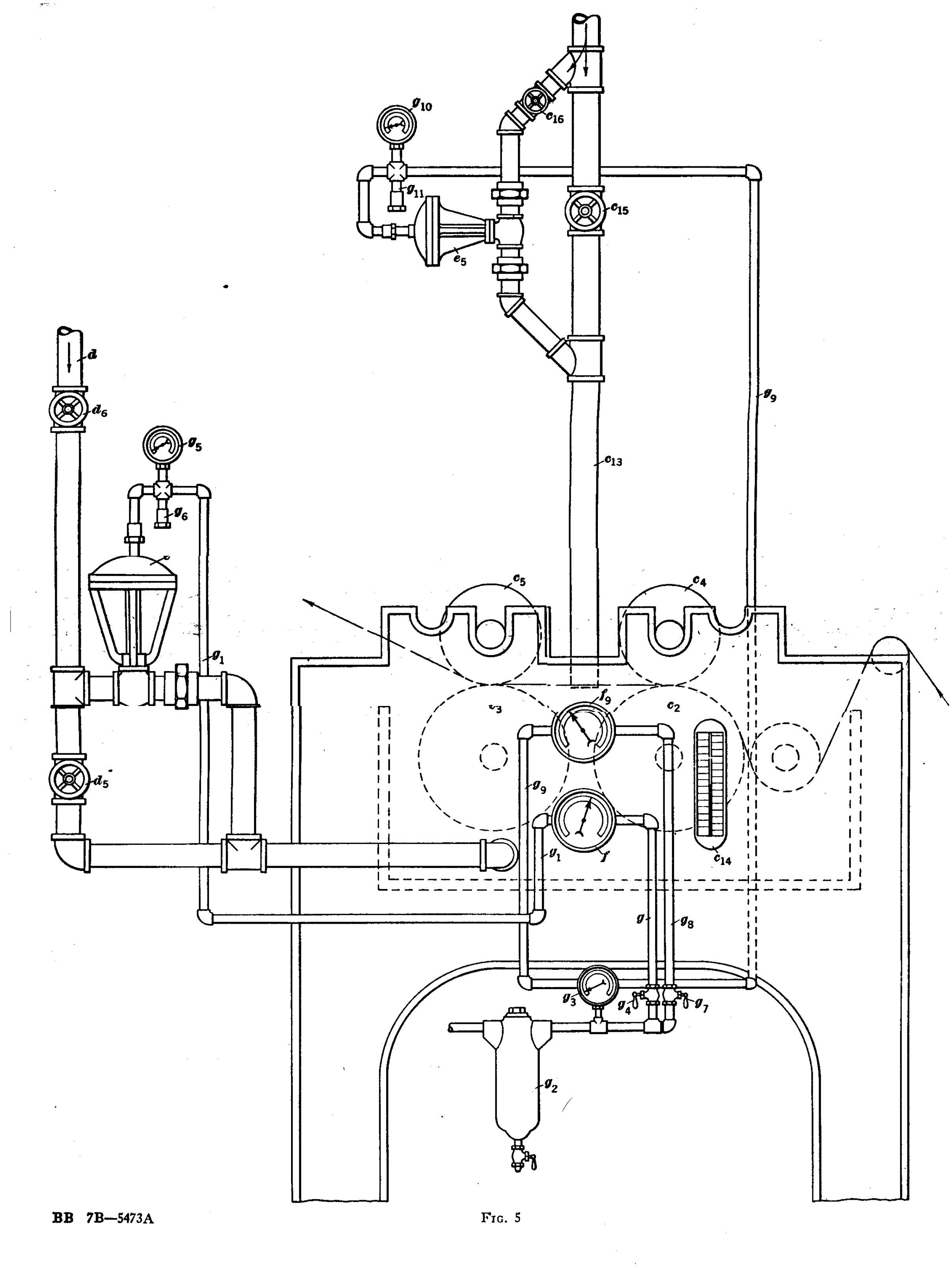

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Fig. 5

unit is immersed in the size to control the air flow to the valve in the steam line and, consequently, the size temperature.

An automatic temperature control unit is often incorporated in a size box, as illustrated in Fig. 5. A by-pass is, in such cases, built into the steam line *d* leading to the size box so as to encircle the hand-operated valve d_5. A diaphragm motor valve *e*, or automatic valve as it is often called, is carried in the by-pass line. Another hand-operated valve d_6 is built into the steam line above the by-pass to stop the flow of steam and to be used for emergency if the diaphragm motor valve is rendered inoperative.

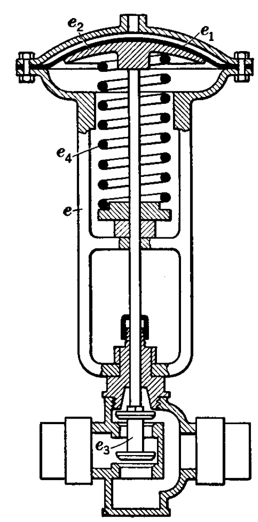

FIG. 6

A diaphragm motor valve is simply a valve used to control the amount of flow of steam, water, liquid, or any other substance passing through a pipe line. The diaphragm motor valve *e*, Figs. 5 and 6, is operated by air pressure acting on a flexible diaphragm e_1, Fig. 6, which rests against a curved plate e_2. The curved plate is attached to a stem of a double-seated valve e_3. A spring e_4 forces the curved plate upward, thus holding the double-seated valve open. Therefore, the application of force, usually in the form of air pressure, to the diaphragm tends to overcome the resistance of the spring and close the valve. But, as the air pressure in the diaphragm chamber is reduced, the spring will gradually open the valve. Not all diaphragm motor valves are constructed to act in this manner. Some valves are built to be opened when air pressure is applied and closed when it is reduced.

Adjustments may be made on most diaphragm motor valves to vary the degree of opening and the period over which they remain open. Usually these variations are made by means of controlling the air pressure in the diaphragm chamber.

A direct-set controller *f*, Fig. 5, or thermostatic unit, is used to control the air pressure acting on the diaphragm motor valve *e* in the steam line. The direct-set controller is so called because it may be adjusted or set directly to regulate the temperature at which the size mixture is to be maintained; that is, the controller permits the air pressure acting on the diaphragm motor valve to increase and thus set it in operation. A self-operated regulator, that is, a diaphragm valve with a thermometric unit directly attached to the diaphragm and that is opened and closed by the expansion and contraction of the fluid within the unit, may be substituted for the direct-set controller unit. But, a self-operated regulator does not possess the degree of sensitiveness ordinarily required for size temperature control, and, therefore, its use is not generally recommended.

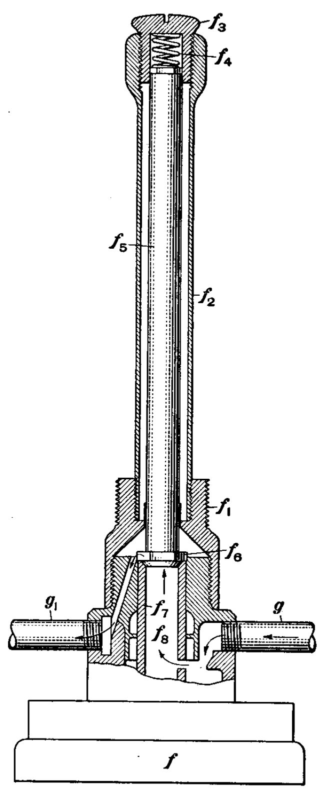

FIG. 7

19. A direct-set controller *f*, or thermometric unit, is illustrated in Figs. 5 and 7. The direct-set controller *f* is installed in the size box about 1 inch above the perforated steam coil but on the opposite side of the size box from where the size pipe c_{13}, Fig. 5, is located. The unit must be installed in this position to insure accurate readings of the size temperature because, if the hot size coming from the storage kettle falls on a part of the controller, inaccurate size temperature will be recorded and maintained. The controller *f*, Fig. 7, is attached to the size-box framework by means of the threaded part of the controller case f_1 and in such a manner that the expansion tube

f_2 extends into the size box. The controller works on the principle of differential expansion of metals, that is, the outer expansion tube, or shell, f_2 is made of copper, a metal that expands and contracts rapidly with slight variations in temperature.

The expansion tube is screwed into the base of the controller, and a cap f_3 is screwed over the other end of the tube to act as a seal. The cap f_3 holds a spring f_4, which fits into a recess in the cap head and forces another metal tube f_5, carrying the valve f_6, against the valve seat f_7. The tube f_5 is composed of a metal that has a low coefficient of expansion, or a metal that expands slightly. As the expansion tube f_2 expands because of its being in contact with the hot size, the pressure exerted by the spring on the tube f_5, and consequently the pressure on the valve f_6, will be reduced. The air under pressure in the air line g will enter the valve chamber f_8. As the air in the line is maintained at about 15 pounds pressure, which is greater than the pressure exerted by the spring f_4, it will force the valve f_6 open and will flow through the air line g_1, which leads to the diaphragm motor valve e, Fig. 5. However, when the size in contact with the copper expansion tube f_2, Fig. 7, cools, the tube will contract, thus increasing the tension of the spring f_4, which will force the valve f_6 back to its seat f_7 again. In this manner, the flow of air through the line g_1 to the diaphragm valve is stopped.

20. Operation of Size-Box Temperature Control.—The temperature at which the size is to be maintained is set on the direct-set controller f, Fig. 5, which is calibrated in degrees Fahrenheit. The actual temperature of the size, however, is shown on the thermometer c_{14} installed on the side of the size box. Steam from the main steam line d is allowed to flow to the size box by opening the valve d_6, which permits the steam to flow through the diaphragm valve e and into the steam coils, care being taken to have the valve d_5 in the line closed. Steam will readily flow through the diaphragm valve because the valve is open due to the lack of air pressure acting on the diaphragm.

A steady supply of compressed air passes through the air strainer g_2, which removes all dirt, water, and oil from the air. The air pressure should always be maintained so that the gage

g_3 will show an air pressure of about 15 pounds. The petcock g_4 in the air line g leading to the direct-set controller f is opened. However, when the slasher is not in operation or when it is operating without the automatic controls functioning, this petcock is closed to stop the flow of air. The air flows into the direct-set controller, but it is not allowed to pass through until the size has reached the temperature set on the controller. By this time, the expansion tube of the controller will have expanded sufficiently to allow the air to pass through the controller unit and into the air line g_1 leading to the diaphragm valve e. Air pressure in this air line will be registered on the gage g_5, which actually indicates the air pressure acting on the diaphragm of the valve. Thus, air pressure acting on the diaphragm tends to close the diaphragm valve and stop the flow of steam to the coils. The air gage, by indicating air pressure in the lines, offers a visual method of informing the slasher tender that the diaphragm valve is closed, and, by showing no air pressure, that the diaphragm valve is open.

If, for any reason, the size mixture cools, the expansion tube of the direct-set controller f will contract and cause the flow of air to the diaphragm valve to be stopped. Whatever air is under pressure in the diaphragm valve or in the air line g_1 will escape through the air-relief valve g_6. The air-relief valve is constructed in such a manner as always to allow a small amount of air to escape from the air line g_1 and the diaphragm valve. However, the amount of air that escapes is not sufficient to reduce the air pressure in the diaphragm valve appreciably, while the valve in the direct-set controller permits air to pass through the air line g_1. But, when the air supply to the air line g_1 is closed, whatever air is in the air line and the diaphragm valve will escape slowly through the air relief valve g_6. Thus, the spring in the diaphragm valve will force the valve open and allow the steam to flow into the coils and heat the size again.

21. Automatic Size-Level Control.—The level of the size in a size box may be controlled automatically by several different systems. First, an overflow type of size-regulation system may be used. Essentially, this system of size regulation consists of placing an overflow tube in the size box at the level at which the size is to be maintained and of feeding the size continually to the size box in sufficient quantities to allow a certain amount of overflow to take place. The size supplied to the size box may be supplied through a gravity feed system or by a pump system. The size storage kettle, in the gravity system, is placed at a height sufficient to cause the size to flow to the size box, and then a pump circulates the overflow back to the storage kettle. A pump system of circulating the size to the size box, however, allows the size storage kettle to be placed at any level, a pump, in this instance, circulating the size to the size box and back to the storage kettle.

Another system of size-level control is based on temperature regulation of the size. This system of size-level control, which is illustrated in Fig. 5, is practically identical in construction and in operation with the controlling unit used to maintain constant size temperature. The size line c_{13} used to carry the size from the storage or the size kettles to the size box is altered slightly to permit the use of automatic controls. A by-pass is built around the valve c_{15} in the size line and a diaphragm valve e_5 is installed in this line. A valve c_{16} is placed above the diaphragm valve in the by-pass line so that the diaphragm valve may be rendered inoperative and the flow of size controlled manually by the valve c_{15} if desired.

A direct-set controller f_9 operates the diaphragm valve in the size line. The direct-set controller is installed in the size box in such a manner that the expansion tube of the controller will be just covered with size when the correct size level is reached. Care must be taken to install the controller in such a position that the hot size coming from the storage kettle will not fall on the expansion tube of the unit. The object of placing the expansion tube at the size level desired is to allow the tube to expand or contract, depending on whether the tube is covered with size or not. In this manner, it controls the flow of size by regulating the air pressure, which closes or opens the diaphragm valve in the size line.

22. Operation of Automatic Size-Level Control.—The temperature-indicating hand on the direct-set controller f_9, Fig. 5, is set a little below the indicating hand on the controller f. The valve c_{16} above the diaphragm valve is closed and the valve c_{15} in the size line is opened. The air supply to the controller is opened and the air flows through the air strainer g_2, the gage g_3, the opened petcock g_7, and into the line g_8, which leads to the direct-set controller f_9. When the size has covered the expansion tube of the direct set controller f_9, the tube will have expanded sufficiently to allow the air to pass into the air line g_9, which leads to the direct-acting diaphragm motor valve e_5 in the size by-pass line. The diaphragm valve is identical with the one in the steam line that leads to the perforated coil in the size box, and the application of air pressure to the diaphragm of the valve will, likewise, close it. When the air gage g_{10}, by registering pressure in the line, indicates that the valve e_5 is closed, the valve c_{15} in the size line is closed and the valve c_{16} in the by-pass line is opened to allow the diaphragm valve to function. The automatic controlling unit will now maintain the desired size level to within a variation of $\frac{1}{2}$ inch.

As size is absorbed by the yarn passing through the size box, the size level gradually decreases until the expansion tube is exposed to the cool atmosphere. The tube contracts because of the cooling effect of the atmosphere and stops the flow of air through the controller f_9. Whatever air remains in the diaphragm valve e_5 and in the air line g_9 escapes through the relief valve g_{11} and thus allows the diaphragm valve to open. Size once again flows through the by-pass and into the size box until it has covered the expansion tube. The expansion of the tube again allows air to flow once more through the system and close the diaphragm valve.

Numerous types of size-box control instruments are available, some much more sensitive than others because of their intricate construction. Regardless of the intricacy of the instrument or of the type of construction used, the principle of operation in most of these instruments is the same, and a comprehensive understanding of one type will permit the operative to understand the operation of most control instruments.

