

International Correspondence Schools
Scranton, Pa.

Chain Warping

PREPARED ESPECIALLY FOR HOME STUDY

By
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PART 1

EDITION 1

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CHAIN WARPING

(PART 1)

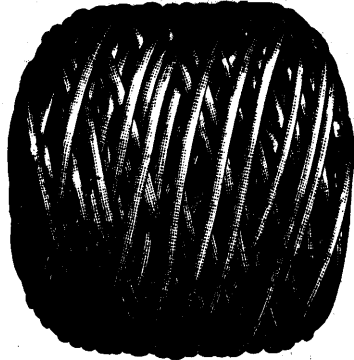
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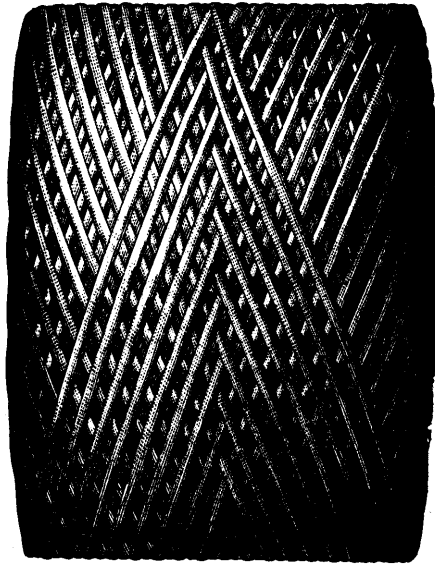
INTRODUCTION

1. The processes intervening between the spinning and the weaving, in ordinary branches of cotton manufacturing, in order to prepare the warp yarn for the loom are: spooling, where the yarn from the cop or bobbin is placed on spools; beam warping, where the yarn is put up on section beams; and slashing, where the yarn is placed on loom beams. By far the larger proportion of cotton warps are made in this manner, especially where the yarn is both spun and woven by the same firm, and for goods that are woven from warps that are not bleached, dyed, printed, or otherwise treated. Where yarn mills produce warps for sale, and in those mills where yarn is both spun and woven, but where it is the practice to bleach, dye, print, or otherwise treat the warp yarn, an entirely different system of making warps is generally used, known as *chain warping*.

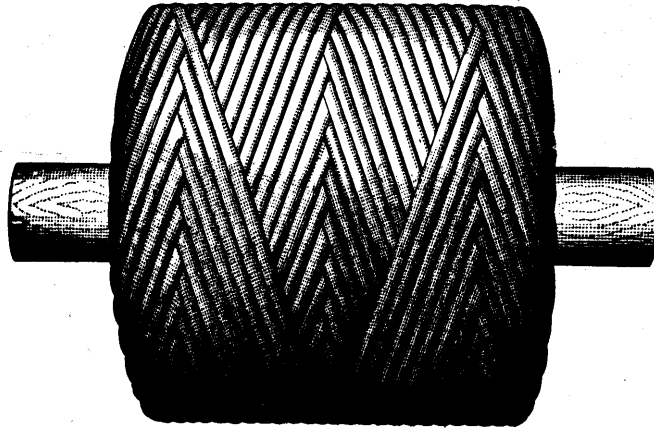
A **chain** consists of a large number of ends of yarn, either single or ply, gathered together so as to form a loose, untwisted rope of yarn of considerable length. Each end in the chain is of the same length, but chains may be made of various lengths. As this form offers, without damage, facilities for transportation that are not possible in the beam-warping system, besides being more convenient and less expensive with regard to freight, it is the method favored by mills producing warps for sale. As it is also the most convenient form in which to bleach, dye, and otherwise treat



(a)



(b)



(c)

FIG. 1

yarn, it is the most suitable way in which mills using colored warps can purchase their warp yarn or make their own warps, as the case may be. The makers of gingham and other colored goods frequently dye and otherwise treat their filling yarns in the chain form, which form is also suited to the requirements of makers of cotton driving ropes and of some other branches of textile work. For these reasons chain warping has increased in recent years.

2. Chains may be put up in bags or they may be balled or linked. When, after warping, the chain is coiled into a round or cylindrical form, it is spoken of as a **ball**; this is the most common method of putting up chains for transportation. A **linked chain** is one that has been arranged to resemble the links of a chain, thus shortening its length, decreasing the risk of damage in transportation, and affording facilities for its suitable handling at future processes. Three styles of balls are shown in Fig. 1 (a), (b), and (c), and two styles of linked chains in Fig. 2 (a) and (b).

The word *chain* is the correct name for all yarn—whether warp or filling, balled or linked—made by the processes of warping described in this Section. The word chain is sometimes misinterpreted, due to the fact that some people consider the term to apply only to that form of chain that is linked and not to the balled form. The term, however, may be properly applied to either form. Since the yarn of which chains are made is generally warp yarn, it is common to speak of chains as warps, as for example ball warps, linked warps, etc.; but this term is not sufficiently comprehensive,

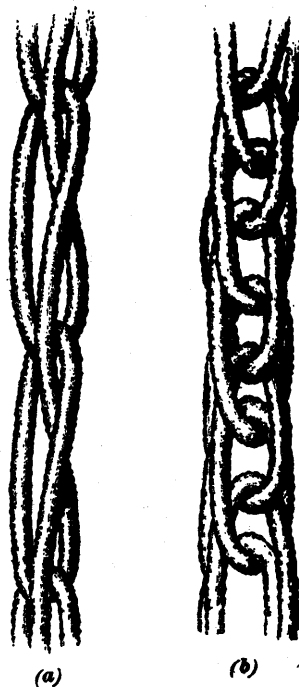


FIG. 2

since filling yarn is sometimes put up in chains, to which the word warp cannot correctly be applied. It also tends to confusion, since the word warp is also applicable to the beamed form of yarn. Therefore, in this Section, the word chain will be used as a comprehensive term covering the product of the various processes and machines for warping herein mentioned.

3. Short- and Long-Chain Systems.—Two systems of making chains are in use, known as the **short-chain system** and the **long-chain system**. The short-chain system is the older method and its use is confined almost entirely to yarns intended for the warp of a fabric. The long-chain system is more generally used at the present time for warp yarns and is almost exclusively used for filling yarns that are chained.

The difference between these systems is partly indicated by their names; the short-chain system is used for warps of a limited length, usually only sufficient to fill one loom beam, which is generally less than 1,000 yards, although sometimes slightly greater than this; the long-chain system is used for making chains of much greater length, sometimes as long as 10,000 yards, or even more. The treatment of the yarn, however, is also somewhat different in the two systems. The operations from the spinning or the twisting frame to the completed loom beam in the short-chain system are: (1) spooling; (2) chain warping; (3) bleaching, dyeing, or otherwise treating the yarn; (4) sizing; (5) beaming to the loom beam; (6) drawing-in. This system is seldom used for filling yarns, so that its consideration for this purpose will be ignored.

The long-chain system when used for warp yarns consists of the following sequence of processes from the spinning or the twisting frame to the completed loom beam: (1) spooling; (2) chain warping; (3) bleaching, dyeing, or otherwise treating the yarn; (4) beaming to section beams; (5) slashing to loom beams; (6) drawing-in. The sequence of processes for the treatment of filling yarn in

the long-chain system after the spinning process is as follows: (1) spooling; (2) chain-warping; (3) bleaching, dyeing, printing, or otherwise treating the yarn; (4) quilling on the long-chain quiller.

For special purposes either of these systems may be slightly modified, according to the requirements of the mill in which the yarn is treated or for special styles of goods, but the processes given are those generally used. This affords a ready method of classifying the systems and indicating the differences between them. In either system, minor differences may also exist in the warping process—for example, the chain may be made on different styles of warpers—or the methods of beaming may vary without affecting the general division of the processes into long- and short-chain systems.

4. Spooling.—The spooling process is usually the same whether the yarn that is to be made into a chain is warp or filling, and whether the process is the long- or the short-chain system. The spooler generally used is the ordinary construction of an upright-spindle spooler, which takes the yarn from a mule cop or spinning bobbin and places it on a double-headed spool. It is possible, and in some cases is customary, to use quick-traverse cross-winding machines for the same purpose, in which case the yarn is built up in cylindrical form on a parallel tube without heads. This machine, however, is not used so frequently in the long- or short-chain systems as the ordinary spooler.

CUTS AND LEASES

CUT MARKS

5. As chains are made in various ways, according to the purpose for which they are intended, a knowledge of the uses of chains and of the later processes necessary to convert them into suitable form for use, either as warp or filling, is advantageous, either as a preparation to the study of chain

warping or to those who have charge of chain-warping work, since a knowledge of the reasons for making chains in certain ways increases the possibility of producing suitable chains intelligently. The chief particulars required for making a chain warp are the counts of the yarn, the total length of the chain, and the number of ends in the chain; these, of course, are essential irrespective of other information. Other particulars required under certain circumstances are the number of cuts or leases in each chain and the kind of leases to be taken.

