REELING AND BALING

REELING

INTRODUCTION

1. A *skein* is one of the forms in which yarn is put up for sale or for convenient handling at a future process. Yarn mills adopt this method of putting up yarn to a large extent for convenience in transportation to their customers, as the skeins can be packed in bags or bales and transported without damage; often, also, customers require the yarn to be put up in this manner, since it is the most convenient form in which filling yarn for certain kinds of goods can be subjected to such processes as bleaching, dyeing, mercerizing, polishing, printing, and so on. Yarn intended for filling is sold in skein form more frequently than yarn intended for warp, although this depends somewhat on the fabric to be woven; for some goods it is customary to put up warp yarn in skeins. Knitting yarn that has to be passed through the processes named is also made into skeins.

The **skein** is made by a process of reeling, and the word indicates a continuous coil of yarn that has been wound around a revolving frame of a known circumference. It is tied around at one or more points in its circumference, so that when removed from the frame on which it is made it forms a loose coil that may be treated or handled without damage and unwound at a succeeding process. Skeins vary in circumference, in the length of the yarn composing them, and also in the manner in which the yarn is arranged.

In the United States, the name skein is applied to any length or description of skein, and the process of making it is called *reeling*. In other English-speaking countries, the word *hank* is more frequently given to a skein when it contains exactly 1 hank, as for example, 840 yards of cotton or 560 yards of worsted, or multiples of these lengths, such as double hanks, containing 1,680 yards of cotton or 1,120 yards of worsted; but the process of making hanks is always called reeling. When lengths that are not complete hanks or multiples of hanks are made, it is customary in these countries to speak of the process as *skeining* or *skein reeling* and of the product as skeins. These terms indicate that the skeins are made of a certain weight or a certain length usually less than that of complete standard hanks.

Reeling is a process common to cotton, woolen, worsted, linen, silk, and other materials, the machine in common use for making skeins being known as a *reel*.

REELS

2. The **reel** is one of the simplest machines used in textile-mill work, its essential parts consisting only of a revolving framework around which the yarn can be wound, a creel to hold the yarn being reeled, and some smaller attachments, such as doffing arrangement, traverse motion, measuring motion, etc.

3. Passage of the Yarn.—An ordinary type of reel used in the United States is shown, in perspective, in Fig. 1 and, in section, in Fig. 2. The yarn passes from the bobbin *a*, which is supported by the spindle *b*, through an eye in the guide wire *c*, and around the revolving framework *d*, which is called a *swift;* the yarn forming the skein is shown at *e*. In American types of reels, the yarn passes downwards from a creel fitted with spindles in the upper part of the reel. In European reels, the creel sometimes is below the swift, the yarn passing upwards to it, but in other cases the arrangement is the same as the American type.

4. Creels are of various types, depending on whether the yarn has to be wound from a cop, a filling-wind bobbin, a warp-wind bobbin, a spool, or from some other formation. The ordinary type of creel is the one shown in Figs. 1 and 2. In this case the machine is shown reeling from warp-wind spinning bobbins, but the creel is so constructed that winding

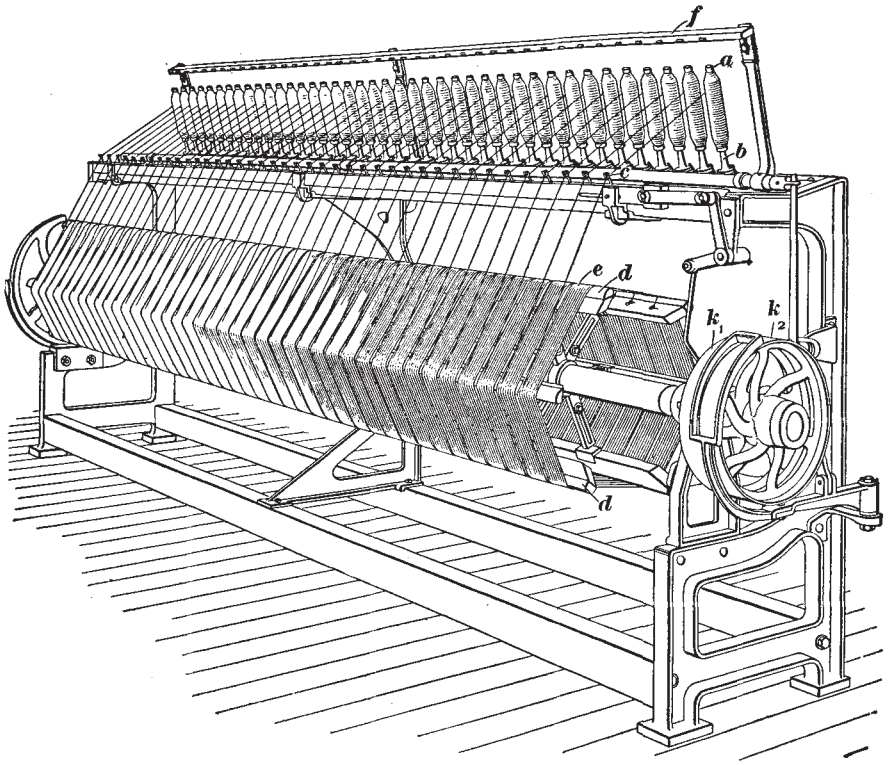


FIG. 1

can take place from warp-wind bobbins, spools, or parallel tubes, or, by using the guide rail *f*, from filling-wind bobbins, or conical tubes.

The creel consists of the framework that supports the spindles *b*, the guide rail *f*, and the receptacle *g* for holding both full and empty bobbins. The spindles are of the common

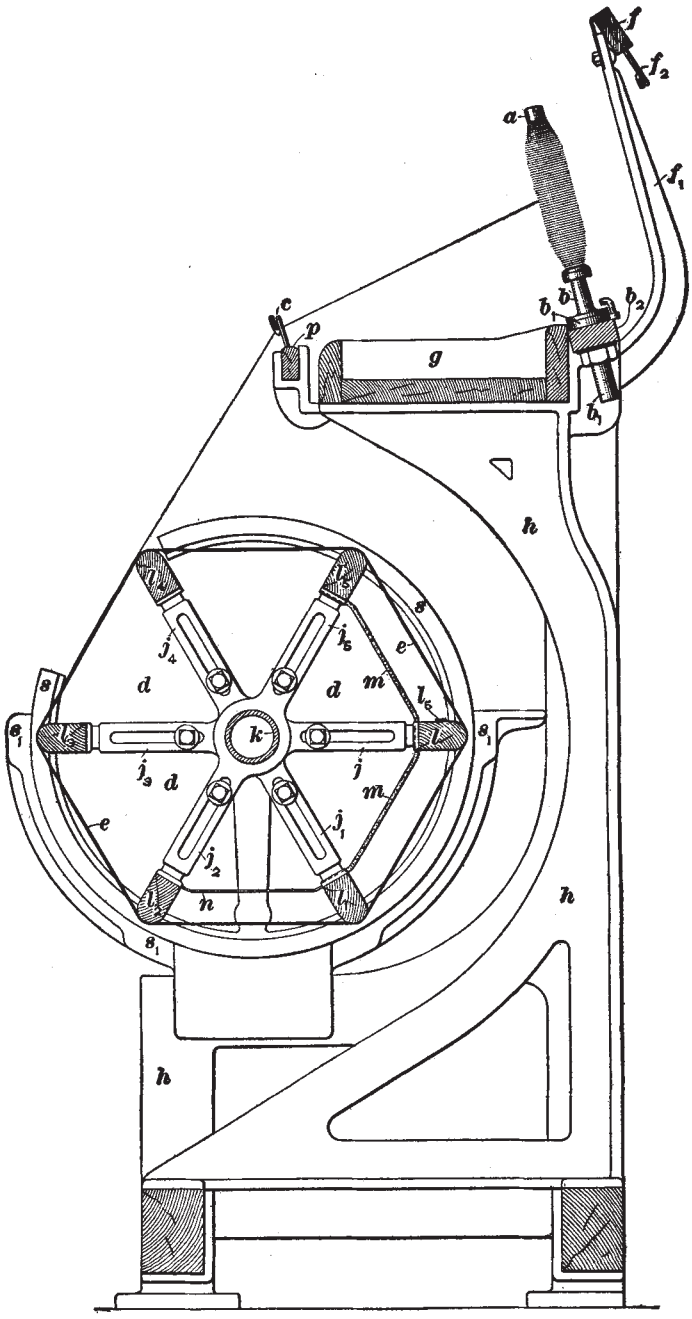


FIG. 2

type and rest in the base b_1, which is supported by the rail b_2. They are made to suit the form of bobbin that is to be used and are constructed to revolve easily by means of a light, uniform pull exerted by the yarn. The spindle shown in use for warp-wind spinning bobbins in Fig. 2 can be used in the same manner for worsted, mohair, and other yarn wound on bobbins with a straight traverse.

