the same pressure obtained as when a larger weight is employed in the system of dead-weighting. The pressure can also be very readily varied by moving the weight on the lever.

A method of lever-weighting is shown in Fig. 17. A saddle d_2 has a bearing at its forward part on the top front roll, and also another bearing on the smaller saddle at *g*. The small saddle has bearings on the back and center rolls. Suspended from d_2 is a rod d_3 linked to a rod *j*. This rod passes through a hole in the roll beam and supports the lever *h*, which is fulcrumed under the roll beam at *f*. The lever *h* carries the weight *w*, the position of which may be varied and thus different pressures obtained on the rolls, as is desired. The method of obtaining the amount of pressure exerted at any point by lever-weighting is somewhat more complicated than in the case of dead-weighting, and in order to make this somewhat clearer, reference is made to Fig. 18, together with the following data: The weight of *w* is 4 pounds; the distance of *w f* is $7\frac{1}{2}$ inches; *p f*, $\frac{3}{4}$ inch; *j k*, $\frac{5}{8}$ inch; *k l*, $1\frac{3}{8}$ inches; *l m*, $\frac{1}{2}$ inch; *m n*, $1\frac{1}{2}$ inches; *l n*, 1 inch; *j l*, 2 inches. The total pressure will equal

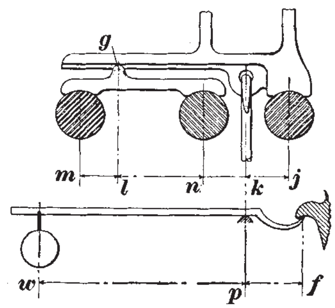


Fig. 18

$$\frac{\text{Weight} \times wf}{pf} = \frac{4 \times 7\frac{1}{2}}{\frac{3}{4}} = 40 \text{ pounds, total weight on all rolls.}$$

Part of this 40 pounds will be distributed on *j* and the remainder on the point *g*.

The pressure on *j* will equal

$$\frac{kl \times 40}{jl} = \frac{1\frac{3}{8} \times 40}{2} = 27\frac{1}{2} \text{ pounds}$$

The pressure at *g* equals $40 - 27\frac{1}{2} = 12\frac{1}{2}$ pounds, or the pressure at *g* will equal

$$\frac{jk \times 40}{jl} = \frac{\frac{5}{8} \times 40}{2} = 12\frac{1}{2} \text{ pounds}$$

The pressure at n will equal

$$\frac{l\,m \times 12\frac{1}{2}}{m\,n} = \frac{\frac{1}{2} \times 12\frac{1}{2}}{1\frac{1}{2}} = 4.1\dot{6}6 \text{ pounds}$$

The pressure at m will equal $12\frac{1}{2} - 4.166 = 8.33$ pounds, or the pressure at m will equal

$$\frac{l\,n \times 12\frac{1}{2}}{m\,n} = \frac{1 \times 12\frac{1}{2}}{1\frac{1}{2}} = 8.33 \text{ pounds}$$

28. In Fig. 19, a system sometimes used for weighting the rolls of a spinning frame is shown. This method differs but slightly from that shown in Figs. 17 and 18. The

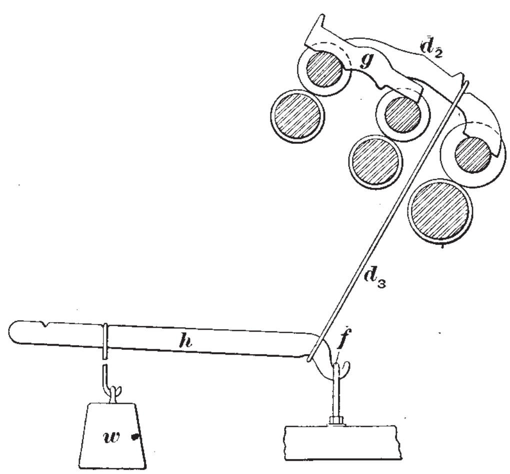


FIG. 19

weight w is supported by the lever h, which at the point f is inserted in a hook fastened to the roll beam. Connected to the lever h is a hook d_3 that is supported by the saddle d_2, which has a bearing on the front top roll and on the saddle g. The saddle g has a bearing on the back and middle top rolls.

29. Metallic rolls do not require so much weight as common rolls; usually a weight of about 14 pounds is used on each end of the four rolls of a drawing frame, although this sometimes differs and a weight of 10 pounds is used for the front, 12 for the second, 14 for the third, and 16 for the fourth. In experimental cases, metallic rolls have been run with as low a weight as 6 pounds. Some prefer to have the heaviest weight on the front roll, claiming that as this roll revolves at the highest speed it therefore requires more weight to keep it steady. The following list of weights, which was taken from machines running medium counts, will give a general idea of the relative weights on the rolls in different machines, but it should be understood that the weights given here will serve simply as a guide, since the weights that are used are largely dependent on the ideas of the builder, the ideas of the purchaser, the construction of the machine, and the class of work to be run.

On the drawing frames using single-boss metallic rolls there was a weight of 18 pounds on each end of the front rolls, giving a total of 36 pounds pressure on the front roll. The second roll carried 16-pound weights, giving a total of 32 pounds. The third and back rolls carried 14-pound weights, giving a pressure of 28 pounds on each roll. All of these were dead-weighted.

On the drawing frames using single-boss common rolls the front rolls carried 22-pound weights at each end, the second rolls 20-pound weights, the third rolls 18-pound weights, and the back rolls 16-pound weights, giving a total weight of 44, 40, 36, and 32 pounds on the front, second, third, and back rolls, respectively.

On the slubbers using double-boss common rolls the front rolls were dead-weighted and carried a weight of 12 pounds, thus giving a pressure of 6 pounds on each boss. The middle and back rolls supported a saddle from the center of which was suspended a 12-pound weight, giving a pressure of 3 pounds on each boss of both middle and back rolls.

On the first intermediates using double-boss common rolls the front rolls were dead-weighted and carried a weight of 16 pounds, giving a pressure of 8 pounds on each boss of the roll. The middle and back rolls carried a saddle from which was suspended an 18-pound weight, thus giving a pressure of $4\frac{1}{2}$ pounds on each boss of both rolls.

The second intermediates using double-boss common rolls were dead-weighted throughout and carried weights of 18, 14, and 12 pounds on the front, middle, and back rolls, respectively, thus giving a pressure of 9 pounds on each boss of the front rolls, 7 pounds on each boss of the middle rolls, and 6 pounds on each boss of the back rolls.

On the roving frames the front rolls were common double-boss rolls, being dead-weighted, and carrying a weight of 8 pounds, thus giving a pressure of 4 pounds on each boss. The middle and back rolls were self-weighted.

WEIGHT-RELIEVING MOTIONS

30. It is necessary to use every precaution to keep a leather-covered roll as perfectly round and smooth as possible, in order to insure good work; and, for this reason, **weight-relieving motions** are applied so that there will not be any pressure on the rolls when they are to stand idle for any considerable length of time. If the pressure were maintained on the rolls during the time that they were stopped, a depression would be formed at the point where the steel roll was in contact with the leather of the top roll, because of the yielding properties of the leather, and when the machine was again started there would be a slightly eccentric running of the roll, which would produce irregularity in the work.

In some cases where there is not a weight-relieving motion, it is necessary to remove the hooks from each weight by hand. An arrangement that makes this operation easier and more simple is shown in Fig. 15. The weights w are suspended from the rolls, as shown, each weight having a hole in it through which an eccentric s passes. By turning the handle s_1 until that part of the eccentric which is farthest from the center of the shaft that supports it is at the top, the weights will rest on the eccentric, and thus the pressure on the rolls is relieved. With this method an eccentric must be provided for each set of weights.

An arrangement by which two eccentrics serve for a number of sets of weights is shown in Fig. 16, and consists of bars e, e_1 that run lengthwise of the machine and pass through holes in the hooks f, f_1 supporting the weights w. These bars have a bearing at each end on an eccentric s and thus, by turning the eccentric by means of the handle s_1, the bars, and consequently all of the weights supported by the hooks through which the bars pass, are raised.

CLEARERS AND TRAVERSE MOTIONS

CLEARERS

31. In order to prevent the accumulation of dirt and fibers on the rolls, what are known as **clearers** are utilized. The construction of a clearer used on railway heads, drawing

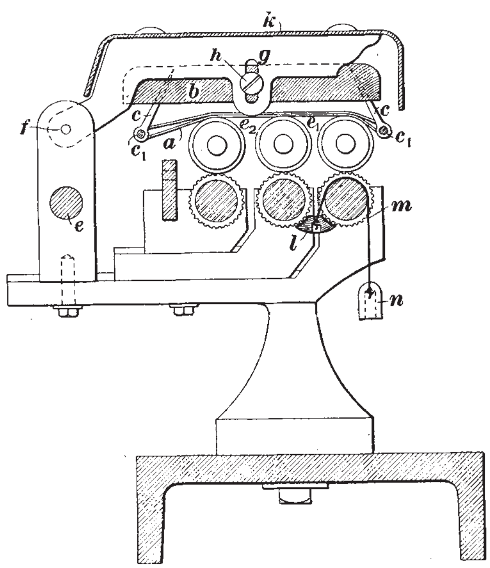


FIG. 20

frames, and fly frames is shown in Fig. 20. It consists of a piece of flannel a supported from a piece of wood b by means of rods c_1 and spikes c; b is held in position by means of screws, similar to h, which pass through a slot in a bracket *g* attached to the roll cover *k*. By this means the wood *b* may have a vertical movement. As the flannel is pressed against the rolls by the weight of the wood, the rolls are effectively cleaned. If clearers of this type are not cleaned as often as necessary, the clearer waste will gather at the points e_1, e_2 and eventually drop into the cotton that is passing through, causing bad work at the next process.

When cleaning by hand, it is necessary to lift the cover, which is hinged at *f*, and remove the waste; to obviate this operation, self-cleaning clearers are sometimes attached. There are several styles of self-cleaning clearers; one that is being used to a very large extent consists of an endless apron of very heavy cloth that passes around two rolls, one of these rolls being situated above the back roll of the frame, while the other is situated over the front roll. The back roll of this clearer motion is driven by gearing and has a very rough surface, thus causing the cloth to revolve, while the front roll is driven by the friction of the cloth passing round it. These rolls are so placed that the cloth will press on the top rolls of the frame, thus cleaning them while the cloth itself is cleaned mechanically by a comb.

Another type of clearer is shown beneath the rolls in Fig. 20. This type may be applied underneath at the spaces between any two lines of rolls, as it is on drawing frames. On fly frames, however, it is usually put between the first and second rolls only. It consists of a piece of wood *l* as long as the box of each frame. Two faces of the clearer are curved in such a manner that they correspond with the curvature of the rolls. This clearer is covered with flannel and is held in position by two pieces of lacing, one at each end, similar to *m*. These lacings pass over the front roll of the two with which the clearer is in contact, and have weights *n* at their ends. By this means the clearer maintains a pressure on the rolls and consequently cleans them.

Another style of clearer used underneath the rolls has a wooden roll covered with coarse woolen cloth, and is held against the bottom roll by springs. This clearer is revolved by frictional contact with the roll, and thus, whenever an end breaks, the clearer winds the cotton on itself and prevents its getting on the steel roll. This type of clearer is applied underneath the front roll.

TRAVERSE MOTIONS

32. Traverse motions in one form or another are used in connection with leather-covered drawing rolls, and have for their objects economy in roll leather and better quality of product. If the strand of cotton were permitted to pass between the leather roll and steel roll at one point continually, a groove would form around the rolls, and consequently they would soon lose their grip on the fibers. To prevent this, a motion is applied whereby the sliver, or roving, is given a traversing motion along the boss of the roll. In its simplest form the motion usually consists of a traverse bar t, Fig. 21,

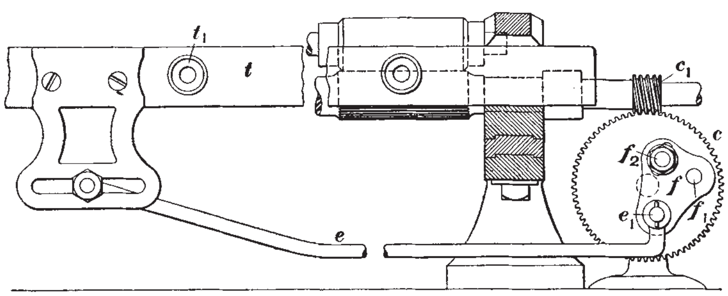


FIG. 21

that carries guides or is drilled with small holes t_1 through which the strand of cotton is passed before entering the back rolls. Attached to the traverse bar is a connecting-rod e that is connected to the crank-stud e_1. The crank-stud is connected to a casting f, which is connected to the worm-gear c by the stud f_1 and nut f_2, thus causing e_1 to be eccentric with reference to c. The worm-gear is on a short shaft and is driven by the worm c_1 on the back roll. As the back roll revolves it gives a traversing motion to the traverse bar t by means of the worm-drive and crank-arrangement.

Most traverse motions are supplied with some means of lengthening or shortening the length of the traverse. With the construction shown in Fig. 21 it is possible, by loosening the nut f_2 and swinging the casting f on the stud f_1, to bring e_1 nearer to or farther away from the center of the gear c, thus decreasing or increasing, respectively, the length of the traverse.

In some cases the traverse bar has attached to it a lever carrying a stud that is kept in contact with a heart-shaped cam by means of a spring. The cam receives motion in the same manner as the crank described, and as it revolves it forces the lever in one direction during a part of its revolution, while the spring serves to draw the lever in the opposite

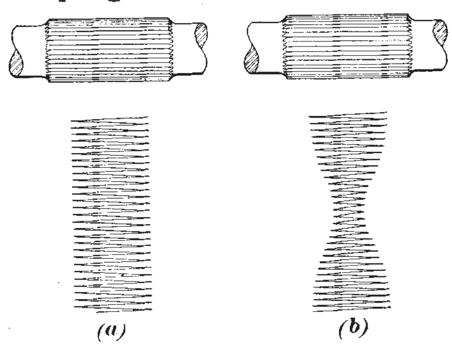
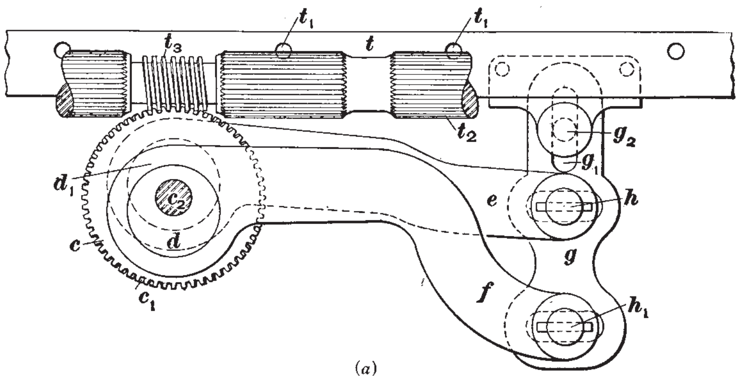


FIG. 22

direction during the remainder of the cam's revolution. The crank-arrangement is more positive than the cam and spring, but at the points of change, or where the crank-stud e_1 is at its dead centers, the motion of the traverse guide is slower than at any other part of the traverse, thus causing the strand of cotton to produce a greater amount of wear at these places. The extent of the traverse given with a cam- or crank-motion is shown in Fig. 22 (*a*).

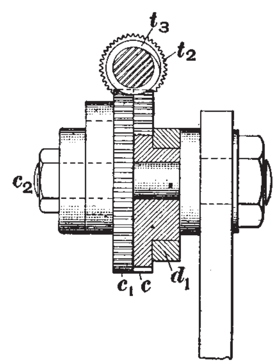
The main principle of construction that has been sought in traverse motions is to have a variable traverse; that is, to have different lengths of sweep so that the traverse will not be continually changing at the same point on the circumference of the roll. An arrangement that gives a variable traverse similar to that shown in Fig. 22 (*b*) is shown in Fig. 23, in which (*a*) is a front view and (*b*) an end view, partly in section.

The back roll t_2 carries a worm t_3 driving two worm-gears c, c_1 that vary slightly in the number of teeth. Forming a part of the worm-gear c_1 is an eccentric d_1, while the eccentric



(*a*)

d is a part of the worm-gear c. The worm-gears c, c_1 are mounted on a stud c_2 that is supported by a bracket attached to the roll beam. Connected to the eccentric d is a lever f that is attached at its other end to a stud h_1 connected to the lower end of the bracket g. The eccentric d_1 also carries a lever e, which is connected to a stud h that is also carried by the bracket g. The bracket g is connected by means of the stud g_2 to the traverse bar t. As the worm-gears c, c_1 have different numbers of teeth and are driven by the same worm, the two eccentrics that form part of these two worm-gears will have their relative positions changed; thus, at one time the eccentrics may coincide, in which case the levers e, f will be moving the bracket g in the same direction and the traverse rod t will be receiving its shortest traverse. At another time the highest parts of



(*b*)
FIG. 23

the eccentrics d, d_1 will be brought diametrically opposite each other, in which case the lever e will be moving in one direction as far as possible, while f will be moving in the other, resulting in the traverse guide receiving its maximum traverse.

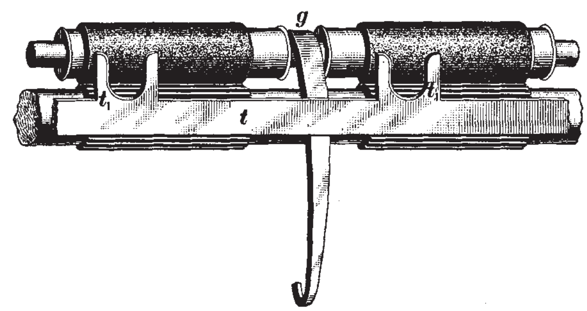


Fig. 24

The slot g_1 in the bracket g allows this bracket to be raised or lowered, thus shortening or lengthening the extreme length of the traverse, as may be desired. When the traverse guides t_1 are at the center of the boss of the rolls,

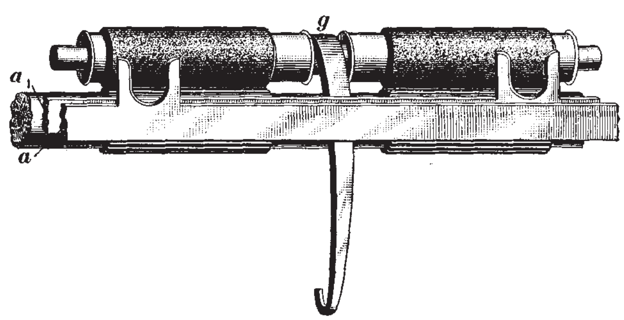


Fig. 25

the bracket g should be exactly perpendicular, and in order to accomplish the settings of the different parts, slots are provided in the bracket g at the points where the studs h, h_1 are situated, thus allowing the bracket to be placed in its correct position.

33. Double-Bar Traverse Motion.—With the traverse motions just described, it will be observed that as the cotton is passing through the guides t_1, Fig. 24, the strand nearest the neck *g*, or where the weight is applied, is under a greater pressure than the strand under the opposite boss, owing to the distance from the weight. It will be seen then that there is only one point in the traverse where the weight is equally divided between the two strands; viz., the center.

To overcome this, a motion known as the **double-bar traverse motion,** Fig. 25, has been introduced. With this motion the strands under each boss are operated by separate bars *a*, a_1, which move all the strands of cotton toward the necks of the rolls at the same time, thus maintaining an equal distance between all the strands and the necks of the rolls and causing the weight to be equally divided at every point of the traverse.

SCOURING ROLLS

34. The cleanliness of the fluted rolls, as well as the leather-covered rolls, is an important question, since if the dirt and other foreign matter that collects in the flutes and bearings of the rolls is not removed, considerable waste and consequent loss of production and bad work will result from the cotton adhering to and winding around the rolls instead of being delivered at the front of the machine. The cotton collecting in the bearings of the rolls will also cause the rolls to bind, and thus wear out the bearings and cause considerable strain on the gearing that drives the rolls.

The rolls should be removed periodically from the different machines in order to properly clean the bearings, necks, and fluted parts, which operation is known as **scouring.** The time for scouring depends largely on the amount of work and the kind and speed of the machine, as well as on other circumstances. The rolls in machines used for carded work should be scoured oftener than those used for combed work, and those for coarse work oftener than those for fine work. The rolls of the drawing frame should be scoured about once a month, while those of the roving frame require scouring only about every 6 months. The times of cleaning the rolls of the frames intervening between the drawing frame and roving frame should be in proportion to the amount and quality of the work that they are producing.

When the bottom rolls are removed for scouring great care should be taken, especially when the rolls are very long, that they do not become bent or strained, since if they are replaced in the machine in this condition they are liable to bind in the stands and produce cut work. In removing the rolls two or three persons are usually employed in lifting them from their bearings and placing them on stands, horses, or brackets suitable for the purpose.

After the rolls have been removed they should be rubbed with a piece of card fillet in order to remove any dirt, hard oil, or other substances that may collect in the flutes. After cleaning the roll in this manner it should be covered with a paste made of oil and whiting and thoroughly scoured by rubbing with another piece of card fillet, care being taken not to rub around the circumference of the roll but lengthwise, so that the wires of the card fillet will follow the grooves of the flutes and clean them.

After this the roll should be wiped with a piece of dry waste, covered with dry whiting, in order to thoroughly dry the flutes before the rolls are replaced. In some cases dry whiting is used in place of the paste. Care should be taken not to allow any of the whiting to collect in the flutes or bearings of the roll.

After the rolls have been scoured they should be examined in order to ascertain if there are any rough places; and if such are found they should be smoothed by using a piece of pumice stone, a piece of very fine emery cloth, or a fine fluted file. In most cases the pumice stone or emery cloth will be found sufficient, and the file should not be used unless absolutely necessary.

The stands or bearings of the machine should be thoroughly cleaned with a piece of dry waste and examined to ascertain if there are any bearings that are badly worn; if there are, they should be replaced, care being taken that the new ones do not stand higher than the others. If any loose joints are found in the roll, the portion containing the same should be removed from the remainder and taken to the machine shop to be repaired. The same care should be used in replacing the rolls that was taken in removing them.

It is advisable after the rolls have been replaced to place a small portion of grease on the necks of all the rolls before the top ones are replaced. This insures a perfect lubrication of the bearings and lasts longer than oil; it also avoids the necessity of frequent oiling, although the rolls should be oiled at least once a week.

If leather-covered top rolls are used in a machine these should be thoroughly cleaned and revarnished and the bearings oiled before being replaced, while if metallic top rolls are used they should be cleaned in a manner similar to the bottom rolls.

RAILWAY HEADS AND DRAWING FRAMES

RAILWAY HEADS

INTRODUCTION

1. A machine in use in some of the older cotton mills of the country but fast passing into disuse is that known as the **railway head.** At one time it was the custom to arrange stationary flat cards in sections of from six to twelve, and instead of having a coiler at each card, as is now customary with the revolving flat card, a long trough was placed in front of each section of cards, so that the sliver was deposited on an apron in the trough, or *railway*, and carried to the head end of the section. At this head end, or delivery end, was placed a machine, called a railway head, from its position at the head of the railway, into which the slivers from the cards were drawn and combined into one sliver. This must not be confused with a somewhat similar arrangement in mills making double-carded yarns, by which the slivers from one section of cards are combined into a lap or portion of a lap to be recarded. Both of these arrangements are now passing out of use, the most popular and most satisfactory method of preparing carded yarns being to use the revolving flat card, at which the sliver is deposited in a can by means of a coiler; the full can is then carried directly to the back of the first drawing frame. In some cases, the sliver is taken from the card to the back of a railway head of modern construction, which takes the place of the first drawing frame.

The older style of railway heads, which are combined with a section of cards, will be only briefly described; but a full description will be given of those that are used entirely separate from the cards. In the older type, when the cotton sliver leaves each card it is delivered into a trough on to an endless apron, about 12 inches wide, that consists of canvas covered with a layer of rubber. At intervals along the trough are sets of wooden rolls, the upper ones resting on the cotton and condensing the slivers, while the lower ones support the apron; both the top and bottom rolls are driven by friction. After passing the point where the last card delivers its sliver into the trough, all the slivers pass between two solid steel rolls, which condense the slivers into a still more compact mass; these rolls are positively driven and the lower roll drives the apron. The assembled slivers, after leaving the apron, form a compressed sheet of cotton, thicker in the center than at the edges, and pass to the back roll of the railway head. The slivers are delivered into the trough in such a manner that more will lie in the center of the apron than at the edges. Thus, the whole of the cotton is more liable to remain on the apron than if it were as thickly distributed at the edges as in the center.

It is obvious that coilers and cans are not needed at each card, the product from a whole section of six, eight, ten, or twelve cards being delivered to one railway head, which deposits it in a can about 20 inches in diameter. In principle this type of railway head differs in no way from those used at the present time, and in construction resembles that described in Art. **10** and illustrated in Figs. 7, 8, and 9.

2. Objects.—The objects of the railway head are as follows: (1) To even the sliver as far as possible; (2) to parallelize the fibers of the sliver. The methods by which these objects are attained are: (1) doubling, or combining several slivers into one; (2) using an evener attachment;

(3) drafting, which causes the fibers to lie more nearly parallel.

It will be noticed that no mention is made of any cleaning action; in fact, in the ordinary layout of cotton mills the cleaning of the fiber from impurities ends with the card. This is not always true, however, because in mills making very fine or high-grade yarn a cleaning process, known as *combing*, is introduced, but this is seldom used in mills making any other class of yarn. It may be accepted as generally true that any machine subsequent to carding is not intended as a cleaning machine.

PRINCIPAL PARTS OF THE RAILWAY HEAD

3. Front and back views of a railway head that takes the sliver from the cans filled at the card are shown in Figs. 1 and 2, respectively, while Fig. 3 shows a plan view of the same machine with covers and certain parts removed. The usual number of cans placed at the back of this machine is eight, although it is also constructed for other numbers. Referring to Figs. 1, 2, and 3, the slivers from the cans at the back of the machine pass through the guides a, over the spoons b, there being one spoon to each sliver, and then to the back rolls c. The slivers are then subjected to the drafting action of four sets of rolls, and passing from the front rolls c_1 are combined into one sliver at the trumpet d, from which they pass to the calender rolls c_2, c_3, through a coiler, and into a can, the coiler and can arrangement being very similar to that found at the card.

Railway heads are built in two styles, single and double, Fig. 1 illustrating what is known as a single railway head. Double railway heads are constructed much the same as single railway heads, the principal difference being that in the former case two machines are combined into a single machine having two heads and, consequently, two deliveries. By this means a slight saving in floor space is effected, by slightly reducing the length as compared with two single heads, and also by reducing the number of passages among the machines; there is also a slight economy of power.

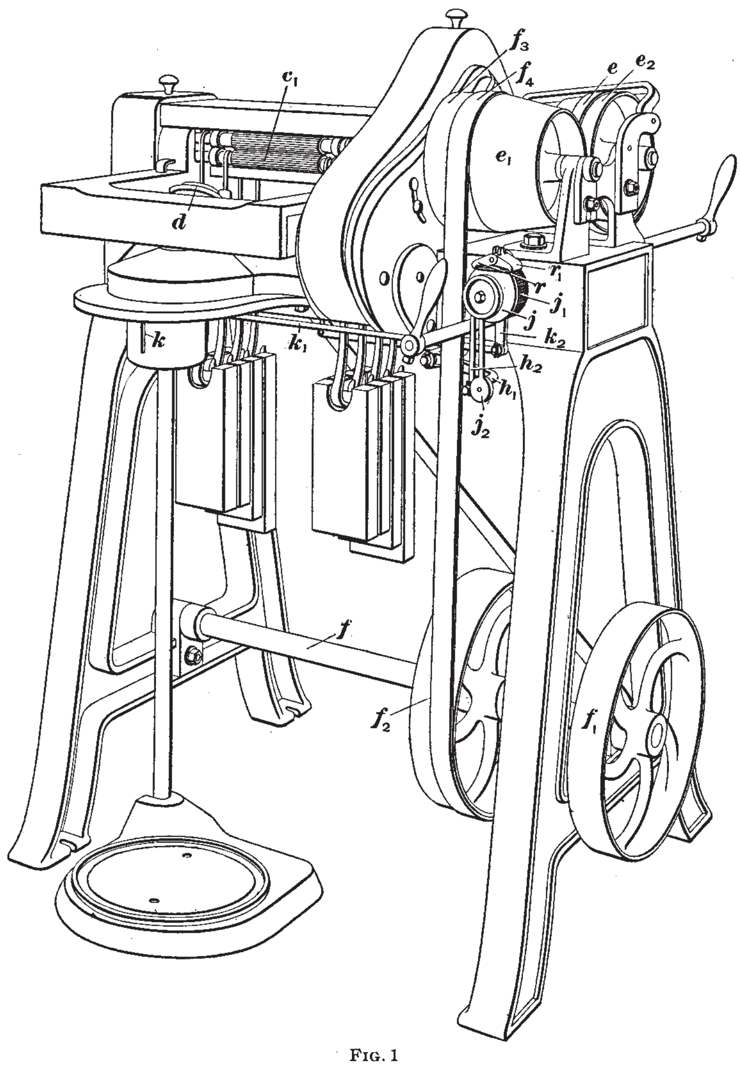


FIG. 1

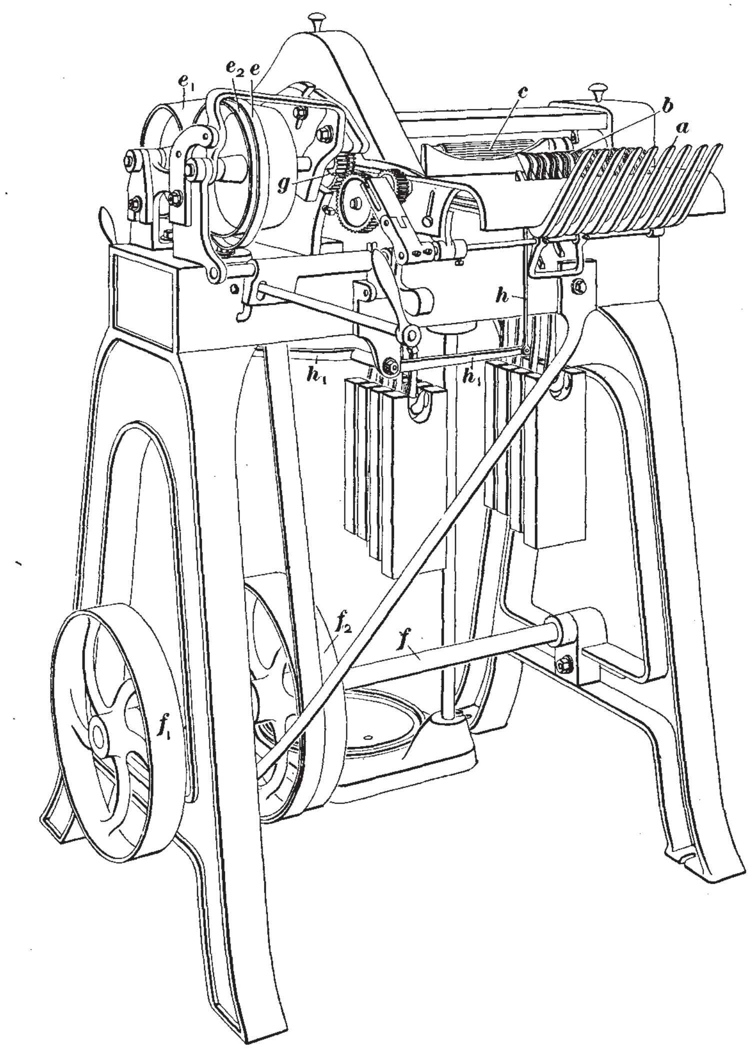


FIG. 2

Stop-motions are provided on railway heads to stop the machine when a sliver breaks or runs out at the back, when the sliver breaks at the front, and when the can at the front becomes too full. Since all these motions are similar to

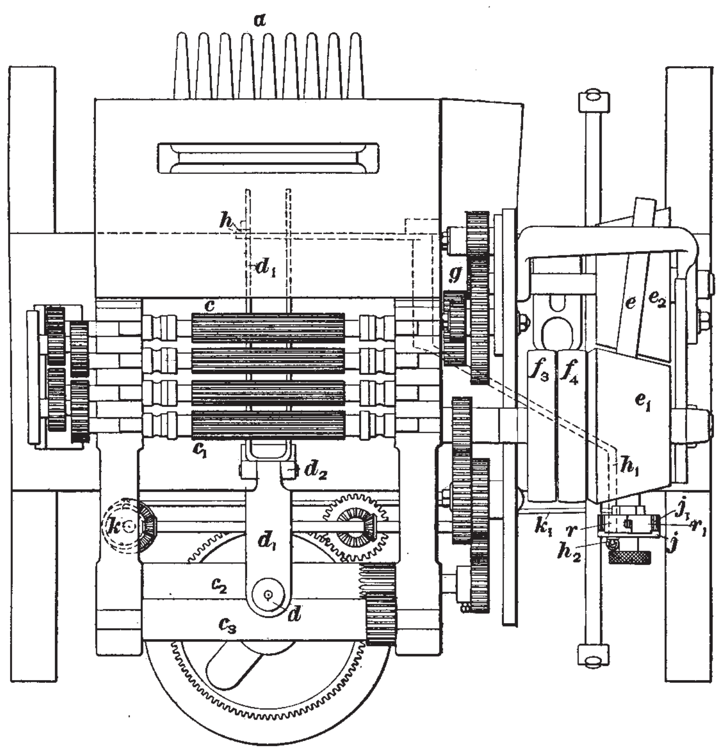


FIG. 3

those serving the same purpose on the drawing frame, which will be fully described later, a description of them is not given here. One motion, however, that is found on the railway head but is not applied to drawing frames, namely, the *evener motion*, is given a complete description.

EVENER MOTION

4. The object of the **evener motion** of a railway head is to so regulate the draft of the machine by means of cones that, in case the total weight of the slivers fed in a given time varies, the weight per yard of the sliver delivered remains the same. These cones may be placed either under the machine or at the side, the latter method being adopted in the machine illustrated in Figs. 1, 2, and 3, where the cones are shown at e_1, e_2. Referring to Fig. 1, the pulley f_1 on the shaft f is driven from the main shaft or countershaft of the room. On the shaft f is another pulley f_2, which drives the tight and loose pulleys f_3, f_4. Both the tight pulley and the cone e_1 are fast on the end of the front roll c_1, so that the speed of these parts is the same and constant. The cone e_1, by means of a friction belt e, drives the cone e_2. This friction belt simply forms a ring that passes loosely around the cone e_2 and is capable of being shifted from one position to another by means of a belt guide. These parts are more clearly shown in Fig. 3. Fast to the shaft with the cone e_2 is the gear g, Figs. 2 and 3, that drives the back rolls c by means of suitable gearing. The back roll drives the third roll; consequently, the draft between these two rolls is always constant, provided that the gears on the ends of these rolls are not changed. This is also true of the front and second rolls, since the second roll is driven from the front. Thus the break draft in this case is between the second and third rolls, so that if the back and third rolls are speeded faster or slower, the break draft and, consequently, the total draft of the machine will be changed. Thus it will be seen that the position of the friction belt between the two cones regulates the draft of the machine. For example, if the friction belt is between the large end of the driving cone e_1 and the small end of the driven cone e_2, then the cone e_2 will be driven at its maximum speed, which in turn will drive the back rolls at their highest speed, thus increasing the feed and diminishing the draft of the machine, since the speed of the front rolls remains the same. On the other hand, if the friction belt is shifted to the small end of the driving cone and the large end of the driven cone, then the cone e_2 will be driven at its lowest speed, which in turn will drive the back roll at its lowest speed, decreasing the amount of stock fed in and increasing the draft. This is the method adopted on railway heads to regulate the weight of the sliver delivered; that is, if the weight fed is too heavy, the draft is increased, whereas if the weight fed is too light, the draft is diminished.

5. In all railways heads, the principle adopted to control the movement of the belt on the cones consists of passing the

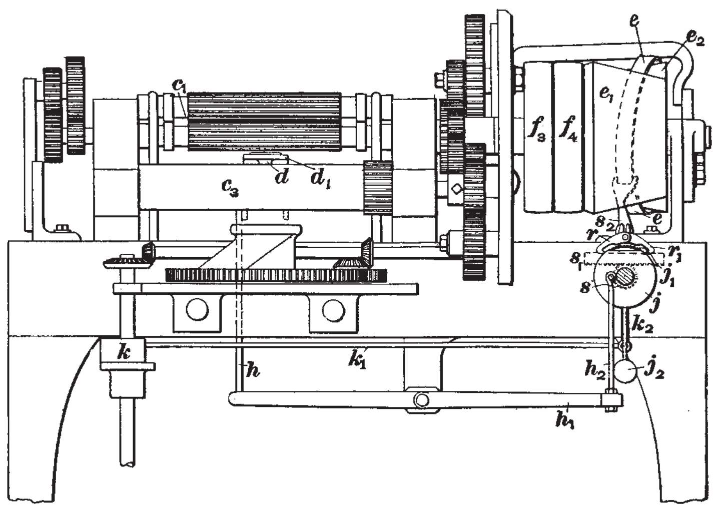


FIG. 4

sliver through a trumpet-shaped guide attached to one end of a lever that is pivoted near its center and carries at its other end an adjustable weight. This weight is so placed on the lever that it exactly balances the downward pull of the sliver when the correct weight is passing through the trumpet; consequently, if the sliver is too light, the trumpet rises, while, on the other hand, if the sliver is too heavy, the trumpet is depressed, the belt in either case being moved to the correct position on the cones to restore the sliver to its correct weight.

In describing the method of regulating the position of the friction belt between the cones, reference is made to Fig. 4, which shows a front view, and Fig. 5, which shows a side view, partly in section, of the parts of this motion; as most of these parts are also shown in Fig. 3 and are lettered the same in each figure, reference should be made to all three figures. The trumpet *d* is situated on a long lever d_1 pivoted at d_2 and connected at its rear end to a rod *h*, which in turn is connected to a rod h_1 running diagonally across the machine

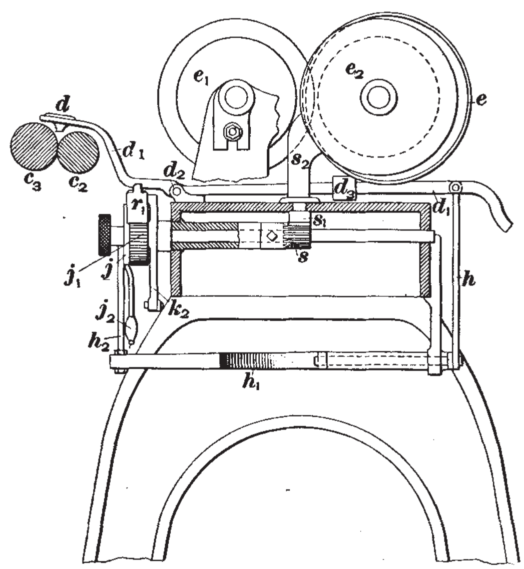


FIG. 5

from back to front, as shown by the dotted lines in Fig. 3. Connected to the rod h_1 at the front of the machine is a vertical rod h_2, which is connected to a shield *j* that nearly covers a gear j_1. The top part of this shield is cut away in order to expose the teeth of the gear j_1 for a short distance. The weight j_2 simply serves to steady the shield. Worked by an eccentric *k* is a rod k_1 that extends across the front of the machine and is connected at its other end to an upright rod k_2, which imparts a horizontal oscillating motion to the pawls r, r_1.

On the shaft with the gear j_1 is a gear s that meshes with the teeth of a rack s_1, which carries the belt guide s_2 that governs the position of the friction belt e.

The action of this mechanism is as follows. The weight d_3 is so placed on the lever d_1 that when the correct weight of cotton is passing through the trumpet d, the pawls r, r_1 rest on the outside of the shield j and the friction belt is at the center of the cones. If, however, the cotton passing through the trumpet is too heavy, the trumpet is pressed down, which action will raise the back end of the lever d_1, causing the rod h to be lifted. The rod h in being lifted brings with it the back end of the rod h_1, thus causing its forward end to be lowered, which in turn lowers the rod h_2, turns the shield to the left, and exposes the gear j_1 to the action of the pawl r. As the gear j_1 is turned, the gear s is turned, moving the rack and the belt guide in such a direction as to shift the friction belt toward the large end of the driven cone, thus causing less cotton to be fed in and decreasing the weight of the sliver delivered at the front. This allows the weight to bring the trumpet and the parts connected with it to their normal positions, causing the shield to again prevent the pawls from acting on the gear j_1. In case the sliver passing through the trumpet at the front of the machine is too light, the action of the different parts will, of course, be the exact reverse of that described. It is possible to so alter the throw of the eccentric k that the action of the pawls will give a change as small as $\frac{1}{2}$ grain to the yard for each motion of the pawls, or as great as $1\frac{1}{2}$ grains to the yard.

6. The chief criticism that can be made on a railway head is that it does not act on the stock passing through it until at least a part of the faulty stock it is supposed to correct has passed beyond the action of the evener motion. For example, the evener motion illustrated here is actuated by the trumpet, which is at the front of the machine, while it regulates heavy or light work by changing the speed of the back rolls; consequently, any sliver that is heavy or light enough to cause the trumpet to change its position will have already passed into the can before the draft of the machine is changed, and the weight of that part of the sliver at least will not be remedied. On some railway heads, the draft of the machine is changed by the evener motion altering the speed of the front rolls, but the same criticism still holds good.

The evener motion of a railway head is the most difficult part of the machine to keep in good running condition, and care should be taken that all of its parts are always clean and that all the moving parts are well oiled and carefully adjusted. There should be no backlash or slippage in any parts that will prevent the friction belt from being immediately moved when too heavy or too light a sliver is passing through the trumpet. The trumpet should be carefully regulated so that it will be in the correct position when the desired weight of sliver is passing through, and after it has once been balanced, care should be taken to keep it in its correct position.

In extreme cases in the North, there is a slight contraction in the trumpet during the night in winter, which affects the sliver slightly when first starting up in the morning, causing it to be a little lighter than the night before. This trouble is not experienced in the South, as the temperature is more even.

7. The draft of a railway head generally slightly exceeds the doublings. The gearing of the machine that has been illustrated is shown in Fig. 6, and the draft between the back roll and calender roll would be as follows with leather-covered top rolls, supposing the belt to be at the center of the cones:

$$\frac{2 \times 32 \times 24 \times 100 \times 60}{24 \times 45 \times 24 \times 30 \times 1\frac{3}{8}} = 8.619, \text{ draft}$$

8. The floor space occupied by a single railway head, such as has been illustrated, is 3 feet $3\frac{1}{2}$ inches by 5 feet 3 inches, while a double railway head occupies 6 feet $4\frac{1}{2}$ inches by 5 feet 3 inches. These dimensions allow for the space occupied by the cans placed at the back of the machine. The type of railway head illustrated weighs,

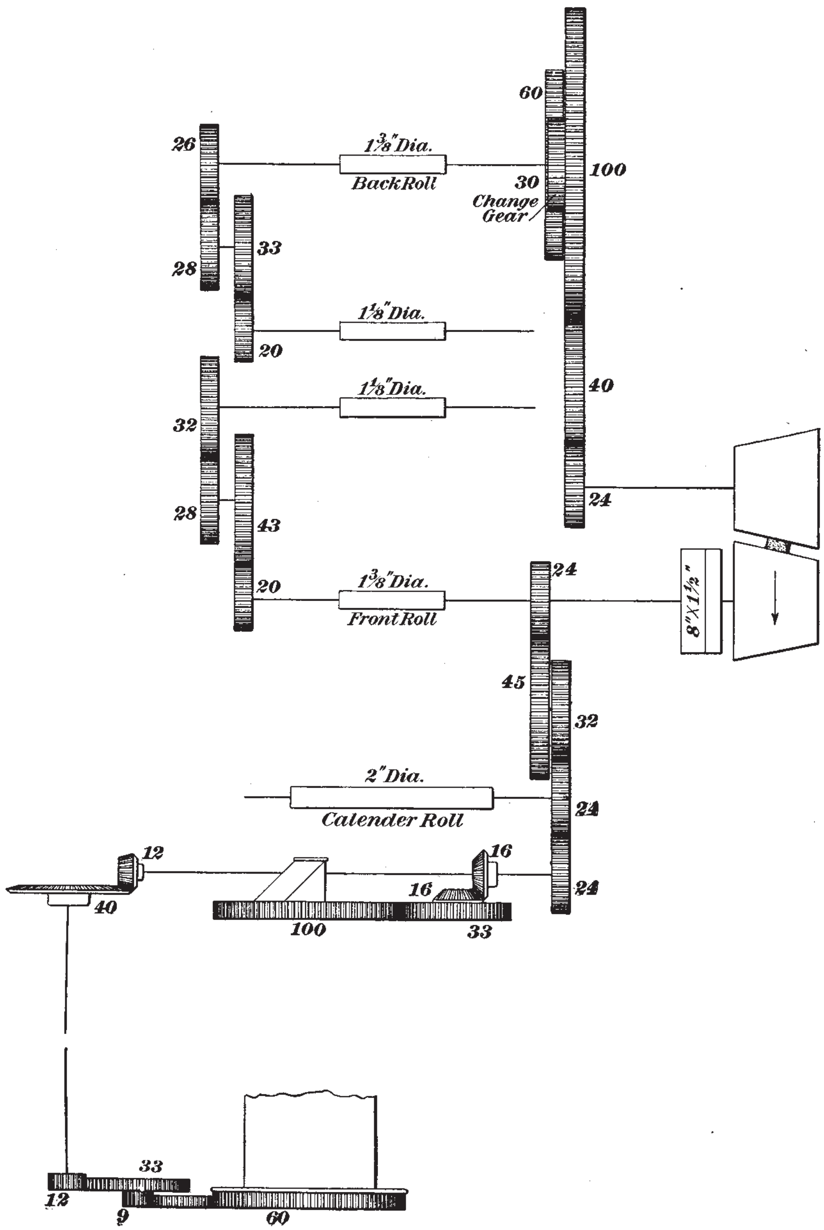

60
26
1⅜" Dia.
Back Roll
30
100
Change Gear
28
33
1⅛" Dia.
20
1⅛" Dia.
40
32
24
28
43
20
1⅜" Dia.
Front Roll
24
8" X 1½"
45
32
2" Dia.
Calender Roll
24
12
16
16
24
40
100
33
33
12
9
60

Fig. 6

approximately, 1,200 pounds per delivery, while about 1 horsepower is required to drive three deliveries.

9. The speed of the front roll of a railway head may be from 300 to 500 revolutions per minute for a $1\frac{3}{8}$-inch roll. The production at 400 revolutions with a 50-grain sliver, making an allowance of 20 per cent. for stoppages, is about 165 pounds in a day of 10 hours; with a 60-grain sliver, about 200 pounds; and with a 70-grain sliver, about 235 pounds.

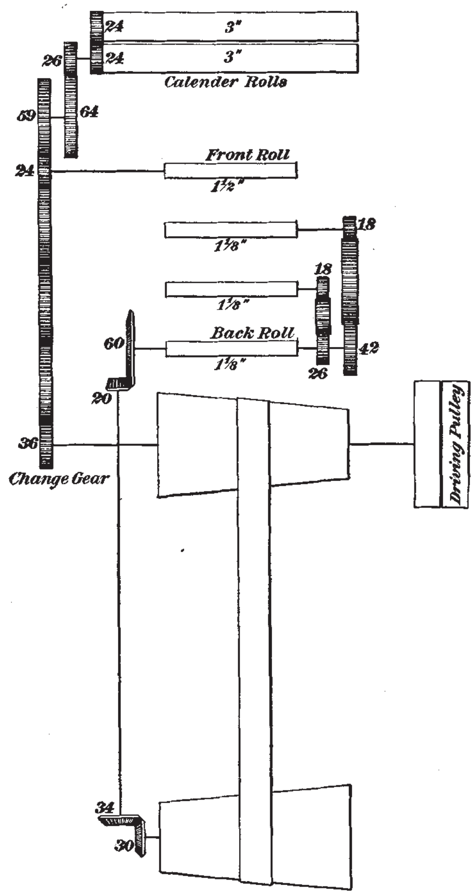


FIG. 7

10. Another type of evener motion, and one that is more commonly found on railway heads, has the cones situated under the roll beam. These cones, which are considerably larger than those in the railway head previously described, are about 13 inches long, $7\frac{1}{4}$ inches in diameter at the large end and 5 inches at the small end, although they vary in different makes. Fig. 7 shows the gearing of the machine under description. The driving pulley is on the shaft with the top cone, while on the other end of this shaft is a gear that drives the front roll by means of carriers; consequently, the front roll is always driven at a constant speed. On the end of the bottom-cone shaft is a bevel gear driving another bevel on an upright shaft that drives the back roll. The third and second rolls are driven from the back roll.

The calender rolls and coiler are driven from the front roll, while the cone belt is required to drive the second, third, and back rolls. Since these rolls are driven through the cones, their speed will depend on the position of the cone belt on the cones and, as in this motion the amount of friction on the trumpet determines the position of the belt on

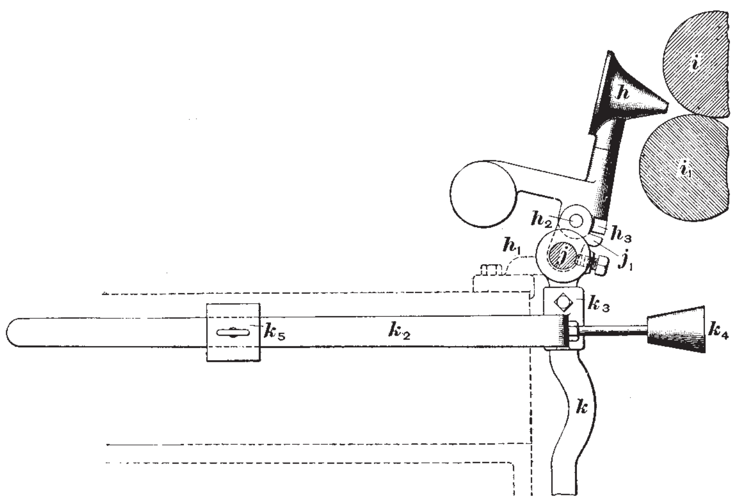


FIG. 8

the cones, the second, third, and back rolls are driven at varying speeds, in order to regulate the weight of the sliver delivered.

Fig. 8 shows a side view of the trumpet and its connections, while Fig. 9 shows two views of the cones and their connections, (*a*) being a back view and (*b*), a side view. The cone belt *a*, Fig. 9 (*a*), is moved along the cones b, b_1 by means of a shipper fork *c* that is cast with a hub c_1, which contains a coarse thread to engage with the thread of the shipper, or evener, screw c_2. Any motion given to this screw will therefore alter the position of the cone belt on the cones. The evener screw has a bearing, or support, in brackets attached to the framework and carries at one end a small gear c_3, Fig. 9 (*a*) and (*b*), that is driven by a gear *d* operated by the pawls e, e_1, which are mounted on the arm e_4 of a casting e_2 that is pivoted at e_3. Another arm e_5 is connected by means of a crank-motion to the gear *f*, which is

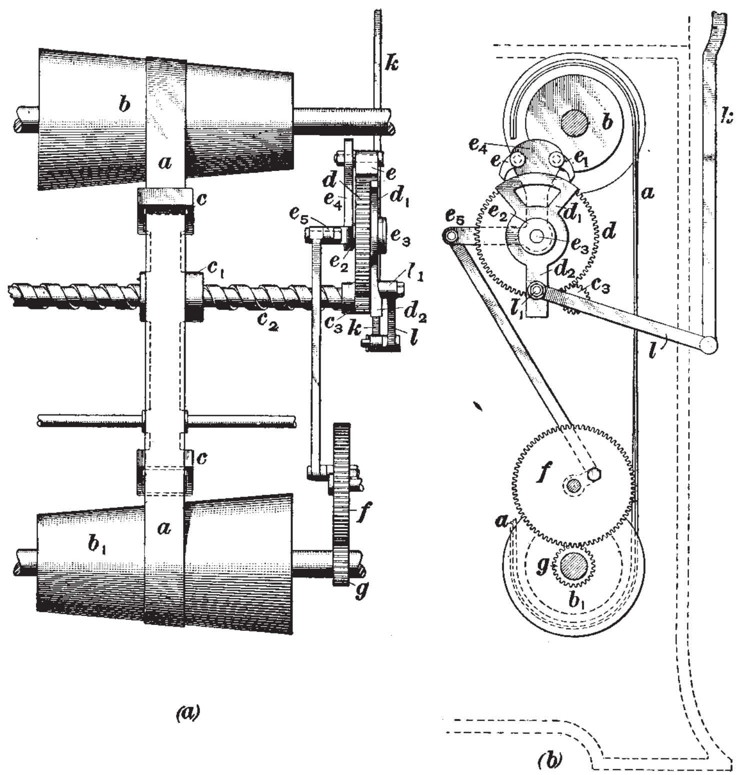


Fig. 9

driven from the gear *g* on the bottom-cone shaft. As the gear *f* revolves it causes the crank-motion to impart an oscillating motion to the bracket, or casting, e_2, thus causing the pawls to rock back and forth. When the weight of the sliver is running even, the pawls are kept out of contact with the gear *d* by means of the guard plate d_1.

Referring to Fig. 8, the bracket h_1, that is attached to the roll beam, supports the trumpet h, which is pivoted at the point h_2. Thus the amount of friction caused by the sliver passing through the trumpet is allowed to regulate the relative position of the trumpet with regard to the calender rolls i, i_1. When the trumpet is drawn forwards by the friction of the sliver, the lug h_3 on the trumpet comes in contact with the lug j_1 on the shaft j. As the amount of friction increases or decreases, the lug h_3 will exert more or less pressure on j_1, thus giving a slight motion to the shaft j.

As the arm k is setscrewed to the shaft j, any motion of the shaft will be imparted to the arm, thus causing the lower end of the arm to swing. A balance arm k_2 fastened to k by a shoulder k_3 carries balance weights k_4, k_5. The latter, which is adjustable, can be moved along the arm k_2 to regulate the weight of the sliver to be delivered. At its lower end, the arm k is connected to a rod l, Fig. 9 (b), that is connected at the point l_1 to the arm d_2, the latter being a part of the casting carrying the guard plate d_1. When the shaft j is moved by the movement of the trumpet, it will move the lower end of the arm k in or out, and thus give a rocking motion to the casting carrying the guard plate d_1, which is pivoted at e_3.

When the sliver is too light, the trumpet will fall away from the calender rolls and cause the arm k to move outwards, thus exposing the teeth of the gear d to the action of the pawl e_1, which will cause the evener screw c_2 to move the belt to the large end of the top or driving cone, thus increasing the amount of cotton fed in and making the sliver heavier. When the sliver is too heavy, the action will be reversed.

The floor space occupied by a single head of this type is about 3 feet 2 inches by 5 feet 10 inches, allowing for the space occupied by the cans at the back. The weight is about 1,150 pounds, and $\frac{3}{4}$ horsepower is required to drive it, while a double head occupies a space of about 6 feet 3 inches by 5 feet 10 inches, the weight being about 2,000 pounds, and about $1\frac{1}{4}$ horsepower is required.

Owing to the objects and construction of railway heads and drawing frames being somewhat similar, the management of railway heads resembles that of drawing frames. Information on this subject can be obtained later in this Section, where the management of drawing frames is fully dealt with.

DRAWING FRAMES

INTRODUCTION

11. The **drawing frame** is the last machine in which any extensive correction of the unevenness of the sliver takes place. It usually follows the railway head in mills that use the latter machine, except when the stock is to be combed, in which case it follows the comber. In the most common arrangement of machines, the railway head is omitted and the drawing frame follows the card, except when combed yarn is being made, when it follows the comber.

The objects of the drawing frame are: (1) to lay the fibers parallel; (2) to correct, as far as possible, any unevenness in the sliver. These objects are accomplished: (1) by drafting, which by pulling the fibers past one another tends to make them lie in a parallel position; (2) by doubling, which has a tendency to even the resulting sliver.

12. Number of Drawing Processes.—At least two processes of drawing will be found in almost every mill; that is, a number of cans of sliver that are made at the front of one drawing frame will be placed at the back of another frame and run into one sliver at the front of this second frame. The number of drawing frames through which the cotton is passed is governed by the class of work to be produced and the number of preceding processes through which the cotton has passed. If the sliver comes direct from the cards there are usually two processes for coarse counts, three for medium counts, and four for fine counts. If the sliver has passed through the railway head, each of the above number of processes is reduced by one process. If the sliver has passed through the sliver- and ribbon-lap machines and the comber, there are generally only two processes unless for very high counts, when three, and even four, are used.

When four processes of drawing are used, the machine that receives the sliver first is called the *breaker*, while the others are named in order *first intermediate*, *second intermediate*, and *finisher*. With three they are called breaker, intermediate, and finisher, while two are designated as breaker and finisher. The four processes are also known as *first*, *second*, *third*, and *fourth drawings*.

13. Arrangement of Drawing Frames.—Drawing frames are generally placed directly in front of each other, the usual method being to place the cans from the card, comber, or railway head, as the case may be, at the back of the breaker drawing frame, and as the sliver is delivered at the front, the full cans are taken and placed at the back of the next drawing frame, this system being followed throughout the processes of drawing. Where the floor space is limited, the frames may be placed in a line instead of in front of each other, in which case the alternate drawing frames face the same way. For instance, where three processes of drawing are used, the cotton is passed through the breaker drawing frame situated at the end of the line. The cans from the breaker are then taken to the intermediate, which is facing in a direction opposite to that of the breaker drawing frame, while the cans from the intermediate are taken to the third drawing frame, which is at the other end of the line and has its delivery on the same side as the delivery of the breaker drawing frame.