Information regarding the number and length of cuts is only necessary in the case of short chains of warp yarn. Cloth is woven in *cuts*, which should be of the same length when for one style of cloth. To indicate to the weaver when a cut of the desired length has been woven, it is customary to mark the warp in some way. In the case of slashed warps made by the ordinary system of warp preparation, this is done by a marking motion in the slasher, which makes a slight impression of coloring matter at the completion of each cut; but as short-chain warps do not pass through slasher, being dressed, or beamed, to a loom beam after having been bleached or dyed and sized, it is necessary that the cuts be marked as the chain is made. Since chain warps are dyed, bleached, or otherwise treated, it would not be satisfactory to mark the cuts with coloring matter, such as colored chalk, for the marks would wash or bleach out or be obliterated in the dyeing process. It is customary, therefore, for the operator to tie a loose band of twine around or through the chain at the proper places. These bands pass through the dyeing and other processes without being removed until the yarn arrives at the beaming process, when as the end of each cut is reached, this cut-marking thread is removed and a fresh mark made in such a way that it will be recognized by the weaver—either by the use of coloring matter or otherwise.

Cut marks are not necessary in the case of long chains of warp yarn, since these chains are afterwards beamed to a section beam and then run through the slasher, which is

provided with an arrangement for automatically placing colored marks on the warp at the completion of each cut. Neither are cut marks necessary for long chains of filling yarn, since this is afterwards quilled to shuttle bobbins, where marks of any kind would, of course, be undesirable.

LEASES

6. In the ordinary system of warp preparation, where the warp yarn, after spooling, is passed through the operations of beam warping and slashing, the ends forming the warp pass in a level, even sheet through these processes, maintaining their position with relation to one another until they arrive at the loom beam, whence they can be woven off, without entanglement, in a smooth, level sheet. It is quite different with chain warps, which are formed by collecting the ends into a loose rope, or strand, of yarn. As the chain subsequently is passed through some such process as bleaching, dyeing, sizing, etc., it would be very difficult, if not impossible, to separate the ends afterwards so as to use them for warp or filling, unless some means were adopted for grouping the ends at intervals. This is accomplished by inserting what are called **leases**. (The word is sometimes spelled *leese*, but *lease* is the preferred form.)

An essential feature of all modern methods of making chains is to arrange the ends in a level, even sheet before condensing, or grouping, them in the form of a chain. A lease is formed by dividing this sheet of yarn, while it is spread out widely and evenly, into a certain number of equal parts by means of bands of twine, so that although the ends are afterwards condensed into a loose rope and passed through a converting process, the yarn may be opened by means of the bands and laid in a sheet with the ends approximately in the same position, with relation to one another, as they were during the earlier part of the warping process. The yarn can then be placed on the loom beam or section beam or quilled without any excessive entanglement of yarn

or waste of material or labor. Leases must be taken both in the long- and the short-chain systems and whether the yarn is intended for warp or filling. The insertion of the lease band is known as *throwing in a lease*, or *taking a lease*. Leases are always taken at each end of a complete chain and, in the case of a long chain, at intervals throughout its length; that is, if a chain is to be made 10,000 yards in length, a lease will be taken at every 500 or 1,000 yards as a precautionary measure in case of an accident of any kind happening to the warp during its passage through the converting or beaming process, resulting in the breakage or entanglement of the yarn. This damage, if slight, will only be a disadvantage until the next lease was reached, as the lease will enable the operator to disentangle the warp and make a fresh start with the ends in their proper position. If the damage is great, the warp must be cut where it occurs and a fresh start made at the next lease band.

7. Thread Lease.—Leases are of two kinds—the *thread lease* and the *pin lease*. In the weaving of warps, it is customary to pass one series of alternate ends over and the other series under a lease rod behind the harnesses in the loom, after which another lease rod is inserted and those ends that were passed under the rear rod are passed over the front one and vice versa. This effectually separates the ends of yarn in readiness for passing through the harnesses and reed of the loom, even if any two or more ends have previously adhered together. The **thread lease** is taken at the chain-warping process with the ends in the same position with relation to one another that they have to occupy in the loom, and the lease is sometimes called for this reason a *weaver's lease*, or a *1-and-1 lease*. This lease is taken by raising every alternate end, which forms an opening through the warp, called a *shed*, one-half of the warp forming the top of the shed and the other half the bottom of the shed. The lease band is passed through this opening and the warp closed and opened again by reversing the positions of the ends, thus forming another shed with those ends that

were in the top of the first shed in the bottom of this shed and vice versa. Another band is passed through this second opening and the ends of the two lease bands tied, thus providing a means of maintaining the lease throughout the succeeding processes to which the warp may be subjected. In taking a thread lease, the warp is separated into two equal portions.

8. Pin Lease.—A pin lease differs from a thread lease in being composed of larger groups; the warp instead of being separated at every alternate end is separated into alternate groups of 2, 3, 4, or any desired small number of ends. Pin leases are commonly taken in groups of 4; in this case the ends in the warp are separated so as to form a shed with the first 4 ends down, the next 4 ends up, the third group of 4 ends down, and the fourth group of 4 ends up, and so on, and a lease band passed through this shed. Another shed is then formed by reversing the positions of the ends, after which another band is passed through this shed and the ends of the two bands tied. A pin lease is sometimes called a *half-beer lease*, or *beamer's lease*. One of the chief uses of a pin lease is to form a coarse division of the ends to facilitate their separation at the beaming process, since it is easier to separate the warp in groups of 4 ends or in larger numbers than to separate each individual end. The warp is first passed through a coarse comb or reed according to the divisions of the pin lease, and then through a finer comb according to the division, of the thread lease. The pin lease also gives facilities for splitting the warp into sections after dyeing or bleaching, in order to make up the assortment of threads forming various patterns in the warp. For instance, with a pin lease of 4 ends and a warp to be woven in groups of 4, 8, 12, 16, or more ends of one color, it is an easy matter to select the number of ends required. A 25-end pin lease is common for colored warps, in order that they may be split into multiples of 25 ends after dyeing, since as the dyed chain is necessarily all one color, frequently portions of several

chains of different colors are used, to make one warp consisting of several different colors.

A pin lease when taken is generally inserted within 1 or 2 yards of the bands that indicate the thread lease. Thread leases are almost always taken at both ends of a warp, pin leases generally only at one end.

9. Other forms of leases are sometimes taken, one of which is spoken of as an **open lease**, where two consecutive thread leases are taken, one the reverse of the other, thus leaving the warp open between them. **Bunch-knot leases** are formed at the ends of each warp by taking a hand lease dividing the warp into five or six approximately equal sections and tying the ends of the sections together where the warp is cut off. The **bout** is a form of lease made by dividing the ends in the chain by hand into groups equivalent in size to several of the groups formed by a pin lease; these are kept separate by a lease band in the usual way. Chains are sometimes ordered *split in the middle*. This is simply a large bout, the chain being divided into two equal parts and kept separate by lease bands.

The open lease and the bouts are seldom used, the most common forms of leasing being the thread lease, the pin lease, and the bunch-knot lease. Where all three of these appear together in a warp, the one nearest the end of the chain is the bunch knot, the second from the end is the thread lease, and the third the pin lease, but this is not an arbitrary arrangement, since various combinations of leases are made to suit the requirements of customers. The number of leases, the number of ends forming the pin lease, and the positions of the leases in the chain are specified by the users of chain warps, any reasonable combination of leases that may be desired being inserted.

10. Bands.—The cord, or band, used for taking and maintaining the lease is made of a number of ends of yarn, usually 16-ply, which are not twisted but simply wound together. It is a good plan for each mill to have its own special lease bands; that is, always to use a band with a

definite number of ends or of special construction so that in case of dispute the warps of that mill can be identified from those of other mills, even after having passed through converting processes.

Water bands are also placed around chain warps when called for. These are merely loops of yarn tied around all the ends of the warp to prevent entanglement in boiling the warp preparatory to the converting process.

