which passes another band, E^1, to the comb pulley, H, also double grooved.

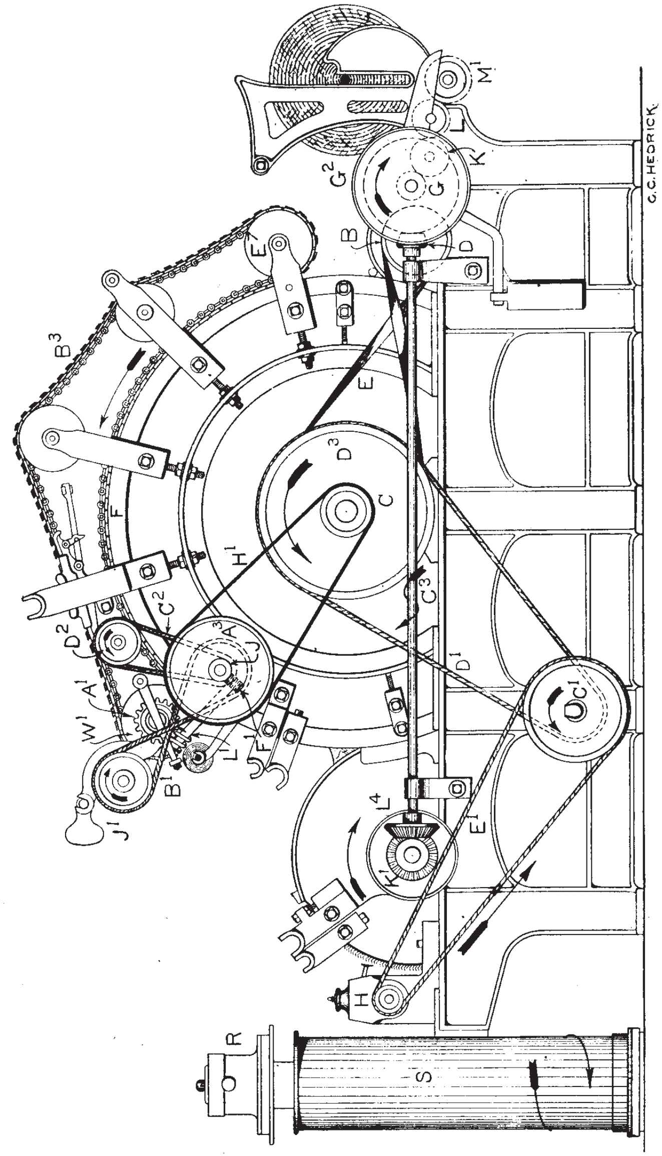


Fig. 59. Elevation of Card, R. H. Side.

The flats, B^3, which pass slowly over the cylinder in the direction indicated by an arrow, are driven from a sprocket wheel which is fastened to the inside of the front block, W^1. Motion is communicated to the latter from the small pulley, C, which is

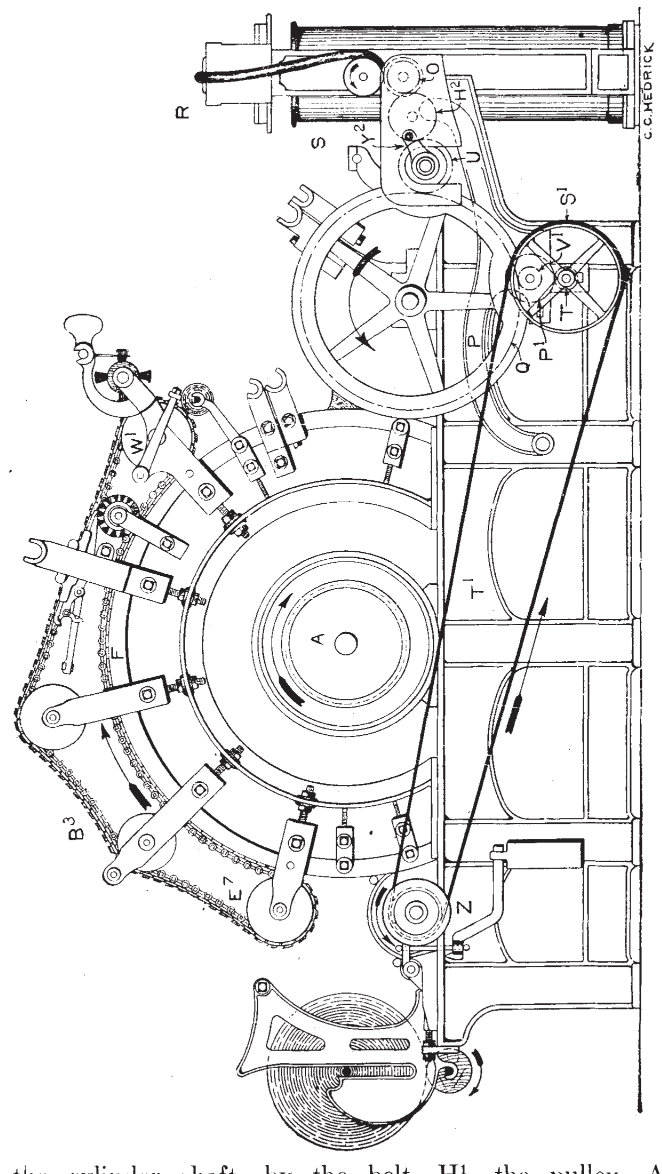


Fig. 60. Elevation of Card, L. H. Side.

upon the cylinder shaft, by the belt, H^1, the pulley, A^3, the worm, J, the worm gear, F^1, the worm, L^1, and the worm gear

A^1, which is upon the front block shaft. The usual speed of the flats is about three inches per minute.

The stripping brush is driven from a groove on the inside of the pulley, A^3, by the band, B^1, and the pulley, J^1, while the dandy brush, by which the backs of the flats are cleaned before they pass around the front block, is also driven from a small groove on the inside of the pulley, A^3, by the band, C^2, and the pulley, D^2.

The feed roll is driven from the doffer by the gears, K^1 and L^4, the side shaft, C^3, and the gears G^2 and D. The front bearing for the side shaft is made so that it may be moved, horizontally, disengaging the gears, K^1 and L^4, when it is desired to stop the feed roll. The lap roll is driven from the feed roll by the gears G, K, L and M^1.

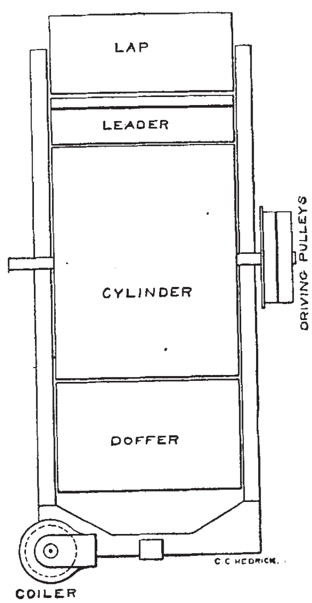


Fig. 61. Plan of R. H. Card.

On the opposite side of the card (Fig. 60) is the main pulley, A, by which the card is driven. The doffer is driven from a pulley, Z, which is upon the leader by the belt, T^1, the barrow pulley, S^1, the pinion, T, and the gear, P^1. Compounded with P^1 is a pinion, V^1, which drives the doffer gear, Q. The gears, T, P^1 and V^1, and the barrow pulley are fixed upon studs which are carried by a lever, P, called the barrow bar. By this, the driving of the feed roll, doffer, calender roll and coiler is controlled. When it is desired to stop these parts, the lever is dropped which disengages the pinion, V^1, from the gear, Q.

The calender rolls are driven from the doffer gear, Q, by the gears U, H^2 and O. The gear, U, is called the rifle gear and revolves upon a sleeve, or bushing, which is connected to a handle, Y^2. By turning this handle about one-quarter of a revolution, the rifle gear is drawn sideways and out of gear with Q which is necessary when is it desired to stop the calender rolls and coiler and still have the doffer turning.

Coiler. We will direct our attention now to the gearing of the coiler, a vertical section of which is shown in Fig. 62. The cotton, after passing between the calender rolls, M and D, enters the coiler, R, through the trumpet, C^4, and is drawn between the calender rolls, D^4, and passes down an inclined hole (or spout) in the coiler gear, S^2, to the can, S, in which it is laid in even and regular coils.

The calender rolls are driven from the upright shaft, L^2, by the gears, N and N^1. L^2 is driven from the bottom calender roll on the card by the gears Y^1, R^2, V and Q^1. By the revolutions of the coiler gear, the inclined hole describes a circle of a little more than half the diameter of the can.

The can rests upon a plate, L^3, called the turn-table, by which it is revolved slowly in the opposite direction from the coiler gear and just fast enough so that the coils shall not overlap and crowd each other.

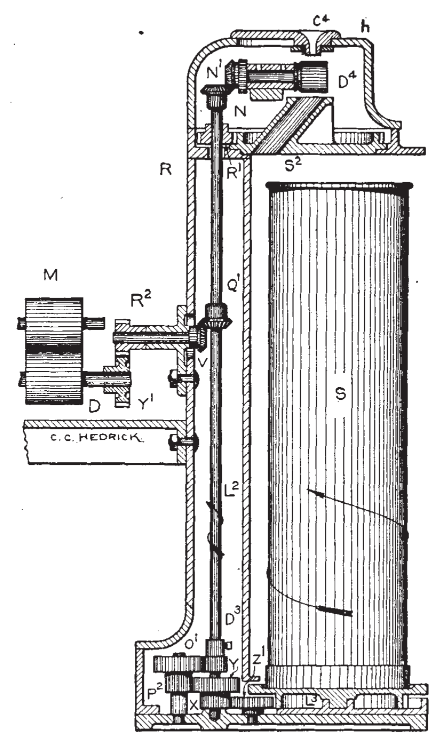


Fig. 62. Vertical section of coiler.

On the under side of the turn-table is a gear, driven from the upright shaft, L^2, by the gears D^3, O^1, P^2, Y, X and Z^1. O^1 and P^2 are compounded and run loose on an upright stud, and Y and X are compounded and run loose on the upright shaft. X drives the turn-table through the intermediate gear, Z^1. A plan of this gearing is shown in Fig. 63.

Fig. 64 is a plan of the coiler top. The trumpet, C^4, is made in the form of a large, flat plate which covers almost the whole of the top. When it becomes necessary to oil the calender roll bearings, it can be done easily by pushing the plate to one side, as shown in the drawing. By this means, piecing is avoided, a feature which will be appreciated by all carders who have had to break the sliver to oil the coiler.

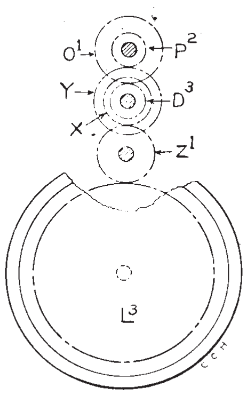


Fig. 63. Plan of turn-table gearing.

Fig. 65 shows a plan of a coiler with the top raised. The calender rolls are kept together by a spring, N^2, on the end of which is a lever, L. When a wind-up occurs on the calender rolls, the tension upon the spring is removed by turning the lever.

Stop Motion. One of the recent improvements, which has been applied to the revolving flat card, is a calender roll stop-motion which stops the revolutions of the feed roll and doffer instantly, when from any cause, the sliver is absent from between the calender rolls.

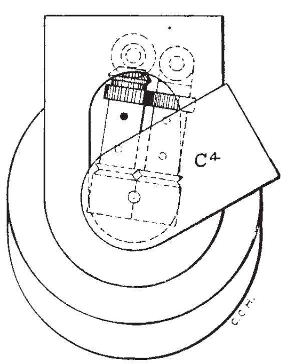


Fig. 64. Plan coiler top.

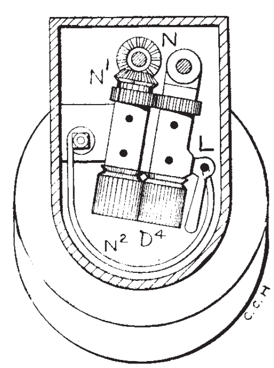


Fig 65. Plan of coiler with top raised

It happens quite frequently that the comb band breaks or jumps from the score pulley, stopping the vibrations of the doffer comb. If this is unnoticed and the doffer runs for several minutes the card wires get filled with fibers and the clothing of the cylinder, doffer and flats becomes badly strained.

When the sliver breaks down from any cause, it often happens that it will wind around the comb-blade. Should the doffer be allowed to run in this condition, a bad jamb in the wires of the doffer is likely to occur.

When the clothing is injured from causes of this kind, considerable time is spent in stripping and brushing out the card, straightening the wires and grinding. Frequently, the clothing is rendered useless, as the foundation for the wires is strained so badly that its elasticity is destroyed and it is necessary to redraw it on both the cylinder and the doffer.

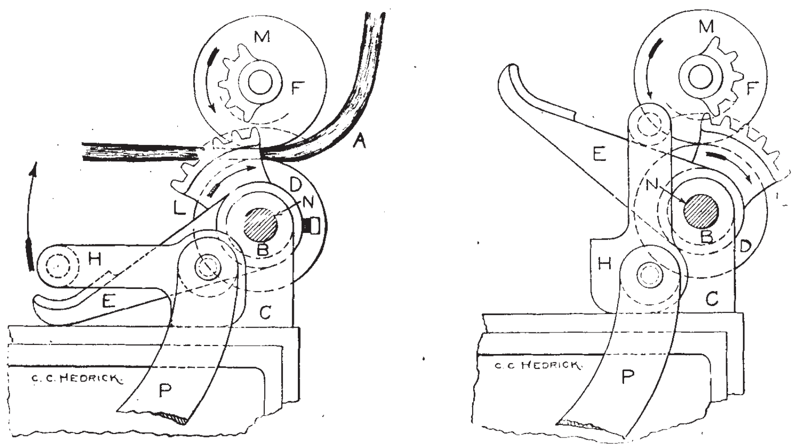


Fig. 66 and 67. Elevations of calendar roll stop motion.

The stop-motion is shown in three views, in Figs. 66, 67 and 68, which should be used in connection with Fig. 60. In Fig. 66, which is a side elevation, the sliver, A, is shown passing between the calender rolls, M and D. Upon the top calender roll, M, is a segment gear, F, which rotates with the calender roll, while a similar segment, L, is fastened to a sleeve, B, which is loose upon the bottom calender shaft, N. On the outer end of this sleeve is a lever, E, whose end rests under the handle of the lever, H, by which the barrow bar, P, is thrown in and out of gear. The barrow bar is raised and in gear, as shown by the horizontal position of the lever, H, and, with the silver between the calender rolls, it will be seen that the teeth of the segment, F, are raised so that it may revolve without imparting motion to the segment, L. Should the sliver break or from any cause allow the calender rolls to come together, the teeth of F would engage with those of L and give to the latter a partial revolution, which would turn the sleeve, B, and with it the lever, E. This would cause the lever, H, to assume the position shown in Fig. 67 and to drop the barrow bar, P, and disengage the gears, driving the doffer. A plan of this device is shown in Fig. 68.

Flexible Bend. As the flats pass forward over the cylinder, they are supported, as we have already seen, by what is called the flexible bend. The surface of the bend is concentric with the cylinder. By this means, the distance between the wires of the flats

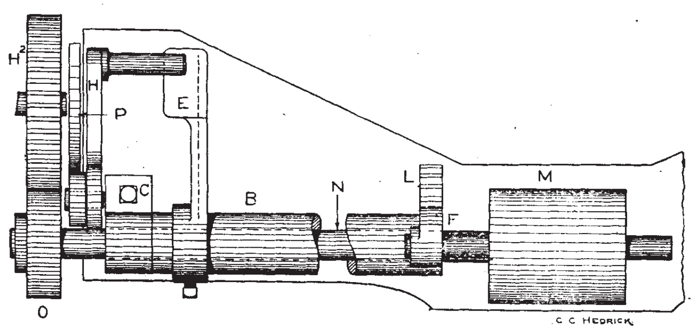


Fig. 68. Plan of calendar roll stop motion.

and the cylinder is maintained and upon the correct setting, or distance between the surfaces, depends, in a great measure, the successful working of the card. If the flats are set too far away, it will be found that the sliver contains little rolls of tangled fibers, called neps, and if set too close, it will show raw, uncarded places and look cloudy and rough, and the wires of the clothing will become faced from rubbing together. These defects are easily distinguishable in the fleece, as it passes from the doffer comb to the calender rolls. The flats should be set as close as possible without injury to the fibers. An average setting is $\frac{10}{1000}$ of an inch.

The wire teeth of the flats and cylinder require grinding, from time to time, owing to their becoming dulled on the points, and, as the grinding operation shortens them slightly, the space between the wire surfaces is increased. In order to preserve the correct relation between these two surfaces, the flats have to be reset, and

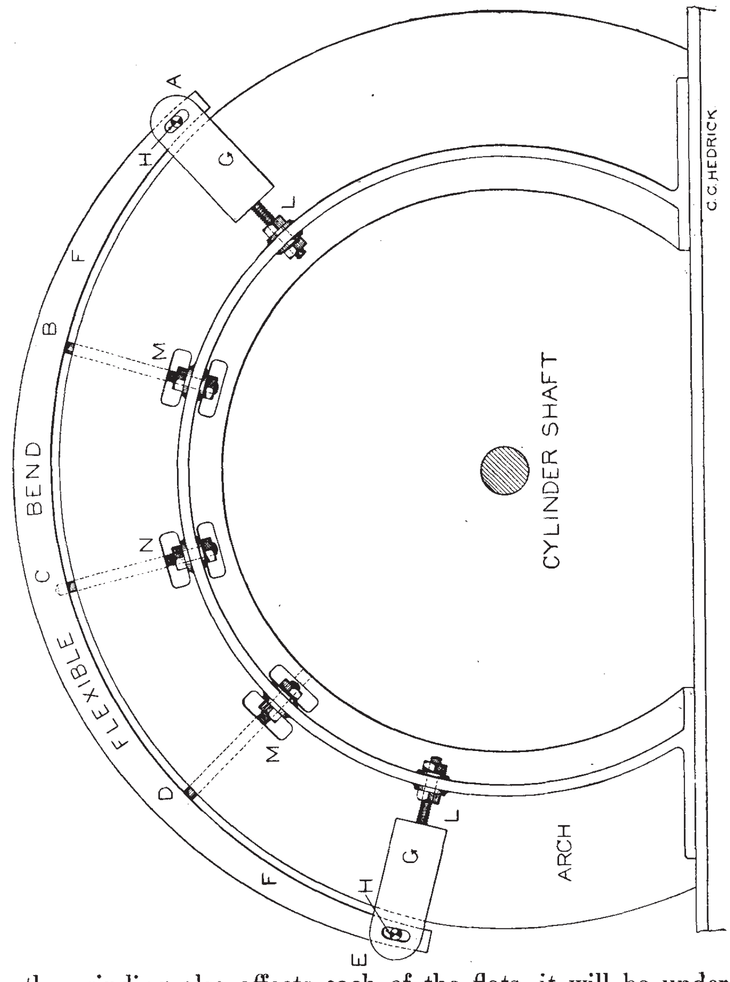
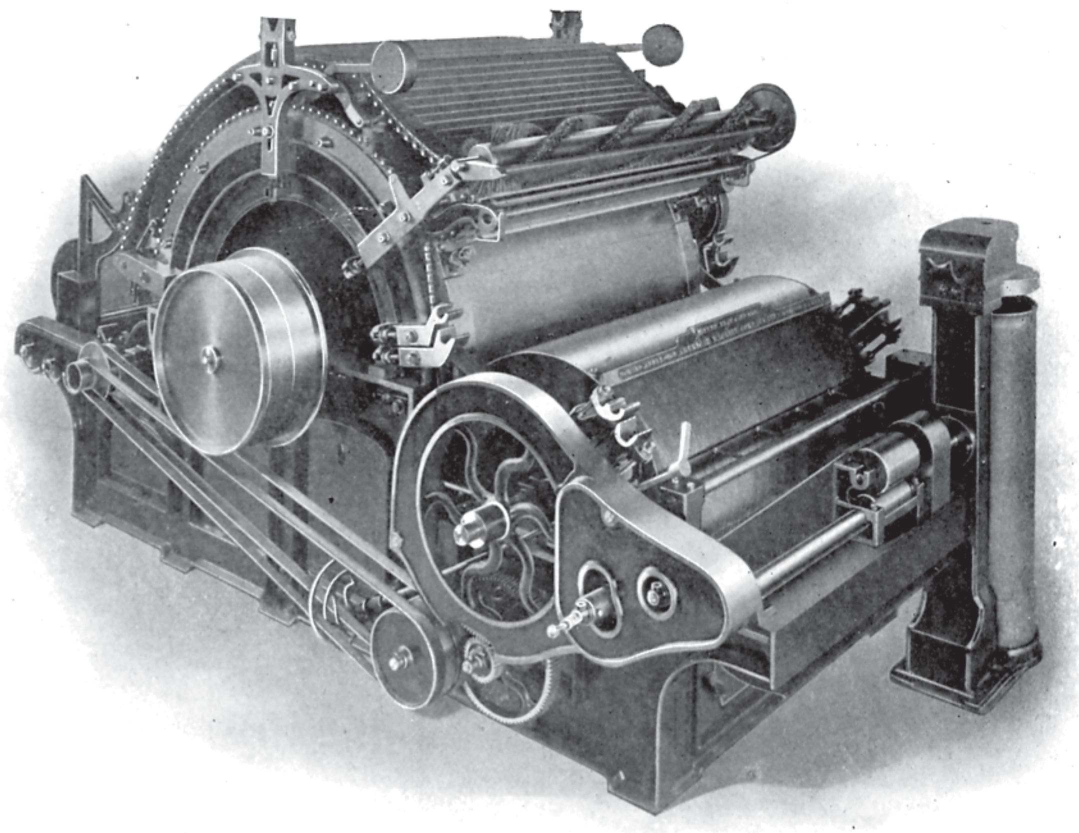


Fig. 69. Flexible Bend, five point adjustment.

as the grinding also affects each of the flats, it will be understood that they must be lowered, bodily, to the same extent towards the center of the cylinder. This is accomplished by changing the radius of the flexible bend.

The most common form of device for changing the radius is

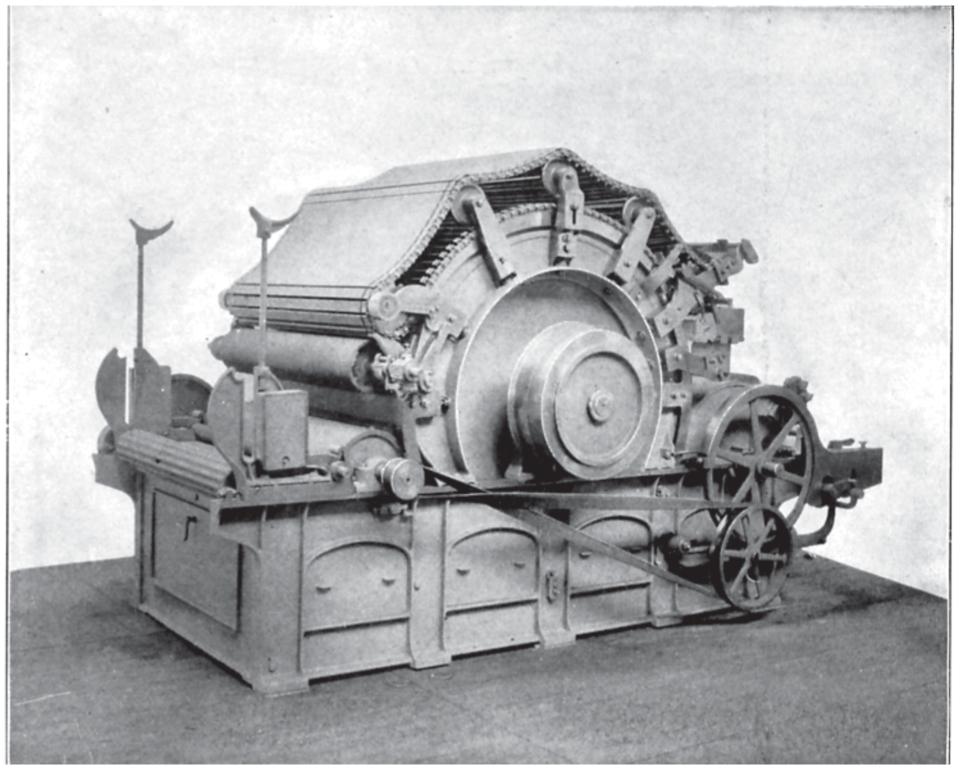


REVOLVING FLAT CARD WITH DOFFER SLOW MOTION
Howard & Bullough Am. Machine Co. (Ltd.)

called the five-point adjustment and is shown in Fig. 69. This differs slightly in design among machinery builders but the principle remains the same. The bend is supported at five equidistant points, the sprocket stand, A, quarter block stand, B, top block stand, C, grinder stand, D, and back block stand, E. At the points, A and E, a stud, H, is screwed into the bend, the outer end of which passes through a slot in the stands, G. In the lower end of the stands is an adjusting screw, L, which passes through the web of the arch upon each side of which are nuts. At the points, B and E, the bend is supported by another adjusting screw, M, which also passes through the web of the arch, the upper end bearing against the under side of the bend. At the center point, C, the bend is supported by an adjusting screw, N, which passes through the web of the arch, as at other points, and the upper end of the screw is screwed into the under side of the bend.

When it is necessary to change the setting of the flats, the screws and nuts on each side of the card, by which the bend is secured to the stands, are loosened. The screw, M, at B and D, should be dropped clear to the bend. The adjusting screws at each of the five points are operated upon in turn, the center point, C, first, then A and E, and last the points, B and D. By so doing, the radius of the bend is made smaller and the flats are drawn radially towards the center of the cylinder. It will be seen that at the center point, C, the adjusting screw enters the bend so that in lowering it this point must fall radially. But at the points, B and D, the adjusting screws simply support the bend, while at the ends, A and E, the studs, H, pass through slots in the stands, G, permitting a slight movement of the bend endwise. The reason for this is very simple. As the radius of the bend is made smaller, it occupies a greater proportion of the circle, and as the center point, C, falls in a radial line, the points A and E, and B and D, must partake of a combined movement, radial and circumferential. The slots in the stands at A and E permit this, while at B and D, the screw, by simply bearing against the under side of the bend, offers no resistance to this movement.

Another style, shown in Figs. 70 and 71, is called the scroll adjustment. The bend, D, is supported at three points by arms, A, B and C, instead of five, as in the first one shown, the bend



REVOLVING FLAT CARD, EXTRA HEAVY FRAME — FEEDER SIDE
Mason Machine Works.

being made proportionately heavier and stiffer. The arms, A and C, are connected to the bend by a stud, F, which passes through a slot in the bend. The movement, endwise, is obtained by having the slot in the bend instead of the arm. The center arm, B, is not fastened to the bend, but acts as a support for it. A pin, E,

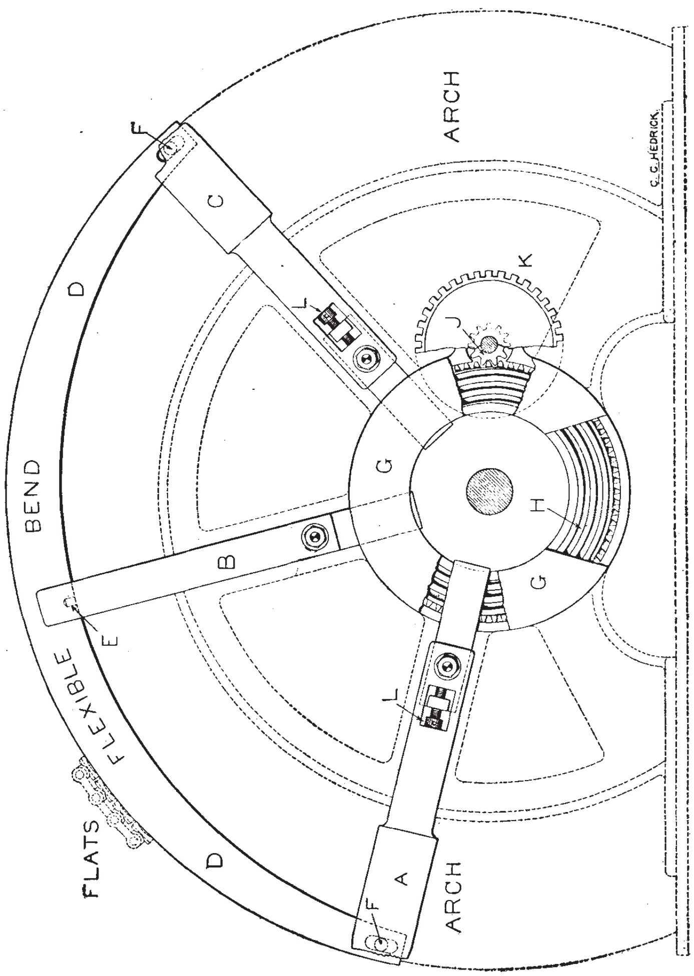


Fig. 70. Flexible Bend, scroll adjustment.

in the arm, prevents any circumferential movement of the bend. The arms are all made in two pieces, partly for convenience in manufacturing and in order to set them alike when the card is first erected. Adjusting screws, L, are provided for the two end ones, which, after being set properly, are secured permanently by dowel pins. The lower end of the arms is provided with teeth, or threads, which work in the threads of a geared scroll, H, the pitch of which is one-half inch. The scroll turns in a recess in the arch which is concentric with the cylinder. Around the periphery of this scroll is cut a gear of 110 teeth, which is in gear with a pinion, J, of 11 teeth, which is fastened to one end of a stud, P; an index wheel, K, having 50 teeth, or notches, is fastened to the other end.

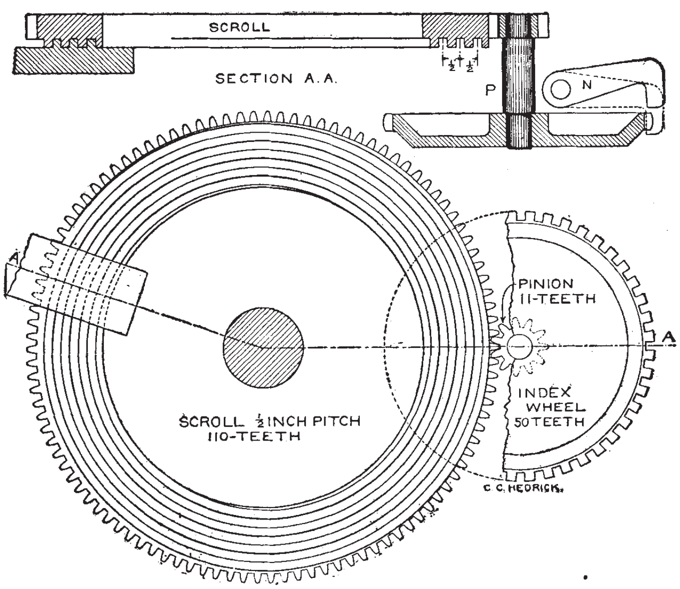


Fig. 71. Section and elevation of scroll.

It will be seen that, as the pitch of the scroll is one-half inch, two revolutions will be necessary to give the arms and bend one inch movement, radially, and, as the scroll has 110 teeth, to give it two revolutions, would require twenty turns of the 11 toothed pinion, which would be equal to 1,000 notches. Thus, if 1,000 notches are required to change the radius of the bend one inch, a movement of one notch will change the radius $\frac{1}{1000}$ of an inch. After the card has been adjusted, a latch, N, can be pushed between the notches of the index wheel and locked, preventing the setting from being changed.

Flat Chain. After the card has been run some time, the chain stretches so that it requires taking up. This is done, ultimately, by removing a link in the chain, but not until it has stretched enough for that; in the meantime, it is customary to put in a quarter block of larger diameter, which is replaced by the original when the link is removed.

A great deal of trouble comes from having the flat chain too tight. All that is necessary is to keep the flats against the back block. This point should not be overlooked. If the chain is slack and the flats hang off as they pass around the back block, they are liable to catch and give trouble, and on the other hand, if very tight, the links and bushings will soon wear out and the

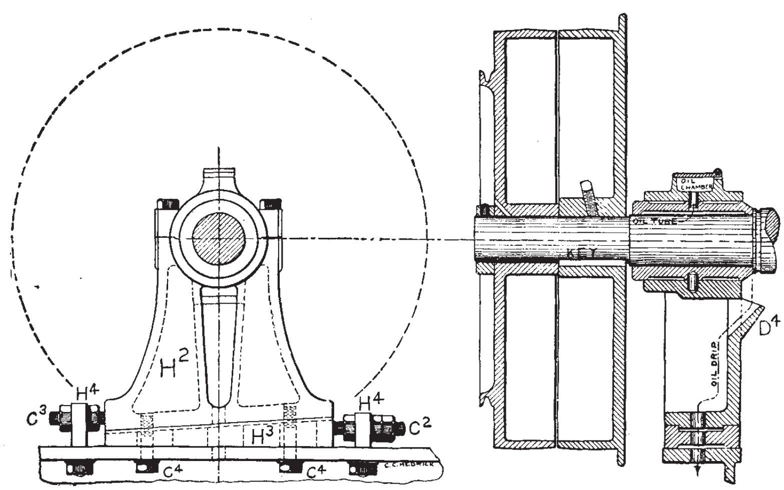


Fig. 72. Adjustable Cylinder Bearing.

flats will give trouble in grinding by not resting freely on the grinding former.