CYLINDER CONSTRUCTION

23. Cylinders.—The purpose of the large metal cylinders *h* and *i*, Fig. 1, is to dry the wet warp yarns as they pass from the size box and around these cylinders. Steam is admitted to the interior of the cylinders to heat them and, as the sized yarns pass around the cylinders, most of the water and moisture in the yarns is evaporated, leaving the solid sizing material deposited firmly on the yarns.

The drying cylinders are usually varied in size, the large cylinder *h* being about 7 feet in diameter and the smaller cylinder *i* about 5 feet in diameter. Both cylinders generally are about 60 inches in width, although they are sometimes constructed with other widths. Two heavy circular metal plates, which are well stayed, are used to form the sides of the cylinders, and metal spiders of the same diameter are used to provide the cylinder with the desired degree of rigidity and strength. Generally, these cylinder heads are insulated to reduce the condensation of steam within them and thus reduce the amount of steam necessary to maintain the desired cylinder temperature. Sometimes the head ends are covered with magnesia or other insulating materials, but these materials have the disadvantage of absorbing moisture in case of a cylinder leak. Usually, several air spaces are provided to insulate the head, these being formed by placing an intermediate sheet of steel, the size of the cylinder head, a short distance from the cylinder head or end plate, and another sheet a slight distance from the intermediate one. The end plates forming the sides of the cylinders are generally attached to the plate forming the circumference of the circle a slight distance from the edge. The two end plates are recessed in this manner so that, when the insulating plates are added to each side of the cylinder, the portion of the cylinder plate forming the circumference will project over them. Thus, the air spaces created by the insulating plates are sealed. Two such air spaces are maintained between the steel sheets at each cylinder head and serve as efficient insulators. Generally, a manhole is built in one side of each cylinder to provide access to the interior whenever repairs are necessary. Pure, heavy, sheet copper is used to form the face, the surface, or the circumference of the cylinder that is in contact with the yarn.

Atmospheric- or vacuum-relief valves must be installed in the side of each cylinder to prevent cylinder damage from the condensation of whatever steam remains in the cylinder after the supply of steam has been stopped, this gradually cooling and changing to water. Whenever condensation takes place, a partial vacuum is created within the cylinder, which will tend to collapse it. Whenever such a vacuum is created, an atmospheric-relief valve will tend to equalize the pressure within the cylinder with that of the atmosphere by allowing air to enter the cylinders.

The slasher cylinders are carried in specially designed bearings, which are supported by the framework, and which require special packing, oiling, and care. Besides performing the function of a bearing, that is, to permit rotation with a minimum amount of friction, these bearings must act as steam and condensate conducts and, at the same time, provide a tight seal under these conditions.

24. Steam Connections.—Steam is carried to the drying cylinders of a slasher from the main steam line. A hand valve is installed in this line to stop the flow of steam when the slasher is inoperative over a long period of time, such as week ends and the like. Each slasher cylinder has its individual steam connections, which join the steam pipe leading to the main line. A valve is placed in each steam line close to the cylinder so that the amount of steam entering each cylinder may be individually regulated. Generally a steam gage is provided to inform the operative as to the steam pressure within the drying cylinders. Safety valves also are built into the steam line between the cylinder and the valve controlling the amount of steam entering each cylinder. For two reasons, the safety valves are usually adjusted to open at a pressure of over 15 pounds. First, the cylinders, because of their size and construction, should not be subjected to steam pressure of over 15 pounds, otherwise the seams and joints may be strained. Second, steam at atmospheric pressure has a temperature of about 212° F., while at a pressure of 15 pounds, the temperature is about 250° F., and yarn in contact with the drying cylinders at this temperature would be severely scorched or burned.

Most slashers, not equipped with automatic controls, have some means of controlling the amount of steam entering the drying cylinders when the slasher is stopped. In some instances, the valve in the steam line works in connection with the shipper handle of the slasher. The linkage system connecting the valve and the shipper handle is such that, when the shipper handle is moved to stop the slasher, the valve is closed, thus stopping the flow of steam to the cylinders. In this manner, excessive cylinder temperatures are prevented and the yarns in contact with the cylinders will not be baked or scorched when the slasher is stopped. However, when the slasher is started, the steam valve will be opened and again permit steam to enter the drying cylinders.

Large quantities of vapor are produced when the wet warp yarns come in contact with the hot size in the size box and the hot drying cylinders. The vapor produces unhealthy working conditions for the slasher attendants, and, condensing on the ceilings of the slasher room, causes them to rot and decay. Also moisture that has condensed on the ceiling often drops on the warp yarns being slashed and stains them, the stains being difficult and sometimes impossible to remove. To obviate this condition, some form of natural or mechanical draft must be used to remove the objectionable vapors. Sheet-metal hoods are placed over the large cylinder and the size box and sometimes extend fully or partly over the small cylinder also. An exhaust pipe runs from the hood to the outside of the building. Usually, some form of mechanical draft is employed, such as a fan placed in the exhaust line to remove the objectionable vapors. A typical hood installation often employed in mills is illustrated in Fig. 1 in its normal position over the size box and the large cylinder.

25. Condensate Removal.—Condensate, that is, the water that collects inside the drying cylinders, is constantly being formed as the slasher operates because the wet yarn cools the cylinder surface and steam, injected into a cold cylinder, condenses. Unless all condensate is removed, it will tend to reduce the cylinder temperature.

Air often accumulates inside the drying cylinder and must be removed if the time required to bring the cylinders to operating temperature is to be reduced to a minimum. Without the removal of air, it may require 15 minutes to heat the cylinders, while, with the air removed, the time may be reduced to as little as 3 minutes.

Some of the older slashers in operation are provided with means for removing only condensate, or water, from the cylinders. A typical installation of this type consists of three buckets attached to the inside of the drying-cylinder surface, these being spaced 120 degrees apart and extending the full width of the cylinder. A pipe runs from each bucket to the center of the cylinder, where the pipes meet and discharge water into a cylinder shaft. The cylinder shaft is hollow on the end opposite to that through which the steam is injected, and a pipe connects the hollow shaft with a steam trap. The water formed by condensation of the steam in the cylinder is scooped up by the buckets as the drying cylinder revolves and is retained until the pipe attached to each bucket reaches an almost vertical position. The water will run down the pipe because of gravity, into the hollow cylinder shaft, and to the steam trap, which allows only condensate to be discharged to the atmosphere.

The cylinder is permitted to revolve and steam to be admitted at one end of the cylinder while condensate is removed at the other end by using air-tight joints or bearings. The shafts that support the cylinder are enlarged and are hollow at each end. The steam pipe fits into one end of the hollow portion of the shaft, and packing is placed between the pipe and the enlarged shaft, thus forming an air-tight joint but, at the same time, permitting cylinder rotation. Likewise, the condensate pipe fits into the other end of the hollow cylinder shaft. While this type of joint is used on the older slasher cylinders, improvements have been made. In many instances, ball bearings are used to support the drying cylinders, and in such cases superior methods of sealing the steam and condensate joints are used.

26. Most modern slasher cylinders are equipped to remove both condensate and air from the cylinders. One method commonly used, and often known as a syphon system, is illustrated in Fig. 8. Three pipes j are spaced 120 degrees apart and pass through a hollow casting, which is bolted to the center of the cylinder on the side opposite the steam inlet. This hollow casting serves as a cylinder shaft. The pipes extend from close

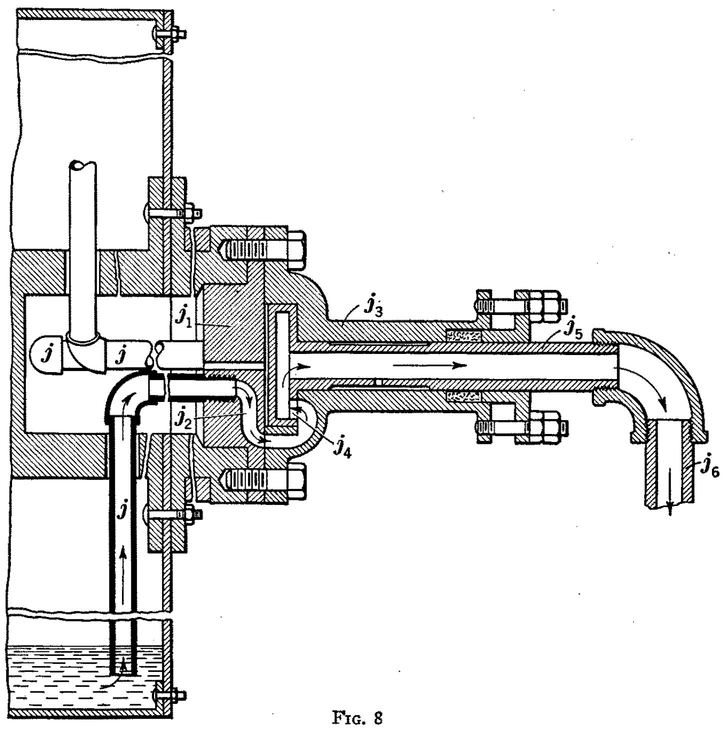

FIG. 8

to the inside surface of the copper plate that forms the circumference of the cylinder to the hollow casting at the center of the cylinder. At the center, they pass through the hollow casting and fit into a circular plate j_1. A passage j_2 extends from the end of each pipe in the plate j_1 through the plate and the casting j_3. Both the plate j_1 and the casting j_3 are bolted to the cylinder and must necessarily revolve with it. The arc-shaped opening j_4 in the stationary, hollow, flange-shaped tube j_5, which is held within the casting j_3 but is attached to the condensate drain pipe j_6, extends $22\frac{1}{2}$ degrees each side of bottom center, or the opening j_4 covers a circular distance of 45 degrees.

As the cylinder revolves and one of the pipes reaches a point $22\frac{1}{2}$ degrees before bottom center, the passage j_2 will begin to uncover the arc-shaped opening j_4. Steam under pressure in the cylinder will now force the condensate and air at the bottom of the cylinder up the pipe j, through the passage j_2, into the hollow tube j_5, and down the discharge pipe j_6. Discharge will continue through this pipe until the cylinder has revolved 45 degrees, or until the passage j_2 from this pipe has moved past the opening j_4. No discharge will now take place until another pipe has moved into such a position that the passage j_2 from this pipe likewise uncovers the opening j_4. As there are three discharge pipes and each pipe discharges for a period of 45 degrees of the cylinder revolution, the cylinder will discharge intermittently three times during one revolution, or for 135 degrees of a revolution, and will not discharge for 225 degrees of the same revolution. By breaking the discharge into three distinct periods, the necessity of a steam trap in the discharge line is eliminated because all condensate and air are at the bottom of the cylinder and will be ejected when the syphon pipes are in the positions described.

There are numerous systems of discharging condensate and air from the slasher cylinders, but most of them are based on the same principles. A thorough understanding of the principles involved in one system will enable the operative to grasp quickly the working principles of most systems.

27. Cylinder Drives.—Yarn stretch, or tension, may exist between the drying cylinders and the head end of a slasher, especially if the drying cylinders are dependent on the passage of yarn around them for their rotation. While many of the older slashers do not have their drying cylinders positively driven, some have been changed to incorporate this feature. Practically all modern slashers are equipped not only with positive-drive cylinders but also with a form of self-releasing cylinder-drive gears. A slasher equipped with positively-driven drying cylinders but not with a self-releasing motion may tend to wind the yarn on the loom beam at a slightly greater surface speed than that at which it is delivered by the drying cylinders. The cylinders, in this instance, will tend to hold the yarn back while the loom beam will tend to pull it forward. As a result, the yarn will slip around the cylinders and be stretched. If rayon yarns are being slashed, bright shining spots will appear on the yarns. A self-releasing motion is applied to drying cylinders to allow them to be driven positively, but if the yarn is drawn forward at a greater surface speed than that at which it is being delivered by the cylinders, the positive driving motion will be disconnected and the cylinders rotated by the yarn pull. When, however, the yarn speed drops below the surface speed of the cylinders, the positive driving motion is once again engaged to drive the cylinders.

The drying cylinders on a slasher are driven by a long side-shaft, which runs from and receives its motion from the drag roll at the head end of the slasher. The side shaft runs the entire length of the slasher and drives the cylinders, the size rolls in the size box, and the stretch control unit if one is employed. Each of the driving cylinders is driven by an individual mechanism; that is, one gear train drives the large drying cylinder and another gear train drives the small drying cylinder, but both gear trains are driven by the same side shaft. The method usually employed to drive a drying cylinder consists of a mechanism connected to the side shaft and slasher frame and consists of a bevel gear on the side shaft which drives another bevel gear carried on a sleeve. A gear on the other end of the sleeve likewise meshes with a gear that is free to rotate on a shaft and that carries a pawl on its inside surface to drive a ratchet gear on the same shaft. A sleeve on the ratchet gear has a pinion gear, which meshes with and drives an annular gear on the drying cylinder. The pawl and ratchet are arranged in such a manner as to provide a positive gear-drive connection between the side shaft and the cylinder when the side shaft is driving the cylinder, that is, when the pawl is driving the ratchet. But, if the ratchet is rotated faster than the pawl, as occurs when the cylinder is being rotated by the yarn at a surface speed in excess of the speed at which it would be driven by the gear train, then the pawl will simply slide over the teeth of the ratchet gear without resting in them and the drive connection between the side shaft and the drying cylinder will be disconnected.

The self-releasing drive motion is applied to both the large and the small drying cylinder. The number of teeth on the large annular gear on each of these drying cylinders is varied so that the surface speeds of each of the cylinders will be equal.

AUTOMATIC CYLINDER CONTROL

28. Advantages.—High-speed slashers are generally equipped with automatic cylinder controls for the purpose of regulating and maintaining a constant drying-cylinder temperature. Many of the older types of slashers are being equipped with automatic cylinder controls by the mills. Some of the advantages produced by the use of automatic cylinder controls may be listed as follows:

First, the drying of the sized yarns may be uniform. Warp yarns, after having passed from the drying cylinders, are sometimes wound on the loom beam in a damp condition because of poor temperature control. Damp yarns promote the growth of mildew. Then, too great a drying temperature is liable to scorch the yarns, leaving them dull and harsh and removing most of their original strength and elasticity. Such yarns are difficult to weave into cloth, and some of them may be so badly tendered as to become worthless.

