BEAM WARPERS

Serial 483 Edition 1

PRINCIPAL PARTS OF WARPERS

ENTWISTLE WARPER

1. Introductory.—Warping, the process that follows spooling, is an important feature of the ordinary method of cotton-warp preparation. As the yarn comes from the spooler, it is taken to the machine known as the **warper,** the object of which is to unwind the yarn from a large number of spools and place it in an even sheet on a beam, which is a cylinder of suitable length with heads at each end. The yarn is then in a more suitable shape for handling in the future processes. Warping is divided into several different classes according to the manner in which the yarn is treated. The class being dealt with at present is known as *beam warping*, from the fact that the yarn as it is unwound from the spools is wound on a beam.

2. The plan on which the warper for beam warping is constructed and operated is simple, as it consists of arranging spools of yarn in a creel so that they revolve with the least possible resistance, while the yarn that they contain is wound on a roll, or beam, rotated by contact with a revolving cylinder. As warpers do not vary much in their general construction, a description of the **Entwistle** will serve as an explanation of all. The special devices will be described later. Fig. 1 shows the creel and warper as they appear when in operation, while Fig. 2 shows a section of the parts

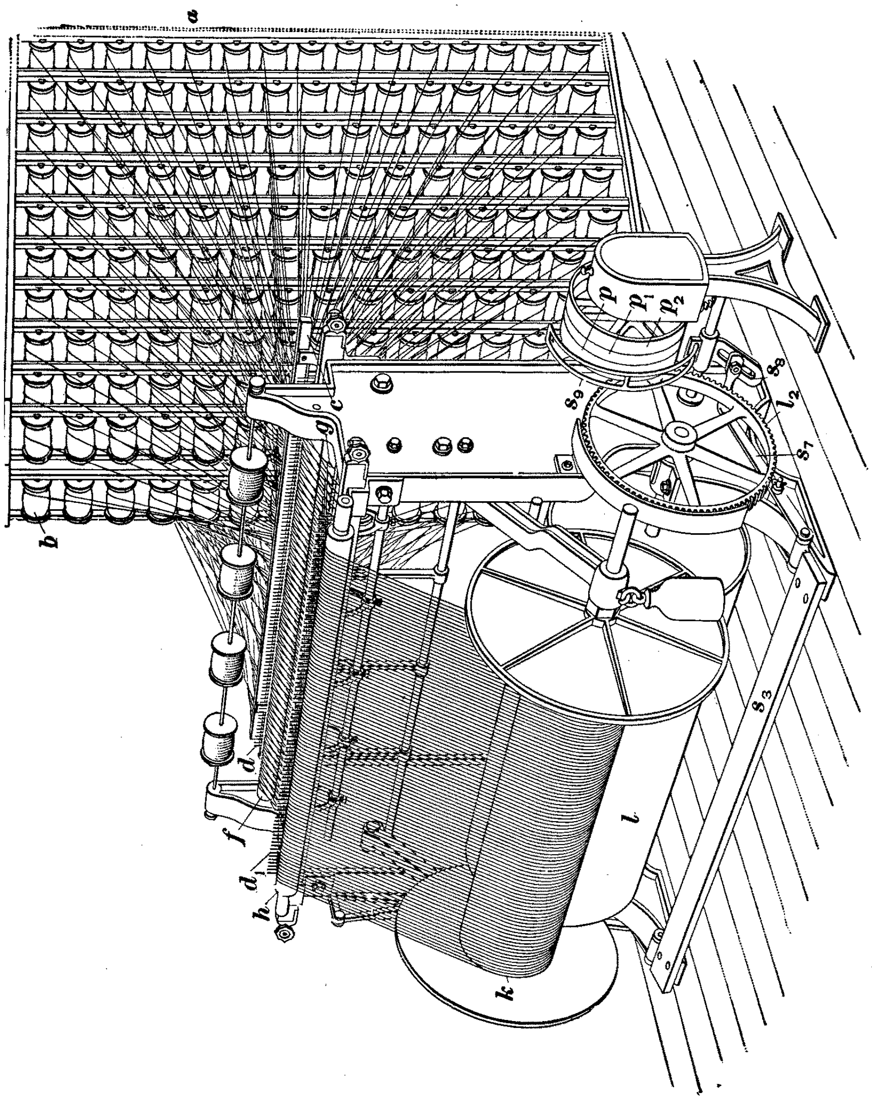


FIG. 1

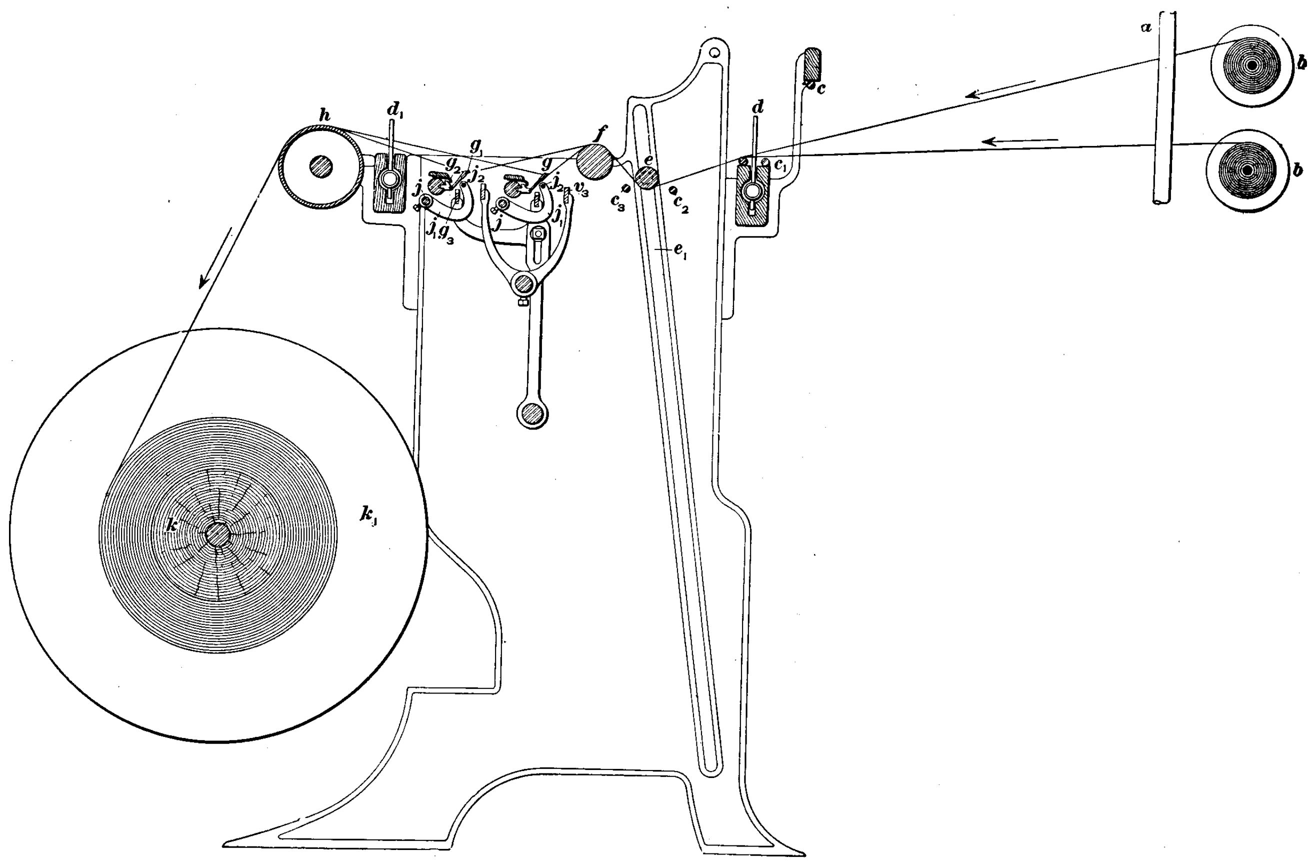


FIG. 2

of the warper with which the yarn comes in contact when passing from the creel to the beam. Referring to these figures, *a* shows the creel that holds the spools *b*. The ends are gathered from the spools and passed between the guide rods c, c_1; they then pass through the expansion comb *d*, under the drop roll *e*, over the guide roll *f*, through the drop wires g, g_1, through the expansion comb d_1, over the measuring roll *h*, and then to the beam *k*, on which they are wound in an even sheet.