Adjustable Cylinder Bearing. While a great deal depends upon careful setting of the flats, many evils arise, such as the wearing of the bearings, due to the weight of the cylinder, the pull of the belt and various minor causes, all tending to alter the position of the cylinder and thus destroying its concentricity with the bend. When such wear takes place, some means must be provided to restore the cylinder to its concentric position.

In Fig. 72 a section and a side elevation of an adjustable cylinder bearing are shown. The cylinder boxes, or bearings, are supported by pedestals, H^2. The lower part of each pedestal rests upon a slightly tapered plate, H^3. Upon either side of the pedestals are lugs, H^4, which are securely fastened to the card frame. From the plate, H^3, projects a screw, C^2, which passes through one of the lugs, while from the pedestal, H^2, projects a screw, C^3, which passes through the other lug.

When a vertical adjustment of the cylinder is required, the tapered plate is given a horizontal movement by turning the nuts on the screw, C^2, but when a lateral adjustment is desired, the pedestal and plate are moved together, both parts being fastened to the card frame by cap screws, C^4.

Sometimes, oil from the cylinder bearings runs down on the cylinder head, particularly if the card has been standing idle for several days. When this occurs, the oil may get upon the clothing of the cylinder, softening the cement with which the several layers in the foundation are stuck together and causing them to separate and puff up in places and destroy the holding power of the wire teeth. To prevent this, the pedestal is made with a lip, D^4, projecting from the back side, directly under the bearing. Any oil that drops will be caught by this lip and carried to the outer side of the card frame, as indicated by the dotted lines.

Leader Clothing. The saw-tooth clothing, with which the licker-in is covered, is made from thin, flat, steel wire, about one-quarter of an inch in width and one-sixty-fourth of an inch thick, with a shoulder on one edge. The teeth are formed by cutting out a portion of the thin edge of the wire, making it resemble the edge of a saw. The wire is inserted in grooves which are cut spirally in the shell of the licker-in, and there are, usually, eight per inch, giving eight rows of teeth for each inch in the length of the face and about 112 teeth for each row in its circumference.

Two views of saw-tooth clothing are given in Fig. 73, showing a portion of the licker-in shell with the teeth inserted and a side elevation of the teeth with the shell in section.

Fig. 74 is an enlarged front view of the teeth, showing the depth to which the wire is let in to the shell, the shoulder of the wire coming just below the surface. After the wire is inserted, the edge of the groove next to the shoulder is upset slightly, by passing a hardened steel disc over its surface, which prevents the wire from pulling out. A licker-in, covered with this style of clothing, requires no cleaning, stripping nor grinding and is superior in every respect to the licker-in covered with leather clothing, which is used on the old style stationary flat cards.

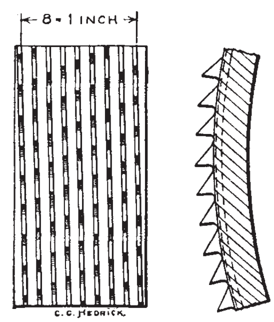


Fig. 73. Saw tooth clothing.

Clothing for Cylinders, Doffer and Flats. The clothing for the cylinder, doffer and flats consists of a foundation made up of from three to five thicknesses of cotton, wool, linen or other materials cemented firmly together, in which is set the wires, forming the teeth, as shown in Fig. 75 —a side elevation. The wire extends from the back side of the foundation at an angle, until a point nearly half way of its length, called the knee, is reached and then bends forward, the upper end returning to a point about over the lower end, as shown by the vertical line, A—B.

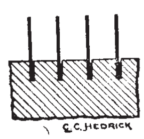
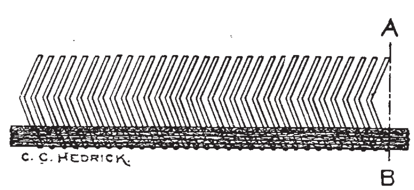


Fig. 74. Section of leader shell, showing saw tooth clothing.

Fig. 76, which is a front view, shows that the teeth, which are made from a coil of wire, are bent into the form of a staple. The two upward projecting prongs are called points and the horizontal part connecting them is called the crown.

Defects in Clothing. A matter of great importance, one which is often overlooked, is the amount of angle or pitch given to the tooth and the position of the point in relation to the crown.



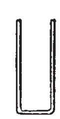


Fig. 75. Fig. 76.
Clothing for cylinder, doffer and flates.

In one sense, the teeth are a series of hooks by which the fibers are caught and carried forward. If the forward inclination of the point is not sufficient, the teeth lose some of their holding power, while if the inclination is too great, the holding power is such as to cause serious defects in carding. To explain this more fully, Figs. 77, 78, 79 and 80, which show several enlarged views of card teeth, will be considered.

In Fig. 77, the crown of the tooth is marked A, the knee is marked B and the point, C. The angle of that part of the tooth between A and B is about fifteen degrees from a vertical line, and this is the average of the wire for cotton card clothing. If the angle is increased, as shown in Fig. 78, it is evident that the tooth must have a much greater holding power, which will cause the short fibers, neps and dirt to be forced to a considerable distance

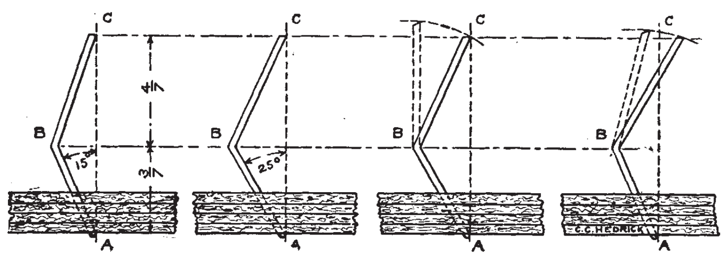


Fig. 77. Fig. 78. Fig. 79. Fig. 80.

Enlarged views of card teeth.

beneath the point. Otherwise, they would be caught by the flats or thrown off, to fall through the screws. In this way, the spaces between the teeth fill rapidly, which necessitates stripping the card much oftener than would be required with the wire set properly and it also makes the removal of the strippings much more difficult.

Another point in connection with the angle of the wire being too great, is illustrated in Fig. 79. If the point of the tooth is pushed back by a tuft of cotton, there is a liability of its straightening at the knee, which, acting as a fulcrum, causes the point to rise into the position shown by dotted lines.

Quite a common defect in card clothing is shown in Fig. 80. If the point of a tooth stands too far forward of an imaginary vertical line, drawn through the crown, and the tooth is forced back while at work, it will rise above its natural plane to such an extent as to cause the point to become faced by contact with the other wire surfaces of the card. The height of the tooth from crown to point is usually three-eighths of an inch and the knee is about three-sevenths of the distance from the crown. Many times, the causes of bad carding can be attributed to some of these faults rather than to the construction of the machine.

Foundation for Clothing. The foundation for the teeth should be of material that has the least possible amount of stretch, in order to hold the wire firmly enough to carry around the fibers which become attached and yet it should be flexible enough so that the wires shall spring back to their original position when they have been deflected by grinding, or by the strain put upon them when the card is in operation. If the foundation is drawn on too tightly, the wires are apt to break at the point where they leave the foundation.

The material, composing the several layers of the foundation, is varied somewhat to suit the different requirements. For the cylinder and doffers, it is generally four-ply: first a thickness of twilled cotton cloth for the crown side, then a layer of coarse linen threads, added to give strength and running lengthwise of the clothing, next a thickness of heavy woolen cloth and last another facing of twilled cotton cloth. Sometimes, an additional facing of rubber is used, which answers a double purpose, giving an elastic support to the wire where it leaves the foundation and protecting the foundation from dampness.

For the flats, a three-ply foundation is almost always used, called double covered or cotton wool and cotton. The crown and face sides are of the twilled cotton and between them is a layer of closely woven heavy woolen cloth. The rubber facing is seldom added, as the flats in passing back over the cylinder are often exposed to the sun's rays, which cause the rubber to harden and disintegrate.

A comparison of tests, made of several kinds of foundations, show that a strip two inches wide of the four-ply above referred to, when put under a tension of 300 pounds, became elongated 2 per cent. Four-ply foundation, cotton, wool and cotton, with rubber face, became elongated $6\frac{1}{2}$ per cent and leather foundation elongated $14\frac{1}{2}$ per cent.

Applying Clothing. The clothing for the cylinder and doffer is made in continuous strips and is called fillet. That used for the cylinder is usually 2 inches wide and that for the doffer is $1\frac{1}{2}$ inches wide. It is drawn on to the surface by a device called a clothing machine, which registers the tension put upon it, the cylinder being clothed under a tension of about 350 pounds and the doffer under about 275 pounds.

Fig. 81 shows a front and a rear elevation of a doffer. On account of the fillet being wound, spirally, around it, the teeth must strike the fibers at a slight angle. It is desirous that this angle be as small as possible, that the danger of the teeth breaking or being turned from their correct position will be reduced to

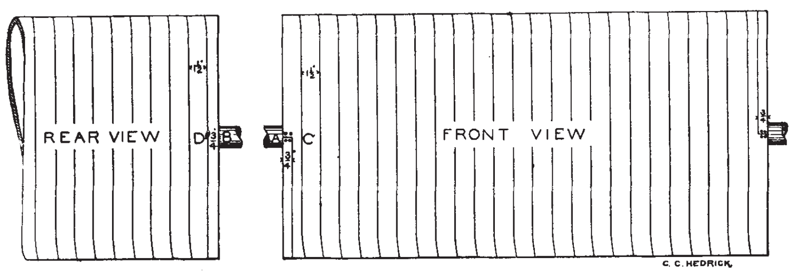


Fig. 81. Front and Rear Views of Doffer.

a minimum and, as the doffer is about one-half the diameter of the cylinder, the clothing is made narrower so that the angle of the spiral shall be nearly the same as that of the cylinder.

In putting on the fillet, it is usually cut so as to form what is called an inside taper, which leaves a straight edge extending the whole distance around on the outside of each end of the doffer. The clothing, which starts at A, is three-quarters of an inch wide and continues this width until half around the doffer, where, at B, it commences to widen, and when it has passed around to the point, C, beside the starting point, A, it is the full width, $1\frac{1}{2}$ inches. At C, the fillet is again cut down to half its width, the portion cut out tapering until it reaches a point half around the doffer at D. From here, it extends in full width to the opposite end of the doffer where it is tapered to finish in the same manner as at the starting point.

In Fig. 82 is shown a strip of fillet with the portion cut away for an inside taper. The letters of reference used are the same as in the preceding illustration.

The fillet for the cylinder is put on with an inside taper, also, and in the same manner, but, as the cylinder is more than twice the diameter of the doffer, a strip of considerable length has to be cut away before the full width is reached.

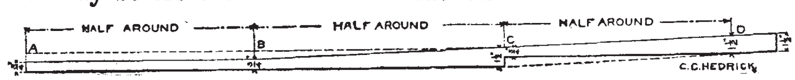


Fig. 82. Strip of Doffer Fillet.

Number of Wire and Points per Square Foot in Clothing. The wire teeth are set into the foundation of card clothing in three different ways, known as open set, seldom used at the present time, twill set, which is used for the flats and rib set, which is used for the cylinders and doffers. The effect on the face of the clothing is about the same, as far as the arrangement of the points is concerned, in all styles of setting.

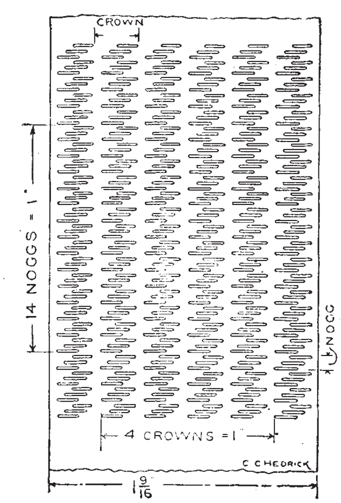


Fig. 83. Rib Set Fillet.

A plan of the back or crown side of a strip of fillet with the rib setting is given in Fig. 83. The crowns, extending across the width of the fillet, are four to the inch, consequently, across a strip of one and one-half inch width, there are six crowns, and, as the foundation is about one-sixteenth of an inch wider than the wire surface, a one and one-half inch fillet covers a surface about one and nine-sixteenths inches wide.

The noggs, which run lengthwise of the fillet, are from ten to twenty-eight to the inch. A nogg consists of a group of three crowns, and, of course, to each crown are two points. The points per square foot can be found in the following way:

Rule.— To find the number of points per square foot, multiply together the number of noggs per inch, the crowns per inch, the crowns per nogg, points per crown and the number of inches in a square foot. Example: In Fig. 83, there are fourteen noggs to the inch; the points per square foot will be 14 × 4 × 3 × 2 × 144, or 48,384.

Each nogg added per inch increases the number of points per square foot 3,456. Thus, by multiplying the number of noggs per inch by this number, the points per square foot can be found.

Example: 3,456 × 14 = 48,384.

The twill set is shown in Fig. 84. The crowns extend lengthwise of the strip and are four to the inch. The noggs are counted across and are from five to fourteen per inch. In each nogg there are six crowns instead of three, as in the rib set, but the number of points per square foot can be calculated in the same way. To illustrate this, it will be seen that in Fig. 84, there are only seven noggs per inch, but as there are just twice as many crowns to each nogg, the points per square foot will be the same as in Fig. 83, which has fourteen noggs per inch.

Example: 7 × 4 × 6 × 2 × 144 = 48,384.

For the twill setting, each additional nogg per inch increases the number of points per square foot 6,912.

When carding low grades of cotton, the wires of the clothing are coarser and the number of points per square foot less, and when carding long staple cotton, the wire is finer and the number of points per square foot on all the clothed surface except the leader is generally increased.

Some machinery builders recommend that the cylinder and flats be covered with the same clothing, while others think that the doffer and flats should be the same. No rule can be given by which the number of points per square foot and the size of the wire can be determined that will fit all cases. For coarse work, No. 29 wire with 62,208 points per square foot is usually used for the cylinder and flats and No. 30 wire with 65,664 points per square foot for the doffer. For medium work, the cylinder and flats are usually covered with No. 30 wire, 65,664 points per square foot and the doffer with No. 31 wire, 72,576 points per square foot. For fine work, the cylinder and flats should have No. 31 wire, 72,576 points per square foot and the doffer No. 32 wire with 79,488 points per square foot.

The following tables give the points per square foot for both rib and twill set clothing:

RIB SET CLOTHING.

Noggs per inch.	Points per square foot.
10	34,560
11	38,016
12	41,472
13	44,928
14	48,384
15	51,840
16	55,296
17	58,752
18	62,208
19	65,664
20	69,120
21	72,576
22	76,032
23	79,488
24	82,944
25	86,400
26	89,856
27	93,312
28	96,768

TWILL SET CLOTHING.

Noggs per inch.	Points per square foot.
5	34,560
5½	38,016
6	41,472
6½	44,928
7	48,384
7½	51,840
8	55,296
8½	58,752
9	62,208
9½	65,664
10	69,120
10½	72,576
11	76,032
11½	79,488
12	82,944
12½	86,400
13	89,856
13½	93,312
14	96,768

Kinds of Wire for Card Clothing. In considering the kind of wire to be used for the teeth, a question arises concerning which there are many opinions. With the leather foundation used on the old style stationary flat card, it is the universal practice to use round iron wire, but on the revolving flat card, this kind becomes dulled quickly on account of the extra amount of work done on this machine. We now use mild steel wire which has been subjected to a process of hardening and tempering. It is claimed by many that the round iron wire tooth is preferable when quality of production, and not quantity, is desired, as it deals more gently with the fibers, consequently they can be given a more thorough carding without excessive injury.

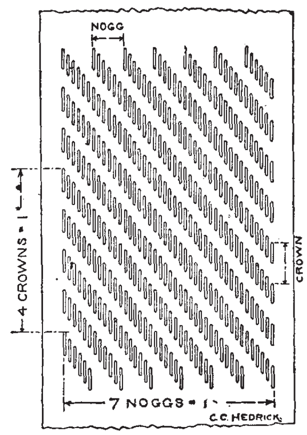


Fig. 84. Twill Set Fillet.

The various kinds of wire used are shown on a very much enlarged scale in plan and elevation in Fig. 85. The one marked A is the ordinary round wire. B represents the so-called needle-pointed, or side-ground wire, and is made from wire of round section by grinding two sides for a short distance below the point. C is the plough-ground wire, also made from a round section by grinding on opposite sides about fifty per cent of its original area as far as the knee. The grinding is done by drawing the fillet over a flat surface, crown side down, the teeth passing between a series of emery discs. The wire marked D is double convex and is oval in section. E is made triangular in section by rolling and is used for napping machines.

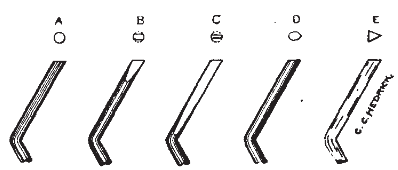


Fig. 85. Card Tooth Wire.

With regard to the respective merits of needle-pointed and plough-ground wire, the latter seems to find the most favor, and

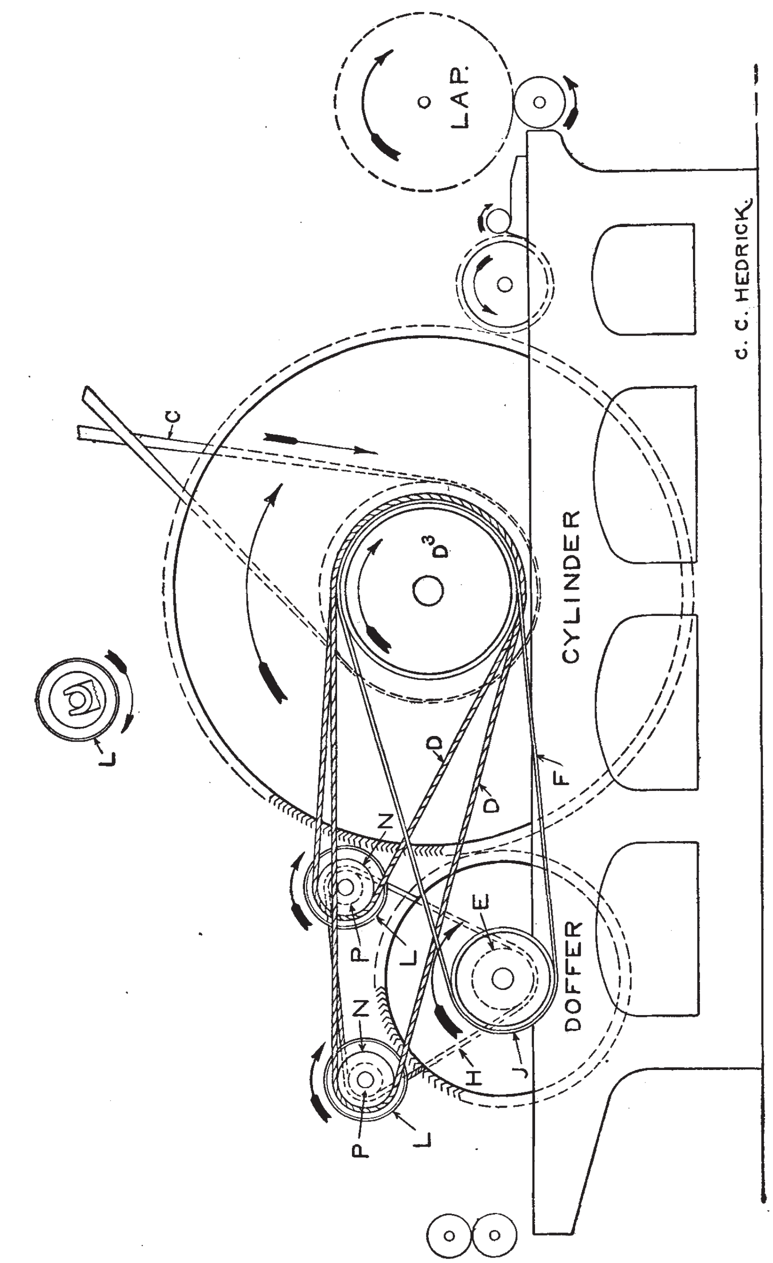


Fig. 86. **Elevation of Card Showing Belting used in Grinding.**

at the present time, is used almost wholly for the revolving flat card. It is a matter hard to decide, how much better results are obtained with it, but it certainly affords a trifle more space between the wires for the reception of dirt, nep and short fibers.

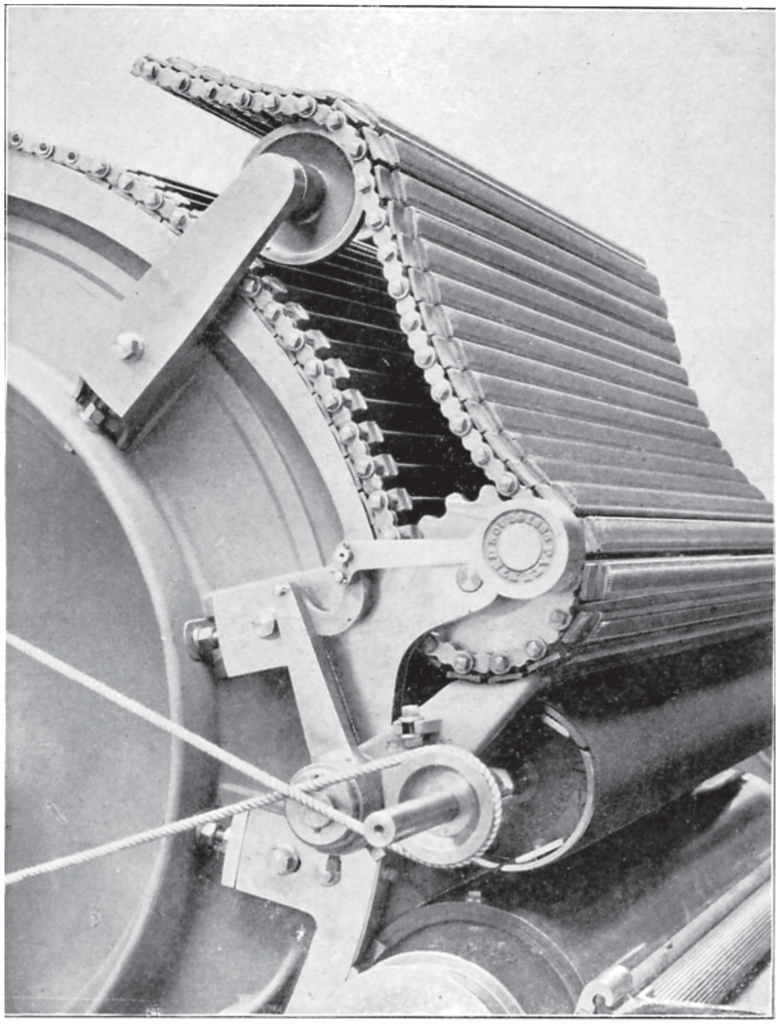
When the card is first put into operation, it is difficult to remove the strippings from plough-ground wire, but after the sides of the teeth become smooth, by constant stripping, they can be removed much easier and better than with any other wire.

Grinding. It is necessary to grind the cylinder and doffer after they are clothed to make the card work successfully. The first grinding requires generally about ten days, depending upon the condition of the clothing. If the wires are too hard, and if some are higher than others, it often takes much longer.

After the first grinding, it is necessary, in the ordinary running of the card, to grind the cylinder and doffer about once in four weeks. When carding long staple cotton, the time is reduced to three or even two weeks. The period depends oftentimes on the ability of the grinder to perform his allotted duty rather than the actual need of the clothing. It is considered that frequent and light grinding is better than to wait until the wires have become so dull that a severe grinding is necessary to restore the points.

Fig. 86 shows a side elevation of a card with the grinder rolls in position. The lap is withdrawn and the cylinder and doffer are stripped and brushed clean. The card is run until all the flats have passed the stripping brush and comb and have been made clean. The main belt, C, is then changed and the cylinder is run backwards or in the opposite direction from that which is required in carding. The side shaft is slid out of gear and the barrow bar is dropped, the doffer being driven by a belt, F, and pulley, J, from the pulley, D^3, which drives the leader when carding. On the end of the grinder rolls are score pulleys, N, which are driven from two scores in the pulley, D^3, by the bands, D and D. A score pulley, E, is placed on the opposite end of the doffer for driving the traverse motion of the grinder rolls by means of the band, H, and pulley, P.

Another method of driving the grinder rolls, which is more simple and is used considerably, is illustrated in Fig. 87. This also requires the belt, F, band, H, and pulleys, J and E, but



APPARATUS FOR GRINDING FLATS FROM THEIR WORKING SURFACES
Mason Machine Works.

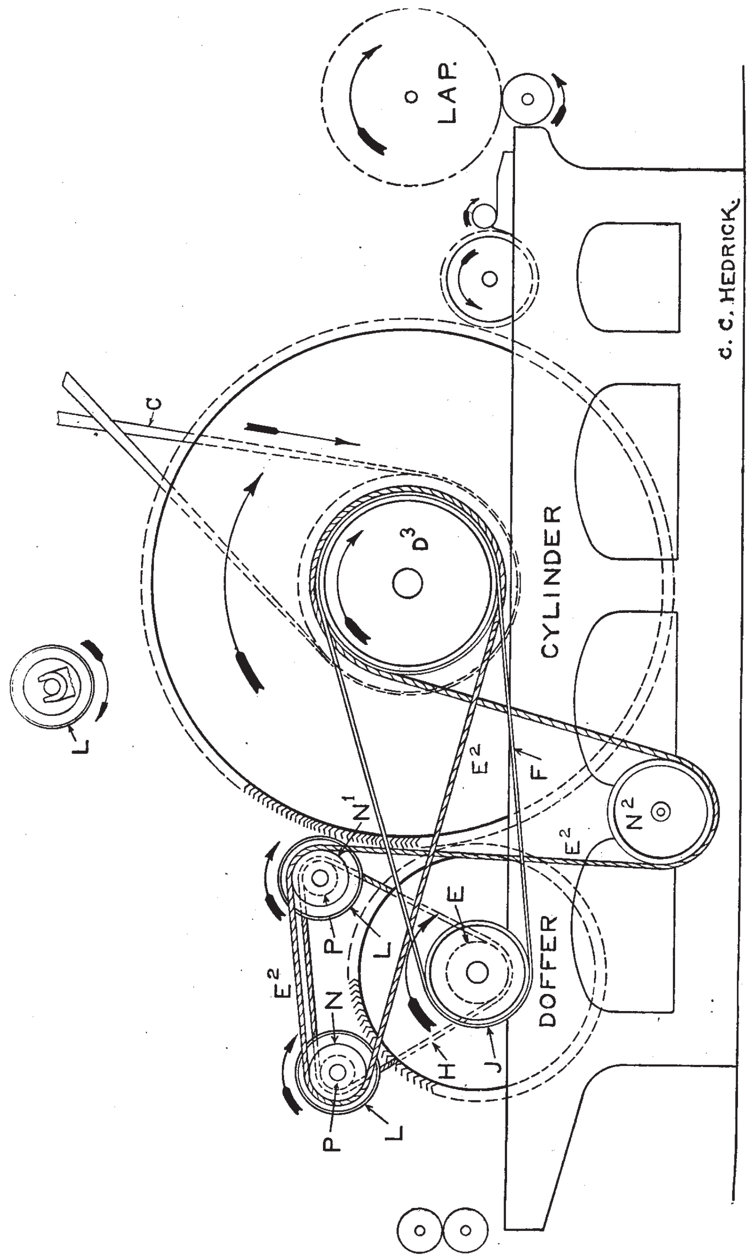


Fig. 87. Elevation of Card Showing Belting used in Grinding.

instead of using the two bands, D and D, for driving the grinders, a single band, E^2, is used that runs from the groove in the pulley, D^3, around the pulley, N, on the doffer grinder, then around the pulley, N^1, on the cylinder grinder, and then down around the intermediate comb pulley, N^2, to the pulley, D^3.

On some makes of cards, this cannot be done, as there is no intermediate pulley, the comb being driven directly from the groove in the pulley, D^3.

Long-roll Grinder. For the first grinding, the long-roll grinder, shown in Fig. 88, is used. After this, in the periodical grinding, unless the wires become jammed or badly worn, it is seldom used.

It consists of an iron roll, seven inches in diameter, which extends across the whole width of the surface to the ground. The roll, which is wound with emery fillet, is supported at either end by bearings, B, which are mounted in the grinder brackets, C.

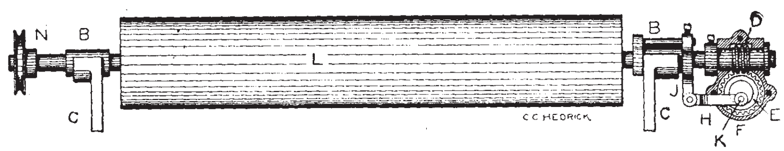


Fig. 88. Long Roll Grinder.

On one end is a score pulley, N, by which the roll is driven, and attached to the other end is a worm, D, which drives a worm gear, E. This gear is enclosed in a case, F, which is shown in section, and which forms a bearing for it to turn in. In the hub of the gear is a pin, K, which is set eccentrically, so that as the gear revolves, the pin describes a circle of about three-eighths of an inch radius. Attached to the pin is one end of a yoke, H, the other end of which is fastened to a downward projecting arm, J, of the bearing. The revolutions of the grinder roll cause the worm gear to turn, and, through the pin in its hub and the connecting yoke, the roll is given a movement, endwise, of about three-fourths of an inch. This is done to prevent the high wires of the clothing from receiving grinding from the same portion of the face of the roll at all times, this preventing the emery fillet from becoming worn and hollow in places.

Traverse Grinders. After the long grinder has been used a sufficient time, the short or traverse grinder, shown in elevation and section in Fig. 89, is used. The grinder roll, L, which is the same diameter as the long grinder, is about four inches wide on the face. It is mounted upon a shell, M, which has a slot, D, extending throughout its length. Within the shell is a reciprocating screw, A, to which the grinder roll is connected by a dog, E, which slides in its threads. A score pulley, N, by which the shell is driven, is fastened to one end while the screw is driven from the other end of the shell by a train of gears, H, J, S and T, which have 22, 16, 15 and 23 teeth, respectively. H is fastened to the shell and drives J which is compounded with S and runs loose on a stud, B. T is fastened to the screw and is driven by

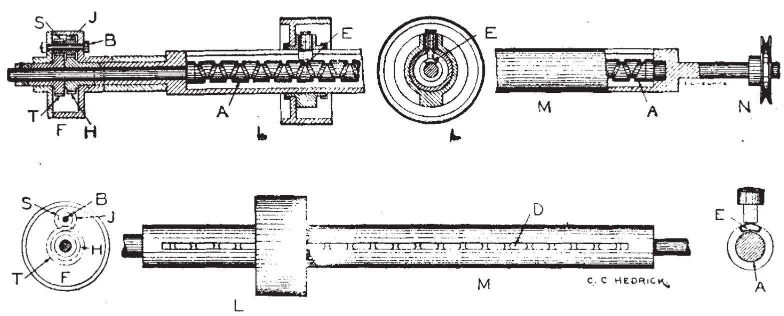


Fig. 89. Traverse Grinder.

S. The gears are enclosed in a case, F, which, to prevent its turning, is fastened to the grinder bracket, C, by a lug. By this means, the shell, which carries the grinder roll, is run at a greater speed than the screw, causing the grinder roll to move longitudinally along the shell, and as the screw is cut with right and left hand threads, a reciprocal movement is given to the grinder, which causes it to move back and forth from one side to the other of the surface being ground.

For each hundred revolutions of the shell, the screw turns 89.67 revolutions in the same direction (10.33 revolutions less than the shell) and as the screw is one and one-half inches pitch, 10.33 revolutions will move the grinder roll $15\frac{1}{2}$ inches along the shell.

Another style of traverse grinder is shown in Fig. 90, which consists of a roll, L, a screw, A, a dog, E, and a shell, M, with a slot, D, all of which are the same as on the grinder shown previously. On one end of the grinder is a pulley, N, which drives the shell; on the other end is a similar pulley, P, of slightly different diameter. The shell and screw are thus run at different speeds and the roll is traversed to and fro on the shell. This style of grinder requires the pulley, E, and band, H, as shown in Figs. 86 and 87 to drive the screw for the traverse.

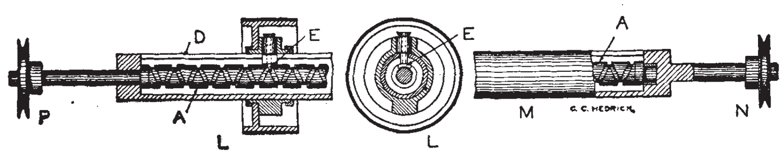


Fig. 90. Traverse Grinder.

Speed of Grinder Rolls. The surface speed of the cylinder is about 2,200 feet per minute and that of the doffer is 1,921 feet per minute. The surface speed of the grinders is about 900 feet per minute in the opposite direction from the cylinder and doffer. This gives a total surface speed for the cylinder grinder of 2,200 feet plus 900 feet, which makes 3,100 feet per minute, and for the doffer, it is 1,921 feet plus 900 feet, which makes 2,821 feet per minute. This is considered as high speed as hardened and tempered steel wire will stand. The doffer is run at a slightly slower surface speed as it does not require as much grinding as the cylinder.