Second, a predetermined regain or amount of moisture may be maintained in the yarns. A standard regain of 6.5 per cent has been adopted for cotton cloth and yarns; that is, a yarn should contain within it 6.5 per cent of moisture based on the bone-dry weight of the material. The maximum amount of flexibility and the greatest weave-room efficiency are obtained in yarns having a theoretical regain of from 7 to 8 per cent. In actual practice, however, it has been found desirable to bring the yarns from the slasher with a regain of about 1 per cent less than the desired theoretical regain in yarn at the weave room. Or, it is often stated that the yarns leaving the slasher should contain from 1 to 2 per cent more moisture than was contained in the raw stock. Also, a regain of 6.5 to 7 per cent, besides giving superior handling qualities to yarn, will increase its strength. Between the points of 3 to 7 per cent regain, a 1 per cent variation in regain will result in a 6 per cent variation in yarn strength; the greater the regain, the stronger the yarn. Manual control of a slasher to produce a desired regain in the yarns slashed is extremely difficult. Then too, there is practically no way of knowing the exact regain in the yarn when the cylinder temperatures are manually controlled. It is usually necessary, when automatic control instruments are not used, to spend a number of hours in the laboratory to determine the amount of regain in yarn. Tables may be prepared to be used with automatic control instruments to show the relationship between regain, yarn speed, and cylinder temperature, thus greatly simplifying the control of regain in the yarns leaving the drying cylinders. One manufacturer of slasher drying-cylinder temperature controls has greatly simplified the control of yarn regain by calibrating certain of the recording instruments to read directly in the percentage regain existing in the warp yarns.

Third, a saving in steam is obtained with control instruments. In some instances, slashers have been operated with a steam pressure of 10 pounds in the cylinders before temperature-control instruments were installed, and afterward the steam pressure was reduced to a little over $1\frac{1}{2}$ pounds with the same drying efficiency being maintained.

29. **Types of Automatic Cylinder Controls.**—Several types of automatic cylinder controls may be used to maintain constant drying-cylinder temperature. For example, one system of slasher control is based on yarn regain.

A small detector roll about 6 inches long and 3 inches in diameter is placed over the guide roll r_1, Fig. 2, at the head end of the slasher. A bracket holds the roll in contact with the yarn. The bracket is well insulated and electric cables extend from the detecting unit to a power supply and recorder. The detector roll is very sensitive to slight changes in moisture content in the yarn and transfers the variation to the recorder in the form of an electric current. The recorder may be placed in practically any part of the slasher room as the only connection with the slasher required is a heavy, well-protected electric cord. The recording unit consists of a scale graduated in per cent regain with an indicator hand to show the regain. A time-regain chart is made, so a permanent record of the regain in the yarn for each loom beam slashed is obtained. Uniform regain is maintained in the yarn by the control system operating a set of diaphragm valves that control the flow of steam to the cylinders. If desired, the unit may be connected to regulate the slasher speed instead of the steam flow and may obtain uniform yarn regain in this manner. The advantage of this control system is that an accurate, visible control over yarn regain is obtained to within the limits of one-half of 1 per cent. The normal operating range for this control unit on cotton is between 6 to 8 per cent regain.

Various types of automatic cylinder controls have been introduced, some of them operating on one drying cylinder only and others on both cylinders. Undoubtedly, the control system illustrated in Fig. 9 (*a*) and (*b*) and having the individual cylinder temperature controlled by the exhaust condensate, may be considered a representative system of slasher cylinder-temperature control. The cylinder temperature remains constant in this system regardless of the slasher speed. The steam is partially shut off to allow the temperature to fall during doffing to prevent baking of the yarns. A thermometric bulb, placed in the condensate line from each cylinder and connected with the temperature recorder-controller instrument, not only makes a permanent record of the temperature of both cylinders on the same chart, but also operates, or controls, the flow of air, which operates a set of diaphragm valves in the steam and condensate lines of both cylinders.

30. The automatic cylinder control unit shown in Fig. 9 (*a*) and (*b*) consists of a recorder-controller instrument *l*, view (*a*), mounted on an instrument board, the board being supported by standards securely fastened to the floor and on the

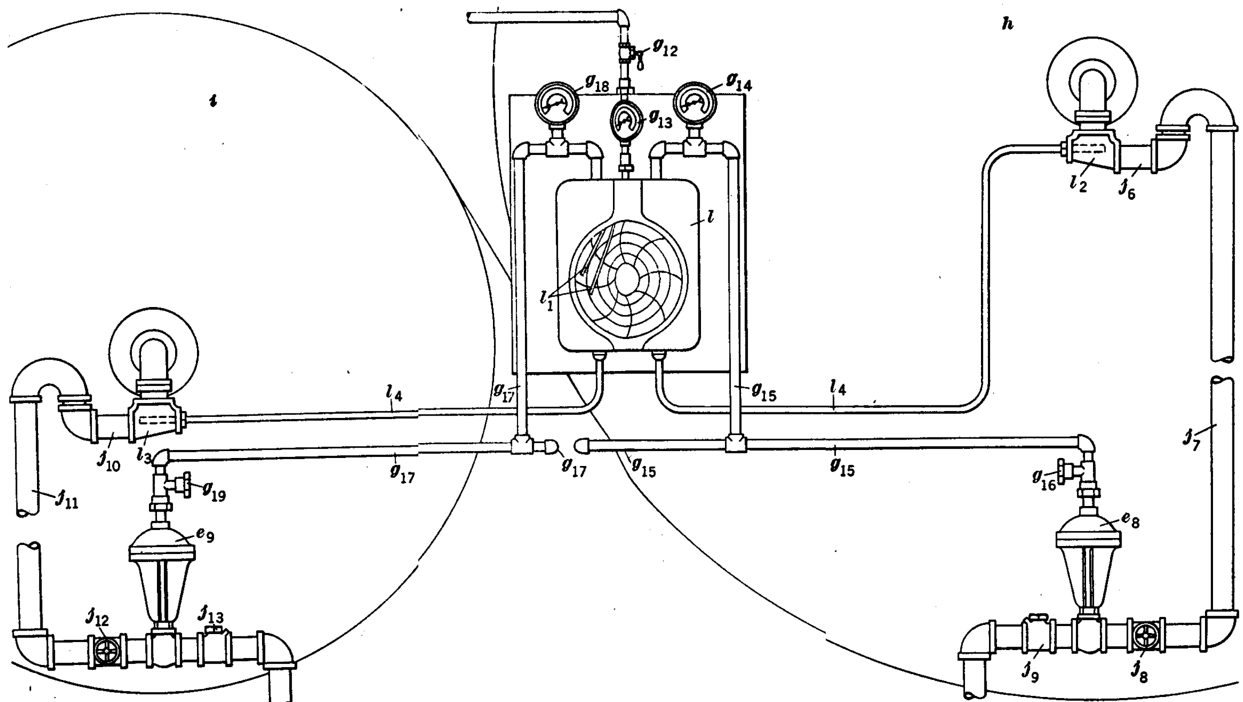

FIG. 9 (*a*)

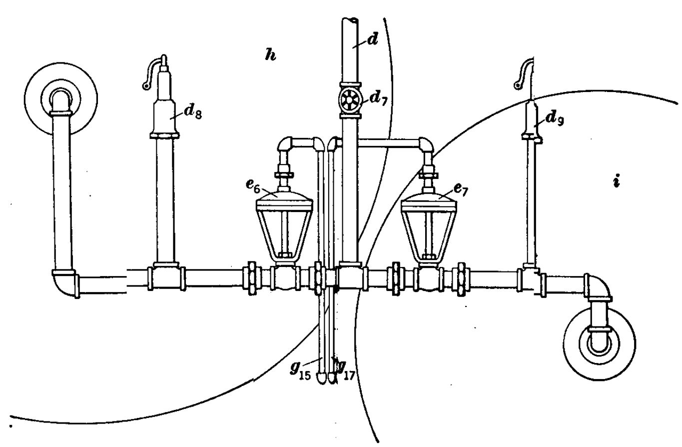

FIG. 9 (*b*)

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same side of the slasher as the condensate pipes. The recorder has a circular chart on which are recorded the cylinder temperature and the period of time over which the temperature is maintained. The two pointers l_1 carry the pens that record the temperature of each cylinder on the chart. Thermometric bulbs l_2 and l_3 are placed in the condensate line from each cylinder. The tubes l_4 connect the bulbs with the recorder-controller. Each bulb actuates one of the pointers l_1 and, in addition, controls a sensitive but powerful pneumatic valve that regulates the flow of air to each set of diaphragm valves. A diaphragm valve is placed in both the steam and the condensate line of each cylinder. The steam and the condensate valves to each cylinder work in conjunction with each other but with a slight differential in the time of closing between the two; that is, the valve in the condensate line closes first. Check-valves j_9 and j_{13} are placed in the condensate lines below the diaphragm valves for the purpose of allowing the condensate to flow in only one direction. If these check-valves were not placed in the lines, the vacuum formed by the steam condensing in the slasher after slashing operations have been stopped, would tend to draw whatever water remained in the condensate lines back to the slasher cylinders. Two relief, or safety, valves d_8, d_9, view (*b*), are placed in the steam line and are set to open at about 15 pounds pressure as a safety measure to prevent the cylinders from being damaged by excessive steam pressures.

31. Operation of Automatic Cylinder Control.—In the automatic temperature-control unit for regulating slasher cylinder temperatures illustrated in Fig. 9, view (*a*) shows the controller installed on the side of the slasher having the condensate pipes while view (*b*) shows the connections on the other side of the slasher where the steam pipes are located.

The pointers l_1, view (*a*), a part of the recorder, which is mounted on the instrument board, are set at the temperature at which it is desired to maintain each cylinder. Steam is admitted from the main line *d*, view (*b*), by opening the valve d_7 and allowing the steam to flow through both diaphragm valves e_6 and e_7 and into the cylinders. Air from the main air line passes through the opened petcock g_{12}, view (a), through the gage g_{13}, and into the controller unit. The air gage shows the pressure of the air entering the controller. The water formed by condensation of the steam within the cylinders after the slasher has been stopped will partially collect in the goosenecks j_6, j_{10}. As steam is admitted to the cylinders and comes in contact with the cold cylinder walls, condensation results and part of this hot condensate also is trapped in the goosenecks. The hot condensate that collects in the goosenecks heats and tends to expand the thermometric bulbs l_2, l_3, which, acting through the flexible tubes l_4, operate a set of sensitive but powerful pneumatic valves that control the flow of air to the diaphragm valves.

A certain amount of condensate collected from the previous run of the slasher will be retained in the goosenecks. Thus, only a small amount of hot condensate that has just been formed, is necessary to heat the cold water in the goosenecks and set the thermometric units in operation. In this manner, the length of time in which the cylinder temperature controls are inoperative while the cylinders are heated, is greatly reduced. When the thermometric bulb l_2, in the gooseneck j_6 of the large cylinder, has expanded sufficiently to cause the pneumatic valve in the controller unit l to open, air flows through the controller and the air gage g_{14} and into the air line g_{15}. The air passes along the line g_{15} to the diaphragm motor valve e_6, view (b), located in the steam line, and also to the diaphragm motor valve e_8, view (a), in the condensate line. When the air gage g_{14} indicates an air pressure of 5 pounds in the line, the diaphragm valve e_8 in the condensate line will begin to close, but the valve e_6, view (b), in the steam line will not begin to close until the air pressure reaches about 7 pounds. By the time the air pressure reaches 10 pounds, both the intake and exhaust valves to the cylinder h are closed. In this manner, the flow of steam to the large drying cylinder is stopped when the cylinder temperature reaches that set for the controller unit.

32. The thermometric bulb l_2, Fig. 9 (a), contracts as the steam in the large cylinder condenses because of the cooling effect of the wet yarn on the cylinder. The condensate discharged from the cylinder will collect in the condensate discharge pipe because the diaphragm valve e_8 has closed this passage. As the condensate cools, the cylinder temperature is reduced. The bulb l_2 contracts and causes the pneumatic valve in the controller unit to close, thus stopping the flow of air. Air in the line g_{15} and in the diaphragm valves escapes through the air relief valve g_{16} and allows the diaphragm valves to open again. Steam once more flows into the large cylinder to heat it, and condensate is again exhausted from it by passing through the gooseneck j_6, the pipe j_7, the hand valve j_8, the diaphragm valve, and the check-valve j_9, and into the return condensate line.

The thermometric bulb l_3 in the gooseneck of the small cylinder regulates the small cylinder temperature in exactly the same manner as the large cylinder temperature was regulated, even to the maintenance of the same differential in pressures between the diaphragm valves in the steam and the condensate lines. The air line g_{17} leads from the controller l to the diaphragm valve e_7, view (b), in the steam line and to the valve e_9, view (a), in the condensate line. An air gage g_{18} in the line indicates the air pressure, and a relief valve g_{19} allows air in the lines to escape so as to open the diaphragm valves. Condensate is removed by passing through the gooseneck j_{10}, the pipe j_{11}, the hand valve j_{12}, the diaphragm valve, and the check-valve j_{13}, and into the return condensate line. Air, steam, and condensate flow through the network of lines and act on the component parts of the system controlling the small drying-cylinder temperature as it does in that network of lines controlling the large drying-cylinder temperature.

When the slasher is stopped for an indefinite period of time, such as when a set of yarns runs out, or the night or the week-end, the steam inlet valve d_7, view (b), is closed. The recorder should be carefully watched after the valve is closed because, when the pointers l_1, view (a), reach the center of the chart, the valves j_8 and j_{12} in the condensate lines should be closed so as to retain whatever water is in the goosenecks. Otherwise, the water will be withdrawn should a vacuum exist in the condensate lines. Ordinarily, the small cylinder control functions more often than the large cylinder control, because of the variation in the degree of dampness of the sheet of yarn between the two cylinders. During normal operation, the diaphragm valves to the large cylinder will be open practically all of the time because the yarn, as it first leaves the size box, passes around the large drying cylinder first. Therefore, this cylinder removes most of the moisture from the yarn.

HEADSTOCK

33. The head end of a slasher, that is, the forward part of a slasher, and this includes all sections from the drying cylinders to the loom beam, is often termed the headstock. The headstock also consists of parts such as the fan *k*, Fig. 2, under which the yarn passes as it leaves the small drying cylinder *i*. Generally, the fan tends to cool the yarn and, to a certain extent, breaks undesirable size formation when numerous ends of warp yarns are stuck together. The sized yarns pass from around the drying cylinder *i*, around the guide rolls b_2, b_3, b_4, and through the split rods m, m_1, m_2, m_3, m_4. A slasher comb *n* tends to separate and guide the yarns at full width through the tension bars b_5, b_6, around the measuring roll *p*, the drag roll *r*, and the guide roll r_1, and to the loom beam *s*.

34. Split Rods.—Split rods are small round rods with flattened ends, which have a length slightly greater than the width of the slasher. The rods are held in brackets on each side of the slasher framework and may be easily removed or replaced. The flattened ends tend to prevent the split rods from turning as they are held in the brackets. Split rods are used to separate the sized warp yarns at the headstock into their component sheets of yarns as they come from the beams in the creel. Thus, all yarns in the sized warp that come from a certain beam in the creel would be separated into the same sheet of yarn. The separating of warp yarns into their component sections prevents the yarns from rolling and becoming tangled with one another, and, in case of yarn breakage, it permits the broken yarn to be located and tied easily. Then, too, split rods serve another purpose, that of breaking whatever size formation tends to stick or hold several yarns together.

35. Slasher Comb.—The slasher comb *n*, Fig. 2, or expansion comb, as it is often called, divides the sized warp ends and guides them at correct width on the loom beam. Several types of slasher combs have been used, but, essentially, each consists of a large number of thin, straight steel needles or teeth, which are set in a base. The base may be regulated so as to change the distance between the needles, the adjustment generally being made by means of a handwheel. Also, it is usually possible to incline the comb at any angle. The comb should be inclined when starting a new set of beams in the creel so that the knots will pass. When it is not possible to incline the comb, a rod is usually provided to raise the sheet of warp yarns above the comb at will.