3. Warper Creels.—The essential features of all **creels** are to have them so constructed that the different ends will be unwound from the spools without snarling; that the pull on the yarn will be as straight as possible; and that there will be the least possible strain on the yarn. The form most generally used at the present time is known as the **V** creel, shown in Fig. 3. It is so constructed that it holds the spools

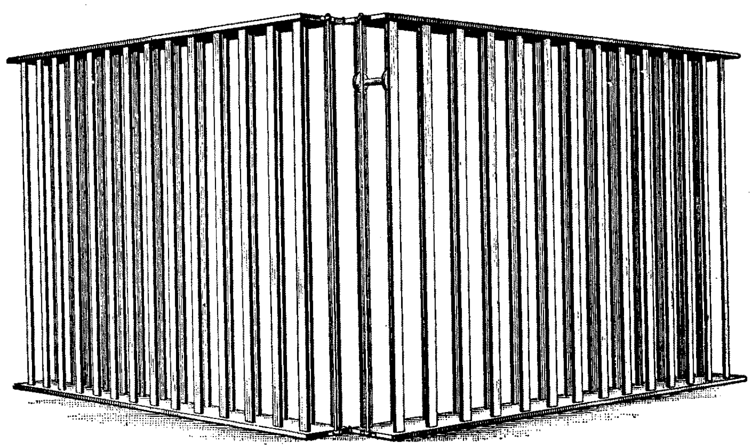


FIG. 3

in tiers; the end from any spool can pass to the warper in as nearly a straight line as possible without rubbing against any other spool. The creels are made of wood but have metal or glass rods on the outside strips to reduce the friction on the threads as much as possible. The ends of the wooden skewers passing through the spools rest in metal or glass steps inserted in or attached to the side of the framework; by this method the least possible resistance to the turning of the spools is obtained. A glass step is shown in Fig. 4. Creels are usually screwed to the floor, but the distance between the strips supporting the spools can in some cases be changed to meet the requirements of different sized spools. Creels generally have a capacity of 15 spools in a vertical row and 17 in a horizontal row; the creel, consequently, holds 510 spools—255 on each side. Different sizes are, of course, met with, creels with a capacity of 780 spools being sometimes used.

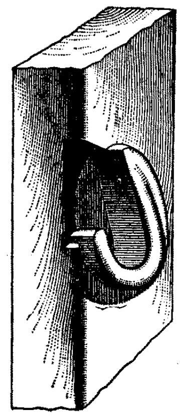


FIG. 4

In passing the ends from the creel to the warper, those from the front of the creel come to the center of the comb d, Fig. 2, while those at the right hand of the creel at the back come to the right-hand side of the comb and those from the left of the creel at the back come to the left-hand side of the comb. The first end taken from either side of the creel should be the one from the top spool in the front row on that side, and the ends should then be taken in regular order downwards. When the ends have been taken from the front row of spools in this manner, the second row should be treated in the same way, and so on until the ends from all the spools in the creel have been taken to the warper.

The **V** creel is not the only style used in connection with warpers, as spools are sometimes placed on an almost horizontal creel immediately behind the machine and also on a vertical creel behind this, while for a small number of ends a curved framework is sometimes used.

4. Expansion Combs.—The first important part of the warper with which the yarn comes into contact as it passes from the creel is the **expansion comb** d, Fig. 2, shown alone in Fig. 5. It is constructed by inserting wire teeth d_2 through spiral springs d_3, which are held by the rods d_4. A rod d_6 that passes through the springs d_3 is connected to a thin brass strap d_7 wound around a stud on the hand wheel d_5. These parts are duplicated at the other end of the comb. The tension on the springs d_3 may be increased or lessened by turning the hand wheel d_5, so that the spaces between the wire teeth may be enlarged or reduced, and the fineness of the comb regulated so as to uniformly distribute the sheet of yarn over the whole width of the machine irrespective of the number of ends being run. The center of an expansion comb is usually designated by having the central

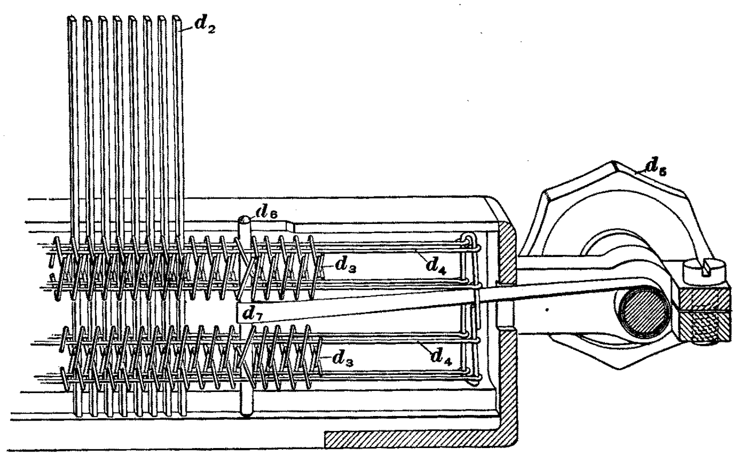


FIG. 5

tooth slightly shorter than the others, so as to readily show where to begin passing the ends through the comb when starting a new set of spools in a warper.

Fig. 2 shows two expansion combs d, d_1 on one warper. In some cases the teeth in the comb at the front of the machine are made of round wire.

5. Drop Roll.—Passing from the expansion comb, the yarn comes into contact with the **drop roll** e, Fig. 2, which takes up any slack yarn that may be let off by the spools and not taken up by the beam. When the warper is stopped for any cause, the momentum of the spools causes considerable yarn to be unwound, which, if not taken care of in some manner, may become snarled and break when the warper is again started. The roll e is a brass roll having bearings that slide in almost vertical slots e_1 constructed in the inside of the frame. It is supported by the yarn alone, the tension of which is sufficient for this purpose except when the ends become slack owing to the warper being stopped; in such cases the roll drops in its guide slots, taking down the slack yarn and, as the yarn is supported on each side of the drop roll by the rods c_2, c_3, Fig. 2, 6 feet of slack yarn can be taken care of, although the roll drops only about 3 feet. It should be understood that, if a smaller amount of yarn is let off, the roll drops only far enough to take up the slack, when it is again supported by the tension of the yarn.

6. Stop-Motion.—The principal object of a warper is to wind on a beam an even sheet of yarn that consists of the same number of ends at all times. To aid in accomplishing this, all modern warpers are supplied with **stop-motions,** which stop the machine if a single end breaks while passing from the creel to the beam. They also lessen the cost of production by reducing the number of persons necessary to tend the machines, since one attendant is then able to operate from four to eight warpers.

The principle on which the stop-motion is constructed is that of having each end that passes from a spool to the beam threaded through a drop wire, which is either held upright or in some cases entirely suspended by the thread. In case any end breaks, the drop wire that it supports falls and, by suitable mechanism, shifts the belt to the loose pulley and stops the machine. The relative position that these drop wires g, g_1 occupy in the warper is shown in Fig. 2, while the mechanism of the stop-motion itself is shown in Fig. 6. The foot-board s_3, Fig. 6, is pressed by the operator when starting the machine; this turns the shaft s, to which is fastened the lever s_2 carrying the weight s_1; at the same time the rod s_4 is lowered until the notch s_6 drops below a hole in the casting s_5, when s_4 falls to the right and is held in this position, although the weight s_1 is constantly tending to raise the foot-board s_3

and the rod s_4. The cam-bowl r attached to the lever r_2 works in the revolving cam r_1. The rod r_3 being attached to the lever r_2, is given an up-and-down motion and slides in the bearing r_4; when in its normal position it just clears the casting x. At its upper end, r_3 supports the part v by means of a suitable projection. As r_3 is pushed up it takes with it v;

