ROPE-MAKING MACHINERY. Hemp Rope.—*Preparation machinery* may be divided into two classes: the drawing or single-chain machine, and the heckling or double-chain

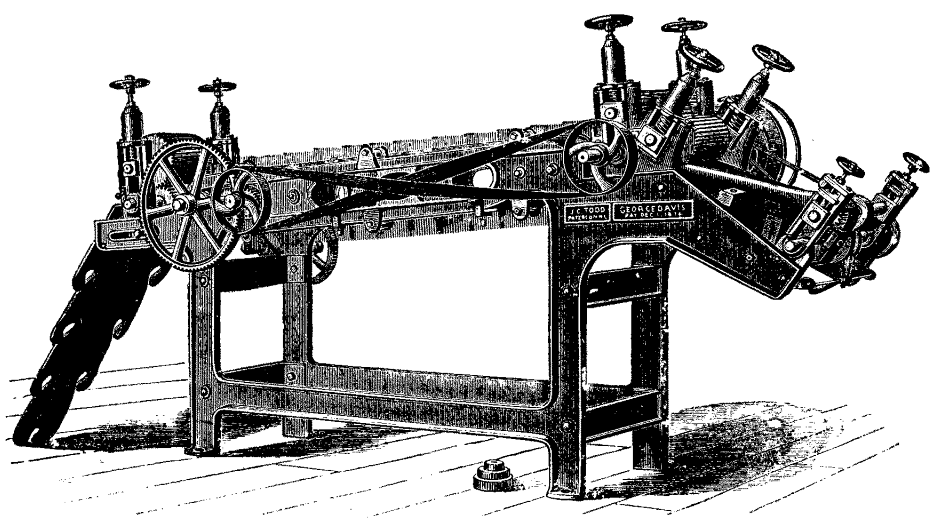

Fig. 1.—Hemp-drawing machine.

machine. A chain is an endless combination of bars linked together, the distance between each two bars being equal. The bars are of iron, round or square, varying in size from $\frac{1}{4}$ in. to $1\frac{1}{2}$ in., and are studded with pins which vary in length, thickness, and distance in about the same relative proportions as the bars. The heavier the bar, the coarser the pin, and *vice versa;* being largest at the beginning of the preparation, and decreasing in size on each successive working machine. At each end of a bar is a "dog," which is moved through guide bars, placed on the sides of the machine, in such a way as to keep the pins in a vertical position. The chains are moved by means of a carrier-wheel, consisting of from five to ten pinions, the distance between each, or width of the pinions, being equal to the distance between the bars. The carrier-wheel is connected to the motive power by gearing, thus permitting changes to be made in the speed of the chain.