36. Drag Roll.—The drag roll *r*, Fig. 2, which serves as a basis for practically all slasher calculations, tends to pull, or drag, the yarn through the slasher and deliver it to the loom beam. The roll is usually made of metal and is about $8\frac{15}{16}$ inches in diameter. While the drag roll and the size roll are geared directly together, the size roll is usually 9 inches in diameter. The difference, or variation, in roll diameter is made so that several layers of cotton cloth may be wrapped around the drag roll to form a blanket. The cloth gives the roll a better grip on the yarns and at the same time prevents the yarn from being cut by the measuring roll *p* or by the guide roll r_1, both of which are in contact with the drag roll. Also, the blanket makes it possible to vary the tension on the yarn between the size roll and the drag roll. If, for instance, the drag roll is lapped with cloth until its diameter is greater than 9 inches, the warp yarns will be placed under a strain, or tension, as they are drawn forward because the drag roll will have a greater surface speed than the size roll. Then, it is advisable never to permit slack yarn to exist between the size and the drag roll. Theoretically, when both rolls have a diameter of 9 inches, no strain is placed on the yarn because the size roll is delivering the same length of yarn that the drag roll is absorbing.

37. Friction Drive for Loom Beams.—The slashed yarn is delivered by the drag roll at a constant rate of speed. The drag roll is driven positively and at a constant number of revolutions per minute; therefore, the surface speed of the drag roll, and consequently the number of yards of yarn delivered by this roll, will be constant. The yarn is wound on a loom beam, which is constantly increased in diameter. If the loom beam is positively driven and adjusted to absorb all of the yarn delivered at the start of a new beam, the surface speed of the loom beam, because of its increasing beam diameter, will increase after a few yards of yarn have been wound. The yarn is, however, delivered by the drag roll at a constant rate of speed and absorbed by the loom beam at a variably increasing rate of speed. Yarn wound under these conditions would be severely strained and eventually broken. The friction drive is a device introduced to prevent breakage by allowing slippage to exist between the drive and the loom beam. As a result, practically no strain is placed on the yarn, although a slight tension, just sufficient to wind an even loom beam is maintained.

The loom beam s, Figs. 10 and 11, is supported at the head end of the slasher by two shafts, the arbors s_2 on each end of the loom beam fitting into recesses in the ends of the shafts s_3. The shaft s_3, Fig. 11, on one side of the slasher is stationary, that is, it is not free to rotate, but it may be moved horizontally so as to accommodate loom beams of varying widths. A handwheel on the end of the setscrew that passes through the slasher framework securely holds the shaft in place.

A shaft s_3, Fig. 10, on the other side of the slasher, is supported by the two vertical members in the slasher framework; that is, it is supported between the two vertical members of the loom-beam, friction-drive mechanism. The arbor s_2 of the loom beam likewise fits into a recess of the shaft s_3 on this side of the slasher. A plate s_4 on the end of the shaft carries a stud s_5, which comes in contact with a dog s_6 that is setscrewed to the arbor of the loom beam. Thus, as the shaft s_3 is rotated, the plate s_4 revolves and forces the dog to turn the beam. If, however, it is desired to adjust the shaft s_3 for a limited distance to allow loom beams of greater width to be accommodated, the collar s_7 on the shaft s_3, may be moved. Therefore, the shafts s_3 may, on both sides of the slasher, be adjusted horizontally for a slight distance.

A keyway is cut the full length of the shaft s_3, and two cast-iron sleeves t are keyed to this shaft in such a manner as to

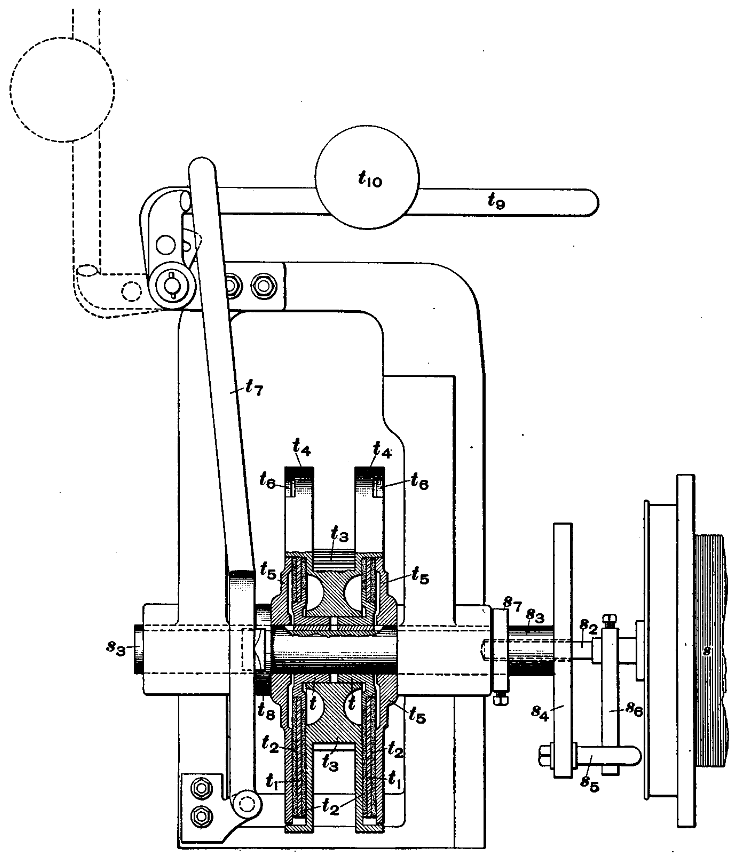

FIG. 10

permit a slight lateral movement. These sleeves, however, are not free to revolve without turning the shaft to which they are keyed. Attached to these sleeves are two friction plates t_1, which consist of thin steel disks covered on both sides with friction pads t_2 of a material possessing a high coefficient of friction,

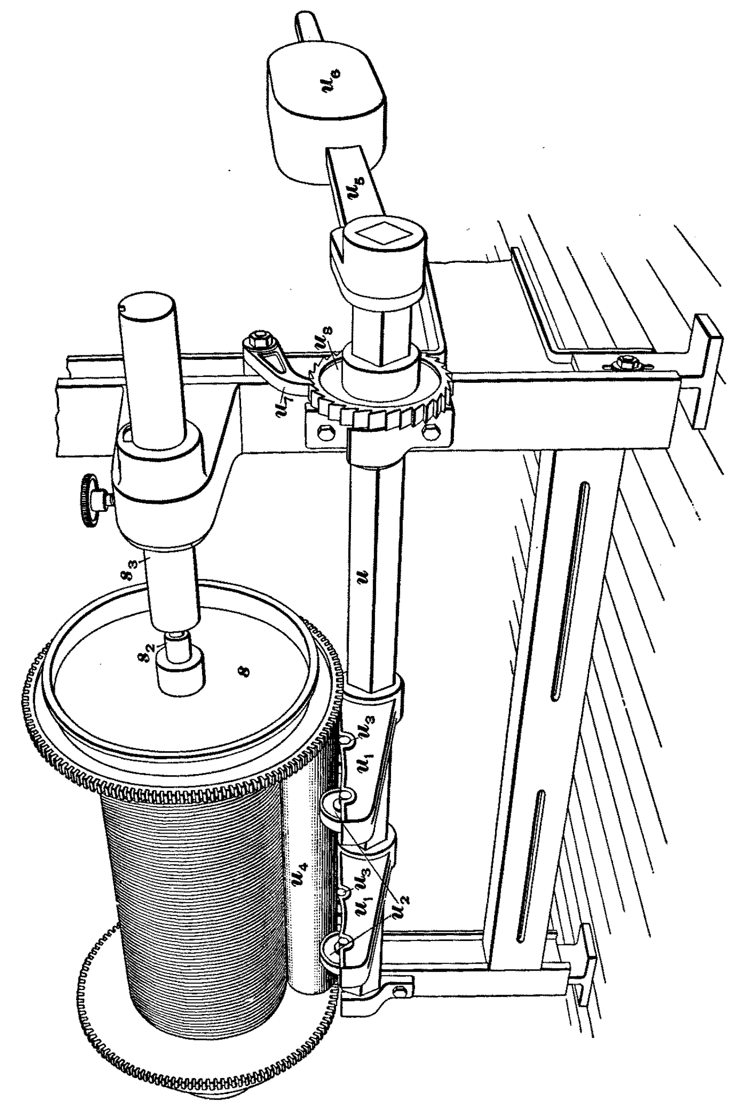

FIG. 11

such as rubber, felt, cork, or similar materials. Therefore, the friction plates and the sleeves act as an integral unit. Gear t_3, which is cast between two disks t_4, is mounted on the sleeves and is free to revolve about them. The gear meshes with the large gear on the drag roll. The ends of the disks, which are an integral part of the gear t_3, are so constructed that notches are cut on their outer surface at frequent intervals about their circumference. The outer plates t_5 are placed on either side of the disks t_4 and have projections t_6 cast on their outer surfaces, which fit into the notches of the disks t_4. Therefore, as the gear t_3 revolves about the sleeves and carries with it the disks, the plates t_5 will also revolve.

38. When it is desired to set the loom-beam in rotation, the shipper handle t_7 is moved to one side and forces the collar t_8, which is free to revolve about the shaft s_3, to one side. The friction mechanism, having a slight lateral movement, will be moved to one side also. Thus, the collar is forced against the plate t_5, which tends to compress the friction pads carried on the sleeve t between the disk t_4 and the plate t_5. As the gear t_3 is constantly rotating but as there is no frictional contact between the disk t_4 and the friction pads when the shipper is in the off position, motion will not be imparted to the sleeves t. However, when the collar t_8 compresses the friction pad between the disk t_4 and the plate t_5, frictional contact is made and the friction pads tend to revolve with the disk t_4, thus turning the sleeve t to which they are bolted and likewise the shaft s_3. The same action takes place on both of the disks t_4, thus giving four frictional surfaces; that is, frictional contact is made between the plate t_5 and one of the frictional sides of the pads, and likewise between the disks t_4 and the other side of the frictional pad, and, as there are two disks and plates, four frictional surfaces result.

A lever t_9 carries an adjustable weight t_{10}. The lever is attached to the slasher framework in such a manner that, when it is moved to one side, it forces the shipper handle to make frictional contact between the friction pads and the plates of the friction drive, thus causing the shaft s_3 to revolve the loom beam. However, the movement of the shipper handle may be varied by adjusting the position of the weight on the lever t_9. Thus, the degree of friction, or the amount of slippage, existing between the plates and the mechanism may be varied, and consequently the speed at which the loom beam s turns may likewise be varied. Because the rotation of the loom beam depends on the frictional contact between the friction disks and the plate surface, the speed with which the loom beam rotates will never equal that of the gear t_3.

The speed of the loom beam may be changed by varying the position of the weight t_{10}. Speed variations should always be adjusted so that the loom beam winds the yarn only as delivered, any undue additional speed of the slasher drive being lost between the frictional surfaces. The closer the weight t_{10} is moved to the end of the lever t_9, the greater will be the pressure placed on the friction pad and, consequently, the greater the winding speed and the amount of tension placed on the yarn. In starting a new loom beam, the weight should be adjusted so that there will be as little slippage as possible at the beginning. Tension on the yarn will vary as the loom beam fills, so it may have to be corrected slightly by changing the position of the weight at intervals of time.

39. Beam Pressers.—A beam presser is used in addition to the friction drive on a slasher to insure the building of a firmly wound loom beam. Although the friction drive tends to wind the warp yarns on the loom beam under tension, the tension at which the yarn is wound will vary as the loom-beam diameter increases. Also, if sufficient tension is applied to the yarns to form a firm and solid loom beam, most of the warp yarns will be subjected to severe strains. But if, after the yarns are wound on the loom beam, a compressive force is applied to the beam, a firm, solid loom beam is created without straining the warp yarn. The object of the presser is, therefore, to form a firm, compact loom beam that may be unwound at the loom without entwining the yarn with other layers of yarn and producing broken ends.

One type of beam presser often used on slashers is illustrated in Fig. 11. The shaft u extends the entire width of the slasher beneath the loom beam s and is supported in place by brackets attached to the slasher framework. Two arms u_1 extend from the shaft u and carry the rollers u_2, u_3. A large presser roll u_4, the width of the loom beam between heads, or flanges, rests on the rollers u_2, u_3. Another lever u_5, carrying an adjustable weight u_6, is attached to the end of the shaft u. The weight, acting through the lever, forces the presser roll u_4 against the yarn of the loom beam. To prevent the roll u_4 from being forced upward when the loom beam is removed, a pawl u_7 slides over the back of the teeth of a ratchet gear u_8 as the loom beam gradually increases in size, thus holding the presser roll in position in case the loom beam is removed suddenly. The action of the pawl does not in any way prevent the presser roll from being forced against the yarn as it is wound on the beam.

A disadvantage of using the cylinder type of beam presser as described is that, in a mill running loom beams that vary slightly in width, some of the yarn in the space near the beam heads will not be wound under pressure. To overcome a defect of this nature, an expansion presser roll is often used. An expansion presser roll is usually made by bringing two roll sections together and using a spring to force the sections against the heads of the beam. A projection on one roll, where the two sections come together, fits into a recess on the other roll and in this manner keeps the yarn for the entire width of the loom beam under action of the expansion roll.

Sometimes it is advisable to use a beam presser with a carriage carrying two presser rolls; that is, a very short roll is carried behind a roll of the expansion type for the purpose of pressing the yarn that passed beneath the joint of the expansion presser roll. When such a carriage is used, three sets of rollers are necessary on each lever arm u_1 to support the presser rolls, the outside set of rolls being placed at an angle so as to replace the action of the spring in the expansion presser roll and force both sections of the divided presser roll against the loom-beam heads. The other presser roll is much shorter than the divided roll and is used to overlap and press the yarn that has not been pressed and that comes from under the divided section of the expansion presser.

The entire presser-roll mechanism, as well as the loom-beam shafts and arbors, must be in perfect alinement. If any one of these parts is out of line with the others, the presser roll will also be thrown out of line and, as a result, will tend to weave back and forth during operation, thus coming in contact with first one head of the loom beam and then the other and making it possible for the yarn to get into this space and be cut. Some beam pressers have a small setscrew threaded through the presser arm close to the square shaft supporting the mechanism. By turning the setscrew, the presser-roll arm may be either raised or lowered slightly to obtain correct alinement of the presser roll with the loom beam.

40. Measuring Motion and Cut Marker.—A measuring motion is usually incorporated in most slashers to indicate to the operative the number of yards of yarn that have passed through the slasher. The measuring device is geared to the measuring roll *p*, Fig. 2, in such a manner as to indicate the number of yards of yarn slashed. On some slashers, another indicator may be used to indicate the speed in yards per minute of the yarn passing.