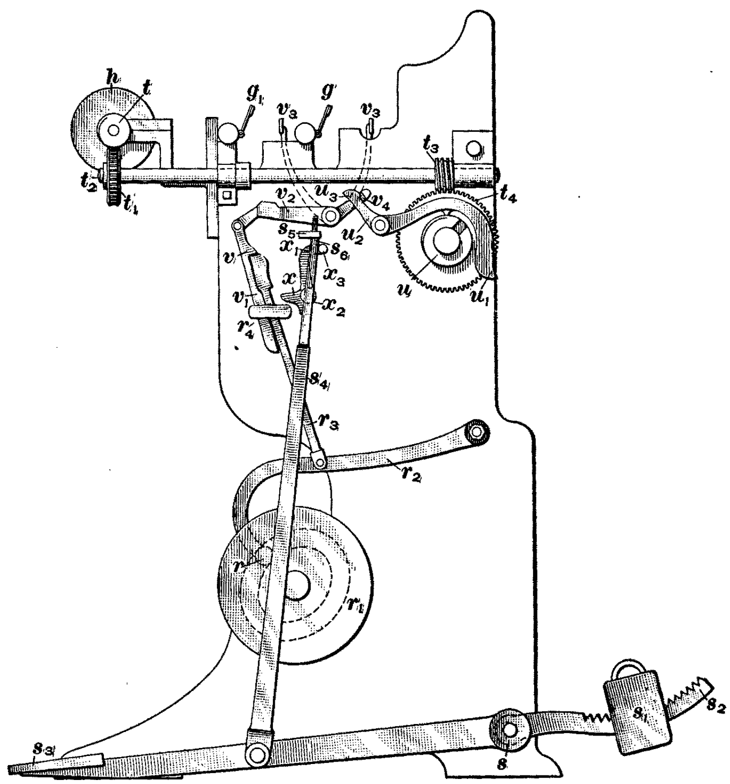


FIG. 6

when, however, it is brought down, it has no other effect on v than to allow it to fall by means of its own weight, which it does if it is not obstructed in any manner. The rod v_2, which works on a shaft on which are fastened the feelers v_3, is connected to v; consequently, as v is worked up and down, it gives an oscillating motion to the feelers v_3. The drop wires are arranged in two rows, which economizes space, since if all the drop wires that are required for the number of ends run were placed on one bar, the space necessary would be considerably in excess of the space required for the ends.

In case any end from the creel breaks while passing to the beam, the drop wire through which it is threaded drops and lies in the path of one of the oscillating bars v_3, thus preventing v from dropping. Consequently, when the rod r_3 is brought down by the action of the cam r_1 and lever r_2, a shoulder on r_3 will come in contact with a shoulder on v at the point v_1. Since v cannot be pushed to the left because of the bearing r_4, the upper end of the rod r_3 will be pushed to the right and its notch will engage with the lever x, causing the upper end x_1 to be thrown to the left, as it swings about the point x_2. As x_1 is brought forwards, the projection x_3 engages with the rod s_4 and pushes it to the left far enough to allow the notch s_6 to be free of the casting s_5; this allows the weight s_1 to push up the foot-board s_3 and with it the rod s_4, shifting the belt to the loose pulley by the mechanism shown in Fig. 1, and stopping the machine. After the attendant has pieced the broken end, it is simply necessary to press down on the foot-board s_3, when the different parts will assume their former positions and the belt will be held on the tight pulley.

The manner in which the foot-board s_3 moves the belt from one pulley to another is shown in Fig. 1. At the driving side of the machine the foot-board is connected by two short arms to a stud that carries a lever s_7, which at its inner end supports a stud working in a slot in the casting s_8 that carries the belt shipper s_9. As the foot-board s_3 is pressed down, the inner end of the lever s_7, together with the stud that it carries, is raised. Owing to the inclined position of the slot in the casting s_8, the stud in rising will move this casting, together with the belt shipper s_9, to the left, shifting the belt from the loose pulley p_2 to either the slow-motion pulley p_1 or the tight pulley p, as may be desired. When the foot-board s_3 rises, the action of course will be opposite to that described and the belt will be carried to the loose pulley p_2.

In this warper, the drop wires are mounted on brass blocks, each of which contains four drop wires. In case any of the wires become damaged, it is possible to remove the blocks containing them by simply sliding them out at one side of the machine; the manner in which they are supported is shown at g_2, Fig. 2. When an end breaks and the drop wire falls, it rests on the horizontal rod g_3, Fig. 2, which brings it directly in the path of the oscillating bars. The arms j_1 support wires j_2 extending the whole length of the machine directly back of each row of drop wires. When the belt is shifted to the tight pulley, the rods j are turned sufficiently to bring the arms j_1, together with their wires j_2, low enough to allow the drop wire when it falls to come in the path of the oscillating bar. When, however, an end breaks and the machine is stopped, the mechanism that shifts the belt to the loose pulley causes the rods j to be turned and the rods j_2 to lift all the drop wires into the position that they assume when held upright by the threads passing through them. By this means the ends that are broken are easily rethreaded as it is not necessary to lift the fallen drop wire.

7. Measuring Motion.—As shown in Fig. 2, the yarn after passing through the drop wires of the stop-motion, next passes through the expansion comb d_1 and then over the *measuring roll* h, which is driven by the friction of the yarn; consequently, when it has made one revolution, a length of yarn equal to the circumference of the roll has been wound on the beam. The gearing by means of which the amount of yarn run is recorded is shown in Figs. 6 and 7. On the end of the measuring roll h,

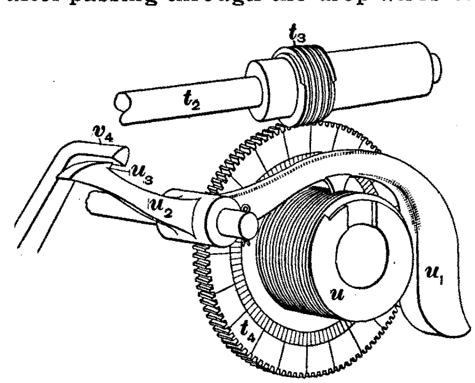


Fig. 7

which is 12 inches in circumference, is a single-threaded worm t that gears with the worm-gear t_1 on the shaft t_2; on the other end of this shaft is the single-threaded worm t_3 gearing with the worm-gear t_4 on what is known as the *measuring disk*. This disk carries a barrel u that contains spiral grooves in which sets a projection on the finger u_1; the gears in this train are as follows: t, single-threaded worm; t_1, 90 teeth; t_3, single-threaded worm; t_4, 100 teeth. By this arrangement one revolution of the barrel u represents 3,000 yards run on the beam. In warping yarn, 3,000 yards is spoken of as one *wrap;* thus, it is frequently stated that one, two, or three wraps have been run, indicating that 3,000, 6,000, or 9,000 yards, respectively, have been run on the beam.

The action of the measuring motion in stopping the warper is as follows: So long as the projection on the finger u_1 is running in the grooves of the barrel u, the different parts are in the position shown in Figs. 6 and 7. When, however, through the revolving of the barrel u, the projection on u_1 is caused to run over the end of the barrel and out of the grooves, the finger u_1 drops, causing the end u_2 to rise and the projection u_3 to catch on v_4, and prevent its rising. This will cause v, Fig. 6, to remain up, and as r_3 is brought down by the action of the cam it will catch the lever x and stop the machine in the same manner as with the stop-motion. The barrel u contains ten grooves, and by setting the projection on the finger u_1 in different grooves when starting a new beam, any number of wraps that may be desired, up to ten, can be run on the beam before the warper is stopped. For example, if the projection is set in the third groove from the end of the barrel, the barrel must make three revolutions before the machine is stopped. As each revolution of the barrel represents 3,000 yards run on the beam, then this will give a length of 9,000 yards in this particular case.

There is usually attached to a warper a clock that indicates the number of yards warped in any given length of time. This clock consists simply of a dial, on the face of which is attached a finger that serves as an indicator. Suitable gearing is introduced to drive the finger from the measuring roll; consequently, as the measuring roll is turned by the yarn passing through the warper, it in turn moves the finger on the dial, and as suitable numbers are placed on the face of this dial, the total number of yards warped during any given time is readily determined by noting the position of the finger. If it is desired at any time to make a new start so as to determine the number of yards warped within another given time, the finger may be moved back to zero.