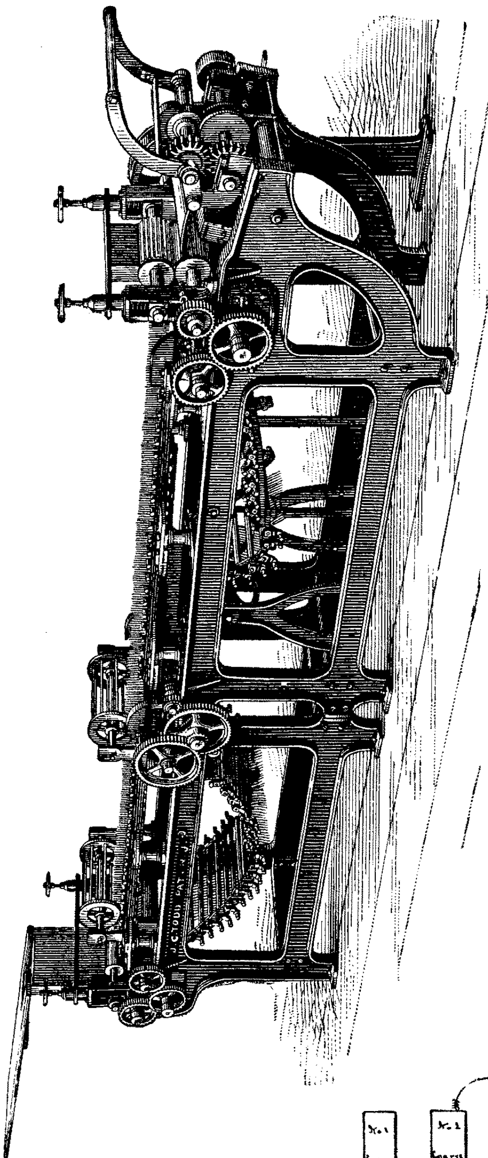

Fig. 2.—Breaker, spreader.

The single-chain machine, Fig. 1, consists of a chain and a pair of fluted iron rollers, placed close to one end of the chain. The rollers, or drawing rolls, as they are called, have a speed of from four to six times that of the chain, and in consequence draw the body of hemp which is on the chain into a sliver four or six times the original length. The term, head of a machine, refers to the end having the drawing rollers.

The second class of preparation machines, Fig. 2, is heavier and stronger than the machines described.

In addition to the chain and drawing rolls of the first class, these machines possess a second chain, moving at from one-sixth to one-tenth the speed of the front or fast chain, the chain nearest the head of the machine. These two chains, one moving six or ten times faster than the other, heckle or comb the hemp, forming it into a sliver made up of the hemp fibers, all extending in the same direction.

We are now ready to understand the preparation of the hemp for the purpose of spinning. The process of preparing and spinning Manila, Sisal, Russian, and American hemp is substantially the same. The hemp is received in tightly compressed bales, which are opened, and each bundle or sheave untied and shaken by hand. It is then passed through a softening machine, consisting of from six to ten pairs of heavy fluted iron rollers. An oil sprinkler at the head of this machine enables the operator to distribute over the hemp a quantity of oil varying according to the kind of hemp, as well as to the use to which the yarn or rope is to be put. The hemp is softened, the fibers separated, and, in the case of Sisal, is ready for the heckling

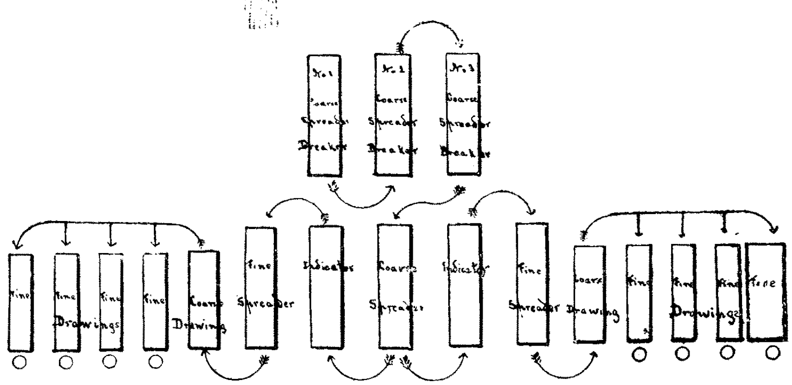

Fig. 3.—Arrangement of a set of hemp machines.