Often, when a stretch-control unit is incorporated in a slasher, a second yardage clock is used and is placed next to the one at the head end of the slasher so that both may be viewed at once. But, the second clock is driven from the stretch control. Thus, one clock indicates the yardage of yarn fed to the slasher, and the other, the yardage of yarn slashed. By taking the difference between the two reads of the clocks, the amount of yarn-stretch may be determined.

A cut marker is often connected to the measuring roll so as to work in conjunction with the measuring motion. The purpose of the cut marker is to indicate on the yarn, usually by means of a spot of fugitive dye, that a certain number of yards of yarn have passed through the slasher. The cut mark also indicates to the weaver that a certain number of yards of cloth have been woven at the loom and that the cloth should be severed from the rest and sent to the finishing room. Generally, 60 yards is considered to be a cut, although 40 yards is sometimes used. The length of a cut is not a specified figure because some mills prefer to use the yardage for cuts which will better suit their requirements. However, cut marks are not applied to all warp yarns slashed, nor are cut markers attached to all slashers. In many instances, yarns are slashed, such as for the warps for sheeting, in which it is desired to keep the woven cloth intact and form as large a cloth roll as possible at the loom beam to simplify finishing operations later.

Cut markers may be placed at various positions on a slasher. For example, the marker is sometimes placed at the head end of the slasher at the guide roll b_4, Fig. 2. Other times, it may be placed between the size box and the drying cylinders, a position of decided advantage, as, in some instances, it allows the cut mark to be well dried and prevents it from staining the rest of the warp when the yarn is wound on the beam.

The length of yarn between cuts may be regulated by changing the number of teeth on a change gear. Most cut markers are constructed in such a manner as to have the number of teeth on the change gear equal to the number of yards of yarn desired in a cut. Thus, if a 60-yard cut is desired, a 60-tooth change gear should be used.

41. Slasher Drives.—Slashers are often driven at slow speed, especially when a new set of warp yarns is to be started or when certain types of yarns are to be slashed. For example, soft, weak yarns must be run at a slow speed to prevent yarn breakage. If such a change in yarn speed is necessary, the change gear must be varied, especially on some of the older slashers. Thus, much time is lost in making the necessary adjustments. A slow-motion drive, as used on many slashers, tends to eliminate the necessity of varying the change gear every time speed changes are necessary.

A slow-motion device, similar to the one illustrated in Fig. 12, is sometimes employed to provide the desired reduction in slasher speed. A tight pulley v, view (a), is setscrewed to a driving shaft v_1. When the driving belt is on the tight pulley, the shaft will turn at its maximum speed. A slow speed pulley w is cast as a part of a sleeve w_1, which is free to revolve

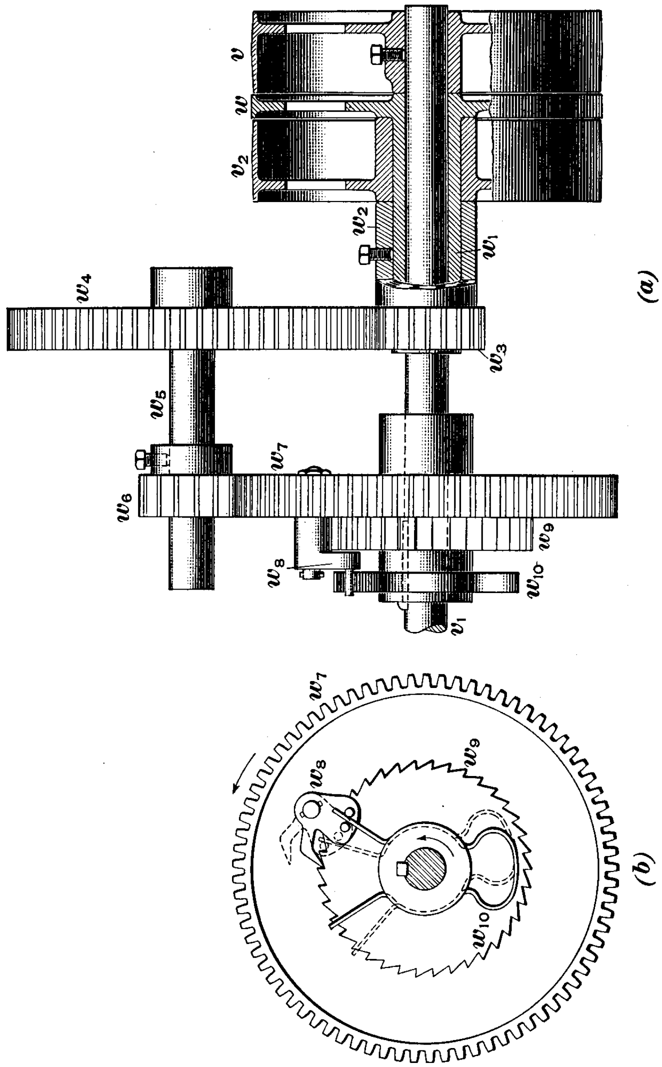

Fig. 12

around the shaft v_1. A loose pulley v_2 is free to revolve around the sleeve w_1. A gear w_3, which meshes with a gear w_4 on a short countershaft w_5, is cast with an extra long hub w_2 and is setscrewed to the sleeve w_1. Therefore, any motion applied to the slow-motion pulley will be imparted to the gear w_3, which turns the gear w_4 and the countershaft w_5. The countershaft carries a gear w_6, which meshes with a gear w_7, which is loose on the shaft v_1. The gear w_7 carries a pawl w_8, which slides over the back of the teeth of a rachet gear w_9, which is keyed to the shaft v_1. As the gear w_7 revolves and carries the pawl around with it, the ratchet gear is turned, imparting motion to the drive shaft v_1. The pawl w_8, view (*b*), carries two pins that are set close together. One end of a wire clip w_{10} passes between the two pins, and the clip is snapped around the hub of the ratchet gear. As the drive shaft rotates in the direction shown by the arrow, it will carry the ratchet gear keyed to it along with the clip. The movement of the clip tends to move the pawl forward and swing it up out of contact with the teeth of the ratchet gear, as illustrated by dotted lines in view (*b*), thus disengaging the slow-motion drive. When the driving belt is moved to the slow-motion pulley, the gear w_7 will carry the pawl forward. Because one end of the clip is between the two pins on the pawl, the clip will be pulled forward and the pawl forced downward to engage with the teeth of the ratchet gear. Thus, the slasher is driven through the slow-motion gear train. Usually, the gears in the slow-motion gear train are chosen in the correct size to drive the slasher at about one-eighteenth its normal speed.

When a slasher is equipped with a slow-motion device as the only means of speed reduction, a gear is attached to one end of the driving shaft to mesh with an idler, or intermediate gear, which in turn drives the drag roll. The gear on the end of the driving shaft, in this instance, is the change gear. A side shaft runs from the draw roll to the cylinders and size rolls.

42. Slasher drives, consisting of only a slow-motion device similar to that described, are usually unable to provide the desired range of yarn speed. As a result, many high-speed slashers include a cone drive, which, in addition to a slow-motion, gear-train device, practically eliminates the necessity of employing change gears except when wide ranges in yarn speeds are desired.

One type of slasher drive employing a cone drive consists of a driving cone attached to the shaft v_1, Fig. 12 (a). Another cone, exactly the same as the one on the driving shaft, is placed parallel to it, but with the large diameter of the driving cone opposite to the smallest diameter of the driven cone. Thus, a belt may be moved the entire length of both cones to act as a driving medium, and the position of the belt on the cones will govern the speed ratio obtained between the driving and the driven cone. A guide rod encircles the driving belt on the cones and is attached to a shipper so that, by moving the shipper, a change in slasher speed may be obtained. By running the main driving belt on the slow-motion pulley and using the cones, a variation in slow speed may be obtained by moving the position of the belt on the cones. High-speed variation may be obtained by using the cones and running the main driving belt on the high-speed pulley. Motion is imparted to the slasher when a cone drive is used by the main driving belt turning the pulley v or w, which in turn rotates the shaft v_1, which carries the driving cone. A belt connects the driving cone to the driven cone, and a pinion gear on the driven cone drives through a carrier gear that meshes with a gear on the drag-roll shaft. Motion to the rest of the slasher is obtained from the side shaft, which is geared to the drag roll.

FOUR-CYLINDER HIGH-SPEED SLASHER

HIGH-SPEED SLASHING

43. High-Speed Slashing System.—Slashing has been referred to as an operation that governs the production of a cotton weaving mill; that is, the number of looms that may be operated at one time is governed by the number of warps available for the looms. Since the warps are formed in the slashing department of a mill and the number of warps available determines the number of looms that may be operated, the slashing-room production tends to limit or to control the weave-room production.

However, many mills produce cotton cloth of one type of construction or of only a limited number of constructions. Mills weaving sheetings, print cloths, ducks, industrial fabrics, and the like are excellent examples of mills with production restricted to fabrics of a limited number of varieties. In such mills, the operation of slashing becomes a routine. Each time the slasher is creeled, the same number of section beams, each containing a number of ends equal to the ends of the preceding beams, are placed in the same positions in the creel. The size mixture is of the same composition. The split rods are placed in the same positions in the warp. Leases are taken like those in the preceding loom beam, and the beam will have a like number of ends and be of a length equal to the first loom beam slashed. Thus, the production of a slasher in such a mill is limited by the time required for creeling a new set of ends and twisting them in, by the time required for doffing the filled loom beams, and by the maximum speed possible to operate the slasher without producing inferior work. Because of the necessity of developing a system of slashing and a slasher suitable for meeting the above requirements, the high-speed slashing system and the four-cylinder high-speed slasher were developed.

The essential purpose of the high-speed slashing system is to reduce the time required to creel a slasher and to permit operation of a slasher at a speed greater than normally possible with a two-cylinder slasher. This system, however, is made possible by the introduction of the four-cylinder high-speed slasher and by automatic size-preparation equipment.

44. Units Composing High-Speed Slashing System. Automatic size-preparation equipment is an essential part of the high-speed slashing system. The equipment is located in the size room and is constructed so as to operate in conjunction with, and to supply size to, the four-cylinder high-speed slasher. Thus, by using automatic size-preparation equipment, it is possible to prepare different batches of size of the same consistency and of the same composition for the slasher with the minimum amount of manual control. In this manner, a supply of size is continually being prepared, or is stored, and, the greater portion of the time formerly required by an operative in preparing a size mixture may now be devoted to productive work about the slasher.

The four-cylinder high-speed slasher used with this system of slashing has two movable creels. The creels are similar in construction to the movable creel described previously. Thus, it is possible for one creel to be moved to one side of the slasher on the track provided for this purpose and be recreeled while the slasher is in operation. In this instance, the other creel at the rear of the slasher contains the section beams from which the yarn slashed is drawn.

The operatives that replace the empty section beams in the creel with full beams need not be skilled or highly experienced. A drawing-in frame mounted on rollers, that is, a frame designed to permit the warp ends in the creel to be drawn forward and counted so that all ends are parallel and in proper order, is used. In this slashing system, it is necessary to move the creel at the rear of the slasher only when it runs out. The creel to one side is rolled on the track to the back of the slasher and locked in place. The warp ends in this creel, which are in proper order, having been so counted in, are simply twisted to those in the slasher when warps of the same construction are to be slashed. In this manner, great reductions in time are possible over that formerly required in recreeling the ordinary slasher.

Then, the slasher itself has been entirely redesigned so as to permit warps to be slashed at speeds about twice that permitted on the ordinary two-cylinder slasher. The use of a stretch control, a size box of improved construction, cylinders of superior design that permit operation under greater steam pressure and higher temperatures, and the like, are slasher improvements that permit higher slasher speeds.

When all the above improvements in slasher construction and operation have been combined so as to form a high-speed slashing system, numerous advantages are accrued. First, slasher efficiency is increased because the period of time the slasher is normally stopped for recreeling, and the like, is reduced materially. Second, the quality of the yarn slashed is improved. Better control over size temperatures and drying temperatures as well as superior control of the preparation of the size are attained, and all these factors tend to deposit size more uniformly on the yarn and maintain the correct amount of moisture within the yarn. Third, production is increased greatly because of higher slashing speeds. Fourth, the use of automatic equipment throughout the size-preparation process and the slashing operations gives better control over these operations and requires fewer operatives. In this manner, the work of the operatives is simplified.

However, the four-cylinder high-speed slasher is not suitable for use in all mills. This slasher has been designed strictly as a high-production unit and for use with a high-speed slashing system. Thus, unless a mill is capable of using a large number of warps, each of which is of the same construction, this slasher cannot be used to advantage. It is claimed that, unless a mill has sufficient production to operate at least three or four slashers of the ordinary two-cylinder type, a four-cylinder slasher may not be used successfully. Then, the character of the warps slashed must be such that changes are not required in the warp. Therefore, only mills producing fabrics of a standard construction, such as sheetings, ducks, standard print cloths, and the like, and producing these cloths in large quantities, may find it economical to employ a four-cylinder high-speed slasher.

ESSENTIAL FEATURES AND PARTS

45. Assemblies.—A four-cylinder high-speed slasher consists of five different sections or assemblies. Each section is complete in itself and has a definite function to perform in regard to slashing. Yet, each section is constructed as a division of a slasher and fits into its respective position so as to form a complete slashing unit. Essentially, the five assemblies which comprise a four-cylinder high-speed slasher are as follows: a movable creel, an improved size box and stretch control unit, redesigned and improved drying cylinders, a new head end, and control instruments for operating the slasher.