8. The **beam** on which the yarn is wound at the warper is shown at k, Fig. 1; another view is given in Fig. 8. The

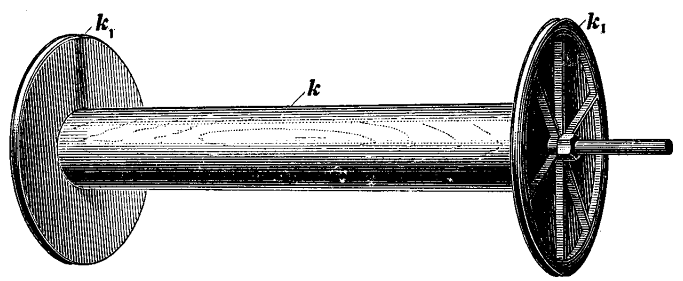


Fig. 8

flanges k_1 are known as the *beam heads*, while k is the *barrel.* Beams for beam warpers are almost always made $54\frac{1}{2}$ inches between the heads, while the cylinders on which they run and by which they are driven are usually 54 inches wide. Beam heads may be either 18, 20, 21, 22, 23, 24, or 26 inches in diameter, while the barrel of the beam is usually 9 inches in diameter. A beam $54\frac{1}{2}$ inches between heads and with a 9-inch barrel will hold about 420 pounds of yarn when the heads are 26 inches in diameter. With 24-inch heads they will hold about 350 pounds; with 22-inch heads, about 285 pounds; and with 21-inch heads, about 255 pounds.

9. Drive.—Figs. 1 and 9 show the methods of driving the beam on which the yarn is wound. The belt that runs from the line shaft to the loose pulley p_2 may be shifted to the pulley p_1, known as the slow-motion pulley, or to the tight pulley *p*. At present it is only necessary to consider pulley *p*, which, being setscrewed to shaft l_7, gives it motion; this shaft carries the gear l_3 of 21 teeth that drives the gear l_2 of 106 teeth on the cylinder shaft l_1. The beam *k* rests against the cylinder *l* and is driven by frictional contact; as a result, the surface speed of the beam remains the same all the time that the beam is being filled, and. since its diameter is con-

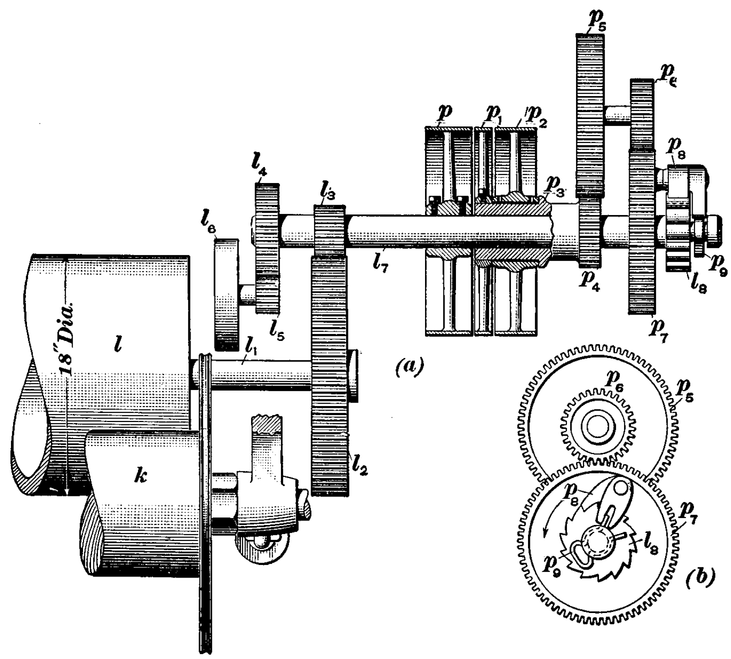


FIG. 9

stantly increasing, the number of revolutions per minute that it makes is constantly growing less. Since it is the winding of the yarn on the beam that draws the yarn from the spools, the yarn is unwound from the spools at the same speed throughout the filling of the beam.

10. Slow-Motion Arrangement.—Attachments are provided on all warpers by means of which they may be run at two speeds. When running at a normal speed, the belt is on the tight pulley *p*, Fig. 9 (*a*); but there are times when the warper should be run slowly; for instance, in starting a warper, it is advisable to impart motion to the spools in the creel gradually, so that the yarn may not be subjected to a sudden strain. The advantage of a slow motion on a warper may be more readily understood when it is realized that the yarn taken by the drop roll must be made to assume a horizontal position before the warper can be run at its highest speed. In starting a warper, the operator shifts the belt to the slow-motion pulley, when the yarn immediately begins to wind on the beam, gradually pulling up the drop roll as the tension of the yarn counteracts the weight of the roll. As soon as the roll has resumed the position that it should occupy while the warper is running, and after the spools have acquired some momentum, the belt is moved to the tight pulley, when the machine will run at full speed.

The method adopted on this warper for altering the speed of the beam is shown in Fig. 9 (*a*). Pulley p_1 is known as the *slow-motion pulley*, since when the belt is running on this pulley, the speed of the cylinder is greatly reduced. As this pulley is fast to sleeve p_3, which is loose on the shaft, it drives gear p_4, which also is fast to the sleeve. Gear p_4 transmits its motion to gear p_7 by means of the compound gear p_5, p_6; a pawl p_8 is attached to the gear p_7 by means of a stud, while its tail is held by a spring p_9, shown more fully in Fig. 9 (*b*). As the gear p_7 revolves in the direction shown by the arrow, the tail is pressed against the end of the spring, and the pawl is caused to engage with the ratchet gear l_8, which being fast to the shaft l_7 gives motion to the cylinder of the warper. The number of teeth in these gears is p_4, 30; p_5, 72; p_6, 30; p_7, 72.

In the slow-motion drive, it must be remembered that the slow-motion pulley, the sleeve to which it is attached, and all the gears in the train (with the exception of the ratchet gear l_8) are loose on the shaft l_7 and, consequently, cannot have any effect on this shaft, except as they affect some mechanism connected to the shaft, which in this case is the gear l_8. When the belt is on the tight pulley the spring p_9, which is sprung around the shaft l_7, tends to revolve with the shaft and thus throws the pawl out of contact with the ratchet gear by engaging its tail. Under these conditions the slow-motion pulley p_1, sleeve p_3, gears p_4, p_5, p_6, and p_7, are stationary unless the friction between the shaft l_7 and sleeve p_3 is sufficient to give a slight motion to the sleeve. The heavy balance wheel l_6 is driven by the gears l_4, l_5, and serves to stop the machine gradually when an end breaks or the desired length has been run on the beam, thus lessening the liability of the ends overrunning on the spools in the creel.

DRAPER WARPER

11. Many parts of the **Draper warper** differ from those of the Entwistle warper. A section through certain of the parts of this warper is shown in Fig. 10; d, d_1 are the expansion combs; c, c_1, guide rods; c_2, c_3, c_4, guide rolls; h, the measuring roll; and e, the roll that takes up the slack yarn. The passage of the yarn from the creel to the beam is also shown, the direction being indicated by arrows.

12. Rise Roll.—As shown in Fig. 10, the slack yarn is taken care of by a **rise roll** instead of a drop roll. This rise roll is carried at each end in a sliding rack e_1, which contains teeth that engage with the gear e_2 on the shaft e_3. Motion is given to the shaft e_3 by means of the weight e_4 and chain e_5. The rise roll is kept down by the tension on the threads, so that should any slack yarn be let off, the weight e_4 drops; this causes the gear e_2 to revolve, and raises the rack e_1 and the roll e. When the yarn becomes tight again, the weight is prevented from dropping and the different parts assume the position shown in Fig. 10. When the machine is started, the tension on the yarn is sufficient to raise the weight, and the roll e consequently drops until the yarn forms a nearly straight line in passing from c_2 to c_3.