The guide rail f is supported by three arms similar to f_1 and carries the same number of guide wires f_2 as there are spindles. In Fig. 2, the rail is shown thrown out of position, as it is only intended to be used in reeling from those forms of yarn in which the end has to be drawn over the nose, such as cops and filling-wind bobbins. When in use, it is in the position shown in Fig. 3. In this case the yarn is shown passing from a cop through the guide wire f_2 in the guide rail f and thence to the guide c in the traverse. When a reel is intended to be used for cops, the revolving spindle and base, such as are shown in Fig. 2 at b and b_1, respectively, are not used, but the creel is constructed with a number of sockets b_2 in which a steel or wooden skewer b_3 can be fitted, as shown in Fig. 3; the cops b_4 are placed on these skewers. These skewers are spoken of as *dead spindles* to distinguish them from the revolving, or *live*, *spindles*. When winding from a wooden bobbin in which the yarn is built with a short traverse, as in the case of filling-wind spinning bobbins, it is not necessary

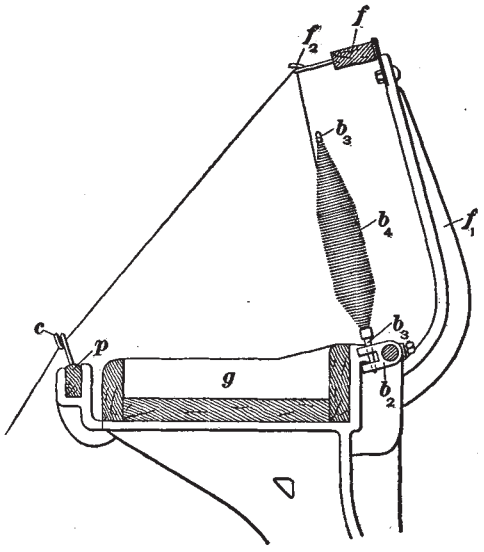


FIG. 3

to adopt the creel construction shown in Fig. 3, as the style shown in Fig. 2 may be used by placing the bobbins on the spindle and drawing forwards the guide rail, passing the end through the eye of the guide wire f_2.

The receptacle g is a long, shallow, wooden box extending the entire length of the frame and supported by the sampsons h. The guide wires c, of which there are the same number as there are spindles, guide the yarn in its passage from the bobbins to the swift; they are of the ordinary type and are screwed into a long wooden rod p that extends the entire length of the frame and forms a part of the traverse motion.

5. The **swift** of the reel, on which the yarn is wound, is shown in Figs. 2, 4, and 5. It consists of several groups of supporting arms evenly distributed throughout the length

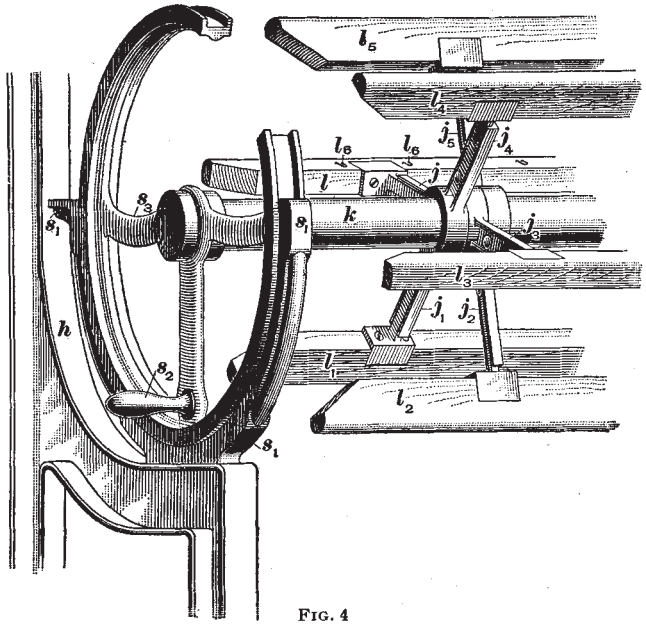


FIG. 4

of the reel. Each group, as shown in Fig. 2, consists of three sets of these arms, j, j_3; j_1, j_4; j_2, j_5; bolted to the arms are extension pieces that carry at their outer ends long

wooden rails $l, l_3, l_1, l_4, l_2, l_5$, respectively. These extension pieces can be moved inwards or outwards, and thus the distance around the swift (usually spoken of as the circumference, although this is not a strictly accurate term) decreased or increased, so that different sizes of skeins can be made. The standard sizes of skeins are 54 inches, 60 inches,

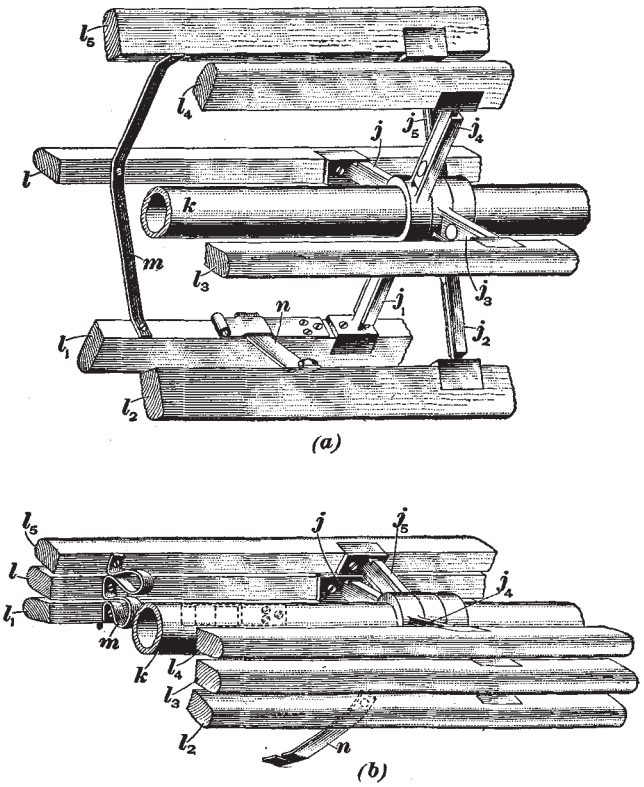


FIG. 5

72 inches, and 90 inches, but only specially constructed reels can be adjusted to make all sizes. Reels are ordinarily constructed to make either 54-inch, 60-inch, or 72-inch skeins.

The arms j, j_3 of the swift are parts of a casting that is fastened on a long, hollow shaft k; the arms j_1, j_4 and the arms j_2, j_5 are similarly constructed, but instead of being

fastened to the shaft k are free to swing on it, and must therefore, in some way, be held rigidly in place when the yarn is being wound on the swift. This is accomplished by means of the leather strap m, Fig. 2 and Fig. 5 (a), and the steel latch n, both of which are attached to the rails, generally at about the middle of the swift. The strap connects the rails l_3, l, l_1, while the latch connects the rails l_1, l_2; thus, each rail is held in its proper position, with an equal distance between each two. When the strap is tightened and the latch n is in position, the arms are held rigidly, as shown in Figs. 2, 4, and 5 (a), and can be revolved in that position. The shaft k revolves in bearings situated at each end of the frame, the tight and loose driving pulleys k_1, k_2 being situated on this shaft, as shown in Figs. 1 and 6.

6. The **traverse motion** used on this reel is shown in Fig. 6 and is very simple. The yarn from each bobbin is wound on the swift over a short section of its length, as shown in Fig. 1. This is accomplished by imparting a slight, but rapid, reciprocating motion to the rail p in which the guide wires c are fastened, which results in the yarn being wound in a zigzag path on the swift, thus producing what is known as *cross-reeling*. In ordinary cross-reeling, the crossings do not occur in the same place with each succeeding layer. The width of the skein depends on the throw of the traverse, which is usually about $2\frac{1}{4}$ inches, depending on the space between spindles.