and combing process. In the case of Manila, owing to the fineness and softness of the hemp at the top or seed end, the fibers are not separated, but are bunched together into a towy mass. In order to separate the fiber and remove the tow, an operation termed scutching is introduced. A bunch of hemp is seized at the middle of its length, and the seed or top end thrown against the rim of a swiftly revolving cylinder. The rim of this cylinder is thickly studded with steel pins or blades about 4 in. long. Being held so that the seed end comes in contact with the rapidly-moving pins, the hemp is teased out, the fibers are straightened, and the tow removed from the hemp, and thrown from the cylinders by centrifugal force. The hemp is sent to the breaker, Fig. 2, a machine of the second class, on the slow chain of which it is fed, and firmly held by the pins which pass through it. In front of the slow chain is the fast chain, the relative speeds being about as 10 to 1. The hemp being firmly embedded on the slow chain, and the pins of the fast chain passing through each portion of the hemp as presented, the fiber is straightened out, and in each revolution of the fast chain a body of hemp is drawn into a sliver of ten times the original length. Naturally, this sliver is not even or uniform throughout its length, due in most cases to irregular feeding, unequal softening of the hemp, and to riding over the pins on the fast chain. To correct the inequalities, 6 or 8 slivers are fed on the slow chain of a second breaker, which operation further completes the separation and straightening of the fiber, and at the same time makes the sliver more uniform throughout its length. The subsequent operations are essentially the same as described above ; 6, 8, or 10 slivers are placed behind spreaders, Fig. 2, consisting of a slow and a fast chain. The bars in these chains are in each successive working brought closer together, and also the pins are finer, and the distance between each two bars or pins made smaller in each case. Sisal receives from 5 to 8, and Manila from 4 to 6 workings on the double-chain machines. The sliver is then considered sufficiently even and the fibers soft and elastic. A number of such slivers are placed back of a drawing frame or single-chain machine, Fig. 1, to be drawn to a size which will admit of its being spun into yarn or thread of from 300 to 600 ft. to 1 lb. The drawing frame, Fig. 1, is made up of a chain studded with fine pins, and in place of a fast chain is a pair of fluted iron rollers, with a speed of four or five times that of the chain. This difference in speed will reduce the slivers to one-fourth or one-fifth the original size by drawing them to a single sliver four or five times the original length. After one or two workings on the drawing frames, the sliver is ready for the spinning or jenny room, where it is spun or twisted into yarn of any desired size.

The diagram, Fig. 3, shows the usual arrangement of the various machines making up a "set." The capacity of this set is from 12,000 to 15,000 lbs. per day.

The main defects of this system are the tendency of the fiber to ride over the pins of the fast chain (which is natural, on account of the speed of this chain), and in the space between the last pin in the detaining chain and the first on the fast, or combing chain, which is of necessity so great as to let a portion of the stock go from one to the other without being cleaned, combed, and straightened. These defects cause an amount of raw or unworked hemp to show in the sliver, and render the number of successive operations necessary to repair this fault.

The machinery, as described and illustrated above, is the type in general use throughout the United States.

Fig. 4 shows the style of chain used in foreign preparation machinery. The great difference between these machines and those previously described is in the mode of drawing the bars or gills. As we have seen, in the former machines the bars are driven by a carrier-wheel, but the bars in this machine are driven by a horizontal screw, which forces the pins in and out of the fiber at right angles. The front chain in this machine consists of two sets of bars, one above the other, shown by Fig. 4, producing an absolute certainty of action, as the pins in the bars intersect and prevent any possibility of the fibers riding over the points of the pins. And on account of the intersecting bars there are twice the number of pins in action at the same time as would be in the case of the machine shown in Fig. 3. The action of this machine is, therefore, much better than that of the former set. There still remains the fault due to the distance between the chains.

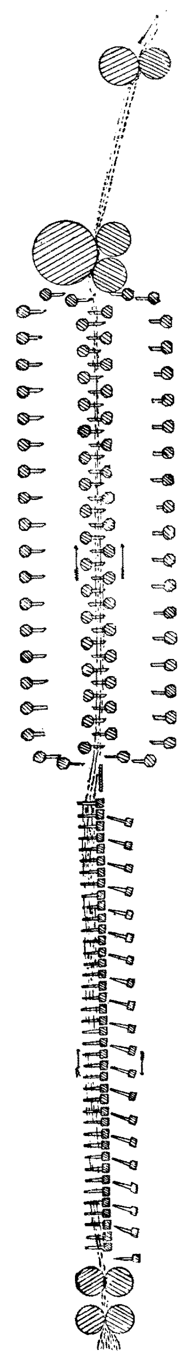

Fig. 4.—Combe, Barbour & Combe's chain.