When grinding the flats, there is no loss in production from stopping as the work is done while the card is in operation.

Flat Grinders. The flat-grinding device, which is a part of the card, is attached in different positions. Upon some cards, the grinding is done as the flats return over the top of the cylinder between the front sprocket and center block; other makers grind just back of the center block, while upon some cards, the flats are ground directly above the licker-in as they pass around the back block.

With the grinding device attached in either of the first two positions mentioned, the flats are ground in an inverted position.

By some, this is considered an evil, the claim being made that the flats deflect slightly in the center by their own weight and cause the grinding roll to bear harder on the ends and when they pass around on to the cylinder, the deflection is in the opposite direction, which produces a convex surface, making the wires in the center a trifle closer to the cylinder than at the ends. This makes an error in setting.

When the flats are ground as they pass around the back block, their working face is downward, in the same position as when they rest upon the bend. By grinding in this position, the

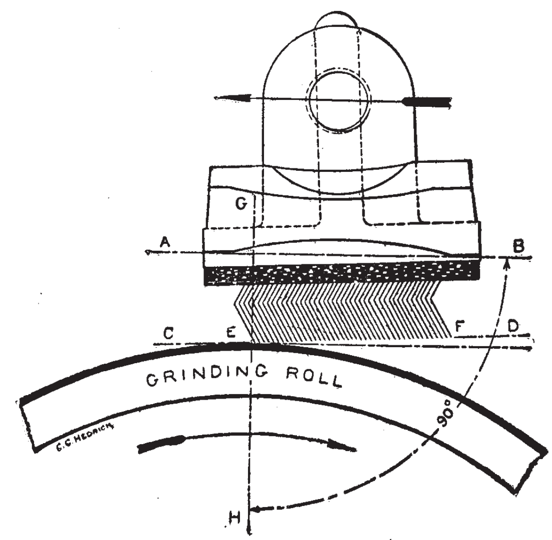


Fig. 91. Elevation of Grinder Roll and Flat.

disadvantage arising from deflection is eliminated. Opinions are divided in regard to which is in the best position. The existing evil, if it can be called such, caused by deflection, is often magnified and no perceptible difference in the working of the card can be seen.

To have the flats alike and perfectly accurate, they should be ground from the same surface which bears upon the bend, but owing to their being closer to the cylinder at the heel than at the toe, this surface is not parallel with the face of the flat. This presents a problem which has been given considerable attention and which will be understood better by referring to Fig. 91.

The surface of the flat which bears upon the bend is indicated by the horizontal line, A — B, and the face by the line, C — D, the heel of the flat by E and the toe by F. The center of the grinding roll is indicated by the vertical line, G — H, which is at right angle to the line, A — B. As the flat which passes in the direction shown by the arrow, comes over the center of the grinding roll, the wires on the heel will receive grinding, but as it ad-

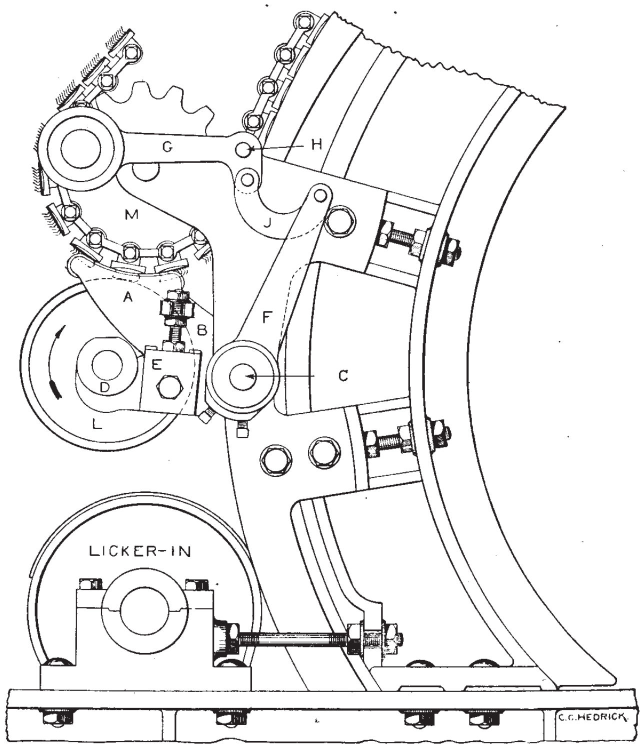


Fig. 92. Elevation Showing Position of Flat Grinders When in Use.

vances until the toe comes to this point, it is evident that it will receive no grinding, owing to the inclination of the wire face. The flats must therefore be tipped, as they pass the grinding roll, so that they shall be ground parallelly to their working face. This necessitates a special surface, called a "grinding former," for the flats to bear upon.

A device for grinding the flats with the face down is shown in Fig. 92. The grinding roll, L, is mounted in self-adjusting bearings, D, which are supported by brackets, E, and which are adjustable from the grinding former, A, by means of the screw, B. The grinding former and bracket, which are connected to the lever, F, are pivoted upon a stud, C. A weight lever, G, pivoted upon

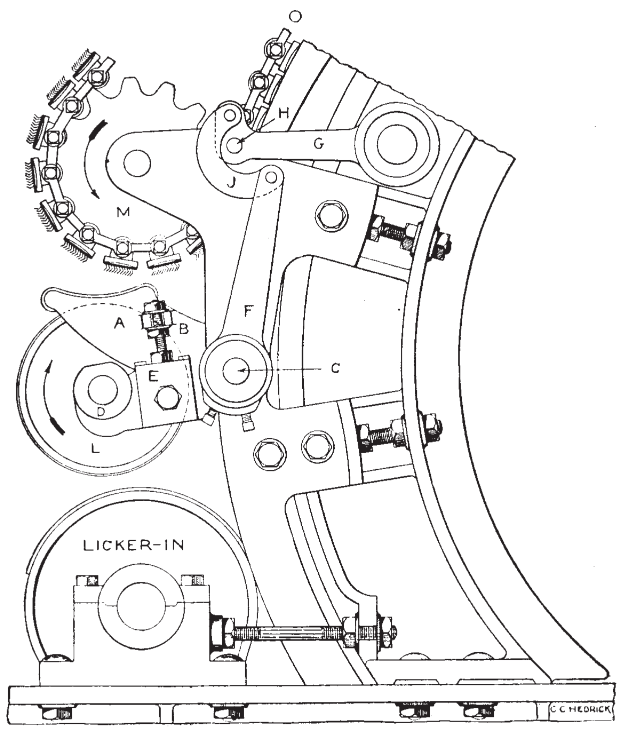


Fig. 93. Elevation Showing Position of Flat Grinder When Not in Use.

a similar stud, H, is connected to the lever, F, by a curved arm, J. The weight lever is thrown forward and holds the former firmly in position against the bearing surface of the flats as they pass around the sprocket wheel, M. The surface of the former is so shaped as to tip the flats enough to cause grinding to take place across the whole width of the face.

Fig. 93 shows the position of the grinding apparatus when the card is not being ground; the weight lever is thrown back, dropping the grinding former out of contact with the flats.

An attachment for grinding the flats, in an inverted position over the cylinder, is shown in Figs. 94 and 95. The grinding roll, L, is mounted in bearings, A, which are adjusted from the grinding bracket, C, by the screws, B. The grinding former, D, is fastened securely to the grinding bracket with the bearing surface down-

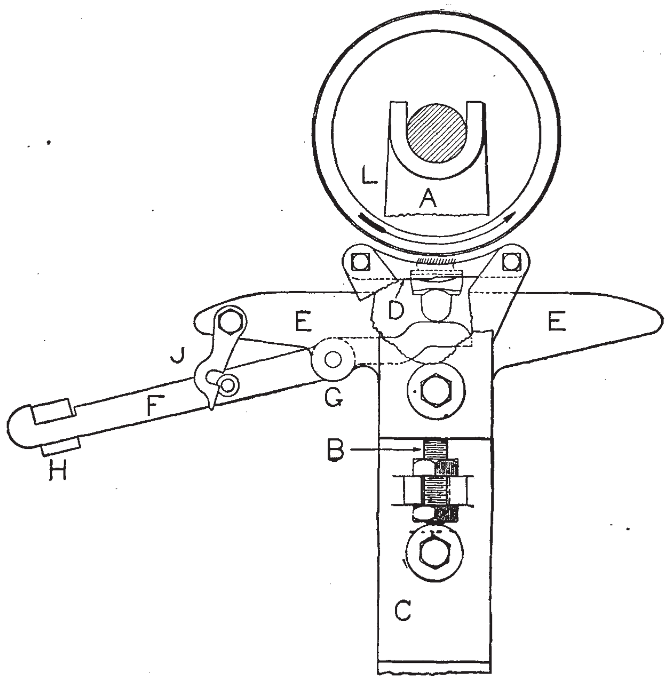


Fig. 94. Elevation Showing Flat Grinder.

ward. The flats are kept in contact with the former by a weight lever, F, which is pivoted upon a stud, G, and which has a weight, H, upon its outer end. As the flats pass along to the grinding former, they are supported upon the projecting arms, E, of the bracket, but as they come directly under the grinding roll, they are raised slightly by the rounding end of the weight lever, and, by means of the weight, are held firmly against the former.

Grinding Former. Figs. 96, 97 and 98 show the grinding former with the flats in three positions. It will be seen that the former is made with an offset, directly under the center of the grind-

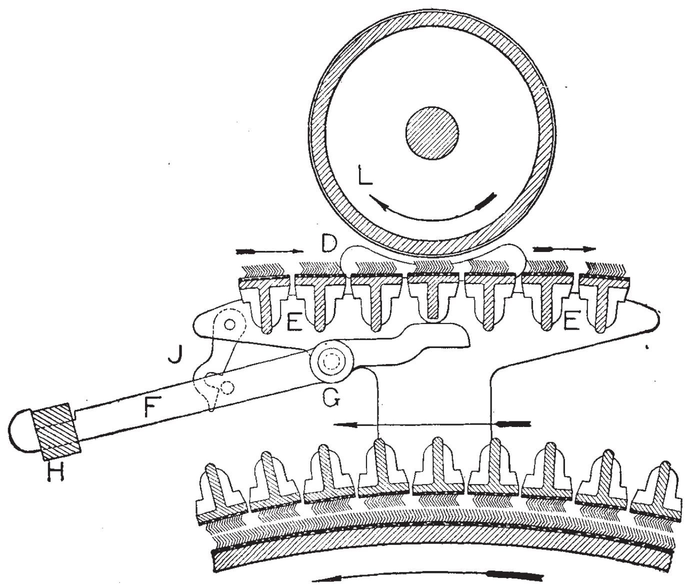


Fig. 95. Section Showing Flat Grinder.

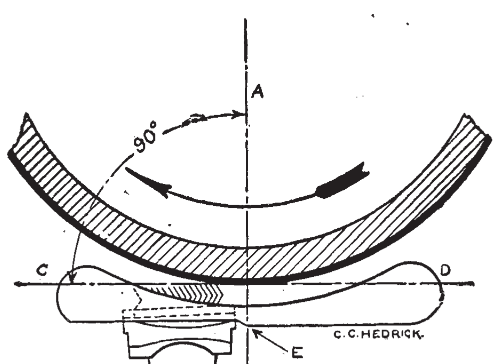


Fig 96. Position of Flat before Grinding.

ing roll, equal to the difference in the height of the bearing surface between the heel and toe of the flat.

In Fig. 96, the flat is shown advancing towards the grinding roll with the wire face at an angle. Fig. 97 shows the flat in contact with the grinding roll. The offset in the former tips the

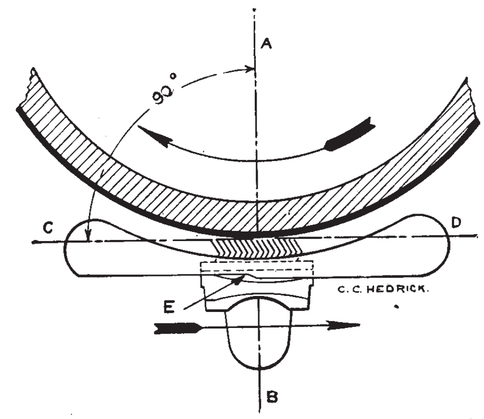


Fig. 97. Position of Flat when Grinding.

flat just enough to cause the wire face to pass horizontally beneath the grinding former. Fig. 98 shows the flat as having

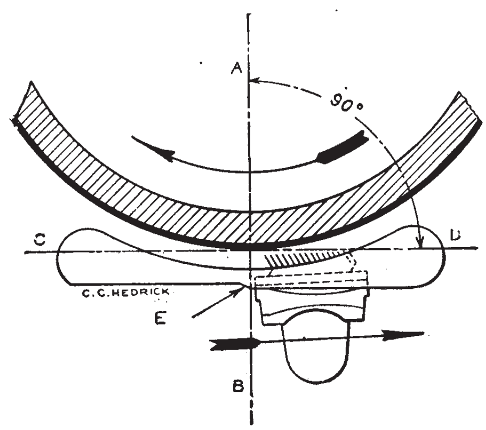


Fig. 98. Position of Flat after Grinding.

passed the grinding roll, its wire face assuming an angular position. When the flats are not being ground, the weight lever is raised and held up by the hook, J. (Figs. 94 and 95.) This drops the short end of the lever out of contact with the flats which pass along clear of the grinding former.

Burnishing. It is necessary, usually, to burnish the teeth of the card clothing, after the card is first ground, to remove the burrs and rough edges which are formed sometimes upon the teeth, particularly when they are overground. Burnishing is also resorted to when the teeth become rusty. Otherwise, the sliver will show streaks of cloudy and uncarded cotton.

Burnishing is done by a revolving wire-toothed brush which is mounted in suitable bearings. Its teeth penetrate from $\frac{1}{32}$ to $\frac{1}{16}$ of an inch below the points of the card teeth and it is usually about seven inches in diameter over the points of the teeth. It is shown in end elevation in Fig. 99. The brush consists of a wooden roll, wound with straight wire fillet, number 32 wire being used, with about $6\frac{1}{2}$ noggs per inch. The wires are about $\frac{7}{8}$ of an inch high, above the crown, and stand radially from the center of the roll.

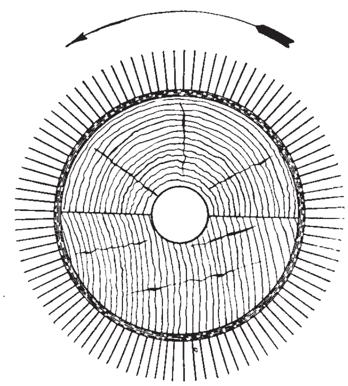


Fig. 99. Elevation of Burnishing Brush.

An elevation of the card with the burnishing brushes in position is shown in Fig. 100. The cylinder and doffer are burnished at the same time. The device for driving the various parts, although very simple, requires some explanation. The brushes, D, D, are supported at each end by stands which are adjusted from the arches of the cylinder and doffer. Upon the ends of the brush shafts are pulleys, E and E. In place of the usual barrow bar pulley is a pulley, H, the face of which has grooves for the bands, B, M and N.

In the face of the loose pulley, A, on the end of the cylinder shaft, is a groove which carries the band, B, for driving the pulley, H, while the burnishing brushes are driven from H by the bands, M and N. The doffer is also driven from the pulley, H, by the gears, T, P^1, V^1 and Q, the last being upon the doffer shaft. On the opposite end of the doffer, shown by dotted lines, is a pulley,

---

WALTER M. GARDNER, F. C. S.

Professor of Chemistry and Dyeing in City of Bradford Technical College.
Author of "Wool Dyeing," etc.

ALBERT AINLEY.

Author of "Woolen and Worsted Loomfixing."

G. F. IVEY.

Author of "Loomfixing and Weaving."

ERNEST WHITWORTH.

Formerly Principal of Designing and Cloth Analysis Department, New Bedford Textile School.
Author of "Practical Cotton Calculations."

DAVID PATERSON, F. R. S. E., F. C. S.

Author of "Color Printing of Carpet Yarn," "Color Mixing," "Color Matching on Textiles," etc.

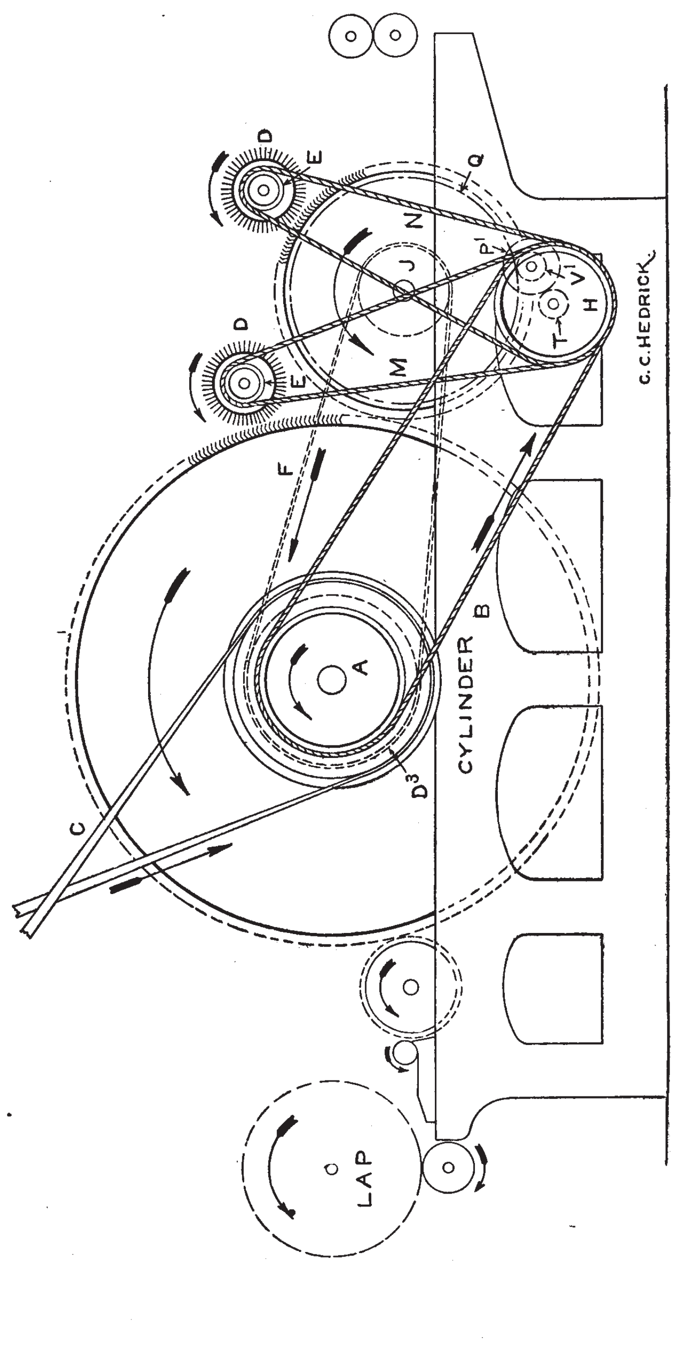


Fig. 100. Elevation of Card Showing Belting used in Burnishing.

J, by which the cylinder is driven through the belt, F, and pulley, D^3. As motion is transmitted to all parts of the machine through the band, B, it must be kept reasonably tight.

The main belt, C, is run on the loose pulley, A, which should be caused to turn backwards, or in the same direction as the cylinder, when grinding and burnishing. This may seem, at a glance, to be unnecessary, as the band, B, can be crossed to give the proper direction to the cylinder and doffer, but should the belt by any cause be moved on to the tight pulley, considerable damage might be done to the teeth of the cylinder, as it would be turning in the opposite direction to the loose pulley, but with the loose pulley turning in the same direction as the cylinder, no accident can happen to the cylinder clothing if the belt should slip on to the tight pulley.

Stripping. Under ordinary conditions, the card requires to be stripped twice each day. For waste and very short and dirty cotton, it should be done four times a day.

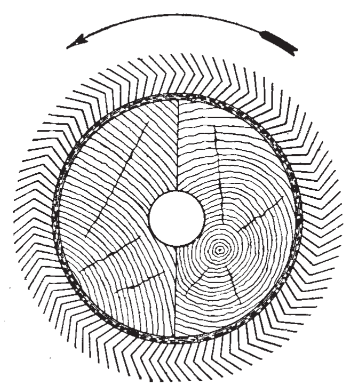


Fig. 101. Elevation of Stripping Brush.

The operation consists in removing the dirt and short fibers which become lodged in the wires of the cylinder and doffer while the card is at work.

The stripping brush, shown in end elevation in Fig. 101, is of about the same size and general appearance as the burnishing brush, except that the wires are bent, similarly to the card clothing teeth, instead of being straight.

Fig. 102 shows the card in elevation with the stripping brush mounted in the stands in position for cleaning the cylinder and doffer. It is set so that its wires penetrate about $\frac{1}{8}$ of an inch into the card teeth and it is driven from a groove in the loose pulley, A, by a band, P, and pulley, S.

The main belt, C, is run on to the tight pulley just far enough to turn the cylinder around very slowly, one revolution being sufficient. The surfaces of the cylinder and brush, which are in contact, turn in the same direction, but, as the brush runs at a much greater speed, the dirt is removed very easily. The band is then taken off and the brush is placed in position for stripping the doffer, being driven by a band, E, in the same manner as is the cylinder. Previous to stripping the doffer, the driving belt is moved on to the tight pulley and allowed to remain while the brush is being placed in position and is then moved back on to the loose pulley for driving the brush. The barrow bar, which has remained down, is now thrown into gear; the doffer is allowed to make one revolution and is driven through the regular gearing, from the momentum acquired by the cylinder, while the belt was on the tight pulley.

It will be seen that the surface of the doffer runs in the opposite direction from the brush, but the wires of each are bent at such an angle that the work is easily accomplished. After the card is stripped, the brush itself needs cleaning, which is done by a hand card.

Calculations. The production of the card is governed by the weight of the sliver per yard and the number of revolutions of the doffer per minute. Although the doffer is not the actual delivery roll, it is considered in the calculations. To have this fully understood, diagrams, showing the gearing of four of the leading makes of revolving flat cards, are shown in Figs. 103, 104, 105 and 106. The gearing of all is very similar so that whatever calculations are made upon one may be very easily followed through upon another. These calculations are figured from the gearing shown in Fig. 106.

The doffer is $24\frac{3}{4}$ inches in diameter on the face of the clothing, therefore, each revolution that it makes will deliver a length of sliver equal to its circumference which is 77.75 inches. But after leaving the doffer, the sliver passes between the calender rolls on the card and then between the calender rolls in the coiler box, where in each case it is subjected to a slight draft. This additional draft, or elongation, reduces the weight of the sliver somewhat from what it weighed at the doffer, so that, as the calender rolls in the coiler are the actual delivery rolls, the length delivered by them at each revolution of the doffer should be

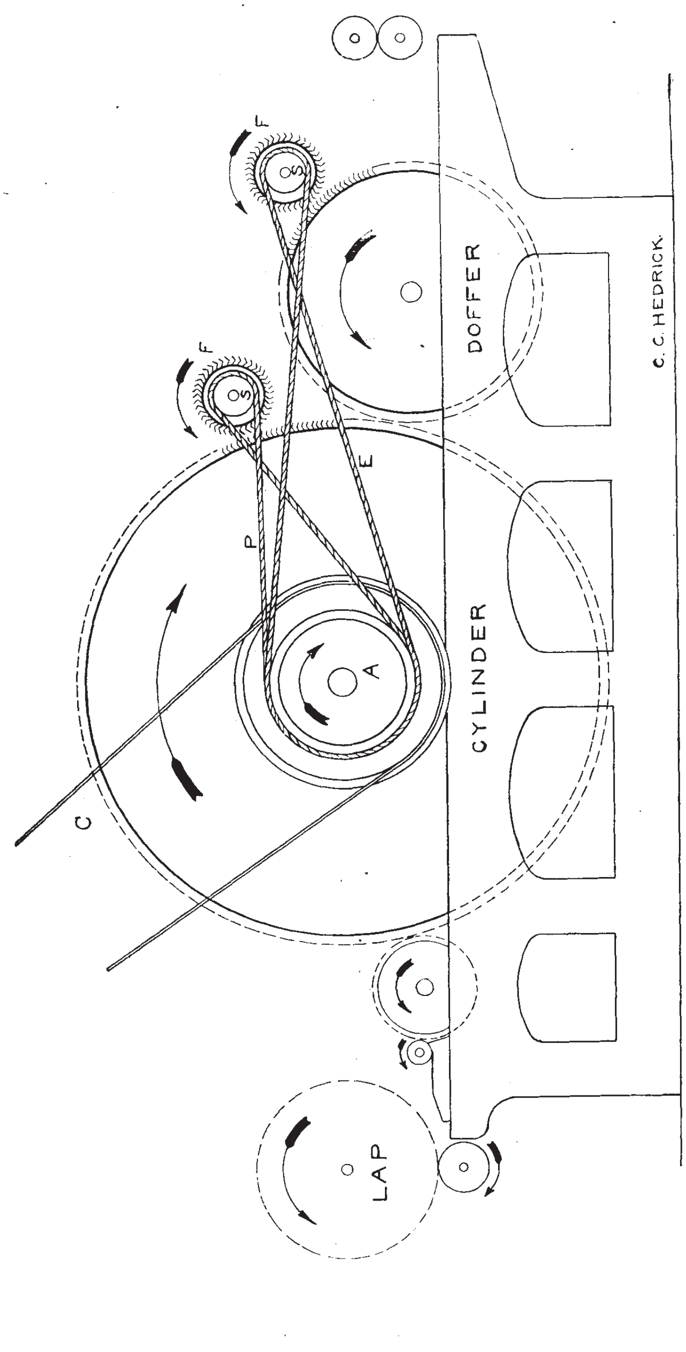


Fig. 102 Elevation of Card Showing Bands used in Stripping.

considered in figuring the production. These rolls are $2\frac{1}{8}$ inches in diameter and make 13.22 revolutions to one of the doffer. This gives a delivery of 88.25 inches for each revolution, instead of 77.75 inches, as when taking the actual circumference of the doffer.

Rule 1. To find the production of the card: Multiply together the number of revolutions of the doffer per minute (13), the number of inches delivered at each revolution (88.25), the weight of the sliver per yard (60 grains) and the number of minutes run per day (600). Divide the product by 7,000 (the number of grains in one pound) multiplied by 36 (number of inches in a yard).

Example: $$\frac{13 \times 88.25 \times 60 \times 600}{7000 \times 36} = 163.89$$

In the above example, the time run per day is given as 600 minutes, or ten hours, no allowance having been made for the time lost in stripping and cleaning, which, under ordinary circumstances, amounts to about 5 per cent.

Rule 2. To find the factor for the production of the card in 10 hours: Proceed as in Rule 1 but omit the revolutions of the doffer and the weight of the sliver.

Example: $$\frac{88.25 \times 600}{7000 \times 36} = .21011$$

Rule 3. To find the production with factor given: Multiply the factor by the number of revolutions of the doffer and the weight of the sliver.

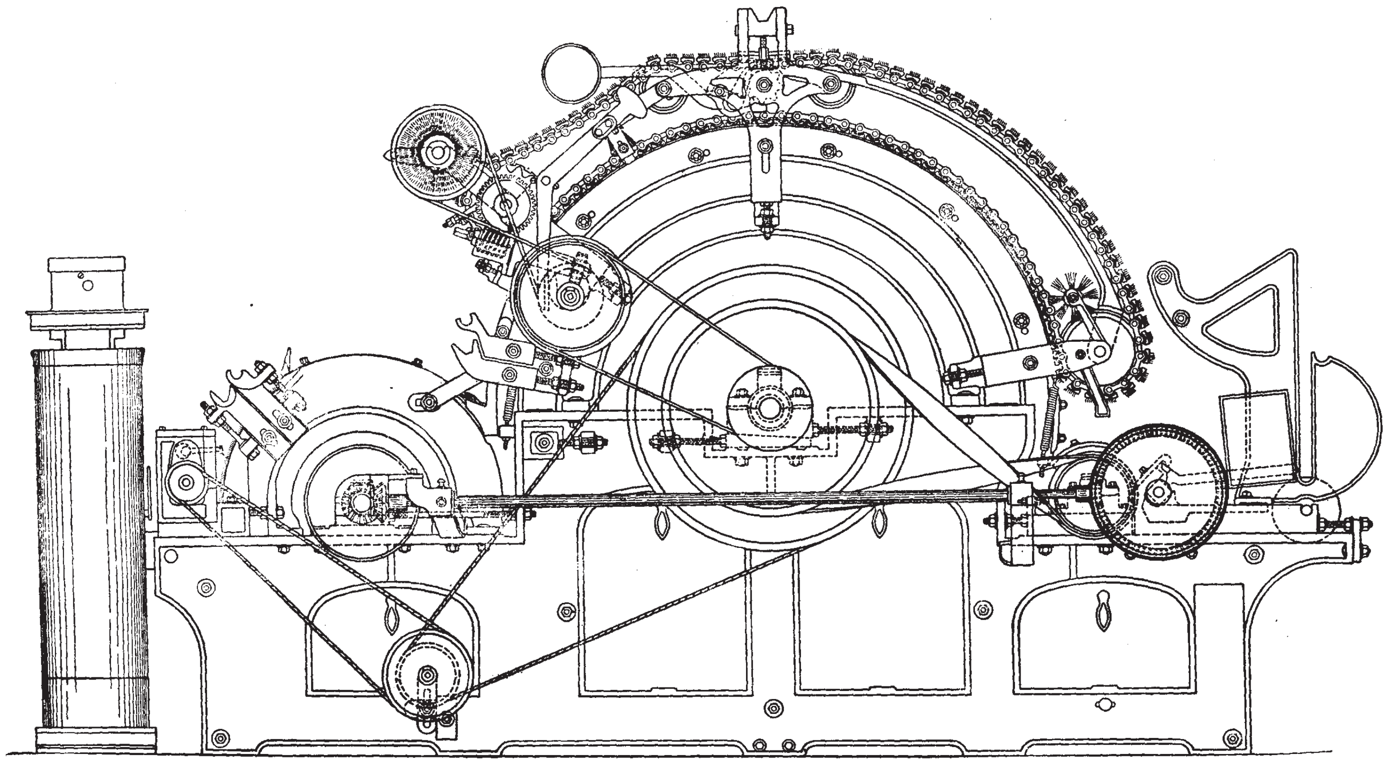
Example: $.21011 \times 13 \times 60 = 163.89$

Rule 4. To find the speed of the doffer: Multiply together the driving gears and the number of revolutions of the cylinder (165 R. P. M.) and divide their product by the product of the driven gears. [The driving gears are D^3, Z, T (change gear, 30 teeth) and V^1.] (The driven gears are B, S^1, P^1 and Q.)

Example: $$\frac{165 \times 18 \times 6 \times 30 \times 20}{7 \times 12 \times 40 \times 192} = 16.57 \text{ R. P. M.}$$

Rule 5. To find the factor for the speed of the doffer: Proceed as in rule 4, but omit the doffer change gear.

Example: $$\frac{165 \times 18 \times 6 \times 20}{7 \times 12 \times 40 \times 192} = .552$$



REVOLVING FLAT CARD, SHOWING DETAILS
Howard & Bullough Am. Machine Co. (Ltd.)

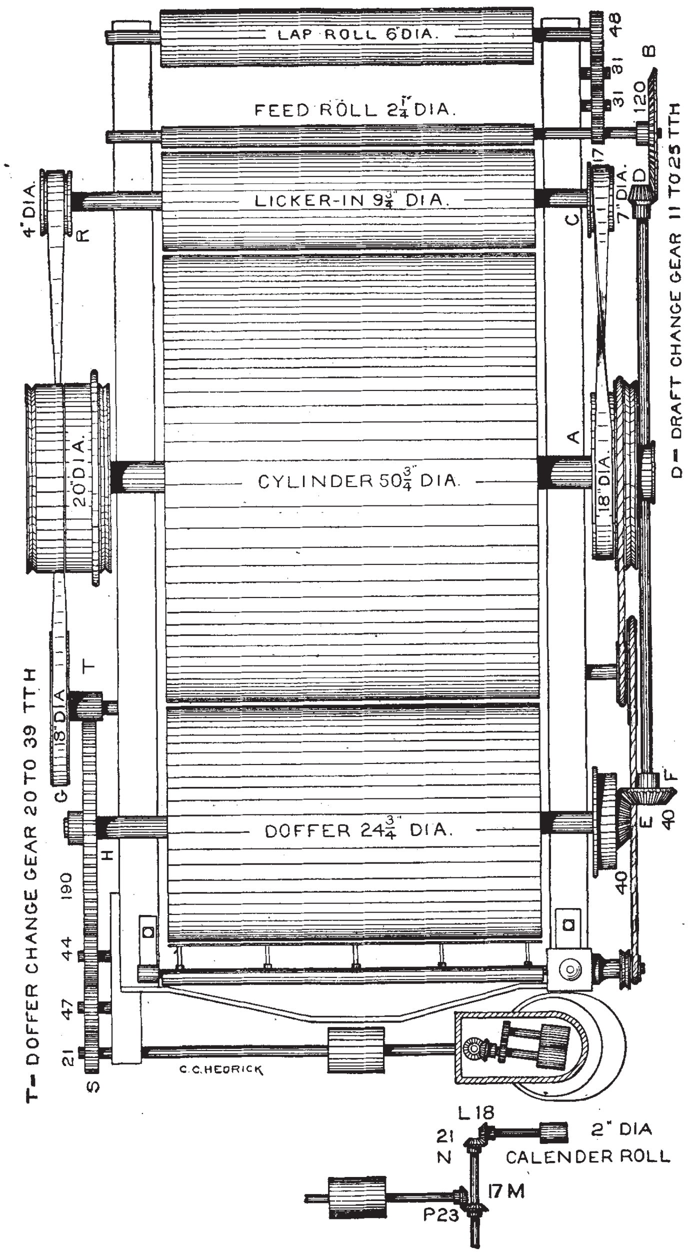


Fig. 103. Diagram of Gearing. Pettee Machine Works Revolving Flat Card.