The rail p receives its reciprocating motion as follows: The shaft k carries a 38-tooth spur gear q, which drives a spur gear q_1 of 62 teeth. On the shaft with q_1 is a crank-arm q_2 connected at q_3 to a connecting-rod q_4, which, in turn, is attached at the point r_1 to a bell-crank lever r pivoted at r_2. Connected to the bell-crank lever at the point r_3 is a connecting arm r_4 that is pivoted to a casting r_5 attached to the rail p. In this manner a rapid traverse is imparted to the guide c as the shaft k rotates.

The crank-arm q_2 is provided with a slot so that the stud q_3 may be moved nearer the center around which it revolves,

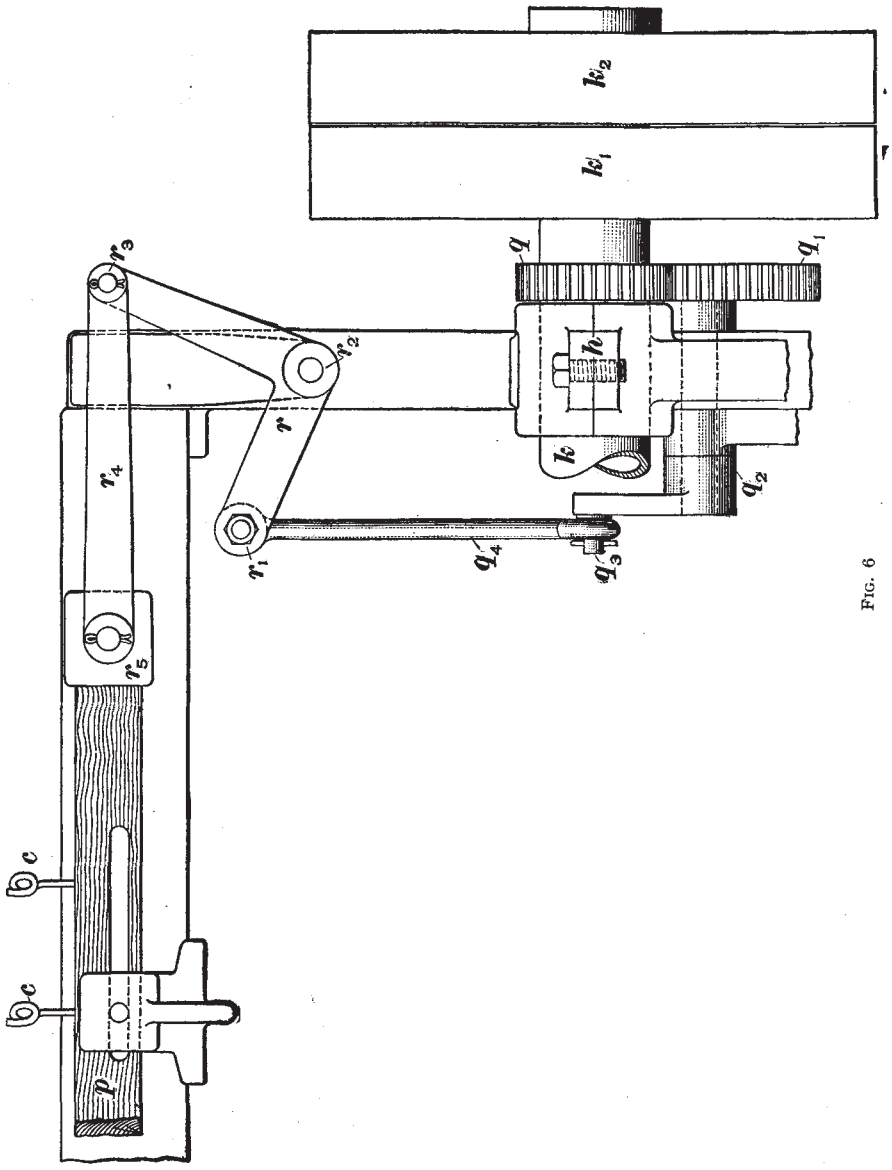


FIG. 6

thus reducing the throw of the crank and consequently lessening the distance through which the guides *c* move, and producing a shorter traverse.

METHODS OF REELING

7. Both the expressions *plain reeling* and *cross-reeling* are frequently applied, in American mills, to the method of making skeins by a machine arranged as described. Plain reeling is often understood to refer to the making of a skein with a narrow traverse, which is usually done in the case of skeins of a short length or skeins through which tie-yarn will not be passed. Cross-reeling is often applied to skeins made on the same machine and with the same traverse motion, but so set as to produce a skein with a wide traverse, which is necessary when the yarn has to be spread sufficiently to enable leasing to be performed; that is, to allow tie-yarn to be passed through the skein. The traverse is sometimes so long as to extend to the extreme limit of the space allotted each skein on the frame or even beyond, in the latter case preventing the use of every spindle. In such cases, alternate spindles only are used for single reeling; for double reeling, when two ends are to be wound together, a supply of yarn is placed on every spindle, but two ends passed through one guide eye. As a matter of fact, both of these methods are really cross-reeling, the only difference being in the length of the traverse. It is preferable not to apply the expression plain reeling to any kind of cross-reeling, as its use tends toward confusion by creating the impression that some other style of reeling than cross-reeling is referred to, and also conflicts with the English practice, where the expression plain reeling means lea reeling. Cross-reeling by means of the mechanism shown in Fig. 6 is one of the simplest and most commonly used methods of reeling in America, but other methods are in use. Among those that differ according to the method of laying the yarn on the swift of the reel are: (1) *Grant*, or *long-diamond*, *reeling*, and (2) *lea*, or *wrap*, *reeling;* while among those that depend on the length

wound on the swift are: (3) *French reeling*, in either cross-reeling or lea reeling, and (4) *skeining*, or *grain reeling*.

8. Grant, or long-diamond, reeling is really a variety of cross-reeling by which the yarn is arranged on the swift with well-defined crossed layers in an elongated-diamond form. This is obtained by giving a quick reciprocating motion to the traverse rod, the time of which has a definite relation to the time occupied by one revolution of the swift; this causes each new layer of yarn to wind on the same part of the swift as some previous layer, thus forming a series of layers in different positions but having the crossings coming together. Some of the longest skeins are made on this system, the reel not being stopped when a hank has been wound, as in some systems, but allowed to run until the skein is sometimes composed of thousands of yards, as many as ten hanks of fine yarn being often made into one skein.

9. Lea reeling is the name given to a method of reeling cotton yarn in which the yarn is arranged on the swift of the reel in separate leas of 120 yards each. As a cotton reel is usually arranged with a circumference of 54 inches, 80 turns of the swift are required to wind 120 yards. The most common method is to reel yarn in 7-lea skeins. For this the cross-traverse motion of the reel is disconnected and an arrangement adopted by means of which the traverse rod remains stationary until the swift of the reel has revolved 80 times, which winds 120 yards around it. Then the traverse is moved slightly and quickly so as again to wind 80 revolutions of yarn, or 1 lea, around the swift, when the traverse is again moved a short distance. This is repeated until there are 7 leas arranged on the swift, consisting of a continuous thread of yarn from the bobbin on one spindle; this arrangement is, of course, repeated along the surface of the swift as many times as there are spindles. A view of a portion of a 7-lea skein is shown in Fig. 7 (*b*). When the reeling of the skein is completed, the swift is stopped automatically. In 6-lea reeling, the yarn is reeled in the same way as in

7-lea, the difference being in the method of tying up, as shown in Fig. 7, where (*c*) represents 7-lea and (*b*) 6-lea; the length of the skein is the same in both cases. The table of measurement for cotton yarn is as follows:

1½ yards = 1 thread, or circumference of a cotton reel
120 yards = 80 threads = 1 lea
840 yards = 560 threads = 7 leas = 1 hank

10. Wrap reeling, as applied to worsted yarn, is on the same general principles as lea reeling for cotton. A worsted reel, however, is usually arranged with a circumference of 72 inches and a wrap, as shown by the table, contains only 80 yards. The table for worsted yarn is:

2 yards = 1 thread, or circumference of a worsted reel
80 yards = 40 threads = 1 wrap
560 yards = 280 threads = 7 wraps = 1 hank

11. French reeling corresponds to ordinary reeling except that the swift is adjusted with a circumference of 1 meter (39.37 inches); yarn is reeled in this way for consumption and sale in those countries in which the meter is the standard of measurement. French reeling may be either cross-reeling or lea reeling. If the latter, the swift is usually revolved 100 times for each division, giving 1 hectometer, and 10 of these divisions (1 kilometer) are made into a skein.