The latest form of preparation machine invented by A. W. Montgomery, New York, is shown in Fig. 5. It embraces the advantages of the old lapper system, and of the Good or two-chain system. This machine consists of the detaining roller, with withdrawing pins of

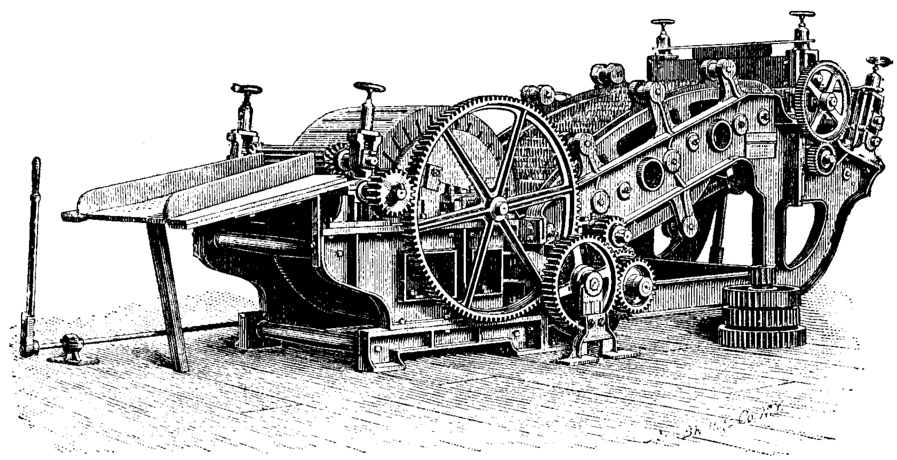

FIG. 5.—Montgomery breaker.

the former, close in front of which is the fast chain of the latter system. In this machine the distance between the detaining pin and combing pin is only 6 or 7 in. Hence only a small portion of the fiber escapes the heckling action in the first working through the machine, and is pretty sure to be thoroughly cleaned and straightened the second time through. The chain takes the hemp from the cylinder, on a line tangent to the detaining cylinder, thus forcing the hemp firmly between the pins and on the bars. The draw at this point is nearly constant. Immediately in front of the chain are the drawing rollers, which, drawing the hemp in about the proportion of one to one and one-half, forms it into a compact sliver. Five workings on this system accomplish the work done by the system represented above. Four workings on machines similar to Fig. 5, and one drawing, fits the sliver for the spinning-room. The capacity of this system is from 18,000 to 25,000 lbs. per day. The arrangement of a "set" is shown by Fig. 6. The jenny, illustrated by Fig. 7, consists of a slow-moving

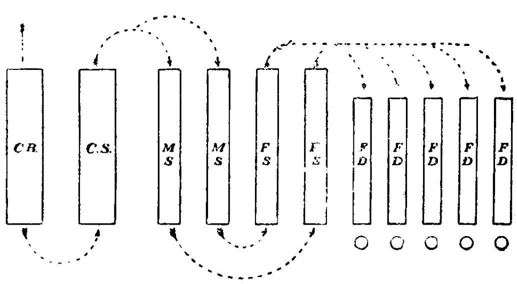

FIG. 6.—Arrangement, Montgomery system.