CONSTRUCTION OF CHAIN WARPERS

METHODS OF CHAIN WARPING

11. Chains may be made by five methods: (1) *hand warping*, by means of the creel and woof, which is the oldest

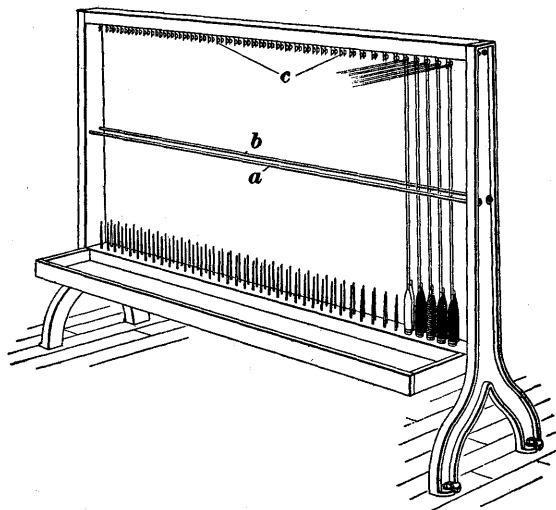


FIG. 3

method, and was formerly used to a large extent in connection with hand-loom weaving but is now seldom seen; (2) *warping mills*, sometimes called upright warpers, circular warpers, or warping reels, an old style of warping rapidly

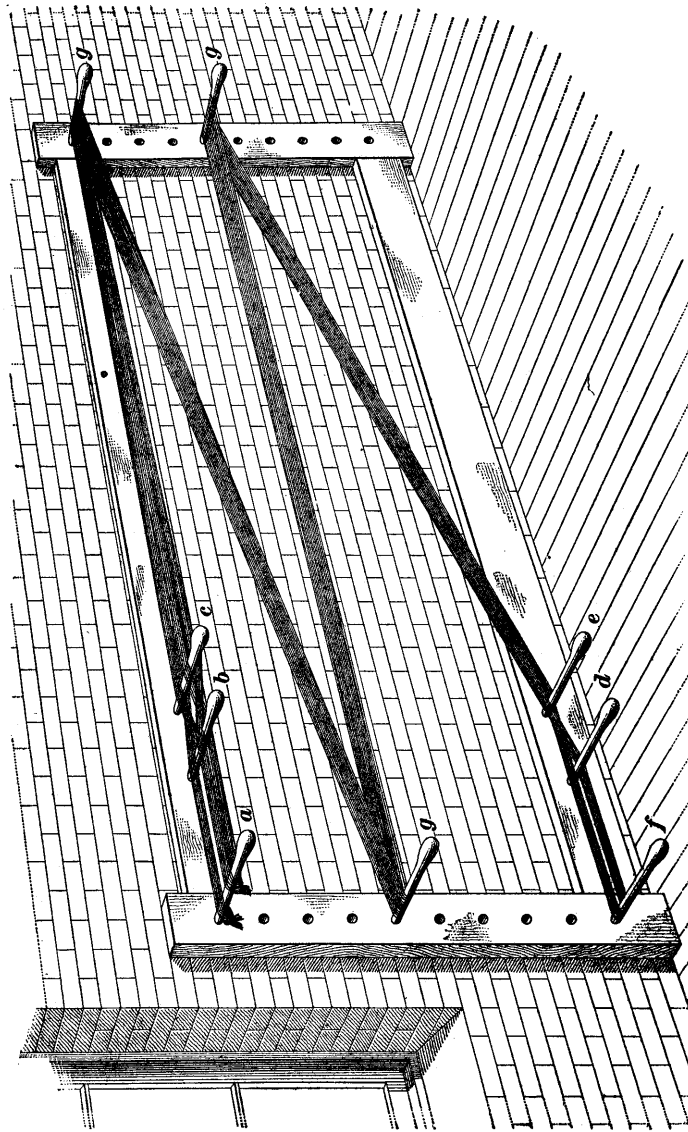


FIG. 4

passing into disuse and only used for short chains of warp yarn, which may be afterwards made into balls or linked warps either by hand or machine; (3) *balling warpers*, which are common beam warpers with the balling attachment and are especially adapted to the making of long-chain warps with less than 800 ends, particularly long chains of filling yarn intended for quilling; (4) *Denn warpers*, which are adapted for making long or short chains (of a small or a large number of ends) that may be put up either in balled or linked form by attachments on the warper itself; (5) *Walcott warpers*, which are used, to some extent, for making short chains with 1,200 ends, or less, that are delivered into a bag or other receptacle without being either balled or linked, but can afterwards be put up in either form by hand or machine.

HAND WARPING

12. Creel.—The method of hand warping requires the use of two wooden or iron frames, one called the *creel* and the other the *woof*. The *creel* consists of a framework supported on feet, as shown in Fig. 3, the lower beam being arranged to carry two rows of skewers, from 40 to 80 in a row, that are supported in holes drilled in the beam; on these skewers, cops or bobbins of yarn are placed. The upper beam contains the same number of guide wires c as there are skewers in the lower beam; the yarn passes through these wires on its way to the woof. Between the upper and lower beams are two guide bars a, b ; the ends from the front row of bobbins or cops pass behind the bar a , while the ends from the back row pass behind the bar b . After being passed through the guides, the ends are gathered together, loosely, by hand, thus forming a continuous strand of as many ends as there are cops or bobbins on the skewers in the creel.

13. The **woof** is a rectangular framework, usually secured to a wall, consisting of two vertical and two horizontal rails, as shown in Fig. 4. Each vertical rail contains from ten to twenty holes to receive pegs. The vertical rails must be

exactly alike as to the number and spacing of the holes, with opposite holes the same distance apart, usually 10 feet, in every case. In each horizontal rail, holes for two additional pegs are also provided. The creel is movable and is placed a few feet from the woof and at an angle with it.

14. Method of Making Warps.—In making a warp, the warper tender first ties the ends together and slips them over the peg *a*; he then selects the ends from the creel in their proper order, but first makes a lease by passing the first end over the thumb and under the forefinger of the right hand, the next end under the thumb and over the forefinger, etc., in this manner separating the even-numbered from the odd-numbered ends. After the lease is made, it is passed over pegs *b, c* in the same manner that it was passed around the thumb and forefinger; as these pegs serve to hold the lease of the warp, they are termed *lease pegs*. All the yarn is then passed around the pegs *g*, until it comes to the pegs *d, e*; here it passes under the peg *e*, over the peg *d*, then around *f*, back under the peg *d*, and over the peg *e*. By this means another lease is formed, of sections containing a greater number of threads than in the case of the pegs *b, c*, which separated the yarn thread by thread. From the peg *e*, the yarn passes back around the pegs *g* in reverse order until it reaches the pegs *b, c*, where a lease is again formed and the ends then knotted around *a* and cut.

The manner in which the warp yarn is wound around the pegs places twice as many ends on the woof as are taken from the creel each time that the yarn is passed back and forth, since it commences and ends at the same point. The length of the warp is governed by the number of pegs that are used; for instance, if there was the usual distance of 10 feet between the vertical rails of the woof and the warp was required to have 480 ends and be 100 yards long, it would be passed across the frame thirty times (30×10 feet = 300 feet = 100 yards), necessitating the use of thirty-one pegs in the vertical rails. If 120 ends were taken from the creel for this warp, four layers would have to be placed on

the woof; that is, the yarn would be passed from a to f and back to a , where it would be tied and cut and the operation then repeated once. This system of hand warping is now entirely out of date, except for making warps for hand looms or small pattern warps in designing rooms or textile schools.

WARPING MILLS

15. A warping mill, Fig. 5, consists mainly of a large circular reel made either 10, 12, 14, 16, 18, 20, 22, or 25 yards in circumference, a heck, and a curved creel. The term *mill* is frequently applied to the reel alone, as this is the main part of the warper. It is constructed around a vertical shaft a that is supported in a footstep secured to the floor, and revolves in a bearing a_1 attached by braces to the ceiling of the room or other suitable support. Around the circumference of the mill vertical rods a_2, a_3, a_4 are secured. The rods a_3, a_4 are shown carrying cross-pieces, or clamps, b, b_1 in each of which are inserted two pegs b_2 , to which the ends of the chain can be secured. The vertical rods are supported from the central shaft by a stayed rigid framework, so that the reel may revolve truly, the bottom of the rods clearing the floor sufficiently to allow the driving belt to pass underneath the mill.

The mill may be driven by hand or power. The driving head c consists of a short, upright shaft c_1 , on which is a flanged belt pulley c_2 that carries a belt c_3 that also passes around another flanged pulley a_5 at the lower end of the central shaft a of the reel. By turning the handle c_4 that is attached to the shaft c_1 , the reel may be driven in either direction by hand. The arrangement for driving by power consists of a horizontal shaft c_5 that carries two clutch pulleys c_6, c_7 , which receive motion from the driving shafting of the room. These pulleys revolve loosely on the shaft and in opposite directions. Between them is a clutch arrangement operated by the handle c_8 , by which either pulley may be caused to drive the shaft c_5 . Thus the shaft may be driven in either direction, according to which pulley is used for driving it, or