12. Skeining, as it is known in England, is sometimes called **grain reeling,** since the skein may be required to weigh a certain number of grains; and is sometimes called *length reeling*, since the skeins are required to be of such a length as gives a designated weight; it is also known as *thread reeling*, since the length required is made up of a certain number of threads, each of which in the case of cotton measures 54 inches, or in the case of worsted, 72 inches. Each skein has to be of an exact weight, generally expressed by the fractional part of an ounce, for example ½, ⅓, ¼, ⅕, ⅙, ⅛, $\frac{1}{10}$, or $\frac{1}{12}$ ounce; it may, however, be expressed in grains, either 200, 100, 75, 50, 25 grains, and so on. In such cases,

the length of yarn that comprises the weight required must be determined by calculation. The arrangement of the reel is similar to that for lea reeling, so as to move the traverse when the required number of revolutions have been made by the swift.

Skeining, or grain reeling, should not be confused with the usual American method of defining the weight of an ordinary cross-reeled skein. It is frequently the custom for American buyers of skeined yarn to specify that each skein shall weigh a certain number of ounces; for instance, $1\frac{1}{2}$, $2\frac{1}{2}$, 3, or 5 ounces, or any other reasonable weight. These weights greatly exceed the customary weights of skeins made by the grain- or thread-reeling systems on reels provided with measuring motions so as to give exact lengths. The customary American method is not to use measuring motions on the reel to give the weight of skein required, but to determine this by supplying to the reel tender cops or bobbins containing a certain weight of yarn. For example, if a 5-ounce skein were required, the mule cops might be spun $2\frac{1}{2}$ ounces in weight and the reel tender instructed to wind two cops on each skein; if a 1-ounce skein were required, a cop might be spun 2 ounces in weight and the reel tender instructed to make two skeins from each cop; or if a 2-ounce skein were required to be made from ring-spun yarn, the bobbins would be doffed from the spinning frame when 2 ounces of yarn had been wound on them, the correct point being predetermined by weighing bobbins of different sizes. This system, of course, is not absolutely accurate and does not produce skeins of absolutely the weight required, but it produces results sufficiently satisfactory for the general buyer of skeined yarns.

13. The terms **single** and **double reeling** refer to the number of ends passing to each skein at the reel; generally each skein contains only one end, so that almost all reeling is single reeling. Occasionally, however, the ends from two or more spindles or skewers are passed together through one guide eye and thence to the reel; this constitutes double

reeling. When two or more ends have been wound together on a spool or tube and then skeined, this also is called double reeling.

TYING

14. After yarn has been reeled on the swift and before it is removed it becomes necessary to tie together the first and last ends of the skein and in some cases to pass an additional piece of yarn around or through the various portions of the skein. This is known as **tying,** or **tying up.** As the object of skeining yarn is to prepare it for handling at some other process, very often a process in which the threads tend to become more or less entangled, such as bleaching, dyeing, etc., it is very necessary that when the yarn is used after such treatment there should be a ready means of finding the end so as to unwind the skein without entanglement. In some methods of tying, it is necessary to loop together several skeins, so that they may be handled together at the next process but readily separated before unwinding afterwards. When an extra piece of yarn is used to tie up skeins, it is generally a red-and-white cotton twist, or grandrelle yarn. Any colored yarn is suitable, preferably one dyed a fast color so as to stand bleaching, in which case it can readily be found after a skein has been bleached or otherwise treated. In some cases ordinary undyed coarse ply yarn is used, while in others two or more strands of single yarn, taken from a corresponding number of cops or bobbins, together with the ends of yarn in the skein, are tied around it.

In cross-reeling, the first end of the skein, which was slipped into the catch l_6, Fig. 2, before the reel was started, is removed and tied to the last end, either with or without a band of colored yarn passing around the skein, as in Fig. 7 (*a*). In case an extra piece of twine or band is not used, one end of the yarn is passed once or twice around the skein and then tied to the other end. Each skein is tied in the same way and the swift is then sometimes turned half way around and another band of colored or uncolored yarn tied loosely around the skein at the opposite side to that where the knot is.

Single cross-reeled yarn, when reeled to exact measurements, consists of 1 hank; in case of cotton, 840 yards would be reeled and then tied in. Double cross-reeled yarn consists of 2 hanks reeled one on top of the other before tying in, making, in case of cotton, 1,680 yards. Single cross-reel is sometimes indicated by the sign *X* and double cross-reel, by the sign *XX*. The words single and double, when used in connection with the word cross, have thus a different meaning than when used in the expressions single and double reeling.

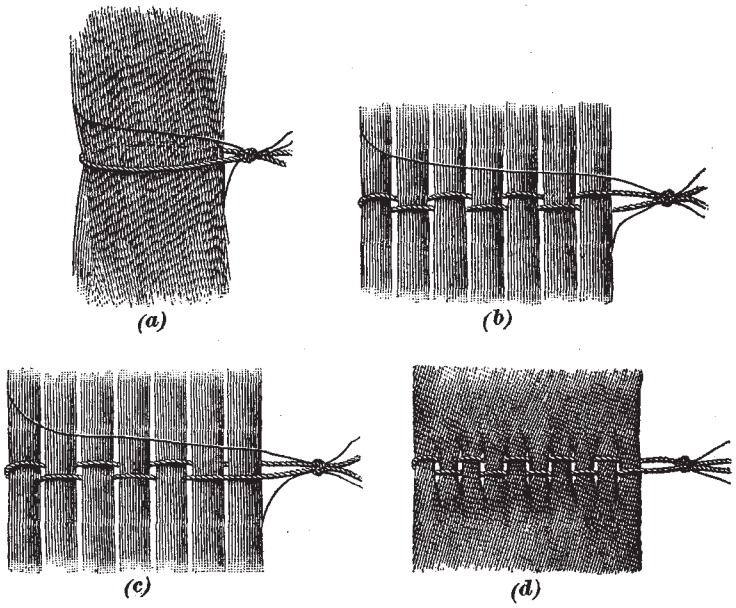
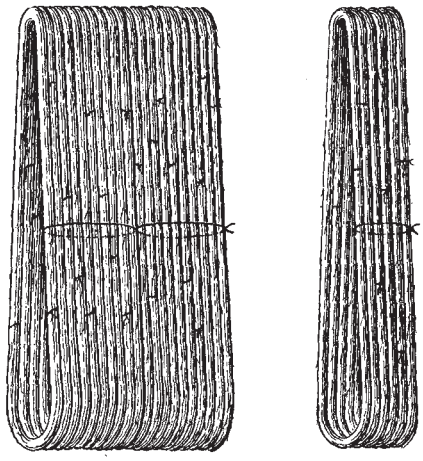


FIG. 7

For tying up yarn that is skeined in 7 leas, two methods are adopted—either 7-lea tying or 6-lea tying. In the *7-lea tying*, a piece of colored yarn is passed up between the first and second leas, down between the second and third, and so on until it encircles the seventh, when it is brought down between the seventh and sixth, and so on alternately until it is brought up between the first and second, as shown in Fig. 7 (*b*). The ends of the tie-yarn

are then knotted with the first and last ends of the skein yarn. In *6-lea tying*, the same method is adopted, except that the first and second leas are kept together within the same loop of the tie-yarn, thus making only 6 divisions instead of 7, as in Fig. 7 (*c*).

Grant-reeled yarn is tied by passing a piece of heavy ply yarn through the spaces produced by means of the system of crossing the ends on the swift, in long-diamond form at two points, one on each side of the swift. This system of winding gives an opportunity of passing the tie-yarn through nine openings in the skein, thus making ten portions of yarn, divided from one another, as shown in Fig. 7 (*d*). Of course these are not separate sections of the skein, as in the case of 6- and 7-lea tying, for the ends crossing from one side of the skein to the other are tied in twice; the only object of this method of tying is to hold the yarn securely in position and prevent the threads becoming entangled in case of mercerization or some other process through which the yarn has to pass.



(*a*) (*b*)

FIG. 8

In French reeling the method of tying is somewhat similar to that used for cross-reeling and lea reeling, the difference between the French and the ordinary reeling being in the length of the skein rather than in the method of arranging and tying the yarn.