13. Walmsley Stop-Motion.—The stop-motion employed on the Draper warper is known as the **Walmsley stop-motion**; it is shown in Fig. 11. Certain parts that complete the operation of this stop-motion are also utilized in stopping the machine in connection with the measuring

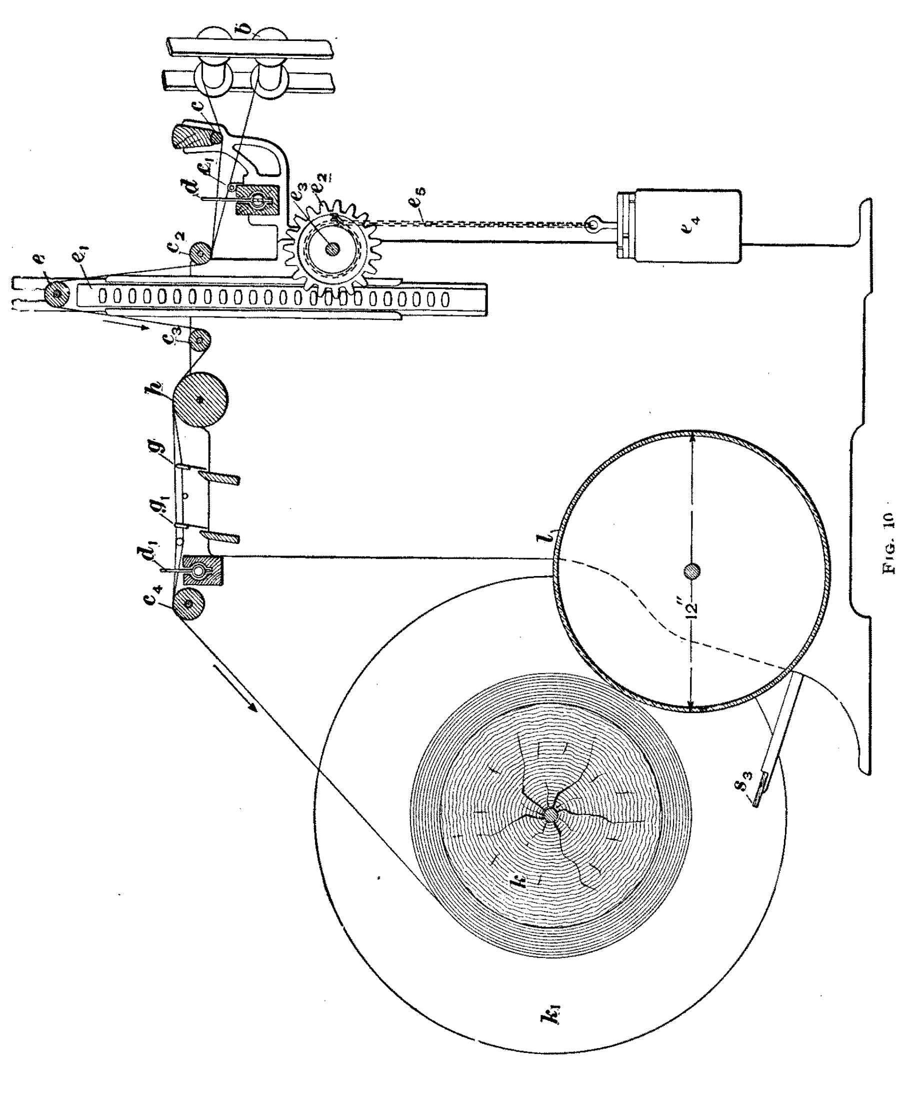


FIG. 10

motion, so that one description will suffice for both. As shown in Fig. 11, a shaft s carries a treadle, or foot-board, s_3 at the front of the machine and also a lever extending toward the back of the machine, on which is a weight s_1. The weight of the foot-board is overbalanced by the weight s_1, so that there is a constant tendency for the foot-board to rise.

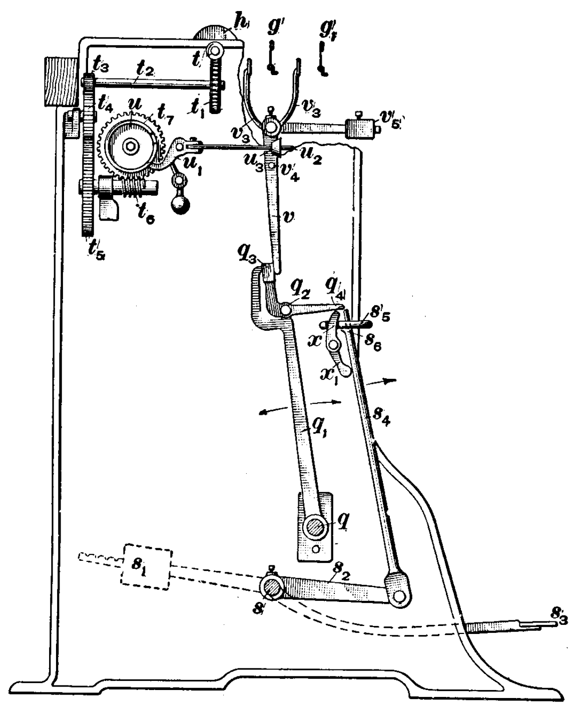


FIG. 11

Attached to the shaft s is a lever s_2 with a vertical rod s_4, carrying a projection s_6 at its upper end; s_5 is a bracket attached to the framework of the machine. When the foot-board s_3 is pressed downwards, s_6 drops below s_5 and catches under it; it is held in this position until the rod s_4 is pushed in the direction of the arrow, when the latch is released and rises together with the lever s_2 and the foot-board, on account of the action of the weight s_1.

The rod q_1, by means of a cam on the cylinder shaft, is moved first in one direction and then in the other, as shown by the arrows in Fig. 11. This rod carries a latch q_3 working on a fulcrum q_2, which has a constant tendency to drop at the end q_4. In the position shown in Fig. 11, it is held against q_1 at its upper end by means of the arm v, which is kept pressed against q_3 by means of the weight v_5. As v is thus given an oscillating motion coinciding with the motion of q_1, the upper end of q_3 is kept pressed against q_1 by v, until other mechanism is brought into operation to prevent it. So long as these parts are kept pressed together, the machine continues to operate; but if by any means the lower end q_4 of q_3 is allowed to drop, it will come into contact with the upper end of the lever x and, at the next backward movement of the rod q_1, the upper end of x is pulled backwards by a projection on the arm q_4 and the lower end x_1 moved forwards into contact with s_4, pressing against s_4 with sufficient force to push the latch s_6 from its position below s_5; this allows the rod s_4 to rise and stop the machine.

14. The parts from s to the arm v form part of the broken-end stop-motion and the measuring motion; they are actuated either by a broken end or the measuring motion. The method by which they stop the warper when an end breaks will be first described; g and g_1 show the drop wires through which the threads pass, the pins being shown in the position they occupy when held upright by the threads. By the contact of the lower end of v with the lever q_1 through the arm q_3, an oscillating motion is given to the rod v and, consequently, to all parts mounted on it, including the arms v_3. When all the drop wires across the frame are vertical, each being supported by a thread, the arms v_3 swing on their fulcrum and the lower end of v keeps q_4 out of contact with x.

Should a thread break and a drop wire fall in front of either arm v_3, and thus hold it, q_1 is carried from v at the next backward movement; q_4 drops over x, pulling it backwards; x_1 is moved forwards; s_4 rises; and the machine stops. As these two drop wires are representative of all of the drop wires across the warper, there being one to each end, it follows that no end can break without a drop wire falling in front of one of the oscillating bars. In this warper, the drop wires are in sets of three, each set mounted on a brass block.