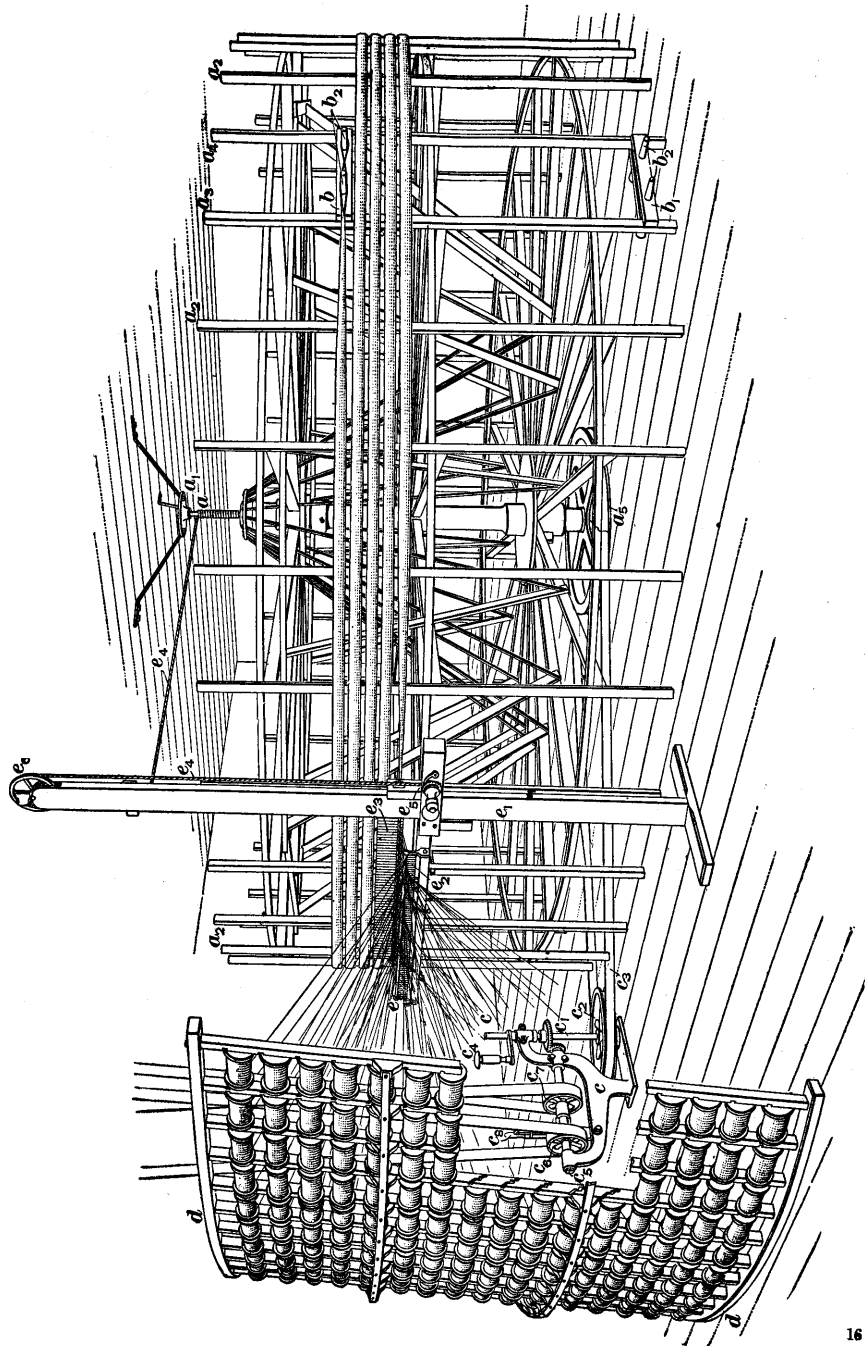


FIG. 5

the shaft may remain stationary and the pulleys revolve loosely, the position of the handle c_2 controlling whatever motion is desired. As the shaft c_2 is connected with the vertical shaft c_1 by means of two bevel gears, the mill may be driven in either direction.

16. The creel d is curved and consists of vertical standards slotted to receive the ends of skewers passing through the spools of yarn. The standards are maintained the required distance from each other by horizontal bars, while the whole framework is attached to the floor and also, by suitable braces, not shown in Fig. 5, to the ceiling of the room.

17. The ends of yarn from the spools pass to the circular reel through the heck e , which is supported by a heck post e_1 up and down which it slides. The heck consists of a framework e_2 with guide rods, between which the yarn passes to a number of porcelain tubes e_3 , known as pot eyes, that are mounted on vertical rods, on which they can rotate. The yarn passes between the pot eyes in groups of the required number of ends for a pin lease. Each end is then conducted through one of a number of wire eyes, not shown in the figure but situated between the pot eyes and the reel; one half of these wire eyes are mounted on one frame, and the other half on another, which arrangement, since either frame may be raised, facilitates the taking of a thread lease; when the lease is not being taken, all the wire eyes are level. From these the yarn passes to the reel, being condensed into a loose rope to form the chain by passing through a trumpet-shaped guide. The heck is raised and lowered on the heck post by means of a rope e_4 , one end of which is attached to the heck at e_5 . The rope passes upwards around the pulley e_6 , then downwards for a short distance and around a small pulley, and thence to the shaft a , to which the other end is attached. As the mill revolves in one direction, this cord winds around the upper part of the shaft, consequently drawing the heck up the post; when the mill revolves in the other direction, the cord is unwound, which allows the heck to fall.

18. Method of Making Warps.—The upper clamp *b* and lower clamp *b*₁ are movable and can be secured to any two of the vertical rods, as required. At the commencement of a warp, the upper clamp *b* is placed near the top of two of the vertical rods, in case a warp that will occupy the whole of the surface of the mill is required; but if a shorter warp is to be made, the clamp is lowered as far as is desired. The mill is then revolved until the heck is wound to the height of this clamp, after which the ends, which have previously been passed through the pot eyes and wire eyes of the heck, are knotted together and passed around the pegs in this clamp. The mill is then revolved slightly, by turning the handle *c*₁, until motion has become sufficiently accelerated, when the handle *c*₁ is moved so as to throw in the clutch, which drives the mill by power in the required direction. As the mill revolves, the chain of warp is wound around it in a spiral manner, because the revolution of the central shaft *a* uncoils the rope *e*₁, which gradually lowers the heck.

The motion of the mill continues until as many layers of chain have been wound around it as are necessary to form the total length of warp desired, when the handle *c*₁ is moved to such a position as prevents any motion being imparted to the mill. The lower clamp *b*₁ is then secured to two of the vertical rods at the lower end of the chain and the ends of the warp passed around the pegs. After the lower end of the warp is secured, the operator again turns the mill slowly by hand and then throws the handle *c*₁ in the opposite direction, so as to cause the mill to be revolved by power in the opposite direction to that in which it was moving. This places another layer of yarn on the previous one, because the heck this time is moved upwards by means of the rope *e*₁ being coiled on the shaft *a*. The mill continues to revolve until the point in the upper part where the chain was commenced is reached, when the ends of the warp yarn are again secured to the pegs in the clamp *b*. This completes one *journey* of the mill, sometimes called one *gang*, or *bout*.

Up to this point, the warp has been made of the required length, but only contains twice as many ends as there are

bobbins in the creel. These are so arranged that this number will be a factor of the total number of ends required in the warp. For instance, if 1,680 ends are required and there are 280 ends in the creel, the heck must move down three times and up three times, making three journeys.

19. Leases are taken on the circular warper at the heck. The thread lease is taken by means of the two frames carrying the wire eyes; the odd-numbered ends pass through the eyes in one frame and the even-numbered through the eyes in the other frame. By raising each frame alternately two sheds are formed and kept apart by the first finger and thumb of the operator until the lease reaches the reel, when he removes them from his finger and thumb and passes them over the pegs b_2 of the clamp b so that the ends occupy the same relation to each other as when on the first finger and thumb; that is, the odd-numbered ends pass over one of the pegs b_2 and under the other, while the even-numbered ends pass under and over in the reverse manner to the odd-numbered ends. The pin lease is taken by what is known as *picking the lease*; that is, the groups of ends that are separated by the pot eyes are taken alternately first under the thumb and over the first finger and then over the thumb and under the first finger, in which order they are placed on the two pegs b_2 .

The length of warp is, of course, determined by the number of revolutions made by the mill. If a warp 400 yards long is to be made on a 16-yard mill, twenty-five revolutions will be given to the mill in each direction. When as many layers as are necessary to give the required number of ends have been wound on the mill, it is stopped and the final lease taken, the ends of the yarn connecting the warp with the heck cut and tied, and the chain removed by hand, the operator usually winding it around his wrist in a ball form.

Circular warping mills are not now used to any great extent, the objections to the system being its crudeness, the large amount of floor space occupied, and the small production, as compared with more modern systems of warping.