15. Banding.—After each individual skein has been tied, it is often necessary to band together several skeins. The arms of the swift are closed like a fan and the desired number of skeins slid together and banded with tie-yarn. A

common method is what is known as *banding in a figure 8*, because the tie-yarn follows the outline of an 8. Two groups, each containing 10 skeins, are arranged on the swift and a piece of tie-yarn passed alternately down and up and then tied, as shown in Fig. 8 (*a*). This holds the 20 skeins together during the succeeding processes and provides for their separation without entanglement by snapping the band. The number of skeins to a group varies; for instance, in some cases only 6 skeins are tied together by means of a band, which in this case is usually an open one that encircles the entire 6 skeins, as shown in Fig. 8 (*b*). When a number of skeins are fastened together by this or any other system of banding, the group is called a *knot*.

SPECIAL MOTIONS

16. Measuring and Traverse Motion.—In many cases, reels intended for ordinary cross-reeling are not fitted with measuring motions, since it is customary to place in the creel a number of bobbins or cops that have all been doffed at one time from the spinning machine and that consequently contain the same length of yarn. The reel is operated until the cops or bobbins are either entirely or almost entirely exhausted, so that each skein contains approximately the same length of yarn. In the case of lea or grain reeling, however, it is necessary to adopt measuring motions that will move the traverse guide after the correct length has been reeled and also stop the machine when the total amount of yarn desired has been wound on the swift. For this, the rods q_4, r_4, and lever r, shown in Fig. 6, are removed, and in place of them is used a vertical rack t, Fig. 9, having at its upper end six steps. By means of a spring p_1, a small bowl p_2 fixed on a pin at the end of the traverse guide rod p is kept constantly pressed against whichever one of the steps happens to be in line with it. The six steps and the face of t below the steps provide seven faces against which p_2 may rest. At the opposite side of the rack a series of seven teeth t_1 are cast, and by means of a dog k_5 attached to a worm-gear k_4 containing 80 teeth (in the case of 7-lea

reeling), which is driven from a single-threaded worm k_3 on the swift shaft k, the rack t is raised 1 tooth every time that the swift makes 80 revolutions. Each time that the rack is moved up 1 tooth, it is raised a sufficient distance to allow the bowl p_2 to come in contact with the face of the next step of the rack, thus allowing the traverse rod p to be

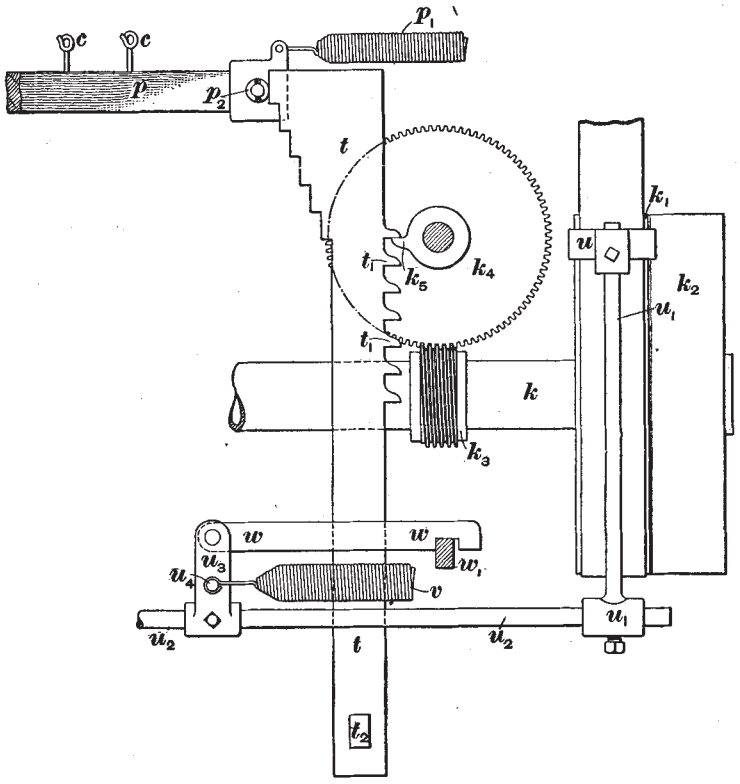


FIG. 9

drawn a short distance nearer the driving end of the reel, which guides the yarn on to a new portion of the swift and gives the lea reeling shown in Fig. 7 (*b*) and (*c*).

In English skeining, or grain reeling, other than 7-lea, the required traverse is given to the rod p by varying the number of teeth in the gear k_4 so that it will have made

one revolution, and the dog k_5 will consequently raise the rack t 1 tooth, when the required length of yarn has been wound on the swift.

17. Stop-Motions.—The belt fork u, Fig. 9, is attached to a vertical rod u_1, which is mounted on a horizontal rod u_2 so arranged that it may slide in suitable bearings and thus move the driving belt from the tight pulley k_1 to the loose pulley k_2, or vice versa. A bracket u_3 is setscrewed to the rod u_2 and carries a pin u_4 to which is attached the coil spring v, which is fastened at its other end to a stationary part of the frame and constantly tends to draw the bracket u_3, together with the belt fork and its connections, toward the loose pulley. Above this spring and also attached to the bracket u_3 is a latch w with a notch at its outer end. When the reel is started, the rod carrying the belt fork is moved far enough along to bring the belt on to the tight pulley and at the same time allow the latch w to drop slightly so that the notch is held against the projection w_1. When the total number of yards required for 1 skein has been wound on the swift, the rack t will have risen a sufficient distance to enable the projection t_2 to raise the latch w, and allow the spring v to ship the belt to the loose pulley.

Such an arrangement as this is usually applied only in Europe, in case of lea and skein, or grain, reeling, where accurate measurements are required. For ordinary American cross-reeling, where exact measurements are of less importance, reels are often provided with a simple measuring motion consisting of an arrangement by which a gong is struck when the desired length of yarn has passed on the swift, leaving it for the attendant to stop the machine; or they may have in addition to the measuring motion a simply constructed stop-motion to automatically stop the machine.

DOFFING

18. When the proper amount of yarn necessary to form the skeins has been wound on the swift, and when the necessary tying of the skeins and the ends of the yarn has been

performed, it becomes necessary to remove the full skeins; this operation is known as **doffing;** in order to accomplish it, the arms of the swift must be brought together. In Fig. 5 (*a*), the swift is shown with the rails spread in working position and held apart by the extended leather strap *m* and the steel latch *n*, while in Fig. 5 (*b*) it is shown in a folded position, with the latch *n* released, the strap loose, and the rails brought together, with the arms in a folded position. In order to close the swift, the latch *n* is slipped from under the spring that holds it when working and turned so that it lies along the rail l_2; the rails l_2, l_4 are then pulled together and both brought in close proximity to the rail l_3. Consequently, the rails l_1, l, l_5, since they are attached, respectively, to the opposite ends of the arms to which the rails l_2, l_3, l_4 are attached, are also brought close together, thus reducing the distance around the swift and allowing the skeins to rest loosely on it. If the skeins are to be banded, it is done when they are in this position, and sometimes the simpler methods of tying, such as those for cross-reeling, are performed with the skeins hanging loose.

The doffing process is then begun by moving the skeins to the doffing end. As the swift consists of one continuous framework, resting in bearings at each end and encircled by the completed skeins, it becomes necessary to in some way pass one part of the skein over the end of the swift and its bearings. Formerly it was the custom to lift the end of the swift completely out of its support, slip the skeins over the end of the swift and its shaft, and then drop the swift back into position. This was a heavy task for the reelers, who are usually women or girls, and also tended to cause oil stains on the skeins by their coming in contact with the bearing of the reel; consequently, devices are now employed by which one part of the skein can be laid in a suitable recess and passed under the bearing of the swift without raising it.