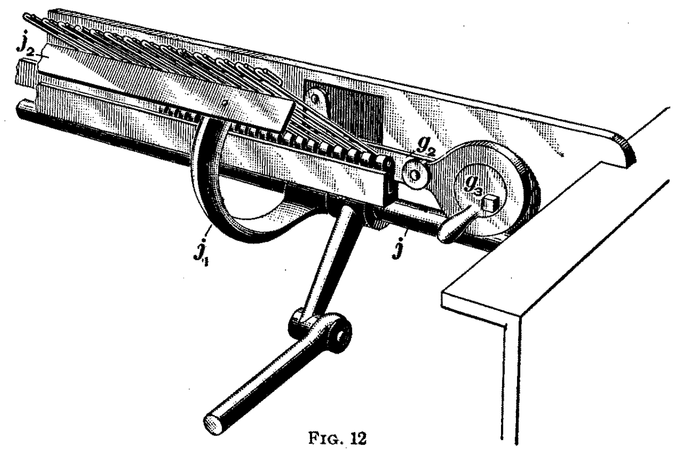


FIG. 12

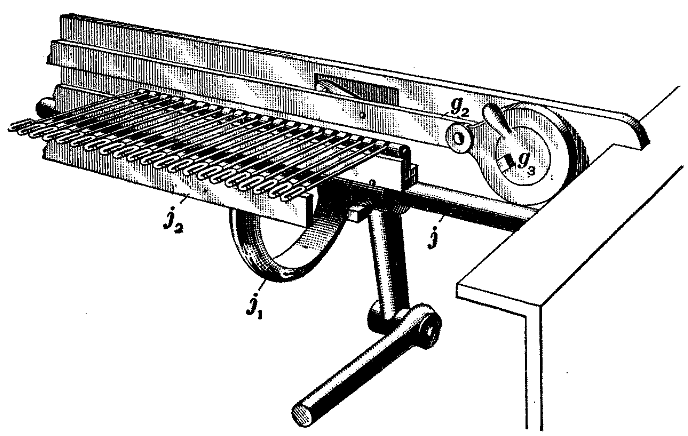


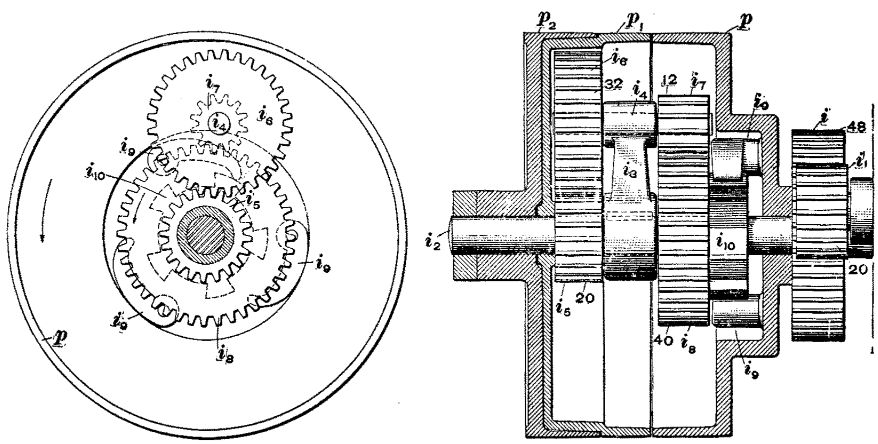
FIG. 13

One feature of the Walmsley stop-motion is shown in Figs. 12 and 13. When the eccentric g_3 is in the position shown in Fig. 12, a locking bar g_2 holds the blocks of the drop wires firmly in position, allowing the drop wires themselves, however, to rise or to fall. When the eccentric is in the position shown in Fig. 13, the locking bar is raised and any one block carrying three drop wires can be removed. The bar j_2, supported by arms similar to j_1 that are mounted on the shaft j, rises when the machine is stopped by the broken-end stop-motion and brings all the drop wires automatically into position to have the ends passed through them.

15. Measuring Motion.—The roll h, Fig. 11, acts as a measuring roll and is 9 inches in circumference. At one end of its shaft it carries a single-threaded worm t driving a worm-gear t_1 of 60 teeth on the shaft t_2. At the other end of t_2 is a gear t_3 of 20 teeth, which by means of a carrier gear t_4 drives t_5 of 100 teeth carried by the same shaft as a single-threaded worm t_6, which drives a 40-tooth worm-gear t_7 on the barrel u. The size of the measuring roll and of the gears intervening between it and the barrel u are such that 3,000 yards of yarn passes the measuring roll when u makes one complete revolution and, if it is set to knock off—that is, to stop the warper—at the end of 3,000 yards, it allows the blade u_1 to rise and the weight u_3 on the other end of the lever u_2 to drop when that number of yards has been measured. The weight u_3 falls on the pin v_4 on the rod v and, at the next oscillation of this rod, u_3 drops behind v_4 and holds the arm v away from q_3, which allows q_4 to come in contact with x and stop the machine.

The barrel u has a spiral groove of 10 complete turns, in any of which the blade u_1 can be inserted. If it were set in the rear one, $10 \times 3{,}000$ yards $= 30{,}000$ yards would be measured; if in the last groove but one, $9 \times 3{,}000 = 27{,}000$ yards would pass the roll. If it were placed one complete turn from the outer end of the barrel, u would revolve only once before stopping the warper and 3,000 yards would be measured. It will thus be seen that either 3,000, 6,000, 9,000, 12,000, 15,000, 18,000, or other multiples of 3,000 up to 30,000 yards can be accurately measured, while intermediate measurements can be made approximately by the position in which the barrel u is set before commencing operations.

16. Slow Motion.—The method adopted on the Draper warper to obtain the slow speed is illustrated in Fig. 14 (*a*) and (*b*). Working loosely on the short stationary shaft i_2 are the tight pulley p, slow-motion pulley p_1, and loose pulley p_2. When the belt is on the tight pulley p, motion is transmitted to the warper through the gear i, which is on the hub of this pulley and drives the gear i_1 on the shaft that imparts motion to the different parts of the warper. When it is desired to put the slow motion in operation, the



(*b*) (*a*)

FIG. 14

driving belt is shipped to the pulley p_1. In order to understand the operation of the slow-motion mechanism it should be remembered that the shaft i_2 is stationary and simply serves as a support for the different parts mounted on it.

Fast to the hub of the pulley p_1 is a gear i_5 that drives a gear i_6 on a shaft supported by an arm i_3 that is keyed to the shaft i_2. On the shaft with the gear i_6 is a gear i_7 meshing with a gear i_8 that revolves loosely on the shaft i_2. On the hub of the gear i_8 is a ratchet gear i_{10}, which when the belt is on the slow-motion pulley is engaged by pawls i_9 that are supported on small studs fastened to the tight pulley p. Thus, when the belt is on the slow-motion pulley p_1, motion is imparted to the tight pulley p, and consequently to the warper, through the gears i_5, i_6, i_7, i_8, i_{10}, and pawls i_9; but owing to the arrangement of these gears, the speed is very much less than when the tight pulley is driven directly by the belt. The tight pulley, when driven directly by the belt, revolves in the direction shown by the arrow in Fig. 14 (*b*), and the pawls i_9 are then inoperative, owing to their passing over the teeth of the ratchet gear i_{10}.

17. Cone Drive.—An attachment is provided on this warper by means of which the beam may be driven at a slower speed as the spools become nearly empty. The advantage of such an arrangement is clearly seen, for a spool filled with yarn is larger in diameter than an empty spool; consequently, if the same length of yarn is being unwound from each in the same time, the spool that is nearly empty must make more revolutions per minute than the other, which is undesirable. In addition, as the diameter of the spool decreases the amount of pull necessary to turn it is increased, which naturally brings more strain on the yarn. If, therefore, the same length of yarn is to be unwound from the spools at all times this length cannot exceed what the yarn will stand when being unwound from the nearly empty spool; consequently, when the spools are full, the warper is not run at its full capacity. It is to overcome this defect that the **cone drive** has been introduced; it is illustrated in Figs. 15 and 16.

The top cone m, which is on the same shaft as the gear i_1, Fig. 14, drives the bottom cone m_1 by means of the belt o_2, the position of which is controlled by the belt guide o_1. Connected to the top of the belt guide o_1 is a chain o that passes around the pulley o_3 and is attached to the pulley o_4. Another chain o_9 that is also attached to the pulley o_4 is connected to the lower end of the belt guide o_1. The action of the two chains o, o_9 is as follows: If the pulley o_4 is revolved in the direction shown by the arrow, the chain o is wound up and the chain o_9 let out, which will draw the belt guide o_1 to the left and move the belt o_2 toward the small end of the top cone m, resulting in the bottom cone m_1 being driven at a