46. Passage of Yarn.—The passage of yarn through a four-cylinder high-speed slasher, as illustrated in Fig. 13, is as

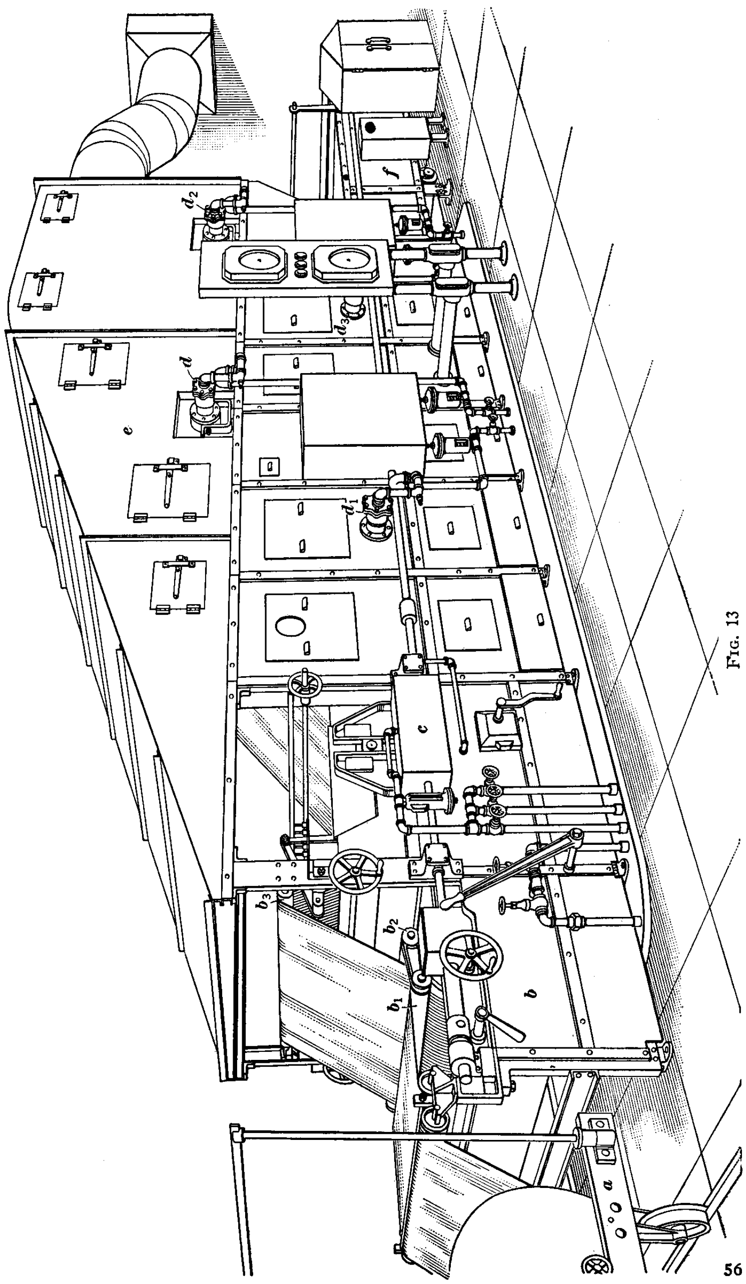

Fig. 13

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follows: Yarn in sheet form is drawn from each section beam in the creel *a*, as in the creel of an ordinary slasher, and is passed forward to the front of the creel where it is united as a single sheet of warp yarn. The yarn passes over a set of guide rolls on the end of the slasher and into the stretch control unit *b*. Two small guide rolls, b_1, b_2, hold the yarn in contact with the greater portion of the circumference of the positively driven drag roll of this unit. Then, the yarn passes around another guide roll b_3 supported in the framework between the stretch control and the size box *c*. It is carried into the size bath by passing beneath the ribbed immersion roll, and the surplus size is squeezed from the yarn as it is drawn forward by the two sets of size and squeeze rolls within the size box.

The yarn passes upward and around the first drying cylinder *d* in the top tier of cylinders next to the size box, down and around the first lower drying cylinder d_1, up and around the other top drying cylinder d_2, and down and around the bottom drying cylinder d_3. As it passes around the drying cylinders, the yarn is dried of all surplus moisture so that the correct amount of regain, or moisture, is left in the yarn. A hood *e* protects the yarn while it is being dried and tends to remove the moist air. In this manner, the drying efficiency of the slasher is increased. The yarn, as it leaves the drying cylinders, passes around a guide roll and a cooling fan, and is finally drawn to the head end *f* of the slasher. Split rods are inserted in the warp to separate the different sheets of warp yarn in the order in which they came from the section beams. The yarn then passes over a guide roll, around the drag roll, around the tension roll, and is wound in proper order on the loom beam.

47. Movable Creel.—A movable or magazine creel, as it is often called, comprises the first assembly. This section, or assembly, consists of two creels, each one mounted on rollers designed to run on a raised metal track on the floor at the back of the slasher but perpendicular to it. Thus, as one creel is exhausted, the other creel may be moved into position. In this manner, the time ordinarily required to creel a slasher is reduced.

The section beams are supported in the creels in antifriction bearings held in adjustable bearing blocks, which may be adjusted to support section beams of varying widths. However, the beams usually accommodated in this creel are generally of greater size and capacity than those used with most other cotton slashers. A beam with a 28- to 30-inch diameter head generally replaces the customary 24-inch beams. Thus, the yarn capacity of a creel is increased, and recreeling operations are less frequent. Each beam then weighs about 725 pounds instead of about 475 pounds.

A friction release is incorporated on the creel. With this device, friction is released while the slasher is in operation, but when the slasher is stopped, friction is applied to each section beam head and stops the beams from rotating and the yarn from overrunning. The friction-release device simply consists of a rope that is passed around the head of each beam on one side of the creel. The rope passes over the head of the last beam of the creel, down and around the next beam head, over and around the next, and so on, until each beam head on one side of the creel is partially encircled by the rope. In each instance, the rope rests in a groove on the end of the head of a beam. By attaching one end of the rope to the creel and the other end to a lever connected to the shipper rod, tension may be applied to the beam heads at will. Thus, the rope is so attached to a lever on the shipper rod running the length of the slasher that, when the shipper is moved to the off, or stop, position, the rope will be tightened. As the rope is tightened, friction is applied to the beam heads and consequently stops the beams from rotating. However, when the shipper handle is moved into the starting position, the rope is loosened and the section beams are permitted to revolve freely.

48. Stretch Control and Size Box.—A stretch control and a redesigned size box comprise the second assembly of this slasher. The stretch control is placed between the creel and the size box, but is built as a part of the size box. The purpose of the stretch control is to draw the yarn under uniform tension from the creel. Thus, the yarn delivered to the size rolls is without strain. If the wet size and squeeze rolls were to draw the yarn forward from the creel without the aid of a stretch control, the yarn would be liable to slip. Yarn slippage occurring between the size and squeeze rolls of a slasher tends to place the yarns under sudden strains and cause excessive yarn stretch. Also, it tends to prevent the drawing forward of the yarn from the creel in an uneven manner.

The stretch control is similar in construction to the control described previously. Essentially, it consists of a framework that supports a 9-inch drag roller having too small guide rollers placed in contact with it. These guide rolls are so located as to hold the yarn from the creel, which passes around the drag roll, in contact with the drag roll for about four-fifths of its circumference. In this manner, the drag roll grips firmly the yarn from the creel and feeds it to the size and squeeze rolls at a uniform rate of speed. The drag roll of the stretch control is driven from the side shaft that runs the entire length of the slasher. The side shaft is driven from the delivery, or drag, roll at the head end of the slasher and drives, in turn, the drying cylinders, the size rolls and the drag roll of the stretch-control unit. By means of suitable gearing the relation between the amount of yarn delivered by the stretch-control unit and the yarn absorbed by any other unit of the slasher may be varied. Thus, it is possible to stretch the yarn passing through the slasher to any given degree.

The size box has been redesigned so as to have a capacity about twice that of a normal size vat. Heavy sheet copper lines the box and two 9-inch copper size rolls are used. The immersion roll employed in this size box is of novel design. The roll is 10 inches in diameter and is constructed of brass. Ribs run the length of the roll so as to raise the yarn drawn around the roll above the roll surface. In this manner, size is permitted to enter the space between the roll and the yarn and practically surround the yarn. Because almost the entire surface of the yarn is exposed to the size mixture, a more even size penetration is attained.

The copper size rolls are supported in antifriction bearings, the squeeze rolls are likewise carried in antifriction bearings, but these bearings are held in crossheads. However, these crossheads are so supported by the framework that, by means of a handwheel, the position of the squeeze rolls may be reversed; that is, the squeeze roll that is next to the drying cylinders may be used in place of the squeeze roll located closest to the stretch control, and vice versa. This interchange of squeeze rolls equalizes the wear on each roll.

The covering of these squeeze rolls, however, is different from that used on the squeeze rolls of an ordinary two-cylinder slasher. While slasher cloth is the common covering for the ordinary squeeze rolls, a special worsted yarn is applied to these rolls as a covering by means of special equipment. Thus, when it is necessary to cover a roll after it has been in service, an additional layer of worsted yarn is wound around the roll. The rolls may, by this means, be kept in ideal working condition with a minimum of care. Slasher cloth, it was determined, would not withstand the added wear encountered with the higher slasher speeds maintained with this slasher. It was found, however, that worsted yarn, when wound around the slasher rolls, would efficiently size the yarns passing through the slasher and would withstand the high yarn speeds employed.

49. Drying Cylinders.—The four-cylinder high-speed slasher differs from a two-cylinder slasher mainly in cylinder assembly. Instead of the customary 5-foot and 7-foot cylinder, as used in a two-cylinder slasher, this slasher has a drying assembly of four cylinders, each 5 feet in diameter. These cylinders are braced internally to permit them to withstand greater steam pressures. Antifriction bearings are used to carry the cylinders, and improved methods of injecting steam and removing condensate are employed. The location of the cylinders in this slasher varies from that of most cotton slashers.

The 5-foot drying cylinders are carried in a steel framework. The two bottom cylinders are carried in the steel framework and held at the same height between the size box and the head-end units of the slasher. The cylinders are in line and are of approximately the same width as the other units of the slasher. The two remaining cylinders are mounted above the lower, or bottom, ones and are staggered; that is, one of the top cylinders is mounted over the two bottom ones but between them. The remaining top cylinder is held at the same level as the other top one, but projects in advance of the lower cylinder and is over the head end of the slasher.

The drying cylinders of the slasher are driven from the side shaft. An automatic gear-release, as described previously, is used. Thus, if the yarn passing through the slasher has a tendency to travel faster than the cylinders are being driven, the cylinder drive will be automatically disconnected and the yarn will then rotate the cylinder. However, when the yarn speed reaches a point where it is less than that of the drying cylinders, the automatic device connects the cylinder drive again and the cylinders will once again pull the yarn through the slasher. By means of the automatic gear-release drive, it is possible to hold yarn stretch to less than $1\frac{1}{2}\%$.

The use of a 5-foot drying cylinder of improved construction permits the utilization of greater steam pressure within the drying cylinder, and consequently a higher cylinder temperature is obtained. Higher cylinder temperatures and increased drying area allow greater yarn speeds with this type of slasher. However, another factor that makes possible increased slashing speeds is the maintaining of a cylinder temperature differential, that is, the adjusting of cylinder temperatures so that no two are alike. The approved practice, in regulating the temperature of the drying cylinders of a four-cylinder slasher, is to have the yarn, after leaving the size box, come in contact with the lowest-temperature cylinder first. This cylinder should have the lowest temperature for two reasons. First, the wet yarn coming in contact with the first cylinder, if dried gradually by that cylinder and a number of others, requires less steam than if practically all the drying was accomplished by the first cylinder. Second, if the first cylinder had a high temperature, the wet size would stick to the cylinder and scorch. By a gradual increase in cylinder temperature, the yarn is dried slowly and trouble with size sticking to the drying cylinder is, in most cases eliminated. Then, by distributing the drying action to four cylinders, higher yarn speeds are permitted.

The enclosure, or hood, *e*, Fig. 13, which is generally placed over the top of the slasher framework, and the side plates of the slasher framework, which are used to protect the drying cylinders and the driving mechanism, completely enclose the drying cylinders. However, side plates are not placed above the size box to enclose the space between the box and the hood. Thus, the operative has access at all times to the size box and the hood above the box facilities in removing all vapor from this unit of the slasher.

The hood of the four-cylinder high-speed slasher is an essential part of it and must be well designed if the slasher is to operate at high speeds. It is necessary, when drying yarn rapidly, to remove practically all of the moist air if maximum yarn speeds are to be maintained. The removal of moist air and the substitution of dry, warm air tends to remove moisture from the slashed yarns. Hot fumes and vapor from the size box also must be removed; otherwise, working conditions in a slasher room will soon become unhealthful for the operatives. Also, if moisture is permitted to collect above the slasher, condensate is likely to drop on the warp being slashed and to stain the yarns.

The hood, which is made of heavy sheet copper so as to resist all chemical action of the hot size fumes, rests on top of the slasher framework and, in this position, encloses practically the entire top of the slasher. The side plates of the slasher framework complete an enclosure that hides and protects practically the entire slasher mechanism. An intricate interior hood-construction separates the front top and bottom drying cylinders from the other two, while another section of the hood surrounds the last two cylinders and the size box. Dampers are placed in each of these sections to regulate the flow and the velocity of the air drawn through the slasher. Generally, the hood is capable of handling 15,000 cubic feet of air per minute. Doors are well spaced in the hood to permit access to the interior for cleaning, removing laps from cylinders, and the like.

50. Head End.—The head end of a four-cylinder high-speed slasher, that is, the section of a slasher forward of the drying cylinders and containing the loom beam, is redesigned completely. The object of changing this section of the slasher is to eliminate two troublesome parts, the cone drive and the friction drive to the loom beam.

The cone drive as ordinarily employed on a slasher is replaced by a two-speed electric motor that drives the drag roll of the slasher through a variable speed transmission. A two-speed electric motor, while it is only one motor, is so constructed that it may be operated at two different speeds, a slow, or low, speed, and a higher speed. A variable speed transmission, however, is a unit so designed as to control or regulate speed. Thus, an almost infinite speed ratio may be had without changing gears, but in most instances, by simply turning a handwheel. The drag roll, in turn, drives all other parts of the slasher. However, the two-speed motor is so designed that at slow speed the slasher is driven 10 yards per minute, and at high speed the slasher speed may be varied from 20 to 120 yards per minute by means of the variable-speed transmission.

The operation of the speed control on the slasher is automatic in nature. Thus, when a push-button switch marked *slow speed* is pressed, the slasher will operate at a speed of 10 yards per minute. Such a speed is well suited to making minor adjustments to the warp, piecing ends, starting a new beam, and the like. When a button marked *full-speed* is pressed, the slasher will increase in speed automatically as the full, or high, speed element of the motor cuts in and until a predetermined yarn speed varying from 20 to 120 yards per minute has been reached. Then, while the slasher is operating at high speed, the speed at which it is operating may be changed at will by means of the variable speed unit to coincide with slashing requirements. Whenever the slasher is operating on full speed, a cooling fan contained in the head end of the slasher is in operation. But, when the slasher operates on slow speed, the separate motor driving the fan is stopped. The slasher drive mechanism, when stopped from full speed, will automatically reset the starting mechanism to operate the slasher at slow speed when it is again started.

The friction drive, as used on most slashers, is eliminated by the substitution of a variable speed transmission, which, driven by the drag roll, drives the loom beam at a variable speed. A clutch is generally built into the drive between the transmission and the loom beam so that the beam may be stopped whenever desired.

The original source of power for the loom beam, however, is the two-speed motor that drives the slasher. This motor drives a variable-speed transmission that is connected to the drag roll. The drag roll, in turn, drives another variable-speed transmission which, through a set of gears, drives and regulates the speed of the loom beam. A method of varying the speed of the loom beam is necessary because the slasher operates continually at the same speed and slashes a constant amount of yarn. But, as this yarn is wound on the loom beam, the beam increases in diameter, and hence its linear speed increases constantly while that of the rest of the slasher remains the same. In other words, the loom beam tends to wind more yarn on the beam than is delivered by the drying cylinders. As a result, the yarn would be strained and eventually broken. Thus, the loom beam must be driven at a speed that constantly decreases so as to allow its surface to have a constant linear speed; that is, the loom beam must tend to wind only the amount of yarn delivered by the drying cylinders.