One style of these doffing devices, shown in Fig. 4, consists of a grooved segment wheel *s* that forms a bearing for one end of the swift shaft *k*. The wheel *s* is supported on four small rollers in the bracket s_1, which is attached to the

end sampson h, the hub of the wheel forming a bearing for the shaft k. The wheel contains three spokes, the central one carrying a handle s_2 that is used to turn the wheel around when doffing, which is the only time that it is necessary to change the position of the wheel from that shown in Fig. 4. A long portion of the rim of the wheel extends beyond the spoke s_3. When it is necessary to remove a skein from the arms of the swift, the skein is first passed over that part of the rim that projects beyond the spoke s_3, and the wheel then

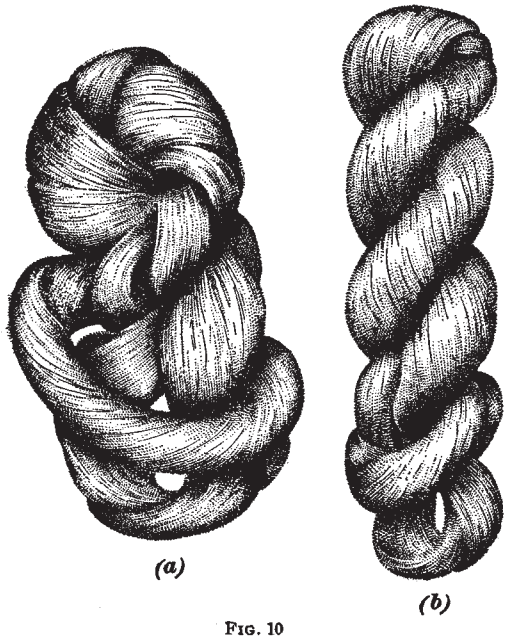


FIG. 10

revolved. In this manner the skein will be detached from the swift. Usually several skeins are removed at one operation.

After all the skeins have been removed from the swift, the rails are spread to their proper positions and the arms fastened by sliding the latch n into the recess provided for it under the spring. The broken ends of yarn hanging from the guide wires are attached to the catches l_6, Fig. 4, after which the reel is ready to be started again to form another set of skeins.

KNOTTING

19. After the skeins are doffed, it is necessary to twist them into some form in which they can be handled without damaging the ends or running the risk of entangling them. This is known as **knotting.** They are very loosely knotted by holding opposite ends of the skein in each hand, twisting it several times, and then passing one end through the loop in the other end, so as to form a loose knot such as is shown in Fig. 10 (*a*). A tightly twisted skein is formed by performing the same operation more carefully; in this case one end of the skein is passed over a curved hook securely attached to a bench and the opposite end of the skein twisted many times. It is then doubled near its center, in which case the excess twist that has been placed in the twisted skein causes the doubled part to twist around itself, as shown in Fig. 10 (*b*). One end of the skein is passed through the loop formed by the other end, when it is ready for bundling or packing otherwise for transportation.

VARIATIONS IN CONSTRUCTION

20. The reel that has been described is one that is constructed in the simplest manner. Other constructions of reels are supplied by different builders, the principal points of variation from the style described being in the form of the swift used, the methods of opening and closing the swift, the arrangements for doffing, for imparting a traverse to the yarn, for measuring the length of yarn reeled and stopping the machine, and in the weight and strength of the framework supporting the operative portions of the reel. The reel that has been described is known as a *single reel. Double reels* are sometimes constructed, in which case there are two swifts, one on each side of the frame. This resembles two single reels placed back to back; otherwise the construction and operation is the same as in the case of a single reel. There is no especial advantage in this style of construction except a slight saving in floor space and a greater solidity of the machine.

Still another form of construction provides for four swifts to each reel. This construction is similar to that of the double reel except that there are two short swifts on each side instead of one long one, both, of course, being in line and each having a bearing near the center of the frame. The driving is performed by means of clutch gearing situated at the center. This construction is sometimes used where children are employed for reeling, who are only competent to tend a small number of ends, or where long skeins are reeled, since this gives an opportunity for the tender to doff one swift while the others are running.

Other styles of reels are those for double reeling and for slack-reeled skeins. For double reeling, the arrangement of the creel provides for its holding more than one cop or bobbin for each guide wire; in other respects the construction and operation of the reel is the same.

Reels adopted for *slack reeling* are required to produce a skein in which not only are two or more ends reeled together, but a slight amount of twist also inserted, as, for example, twenty turns per foot of reeled yarn. In this arrangement, the yarn is usually reeled from cops or more commonly ring-spinning bobbins; the creel is constructed with two or more spindles mounted in a casting, which in turn is mounted on a vertical spindle resting in bearings and capable of being revolved. Immediately beneath the creel is a horizontal shaft extending the whole length of the frame and carrying bevel gears that gear into smaller bevel gears attached to the vertical spindles. The long spindle shaft is driven from one end of the reel and rotates the castings carrying vertical creel spindles; consequently, at the same time that the yarn is being drawn from the cops or bobbins, each group of cops or bobbins is also being revolved, thus imparting a small amount of twist to the yarn passing on to the swift of the reel. In other respects the construction of the reel and its operation is the same as the common single reel. The expression **slack reeling** is an abbreviation of slack-twisted reeling.

CALCULATIONS

21. Production.—Reels are stopped for a large portion of the time, from 35 to 75 per cent. of the time being occupied in doffing, piecing, and creeling. The least loss of time occurs in reeling fine yarns and making long skeins, but the coarser the yarn or the shorter the length of skein, the greater is the loss of time for doffing, since the skein is completed so much more quickly in the case of coarse yarns, as there is less length on the bobbins, or in the case of reeling from small cops or bobbins. In such cases, the time occupied in replacing the supply of yarn in the creel is greater than when reeling fine yarns or reeling from cones or cheeses. The skill or industry of the tender also affects the allowance to be made for loss of production.

22. Before the production of a reel can be ascertained it is necessary to find the number of revolutions per minute of the swift, and also its circumference. Example 1 illustrates how the speed of the swift is calculated; the circumference of the swift is ascertained by measuring.

EXAMPLE 1.—Find the revolutions per minute of the swift when the countershaft makes 250 revolutions per minute and carries a 6-inch pulley driving a 12-inch pulley on the shaft of the swift.

SOLUTION.— $\frac{250 \times 6}{12} = 125$ rev. per. min. of the swift. Ans.

EXAMPLE 2.—Find the length of time consumed in winding one set of skeins that are 840 yards long, if the swift makes 125 revolutions per minute and is 54 inches in circumference.

SOLUTION.— $\frac{840 \times 36}{54 \times 125} = 4.48$ min. Ans.

To find the production, in pounds per spindle, for a given time, when the circumference of the swift, the revolutions per minute, the counts of the yarn, and the allowance for stoppages are given:

Rule.—*Divide the product of the number of revolutions per minute of the swift, its circumference in inches, 60 (the minutes in an hour), and the hours run, by the product of 36 (the inches in a yard), the yards in a hank, and the counts of the yarn being*

reeled; this gives the production in pounds supposing the reel to be running constantly. To find the actual production, multiply the calculated production by the percentage of time during which the reel is running.

EXAMPLE 3.—Find the number of pounds of yarn delivered per spindle per day of 10 hours when reeling No. 10s yarn in 54-inch skeins on a swift making 125 revolutions per minute, assuming that 55 per cent. of time is lost.

SOLUTION.— $\frac{125 \times 54 \times 60 \times 10}{36 \times 840 \times 10} = 13.392$ lb. per spindle per day; 100 per cent. − 55 per cent. = 45 per cent., time run; $.45 \times 13.392 = 6.026$ lb. Ans.

EXAMPLE 4.—Find the production of a reel per day if it contains 50 spindles and produces 6.026 pounds per spindle per day.

SOLUTION.— $50 \times 6.026 = 301.3$ lb. per day. Ans.

23. The length of reels depends on the number and gauge of the spindles and may be determined by multiplying the number of spindles by the gauge and adding 27 inches for the extra length occupied by the head end and foot-end. Thus, a 50-spindle reel with a $2\frac{3}{4}$-inch gauge occupies $(50 \times 2\frac{3}{4}) + 27$ inches, which equals $164\frac{1}{2}$ inches, or 13 feet $8\frac{1}{2}$ inches.

Reels are made in various sizes from 30 to 60 spindles, the common size containing 50 spindles; the gauge may be either $2\frac{3}{4}$, 3, $3\frac{1}{4}$, $3\frac{1}{2}$, $3\frac{3}{4}$, or 4 inches.

The width of the reel depends on whether it is single or double and also on the size of the swift—whether it is intended to make 54-, 60-, 72-, or 90-inch skeins. A 50-spindle reel with a $2\frac{3}{4}$-inch gauge and adapted to make skeins of as great a circumference as 72 inches, is 28 inches in width. This, of course, does not provide for the space to be allowed for passages between the reels.

From five to eight reels are estimated to require 1 horse-power, according to their size.

MANAGEMENT

24. Although a reel is simple in construction and has but few mechanical motions, it is necessary to see that it receives careful and periodical oiling and cleaning, and especially

that this is so performed as to prevent stains on the yarn. The doffing device, swift rails, and creel should be kept clean, in order to prevent the production of dirty skeins. The spindle bases, in case the creel is equipped with revolving spindles, should be cleaned out once a year, and the friction should be properly adjusted at all times in order to insure proper winding.