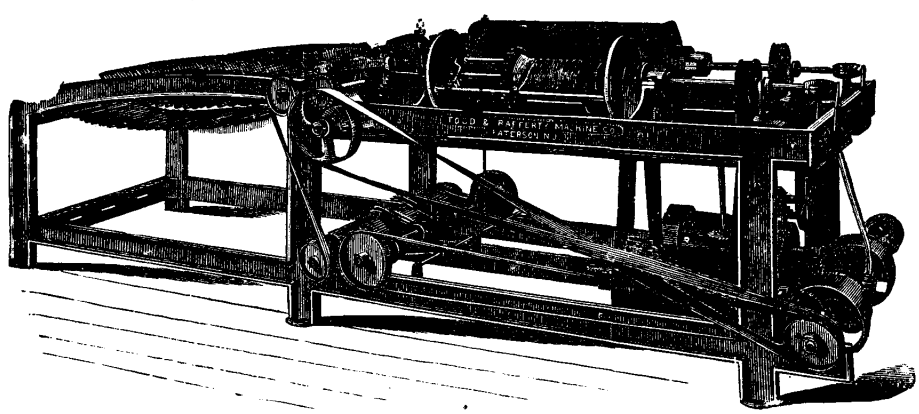

FIG. 7.—Hemp spinning-jenny.

chain, in front of which is the flier containing a pair of capstan wheels. Each revolution of the flier causes the capstan wheels to draw in a certain uniform amount of sliver. Each revolution of the flier puts one turn into the hemp drawn through, forming it into a thread; and at the same time winds an equal amount of spun yarn on the bobbin, which holds about 15 lbs. The bobbins are sent to the rope-walk or rope-machine room to be made into rope. Rope of a diameter of ¾ in. or less is made on rope machines, Figs. 8 and 9. That of larger diameter is made in the rope-walk, although rope machines have been built to make the larger sizes. Fig. 8 represents the "former," on which the yarns are twisted into strands, and Fig. 9 the layer, on which these strands are "laid up" into rope. The size of a rope determines the number of threads necessary to make it. One-third this number are twisted together into a strand when a hawser-laid rope is wanted, and one-fourth when a shroud-laid rope is required. Either the three or four strands, as the case may be, are in turn twisted together to form a rope. The two operations are performed at the same time on some rope machines, but separately on others and in the rope-walk. A description of the rope-walk process will suffice for both. In the rope-walk the bobbins are mounted upon a rack; the requisite number of threads to make a strand are passed through the same number of holes in a perforated plate to and through a trumpet-shaped tube, and fastened to a hook on the forming machine. This hook can be geared to revolve a definite number of times per each foot of travel of the "former;" in this way a regular amount of turn is put into the strand. The turn varies with the size of the strand, more turn being required in the small than in the large sizes. The length of the track limits the travel of the "former" and the length of the strand. Six strands are usually made at one time. As many strands as are required for the rope are stretched at full length along the walk, and attached at each end to hooks on the laying machines—the foreboard, being at one end, is stationary, and the

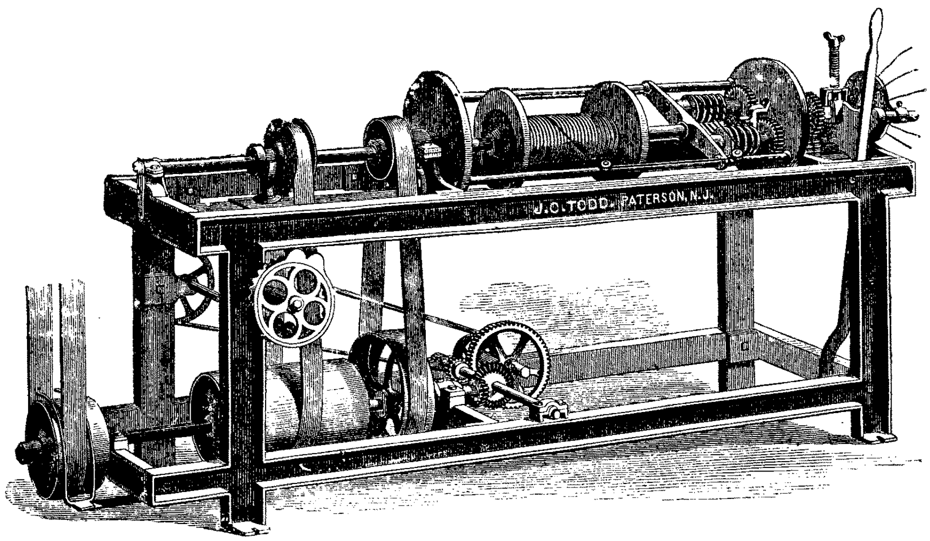

FIG. 8.—Strand-forming machine.