GENERAL CONSTRUCTION

14. Fig. 10 shows a view of the front of a drawing frame, the construction of which very closely resembles that of a railway head, with the exception that no evener motion is attached. One complete drawing frame is called a **head**. Several heads, however, may be connected by one shaft and

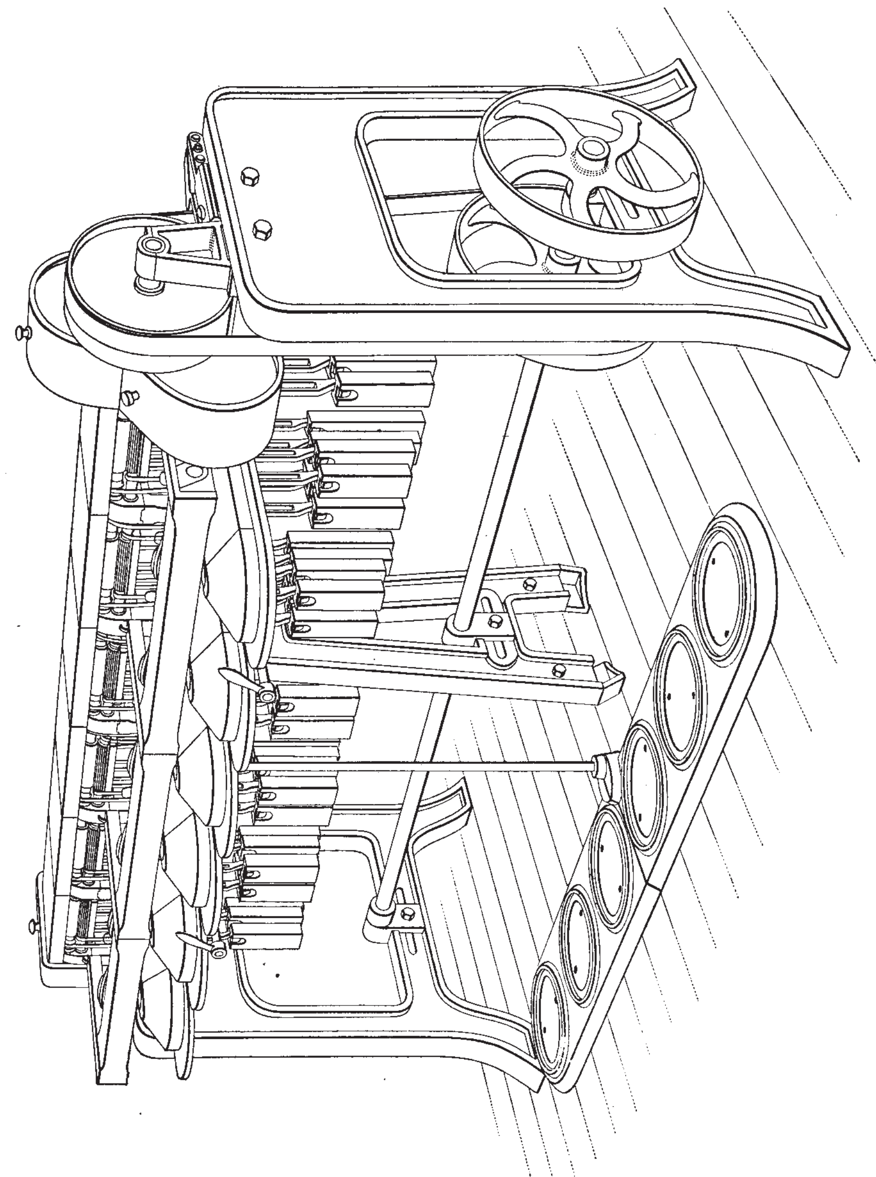
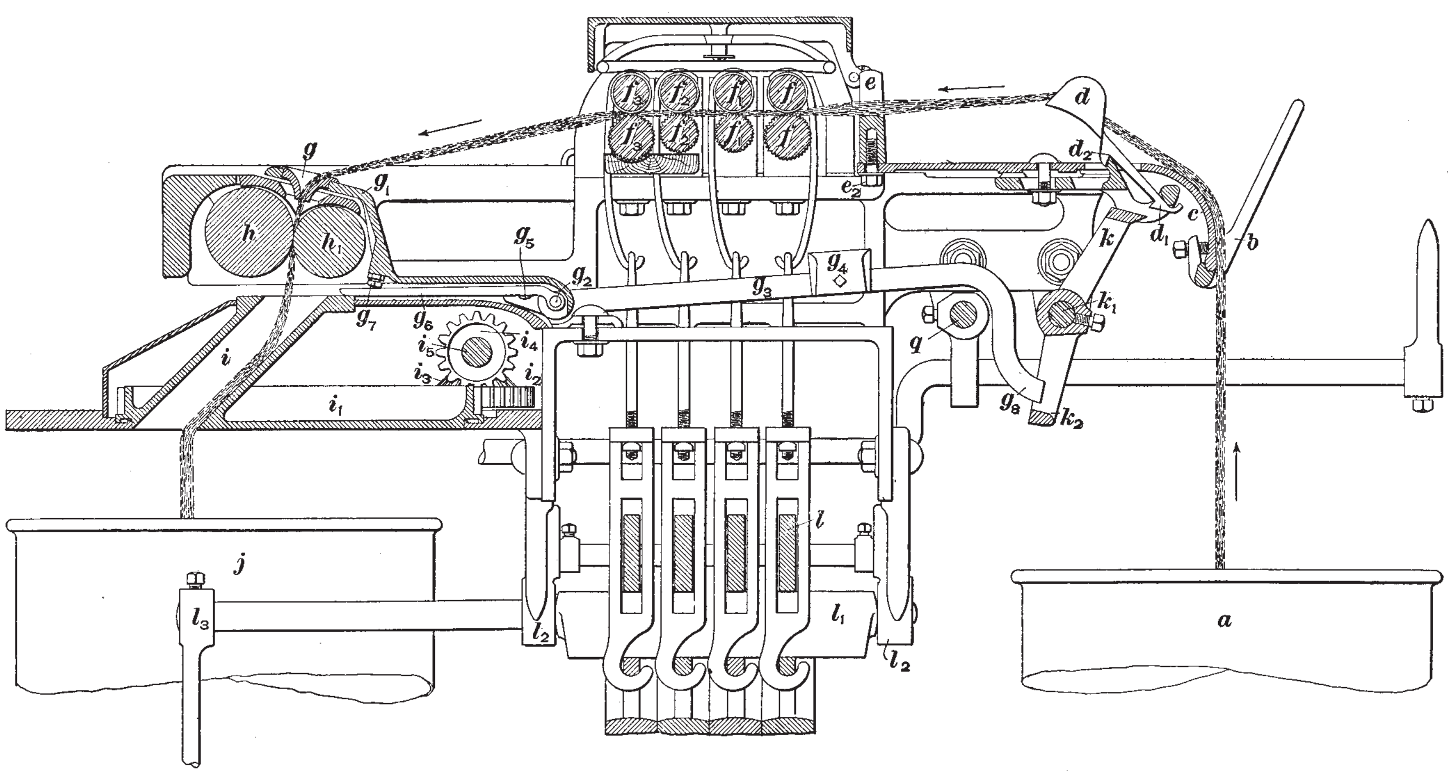


Fig. 10

still be called a drawing frame, or more accurately, a *line of drawings*. Each head consists of a number of deliveries, while each delivery has its own coiler and its own set of drawing rolls, which receive a number of slivers at the back, subject them to the desired draft, combine them into one sliver at the front, and deposit it in a can. For example, if four, six, or eight slivers side by side are passed through four sets of rolls and combined at the trumpet at the front of the machine into one sliver, that part of the machine is called a delivery, and a number, or set, of these deliveries is called a head.

A line of drawings usually consists of three heads, while a head may contain from four to eight deliveries. Fig. 10 represents a drawing frame with one head of six deliveries; if, however, the lower shaft were extended and another pulley mounted on it to drive another set of gearing, which in turn governed six other deliveries, it would represent a line of drawings consisting of two heads with six deliveries each.

Fig. 11 represents a cross-section of one delivery of the machine shown in Fig. 10; the arrows in this figure indicate the direction in which the stock passes through the machine. Usually six cans similar to *a* are placed behind each delivery, each sliver passing through the guide *b*, over the plate *c*, and the spoon *d*, there being one spoon for each sliver. The slivers next pass over another guide plate *e* and then to the four sets of rolls f, f_1, f_2, f_3, where the necessary draft is inserted. From these drawing rolls the slivers pass to the trumpet *g*, where they are combined into one, then through the calender rolls h, h_1, through the coiler tube *i*, and to the can *j*. The guide *b* consists of a number of fingers, between each two of which a separate sliver passes; in this manner the slivers are prevented from licking or splitting. The plate *c* is highly polished, thus preventing the fibers from adhering to it, while it also forms a cover for the working parts beneath. The guide *e* consists of a casting carrying two projecting lugs, the distance between which is about equal to the width of all the slivers passing through the



a
b
c
d
d_1
d_2
e
e_2
f
f_1
f_2
f_3
g
g_1
g_2
g_3
g_4
g_5
g_6
g_7
g_8
h
h_1
i
i_1
i_2
i_3
i_4
i_5
j
k
k_1
k_2
l
l_1
l_2
l_3
q

Fig. 11

delivery. This guide is secured to the plate e_1 by two screws similar to e_2.

The drawing rolls are of the ordinary type; leather-covered top rolls are shown in this illustration, although for coarse work metallic rolls are generally preferred. The length of the top rolls for each delivery varies from 15 to 18 inches, while each bottom roll is generally made in one length for the whole head or, as in more modern construction, in sections pieced together so that they revolve as one roll. The top rolls are weighted in the manner usually adopted for weighting leather-covered rolls on drawing frames. The weighting arrangement is equipped with a weight-relieving motion, as shown at l, l_1, l_2, l_3. The draft inserted in the sliver by these rolls, though not arbitrary, is usually about equal to the number of doublings, thus producing a sliver at the front of about the same weight as each end fed in at the back.

The trumpet g is supported by the lever g_1 and derives its name from being trumpet-shaped. It occupies a nearly upright position, having the smaller part of the hole at the delivery end. The sliver enters the larger end of the trumpet and is condensed by being drawn through the smaller part. The calender rolls h, h_1 are smooth steel rolls extending along the machine parallel to one another, and to the front rolls. The rear roll h_1 is about 2 inches in diameter, while the front one h is slightly larger. These rolls are solid and self-weighted, and serve to condense the sliver and draw it through the trumpet g. Their surface speed is just sufficient to prevent any slackness of the sliver as it comes from the front rolls. The coiler connections at the front of the drawing frame are very similar to those attached to the card. The oblique tube i is connected to the plate i_1, which has teeth on its rim and is driven by the gear i_2; the gear i_2 is compounded with the bevel gear i_3, which is driven by the bevel gear i_4 on the shaft i_5. This shaft extends the entire length of the machine and has at each delivery a gear similar to i_4, which drives the gears that give motion to the coiler for that delivery.

15. The diameters of the cans into which the sliver is delivered at the front vary from 9 to 12 inches, advancing by inches, those generally used being 10 inches in diameter. In former years they were made wholly of tin, but those now used are generally made of a paper pulp, which has the advantage of being lighter and cheaper. Although lighter, they are more durable than the metal cans, and seldom show the principal defects of the latter type of can; namely, ragged edges and loosened or detached bottoms.

STOP-MOTIONS

16. The principal parts of a drawing frame that call for a somewhat more detailed description are those connected with the various **stop-motions.** If one of the cans at the back should become empty or if one of the slivers should break before reaching the back rolls and the machine should continue to run, the reduced weight of the sliver delivered at the front would tend to produce unsatisfactory work at the later processes. As it is of vital importance to have the sliver that comes from the drawing frame of a uniform weight, devices are applied to stop the machine when an end breaks or runs out at the back. Additional motions are also applied to stop the machine when the sliver breaks between the front rolls and calender rolls, when the cans at the front of the machine become full, and in some cases when any part of the cotton laps around the calender or the drawing rolls. There are two general classes of stop-motions applied to drawing frames—*mechanical* and *electrical*. As the mechanical stop-motions are older and more commonly met with, they will be described first.

MECHANICAL STOP-MOTION

17. The method adopted to automatically ship the belt from the tight to the loose pulley and thus stop the machine will be described with reference to Figs. 11, 12, and 13, Fig. 12 being a plan view and Fig. 13 a sectional elevation, taken on line $x x$ of Fig. 12. The driving belt runs on the tight and loose pulleys u, u_1, Fig. 12, and is governed by the belt guide r, which is fastened to the rod q and extends outwards above the spring s and shaft k_1. Working loosely on

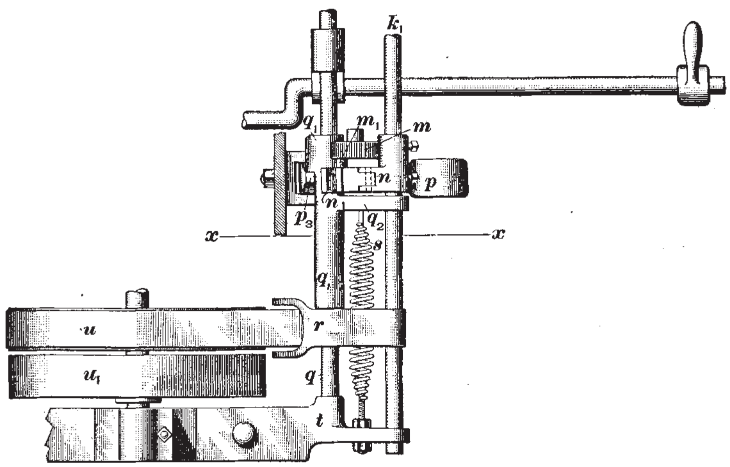


FIG. 12

this rod is the casting q_1, which is kept pressed against the belt guide by means of the spring s, one end of which is fastened to the bracket t, while the other end is connected to the arm q_2 of the casting q_1, this arm working loosely on the shaft k_1. By this means the casting q_1, unless held in position by some other mechanism, will force the belt guide r in such a direction that the belt will be shipped from the tight pulley u to the loose pulley u_1.

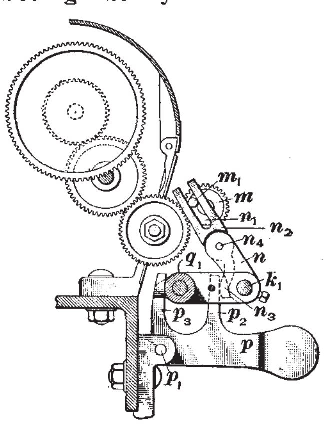


FIG. 13

The method adopted to hold the casting q_1 in position when the belt is on the tight pulley is more clearly shown in Fig. 13. Pivoted at the point p_1 is the casting p, which carries two arms p_2, p_3. When the machine is started by means of shipping the belt from the loose to the tight pulley, the belt guide *r*, Fig. 12, carries the casting q_1 along with it as the shipper and rod move. The projection on the casting q_1 is beveled off on the side that comes in contact with p_3 when the belt is being shipped to the tight pulley. Thus the outer end of *p* is raised until the projection on q_1 passes the arm p_3, when it falls and allows p_3 to hold the casting securely in position. Set-screwed to the shaft k_1 is the knuckle-jointed lever *n*. The upper end n_2 of this lever contains a slot n_1, in which works a pin m_1, which is a part of, and revolves with, the gear *m*. Thus, as the gear revolves, the pin m_1 moves the upper end of the lever alternately backwards and forwards, which imparts an oscillating motion to the shaft k_1, provided that this shaft is free to oscillate, since under these conditions the fulcrum of the lever will be at the point at which it is attached to the shaft. If, however, the shaft k_1 is prevented from oscillating, the fulcrum of the lever will be at the point n_4, and as the part n_2 is forced out by the pin m_1, the arm n_3, which is a part of n_2, will be forced against the arm p_2, pushing up the casting *p*, since it swings on p_1, and allowing the arm p_3 to release the casting q_1.

18. Drawing frames equipped with the **mechanical stop-motions** automatically stop when the sliver breaks or runs out at the back, when the sliver breaks in front, and when the cans at the front become full.

The manner in which the machine is stopped when a sliver at the back breaks or runs out is described with reference to Figs. 11, 12, and 13. Referring to Fig. 11, it will be noted that each sliver passes over a guide *d*, known as a **spoon,** that is supported at the point d_2 but is free to swing up and down, its lower end being slightly heavier than its upper end. The weight and tension of the sliver in passing over the spoon is sufficient to lower the upper end of the spoon. Should the sliver break or run out, however, the spoon will be released, its lower end will drop, and the projection d_1 will engage with a projection on the arm *k*, which being set-screwed to the shaft k_1 oscillates with that shaft. As the projection d_1 engages with the projection on the arm k, the shaft k_1 is prevented from oscillating, thus causing the arm n_3, Fig. 13, to be forced against p_2, bringing p_3 out of the path of q_1, and allowing the spring s, Fig. 12, to force the casting against the belt guide, shipping the belt from the tight to the loose pulley and stopping the machine.

19. The mechanism that stops the machine in case the sliver breaks between the front rolls and calender rolls is as follows, reference being made to Fig. 11. A lever g_3 that is pivoted at g_2 carries a weight g_4 that tends to lower the outer end g_8. At its forward end the lever g_3 carries a lug g_5 that bears against the lever g_6, which in turn bears against an adjusting screw g_7 carried by the lever g_1 that supports the trumpet g. In case the sliver is running through the trumpet properly, the weight and tension of the sliver is sufficient to cause the lever g_1 to hold down the lever g_6; and since this lever rests on the lug g_5, the weight g_4 will be prevented from lowering the outer end g_8 of the lever g_3. On the other hand, if the sliver breaks at the front of the machine, the outer end of the lever g_3 is forced down by the weight, and the part g_8 comes in contact with the front of the projection k_2 on the arm k, which action prevents the shaft k_1 from oscillating and stops the machine in the manner previously described.

20. When the can j, Fig. 11, is filled, the sliver gradually presses the plate i_1 up, forcing the upper end of the tube i against the lever g_6, which allows the weight g_4 to force g_8 into the path of the projection k_2, thus stopping the machine in the same manner as when the sliver breaks at the front.

ELECTRIC STOP-MOTIONS

21. Introductory.—A principle that has been extensively applied to drawing frames is that of automatically stopping the machine through the use of electricity. But in considering **electric stop-motions** it will first be necessary to give some attention to certain laws of electricity that make it possible to apply this class of stop-motions to cotton-mill machinery.

The electric current must always be generated by some suitable apparatus, which for stop-motions on drawing frames generally consists of a dynamo placed above the frames. If suitable connections are made, an electric current will flow from one part of the dynamo through the connections and back again to the dynamo, forming what is known as a *circuit*. In order to have a current of electricity, there must always be a complete route, or circuit, from the source of the electric current through the various connections, and back again to the place from which it started. If there is more than one route that the current can follow, it will divide into two or more separate currents, but the maximum current will always flow through the path of the least resistance. If for any reason the circuit is broken, the flow of electricity will stop. The two ends, at the place where the circuit is divided, are known as *terminals*, one of which is termed positive and the other negative. That terminal from which the current would flow, if connected with the other terminal, is called *positive;* while the terminal into which the current would flow from the positive terminal is called *negative*.

Substances are divided into two classes as regards the resistance they offer to the flow of electricity, and are known as **conductors** and **non-conductors**, the former consisting of those substances through which an electric current can readily pass, while the latter comprises substances that offer great resistance to the flow. When two conductors come in contact, the current readily flows from one to the other. If it is desired to prevent this flow, the bodies must be *insulated;* that is, they must be separated by some substance that is a non-conductor. Metals are good conductors, while glass, silk, cotton, etc. are poor conductors. Thus, if a current of electricity is passing from one piece of metal to another, as, for instance, the top and bottom rolls of a drawing frame, and some non-conducting substance, such as cotton, is brought between the points of contact of the two pieces of metal, the circuit will be broken and the current stopped.

If a piece of soft iron is surrounded by coils of wire through which an electric current passes, the iron becomes magnetized and has the power of attracting certain other metals, such as iron and steel. A piece of iron magnetized in this manner is known as an *electromagnet*.

22. Operation of the Electric Stop-Motion.—Fig. 14 is a section of a drawing frame equipped with the electric stop-motion, while Fig. 15 is a portion of a front view of the same machine. The electric current passes from the dynamo through the rod a into and through the several parts of the machine and leaves it through the rod a_1 to enter the dynamo. As far as possible, the path that the current takes through the drawing frame has been indicated by means of arrows. Otherwise, those parts that are connected with the positive terminal of the dynamo are indicated by being cross-hatched in two directions, when in section, and by a dark surface shading, when not in section. Those connected with the negative terminal are shown in the ordinary manner.

It will be noticed that, with few exceptions, the whole frame of the machine with all the rolls, except one, are negative; this positive roll is marked m. Among the positively charged parts the most important are the cover p_1, back plate k_3, connecting piece k_2, roll m, rod k_1, and springs t, s.

It is of importance that the positively charged parts shall be electrically insulated from those negatively charged. This is attained by interposing plates or disks of insulating material between them. The presence of these insulating parts at any place is indicated in the drawings by means of full black surfaces. The action of the stop-motion depends on devices by means of which connections are made between the insulated parts, in order that an electric current may pass from one to the other.

The path of the electric current through the machine is as follows: From the rod a through the electromagnet b, b_1, then through the parts l, j, k, and the rod k_1 that extends across the frame. Electrically connected with this rod are two springs s, t, these springs being duplicated at each

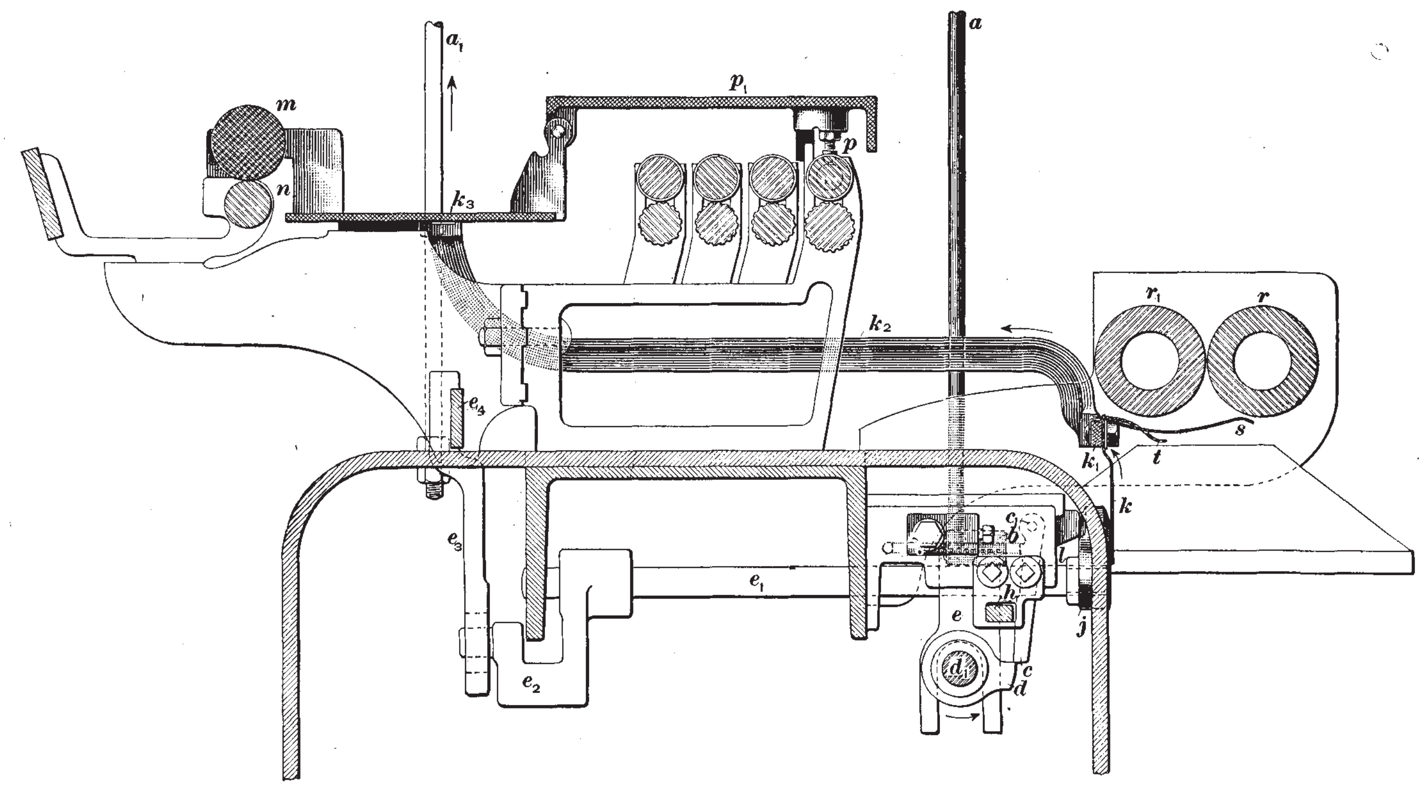


FIG. 14

delivery. From the rod k_1, the current passes through the connecting piece k_2 that extends to the back of the frame and forms a connection with the back plate k_3. From here the current passes to the cover p_1 and roll *m*.

It should be noticed that as long as the various parts are kept insulated from each other no electric current will pass through. It is only in case any one of the insulating plates is, as it were, bridged over that a current will flow. The current in all cases makes its start through the electromagnet *b*, b_1; this will therefore always be set in action first and will attract the small finger *c*. As this finger is pivoted at c_1 its lower part swings over, coming in contact with a dog *d* that is a portion of *f*, which, although loose on the coiler shaft d_1, ordinarily revolves with it, being driven by frictional contact with the part *g*, which revolves with the shaft d_1, since the surfaces of these parts that are in contact are at an angle with the shaft. The part *g* is on a keyway on the shaft d_1; consequently, it must revolve with the shaft, but is capable, however, of being pushed lengthwise of the shaft. As *d* and *f* are stopped by the finger *c*, the part *g*, continuing to revolve, will be pushed lengthwise of the shaft because of the shape of the parts *f*, *g*. This action of *g* throws the lever *e* to the right, which, since *e* is fastened to the shaft e_1, gives the latter a partial revolution. Setscrewed to the shaft e_1 is a casting e_2, an arm of which works in a slot in the upright rod e_3, which controls the shipper rod e_4 to which the belt shipper is attached. As the shaft e_1 is turned by the lever *e*, it throws the casting e_2 over to one side, moving the rod e_3 and, consequently, the shipper rod e_4 in such a direction that the belt will be shipped from the tight to the loose pulley.

The action of the rod *h* should be noted in this connection. As the lever *e*, to which it is fastened, is forced over by *g*, it brings with it the rod *h*, which is so shaped that it forces the finger *c* out of contact with the revolving dog *d*, thus placing these parts in their initial positions.

Drawing frames equipped with the electric stop-motion shown in Figs. 14 and 15 stop when the sliver breaks or

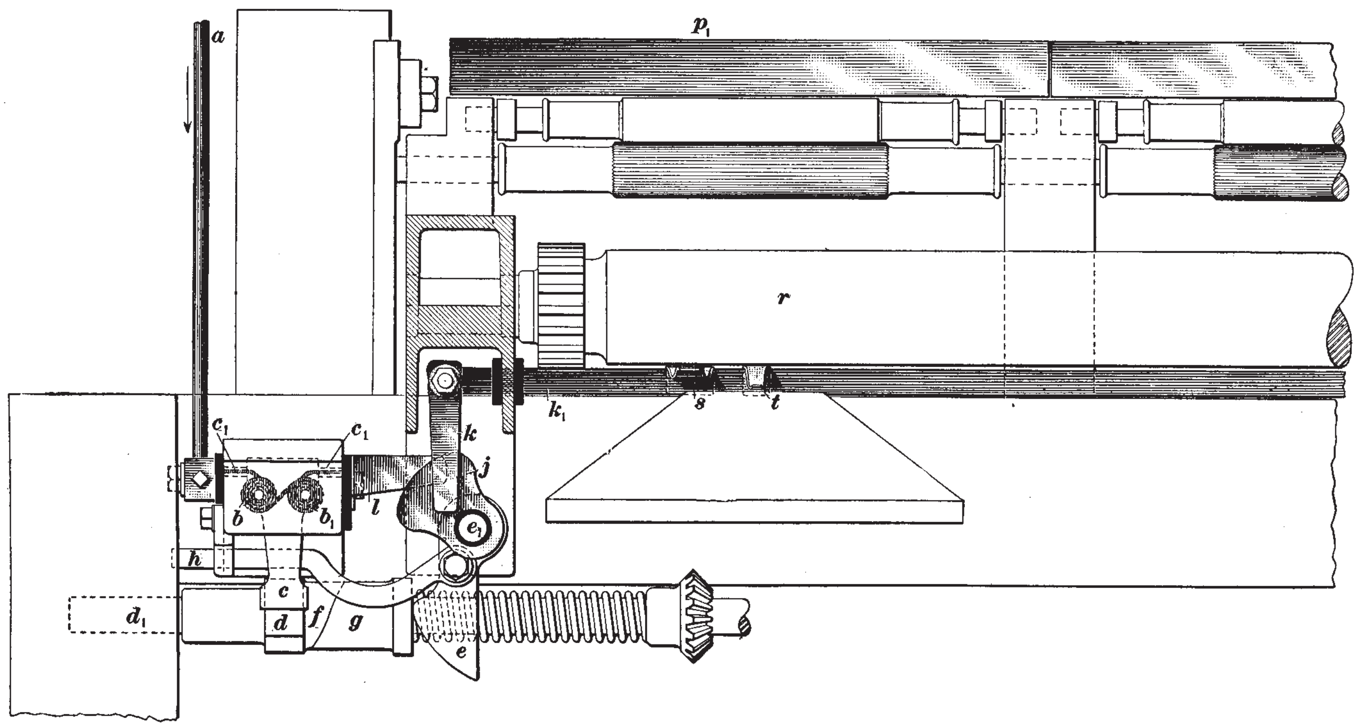


FIG. 15

runs out at the back, when laps form on the top or bottom front drawing rolls, when the sliver breaks in front, and when the cans at the front become full.

23. The rolls *m*, *n* are known as the *top* and *bottom preventer rolls*, respectively; they are also sometimes called *detector rolls*. They are frequently found applied to both railway heads and drawing frames, and are considered an advantage both in working the stop-motion when an end breaks or runs out at the back and in making a piecing at the back. With these rolls, the tension on the sliver is more even, thus keeping the spoons in their correct position and causing the stop-motion to act more quickly. A piecing at this place is desirable since, as it does not require tall help to run the frames, small boys, girls, or women may be employed, whereas when the piecing must be made close to the back rolls taller help is required.

As shown in Fig. 14, the roll *m* is positive, while *n* is negative; consequently, if these rolls are allowed to come in contact, a circuit will be formed and the machine stopped. The lower roll *n* extends the entire length of the machine, while the top roll *m* is made in shorter lengths, there being one of these rolls for every two slivers at the back. As long as the slivers are passing between these two rolls they are prevented from coming in contact. Should either sliver break or run out, however, the end of the roll under which it passes will drop and, coming in contact with the lower roll *n*, will form a circuit and stop the machine. By referring to Figs. 14 and 15, it will be seen that the drawing rolls are negative and the covers positive. The front top roll rests in bearings and is capable of being raised if any obstruction comes between it and the bottom roll. Fastened to each cover of the drawing frame are two adjustable screws, similar to *p*, that are so set that they will not come in contact with any part of the rolls so long as the cotton is running through the machine properly. If the cotton laps around either the top or bottom roll, the increased size of the bulk of cotton between the two rolls will cause the top roll to be raised in its bearings until it comes in contact with one of the screws *p*, when a circuit will be formed and the machine stopped.

The back calender roll r_1 extends the entire length of the frame, while the front calender roll *r* is made in sections, each of which is only long enough to serve for two deliveries and rests in inclined bearings. As long as the cotton is passing between the rolls, the thickness of the sliver will push the roll *r* up slightly in its bearings. However, should either sliver that passes between any one of the front calender rolls and the back calender rolls break, the end of the front calender roll that was supported by that sliver will drop and come in contact with the spring *s*. As one of these parts is negative and the other positive, a circuit will be formed and the machine stopped.

As the can at the front of the machine becomes full, the pressure of the sliver in the can raises the top of the coiler until it comes in contact with the spring *t*, when the machine will be stopped, owing to a circuit being formed by the contact of these two parts, one of which is positive and the other negative.

GEARING

24. Each head in a drawing frame is driven separately from any other head in regard to its individual gearing, but all the heads are driven by what is called the lower or main shaft, which runs underneath the frame; this shaft is shown in Fig. 10, and also in Fig. 16, which is a plan of the gearing of the machine similar to that shown in Fig. 10. At each head is a pulley that is connected with a tight-and-loose pulley on the front roll of that particular head by means of an open belt. The lower or main shaft is driven from the main shaft or countershaft of the room.

Referring to Fig. 16, a gear of 24 teeth on the front roll drives, by means of suitable gearing, the calender rolls and the coiler connections. Another gear of 24 teeth, situated on the front roll, drives the back roll. The gear of 26 teeth on this back roll drives the third roll. Thus, the draft between these two rolls is constant, provided that the gears connecting the rolls are not changed. The wide-faced gear of 60 teeth on the back roll drives, by means of a carrier, the gear *m*, shown in Fig. 13 but not in Fig. 16. The gear

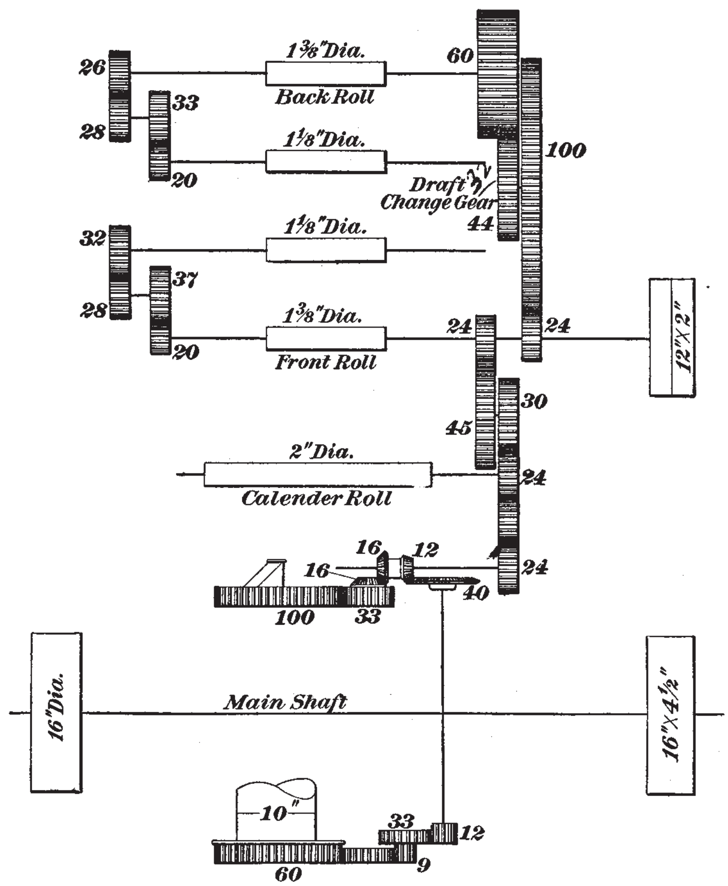


FIG. 16

of 20 teeth on the front roll drives the second roll, and consequently the draft between these two rolls is constant, provided that the gears connecting them are not changed. Thus it will be seen that the break draft of this machine comes between the second and third rolls.

The draft of a drawing frame with common rolls, and geared as shown in Fig. 16, would be as follows, the draft being figured from the calender roll to the back roll:

$$\frac{2'' \times 30 \times 24 \times 100 \times 60}{24 \times 45 \times 24 \times 44 \times 1\frac{3}{8}''} = 5.509$$

MANAGEMENT OF DRAWING FRAMES

25. The arrangement of the cans at the back of the frame is an important point to be considered. The usual practice is to place full cans of sliver behind the breaker drawing frame. This is all right for the breaker, as there is never the same amount of sliver in the different cans, due to the cards or combers being separate; therefore, the cans will be emptied at different intervals, thus insuring that no two piecings will come together and that the frame will not remain stopped for any length of time waiting for the attendant to piece more than one end. This, however, is not the case with the first and second intermediates and finisher, since in this case if a sliver breaks the whole head is stopped, and consequently when one can is full they are all full, if empty cans were inserted at the front at the same time; and if they are all taken out at once and fed immediately to the next machine at the same time, it is evident that they will all be emptied at about the same time, necessitating several piecings in a short length of sliver. To remedy this defect, it is better to feed the frames in sections so that some of the cans at the back of any drawing frame will be full, others three-fourths full, still others half full, and so on.

26. The relative weight per yard of the sliver delivered to the weight per yard of each sliver fed, depends on the relation of the number of ends fed, or doubled, at the back of one delivery to the total draft of the machine. It is the general plan in the drawing frame not to have the draft exceed the doubling. That is, if 6 ends are put up at the back of each delivery, the draft is not generally more than 6.

27. Both top and bottom metallic rolls should receive careful attention to prevent licking, which is frequently caused by the flutes collecting and holding the dirt. On this account metallic rolls require cleaning oftener than common rolls.

Where common top rolls are used, they should be relieved of the weights if a stoppage occurs for more than 48 hours. This helps to prevent the leather top rolls from becoming fluted.

28. Before the leather top rolls are put into the drawing frame, they must be varnished, the frequency of subsequent varnishing depending on the varnish used, the weight of sliver produced, and the speed at which the rolls are run. Any roughness on the surface of these rolls causes licking, and careful attention should therefore be given to them, as licking produces waste, light sliver, and loss in production through stopping the head to remove roller laps. Any top roll that shows impressions of the flutes of the bottom steel rolls on the leather, or becomes fluted, as it is called, should be immediately recovered.

29. Sometimes in changing from coarse to fine work, or, in other words, from a heavy to a light sliver, the trumpet must be changed. This is on account of the sliver being so light and the small end of the trumpet so large that the friction and weight of the sliver will not be sufficient to keep the trumpet in its proper position, thus causing the frame to be stopped continually.

30. There should be very little waste made at the drawing frame, so that if a large amount is made it may be taken as an indication that some part of the frame is not properly adjusted, or that the operators are not attending to their work as they should. The drawing frames should be kept free from dirt, dust, and short fiber. Oil should not be allowed in places where it is not required. In order to insure clean work the tenders should wipe or brush the frames about every two hours; this takes very little of their time but greatly helps to improve the quality of the yarn. A thorough cleaning of all parts of the frame should take place twice a week.

All bolts, nuts, screws, etc. should be looked after and kept tight. Stop-motions should be kept in working order, as otherwise a great deal of bad work will result. All quickly moving parts, such as the top and bottom rolls, lower shaft, etc., should be oiled twice a day, and every moving part of the frame should be oiled once a week, care being taken not to get the oil on any surrounding parts that do not require oiling. The boxes of the lower shaft should be partially filled with tallow.

31. Weighing the sliver at the finisher drawing frame is a very important matter and should be done at least twice a day, while in fine work three, and sometimes four, times a day is advisable. If the weight of the sliver is properly adjusted at this point, there will be fewer changes in the subsequent processes. It is also best to have the stock running evenly as early as possible. The sliver is generally prepared for weighing by what is known as the measuring board, which usually consists of two boards 6 inches wide and 36 inches long hinged together on one of the side edges. One head of the frame is stopped and the cans at the front taken out. After it has been ascertained that all the ends are up at the back, the head is again started and run until about $1\frac{1}{2}$ or 2 yards has been delivered. The machine is then stopped and the ends of the slivers gathered together with one hand, while with the other hand they are broken off at the top. The slivers are now placed on one of the measuring boards, care being taken to have each sliver straight; the boards are then closed and the ends of the slivers projecting over the two ends of the board cut with a pair of shears or a sharp knife. The slivers are now taken from the board and weighed on a pair of scales. This weight is divided by the number of deliveries in a head, the result being the average weight of a sliver for that head. A variation of more than 2 grains over or under the standard for each sliver should not be allowed, and if this amount of variation is on the same side of the standard for two weighings, the draft gear should be changed. Sometimes the sliver from each delivery is weighed separately instead of being taken as in the method previously described.

32. In connection with drawing frames equipped with an electric stop-motion care should be taken that all the metallic connections are screwed tightly together, in order that a circuit may be made and the machine stopped under any of the conditions previously mentioned. The preventer rolls should be kept free from oil, since if sufficient oil at any time collects on either of these rolls, it will form a film over the surface of the roll, and if under these conditions an end should break, thus allowing the top roll to come in contact with the bottom roll, the frame would not stop, as oil is a non-conductor and prevents the flow of the current. The contact springs between the calender rolls and coiler top should be kept clean and free from oil, in order that the current may not be prevented from flowing from one part to another when they come in contact. Care should be taken that positive and negative parts of the frame do not come in contact with each other when the cotton is passing properly through the machine, since the current will then return to the dynamo without passing through the proper channels, in which case the current is said to be *short-circuited*. Under this condition the stop-motion will not accomplish its purpose, and one of the two following things will happen: If the frame becomes short-circuited before the current reaches the magnet box, the stop-motion will not operate when an end breaks, since the current will be returned through the frame to the dynamo without passing through the magnet box. If the frame becomes short-circuited after the current has left the magnet box, the machine will be stopped, although the sliver may be running through the machine correctly. In order that the stop-motion shall operate quickly, which is very desirable, the finger that comes in contact with the revolving dog should be within $\frac{1}{16}$ inch of the dog when the machine is running.

33. Care of Drawing Frame.—The steel rolls should be carefully scoured at least once a month. Leather top rolls should be examined periodically so that the frames will not continue to run with rolls that are fluted, channeled, or otherwise defective. Steel rolls that are not running true may occasionally be found by raising the top clearers and noticing whether any of the top rolls are jumping. The top rolls should be examined frequently to see that the varnishing is not neglected. The back of each frame requires watchfulness on the part of the one in charge to see that the right number of ends are being fed. Spoons should be examined periodically to see that they are well balanced and that the lower end drops immediately when the end of the sliver breaks or even when it comes through very light; the spoons should always work easily. Bad piecings should be looked out for, more especially those that are too long. If the drawing frame piecing is made 6 inches too long at the back, that amount of extra material will extend through many yards of the finished yarn. The guides at the back of the drawing frame should always be arranged so that the ends at the back will be separated as widely as the rolls will allow; bad drawing results if the ends are not spaced sufficiently far apart and one end rides on another.

Occasionally, drawing-frame tenders have been known to pass cans of material forwards without putting it through the frame. Where the frame that is skipped has a draft equal to the number of doublings, this does not make much difference to the ultimate weight of the yarn, but if the frame is one where a considerable alteration is made in the weight of the sliver, the omission becomes serious and causes irregular work. In any case, the practice should not be allowed.

The covers over the rolls should be examined daily by the one in charge—or even several times a day—in order to make sure that the tenders are picking off the clearer waste; this should be done every hour, for if the waste is left on the clearer, it is apt to be drawn forwards with the sliver and cause dirty slubs in the roving and unsatisfactory work at the future processes. The tenders should not be allowed to run the cans too full.

It should be remarked in connection with the drawing frame, as in connection with almost every other machine in the mill, that high speeds do not always pay. There is a limit to the capacity of every machine, beyond which the work done deteriorates, or the excessive number of stoppages, through breakages and stock running out, prevents any advantage being gained by an excessively high speed.

In some cases, experiments have been made in connection with drawing frames in the direction of using fewer processes of drawing, in order to save labor cost. Drawing is not an expensive process as regards labor cost, and for this reason it is not advisable to use less than two drawing frames for numbers lower than 16s, unless the railway head is also used; not less than three drawing frames, or one railway head and two drawing frames, for numbers 16s to 70s; and not less than four processes of drawing for numbers finer than 70s, unless the sliver-lap and ribbon-lap machines are used in connection with the comber. These arrangements are not absolute and depend on the quality of the yarn desired.

In other cases, experiments have been made with a view to using extra processes of drawing so as to reduce the number of processes of fly frames where the labor cost is higher, but satisfactory results have not always been obtained.

34. The **floor space** occupied by a drawing frame similar to the one described and consisting of one head of six deliveries, is about 10 feet 6 inches by 5 feet 8 inches, allowing sufficient space for six cans at the back of each delivery. Drawing frames weigh, approximately, 700 pounds per delivery and, although the horsepower required to drive a frame varies somewhat with the class of work being run, it may be stated as a fair estimate that between four and five deliveries require 1 horsepower.

The speed of the front roll of a drawing frame may be from 250 to 700 revolutions per minute for a $1\frac{3}{8}$-inch roll. The production at 350 revolutions per minute with a 50-grain sliver, making an allowance of 10 per cent. for stoppages, is about 168 pounds in a day of 10 hours; with a 70-grain sliver, about 235 pounds; and with an 85-grain sliver, about 285 pounds.

35. It should be understood that the machines that have been described do not cover all the makes of railway heads and drawing frames, nor do the stop-motions and evener motions described in connection with the machines illustrated include all the different methods adopted to accomplish the same objects. However, it may be stated that the general principles of the different motions will be found to be similar, and if the descriptions given are fully understood, there should be no difficulty in tracing the action of any part of these machines that may be met with under different circumstances.

COMBERS

(PART 1)

COMBING EQUIPMENT

INTRODUCTION

1. When a cotton yarn is to be manufactured, it is first essential to select the grade of cotton that is suitable for the quality of yarn desired, after which it is necessary to determine the different processes that the cotton must pass through in order to obtain the required product. This usually means deciding whether or not the cotton shall be combed.

A lot of cotton, even if of the same grade, will never be found to contain an absolutely uniform staple, and the fibers that are below the average length will weaken the yarns spun from this lot. For very fine yarns, or for a high grade of yarn even when of coarse numbers, it is customary to adopt the processes of **combing** and those incidental to it; while for coarse or medium yarns, or yarns that are not required to be of superior quality, the picking and carding processes are usually considered sufficient for cleaning purposes. In these processes a large portion of the short fibers remain, but their presence in coarse and medium warp and filling yarns does not injure the quality to any great extent so long as the cotton selected is suitable; that is, generally speaking, in warp yarns that are not finer than 45s and filling yarns not finer than 90s.

2. Object of Combing.—For fine yarns it is essential that the short fibers should be removed, and to accomplish this the process known as combing is introduced. Therefore, for warp yarns finer than 45s and filling yarns finer than 90s, or even for coarser numbers than these when a high grade of yarn is required, it is customary, in addition to the selection of the proper stock, to remove by the process of combing all fibers that are not of the required length. Combing, however, is an expensive operation, as considerable waste results from this process, and it is only profitable to comb when high-grade work is required.

3. In order to distinguish the different processes through which the cotton has passed, yarns are termed **carded yarns** and **combed yarns.** When yarns are spoken of as being carded, it may mean that they have been subjected to one process of carding or that they have been double-carded. Combed yarns may be single-combed or double-combed, and in either case they may have been carded once or twice, but double carding and double combing are not practiced to any considerable extent.

The process of combing is usually performed immediately after carding and before the drawing process, although in some cases one drawing process is used between the carding and the combing process. With the combing process a higher grade of yarn than that obtained with the carding process alone can be made from the same stock, or the same grade of yarn can be produced from a lower quality of stock.

4. A combing equipment usually includes three kinds of machines: (1) the *sliver-lap machine*, which has for its object the making of a lap from a number of card slivers; (2) the *ribbon-lap machine*, the object of which is to combine several of the laps from the sliver-lap machine into a firm and even lap; (3) the *comber*, the object of which is to remove all fibers that are under a length suitable for the yarn required.

When the drawing frame is introduced, the combing equipment generally consists of drawing frames, sliver-lap machines, and combers.

SLIVER-LAP MACHINE

CONSTRUCTION AND OPERATION

5. Before the cotton can be combed, it must be placed in a suitable form for the combing machine, and for this purpose it is taken in cans, either from the card or drawing frame, to the **sliver-lap machine,** an illustration of which is given in Fig. 1.

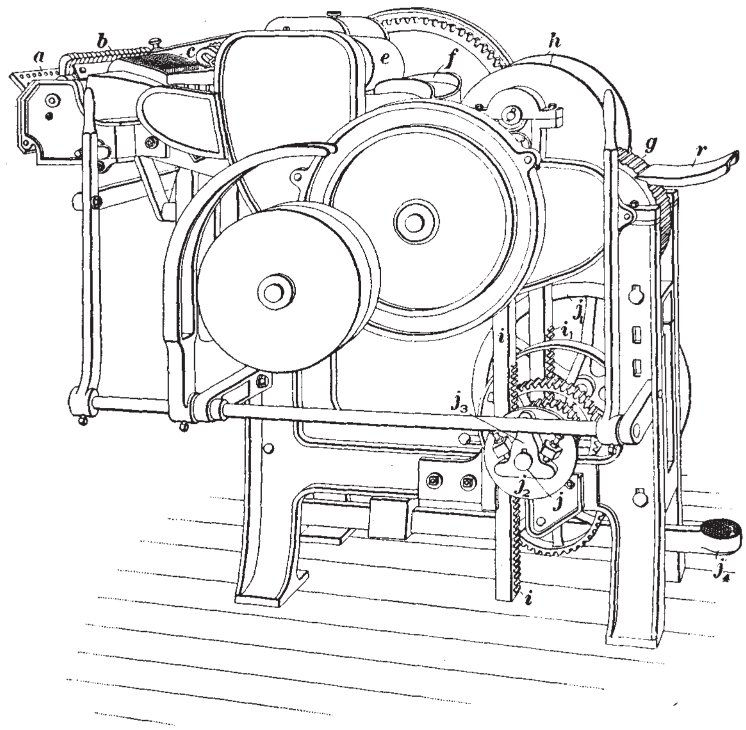


FIG. 1

From fourteen to eighteen cans of sliver are placed at the back of this machine, the number being governed by the width of lap required, which is usually $7\frac{1}{2}$, $8\frac{3}{4}$, or $10\frac{1}{2}$ inches. The slivers pass from the can, through a guide plate, over spoons that operate a stop-motion, and then through a suitable conductor to the drawing rolls. In Figs. 1 and 2, *a* is the guide plate, *b* the spoons, and *c* the conductor. The drawing rolls *d* consist of three pairs of rolls, and are similar in construction to those of drawing frames. From the drawing rolls, the sheet of slivers passes between two pair of smooth calender, or presser, rolls *e*, where it is pressed into a uniform sheet. These rolls are solid and are usually 5 inches in diameter; the top rolls are weighted by means of weights

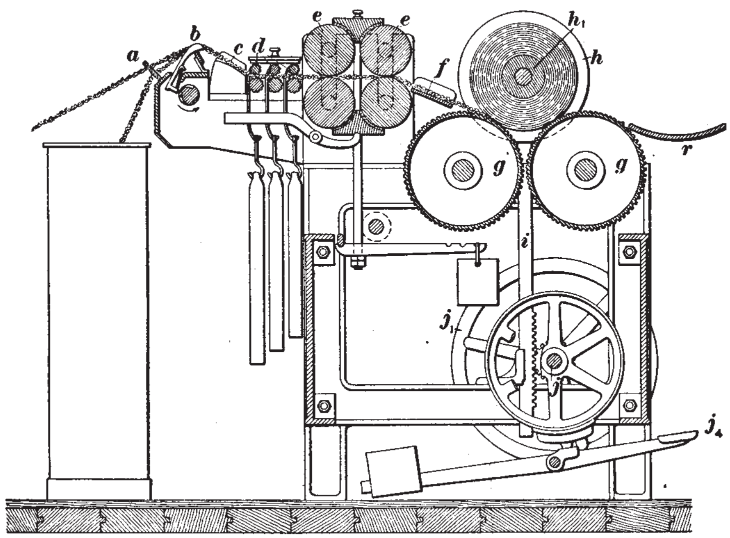


FIG. 2

and levers. The bearings of the top rolls are in vertical slots, thus allowing them to rise if an excessive amount of cotton comes between them and the bottom rolls. From the smooth calender rolls the cotton passes over a polished guide plate *f* with adjustable sides, and is then wound on a wooden roll, or spool, h_1, which rests on the fluted calender rolls *g*, and between the two plates *h*.

The wooden spool is made the width of the lap required, with a diameter of about 4 inches, and is held in position by a spindle passing through the hubs of the plates. On one end of this spindle is a double thread, which screws into a similar thread on the hub of one of the plates. On the other end of the spindle is a collar and hand wheel, the distance from the collar to the thread being such that when the spindle is passed through the plates and spool and screwed up tight, the spool will be held firmly between the plates. The plates are supported by racks i, i_1, Fig. 1, the teeth of which engage with gears on the shaft j. The gear on the shaft j that engages with the rack i_1 is fastened to the shaft, while the gear engaging with the rack i is mounted on a sleeve that carries the disk j_2. This disk is secured to the casting j_3 in such a manner that it is adjustable, while the casting j_3 is keyed to the shaft j. This method of connecting the different parts provides a means of adjusting the rack i with relation to the rack i_1. When the racks are down in position, the spool rests between the upper parts of the calender rolls g and is in contact with both of them. The spool is usually made $\frac{1}{16}$ inch longer than the rolls, so that the plates will not bind on the edges of the rolls. As the fluted calender rolls revolve, the spool and plates revolve with them; by this means the sheet of sliver is wound on the spool and the lap formed. The diameter of the plates is greater than that of the full lap required, and, being in contact with the ends of the spool, the lap is built up the same width as the spool, with perfect sides.

A full lap should be from 12 to 14 inches in diameter, should have straight, smooth sides, and be hard and firm. To remove a full lap the friction is released by pressing down on the friction lever j_4 and the racks slightly raised by the hand wheel j_1 on the shaft j. The spindle is then removed by unscrewing it from the plate and withdrawing it from the spool, allowing the lap to be rolled on to the table r. The firmness of the lap is governed by the amount of friction placed on the friction motion of the racks; the smoothness of the sides, by the position of the conductor c and the adjustable sides of the guide plate f. The sides of the conductor c should be so adjusted that the sheet delivered to the calender rolls will be somewhat wider than the lap required. A selvage is formed on each side of the lap by the guide plate *f* and the circular plates *h*.

6. Stop-Motions.—There are two stop-motions, one to stop the machine when an end of sliver breaks at the back and the other to stop the machine when the lap is full.

7. The **sliver stop-motion** consists of unevenly balanced spoons *b*, the bottom ends of which are heavier than the top. Each spoon is so adjusted that the weight of the sliver holds down the upper part. When an end breaks and passes over a spoon, the spoon is released and the lower end comes in contact with a tumbler, or rocker. The shaft is stopped, and a catch on a shipper rod being released, a spring forces the rod outwards, causing the belt to be shipped to the loose pulley.

8. The **full-lap stop-motion** is operated as follows: As the rack is raised by means of the increased diameter of the lap, a dog on one of the racks comes in contact with a rod that extends back and connects with the catch on the shipper rod. As the dog passes the rod, it causes it to be moved backwards and releases the catch on the shipper rod. The dog is adjustable on the rack, so that different sizes of laps may be made.

9. Settings.—The setting points and adjustments on a sliver-lap machine are as follows: The proper adjustment of the stop-motion spoons, so that the spoon will act immediately when an end breaks; the regulation of the distances between the centers of the drawing rolls; the proper adjustments of the sliver conductor and guide plates so that a good selvage will be made; and the proper adjustment of the racks so that they will be perfectly plumb and level, since, if the racks are out of level, it will cause the plates to bind on the edges of the fluted calender rolls and will make an imperfect lap. The brake shoe on the friction motion also needs attention, and care should be taken not to allow oil to get on it.

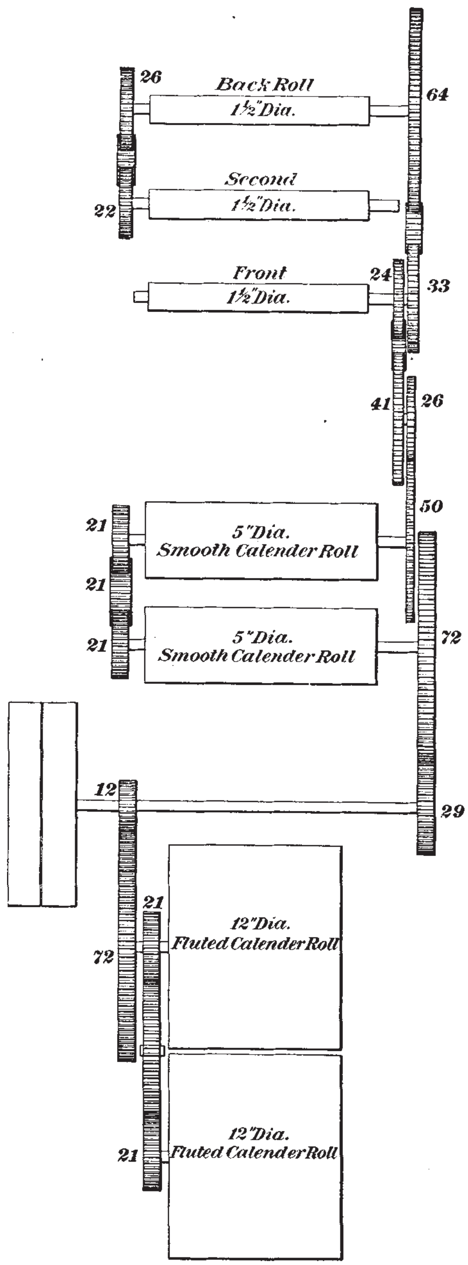

26
Back Roll
1½"Dia.
64
Second
1½"Dia.
22
Front
1½"Dia.
24
33
41
26
50
21
5"Dia.
Smooth Calender Roll
21
21
5"Dia.
Smooth Calender Roll
72
12
29
21
12"Dia.
Fluted Calender Roll
72
12"Dia.
Fluted Calender Roll
21

FIG. 3

10. Fig. 3 is the plan of gearing for a sliver-lap machine; the draft, figured from the front fluted calender roll to the back drawing roll, is as follows:

$$\frac{12 \times 21 \times 12 \times 72 \times 21 \times 26 \times 24 \times 64}{21 \times 72 \times 29 \times 21 \times 50 \times 41 \times 33 \times 1\frac{1}{2}} = 1.954$$

The amount of draft is usually from 1.75 to 2.5. The weight per yard for a $7\frac{1}{2}$-inch lap for medium numbers is from 230 to 300 grains if it is to be used on the ribbon-lap machine, and from 200 to 250 grains if for use on the comber.

The 5-inch calender rolls is of the sliver-lap machine make from 50 to 100 revolutions per minute, and the machine produces from 400 to 950 pounds per day, allowing 10 per cent. for stoppages. The weight of a sliver-lap machine is about 2,200 pounds, while the floor space occupied is about 5 feet $3\frac{1}{2}$ inches by 3 feet 1 inch. About 1 horsepower is required to drive it.

RIBBON-LAP MACHINE

CONSTRUCTION AND OPERATION

11. Object.— It is not absolutely necessary to use a **ribbon-lap machine** in the combing process, as the laps from the sliver-lap machine may be taken directly to the comber. If, however, the lap from the sliver-lap machine is unrolled for about a yard and held to the light, it will be seen that the slivers merely lie side by side, and that the lap is uneven, showing both thick and thin places. Therefore, to have a more even lap, the ribbon-lap machine is used. The usual doubling on the ribbon-lap machine is 6 into 1, and the laps fed are generally 1 inch narrower than the laps to be made for the comber.

12. A view of a ribbon-lap machine is shown in Fig. 4; Fig. 5 (*a*) and (*b*) shows sections through the machine. The laps from the sliver-lap machine are placed on the wooden rolls a, a_1, Fig. 5 (*a*), and the sheet passes over the plate b, which acts both as a guide and stop-motion. On the under

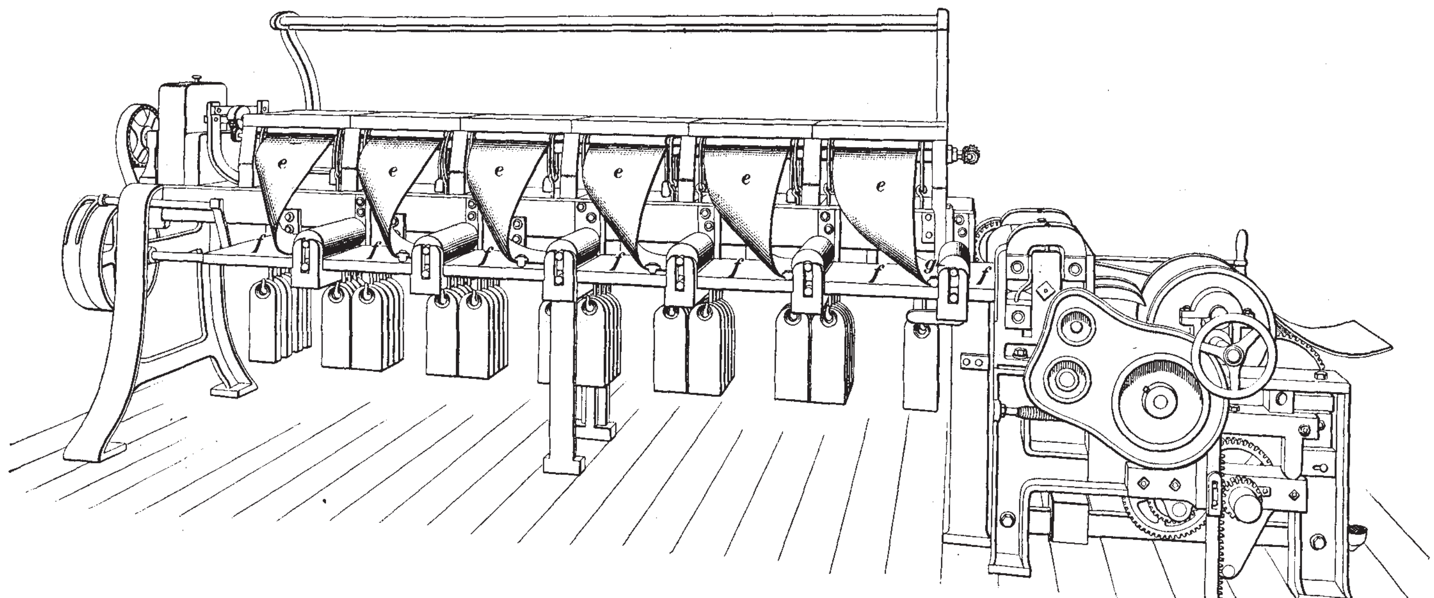
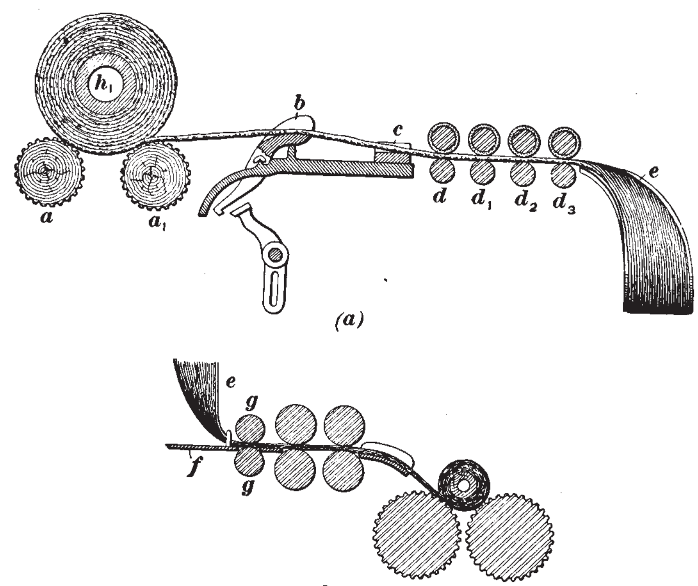


Fig. 4

side of this plate is a hook that acts similarly to the bottom part of the spoon described in connection with the sliver-lap machine. There is a slight draft between the wooden lap rolls and the back drawing rolls, and as the sheet of cotton passes over the plate *b*, the tension serves to hold it down. If the lap breaks or the spool runs empty, the plate rises and stops the machine.