Rule 6. To find the speed of the doffer: Multiply the factor by the number of teeth (30) in the doffer change gear.

Example: $.552 \times 30 = 16.56$

Rule 7. To find the number of teeth in the doffer change gear that will give the required revolutions of the doffer: Divide the required number of revolutions by the factor.

Example: $16.56 \div .552 = 30$

In Rule 5, the factor for the speed of the doffer is figured with the cylinder at 165 R. P. M., but as the cylinder is often run at other speed, it is convenient to have a factor which can be used with the cylinder at any speed.

Rule 8. To find the factor for the speed of the doffer with the cylinder at any speed: Multiply together the driven gears and divide the product by the product of the driving gears, omitting the doffer change gear.

Example: $$\frac{7 \times 12 \times 40 \times 192}{18 \times 6 \times 20} = 298.66$$

Rule 9. To find the speed of the doffer: Multiply the number of revolutions of the cylinder by the number of teeth in the doffer change gear and divide the product by the factor.

Example: $$\frac{165 \times 30}{298.66} = 16.57 \text{ R. P. M.}$$

Rule 10. To find the number of teeth in the doffer change gear when the speeds of the cylinder and doffer are given: Multiply the factor by the number of revolutions of the doffer and divide the product by the revolutions of the cylinder.

Example: $$\frac{298.66 \times 16.57}{165} = 29.99$$

Rule 11. To find the draft of the card between the feed roll and the calender rolls in the coiler box: Multiply together the driving gears and the diameter of the coiler calender roll and divide the product by the product of the driven gears multiplied by the diameter of the feed roll, omitting all intermediate gears. [The driving gears are G^2, L^4, Q, Y^1, V and N, and the driven gears are D, (change gear 16 teeth) K^1, O, R^2, Q^1 and N^1.] As L^4

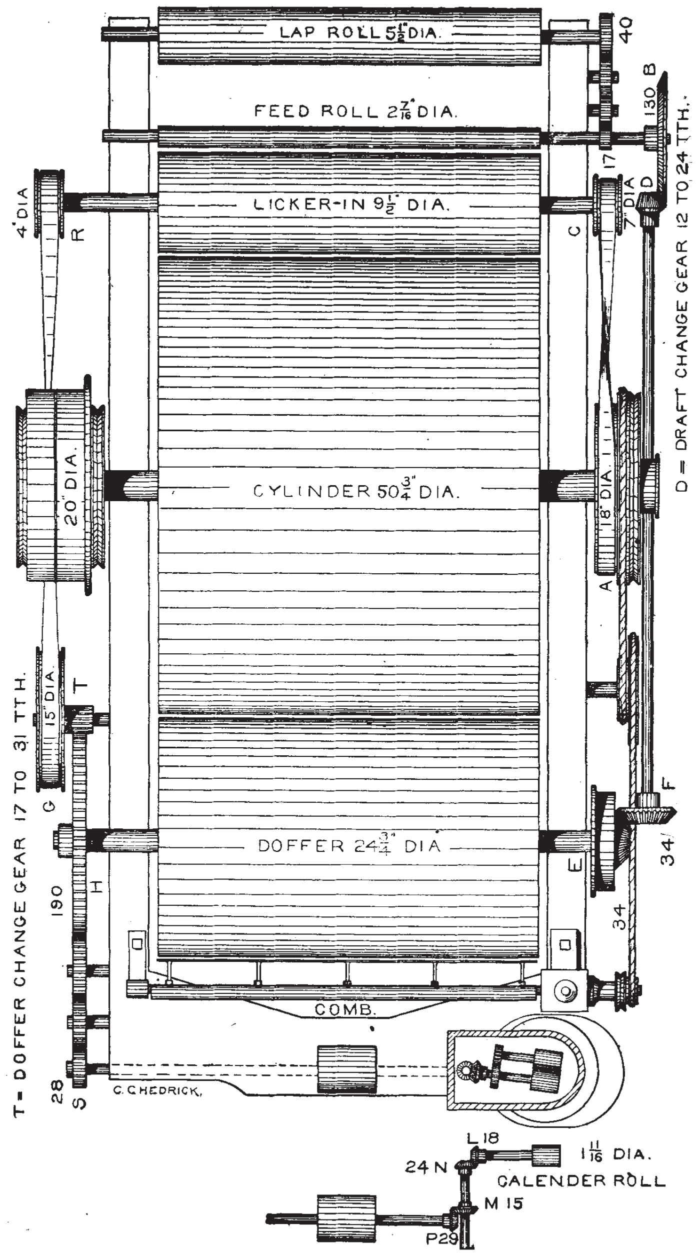


Fig. 104. Diagram of Gearing. Mason Machine Works Revolving Flat Card.

and K^1, V and Q^1 and N and N^1 are in pairs, they may be omitted in the calculation. In order to avoid fractions, the diameter of the feed roll, which is $2\frac{1}{4}$ inches, can be called 18, as there are $\frac{18}{8}$ in $2\frac{1}{4}$ inches, and the diameter of the coiler calender roll, which is $2\frac{1}{8}$, can be called 17.

Example: $$\frac{120 \times 192 \times 31 \times 17}{16 \times 30 \times 15 \times 18} = 93.68$$

Rule 12. To find the draft factor: Proceed as in Rule 11 but omit the draft change gear.

Example: $$\frac{120 \times 192 \times 31 \times 17}{30 \times 15 \times 18} = 1499.02$$

Rule 13. To find the draft: Divide the factor by the number of teeth in the draft change gear (16).

Example: $1499.02 \div 16 = 93.68$

Rule 14. To find the number of teeth in the draft gear when the draft is given: Divide the factor by the draft.

Example: $$1499.02 \div 93.68 = 16$$

Rule 15. To find the draft of the card necessary to make a sliver of a certain weight from a lap of a given weight: Multiply the weight of the picker lap in ounces per yard (14) by the number of grains in one ounce (437.5) and divide the product by the weight of the sliver in grains per yard, that it is desired to make (60).

Example: $$\frac{14 \times 437.5}{60} = 102.08$$

In the foregoing rule, no allowance has been made for the loss in weight in carding due to fly and strippings, which amounts, on an average, to 5 per cent, which should be considered.

Example: $$\frac{14 \times 437.5 \times .95}{60} = 96.97$$

Rule 16. To find the length in feet of fillet necessary to cover a cylinder or doffer: Multiply together the length of the face of the doffer (41") by its diameter and 3.1416 and divide the

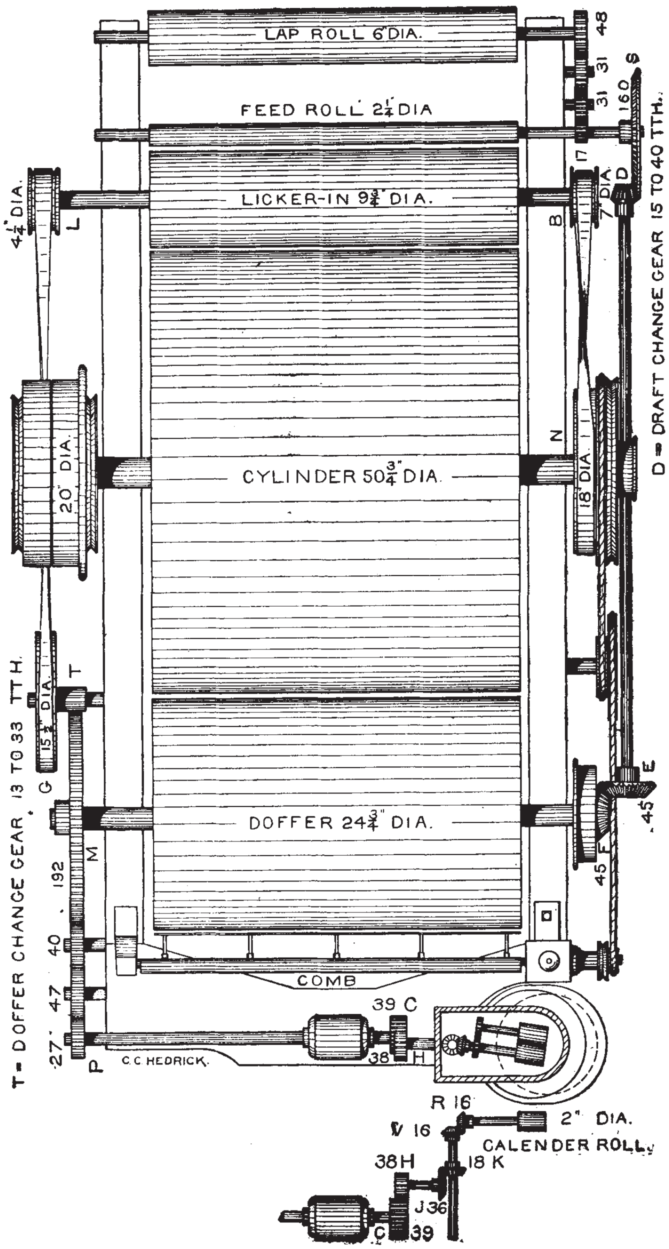


Fig. 105. Diagram of Gearing. Whitin Machine Works Revolving Flat Card.

product by the width of the fillet ($1\frac{1}{2}''$) multiplied by 12 inches.

Example: $$\frac{41 \times 24 \times 3.1416}{1\frac{1}{2} \times 12} = 171.74$$

The following are the draft factors and factors for the speed of the doffer for the cards shown in Figs. 103, 104 and 105.

Fig. 103. Draft factor. The driving gears are B, F, H, P and N. The driven gears are D (change gear), E, S, M and L. E and F are in pairs. The feed roll is $2\frac{1}{4}$ inches in diameter and the coiler calendar roll is 2 inches in diameter. Their diameters can be called 9 and 8 respectively

$$\frac{120 \times 190 \times 23 \times 21 \times 8}{21 \times 17 \times 18 \times 9} = 1523.31$$

Factor for the speed of the doffer with the cylinder at 165 R. P. M. The driving gears are A, R and T (change gear). The driven gears are C, G and H.

$$\frac{165 \times 18 \times 4}{7 \times 18 \times 190} = .4962$$

Fig. 104. Draft factor. The driving gears are B, F, H, P and N. The driven gears are D (change gear) E, S, M and L. E and F are in pairs. The feed roll is $2\frac{7}{16}$ inches in diameter, or $\frac{39}{16}$, and the coiler calender roll is $1\frac{11}{16}$ inches in diameter, or $\frac{27}{16}$. The diameters may be called 39 and 27, respectively.

$$\frac{130 \times 190 \times 29 \times 24 \times 27}{28 \times 15 \times 18 \times 39} = 1574.28$$

Factor for the speed of the doffer with the cylinder at 165 R. P. M. The driving gears are A, R and T (change gear). The driven gears are C, G and H.

$$\frac{165 \times 18 \times 4}{7 \times 15 \times 190} = .5954$$

Fig. 105. Draft factor. The driving gears are S, E, M, C, J and V. The driven gears are D (change gear), F, P, H, K and R. E and F and V and R are in pairs. The diameter of the feed roll and the coiler calender roll can be called 9 and 8, respectively.

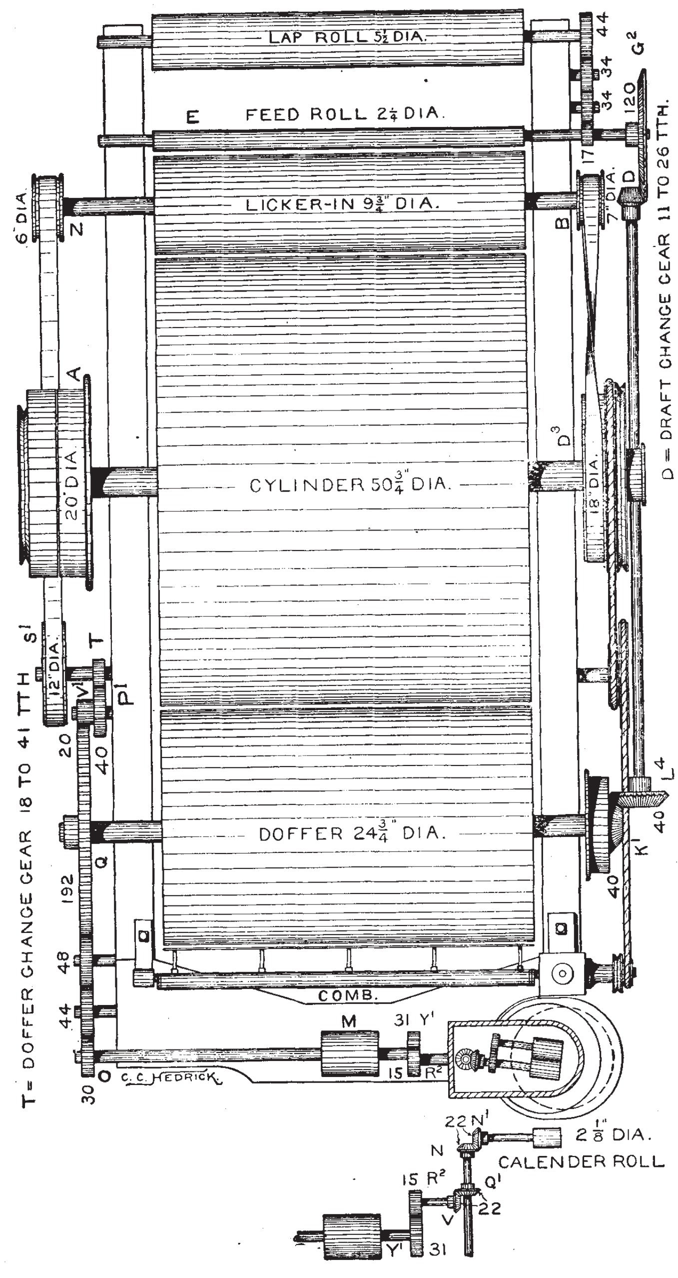
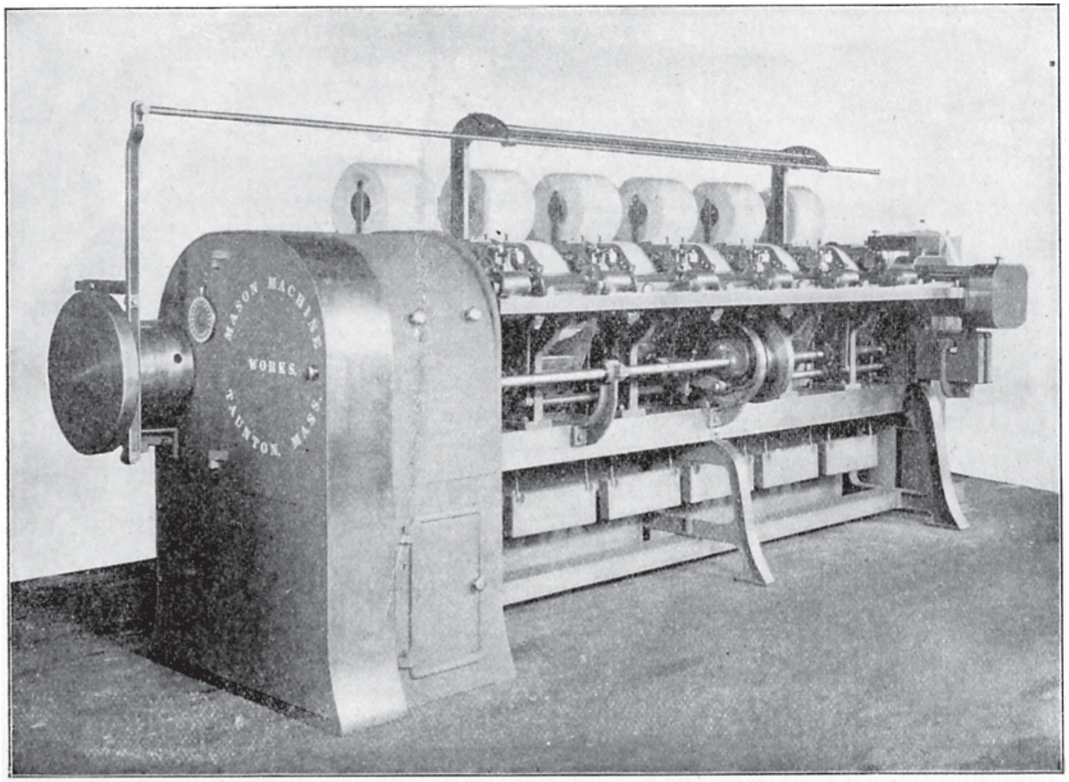


Fig. 106. Diagram of Gearing. Lowell Machine Shop Revolving Flat Card.

$$\frac{160 \times 192 \times 39 \times 36 \times 8}{27 \times 38 \times 18 \times 9} = 2075.94$$

Factor for the speed of the doffer with the cylinder at 165 R. P. M. The driving gears are N, L and T (change gear). The driven gears are B, G and M. The diameter of L, which is $4\frac{1}{4}$ inches, can be called 17, and the diameter of G, which is $15\frac{1}{2}$ inches, can be called 62.

$$\frac{165 \times 18 \times 17}{7 \times 62 \times 192} = .6059$$



MASON-HEILMAN COMBER, FOR COMBING FINE COTTON
Mason Machine Works.

COTTON SPINNING.

PART III.

COMBING.

In the manufacture of the finer qualities of yarn which demand long staple cotton, the combing process, which is necessary, follows carding, although the card sliver is very often subjected to one process of drawing before it is combed. Briefly speaking, the operation of combing, which is entirely different from all other branches of cotton spinning, consists in removing the short fibers and neps which remain in the sliver after carding.

Combed yarns are used for various purposes, among which may be mentioned hosiery and underwear, sewing thread, laces and fine cotton fabrics.

In considering the uses for combed yarns, three important points should be kept in view in order to thoroughly understand the merits of combing; first, the length of the cotton fibers, second, the twist per inch in the yarn and third, the counts of yarn spun.

Yarn depends, mainly, for its strength upon the amount of twist it contains and the length of the fibres. For hosiery and underwear, it must be soft twisted so that it will be smooth to the touch, and, in order that it shall be sufficiently strong, long staple cotton must be used.

Yarn for thread and fine cotton fabrics is much harder twisted, and, as the fine numbers of yarn contain comparatively few fibers per cross section, they must be long enough to receive a sufficient number of twists. It will thus be seen that the fibers in combed yarn must be approximately uniform in length which result can be obtained only by combing.

Arrangement of Combing Machines. There are generally three machines used in the combing process, viz: The sliver lap machine, the ribbon lapper and the comb, although very often the ribbon lapper is not used. In that case, the slivers, after leaving the card, are put through one process of drawing and from the drawing frame are put through the sliver lap machine and made into a lap for the comb. When all three machines are used, the drawing process is usually omitted before combing and the ribbon lapper, which corresponds to it, is used instead. But in all cases, the sliver lap machine is necessary to prepare the laps for combing and two or three drawing processes are necessary after combing.

To make this perfectly clear, the different arrangements of the machines used in combing are given below.

With the ribbon lapper the machines used are:

1. Sliver lap machine.
2. Ribbon lapper.
3. Comb.

When the ribbon lapper is omitted, the machines used are:

1. Drawing frame.
2. Sliver lap machine.
3. Comb.

When the drawing frame is used with the ribbon lapper, the following machines are used:

1. Drawing frame.
2. Sliver lap machine.
3. Ribbon lapper.
4. Comb.

Sometimes double combing is resorted to for the very best yarn. The machines are then arranged in one of the two following orders:

1. Sliver lap machine.
2. Ribbon lapper.
3. Comb.
4. Sliver lap machine.
5. Ribbon lapper.
6. Comb.

If the ribbon lapper is omitted.

1. Drawing frame.
2. Sliver lap machine.
3. Comb.
4. Drawing frame.
5. Sliver lap machine.
6. Comb.

Sliver Lap Machine. The sliver lap machine prepares the laps for the comb by laying the card or drawing frame slivers, as the case may be, in the form of a narrow sheet which is wound upon a wooden core, or spool, into a lap 12 inches to 14 inches in diameter. The number of slivers at the back of the machine

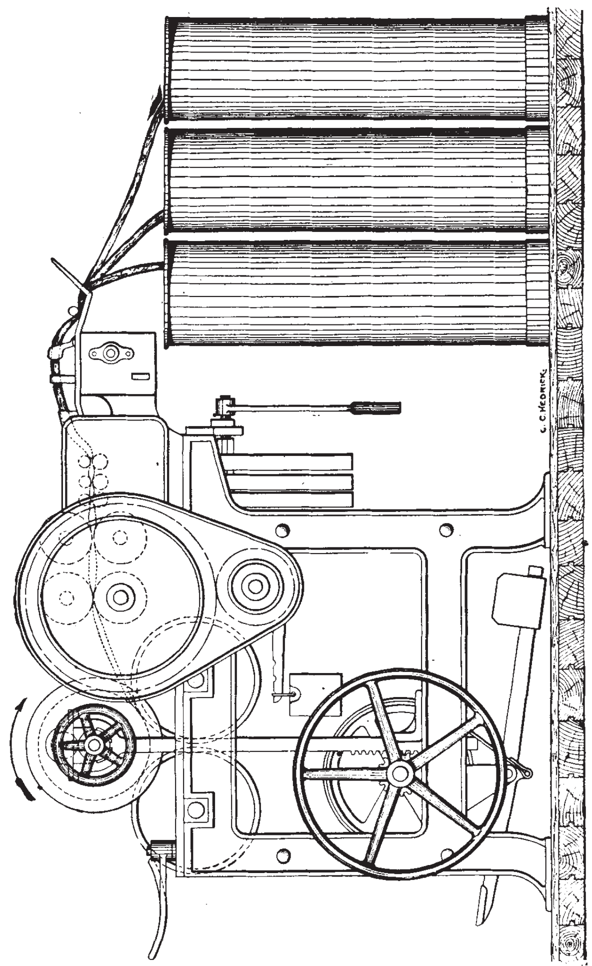


Fig. 107. Elevation of Sliver Lap Machine.

depends upon their weight and the width of the lap to be made. In the earlier types of these machines, the laps were made 7 to 9 inches in width but the present ones are built to make a lap 10 to 11 inches wide. This will require fourteen to twenty slivers, and, as the laps must be free from thin places, the machine is provided with a stop motion, which instantly operates, when a sliver breaks or a can becomes empty.

An elevation of the machine is shown in Fig. 107 and a sec-

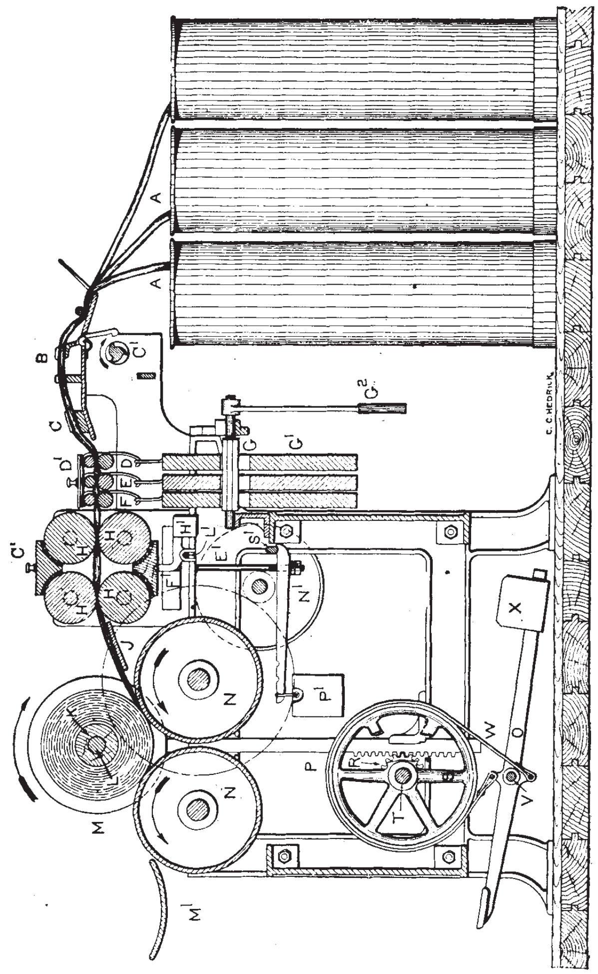


Fig. 108. Section of Sliver Lap Machine.

tion in Fig. 108. From the cans, A, the slivers are drawn over the stop-motion spoons, B, and through the guides, C, and between three pairs of draft rolls, D, E and F, where they are subjected to a slight draft, from two to three usually being sufficient, as all that is required is to straighten the slivers slightly, so that the needles of the comb may deal more gently with the fibers, particularly when the ribbon lapper is omitted between the sliver lap machine and the comb. From the draft rolls, the slivers next pass between two pairs of heavily weighted smooth calender rolls, H H, and, H H, and are formed into a thin, fleecy sheet which is drawn forward and wound upon a wooden spool into a lap, which is revolved by contact with a pair of fluted lap rolls, N N. The ends of the laps are formed by a pair of plates, M, which revolve with the lap, making very even selvages.

Directly beneath the lap rolls is a friction or break pulley, S, which is keyed upon a shaft, T. Around this pulley is a leather strap, W, both ends of which are fastened to a foot lever, O, which is hung upon a stud, V. Upon the long end of the foot lever is a weight, X. The lever is balanced so that the weight keeps the strap tight at all times. Upon each end of the shaft with this pulley is a pinion, R, in gear with a rack, P, the end of which is connected to the lap roll arbor, L, which passes through the spool upon which the lap is wound. As the lap increases in diameter, it lifts the racks, the upward movement of which is retarded by the friction of the strap around the break pulley. By this means, the laps are wound very firmly and compactly.

In addition to the back stop-motion, the machine is provided with a full lap stop-motion, or measuring device, whereby the size and weight of the laps may be governed. This is operated by a projecting piece on one of the racks which comes in contact with the stop-motion arm as the lap reaches its full diameter. To remove the lap, the attendant presses upon the foot lever, releasing the strap from around the break pulley. The lap is then raised clear of the lap rolls by the hand wheel, N, and the arbor is withdrawn.

The draft rolls are dead weighted, each roll having an independent weight, G^1, hung by stirrups, in the usual manner. In each weight is a square hole through which extends the shaft, G, which has a cam-shaped projection along its face. This shaft is supported by bearings at each end and at one end is a handle, G^2, by which the shaft may be turned. When it is desired to remove the weight from the draft rolls, this shaft is given a quarter revolution and its cam-shaped face brought against the upper side of the hole in the weights. In this manner, the weight may be entirely removed from the rolls and transferred to the shaft.

The top pair of calender rolls is provided with a top clearer, C^1, which consists of a heavy iron piece, lined with clearer cloth. The underside of this piece is shaped to fit the outline of the calender rolls, its weight holding it firmly down upon them. The clearer, F^1, for the under pair of calender rolls is also shaped to fit the rolls but is of wood instead of iron. It is held up against the rolls by a counterweight, H^1, which is hung upon a stud, L^1. The draft rolls are also provided with a clearer, D^1. In addition to their own weight, the top calender rolls are lever weighted, the rod, E^1, connects the yoke which is over the bearings of the top rolls with the weight lever, N^1, upon which is the weight, P^1. The fulcrum for the weight lever is a projecting lug, S^1, upon the frame of the machine.

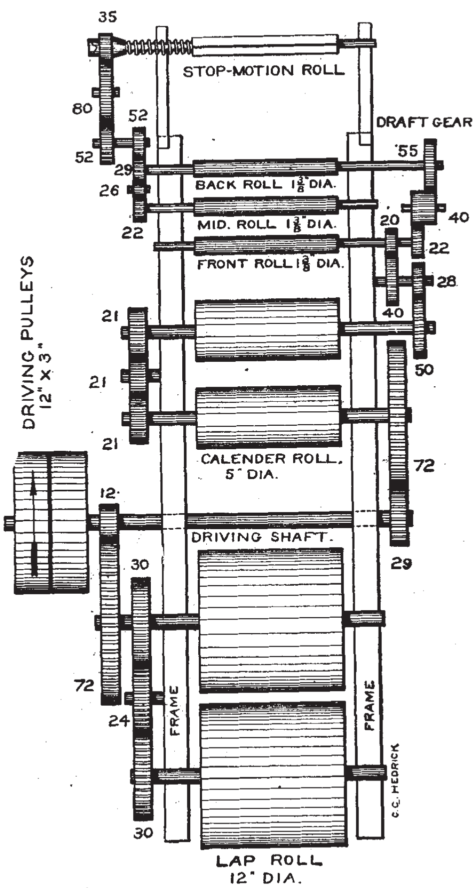
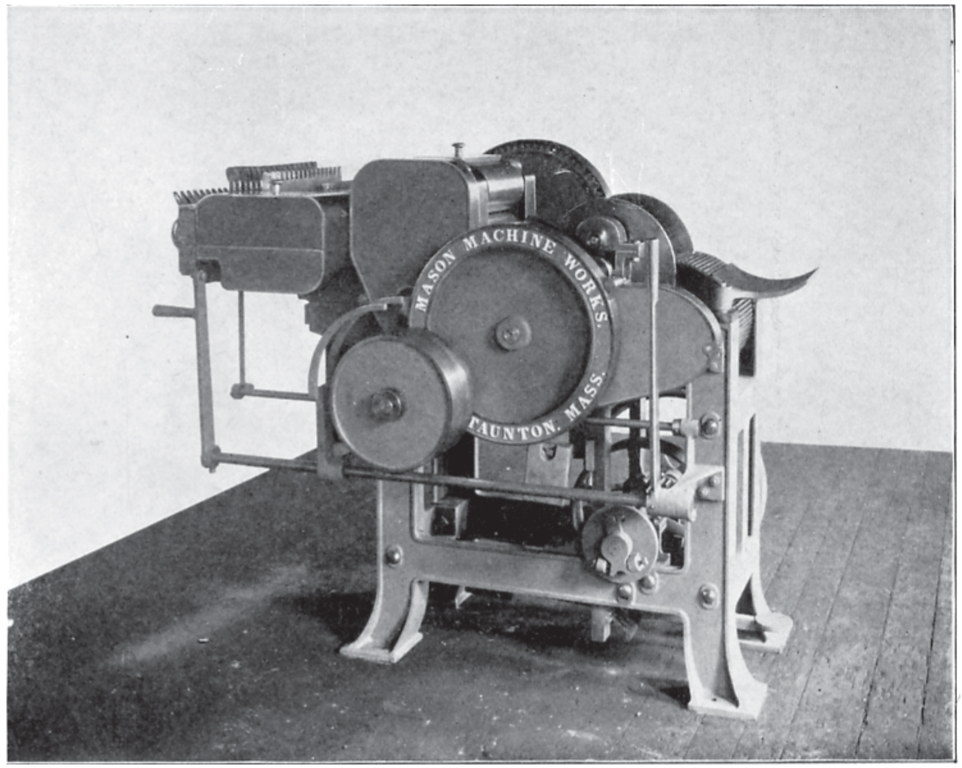


Fig. 109. Diagram of Gearing of Sliver Lap Machine.

Calculations. Fig. 109 is a diagram of the gearing of the sliver lap machine.

Rule 1. To find the draft: Multiply the number of slivers, entering at the back (16), by their weight in grains per yard



SLIVER LAP MACHINE
Mason Machine Works.

(42.5) and divide the product by the weight of the lap in grains per yard (272).

Example: $\frac{42.5 \times 16}{272} = 2.5$

This will require a draft gear of 55 teeth which is shown on the plan of the gearing.

Rule 2. To find the production of the machine: Multiply together the revolutions of the calender roll per minute (60), the circumference of the calender roll (15.70″), the weight of the lap in grains per yard (272) and the minutes run per day (600) and divide the product by 7,000 (the number of grains in one pound) multiplied by 36 (inches in one yard).

Example: $\frac{60 \times 15.70 \times 272 \times 600}{7{,}000 \times 36} = 610.5$

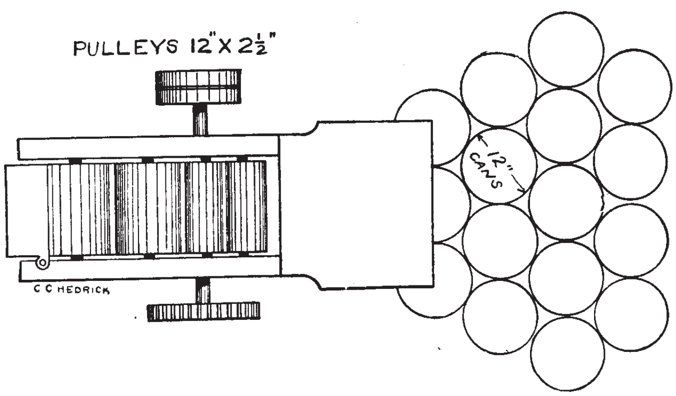


Fig. 110. Plan of Sliver Lap Machine.