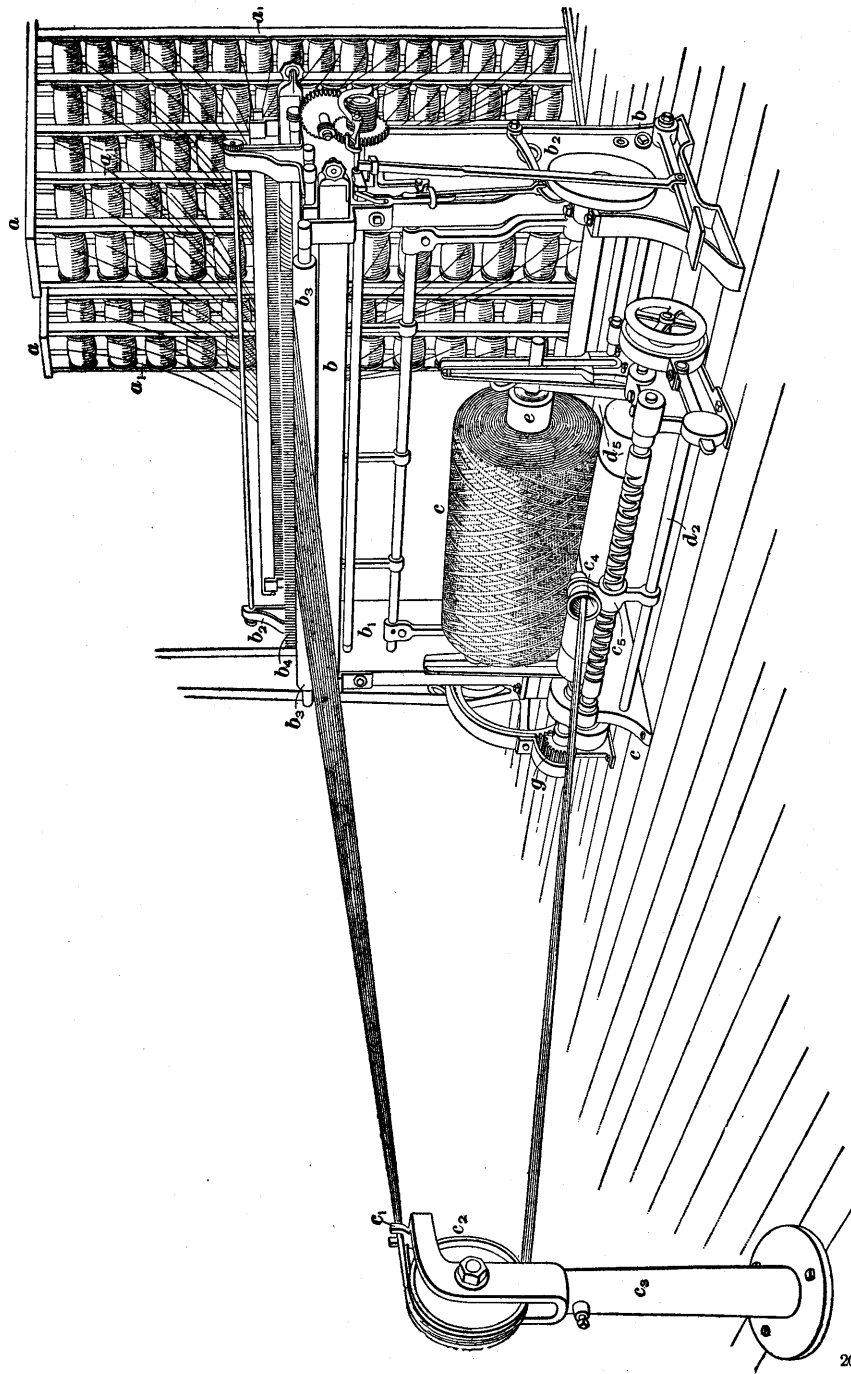


FIG. 6

There is also a defect in all warps made on this principle, especially those of any bulk, owing to the fact that the outer layers of yarn are longer than the inner layers, which causes the ends that were warped last to be slacker in the warp in the loom than those wound on first.

BALLING WARPERS

CREEL AND WARPERS FRAME

20. The ordinary section-beam warper used in the regular cotton-warp-preparation system for making section beams is so constructed that it can also be used in connection with a balling attachment placed in front of it for making ball warps. When a balling warper is intended only for making balls it is constructed in many respects like the common section-beam warper, but without those parts of the mechanism necessary in making a beam. A **balling warper** suitable for making balls only is shown in Fig. 6, and consists of the creel *a*, the warper proper, or warper frame, *b*, and the balling attachment *c*.

21. Passage of the Yarn.—The yarn passes from the creel *a* through the various parts of the warper proper *b*, including the reed *b*, over the front roll *b*, to the guide fork *c*, and around the return wheel *c*. It then passes through the trumpet *c*, and is wound on the wooden core *e*.

22. The creel *a* is what is known as a **V-shaped creel**, since it consists of two sides similar in construction that rest on the floor in the shape of a **V**, connected at the end nearest the warper and separated at the rear end by a distance of about 5 feet. A number of vertical standards *a*, are connected at the top and bottom to crosspieces, by which they are held a sufficient distance apart to allow a spool to be placed between each pair of vertical standards. Attached to the insides of the standards are a sufficient number of iron bearings for the spools required; sometimes instead of iron steps, recesses are cut in the wooden framework and

porcelain or glass steps inserted. The steps are placed in horizontal rows and hold the iron or wooden skewers on which the spools are mounted. The V shape of the creel permits those ends from the rear vertical rows to pass to the warper without coming in contact with the ends from those vertical rows near the front.

23. The warper frame consists of two upright standards b_1 , b_2 that are rigidly attached by means of rods and support rolls, guide rods, reeds, etc., which maintain the yarn in an even horizontal sheet until it reaches the front roll b_3 . The guide fork c_1 that serves to condense the yarn into a chain and the return wheel c_2 are supported by a stand c_3 attached to the floor. The return wheel c_2 revolves freely and serves merely as a guide for the chain in its passage to the balling attachment.

24. Leasing.—The kind of lease usually taken at this style warper is the thread lease, for which it is customary to use a reed, as shown at b_4 , Fig. 6. The reed for the machine under consideration consists of a foundation supporting a number of steel wires, in about the center of each of which is an eye. The yarn is threaded through the drop wires of the stop-motion mechanism and then through the reed, alternate ends passing through eyes in the steel wires, while the other ends pass through the *dents*; that is, between the wires. When the machine is running, the ends emerge in an even sheet and are then gradually condensed to form the chain. When it is necessary to take a lease, the reed is alternately raised and lowered by suitable mechanism. Raising the reed also raises the ends that pass through the eyes, while lowering the reed depresses these ends; on the other hand, the ends that pass through the dents remain in their normal position during the whole time.

For some makes of balling warpers, instead of using perforated steel wires a leaded reed is used. This consists of stiff, steel wires so connected as to stand upright on a firm foundation, the lower half of each alternate dent being filled with lead. Each end in the warp passes through a dent, so

that only alternate ends pass through the leaded dents. When it is desired to take a lease the reed is raised, which

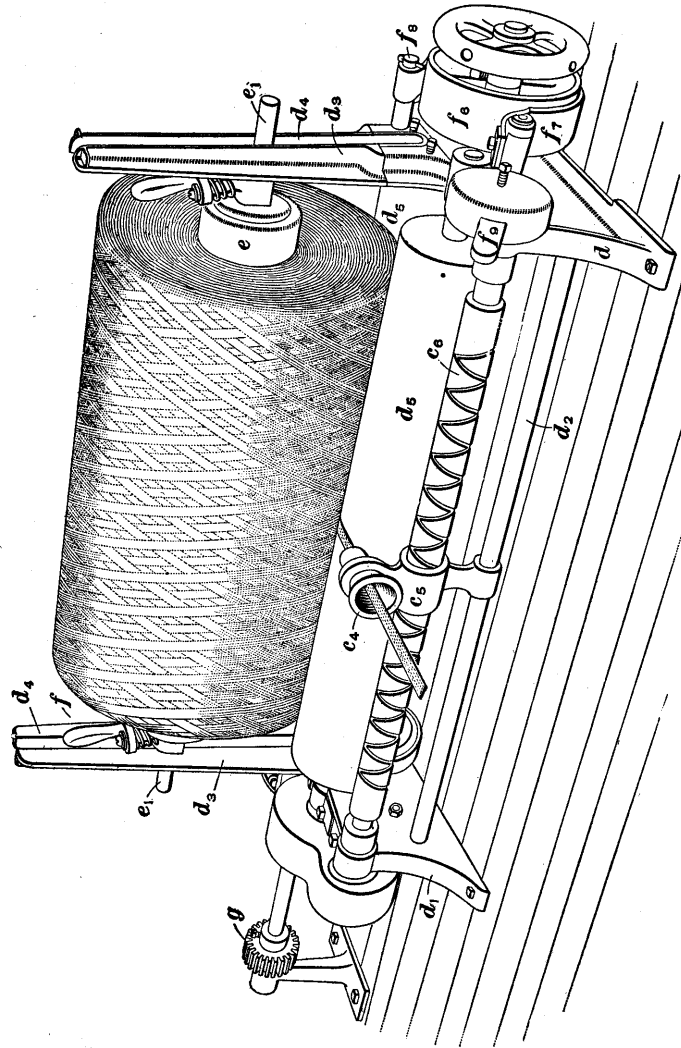


FIG. 7

lifts those ends in the leaded dent, while those in the other dents remain down, thus enabling twine to be passed between alternate ends so as to produce a lease.