The sheet passes from the plate *b* through the guides *c* to the drawing rolls d, d_1, d_2, d_3. The cotton then passes through



(a)

(b)

FIG. 5

these drawing rolls, of which there are usually four pair, the diameter of the first, third, and fourth, counting from the front of the machine, being $1\frac{1}{2}$ inches, and that of the second, $1\frac{3}{8}$ inches. The draft between the front and back drawing rolls usually about equals the doublings. The drawing rolls are constructed similarly to the rolls of drawing frames. The top rolls are weighted by dead-weights, two weights being used on each roll.

From the front drawing roll, the sheet of cotton passes over a curved plate *e*, Figs. 4 and 5, to the table *f*, along which it passes at right angles to the direction in which it passed through the drawing rolls. The cotton, in passing from the curved plate to the table, passes between the calender rolls *g*, which are known as the table calender rolls. In front of each pair a guide finger is placed on each side of the table to prevent the sheet from spreading. Each sheet, in passing from the driving end of the machine to the lap head, is carried under the sheet that is next to it in the direction of the lap head. The table calender rolls serve to condense the several layers of cotton into one sheet and to pass it forwards. From the last pair of table calender rolls, the sheet passes to the smooth calender, or presser, rolls of the lap head.

The curved plates *e*, over which the cotton passes from the drawing rolls to the table, are very highly polished. In some cases the plates are nickel-plated, and in others they are covered with thin sheet brass, sheet brass taking a better polish than cast iron, of which the plates are made. It is necessary that these plates be kept clean and polished, as the least particle of dirt or oil on the plates will cause the ends to break, and as there is no stop-motion on this part of the machine, it will continue to run until stopped by the attendant, thus causing uneven laps and considerable waste.

The lap head is constructed similar to the one on the sliver-lap machine, and the passage of the cotton through it is exactly the same as in the sliver-lap machine.

It is necessary that the table calender rolls, table, and lap head be perfectly level and in line; if they are not, there will be some difficulty in getting the several sheets to run to the lap head properly.

13. Settings.—The points of adjustment and setting are the same as on the sliver-lap machine. The plate for the stop-motion should be correctly balanced; the distances from center to center of the drawing rolls should be properly regulated; the guides should be so adjusted as to make the

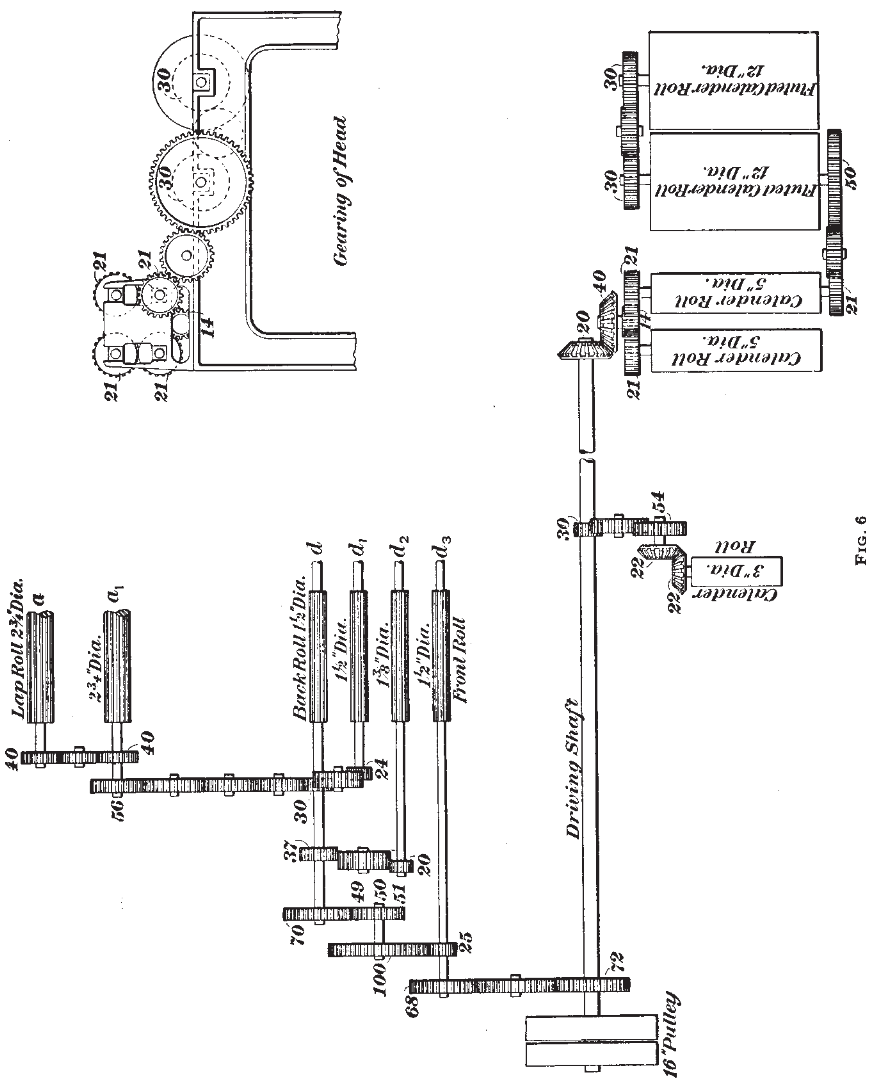

Gearing of Head
Lap Roll 2¾"Dia.
Back Roll 1½"Dia.
Front Roll
Driving Shaft
16" Pulley
Fluted Calender Roll 12" Dia.
Calender Roll 5" Dia.
Calender Roll 3" Dia.

FIG. 6

sheets of the desired width; and the racks and friction motion of the lap head should be set correctly, as mentioned in connection with the sliver-lap machine.

14. The speed of the 5-inch calender rolls of the ribbon-lap machine is from 80 to 110 revolutions per minute. The production varies from 600 to 1,100 pounds per day of 10 hours with 10 per cent. allowed for stoppages. This machine weighs about 4,500 pounds with all weights attached, and requires 1 horsepower to drive it. The floor space required is about 14 feet 2 inches by 4 feet.

15. Fig. 6 is the plan of gearing for a ribbon-lap machine; the draft, figured from the front fluted calender roll to the back drawing roll, with a 50-tooth draft gear, is as follows:

$$\frac{12 \times 30 \times 21 \times 14 \times 20 \times 68 \times 100 \times 70}{30 \times 50 \times 21 \times 40 \times 72 \times 25 \times 50 \times 1\frac{1}{2}} = 5.923$$

SINGLE-NIP COMBER

CONSTRUCTION AND OPERATION

16. The **comber** is employed to select, from cotton that has been carded, the fibers suitable for the class of yarn required. In addition to removing the fibers that are below the standard length, it combs the fibers to be used and makes them lie in parallel positions. It also takes out neps, dirt, and foreign matter that were not removed in the previous processes. The combing machine commonly used, which depends on a combination of somewhat intricate movements for the attainment of its objects, was invented by M. Heilmann, of Mulhouse, in Alsace, Germany. Although numerous improvements have been added by other inventors, it is still spoken of as the Heilmann comber.

A comber is divided into several sections, called **heads;** and as now constructed usually contains six or eight heads, although it may be constructed with a larger or smaller number, as required. Each head is complete in itself and receives one of the laps delivered by the ribbon-lap machine, but the motions for all the heads derive their power from the same source. While each head is complete in itself, corresponding parts of each head must act at the same time, the results obtained depending on the accuracy with which the corresponding parts of each head work together.

17. Passage of the Stock.—Briefly stated, the laps from the ribbon-lap machine are placed on lap rolls and are fed intermittently by a pair of feed-rolls. When the laps from the ribbon-lap machine are used, they should not weigh more than 300 grains per yard, and when laps are used that come directly from the sliver-lap machine, they should not be heavier than 260 grains per yard. The fringe of cotton is gripped by a pair of nippers, which holds it in such a position that it will be acted on by a cylinder having a portion of its circumference covered with steel points. These points, or needles as they are called, remove short fibers, neps, and foreign substances that were not removed in the previous processes; this waste is then taken from the needles by a revolving brush and ultimately arrives at the waste can.

During this operation, the fringe of cotton that is being combed is entirely separate from the fringe of cotton previously combed, and therefore, in order to have the product delivered in a continuous sliver, it is necessary to detach the newly combed fibers from those not combed, and also to bring back a portion of the cotton previously combed so that it may be pieced up with the fibers that have just undergone the combing operation. After piecing-up has been effected, the cotton just combed is carried forwards and the rear ends of the fibers receive a combing action by means of a top comb, which tends to remove still more short fibers. This cycle of operations is then repeated with a new group of fibers, resulting in the production of a continuous web of combed fibers, which is drawn through a trumpet that condenses it into a sliver and is then delivered on a table, together with similar slivers from the other heads of the comber. From the table the cotton passes through a draw-box and then through a trumpet that condenses all the slivers into one, which is placed in a can by a coiler similar to that used on the card.

18. Principal Motions of the Comber.—The several actions of a comber must necessarily work intermittently, as it would be impossible to run a lap of cotton continuously and to draw a comb through it. For this reason the tuft of cotton being combed must be held firmly at the time of the combing, first at one end and then at the other, and in order to do this, the feed must be stopped. The various motions may be summarized as follows: (1) The feed-motion, by which the lap is fed to the machine; (2) the nipper motion, which holds the cotton during the combing operation; (3) the combing operation by the half lap; (4) the backward and forward motion of the delivery roll, or the piecing-up motion; (5) combing by the top comb; (6) the delivery of the stock to the calender rolls, draw-box, and coiler.

FEED-MOTION

19. Views of a comber are given in Figs. 7 and 8, and a sectional view is shown in Fig. 9. It will also be of advantage in studying the different parts of the comber to make frequent reference to Fig. 27, which shows a plan of the gearing of this machine. In describing the comber it will only be necessary to deal with one head, as each head performs the same work. The lap b, Fig. 9, is placed on the lap rolls a, a_1, and, as it unrolls, the sheet passes over the apron a_2 to a pair of feed-rolls c, c_1. The apron a_2 rests at an angle of about 45° and terminates a little above the nip of the two feed-rolls c, c_1. The apron may be so adjusted that it will assume a greater or less angle, and it is also possible to regulate its distance from the feed-rolls. This apron is usually made of sheet iron, its upper surface being polished or tinned so that there will be as little friction as possible on the cotton. The lower edge of the apron carries a brush, the ends of the bristles of which just touch the bottom feed-roll and keep it clean. This brush is adjustable in such a manner that the correct contact of the ends of the bristles and the bottom feed-roll may be maintained as the brush wears.

20. Feed-Rolls.—The lower feed-roll c is constructed in one piece and is long enough to serve for all the heads. It is fluted in sections corresponding in number to the number of heads of the comber. Each section, or head, has a top roll c_1, which is slightly longer than the width of each lap. This top roll is made of steel and is fluted to correspond with the flutes of the lower roll. It resembles a

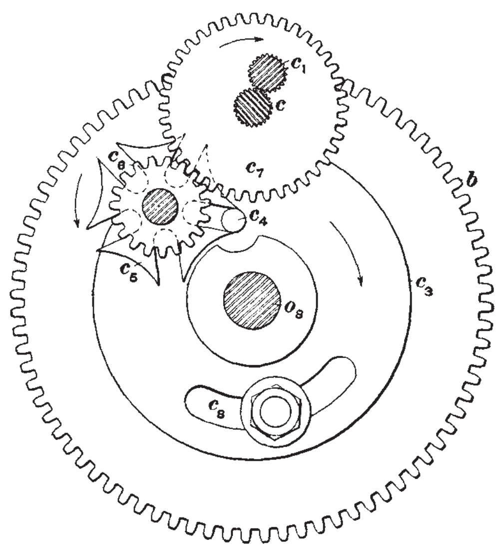


FIG. 10

metallic roll, with the exception that it has no collars; its flutes also have a little finer pitch. It is held in direct contact with the bottom roll by means of an arm c_2 and a spring c_3, as shown in Fig. 9, and receives motion from the lower roll. The lower feed-roll is usually about $\frac{3}{4}$ inch in diameter. The objects of these feed-rolls are: (1) To revolve and deliver a certain length of cotton to the combing mechanism; (2) to stop revolving after the desired length has been delivered and to remain stationary while the combing action takes place.

The method by which the feed-roll receives an intermittent motion is shown in Fig. 10. The feed-roll receives its motion from the cylinder shaft o_8, in the following manner. The gear b is fast to the cylinder shaft and carries a disk plate c_3 from which a pin c_4 projects. A short distance from the center of the cylinder shaft is a stud carrying a star gear c_5. The pin c_4 engaging with the teeth of this star gear turns it during a part of a revolution of the cylinder shaft. The star gear is so constructed that after the pin has engaged with one tooth and turned it, the next tooth will be in position to engage with the pin at the next revolution of o_8. Compounded with the star gear c_5 is a gear c_6 that meshes with a gear c_7 on the lower feed-roll c. Thus, it will be seen that for every revolution of the shaft o_8 the feed-roll is turned a portion of a revolution and the cotton fed to that extent. This intermittent action of the feed-rolls is transmitted to the lap rolls, as the lap rolls are driven from the lower feed-roll.

NIPPERS

21. The fringe of cotton that is fed by this intermittent action of the feed-rolls passes forwards to the mechanism that holds it during the combing process, which is known as the **nippers.** By a combination of levers, the nippers are made to act in such a manner that they open to receive the cotton delivered from the feed-rolls and then close and grip the cotton after it has been passed to them. They again open and release the cotton after it has been combed by the half lap and remain in this position until the next portion of cotton has been delivered to them. The nippers and their attached levers are shown in Fig. 11, reference being made to this figure and also to Fig. 12 in the following description.

22. Cushion Plate.—The nippers are composed of two separate parts, both capable of being moved. The lower part h consists of what is known as the **cushion plate,** Fig. 11. It consists of a flat metal plate slightly longer than the width of the lap. The round nose h_1 of the plate, Fig. 11, is usually covered with a strip of leather similar to that used for covering rolls, and is fastened by metal strips h_2, h_2. This leather acts as a cushion and prevents the fibers from being injured when pressed against

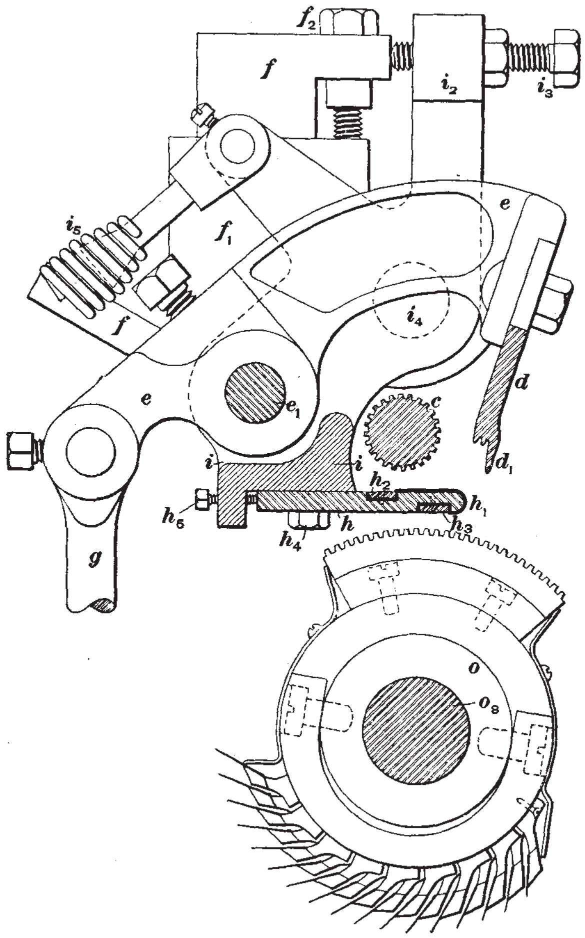


Fig. 11

the plate. The cushion plate is made fast to the frame *i* by means of three screws, which are inserted on the under side of the plate; one of these screws h_4 is shown in Figs. 11, 12, and 13. In some cases the cushion is applied to the nipper knife in place of the plate. When this is done a strip of leather about $\frac{3}{16}$ inch thick and $\frac{3}{4}$ inch wide is used, and is fastened to the nipper knife by a strip of steel and small

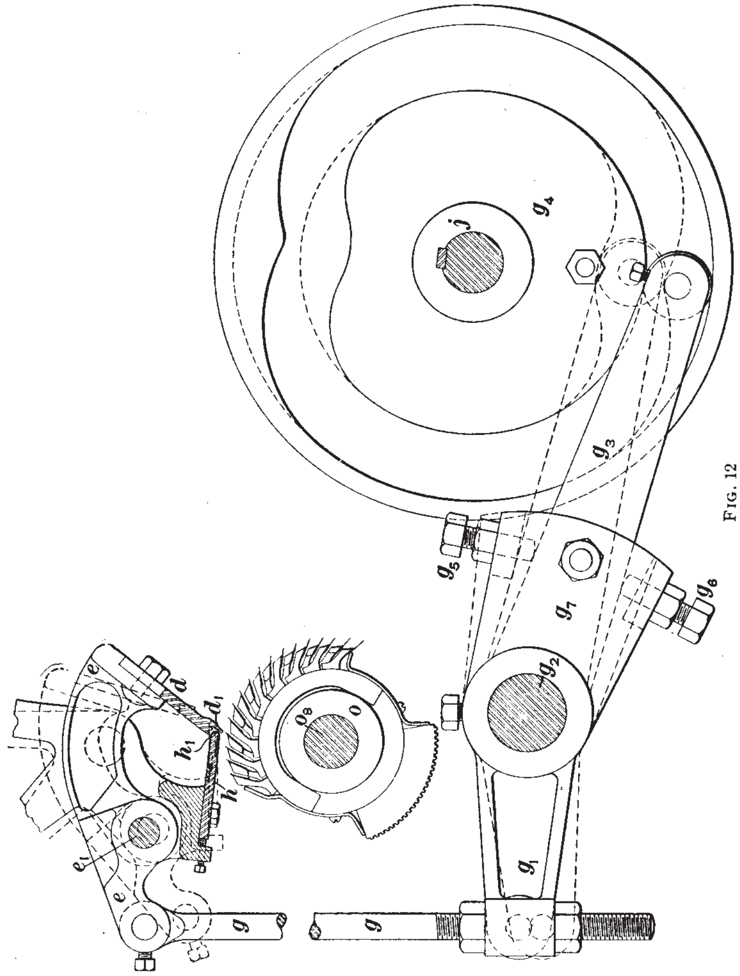


Fig. 12

screws, the lower part of the steel strip acting as the overhanging lip of the nipper knife.

23. Nipper Knife.—The upper part $d d_1$, of the nippers in Fig. 11, is known as the **nipper knife.** It consists of a flat bar of steel; the lower edge is usually fluted and has an overhanging lip d_1. The nipper knife is supported by two arms e, Fig. 11, which are connected to the frame i by the shaft e_1. Two stands and brackets f, f_1, Fig. 11, support the frame i by means of studs i_4. As the cotton must be gripped between the nipper knife d and the cushion plate h, it is evident that these parts must have a movement that will change their position from that shown in Fig. 11. This is accomplished by the movement of the nipper knife.

As shown in Fig. 11, the arms e extend beyond e_1 in the direction opposite to that of the nipper knife. This forms a connection for the rod g, Fig. 12, that is connected to the lever g_1, while this lever is connected to the shaft g_2. Extending from the shaft g_2 is an arm g_3, the end of which carries a cam-bowl that works in the cam-course of the cam g_4 on the shaft j, known as the **cam-shaft.** The shaft g_2 runs the entire length of the heads, and the nipper rods g for each head are connected to it by the method shown. The shaft g_2 receives an oscillating motion from the cam and, in turn, imparts a similar motion to the shaft e_1 of each head. The arms e being connected to this shaft, the nipper knife will rise and fall, its lowest and highest positions being indicated by the full and dotted lines in Fig. 12.

When the nippers receive the cotton, they are in the position shown in Fig. 11, but as soon as the proper amount has been fed, the nipper knife descends, through the action of the cam, and firmly grips the fringe of cotton between itself and the cushion plate, the cushion plate at this point being in the position shown by the dotted lines in Fig. 12. When the knife has securely gripped the fringe of cotton, however, the cushion plate is not in the proper position to allow the cotton to be combed, and it must be lowered so that it will assume the position shown by the full lines in Fig. 12. In order to accomplish this, the knife, which has not reached the full extent of its travel when it comes in contact with the cushion plate, is forced farther down by the cam and carries the cushion plate with it. The cushion plate is capable of being forced down, since it is suspended by the studs i_4,

Fig. 11, which project from the frame *i* and have bearings on the bracket f_1 connected to the stand *f*. Thus, the entire frame *i* can swing on the studs i_4 and cause the cushion plate *h* to come nearer the cylinder. By this movement the cushion plate and the front lip of the knife are brought close to the needles, thus enabling the cotton to be combed very close to the grip.

As the nipper knife is raised by the action of the cam, the swing frame *i* is brought back to its original position by means of the springs i_5, Fig. 11. These springs are always

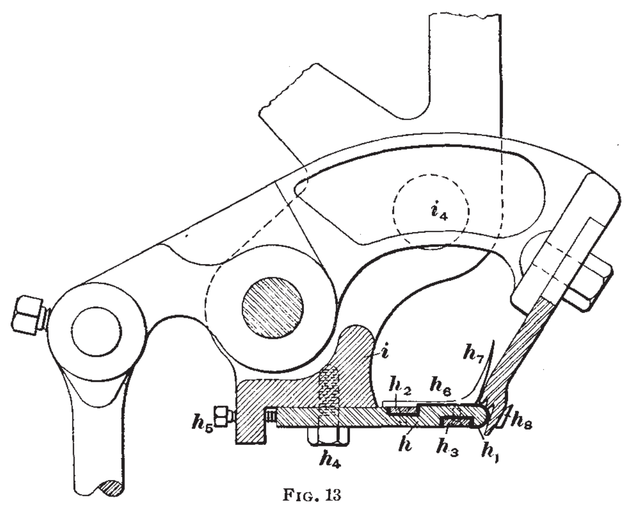


Fig. 13

tending to pull the cushion plate up, but when the knife moves downwards, the tension of the springs is overcome by the positive motion of the knife received from the cam. The position of the cushion plate when the knife is not pressing on it is governed by the distance that the setscrew i_3 projects through the bracket i_2. The setscrew comes in contact with the stand *f* and prevents the swing frame from moving any farther, but the knife continues to rise and thus the nipper is opened and the fringe of cotton released.

24. As the needles o_7 shown in Fig. 15 pass through the fringe of cotton projecting beyond the nippers, there is a tendency of the lap to spread, which is also increased by the operation of the feed-rolls. In order to avoid this spreading, a device is used on the cushion plate, a view of which is given in Figs. 13 and 14. It consists of a plate h_6 placed at each end of the cushion plate. These plates carry two projecting pieces h_7, h_8, between which the nipper knife descends, h_7 being curved so that the knife will not come in contact with it. By this means, it is practically impossible for the lap to spread when being combed.

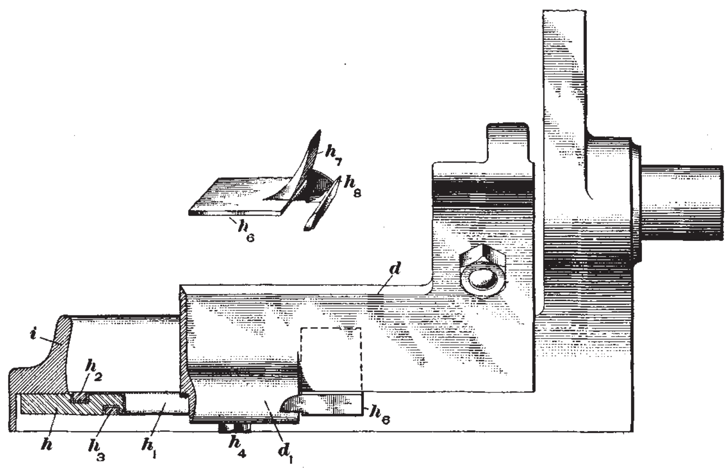


FIG. 14

COMBING OPERATION BY THE HALF LAP

25. **Cylinder.**—The cylinder consists of three principal parts—the **central stock,** or **barrel,** o_1, Fig. 15, the **half lap** o_2, and the **fluted segment** o_3—the other parts o_4 and o_5 being known as **making-up pieces.** The central stock is secured to the cylinder shaft o_8 by means of screws. The outside of this stock is shaped so as to receive the half lap and the fluted segment, which are secured to it by screws, as shown in Fig. 15. The half lap is composed of two parts—the *comb stock* and the *matrices.* The comb stock is formed to receive a series of matrices, or strips, o_6, to which are fastened seventeen rows of needles o_7 made of round steel tapered to a point. These needles are so spaced that their number varies from thirty to ninety per inch, while the diameter decreases as the number per inch increases; thus, the needles in the front row of the half lap—that is, those that come in contact with the cotton first—are the most widely spaced, and are also of the largest diameter; the number of needles in the succeeding rows increases, until the finest spacing, that is, the

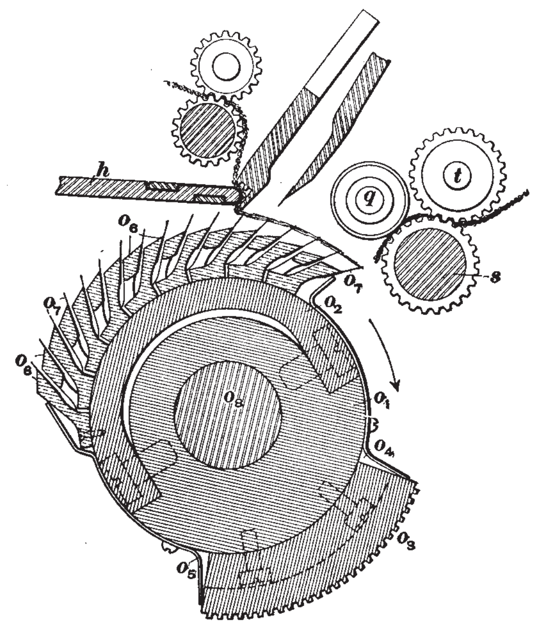


FIG. 15

largest number per inch, occurs in the seventeenth row, in which there are ninety needles per inch, the needles in this row being also of the smallest diameter. For medium work, the number of rows of each number of wire from which the needles are constructed is as follows, commencing with the front row of the half lap and following in the order named: Four rows of 20s, three rows of 22s, two rows of 24s, two rows of 26s, two rows of 28s, three rows of 30s, and one row of 33s. For very fine work, the arrangement of the needles is sometimes as follows: Six rows of 22s, three rows of 24s, two rows of 26s, two rows of 28s, two rows of 30s, and two rows of 33s.

When setting the needles they are placed in a gauge, point down. The matrix to hold them is placed against the row of large ends while the needles are in the gauge and they are then soldered to the matrix, after which the gauge is removed. The matrices to which the needles are attached are usually made of brass and planed and shaped so as to lie accurately in their proper positions, in order to give the needles the correct angle when they are secured by the setscrews that hold them to the comb stock. By having the half lap constructed in this manner, it is a simple matter to remove it from the machine when a row of needles becomes injured, and then by removing the matrix the damaged needles may be readily replaced. In addition to having the rows of points of the needles in the half lap concentric, each row of needles should be exactly parallel with the cylinder shaft. The width over all of each row of needles is usually a little in excess of the width of the lap, so that the edges of the lap will receive an effective combing.

As the cylinder shaft on which the half lap is mounted is constantly revolving, it will be seen that each fringe of cotton gripped by the nippers will be subjected to the action of the half lap. This action takes place immediately after the cotton has been gripped by the nippers and the cushion plate has been forced down by the nipper knife. The half lap is placed on the cylinder in such a position that the largest and heaviest needles are caused to act first on the fringe of cotton to be combed, in order that they may do the heaviest work and make it easier for the finer needles that follow and give a more effective combing. Any fibers that are not held firmly by the nippers are combed from the fringe of cotton, so that only fibers of sufficient length are left. In addition to these short fibers, dirt and neps are also removed, while the fibers held by the nippers are combed out and laid parallel.

The short fibers and foreign matter that are removed from the fringe are carried by the needles of the half lap until the brush *p*, Fig. 9, removes them and deposits them on the doffer r, which works at a much slower speed than the brush. The doffer has its surface covered with a clothing, composed usually of leather, having heavy wire teeth inserted in it at an angle. The doffer is not in direct contact with the brush, but as the brush revolves, the centrifugal force throws out the short fibers, and the needles of the doffer are thus enabled to secure them.

26. The Doffer Comb.—As r revolves, the waste is stripped from it by means of a **comb** r_2 that acts on the same principle as the doffer comb of a card. The waste then drops into a can, there usually being one can for two heads. In some cases, however, the waste is wound on a roll. At the back of the cylinder, brush, and part of the doffer there is a tin cover p_3, Fig. 9, which is of a special shape, made in one piece and called the **brush tin.** Another cover, known as the **waste chute,** covers the cylinder and brush on the other side, and is shown at p_4. These covers prevent the escape of waste and also act as a protection against any foreign substance coming in contact with the moving parts.

PIECING-UP MOTION

27. After the cotton has been combed and the nippers opened, the fringe of cotton comes under the action of the **piecing-up motion.** It should be understood that the fringe of cotton being combed is not connected to the cotton previously combed, and in order to have a continuous sliver, each fringe of cotton is pieced up to the cotton immediately in front of it. In order to accomplish this, a portion of the previously combed cotton must be returned, while the fringe must be in a position to be attached to it and carried forwards.

It is the object of the fluted segment, which is a part of the cylinder, to support the fringe of cotton that has just undergone the combing action. The finely fluted surface of the segment is at such a distance from the center of the cylinder shaft that it can come in contact with the under side of the combed fringe and thus support it until it is detached. A view of the segment supporting the fringe is shown in Fig. 16. When the fringe is held in the position shown, the operation of piecing-up and detaching is performed by three rolls *q*, *s*, *t*; *q* is sometimes termed the *leather detaching roll;* *s*, the *steel detaching roll;* and *t*, the *brass roll.* In other instances *t* is called the *piecing roll.* In this Section, however, *q* will be known as the *leather detaching roll;* *s*, the *delivery roll;* and *t*, the *top roll.* These names are strictly in accordance with the duties and positions of the rolls, as *q* detaches the cotton, and, although *s* assists in this operation, its chief function is to deliver the cotton after it has been detached. The roll *t* also aids in delivering the cotton, and as it is directly above the delivery roll, it may be termed the top roll.

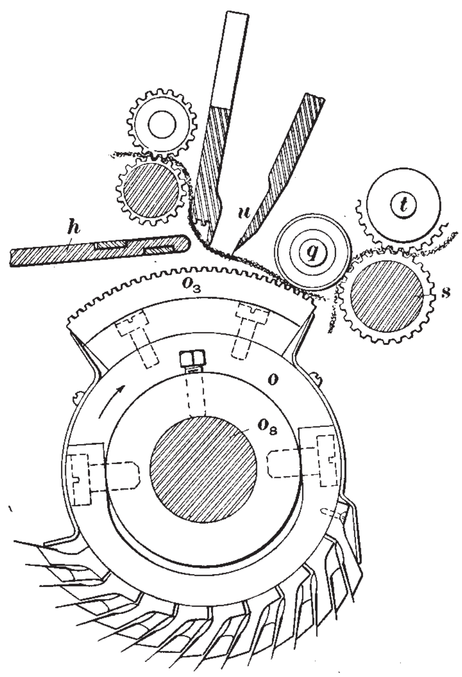


FIG. 16

28. The **delivery roll** *s* is made in one piece long enough to serve for all the heads. Opposite each head is a fluted section, the flutes usually being spaced differently from those of the feed-roll. When a lap $8\frac{1}{2}$ inches in width is used, the fluted section is generally 11 inches wide and contains about fifty flutes for each inch of diameter. The diameter of the roll is usually $\frac{7}{8}$ inch. The roll revolves in bearings on the framework and is in such a position that it is just clear of the needles of the half lap and the segment. The parts of the bearings in contact with the roll are usually made of brass.

29. The **leather detaching roll** q, Fig. 17, is in contact with the delivery roll. The leather portion of the detaching roll is slightly wider than the fluted segment of the

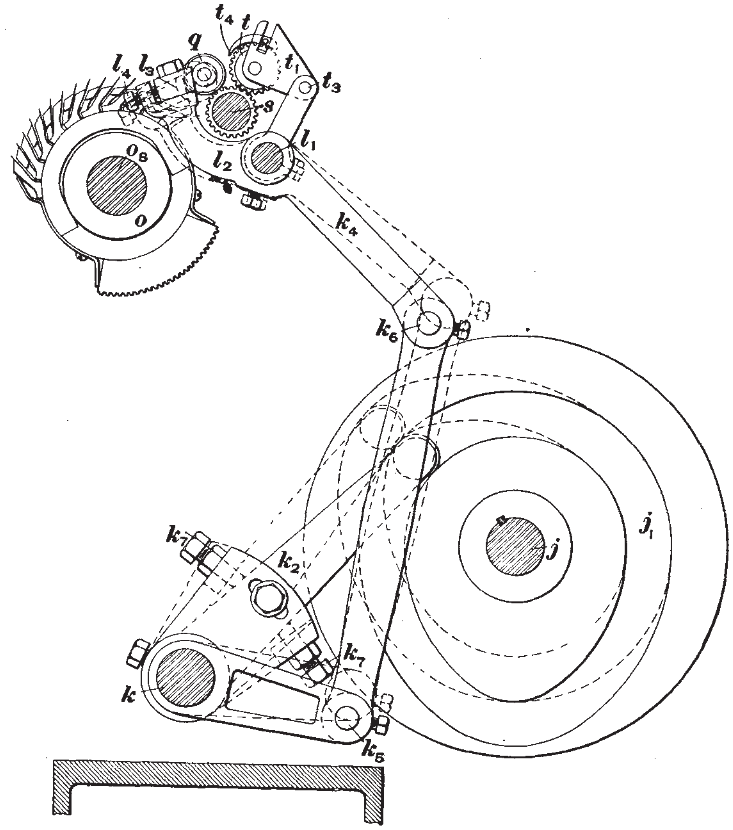


Fig. 17

cylinder and resembles a top roll of the common type, being shown in Fig. 18. The boss of the roll is generally about

Fig. 18

$10\frac{1}{2}$ inches in length and $\frac{13}{16}$ inch in diameter. The skins used for covering should be of the finest quality, as so few fibers are dealt with that any irregularity of the roll produces bad work. This roll has brass bushings q_1, Fig. 18, for bearings, which are supported by the blocks l_3, Fig. 17.

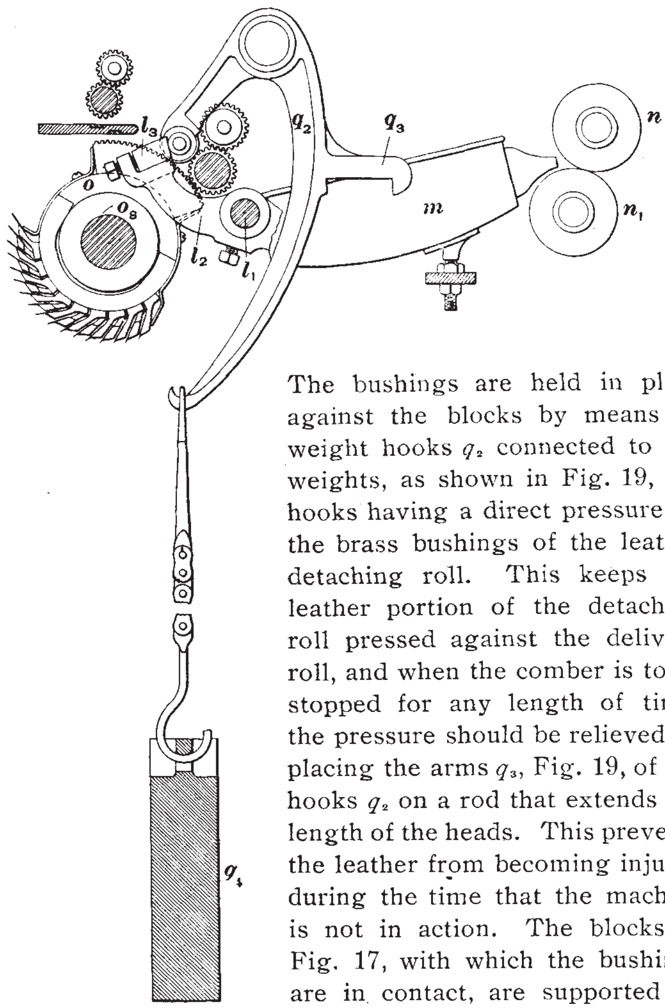


Fig. 19

The bushings are held in place against the blocks by means of weight hooks q_2 connected to the weights, as shown in Fig. 19, the hooks having a direct pressure on the brass bushings of the leather detaching roll. This keeps the leather portion of the detaching roll pressed against the delivery roll, and when the comber is to be stopped for any length of time, the pressure should be relieved by placing the arms q_3, Fig. 19, of the hooks q_2 on a rod that extends the length of the heads. This prevents the leather from becoming injured during the time that the machine is not in action. The blocks l_3, Fig. 17, with which the bushings are in contact, are supported by means of brackets l_2, one of which is shown in this figure. Each head requires two of these brackets, which are fast to the shaft l_1, which is long enough to serve for two heads and consequently to support four brackets. The shafts have bearings on the framing of the comber and are capable of being moved. The brackets, with their connections, are known as the *horsehead*, or *lifter*.

30. The **top roll** t, Fig. 17, is generally constructed of brass and contains flutes that correspond to the flutes of the delivery roll. The fluted section, however, is usually a little shorter than the fluted section of the delivery roll. This roll is supported by brackets t_1, fast to the shaft l_1, and, as the bearings of the roll are pivoted at t_3, the top roll is always in contact with the delivery roll.

31. Operation of the Rolls.—In order that these rolls may detach the combed cotton from the remainder of the lap, they must be close enough to the fluted segment to secure the cotton at the time of detaching. The position of the rolls when detaching is shown in Fig. 16. By a comparison of this figure with Fig. 15, it is obvious that if, during the combing operation, the detaching roll were in the position that it occupies when detaching, the needles of the half lap would come in contact with the detaching roll. It is therefore necessary that the position of the detaching roll should be alternately changed so that the roll will be near enough to the segment to secure the fibers when detaching and also be out of the path of the needles during the combing action. In order to effect this change in the position of the detaching roll, it is necessary to give the shaft l_1, Fig. 17, which is primarily the support for the roll, a partial revolution. As shown in Fig. 17, there extends from the short shaft l_1 an arm k_4, which, with other connections, serves to connect l_1 with the shaft k. The connection between l_1 and k is jointed at k_5 and k_6; consequently, if k revolves it will turn l_1 without tending to lift it in its bearings. There are three of these connections for a comber of six heads, there being one for each shaft l_1. The shaft k is similar to the shaft g_2 shown in Fig. 12 and extends the entire length of the heads. Fig. 9 shows the relative positions of these shafts.

Extending from the shaft k is an arm k_2, Fig. 17, which carries at its other end a cam-bowl that runs in the course of the lifter, or horsehead, cam j_1. This cam is on the shaft with, and very close to, the nipper cam g_4 shown in Fig. 12. As the cam-shaft j revolves, the shaft k receives an oscillating motion that is transmitted to the shaft l_1 by means of the connections previously described. This motion of l_1 swings the horsehead with l_1 as a center and thus brings the leather detaching roll q in contact with the fluted segment, as shown in Fig. 16. The range of movement of the horsehead is shown by the full and dotted lines in Fig. 17. The full lines show the position of the horsehead and rolls during the combing process, or when the roll is out of the path of the half lap, while the dotted lines show the position of the horsehead and rolls when the detaching roll is in the position it assumes when in operation.

As previously stated, the detaching roll q is supported and its motion governed through being held firmly against the blocks l_3 of the brackets l_2, Fig. 17, by the weights q_4, Fig. 19. When, however, the horsehead is moved back to the limit of its motion, shown by the dotted lines in Fig. 17, the blocks l_3 are so far back that they are not in contact with the brass bushings of the detaching roll. The leather portion of the roll, however, has a bearing directly on the fluted segment, as shown in Fig. 16. As the weights q_4, shown in Fig. 19, are holding the detaching roll against the fluted segment, it is obvious that the fringe of cotton will be effectively gripped between them. The detaching roll is at all times in contact with the delivery roll, around which it moves with the action of the horsehead. As the top roll is connected to the shaft l_1, it also has a movement similar to the detaching roll, and consequently moves around the delivery roll and assumes the position shown in Fig. 16. A clearer t_4, Fig. 17, which is above the top roll and serves to keep it clean, is also supported by the bearings that support the top roll and has a motion similar to this roll.

32. In addition to the rolls being placed in the required positions, they must also have a rotary motion in both directions in order to carry back a portion of the cotton previously combed, to which the detached portion must be connected in order to deliver the cotton in a continuous line. The mechanism by means of which the delivery roll derives a motion in both directions is shown in Figs. 20, 21, and 22. This motion is also imparted, by means of frictional contact, to the detaching roll and top roll. The mechanism shown in these figures consists of a cam s_1 situated on the cam-shaft j, which also supports the nipper cam and the cam for placing

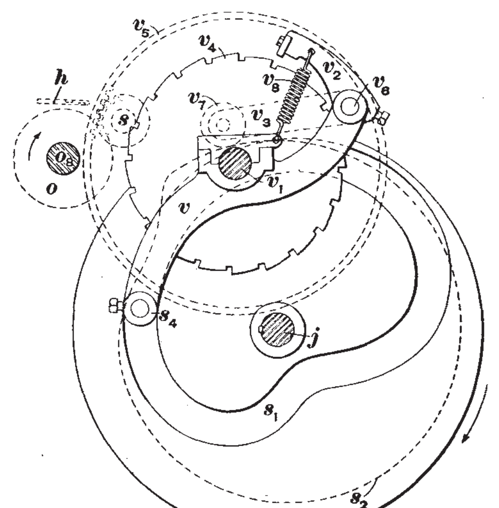


FIG. 20

the detaching roll in position. Running in the cam-course of s_1 is a bowl s_4 fastened at one end of a lever v, the lever being pivoted on a shaft v_1 borne by the frame of the machine. The other end of the lever has a pawl v_2 hinged to it at v_6, which is connected to an auxiliary lever v_3; v_3 also carries a bowl v_7 in contact with a cam s_2, which is in a position adjoining s_1. It will be seen, therefore, that the action of the pawl v_2 will be governed by the two cams s_1, s_2 through the levers v, v_3.

The pawl v_2 is shown as being over the gear v_4. It is held in this position by an arm similar to v situated on the other side of the gear v_4. This second arm does not have any cam-bowl but, being connected to the other, forms a good support for the pawl v_2 that engages with the teeth of the gear v_4. The construction of the gear v_4 is shown in Fig. 20. This gear is fixed to the shaft v_1, on which v is pivoted. On the same shaft with the gear v_4 is an annular gear v_5 engaging with a gear on the delivery roll s, the relative position of which with the cylinder o is shown in Fig. 20. The backward and forward motions required of the delivery roll must be imparted by the pawl v_2 through the gears v_4, v_5 and the

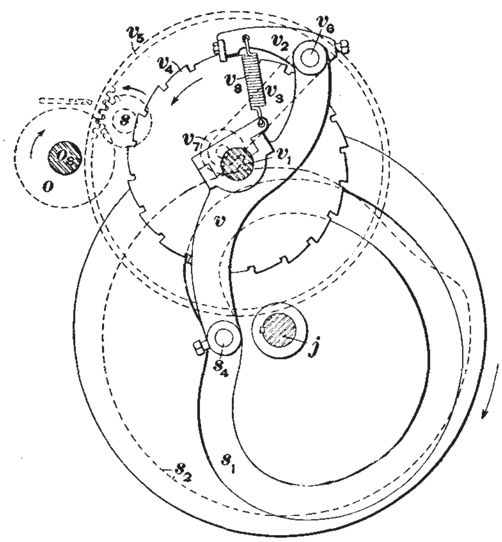


FIG. 21

gear on the delivery roll, the extent of the movement of the delivery roll being governed by the movement of the gear v_4 and the relative number of teeth in the gears by which the delivery roll is driven.

33. The manner in which the pawl acts on the gear v_4 may be seen by reference to Figs. 20, 21, and 22. The pawl v_2 is always tending to be drawn toward the gear v_4 by two springs v_8, only one of which is shown. These springs, however, cannot bring the pawl into connection with the gear until they are allowed to do so by the cam s_2. As the cam-shaft revolves and the portion of the edge of the cam that is nearest its center comes in contact with the bowl v_7, the pawl hinged at v_6 will be drawn down by the springs until it is in contact with one of the teeth of the gear v_4.

The cam s_1 will also be moving during this time in the direction indicated by the arrow, and the bowl will come in contact with that part of the cam nearest the center. This position is shown in Fig. 21. Changing the position of the

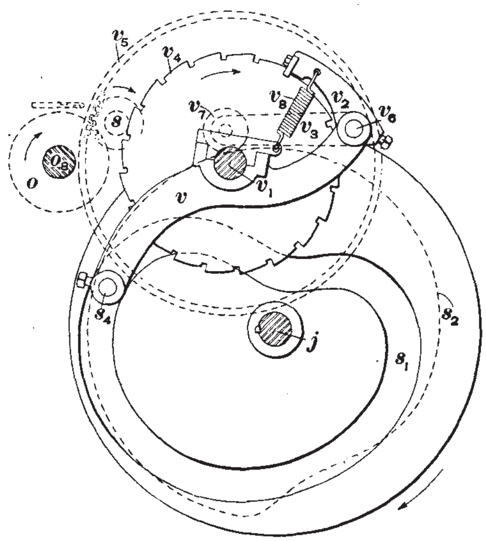


FIG. 22

cam from that shown in Fig. 20 to that shown in Fig. 21 results in moving the gear v_4 in the direction shown by the arrow. The delivery roll s will receive a similar motion and carry back a portion of the cotton previously combed.

The further rotation of the cam s_1 will cause the cam-bowl s_4 to be forced from the center j and this will cause the pawl v_2, and consequently the gear v_4, to move in an opposite direction to that first described. The positions that these parts assume during this motion are shown in Fig. 22. It is therefore evident that the delivery roll will have two motions, one of which returns a portion of cotton previously combed while the other delivers the cotton that is detached. After the latter movement has taken place, the cam s_2 having moved sufficiently far will remove the pawl from the gear v_4. When the pawl is next allowed to engage with the gear v_4, it will be in such a position that it will drop into the next tooth beyond the one with which it previously engaged.

The delivering movement of the delivery roll is about double its movement in the opposite direction, and the length of cotton actually delivered is dependent on the amount that the former exceeds the latter.

34. The operation of piecing-up may therefore be briefly stated as follows: It is necessary to detach a combed fringe of cotton from a lap and connect it to cotton already combed. The combed fringe of cotton is supported by the fluted segment o_3, as shown in Fig. 16. In order to connect this fringe the cotton immediately in front of it is brought back, by turning the delivery roll in the desired direction, and falls in a space between the half lap and the fluted segment. After the required amount of cotton has been returned, the detaching roll is brought in contact with the fluted segment so that it will grip the cotton to be detached. The delivery roll is then revolved in the opposite direction to that by which it returned the cotton previously combed, and at the same time the detaching roll and the segment detach the cotton from the layer brought forwards by the feed-rolls. During these motions the forward ends of the fibers detached are placed above and upon the rear ends of the fibers that were returned, and thus they are joined together between the detaching roll q and the delivery roll s, after which the detaching roll is moved out of the path of the half lap so that it will not interfere with the operation of combing the next tuft of cotton held by the nippers.

COMBING BY THE TOP COMB

35. Another operation performed in connection with that of detaching is the combing of that portion of the fibers held by the nippers when the half lap is in action and which, consequently, cannot be combed by the half lap. This portion of cotton is combed by the action of the top comb shown at the lower end of the plate *u*, Fig. 23. This comb is constructed with one or two rows of needles soldered to the plate, it being claimed on the one hand that two rows of needles give a more effective combing, while on the other hand it is stated that dirt collects between the two rows of needles and afterwards drops back into the cotton. Another disadvantage of two rows of needles is that they are more liable to come in contact with some of the moving parts during the operation of piecing-up because of the small space between the nippers and the detaching roll. It is also more difficult to straighten the needles if they become bent or hooked than when a single row is used. When made with two rows, there is usually a coarse row with 30 teeth per inch and a finer row with 60 teeth per inch.

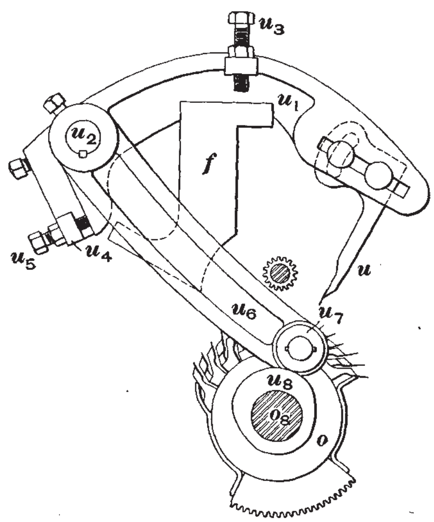


FIG. 23

The plate, or blade, to which the needles are soldered is supported by brackets u_1, Fig. 23, there being two for each comb, or head. These brackets are connected to the shaft u_2, which extends the length of the heads and supports the brackets for each head. At one end of this shaft is a lever u_6 carrying a cam-bowl u_7, which is in contact with the cam u_8 on the cylinder shaft o_8. As the cylinder shaft revolves, the top comb will be alternately raised and lowered by the action of the cam. The comb is given this movement because when the half lap is combing, as shown in Fig. 15, the top comb must be up out of the way so that it will not interfere with the action of the half lap. The top comb is lowered immediately after the half lap has passed and before the operation of detaching takes place. It is shown almost in position in Fig. 24, where the half lap has just passed; while in Fig. 16 it is shown in its combing position. As the fibers are detached by the detaching roll and segment the top comb is in its lowest position and the fibers that were held by the nippers are drawn through the comb by the detaching roll and segment; in this manner dirt and any

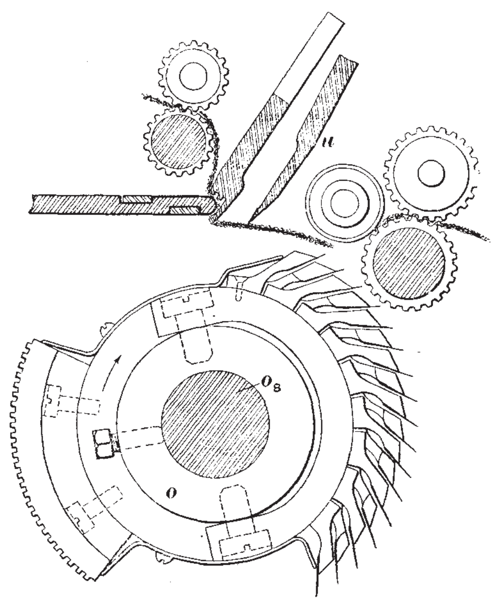


FIG. 24

fibers too short to be held by the segment and detaching roll are removed, after which the comb is raised so that it will not interfere with the action of the half lap. The matter combed out by the top comb that is not retained by the fringe projecting from the feed-rolls drops into the space on the cylinder between the fluted segment and the half lap. The matter retained by the fringe is removed by the half lap during its next combing operation.

DELIVERY OF THE STOCK

36. Calender Rolls.—The cotton when freed from the action of the top roll and delivery roll is delivered into a pan made of tin and shaped somewhat like a right triangle with its base adjoining the delivery roll. A side view of one of these pans is shown at *m*, Fig. 9. Each pan is from about $1\frac{1}{2}$ inches to 2 inches deep, its bottom being perforated so that any foreign substances that fall from the cotton will pass out of the pan and thus be prevented from entering the cotton again. At the end of the pan farthest from the delivery roll is a trumpet, as shown in Fig. 9, which has its larger end in the pan. The cotton when delivered in the pan is in the form of a transparent web nearly as wide as the leather portion of the detaching roll. It is drawn through the trumpet by the table calender rolls, which are shown at n and n_1, Fig. 9. By this means the web is condensed into the form of a sliver and delivered on a table, as shown in Fig. 25.

37. The **table** and the **table calender rolls** for a comber of six heads are shown in Fig. 25. The lower calender rolls are on a shaft that extends the length of the heads, while the upper ones, which are self-weighted, receive motion by frictional contact with the lower rolls. These rolls revolve continually at the required speed to take up the excess amount of cotton delivered by the delivery roll over that carried back for piecing-up, or in other words, the net amount delivered by the delivery roll. As these rolls are revolving continually in one direction, and as the delivery roll sometimes moves in the same direction and at other times in an opposite direction, the web of cotton in the pan is alternately slack and tight, which gives a wavy motion to the web. The web at any time should not be so slack that it will fall to the bottom of the pan, nor should it be so tight that it will be strained.

The table on which the slivers are delivered is about 7 inches wide. Its surface is polished in order to present the least possible resistance to the slivers as they pass over it. Guides are placed on this table at various distances from

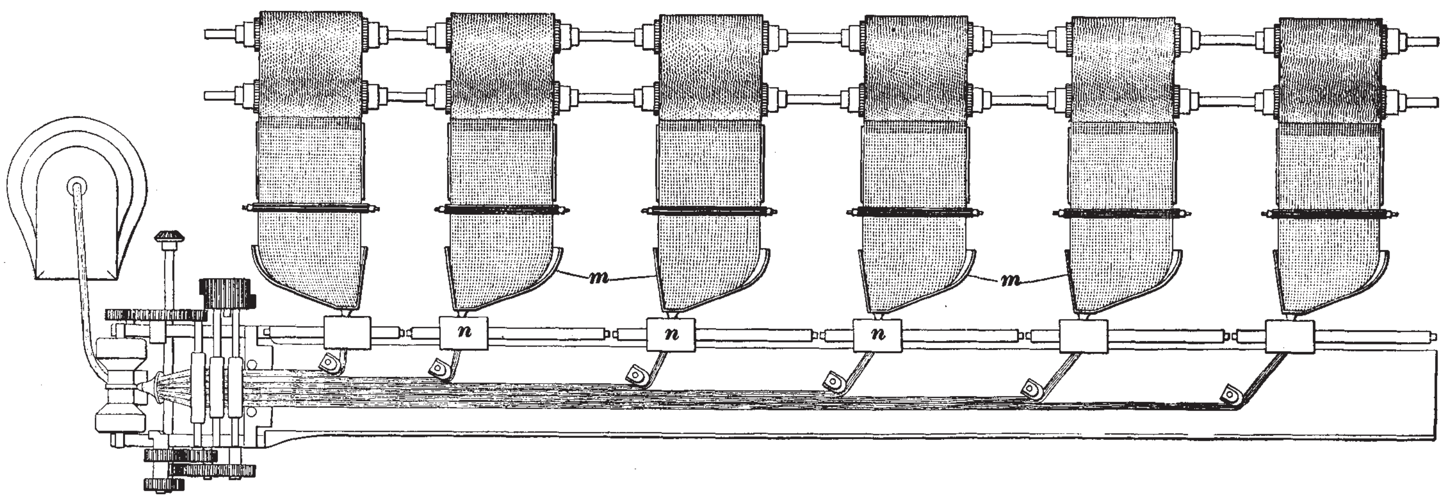


Fig. 25

the calender rolls so that the different slivers will be guided on the table and lie in a position side by side instead of crowding on one another. In this manner, the slivers are drawn along the table by the back rolls of a set situated in the draw-box shown in Fig. 25.

38. The Draw-Box.—Up to this point each lap and the sliver formed from each lap is treated individually. All the slivers are, however, drawn into the **draw-box** together. The draw-box has three pair of rolls, which may be either of the common or metallic types, and these rolls give to the sliver a slight draft, although the principal draft of a comber is between the feed-rolls and the table calender rolls.

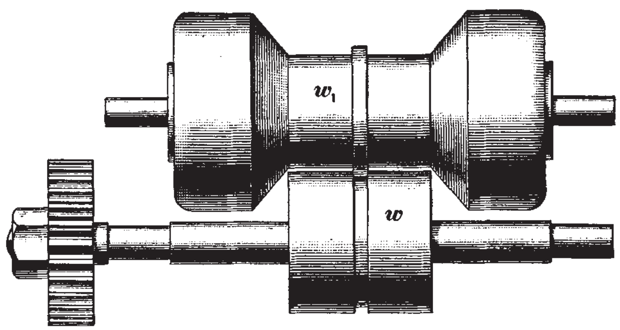


FIG. 26

39. The slivers after being subjected to the draft of the drawing rolls are drawn through a trumpet by a pair of calender rolls and are thus condensed into one sliver. The calender rolls that draw the slivers through the trumpet are different in construction from most calender rolls; they are shown in Fig. 26. The bottom roll w has a groove into which the small end of the trumpet projects, while the top roll w_1, which is driven by frictional contact, has a collar that fits into the groove of the bottom roll. As the sliver runs in the groove of the lower roll it will be effectively condensed by the top roll, which is self-weighted.

From these calender rolls the sliver passes to a coiler, which is similar to the coilers described in connection with other machines.

SUMMARY

40. As the operation of a comber is somewhat complicated, which is due to the many different mechanisms that are brought into action, a short summary will be given here, as an aid to the understanding of the operations as a whole.

In order to bring the cotton into a position to be combed, it is first necessary that a certain length should be delivered by the feed-rolls. After the cotton has been fed by these rolls, the nipper knife descends and not only grips it firmly but also, by depressing the cushion plate, brings the fringe of cotton into a suitable position to be acted on by the needles of the half lap. The cylinder is in such a position that, when the nipper knife has completed its downward motion, the first row of needles on the half lap enters the end of the fringe of cotton, and, as the cylinder revolves, the successive rows of needles remove all the fibers that are too short to be retained by the nippers, as well as the neps that have been left in the cotton. After the needles on the half lap have passed the fringe of cotton, the ends of the fibers fall into the gap left between the needles and the segment, and the nipper knife, together with the cushion plate, begins to rise. When the cushion plate has reached its uppermost position, the further lifting of the nipper knife releases the fibers at this point. During this operation the portion of the cotton previously combed has been brought back and is now ready to be pieced up with the cotton that has just undergone the combing operation by the half lap.

The cylinder having revolved until the fluted segment is in the desired position, the detaching roll descends and grips the cotton firmly between itself and the fluted segment. The further revolving of the fluted segment, together with the detaching roll, draws away the fibers that are not held by the grip of the feed-rolls, and since the top comb has by this time dropped into such a position that it protrudes into the end of the lap just in advance of the portion that has not been cleaned by the needles of the half lap, it efficiently combs this portion of the fibers. At the beginning of this operation the forward ends of the fibers being combed are carried forwards sufficiently to overlap the rear ends of the fibers that were returned; consequently, the forward rotation of the delivery roll, which occurs while the detaching roll is in contact with the segment, assists in piecing up the fibers just detached to those previously combed, and delivers them into the pan.

It should be clearly understood at this point that all the fibers do not project from the feed-rolls to the same extent at one time. For example, some of the fibers may not be gripped by the feed-rolls at all, while other fibers may project beyond the feed-rolls a quarter of their length, some half of their length, and some three-quarters of their length; consequently, when the detaching action takes place, only those fibers that project entirely beyond the feed-rolls are gripped and drawn forwards by the action of the detaching roll and fluted segment, while those fibers that project only partly beyond and are still gripped by the feed-rolls form a fringe of cotton that is always present in front of the feed-rolls. At the next delivery of the feed-rolls those fibers that previously projected only partly beyond the rolls may now project entirely beyond the rolls, and consequently at the next detaching operation these fibers will be drawn forwards in a manner similar to those previously detached.