The tenders should be supervised so as to see that when an end breaks down or runs out it is immediately replaced and pieced up, each knot being carefully tied as small as possible without projecting ends, and not merely replaced in the mass of yarn forming the skein without being tied.

Where the swifts are adjustable in size, as is the usual custom, the circumference of the swift should be measured from time to time to insure the proper size of skein being made and guard against any wilful or accidental change in length of the arms. Waste should be reduced as much as possible at all times, especially in reeling from cops, so as to insure the whole of the yarn, as far as possible, being unwound from the cop tube or cop bottom. Great care should be exercised in tying, banding, doffing, and knotting skeins so that this may be done in accordance with the requirements of the purchaser of the yarn.

BUNDLING AND BALING REELED YARNS

25. When in the form of skeins, yarn is in a suitable state to be packed for transportation without much risk of damage. The yarn is so arranged that it may either be packed loosely in bags or subjected to considerable pressure in bales, in order to compress it into the smallest possible space, with the thread of yarn arranged in such a way and the skein so tied up and banded that after the bale is opened the yarn will not be found to have suffered from the pressure to which it has been subjected. As the skein is a suitable form to withstand such compression, yarn is consequently often reeled merely for the convenience of transit when it has to be transported long distances, especially if by ocean transit.

Three methods of packing skeins are in common use: (1) soft bales, or loose packing in bags; (2) pressed bales subjected to moderate pressure; (3) bundling, succeeded by compressed baling under intense pressure.

SOFT BALES

26. Skeined yarn is commonly packed loosely in bags when it has to be transported by land and not to any great distance. A bag of burlap is made of the required dimensions with a sheet of paper sewed in with the burlap so as to form a lining. The method of packing the yarn is to suspend this bag with the mouth open, from two rods, each having a hook at each end, so as to hold the mouth of the bag open in rectangular form. The skeins loosely knotted, as shown in Fig. 10 (*a*), are thrown into the bag and tramped down until the bag is full, when the mouth is sewed up. The soft or hand-formed bale is preferred to the compressed bale by some purchasers of yarn, because it may be more readily opened. A common size of these soft bags of yarn is from 250 to 300 pounds in weight, $4\frac{1}{2}$ feet in length, $3\frac{1}{2}$ feet in width, and $2\frac{1}{2}$ feet in thickness.

PRESSED BALES

CONSTRUCTION OF BALING PRESS

27. Where yarn has to be transported a considerable distance, either by rail or water, for domestic trade, it is more commonly put up in pressed bales. Fig. 11 is a view of a baling press known as a *togglejoint power press*. The box *a*, in which the skeins are placed while being pressed, is constructed of hardwood and is firmly held together by means of heavy iron ribs on its outer side. The box can be opened or closed when necessary by releasing the eccentric handles a_1, Fig. 11, and a_1, a_2, Fig. 12. Fig. 12 shows the box open after a bale has been removed. The framework of the press is composed of the bed *b*, Fig. 11, and the head *c*, both

of which may be made of either cast iron or wood. The upright rods or columns *d* are usually made of steel and serve to connect the bed *b* with the head *c*. Running horizontally across the machine below the head and between the columns is the screw *e*, which imparts motion to the working arms f, f_1, f_2, f_3. This screw has a right- and a left-hand thread

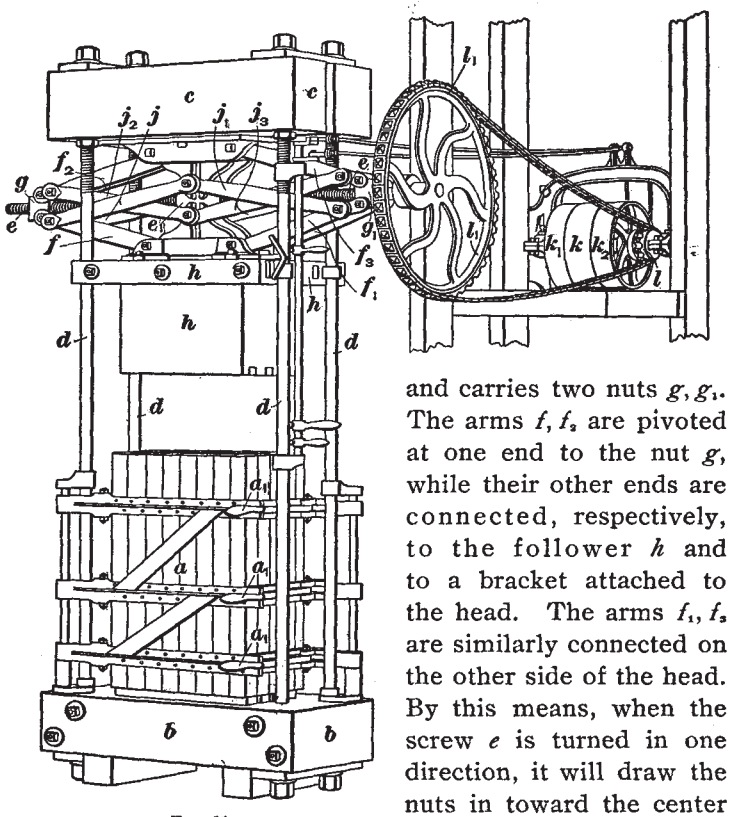


FIG. 11

and carries two nuts g, g_1. The arms f, f_2 are pivoted at one end to the nut *g*, while their other ends are connected, respectively, to the follower *h* and to a bracket attached to the head. The arms f_1, f_3 are similarly connected on the other side of the head. By this means, when the screw *e* is turned in one direction, it will draw the nuts in toward the center of the screw, straighten out the working arms, and force down the follower *h*. When the screw is turned in the opposite direction, it will draw the nuts out, cause the arms to fold up, and thus raise the follower. The arms j, j_1, j_2, j_3 serve merely to steady the working parts. The bed and follower are constructed with

recesses through which cords may be passed while the yarn is under pressure and secured before pressure is released.

28. An automatic power attachment is used in connection with the press and consists of a bracket and short shaft carrying three pulleys—k, which is attached to the shaft, and k_1, k_2, which are loose on the shaft. The bracket also carries two rods, with belt shippers, springs, and lever attachment for shipping the belts from one pulley to another. One loose pulley is driven by a crossed belt, while the other is driven by an open one and consequently revolves in the opposite direction. On the shaft with the pulleys is a small sprocket gear l that drives by means of a chain a large sprocket

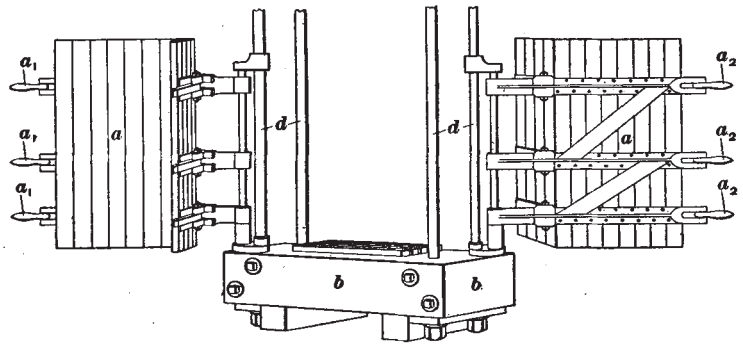


FIG. 12

gear l_1 on the same shaft as the screw e. In operation, one belt is first shifted to the tight pulley, which turns the screw in such a direction that the follower is forced downwards until the yarn has been compressed sufficiently, when the belt is automatically shipped to its loose pulley. After the bale has been secured with cords, the other belt is shipped from its loose pulley to the tight pulley, which reverses the screw and raises the follower.

Before closing the box prior to inserting the yarn, the required number of pieces of cord of sufficient length to pass around the entire bale are placed in position in the grooves in the bed. A piece of burlap of sufficient size to cover the lower side of the bale and half of the surrounding four sides

is placed in position on top of the bed and covered with paper, after which the box is closed and fastened. The required amount of yarn is deposited in the box and the top covered with paper and a piece of burlap similar to the first piece, after which the follower is allowed to descend and subject the yarn to the necessary pressure to produce a bale of the desired size. The box is then opened and the edges of the two pieces of burlap sewed together so as to cover the bale completely, when it is ready for tying. The cords are passed upwards and drawn through their respective grooves in the follower by means of a hook, after which they are tied tightly around the bale. The follower is allowed to rise so that the bale can be removed and marked, with a stencil or otherwise, indicating the necessary shipping marks and information as to contents of the bale, after which it is ready for shipment. Other methods are in use for covering the bale, but they are all similar to a certain extent to the one described.