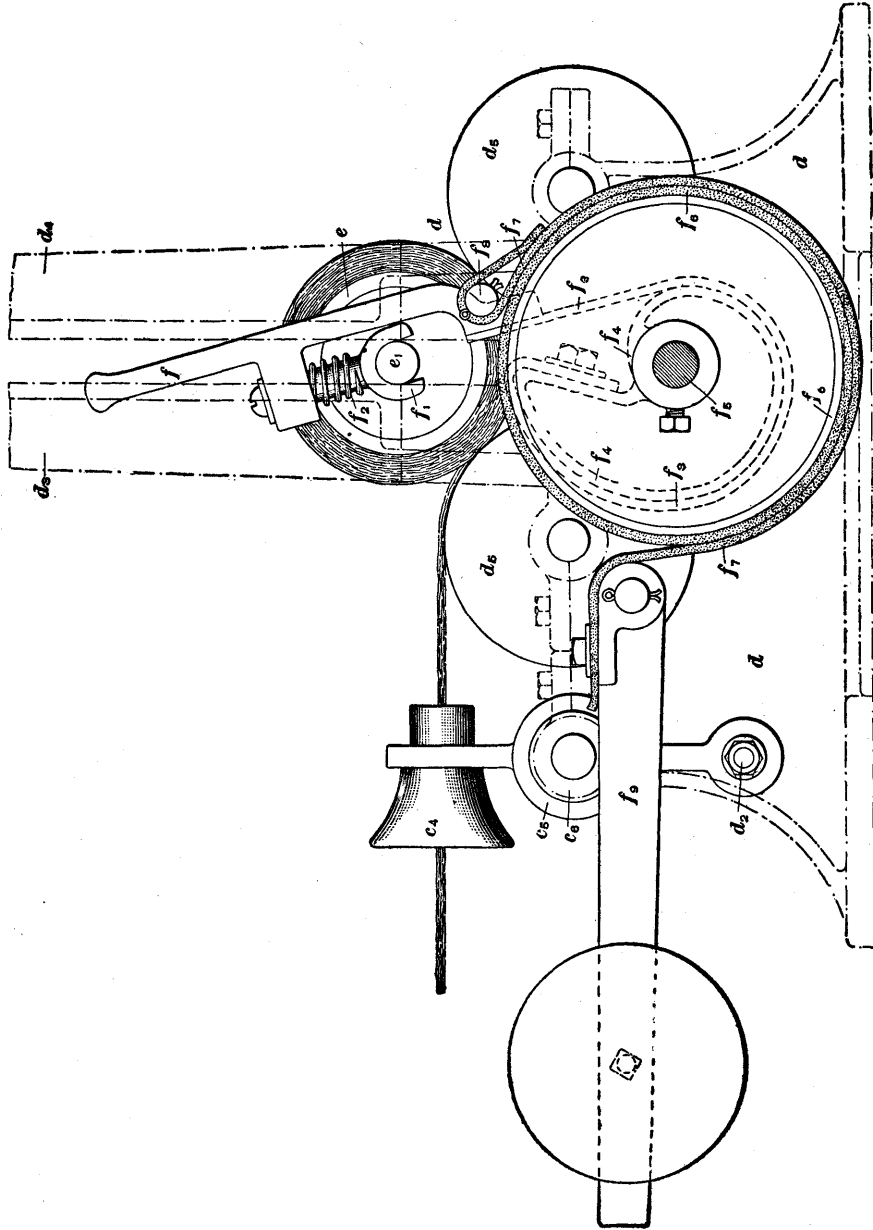


FIG. 8

CONSTRUCTION OF BALLING ATTACHMENT

25. A larger view of the balling attachment alone is shown in Fig. 7, while Fig. 8 is an end elevation with the hand wheel removed and the framework shown in dot-and-dash lines so that the various working parts can be more clearly seen. The attachment consists of two upright supports d, d_1 that form the sides and are connected by cross-bars secured to each side, one of which is shown at d_2 . The upper portion of each support terminates in two upright arms d_3, d_4 that serve as guides for the shaft e , during the formation of the ball. For convenience in doffing, etc., the upper parts of these arms are made removable. Mounted in bearings on the supports d, d_1 are two rolls d_5 about $5\frac{3}{4}$ inches in diameter, which are connected by gearing so as to revolve at the same circumferential speed. The ball rests on these two rolls and is wound around a wooden core e , through which is a square hole for the shaft e ; the latter is squared at its central part, but has circular ends that rest between the two pairs of vertical guides. Sometimes the shaft e is replaced by an expanding mandrel, in which case a paper tube is passed over it and the mandrel expanded, in order to cause the tube to be gripped and be driven by the rolls on which it rests.

26. Driving.—The machine is driven in the usual manner for warpers of this or the beam type; that is, it has the tight-and-loose and slow-motion pulleys. On the same shaft with the pulleys is a small spur gear driving the gear g , Figs. 6 and 7, through a large carrier gear. The gear g is situated on the shaft of one of the rolls. Another gear on this roll shaft drives, by means of carrier gears, a gear on the end of the other roll shaft and a gear on the end of the traverse worm-shaft c_6 ; both rolls d_5 revolve in the same direction. As the core e rests on the rolls d_5 , it is revolved at the same surface speed as these rolls; and as they are positively driven, the yarn is drawn off the spools in the creel, through the warper, and wound around the core.

27. Traverse Motion.—In order to produce the cylindrical form of ball desired, it is necessary to give a traverse motion to the trumpet c_4 , and consequently to the chain passing through it, which when only one ball is formed at a time is generally almost equal to the width of the core—the trumpet is moved almost to one end of the core, is then reversed and moved almost to the other end, and again reversed, with a movement comparatively slow and even, so as to build up the chain on the core in successive layers of spiral coils.

The traverse motion is obtained by means of a heavy steel screw c_6 mounted in bearings in the end pieces of the baller. The shaft has a continuous double thread cut deeply into its surface, one thread right-hand and the other left-hand, connected at each end. Around the threaded portion is passed a bracket c_5 , which carries a pin that projects into the thread.

The lower end of the bracket is enlarged to fit over the rod d_2 , which serves to hold it in an upright position and steady it; as it carries the trumpet c_4 at its upper end, the rotary movement of the screw shaft will produce a horizontal reciprocating movement of the trumpet, thus giving the desired traverse to the chain. The speed of the screw shaft is so regulated as to give an open spiral wind of the chain on the core.

28. Winding Mechanism.—At each side of the baller is a casting f , Fig. 8, that has a handle at its upper end and carries a lug, through which passes the shank of a fork f_1 that rests on the shaft z_1 . On the shank of this fork, between its arms and the lug of the casting f , is a spring f_2 , that has a tendency to force the forked portion as far from the lug as is allowed by the washer secured to the upper end of the shank of the fork. At the lower end of the casting f is attached a leather strap f_3 , which passes down and around a scroll-shaped casting f_4 , shown in dotted lines, mounted on the shaft f_5 . Securely attached to this shaft is a friction pulley f_6 (Figs. 7 and 8), partly around which passes a

friction strap f , that is secured at one end to a stud f_s on the stand d and at the other end to a weighted lever f_w .

This friction mechanism is necessary in order to keep the core pressed on the driving rolls d_s with sufficient pressure to wind the chain on its surface. When a ball is first started, the shaft e_s of the core is in its lowest position and the casting f also being in its lowest position allows the scroll f_s to assume a position practically as shown in Fig. 8 and almost the whole length of the strap f_s to be wound around it. When the scroll f_s is in the position shown, the strap f_s acts on the small diameter of the scroll, and hence a greater pressure is exerted on the core because a greater force is required to turn the friction pulley f_s under these conditions. As the ball increases in size, the ends of the shaft e_s rise between the vertical guides d_s, d_w , thus raising the casting f and causing the scroll f_s , shaft f_s , and friction pulley f_s to revolve so that the strap f_s will be gradually unwound from the surface of the scroll. As the strap f_s is unwound from the surface of the scroll in consequence of the increasing diameter of the ball raising the casting f , the effective diameter of the scroll increases so that the leverage of the strap f_s is increased and less force is required to raise the core. The decrease in the amount of power, or pressure, required to overcome the friction is necessary in order that an even tension may be obtained; for as the ball increases in size, it also increases in weight, thus counterbalancing the decrease in the amount of power required to overcome the friction, so that the tension for winding the yarn will be practically the same throughout the building of the ball. An even tension is required to make a perfectly formed ball. If the tension at the beginning were less than at the finish, the ends of the ball would bulge out and be ragged. If the tension were less at the finish than at the beginning, a soft ball would be formed. If a circular disk were used in place of the scroll, the leverage would be the same all the time; consequently, the same amount of tension would be caused by the friction mechanism throughout the building of the ball, and as the

ball increased in size and weight, the amount of tension would be increased, due to the increased weight of the ball.