traveller at the other moves up and down the walk. The hooks of both machines are set revolving, continuing the "foreturn" placed in the strand during the forming process. Why this step is necessary has been explained. At one of the "laying" machines, each strand is in turn removed from its hook and laid in one of three equidistant concentric grooves of a cone-shaped block called a "top," and then fastened together on the center hook of the machine. The hooks of the two machines are now set revolving, the direction of turn at one end being the opposite of that at the other end. As a consequence, being fastened at one end to one hook, and at the other end to three hooks, the strands turn or twist on themselves at the end where there is one hook. As the twist is communicated to the strands between the single hook and the "top," the latter is pushed forward, leaving the laid rope behind it. Care must be exercised in guiding the block, for on its uniform motion depends the firmness of the rope, as well as the regular and uniform character of its "lay."

Trautwine says: "The tarring of ropes is said to lessen their strength, and when exposed to the weather, their durability also. We believe that the use of it in standing rigging is partly to diminish contraction and expansion by alternate wet and dry weather." Haswell speaks of tarred ropes being 25 per cent. weaker than white or untarred ropes. Russian hemp rope agrees with the conclusion laid down by both writers; but the Manila and Sisal hemp ropes were not affected at all in strength, although 20 per cent. of tar was added. The loss in strength was due to the tarring process. The ropes were formerly passed through a tar bath of a temperature of from 210° to 240° F. This temperature, being sufficient to singe off the hairs or stray fiber usually appearing on the surface of a rope.

was high enough to cause it to crisp, and hence by impairing the elasticity and stretch of the rope, cause it to break at from 20 to 35 per cent. less weight than before it was tarred. By the use of the Montgomery tarring process, the necessity for the high temperature of the tar bath is avoided, and the rope is treated to a bath at 140° to 150° F. Rope so treated is uniformly tarred, and at least maintains, if it does not improve, its strength. This process liquefies but does not evaporate the tar, as happens when the tar is heated to and maintained at a high temperature. The light oils, and even the carbolic oils, of tar will be driven off at the temperature of 250°, and in a short time there would be nothing left but hard pitch. Rope tarred with such a substance will immediately upon its removal from the bath become hard and stiff, while for actual use tarred rope should be soft and pliable. In the latter case the life of the tarred rope is equal to, if not greater than, of a

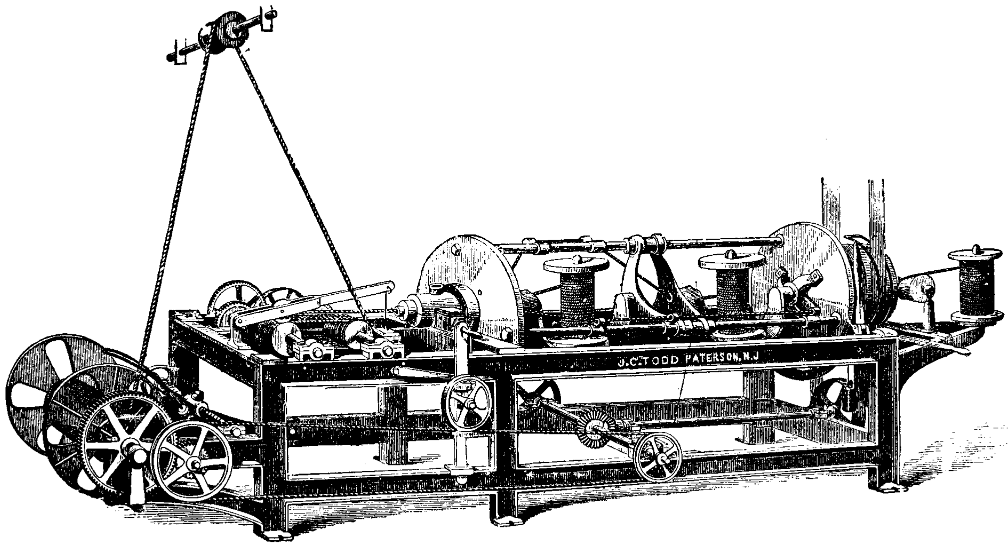

FIG. 9.—Rope-laying machine.