From this amount should be deducted about ten per cent for time lost in doffing.

An examination of the gearing will show that on the driving shaft is a pinion of 29 teeth which drives the calender roll gear of 72 teeth. The driving pulleys thus make 2.48 revolutions to one of the five inch calender rolls. The speed of the driving pulley is from 125 to 250 revolutions per minute.

A plan of the sliver lap machine is shown in Fig. 110. The floor space, occupied with 16 cans at the back, is 9′ 0″ long by 4′ 2″ wide. The driving pulleys are always on the left hand side.

The following table gives the production of the sliver lap machine per day with the lap weighing from 200 to 310 grains per yard and the speed of the calender rolls from 50 to 100 revolutions per minute.

SLIVER LAP MACHINE.

Production Per Day of 10 Hours, Less 10 Per Cent for Cleaning, etc.

Rev. per Min. of Driving Pulleys.	Rev. per Min. of 5-inch Calender Rolls.	Weight of Lap in Grains per Yard.											
		200	210	220	230	240	250	260	270	280	290	300	310
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
124	50	336	353	370	387	404	420	437	454	471	488	505	522
136	55	370	388	407	426	444	463	481	500	518	537	555	574
148	60	404	424	444	464	484	505	525	545	565	585	606	626
161	65	437	459	481	503	525	547	559	591	613	634	656	678
173	70	471	494	518	542	565	589	612	636	659	683	706	730
198	80	538	565	592	619	646	673	700	727	753	781	808	835
223	90	606	636	666	696	727	757	787	817	848	878	909	939
248	100	673	706	740	774	807	841	875	908	942	976	1010	1044

Ribbon Lapper. The ribbon lapper, which is used as an intermediate process, between the sliver lap machine and the comb, is, in one sense, a drawing frame, with the exception that the fibers, instead of being drawn in the form of a sliver, are spread out in a sheet.

The laps are placed upon the lap rolls, side by side, at the back of the machine, which is built usually to take six. The laps are drawn full width between four pairs of draft rolls, having a draft of about six. Passing downward around highly polished plates and under calender rolls, they are brought together, one above another, upon the sliver plate of the machine. This forms a lap of six thicknesses, but, as each lap has been subjected to a draft of about six, their combined weight is the same as was that of each lap at the back of the machine. The laps are drawn along the sliver plate by the calender rolls and then pass between two pairs of heavily weighted calender rolls, which consolidate the six laps into one sheet. This sheet now passes forward and is wound upon a wooden spool by contact with two lap rolls into a lap ready for combing.

The device for winding the lap is exactly the same in detail as that used on the sliver lap machine.

The laps, put in at the back of the ribbon lapper, are usually made about one inch less in width than those required for the comb, as they spread some when passing through the draft rolls.

The ribbon lapper is provided with two stop-motions, one which stops the machine immediately if a lap runs out at the back and one, called a full lap stop-motion, which regulates the length of the laps, so that they will all be wound to the same diameter.

Fig. 111 shows a diagram of the gearing of the ribbon lapper. The driving pulleys are 16 inches in diameter by 3 inches

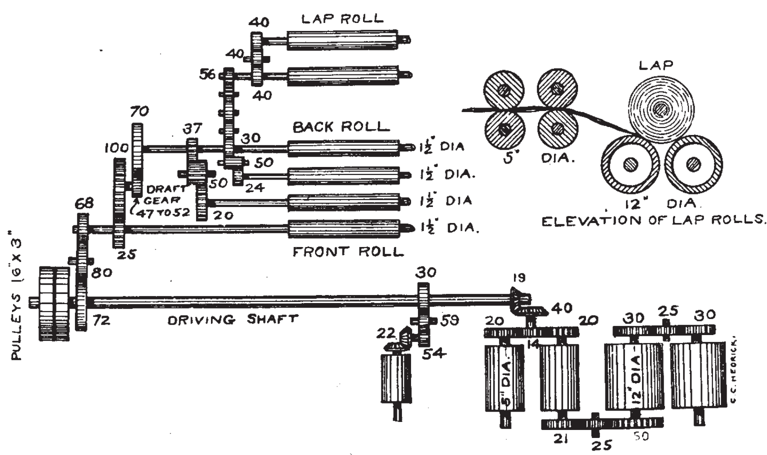


Fig. 111. Diagram of Gearing of Ribbon Lapper.

face and make three revolutions to one of the five inch calender roll. The usual speed for the driving pulleys is from 250 to 300 R. P. M.

The draft of the ribbon lapper is principally between the back and front rolls, but in addition, there is also a slight draft between the front roll and the calender rolls which is necessary to draw the sliver along the sliver plate.

The draft change gear is from 47 to 52 teeth which gives a range in draft of 5.63 to 6.23. This is figured between the back roll, which is $1\frac{1}{2}$ inches in diameter, and the five inch calender roll and can be found in the usual manner.

The ribbon lapper occupies a floor space of 14′ 2″ length by 4′ 7″ width and is built both right and left hand.

For the production of the ribbon lapper, use the production table for the sliver lap machine, as the calender rolls for both machines are the same diameter.

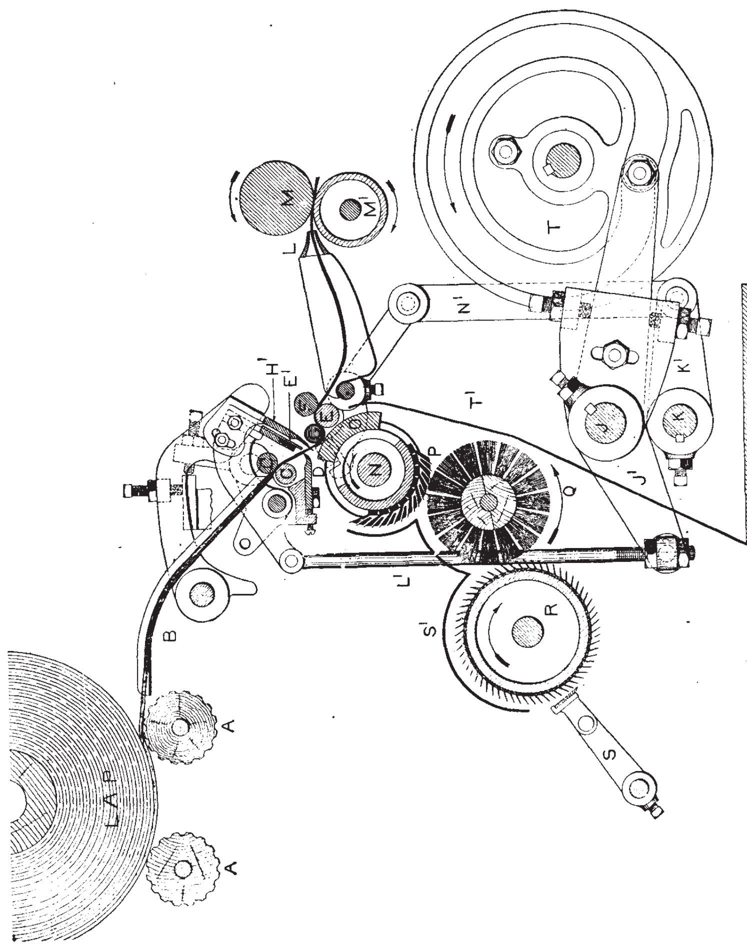


Fig. 112. Section through Comb.

Comb. After the laps have been formed on the sliver lap machine, or the ribbon lapper, they are taken to the comb upon which the actual operation of combing is carried on. The comb is divided into either six or eight heads, or sections, a six-headed comb being most generally used.

Each head is exactly like the others so that a description of the movements of one answers for all and it should be understood that, although the functions of one part depend closely upon those of another, each movement will be considered a separate action.

Fig. 112 is a section through a comb, showing enough of the principal parts to enable its workings to be explained.

The lap is placed upon the fluted lap rolls, A and A, by which it is slowly unwound. The cotton passes down a smooth plate, B, and is drawn between the feed rolls, C and C. The movement of these rolls is intermittent and is governed by the length of the staple of cotton being worked and the draft of the machine.

From the feed rolls, the lap passes down between the cushion plate, D, and the nipper, E^1, which are at this particular instant apart, to allow it to pass through.

When the length has been delivered by the feed rolls, their movements cease and the nipper is brought into contact with the cushion plate and the cotton, which is between them, is held firmly.

Just beneath the cushion plate is the cylinder shaft, N, upon which are the cylinders, one for each section. The cylinders are made up of two parts, the fluted segment, O, and the half lap, P, which are separated by a portion which is smaller in diameter.

The surface of the fluted segment is similar to a feed roll while the half lap is composed of a series of rows of needles each row finer than the preceding one. The rotary motion of the cylinders, unlike that of the feed rolls, is continuous and, as they revolve, the needles pass through that portion of the lap which projects downward from between the nipper and the cushion plate and removes the short fibers and neps.

Front of the nippers are the detaching rolls, E, F and G. E is a steel fluted roll which is driven from one end of the comb. F is a brass fluted top roll, driven by contact with E, and G is a leather covered roll heavily weighted also driven by contact with E.

All of these rolls have a rotary motion both backwards and forwards, while F and G have in addition a slight movement, circumferentially, about E. The functions of these three rolls, in connection with the fluted segment, are to detach the fibers, which have just been combed, from the mass held between the cushion plate and nipper and to attach them to those which were combed, previously, so as to make a continuous sliver.

After the needles have passed through the cotton, the rolls, E, F and G, turn backwards a portion of a revolution so that the cotton, which is between them, will be in a position to be attached, or "pieced up." Meanwhile, the partial revolution of the cylinder has brought the front edge of the fluted segment around

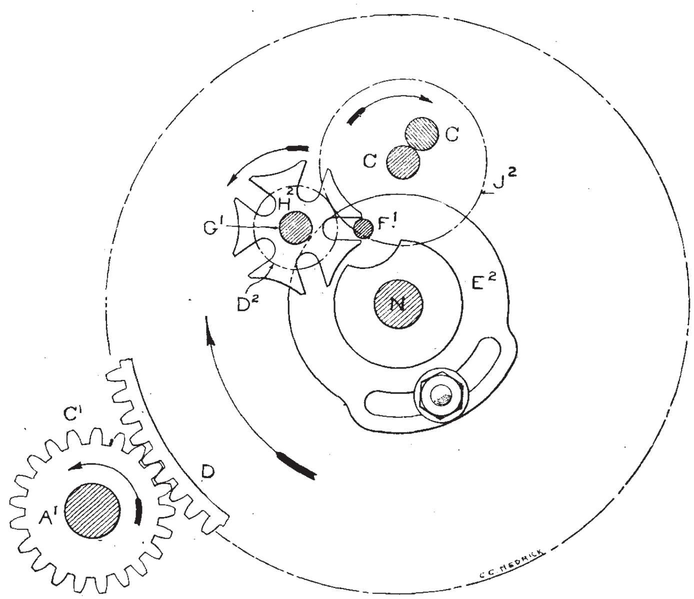


Fig. 113. Elevation of Feed Roll Gearing.

against the combed fibers which are hanging from between the cushion plate and nipper and as it continues to turn, they are made to lie upon its surface.

At this point, the detaching rolls, which have ceased their backward movement, now turn forward and the leather roll, G, which during its backward movement was clear of the cylinder, is moved circumferentially about the steel roll, E, until it comes in contact with the fluted segment. When these surfaces touch, the fibers are carried forward and are overlapped on the end of those ahead and, as the forward movement of these rolls is considerably more than the backward, the fibers are drawn steadily onward.

At the same time that the rolls commence to turn forward, the top comb, H^1, descends into the path of the cotton and the end of the fibers that were between the cushion plate and the nipper also receive a combing.

From the detaching rolls, the sliver is drawn forward through the trumpet, L, by the calender rolls, M and M^1, and along the table with the other slivers where they pass through a draw box that usually has a draft of five. From here, they pass, as one sliver, through the coiler into a roving can.

The short fibers and neps are removed from the cylinder teeth by a revolving brush, Q, which is placed beneath the cylinder. The surface speed of the brush is slightly greater than that of the cylinder and, as the bristles extend about one-eighth of an inch below the points of the needles, these are thoroughly cleaned.

The fibers are removed from the brush by a slowly revolving doffer, R, which is covered with very coarse card clothing, and they are removed from the doffer in a thin fleece, by an ordinary doffer comb, S, the cotton falling into a box below. Sometimes, the comb is provided with a roll for winding the waste into a lap as is done by the stripping roll on a revolving flat card.

On each side of the cylinder and brush are covers, S^1 and T^1, which prevent the fly from escaping. The brush is adjustable as the continual wear shortens the bristles very rapidly. The doffer and doffer comb are adjustable with respect to the brush.

Feed Motion. First in order, in considering the movements of the comb in detail, comes the feed motion. The feed rolls are driven from the main driving shaft of the comb and, as their motion is intermittent while that of the driving shaft is continuous, a device called a pin and starwheel is used which is shown in elevation in Fig. 113 and in section in Fig. 114. The cylinder shaft, N, is driven from the driving shaft, A^1, by the pinion, C^1, and the gear, D. Around the hub of the gear is an adjustable plate, E^2, which carries the pin, F^1. Upon one end of the stud, G^1, is the five-toothed starwheel, H^2, and upon the other, the draft change gear, D^2, which ranges from fourteen to twenty teeth.

Running with the draft gear is another gear, J^2, of thirty-eight teeth. This is keyed to the end of the bottom feed roll, C, any movement given to the starwheel would thus be communicated to the feed rolls.

During a portion of each revolution of the cylinder shaft, the pin, F^1, which describes a circle of about five inches in diameter, engages one of the teeth of the starwheel, causing it to turn one-fifth of a revolution, when it remains stationary until it is advanced another tooth by the pin at the next revolution of the cylinder.

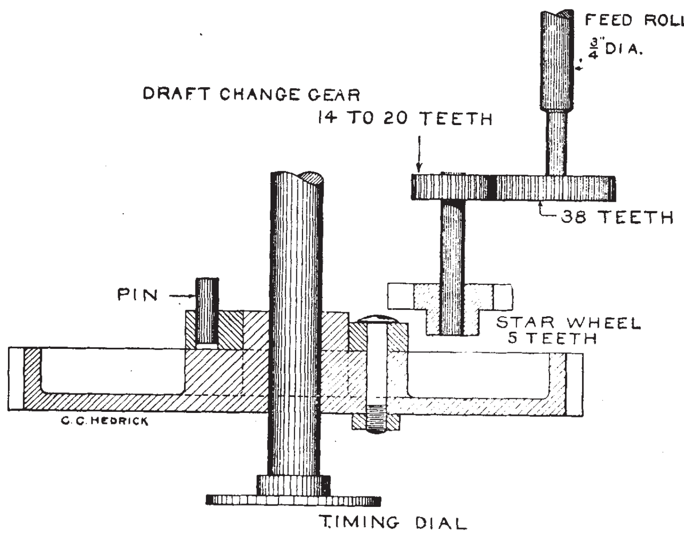


Fig. 114. Section of Feed Roll Gearing.

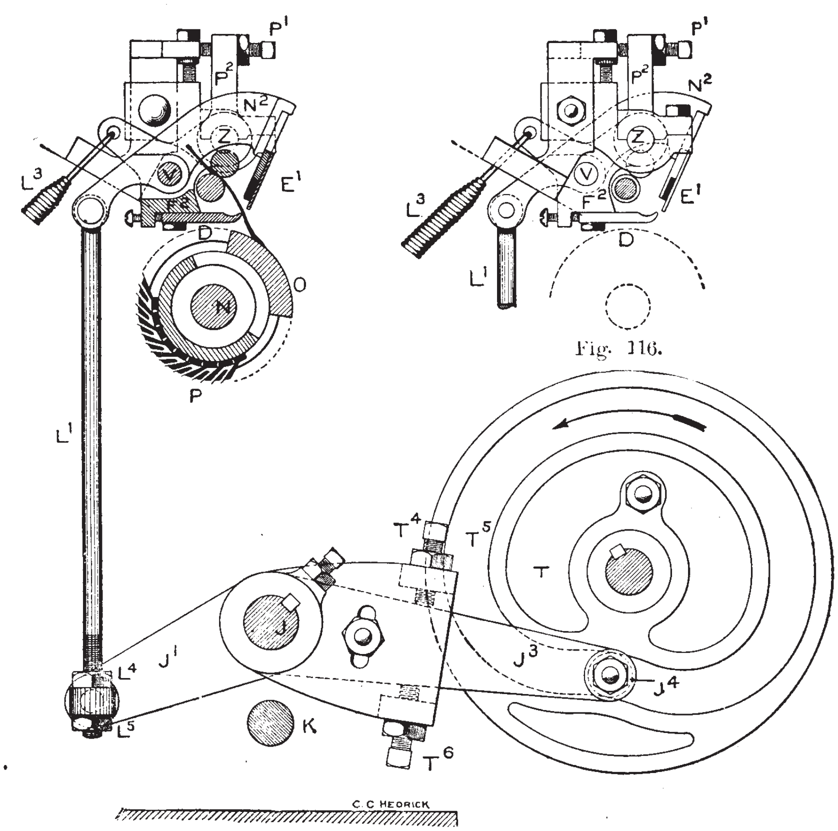
To prevent any movement of the starwheel, while it is not being acted upon, the face of its teeth are made concentric with the plate, E^2, on the hub of the gear, D, with which it is in contact.

The movement of the feed roll, at each revolution of the cylinder shaft, is very slight. The largest draft gear (twenty teeth) will cause the feed roll, which is three-fourths of an inch in diameter, to deliver only about one-quarter of an inch of cotton.

The lap rolls, upon which the lap rests, are also given an intermittent motion, corresponding to that of the feed rolls, and are driven at one end of the comb from the bottom feed roll.

Timing Dial. All of the various parts of the comb are timed to operate in regular order and, as each part is dependent upon the others, any great variation from the proper timing will cause bad work and is liable to injure the combs and needles.

The parts are set by the index, or timing dial, which is on the head end of the cylinder shaft and is shown in the section of the feed roll gearing and in the diagram of the nipper cam, Fig. 120.



Figures 115 and 116. Nipper Cam and Levers.

The dial is divided into twenty parts, numbered 1 to 20, each part being subdivided into quarters. Above the dial is an index finger, fastened to the comb frame. In setting, the driving shaft is turned by hand until the index finger points to the proper figure. The feed rolls are usually timed to commence turning at $4\frac{1}{2}$.

Nipper and Cushion Plate. Fig. 115 shows the cam and levers for operating the nipper and cushion plate and Fig. 116 shows the parts detached from the cam.

The cushion plate, D, is generally of steel with a dull-pointed edge and the nipper knife, E^1, also of steel, is recessed to receive a cushion of leather or rubber. This cushion prevents the fibers from becoming cut, or otherwise injured, when the cotton is gripped between the cushion plate and nipper.

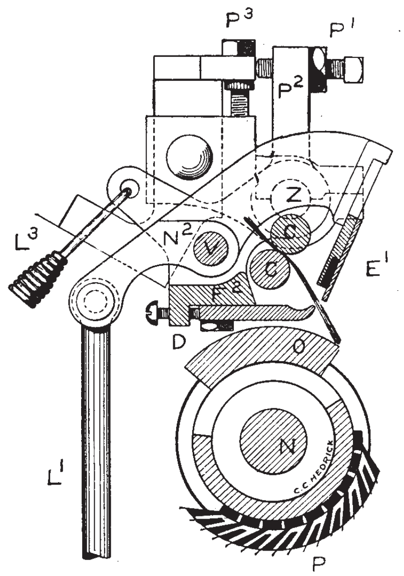


Fig. 117. Section showing Nipper and Cushion Plate.

Both the cushion plate and the nipper are carried by a cradle, F^2, which has a slight rocking movement around its fulcrum, Z. The nipper arm, N^2, is also hung upon a fulcrum on the cradle at V. In the upright cradle arm, P^2, is the nipper setting screw, P^1, which bears against a stop, formed by the frame of the machine. The cradle is held in its normal position, which is with the screw bearing against the stop, by a strong spring, L^3, one end of which is fastened to a horn on the cradle, the other to the frame of the comb.

The connection to the nipper cam, T, by which the nipper and cushion plate are caused to open and close, is by means of the upright rod, L^1, the horizontal nipper shaft lever, J^1, and the nipper cam lever, J^3. The last named carries a roll, J^4, that runs in a groove, T^5, in the face of the nipper cam.

The nipper cam lever, J^3, is made in two parts which enables a very fine adjustment to be made by means of the screws, T^4 and T^6. The part carrying the screws is keyed to the nipper shaft, J. This shaft runs the whole length of the machine, and to it are also keyed the horizontal nipper shaft levers, J^1, which connect with the back end of the nipper arms, N^2, by the upright rods, L^1. The nipper cam makes one revolution to one of the cylinder and, at each revolution, the opening and closing of the nipper and cushion plate takes place which corresponds to the movements of the cylinder.

To follow these movements, Figs. 117, 118, 119 and 120 have been made. Figs. 117 to 119 are sections showing the different positions of the nipper and cushion plate in relation to the

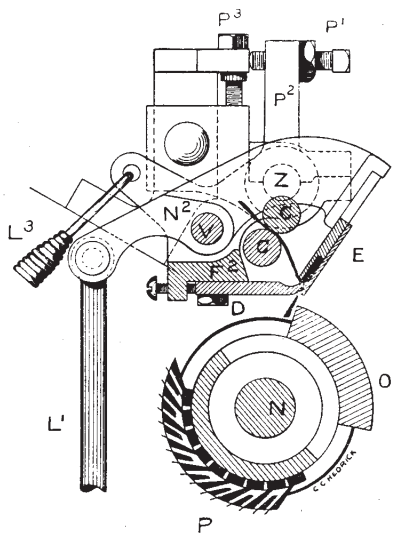


Fig. 118.

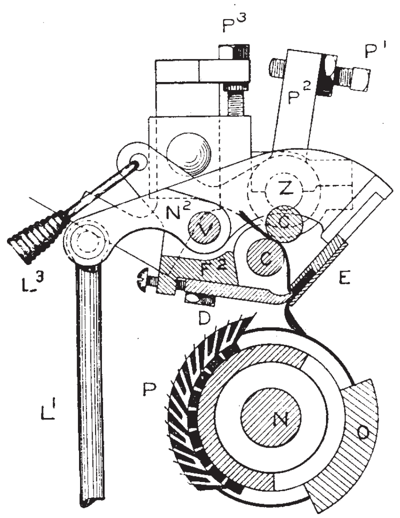


Fig. 119.

Sections showing Nipper and Cushion Plate.

fluted segment and half lap. Fig. 120 is a diagram of the nipper cam showing certain points which correspond to the figures on the timing dial.

In Fig. 117, it is assumed that the needles have finished combing and the nipper and cushion plate are open to allow the fibers to be drawn forward by the fluted segment. The opening movement commences at about $3\frac{1}{2}$ by the timing dial. The front edge of the fluted segment comes against the fibers and is about half by when the nipper and cushion plate are wide open which is at $6\frac{1}{2}$.

By referring to the diagram of the nipper cam (Fig. 120), it will be seen that the point marked $6\frac{1}{2}$ is just at the cam roll and the index finger points midway between 6 and 7 on the dial. As the cam continues to turn, the nipper cam lever, J^3, is depressed owing to the shape of the groove in which the cam roll, T^4, runs. This depression causes the nipper shaft, J, to turn slightly and an upward movement of the rod, L^1, takes place through the nipper shaft lever, J^1.

The upward movement of the rod, L^1, causes the nipper arm, N^2, to turn about its fulcrum at V which brings the nipper

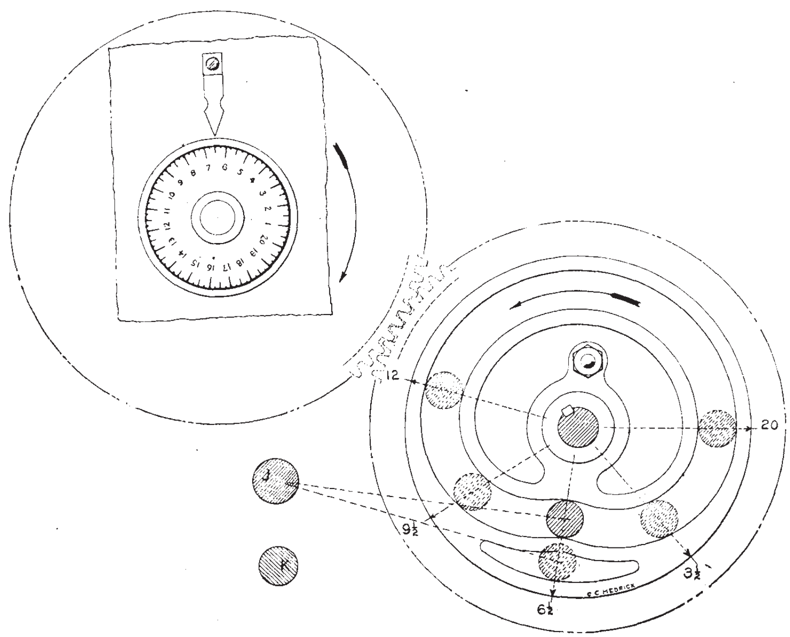


Fig. 120. Diagram of Nipper Cam.

knife into contact with the cushion plate, gripping the cotton firmly. This takes place when the dial is at 9½ and the parts are in the position shown in Fig. 118.

The back edge of the fluted segment has passed by the front of the cushion plate and this brings that portion of the cylinder, which is smaller in diameter than the segment and half lap, just beneath the cushion plate and nipper and permits the end of the lap, which is held suspended between them, to assume a position so that the needles of the half lap may thoroughly comb the mass of cotton.

We have seen in Figs. 117 and 118, that the movement of the nipper arm, N^2, is simply around its fulcrum, V, but, as the nipper cam continues to revolve, the nipper cam lever is moved away from the center of the cam, causing a still greater depression of the nipper knife. It is evident that it must bear with considerable more force against the cushion plate. This pressure causes the spring, L^3, to yield and the cradle to move slightly around its fulcrum, Z, as shown by the position of the parts in Fig. 119.

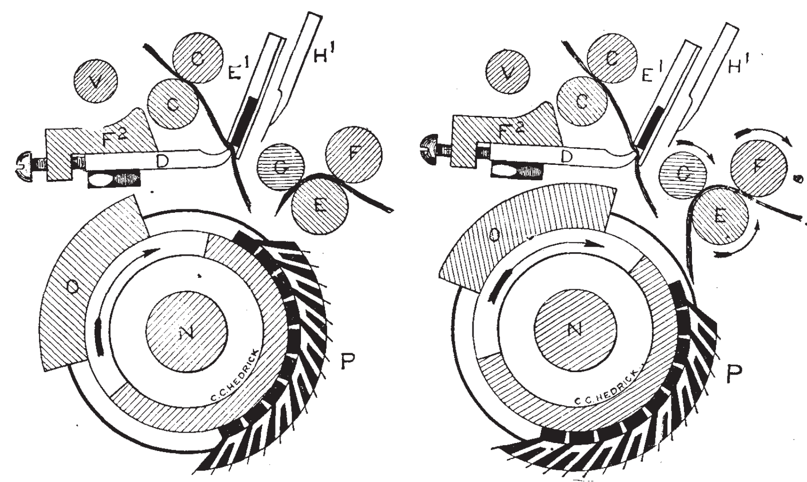


Fig. 121. Fig. 122.
Sections showing Detaching Rolls and Cylinder.

This double motion of the nipper knife, first around its own fulcrum and then around the fulcrum of the cradle, brings the cotton down near the needles just previous to the commencement of the combing action. This occurs when the timing dial is at about 12, the parts remaining in the position until all of the needles have passed through this cotton which is at about 20. The nipper and cushion plate then commence to raise, from the cylinder, into a position so that the cotton may be detached and they then open and the cycle of movements is repeated.

Detaching Roll Motion. Following in regular order, the next feature, and one which requires considerable explanation, is the detaching roll motion, by which the fibers are detached from between the nipper and cushion plate and attached to those fibers that have already been combed at a previous operation, as referred to in the general description of the comb.

It will be less confusing to first follow the movements of the detaching rolls and then the mechanism for obtaining these movements. Fig. 121 shows the rolls in stationary position with the end of the sliver protruding from between the leather covered detaching roll, G, and the steel detaching roll, E, in the position it was left when the rolls ceased their forward rotary motion. The

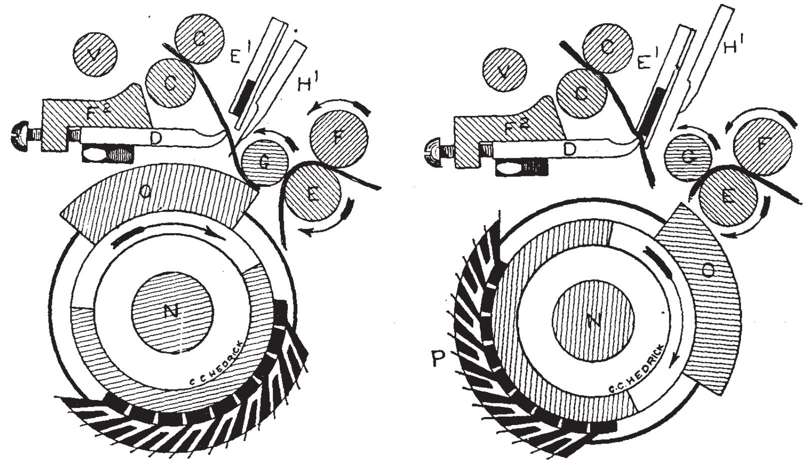


Fig. 123. Fig. 124.
Sections showing Detaching Rolls and Cylinder.

leather covered roll is raised to its highest position above the path of the fluted segment, O.

The first movement of the detaching rolls is to turn backwards to the position shown by the parts in Fig. 122. This movement occurs just after the needles have finished combing, and is sufficient to turn the sliver, which is shown hanging downwards in the space between the fluted segment and half lap, back about one and one-half inches. The front edge of the fluted segment is just coming into contact with the fibers which are hanging from between the nipper, E^1, and the cushion plate, D, and the leather detaching roll has started to move around the steel roll in the direction of the nipper.

Fig. 123 shows the rolls at the commencement of the forward movement. The fluted segment has continued to revolve and its front edge has swept along under the down hanging fibers which are to be detached. This action causes them to lie on the surface of the fluted segment and extended in the direction of the leather covered roll which has moved around the steel roll into contact with the fluted segment. The instant that these surfaces touch, the detaching rolls commence to turn forward and the fibers, lying on the surface of the fluted segment, are drawn forward between it and the leather covered roll.

The finish of the forward movement of the rolls is shown in Fig. 124. The front end of the fibers, between the fluted segment and the leather covered roll, are over-lapped on the top of those that were turned backward. The continued forward movement, which is about two and one-half inches, draws them upward between the rolls, G and E, and F and E, until their back end is in the same position as shown in Fig. 121. The pressure of the leather covered roll on the steel roll incorporates the newly combed fibers with those that were turned back.

The roll, G, moves around the roll, E, so that its surface is raised from contact with the fluted segment. The rolls all cease their forward movement and remain stationary, until the next revolution of the cylinder, when the operation of detaching, and piecing-up is repeated. The approximate gain in the distance the sliver is moved forward is one inch.

It would seem on closely studying Figs. 123 and 124 that the end of the sliver, which was turned back for piecing-up, would be rolled up between the roll, E, and the fluted segment, O, particularly as these surfaces turn in opposite directions, while O is passing E, but this cannot happen as there is a space of about one-sixteenth of an inch between them and the sliver simply touches lightly against the surface of O, as it is drawn upward between E and G.

Top Comb. At this point, reference should be made to the movements of the top comb, H^1, which are connected closely with the movements of the detaching rolls. When the fibers are being combed by the needles, it is evident that the end, held between the nipper and cushion plate, can receive no combing but as they are liberated by the opening of the nipper and are carried forward for piecing-up, the top comb, H^1, descends into the path of the cotton and it receives combing by being drawn through the teeth as shown by the position of the comb in Fig. 123. It is then quickly withdrawn and remains up, clear of the fibers, until the movements of the detaching rolls are repeated.