29. Measuring Motion.—On most ball warpers, an arrangement is provided to register the number of yards of chain passing through the machine by means of a finger, or fingers, moving around the face of a graduated dial, the arrangement being called a *clock*, sometimes a *lease clock*. Combined with the measuring arrangement, there is usually an arrangement by which the warper is stopped automatically when certain lengths have been warped, a bell also being rung to notify the operator. The measurements required to be recorded are the terminations of cuts, the points where it is desired to insert leases, and the termination of the complete chain. The cut lengths are generally short, usually about 50 yards; the leases are inserted at regular intervals, usually every 500 or 1,000 yards; while the complete chain varies from 1,000 to 10,000 yards, or more.

Elevations of a mechanically operated lease clock are shown in Fig. 9 (*a*) and (*b*). The clock is driven from the shaft of a measuring roll, which carries a single worm h that drives a worm-gear h_1 of 48 teeth. The yarn passes over this measuring roll in its passage through the warper proper. On the same stud with h_1 is the gear h_2 of 16 teeth, which drives the *cut change gear* h_4 by means of the carrier gear h_3 . The change gear is held on its stud by means of a nut, as shown, and is in a convenient place for removal and replacement with another gear, thus affording a ready means of altering the length of the cuts. On the same shaft with h_4 is a gear h_5 of 16 teeth driving a gear h_6 of 64 teeth, on the same stud with which is a gear h_7 of 16 teeth driving the *lease change gear* h_8 . Different sizes of gears at h_8 give different lengths between the leases, in the case of long chains; or different lengths of complete chains, in the case of short chains. On a short supporting shaft j is mounted a curved arm j_1 with its upper end resting against a collar j_2 that is on the same sleeve as, and revolves with, the cut change gear h_4 . In this collar is cut a notch sufficiently large to allow the

point of the curved arm j_1 to drop into it when the collar has revolved until it is in a suitable position. As this arm drops into the notch, it causes a hammer j_3 to strike the

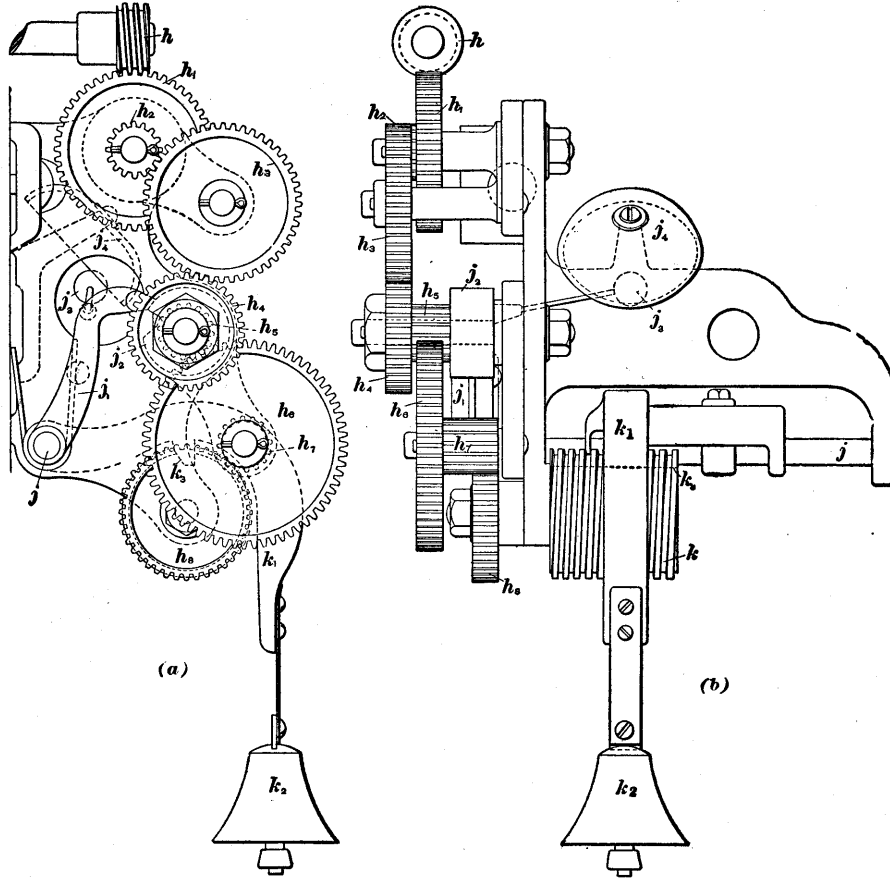


FIG. 9

small gong j_4 , thus indicating to the operator that a cut has passed the measuring roll.

On the stud that carries the lease change gear is a barrel k carrying coarse spiral threads, between which rests the curved finger of a casting k_1 , which is also supported on the shaft j , on which it can slide. This barrel has a groove k_2 ,

cut lengthwise along its surface, which is wide and deep enough to allow the finger of the casting k_1 to drop into it. When the warper is started, the finger is just beyond this groove. The number of teeth in the train of gears is such as will cause the barrel to make one revolution while the number of yards required between lease bands is passing through the machine, so that when it is necessary to insert a lease, the barrel will have revolved until it is in the right position for the finger of the casting k_1 to drop into the groove, when the vibration of the bell k_2 will cause it to ring. Therefore when the gong rings, the operator knows that a cut has been completed; and when the bell rings, that a lease has been completed, or, in the case of short chains, a complete chain finished.

The thread around the barrel k is such as to provide a number of grooves, usually ten altogether; at each revolution the curved arm k_1 is moved a slight distance outwards, so that ultimately, when the barrel has made the required number of revolutions, the finger of the curved arm escapes altogether from the barrel and falls from it for some distance. The belt is then shipped from the tight to the loose pulley by means of suitable mechanism and the warper stopped, thus indicating the completion of a chain. For example, if six leases are required in a complete warp, at the start the finger is placed in such a groove of the barrel that six revolutions will free it and cause the warper to stop.

30. Calculations for Measuring Motion.—To find the number of yards in a cut when the circumference of the measuring roll and the number of teeth in the gears operating the cut-indicator gong are known:

Rule.—*Divide the product of the driven gears and the circumference of the measuring roll, in inches, by the product of the driving gears and 36 (the inches in 1 yard).*

EXAMPLE.—Find the number of yards in a cut when the measuring roll is 12 inches in circumference and carries a single worm driving a worm-gear of 48 teeth, with which is compounded a 16-tooth gear driving, through a carrier gear, the cut change gear of 50 teeth.

$$\text{SOLUTION.}— \frac{48 \times 50 \times 12}{1 \times 16 \times 36} = 50 \text{ yd. per cut. Ans.}$$

31. To find the size of the cut change gear required to produce a certain length cut when the circumference of the measuring roll and the number of teeth in the gears operating the cut-indicator gong are known:

Rule I.—*Apply the rule for finding the length of the cut, in yards, substituting the length, in yards, of the cut required in place of the number of teeth in the cut change gear.*

EXAMPLE 1.—Find the size of the cut change gear required to produce a 50-yard cut with the train of gears given in the example in Art. 30. The measuring roll is 12 inches in circumference.

$$\text{SOLUTION.}—\frac{48 \times 50 \times 12}{1 \times 16 \times 36} = 50\text{-tooth gear. Ans.}$$

Another rule for finding the size of the cut change gear is as follows:

Rule II.—*Divide the number of yards in the cut desired by the constant for the train of gears operating the cut-indicator gong.*

The constant is found by applying the rule in Art. 30, considering the cut change gear as a 1-tooth gear.

EXAMPLE 2.—Same as example 1.

$$\text{SOLUTION.}—\frac{48 \times 1 \times 12}{1 \times 16 \times 36} = 1, \text{ constant for the cut change gear.}$$

$$50 \div 1 = 50\text{-tooth gear. Ans.}$$

From the above calculations it will be seen that the number of teeth in the cut change gear is equal to the number of yards in a cut; thus, a 40-yard cut requires a 40-tooth change gear; a 50-yard cut, a 50-tooth change gear; etc.

32. To find the number of yards between leases when the circumference of the measuring roll and the number of teeth in the gears operating the lease-indicator bell are known, apply the rule in Art. 30.