From the delivery roll, the cotton passes into the pan, through the trumpet, between the table calender rolls, and is delivered on to the table, along which it is drawn together with the other slivers that have been delivered by the various heads. From the table the slivers pass to the draw-box, where they are given a slight draft, after which they pass through a trumpet and between a pair of calender rolls, where they are condensed into one sliver. From the calender rolls the sliver passes to the coiler and then to the can.

GEARING

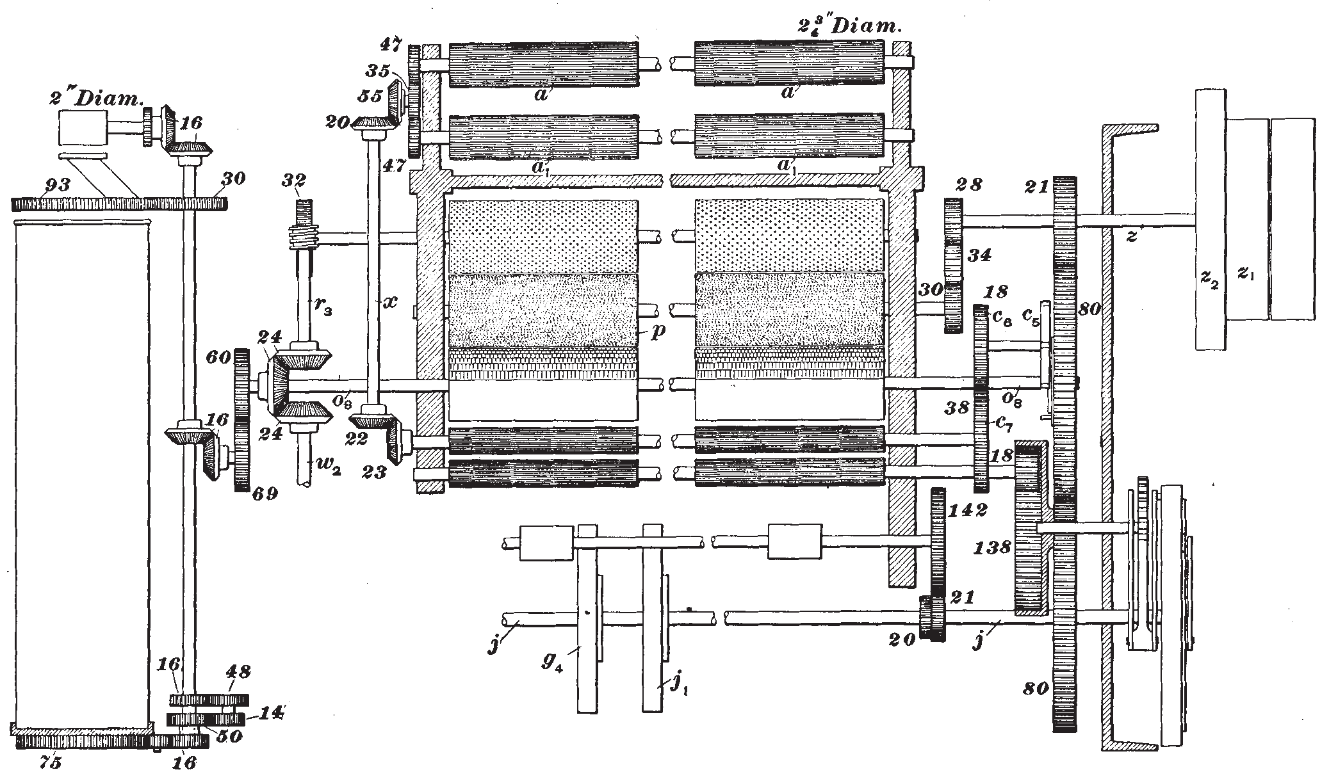
41. A plan of the gearing of a comber is shown in Fig. 27, and from this figure the manner in which the various mechanisms receive their motions may be seen. The pulley z_1 is driven from the shafting of the room. This pulley is firmly keyed to the short shaft z, which is carried by the framing and steadied in its motion by the balance wheel z_2 in order to prevent a variation of speed, which might be caused by the intermittent actions of some of the parts of the comber.

On the shaft z is fixed a pinion of 21 teeth, which drives a gear of 80 teeth on the cylinder shaft o_8. Meshing with the gear of 80 teeth on the cylinder shaft is a gear of 80 teeth on the cam-shaft j; consequently, the cam-shaft and cylinder shaft revolve at the same speed. On the cam-shaft, the positions of the various cams are shown, these being the nipper cam g_4, the cam j_1 for placing the detaching roll in its required position, and the cams s_1, s_2, Fig. 20, these two latter cams being situated at the extreme right of the cam-shaft in Fig. 27. The shaft supporting the lower table calender rolls is driven from the cam-shaft as shown.

Combers were first constructed with a short cam-shaft, and the cams were placed nearer the driving end of the machine. The connections to the shafts from which the nippers receive motion and from which the detaching roll is placed in position were at one end of these shafts. When constructed in this manner, the torsion on the shafts was such that the parts for each head that received motion from these shafts did not work simultaneously. The first remedy was to make the shafts larger, but later the combers were constructed with the nipper and lifter cams in the center of the comber, so that the connection was made to the centers of the shafts that they operated.

The disk containing the pin from which the feed-roll receives motion, as shown in Fig. 10, is attached to the gear of 80 teeth on the cylinder shaft. The star gear c_5 of 5 teeth, shown in Fig. 27, is on a short shaft, the other end of which carries the draft change gear c_6, which drives a gear c_7 on the feed-roll. At the other end of the feed-roll is a gear that, by means of the shaft x, drives the lap rolls a, a_1.

The brush p, which cleans the needles of the half lap used in the combing process, is driven from the shaft z through



2" Diam.
16
93
30
32
r_3
x
24
60
24
o_8
16
w_2
22
23
69
20
55
35
47
47
$2\frac{3}{4}$" Diam.
a
a
a_1
a_1
p
28
34
30
18
c_6
c_5
o_8
38
c_7
18
142
138
21
20
21
80
80
z
z_2
z_1
j
g_4
j_1
j
16
48
14
50
75
16

Fig. 27

a carrier gear, change gears being provided for driving the brush shaft at different speeds. The cylinder shaft at its end opposite to that of the gear of 80 teeth has a gear that drives the doffer by means of the shaft r_3, and also the drawing rolls of the draw-box and the calender rolls by means of the shaft w_2. From this end of the cylinder shaft, the coiler is driven by the gear of 60 teeth, change gears being provided so that the speed of the coiler may be altered in order to have the coiler properly take up the sliver. The comb for removing the waste from the doffer is not shown in the figure, but it is driven by a simple crank-motion, the stud that turns the crank being at the extreme inner end of the shaft z.

42. The draft for the gearing shown in Fig. 27, with an 18-tooth draft change gear, figuring from the 2-inch coiler calender roll to the $2\frac{3}{4}$-inch lap roll at the back of the comber, is as follows:

$$\frac{2 \times 16 \times 16 \times 60 \times 5 \times 38 \times 22 \times 55 \times 47}{16 \times 16 \times 69 \times 1 \times 18 \times 23 \times 20 \times 35 \times 2\frac{3}{4}} = 23.579$$

As the comber removes a very large percentage of waste from the cotton that passes through it, it is not possible to figure accurately the weight of the sliver produced by simply taking into consideration the weight per yard of the lap fed in, the number of doublings, and the draft of the machine. An example will make this point clearer.

Example.—Suppose that a comber with a draft of 23.579 has six laps up at the back, each lap weighing 260 grains per yard, and it is desired to find the weight per yard of the sliver delivered.

Solution.—Multiplying the weight per yard of the laps fed in by the number of laps, and dividing by the draft gives 66.1605 grains as the weight per yard of the sliver delivered; $\frac{260 \times 6}{23.579} = 66.1605$. If 20 per cent. of the cotton that passes through the machine is taken out as waste, the result obtained above must be diminished by 20 per cent., in order to obtain the actual weight per yard of the sliver delivered; 20 per cent. of 66.1605 is 13.2321, which deducted from 66.1605 gives 52.9284 as the grains per yard of the sliver produced. Ans.

VARIATIONS IN CONSTRUCTION

43. Quadrant Motion.—A different mechanism for imparting the rotary motions to the delivery roll is shown in

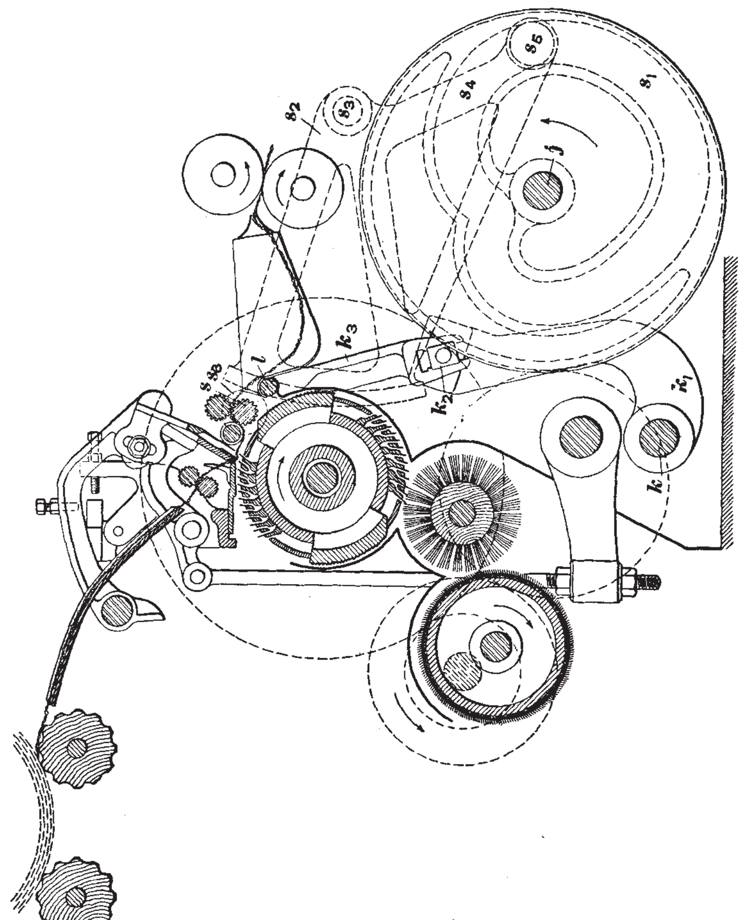


FIG. 28

Figs. 28, 29, and 30, and is applied to combers that have their other parts constructed in a manner similar to those described.

This mechanism consists of a cam s_1 known as the *quadrant cam*, which is fast on the cam-shaft j. Working in the cam-course is a bowl s_5 that is supported by the lever s_2 centered at s_3. The other end of this lever contains teeth, and it is from the shape of the lever that the name quadrant is derived. The toothed portion s_4, Fig. 30, of the lever s_2 connects with a gear s_6 loose on the delivery roll s. At one end of the gear s_6 is one part of a clutch that, when brought in contact with the other part s_7 that is fast to the delivery roll s, will impart any motion of the gear s_6 to the delivery roll. The cam v_1, Fig. 30, which is also on the cam-shaft, by means of the lever v_2 that is centered at v_3, moves the part of the clutch that is loose on the delivery roll into, and out of, contact with the other part. It will be seen that with this construction the delivery roll will receive motion from the cam s_1 during the time that the parts of the clutch are held in contact by the cam v_1. When in action, the clutch is first connected by means of the cam v_1 acting on the lever v_2, Fig. 30, the clutch corresponding to the pawl v_2 in the mechanism previously described.

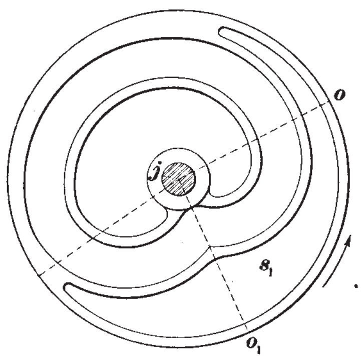


FIG. 29

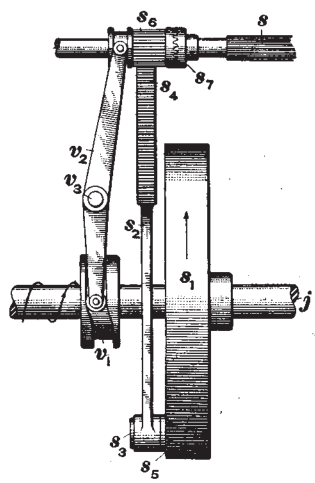


FIG. 30

The delivery roll then begins to turn back as the bowl of the cam s_1 leaves the line o, Fig. 29, and approaches the line o_1. At the line o_1, the cam-bowl commences to move from the center of the cam-shaft, thus reversing the motion of the delivery roll. This reverse motion ceases when the clutch is disconnected by means of the cam v_1, Fig. 30, which occurs at the time that the cam-bowl s_6 is about to enter that part of the cam-course that is nearly concentric with the cam-shaft. The points at which the clutch is connected and disconnected will govern the character of the piecing in the same manner as the action of the pawl described in connection with Figs. 20, 21, and 22.

44. Another method of lifting the leather detaching roll is shown in Fig. 28. On the lifter shaft k is an arm k_1 that carries a stud on which works loosely a square block k_2; on the shaft l is an arm k_3, on the lower end of which is a cut-out into which the square block k_2 fits. As the arm k_1 is moved by the action of the lifter cam, it, in turn, moves the arm k_3 and shaft l and so lifts and lowers the leather detaching rolls. One point of improvement claimed for this method is that there is less lost motion, and therefore a more accurate setting of the leather detaching roll is obtained.

Another method of lifting the leather detaching roll is to connect the shafts l directly to the lifter cams, using a separate cam for each shaft, which usually operates the rolls for two heads.

DOUBLE-NIP COMBER

45. Purpose.—In order to obtain a greater production than is obtained with a comber constructed as previously described, machines known as **double-nip combers** are built. These combers act on two portions of cotton during each revolution of the cylinder, whereas in a single-nip comber only one portion of cotton is treated for every revolution of the cylinder.

46. Construction.—The cylinder of a double-nip comber contains two half laps and two fluted segments, but the half laps have only thirteen rows of needles in place of the seventeen of the single-nip comber, since two half laps of seventeen rows each would occupy too much space. The segments are also made correspondingly narrower. The segments and the half laps are arranged alternately on the cylinder with slight spaces between them, in order that the cotton may assume the positions shown in Fig. 16 and thus be properly pieced up. A sectional view of a double-nip comber equipped with a clutch and quadrant is shown in Fig. 28.

In order that a portion of cotton shall be presented to each half lap, or that the feed-rolls shall receive motion twice for every revolution of the cylinder, another pin is placed on the disk plate, shown in Fig. 10, in such a position that the two pins will be exactly opposite each other. The other intermittent motions of the machine must therefore have two movements for each revolution of the cylinder shaft; this is provided for by having the gearing arranged in such a manner that the cam-shaft receives two revolutions for every revolution of the cylinder shaft, thus causing the parts that receive their movement from the cams on the cam-shaft to perform their work twice during this time.

47. A comber with a double nip gives a greater production than a comber with a single nip, but does not, however, clean the cotton so well, because of the smaller number of needles acting on the fringe. Another disadvantage of the double-nip comber as compared with the single-nip comber is due to some of the parts running at such a high speed that they not only wear out more quickly but easily get away from their proper settings and timings, thus producing bad work.

COMBERS

(PART 2)

SETTING AND TIMING

INTRODUCTION

1. Aside from the general construction of a comber, two subjects closely related to the machine and very important to the success of the combing process that should be considered in this connection are *setting* and *timing*. The **setting** of a comber implies regulating the distance between its working parts by gauges. **Timing** is a process that has arisen from the fact that a comber is intermittent in its action and that it is therefore necessary to time the motions of its various parts so that they will be performing their work when some working part that is taken as a basis for timing is performing a certain operation.

Although the range within which these settings and timings can be regulated and worked successfully is very limited, it is very seldom that two persons in charge of combers will agree on these questions. The principal points to be taken into consideration, however, are the length of the staple of the cotton to be used, the weight of the lap fed, the kind of cotton used, the quality of the work required, and, as a consequence of the last, the amount of waste to be combed out.

It is obvious that a different combination of settings and timings will be required when cotton with $1\frac{1}{4}$-inch staple is being used than when the cotton has a $1\frac{3}{4}$-inch staple. This is also true in connection with medium or low grades of combed yarn as compared with fine yarns, since it is not necessary to take out so much waste in the former case.

SETTING

2. Gauges.—The several kinds of gauges used in setting a comber are shown in Fig. 1, and include the regular comber gauge (*a*), the step gauge (*b*), the finger gauge (*c*), the quadrant gauge (*d*), the cradle gauge (*e*), and brush gauge (*f*).

1. *Comber Gauge.*—There are several gauges similar to *a*, the blades of which vary from No. 12 to No. 28 in thickness. They are numbered according to a wire gauge and decrease in thickness as the numbers increase, a No. 20

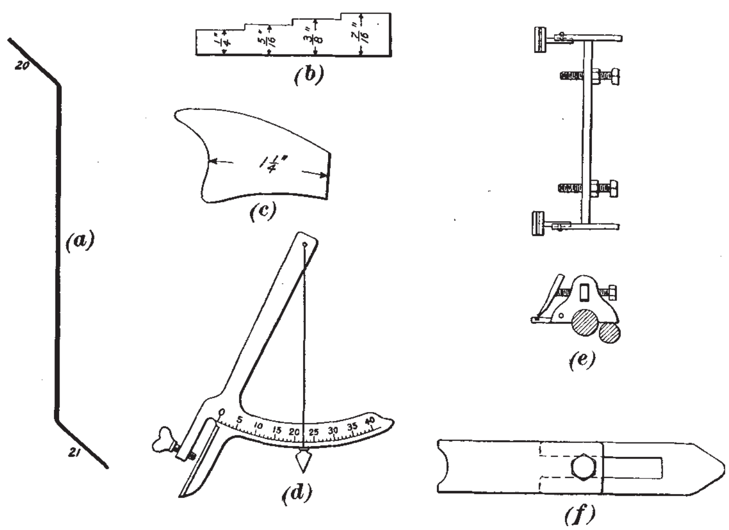


FIG. 1

meaning that the gauge is equal in thickness to a No. 20 wire. These gauges are about $\frac{5}{8}$ inch wide, and usually about $4\frac{1}{2}$ inches long. Each really consists of two gauges, one at each end; for example, the one shown in Fig. 1 (*a*) has a No. 20 gauge at one end and a No. 21 gauge at the other end. For settings finer than a No. 23 gauge, strips of paper are sometimes used, although this method is not as reliable as the use of the regular gauges.

2. The *step gauge* (*b*) is composed of one piece with steps, each step being $\frac{1}{16}$ inch thicker than the preceding one. The

first step is generally $\frac{1}{4}$ inch in thickness. The width of this gauge is about $\frac{1}{4}$ inch.

3. The *finger gauge* (*c*) is measured from the arrowhead on the curved portion to the arrowhead on the straight end and varies from $1\frac{1}{8}$ inches to 2 inches in length; it is about $\frac{3}{16}$ inch in thickness.

4. The *quadrant* (*d*) is used for determining the angles of top combs.

5. The *cradle gauge* (*e*) is used to hold the top comb in position while it is being fastened to the comb arms.

6. The *brush gauge* (*f*) is used for setting the brush shaft parallel to, and at the required distance from, the cylinder shaft.

Assuming that a comber has merely been set up and that the cylinders are loose on the cylinder shaft, the parts that require setting with gauges and the gauges used for making each setting are given in Table I.

TABLE I

Parts to be Set	Gauge	Size of Gauge
Delivery roll from segment	Comber	No. 23
Front flute of segment from delivery roll	Finger	$1\frac{1}{8}$ inches
Feed-roll from delivery roll	Finger	According to staple
Cushion plate to nipper knife	With paper	
Distance of setscrew i_3 from stand when *d* is down, Fig. 3	Step	$\frac{1}{4}$ to $\frac{3}{8}$ inch
Cushion plate from delivery roll	Finger	According to staple
Distance of nipper from half lap when nipper is in its lowest position	Comber	No. 20
Brush to half lap	Brush	
Top comb set at angle of from 25° to 30°	Quadrant	
Top comb from fluted segment	Comber	No. 20 or 21
Distance of blocks l_3, Fig. 8, from bearings of detaching roll when resting on segment	Comber	No. 23
Top roll from leather detaching roll	Comber	No. 21

3. Setting the Various Parts.—1. In making any setting in any machine, some one point, usually a shaft, is taken as a basis. In the comber, the cylinder shaft is primarily the base of all settings, from the fact that the cylinder, which is used to set from for certain settings, is centered on that shaft; but as the delivery roll is a more convenient point from which to work when making certain of the settings, it is given a true and accurate setting with a certain definite relation to the cylinder, and after being certain that it will revolve freely in its bearings, these bearings are secured, and the delivery roll becomes the base of certain of the settings of the comber.

The cylinder shaft and delivery roll of the comber revolve in bearings that do not have any motion during the various operations of the comber, and which after the first setting have a definite relation to each other as to distance. The fact that the cylinder can be moved on the cylinder shaft does not affect the distance between the faces of the segment, or the half lap of the cylinder, and the face of the delivery roll.

In order to have the cylinder and delivery roll in their proper relative positions, it is first necessary to *line up* the delivery roll, which is done by presenting each fluted segment of the comber to the delivery roll and moving the bearings of the delivery roll until the space between the surface of this roll and the surface of each fluted segment is equal to a No. 23 comber gauge. The distance should be tested at both ends of each segment. When this has been done, the cylinder shaft and all parts carried on the cylinder shaft have a definite relation as to distance from the delivery roll, and although certain settings are made from either base, they do not conflict with one another.

2. *Front Flute of Segment From Delivery Roll.*—After setting the delivery roll and being positive that it revolves very freely in its bearings, the index gear (which will be described later) should be placed at 5, after which the cylinders are fastened on the cylinder shaft. One cylinder is first secured so that the front edge of its fluted segment

approaches within a certain distance of the face of the delivery roll, after which each of the other cylinders of the comber is set with its fluted segment the same distance away. When this has been done, the first flutes of all the segments across the comber will be in one straight line. A finger gauge $1\frac{1}{8}$ inches long may be used, but care should be taken in making this setting that the position of each segment is accurate, since the perfect alinement of these parts is vital to the quality of the product.

When making this setting, the curved face of the finger gauge is placed on the flutes of the delivery roll and the cylinder turned on its shaft until the front part of the segment comes in contact with the opposite face of the gauge. The space between these two parts should first be tested at one end of the segment, and when this end is in its correct position the cylinder is secured by means of a setscrew to the shaft at this end, after which the gauge is passed along the length of the segment to make sure that it is the correct distance at all points from the delivery roll; the cylinder is then fastened at its other end by means of a setscrew. The same method is adopted with each of the other cylinders, care also being taken to have all the cylinders exactly in the centers of the heads.

3. *Feed-Roll From Delivery Roll.*—Setting the feed-roll from the delivery roll is accomplished by moving the bearings of the feed-roll. This is a very important setting, since if these rolls are not exactly parallel, there will be a strain on the fibers at one side and only a partial detachment of the fibers on the other side during the operation of detaching. The feed-roll must also be parallel to the cylinder, otherwise one side of the lap will be combed more than the other. If any of these faults exist, a cloudy and uneven web will be produced. The finger gauge is used for this setting; its curved face should be on the flutes of the delivery roll, while the opposite face should be in contact with the flutes of the feed-roll, but these rolls should not be set so close that the gauge cannot have an easy upward movement. The distance should be tested at both ends of each fluted section.

This setting of the feed-roll varies according to the staple and nature of the stock, as shown in Table II.

TABLE II

Cotton	Length of Staple Inches	Size of Gauge Inches
American	About $1\frac{1}{4}$	$1\frac{11}{16}$ to $1\frac{13}{16}$
Egyptian	Up to $1\frac{1}{2}$	$1\frac{13}{16}$ to $1\frac{15}{16}$
Egyptian and sea-island	$1\frac{1}{2}$ and longer	$1\frac{15}{16}$ to 2

4. *Cushion Plate to Nipper Knife.*—Before setting the nippers, the cushion plate must be adjusted so that the nipper knife, when down, will be in contact with the cushion plate at an even pressure throughout its entire width. If it does not touch along its entire edge, the fibers will be held tightly at one side, while on the other side they will be held loosely. The cotton that is not held securely by the nippers will be pulled out by the half lap and eventually arrive at the waste can, causing a waste of good cotton.

The efficiency of the half lap also depends on this setting. Care must also be taken that the *nose*, or front edge, of the cushion plate is evenly and properly covered, in order that it may present a perfectly even surface along its entire length. In setting the parts, two strips of ordinary writing paper, one at each end of the knife, should be placed between the front part of the cushion plate and the overhanging lip of the nipper knife, and the setting between these parts made as close as possible and yet allow the two strips to be easily drawn from between the lip of the knife and the round nose of the cushion when the knife is in contact with the cushion plate. The same test is then made in the center and between the ends and the center. The fluted edge of the knife should be set so that a narrow strip of paper will be held firmly between the cushion plate and the nipper knife when the knife is pressed down on the cushion plate.

Setting the cushion plate to the nipper knife is performed by loosening three screws similar to h_4, Fig. 2, and moving the plate to the knife by screws similar to h_5. After the proper setting has been secured, the screws h_4 are screwed as tightly as possible.

5. *Distance of Setscrew From Stand.*—Before the cushion plates are set to the delivery roll, the setscrew i_3, Fig. 3, should be adjusted. In making this setting, it is a good plan to have the screw project through the arm i_2 so that when it is resting against the stand f, the arm i_2 will be in a perpendicular position. This can be accomplished by holding a level on the front face of the arm i_2 and turning

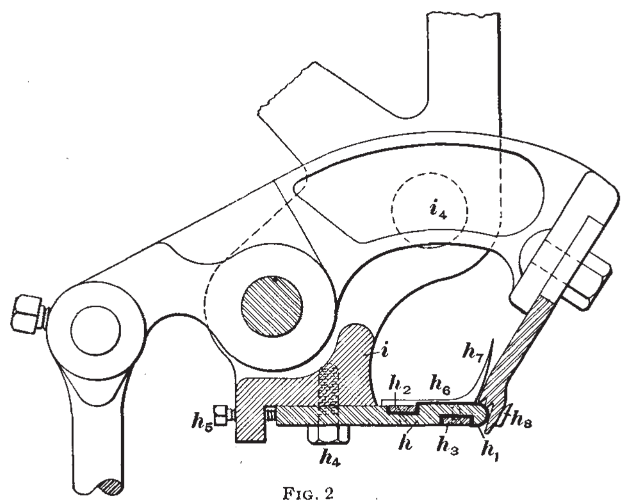


Fig. 2

the screw i_3 until the arm i_2 is in the required position. This should be done at each head. The only object of this setting is to have each head set alike and thus have some definite basis to work from when making future settings.

6. *Cushion Plate From Delivery Roll.*—It is now necessary to set the cushion plates the desired distance from the delivery roll. The position of the cushion plates with relation to the portion i and the nipper knife has been determined and must not be disturbed; therefore, in order to adjust any one of the cushion plates to the delivery roll, the whole nipper mechanism must be moved. In making the setting between the

cushion plate and the delivery roll two operations are employed. In the first case a general setting is made by loosening the bolts (not shown in Fig. 3) that attach the

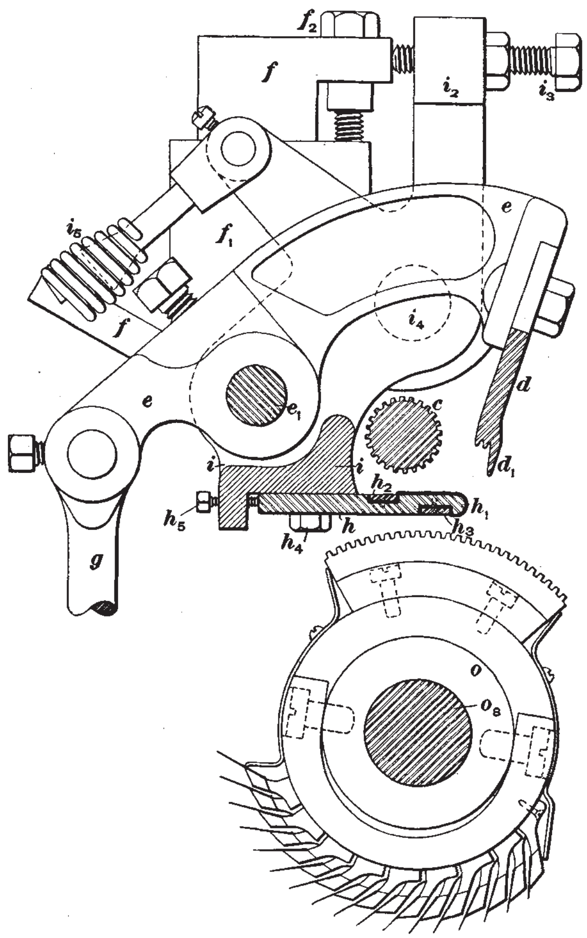


Fig. 3

nipper-mechanism stands f to the framework, and moving this mechanism on the framework nearer to, or farther from, the delivery roll until the cushion plate is exactly the same distance from the delivery roll at each end, which insures the delivery roll and the nose of the cushion plate being parallel. Afterwards a more accurate setting is made by means of the setscrews i_3.

The entire operation is as follows: After loosening the bolts that attach the nipper-mechanism stands *f* to the framework, the finger gauge is placed with its curved face on the delivery roll and the nipper mechanism moved forwards until the round nose of the cushion plate is against the straight face of the gauge. This distance is tested at each end of the cushion plate and at intervals between. When the cushion plate has been set parallel to the delivery roll, the nipper mechanism is tightly secured on its seat by means of the bolts. Next, the gauge is again inserted at each end of the cushion plate and at intervals along the plate, and by means of the setscrew i_3 the setting is made so close that the gauge cannot have an easy vertical movement.

As the bracket *i* that carries the arm i_2 swings on the center i_4, the effect that is produced on the nipper mechanism by moving the setscrew i_3 can readily be seen. The settings of the cushion plate are governed by the length of the staple, the class of cotton, and the weight of the lap used. General settings for this part of the comber are given in Table III.

TABLE III

Cotton	Length of Staple Inches	Size of Gauge Inches
American	$1\frac{1}{4}$	$1\frac{1}{8}$ to $1\frac{3}{16}$
Egyptian	$1\frac{1}{4}$ to $1\frac{1}{2}$	$1\frac{3}{16}$ to $1\frac{1}{4}$
Sea-island	Over $1\frac{1}{2}$	$1\frac{1}{4}$ to $1\frac{7}{16}$

7. *Distance of Nipper From Half Lap When Nipper is in Its Lowest Position.*—The setting of the nipper to the half lap is performed by the sliding bracket f_1, Fig. 3, and setscrew f_2. The bolt holding the sliding bracket f_1 should be loosened and a step gauge placed between the end of the setscrew i_3 and stand *f*. The object of inserting a step gauge at this

place is to swing the nipper mechanism on the center i_4 until the nipper knife is in exactly the same position that it assumes when the cotton is being combed by the needles on the half lap. A step gauge must therefore be selected that gives the exact throw to bring the nipper knife into the required position. During this setting, however, the nipper knife is pressed down on the cushion plate and the lip d_1 projects beyond this plate. The setting is made by inserting a No. 20 comber gauge, Fig. 1 (*a*), between the edge of the nipper knife and the needles of the half lap. The cylinder shaft should be turned so that the points of the needles come directly under the edge of the nipper knife. Each end of the nipper is then accurately adjusted by either raising or lowering it by means of the setscrews f_2. The cylinder shaft should then be turned and the gauge inserted between each row of needles and the nipper knife.

When the setting is completed, it should be possible to move the gauge the entire width of the nipper without too much resistance. In passing the gauge between the nipper knife and the needles, it is a good plan to slide the gauge on the edge of the knife, that being a smooth surface. When this setting has been completed, the bolts that hold the sliding brackets f_1 to the stands f should be tightened. The springs i_8 should next be put on and adjusted to the proper tension. This may be done by the nuts on the spring screw. This method of setting is of course adopted at each head on the comber.

8. *Setting the Top Comb.*—One of the top combs should next be set at an angle of from 25° to 30°. When making this setting, the detaching roll should be on the fluted segment in position to detach, and particular care taken to have the top comb set so that it will not come in contact with the nippers or leather detaching roll. The brackets u_1, Fig. 4, should be loose on the shaft u_2 so that they will allow the adjustment of the comb. The screws holding the comb to the brackets u_1 should also be loose. The quadrant gauge is used in making this setting, it being so constructed that its lower part fits over the blade of the comb, to which it

is secured by a thumbscrew. The comb is so set that the plumb-bob on the gauge will fall in a position to give the correct angle, which can be learned from the scale on the gauge. When the top comb is at the correct angle and not in contact with either the nippers or leather detaching roll, the screws that fasten the comb at each end to the brackets u_1, Fig. 4, should be secured.

After one comb has been placed in position with the use of the quadrant gauge, the remaining top combs to be set are in some cases placed in position by what is known as a **cradle,** Fig. 1 (*e*), which consists of a casting having two bearing points for the comb to rest on and two setscrews that bear against the blade of the comb. By moving these setscrews, the comb may be held at any desired angle. Having set one comb, the cradle is set on the fluted segment, the base of the cradle being curved to conform to the curvature of the segment. The top comb, which has been set by the quadrant gauge, is then lowered on to the cradle and the screws of the cradle regulated so that they just bear against the blade of the comb. After having regulated the screws of the cradle, it is merely necessary, when it is desired to set another top comb, to place it in the cradle and then place the cradle on the fluted segment and secure the comb to the brackets u_1, Fig. 4, while the comb is held in position, after which the cradle is removed.

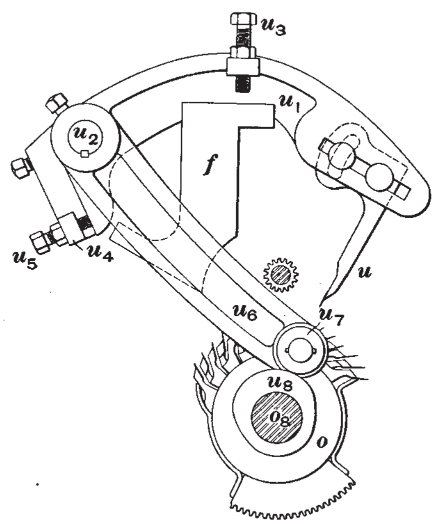


FIG. 4

The quadrant gauge of course could be used for each head, but it saves time and is sufficiently accurate to use the cradle gauge after the top comb of the first head has been set, especially when a large number of combers have to be set.

9. *Top Comb From Fluted Segment.*—When the top comb has been set to the proper angle, the distance between it and the fluted segment is regulated by means of the screws u_3, Fig. 4. A No. 20 gauge may be used and the comb adjusted so that the gauge will pass between it and the fluted segment without too much resistance. In passing the gauge between the top comb and fluted segment, it is a good plan to slide the gauge on the fluted segment and drop the comb so that the points of the needles can be felt as the gauge passes under them. The same method of setting the top comb is then employed at each head of the comber. When the top combs have all been set the proper distance from the fluted segment, the brackets u_4 should be secured to the shaft u_2 and the screws u_3 adjusted. To accomplish this, the cam u_8 on the cylinder shaft is turned so that the bowl u_7 will be on the part of the cam nearest the center. A gauge about the thickness of a No. 18 comber gauge is placed between the bowl and the cam, and the brackets u_4 secured to the shaft u_2 while it is held in this position. The setscrews u_5 should now be set so that a piece of paper can be drawn between the ends of the screws and the projections on the brackets u_1. These screws should be adjusted so that the paper will be drawn out at an even tension at each head. Care should be taken while this is being done that the screws u_3 are resting on the stands f. After all these brackets have been set, the gauge should be removed and the lever u_6 raised by hand; by watching carefully, it may then be ascertained whether or not the top combs move exactly together.

The last two settings mentioned in Table I are more readily made after certain of the timings have been made, and will be described later.

MINOR SETTINGS

4. **Adjusting the Nipper Rods.**—The connections may now be made between the nipper cam and the brackets e, Fig. 3, that operate the nipper knife. To accomplish this,

disconnect the cam-shaft from the cylinder shaft by sliding the gear on the cam-shaft out of gear with the one on the cylinder shaft with which it meshes. The cam-shaft should

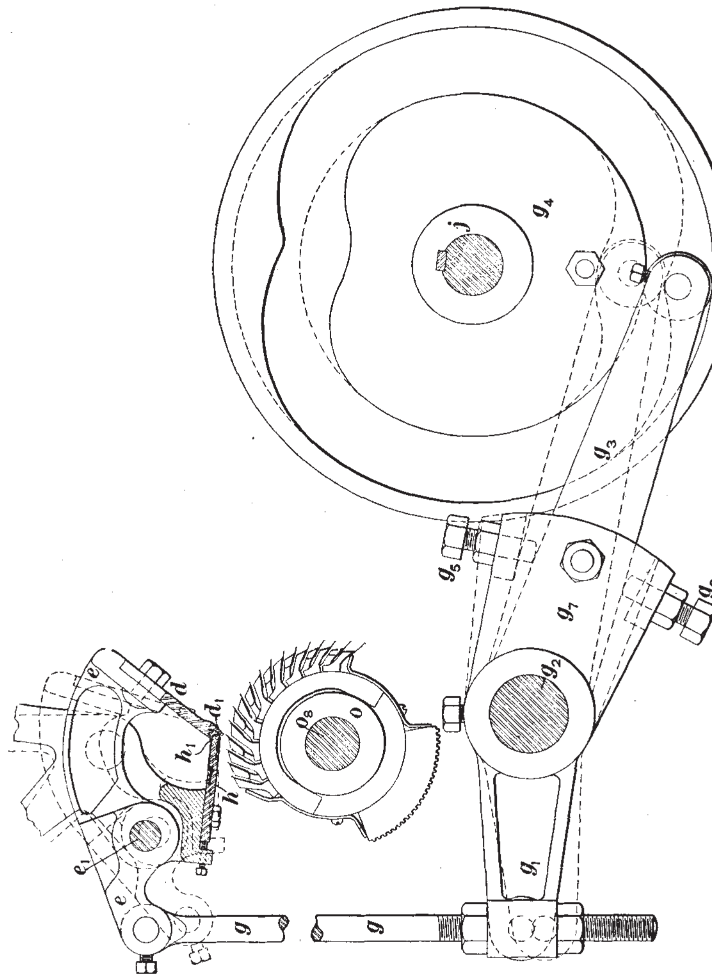


FIG. 5

then be turned until the cam-bowl operated by the nipper cam g_4, Fig. 5, is in the position that it should occupy when the cushion plate is at its lowest position; that is, the cam-bowl will be at the toe of the cam, or the point farthest from the center of the cam, as shown in full lines, Fig. 5. When the cam-bowl is in this position, place the step gauge between the end of the setscrews i_3 and the stands f, Fig. 3, and connect the rod g, Fig. 5, to the bracket g_1 and nipper bracket e, Fig. 3, commencing with the rod nearest the driving end of the machine and setting that rod in each head. These rods should be so adjusted by the nuts at the bottom of the rods that the step gauge may be moved between the stand and the screw i_3 without a great amount of resistance. When this has been accomplished, the other rods of each head similar to g may be connected and adjusted in like manner. After this is done, the step gauge should pass between the ends of all the screws i_3 and the stands f with the same resistance.

The step on the step gauge to be used between f and i_3 depends on the distance that the cushion plate has to be depressed in order to bring it in the proper position for combing; a $\frac{1}{4}$-inch or $\frac{3}{8}$-inch gauge is generally used.

The cam-shaft and cylinder shaft may now be connected. Before this is done these two shafts should be placed in their correct relative positions. First, the cam-shaft should be in the same position that it occupied in making the previous setting; that is, the cam-bowl on the nipper cam should be in a position farthest from the center of the cam. Next, the cylinder shaft should be turned so that the pointer will stand at 17 on the index gear. The gear on the cam-shaft may then be placed in gear with the gear on the cylinder shaft and secured by bolting it to the flange of the sleeve on the cam-shaft.

5. The Revolving Brush.—The revolving brush p, Fig. 6, that cleans the needles on the half lap should be set so that the ends of the bristles will just touch the brass bars that hold the needles. This setting is governed by the extent to which the brush cleans the needles. If it is noticed that waste remains on the half lap after the needles have been brushed, the brush should be set closer, although no attempt should be made to set the brush so near to the half lap that

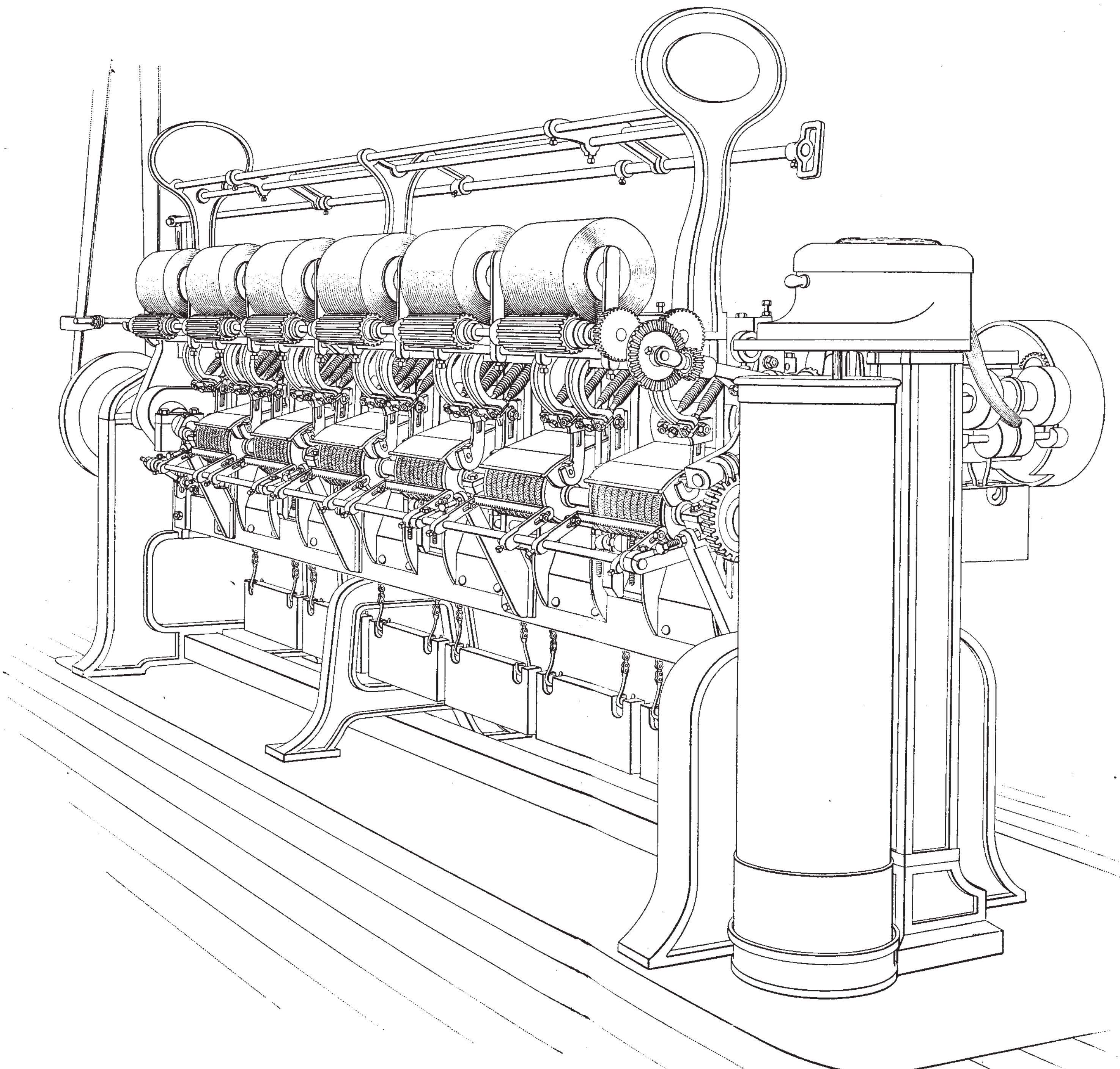


Fig. 7

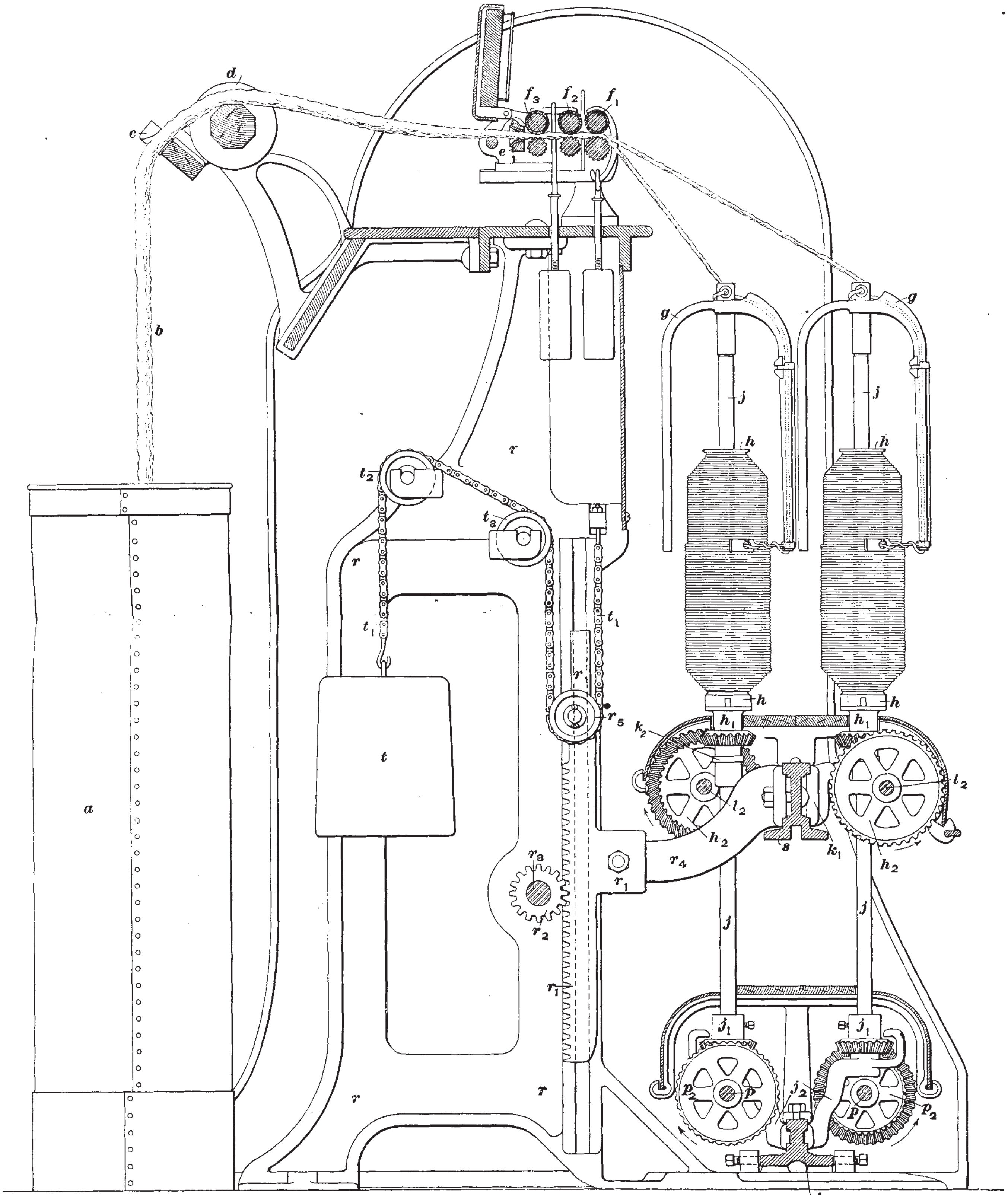


FIG. 3

§ 24 15405

Double-page spread rotated 90° and reduced to 67% to fit on page.

those small portions of cotton that become wedged in the spaces between the bars holding the needles will be removed, since these small portions are held so firmly that it is usually necessary to pick them out with a piece of sheet metal.

The bearings of the brush shaft are held in slides in upright supports, and when it is desired to set the brushes the nuts that hold the bearings of the brush shaft are loosened and the position of this shaft regulated by screws similar to the screw p_2, Fig. 6. These screws are connected to the brackets that support the brush shaft and their heads are in contact with projections on the framing. An adjustable gauge sometimes used for setting the brush shaft is shown in Fig. 1 (f), and is composed of two parts, one having a slot through which a bolt passes, thus allowing the gauge to be made longer or shorter and held at any desired length by the bolt. One part of the gauge has a curved face similar to the finger gauge, while the other part is brought to a point at one end. When it is desired to set the brush shaft closer, the gauge is set so that the length from the center of the curve to the point is slightly less than the distance between the circumferences of the brush shaft and cylinder shaft. The curved face of the gauge is then placed on the brush shaft and this shaft moved nearer the cylinder shaft until the point of the gauge comes in contact with the latter. The gauge should be tried at both sides of every head. The brushes of the heads are all on one shaft, and consequently in setting them care should be taken not to set one so much out of line with the others that the shaft will bind in its bearings.

6. The Doffer.—The doffer r, Fig. 6, which receives the waste cotton from the brush, should be set about $\frac{1}{16}$ inch from the brush. The bearings of the doffer shaft are moved by means of screws similar to the one shown at r_1, Fig. 6. The doffers for all of the heads are carried on one shaft, and in setting them care must be taken to see that this shaft can revolve freely in its bearings. The bearings of the doffer-comb shaft are attached to the bearings of the doffer shaft, so that the relative positions of the doffer and doffer comb are not changed when the doffer shaft is set closer to the brush shaft. Adjustments are provided, however, for setting the doffer comb to the doffer by having slots in the brackets that support the comb. The comb should be set about $\frac{1}{16}$ inch from the doffer at the lowest point of its stroke and at an angle of about 30° from the perpendicular at the upper part of its stroke.

7. Top Feed-Roll.—The top feed-roll is now placed in position and adjusted so that it will be parallel with the bottom feed-roll and in such a position that the ends of the arms c_2, Fig. 6, will not come in contact with the ends of the nipper bracket. The adjustment is made by moving the stud on which the arms c_2 are pivoted. The springs c_3 should now be put on and adjusted so that the tension will be equal on both ends of the roller.

The tins that cover the brushes and cylinders should be set square and true and in such a position that they will not be in contact with the cylinders, brushes, or doffers. The lap apron should be placed in position and adjusted so that it is level and true and exactly in the center of the head. The brush for cleaning the feed-roll, which is adjustable on the lap apron, should be so set that the ends of the bristles will just touch the flutes of the bottom feed-roll.

8. Sliver Pans.—The sliver pans should be placed in position and adjusted so that they set squarely on the shaft l_1, Fig. 6, and so that the trumpets are in their proper positions relative to the calender rolls.

9. Draw-Box.—The rolls of the draw-box should be set the proper distances from center to center according to the staple being run. The description of other settings will be better understood after the timing of certain parts has been considered, and therefore will be given later.

TIMING

10. After all the parts are set, the cams must be adjusted so that they will operate the different motions, or place in position the different parts that they control, at exactly the right moment when they are required to perform their work. In order to regulate this timing and indicate the time when each operation should be set in motion or each part in position, it is necessary to take some revolving part of the comber as a basis from which to work and to time all parts in relation to it. The cylinder is taken as a basis, as all the intermittent movements of the comber are completed within the time occupied by one revolution of the cylinder. It is furthermore necessary to have some means of indicating in what position the cylinder should be when each individual motion takes place or each individual part arrives in its proper position.

For this purpose, a gear of 80 teeth, on the cylinder shaft, is divided into twenty equal parts, or sections, which are numbered on the rim of the gear from 1 to 20, each section containing 4 teeth. This gear is known as the **index gear.** A vertical index finger is placed on a stationary part of the comber directly over the cylinder shaft, pointing upwards, and indicates by its relation to the position of the index gear the position of the cylinder.

The numbers are so placed that as the cylinder revolves, No. 1 is first brought opposite the index finger, then No. 2, No. 3, and so on up to 20. Each section of the index gear is spoken of as a whole number, and each tooth in a section is spoken of as $\frac{1}{4}$; that is, if the cylinder has revolved until the comber is said to be at $5\frac{1}{2}$, it indicates that the index finger is at the second tooth beyond the section marked 5 on the index gear, or 22 teeth from the section marked 20. It is sometimes the custom in a mill to read as a clock is read, the position of the gear with reference to the index finger; thus, the above timing would be read as *half-past five.* If the index is at 7, or if it is said to be *7 o'clock*, it means that the cylinder has been revolved until seven sections, or 28 teeth, have passed the index finger.

From this description it will be seen that if the motions of a comber are listed according to their precedence and the timing of each indicated according to the position of the index gear with relation to the index finger, the timing will be indicated by continually increasing numbers, and a comparison of the timings will show at a glance the relation between the different motions and the relative time that will elapse between them.

The actions to be timed are: (1) The motion of the feed-rolls; (2) the motion of the nippers; (3) the placing of the detaching roll and top roll in position for detaching; (4) removal of detaching roll from detaching position; (5) motions of the delivery roll; (6) movement of the top comb.

11. Timing the Feed.—The time when the feeding begins to take place varies from $4\frac{1}{2}$ to 6, owing to the fact that more waste is taken out of some cottons than others, and the later the feed the more waste is taken out. When combing Egyptian cotton, the feeding is done comparatively early, as the fibers of this cotton do not vary much from the average length, thus requiring the least waste to be removed; consequently, this cotton is the easiest to comb. The fibers of the sea-island cotton vary from the average length more than the fibers of other cottons that are combed, so that sea-island is fed late; Peelers and other American cottons occupy about a central position between these extremes.

When **timing the feed** the cylinder is turned to the desired position and the pin c_4, Fig. 7, so placed that it will just enter the star gear. The position of the disk c_3 that carries the pin may be changed in relation to the index gear b by means of the slot c_8, so that the time that the pin enters the star gear may be altered.

12. Timing the Nippers.—In order to time the nippers, set the index gear at 9 and loosen the nipper cam, which is bolted to a sleeve on the cam-shaft. This sleeve carries a disk that has a slot similar to c_8, Fig. 7, and the cam is fastened to the sleeve by means of a bolt passing through the cam and entering the slot, thus allowing the cam to be moved on the sleeve. This cam should be fixed on the sleeve in such a position that it will cause the screws i_3, Fig. 3, just to leave the stands when the index gear is at 9. By placing a slip of paper between the screw i_3 and the stand and pulling on it lightly, at the same time turning the driving shaft of the machine, the time when the paper is released will denote the time when the screws i_3 are leaving the stands.

If it is not possible to have the screws i_3 leave the stands when the index gear is at 9, because of the relative positions

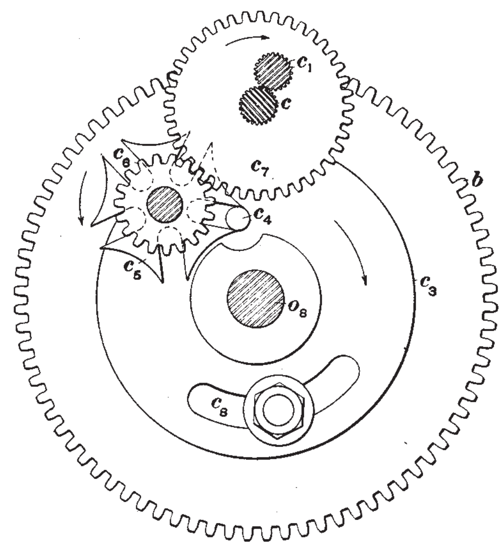


Fig. 7

of the cylinder shaft and the cam-shaft, the gear on the cam-shaft may again be moved out of gear and the cam-shaft turned until the nipper cam is in the desired position, when the gear may again be meshed with the index gear. In order to avoid the liability of having to move the cam-shaft when timing the nippers, the gears on the cam-shaft and cylinder shaft may be meshed when the index gear is at 17 and the bowl on the nipper cam is in the position it should be when the rods g, Fig. 5, are set. The relative positions of the cylinder shaft and cam-shaft will then be such that the motions received from the cam-shaft may be adjusted by slightly altering the positions of the cams on their respective sleeves, which are keyed to the cam-shaft.

The nipper knife should leave the cushion plate at about $4\frac{1}{2}$; this can also be set by placing paper in the nippers and noting when it is gripped as the driving shaft of the machine is turned. If, after having set the cam so that the screws i_3, Fig. 3, leave the stand at 9, the knife does not leave the cushion plate at exactly the proper time, a further adjustment of the nippers may be made by means of the screws g_5, g_6, Fig. 5.

The lever g_3 gives motion to the nipper shaft g_2 through the casting g_7 by means of the screws g_5, g_6. If, therefore, the nipper cam is not placed in position for the screws i_3, Fig. 3, to leave the stands when the index gear is at 9, the screws on the casting g_7 may be adjusted, changing the relative positions of the nipper shaft g_2 and the cam. These adjustments may be made until the relative position of the nippers with the cam-bowl in the cam-course is correct when the cam-bowl is at any point in the course.

13. Placing the Detaching Roll and Top Roll in Position for Detaching.—The lifter cam j_1, Fig. 8, which controls the leather detaching roll q, next requires adjusting. This cam is mounted and fastened in the same manner as the nipper cam and should be placed in position so that the leather detaching roll will come in contact with the fluted segment when the index gear is at $6\frac{3}{4}$. This may be tested by placing strips of paper on the fluted segment and observing when they are held between the segment and the roll.

14. Distance of Blocks From Bearings of Detaching Roll When Bearing on Segment.—The two last settings mentioned in the list of settings may now be made. The lifter cam should be in such a position that, when the roll touches the segment, the blocks l_3, Fig. 8, will not be in their lowest positions, but will continue to move down as the cam revolves. When the blocks l_3 are in their lowest positions, there should be a space between them and the brass bushings of the leather detaching roll equal to a No. 23 comber gauge. The blocks may be adjusted by the screws l_4, Fig. 8, so that the distance between them and the brass bushings may be regulated when the cam has lowered the

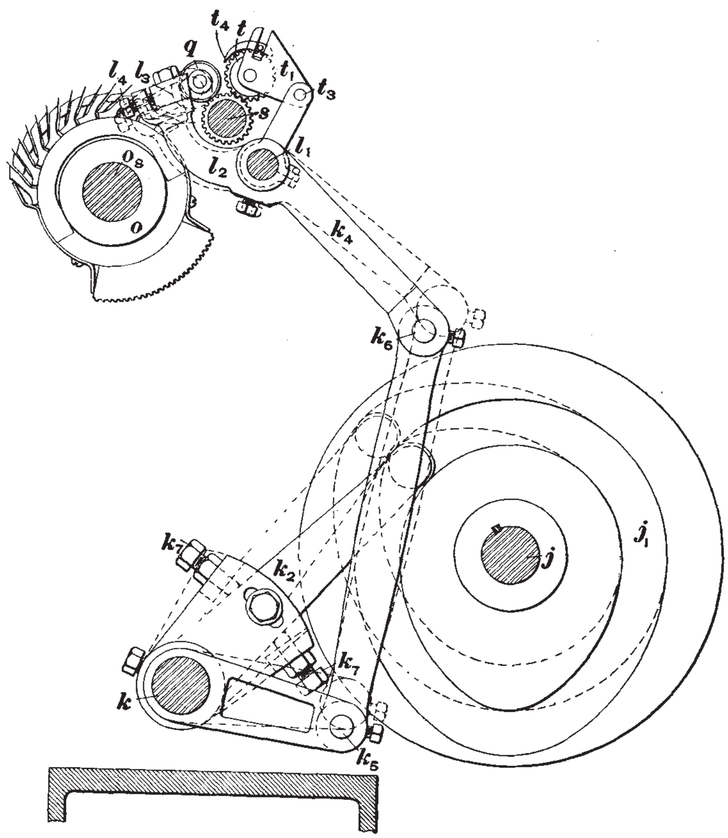


Fig. 8

blocks as far as possible. When this setting has been made as described, it is certain that the detaching roll is properly in contact with the fluted segment.

15. Setting the Top Roll From Leather Detaching Roll.—When the detaching roll is properly in contact with the fluted segment, the top roll should be set from the detaching roll with a No. 21 comber gauge. This is accomplished by loosening the setscrews that hold the supports for the bearings of the roll to the shaft l_1.