The press described, which is the style commonly in use, forms a bale 24 inches long, 20 inches deep, and 24 inches high, weighing from 220 to 270 pounds. It is one of the smallest styles of yarn baling presses in general use. When the follower is in the highest position, the distance between it and the bed of the press is 44 inches. This is spoken of as the *daylight space*, or *piling space*. It is not possible, nor necessary, to bring the follower down to the bed of the press, the exact distance of its movement varying from 20 to 24 inches, this being adjustable according to the position at which the knock-off is set. For example, if the knock-off is set so that the follower has a total downward movement of 21 inches, yarn may be piled in the box to a height of almost 44 inches and reduced by pressure to a height of 23 inches. The pressure capable of being exerted by the follower of this press in compressing the yarn is 70 tons. Yarn bales are made in various sizes, according to the custom of the mill, the requirements of the buyer, and the size of the press. The baling presses are made in many styles and sizes, some of them being considerably larger than the one described, both in length and width of the box,

in the distance through which it is possible for the follower to move, in the height of the bale that is made, and in the amount of pressure that can be exerted. A better grade of press is also made, constructed entirely of iron and steel, but the general principles of its construction and operation are the same as already described.

BUNDLES

CONSTRUCTION OF BUNDLING PRESS

29. When yarn is sold in skeins for export, especially when it has to be transported long distances by sea, as for instance to India, China, and Japan, it is customary first to put up the yarn in small bundles of either 5 or 10 pounds in weight, more commonly 10 pounds. A number of these bundles are then packed into bales of from 300 to 600 pounds in weight by means of a heavy baling press. It is customary in foreign countries to sell this yarn to retail customers, in 5- or 10-pound lots, which is the reason for first making up the yarn in bundles.

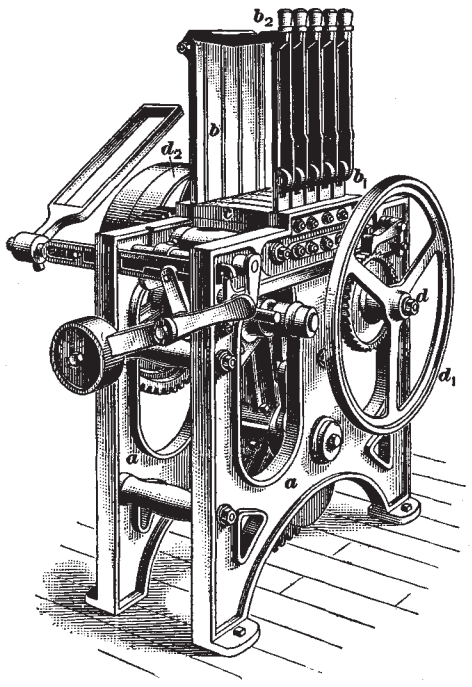


FIG. 13

The machine used for putting up the skeins in these small 5- or 10-pound bundles is known as a **bundling press.** A common type of these machines is shown in Fig. 13 and consists of a

framework *a* that supports the required mechanism for forming the bundle. Securely attached to the upper part of this framework are two sets of vertical bars *b*, b_1, which form the sides of an open-ended box for holding the yarn. Each set consists of five individual bars, the inner surface of which is polished. The bars are a slight distance apart, so that a piece of twine can be passed between them for tying up the bundle. The top of the box for holding the yarn is formed by a set of five short horizontal bars b_2. These bars are hinged at one end to the vertical bars of the set *b*, while the other ends terminate in slots. Near the lower end of each bar in the set b_1 is hinged a lever that extends upwards and terminates in a handle; these levers serve to lock the horizontal bars b_2 firmly in position while the yarn is being subjected to the pressure of the follower *c*.

The follower in this case, as in most bundling presses, forms the bottom of the yarn box and is raised in order to subject the yarn to the required pressure to produce a bundle of the desired size. This is accomplished by suitable mechanism driven from the shaft *d*, which can be operated by power or hand. When the machine is driven by hand, the required motion is obtained by turning the hand wheel d_1, and when it is operated by power it is driven from the tight pulley d_2, which is attached to the shaft *d*.

30. When it is desired to form a bundle, the follower should be in its lowest position, as shown in Fig. 13; four pieces of twine are then dropped between the vertical bars so that they rest on the upper surface of the follower. On these pieces of twine a piece of heavy paper board, known as a *back*, is placed, and on this back are arranged layers of skeins, which have been knotted as shown in Fig. 10 (*b*), the number of skeins used depending on the size or weight of the bundle required; for example, for a 10-pound bundle of 40s yarn, 40 skeins each containing 10 hanks, or 8,400 yards in the case of cotton, would be used. After the required number of skeins have been properly arranged in the yarn box, another back is placed on top of the yarn and the horizontal

bars b_2 turned down and locked in position, by means of the vertical levers attached to the vertical bars b_1; the machine is then started, which raises the follower and compresses the yarn. When the bundle has been reduced to the required size the machine is stopped, the twine drawn tightly around the bundle, between the bars, and the ends of each piece tied together in a square knot. The follower is then lowered, the horizontal bars unlocked and turned back, and the bundle removed, wrapped in wrapping paper, and tied again with twine.

In some cases before the upper *back* is placed in position, a piece of tissue paper a little longer than the yarn box and about the width of it is inserted, which thus hangs down over the ends of the skeins. In certain cases, for foreign trade with India, China, etc., the backs, tissue paper, twine, wrapping paper, etc., must be of specific colors, in order to comply with the demands of the trade in these countries.

BALING

31. When the yarn has been made into bundles, they are shipped to the merchant who prepares them for export in compressed bales. This is done by placing a number of these bundles, from 25 upwards, between the platforms of a very powerful baling press, in which they are compressed between sheets of burlap lined with tarred paper and secured by a number of broad iron bands riveted or buckled around the bale. The ends of the burlap are neatly folded and sewed up, and the bale marked with the necessary shipping marks. By this means the yarn is compressed into very small space, which is desirable for ocean freight; the tarred paper prevents damage from moisture during transit.

REELING AND BALING

EXAMINATION QUESTIONS

(1) Define: (*a*) double reeling; (*b*) slack-reeled yarn; (*c*) 7-lea reeling; (*d*) 5-ounce skein.

(2) What is the reason for adopting a doffing device on a reel?

(3) (*a*) How many revolutions of a 54-inch swift would be necessary to reel 1 hank of cotton yarn in 1 skein? (*b*) How many revolutions of a 72-inch swift to reel 1 hank of worsted? Ans. { (*a*) 560 rev. (*b*) 280 rev.

(4) What is meant by banding skeins?

(5) Find the number of pounds of yarn delivered per spindle per day of 10 hours when reeling 18s yarn in 54-inch skeins, the swift making 120 revolutions per minute, assuming that 50 per cent. of time is lost. Ans. 3.571 lb.

(6) Explain the method of holding the arms of the swift in position for reeling, as shown in Fig. 1.

(7) Explain how a reel making 60-inch skeins would be adjusted if it were desired to make 54-inch skeins.

(8) Explain the American method of obtaining any desired weight of skeins. Does this give absolutely accurate results?

(9) Define: (*a*) live spindle; (*b*) skein; (*c*) swift; (*d*) reeling.

(10) (*a*) What are the objects of reeling yarn? (*b*) Is reeled yarn more frequently intended for warp or for filling?

(11) Is it possible to wind from both warp- and filling-wind ring-spinning bobbins with a reel fitted with spindles similar to those in Figs. 1 and 2? If so, what change is necessary in the creel when changing from warp wind to filling wind? Describe the passage of the yarn from the bobbin to the swift in each case.

(12) What is the length of a reel with 40 spindles and a $3\frac{1}{4}$-inch gauge? Ans. 13 ft. 1 in.

(13) Explain, fully, one method of baling skeined yarn for the market by using a press similar in construction to the one shown in Fig. 11. Refer to the materials used for covering and the relative positions of such materials with regard to the yarn.

(14) How many skeins of cotton yarn are required for a 10-pound bundle of 25s yarn, each skein containing 5 hanks?

(15) State, briefly: (*a*) the object of tying reeled yarn; (*b*) three methods of tying yarn.

(16) What are important points in the management of reels?