A novel method of controlling the speed of the loom beam, and hence the tension under which the yarn is wound, is employed in this slasher. The drag roll has two rolls in contact with its surface and so placed as to keep the yarn passing around it in contact with the greater portion of the circumference of the drag roll. The roll in contact with the drag roll on the side nearest the loom beam is held in movable brackets and is called the tension roll. These brackets are so connected to a linkage system as to control the ratio of speed in the variable-speed transmission. Thus, if the yarn being wound on the loom beam is under tension, the yarn will tend to pull the tension roll away from the drag roll. This action, in turn, moves the brackets holding the tension roll and, because of the leverage system, varies the ratio in the variable-speed transmission. In this manner, the yarn wound on the loom beam is kept under constant tension because, if the tension on the yarn is increased beyond that point which is to be maintained, the variable-speed transmission will reduce the speed of the loom beam. Then, if the yarn becomes slack, the transmission will increase the speed of the loom beam slightly. However, if it is desired to increase or decrease the initial tension and that under which the entire loom beam is wound, adjustments are provided for this purpose.

Split rods, slasher combs, cut markers, and other equipment of an auxiliary nature, especially that equipment which is interchangeable on slashers, is practically the same on the four-cylinder type of slashers as is found on the ordinary type.

51. Slasher Control.—A form of slasher control is included and considered as a part or unit of a four-cylinder high-speed slasher. Such a system of control, which is necessary on slashers of this type if maximum yarn speeds are to be maintained and quality is to be expected of the sized yarns, generally includes five points of automatic control. Some form of size-box temperature control is the first point, and level control, the second. The purpose of the temperature control is to maintain a constant temperature of the size within the size box. The level control assures the operative that the same level of size is always held in the size box. Both of these controls are of the same type and operate in the same manner as those described previously in connection with the two-cylinder slasher.

The third point of automatic control is the temperature regulation of the drying cylinders. Thus, it is possible to keep the temperature of the drying cylinders constant. If the slasher speed also is constant, the sized yarns will be dried with the same moisture content remaining in them. These temperature-control instruments are likewise similar to those used on a two-cylinder slasher.

Automatic slasher control, as utilized with the four-cylinder slasher, does not stop with size-box and drying-cylinder control, but is extended to include size preparation and storage control. Thus, a unified slashing system is created with automatic control extended to include most variable factors that might be encountered in the sizing of cotton warp yarns.

Size preparation may be considered as the fourth point of automatic control. The size equipment is so constructed and regulated that, after the size ingredients have been placed in the size kettle, the period of time and the temperature of size cooking are controlled automatically.

The fifth point of automatic control is that of size storage. After the size has been prepared, it must be stored in suitable kettles for future use. The temperature at which the size should be stored must be regulated carefully. This temperature is, however, regulated automatically with this system of slashing.

SIZE EQUIPMENT

CONSTRUCTION

NON-AUTOMATIC SIZE EQUIPMENT

52. Classes of Equipment.—Size-room equipment, that is, the machinery used in preparing the size mixture, is divided into two classes, namely, non-automatic, or manual-controlled, equipment and automatically controlled equipment. The equipment used in both classes is practically the same, the only difference being that control instruments are added to the automatic equipment to regulate and control its operation, its period of size cooking, and the size temperature, thus replacing manual labor for these important operations. The purpose of using size equipment of both classes, whether automatic or not, is likewise the same, that is, to efficiently prepare, cook, and distribute the size mixture to the size boxes of the slasher.

53. Equipment Lay-Out.—Size equipment in mills varies according to their individual requirements. A small mill may use only a small open kettle with an open steam pipe for heating and preparing size, and the mixture would be agitated by hand and a drain at the bottom of the kettle would withdraw the prepared size. A large mill requiring large quantities of size, such as a mill producing print cloths or sheetings, would have an elaborate size-room lay-out. In one such arrangement, the storage kettles or tanks are placed on a balcony or gallery, suspended from the ceiling beside the line of slashers, and the size mixture prepared in several size kettles located beneath the balcony, is forced into the tanks by a small rotary pump. The size must be held at a fairly constant temperature in the storage kettles until required, when it will flow from the storage kettles to the size boxes of the slashers because of gravity. Also, with such a lay-out, the size may be constantly circulated by a pump throughout a pipe system that carries the size to each slasher size box.

54. Size Kettles.—The size kettle, or container, within which the size is prepared is, in reality, a large cylindrical drum. A type of size kettle found in many mills consists of a cast-iron shell in cylindrical form that is lined with thin sheet copper. A stirrer, that is, a rod carrying blades, is built into the center of the size kettle and is rotated to stir the size. Stirrers may be had in several forms. One type of stirrer consists of a rod carried in a step bearing at the bottom of the size kettle and a bearing at the top of the kettle, the top bearing extending through the plate that covers the kettle. A bevel gear at the top of the rod usually meshes with another bevel gear on a shaft that carries a tight and a loose pulley. Baffle plates extending from the inside of the size kettle, and close to the stirrer blade, tend to stop any tendency of the size mixture to move as a mass when the stirrer blades revolve. Instead, the baffle plates cause currents of moving size within the size mixture, which have a blending action.

A door is usually built in the top of the plate covering the size kettle. The door is either bolted or held securely in place after the ingredients have been placed in the size kettle. A pipe attached to a steam line connects with the size kettle so that steam may be admitted to the perforated steam coil in the bottom of the kettle. The steam ejected from the coil and into the size to heat it tends to establish currents in the size mixture and helps to mix and keep the mixture in motion. A drain at the bottom of the kettle is provided so that the mixture may be drawn from the size kettle after it has been prepared.

Another type of stirrer, sometimes used in a size kettle, is known as a double stirrer. A stirrer of this type consists of one rod carried within another and both rotating in the opposite direction and carrying blades. Thus, one stirrer blade tends to work against the other. As a result, a turbulence is created within the size mixture. Installations of this type are often troublesome because a step bearing must be carried within the kettle for the stirrer, and the problem of lubricating this bearing together with the stirrer rods, which rotate in opposite directions but one within another, becomes acute. This is especially true because the hot size mixture comes in contact with part of these bearings and bearing surfaces.

Many of the mills employing automatic size equipment use a size kettle that is constructed specially for their purposes and that incorporates many important advancements. Heavy, pure sheet copper is used in the fabrication of this kettle, which is designed in various sizes to hold from 150 gallons to about 400 gallons of size. By constructing the entire kettle of sheet copper, freedom from leaks is practically assured. Leaks occurring in cast-iron size kettles that are lined with copper are troublesome to repair, and the repairs are seldom satisfactory. A single stirrer is used when baffle plates are attached to the inside of the kettle. The stirrer, supported by antifriction bearings held in the top plate of the kettle and in a bracket raised above the top plate on the outside of the kettle, is held rigidly without the necessity of a bearing within the size kettle. Practically all lubrication troubles, so prevalent with the earlier size kettles, are eliminated. The stirrer may be driven either by an electric motor mounted on the top plate of the kettle or by the usual line of belts and pulleys.

55. Storage Kettles.—Storage kettles are used specifically for the purpose of storing the prepared size until it is required at the size box of the slasher. Therefore, some provision must be made to keep the size at a constant temperature, usually several degrees above that temperature maintained at the size box.

The actual construction of the storage kettle is the same as that of the size kettle except that baffle plates are omitted; that is, the stirrer is often retained without the baffle plates, and the entire size mixture then moves as a mass instead of being agitated violently. The baffle plates are omitted because the violent agitation of the size mixture, which they produce, tends to reduce its consistency, or thickness. Also, as dilution due to steam condensing in the mixture is not desirable; a closed steam coil is used to heat the mixture.

Whenever solid-copper size kettles or storage kettles are used, it is advisable to insulate them thoroughly. Asbestos, protected with a sheet steel covering, makes a fine insulation that will not only reduce steam consumption but will prevent damage to the copper kettles. Copper, being a soft metal, does not have the resistance to hard usage and banging that steel does.

AUTOMATIC SIZE EQUIPMENT

56. Advantages.—Automatic control equipment, when used on slashers, greatly improves the quality of slashing by controlling a number of variable factors, namely, variation in size level, in size temperature, and in yarn-drying temperature. By controlling these factors, automatic equipment allows size to be applied evenly and uniformly to yarn so that each loom beam slashed will have the same characteristics. But, unless size entering the size box of the slasher is of uniform quality, the use of automatic equipment at a slasher will not correct size variation, and uneven slashing is liable to result. Therefore, automatic controlling instruments must be utilized also at size-preparation processes if the full benefits of automatic controls at a slasher are to be realized.

Automatic size controls, when used at the size-preparation processes, enable the operative to duplicate any size mixture that has been made previously. Records are made of each batch of size, including the temperature to which the mixture was raised previous to cooking, the time required for this temperature rise, and, the temperature and the time required for cooking. These factors are continually recorded and automatically controlled or regulated throughout the preparation of size by an automatic size-control unit. Therefore, from the records made of previous batches of size, data are available to enable duplication of size mixtures. Thus the operative is always assured of producing a size of uniform quality.

57. Units in Automatic Size Equipment.—A typical size room, illustrated in Fig. 14 and equipped with automatic size controls, is capable of supplying size to four slashers that are slashing the same type of yarns and that are using the same size mixture. The size equipment consists of a size kettle *a*, for cooking and preparing the size, and a storage kettle *b*. A circulating system is used in this instance to carry size to the slashers. A pump *p* continually circulates the size throughout the system. A temperature regulator *c* controls both the flow of steam to the size kettle and the period of time over which the steam flows. The recording thermometer *d* permanently records the temperature at which the size is cooked, the length of cooking, and the number of batches of size cooked in 24 hours.

The size kettles are set on a raised platform, which extends beyond the size kettles just enough to enable the operative to stand on the end and load the kettles. Space is left between the kettles to allow the operative free access to the various valves and controls that must be operated by hand. A cement floor is generally laid over the wooden flooring as it is much easier to clean and wash than wood, and a drain is provided. The size kettle *a* is identical with the non-automatic size kettle previously described. Most size kettles, as well as storage kettles, used with automatic size equipment, are, however, generally of greater capacity than those not so equipped. Mills slashing warps to be used for the production of sheetings, print cloths, ducks, industrial fabrics, and the like, usually utilize kettles that contain up to 400 gallons of size. A small copper container *j* is usually attached to the top of such size kettles and is used to liquefy the softener and gums required in the size mixture. Gums and softeners do not readily mix with starch while in solid form, but are easily mixed when liquefied.

The size storage kettle *b* is practically the same as the size kettle *a*, except that a closed steam coil, instead of the perforated coil utilized in the size kettle, is used to keep the size at the required temperature, and that baffle plates are eliminated. The storage kettle is equipped with the same kind of automatic temperature control as that used at the size box for maintaining uniform size temperature. The size outlet to the storage kettle,

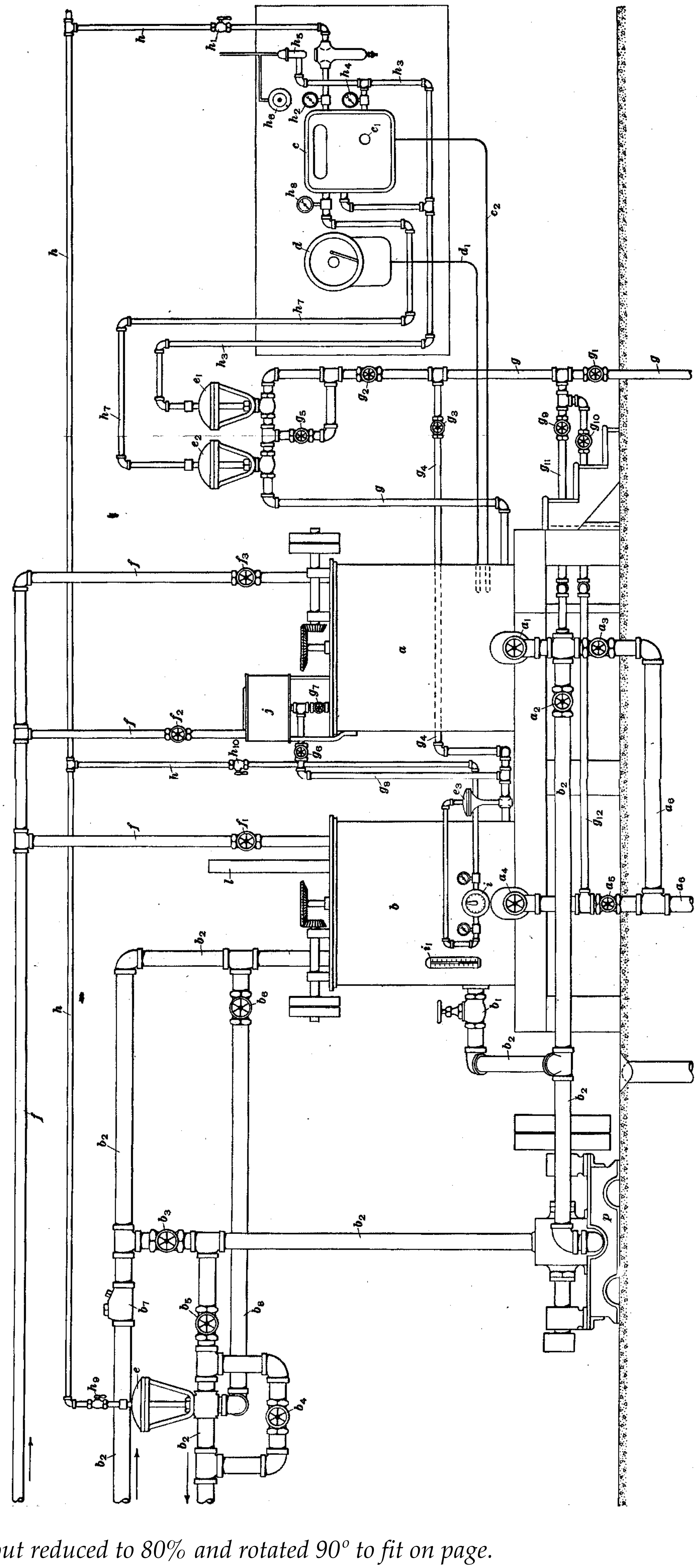

Fig. 14

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Foldout reduced to 80% and rotated 90° to fit on page.

which has the valve b_1 in the size line, is located above the bottom of the kettle to prevent the size from caking around the coils, a condition that would occur if the size level is lowered to such a point in the kettle that the size just covers the steam coils. Any caked size that forms will, when new size is added, soften, break into small pieces, and, if circulated throughout the system, clog the pipe lines and diaphragm valves. Another outlet leads directly from the bottom of the storage kettle to the drain so as to remove all cakes of size, nails, and other foreign matter that accumulates in the bottom of the storage kettle. It is essential that all pipes used to convey the size be of brass to prevent chemical action and the formation of rust within them. If rust should form in the size pipes, it would be carried to the size box and stain the yarn as it is immersed in the size bath.