16. Removal of Detaching Roll From Detaching Position.—The lifter cam should now be in position so that, in addition to causing the detaching roll to come in contact with the segment at $6\frac{3}{4}$ and moving the blocks the required distance from the bushings, it will also remove the detaching roll from the segment at $9\frac{1}{2}$. This can also be tested by paper placed between the segment and the roll, which should release the paper at $9\frac{1}{2}$. If the cam is in its proper position when the detaching roll touches the segment, but is not in a position to remove the detaching roll at the proper time, it can be remedied by an adjustment provided on the lever k_2, Fig. 8, similar to the one described in connection with the lever g_3, Fig. 5. This adjustment is for the purpose of regulating the position of the lifter shaft k in relation to the cam, so that the latter may be in a position to place the roll in the correct positions at the given times. Any adjustment made by the screws k_7 will change the distance between the blocks l_3 and the brass bushings on the leather detaching roll.

17. Timing the Motions of the Delivery Roll.—The cam that gives to the delivery roll the rotary motion, which is transmitted to the detaching roll and the top roll, should be set so that when the index finger is at about $1\frac{1}{2}$, the cotton will be started back to be pieced up and, when the index is at about 6, this motion should be reversed and the cotton delivered. The cam that places the pawl of this motion in and out of contact with the gear v_4, Fig. 9, is joined to the cam that imparts the rocking motion to the pawl and, when the latter cam is set, the former is usually very near its correct position. It is capable of being adjusted independently, however, so that it will correctly govern the time that the pawl is placed in, and taken out of, contact with the gear v_4. The pawl is allowed to come in contact with the gear when the index gear is at about $1\frac{1}{4}$, the time that this pawl is placed in contact with the gear and taken out of contact governing the amount of overlap in the piecing. The usual amount of overlap is about $\frac{3}{4}$ inch, or practically half the length of the fibers.

18. The Top Comb.—The time when the top comb should first be down varies from 5 to 6. The top comb should always be down when the detaching commences. The timing of the comb may be regulated by moving the

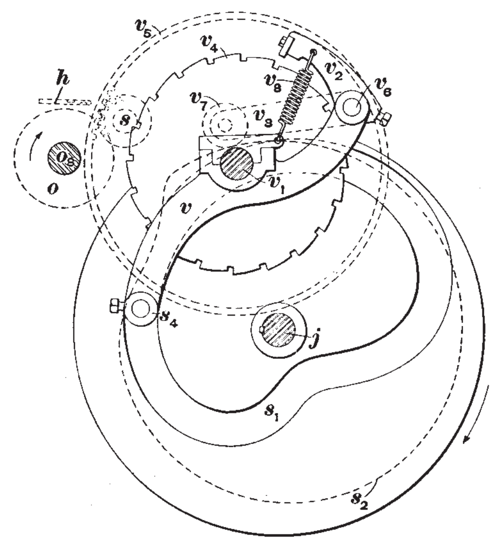


FIG. 9

cam u_8, Fig. 4, which is on the cylinder shaft and imparts motion to the top-comb shaft u_2.

19. In regard to settings and timings it may be stated that more waste may be removed by feeding at a late period, by nipping later, by closer settings of the nippers and top combs to the cylinders, and by increasing the angle of the top comb. The following are good settings and timings for a comber running a lap of 260 grains of Egyptian cotton with a staple of $1\frac{3}{8}$ inches and removing about 16 per cent. waste:

Feed-roll from delivery roll	$1\frac{1}{16}$-inch finger gauge
Cushion plate from delivery roll	$1\frac{3}{16}$-inch finger gauge
Distance of screws i_3 from stands	$\frac{1}{4}$-inch step gauge
Distance of nipper from half lap	No. 20 comber gauge
Angle of top comb	28°
Top comb from fluted segment	No. 20 comber gauge
Distance of blocks l_3 from bearings of detaching rolls	No. 23 comber gauge
Top roll from leather detaching roll	No. 21 comber gauge
Feeds at	5, index gear
Nipper knife leaves cushion plate at	$4\frac{1}{2}$, index gear
Nipper knife touches cushion plate at	$8\frac{3}{4}$, index gear
Leather detaching roll touches segment at	$6\frac{3}{4}$, index gear
Leather detaching roll leaves segment at	$9\frac{1}{4}$, index gear
Delivery roll reverses at	2, index gear
Delivery roll delivers at	$6\frac{1}{2}$, index gear
Top comb down at	6, index gear

20. Because of the difference in construction between double- and single-nip combers, there is a slight difference in timing. This is shown by the following comparison of these types when equipped with the quadrant motion. This timing is for sea-island cotton.

	Single-Nip	Double-Nip
Feeds at	5	$4\frac{1}{2}$ and $14\frac{1}{2}$
Nippers close	$9\frac{1}{4}$	$9\frac{1}{4}$ and $19\frac{1}{4}$
Leather detaching roll touches segment	$6\frac{3}{4}$	$6\frac{3}{4}$ and $16\frac{3}{4}$
Delivery roll reverses	$20\frac{3}{4}$	$20\frac{3}{4}$ and $10\frac{3}{4}$
Delivery roll delivers	6	$6\frac{3}{4}$ and $16\frac{3}{4}$
Top comb down	$5\frac{1}{2}$	$4\frac{1}{2}$ and $14\frac{1}{2}$
Clutch thrown in	$20\frac{1}{2}$	$20\frac{1}{2}$ and $10\frac{1}{2}$

21. In some cases where especially fine yarns are to be produced, the percentage of waste taken out by the combing is not considered sufficient and **double combing** is performed. Where this process is used, the cans of sliver delivered from the combers may be placed at the back of the sliver-lap machine and the entire process repeated, or as is more often done, the cans may be placed at the back of a ribbon-lap machine that, instead of having lap rolls, has a back similar in construction to that of the sliver lap, each delivery, however, being fed only 8 or 10 ends. The laps from this machine are then placed on the lap rolls of the comber. After the combing operation the cotton is subjected to the drawing processes, whether it has been combed once or twice.

MANAGEMENT OF THE COMBER ROOM

22. Important Points.—As the comber room uses only the best cotton, from which the finest and the special grades of yarn are produced, there are a great many important points to be looked after, especially those in relation to economy.

1. The *needles* on the half lap should receive careful attention and any that are bent or crooked should be straightened by a pair of special pliers provided for this purpose. If there are too many bent or broken needles, the half lap should be taken out and new needles put in. Extra half laps are usually provided so that the machine will not have to remain idle during the time that a half lap is being repaired.

If the several matrices to which the needles are attached are not carefully joined to each other, there will be a large accumulation of waste, which will become so strongly fastened that the brush will not be able to remove it. These collections of cotton should be removed by hand at the back of the comber.

2. The *brushes* that clean the half laps should have the waste removed from their bristles about once a month. When performing this operation, a rake, shown in Fig. 10, is used. When cleaning the brushes, the feed-roll should be thrown out of gear and the ends allowed to run through so

that the dust will not get into the good cotton. The laps should also be protected by a cloth.

As the bristles on these brushes wear down, they should be readjusted so as to be kept in contact with and clean the cylinder needles. As the brushes become smaller by the bristles being worn down, it is sometimes found necessary to change the speed of the brush shaft. Through continued wear and readjustment the bristles become short and soft and the old brushes should then be replaced by new ones. When replacing the old brushes with new ones, a complete new set should be used and care should be taken that they are all of equal diameters, as all the brushes for the heads of a comber are mounted on one shaft.

3. The condition of the *leather detaching roll* has much to do with the quality of the work. This roll should be perfectly true and should be varnished about once a week.

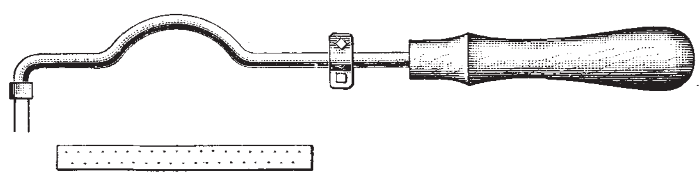


FIG. 10

Care should also be taken in oiling this roll to see that sufficient oil is put on its bearings to give them proper lubrication, and at the same time that the amount is not so large that the oil will run out on the web and cause bad work. Thick and thin places in the web are sometimes an indication that the detaching roll is in poor condition, that is, improperly covered or varnished, or that the bearings of the roll are not properly lubricated. This defect may also be caused by the detaching roll not touching the segment at the proper time.

4. *Top combs* should be looked after very carefully, since if the needles are bent, hooked, or broken out, the web of cotton will be stringy when it enters the pan, due to the fact that the cotton passing through is not properly combed by the top comb. These should be brushed out twice a day with a

stiff brush furnished for this purpose. They should also be looked over once a week, when the needles should be straightened and smoothed or, if in the opinion of the one looking them over, their condition is not good enough, the top comb should be taken out and reneedled. If the points of the needles are only slightly damaged, they may be remedied by being rubbed with a piece of fine emery cloth fixed to a board.

5. The *table*, *table calender rolls*, and *top of the coiler* should be cleaned and polished with whiting twice a week and all dirt kept from these parts of the machine.

6. The *pans* should be wiped out with whiting at least once a week and should always present a bright appearance; all dirt should be kept out of the flutes of the feed-rolls, delivery rolls, and top rolls.

7. While cleaning the front of a comber the machine should be stopped, because all loose fly, dirt, and dust that have been taken out of the cotton and have accumulated on the parts to be brushed are liable to return to the combed cotton. When starting the comber, the end should be broken at the coiler and allowed to run about half a minute before it is pieced up, to insure that no dirty cotton passes through with the good cotton into the can.

The ceiling should be brushed and hangers and pulleys cleaned at a time when the combers are not running. When the combers are started again after the ceiling has been cleaned, the ends should be broken at the coiler and all dirt brushed from the front of the comber before the end is pieced up.

8. In the comber, *single* and *double* should be looked out for. If an end breaks on the table or in one of the pans and the other five ends continue to run through the draw-box, it makes the resulting sliver too light. Whenever an end is seen to be broken, it should be pieced up and the sliver that has been delivered into the can for the period that the end has been broken should be removed. In the case of double —that is, where one end has broken on the table and after a time has doubled on itself and been drawn along by the

friction of the other slivers—the amount of sliver delivered into the can during that period should also be removed.

23. Oiling and Cleaning.—In the comber, as in every other machine in a mill, certain parts must be oiled; this should be periodically attended to. All the more important parts ought to be, and generally are, oiled by one whose special duty it is to attend to this. These parts consist of all the gearing and motions that need oiling in the headstock of the comber, all the cam-courses and cam-bowls and the loose pulleys. If the cam-courses and cam-bowls are allowed to become dry, the bowls will wear away very quickly and become too small for the course, thus causing bad work.

About once or twice a year all the working parts of the comber should be taken down, thoroughly cleaned, and any parts needing repairs should be attended to, such as cushion plates recovered, needles repaired, new brushes put in, or the fillet on doffers replaced. When this has been attended to, the parts should be put together and set as previously described.

24. Waste.—The amount of waste being removed by the various machines combing different kinds of cotton should be ascertained often enough to insure that the proper percentage of waste is being taken out. This is done as follows: After making certain that the laps are all right and that the comber is working properly, the waste cans at the back are removed and boards placed on supports in such positions that the waste will be delivered from the doffers on the boards. The boards generally used for this purpose are about $\frac{3}{8}$ inch thick and have their tops varnished in order to obtain a smooth surface. The comber is then operated until the doffer comb is at the lowest part of its swing, after which the waste at the back is all removed and the sliver broken at the point where it is leaving the front calender rolls. The comber is next started and allowed to run until it has made about 40 nips. The cotton delivered by the front calender rolls is then kept as one portion, while the waste delivered on the boards is taken as another portion. These two portions of cotton are placed on a pair of scales, Fig. 11, which, instead of denoting weight, denotes the percentage of waste.

Another method for finding the percentage of waste is to weigh each portion and add the weight of waste to the weight of combed cotton and divide this result into the weight of the waste. If the comber is taking out too much or too little waste, any of the settings and timings that have been described as regulating the amount of waste may be changed. The amount of waste will vary under the very

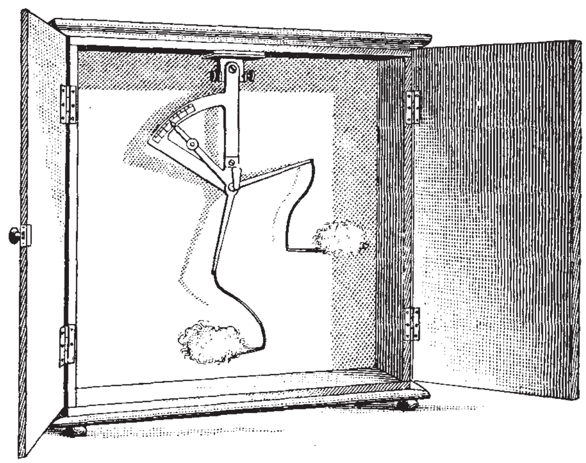


Fig. 11

best circumstances from 1 to 3 per cent., and due allowance should be made for this.

Example.—If 60 grains of sliver is delivered from a certain comber in a given number of nips and the waste amounts to 15 grains, what percentage of waste is being removed?

Solution.— 60 gr. weight of sliver
15 gr. weight of waste
75 gr. total weight
15 ÷ 75 = .20, or 20 per cent. Ans.

25. Speed of Comber.—In speaking of the speed of a comber it is said to make so many **nips** per minute and not revolutions per minute, as in the case of the other machines that have been described. By this is meant that every time the nipper jaws close a nip is made, which in the case of a single-nip comber is one for each complete revolution of the cylinder shaft. In the double-nip machine the comber makes two nips to every complete revolution of the cylinder shaft. A good working speed for a single-nip comber is about 85 nips per minute, while a double-nip comber produces good work when running 120 nips per minute.

26. The weight of a comber with six heads is about 3,500 pounds, and with eight heads 4,500 pounds. A single-nip comber with six heads requires $\frac{5}{8}$ horsepower and with eight heads $\frac{3}{4}$ horsepower, while a double-nip comber of six heads requires $\frac{3}{4}$ horsepower and with eight heads $\frac{7}{8}$ horsepower. The floor space occupied by a single nip 6-head machine for $8\frac{3}{4}$-inch laps, and also for an 8-head machine of the same type is about 13 feet by 3 feet 5 inches and 16 feet by 3 feet 5 inches, respectively.

The production of a single-nip comber varies from 225 pounds to 450 pounds per week of 60 hours, while the production of a double-nip varies from 300 pounds to 550 pounds per week of 60 hours.

FLY FRAMES

(PART 1)

GENERAL CONSTRUCTION OF FLY FRAMES

INTRODUCTION

1. After the sliver has been formed at the card and its structure improved at the drawing frames or perfected by the use of combing machinery, much foreign matter and impurities have been removed from the raw stock, the fibers have been carded, straightened, and laid parallel to one another, and the sliver has been evened throughout its whole length, but it is still in too bulky a form and must be further attenuated before it is sufficiently fine to be run through the machine that completes the operation of making it into yarn.

In addition to attenuating the sliver until the required weight per yard is obtained, the opportunity is also taken, in several machines, to multiply the number of doublings, which not only tends to retain the evenness of the sliver produced at the drawing frames, but also to improve on it. The sliver, as it is attenuated by the processes that follow the drawing frames, is known as **roving**; an idea of the extent to which this roving is drawn out before it is considered suitable to be spun into yarn by the mule or spinning frame may be gained by considering that a common weight for sliver at the drawing frame is 60 grains to the yard, from which roving weighing 1.19 grains to the yard is commonly made before being spun into yarn, the sliver thus having been reduced in weight in about the proportion of 50 to 1. For finer work a sliver of

45 grains to the yard might be made into a roving of .3 grain to the yard or an attenuation in the proportion of 150 to 1. It would be impossible to properly perform this attenuation by one process, and consequently the cotton must pass through three or four machines before going to the mule or spinning frame.

The machines used in modern mills to effect this attenuation are known collectively as **fly frames,** although sometimes called **speeders.** The expression fly frames should be applied generally to all these frames as at present constructed, since the term speeder really refers to a machine that is not now made and is only in use to a very small extent. It is probable, however, that the term has obtained such a hold in some manufacturing districts that it will never pass into disuse. Fly frames are divided into *slubbers*, *intermediates*, and *roving frames* where three frames are used between the drawing and spinning frames. Where four frames are used they are generally known as the *slubber*, *intermediate*, *roving frame*, and *jack frame;* in this case the word jack is used to indicate a fine roving frame, sometimes called a *jack roving frame.* The frame following the intermediates is sometimes called a *fine frame.* A much better method of naming the machines, which is used in some parts of the United States and should be uniformly adopted, is to speak of the first machine after the drawing as the slubber; the last machine before the spinning as the roving frame; while the intermediates, if more than one in number, are spoken of as the first and second intermediates, respectively.

All the machines classed under the head of fly frames are practically of the same type of construction, the only differences being in the details. One point to be noted, however, is that since the roving is gradually drawn finer at each succeeding process, it is necessary that certain parts of the intermediate frame should be smaller than the same parts of the slubber, in order to accommodate themselves to the decreasing size of the roving; the same is also true in regard to the roving frame as compared with the intermediate.

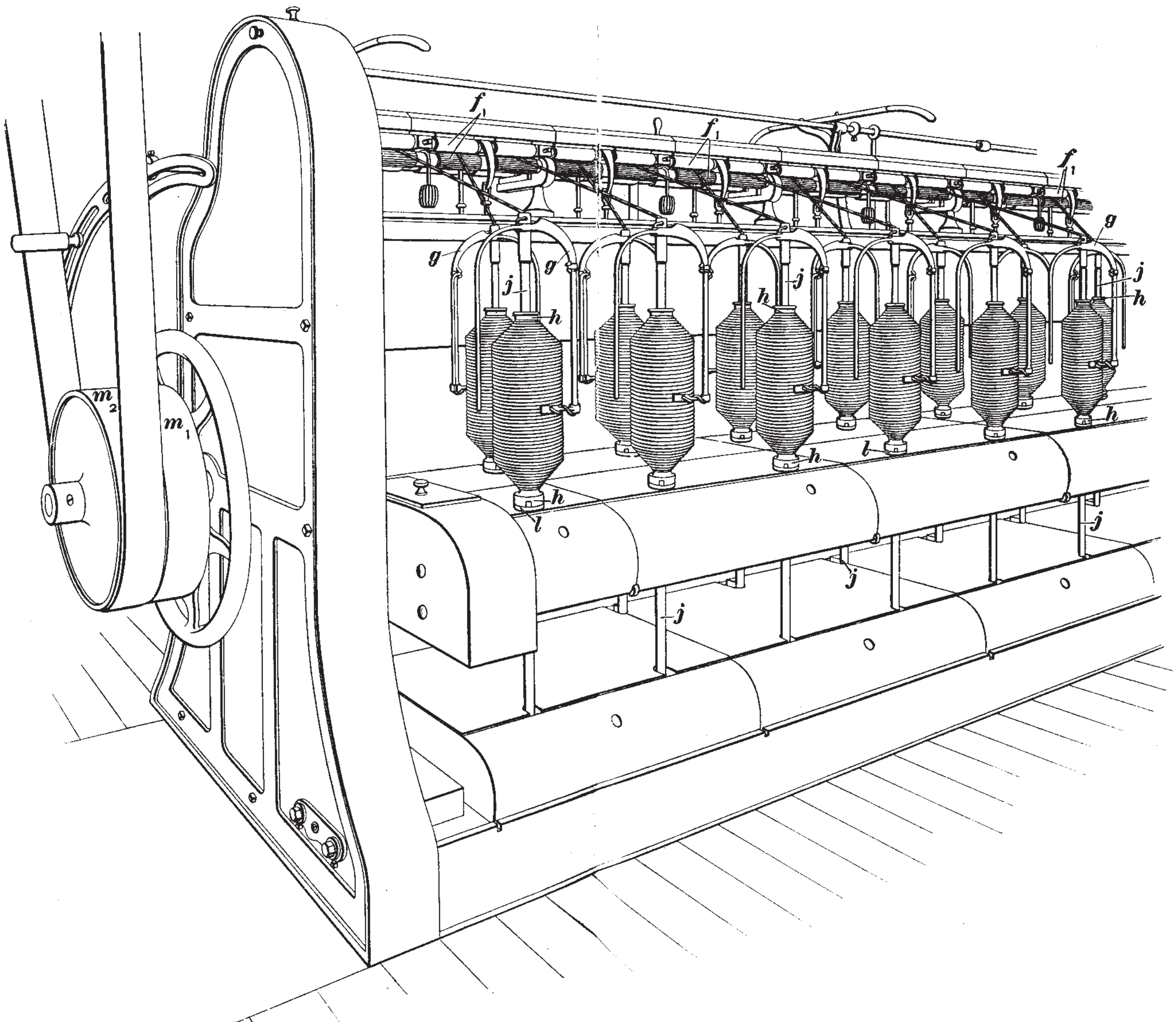


FIG. 1

2. Fly frames have as their objects: (*a*) the reduction of the thickness of the sliver, (*b*) the evening of the product, (*c*) the twisting of the roving, (*d*) the winding of the roving on a bobbin. The attenuation of the sliver renders the third object necessary, since, as the sliver is reduced in size, it naturally becomes weaker and must be twisted in order to enable it to hold together in passing to the next process. Twisting the sliver is followed by winding it on a bobbin, since the reduced sliver must be laid in such form as will allow it to be rapidly revolved around a spindle. The last two objects will be found to be far more difficult of attainment than the first.

The principles adopted to obtain the objects mentioned are: (*a*) roll drafting; (*b*) doubling; (*c*) securely holding the roving at two points, viz., the bite of the delivery rolls and the bobbin on which the roving is wound, and also passing it through what is known as a *flyer*, which revolving rapidly inserts the necessary twist; (*d*) having either the surface speed of the bobbin exceed the speed of the flyer or the speed of the flyer exceed the surface speed of the bobbin, the excess speed of one part over the other in either case being sufficient to take up the roving delivered by the delivery rolls. Although these are the four main principles, several minor mechanical problems present themselves in the construction and operation of fly frames and are solved by the adoption of other mechanical principles, as will be observed later.

As previously mentioned, slubbers, first and second intermediates, and roving frames differ very slightly in construction, the principal point that would be noticed by a person looking at the different machines being in the manner of feeding. With the slubber, the cans from the drawing frames are placed directly behind the machine and the sliver fed from the cans, while with the fly frames that follow the slubber, creels are provided in which to set the bobbins of roving, which is the form in which the cotton is delivered by all of these machines.

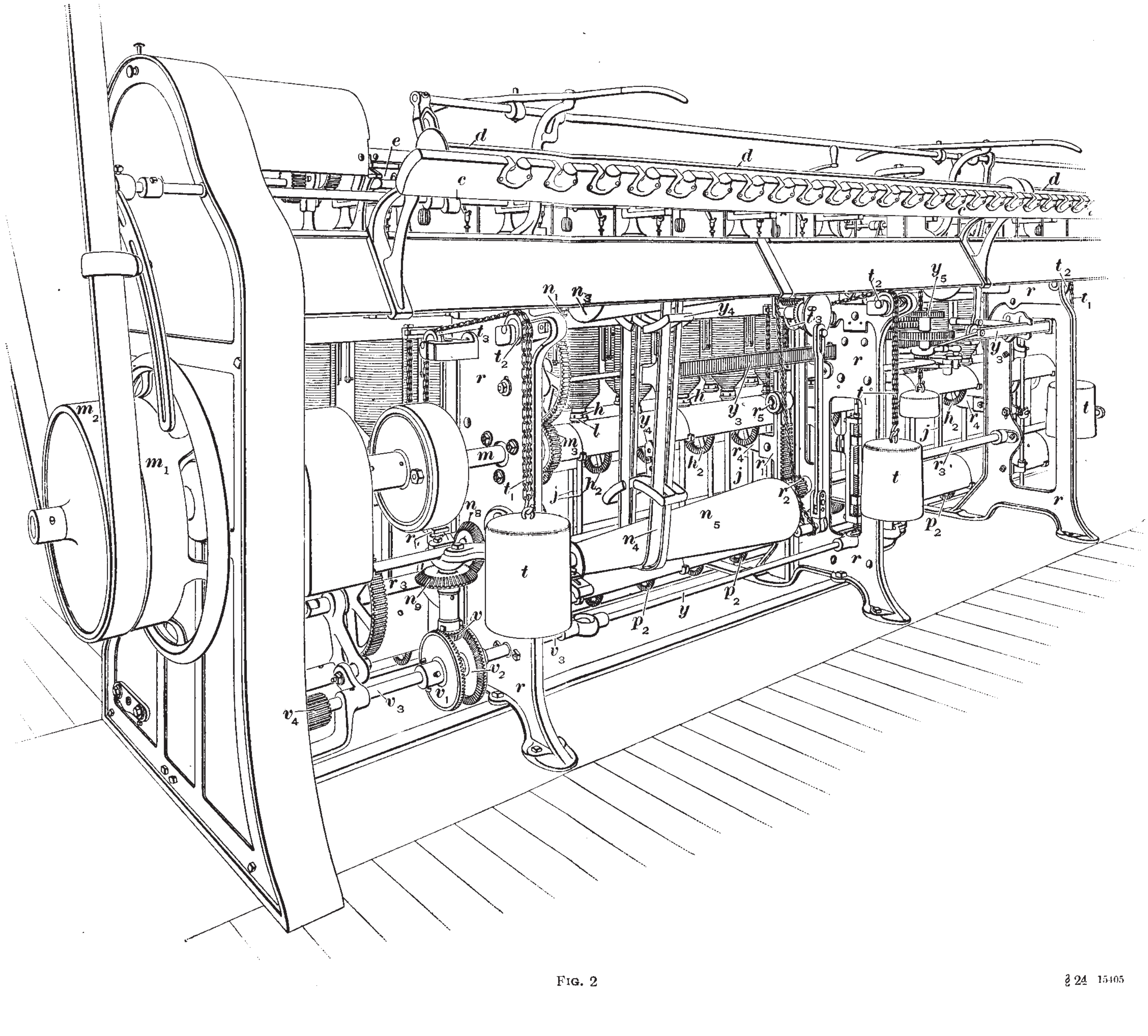
THE SLUBBER

PASSAGE OF THE STOCK

3. As the **slubber** may be considered the simplest form of fly frame, and as it is the first machine in the series, it will be referred to in giving a general description of the construction of these machines. Fig. 1 shows a front view of a portion of a slubber, while Fig. 2 gives a view of the back of the same machine; Fig. 3 is a cross-section through the essential parts of the machine. Referring to Fig. 3, the cans *a* that come from the finisher drawing frame are placed behind the slubber and the sliver *b* passed to the guide board *c*. In the slubber, which in this respect is unlike any of the other fly frames, no doubling takes place, each end of sliver being treated individually. From the guide board *c*, the sliver passes over the lifter roll *d*, through the traverse guide *e*, and then through three sets of rolls f_3, f_2, f_1, which insert the necessary draft. From the drawing rolls, the sliver passes through the upper part of the flyer *g* and then out at its lower part, where it is wound around an arm supported by the flyer. From this arm, the cotton, which having been reduced in size by the drawing rolls of the slubber is now known as roving, passes to the bobbin *h*, on which it is compactly wound. The flyer *g* is supported by the spindle *j*, while the bobbin *h* rests on a flange that forms the upper part of the gear h_1. The gear h_1 is known as the bobbin gear and revolves loosely on the bolster *k*, Fig. 9. In Fig. 3, two ends are shown at the front, although for convenience only one sliver is shown at the back. Each end shown at the front is produced from a separate sliver fed behind the frame.

PRINCIPAL PARTS

4. The *guide board c* through which the sliver passes as it comes from the can is simply a long board with guide holes cut in it at suitable intervals, to prevent one sliver from coming in contact with another. The *lifter roll d* extends



d
e
c
m
m_1
m_2
n
n_1
n_3
n_4
n_5
n_8
n_9
t
t_1
t_2
t_3
r
r_1
r_2
r_3
r_4
r_5
h
h_2
j
l
p_2
y
y_3
y_4
y_5
v
v_1
v_2
v_3
v_4

Fig. 2

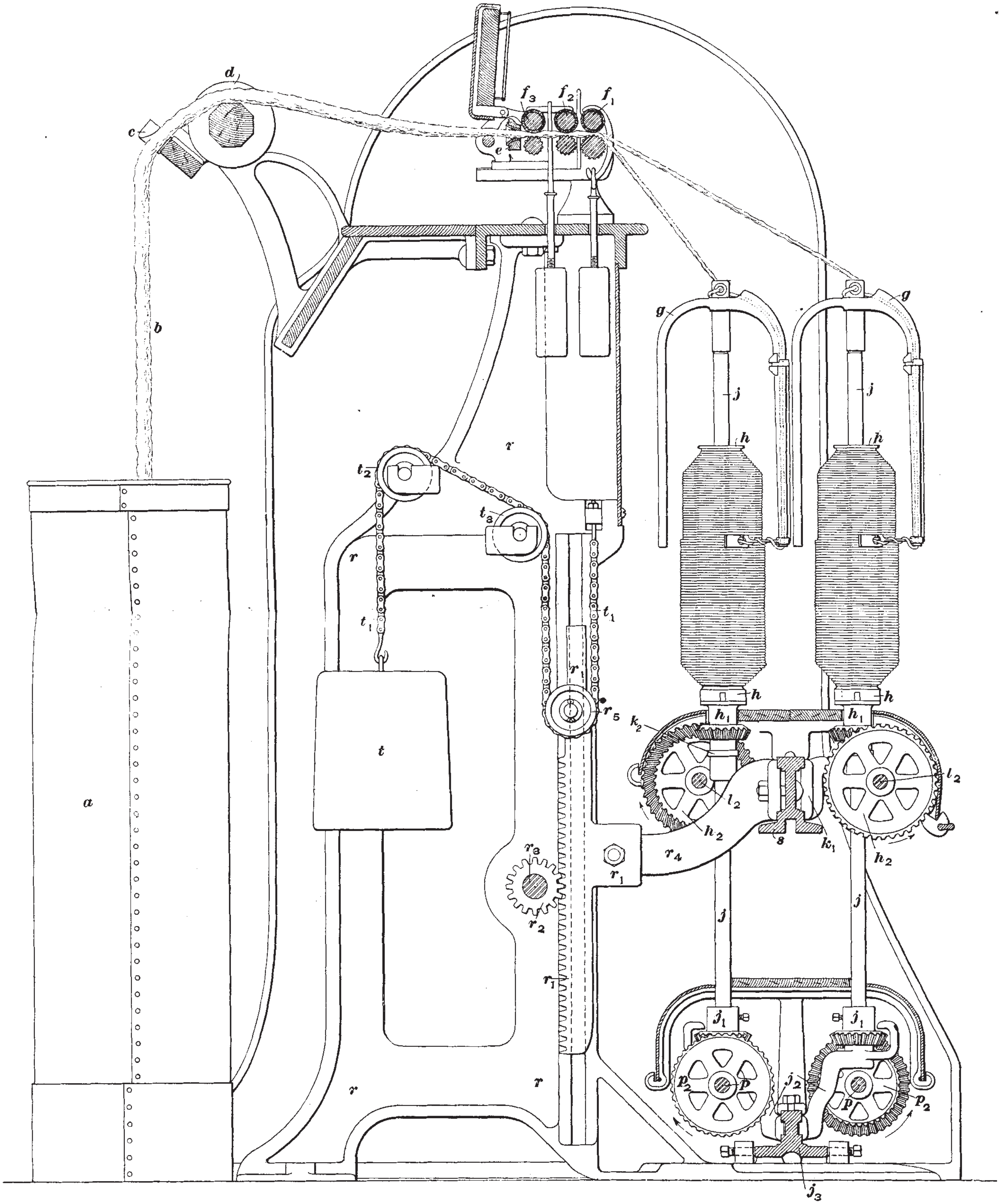


FIG. 3

§ 24 15405

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

the entire length of the frame. At one end it carries a sprocket gear driven by a chain that derives its motion from a sprocket gear on the bottom back drawing roll. The lifter roll revolving in the direction in which the sliver is moving serves to reduce the strain that would be brought on it should it be drawn up by the action of the drawing rolls alone.

The *traverse guide e*, by guiding the sliver first to one part of the drawing rolls and then to another, prevents continual wear on any one part of the rolls. As the objects of traverse motions as well as their different constructions have been dealt with, no further mention of them need be made here.

The *drawing rolls* of a slubber may be either of the metallic or of the common type, although when running very fine work the common rolls are almost universally used. In the fly frames that follow the slubber, which deal with the stock after it has been attenuated considerably, common rolls are almost wholly adopted. There are usually three sets of drawing rolls in fly frames, and whether metallic or common, they are similar in construction to those in a drawing frame. Clearers are also provided for both top and bottom rolls, although it is frequently the custom to run intermediate and roving frames without bottom clearers.

5. The Flyer.—A view of the **flyer,** to which the cotton passes from the front drawing rolls, is shown in Fig. 4. It consists of a *boss* g_1 that contains a hollow portion g_2 into which the spindle projects, two downward projecting *arms*, or *legs*, g_3, g_4, and a *presser* g_5. The upper portion of the boss of the flyer is carefully rounded and smoothed and at its top contains a hole that extends downwards and has an opening g_6 on each side. The projecting leg g_3 is solid and serves simply as a balance for the other leg g_4. The leg g_4 is hollow and carries two lugs, or projections, g_7, g_8 that act as bearings for the presser. The presser, or as it is sometimes called, the *presser finger*, is, as shown in the figure, a round rod hooked at its upper end and bent to a right angle at its lower end. The hollow leg g_4 is slightly tapered at its lower end, and the presser is so shaped at this point that it forms a circular clamp through which the lower end of the leg g_4 is passed. The inner part of the presser is flattened out into a palm, or paddle, g_9 and is formed with a guide eye. The horizontal part of the presser is of such a length that the guide eye in the palm always comes about opposite the center of the bobbin when the bobbin is empty. The roving in

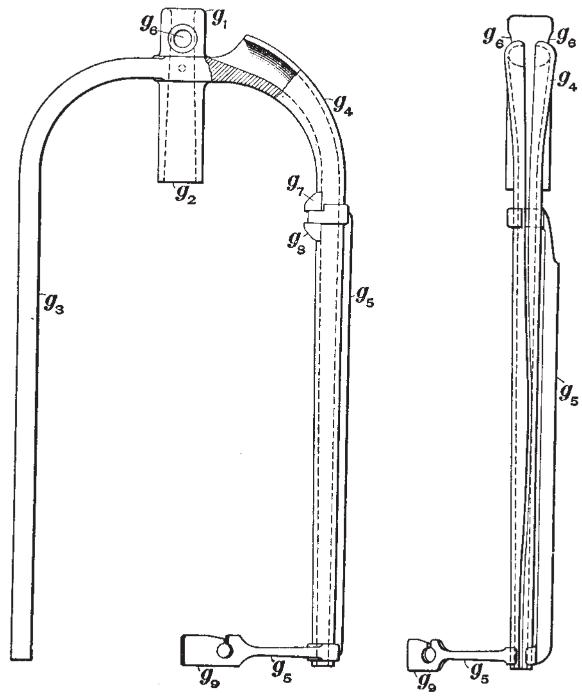


FIG. 4

coming from the delivery rolls passes into the hole at the top of the boss of the flyer and out through the opening at the point g_6, as shown in Fig. 4. It is then wound partly around the boss, passes down the hollow leg g_4, and is wrapped around the horizontal part of the presser once or twice. It then passes through the guide eye in the palm to the bobbin, on which it is wound. Wrapping the roving twice around the horizontal arm of the presser is the more common practice, although when flyers are new and comparatively rough once around will be found to be sufficient. If the leg g_4 of the flyer were made perfectly tubular, it would be difficult to thread the roving through it in case of breakage. Therefore, the hollow leg is not completely closed, but an opening remains from top to bottom, shown slightly curved in Fig. 4, through which the end of roving may be passed. As this slot is curved it prevents the roving flying out when the flyer is revolving at a high speed. Sometimes, especially for coarse work or machines that are not intended to run at a high speed, the slot is straight.

The flyers are carefully constructed of such a quality of material as will take and maintain a high polish, as it is necessary that all the parts of the flyer with which the cotton comes in contact shall be perfectly smooth. Otherwise, there is a tendency to develop undesirable friction as the roving passes through the eye and down the leg of the flyer, and in some cases small lumps of cotton are thus formed, which pass forwards at intervals, deteriorating the quality of the yarn.

Certain parts of the flyer have an important bearing on the hardness or softness of the bobbin that is made. By this is not meant the hardness or softness of the roving itself, which is determined by the amount of twist inserted, but the feel of the completed bobbin. If the roving were wound on the bobbin without the application of any pressure, the result would be a soft, loosely wound mass of material. To prevent this the flyer is so constructed that the palm g_9 exerts a slight continuous pressure on the bobbin as the roving is being wound thereon. This is done by making the vertical rod of the presser sufficiently heavy to tend to fly outwards as the flyer revolves, which it does at a high speed. The result of this is to throw the palm g_9 inwards, since the vertical rod is capable of swinging partially around the leg g_4. There is some tendency also for the palm itself to fly outwards due to centrifugal force, but the excess weight of the vertical rod and its greater distance from the spindle are sufficient to overcome the centrifugal force of the palm g_9 and bring a slight pressure constantly to bear on the bobbin.

By altering the relative weights of the vertical rod and the palm, almost any degree of firmness of the full bobbin can be obtained, but this is a point for the machine builder to experiment with and decide on before building the frame, and should not be changed after the machines are installed in the mill unless so advised by the builders.

Bobbins can be made harder by inserting more twist in the roving, as well as by increasing the pressure of the palm on the bobbin.

6. The Spindle.—The **spindle,** as shown in Figs. 3 and 5, is a long steel rod. Its upper end, which is tapered, extends into the hollow part g_2, Fig. 4, of the flyer, where it comes in contact with a wire pin that is fitted into holes bored in the sides of the flyer. This pin fits into the slot in the upper end of the spindle and in this way the two parts are made to act as one. At its lower end the spindle is slightly reduced in diameter, and at its extreme end tapers to a point. This end of the spindle rests in a footstep, which is generally a recess in a bracket, except on English types of frames, where it is a removable piece of metal.

Spindles are made of hardened steel and ground to exact dimensions. They vary from $\frac{5}{8}$ inch to $\frac{7}{8}$ inch in diameter according to the frames for which they are intended, being of smaller diameter and shorter on roving frames and of greater diameter and longer on slubbers. The spindles in all fly frames are arranged in two rows, one behind the other. The spindles in the back row do not come directly behind those in the front row, but are generally set in such a manner that a spindle in the back row will come half way between two of the spindles in the front row, as shown in Fig. 6; this figure gives a view of five spindles, flyers, and bobbins

FIG. 5

as they would appear when looked at from above. It is customary to describe the gauge of the spindles, that is, the distance from the center of one spindle to the center of the next spindle in the same row, as so many inches; for instance, 6 inches, etc. Another method is to state the number of spindles in a certain number of inches; for instance, if the distance from the center of one spindle to the center of the next spindle in the same row is 6 inches, then the frame is spoken of as having 6 spindles in 18 inches; there being two rows of spindles and the spindles in each

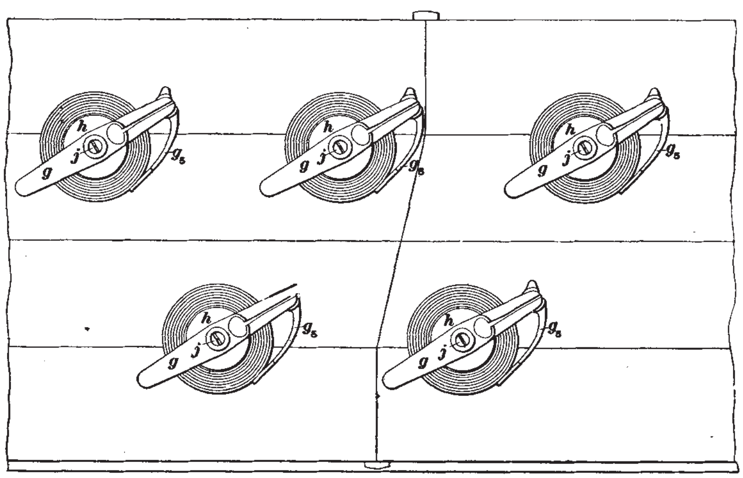


FIG. 6

row being spaced alike. The total number of spindles in a frame varies and is dependent on the gauge of the spindles and the length of the frame. Fly frames as a rule do not often exceed 36 feet in length, and are seldom built less than 20 feet in length.

7. The Footstep.—The **footstep bearing,** or **footstep,** j_2 in which the base of the spindle rests is shown in Figs. 3 and 7. These steps are bolted to the step rail j_3 that extends the entire length of the frame, very near the floor; a cross-section of the step rail is shown in Fig. 8. It will be noticed that both sides of the rail are made alike and will thus allow the footsteps to be placed on each side; the two rows of spindles necessitate this arrangement. At frequent intervals along the step rail are set footsteps that carry a bearing for the spindle shafts p. The two spindle shafts, one for each row of spindles, carry gears p_2 that drive gears j_1 setscrewed to the spindles, and thus give the spindles their motion. The spindle shafts, spindle steps, step rails, and the gears both on the spindles and

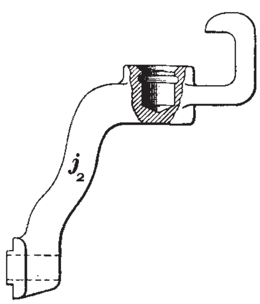


FIG. 7

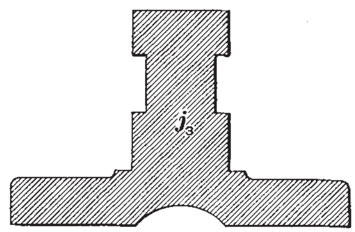


FIG. 8

on the spindle shafts are completely enclosed in order to prevent any dirt or loose cotton from collecting on the various parts.

8. The Bolster.—As the spindles are of considerable length, it is absolutely necessary that some bearing be provided for them in addition to the support formed by the step, in order to support them in a vertical position, and so that they may run true. This is accomplished by having a bolster, shown in Fig. 9, through which the upper part of the spindle projects. The bolster consists of a collar k, through which the spindle passes, the upper part being bored to such a diameter as will just fit the outside diameter of the spindle. At the lower part of the bolster is a shoulder k_1, that fits a recess in the bolster rail, to which it is firmly bolted. The bolster rail, a cross-section of which is shown in Fig. 10, is made alike on both sides, in order to provide for bolsters for each row of spindles.

At one time, the collars used to support the spindles vertically were rather short, not projecting much above the bolster rail, but it is now the universal custom to use long collars, such as that shown in Fig. 9. The advantage of the short collar was in being able to use a bobbin of less outside diameter and thus have more stock wound on it, as the shortness and small diameter of the collar did not require as great an opening, or hole, in the bobbin; consequently, allowing the outside diameter of the bobbin to be less in proportion. The disadvantage of the use of the short collar was due to the fact of its supporting the spindle at a point a considerable distance from its upper end, even when the bobbin rail was at its highest position. As the bobbin rail moved downwards this defect was accentuated,

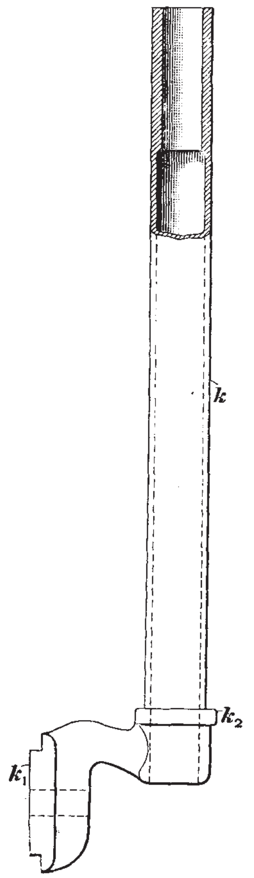


FIG. 9

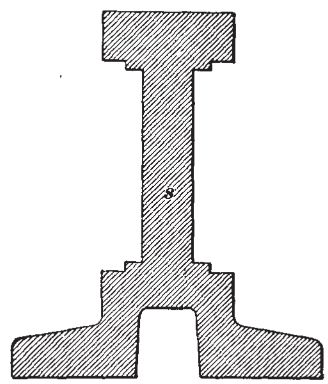


FIG. 10

and since the spindle and flyer ran at high speed and had no support at any point in the upper half of the length of the spindle, this tended to develop vibration and wear. In using such a collar as is shown in Fig. 9, the bearing part that supports the spindles is placed a considerable distance above the bolster rail and several inches nearer the top of the spindle, which is conducive to steady running of the spindles. The spindle has a bearing only in the upper part of the collar, for about 2 inches, the lower part being bored out to a larger diameter than that of the spindle. This method of construction reduces the amount of friction that would take place should the spindle bear against the entire length of the collar.

9. The Bobbin.—Fig. 11 shows a cross-section of a long-collar bobbin used on fly frames. Such bobbins are usually constructed of wood, although sometimes made of paper or corrugated metal. The cheapest bobbins are those made of plain wood without any protection whatever, but it has been found an advantage to have the lower end of the bobbins protected by a wire placed in a groove, or even by a metal shield surrounding the base of the bobbin and partially embedded in it. The cost of a bobbin constructed in this manner

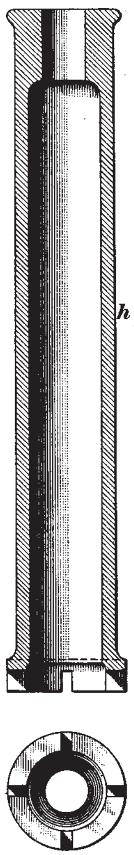


Fig. 11

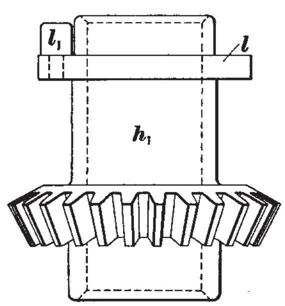


Fig. 12

is higher, but breakage and wear and tear of the bobbin are very much less.

When the bobbin is in position on the frame, the smaller hole at the top of the bobbin receives the spindle and the larger opening encloses the collar, which is thus entirely covered by the bobbin.

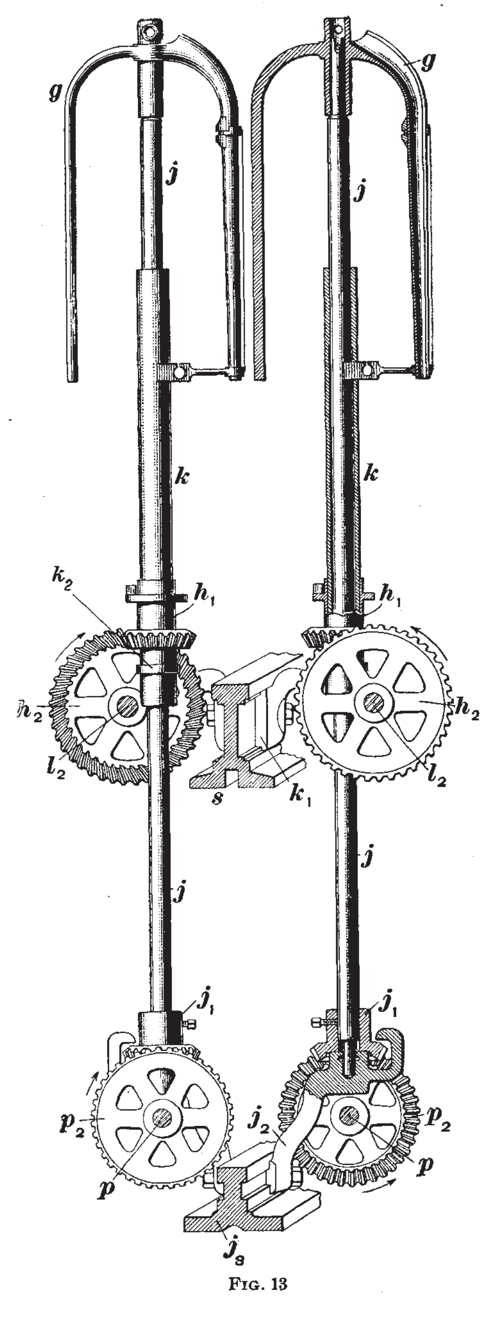


Fig. 13

The bobbin gear, shown in Fig. 12, rests on a projection k_2, Figs. 3 and 9, carried by the bolster. It is not fastened in any manner to the bolster and is thus free to revolve loosely around the long collar that furnishes a bearing for the spindle. Motion is imparted to the bobbin gear h_1 by means of a gear h_2 setscrewed to the bobbin shaft l_2, which is supported by bearings fastened to certain of the bolsters. As shown in Fig. 12, the bobbin gear carries a flange l on which the bobbin rests. A projection l_1 on this flange extends into one of several slots in the base of the bobbin, and thus drives the bobbin. In case long collars are used on bolsters, the collar extends for some distance into the bobbin, and it is very essential that the bobbins on any fly frame should be well constructed to exact dimensions, so as to grip the bobbin gear well and fit the spindle and collar as closely as possible without binding. Bobbin gauges are now made by several manufacturers of fly frames to test accurately the inside and outside diameters of a bobbin, and it is advisable to have a set of these gauges with which to test new bobbins before they are run.

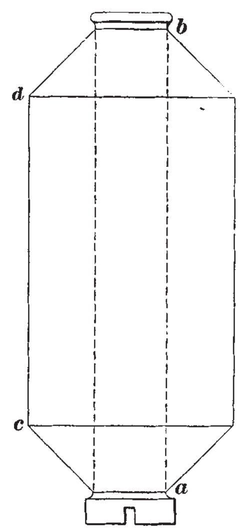


FIG. 14

The bobbin gears, the gears on the bobbin shafts, the bobbin shafts, the bobbin rail, and the lower ends of the bolsters are completely enclosed, in order to prevent as far as possible any fly or dirt from collecting on the various parts. Fig. 13 shows the connection between those parts of a fly frame that have been described, such as the footstep, spindle, bolster, bobbin rail, step rail, flyer, etc. It will be noticed that two rows of spindles are shown, many of the parts in one row being shown in section, while the parts in the other row are shown in full. By comparing this figure with those that show the different parts separate, a good idea will be obtained of the relative position of each part.

The manner in which the roving is built up on the bobbin is shown in Fig. 14. It is wound in close spirals around the empty bobbin until the entire length of the bobbin, with the exception of about $\frac{1}{2}$ inch at the top and 1 inch at the bottom, is covered; the complete length of roving that extends from the bottom to the top of the bobbin is known as a layer. It is the object to build up the bobbin with cone-shaped ends, as shown in Fig. 14; consequently, each succeeding layer on the bobbin must be a little shorter than the preceding one, this being continued until the distance *a b*, Fig. 14, is reduced to the distance *c d*.

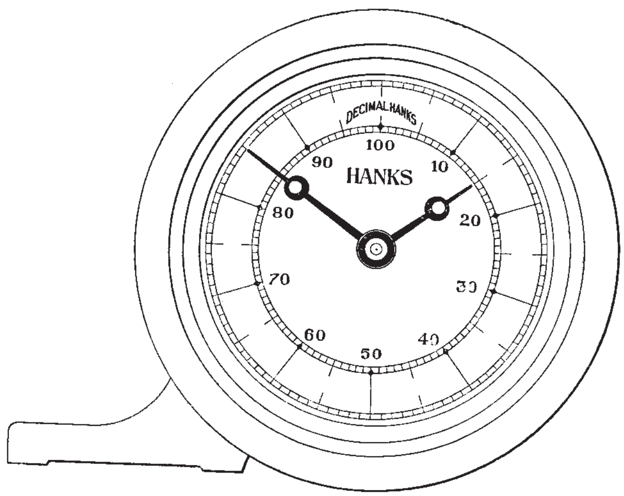


FIG. 15

10. Hank Clocks.—Fig. 15 shows an instrument known as a **hank clock,** which is attached to all fly frames. The object of the clock is to register the number of hanks of roving that pass the delivery rolls. This clock is usually situated at the foot end of the frame and has attached to it a worm-gear that is driven by a worm situated on the end of the front roll. By considering the diameter of the front roll and by having a suitable number of teeth in the worm-gear and the gears forming the clock, the exact length that passes the delivery rolls will be indicated on the hank clock, the length, however, being expressed in hanks. This clock is read on the same principle as most clocks or indicators. The short hand indicates the number of hanks, while the long one indicates the fractions of a hank in one-hundredth parts.

METHOD OF INSERTING TWIST

11. It is necessary to insert a small number of turns per inch in the roving after it leaves the front drawing rolls, in order to enable the fibers to hold together and withstand the strain of being wound on the bobbin and unwound at the next process. In common with all cotton-yarn-preparation machines where twist is inserted in a strand of material, the strand is held at one point while it is revolved at another. Strictly speaking, the strand is also held at this point, but by a revolving mechanism. In fly frames, the roving is gripped between the bottom and top front rolls as it is being delivered, and is also held by the bobbin on which it is being wound, although as the roving passes through the hole in the boss of the flyer and down the hollow leg, the top of the boss of the flyer practically forms the termination of the grip of the roving at this point. Consequently, the roving may be considered as being firmly held here, and since the spindle and flyer are making from 600 to 1,400 revolutions per minute, the roving is being twisted all the time.

The rolls of course are constantly delivering roving and the bobbins taking it up as fast as it is delivered, so that while the roving that is being twisted at any one time is in a suitable position to receive the twist, a new supply is constantly being brought under the twisting operation, at a regular and uniform rate of speed, and that portion already twisted is passing from the influence of the twisting mechanism and on to the bobbin. In ascertaining the amount of twist per inch inserted in the roving, it is therefore necessary to obtain data as to the number of inches of roving delivered by the rolls during a certain period, and the number of turns made by the spindle during the same period.

If, for example, the flyer makes 25 revolutions while the rolls deliver $12\frac{1}{2}$ inches of roving, then there will be $25 \div 12\frac{1}{2} = 2$ complete turns put into an inch of the roving delivered.

WINDING THE ROVING ON THE BOBBIN

12. The front rolls of a fly frame rotate at a constant rate of speed while the machine is in motion; hence, a uniform length of roving is being constantly delivered. Suitable means must be provided for winding this roving on to the bobbin as fast as it is delivered, but at the same time the mechanism for winding must be such that the roving will not be broken or strained. As shown in Fig. 13, the flyer is supported by the spindle, which also imparts a rotary motion to it, while the bobbin, although placed on the spindle and rotating on the same center as the flyer, is driven by an entirely separate mechanism. The roving is wrapped around the bobbin because of the difference in the velocity of the bobbin and the flyer eye, since if both revolved in the same direction and at the same speed the roving could not be drawn through the eye of the flyer and wound around the bobbin. In considering the action of the flyer and bobbin in winding the roving about the latter, it will be found that there are several possible methods by which this may be accomplished.

1. A uniform rotary motion may be imparted to the flyer alone, the bobbin remaining stationary. This method, however, is not practicable, because as the roving is wound around the bobbin the diameter of the latter increases, and therefore a greater length of roving will be required for each successive revolution of the flyer; hence, if a uniform amount of roving is delivered by the drawing rolls the strain on it will quickly increase until sufficient to cause it to break. This difficulty might be remedied by uniformly decreasing the speed of the flyer as the diameter of the bobbin increases, but as the speed of the flyer governs the amount of twist in the roving, a variation in the turns per inch would ensue in this case.

2. A rotary motion may be given to both the flyer and the bobbin, the speed of the flyer being just sufficiently in excess of that of the bobbin to wind the roving on to the latter as fast as it is delivered by the drawing rolls of the frame. Since in this case the flyer is moving faster than

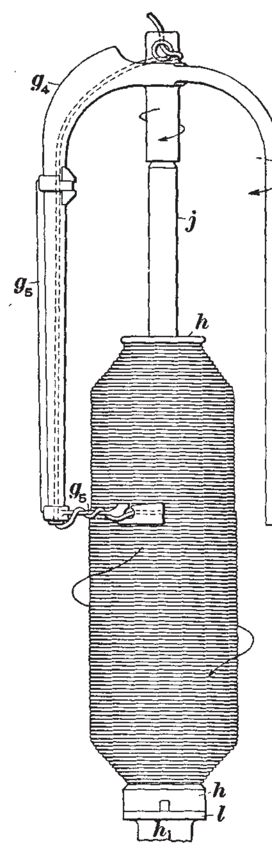


FIG. 16

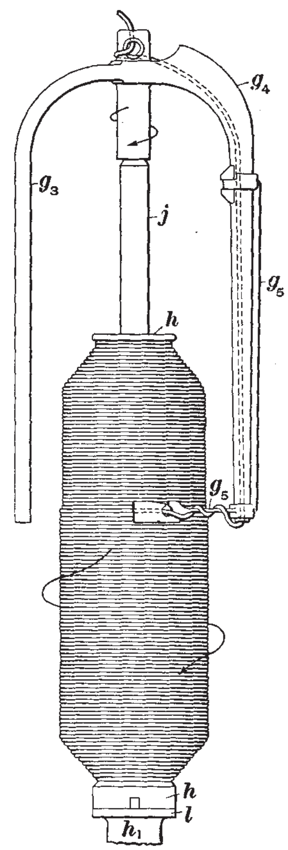


FIG. 17

the bobbin, or leading it, the arrangement is known as a *flyer lead*, and a frame thus equipped is called a *flyer-lead frame*. Fig. 16 illustrates the relative positions of the flyer, bobbin, and roving in a flyer-lead frame. In considering the operation of this arrangement it will be remembered that in a given length of time the front drawing rolls of the frame deliver a definite length of roving. Assume, for the purpose of illustration, that this definite length is 6 inches. Then, in order to wind this length of roving on to the bobbin in a flyer-lead frame, the eye of the presser on the flyer must move just 6 inches farther than a point on the surface of the bobbin during the length of time that it takes for the drawing rolls to deliver 6 inches of roving. This gain, or lead, of the flyer over the bobbin is independent of the actual velocities of the flyer and bobbin, both of which are of course rapidly rotating in the same direction. Flyer-lead frames were formerly very popular, but are not used to a great extent at the present time.

3. There is another method of winding the roving on to the bobbin in which the bobbin rotates at a speed just sufficiently in excess of that of the flyer to cause it to wind on the roving as fast as it is delivered by the drawing rolls. This is the arrangement that is almost always adopted on modern fly frames, and since in this case the bobbin rotates faster, or leads the flyer, it is known as the *bobbin-lead method*, fly frames thus equipped being known as *bobbin-lead frames*. Fig. 17 shows the position assumed by the bobbin, flyer, and roving in a bobbin-lead fly frame. The front rolls always deliver a uniform length of roving in any given length of time, and for the purpose of illustration it may also be assumed in this case that the length delivered in a given period of time is 6 inches. Then, in order to wind this length of roving on to the bobbin in a bobbin-lead frame, a point on the surface of the bobbin must move just 6 inches farther than the eye of the flyer presser during the length of time that it takes for the drawing rolls to deliver 6 inches of roving. This gain, or lead, of the bobbin over the flyer is independent of the actual velocities of the bobbin and flyer, both of which are of course rotating rapidly in the same direction, as was the case in the flyer-lead frame, only in this case the bobbin has the greater speed.

13. In both flyer-lead and bobbin-lead fly frames, the speed of the delivery of the roving and the speed of the flyers are constant. This is necessary, because if the speed of the drawing rolls were made variable the production of the frame would be altered, and also because, in order to produce an even roving, the sliver should be drawn at a regular and uniform speed. A variable speed of the flyers is impracticable, because this would produce a variation in the amount of twist in the roving. In order, therefore, to compensate for the constantly increasing diameter of the bobbin, a variation must be made in its speed, so that the tension on the roving during the winding will be the same whether the bobbin is empty or full. If the bobbin did not increase in diameter as it filled with roving, the speeds of the flyer and bobbin could be easily regulated so that the exact amount of roving delivered would be taken up. The conditions are more difficult than this, however, because one revolution of a full bobbin requires a much greater length of roving to make one turn around the bobbin than does one revolution of an empty bobbin; in other words, the circumferential speed of the bobbin must be the same, no matter what its diameter is, whether full, empty, or in any intermediate condition. For example, suppose that the diameter of an empty bobbin is 2 inches and of a full one 4 inches; then in the first case only $2 \times 3.1416 = 6.2832$ inches of roving will be required to make one turn around the bobbin, while in the latter case $4 \times 3.1416 = 12.5664$ inches will be required to accomplish the same result. Thus, as the length of roving delivered is a constant quantity, and as the difference in the circumferential speed of the bobbin and of the flyer must also be constant, the speed of the bobbin must be constantly varied as the winding progresses.