EXAMPLE.—Find the number of yards between leases when the measuring roll is 12 inches in circumference and carries a single worm driving a worm-gear of 48 teeth. Compounded with the worm-gear is a 16-tooth gear driving the cut change gear through a carrier gear. On the same stud with the cut change gear is a 16-tooth gear driving

a 64-tooth gear that is compounded with a 16-tooth gear driving the lease change gear. The cut change gear in this case has 50 teeth, while the lease change gear has 80 teeth.

$$\text{SOLUTION.}— \frac{48 \times 50 \times 64 \times 80 \times 12}{1 \times 16 \times 16 \times 16 \times 36} = 1,000 \text{ yd. Ans.}$$

33. To find the constant for the lease change gear:

Rule I.—*Apply the rule for finding the number of yards between leases, considering the lease change gear as a 1-tooth gear.*

EXAMPLE 1.—Find the constant for the lease change gear for the train of gears given in the example in Art. 32, the measuring roll being 12 inches in circumference.

$$\text{SOLUTION.}— \frac{48 \times 50 \times 64 \times 1 \times 12}{1 \times 16 \times 16 \times 16 \times 36} = 12.5, \text{ constant for the lease change gear. Ans.}$$

To find the size of the lease change gear required to produce a given length of chain between lease bands:

Rule II.—*Divide the number of yards desired between lease bands by the constant.*

EXAMPLE 2.—Find the size of the lease change gear required to produce 1,000 yards of chain between leases.

$$\text{SOLUTION.}— 1,000 \div 12.5 = 80\text{-tooth gear. Ans.}$$

34. To find the number of cuts between leases:

Rule.—*Divide the number of yards between leases by the number of yards in a cut.*

EXAMPLE.—Find the number of 50-yard cuts between lease bands 1,000 yards apart.

$$\text{SOLUTION.}— 1,000 \div 50 = 20 \text{ cuts between lease bands. Ans}$$

35. The fact that the gearing of the measuring motion is constant with the exception of the lease and cut change gears affords a short method of finding the size of the lease change gear required to produce a given length of chain between lease bands. It will be noted that the constant found in Art. 33 (12.5) is one-fourth the number of yards in a cut, or the number of teeth in the cut change gear (50). The relation of these items is always the same, because the number of teeth in the cut change gear is the only variable

quantity in the calculation, which without this item equals $\frac{1}{4}$. The constant, therefore, may always be found by dividing the number of yards in a cut by 4. As the rule for finding the number of cuts between leases requires that the number of yards between leases shall be divided by the number of yards in a cut, and as the rule for finding the size of the lease change gear requires that the number of yards between leases shall be divided by the constant, which it has been proved is always one-fourth of the number of yards in a cut, the number of cuts between leases must always be one-fourth of the number of teeth in the lease change gear. This gives the following short rule for finding the lease change gear required:

Rule.—*Multiply the number of cuts between lease bands by 4.*

EXAMPLE.—Find the size of the change gear required to produce 1,000 yards of chain between leases, the cuts being 50 yards in length.

SOLUTION.—Applying the rule for finding the number of cuts between leases, $1000 \div 50 = 20$ cuts; $4 \times 20 = 80$ -tooth gear. Ans.

36. In the case of short chains, where it is intended to stop the warper and cut off the chain when the barrel *k* has made one revolution, the preceding calculations as to the length between lease marks can be considered as applying to the total length of the chain. In the case of long chains, as the number of leases in the chain is known, no calculation is necessary; the finger is simply placed in such a groove of the barrel *k* that the latter must turn around as many times as there are to be leases in the chain before the finger is allowed to drop from it. For example, if a warp of 4,000 yards is required with 500 yards between leases, the barrel must turn around eight times before the chain will be complete; the finger will therefore be set first in such a groove as will require eight revolutions of the barrel to release it.

By suitable arrangement of the fingers and their connection with the stop-motion, balling warpers can be constructed so that the warper is stopped at the end of a cut and of a lease as well as at the end of the completed chain.

37. In the preceding description, references have been made to the baller as equipped for making one ball. In this case, it is customary to build the baller so as to take cores either 30 or 36 inches long, the length of the balls being slightly less than this. Balls can be made of any width narrower than the maximum size for which the machine is constructed, by changing the traverse screw to one of the required length. When exceptionally narrow balls are required, it is customary to make two or even three at the same time on one core. This is accomplished by using a traverse-guide shaft with either two or three guides, as the case requires, the shaft in each case having a corresponding number of sets of threads, so that each guide is operated by a separate set of threads. Thus, if a 36-inch baller is used and two balls formed at the same time, each ball will be slightly less than 18 inches in length, while in case three balls are made, each ball will be slightly less than 12 inches. The number of ends that can be placed on one ball depends on the creel capacity. The largest creels are made for 810 ends, but this is an unusual size, the creels being usually constructed for 510 spools.

38. A warper similar to that described is usually driven by a $1\frac{1}{2}$ -inch belt and requires about $\frac{1}{2}$ horsepower. The warper tenders are usually women or girls, one of whom attends to two or more warpers, depending on her ability, the speed of the machine, the counts and quality of the yarn run, as well as many other important points.

The speed of the warper is such as to deliver from 50 to 60 yards of chain per minute when the belt is on the tight pulley; but the net production is about 25 per cent. less than this, on account of stoppages for replacing spools in the creel, leasing, doffing, cleaning, and repairing broken ends, including the allowance that is necessary for the time during which the belt is on the slow-motion pulley.

No definite information can be given as to the number of ends or the length and weight of the balled chains, since this varies very widely according to requirements of pur-

chasers. Balls may be made as heavy as 300 pounds or more and from this downwards as light as is required. Balls are shipped on the cores on which they are built; each ball is wrapped with burlap lined with paper, the ends of which are then sewed. Ballers provided with expanding mandrels over which paper tubes can be placed are sometimes used in order to avoid the expense of shipping balls on the wooden cores, since the paper tubes are much lighter and save freight as well as the expense of returning empty cores.

VARIATIONS IN CONSTRUCTION

39. The arrangement shown in Fig. 6, with the return wheel at the extreme forward end of the apparatus and the balling attachment beneath the sheet of ends, is one commonly used where it is desired to economize in floor space; about 22 feet by 7 feet is occupied by this arrangement. Other arrangements are possible; for instance, the balling attachment may be placed ahead of the return wheel, the yarn passing in almost a straight line from the warper proper to the balling attachment, instead of returning on itself, as shown in Fig. 6. This renders all parts of the warper and balling attachment more accessible, but occupies about 28 feet by 7 feet of floor space. Neither of these arrangements affords the attendant the greatest possible facility of access to the yarn in the warper, such as is required in order to properly piece up the broken ends and pass them through the eyes of the stop-motion. To provide for this, two other methods of applying the balling attachment to the warper are sometimes used. One is to carry the sheet of ends from the warper to the ceiling of the room, pass it over a roll, and then bring it down to the guide eye of the balling attachment; the sheet of ends is contracted as it passes downwards. The balling attachment is placed in any convenient position so that the yarn by passing over the roll will form an arch, under which the attendant can pass and more easily reach the various parts of the warper. The other arrangement is to construct a platform between the

warper and the balling attachment and pass the sheet of ends downwards and underneath this platform, then upwards and around a guide pulley attached to the ceiling, and then downwards to the guide eye of the balling attachment. In this case, the operator can stand on the platform under which the ends are passing and replace broken ends in the most convenient manner.

Another arrangement, known as the *Clark balling attachment*, is similar in many respects to the one shown in Fig. 6, except that the balling apparatus rests against, and is driven by, the regular cylinder of the beam warper, thus avoiding the necessity of a separately located balling attachment.

CHAIN WARPING

(PART 1)

Serial 642 A

Edition 1

EXAMINATION QUESTIONS

Notice to Students.—*Study the Instruction Paper thoroughly before you attempt to answer these questions. Read each question carefully and be sure you understand it; then write the best answer you can. When your answers are completed, examine them closely, correct all the errors you can find, and see that every question is answered; then mail your work to us.*

(1) Mention and briefly describe three arrangements of balling warpers, having regard to the method by which the chain is conducted from the warping frame to the balling attachment.

(2) Explain how balled chains are usually prepared for shipment.

(3) If a chain of 1,440 ends, 600 yards long, is to be made at a circular warping mill with 240 ends in the creel, the mill being 20 yards in circumference, how many times must the mill revolve in each downward and upward movement, and how many journeys must be made, a journey being considered as a complete downward and upward movement of the heck?

(4) (a) What is a chain? (b) What are the advantages and objects of putting yarn up in this form instead of on section beams?

(5) (a) In what kind of warps are leases taken?
(b) Name and define the two principal kinds of leases.
(c) Why are leases taken in warps?

(6) Name three principal items of information that are absolutely necessary before commencing to make a chain.

(7) If a chain is to be made with 55 yards in each cut, what size of cut change gear will be required for the measuring motion shown in Fig. 9?

(8) Explain the traverse mechanism by which a horizontal traverse is imparted to the chain during the building of a cylindrical ball.

(9) What are the two principal forms in which chains are put up?

(10) When filling yarns are to be chained, is the long-chain or the short-chain system usually employed?

(11) When operating a balling warper fitted with a lease clock similar to the one shown in Fig. 9, what is indicated: (a) when the gong rings? (b) when the bell rings?

(12) Give the general sequence of the processes after the yarn leaves the spinning machines for making: (a) short-chain warps; (b) long-chain warps.

(13) What is the necessity for marking cut lengths in a warp, and how is this done: (a) on the short-chain system? (b) on the long-chain system?

(14) Is the hand-warping method used at the present time; if so, to what extent?

(15) What is the special object of a 25-end pin lease sometimes inserted in chains?

Mail your work on this lesson as soon as you have finished it and looked it over carefully. DO NOT HOLD IT until another lesson is ready.