58. Operation of Automatic Size Equipment.—The following precautions must be taken before actual preparation of the size mixture is possible in the automatic equipment illustrated in Fig. 14. The valves a_1, a_2, b_1 in the size circulation line b_2 and the drain valves a_3, a_4, a_5 in the drain line a_6 are closed so as to confine the size to the size and storage kettles. The valve b_3 in the circulation line b_2 is closed to prevent the pump p in the same line from forcing size into the storage kettle. The valve b_4 in the by-pass line around the diaphragm valve e, which is located in the size line to the slasher, is closed to allow the diaphragm valve to operate properly. The valves f_1, f_2, f_3 in the water pipe line f that control the supply of water to the kettles must be closed. The valves g_1, g_2 in the main steam line g are open to allow the diaphragm valves located in the steam line to function. The valve g_3 in the steam line g_4, which leads to the storage kettle, the valve g_5 in the by-pass line around the diaphragm e_1 in the steam line, the valves g_6 and g_7 in the steam line g_8, which leads from the steam line g_4 to the small copper container j, and the valves g_9 and g_{10} in the steam lines g_{11} and g_{12}, which lead to the size line b_2 and the drain line a_6, respectively, are all closed. The size circulation line b_2 to the slasher is open for size to flow when the storage kettle valve b_1 and the size line valves b_5 and b_6 are opened. All other outlets and drains and all steam connections have now been closed with the exception of those lines having diaphragm valves located in them. The size equipment is ready to be loaded with its ingredients and the automatic controls turned on to regulate the cooking of the size mixture.

The water valve f_3 is opened to allow the desired amount of water to flow into the size kettle. The amount of water in the kettle, in gallons, is usually determined by noticing the height of the water within. If, for example, 168 gallons of water are required by the size formula and the size kettle used holds 5.99 gallons for every inch of the height of the kettle, then the water should run until a height of about 28¼ inches is reached. The correct weight of gum and softener required by the size formula is placed in the copper container j at the top of the size kettle while the water is running. The steam valve g_3 and g_6 are given a partial turn so as to allow just enough steam to enter the container to melt the gum and softener. After the water has reached the desired level in the kettle, the stirrer in the kettle is started and the correct weight of starch added. The lid, or cover, to the size kettle is closed and locked because severe burns will be received by the operative if the kettle is opened while in operation. A key with which to operate the control regulator c is inserted in the key hole c_1 and turned. Air from the main air line h is allowed to enter the regulator by opening the valve h_1. Within a period of three seconds after the valve h_1 is opened, the following action takes place.

59. Air pressure in the main air line h is indicated by the gage h_2, and air flows through the intricate valve and pipe arrangement inside the regulator c and out through the air line h_3. When the air gage g_4 shows 5 pounds air pressure in this line, the air switch h_5 will open and turn on a red signal light h_6. The operative should never open the size kettle when the red signal light is burning as this is a danger signal and indicates that steam is entering the size kettle. When the air pressure in the line h_3 reaches 15 pounds, the diaphragm valve e_1 opens, that is, the air pressure in the line forces the valve stem of the diaphragm valve down and opens the valve for the steam to pass. A valve of this type acts as a safety measure because, if the air supply in the controlling line is shut off at any time, the valve will automatically close and shut off the supply of steam entirely. However, this valve only opens or closes the steam line, while the amount of steam admitted to the size kettle is regulated by the diaphragm valve e_2.

A thermometric bulb and capillary tubing c_2 leads from the size kettle to the regulator c and controls a small diaphragm valve inside the regulator, which, in turn, governs the air pressure on the diaphragm valve e_2. The pressure of the air passing through the air line h_7 to the diaphragm valve e_2 is indicated by the gage h_8. The air pressure in this line will determine the amount of steam that the diaphragm valve e_2 allows to pass to the size kettle. The operative may easily determine the number of times steam is admitted to the kettle by noticing the number of times pressure is indicated on the gage h_8.

The recording thermometer d simply makes a permanent record of the size temperature. The bulb and capillary tubing d_1 that extends from the size kettle to the thermometer d is the medium used for conducting the heat to the indicating unit. When the recording unit shows that the size has reached a temperature of 180° F., the liquefied content of the copper container j is allowed to flow into the size kettle by closing the steam valve g_6 and opening the valve g_7. This valve must be closed after the container has been drained. The object in having the size mixture at 180° F. is to assure the operative that the starch in the kettle has gelatinized; thus, hard specks will not be formed in it when the softeners and gums in liquefied form are added for softeners, gums, and starches, when in liquid form, will blend and mix readily. If not all of the starch has gelatinized, it will not blend with the others, and therefore much of the adhesive and softening qualities usually added to the size by the gums and softeners will be lost. The temperature of the size continues to increase until about 210° F. is reached; then the size is cooked for as long a period of time as set on the regulator c. A time disk in the regulator controls the period of time the size is cooked.

When the period of cooking is about over, a pin in the time disk opens a valve in the regulator, which allows the air in the line h_3 to escape, and consequently closes the diaphragm valve e_1 in the steam line g. When the gage h_4 shows an air pressure in the line h_3 of less than 5 pounds, the switch h_5 will close and shut off the red signal light h_6. Usually, when the red signal light goes out, it is an indication that the size mixture has been cooked completely. Air pressure will continue to be maintained in the air line h_7, and the air gage h_8 and the diaphragm valve e_2 will continue to function. This is a safety precaution designed to stop the flow of steam in case there is leakage in the valves in the steam line g or in the other diaphragm valve e_1. The diaphragm valve e_2 will continue to operate until the size has been removed from the kettle; then the air flow in the regulator and to the air line h_7 will be closed because of the contraction of the thermometric fluid in the bulb and capillary tubing c_2.

60. A number of test runs were made to determine the degree of control the automatic regulator maintained over size cooking. The results of the test were as follows: The temperature of the mixture was 52° F. when steam was first admitted to the size kettle. The steam flowed for 4 minutes, 40 seconds before the regulator started controlling the flow of steam; then for 20 minutes steam flowed intermittently 23 times. The average length of time the diaphragm valve was opened was 20 seconds, while the valve was closed for about 30 seconds at a time. At the end of 20 minutes, the size temperature was 160° F. It then required 9 minutes, 45 seconds to raise the temperature to 180° F., 25 openings taking place during this time. The average length of time per opening was 12 seconds and the average time closed 13 seconds; the longest opening of the 25 was for 18 seconds and the shortest opening for 5 seconds. It required 16 more openings over a period of 20 minutes to keep the size at 210° F.

61. Flow of Size Through System.—The size, having been thoroughly cooked, is ready for use at the slasher. Usually, it is transferred to the storage kettle and kept at a constant temperature. From the storage kettle, size is continually circulated throughout the system so as always to maintain a reserve supply of size at the size boxes. The size is transferred from the cooking kettle to the storage kettle by closing the valves a_3, a_4, b_1, Fig. 14. If either the valve a_3 or a_4 is left open, the size will flow down the drain. The pump p is set into operation and the valves a_1 and a_2 are opened to allow the size to flow from the size kettle and into the circulation line b_2. The petcock h_9 in the main air line h is opened and the air pressure in the line acts on the diaphragm of the three-way diversion diaphragm valve e in the size line and opens it. The size will flow from the kettle a, through the valve a_2 and the line b_2, to the pump p. The size pump forces the size through the circulation system to the slashers, that is, up pipe b_2, through the valve b_5 and the diaphragm valve e and along the line to the slashers.

The size not required at the slashers will be returned through the upper line b_2 in the direction indicated by the arrow and will pass through the check-valve b_7 and into the storage kettle b. The check-valve is installed to prevent size in the top line b_2 from flowing back to the slashers when the valve b_3 is opened to force size directly into the storage kettle. The valve a_1 in the size kettle and the valve a_2 are closed after the size has been removed from the kettle. The valve b_1 at the storage kettle must be opened to allow the size to be circulated throughout the system. If, however, it is desired to transfer the size directly to the storage kettle after the size has been cooked, the valves b_1 and b_5 in the size line are closed. The valve b_3 in the line b_2 is opened and the pump will then force the size up the line b_2, through the valve b_3, and into the storage kettle. The check valve b_7 prevents the size from being forced into the slasher circulation line.

The container j and the size kettle a should be cleansed with water after transferring the size and before the next batch of size is prepared. The size transferred to the storage kettle must be held at a uniform temperature. The automatic temperature regulator i usually accomplishes this purpose, the regulator being identical with the one used to maintain constant size temperature at the size box. The temperature of the size in the storage kettle is shown by the thermometer i_1, and the temperature at which the size is to be maintained is set on the regulator *i*. The valve h_{10} in the air line is opened to supply air under pressure for the operation of the diaphragm valve e_3. The amount of air that passes to the valve is controlled by the regulator *i*. The steam to the storage kettle is turned on by opening valve g_3 in the steam line g_4.

62. Some form of safety control must be installed in the system to operate if the air pressure in the air lines running from the diaphragm valves to the control regulators is lowered or is cut off. A form of control is necessary because a reduction in air pressure in the air lines leading to the diaphragm valves at the size box will open these valves. Unless some means is provided to close the valves, the size will soon fill the size boxes and overflow onto the floor of the slasher room. One method of overcoming this difficulty is to use a three-way diversion diaphragm valve *e* in the size line b_2 close to the storage kettle. A reduction in air pressure in the main air lines will close the valve *e*, but the valve is so constructed that when it is closed, only the main size line b_2 is closed; therefore, size entering the valve will flow out through the diversion opening into the line b_8 and be returned to the storage kettle.

As soon as the air pressure in the main air lines become normal again, the diaphragm valve *e* will open, closing the passage to the pipe b_8, and once again allow the size to flow through the pipe b_2 and to the slashers. It is, however, possible to obtain size at the slashers when the diaphragm valve *e* is closed by opening the valve b_4 in the by-pass line around the diaphragm valve, as the pump will then force the size through the circulation lines. Under such conditions, the admittance of size into the size boxes could be controlled by the hand valves in the size lines at the size boxes. When this method is used to obtain size at the slashers, the valve b_6 in the line b_8 is closed. Ordinarily, the valve b_6 is always left open as a safety measure to allow the three-way diaphragm valve to send the size back to the storage kettle when the air pressure in the main air line is reduced. Otherwise, if the valve b_6 is not always open, the size will not be by-passed back to the storage kettle.

63. Cleaning Size System.—It is necessary to clean thoroughly all of the size equipment, especially the size lines, after each day's work, before week ends, and before shutdowns; otherwise, lumps or deposits of size will form in the lines and often clog them. The first step in cleaning the size system is to drain the size kettles and pipe lines of all the remaining size. The valve b_1 in the storage kettle is closed and the valves a_4 and a_5 are opened to allow the size remaining in the storage kettle to flow down the drain a_6. The valve a_4 is then closed, and the valve a_1, which controls the flow of size from the size kettle, and the valve a_2 in the size line are opened. Water that was previously admitted to the size kettle and heated by admitting steam to the kettle through the by-pass line and valve g_5 while the contents of the storage kettle were draining, will now flow through the line b_2 to the pump. The pump is set in operation, and the hot water from the size kettle is circulated throughout the system and is finally forced into the storage kettle. The valve b_6 in the relief line b_8 should be closed and the valve b_4 in the by-pass line opened. The petcock h_9 in the air line is closed, shutting off the air supply and closing the diaphragm valve *e*. The closed valve will allow the water to be forced through the by-pass. Each diaphragm valve and each by-pass at the slasher size box should be opened momentarily by the attendant to flush these lines.

The valve b_6 is next opened and b_4 closed, the diaphragm valve still remaining closed, to flush the relief line b_8. The valve b_3 is next opened and valve b_5 closed to force the hot water up into the top return size line b_2. The trap b_7 prevents the water from flowing toward the size boxes of the slashers and, as a result, the water enters the storage kettle. The valves a_1 and a_3 are opened and the hot water remaining in the size kettle is run down the drain. After the size kettle has been emptied of water, the pump is stopped and the valve a_1 at the size kettle is closed. The valve b_1 is momentarily opened to flush the pipe b_2 leading from the storage kettle, the water running through the pipe b_2, the valves a_2, a_3, and down the drain a_6. The valve b_1 at the storage kettle is closed and whatever water remains in the vertical or the horizontal pipes b_2 flows down the drain also. The water remaining in the storage kettle is drained through the valves a_4 and a_5. The valve a_3 is closed after all the water has drained from the storage kettle.

Steam should be blown through the size system to remove all traces of water. Usually, steam is blown through each group or network of size pipes for one-half minute. The steam valve g_9 is opened and the following groups of valves are closed or opened. The valve b_6 in the diversion line is closed and the drain valve a_4 at the storage kettle is opened. The by-pass valve b_4 is opened and the air valve h_9 is closed, thus closing the diaphragm valve *e*. The steam enters the pipe g_{11} and flows into the size line b_2, passing through the pump up the line b_2 and through the by-pass and around the diaphragm valve *e*, around the slasher circuit, and to the storage kettle. Next, the by-pass valve b_4 is closed and the valve b_6 in the diversion line b_8 is opened, the valve h_9 controlling the diaphragm valve still being closed. The steam now passes through the pump, up line b_2, through the valve b_5 and into the three-way diaphragm valve. As the diaphragm valve is closed, the main size line b_2 will be closed, but the relief line b_8 is opened. The steam passes through the line b_8 and valve b_6, into the storage kettle, and down the drain.

The valve b_6 is closed and the air valve h_9 is opened to allow the diaphragm valve to open the main size line b_2. The steam now passes through the diaphragm valve and along the size supply line b_2 to the slashers and returns along the upper pipe line b_2 and into the storage kettle. Each diaphragm valve at the slasher should be opened to allow steam to pass through it and drive out the water remaining in the line. The valve b_5 is closed and the valve b_3 opened to allow the steam to pass upward through the vertical pipe b_2 and return to the size storage kettle. The check-valve b_7 prevents the steam from flowing back to the slashers through the upper return pipe b_2. Steam should be blown through the size system until it flows into the size storage kettle *b*, as determined by watching the vent pipe *l*.

When the steam is forced through the vent pipe in appreciable quantities and comes in contact with the cold atmosphere, it will condense into water vapor and form a visible, white vapor or cloud. The valve g_9 in the steam line g_{11} should be closed when the white vapor appears in great quantities. The closing of this valve shuts off the supply of steam being blown into the size system. The valve b_3 in the size line b_2 should be closed and the valve b_5 opened shortly after the steam valve is closed. It is necessary to blow the drain lines with steam, but, before this is done, the rest of the size system is closed from the drain by closing the valves a_2 and a_3 to prevent steam from entering the lines already dried. The valve a_4 in the storage kettle is closed and valve a_5 opened. The steam valve g_{10} is opened for a minute to blow the drain line. The steam passes through the line g_{12} and the valve a_5 and down the drain line a_6. The main steam line valve g_1 is closed together with the auxiliary valves g_2 and g_3 after the drain has been blown with steam.

64. Size-Equipment Requirements.—A mill may, in some instances, be operating on a mass production scale and require the use of two different sizes at one time, each size having entirely different characteristics. In such a case, automatic size cooking may be used to advantage by using two cooking kettles and two size kettles. Two regulators are installed, one regulator to control each size kettle. Each size kettle is equipped with its own recording thermometer. Two supply lines run to each slasher, and each supply line is so connected to the storage kettles that size may be circulated through either supply line from either storage kettle, or may be pumped from either size kettle to either of the storage kettles.