In a flyer-lead frame, since the flyer rotates at a speed greater than that of the bobbin, the latter must have its slowest speed when empty and its greatest speed when filled, and must constantly and uniformly increase in the number of revolutions per minute between these two extremes. This is the principal objection to a flyer-lead frame—the larger and heavier the bobbins become, the faster they must be driven, hence the greater the amount of power required to drive the machine.

In a bobbin-lead frame, however, since the speed of the bobbin is greater than that of the flyer the bobbin must rotate at its greatest speed when empty and at its slowest speed when full, and must constantly and uniformly decrease in the number of revolutions per minute between these two points. For this reason the bobbin-lead frame is preferred to the flyer-lead, since in this case as the bobbins grow large and heavy, it is not necessary to drive them so fast, and the consumption of power is therefore more uniform.

Although the mechanism for producing this variable speed of the bobbins is described later, it will be of advantage to note that with the introduction of cones it is possible, by making use of suitable gearing, to alter the speed of the bobbins.

14. Traverse of Bobbins.—It will be remembered that the lower end of the bolsters, the bolster rail, the bobbin shafts, and the toothed portion of the bobbin gears are completely enclosed. These parts combined form what is known as the carriage, which is given a vertical reciprocating motion in order to give the necessary traverse to the bobbins. As the bobbins are placed over the bolsters and rest on the bobbin gears, which form a part of the carriage, they receive a vertical reciprocating motion in addition to their rotary axial motion received from the bobbin gears. As the flyer eye continues to revolve in one plane during this traverse of the bobbin, the spindle rail being stationary, the roving is wound on the bobbin in coils, which vary in pitch according to the velocity of the vertical movement of the bobbin.

Fig. 3 illustrates one method of imparting the vertical motion to the carriage. The legs r support the various parts of the frame, their number varying according to the length of the frame. These legs are known as **sampsons**, and have on one face a groove in which a portion of a rack r_1 slides. As the rack r_1 has an up-and-down motion, the groove in the sampson serves to steady and guide it in order that it may mesh properly with the gear r_2 setscrewed to the shaft r_3, which extends the entire length of the frame. The racks are connected to the carriage by means of arms r_4 securely bolted to the bolster rail s. As the gear r_2 revolves first in one direction and then in the other, the carriage is given a vertical reciprocating motion for a certain distance, which is regulated by the period of rotation of the gear r_2 in either direction. In addition to the steadying of the carriage by the racks, there is a slide connection between the head and foot sampsons and the corresponding ends of the bolster rail that helps to steady and guide it, and if properly adjusted insures a free and perfect motion of the carriage. As the carriage has considerable weight, it is balanced by suitable mechanism, the usual method being to hang weights by means of chains at each sampson. Referring to Fig. 3, the weight t is supported by means of a chain t_1 attached to a bracket, the chain passing around a pulley r_5 attached to the rack r_1 and also over pulleys t_3, t_2 attached to the sampson; the weight is arranged to balance the rail when the bobbins are half full.

Another method of balancing the carriage is shown in Fig. 18. Weights t are suspended from a chain t_1 that passes around pulleys t_2, t_3 and is attached to a drum r_5 on the shaft r_6, which carries a gear meshing with teeth in the lever r_4. The forward end of this lever bears directly against the under side of a small pulley carried by a bracket s_1 that is attached to the bolster rail s. This method prevents any possibility of the racks binding in the slides, which sometimes happens with the other method, unless a great deal of care is taken with the racks and slides.

The latest method of overcoming the weight of the carriage and bobbins is by means of a self-balanced carriage. With this motion the carriage is divided at the center of its length into two equal parts, and when one section is descending the other is ascending; consequently, one section counterbalances the other. The carriage is supported and guided by means of racks and pinions, as shown in Fig. 3, with the exception of the weights. The racks r_1 for one section of the carriage face in the direction shown in Fig. 3, while the

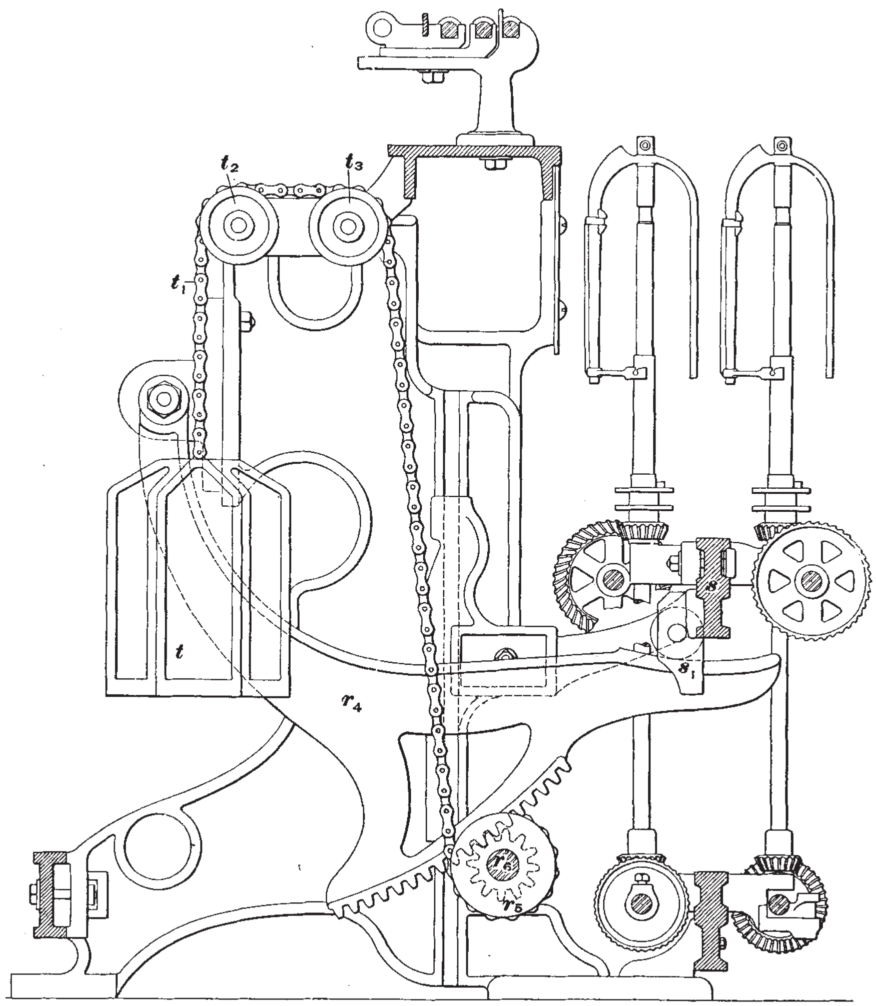


Fig. 18

the carriage will ascend and the other descend, thereby balancing each other.

Since the carriage is divided into two parts, it is necessary to use a second mechanism in order to drive the bobbins of the second section. This mechanism is situated in about the center of the frame and is driven from the first by means of a long shaft that extends from the head of the frame to the second section. This shaft carries a gear at the head end that is driven from a gear placed on the sleeve between the gears h_5, h_6, Fig. 19. At the opposite end of this shaft is a gear that drives the second mechanism by means of a carrier gear. By adopting this last method, the carriage is accurately balanced at all times during the building of the bobbins, while with the other motions the carriage is only accurately balanced when the bobbins are half full.

The description of the method of reversing the direction of motion of the gear r_2, Fig. 3, and the different mechanical arrangements that are necessary in order to allow the carriage to rise and fall and still have the driving arrangement of the bobbin shafts intact, will be given in detail later.

GEARING

15. Method of Driving the Drawing Rolls.—Fig. 19 gives a diagrammatic view of the gearing for a slubber. The parts are not in all cases shown in the exact position that they occupy in the frame, since the method of gearing could not then be clearly indicated. On the shaft m, which is known as the **jack-shaft** and is the main driving shaft of the frame, are placed the tight-and-loose pulleys m_1, m_2, respectively, which are driven either from the line shaft of the room or from a countershaft belted to the line shaft. On the end of the jack-shaft m is a gear m_3, known as the **twist gear,** which through the intermediate gear m_4 and gear n_1 drives the top cone shaft n. This shaft carries at the head, or driving, end a gear n_2 that drives a gear f on the bottom front roll f_1. The method of driving the two back rolls from the front roll is shown in Fig. 19.

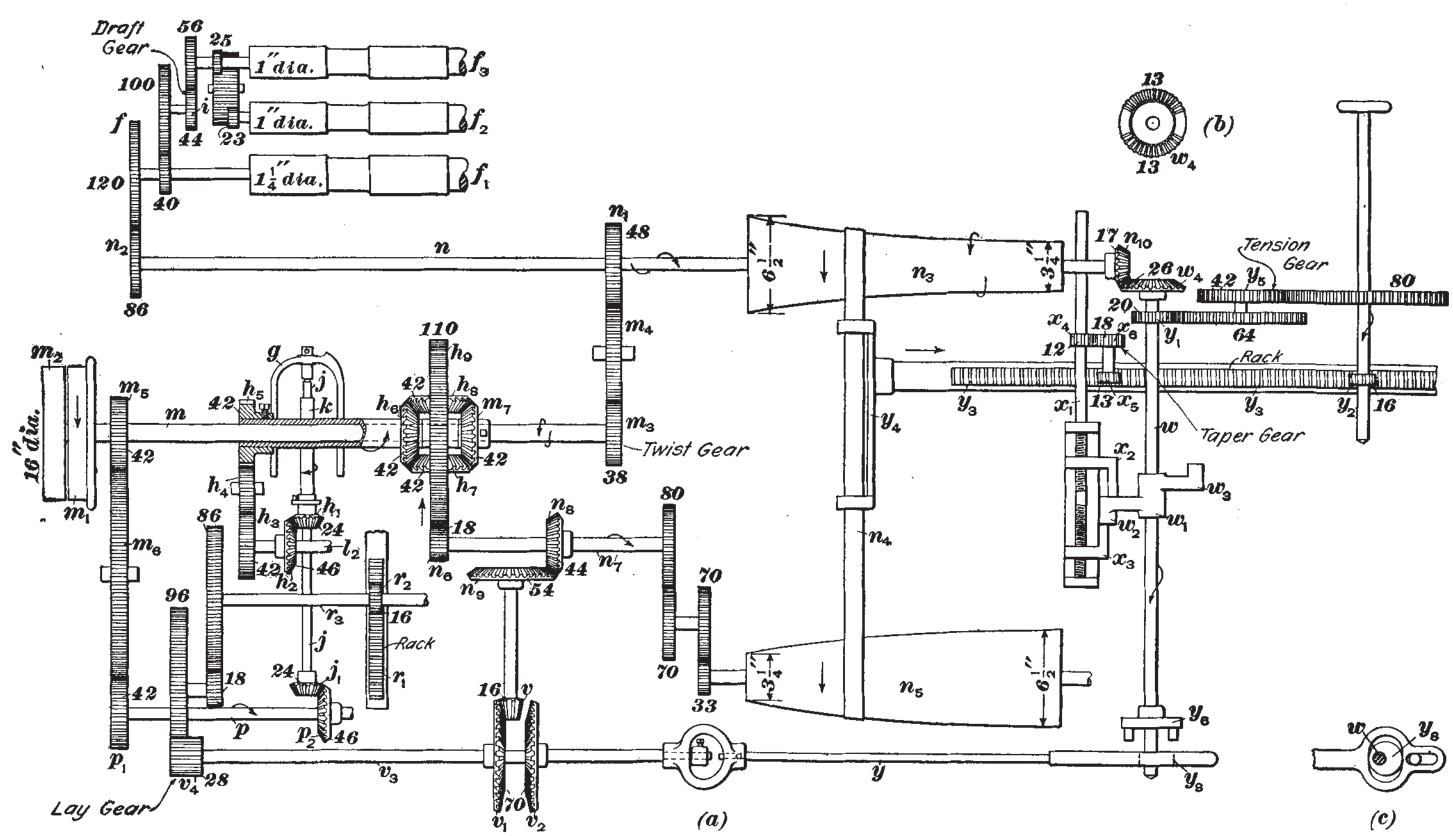

Draft Gear
Tension Gear
Taper Gear
Twist Gear
Lay Gear
Rack
1" dia.
1" dia.
1¼" dia.
16" dia.
(a)
(b)
(c)

Fig. 19

16. Method of Driving the Spindles.—On the end of the jack-shaft that carries the tight-and-loose pulleys is a gear m_5 that, through an intermediate, or carrier gear, m_6, drives a gear p_1 that is on the spindle shaft p. Gears on this shaft similar to p_2 drive the gears j_1 that are setscrewed to the spindles j. It will be remembered that there are two rows of spindles in all fly frames; consequently, there must be two spindle shafts similar to p. Only one shaft is shown in Fig. 19, as the two shafts are placed one directly behind the other. The one shown is the back spindle shaft, which always receives its motion direct from the jack-shaft of the frame. Gearing with the gear p_1 is a gear on the end of the front spindle shaft by which this shaft receives its motion.

An important point to be noted in this connection is that since the gear on one shaft is driven directly by a gear on the other shaft without the use of any intermediate gear, the two spindle shafts must revolve in opposite directions. If with this arrangement the gears on each spindle shaft were connected to the gears on the spindles that they drive in exactly the same manner, the two rows of spindles would revolve in opposite directions. In order to overcome this difficulty the gears on one spindle shaft are placed on one side of the gears on the spindles that they drive, while the gears on the other spindle shaft are placed on the opposite side of the gears on the spindles that they drive, as shown in Fig. 13.

17. Method of Driving the Bobbins.—Referring again to Fig. 19, it will be noticed that a gear m_7 is setscrewed to the jack-shaft. This gear through the gears h_7, h_8 drives the gear h_6, which is setscrewed to a sleeve that is loose on the jack-shaft. This sleeve carries another gear h_5, which through a carrier gear h_4 drives the gear h_3 on the back bobbin shaft l_2. The bobbin shaft carries bevel gears h_2 that drive the bobbin gears h_1. These bobbin gears are illustrated in Fig. 12 and carry a flange, a projection of which engages with a slot in the bottom of the bobbin and thus causes the bobbin to revolve with the bobbin gear. A gear on the front bobbin shaft is driven directly from the gear h_3, Fig. 19, on the back bobbin shaft, and since these shafts revolve in opposite directions, it is necessary, in order to have all the bobbins revolve in the same direction, to place the gears on one bobbin shaft on one side of the bobbin gears that they drive, while the gears on the other bobbin shaft must be placed on the opposite side of the bobbin gears that they drive. This arrangement is also shown in Fig. 13.

DIMENSIONS OF FLY FRAMES

18. Fly frames are spoken of not only according to the name of each kind of frame, but also by the number of spindles, the length of the bobbin that the first layer of roving covers (known as the *traverse* of the bobbin), and the diameter of the full bobbin. Thus, a frame spoken of as a 96-spindle · 9 in. × $4\frac{1}{2}$ in. indicates that the frame has two rows of spindles, 48 in each row; that the greatest possible traverse on the bobbin is 9 inches in length; and that when the bobbin is full it cannot exceed $4\frac{1}{2}$ inches in diameter. The traverse of a bobbin used on slubbers is usually from 10 to 12 inches; on first intermediates, from 8 to 10 inches; on second intermediates, from 7 to 8 inches; and on roving frames, from 5 to 6 inches. The reason for this gradual reduction in the traverse of the bobbin is that as the roving becomes reduced in size it is necessary to wind it on a smaller bobbin, so that the bobbin will not be too large to be pulled around by the roving when placed in the creel of the succeeding machine.

The diameter of the full bobbin that can be made depends on the distance between the spindles, which is so arranged as not to make too large a bobbin, for the same reason as that given above. In most cases the diameter of the full bobbin is one-half the length of the traverse; for example, a 12-inch traverse frame makes a 6-inch bobbin, usually written 12 × 6. Other sizes are referred to as 10 × 5, 9 × $4\frac{1}{2}$, 8 × 4, 7 × $3\frac{1}{2}$, 6 × 3, etc. There are exceptions to this rule in very fine frames, where the bobbin is often made smaller in diameter, as, for example, a 6 × $2\frac{1}{2}$ frame. In this connection it should be noted that the diameter of a full bobbin made on a fly frame is not equal to the space between two spindles in the same row. For example, on a 12 × 6 frame the space between the spindles in the same row is 10 inches, although the diameter of the full bobbin is only 6 inches. This allows sufficient space for clearance of the flyers while revolving.

The following table gives the standard sizes of frames as made by one machine builder:

TABLE I

Frame	Size Inches	Space Between Spindles Inches	Number of Spindles
Slubber	12 × 6	10	24 to 68
Slubber	12 × 6	9½	24 to 68
Slubber	11 × 5½	9	28 to 72
Slubber	10 × 5	9	32 to 76
Slubber	9 × 4½	7½	30 to 96
First intermediate	10 × 5	8	40 to 104
First intermediate	10 × 5	7½	42 to 108
First intermediate	9 × 4½	7	48 to 114
First intermediate	9 × 4½	6½	48 to 114
First intermediate	8 × 4	6	48 to 136
First intermediate	8 × 4	5⅞	48 to 136
First intermediate	8 × 4	5⅔	66 to 132
Second intermediate	8 × 3½	5¼	56 to 144
Second intermediate	7 × 3½	5¼	64 to 152
Second intermediate	7 × 3½	5	64 to 152
Second intermediate	7 × 3	4¾	72 to 160
Second intermediate	7 × 3	4½	72 to 160
Second intermediate	6 × 3	4½	80 to 168
Roving	6 × 2½	4¼	88 to 176
Roving	5 × 2½	4¼	96 to 184
Roving	4½ × 2¼	4	112 to 200

Fly frames are not usually constructed over 36 feet in length, as the torsion on the rolls and shafts would be excessive if this length were increased to any great extent. The modern tendency is to use frames of about this length, and Table I is prepared on this basis.

The main driving pulley, or the pulley on the jack-shaft, of the frame is usually about 16 inches in diameter with a 2-inch face, although pulleys are used that range from 12 to 16 inches in diameter, with faces from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches in width.

The weights of the frames vary considerably according to the make, the number of spindles, and the gauge; a 72-spindle slubber will weigh about 7,800 pounds; a 120-spindle first intermediate will weigh about 10,750 pounds; a 144-spindle second intermediate, about 9,250 pounds; and a 200-spindle roving frame, about 9,780 pounds.

The horsepower required to drive a frame varies considerably; therefore, no table can be given that will be accurate under all conditions, as various matters affect the amount of power required. The following table may be used as a guide to determine the amount of horsepower required.

TABLE II

Frame	Gauge Inch	Spindles per Horsepower
Slubber	9	35
First intermediate .	7	60
Second intermediate	$5\frac{1}{4}$	75
Roving	$4\frac{1}{4}$	95

FLY FRAMES

(PART 2)

PRINCIPAL MOTIONS OF FLY FRAMES

MECHANISMS FOR CONTROLLING SPEED OF BOBBINS

DIFFERENTIAL MOTIONS

NOTE.—In this Section the bobbin-lead type of fly frames will be dealt with exclusively.

1. Introductory.—In order to wind the roving on the bobbin it is necessary that the excess circumferential speed of the bobbin over the flyer shall be equal to the circumferential speed of the front roll, so as to take up the roving as fast as it is delivered by the front roll. If the bobbin made the same number of revolutions per minute continually, it would gradually strain and break the roving as the bobbin increased in diameter; therefore, some arrangement must be adopted by which the number of revolutions per minute of the bobbin may be gradually reduced as the bobbin grows larger. The speed of the bobbin is regulated and controlled by two mechanisms that act in combination. One is known as the *differential motion*, more commonly called the *compound* in America, while the other consists of two cones and connections. The object is to provide a ready means of automatically reducing the number of revolutions per minute of the bobbin in exact proportion to the increase in its diameter.

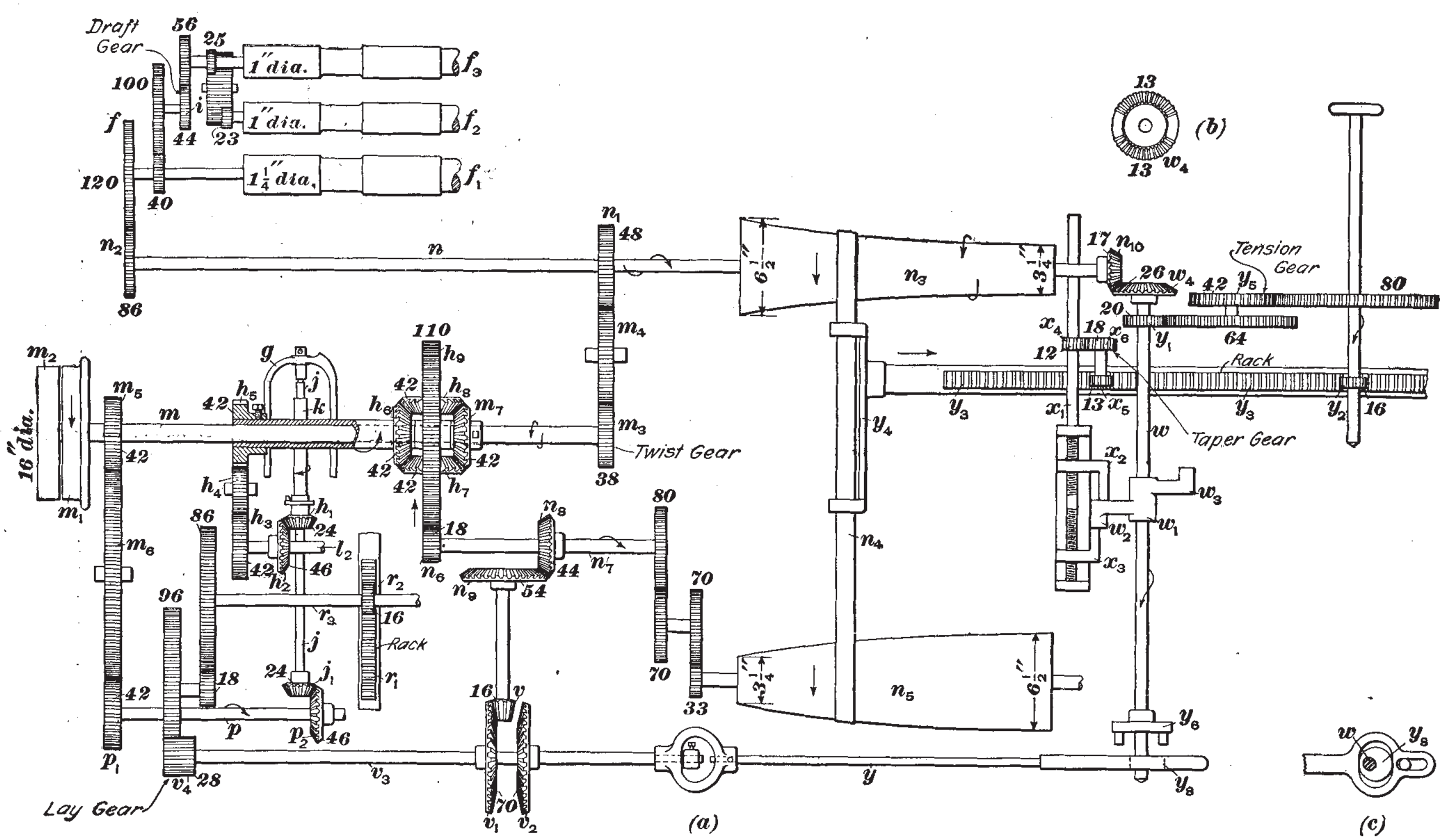

Draft Gear
Twist Gear
Rack
Tension Gear
Taper Gear
Lay Gear
16" dia.
1" dia.
1" dia.
1¼" dia.
(a)
(b)
(c)

FIG. 1

2. Referring to Fig. 1, the gear m_7 on the jack-shaft drives the bobbins, its motion being imparted through the gears h_7, h_8 to the gear h_6, which is on a sleeve with h_5. The gear h_5 drives the bobbin shaft l_2 through the gears h_4, h_3, the bobbin receiving motion from this shaft by means of the gear h_2 and bobbin gear h_1. The speed of the gear m_7 is constant, but by a peculiar arrangement of the gears h_6, h_7, h_8, h_9 it is possible to alter the speed of the gear h_6 independently of m_7; this in turn alters the speed of the gear h_5 and consequently that of the bobbins. This alteration in the speed of the gear h_6 is obtained by imparting motion to the gear h_9 by an entirely independent mechanism. Dealing first with the method of driving the gear h_9, it will be noticed that the top cone shaft n carries a cone n_3 that, by means of a belt n_4, drives a bottom cone n_5. At the beginning of a set, that is, when the first layer of roving is being wound on the bobbins, the cone belt is at the large end of the top cone and at the small end of the bottom cone, but as the bobbins gradually grow larger the belt is moved along the cones, until at the finish of a set, that is, when the bobbins are full, the belt is at the small end of the top cone and the large end of the bottom cone. As the top cone is the driver, any parts receiving motion from the bottom cone will have their highest speed at the beginning of a set and their lowest speed at the finish. The manner in which the cone belt is moved along the cones as the bobbins are built will be fully explained later.

Referring again to Fig. 1, it will be noticed that a gear on the end of the bottom-cone shaft drives, through suitable gearing, the gear n_6, which meshes with the gear h_9; consequently, as the belt is moved from the small to the large end of the bottom cone, or, in other words, as the bobbins become full, the speed of the gear n_6 and therefore that of the gear h_9 will be lessened. The gears h_6, h_7, h_8, h_9, m_7 form the **compound,** or **differential motion,** and in order that the effect of lessening the speed of the gear n_6 may be fully understood, reference will now be made to Fig. 2, which is a view of the compound alone. The large gear h_9 is known as the *sun gear* and supports the two bevel gears h_7, h_8 by means

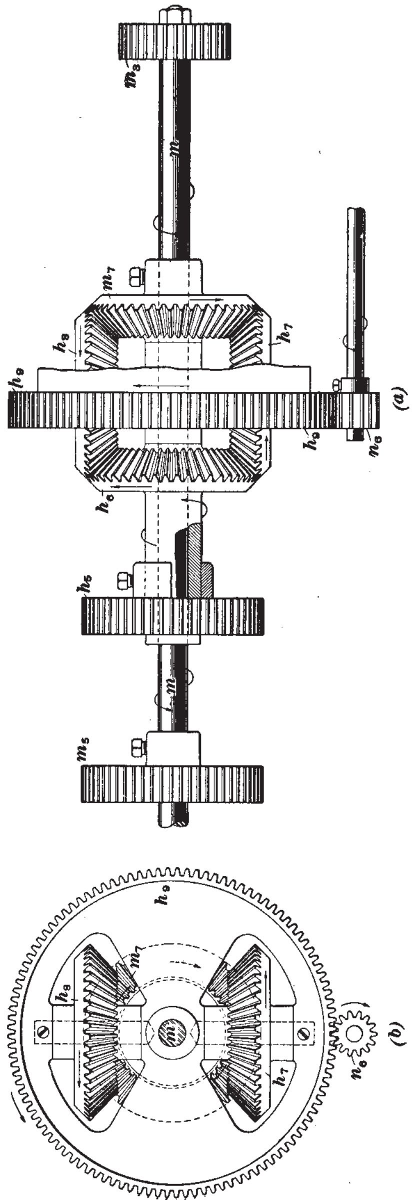


Fig. 2

of studs on which these gears work loosely, as shown in Fig. 2 (*b*). Thus, if the gear h_9 revolves it carries with it the two bevel gears h_7, h_8, which at the same time are free to revolve on the studs on which they are mounted. The action of these gears is as follows: The gear m_7 being fixed to the jack-shaft m drives the gear h_6 through the intermediate gears h_7, h_8. The gear h_7 performs the same work as h_8 and for present consideration may be imagined as not existing, being used merely to balance h_8 and cause the whole arrangement to revolve more uniformly. The gears m_7, h_6 are of the same size, and consequently if h_9 were held still, or prevented from revolving, m_7 would drive h_6 at the same speed as the shaft m, but in the opposite direction. If, however, h_9 is made to revolve in the same direction as h_6, the latter makes not only the number of revolutions that it derives through being driven by m_7, but an additional number of revolutions caused by the acceleration that h_9 gives it.

3. One not acquainted with mechanics may be surprised that h_9 causes h_6 to be accelerated 2 revolutions for each revolution that h_9 makes. Since, however, this is a well-known fact, no mathematical proof will be given, but if the privilege of experimenting with a compound in a mill can be obtained it can easily be proved that by holding m_7 still and turning h_9 around once h_6 will revolve twice. Another test may be made with an ordinary yarn wrapping reel, in which a similar contrivance is used. It will be found that the reel makes two revolutions when the handle is turned once, although each of the gears that form the compound has the same number of teeth; the handle of the reel acts the same as gear h_9, Fig. 2.

To take an actual example, suppose that the jack-shaft m makes 400 revolutions per minute. If h_9 is held still, h_6 will make just 400 revolutions per minute, but in the opposite direction to m_7. Supposing that h_9 is now caused to revolve 20 times per minute in the same direction as h_6, it will be found that h_6 makes 440 revolutions per minute, since $400 + (20 \times 2) = 440$. Suppose that without stopping the frame, the number of revolutions of h_9 is automatically reduced to 15; then it will be found that h_6 makes 430 revolutions; thus, $400 + (15 \times 2) = 430$. Suppose, again, that the speed of h_9 is decreased to 10 revolutions per minute; then h_6 will make 420 revolutions, but always in the opposite direction to m_7; thus, $400 + (10 \times 2) = 420$. If the train of gears between the gear h_5 and the bobbins is so arranged that the bobbins make $2\frac{1}{2}$ times as many revolutions as the gear h_5, which is on the same sleeve as h_6, then in the first case the bobbins will make $440 \times 2\frac{1}{2} = 1{,}100$ revolutions, while in the last case they will make 1,050 revolutions, so that it will be seen that their speed has been automatically reduced from 1,100 to 1,050 revolutions per minute as the bobbin has increased in size.

It will thus be seen that this arrangement provides the varying conditions necessary for the building of a bobbin. When the roving is being wound on an empty bobbin, the latter must be rotated at its highest speed in order to wind on the roving delivered; this speed is attained by having the cone belt at the large end of the driving cone and the small end of the driven cone. As the roving is wound on the bobbin and the bobbin increases in size, a gradual reduction of the speed of the bobbin is required, so that it may revolve at its slowest speed when the bobbin is full. By this time the cone belt has been moved along the cones until the small end of the driving cone is driving the large end of the driven cone. As the speed of the driven cone gradually diminishes, that of the gear n_6 decreases also, since it is driven from the bottom cone. Consequently, the gear h_9 will be driven more slowly, as well as the gear h_6 and the gears that drive the bobbins, since these are driven from the gear h_5, which is on the same sleeve as the gear h_6.

4. The compound just described is an old type and is found on most of the older frames. The one great objection to it is the unnecessary strain on the cone belt on account of the friction caused by the sleeve that carries the gears h_6, h_5, and also the one that carries the sun gear h_9. These sleeves and gears revolve in an opposite direction to that of the jack-shaft *m*. The compounds shown in Figs. 3, 4, and 5 are built to avoid this fault and are so constructed that all parts revolve in the same direction. Although these styles differ in construction, they all have the same objects in general; that is, they are all constructed to drive the bobbins at a varying speed in order to effect winding, and in the last three types are constructed to reduce the strain on the cone belt by reducing the amount of friction and thereby reducing the liability of its breaking. The amount of oil consumed is also reduced to a minimum. As far as possible, the parts in Figs. 2, 3, 4, and 5 that perform similar work have the same reference letters.

Fig. 3 shows a compound that is peculiar in construction but very simple and accurate in its workings. On the main shaft m is a boss, or cross-piece, q for the reception of, and to form a bearing for, the small cross-shaft q_1 that carries the two bevel gears h_7, h_8. Loose on the shaft m is a bell, or, as it is sometimes called, socket, gear h_5, which through its connections drives the bobbins. Attached to the gear h_5 is a bevel gear h_6. Beyond the cross-shaft and fast on a sleeve is the gear h_9, which is driven from the bottom cone by a train of gears. On the opposite end of this sleeve, which is loose on the shaft m, is a bevel gear m_7 that meshes with the larger bevel gear h_8. The shaft m being positively driven at a constant speed, imparts motion to the bell gear h_5, since the cross-shaft q_1 and the parts connected with it turn the bevel gear h_6 of which h_5 is a part, and if it were not for the additional speed imparted through the gear h_9,

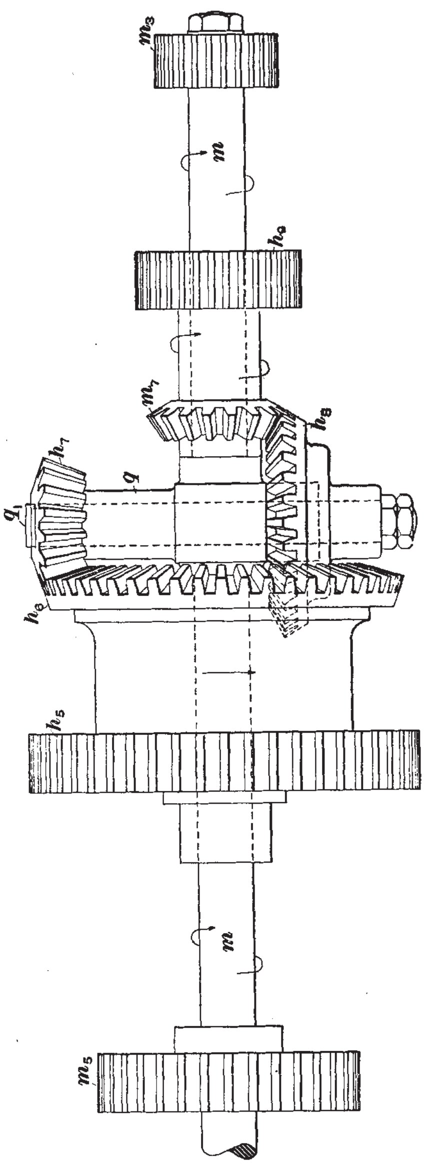


Fig. 3

the gear h_5 would make the same number of revolutions as *m*; h_9, however, is positively driven in the same direction as *m* through the cones, while m_7, being on the same sleeve with h_9, drives h_8 and consequently h_7 on the other end of the cross-shaft. As h_7 meshes with h_6, the latter and also h_5 receive an accelerated motion in addition to that derived through the motion of the shaft *m*.

The effect of the combined forces acting on h_5 is to cause it to revolve at such an accelerated speed that, when winding is being performed at the beginning of a set of bobbins, the empty bobbins revolve so much faster than the spindles as to wind on the roving delivered by the rolls. As the gear h_9 is driven from the bottom cone and the speed of this cone is reduced in the usual manner, the speed of h_9 is gradually reduced as the bobbins are built up, resulting in the diminishing of the speed of h_6 and h_5; the speed of these gears, however, is not reduced at any time so as to be less than the speed of the shaft *m*, thus always insuring that the bobbins revolve faster than the spindles and that winding is constantly taking place.

In this compound, all the gears that are loose on the shaft *m* revolve in the same direction as the shaft; thus, the power required to drive them is greatly reduced in comparison with the old-style compound, since there is only a very slight amount of friction between the gears and the shaft. An advantage over the older form of compound will be readily seen in the saving of power and the lessening of the strain on the working parts, especially on the cone belt, where the strain is lessened to a very great degree. In this compound, the revolution of the shaft *m* becomes a help to the cone belt instead of an obstacle, as in the old form of compound. The greatest strain put on the belt is no more than is required to revolve the bobbins at their maximum speed of about 100 revolutions per minute beyond those run by the spindles. The shaft helps to the extent of the number of revolutions that it drives the spindles, and the balance, which varies from 100 revolutions to none, is easily obtained with little strain on the cone belt. It is obvious that with the strain thus reduced, the cone belt will almost entirely cease to be a trouble or the cause of bad work.

5. Fig. 4 (*a*) and (*b*) shows views of a compound widely different from those described. It uses spur gears instead of bevel gears, thus reducing the amount of friction. The gear h_9 is on a sleeve that carries at its opposite end a gear m_7; this sleeve is loose on the jack-shaft m and revolves in the same direction. The gear h_9 is driven by the cones

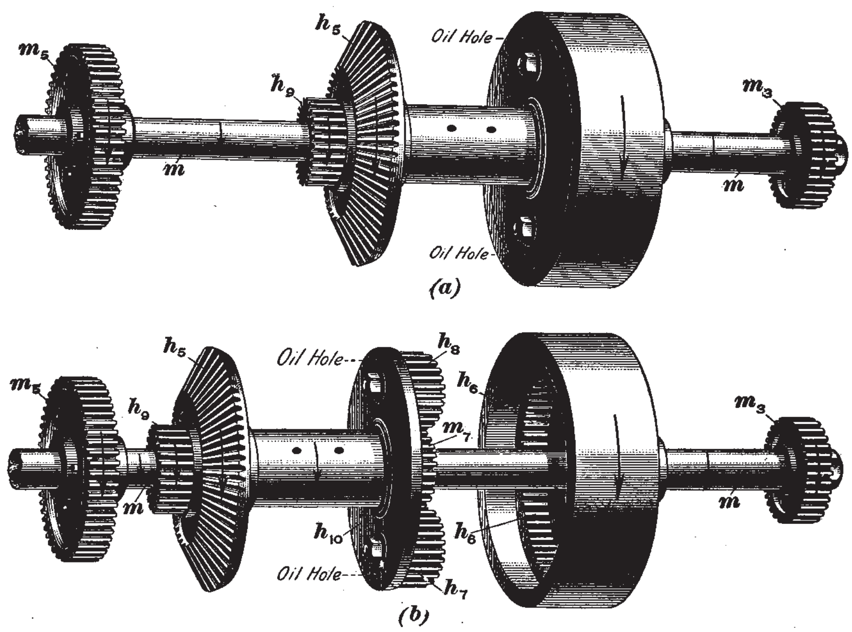


Fig. 4

in the usual manner, its speed depending on the position of the belt on the cones, while the gear m_7 causes the gears h_7, h_8 to revolve on their axes. The annular gear h_6, which is fast to the jack-shaft m and revolves with it, gives motion to the disk h_{10} simply because the gears h_7, h_8, which are on studs fastened to the disk, mesh with its teeth. The gears h_7, h_8 have two motions; they revolve on their axes and also around the annular gear h_6. Thus, the disk h_{10} is caused to revolve at a greater speed than the jack-shaft, and as it is on the same sleeve as the gear h_5, it causes h_5 to revolve and give motion to the bobbins. When the speed of the gear h_9 is reduced by the cones, it reduces the speed of the gear m_7, and consequently that of the gears h_7, h_8, as well as that of the gear h_5, thus driving the bobbins more slowly. The sleeve that carries the gear h_5 and the disk h_{10} is outside of the one that carries the gears h_9, m_7, but it revolves in the same direction; thus there is a sleeve within a sleeve, forming what might be called a *double*, or *compound*, *sleeve*. The gearing in this compound is protected from dust and dirt by a shell or casing, which also forms an oil chamber so that the gears and sleeves are well lubricated at all times. Fig. 4 (*a*) shows the compound closed and in working position, while Fig. 4 (*b*) shows it open with the internal parts exposed to view.

6. A compound that is novel, compact, and very effective is shown in Fig. 5 (*a*) and (*b*); (*a*) is a plan view partly in section, while (*b*) is a sectional elevation. The jack-shaft m carries the twist gear m_3 and the spindle gear m_5, while the compound is situated between these two gears. Loose on the jack-shaft is a sleeve carrying the gear h_9 and the cam h_{10}. The cam is circular and has a beveled face, as shown in the elevation (*b*). Inside the shell, or bell, portion of the cam is the bevel gear m_7 fast to the jack-shaft m. Bearing against the face of the cam h_{10} is a circular disk q_2 that revolves freely on a spherical bearing q_5. This disk has 36 teeth on each side, as shown at q_3 and q_4; q_3 meshes with m_7, which has 32 teeth, while q_4 meshes with the bevel gear h_6, which has 36 teeth and is fastened to a long sleeve that is loose on the jack-shaft and carries the spherical bearing q_5 and the gear h_5 that drives the bobbins. As the jack-shaft revolves, it carries the bevel gear m_7 with it; and as m_7 meshes with q_3, it causes the circular disk to revolve on the spherical bearing. Since q_4 forms a part of the circular disk, it will revolve with the disk and impart motion to the bevel gear h_6 and the bobbin gear h_5, because q_4 meshes with h_6.

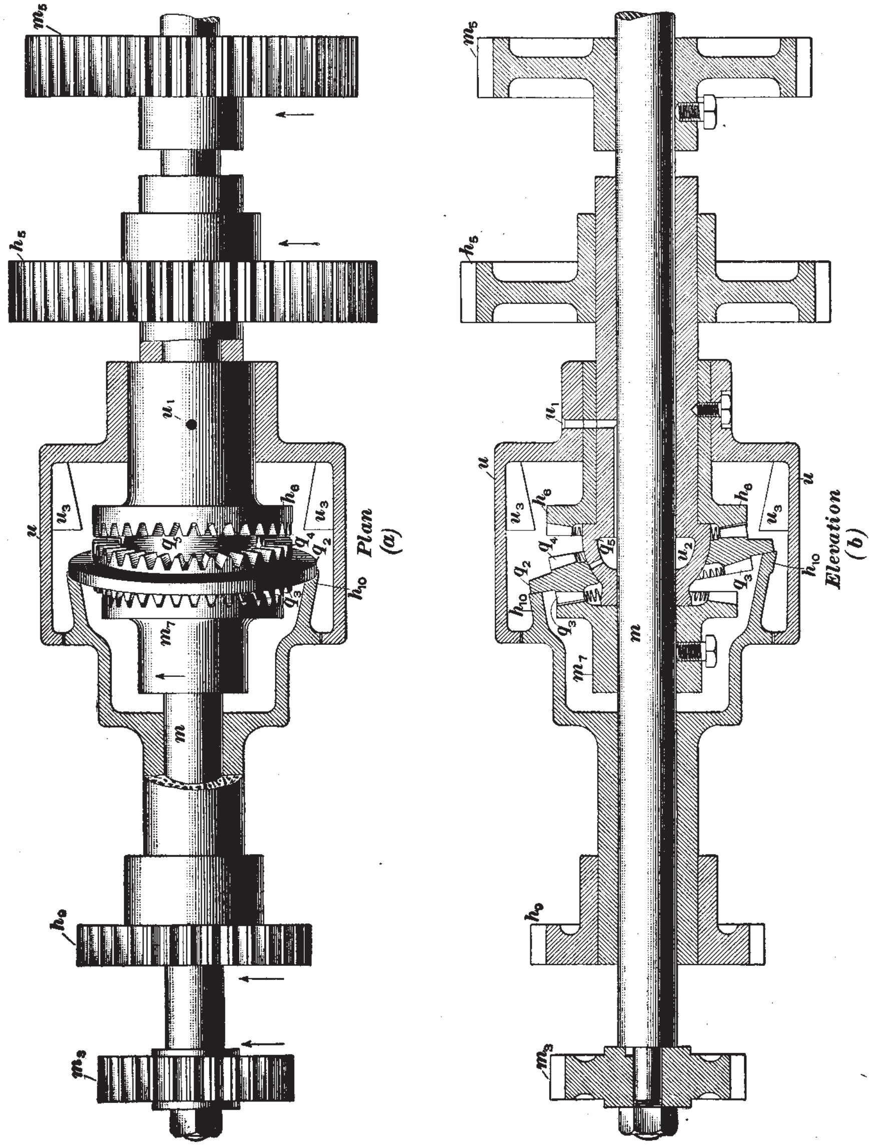


FIG. 5

At the beginning of a new set of bobbins, the bobbin gear h_5 makes the same number of revolutions per minute as the jack-shaft, and drives the bobbins at the required speed to wind on the correct amount of roving. As the gear h_9 is driven from the cones, it is the only medium for altering the speed of the bobbins. When commencing to wind a new set of bobbins, this gear makes the same number of revolutions per minute as the jack-shaft; consequently, for the present the cam may be considered as not existing, as it maintains the same relation between the gears m_7, q_3, q_4, h_6, thus allowing them to act as clutch gears, because the same teeth of the gears mesh with each other for the time being, and cause h_5 to make the same number of revolutions as the jack-shaft.

At the completion of each layer of roving on the bobbins, the cone belt is moved along the cones, thereby decreasing the speed of the gear h_9 and the cam h_{10}. As the speed of the cam is decreased, it causes the circular disk to oscillate on the spherical bearing and change the points of contact of the gear m_7 with q_3, and q_4 with h_6. This oscillating motion of the disk causes q_3 to roll around the gear m_7, and as m_7 is smaller than q_3, it causes a direct loss of speed to the circular disk, because it requires more than one revolution of the gear m_7 to give q_3 one complete turn. Since the speed of the disk is reduced, the gears h_6, h_5 are affected in a similar manner, which causes the bobbins to make fewer revolutions per minute. The gradual reduction in the speed of the bobbins in a bobbin-lead frame is necessary in order that the bobbins may retain their proper circumferential speed, as their diameters increase with each new layer of roving.

This entire motion is protected by a shell, or casing, u and may be thoroughly oiled by means of the oil hole u_1, which extends through the boss of the casing and the sleeve of the spherical bearing to the jack-shaft, and there connects with a passage in the sleeve of the spherical bearing. This passage ends at a chamber u_2 that is in the spherical bearing. A hole in the bearing allows the oil to be distributed on the face of the bearing and to pass into the large chamber, where it is distributed by the projections u_3 on all of the remaining parts, thus insuring a perfect lubrication at all times.

THE CONES

7. Any one of the four types of compounds described provides a method of controlling the speed of the bobbins and gradually reducing it as they increase in diameter, if the speed of the controlling gear of the compound itself is suitably reduced. The action of the compounds shown in Figs. 2, 3, 4, and 5 is governed by the gears lettered h_9 in each case. If in any one of these compounds the speed of this gear is reduced, the speed of the bobbins is reduced. To secure the suitable reduction of the speed of the controlling gear in compounds on fly frames, a pair of cones is always introduced between the source of power applied to the machine and the compounds. These cones as used in combination with the ordinary type of compound are shown in Fig. 1; the top cone n_3 is concave and has a diameter of $6\frac{1}{2}$ inches at one end and $3\frac{1}{4}$ at the other, while the lower cone is convex and has a diameter of $6\frac{1}{2}$ inches at the large end and $3\frac{1}{4}$ at the small end. These cones are connected by a belt, by which the upper cone drives the lower cone; this belt is gradually moved from the larger end of the top cone to the smaller end during the filling of the bobbin, a slight movement being given to it each time that the traverse of the frame is changed. This movement is so proportioned as to bring the cone belt to the small end of the upper cone by the time the bobbins are filled.

As the length of roving wound on the bobbin always equals the excess surface speed of the bobbin over the flyer, if a bobbin starts with a certain number of revolutions per minute, its rotary movement in excess of that of the flyer must be decreased in direct proportion to its increase in diameter. If the diameter of the full bobbin is four times that of the empty one, which is common in fly frames, the excess speed must be reduced to one-quarter. For instance, if the empty bobbin is 1 inch in diameter and the full bobbin 4 inches in diameter, this means that the diameters of the cones must be arranged to give a reduction of 4 from one extreme to the other. The diameters suitable for this and such as are generally adopted are those mentioned, and it is obvious that the lower cone will revolve four times as fast when driven from the large end of the upper cone as it will when driven from the small end; thus, $6\frac{1}{2} \div 3\frac{1}{4} = 2$; $3\frac{1}{4} \div 6\frac{1}{2} = .5$; $2 \div .5 = 4$.

Formerly cones were made with a straight surface, diminishing equally from the large to the smaller end of the cone, but it has been found in practice that a concave upper cone and a convex bottom cone give more even winding, and they are now usually so constructed. When the belt is on the large end of the top cone and driving the small end of the bottom cone, the roving is being wound on the bare bobbin.

BUILDER MOTIONS

8. There are several very important points that should be considered in connection with the winding of the roving on the bobbin. It is customary to have each succeeding layer of roving slightly shorter than the preceding one, thus forming a taper at both ends of the bobbin. Thus, as is shown in Fig. 6, the first layer of roving that is placed on the bobbin extends from *a* to *b*, while the last layer extends only from *c* to *d*. Consequently, it becomes necessary to introduce some mechanism by means of which the traverse of the carriage may be shortened each time one complete layer of roving has been placed on the bobbin. It might naturally be supposed that since the traverse is shortened as the bobbin grows larger, the time occupied by the carriage in making the traverse will be lessened; but this is not so, since with each layer of roving the diameter of the bobbin is increased and consequently, although the part of the bobbin that is covered by the layer is less, there is actually a greater length of roving. Still another point to be noted is that in order to make a well-wound bobbin it is necessary that there should be only a slight space between any two adjacent coils in the same layer of roving, and that this space should be maintained throughout the building of the bobbin. It will be seen that the distance between two adjacent coils of roving will depend on the speed at which the bobbin is traversed.

It would be a comparatively simple matter to so regulate the speed of the carriage that the roving would be wound correctly for one layer, but the principal difficulty in building the bobbin lies in the fact that the correct speed of the carriage for an empty bobbin is not the correct speed for the bobbin after it has had several layers of roving wound on it. That this is so may be readily seen if it is considered that with each additional layer of roving the bobbin is increased slightly in diameter and that consequently it takes a greater length of roving to form one complete coil around the bobbin. Therefore, in order that the same space may exist between two consecutive coils in any layer throughout the filling of the bobbin, the speed at which the carriage, and consequently the bobbin, traverses up and down must be lessened as the bobbin becomes larger.

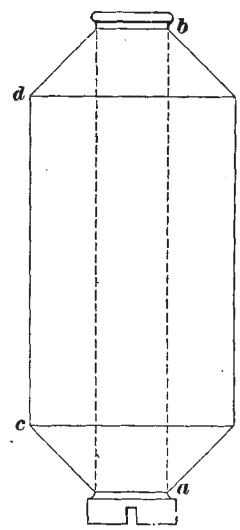


FIG. 6

Referring again to Fig. 1, the shaft n_7, which is driven from the bottom cone, carries a bevel gear n_8 that drives the bevel gear n_9 on an upright shaft. At the lower end of this upright shaft is a bevel gear v that by means of the gears v_1, v_2, the action of which will be explained later, gives motion to the shaft v_3. The gear v_4 on the end of this shaft drives, through suitable gearing, the shaft r_3, which carries the gear r_2 that imparts motion to the rack r_1. Since the motion of this train of gears is derived from the bottom cone, the rack and, consequently, the carriage will be driven at a speed that is uniformly decreasing as the bobbins are becoming full, which is the result desired.

AMERICAN TYPE OF BUILDER

9. In order to shorten the length of the traverse with each layer of roving placed on the bobbin and also to reverse the direction of the traverse, the **builder motion** is applied to all fly frames. A view of a builder motion that illustrates the style generally used on American-built frames is given in Figs. 1 and 7. Its parts are as follows: Attached to the carriage, and consequently rising and falling together with it, is a bracket x, Fig. 7, carrying a casting that supports a central shaft x_1 on which right- and left-hand threads are cut. The upper thread carries the jaw x_2, and the lower thread the jaw x_3; therefore, by turning the shaft x_1 in the proper direction the two jaws can be brought closer together, the upper jaw x_2 projecting beyond the lower jaw x_3 and being capable of sliding outside, as shown in the illustrations. The upper part of the shaft x_1 is made square and projects through a gear x_4 supported by a bracket. As the gear x_4 is not setscrewed to the shaft x_1, any vertical movement of one will not affect the other, and yet on account of that part of the shaft that projects through the gear being square, and the aperture in the gear being of such a shape as to fit the shaft, any rotary motion of one will be communicated to the other. In studying this motion it should be understood that as the bracket x is raised and lowered by the carriage it takes with it the shaft x_1 and the jaws x_2, x_3. Another upright shaft w, known as the **tumbler shaft,** carries a dog w_1 having two arms w_2, w_3. At the bottom of the tumbler shaft is a circular disk y_6 with two lugs, shown in plan in Fig. 7 (*b*), against each of which, in turn, a lever y_7 is pressed by means of a strong spring in such a manner as to tend to move the shaft a small portion of a revolution. At the upper end of the shaft is a gear w_4 composed of four sections, also shown in plan in Fig. 1 (*b*); two of these sections that are directly opposite each other have 13 teeth each, while the other two sections are blank.

10. The action of this part of the mechanism is as follows: Suppose that the parts are in the position shown in Fig. 7; then the spring acting on one of the lugs on the disk at the foot of the shaft *w* is tending to give this shaft a partial revolu-

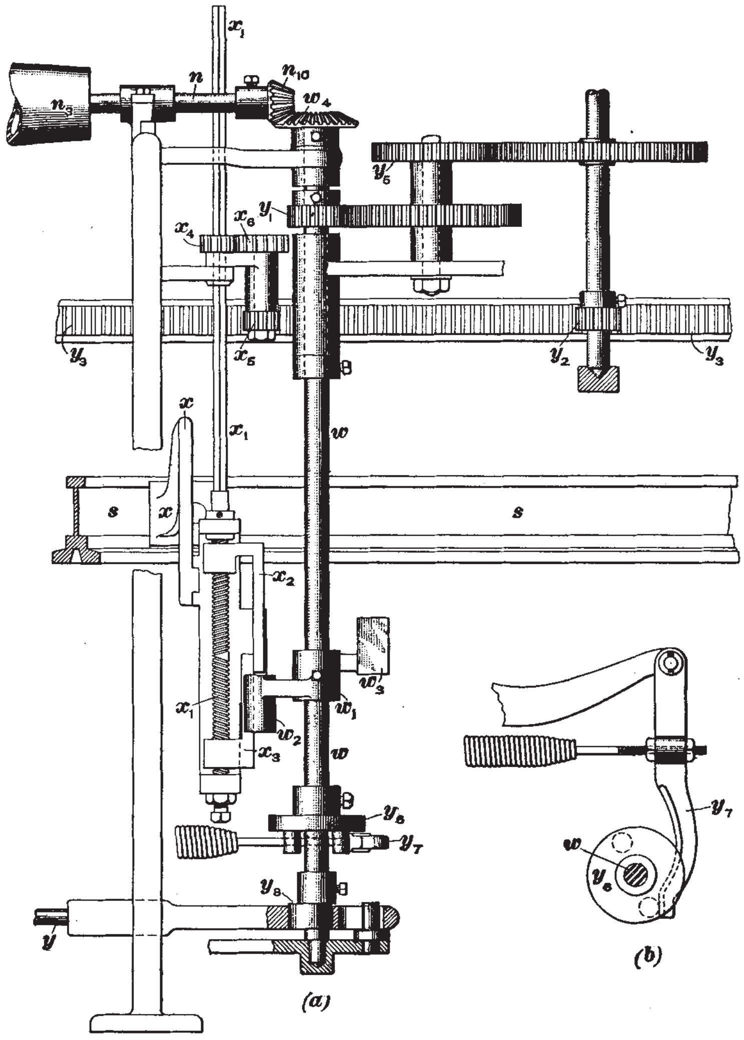


FIG. 7

tion but is prevented from doing so by the arm w_2 bearing against the jaw x_3. The carriage when the parts are in this position is moving up, and when it has risen sufficiently so that the jaw x_3 is raised above the arm w_2, the spring is allowed to act on the shaft w and turn it until the gear n_{10} on the end of the top-cone shaft engages with the teeth in one of the sections of the gear w_4. These two gears continue to engage until a blank section on the gear w_4 is presented to n_{10}, at which point the spring at the foot of the shaft w will act on the second lug and further turn the shaft until the arm w_3 comes in contact with one of the jaws. The entire motion of the shaft w at any one time is thus equal to half a revolution. It should be noted that although the carriage at the time these actions take place is sufficiently high to allow the arm w_2 to pass under the jaw x_3, the arm w_3, owing to its being situated in a higher plane than w_2, will come in contact with the jaw x_3, and as the carriage is lowered, with the jaw x_2 also. When the motion of the carriage is downwards, the arm w_3 is bearing against the jaws, and as the jaw x_2 is brought low enough to free this arm the shaft w is given a half revolution in the same manner as that described.

In making this half revolution, the tumbler shaft accomplishes a change in three parts of the frame at the same time: (1) The carriage is driven in an opposite direction, that is, if it was going up before, it is going down after the shaft has turned; (2) the belt is moved along the cones for a short distance; (3) the length of the traverse is shortened. Dealing with these points separately and in the order given above, when the tumbler shaft is given a half revolution it turns the cam y_8 situated at its lower end, a plan view of which is shown in Fig. 1 (c). This action results in giving the rod y, Fig. 1, a longitudinal motion. This rod is jointed to the rod v_3 in such a manner that the latter is allowed to revolve without in any way affecting the former, and yet any longitudinal motion of one will affect the other. On the rod v_3 are shown two gears v_1, v_2, the teeth of which face each other; these are known as the **twin gears.** They are so adjusted on the rod that a movement in either direction of the rod y causes one or the other of the two gears to come in contact with the bevel gear v. It will be seen that the direction in which the shaft v_3 rotates will be periodically reversed; i. e., if it were turning from right to left before the tumbler shaft turned, it will be turning from left to right afterwards. As the carriage is primarily driven by the shaft v_3, the direction of movement of the carriage will thus be reversed at every turn of the tumbler shaft.

On the tumbler shaft is placed a gear y_1 that through a suitable train drives the gear y_2 gearing into the rack y_3, which carries at one end a belt guide y_4, Fig. 1; consequently, as the tumbler shaft is revolved, the gear y_1 will turn y_2, thus giving motion to the rack y_3 and through the belt guide y_4 moving the belt a short distance toward the small end of the top cone.

As the rack is moved, it imparts motion to the gear x_5 which through the gear x_6 turns the gear x_4 and consequently the shaft x_1. The movement of the shaft x_1 brings the jaws x_2, x_3 closer together, which allows the arms w_2, w_3 to escape the jaws when the carriage has made a shorter traverse than was previously necessary.

11. Change Gears.—In connection with this builder motion there are the following very important change gears, reference being made to Fig. 1: the lay gear v_4, the tension gear y_5, the taper gear x_6, and the rack gear y_2. The *lay gear* v_4 forms part of the train of gears that regulate the speed at which the carriage moves up and down, and consequently the distance between any two consecutive coils of roving on the bobbin. In case the correct distance is not maintained between the coils, this gear is the one that is changed. The *tension gear* y_5 regulates the distance that the cone belt moves along the cones at each reversal of the traverse of the carriage, and consequently controls the tension of the roving between the delivery rolls and the flyer, since if the belt is moved a shorter distance along the cones, it causes all the motions controlled by the cone belt to tend toward winding more quickly and thus increase the tension of the roving, while on the other hand if the cone belt is moved a greater distance, the reverse will be true. The *taper gear* x_6 regulates the distance that the jaws of the builder motion will be brought toward each other at each reversal of the carriage, and consequently regulates the taper on the bobbin. The *rack gear* y_2 regulates the distance that the rack moves at any one time, and consequently also regulates both the tension and the taper at the same time. By changing the rack gear to a smaller gear the rack is moved a shorter distance, thus causing the jaws of the builder to come together more slowly and the belt to be moved along the cones more slowly.