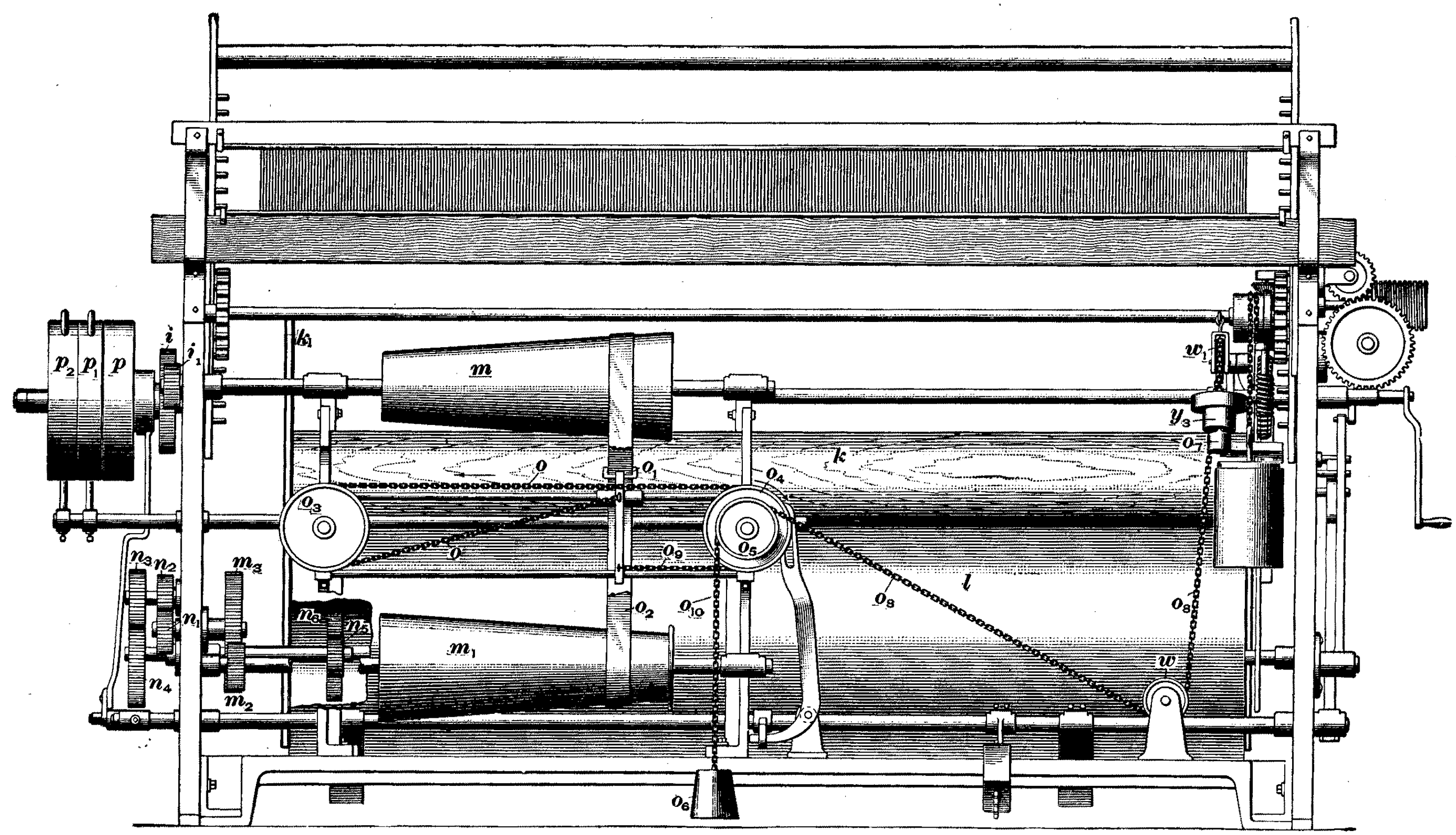

p
p1
p2
i
i1
k
k1
l
m
m1
m2
m3
n1
n2
n3
n4
n5
n6
o
o1
o2
o3
o4
o5
o6
o7
o8
o9
o10
w
w1
y3

FIG 15

slower speed. If the pulley o_4 is revolved in the opposite direction, the chain o_9 will be taken up and the chain o let out, moving the belt guide, together with the belt, to the right and increasing the speed of the bottom cone. The pulley o_4 is controlled by two chains o_{10}, o_8, each of which is attached to the pulley o_5 on the stud with the pulley o_4. The chain o_{10} supports the weight o_6, while the chain o_8 passes partly around the pulleys w, w_1 and supports the weight o_7. The weight o_6 is made heavier than the weight o_7; consequently, if only

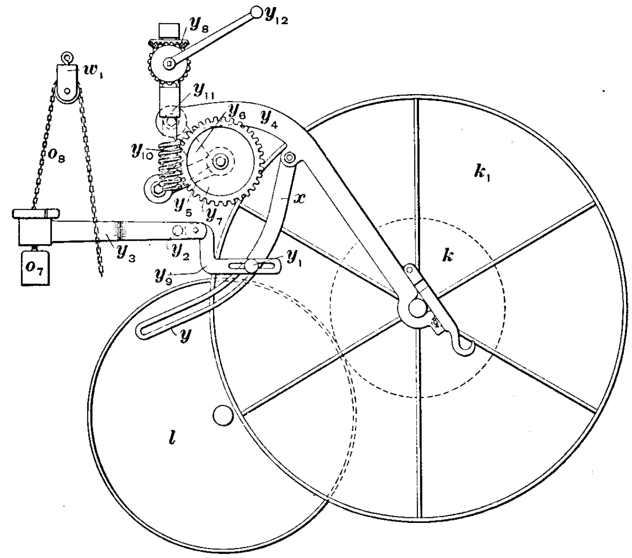


FIG. 16

these two weights were considered, the chain o_{10} would revolve the pulley o_5, together with pulley o_4, in the direction opposite to that shown by the arrow. When, however, the machine is running, an arm y_3, which is weighted at this end, rests on the weight o_7, and the combined weight of these two parts is sufficient to overbalance the weight o_6, causing the pulleys o_4, o_5 to revolve in the direction shown by the arrow and the belt to be moved gradually toward the small end of the driving cone m. The manner in which the arm y_3 is controlled is explained in connection with Fig. 16.

The beam k is supported by arms y_4, which are fulcrumed at points y_{11}. When an empty beam is placed on the cylinder l, the diameter is of course the smallest, being only that of the barrel k. As yarn is wound on the beam, the diameter becomes larger, which causes the arm y_4 to rise. To the arm y_3, which is fulcrumed at y_2, is connected a short arm y_9 with a slot into which a pin y_1 is bolted; this pin engages with a slot y in the arm x. The slot in the arm y_9 allows the pin y_1 to be accurately adjusted with the slot y, while the arm y_3, being weighted at its outer end, keeps the pin pressed against the upper end of slot y. As the arm x is attached to the arm y_4, which carries the bearings of the beam, it follows that as the arm y_4 rises, the arm x will also rise and with it the slot y. This action of the different parts allows the outer end of the arm y_3 to drop, thus causing the weight o_7 to descend also and move the belt toward the smaller end of the driving cone m by means of the chains o, o_8. When an empty beam is placed in the warper, the arm x will assume its lowest position, which will push down the pin y_1 and bring the weighted end of lever y_3 to its highest position. As the warper is started, the chain o_{10}, Fig. 15, will, on account of the weight o_6 overbalancing the weight o_7, revolve the pulleys o_4, o_5 in the direction to move the belt toward the large end of the top cone. This action will continue until the weight o_7 has been raised sufficiently to come in contact with the arm y_3, when the belt should be at the largest diameter of the driving cone m.

In this manner the size of the beam regulates the position of the belt. In order that this motion may act to the best possible advantage, it is necessary that full spools should be placed in the creel when an empty beam is placed in the warper, since in this manner the beam becomes larger as the spools are gradually reduced in size; consequently, the number of revolutions per minute that the spools make is approximately the same throughout the filling of the beam. Since one set of spools will not fill two beams, the spools are generally broken out and full ones inserted after a beam has been filled. The partly full spools are refilled at the spooler.

The manner in which the bottom cone drives the cylinder is as follows: The gear m_2, Fig. 15, is on the bottom cone shaft and drives m_3. On the shaft with m_3 is the gear n_1 that drives n_2, this gear being on a sleeve with n_3; n_3 drives n_4, which is on a shaft extending into, but not connected to, the cylinder and carries at its other end the gear n_5 that drives n_6 on the cylinder shaft. The number of teeth on each of these gears is as follows: m_2, 24; m_3, 64; n_1, 23; n_2, 23; n_3, 28; n_4, 48; n_5, 20; n_6, 46.