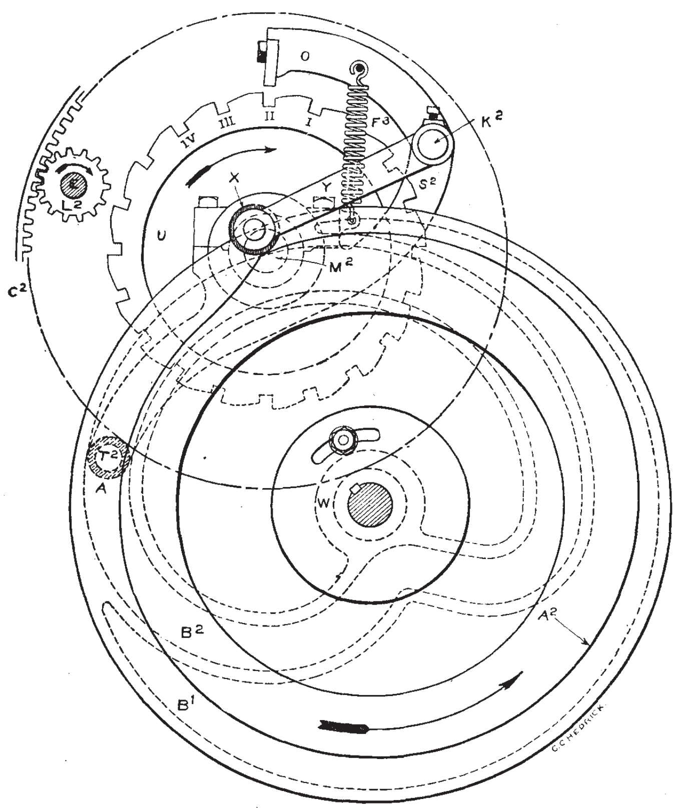


Fig. 125. Elevation Showing Detaching Roll Cams.

Detaching Roll Cams. To obtain the various movements of the detaching rolls, three cams are employed; those which impart rotary motion to all of the rolls are shown in Figs. 125 to 130 inclusive and the lifting cam which causes the rolls, F and G, to move around E is shown in Fig. 131.

Reference should be made first to Figs. 125 and 126 which show respectively the extreme forward and backward positions of the detaching roll cam lever. On the cam shaft, W, is keyed a cam, B1, in one side of which is a groove, B2. In this groove runs a roll, T2, which is carried by the detaching roll cam lever, S2, the shaft, M2, acting as a center around which, S2, is free to turn. Upon this same shaft are fastened a wheel, U, having

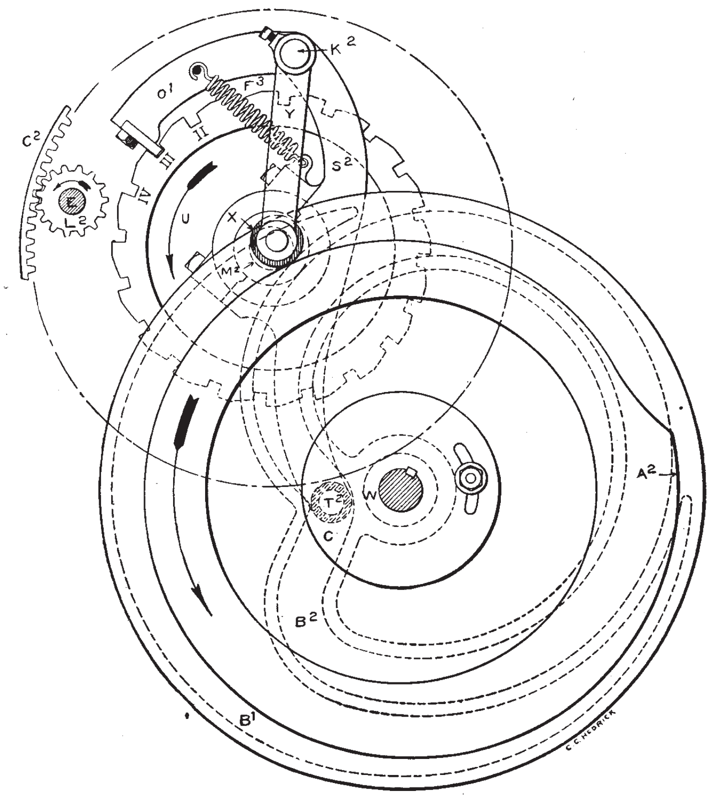


Fig. 126. Elevation Showing Detaching Roll Cams.

twenty teeth, or notches, and an internal gear, C2, of 138 teeth. A pawl, O1, which is fastened to a stud, K2, and which is carried by the upper end of the detaching roll cam lever, engages in the notches of the notched wheel and is held in contact with them by a spring, F3, while the internal gear is in contact with the pinion, L2, of eighteen teeth, which is fast on one end of the detaching roll, E.

As the cam revolves, the shape of the groove in it is such as to cause the pawl to move back and forth. The sides of the notches are square which permits the pawl to engage with them in either direction. This motion is communicated to the roll, E, by the notched wheel, the internal gear and the pinion causing it to rotate forward and backward.

By examining the drawings, it will be seen that on the side opposite from the groove in the cam, B^1, is another cam, A^2, on

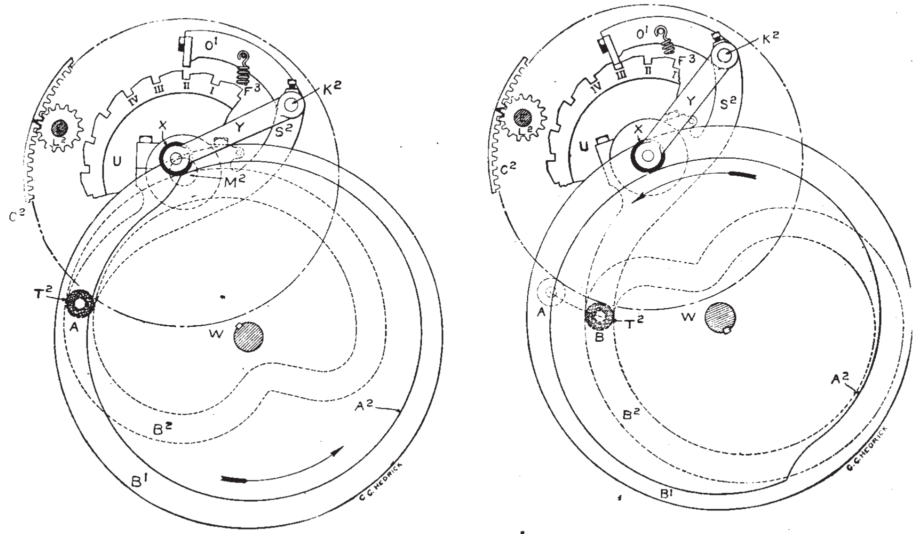
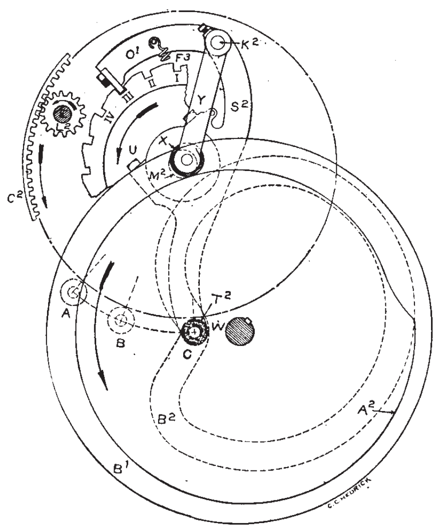


Fig. 127. Fig. 128.
Diagrams of Detaching Roll Cams.

the periphery of which runs a roll, X, which is fastened to the lower end of the arm, Y. The other end of the arm is fastened to the same stud as the pawl, O^1. This cam simply acts on the pawl, moving it in and out of contact with the notched wheel at the proper time.

The next four drawings Figures, 127, 128, 129 and 130, show the positions at different stages. All the parts, not absolutely essential to explain these movements, are omitted. Fig. 127 shows the position of the cams after the detaching rolls have finished turning forward. The cam roll, T^2, is on the largest diameter of the cam which is indicated by the letter, A. The nose of the cam, A^2, has just come into contact with the roll, X, which has lifted the pawl, O^1, out of the notch in the notched wheel, marked by the numeral, II.

Fig. 128 shows the cams as having made about one-half of a revolution. This movement has advanced the cam roll from A to B and has caused the pawl to move from above notch II to III while the gradually decreasing diameter of the cam, A^2, has caused the cam roll, X, to drop and allow the spring, F^3, to draw the pawl into notch III. But it will be noticed that as yet no movements of the detaching rolls has taken place.



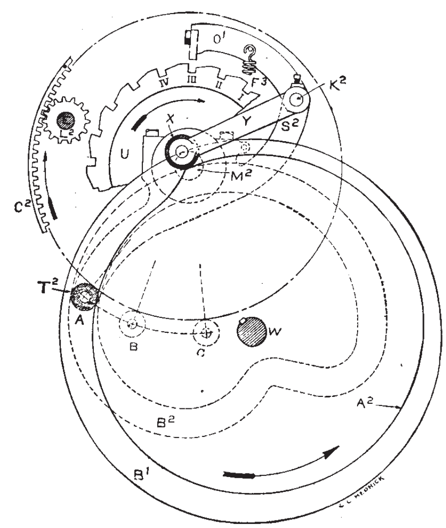


Fig. 129. Fig. 130.
Diagrams of Detaching Roll Cams.

In Fig. 129, the cams are shown as having completed about three-quarters of a revolution. The cam roll, T^2, is on the smallest diameter of the groove at C. The pawl, which is shown just entering notch III in Fig. 128, has engaged the whole depth of it and the continued revolution of the cams has turned the notched wheel to its extreme backward position, as indicated by the arrow. This movement through the internal gear, C^2, and the pinion, L^2, rotates the steel detaching roll, E, and turns back about one and one-half inches of sliver. The distance moved by the internal gear is shown by the relativ e positions of a dark spot marked upon the gears in Figs. 127, 128 and 129.

The completion of the revolution of the cams is shown in Fig. 130. The cam roll has moved from C back to A and the nose of the cam, A^2, has come into contact with the cam roll, X. This action lifts the pawl out of notch III, the parts remaining in the same relative positions as in Fig. 127, except that the notched wheel has advanced one notch, and at the next revolution of the

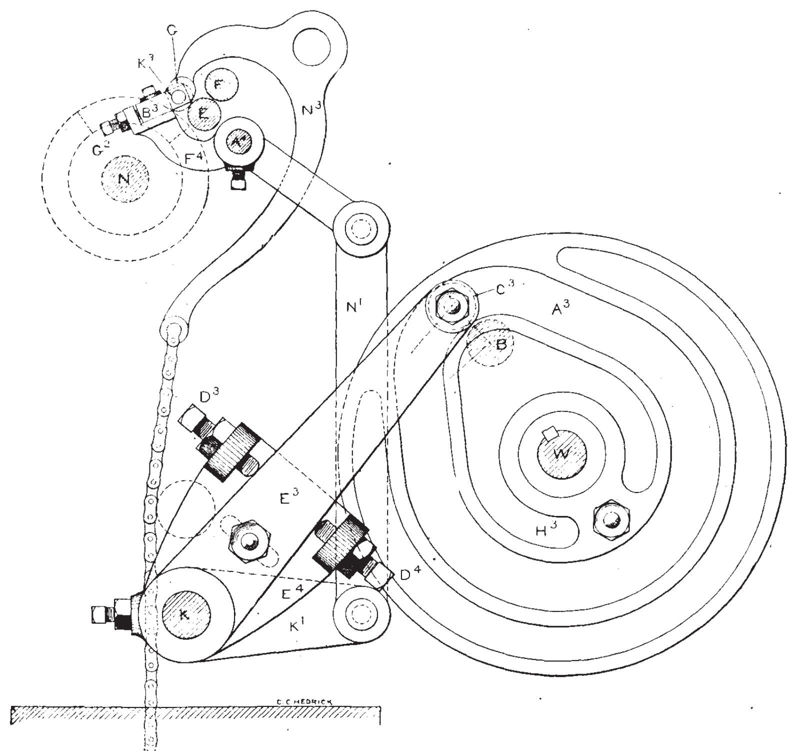


Fig. 131. Elevation showing Lifting Cam.

cam, the pawl will drop into notch IV. The point, marked by the dark spot, has advanced in the same proportion as the notched wheel, as will be seen by its position above the pinion.

The detaching rolls turn backwards at about $1\frac{1}{2}$ by the timing dial and continue until about 6. The forward movement then commences and continues until about 11.

Fig. 131 shows the device for moving the leather covered detaching roll in and out of contact with the fluted segment.

On the cam shaft, W, is fastened the lifting cam, H^3, with a groove, A^3, cut in its face. In this groove runs a roll, C^3, which is carried in one end of the lifting cam lever which is made in two parts, E^3 and E^4. The part, E^3, which carries the cam roll, is in reality loose on the lifting shaft, K, while the part, E^4, is keyed to K. The two parts are connected by the adjusting screws, D^3 and D^4, which are screwed through lugs on E^4 and bear against the sides of E^3. This permits a very close adjustment to be made when setting the parts. The lifting shaft, K, extends the whole length of the comb and upon it are fastened the lifting shaft arms, K^1, which are connected to the top lifting lever, F^4, by the upright arms, N^1.

On the back end of F^4 is a block, B^3, which bears against the bushing, K^3, on the end of the roll, G. These bushings are made square on the outside so as to give ample wearing surface against the blocks. A set screw, G^2, in the end of F^4, bears against the block which allows for adjustment. A weight, not shown in the drawing but connected to the stirrup, N^3, by a chain, holds the bushing firmly against the block. It also keeps the roll, G, in contact with the steel roll, E, and the fluted segment.

The drawing shows the position of the cam and parts with the roll, G, in contact with the fluted segment, the outlines of which are shown by dotted lines. As the cam revolves, the groove in its face causes the roll, C^3, to move from the position it is in towards the center of the cam to a point marked B, as shown by dotted lines. This movement causes the roll, G, to move around the roll, E, out of contact with the fluted segment. The cam roll continues on the small diameter of the groove until it is moved out at the next revolution.

Top Comb Motion. Fig. 132 shows the eccentric for operating the top combs. These combs, H^1, are carried by the comb arms, M^3, which are centered on the top comb shaft, N^3, at one end of which is an arm, W^1, which carries a roll, S^3. This roll runs on an eccentric, O^2, which is fastened on the cylinder shaft, N. At each of the comb arms is a dog, N^4, which is fastened to the top comb shaft and through a lug on the dog is a set screw, W^2, which bears against the comb arms. The arms are thus free to be turned up out of the way for cleaning or repairing the needles. As the eccentric turns, the top comb shaft is turned slightly and the combs put in and out of contact with the cotton.

Timing and Setting. The successful working of the comb depends almost wholly upon the timing and setting of the various parts so that one movement will follow another at the proper time. These can be varied, slightly, according to the length and quality

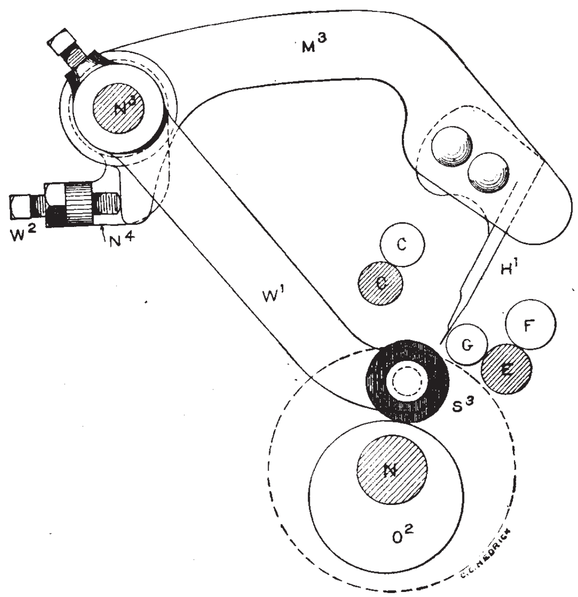


Fig. 132. Top Comb Eccentric.

of the cotton being used and the judgment of the one in charge of such work. The following are average timings and settings:

To set the cylinder: Turn the cylinder shaft around until number 5 on the timing dial comes beneath the index finger, then set the front edge of the fluted segment from the flutes of the steel detaching roll with $1\frac{1}{8}$-inch gauge and tighten the cylinders on the shaft.

To set the feed roll: Use $1\frac{15}{16}$-inch gauge between the flutes of the steel detaching roll and flutes of the feed roll, then tighten feed roll slides into place.

To set the cushion plates to the nipper knives: Put the cushion plate in place and set it up against the nipper knife with one thickness of ordinary writing paper between it at each end. Press the nipper firmly against the cushion plate and see that each piece of paper is held securely. This sets the cushion plate parallelly with the nipper knife.

To set the cushion plates from the steel detaching roll: Use 1¼-inch gauge between the lip of the plate and the flutes of the detaching roll.

To set the nipper knives from the fluted segments: First disconnect the upright rods, L^1, and use number 20 gauge between the edge of nipper knife and segment. The nipper stop screw, P^1, must project through the arm about one-quarter of an inch and a ¼-inch gauge must be placed between the point of the screw and the nipper stand. After setting the right-hand screw, remove the gauge and bring the left-hand screw up against the nipper stand. Next put a strip of writing paper between the point of each screw and stand and see that it draws with the same tension from each. The cylinder shaft should now be turned around until number 17 on the dial is under the pointer; the cam roll will then be on the largest diameter of the nipper cam. Put on the right-hand connecting rod and spring, try ¼ inch gauge between the nipper screw and stand, and adjust the nuts on the upright rod until the gauge will draw out with ease. After this, put on the left-hand rod and spring and have the gauge draw out with the same tension. Turn the cam back to the first position and try number 20 gauge, between the nipper knife and the half-lap, and see that everything is free.

To set the leather detaching rolls: Turn the cylinder shaft around until the dial is at 6¾, then put the rolls in position with the end bushings on and attach weights. Let the rolls rest against the fluted segment. Use number 23 gauge between the lifter block and bushing of roll. Set the right-hand side of one roll first; then turn the detaching roll cam around so as to bring the block up against the gauge. Next try the gauge between all of the other blocks and bushings and set the blocks up so that the gauge will draw from each with the same tension and tighten blocks in place. Put a strip of writing paper between the fluted segment and the leather detaching rolls at each end and adjust the cam lever so that the rolls will touch the segments at 6¾.

To time the nippers: Turn the cylinder shaft around until $9\frac{1}{4}$ comes under the pointer. Loosen the nipper cam and turn it around until the nipper stop screws leave the stands at $9\frac{1}{4}$ then make nipper cam fast on the shaft.

To set the top combs to the leather detaching rolls: Remove the end bushings from the leather roll and put $\frac{1}{32}$ inch gauge between it and the steel roll and have it touch, lightly, against the top comb, which should be inclined about thirty degrees, then remove the gauge from between the rolls and see that the leather roll is free from the comb.

To set the top combs to the fluted segments: Use number 20 gauge between the points of the comb needles and the segment. Set the comb by the stop screws with a strip of paper under each which should draw out with the same tension. Loosen the top comb eccentric and turn it around until the throw is downward and wedge the eccentric arm in place. Turn all the stop screws against the top comb arms and set each with a strip of paper. After setting all the combs, turn the shaft around to number 5 on the dial and set the top comb eccentric so that a strip of paper will not draw from between the nipper stop screw and stand.

To time the feed rolls: Turn the cylinder shaft around until the dial shows $4\frac{1}{2}$ under the pointer, then set the pin so that the feed rolls will start forward.

To time the detaching rolls: Turn the cylinder shaft around until the dial is at 6, then set the detaching roll cam so that the rolls will start to turn forward. The brass top rolls should be set from the leather rolls with number 21 gauge and their flutes should be in mesh with the flutes of the steel roll.

Owing to the naturally irregular disposition of cotton fibers, it is impossible to remove the waste without removing more or less long fibers, nor can the percentage of waste be known until after the cotton has been combed, as some varieties are much cleaner than others and contain fewer short fibers. The amount of waste is often increased by the faulty timing and setting of the parts.

There are various ways of controlling the amount of waste. In the top comb, the dropping varies from $4\frac{1}{2}$ to $6\frac{1}{2}$. If dropped at $4\frac{1}{2}$, more waste is combed out, as the comb needles enter the lap before it is drawn forward by the detaching rolls, while if dropped at $6\frac{1}{2}$, they do not enter the lap until after it has started, consequently some of the fibers escape combing.

The angle of the top comb and its distance from the fluted segment also control the amount of waste. The comb needles, which act as hooks upon which the fibers are caught, enter the lap at about right angles to the direction that it is drawn. Now it is evident, that the more acute this angle the greater is the retaining power, so that more waste will be removed. The nearer the needles are allowed to approach the fluted segment, the more they penetrate the mass of cotton, thus giving it a more thorough combing.

The time of starting the feed rolls varies from 4 to 6; if started at 6 more waste will be made than if started at 4, as the later the feed rolls start, the more the lap is liable to curl and not pass freely between the nipper and cushion plate. Curling causes the lap to bunch in places and when these bunches are acted upon by the cylinder needles, more of the long fibers are combed out than would be the case if the lap were perfectly smooth and even.

The closing of the nippers takes place from 9 to 10. If closed at 10 more waste is made than at 9. The reason for this is very apparent. If the nipper does not close until the comb needles have commenced to work, the cotton will draw from between the nipper and cushion plate. This late closing, as it is called, should be avoided, as many of the long fibers will be combed out with the waste which would otherwise be carried forward with the sliver.

The leather detaching roll is brought into contact with the fluted segment at $6\frac{3}{4}$. If brought into contact before $6\frac{3}{4}$ more waste is made.

The length of time the leather detaching roll is allowed to remain in contact with the fluted segment also controls the waste. A number 25 gauge, used between the lifter blocks and the bushings of the leather roll, will give more waste than a number 21 gauge, as it is thinner and allows the leather roll to remain in contact with the fluted segment longer.

The leather detaching roll starts to turn forward at $6\frac{1}{4}$. If started before this, more waste is made than if started after, as the forward rotary movement of the roll together with the rotary movement of the fluted segment detaches the cotton from between

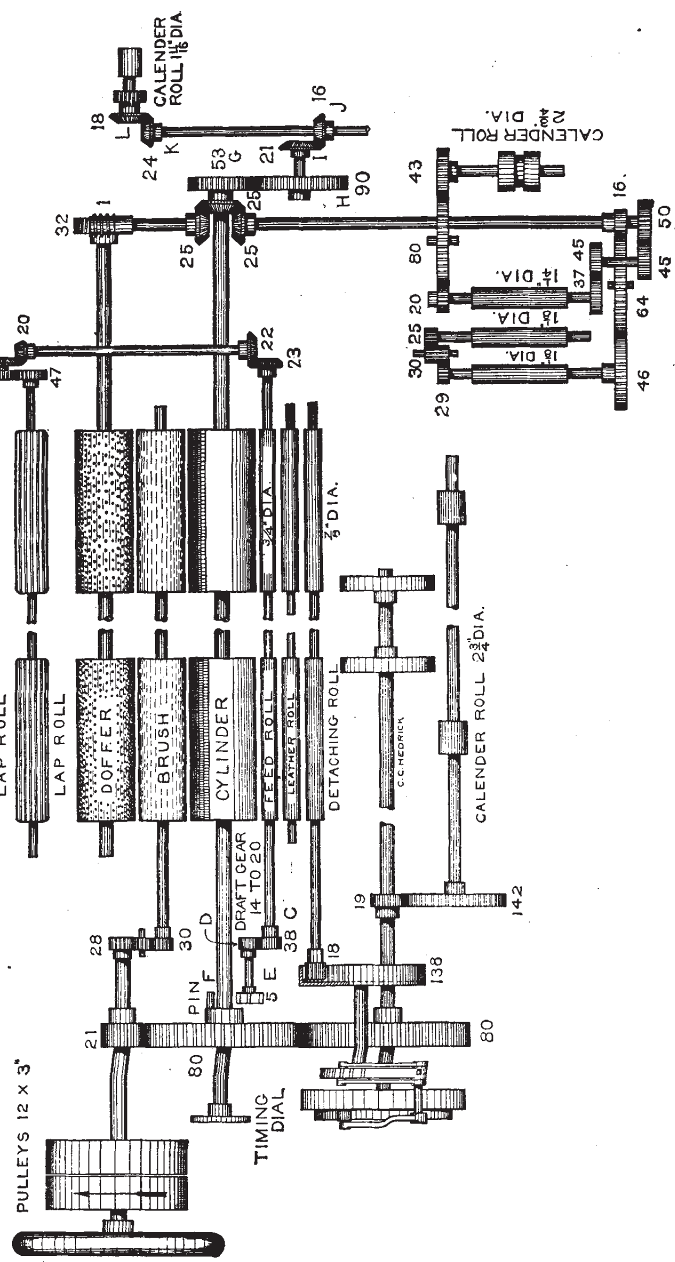


Fig. 133. Diagram of Comber Gearing.

the nipper and cushion plate, and, if this movement commences before the nipper is opened sufficiently to allow the cotton to be drawn forward, the fibers are broken.

Gearing. In order to work out the various calculations, a diagram of the comber gearing is given in Fig. 133. The usual speed of the driving pulleys, which are twelve inches in diameter by three inches face, is about 300 revolutions per minute. On the outer end of the driving shaft is a heavy balance wheel, which serves a double purpose, namely, to enable the cylinder shaft to be turned readily when setting the various parts and to prevent any fluctuations in the speed of the comb, as the cylinder shaft turns much harder while the needles are passing through the cotton than at any other time. Were it not for this balance wheel, the comb would run with considerable vibration, which tends to loosen the screws and bolts, as well as to disturb the settings.

On the inside end of the driving shaft is a gear of 21 teeth, in gear with one of 80 teeth which is fastened to the cylinder shaft. The speed of the cylinders is therefore about 78 revolutions or nips per minute.

The feed roll, which is $\frac{3}{4}$ of an inch in diameter, is driven from the cylinder shaft by a pin and a star-wheel having 5 teeth. On the same stud as the star-wheel is the draft or change gear, D, of from 14 to 20 teeth, by which the feed is regulated.

The calender rolls in front of the cylinders are driven from the cylinder shaft by a gear of 80 teeth which drives a similar gear of the same number of teeth. On the shaft with the latter is another gear of 19 teeth, which drives one of 142 teeth, which is upon the calender roll shaft.

The draft rolls are driven from the foot end of the cylinder shaft by a gear of 25 teeth, which drives another of 25 teeth. On this same shaft are two gears, one of 16 teeth, which drives the back roll through an intermediate of 64 teeth and one of 46 teeth which is upon the back roll.

The front roll is driven from the gear of 50 teeth, through the double intermediate of 45 teeth and the gear of 37 teeth. The calender roll in front of the draft rolls is driven from the other end of the front roll by the gears of 20, 80 and 43 teeth. The middle roll is driven from the back roll by the gears of 29, 30 and 25 teeth.

The coiler is also driven from the cylinder shaft, through the gears of 53, 90, 21 and 16 teeth, the last being upon the upright shaft in the coiler. At the top of this shaft is a gear of 24 teeth, driving an 18 toothed gear which is upon the calender roll.

The lap rolls are driven from the feed roll by the gears of 23, 22, 20, 55, 35 and 47 teeth. The first and last mentioned are upon the feed roll and lap roll respectively, and, as the motion of the feed roll is intermittent, the lap rolls receive a corresponding movement.

The doffer is driven by a single worm and worm gear of 32 teeth and a bevel gear of 25 teeth, from the same gear which drives the draft rolls. The brush and the doffer comb are driven from the driving shaft, the brush by the gears of 28, 35 and 30 teeth and the comb by a connecting rod, one end of which is fastened to an arm on the cam shaft and the other working on a pin set eccentrically in the 28 toothed gear on the driving shaft. By this means, the comb is given an oscillating motion.

Calculations. The production of the comb is governed by the weight of the laps per yard, the number of revolutions that the cylinder makes per minute, the draft of the comb and the amount of waste. A glance at the diagram of the gearing will show that the calender rolls in the coiler are the last through which the sliver passes, and the length delivered by them at each revolution of the cylinder should be taken into account in figuring the production. These rolls are $1\frac{1}{16}$ inches in diameter and make 1.03 revolutions to one of the cylinder, which gives a delivery of 5.3 inches for each revolution.

Following are the principal calculations for the comb.

Rule 1. To find the production of the comb in pounds: Multiply together the number of revolution of the cylinder per minute (80), the number of inches of sliver delivered at each revolution (5.3), the weight in grains of one yard of lap, less the percentage of waste (212.5), the number of laps (6) and the number of minutes run per day, less 10 per cent for time lost in cleaning (540). Divide the product by 7,000 (the number of grains in one pound), multiplied by 36 (the number of inches in a yard) and by the draft of the comb (24.47).

Example: $$\frac{80 \times 5.3 \times 212.5 \times 6 \times 540}{7000 \times 36 \times 24.47} = 47.34$$

In this example, the weight of the laps is given as 212.5 grains, or 250 grains less 15 per cent for waste which is a fair average.

Rule 2. To find the draft of the comb between the calender rolls in the coiler and the feed rolls: Multiply together the driving gears and the diameter of the coiler calender rolls and divide the product by the product of the driven gears multiplied together with the diameter of the feed roll. (The driving gears are C, E, G, I and K, and the driven gears are D, draft gear 18 teeth, F, H, J and L.) To avoid fractions, the diameter of the feed roll, which is $\frac{3}{4}$ of an inch can be called 12 as there are $\frac{12}{16}$ in $\frac{3}{4}$ of an inch and the diameter of the coiler calender rolls, which is $1\frac{11}{16}$ inches, can be called 27.

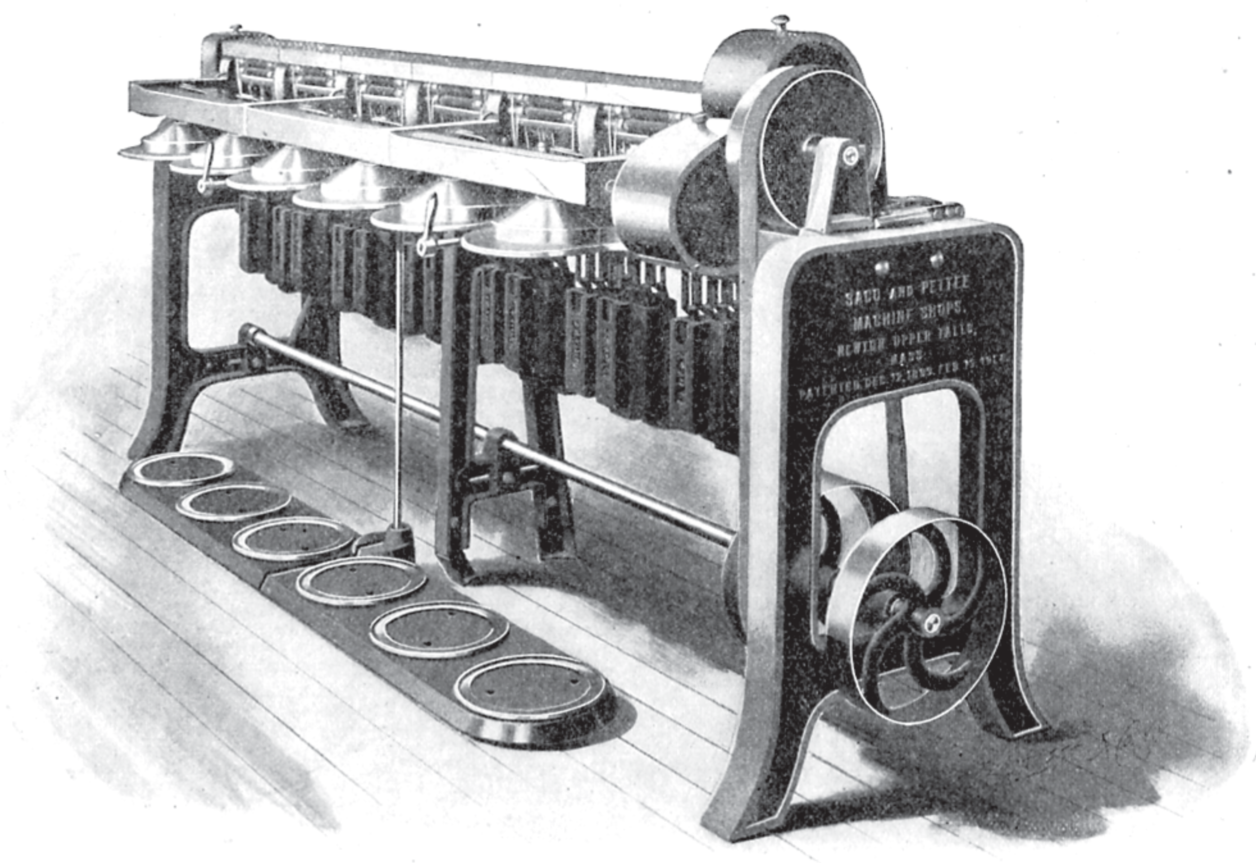
Example: $\frac{38 \times 5 \times 53 \times 21 \times 24 \times 27}{18 \times 1 \times 90 \times 16 \times 18 \times 12} = 24.47$

Rule 3. To find the draft factor: Proceed as in rule 2 but omit the draft change gear D.

Example: $\frac{38 \times 5 \times 53 \times 21 \times 24 \times 27}{18 \times 1 \times 90 \times 16 \times 12} = 440.53$

Rule 4. To find the draft: Divide the factor by the number of teeth in the draft gear (18).

Example: $440.53 \div 18 = 24.47$.



IMPROVED DRAWING FRAME — FRONT VIEW
Saco & Pettee Machine Shops.

COTTON SPINNING

PART IV

DRAWING

In all the processes previously described, except when combing was introduced before drawing, the principal object has been to free the cotton from as much foreign substance as possible, and no attempt has been made to form a thread. When the sliver leaves the card, the fibers are in a very irregular and confused mass and it is evident that the fibers must be straightened and parallelized to reduce the sliver to a thread.