ENGLISH TYPE OF BUILDER

12. Fig. 8 (*a*) and (*b*) shows a style of builder motion that is found on English-built frames. Fig. 8 (*a*) shows this motion as it appears on the frame, while Fig. 8 (*b*) shows the motion with certain of the parts removed in order that its action may be more clearly explained. Attached to the carriage of the fly frame is a bracket x that has a slot x_1 cast in it. A stud x_2 that works in this slot carries a bar x_3, known as the **poker bar,** that passes through a cradle a loose on the shaft b. Attached to the bracket x is an arm y that has connected to it at y_1 a cradle c centered at c_1. It should be carefully noted that as the carriage traverses up and down it will carry with it the bracket x and thus cause the poker bar x_3 to give a rocking motion to the cradle a. At the same time the cradle c will also receive a rocking motion, due to its being connected to the bracket x by the arm y. A vertical shaft d carries the two gears y_2, d_1. The gear y_2 engages with the rack y_3 that carries the belt guide, while the gear d_1 engages with the gear d_2, which is fastened to the shaft b. Fastened to the same shaft are the gears e, e_1, the gear e_1 engaging with teeth on the under side of the poker bar x_3 while the gear e is a ratchet gear and has working in its teeth the stop-pawls e_2, e_3. At the top, or head, of the vertical shaft d is a drum d_3 on which is wound a chain f carrying a weight g; this weight exerts a constant pull on the chain, and were it not for the engagement of the stop-pawls e_2, e_3 with the teeth of the ratchet gear e, would cause the shaft d to revolve until the chain was entirely unwound from the drum. The cradle h, which is loose on the shaft b,

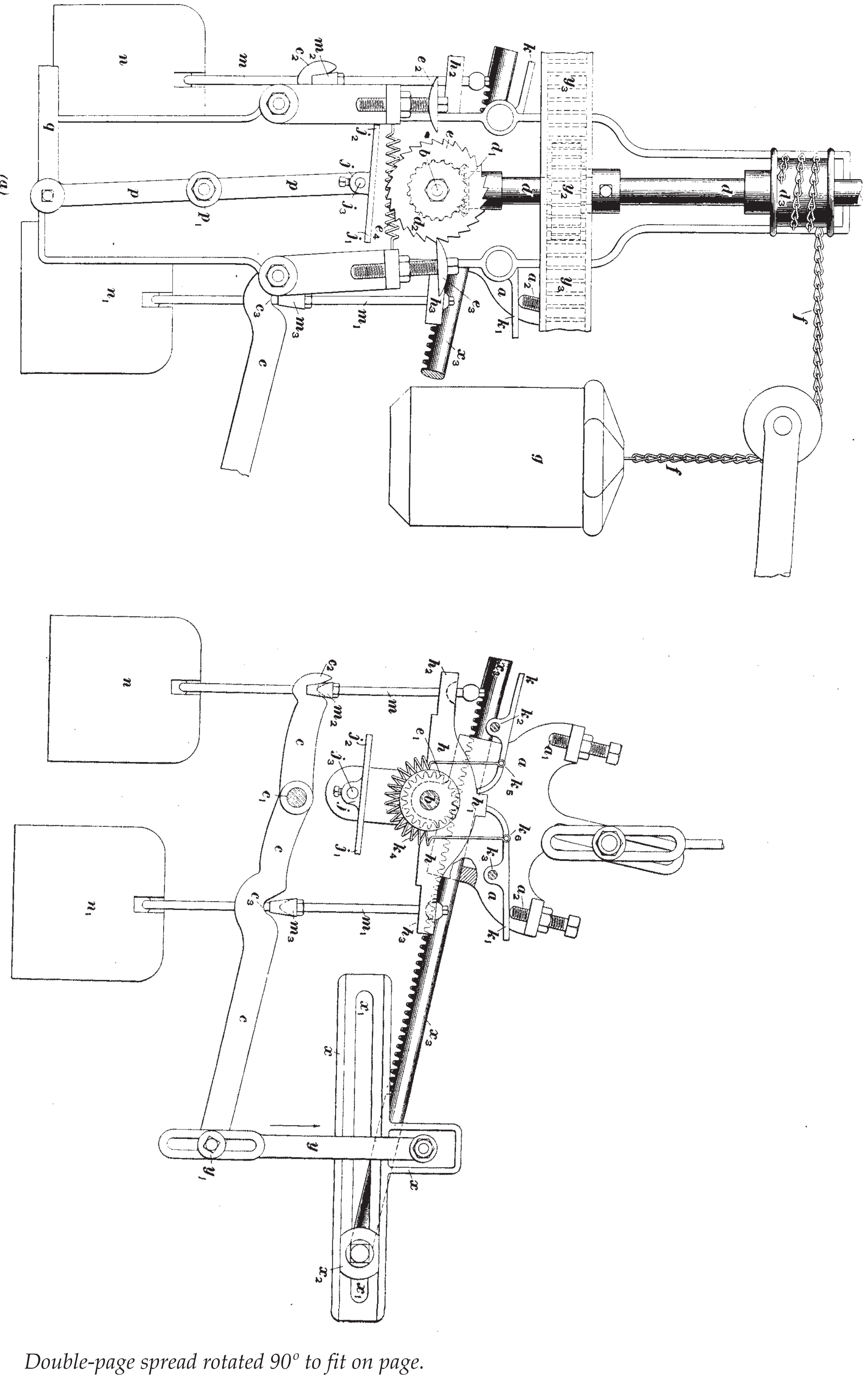


FIG. 8

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

carries at its lower end a stud j_3 and bracket j, which has two projecting arms j_1, j_2, while at its upper end the cradle has three projections h_1, h_2, h_3. The projection h_1 forms a shoulder against which the two pigeon levers k, k_1 are kept in contact by means of the spring k_4 that passes under the stud b and is connected to the levers at k_5, k_6, respectively, thus exerting a continual pull on the levers k, k_1 in a downward direction toward the shaft b. The levers k, k_1 are centered on studs k_2, k_3 that are secured to the frame. Directly above the points c_2, c_3 of the cradle c are two hooks m_2, m_3 that form part of the rods m, m_1, respectively. The rod m has the weight n attached to its lower end, while at its upper end it passes through the projection h_2 of the cradle h. The rod m_1 is connected to the cradle h in exactly the same manner and carries the weight n_1. Consequently, if the weights are not supported at the points c_2, c_3 by means of the hooks m_2, m_3, they will be suspended from the projections h_2, h_3.

13. The operation of the parts is as follows: Assuming that the carriage is ascending, as indicated by the arrow, carrying with it the poker bar x_3 and raising the right-hand side of the cradle c, as the rail ascends, the point c_2 descends until the rod m with weight n is resting entirely on the end h_2 of the cradle h; the weight n tends to pull h_2 downwards but is prevented from doing so by the lever k being in contact with the shoulder h_1. When the carriage has ascended far enough, the setscrew a_1 that is attached to the cradle a forces down the lever k at its outer end, thus releasing the shoulder h_1 and allowing the cradle h to be pulled over by the weight n, which as previously stated was hanging from h_2, due to the descent of c_2. Not only does the ascent of c_3 allow the rod m attached to the weight n to rest on h_2, but it simultaneously raises the rod m_1 attached to the weight n_1 from the projection h_3, by raising the point c_3 and allowing the weight to be borne by the cradle c at this point, thus avoiding any pull of n_1 on h_3 and also allowing the cradle h to rock freely. The cradle h carries at its lower extremity the bracket j; therefore, if the center of motion is at b, any movement of h_3 will cause the shoulder h_1 to swing in a similar direction and thus transmit to j a like movement, but in an opposite direction. The downward movement of h_2 causes the shoulder h_1 to swing to the left, and j to swing to the right. In doing so, the arm j_1 forces the pawl e_3 out of contact with the ratchet e and allows the weight g to rotate the vertical shaft d until the pawl e_2 engages with the ratchet e; since e_2 and e_3 are connected by the spring e_4, which has a tendency to draw them together, e_2 will therefore engage with the ratchet e after it has turned half a tooth. The rotation of the shaft d will communicate motion to the rack y_3 by means of the gear y_2, thus moving the belt along the cones for a short distance. At the same time, the gear e_1 will move the poker bar slightly to the left, thus bringing the stud x_2 nearer the cradle a; consequently, on the next traverse the setscrew a_2 will force down the lever k_1 when the carriage has moved a shorter distance than on its previous traverse. Attached to j_3 is an arm p that is centered at p_1. Connected to the lower end of this arm is a rod q that is jointed to the shaft carrying the twin gears. As j_3 is forced one way or the other by the action of the cradle h, it swings the arm p, which, acting on the rod q, causes the opposite twin gear to engage and thus reverses the direction of motion of the carriage.

METHODS OF DRIVING BOBBIN SHAFTS

14. Horse-Head Motion.—Referring again to Fig. 1, it will be remembered that the gear h_5, which is carried by a sleeve on the jack-shaft m, drives, by means of the intermediate gear h_4, the gear h_3 on the end of the back bobbin shaft. An important point to be noted in connection with this drive is that the jack-shaft, which carries the gear h_5, revolves constantly in the same position, while the gear h_3 on the bobbin shaft, which is driven from the gear h_5, is receiving a vertical reciprocating motion, since the shaft carrying this gear forms a part of the bobbin carriage; consequently, some special device must be adopted to keep the three gears h_5, h_4, h_3 constantly in mesh with each other. Fig. 1 shows simply a diagrammatic view of the gearing of a fly frame, and consequently the device adopted in this connection is not shown; but by referring to Fig. 9 the method adopted to compensate for the rise and fall of the bobbin shaft can be understood. This construction, which is very frequently adopted on fly frames, is commonly known as the **horse-head motion.** The three gears h_5, h_4, h_3 correspond to the same gears in Fig. 1. Swinging loosely on the bearing that carries the jack-shaft *m* is an arm *z* that carries at its other end a stud on which the intermediate gear h_4 revolves. Swinging loosely on this same stud is an arm z_1

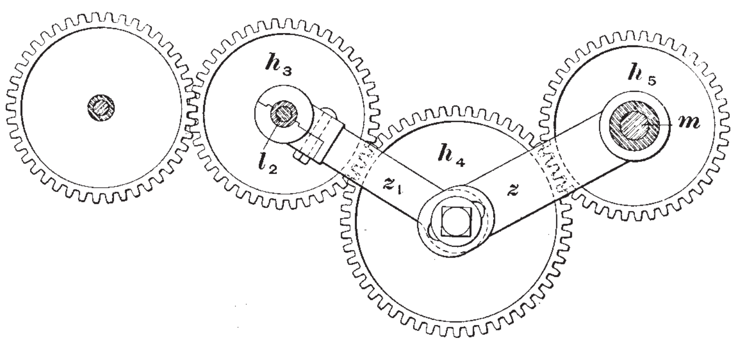


FIG. 9

that is attached at its opposite end to the bearing of the back bobbin shaft, on which shaft is the gear h_3. This connection is similar to that between the arm *z* and the bearing of the jack-shaft. Since the length of the two arms is always constant and this length is just sufficient to allow the teeth of the three gears to mesh properly, it will readily be seen that as the bobbin shaft rises and falls it will necessarily take the intermediate gear with it and hold it in the correct position for the teeth of the three gears to mesh properly.

15. Vertical and Angle Shaft Motion.—Another method of obtaining the same result is shown in Figs. 10 and 11; it is known as the **vertical and angle shaft motion.** The parts of this motion are as follows: A vertical shaft *a* extends from the under side of the roll beam almost to the floor, having its lower end pointed and resting in a footstep and its upper end resting in a bearing that is secured by bolts to the under side of the roll beam. On this shaft is a sleeve *b* that extends into the gear-box at the head of the carriage and is supported by a bracket *c* and flange b_1.

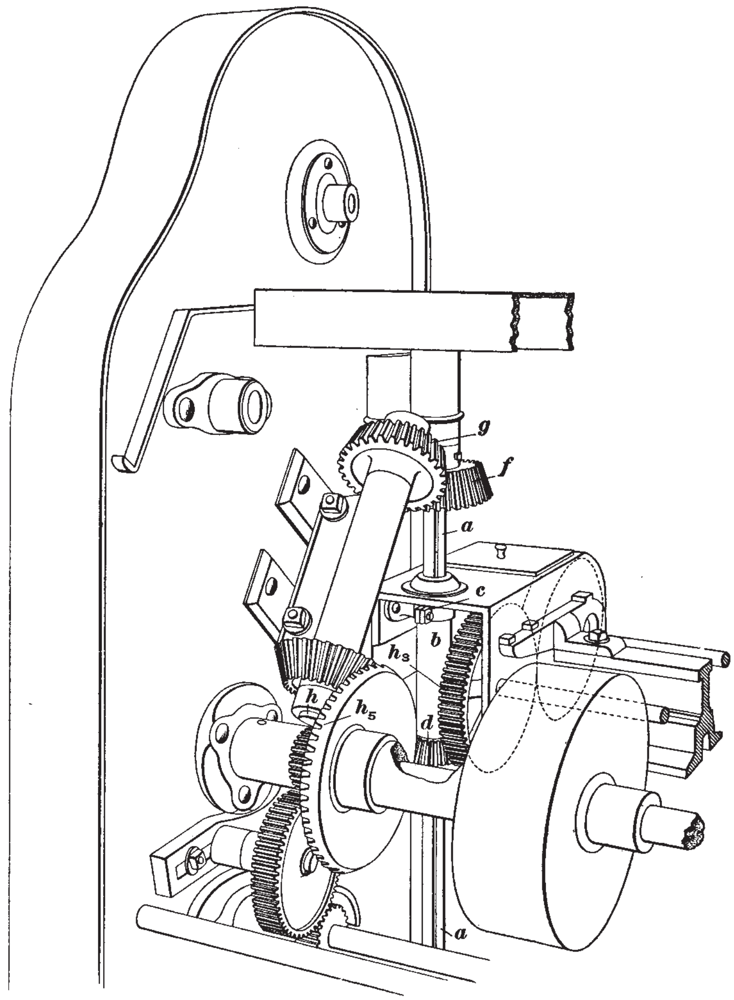


Fig. 10

The sleeve *b* is key-seated to the vertical shaft, and consequently as the shaft revolves will receive a rotary motion; it is, however, free to be moved up and down on the shaft *a* as may be desired. It will be seen from the construction that as the carriage receives its traversing motion it takes with it the sleeve *b*, fastened to which is a gear *d* that gears into the gear *e* on the back bobbin shaft. Setscrewed to the upper end of the vertical shaft *a* is a bevel gear *f* receiving motion from the bevel gear *g* at the upper end of the angle

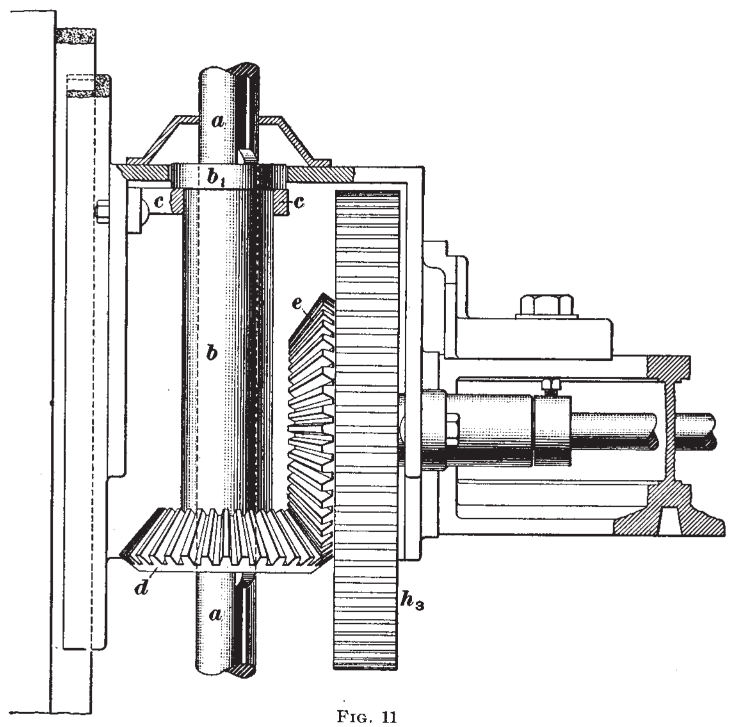


Fig. 11

shaft *h*. At the lower end of this angle shaft is another bevel gear driven by the beveled bobbin gear h_6 on a sleeve on the jack-shaft. By this means the vertical shaft *a*, which receives motion from the jack-shaft through the train of gears just described, is constantly imparting motion to the gear *d* on the sleeve *b*, although this sleeve traverses up and down the shaft together with the bobbin rail.

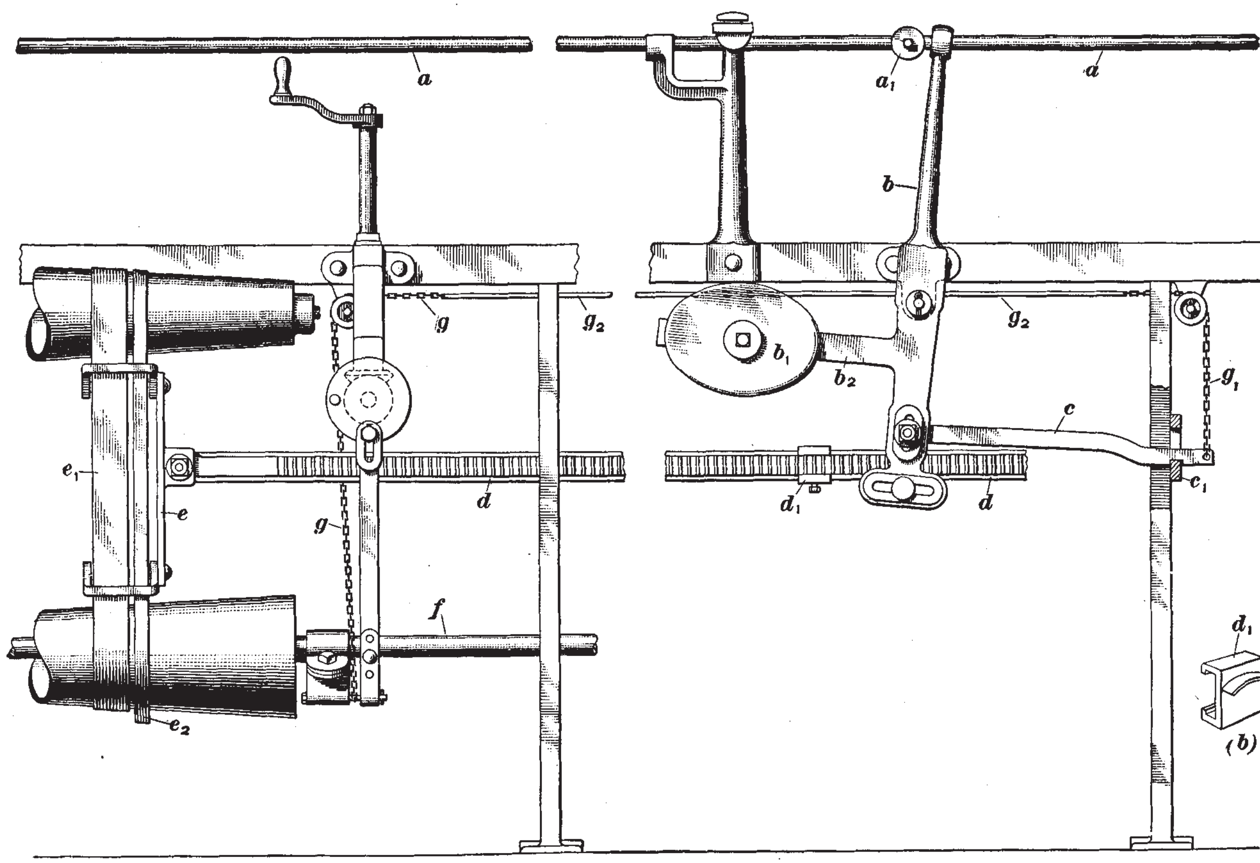
STOP-MOTIONS

16. The **full-bobbin stop-motion** of a fly frame is very simple and is found on most fly frames. The shipper rod *a*, Fig. 12 (*a*), extends the entire length of the frame and passes through the eye of the knock-off lever *b*, which is pivoted to a bracket attached to the roll beam. The knock-off lever carries an arm b_2 that supports a heavy weight b_1, while near the lower part of the lever is pivoted a knock-off latch *c* that passes through an opening in one of the sampsons; this sampson carries a bracket c_1 that is engaged by a slot in the latch, thus holding the latch in position. The rack *d*, which carries the belt guide *e*, also has a knock-off dog d_1 attached to it by means of a setscrew. A perspective view of this knock-off dog is shown in Fig. 12 (*b*).

During the building of the bobbin the cone belt is moved along the cones by the movement of the rack, which moves slightly toward the foot end of the frame at the completion of each traverse. When the bobbins have become full the belt is at the small end of the top cone and the rack has moved some distance to the right; consequently, on account of the position of the knock-off dog on the rack, this dog passes under the knock-off latch and raises it, thus allowing the weight b_1 to throw the upper end of the knock-off lever *b* to the left so that it strikes the ball a_1 attached to the shipper rod. As the lever continues its movement it moves the shipper rod toward the head end of the frame and ships the driving belt from the tight to the loose pulley.

The frame can be set to knock off whenever the bobbins have attained their correct size. This is accomplished by moving the knock-off dog on the rack so that it will pass under the latch and release it when the bobbins are of the desired size.

17. A great deal of trouble and bad work results on fly frames from the cone belt breaking. In Fig. 12 (*a*) a patent knock-off motion is shown, which stops the frame and at the same time prevents the ends from breaking down at the front



(a)
FIG. 12

when the cone belt breaks. The lower cone is supported by a frame that swings on the back shaft f and is capable of being raised or lowered; the shaft f is the one that imparts motion to the racks that actuate the carriage. The chains g, g_1 and the rod g_2 form a connection between one of the bearings of the bottom cone and the knock-off latch. The shipper e carries two belts e_1, e_2. The wide belt e_1 is the main cone belt and is used to drive the bottom cone. The belt e_2 is a little longer than e_1, so that it will not come in contact with the bottom cone when the frame is running properly. When the belt e_1 breaks, the lower cone falls until it comes in contact with the auxiliary belt e_2, which is long enough to allow the lower cone to drop sufficiently to release the latch c by means of the chain-and-rod connection. When the latch c is released the knock-off lever forces the shipper rod toward the head of the frame, so that the belt is moved from the tight to the loose pulley. The auxiliary belt keeps the lower cone in motion until the frame has stopped, and thereby prevents the ends from breaking down at the front.

CREEL

18. Although the slubber has been taken to illustrate the construction of fly frames, it will be found that the descriptions given will apply equally well to any of the machines grouped under the head of fly frames. Outside of the difference in the size of the parts of the different frames, the only noticeable difference between the slubber and the other frames is in the manner of feeding the cotton at the back. As the slubber takes the sliver from the cans that are filled at the drawing frames, these cans are placed behind the slubber in a similar manner to that adopted at the drawing frames and other machines to which the cotton is fed from cans. On the other hand, the roving comes to the later fly frames on bobbins, and it is consequently necessary to provide some means by which these bobbins may be supported and yet allowed to revolve freely as the roving is being unwound from them. Any arrangement in cotton-mill machinery that

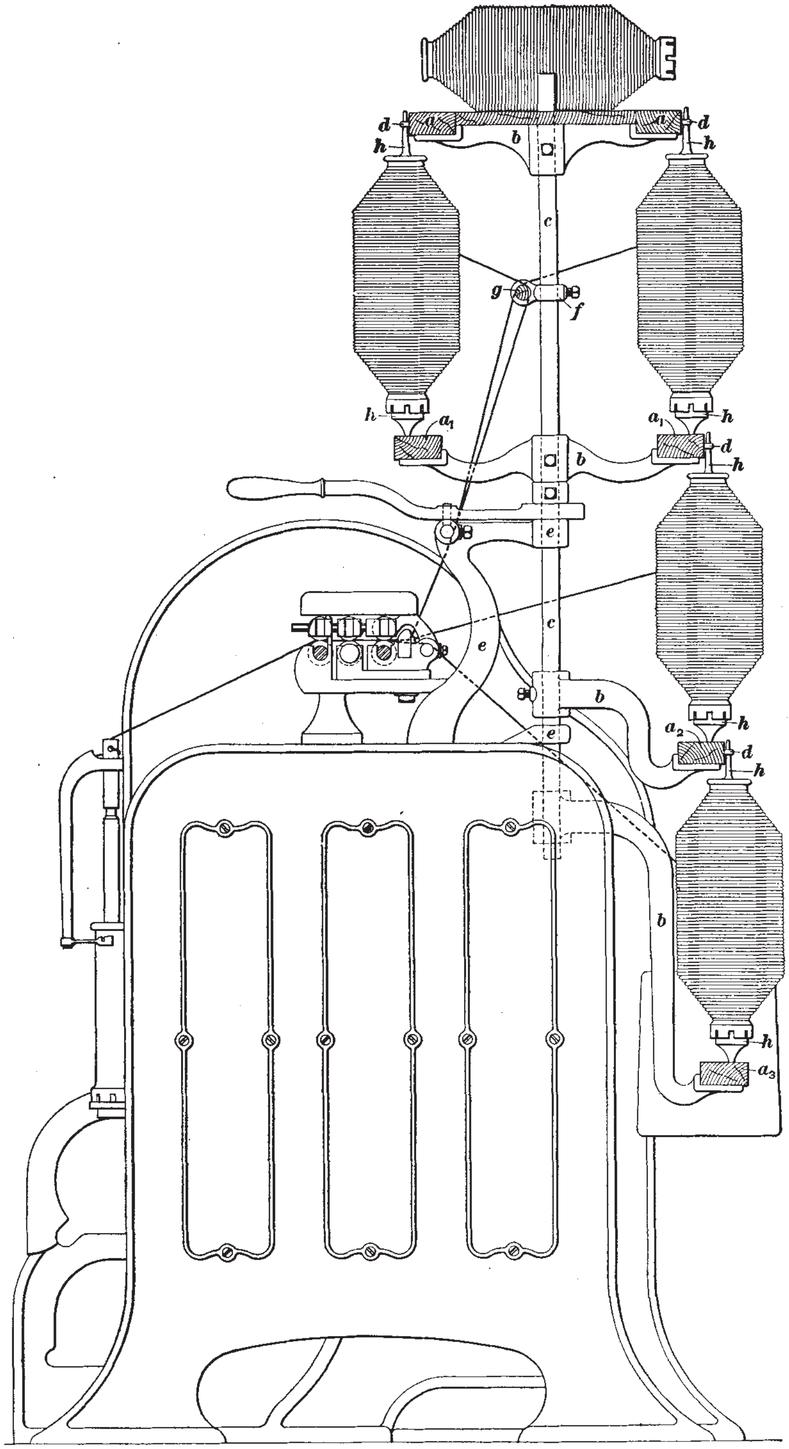


Fig. 13

serves to support bobbins or spools is generally termed a **creel.** Fig. 13 shows the creel, together with other parts, of a first intermediate fly frame. The creel consists of a framework that extends the entire length of the machine at the back and is built up of the required number of wooden rails a, a_1, a_2, a_3, which are supported by brackets b that are setscrewed to the rods c and are capable of being adjusted up or down in order to have the desired space between any two. On their upper sides the rails, with the exception of the top ones, carry glass cups, or steps, while directly over each cup is a metal eye d fastened to the rail above. The rods c to which the brackets b are setscrewed are supported by brackets e bolted to the roll beam; these rods, in addition to carrying the brackets b, also support small brackets f through which the rod g passes. This rod serves as a guide for the roving as it is unwound from the upper bobbins.

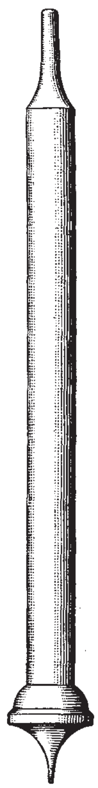


FIG. 14

In placing the full bobbins in the creel wooden skewers are used. These skewers are shown at h, Fig. 13, a skewer alone being shown in Fig. 14. They are slightly longer than the bobbins and, as shown in Fig. 13, pass completely through them, the lower end of each skewer resting in the cup on the top of the rail, while its upper end passes through the eye inserted in the edge of the rail above. A shoulder at the lower end of the skewer prevents the bobbin from dropping below this position, and as it is practically only the friction of the bottom point of the skewer in the glass cup that must be overcome, the bobbins revolve with a minimum of resistance.

The top of the creel is of sufficient width to support full bobbins, and it is the custom to place them side by side and from two to three tiers high along the entire top of the creel. This provides for a sufficient number of full bobbins to take the place of those already in the creel when they become empty.

FLY FRAMES

(PART 3)

MANAGEMENT OF FLY FRAMES

CALCULATIONS

1. In connection with fly frames there are numerous calculations that it is necessary to understand. Many of these refer to speeds and drafts, on which general information and rules have been given in dealing with mechanical and draft calculations; examples of all necessary calculations are given in this Section, but the rules dealing with speeds and drafts are omitted. The examples apply to the gearing shown in Fig. 1, and to a bobbin-lead type of frame.

EXAMPLE 1.—Find the speed of the jack-shaft when the main shaft makes 300 revolutions per minute and carries a 20-inch pulley driving a 16-inch pulley on the jack-shaft.

SOLUTION.— $\frac{300 \times 20}{16} = 375$ rev. per min. of jack-shaft. Ans

EXAMPLE 2.—Find the revolutions per minute of the top-cone shaft when the jack-shaft makes 375 revolutions per minute and carries a 38-tooth twist gear driving a 48-tooth gear on the top-cone shaft.

SOLUTION.— $\frac{375 \times 38}{48} = 296.875$ rev. per min. of top-cone shaft. Ans.

EXAMPLE 3.—Find the revolutions per minute of the front roll when the top-cone shaft makes 296.875 revolutions per minute and carries an 86-tooth gear driving a 120-tooth gear on the front-roll shaft.

SOLUTION.— $\frac{296.875 \times 86}{120} = 212.76$ rev. per min. Ans.

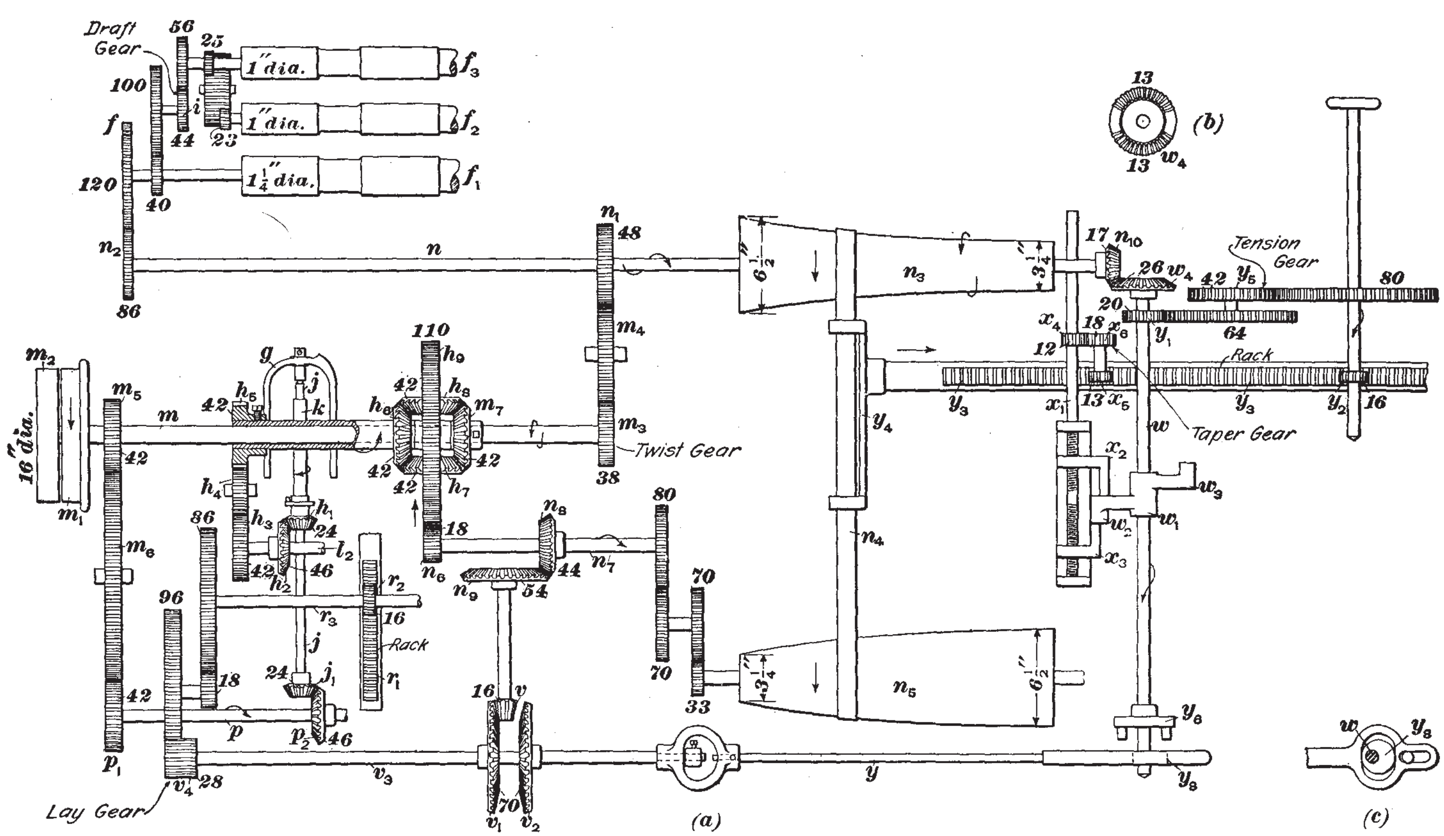

Draft Gear
1" dia.
1" dia.
1¼" dia.
Twist Gear
Rack
Lay Gear
Tension Gear
Rack
Taper Gear
16" dia.
(a)
(b)
(c)

Fig. 1

EXAMPLE 4.—Find the length of roving delivered per minute by the front roll when it is 1.25 inches in diameter and makes 212.76 revolutions per minute.

SOLUTION.— $\frac{212.76 \times 1.25 \times 3.1416}{36} = 23.208$ yd. per min. Ans.

EXAMPLE 5.—Find the number of revolutions of the spindles to 1 revolution of the jack-shaft when the jack-shaft carries a 42-tooth gear driving a 42-tooth gear on the spindle-gear shaft, which carries a 46-tooth gear driving a 24-tooth gear on the lower end of the spindle.

SOLUTION.— $\frac{1 \times 42 \times 46}{42 \times 24} = 1.916$ rev. of spindles to 1 rev. of jack-shaft. Ans.

EXAMPLE 6.—Find the revolutions per minute of the spindles when the jack-shaft makes 375 revolutions per minute and the spindles make 1.916 turns to one of the jack-shaft.

SOLUTION.— $375 \times 1.916 = 718.5$ rev. per min. of spindles. Ans.

2. To find the twist, or turns, per inch:

Rule I.—*Divide the revolutions per minute of the spindles by the length of roving, in inches, delivered by the front roll in the same time.*

EXAMPLE 1.—Find the turns per inch being placed in the roving if the spindles make 718.5 revolutions per minute and the front roll delivers 23.208 yards per minute.

SOLUTION.— $23.208 \times 36 = 835.488$ in. per min.; $718.5 \div 835.488 = .859$ turn per in. Ans.

Rule II.—*Taking into consideration all the gears, with the exception of the carrier gears, from the front roll to the spindles, assume that the front-roll gear is a driver. Multiply together all driving gears and divide by the product of all the driven gears. Divide the quotient thus obtained by the circumference of the front roll.*

EXAMPLE 2.—Find the turns per inch being inserted in the roving with the following arrangement of gears: the front roll is 1.25 inches in diameter; front-roll gear has 120 teeth; gear on end of top-cone shaft, 86 teeth; top-cone gear, 48 teeth; twist gear, 38 teeth; jack-shaft gear, 42 teeth; spindle-shaft gear, 42 teeth, gear on spindle shaft driving spindle, 46 teeth; gear on spindle, 24 teeth.

SOLUTION.— $\frac{120 \times 48 \times 42 \times 46}{86 \times 38 \times 42 \times 24} = 3.378$; $\frac{3.378}{1.25 \times 3.1416} = .86$ turn per in. Ans.

3. To find the constant for twist:

Rule.—*Apply rule II, in Art.* **2**, *for finding the twist, considering the twist gear as a 1-tooth gear.*

EXAMPLE—Find the constant for twist, using the train of gearing given in example 2 in Art. **2** for finding the twist.

SOLUTION.— $\frac{120 \times 48 \times 42 \times 46}{86 \times 1 \times 42 \times 24} = 128.372$; $\frac{128.372}{1.25 \times 3.1416} = 32.689$, constant dividend for twist. Ans.

The constant dividend divided by the twist gear equals the twist per inch; thus, $32.689 \div 38 = .86$, twist per in. Ans.

4. To find the speed of the bobbins:

Rule.—*Find the amount of roving wound on the bobbins per minute and divide by the circumference of the bobbin. Add the result thus obtained to the speed of the spindles per minute, and the answer is the speed of the bobbins per minute.*

EXAMPLE 1.—Find the speed of the bobbins at the beginning of a set when the diameter of the bobbin is 1.75 inches; the speed of the spindles, 718.5 revolutions per minute; and the front roll delivers 835.488 inches per minute.

SOLUTION.— $\frac{835.488}{1.75 \times 3.1416} = 151.967$ rev. per min. of bobbins over speed of spindles. Speed of the spindles, 718.5 rev. per min.; speed of bobbins over that of the spindles, 151.967. $718.5 + 151.967 = 870.467$, speed of bobbins at beginning of set. Ans.

EXAMPLE 2.—Find the speed of the bobbins at the finish of a set when the diameter of the full bobbin is 6.125 inches; the speed of the spindles, 718.5 revolutions per minute; and the front roll delivers 835.488 inches per minute.

SOLUTION.— $\frac{835.488}{6.125 \times 3.1416} = 43.419$ rev. per min. of the bobbins over the spindles. The number of revolutions per minute of the spindles is 718.5; the speed of the bobbins over that of the spindles is 43.419. $718.5 + 43.419 = 761.919$ rev. per min. of bobbins at the finish of a set. Ans.

The reduction of the speed per minute of the bobbins from an empty bobbin to a full bobbin in the above case is $870.467 - 761.919 = 108.548$ revolutions.

5. Drafts.—The draft of a fly frame is calculated in the usual manner.

EXAMPLE 1.—Find the total draft of the rolls shown in Fig. 1, using a 44 draft gear.

SOLUTION.— $\frac{1.25 \times 100 \times 56}{40 \times 44 \times 1} = 3.977$, total draft. Ans.

The constant for draft is found in the same manner as the total draft, except that the draft gear is considered as a 1-tooth gear.

EXAMPLE 2.—Find the draft constant for the rolls shown in Fig. 1.

SOLUTION.— $\frac{1.25 \times 100 \times 56}{40 \times 1 \times 1} = 175$, constant. Ans.

EXAMPLE 3.—Find the draft between the second and third rolls.

SOLUTION.— $\frac{1 \times 25}{23 \times 1} = 1.086$, draft between second and third rolls. Ans.

EXAMPLE 4.—Find the draft between the front and second rolls if the draft gear contains 44 teeth.

SOLUTION.— $\frac{1.25 \times 100 \times 56 \times 23}{40 \times 44 \times 25 \times 1} = 3.659$, draft between front and second rolls. Ans.

6. Change Gears.—In addition to the calculations given there are several in connection with fly frames that apply particularly to the gears that should be used to produce satisfactory work. It will readily be understood that if a frame is running on a certain hank roving and it is desired to change to a different hank, certain gears must be changed in order that correct results may be obtained. In changing from one hank to another some or all of the following gears must be altered (the reference letters apply to Fig. 1): (1) the twist gear m_3, which alters the speed of the rolls and regulates the turns per inch placed in the roving; (2) the tension gear y_5, which regulates the movement of the belt along the cones; (3) the draft gear i, which alters the hank of the roving delivered; (4) the taper gear x_8, which alters the taper of the bobbin; (5) the lay, or traverse, gear v_4, which alters the speed of the traverse of the carriage.

These are the American names for these gears; the English builder motion is different from the American and the English name for tension gear is rack wheel, for taper gear is taper wheel, and for lay gear is lifter wheel.

The most important change to make is in the draft change gear, which regulates the size of the roving. It is generally customary at the same time to change the twist gear, because this should vary with every change in the hank of the roving. The tension gear is also frequently changed. It is not customary, however, to change the lay gear unless the change in the hank of the roving is extensive. If the slubber roving is changed .3 hank, the first intermediate roving .5 hank, the second intermediate roving .75 hank, or the finished roving a whole hank, the lay gear will ordinarily be changed.

It is seldom that the taper gear is changed in the mill, since the gear that is placed on the frame by the builders usually serves for the range of different hank roving that the frame is intended to make.

It is important to bear in mind whether an increase or decrease in the size of a gear must be made to produce certain results. On the usual construction of American-built frames, in making a change to produce finer work the draft gear, the twist gear, the lay gear, and the tension gear would be changed to smaller gears; on the other hand, if the frame must be changed to make coarser work, they would be changed for larger gears, if required to be changed at all.

The same statement is correct with regard to English-built frames, or American-built frames having an English type of builder, with the exception of the tension gear, which in case of changing the frame finer, would be changed to a gear having a larger number of teeth, or in case of changing the frame coarser, to a gear having a smaller number of teeth.

The following rules apply to the method of figuring the different change gears when the gears that are on the frame and the hank roving being produced are known. From the calculations previously given it is possible to obtain the draft and twist gears without this data, but for the tension and lay gears this data is always necessary, since the correct gear for starting up a frame was obtained by the builders largely by experiment and not by calculation. Even when the gear to use for a certain hank roving is known, the calculated gear for another hank does not always give satisfactory results, since the changing of these gears is largely a matter of experience and observation, owing to a number of different points affecting the results produced by them, such as the amount of twist put in the roving, the condition of the cone belt, the number of times that the roving is wound around the presser on the flyer, and so forth.

7. To find the draft gear to be used for a certain hank roving when the draft gear that is on and the hank roving that it produces are known:

Rule.—*Multiply the draft gear being used by the hank roving that it produces, and divide the result by the hank roving that is to be made.*

EXAMPLE.—If 4-hank roving is being produced with a 32-tooth draft gear, what draft gear will a 6-hank roving require?

SOLUTION.— $32 \times 4 = 128$; $128 \div 6 = 21.333$, or practically a 21-tooth draft gear. Ans.

8. To find the twist gear to be used for a certain hank roving when the twist gear that is on and the hank roving that is produced are known:

Rule.—*Multiply the square root of the hank being made by the twist gear, and divide by the square root of the hank required.*

In examples in which the diameter of the roving affects the size of the gear to be used it is necessary to consider the square roots of the hanks, since the diameters of rovings vary inversely as the square roots of their hanks.

EXAMPLE.—If .36-hank roving is being made with a 54-tooth gear, what twist gear is required for a .64-hank?

SOLUTION.— $\sqrt{.36} = .6$; $\sqrt{.64} = .8$; $.6 \times 54 = 32.4$; $32.4 \div .8 = 40.5$. Either a 41-tooth or a 40-tooth gear may be used. Ans.

9. To find the tension gear to be used for a certain hank roving when the tension gear that is on and the hank roving that is produced are known, the frame having the American type of builder:

Rule.—*Multiply the square root of the hank being made by the tension gear, and divide by the square root of the hank required.*

EXAMPLE.—If .36-hank roving is being made with a 50-tooth tension gear, what tension gear is required for a .64-hank?

SOLUTION.— $\sqrt{.36} = .6$; $\sqrt{.64} = .8$; $.6 \times 50 = 30$; $30 \div .8 = 37.5$. Either a 37-tooth or a 38-tooth gear may be used. Ans.

To find the tension gear to be used for a certain hank roving when the tension gear that is on and the hank roving that is produced are known, the frame having the English type of builder:

Rule.—*Multiply the square root of the hank required by the tension gear, and divide by the square root of the hank being made.*

EXAMPLE.—If .36-hank roving is being made with a 20-tooth tension gear, what tension gear is required for a .64-hank?

SOLUTION.— $\sqrt{.36} = .6$; $\sqrt{.64} = .8$; $.8 \times 20 = 16$; $16 \div .6 = 26.666$. A 27-tooth gear would be used. Ans.

10. To find the lay gear to be used for a certain hank roving when the lay gear that is on and the hank roving that is produced are known:

Rule.—*Multiply the square root of the hank being made by the lay gear, and divide by the square root of the hank required.*

EXAMPLE.—If .36-hank roving is being made with a 33-tooth gear, what lay gear is required for a .64-hank?

SOLUTION.— $\sqrt{.36} = .6$; $\sqrt{.64} = .8$; $.6 \times 33 = 19.8$; $19.8 \div .8 = 24.75$. A 25-tooth gear should be used. Ans.

11. Production.—To find the production of a fly frame, in pounds:

Rule.—*Multiply the hanks per spindle, as indicated by the hank clock, by the number of spindles, and divide by the hank roving.*

EXAMPLE.—A clock on a 72-spindle frame registers 75 hanks of .5-hank roving turned off in a week. What is the production in pounds?

SOLUTION.— $\frac{75 \times 72}{.5} = 10{,}800$ lb. production. Ans.

12. Average Hank.—To find the average hank, or average number, of the roving when several hanks are being run:

Rule.—*Multiply the pounds of each hank produced by the number of the hank, and divide the total of the products thus obtained by the total of the pounds produced.*

EXAMPLE.—If 1,800 pounds of .50-hank, 700 pounds of 1.50-hank, 850 pounds of 2-hank, 800 pounds of 2.25-hank, 750 pounds of 4-hank, and 700 pounds of 10-hank are produced in a week, what is the average hank of the roving?

SOLUTION.—

	1800 ×	.50 =	900
	700 ×	1.50 =	1050
	850 ×	2.00 =	1700
	800 ×	2.25 =	1800
	750 ×	4.00 =	3000
	700 ×	10.00 =	7000
Total,	5600 pounds		15450 hanks

15,450 ÷ 5,600 = 2.758, average hank. Ans.

STARTING FLY FRAMES

13. Draft.—In starting fly frames, one of the first points to be considered is the arrangement of the **drafts** in the different frames. As a general rule, the drafts in the intermediate frames should be less than the draft in the roving frame and slightly greater than that in the slubber. It is not always possible, however, to arrange a series of fly frames so as to give the best theoretical drafts, since one process must keep up with another, and it is customary for those in charge to change the drafts until the production of one nicely balances that of the other; that is, if the slubbers are making too many bobbins for the intermediates, the draft of the slubber is increased so as to make a finer roving, and the draft in the intermediates decreased because finer roving is fed at the back, thus making the same hank at the front as in the former case but using a greater length of back roving. Speaking generally, it may be said that on coarse work or in mills making below 36s yarn it is best to arrange the draft of the slubber about 4, intermediate about 5, and the roving frame about 6. The following is an organization used when starting fly frames for 28s warp and 36s filling. A 55-grain sliver at the drawing frame (equal to about .151 hank) and 4.5 draft at the slubber gives .68-hank slubbing; 5.5 draft at the intermediate, doubling 2, gives a 1.87-hank roving; and a 6.5 draft at the roving frame, doubling 2, gives a 6.07-hank roving. Other organizations are as follows: For a 4.5-hank roving at the roving frame, a .5-hank roving is usually produced at the slubber and a 1.5-hank roving at the intermediate, with a draft of 6 at both the intermediate and roving frames. For a 10-hank roving, the following are good drafts: slubber, 4; first intermediate, 4.5; second intermediate, 5; roving frame, 5. For a 20-hank roving, the following are good drafts: slubber, 4.5; first intermediate, 5; second intermediate, 6; roving frame, 6.5.

In connection with the drafts in the different fly frames, an important point always to be taken into consideration is the production that different drafts will give. In making any change of hank, it should be clearly understood that changing to finer roving means reduced production, not only on account of the reduced weight per yard of the roving, but also because the speed of the front roll must be reduced in order to obtain the extra twist that is required for the finer hank. Sometimes the experiment is tried of putting a small pulley on the frame so as to bring the speed of the front roll up to the original speed and increase the speed of the spindles, but this is not often advisable, as too great speed makes the work run badly and consequently reduces the production.

14. Twist.—Having obtained the correct drafts for the different frames, the next important point to be considered is the **twist** to be placed in the roving. In this connection, it should be distinctly understood that the amount of twist in the roving depends on the relation that the speed of the spindles bears to that of the front rolls. Twist may be increased in roving either by decreasing the speed of the delivery rolls or increasing the speed of the spindles. The spindles of each kind of fly frames in a mill are usually run at a certain number of revolutions per minute, which has been found most desirable in practice, and any great increase over this number causes the work to run badly. On this account, whenever it is desired to insert more twist in the roving, it is the usual practice to decrease the speed of the front rolls. This, however, decreases the production of the frame, and consequently no more twist should be placed in the roving than is absolutely necessary to allow it to draw off well at the next process without stretching and breaking. Not only does any twist above this amount decrease the production, but it also makes the roving draw badly and is liable to damage the leather top rolls on the next frame. The amount of twist placed in roving varies according to the hank being produced and the stock being used. It has been found practical to insert a number of turns per inch that is equal to the product of the square root of the hank and certain numbers used as constants. The following table gives the constants that are commonly used for American, Egyptian, and sea-island cotton on the slubber, first intermediate, second intermediate, and roving frames.

TABLE I

Cotton	Slubber	First Intermediate	Second Intermediate	Roving Frame
American . . .	1.0	1.1	1.20	1.3
Egyptian . . .	.9	1.0	1.10	1.2
Sea-island . . .	.7	.8	.90 to .95	1.0

It is generally assumed that a good test for determining whether sufficient twist is being placed in the roving is to feel each bobbin to see that it is not too hard or too soft, although it should be borne in mind that a hard bobbin may be formed from roving having less than the standard twist if a presser with a heavy vertical rod is used.

15. Speed.—It has been stated that the spindles on fly frames are run at a uniform speed, but in this connection it may be well to consider what speeds are best for the different frames. The speed of the spindles on a slubbing frame may slightly exceed 600 revolutions per minute; on a first intermediate frame 900 revolutions per minute is a good speed; on a second intermediate, 1,200; and on a roving frame, 1,500 revolutions per minute. These speeds, of course, are often exceeded in many mills. In some cases it would be more accurate to give the speeds at 800, 1,000, 1,300, and 1,600 revolutions, respectively, for the four machines. Experience, however, has demonstrated that in fly frames high speeds, particularly when the cotton is not up to the standard, are objectionable. No definite number of revolutions per minute can be given for the spindles of fly frames, since this is dependent largely on circumstances. It may sometimes be advisable to run more slowly than the speeds given above, since old frames, coarse work, or inferior stock will necessitate slower speeds than new frames, fine work, or good stock.

When once the correct ratio of speed between the front roll and the spindle has been found, the only way of increasing production is to increase the speed of the whole frame. Theoretically, every time the frame is speeded up the production ought to increase, although in practice this is not found to be so, since there is a limit to the speed of every machine beyond which it is not advisable to go, because an excessive speed causes unnecessary wear and tear to take place and results in a large number of ends breaking; this is an especially important matter in connection with fly frames, since the whole frame must be stopped to piece one broken end.

16. Build of Bobbin.—After deciding on the draft to be used in the frame and the number of turns per inch to be inserted in the roving, a few bobbins may be placed in the creel, considering that one of the frames other than the slubber is being dealt with. The ends of roving from two bobbins are passed through the drawing rolls and pieced at the front. One layer should then be run on the bobbin and the length of traverse adjusted so as to obtain a layer of as great a length as possible without the finger of the presser striking the ends of the bobbin. The proper lay gear may also be chosen at this point. In order to obtain a well-built bobbin, the coils in the first layer should be laid so that the wood of the bobbin can barely be seen between them. Should the first experimental bobbin show the coils either closer or farther apart than this, the lay gear should be changed accordingly. The correct lay gear is largely a matter of experiment and experience, and different millmen have different ideas as to the correct gear that should be used. For accurate work, it is advisable to count the number of coils per inch that are made on the bare bobbin, when satisfactory results are obtained, for various hanks of roving. From these records a table of constants can be prepared, which can be used for reference. It is found in practice that the most suitable number of coils per inch varies from seven to ten times the square root of the hank roving being produced, the smaller multiplier being used for slubbers and intermediates and the larger one for roving frames. For example, in case of making 4-hank roving, the square root of which is 2, if 10 is used as a multiplier, 20 coils per inch will be placed on the bare bobbin. Other factors enter into the question as to the spacing of these coils; for instance, the amount of twist placed in the roving, the grade of cotton being used, and whether the stock has been carded or both carded and combed, all have an effect on the number of coils per inch that can be advantageously placed on the bobbin.

17. Tension.—By referring to Fig. 1, it will be noted that on the end of the bottom cone is a gear driving, by means of suitable gearing, a gear on the compound. When starting up a new frame, it should be carefully noted whether the roving is running at the correct tension; and if it is not, this cone gear should be changed until the right tension is obtained. A gear of fewer teeth will drive the bobbins more slowly, causing less tension on the ends, while a gear of more teeth has the opposite effect. In some cases, instead of changing the cone gear, the proper tension is obtained by starting the belt at a different position on the cones. This, however, is not good practice and should not be allowed. The belt should always be started at the end of the cones when winding the first layer on the bobbin, and the cone gear be of such size as to give the proper tension with the belt in this position. This cone gear should be changed only when the frame is being started for the first time, and after the correct gear has once been obtained it should not be changed unless the diameter of the empty bobbin is changed. It is very important to have the tension properly adjusted, since a difference of from 10 to 15 per cent. in the weight of the roving on the full bobbin may be made by not having the correct cone gear, besides causing the frame to produce unsatisfactory work.

18. Creeling.—After the different gears have been put on and the length of the traverse has been adjusted, the frame may be considered ready for starting up. The next process is **creeling**; that is, placing the bobbins of roving in the creel at the back of the frame and passing the ends of roving from them to the rolls. In this connection, it is important to note that all the bobbins placed in the creel at one time should not be of the same size, since in this case they would all become empty at about the same time and thus cause the tender to replace empty bobbins with full ones in so short a period of time that it would either necessitate stopping the frame or result in certain bobbins running empty before full bobbins had been put in their place. In creeling, it is good practice to put up two rows of full bobbins and two rows of half-filled bobbins, having the roving from one full and one half-filled bobbin run together, thus causing only a part of the bobbins to become empty at one time and obviating the difficulty that arises when the bobbins all run empty at the same time.

Other points to be noted in creeling are that bobbins should not be inserted that will touch the next bobbin, since this prevents the easy unwinding of the roving. Sometimes bobbins unwind too freely, resulting in what is known as overrunning. To prevent this a little piece of cotton is sometimes inserted under the foot of the skewer to cause friction and thus retard the rotation of the bobbin. On the other hand, bobbins containing roving that is too soft are sometimes placed in the creel at the back of the frame, in which case the roving breaks instead of unwinding. To remedy this difficulty the skewers are taken out and sharpened at the bottom so as to lessen the friction.

19. Having pieced up all the ends, the frame may be started. During the time that the first set is being filled the different parts of the frame should be carefully watched, especial notice being taken of the tension on the roving and the build of the bobbin. Frames vary somewhat in their capacity for making a well-built bobbin, but as a rule the taper of the ends of a full bobbin should not be too great, since, if the slant is too great, it prevents the winding of a sufficient length of roving on the bobbin and necessitates too frequent creeling at the succeeding processes. On the other hand, the ends of the bobbin should not be built in such a manner that they will be almost at right angles with the bobbin, since in this case the ends are liable to run under during winding and thus cause unnecessary breakage of ends.

CARE OF FLY FRAMES

20. Single and Double.—After the frames have been well started, several points in the management need careful attention. Perhaps the most important points are what are technically known as **single** and **double.** These may be caused in several different ways. For example, in fly frames that follow the slubber, where two ends are run into one at the back, it frequently happens that only one end passes through the guide eye of the traverse rod, while the end that should be joined to this one runs through a guide eye with two other ends; thus, instead of having two ends in each case, in one case there will be a single end and in the other, three ends. Again, it frequently happens that certain of the ends as they leave the delivery rolls at the front of the frame break, and the strong current of air set up by the rapidly revolving flyers causes these ends to become twisted in with an end running on to another bobbin. If the tender does not notice this at the time it occurs, there is a liability of several layers of roving being wound on the bobbin that contain double the thickness that they should. In still other cases, when an end breaks as it comes from the delivery roll, it may happen that only part of the roving is twisted in with the adjoining end, while the other part winds around one of the rolls, forming what is called a roll lap. All these cases occur frequently on fly frames and are the cause of bad work. As will be seen, when double, which is greater than the required size, for the reasons just given, is wound on the bobbin, the diameter of the bobbin will be increased out of its regular proportion, thus causing the roving to be strained; while on the other hand, in case of single, which is less than the required size, the diameter of the bobbin is not increased in its correct proportion, causing the roving to run slack. When single or double occurs on fly frames, it is necessary for the tender to stop the frame and unwind the defective roving from the bobbin. In some cases so much imperfect roving has been wound on the bobbin that the correct diameter of the bobbin cannot be obtained in that set. It then becomes necessary to break out the ends fed to it, thus causing a spindle to be unproductive throughout the filling of the rest of the set, and consequently the production of the frame to be lessened. This is a practice that should not be allowed, and tenders should be required to watch their frames carefully for single or double rovings and correct the defect immediately. If the single or double roving is not removed from the bobbin, it passes forwards to the next process and there working in with a perfect end produces roving or yarn of the wrong number.

21. Piecing.—The piecing of roving, when broken at the front, is accomplished as follows: The frame is stopped and the tender unrolls an arm's length of roving from the bobbin, twisting it slightly by rolling it between the palms of the hands in order to give it greater strength. The roving is then inserted in the hollow leg of the presser by holding the loose end in one hand and with the other hand sliding the roving along the slot in the side of the leg. That part of the roving that passes from the bottom of the hollow leg to the bobbin is now wound around the presser as many times as necessary and inserted in the eye of the presser, while the upper, or loose, end is passed partly around the boss of the flyer, through the hole in the side of the boss, out at the top, and overlapped and twisted with the roving projecting from the front roll. In piecing the roving by twisting in this manner long piecings should be avoided, since they cause the yarn to be too thick for some distance. Moreover, hard piecings should be avoided, since they do not draw well in the drawing rolls of the next process. After a piecing has been made, the frame is started slowly; very frequently it will be found that the end will remain slack for some time. In such cases it is sometimes the practice for the tender to retard the motion of the top front roll by pressing it with the finger or thumb, in order to cause the roving to become tight. This is not advisable, however, as it causes the roving for some distance to be thicker than usual; it is preferable to so adjust the bobbin before starting the frame that there will be as little slack as possible.

22. Doffing.—After a set of bobbins has been filled, it becomes necessary to remove the full bobbins and replace them with empty ones. This is known as **doffing,** and before the frame is stopped for this operation everything that is possible should be done to lessen the time to be devoted to this operation, since it causes a loss of production. Such points as having the empty boxes ready for the full bobbins must be looked out for before stopping the frame; also where it is possible, as in the case of the slubber or first intermediate, the empty bobbins should be laid on the carriage of the frame between the spindles, so that they will be ready to be placed on the spindles. The operation is then as follows: After the frame has stopped, the cone belt is slackened by raising the bottom cone, so as to reduce the speed of the bobbin—when the frame is started again—to the same speed as the flyer and thus prevent any more roving from being wound on the bobbin; the frame is then run for an instant in order to cause a few coils of roving to form at the top of the flyer. The front row of flyers is then taken off and laid on the top of the top clearer covers, care being taken not to break the ends of the roving. The full bobbins are then removed from the front row of spindles and each replaced by two empty bobbins, the bottom one being intended to remain on the front spindles and the other to be subsequently placed on the back spindles. After doffing the front row of spindles, the tender doffs the back row of spindles by lifting the flyer, and replacing the full bobbin with the extra empty bobbin previously placed on the front row of spindles. The flyers for the front row of spindles are then placed in position. The end of roving is now laid on each bobbin and wound around in such a way that the outside coils will bind the inner ones, the coils of roving previously formed at the top of the flyer giving sufficient length to wind around the bobbins to make a new start. The cone belt is wound back to the other end of the cones by means of the rack and tightened by lowering the bottom cone, when the frame is ready to start.

23. Breaking Out.—In some cases, where a very radical change is made in the number of the yarn to be spun from the roving, it becomes necessary to make a considerable change in the hank of the roving being produced by the different frames. When any considerable change is made in fly frames, it is generally the custom to run the bobbins that are in the creel until half of them are almost empty and then remove all the bobbins from the creel, working them up in other frames. The creels are refilled with new bobbins of the correct hank, care being taken that half of them are half bobbins and that the other half are full bobbins, and the ends from these new bobbins pieced up to the ends of the old roving projecting from the back roll. These piecings should be run through to the front and on to a set of empty bobbins, after which the short lengths should be removed from the bobbins so as to avoid any piecings or incorrect roving going forwards to the next process. This entire operation is technically known as **breaking out** and is an expensive process, since it is one that reduces production very largely; in many mills it is customary when making only a small change, say from 4-hank to 5-hank or from 10-hank to 12-hank, to do so by merely changing the necessary gears, thus avoiding this process.

24. Oiling.—In order to keep the machines in good condition, **oiling** should be carefully attended to; in large mills, there is usually some person who makes the oiling of machines his sole occupation. In small mills, it should be in charge of one of the section hands and not left to the tender. The rolls or gearing revolving at about the same speed as the front roll should be oiled every day; the bearings of the top and bottom cones, the jack-shaft, the horse head, certain parts of the compound, and all bearings around the compound, about twice a day. About once a month, the compound should be opened up—that is, slipped apart—and oiled and cleaned. When high speeds are employed, tallow should be used on the internal gears of the compound. The amount of oiling required by the spindle footsteps depends on their construction, but should be done at least once a month, while the upper bearings, or bolsters, should be oiled about once a day. All revolving parts not mentioned should be oiled at least once a week.