18. Beam Doffer.—Another device provided on the Draper warper is the **beam doffer,** by means of which it is

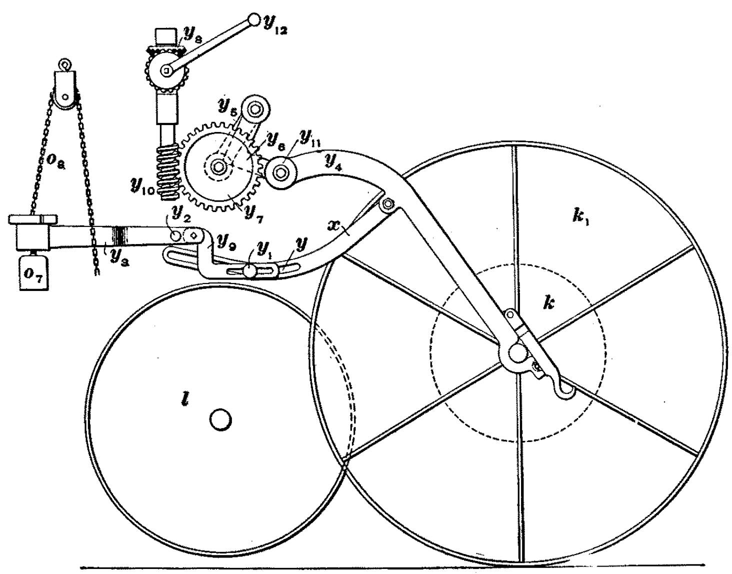


FIG. 17

possible for one man to place the filled beam on the floor with very little exertion. It is shown in Fig. 16 as it appears when the warper is in operation, while Fig. 17 shows the different parts in the positions that they assume when the beam has been lowered to the floor. This arrangement consists of a crank-arm y_5 supporting the two arms y_6, y_4 in such a manner that the distance between the centers of the beam k and the gear y_7 is short when the beam is running, but may be increased by turning the crank y_{12}. The rotary motion of this crank transmitted by the gears y_8, worm y_{10}, and worm-gear y_7 moves the crank-arm y_5 and arms y_6, y_4 into the position shown in Fig. 17, thus lowering the beam, as shown, to the floor or to a beam truck placed to receive it.

CALCULATIONS AND MANAGEMENT OF WARPERS

CALCULATIONS

19. The **calculations** that are required in connection with warpers relate almost entirely to speed and, consequently, will not require any detailed description. One illustration, however, will be given as an aid in solving any problems that may be met with in connection with warpers.

EXAMPLE.—Find the greatest speed of the cylinder of the warper illustrated in Figs. 14 and 15 if the tight pulley p is driven 200 revolutions per minute.

NOTE.—The cones are $4\frac{1}{4}$ inches in diameter at their small ends and $6\frac{1}{4}$ inches in diameter at their large ends.

SOLUTION.—

$$\frac{200 \times 48 \times 6\frac{1}{4} \times 24 \times 23 \times 28 \times 20}{20 \times 4\frac{1}{4} \times 64 \times 23 \times 48 \times 46} = 67.13 \text{ rev. per min.} \quad \text{Ans.}$$

MANAGEMENT

20. The **management** of a warping equipment requires careful attention, more particularly with regard to obtaining hard and level beams, free from ridges or soft sides near the beam head. The existence of ridges indicates a wrong division of the ends in the comb, while soft sides show that the comb has not been adjusted to suit the width of the beam. All knots that are made during the filling of a beam should be made as small as possible in order to facilitate the weaving process. In beam warping, it is customary to run the ends so that in being wound on the beam they will run over instead of under the beam, it being claimed that when wound in this manner it is easier to find and tie any broken ends.

Warpers are usually tended by women, who can give attention to from two to eight machines, the number depending on the class of yarn that is being run, and the amount of assistance that is rendered them in refilling the creels and other work, outside of that of actually operating the machines. The attendants are usually paid by the piece.

21. The actual production of warpers should be estimated at from 65 to 75 per cent. of the production figured on the basis that the machines are run constantly, as warpers are stopped from $1\frac{1}{2}$ to 2 hours for creeling after each set of spools has been run off. The production is usually figured at 70 yards per minute for 20s; 60 yards per minute for 40s; 50 yards per minute for 60s; 45 yards per minute for 80s; and 40 yards per minute for 100s. This estimate will vary in different mills, according to the speed of the machines, the quality of the yarn, and the number of warpers being run by each tender.

Table I gives the production per week of 60 hours for yarns from 8s to 50s, the number of ends on the beam varying from 260 to 440 and the speed of the warper being about 54 yards per minute. The production with other speeds can easily be figured by proportion. This table provides for an allowance of $33\frac{1}{3}$ per cent. lost time for stoppages.

22. As a number of the section beams on which the yarn is wound at the warper are later wound on one loom beam, it is necessary before making any beams on the warper to first find how many should be made and just how many ends there should be on each beam. For example, suppose that it is desired to ultimately place 1,790 ends on a loom beam. Before the section beams are made for this loom beam, the number of ends to be placed on each section beam must be ascertained. Thus, in this case it would be possible to make four section beams, three beams containing 450 ends each, and one beam containing 440 ends, the total number of ends being 1,790, which is the number desired for the loom beam. Any other division could be made so long as the number of ends placed on any one section beam did not exceed the number of spools that it is possible to run in the creel of the warper.

TABLE I

Number of Ends	260	300	320	340	360	380	410	440
Number of Yarn	Pounds Warped in 60 Hours							
8	5,015	5,785	6,171	6,557	6,943	7,329	7,907	8,485
10	4,011	4,629	4,937	5,246	5,555	5,863	6,325	6,789
12	3,343	3,857	4,181	4,372	4,629	4,885	5,271	5,657
14	2,865	3,305	3,527	3,747	3,967	4,188	4,519	4,849
16	2,507	2,893	3,085	3,279	3,471	3,664	3,953	4,243
18	2,229	2,571	2,743	2,915	3,085	3,257	3,515	3,771
20	2,005	2,315	2,468	2,623	2,777	2,931	3,163	3,395
22	1,823	2,104	2,244	2,385	2,525	2,665	2,875	3,085
24	1,671	1,925	2,057	2,185	2,315	2,443	2,636	2,829
26	1,543	1,780	1,899	2,017	2,136	2,255	2,433	2,611
28	1,433	1,653	1,763	1,873	1,983	2,094	2,259	2,425
29	1,383	1,596	1,703	1,809	1,915	2,021	2,181	2,341
30	1,337	1,543	1,645	1,749	1,851	1,955	2,109	2,263
32	1,253	1,447	1,543	1,639	1,736	1,832	1,977	2,121
34	1,180	1,361	1,452	1,543	1,633	1,725	1,861	1,997
36	1,115	1,285	1,371	1,457	1,543	1,629	1,757	1,885
38	1,056	1,219	1,299	1,380	1,461	1,543	1,665	1,787
40	1,003	1,157	1,235	1,311	1,389	1,465	1,581	1,697
44	912	1,052	1,123	1,192	1,262	1,332	1,437	1,543
50	806	925	987	1,049	1,111	1,171	1,265	1,357

23. A standard warper with a 54-inch cylinder and with a creel for 400 spools occupies over all a space of about 17 feet by 7 feet 6 inches, while a larger warper with a creel for 450 spools occupies a space of 18 feet by 8 feet. The warper itself without the creel occupies 3 feet 6 inches by 7 feet 6 inches. The driving pulleys of a warper are usually 10 inches in diameter and are driven by a 2-inch belt. From $\frac{1}{4}$ to $\frac{1}{2}$ horsepower is required to drive one warper.

In equipping a mill, it is customary to estimate on about eighteen beams to each warper, in order to afford a sufficient supply for storing yarn and making up the assortments for the slasher; these beams are sometimes called *section beams*, sometimes *slasher beams*.

The weight of the warper itself, that is the machine, is about 1,000 pounds, and of a creel for 450 ends about 450 pounds, so that the shipping weight of a warper with creel and beams is from 2,500 to 3,000 pounds.

A warper is said to be right-hand if the driving pulleys are on the right-hand side when the observer is standing in front of the warper, that is, facing the beam, and left-hand if the driving pulleys are on the left hand when the observer is in the same position.