The object of the drawing process is threefold: To make the fibers lie in parallel order, to make the sliver as even in weight as possible by doubling a certain number at the back of the machine, and to reduce the weight of the sliver, if necessary, by a certain amount of draft.

Drawing is carried out on two distinct types of machine, the Railway Head and the Drawing Frame.

RAILWAY HEAD

Originally, the railway head was used in connection with the stationary flat card as the first drawing process, which was followed by a second and, usually, a third process in which the drawing frame was used. With the general adoption of the revolving flat card the railway head is gradually falling into disuse, but as many of the older mills are still equipped with them and as they are found, occasionally, in operation in some of the most recently constructed mills, it seems fitting that a brief description of the operations and arrangement of the machine and its connection with the stationary flat card shall be given.

Fig. 134 shows in plan two lines of stationary flat cards with a railway head at the end of each line. The slivers, from the calender rolls of the cards in each line, are delivered into a railway trough or box, and on to an endless belt and are carried to the head end of the trough. Here they pass between a pair of rolls and are drawn between guides and passed between the draft rolls of the railway head into a can which is then taken to the back of the drawing frame.

The railway head is built both single and double. A single head, or delivery, is designed to take care of the slivers from six to

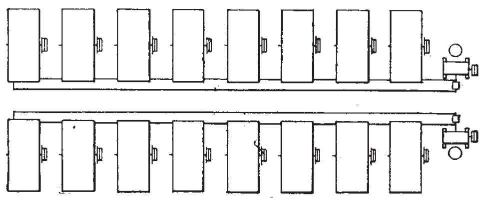


Fig. 134. Plan of Two Single Lines of Cards.

twelve cards. In the illustration (Fig. 134) there are eight cards in each line, delivering into one single railway head.

In most cases two single, or one double, railway heads are used with a double line of railway troughs, placed as shown in Fig. 135. This illustration shows two sections of seven cards in each line, delivering into separate boxes.

The doffers are driven from the railway head to which they are connected by feed shafts, running parallel to the troughs, and with the stopping of the railway head, the delivery from the cards

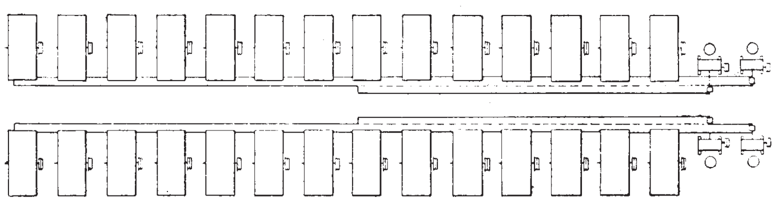
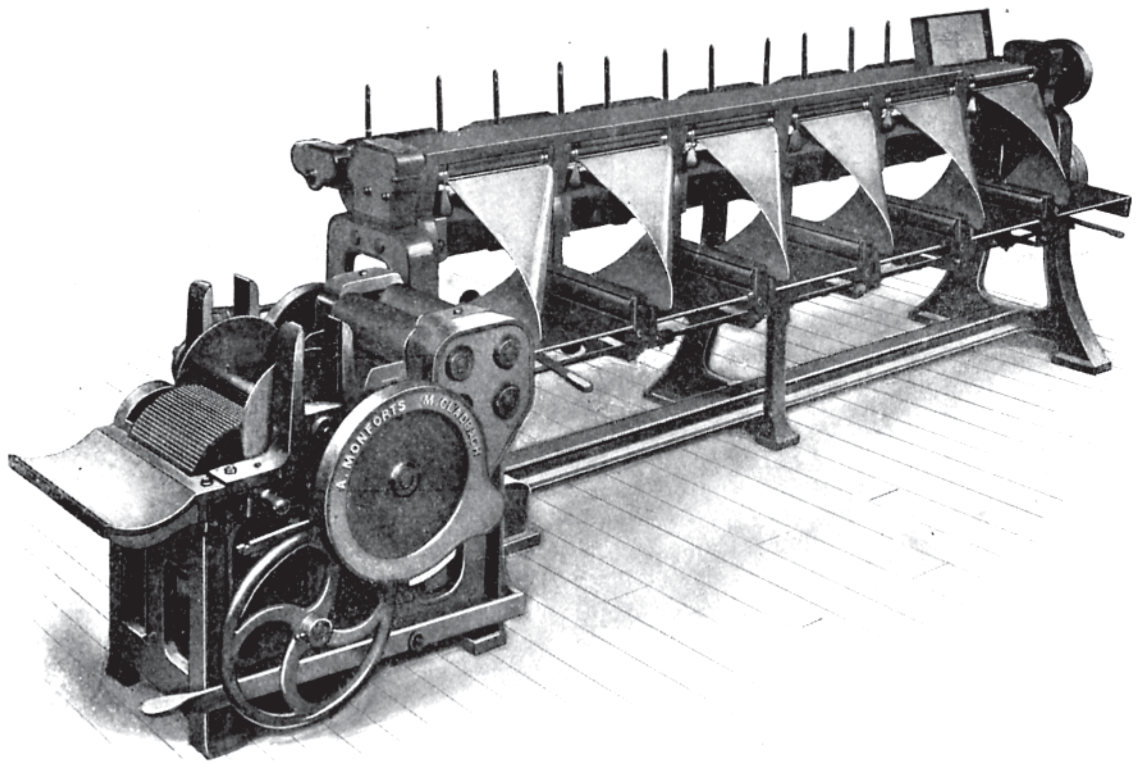


Fig. 135. Plan of Two Double Lines of Cards.

also must cease. This brings about a condition for which the railway head was primarily designed and which needs considerable explanation.

As the cards require grinding periodically, it is evident that one card at a time must be stopped. This reduces the number of ends, or slivers, entering the railway head, and causes a corresponding reduction in the weight of the sliver delivered. That is, if there are eight cards, each delivering a fifty grain sliver, we shall have four hundred grains entering the back of the railway head and



RIBBON-LAP MACHINE EQUIPPED WITH FULL LAP STOP MOTION
Mason Machine Works.

with a draft of eight the sliver delivered at the front will weigh fifty grains:

$$\frac{8 \times 50}{8} = 50$$

Now, if we drop out one sliver, we will have three hundred and

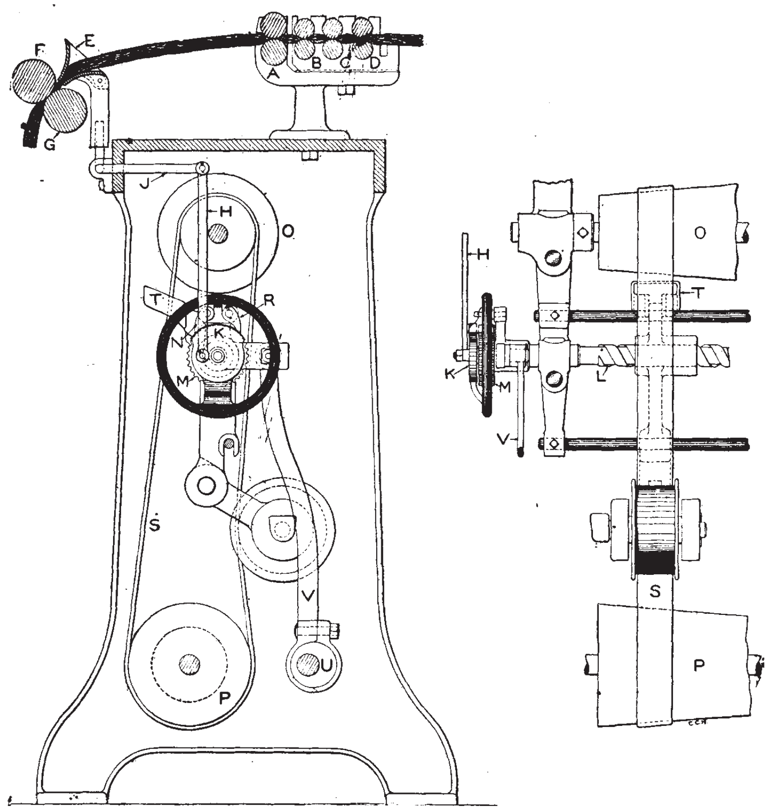


Fig. 136. Section of Railway Head Showing Evener.

fifty grains only, entering the railway head and with the same draft the delivered sliver will weigh 43.75 grains:

$$\frac{7 \times 50}{8} = 43.75$$

To overcome this difficulty, the railway head is provided with an evener motion which is shown in Fig. 136.

Evener Motion. The sliver from the railway troughs passes between the draft rolls, D, C, B, and A and then through the trumpet, E, and between the calender rolls, F and G. The speed of the back roll, D, is constant as a certain relation must be maintained between it and the speed of the card calender rolls, and to increase or decrease the weight of the sliver, the speed of the front roll must be changed.

The front roll is driven through a pair of cones, O and P, by a belt, S. P is the driver, running at a constant speed, and drives the back roll gearing. The speed of O is changed according to the

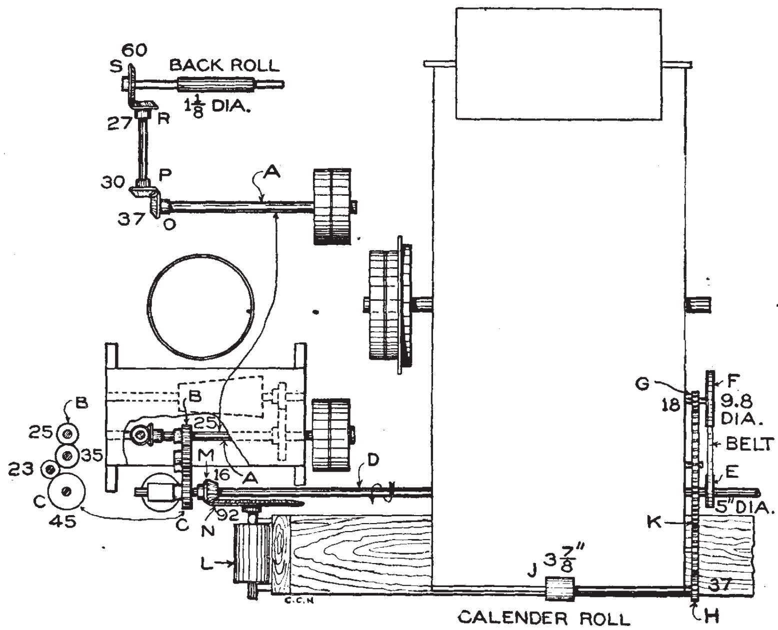


Fig. 137. Gearing Connecting Cards with Railway Head.

position of the cone belt. If the sliver is too heavy, the front roll must run faster to increase the draft and reduce the weight, while if it is too light, a corresponding decrease in the speed must take place.

The cone belt, S, passes through a guide, T, which is mounted upon the screw, L. Fast upon one end of the screw is a gear, M, while loose upon the same end is a shield, K, and a pair of pawls, N and R. The pawls are given a reciprocal motion by the eccentric, U, and arm, V, and the shield is connected to the trumpet by the rod, H, and the lever, J.

The trumpet is balanced so that when the sliver is at its normal size, the shield, K, prevents either pawl from engaging the teeth of the gear, M. But should there be a thin place, from an end being out or from any cause, the trumpet will fall back immediately and, through the connections, allow the pawl, N, to engage the teeth of the gear. This turns the screw and moves the cone belt towards the large end of the driven cone, O, making a reduction in the speed of the front roll and a corresponding reduction in the draft, which will continue until the light portion of sliver has passed through the hole in the trumpet.

If the sliver is too heavy, the reverse action of the parts described takes place and the speed of the front roll is increased.

The action of the evener depends wholly upon the friction of the sliver in passing through the hole in the trumpet and, while no great change takes place in the weight of the cotton entering the back of the railway head, unless an end is out, the thick and thin places in the sliver keep the trumpet moving back and forth continually changing, to a slight extent, the speed of the front roll.

The defect in the evener motion is very apparent. As the evener is so slow in its movements, a considerable length of sliver must be delivered before the speed of the front roll is changed enough to rectify the weight.

Gearing. The gearing, connecting the cards with the railway head, is shown in Fig. 137. On the driving shaft, A, is a gear, B, of twenty-five teeth, which drives another gear, C, which has forty-five teeth, on the feed shaft, D, through two carrier gears of twenty-three and thirty-five teeth. On the feed shaft at each card is a feed pulley, E, five inches in diameter, which drives the doffer pulley, F, 9.8 inches in diameter, by a belt, and on the same stud with the doffer pulley is a gear, G, of eighteen teeth, which drives the card calender rolls, J, through the calender shaft gear, H, of thirty-seven teeth and the doffer gear, K, of one hundred and eighty teeth.

The railway trough drum, L, which is six inches in diameter, is driven from the feed shaft by the bevel gears, M, of sixteen teeth, and N, of ninety-two teeth, and the back roll of the railway head is driven from the driving shaft by the bevel gears O,P,R and S of thirty-seven, thirty, twenty-seven and sixty teeth respectively, shown in the detached sketch in the upper left hand corner.

Between the back roll of the railway head and the railway trough drum, there is a slight draft and between this drum and the card calender roll, there is also a draft which may be ascertained in the usual manner.

Draft between railway head back roll and railway trough drum:

$$\frac{9 \times 27 \times 37 \times 45 \times 92}{60 \times 30 \times 25 \times 16 \times 48} = 1.07$$

Draft between the railway trough drum and the card calender rolls:

$$\frac{48 \times 16 \times 9.8 \times 37}{92 \times 5 \times 18 \times 31} = 1.08$$

The revolutions of the railway head driving pulley determine the speed of the card doffers and determine the production of the card. Thus, when a change in the production of the card is required and the weight of the sliver is to remain the same, the speed of the driving pulley must be changed. In Fig. 137, the driving pulleys are shown as making 35.28 revolutions per minute to one of the doffer.

$$\frac{180 \times 9.8 \times 45}{18 \times 5 \times 25} = 35.28$$

Fig. 138 shows a diagram of the draft gearing of the railway to which reference will be made under the head of calculations.

DRAWING FRAMES

Arrangement. When drawing frames are used, they are arranged in two and often three processes, or sets, usually placed across the mill as shown in plan in Fig. 139 and in elevation in Fig. 140. They are built with from two to eight deliveries to a head and from one to five heads to a frame. When more than one head is used to a process, they are coupled together and all are driven from an underneath shaft; thus in Figs. 139 and 140 each process consists of one frame of four heads with six deliveries to each head, or twenty-four deliveries to each process. On the right end of each frame is a pulley, A, which is driven from a similar pulley, B, on the main line by a belt, D. The pulley, A, is upon an underneath shaft, F, which extends the length of the frame, and upon it are the pulleys, C, for driving each individual head. The shaft, F, is in motion all of the time that the main line is running, motion being transmitted to the tight and loose pulleys of each head by the belts, E. By this means the stopping of one head in a process does not affect the others.

Sometimes the drawing frames are arranged longitudinally, as shown in Fig. 141. They are then coupled with coilers or deliveries placed alternately as in the drawing, which shows three proc-

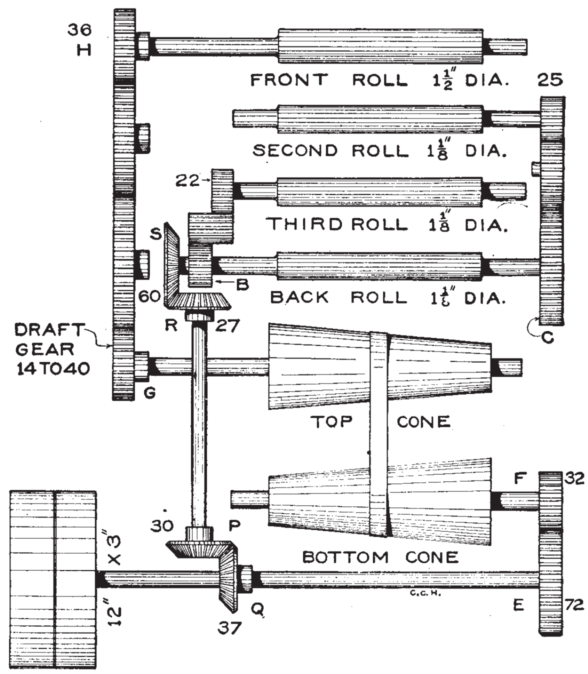


Fig. 138. Diagram of Railway Head Draft Gearing.

esses. The cans from F and H deliver in the same alley while those from G deliver at the back of H.

When one head is used in a process, it is referred to as a frame and the underneath shaft is generally omitted, the frame being driven directly from an overhead counter shaft in the same way as in Fig. 142.

The most commonly used arrangement of drawing frames, with respect to cards, is the one shown in Fig. 139.

The principal point to be kept in mind is, that the cans of sliver shall be taken in as direct a line as possible, from the card coilers to the back of the first process of drawing, and that no unnecessary movements shall be made by the tenders of the drawing frame.

Operation. The actual operation of drawing is very simple and consists of passing the slivers between several pairs of rolls, each pair running at a greater speed than the preceding one. The rolls are set at a certain distance apart, slightly more than the length of the cotton fibers, so that two pairs cannot have any direct contact with the same fibers at the same time.

What actually takes place may be described best by referring

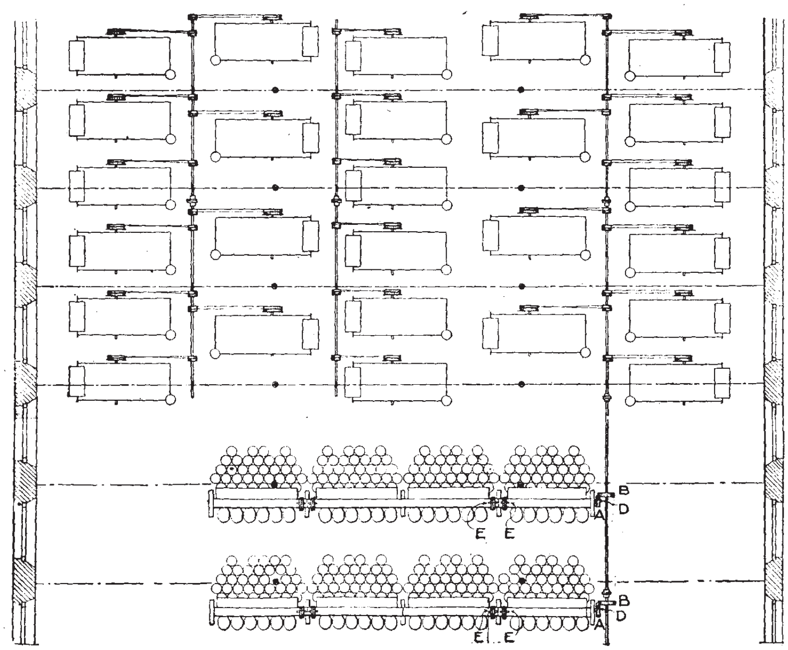


Fig. 139. Plan of Card Room Showing Drawing Frames.

to Fig. 143, which shows in section four pairs of drawing frame rolls.

The cotton enters between the back rolls, DD, and is drawn between the next pair, CC. Now as the speed of CC is slightly more than that of DD, it is evident that the fibers, which are under the influence of rolls, CC, will be withdrawn from the mass between DD, the friction existing among the fibers causing them to straighten in being drawn one by another. This action is still further carried out as the sliver is drawn between the remaining rolls in the set.

Fig. 144 shows a general section of a drawing frame. The slivers, S, are drawn upward through the sliver guide, T, and be-

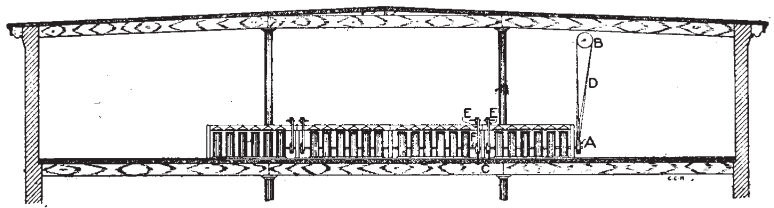


Fig. 140. Elevation Showing Drawing Frames.

tween the fluted carrier roll, P, and the top roll, N¹, then between the four pairs of draft rolls, D,C,B,A, where it receives a draft, usually as great as the number of cans put up at the back. Thus,

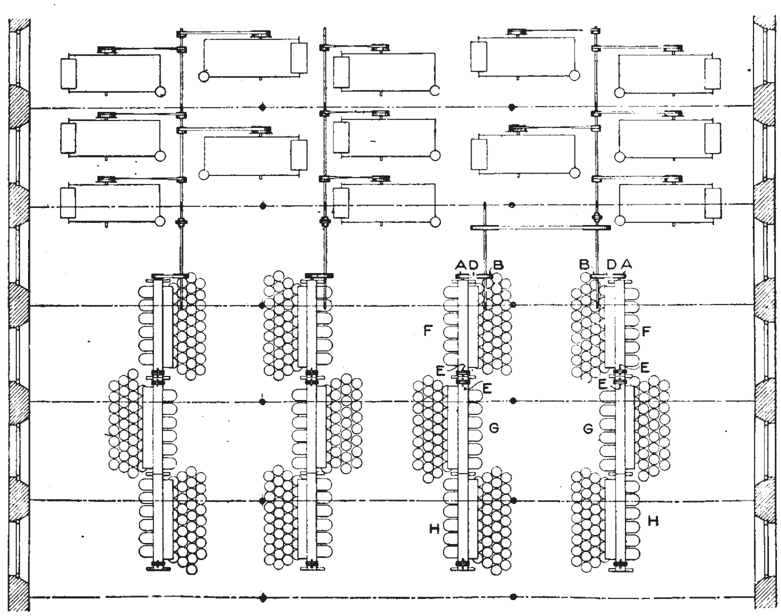


Fig. 141. Plan of Card Room Showing the Drawing Frames Arranged Longitudinally.

if there are six cans at the back, and the sliver from these cans is drawn through as one sliver, or doubled six into one, the machine is given a draft of six, so that the weight of the sliver being delivered is the same as the weight of that from each can. While this is the usual practice, it is not a rule to follow, as general conditions and requirements determine the best draft and weight of sliver to be adopted.

Upon leaving the draft rolls, the sliver is drawn over the

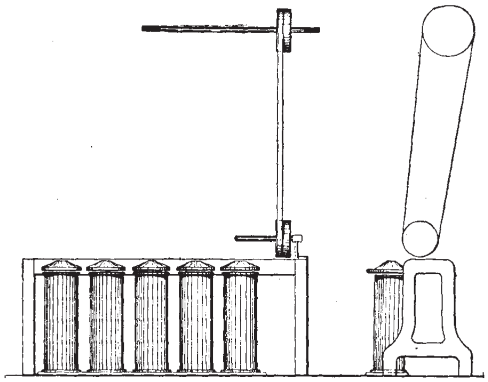


Fig. 142. Front Elevation of Drawing Frame Driven from Above.

sliver plate, J, through the trumpet, N, and between the calender rolls, E and F. From this point, it falls through the spout of the coiler, G, and is coiled in the can, H.

Stop Motions. The drawing frame is provided with four stop motions: A full can stop motion which operates when a set of cans

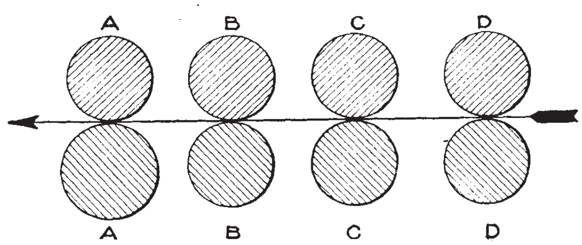
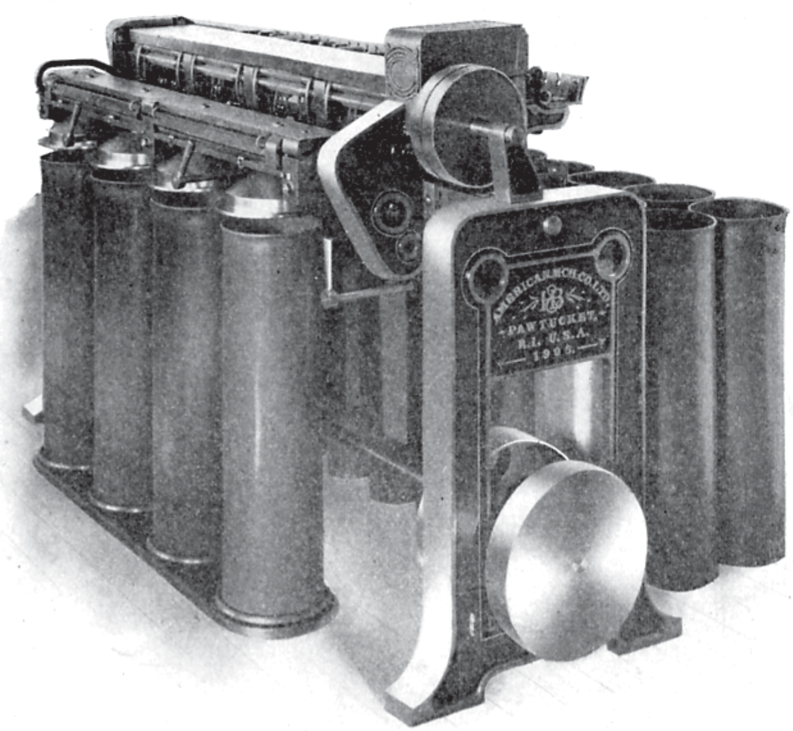


Fig. 143. Section Showing Draft Rolls.

at the front of the machine becomes full, two calender roll stop motions which operate when the sliver is absent from between the calender rolls or when a "wind-up" occurs on either of them, and a back stop motion which causes the head to stop when the sliver breaks at the back of the frame or a can becomes empty.

The necessity for a back stop motion becomes more apparent when we consider that after the drawing processes there is no opportunity to rectify, to any extent, the inequalities in the weight



DRAWING FRAME WITH ELECTRIC STOP MOTION
Howard & Bullough Am. Machine Co. (Ltd.)

of the sliver. When we realize that in doubling six into one, the breaking of an end means 16% difference in the weight of the sliver, we soon see the need of a stop motion. If six slivers, each

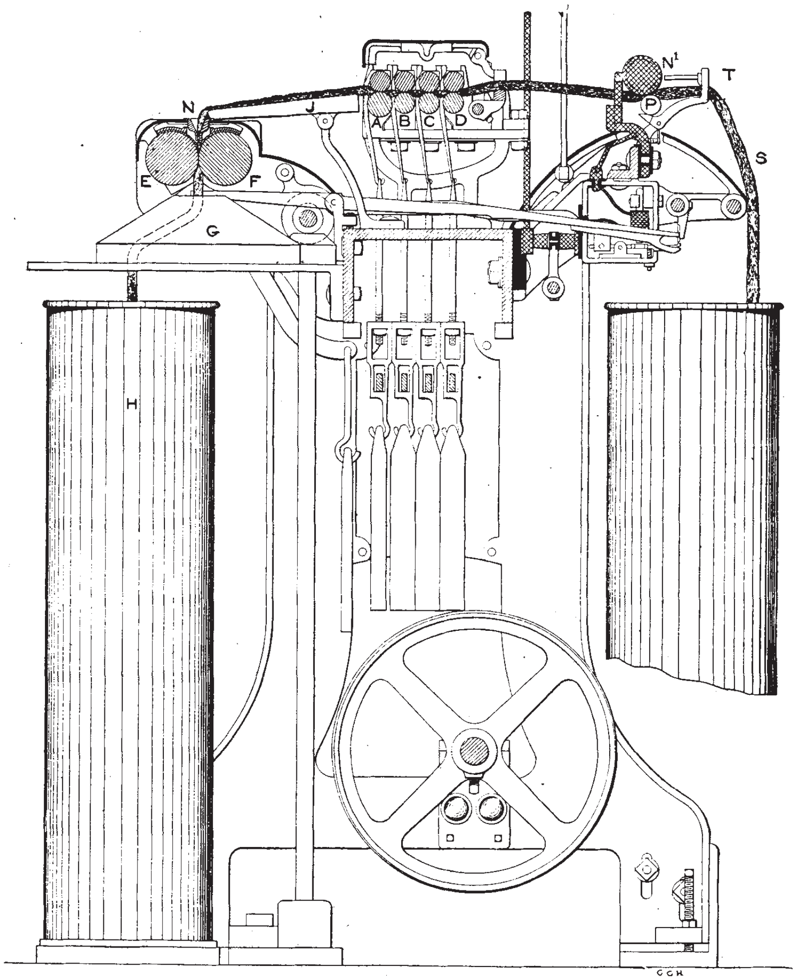


Fig. 144. General Section of Drawing Frame.

weighing sixty grains per yard, were doubled with a draft of six we should still get a sixty grain sliver, but if an end should break, the weight of the slivers would be fifty grains, or 16% lighter.

Of back stop motions, there are two styles used, mechanical and electrical. Opinions are divided as to which is the better one.

Electrical Stop Motion. The principle, upon which the electric back stop motion operates, depends upon the fact that cotton is an insulator or non-conductor of electricity and that the slivers, passing between two rolls connected with opposite poles of an electric generator, prevent the flow of the electric current. As long as the sliver is between these rolls, the stop motion remains inoperative, but should it break and allow the rolls to come together, the circuit is completed and the machine stops instantly.

Fig. 145 shows a section of the electric back stop motion magnet box which should be referred to in connection with Fig. 144. The electric current for operating this stop motion is con-

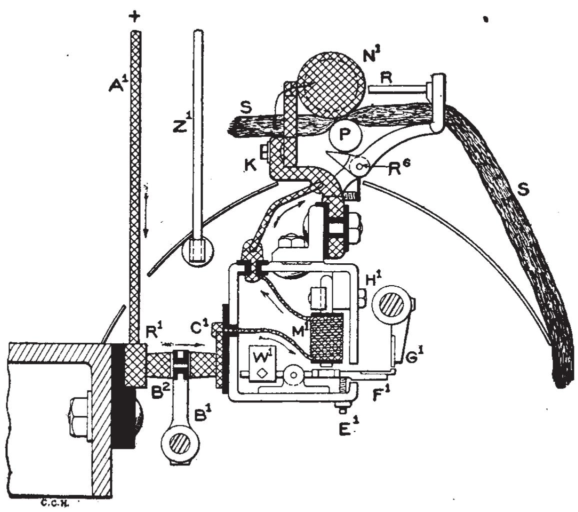


Fig. 145. Magnet Box for Electric Back Stop Motion.

ducted by means of rods, or wires, from the generator, which is conveniently located and is usually furnished for a certain number of deliveries of drawing.

The positive pole or wire, A^1, is indicated by the sign + and the negative wire, Z^1, by the sign –. The machine is practically divided into positive and negative poles by insulating material throughout, the terminals of the poles being at the rolls P and N^1. The current flows from the generator, as indicated by arrows, to the contact block, R^1, through the contact springs, B^2, contact plate, C^1, and the electro-magnet, M^1. From the electro-magnet it passes upward on the wire connection to the stop motion roll stand, K, and terminates in the top roll, N^1, which runs in contact with K. The only point where the current can return to the generator is through the bottom or carrier roll, P, which is connected by the framing of the machine to the negative pole Z^1. So long as the sliver is between the rolls N^1 and P, the circuit is broken and no flow of the electric current takes place, but, should a sliver break or run out, the top roll, N^1, falls into contact with the carrier roll, P, completing the circuit from A^1 to Z^1. The instant that the current flows through the electro-magnet, it attracts the armature F^1 into the path of the vibrating arm G^1. As a consequence, the movement of the arm is arrested and the stop motion spring released, shipping the belt on to the loose pulley. The device for releasing the spring rod is the same for the electric stop

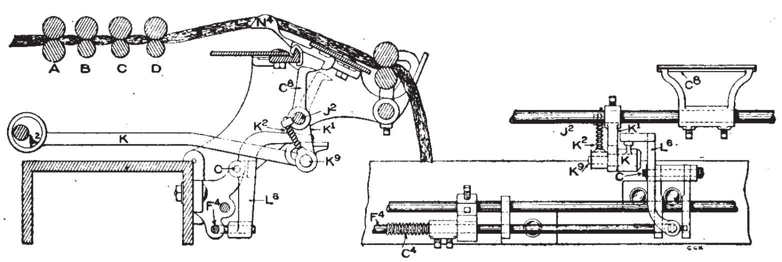


Fig. 146. Device for Releasing Stop Motion Spring.

motion as for the mechanical one and will be referred to in another paragraph.

The carrier roll, P, is fluted and extends the whole length of the head, but the top rolls, N^1, are made in short lengths with two bosses, one for each end of sliver. A lug on the stand, K, projects into a groove between the bosses and prevents any movement of the top rolls, longitudinally, on the carrier roll.

The sliver guide, R, which is pivoted at R^6, has a longitudinally projecting arm, which is just clear of the underside of the carrier roll. If the cotton should collect and wind up on the carrier roll, its increased diameter would depress the horizontal arm, causing the sliver guide to turn about the center R^6 and the adjustable pin R in its upper end will come in contact with the top roll. This completes the circuit and causes the frame to stop just as if the top rolls and carrier roll were brought into contact.