25. Care of Rolls.—The bottom drawing rolls on fly frames should be scoured at least once in 6 months.

The replacement of old top rolls with new ones is an important matter, and it is usual to allow so many rolls a week per frame or per hundred spindles in the room. This is something for which no definite rule can be given, as the condition of the frames, the care of the rolls, the stock being run, and the hank of the roving all make a difference as to the number of rolls that should be allowed. Generally speaking, coarse roving requires more rolls than fine roving, and old frames more rolls than new frames. In one mill on medium numbers, it is customary to allow three new rolls weekly to each slubber and each intermediate frame, and four new rolls weekly to each roving frame. In this connection, it should be understood that the number of spindles in a roving frame is about double that in a slubber.

When solid top rolls are used, the rolls that are taken out of the front row should be moved to the second row and the rolls from the second row moved to the back row, the rolls in the back row being taken out to be recovered. In case the front rolls are shell rolls, which is usual with fly frames constructed at the present time, new shells replace the old ones that are taken out to be recovered, while new rolls are placed in the second row and the rolls taken out of the second row placed in the back row, the rolls in the back row being taken out to be recovered. Owing to the fact that the front rolls revolve at a much greater speed than the back rolls and that the larger part of the drafting is accomplished between the two front pairs of rolls, it is possible to run poorer rolls on the back row without injuring the stock.

26. In order to obtain the best results on fly frames, it is absolutely necessary that all parts should be kept as clean as possible. The creels should be brushed out twice every day and flyers should be wiped at every doff when running medium counts; when running fine roving, this should be done even more frequently. Twice a week the head-end covers should be taken off and the gearing cleaned. About once a month, the covers should be taken off the spindle and bobbin gears and all the waste picked off the gears and shafts. The head of the flyer should be kept clean and also the slot in the top of the spindle, so that the pin will fit accurately in it. Particular care should be taken to keep the rolls, roll beams, and clearers clean. If the steel rolls are allowed to become dirty or lapped with cotton they will produce bad work, frequently resulting in lumpy and uneven roving and causing the ends to break at the succeeding processes. In general, it may be said that the floors of the room should be kept clean. Waste should be put in its proper place and not allowed to drop on the floor. Boxes and baskets should be provided for the empty and full bobbins, and should always be kept in their proper places.

COMMON DEFECTS

27. The following are some of the defects frequently met with in fly frames, together with their remedies:

1. *Breaking of ends* between the front roll and the bobbins sometimes results from the following causes: twist gear, draft, or other roll gears slipping or breaking; top-cone gear slipping; cones becoming loose; cone belt breaking; rolls breaking at the joints; spindle- or bobbin-shaft couplings becoming loose; driving gears at the head of the bobbin or spindle shafts breaking or becoming loose; bobbin, bobbin-shaft, spindle, or spindle-shaft gears breaking or becoming loose; any obstruction preventing the proper traverse of the carriage.

2. *Slack ends* on American-built frames are sometimes caused by the tension gear being too large. In trying the tension of the roving it is customary to place the forefinger under the roving as it is being delivered from the front roll to the flyer and draw it up slightly until it is tight, judging the tension in this way. A better way is to get the eye on a level with the flyer and by glancing from the boss of the flyer to the front roll note the slackness in the roving. If there is not quite enough tension, the roving will run all right for a short length of time, but will then partially curl around the boss of the flyer, afterwards running along all right again. If a greater amount of tension is needed, the roving will wind round the boss of the flyer and break, although this is sometimes caused by the end breaking in the flyer. The tension of the roving is an important matter and should be carefully watched at all times, as there are several points that will affect it. For example, the cone belt may slip because it is

too slack or too heavily loaded; because the spindle bolsters are not properly oiled or are allowed to become clogged with dirt or cotton; because the bolsters are not properly adjusted or are not plumb, thus causing the bolster rail to run hard; or because the racks bind in the slides. As the lifting motion is driven through the cones, any drag on the bobbin rail is liable to cause the belt to slip and thus affect the tension.

3. *Incorrect Traverse.*—Sometimes the clutch gear between the twin gears becomes loose or has been set wrong, in which case there will either be no traverse given to the carriage or the traverse will be imperfect and the roving that is being delivered will be wound on the bobbin in one place, thus producing a ridge on the bobbin.

4. *Running over and under* of the roving on the bobbins is a serious defect, and every means should be adopted to prevent it. The following are some of the precautions that should be taken: All gears from builder to carriage must be in their places and firm on their individual studs and shafts. The spring at the bottom of the tumbling shaft must exert its proper tension. If it has not enough tension to pull the tumbling shaft around so that the teeth on the gear fixed at its upper end come in contact with the top-cone gear, it will cause either running over or under of the roving. The clutch gear situated between the twin gears must be tight and properly adjusted; the twin gears must also be properly adjusted and tight on their shaft. Running over or under is also frequently caused by the carriage not being perfectly level during its entire traverse. Individual bobbins are spoiled by the bobbins not being correctly fitted or not resting properly in their places. At times the pin breaking in the boss of the flyer will cause the roving to run under or over either because of the flyer settling down or because of centrifugal force causing the flyer to rise.

5. *Imperfect Flyers.*—It is very important that flyers should be smooth inside and outside at all points where cotton passes and should fit well on the tops of the spindles so as to obviate the necessity of hammering them down and thus making them rough at the top. When the presser on the flyer leg works

stiffly and consequently does not exert enough centripetal pressure on the bobbin, it causes soft bobbins and a weak roving that will often break when being unwound at the next process, thus causing annoyance and bad spinning at the final operation.

6. When the small bevel gear that drives the bobbins is not properly meshed with the bobbin gear, or when either gear is worn, it will cause the bobbin to jump and will break the end or stretch the roving. This may be obviated by having a systematic inspection of these gears and requiring that such cases be reported at once. Sometimes the same effect is produced when a bobbin shaft is crooked or strained, or when a section of the shaft works loose and slides slightly in its bearings. In this case it will affect several bobbins. The same is also true of the spindles, in which case the spindles will jump up and down, instead of the bobbins.

Sometimes the help after neglecting to piece up an end promptly, find that the bobbin is too small in diameter to take up all the roving that has been delivered by the rolls. In order to remedy this and not to be blamed for running an empty spindle, they will pack cotton under the weight hook to cause extra friction on the top roll and reduce its speed, or they will hold the top roll with one thumb to attain the same object. This causes two or four ends to be heavier than the others that are being made, to the extent of as much as 30 or 40 per cent. for a short distance, which obviously causes undue variation in the numbers of the yarn at the spinning room.

SIZING

28. It is customary to test the numbers of roving, or in other words to *size roving*, by reeling off a standard length from bobbins. The length usually taken in case of slubber and first intermediate roving is 12 yards; for second intermediate or fine roving, 24 yards. The bobbin is placed on a skewer in a frame usually adjustable for large or small bobbins, the end passed through a guide eye to the reel, which is

18 or 36 inches in circumference, and the desired length measured off. When this is done the end is broken, the roving weighed on a small pair of scales known as **roving scales,** and the hank of the roving calculated.

In some cases the roving is sized at the draw ng frame, while in other cases the slubber is taken as the starting point; the roving delivered is weighed two or sometimes three times a day, two bobbins being taken from a doff. Twelve yards are reeled off each bobbin and weighed and the average taken. If the average varies considerably either way from the correct weight of that number of yards of the hank being made, the draft gear is changed. These averages are kept in a special book for this purpose, which can be referred to at subsequent dates. The bobbins from frames finer than the slubber are weighed generally once a day, two or even more bobbins being taken from each frame. Where there is a difference from the standard of $2\frac{1}{2}$ grains in hanks from 1.5 to 4, or a difference of 2 grains in hanks from 4 to 12, a change is made. After the roving has been weighed, in mills where a high standard is maintained, a certain number of bobbins, usually 16, of the different hanks of roving is taken to the spinning room and the yarn made from them sized and tested for strength, a record being made and a copy sent to the overseer of carding. This is the method adopted in fine-yarn mills; in other mills, the bobbins are not sized so often.

Care should be taken in selecting the bobbins to be sized that they contain no single or double. Where more than one frame is on a certain hank or grade of work, the different frames should be sized in their turn. If the gear on one frame is changed on a certain hank or grade of work, all the frames running under similar conditions should be changed. This not only applies to roving frames, but to all machines in a mill where changes must be made.

There are various systems of keeping numbers and various limits set for the number of grains that roving should be allowed to vary from either side of the standard before changing the draft gear. The one explained may be taken as a basis.

A SERIES OF QUESTIONS

RELATING TO THE SUBJECTS
TREATED OF IN THIS VOLUME.

It will be noticed that the questions contained in the following pages are divided into sections corresponding to the sections of the text of the preceding pages, so that each section has a headline that is the same as the headline of the section to which the questions refer. No attempt should be made to answer any of the questions until the corresponding part of the text has been carefully studied.

COTTON

EXAMINATION QUESTIONS

(1) Give the names of six different cottons raised in the United States and state where each is cultivated.

(2) Give a list of the full grades of American cotton.

(3) Describe the general appearance, as seen under a microscope, of (*a*) the mature cotton fiber; (*b*) the immature cotton fiber.

(4) Name the processes through which cotton passes after being picked and before it is shipped away from the cotton belt.

(5) How many pounds of cellulose are generally found in 100 pounds of cotton?

(6) Give a list of the four most important cotton-raising countries, naming them in the order of their importance as regards the size of their crops.

(7) Explain how and why each full grade is subdivided, and illustrate the method, taking the full grade middling for an example.

(8) What special characteristic does the mature, or ripe, cotton fiber have that aids the formation of a strong thread?

(9) Name some of the leading cotton markets of the United States.

(10) Give a list of the points to be determined when judging cotton, stating them in the order of their importance.

(11) What substances in addition to cellulose make up the weight of cotton?

(12) Give the counts of yarn usually made from the following cottons and state whether for warp, filling, or both: Brown Egyptian, benders, rough Peruvian, gulf, and Texas.

(13) Explain, fully, in what manner and on what terms cotton is usually handled commercially between the grower and the New England manufacturer.

(14) Name some of the causes of tinges in cotton.

(15) About how much cotton fiber could be expected from 600 pounds of seed cotton?

(16) State the object of the cotton gin and the manner in which the saw gin accomplishes this object.

(17) What is meant by the expression staple of cotton?

(18) Describe the usual method of determining the staple.

(19) What is meant by the term $1\frac{1}{4}$-inch cotton?

(20) Describe, fully, the principal characteristics of brown Egyptian cotton, and state how it differs from American cotton.

PICKERS

(PART 1)

EXAMINATION QUESTIONS

(1) What benefits are obtained by the use of automatic feeders?

(2) A mixing of 120 bales is to be made comprising 24 bales marked A B C; 12 marked D E F; 36 marked G H I; and 48 marked K L M. State the number of sections to be made and give the best order of arranging the bales in a section.

(3) Describe the best method to follow when making a mixing by hand.

(4) Why is picking machinery more liable to fire than other cotton-mill machinery?

(5) State the object of a bale breaker and describe, in a few words, how it accomplishes this object.

(6) What are the objects of the opener that is sometimes connected to the automatic feeder?

(7) If it were desired to reduce the amount of cotton fed by the machine shown in Fig. 6, how would it be done?

(8) Describe a good manner of arranging mixing and picking machinery in a picker room or rooms.

(9) Describe the principal advantages derived from the mixing of cotton.

(10) State, clearly, when and why it is not advisable to complete the blending of different kinds or colors of cotton at the mixing bins.

(11) Describe the passage of the cotton from the hopper of the automatic feeder to the feed-apron of the opener, and the actions of the various parts on the cotton.

(12) Describe how the cotton is prevented from clogging the teeth of the stripping roll used in the feeder shown in Fig. 7.

(13) How is the cotton conveyed from the opener to the machine that next operates on the stock?

(14) Name three principal classes of trunking employed to convey the cotton in mills, and describe, briefly, the manner in which these classes differ.

(15) In what way does a cleaning trunk serve to remove some of the foreign matter from the cotton?

(16) Describe one method of removing dirt and dust from a horizontal cleaning trunk.

(17) Why is a large mixing to be preferred to a small mixing?

(18) Describe the method adopted to relieve the rolls of a bale breaker in case an excessive amount of cotton is fed to them.

(19) Describe the operation of the doffer beater shown in Fig. 7.

(20) Figure the speed of the top carrier roll of the automatic feeder shown in Fig. 10 when the cone belt is at the central position of the cones and the doffer beater makes 450 revolutions per minute. Ans. 11.469 rev. per min.

(11) In what manner does the method of feeding a breaker picker differ from that adopted with an intermediate or finisher?

(12) What parts of a breaker picker are usually stopped when the full lap is being removed?

(13) How is the cotton prevented from being drawn between the casing of the picker and the cages as it is carried to the latter by the air-current?

(14) What would cause one side of a lap to be softer than the other?

(15) Explain the objects of the cages found in pickers.

(16) What are the objects of a condenser and gauge box as applied to a breaker picker?

(17) Explain the manner in which an evener motion regulates the feed of a picker.

(18) If the beater shaft shown in Fig. 16 makes 1,500 revolutions per minute, what will be the speed of the fans?

Ans. 1,125 rev. per min.

(19) What change gear must be used on the measuring motion shown in Fig. 26 in order to give a 45-yard lap?

Ans. 51.567, or a 52-tooth gear

(20) If the two draft change gears shown in Fig. 27 were the same size (45 teeth each), what draft would the machine have when the belt was in the center of the cones?

Ans. 2.814, draft

COTTON CARDS

(PART 1)

EXAMINATION QUESTIONS

(1) Explain the manner in which the cotton is made to leave the licker and become deposited on the cylinder.

(2) Explain the manner in which the sliver is placed in the can at the front of the card.

(3) Name the principal points of the card at which the cotton receives a cleaning action.

(4) Explain, briefly, the construction of the cylinder.

(5) Explain the manner in which the cotton is made to leave the cylinder and become deposited on the doffer.

(6) What should be the approximate distance between the bite of the feed-roll and the lower edge of the face of the feed-plate relative to the length of the staple?

(7) What are the back and front knife plates of a card? State their objects.

(8) Name the objects of carding.

(9) Explain the manner in which centrifugal force helps to clean the cotton passing through a card.

(10) Explain the manner in which the flats are cleaned automatically.

(11) Explain the effect on the carding action of the flat of having the distance between its surface and that of the cylinder greater at one edge of the flat than at the other.

(12) Explain two methods of stopping the feed and delivery of cotton at the card without breaking down the end at the coiler.

(13) By what method is the cotton taken from the doffer?

(14) Explain, briefly, the construction of the licker.

(15) Describe the construction of the flats of a revolving flat card, stating the manner in which they are supported and driven.

(16) If it is desired to drive the cylinder of the card shown in Fig. 23, 160 revolutions per minute, what size pulley must be placed on the driving shaft if the driving shaft makes 320 revolutions per minute? Ans. 10-in. pulley

(17) Find the surface speed of a 50-inch cylinder making 160 revolutions per minute. Allow $\frac{3}{4}$ inch on the diameter of the cylinder for clothing. Ans. 2,125.816 ft. per min.

(18) Find the speed of the licker of the card shown in Fig. 23 when the cylinder makes 160 revolutions per minute. Ans. 576 rev. per min.

(19) From Fig. 23, find the speed of the doffer when the cylinder makes 170 revolutions per minute. Ans. 15.747 rev. per min.

(20) Find the draft between the feed-roll b_1, Fig. 23, and the calender roll o_2. Ans. 81.428 draft

COTTON CARDS

(PART 2)

EXAMINATION QUESTIONS

(1) How do the stationary-top flat card, the roller-and-clearer card, and the revolving-top flat card differ?

(2) Describe, briefly, the operation of the roller-and-clearer card on the cotton.

(3) Explain what is meant by double carding and state why the process is going out of practice.

(4) Explain why a material that will stretch excessively is unsuitable for the foundation of card clothing.

(5) State some of the advantages and disadvantages of rubber-covered clothing.

(6) What kind of wire makes the most desirable card clothing? Why?

(7) Explain, fully, what is meant by plow-ground wire and why card clothing so ground is desirable.

(8) For an average grade of cotton, what number wire, American gauge, is suitable: (*a*) for the cylinder? (*b*) for the doffer and flats? (*c*) State the diameters of these numbers of wire, in inches.

(9) What disadvantage is there in too great a forward inclination of the card teeth?

(10) What effect does the relative height of the knee of the tooth have on its flexibility?

(11) Describe, fully, how a tail-end is shaped for an inside taper.

(12) Find the points per square foot in a sample of 8-crown, twill-set clothing having 10 noggs per inch and 6 teeth per nogg. Ans. 69,120 points

(13) Find the points per square foot in a sample of 8-crown, rib-set fillet having 18 noggs per inch and 3 teeth per nogg. Ans. 62,208 points

(14) From the following data, find the length of fillet required to cover the doffer, allowing the usual length for tail-ends: width of fillet, $1\frac{1}{2}$ inches; width of doffer, 40 inches; diameter of doffer, 27 inches. Ans. 195.564 ft.

(15) Find the total number of points in the clothing on a cylinder 50 inches in diameter and 40 inches wide, using the number of points per square foot found in question 13.

Ans. 2,714,342 points

COTTON CARDS

(PART 3)

EXAMINATION QUESTIONS

(1) State, approximately, the number of the gauge ordinarily used for the following settings: (*a*) feed-plate to licker; (*b*) mote knives to licker; (*c*) licker to cylinder; (*d*) flats to cylinder.

(2) What would be done to prevent the web following the doffer instead of being stripped clear by the doffer comb?

(3) When grinding, why is the cylinder run in the reverse direction to that in which it runs when carding?

(4) Describe the method of setting the grinding rolls to the cylinder and doffer.

(5) Explain an arrangement for setting the licker to the licker screen that overcomes the difficulty arising from its being so difficult to insert a gauge between these parts.

(6) Explain, briefly, the operation of preparing a card for grinding.

(7) How does the method adopted for grinding a card that is newly clothed differ from the method adopted for grinding a card that has been in use for some time?

(8) Describe a burnishing brush and state when and why it is used.

(9) If the strippings leave the flats in a continuous web instead of being merely joined by a few fibers, how can this defect be remedied?

(10) State the principal points that govern the frequency with which cards should be stripped.

(11) Referring to the grinding arrangement shown in Figs. 6 and 7, state, briefly, how the flat is held in position so that it is ground evenly across its entire width as it passes under the grinding roll.

(12) Describe, briefly, the manner in which the doffer is set to the cylinder, stating the space that usually exists between these two parts of the card.

(13) (*a*) What objection is there to having the flats stationary while grinding the cylinder? (*b*) In what direction should the flats be run while the cylinder is being ground?

(14) Describe the method of giving the traversing motion to the traverse grinder.

(15) Describe a convenient device that is largely used for removing the strippings from the stripping roll.

(16) State two methods of sharpening the teeth of the licker.

(17) In what manner could the web be prevented from sagging between the doffer and the calender rolls?

(18) Explain how the flats are set closer to the cylinder by the setting device shown in Fig. 11.

(19) What is the objection to stripping the doffer while the card is running?

(20) State what parts of a revolving flat card are stripped automatically and also what parts are stripped by hand.

(21) State the chief points of difference between a dead roll and a traverse grinder.

(22) State, briefly, the object of stripping, and describe the ordinary method of stripping the cylinder of a card.

(23) How would you determine whether or not a card needed to be ground?

(24) Will more or less waste be made if the speed of the flats of a revolving-top flat card is increased from $3\frac{1}{2}$ inches to $4\frac{3}{4}$ inches per minute?

(25) What will be the production, in pounds, for 60 hours, of 60 cards with 26-inch doffers, making $12\frac{1}{2}$ revolutions per minute, sliver weighing 60 grains per yard and allowing $7\frac{1}{2}$ per cent. loss for stoppages? Allow $\frac{3}{4}$ inch on the diameter of the doffer for clothing. Ans. 49,972 lb.

DRAWING ROLLS

EXAMINATION QUESTIONS

(1) Are the same size weights used on metallic and common rolls? Give reasons for answer, and an example of weighting each kind of rolls.

(2) Explain, clearly, why the distance between two pair of rolls should exceed the average length of the staple being run.

(3) Why is it that in some machines there is a greater distance between the rear and third pairs of rolls than between the front and second pair?

(4) Explain why the flutes of bottom rolls are sometimes unevenly spaced when leather-covered top rolls are used.

(5) What is the object of covering the top rolls with leather?

(6) What is the difference between a single- and a double-boss roll?

(7) Describe one system of weighting drawing rolls.

(8) Describe one type of both top and bottom clearers.

(9) Explain, clearly, why the length of staple affects the diameters of the rolls to be used.

(10) Describe one arrangement by which rolls can be quickly relieved of their weight.

(11) Explain the advantages that metallic rolls have over the common leather-covered rolls for drawing frames.

(12) Explain the differences that exist in the methods of driving leather-covered top rolls and metallic top rolls.

(13) What can be said regarding the advantages and disadvantages of loose-boss rolls as compared with solid rolls?

(14) Explain the object of varnishing leather-covered rolls.

(15) Explain why metallic rolls do not crush the fibers passing between them.

(16) Explain the terms self-weighting, dead-weighting, and lever-weighting as applied to drawing rolls.

(17) Explain, briefly, the material with which leather-covered rolls are covered and how it is applied.

(18) What is the object of using a traverse motion in connection with drawing rolls?

(19) How are the different sections in a line of bottom rolls connected?

(20) Explain, briefly, one method of adjusting the bottom rolls with relation to one another.

RAILWAY HEADS AND DRAWING FRAMES

EXAMINATION QUESTIONS

(1) What are the advantages of preventer rolls as used on railway heads and drawing frames?

(2) State the causes from which the drawing frame with a mechanical stop-motion will be automatically stopped.

(3) Explain, briefly, the manner in which the electric stop-motion operates when a sliver breaks or runs out at the back of a drawing frame.

(4) What are the objects of a railway head?

(5) Describe the passage of the cotton through a drawing frame similar to the one shown in Fig. 11, naming the parts with which it comes in contact.

(6) Explain the terms head and delivery as applied to drawing frames.

(7) Explain how the casting p, Fig. 13, is raised when the motion of the shaft k_1 is checked.

(8) Describe a method of sizing the sliver at a finisher drawing frame.

(9) State the objects of drawing frames.

(10) Explain why the evener motion of a railway head does not fully attain its object.

(11) What property does cotton possess that makes it possible to apply electric stop-motions to drawing frames?

(12) Explain, clearly, the action of the evener motion illustrated in Figs. 8 and 9 when the sliver being delivered becomes heavier than it should.

(13) Explain, briefly, the manner in which the objects of drawing frames are accomplished.

(14) Explain a method of arranging the cans at the back of a finisher drawing frame that will prevent a number of cans for one delivery from becoming empty at one time.

(15) Describe, briefly, the method of connecting a railway head with a section of cards.

(16) When a railway head is not used, how many processes of drawing are used for: (*a*) coarse counts? (*b*) medium counts? (*c*) fine counts?

(17) What are some of the causes of an electric stop-motion on a drawing frame failing to operate?

(18) Figure the draft between the front and back drawing rolls of a railway head, referring to Fig. 6, using a 50-tooth change gear, with the belt at the center of the cones. Ans. 5

(19) If the sliver that comes from the card weighs 50 grains per yard and is put through four processes of drawing, what will be the weight of the sliver as it comes from the finisher drawing frame if the following doublings and drafts are adopted: 6 ends up, draft of 5.25 on breaker; 6 ends up, draft of 5.50 on first intermediate; 6 ends up, draft of 5.75 on second intermediate; and 6 ends up, draft of 6 on finisher? Ans. 65.047 gr.

(20) Figure the break draft for a drawing frame, referring to Fig. 16, using a 44-tooth change gear. Ans. 1.753

COMBERS

(PART 1)

EXAMINATION QUESTIONS

(1) Name the parts of the comber with which the waste comes in contact when passing from the half lap to the waste can.

(2) Name the objects of the ribbon-lap machine.

(3) What stop-motions are provided on a sliver-lap machine?

(4) State, clearly, the object of the cushion plate and nipper knife of a comber.

(5) What is the distinction between a carded yarn and a combed yarn?

(6) Describe the passage of the cotton through a sliver-lap machine, naming (but not describing) the parts with which the cotton comes in contact.

(7) Explain what is meant by the term head as applied to combers.

(8) What would take place on a comber if the nipper knife were not pressing on the cushion plate when the needles on the half lap were passing through the cotton?

(9) Name the objects of the sliver-lap machine.

(10) Describe how the newly combed portion of cotton is pieced up to that previously combed.

(11) Explain, briefly, the manner in which the feed-rolls of a comber are given an intermittent action.

(12) Describe the passage of the cotton through a ribbon-lap machine, naming (but not describing) the parts with which the cotton comes in contact.

(13) Describe, briefly, the construction of a comber cylinder.

(14) Explain the principal points of difference between single-nip and double-nip combers.

(15) State the object of having the needles in succeeding rows on the half lap of the cylinder finer than those in the preceding rows.

(16) Name the objects of the comber.

(17) Give a brief general description of the construction of the feed-rolls of a comber.

(18) State the object of the top comb.

(19) Figure the draft between the back roll d, Fig. 6, and the front roll d_3, using a 50-tooth change gear.

Ans. 5.6 draft

(20) Figure the constant for total draft for a sliver-lap machine geared as shown in Fig. 3, considering the gear on the end of the front roll as the change gear.

Ans. 64.488, constant

COMBERS

(PART 2)

EXAMINATION QUESTIONS

(1) What parts of the comber are taken as a basis for all the settings?

(2) What is the index gear of a comber, and what is its object?

(3) Name the points that must be taken into consideration when timing and setting a comber.

(4) What is meant by double combing?

(5) Explain, fully, the method of finding the percentage of waste removed by a comber.

(6) Name the parts of the comber that are set by the comber gauges, Fig. 1 (*a*).

(7) Explain, briefly, the operation of setting the top combs.

(8) Explain why the time for feeding varies on combers running Egyptian, sea-island, and American cotton.

(9) State, briefly, some of the most important points that should receive attention in the care of combers.

(10) What would result from changing the angle of the top comb of a comber from 26° to 28°?

(11) Explain the distinction that is made between the terms setting and timing as applied to combers.

(12) What defects are caused by the feed-roll not being parallel with the cylinder?

(13) What part of the comber is taken as a basis for timing the different parts?

(14) What is meant by the statement that the nipper knife leaves the cushion plate at $4\frac{1}{2}$?

(15) Name the parts of the comber that are set by the finger gauge.

(16) What defects are caused by the nipper knife's not having an even pressure on the entire width of the cushion plate?

(17) Give a list of the motions on a comber that must be timed.

(18) Explain the manner in which the delivery roll of a comber is lined up.

(19) State the settings and timings that may be changed on a comber when desiring to remove more waste from the cotton being run.

(20) If 48 grains of waste is taken from a comber during the same time that 252 grains of sliver is being delivered, what is the percentage of waste being taken out?

Ans. 16 per cent.

FLY FRAMES

(PART 1)

EXAMINATION QUESTIONS

(1) Explain the terms: (*a*) bobbin lead; (*b*) flyer lead.

(2) Name the principal objects of fly frames.

(3) How would it be possible when examining a fly frame to tell whether it was a bobbin-lead or flyer-lead frame?

(4) Explain how all the spindles of a fly frame are made to revolve in one direction, although the shafts driving the spindles revolve in opposite directions and drive the spindle gears directly.

(5) Explain how the bobbins are driven from the jack-shaft.

(6) What is meant by the expression $5 \times 2\frac{1}{2}$ frame?

(7) Explain, fully, how a fly frame inserts twist in the roving.

(8) Describe the method of balancing the carriage of the fly frame shown in Fig. 3.

(9) Explain the object of the presser and state how it accomplishes this object.

(10) State how the shape of a full bobbin, as made on a fly frame, is obtained.

(11) What part of a fly frame has its speed changed in order to compensate for the increasing diameter of the bobbin throughout the filling of a set?

(12) What is meant by the gauge of the spindles?

(13) Give a brief general description of the passage of the cotton through the slubber.

(14) Describe the position of the spindles on fly frames, with regard to each other.

(15) Give a full description of the manner in which the spindles of fly frames are supported.

(16) Explain the objects of the lifter rolls on slubbers.

(17) Describe the method adopted on fly frames to wind the roving on the bobbin in ascending and descending coils.

(18) Describe the bolster, stating how it is supported.

(19) State, fully, what parts of a fly frame are included in the carriage.

(20) Give a general description of the flyer, stating how it is driven and the manner in which the roving passes through it.

FLY FRAMES

(PART 2)

EXAMINATION QUESTIONS

(1) Explain, fully, why it is that although the traverse of the roving on the bobbin is shortened with each layer that is wound on, the time consumed by the traverse must be greater.

(2) Give a description of the creel of a fly frame.

(3) If the number of revolutions of the bobbins and spindles are carefully regulated to obtain the correct winding for the first layer of roving that is placed on the empty bobbin, why cannot these speeds be maintained throughout the filling of the bobbins?

(4) What advantages have the later types of compounds over that shown in Fig. 2?

(5) How is the traverse of the carriage of a fly frame reversed?

(6) Explain what means are adopted to allow the gear *d*, Fig. 11, to slide up and down on the shaft *a* and yet be driven by this shaft.

(7) Explain, stating the reasons, why it would not be possible to build a bobbin if the spindles and bobbins of a fly frame made the same number of revolutions per minute.

(8) What are the objects of the builder motion?

(9) What parts of a fly frame are affected by a change in the number of teeth of the tension gear?

(10) Why is it necessary, when the bobbins are full, for the bottom cone to revolve at about one-fourth of its maximum speed?

(11) With a bobbin-lead frame, when do the bobbins attain their highest speed?

(12) If the lay gear of a fly frame is changed to one having a different number of teeth, what parts are affected?

(13) What difficulty is met with in driving the bobbin shafts of a fly frame?

(14) State how the speed of the carriage is decreased as the bobbins become full.

(15) What mechanism is introduced to alter the speed of the gear h_9, Fig. 2, during the filling of the bobbins?

(16) How will the shape of the bobbins be affected if the gear x_6, Fig. 7 (*a*), is increased in size?

(17) Describe, briefly, the horse-head motion.

(18) Explain, briefly, how the lift of the carriage is shortened when a fly frame is equipped with the motion shown in Fig. 7.

(19) Explain, briefly, the action of the builder motion shown in Fig. 8.

(20) Referring to Fig. 2, if the jack-shaft makes 380 revolutions per minute and the gear h_9 makes 18 revolutions per minute, what will be the speed of the gear h_8?

Ans. 416 rev. per min.

FLY FRAMES

(PART 3)

EXAMINATION QUESTIONS

(1) Explain the terms single and double and give some of the causes of single and double on fly frames.

(2) Name two parts of a fly frame that may have their speeds changed in order to change the twist that is placed in the roving, and state which it is usual to change.

(3) State the important points that should be noted when creeling.

(4) What faults result from the taper of a full bobbin being: (*a*) too sharp? (*b*) too blunt?

(5) What causes will result in the full bobbins being too hard?

(6) Give a short description of the care of rolls in fly frames.

(7) Explain the terms piecing, doffing, and breaking out, stating when it is necessary to perform these operations on fly frames.

(8) What would be the standard number of turns per inch for 5-hank roving made on a roving frame running American cotton? Ans. 2.906 turns per in.

(9) If a 25-tooth tension gear is used for a 3-hank roving made on a frame with an American type of builder, what gear will be used for a 5-hank roving? Ans. 19-tooth gear

(10) What is the speed of the front roll, referring to Fig. 1, when the main shaft makes 380 revolutions per minute and carries a 20-inch pulley driving a 16-inch on the jack-shaft?

Ans. 269.496 rev. per min.

(11) Find the average hank roving in a room with the following arrangement of frames whose hank clocks register the following number of hanks for the week: two slubbers of 72 spindles each, 65 and 69 hanks, respectively, of .60-hank roving; four intermediates of 120 spindles each, 68, 60, 70, and 63 hanks, respectively, of 2-hank roving; and eight roving frames of 144 spindles each, 55, 60, 48, 53, 51, 56, 54, and 49 hanks, respectively, of 5.75-hank roving.

Ans. 2.412, average hank

(12) If a 38-tooth draft gear is used to produce a .90-hank roving, what draft gear will be used for a 1.00-hank roving?

Ans. 34-tooth gear

(13) What hank roving will be produced with a 32-tooth draft gear, if the draft constant is 200 and there are 2 ends of 1.92-hank roving up at the back?

Ans. 6-hank

(14) If a 31-tooth twist gear is used for a 1.20-hank roving, what twist gear will be used for a 1.60-hank roving?

Ans. 27-tooth gear

(15) If a 23-tooth lay gear is used for a 5-hank roving, what lay gear will be used for a 7-hank roving?

Ans. 19-tooth gear

(16) How many times must a 1.125-inch front roll of a fly frame turn to register a hank on the clock?

Ans. 8,556.149

(17) If a frame turns off 38 hanks per spindle of 18-hank roving in a week, how many pounds will seven frames each having 200 spindles turn off in the same time?

Ans. 2,955.555 lb.

(18) A 50-grain sliver is run through the slubber with a draft of 4.5; first intermediate with a draft of 5 and doubling 2; second intermediate with a draft of 5.5 and doubling 2;

roving frame with a draft of 6 and doubling 2; what hank roving will be produced by the roving frame?

Ans. 15.483-hank roving

(19) If a bobbin full of roving weighs 3 pounds 7 ounces, and contains 1,235 yards, what is the hank roving, allowing 7.75 ounces as the weight of the bobbin? Ans. .497-hank

(20) With a 68-spindle slubber geared as shown in Fig. 1 and producing .5-hank roving, what will be the production, in pounds, in a week of 60 hours if the jack-shaft has a speed of 344 revolutions per minute, allowing 20 per cent. for stoppages? Ans. 9,927.239 lb.

INDEX

NOTE.—All items in this index refer first to the section and then to the page of the section. Thus, "Brush 18 25" means that brush will be found on page 25 of section 18.

A	Sec.	Page
Adjusting points	20	21
" screw, Evener	17	35
" the nipper rods	23	12
Adjustments, Beater and feed-roll	17	34
Air-current, Regulation of	17	39
America, Cotton used in	14	12
American and British wires	19	13
" cotton	14	13
" type of builder	25	16
Angle shaft and vertical motion	25	23
Apron, Lifting	16	20
Arboreum, Gossypium	14	1
Arrangement of drawing frame	21	18
" " machines	16	14
Automatic feeder	16	17
" "	16	26
Average hank, Rule to find	26	9
B		
Back knife plate	18	19
" " " Setting the	19	67
Bale breaker	16	10
" breakers, Care of	16	13
Baling and ginning cotton	14	16
" cotton	14	26
Barbadense, Gossypium	14	1
Barrel, Central	22	22
Bars, Grid	17	11
" Inclined cleaning	17	14
" " grate	17	14
Beater, Action of the	17	10
" and feed-roll adjustments	17	34
" Doffer	16	23
Beaters, Types of	17	8
Blocks, Distance of, from bearings of detaching roll	23	20
Bloom of cotton	14	30
Bobbin, Build of	26	12
" The	24	12
" Winding the roving on the	24	17
Bobbins, Mechanisms for controlling speed of	25	1
" Method of driving the	24	26
" Rule to find the speed of the	26	4
" shafts, Methods of driving	25	22
" Traverse of	24	21
Bolster, The	24	10
Bottom rolls	20	1
Box, Comb	18	30
" Scale	17	25
Breaker, Bale	16	10
" Floor space of a	17	21
" picker	17	5
" " Draft of a	17	20
" pickers	17	1
Breakers, Care of bale	16	13
Breaking of ends	26	21
" out	26	18
British and American wires	19	13
Brown Egyptian cotton	14	15
Brush	18	25
" and hackle comb	19	69
" Burnishing	19	55
" tin	22	25
Builder, American type of	25	16
" English type of	25	20
" motions	25	14
Build of bobbin	26	12
Burnishing	19	55
" brush	19	55
C		
Cage sections	17	4
Calculations, Card cloth	19	15
" Change gear	26	5
" relating to fly frames	26	1
" Speed	18	39
Calender rolls	22	37
" " Smooth	17	16

	Sec.	Page
Cam-shaft	22	20
Capacity of automatic feeders	16	27
Carborundum wheel	19	55
Card cloth calculations	19	15
" clothing	19	9
" " English method of numbering	19	20
" " Noggs and points in	19	19
" construction	18	3
" "	19	1
" cylinders	18	16
" frame	18	26
" gearing	18	33
" Grinding a new	19	46
" Production of the	18	42
" Roller-and-clearer	19	5
" room, Management of	19	70
" Setting the	19	56
Carding	18	1
" beater	17	8
" Double	19	8
Cards, Care of	19	29
" Cotton	18	1
" "	19	1
" "	19	29
" Dimensions of	18	42
" Method of clothing	19	22
" Stripping	19	32
" Weight and horsepower of	18	42
Care of cards	19	29
" " drawing frame	21	38
" " feeders	16	27
" " fly frames	26	15
" " machinery, Proper	19	73
" " pickers	17	39
" " rolls	26	19
Causes of uneven laps	17	40
Central barrel	22	22
" stock	22	22
Change gear calculations	26	5
" gears	17	37
" "	25	19
Chisel-point wire	19	12
Chute, Waste	22	25
Classification and selection of cotton	14	27
Cleaning and oiling pickers	17	42
" " " the comber	23	28
" bars, Inclined	17	14
" the stripping roll	19	35
Clearer-and-roller card	19	5
Clearers and traverse motions	20	33
Clocks, Hank	24	15
Cloth covering, Method of putting on	20	7
" Roller	20	7
Clothing, Card	19	9
" cards, Method of	19	22
" Cylinder and doffer	19	23
" English method of numbering card	19	20
" Noggs and points in card	19	19
" flats	19	22
Coiler	18	31
" head	18	31
Comb box	18	30
" Combing by the top	22	34
" Doffer	18	30
" "	22	25
" Setting the doffer	19	69
" " " stripping	19	68
" " " top	23	10
" Timing the top	23	23
Comber, Construction of double-nip	22	47
" Construction of single-nip	22	13
" construction of, Variations in	22	45
" Double-nip	22	47
" Gearing of a	22	41
" Management of the	23	25
" Oiling and cleaning the	23	28
" Principal motions of the	22	15
" Purpose of double-nip	22	47
" Single-nip	22	13
" Speed of	23	29
Combers	22	1
"	23	1
" Setting various parts of	23	4
" Size of gauge settings for	23	3
Combing by the top comb	22	34
" Double	23	25
" equipment	22	1
" operation by the half-lap	22	22
Combs, Flat-stripping	18	24
Common rolls	20	1
Compound motion	25	3
Condenser and gauge box	17	1
Conductors, Electric	21	27
Cones, The	25	13
Connecting sections, Method of	20	3
Constant for twist, Rule to find	26	4
Constants, Twist	26	11
Construction, Card	18	3
" Former methods of card	19	1
" of card clothing	19	9
" " double-nip comber	22	47
" " drawing frames	21	18
" " fly frames	24	1

	Sec.	Page
Construction of single-nip comber	22	13
" " sliver-lap machine	22	3
" " sliver-lap machine	22	8
" " the breaker picker	17	5
" Variations in comber	22	45
Controlling speed of bobbins	25	1
Cotton	14	1
" American	14	13
" at the mill, Receipt of	16	6
" Baling	14	26
" Bloom of	14	30
" Brown Egyptian	14	15
" cards	18	1
" "	19	1
" "	19	29
" characteristics, Tables of	14	16
" Classification of	14	27
" cultivation	14	1
" Dampness of	14	30
" Dirt and sand in	14	29
" Exportation of	14	34
" Fair	14	28
" fiber, Measurements of	14	8
" " Structure of the	14	5
" Ginning and baling	14	16
" Grade of	14	28
" Growth and development of	14	2
" Gulf, or New Orleans	14	14
" Judging	14	27
" Long-stapled	14	17
" Low middling	14	28
" Marketing	14	27
" markets of the United States	14	32
" Medium-stapled	14	20
" " to long-stapled	14	18
" Middling	14	28
" Mill purchases of	14	33
" mixing	16	6
" " Varieties of	16	9
" Ordinary	14	28
" pickers	17	1
" Principal species of	14	1
" Quantity and quality of	14	9
" regions, Productive	14	10
" samples	14	27
" Sea-island	14	12
" Selection of	14	27
" Short-stapled	14	21
" Staple of	14	29
" stock, Condition of	16	1
" Testing yarns and fabrics containing	14	9
Cotton, Texas	14	15
" Uplands	14	14
" used in America	14	12
" yarn mills	16	2
" " Production of	16	2
Cottons of the world	14	9
Counts	19	21
Cover, Licker	18	16
Covering for rolls, Leather	20	8
" Method of putting on cloth	20	7
" Method of putting on leather	20	12
" top rolls	20	6
Cradle	23	11
Creel	25	28
Creeling	26	14
Cultivation, Cotton	14	1
Cushion plate	22	17
" " settings	23	9
Cylinder	22	22
" and doffer, Clothing	19	23
" " " Grinding the	19	44
" end waste	19	41
" screen	18	26
" " Setting the	19	66
Cylinders, Card	18	16

D

	Sec.	Page
Dampness of cotton	14	30
Dead rolls	19	37
Deadweighting	20	25
Defects of fly frames	26	21
Delivery of the stock	22	37
" roll	22	26
" " Timing the motions of the	23	22
Detaching, Placing rolls in position for	23	20
" position, Removing detaching roll from	23	22
" roll, Distance of blocks from bearings of	23	20
Development and growth of cotton	14	2
Device, Stripping	16	20
Diameter of wire	19	13
Differential motions	25	1
Dimensions of cards	18	42
" " fly frames	24	27
Dirt and sand in cotton	14	29
Doffer	18	27
"	18	40
" and cylinder, Clothing	19	23
" " " Grinding the	19	44
" beater	16	23
" comb	18	30

	Sec.	Page
Doffer comb	22	25
" " Setting the	19	69
" Setting the	19	64
" " "	23	15
Doffing	26	17
Double-bar traverse motions	20	39
" boss rolls	20	5
" carding	19	8
" combing	23	25
" nip comber	22	47
Draft	18	41
" gear, Rule to find	26	7
" in fly frames	26	9
" of a breaker picker	17	20
" " intermediate and finisher pickers	17	39
Drafts of fly frames	26	4
Draw box	22	39
" " Setting	23	16
Drawing frame, Arrangement of	21	18
" " Care of	21	38
" " gearings	21	33
" " Space occupied by a	21	40
" frames	21	17
" " and railway heads	21	1
" " Management of	21	35
" processes, Number of	21	17
" rolls	20	1
" " Method of driving the	24	24
" " of a slubber	24	5
" " Settings of	20	21
Driving bobbin shafts	25	22
" the bobbins	24	26
" " drawing rolls	24	24
" " spindles	24	26

E

	Sec.	Page
Economy of management	19	72
Egyptian cotton, Brown	14	15
Electric conductors	21	27
" stop-motion	21	26
Emery wheel	19	54
Ends, Breaking of	26	21
" Slack	26	21
English counts	19	22
" method of numbering card clothing	19	20
" type of builder	25	20
Equipment, Combing	22	1
Evener adjusting screw	17	35
" motion	21	7
" motions	17	25
Exportation of cotton	14	34

F

	Sec.	Page
Fabrics and yarns containing cotton, Testing	14	9
Fair cotton	14	28
Feeder, Automatic	16	17
" "	16	26
Feeding and opening machine	16	17
" pickers, Methods of	17	1
" Two-roll method of	18	12
Feed-motion	22	15
" plate	18	7
" " Setting the	19	66
" roll	17	27
" "	18	7
" " and beater adjustments	17	34
" " Operation of	17	27
" " Setting the top	23	16
" " settings	23	6
" rolls	22	16
" Timing the	23	18
Fiber, Measurements of the cotton	14	8
" Structure of the cotton	14	5
Fillet	19	15
" winding machine	19	25
Filleting	19	15
Finisher and intermediate pickers	17	23
" and intermediate pickers, Draft of	17	39
Flat card, Revolving-top	18	3
" " Stationary-top	19	2
" point wire	19	12
" stripping combs	18	24
Flats	18	19
"	18	40
" Clothing	19	22
" Grinding the	19	47
" Setting the	19	57
Floor space occupied by drawing frame	21	40
" " of a breaker	17	21
Fluted segment	22	22
Flyer, The	24	5
Flyers, Imperfect	26	22
Fly frame, Rule to find production of	26	8
" frames	24	1
" "	25	1
" "	26	1
" " Care of	26	15
" " Defects of	26	21
" " Dimensions of	24	27
" " Draft in	26	9
" " Drafts of	26	4
" " Gearing	24	24
" " Horsepower required to drive	24	29
" " Management of	26	1

	Sec.	Page
Fly frames, Oiling	26	19
" " Principal motions of	25	1
" " Speed of	26	12
" " Starting	26	9
Footstep bearing	24	9
Formation of the lap	19	8
Frame, Arrangement of drawing	21	18
" Card	18	26
" Care of drawing	21	38
Frames, Drawing	21	17
" Fly	24	1
" Management of drawing	21	35
Frequency of stripping cards	19	33
Front knife plate	18	29
" " " Setting the	19	69
Full-bobbin stop-motion	25	26
" lap stop-motion	22	6

G

	Sec.	Page
Gauge box and condenser	17	1
" settings for combers, Size of	23	3
Gauges	19	57
" Table of American and British wire	19	13
" used in setting combers	23	2
Gear calculations, Change	26	5
" Index	23	17
" Twist	24	24
Gearing	17	19
" Card	18	33
" Fly-frame	24	24
" of a comber	22	41
" of a picker	17	37
" of the automatic feeder	16	26
Gearings, Drawing-frame	21	33
Gears, Change	17	37
" "	25	19
" Twin	25	18
Gin, Knife-roller	14	24
" Macarthy	14	25
" Roller	14	24
" Saw	14	16
Ginning and baling cotton	14	16
Good middling cotton	14	28
" ordinary cotton	14	28
Gossypium arboreum	14	1
" barbadense	14	1
" herbaceum	14	1
" hirsutum	14	1
Grade of cotton	14	28
Grate bars, Inclined	17	14
Grid bars	17	11
Grinder, Horsfall	19	38
" Traverse	19	38
Grinding	19	36
Grinding a new card	19	46
" Operation of	19	44
" Plow	19	12
" Preparation for	19	40
" rolls	19	36
" the flats	19	47
" " licker	19	54
Growth and development of cotton	14	2
Guide, Traverse	24	5
Gulf, or New Orleans, cotton	14	14

H

	Sec.	Page
Hackle comb and brush, Setting the	19	69
Half lap	22	22
Hank clocks	24	15
" Rule to find average	26	9
Head, Coiler	18	31
" Principal parts of the railway	21	3
Herbaceum, Gossypium	14	1
Hirsutum, Gossypium	14	1
Horsehead motion	25	22
Horsepower and weight of cards	18	42
" required to draw fly frames	24	29
Horsfall grinder	19	38

I

	Sec.	Page
Imperfect flyers	26	22
Incorrect traverse	26	22
Index gear	23	17
Indicator, Speed	19	75
Inserting twist, Method of	24	16
Intermediate and finisher pickers	17	23
" " finisher pickers, Draft of	17	39

J

	Sec.	Page
Jack-shaft	24	24
Judging cotton	14	27

K

	Sec.	Page
Knife beater	17	9
" Nipper	22	19
" plate, Back	18	19
" " Front	18	29
" " Setting the	19	67
" roller gin	14	25
Knives, Mote	18	14

L

	Sec.	Page
Lap, Formation of the	19	8
" Half	22	22
" head	17	7
" rack	17	17
" roll	17	16
" Weight of	17	41

	Sec.	Page
Laps, Causes of uneven	17	40
Lay gear, Rule to find the	26	8
Leather covering for rolls	20	8
" " Method of putting on	20	12
" detaching roll	22	27
" detaching roll, Setting the top roll from	23	21
Lever-weighting	20	28
Licker	18	13
"	18	39
" cover	18	16
" Grinding the	19	54
" screen	18	16
" " Setting the	19	67
" Setting the	19	64
Licking	17	40
Lifting apron	16	20
Long-stapled cotton	14	17
" " " Medium to	14	18
Loose-boss rolls	20	5
Low middling cotton	14	28
M		
Macarthy gin	14	25
Machine, Feeding and opening	16	17
" Fillet-winding	19	25
" Ribbon-lap	22	8
" Sliver-lap	22	3
Machinery, Proper care of	19	73
Machines, Arrangement of	16	14
" Setting of sliver-lap	22	6
" Settings of ribbon-lap	22	11
Making-up pieces	22	22
Management, Economy of	19	72
" of card room	19	70
" " drawing frames	21	35
" " fly frames	26	1
" " the comber room	23	25
Marketing cotton	14	27
Markets of the United States, Cotton	14	32
Measurements of cotton fiber	14	8
Measuring motion	17	32
Mechanical stop-motions	21	23
Mechanism for controlling speed of bobbins	25	1
Medium-stapled cotton	14	20
" to long-stapled cotton	14	18
Metallic rolls	20	15
Method of driving the bobbins	24	26
" " " the drawing rolls	24	24
" " " the spindles	24	26
" " feeding, Two-roll	18	12
" " inserting twist	24	16
Method of mixing	16	8
Methods of driving bobbin shafts	25	22
" " stripping cards	19	32
Middling cotton	14	28
" fair cotton	14	28
Mill purchases of cotton	14	33
" Receipt of cotton at the	16	6
Mills, Object of cotton-yarn	16	2
Mixing cotton	16	6
" Method of	16	8
" Size of the	16	7
" varieties of cotton	16	9
Mote knives	18	14
Motion, Compound	25	3
" Double-bar traverse	20	39
" Evener	21	7
" Horsehead	25	22
" Measuring	17	32
" Piecing-up	22	25
" Vertical and angle shaft	25	23
Motions, Builder	25	14
" Clearers and traverse	20	33
" Differential	25	1
" Evener	17	25
" of fly frames	25	1
" " the comber	22	15
" " " delivery roll, Timing the	23	22
" Traverse	20	35
" Weight-relieving	20	32
N		
Needle-ground wire	19	12
" point wire	19	12
New card, Grinding a	19	46
" Orleans, or Gulf, cotton	14	14
Nipper knife	22	19
" rods, Adjusting the	23	12
Nippers	22	17
Nogg	19	17
Noggs and points in card clothing	19	19
Non-conductors	21	27
Numbering card clothing	19	20
Number of drawing processes	21	17
O		
Object of combing	22	1
Objects of carding	18	1
Oiling and cleaning pickers	17	42
" " " the comber	23	28
" fly frames	26	19
Opener	16	27
Opening and feeding machine	16	17
Operation of feed-roll	17	27
" " grinding	19	44
" " ribbon-lap machine	22	8

	Sec.	Page
Operation of single-nip comber	22	13
" " sliver-lap machine	22	3
" " stripping cards	19	34
" " the breaker picker	17	5
" " " electric stop-motion	21	28
Operations of the rolls	22	29
Ordinary cotton	14	28

P

	Sec.	Page
Pans, Setting sliver	23	16
Passage of the stock	22	14
" " " "	24	4
Picker, Breaker	17	5
" Draft of a breaker	17	20
" Gearing of a	17	37
" Objects of the breaker	17	5
" rooms	16	13
Pickers	16	1
" Breaker	17	1
" Care of	17	39
" Cotton	17	1
" Draft of intermediate and finisher	17	39
" Intermediate and finisher	17	23
" Methods of feeding	17	1
Pieces, Making-up	22	22
Piecing of roving	26	16
" up motion	22	25
Placing detaching and top rolls in position	23	20
Plate, Back knife	18	19
" Cushion	22	17
" Front knife	18	29
" Setting of the back knife	19	67
Plow-grinding	19	12
Points, Adjusting	20	21
" and noggs in card clothing	19	19
Poker bar	25	20
Porcupine beater	17	8
Position, Placing detaching and top rolls in	23	20
Preparation for grinding	19	40
Principal species of cotton	14	1
Principles of carding	18	2
Production of a fly frame	26	8
" " the card	18	42
" Quality of	19	70
" Quantity of	19	72
Purchases of cotton, Mill	14	33
Purpose of double-nip comber	22	47

Q

	Sec.	Page
Quality and quantity of cotton	14	9
" of production	19	70
Quantity of production	19	72
" and quality of cotton	14	9

R

	Sec.	Page
Rack, Lap	17	17
Rail, Stripping	17	13
Railway head, Principal parts of the	21	3
" heads and drawing frames	21	1
Recipes for roll varnish	20	13
Regulation of air-current	17	39
Revolving brush	23	14
" top flat card	18	3
Ribbon-lap machine	22	8
" " machines, Settings of	22	11
Rigid-blade beater	17	9
Rods, Adjusting the nipper	23	12
Roll, Cleaning the stripping	19	35
" Delivery	22	26
" Lap	17	16
" Leather detaching	22	27
" Top	22	29
" varnish, Recipes for	20	13
Roller-and-clearer card	19	5
" cloth	20	7
" gin	14	24
Rolls, Advantage of metallic	20	17
" Bottom	20	1
" Calender	22	37
" Care of	26	19
" Common	20	1
" Covering top	20	6
" Dead	19	37
" Double-boss	20	5
" Drawing	20	1
" Grinding	19	36
" Leather covering for	20	8
" Loose-boss	20	5
" Metallic	20	15
" Method of driving the drawing	24	24
" of a slubber, Drawing	24	5
" Operations of the	22	29
" Rules governing setting of	20	18
" Scouring	20	39
" Setting and weighting	20	18
" " top	20	24
" Settings of drawing	20	21
" Single-boss	20	5
" Smooth calender	17	16
" Solid-boss	20	5
" Top	20	4
Room, Management of the comber	23	25
Rooms, Location of picker	16	14
" Picker	16	13
Roving on the bobbin, Winding the	24	17
" Piecing of	26	16
" Running over and under of the	26	22

	Sec.	Page
Roving scales	26	24
" Tension of	26	13
Rule to find average hank	26	9
" " find production of a fly frame	26	8
" " find the constant for twist	26	4
" " find the draft gear	26	7
" " find the lay gear	26	8
" " find the length of filleting for cylinder doffer	19	25
" " find the number of sections of a mixing	16	8
" " find the points per square foot of card clothing	19	17
" " find the speed of the bobbins	36	4
" " find the tension gear	26	7
" " find the twist gear	26	7
Rules governing setting of rolls	20	18
" to find the twists or turns per inch	26	3
Running over and under of the roving	26	22

S

	Sec.	Page
Samples, Cotton	14	27
Sand and dirt in cotton	14	29
Saw gin	14	16
Scale box	17	25
Scales, Roving	26	24
Scouring rolls	20	39
Screen, Cylinder	18	26
" Licker	18	16
" Setting the cylinder	19	66
" " " licker	19	67
Screw, Evener adjusting	17	35
Sea-island cotton	14	12
Sections, Method of connecting	20	3
Segment, Fluted	22	22
Selection of cotton	14	27
" " skins	20	10
Self-weighting	20	25
Setting and timing combers	23	1
" " weighting rolls	20	18
" combers	23	2
" draw box	23	16
" of rolls, Rules governing	20	18
" sliver pans	23	16
" the back knife plate	19	67
" " brush and hackle comb	19	69
" " card	19	56
" " cylinder screen	19	66
" " doffer	19	64
" " "	23	15
" " " comb	19	69
" " feed-plate	19	66
Setting the flats	19	57
" " front knife plate	19	68
" " grid bars	17	12
" " licker	19	64
" " " screen	19	67
" " stripping comb	19	68
" " top comb	23	10
" " top feed-roll	23	16
" " top roll from leather detaching roll	23	21
" " various parts of combers	23	4
" top rolls	20	24
Settings, Cushion plate	23	9
" Feed-roll	23	6
" for combers, Size of gauge	23	3
" Minor	23	12
" of drawing rolls	20	21
" " ribbon-lap machines	22	11
" " sliver-lap machines	22	6
Shafts, Methods of driving bobbin	25	22
Short-stapled cotton	14	21
Side-ground wire	19	12
Single-boss rolls	20	5
" nip comber	22	13
Size of gauge settings for combers	23	3
" " the mixing	16	7
Sizing	26	23
Skins, Selection of	20	10
Slack ends	26	21
Sliver	18	2
" lap machine	22	3
" " machines, Settings of	22	6
" pans, Setting	23	16
" stop-motion	22	6
Slubber, Drawing rolls of a	24	5
" The	24	4
Smooth calender rolls	17	16
Solid-boss rolls	20	5
Speed of fly frames	26	12
Spindles, Method of driving the	24	26
Splitting	17	40
Species of cotton, Principal	14	1
Speed calculations	18	39
" indicator	19	75
" of bobbins, Mechanisms for controlling	25	1
" " comber	23	29
" " the bobbins	26	4
Speeders	24	2
Spindle, The	24	8
Staple of cotton	14	29
Starting fly frames	26	9
Stationary-top flat card	19	2
Stock, Central	22	22

	Sec.	Page
Stock, Condition of cotton	16	1
" Delivery of the	22	37
" Passage of the	22	14
" " " "	24	4
Stop-motion, Electric	21	26
" " Full-bobbin	25	26
" " Full-lap	22	6
" " Operation of the electric	21	28
" motions	21	23
" "	25	26
" " Sliver	22	6
Stripping cards	19	32
" comb, Setting the	19	68
" device	16	20
" rail	17	13
" roll, Cleaning the	19	35
Structure of the cotton fiber	14	5

T

	Sec.	Page
Table of American and British wire gauges	19	13
" " cushion plate settings	23	9
" " dimensions of fly frames	24	28
" " English counts	19	22
" " feed-roll settings	23	6
" " gauge settings for combers	23	3
" " horsepower required to draw fly frames	24	29
" " long-stapled cotton	14	17
" " medium-stapled cotton	14	20
" " " to long-stapled cotton	14	18
" " noggs and points in card clothing	19	19
" " settings of drawing rolls	20	21
" " short-stapled cotton	14	21
" " twist constants	26	11
" " weights of lap	17	41
Tables of cotton characteristics	14	16
Teeth	19	11
Tension gear, Rule to find the	26	7
" of roving	26	13
Testing yarns and fabrics containing cotton	14	9
Texas cotton	14	15
Timing	23	17
" and setting combers	23	1
" the feed	23	18
" " motions of the delivery roll	23	22
" " nippers	23	18
" " top comb	23	23
Tin, Brush	22	25
Top comb, Combing by the	22	34
" " Setting the	23	10
" " Timing the	23	23
" ground wire	19	12
" roll	22	29
" " in position, Placing the	23	20
" " from leather detaching roll, Setting the	23	21
" " weighting	20	24
" rolls	20	4
" " Covering	20	6
" " Setting	20	24
Traverse grinder	19	38
" guide	24	5
" Incorrect	26	22
" motions	20	35
" " Double-bar	20	39
" of bobbins	24	21
Trunk, Horizontal cleaning	16	28
" Plain conducting	16	28
Trunking	16	28
Trunks, Inclined cleaning	16	30
Turns or twists per inch, To find	26	3
Twin gears	25	18
Twist	26	10
" gear	24	24
" " Rule to find	26	7
" Method of inserting	24	16
" Rule to find the constant for	26	4
Twists or turns per inch	26	3
Two-roll method of feeding	18	12
Type of builder, American	25	16
" " " English	25	20
Types of beaters	17	8

U

	Sec.	Page
Uneven laps, Causes of	17	40
United States, Cotton markets of the	14	32
Uplands cotton	14	14

V

	Sec.	Page
Variations in comber construction	22	45
Varieties of cotton, Mixing different	16	9
Varnishing	20	13
Vertical and angle shaft motion	25	23

W

	Sec.	Page
Waste	18	41
"	23	28
" chute	22	25
" Cylinder-end	19	41
Weight and horsepower of cards	18	42
" relieving motions	20	32
Weighting and setting rolls	20	18

	Sec.	Page
Weighting, Top-roll	20	24
Weights of lap	17	41
Wheel, Carborundum	19	55
" Emery	19	54
Winding the roving on the bobbin	24	17
Wire, Chisel-point	19	12
" Diameter of	19	13
" Flat-point	19	12
" Needle-ground	19	12
" " point	19	12
Wire, Side-ground	19	12
" Top-ground	19	12
Wire gauges, British and American	19	13
World, Cottons of the	14	9

Y

	Sec.	Page
Yarn-preparation processes	16	1
" Production of cotton	16	[illegible]
Yarns and fabrics containing cotton, Testing	14	