For explaining the device for releasing the stop motion spring, Figure 146 has been prepared. It shows a section of the drawing frame and all parts not actually necessary in the explanation are omitted. The rocker shaft, J^2, is operated by an eccentric, L^2, and is connected with it by an eccentric arm K, and a rocker arm K^1. A pin, K^9, in the eccentric arm, rests in the bottom of a slot in the rocker arm and is held in place by a spring K^2.

When any of the stop motions operate, the movements of the rocker shaft are arrested, and as the eccentric arm is positive in its movements, the stopping of the rocker shaft causes the pin in the eccentric arm to rise in the slot in K and in so doing, it is brought into contact with the latch lever, L^6. This causes the latch lever, which turns on a pin at C, to be withdrawn from a groove in the

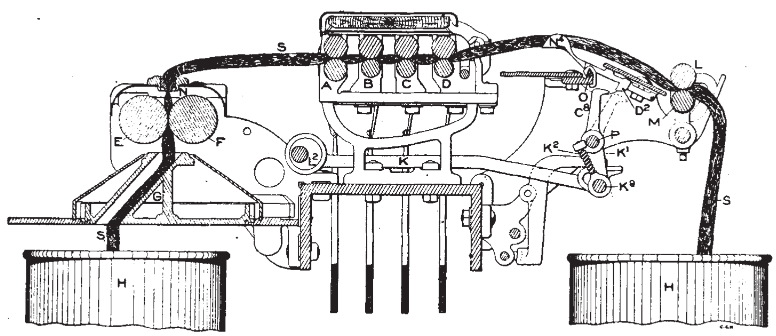


Fig. 147. Mechanical Back Stop Motion.

spring rod, F^4, releasing the spring, C^4, and moving the belt on to the loose pulley.

Mechanical Back Stop Motion. A drawing frame with a mechanical back stop motion is shown in section in Fig. 147. The slivers are drawn from the cans between two rolls, L and M. The roll, M, is continuous while L is made in short sections covering two slivers. From these rolls, the slivers pass forward over stop motion spoons, N^4, and between the draft rolls, D, C, B, and A, and finally pass as one sliver through the trumpet, N, between the calender rolls, E and F, and are coiled up in the can, H, by the coiler gear G.

The stop motion spoons are mounted upon a knife edge, O, and they are so balanced, that when the sliver passes over them, the back ends, D^2, are held clear of the path of the rocker arm C^8. If a sliver breaks, the back end, which is heavy, falls instantly into the path of the rocker arm and arrests its motion and the machine is stopped immediately.

All parts, forward of the spoons, are substantially the same as those shown and described for the electric stop motion, and need no further explanation.

Some drawing frames, with mechanical back stop motions, are built without the carrying rolls, L and M, shown in Figure 147. This works very well for the first and second processes of drawing after carding, but for stock which has been combed, it becomes necessary to have these rolls to lift the sliver out of the cans, as the slightest strain will cause it to pull apart. With very short

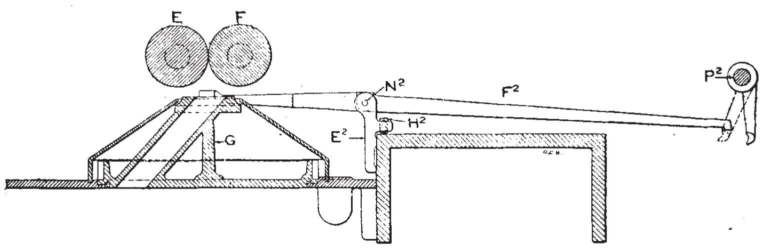


Fig. 148. Full Can Stop Motion.

cotton and waste, it is also a help toward preventing the sliver from parting.

Full Can Stop Motion. The full can stop motion, as the name implies, stops each individual head when the cans in that head become full. This stop motion, which is connected with one can in each head, serves as a guage for the others as the cans are usually emptied in sets.

The stop motion is shown in Figure 148, which may be considered with Figure 144. Bolted to the table is a slotted stand, E^2, carrying a lever, F^2, which is mounted upon a pin, N^2. In its normal position, one end of this lever rests lightly upon the top of the coiler gear, G, and the other just above a projection of the arm, J^2, which is fastened to the rocker shaft, P^2.

When the can becomes full, the cotton presses upward against the underside of the coiler gear, G, causing it to raise the short end of the lever, F^2, and this lever turning about the pin, N^2, its long end is lowered into the path of the arm, J^2, thus arresting the motion of the rocker shaft, P^2. This, as before described, releases the stop motion spring which causes the belt to be shipped on to the loose pulley.

The screw at H^2 serves as a means for a very fine adjustment of the stop motion.

Figure 149 shows a device for stopping the drawing frame if the sliver should "wind up" on either of the calender rolls or "break down" before it gets to them. This stop motion, which is really two stop motions operated by one mechanical device, is caused to operate by the rising and falling of the outer calender roll, E. The bearing, E^4, for the roll, is free to move in a slot in the calender stand, while the bearing for F is fast. Against the underside of E^4 is a lever, C^3, pivoted at M^2 and heavier at its

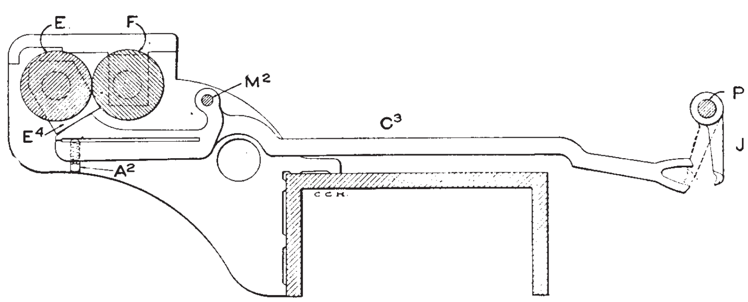


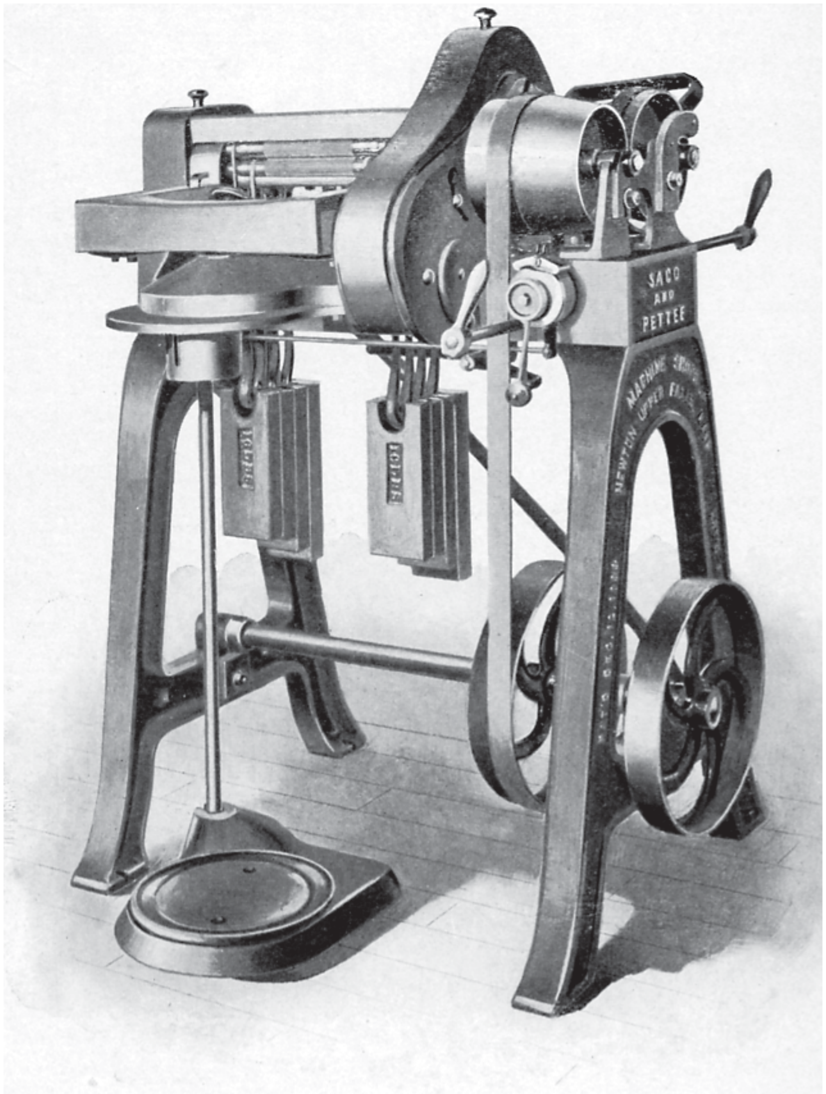
Fig. 149. Calender Roll Stop Motion.

long end which is forked so as to engage the rocker shaft arm, J^2, when either raised or lowered.

If the sliver winds up on either calender roll, the increased diameter caused will move the roll, E, away from the roll, F, and in so doing will allow the lever, C^3, to rise and its long end to engage the rocker shaft arm, J^2. While if from any cause the sliver breaks down, the roll, E, will fall slightly against F and depress the short end of the lever, C^3, causing the long end to be brought into contact with J^2.

In the short end of the lever, C^3, which is split, is an adjusting screw, A^2, for setting the stop motion.

Clearers. The electricity, generated by the friction of the rolls and belts of the drawing frame, causes the loose fibers and flyings to adhere to the draft rolls and unless some means are taken to prevent this happening, the accumulation becomes detached from time to time, and is carried along with the sliver. This makes the



IMPROVED RAILWAY HEAD—FRONT VIEW
Saco & Pettee Machine Shops.

work dirty and uneven, and frequently causes the sliver to break.

The device employed to collect the loose cotton is called a clearer and several styles are in use. The one most commonly used is shown in Figure 150. For the top rolls, this consists of a flat piece of wood, A, with wires, B, driven into the underside and supporting a flannel apron C. The apron rests lightly against the top of the rolls, and as they revolve the loose cotton is gradually collected by the rough surface of the apron, which has to be cleaned or "picked" at regular intervals. If the accumulation is allowed to get too large it will become loose from the clearer and pass in with the sliver, hence the clearer should be cleaned as often as the case demands.

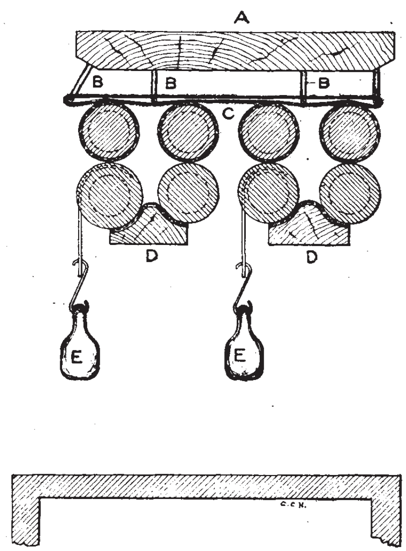


Fig. 150. Common Top Clearer.

For the bottom clearer, strips of wood, D, covered with flannel are used. They conform in shape to the outline of the rolls and are held in contact with the flutes by weights, E. The straps holding the weights pass upward and around the bottom rolls.

Another style of clearer is shown in Figure 151, This consists of two wooden rolls, A and B, supported in a frame, C. Around the roll is an apron, D, of heavy flannel or carpet. The roll, A, is covered with perforated tin and acts as a driver for the apron, while the roll, B, is a carrier with an adjusting screw, E, for keeping the apron tight. On the top of the frame is a comb, K, with the blade set close to the apron. Motion is given to the comb by an arm, F, from an eccentric, G. This arm also carries a pawl, H, which engages with the teeth of the ratchet gear, J, and through the gears, L and M, the roll, A, is turned slightly at each forward movement of the arm, F.

By this means the apron, as it moves around slowly, wipes the top of the rolls and the cotton, which is collected, is combed into a roll as it reaches the comb when it is removed very easily.

A set screw, N, is for adjusting the frame so that the apron shall just touch lightly on the top of the rolls, as any great pressure will cause them to slip on the bottom rolls and make uneven work. All that is necessary is to simply wipe them lightly and not retard their rotation.

Diameter of Fluted Rolls. The size of the fluted rolls, on most makes of drawing frames for ordinary length staple cotton, is shown in Figure 152. Sometimes this is varied and the back

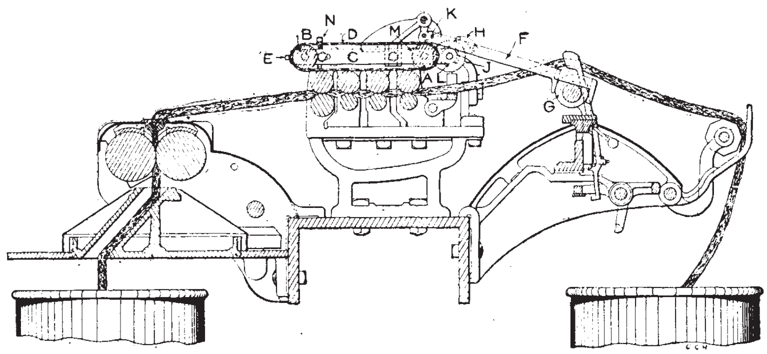


Fig. 151. Revolving Top Clearer.

roll is made one and three-eighths inches in diameter instead of one and one-eighth inches diameter.

As a rule, when the frame is to be used for long staple cotton, the rolls are made larger in diameter, as the large rolls lessen to some extent the trouble from roller laps. The most common sizes are shown in Figures 153.

For very short lap cotton, and when a large percentage of waste is to be used, the rolls are made of the diameters indicated in Figure 154.

Setting of Rolls. In regard to setting the fluted rolls, no exact rule can be given except that the distance between the centers of the front and second rolls should be from one-quarter to three-eighths of an inch more than the average length of staple being worked, and this distance is made greater between the centers of the second and third rolls, and still greater between the centers of the third and back rolls. Thus, in Figure 152, the distance between the centers of the front and second rolls is one and three-eighths inches, between the second and third rolls, one and one-half inches, and between the third and back rolls, one and five-eighths inches.

These distances vary under different conditions. If a sliver

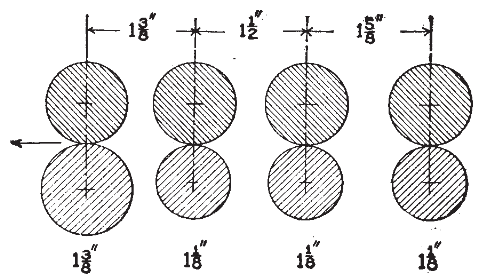


Fig. 152. Draft Rolls for Ordinary Length Staple Cotton.

of eighty grains is being run, the distance between the centers of the rolls should be greater than when running a fifty grain sliver. This is due to the fact that not only the fibers directly in contact with the bite of the roll are being drawn, but the surrounding ones are acted upon also, and as the mass of cotton in a heavy

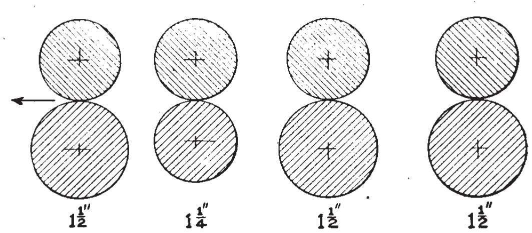


Fig. 153. Draft Rolls for Long Staple Cotton.

sliver is considerable, it is impossible to produce a sliver of even weight unless there is more space between the bite of the several pairs of rolls.

If the draft is short, the rolls may be set closer than when an excessive draft is used, but with a very long draft the rolls must be set more open. In all cases the speed must be reduced with a large draft or a large amount of waste will be made.

Top Rolls. There are two kinds of top rolls used, leather covered rolls and metallic rolls. The leather covered rolls are made in two styles, shell and solid. The shell roll, which is generally used for all four lines, is shown in Fig. 155. This roll is made in three parts, the *arbor*, the *shell* and the *bushing*. The arbor is stationary and the shell revolves upon it. This gives a long bearing surface for the shell and a chance for a thorough lubrication of the arbor.

The ends of both arbor and bushing are made alike and are

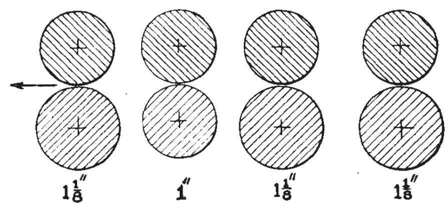


Fig. 154. Draft Rolls for Short Staple Cotton.

held in place in the slides of the roll stands. The shoulders, A bear against the sides of the stands to prevent end movement to the rolls and the weight hooks are hung upon the necks of the rolls at B.

A section of the shell and bushing, in position upon the

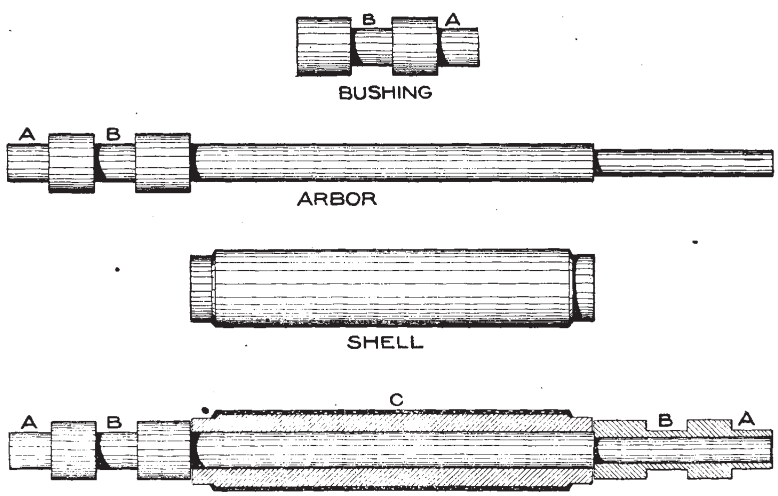


Fig. 155. Shell Top Roll.

arbor, is shown in the lower view of the drawing. The boss of the shell, C, is first covered with specially woven cloth and then with roller leather made from sheepskin.

The solid top roll, which is sometimes used, is the same in outline as the shell roll. The weight hooks are hung in the same manner, but as the whole roll revolves, it necessitates oiling the neck of the roll where the weight hook bears.

The weighting is so arranged that the pressure may be removed from the top rolls when the machine is to stand idle for any length of time. This prevents the leather from becoming grooved by the flutes of the bottom roller.

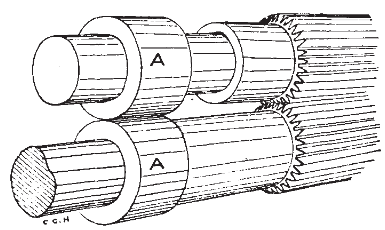


Fig. 156. Perspective View of Metallic Top Rolls.

As previously mentioned, the shell roll is generally used for all four lines, but for the back line a steel fluted roll, the same as the bottom roll, is sometimes used.

When metallic top rolls are used, the production of the drawing frame is greatly increased, owing to the fact that the flutes of the rolls interlock and the sliver, in passing between them, is made to follow the outline of the flutes. This point may be seen by examining Figures 156 and 157. The rolls are prevented from bottoming by collars, A, at each end of both top and bottom rolls.

If the sliver follows the exact outline of the flutes, a one and three-eighths front roll will deliver, in one revolution, five and seventy-four one-hundredths inches, while a common roll, of the same diameter, will deliver only four and thirty-one one-hundredths inches, which shows that the delivery of a metallic roll is thirty-three per cent greater, but as a fact, unless the sliver is extremely light, it will not follow the outline of the flutes closely enough to deliver this amount. It is plain that on a heavy sliver, the thickness prevents the flutes from interlocking as deeply as with a light one; consequently, one revolution of the front roll will not

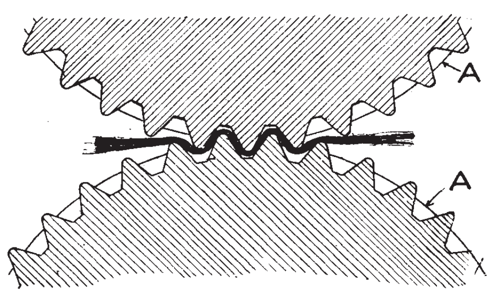


Fig. 157. Enlarged Section of Metallic Top Rolls.

deliver as great a length and, for this reason, it is impossible to figure the exact production of a drawing frame with metallic rolls. It is, however, safe to estimate from twenty-five to thirty-three per cent greater production than with the common roll.

The front metallic roll, one and three-eighths inches in diameter, is made with forty-four flutes, and in figuring the draft, this should be called $\frac{11}{6}$ or $1\frac{5}{6}$ inches in diameter, which is thirty-three per cent greater than a common roll. The second roll, $1\frac{1}{8}$ inches in diameter, is made with thirty-six flutes and should be called $\frac{9}{6}$ or $1\frac{3}{6}$ inches in diameter. The third roll, $1\frac{1}{8}$ inches in diameter,

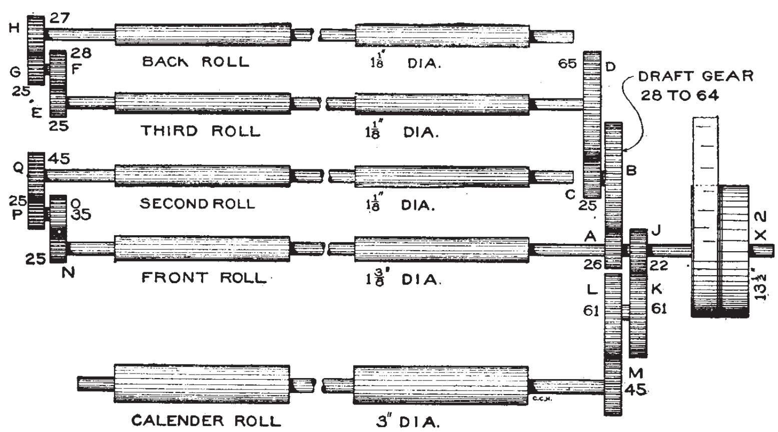


Fig. 158. Diagram of Drawing Frame Draft Gearing.

is made with twenty-seven flutes and should be called $\frac{9}{6}$ or $1\frac{3}{6}$ inches in diameter, and the back roll, $1\frac{1}{8}$ inches in diameter, is made with eighteen flutes and is called $\frac{10}{6}$ or $1\frac{4}{6}$ inches in diameter. With these points, it is comparatively easy to figure the draft.

A diagram of the draft gearing is given in Fig. 158 from which the usual calculations may be made.

CALCULATIONS

Rule 1. To find the draft of the drawing frame between the calender rolls and the back roll: Multiply together the driven gears and the diameter of the calender rolls and divide the product by the product of the driving gears multiplied together with the diameter of the back roll. The driven gears are L, J, B, (draft change gear, 41 teeth) D, F and H, and the driving gears are M, K, A, C, E and G. The diameter of the calender rolls is 3 inches and may be called 24, and the diameter of the back roll is $1\frac{1}{8}$ inches and may be called 9.

Example: $\frac{61 \times 22 \times 41 \times 65 \times 28 \times 27 \times 24}{45 \times 61 \times 26 \times 25 \times 25 \times 25 \times 9} = 6.46$

Rule 2. To find the draft factor: Proceed as in the above rule but omit the draft change gear, B.

Example: $\frac{61 \times 22 \times 65 \times 28 \times 27 \times 24}{45 \times 61 \times 26 \times 25 \times 25 \times 25 \times 9} = 0.1576$

Rule 3. To find the draft: Multiply the factor by the number of teeth in the draft change gear.

Example: $0.1576 \times 41 = 6.4616$

Rule 4. To find the number of teeth in the draft gear: Divide the required draft by the factor.

Example: $\frac{6.4616}{0.1576} = 41.$

The draft of the drawing frame is divided between the rolls in the following manner: Between the front roll and the second roll, it is 3.08 draft and may be found by applying the same rule as for the total draft.

Example: $\frac{45 \times 35 \times 11}{25 \times 25 \times 9} = 3.080$

An examination of the diagram of the gearing, Fig. 158, will show that the draft between the front and second rolls is not affected by changing the total draft of the machine, and unless the total draft is made unusually short, the draft between these rolls is not changed, but, between the second and third rolls, the draft is affected when changing the draft gear, B. Thus, with a 41 tooth draft gear, which is correct for a total draft of 6.46, the draft between the second and third rolls is 1.626.

Example: $\frac{25 \times 25 \times 41 \times 65 \times 9}{45 \times 35 \times 26 \times 25 \times 9} = 1.626$

The draft between the third and back rolls is 1.209 and is not affected by changing the total draft as the back roll is driven from the third.

Example: $\frac{27 \times 28 \times 9}{25 \times 25 \times 9} = 1.209$

Between the front fluted rolls and calender rolls there is a slight draft which can be regulated by changing the gear, L. of 61 teeth.

Example: $$\frac{24 \times 61 \times 22}{45 \times 61 \times 11} = 1.066$$

The total draft may be found by multiplying together the draft between the rolls.

Example: $3.080 \times 1.626 \times 1.209 \times 1.066 = 6.45 +$

Rule 5. To find the production of the drawing frame: Multiply together the number of revolutions of the front roll per minute (300), the number of inches delivered by the calender rolls at each revolution of the front roll (4.60), the number of minutes run per day (600) and the weight of the sliver in grains per yard (60). Divide the product by the number of grains in one pound (7,000) multiplied by the number of inches in one yard (36).

In figuring the production of the drawing frame, the number of inches, delivered by the calender rolls at each revolution of the front roll, should be considered as there is a draft of 1.066 between them with a 61 tooth gear at L. The calender rolls deliver 4.60 inches at each revolution of the front roll.

Example: $$\frac{300 \times 4.60 \times 600 \times 60}{7000 \times 36} = 197.14$$

From the number of pounds given in the above example there should be deducted about 20 per cent for time lost in cleaning, oiling and piecing broken ends.

Rule 6. To find the factor for the production of the drawing frame: Proceed as in Rule 5, but omit the revolutions of the front roll and the weight of the sliver.

Example: $$\frac{4.60 \times 600}{7000 \times 36} = .1095$$

Rule 7. To find the production with the factor given : Multiply the factor by the number of revolutions of the front roll and the weight of the sliver.

Example: $.1095 \times 300 \times 60 = 197.1$

Rule 8. To find the draft necessary to make a sliver of a certain weight: Multiply together the number of slivers entering at the back of the drawing frame (6) by their weight in grains per yard (60) and divide by the weight in grains per yard of the sliver being delivered.

Example: $$\frac{60 \times 60}{60} = 6.$$

Rule 9. To find the weight of the sliver being delivered: Multiply together the number of slivers entering at the back (6) by their weight in grains per yard (60) and divide by the draft (6).

Example: $$\frac{6 \times 60}{6} = 60.$$

To find the draft of the railway head: Proceed as in Rule 1. A diagram of the gearing is given in Fig. 138. The draft change gear is on the end of the top cone shaft and the cone belt should be considered midway of the ends of the cones when the diameters of both are equal. The driven gears are S, P, E and G (draft change gear 40 teeth) front roll $1\frac{1}{2}$ inches diameter. The driving gears are R, Q, F and H, and the back roll is $1\frac{1}{8}$ inches diameter.

Example: $$\frac{60 \times 30 \times 72 \times 40 \times 12}{27 \times 32 \times 37 \times 36 \times 9} = 6.$$

It is usually customary to also change the draft between all of the rolls when changing the total draft of the railway head. Between the back and third rolls, this change is effected by changing the gear, B, and between the third and second rolls by changing the gear, C. The table shown herewith gives the correct gears for the changes in draft.

TABLE OF CHANGE GEARS

Draft.	No. of Teeth in Gear G.	No. of Teeth in Gear B.	No. of Teeth in Gear C.	Draft.	No. of Teeth in Gear G.	No. of Teeth in Gear B.	No. of Teeth in Gear C.
2.10	14	32	24	4.20	28	57	32
2.23	15	32	24	4.35	29	58	33
2.40	16	34	25	4.50	30	61	34
2.55	17	37	26	4.65	31	63	34
2.70	18	37	26	4.82	32	66	35
2.86	19	40	27	4.95	33	67	35
3.00	20	42	28	5.10	34	68	35
3.15	21	42	28	5.25	35	71	36
3.30	22	45	29	5.40	36	72	36
3.45	23	47	30	5.55	37	73	37
3.60	24	50	30	5.70	38	74	37
3.75	25	52	31	5.87	39	74	37
3.90	26	53	31	6.00	40	74	37
4.05	27	55	32				

FLY FRAMES.

In the process which follows drawing, the machines employed are called fly frames or roving machines. The fly frame continues the drawing process, but the cotton is manipulated in a

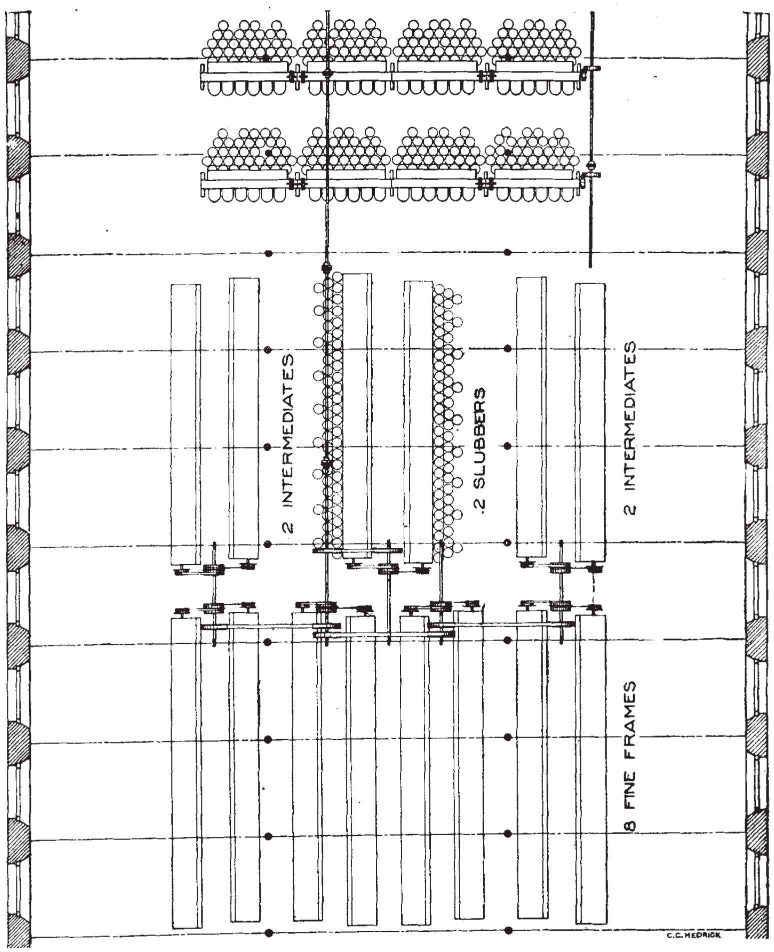


Fig. 159. Plan of Card Room Showing Fly Frames.

different manner. Two, three, and sometimes four machines are necessary, depending upon the number of yarn it is intended to finally spin, as the cotton from the roving machine goes directly to the spinning frame.

The machines are practically the same in mechanical detail, differing only in size and weight. The machine first used is called the slubber, the second is the intermediate, and the third is called the fine frame. When a fourth is necessary to reduce the cotton to the correct weight, it is called the jack frame.

The fly frames may be arranged longitudinally or transversely of the mill. The most common arrangement is shown in Fig. 159. In this illustration there are three processes. The slubbers are placed, as a pair, directly in front of the drawing frames, the intermediates are placed on each side of the slubbers and the fine frames extend across the mill in an adjoining row.

When practicable, each pair of machines should be driven from the same counter shaft pulley, which has two faces divided by a flange. The counter shaft should be placed about over the

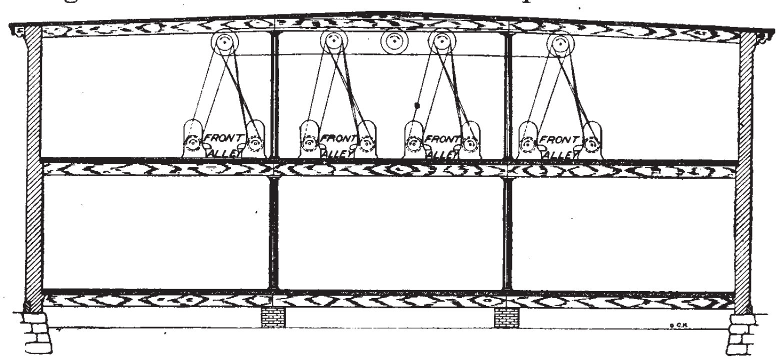


Fig. 160. Sectional Elevation Showing Fly Frames.

center of the front or work alley. The reason for this is very apparent if we examine Fig. 160, which is a sectional elevation showing the fine frames illustrated in the previous drawing. The driving pulleys, which are near the back side of the machine, turn toward the back, which necessitates a cross belt for one and a straight or open belt for the other. With the counter shaft over the work alley, the point where the belts separate is high enough to allow passage beneath, but if the shaft were in the back alley, there would not be passage room.

Before entering upon a description of the fly frame, the methods of numbering yarns and roving and the tables of weights and measures, used in cotton manufacturing, should be fully understood.

In all processes, up to the present one, reference has been made to cotton as weighing a certain number of grains or ounces