white rope of the same size; and at the same time the amount of expansion and contraction is reduced to a minimum. Russian and American hemp, being soft and spongy in their nature, absorb the tar, swelling the fiber, and consequently lessening its stretch. With the hard and wiry fiber of Manila and Sisal, on the other hand, the tar remains upon the outside, acting as a preservative against the weather. A peculiarity about tarred ropes is that the three strands are liable to break at one time. In the case of white rope, one strand breaks while the remaining two set themselves, and will stand nearly seven-ninths, instead of two thirds, the strain which caused the first strand to part. In practice the greatest number of breaks occur at the splices, caused probably by the sawing of a strand on its neighbor. The more turn or harder laid the rope, the stronger it is. This, however, is true only up to a certain limit, as excessive turn would of itself cut the rope. "Hard" turn ropes were found to be fully 10 per cent. stronger than ordinary turn ropes.

Recent tests made at the Watertown Arsenal, to determine the breaking strain of Manila rope, gave as the strength per square inch of section 9,500 lbs., when the rope was clear of splices, and 7,000 lbs. when spliced.

WIRE-ROPE MACHINES.—*Lang's Laid Rope.*—In the construction of roping known as "the Lang lay," the wires forming the strands, and the strands comprising the rope, are all laid in the same direction. Upon comparing the two illustrations, Figs. 10 and 11, the difference between an ordinary rope and one according to the last-mentioned construction will be readily apparent. In Fig. 11, it will be noticed that both the wires composing the strands and the strands forming the rope are laid in a right-hand direction, and, consequently, the component wires follow a dextral spiral axially to the rope. An advantage of this construction is that a longer continuous surface of any wire is exposed to wear, and the crowns of the strands are less pronounced; therefore, whilst more uniform wear is promoted, the cutting tendency of the wires is reduced, and the durability of the rope correspondingly increased.

FIG. 10.—Ordinary rope.

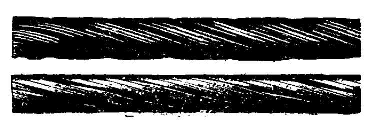

FIG. 11.—Lang's rope.

Latch and Bachelor's Locked-coil Rope.—The principle incorporated in this manufacture consists in the employment of various suitably shaped wires, which, when closed together, interlock and present a structure with a uniform wearing surface, in which each component wire is permanently held in its proper normal position. The transverse section, Fig. 12, shows a rope composed of an ordinary wire core, around which a series of cylindrical and radial wires are closed, followed by an outside shell of sectional wires, which are locked or held down in position. The various succeeding layers of wires are laid in alternate directions—*i.e.*, one to the right hand and the next to the left, and so on, as in the manufacture of some compound strands previously referred to.

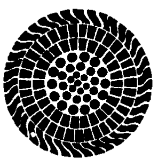

FIG. 12.—Wire rope section.

The modern type of wire-stranding and rope-closing machinery is shown in Figs. 13 and 14. The selected wires of requisite gauge are contained or coiled upon the bobbins shown, or mounted in the "flyers," carried by the circular frame, which is fixed to a horizontal shaft mounted in bearings, so as to be free to revolve through the intervention of appropriate gearing. The outer ends of the wires are passed through apertures provided in the annular framing and nozzle plate running in the headstock bearing, and thence are carried through the fixed closing block or die—shown closed by means of the weighted lever—to the

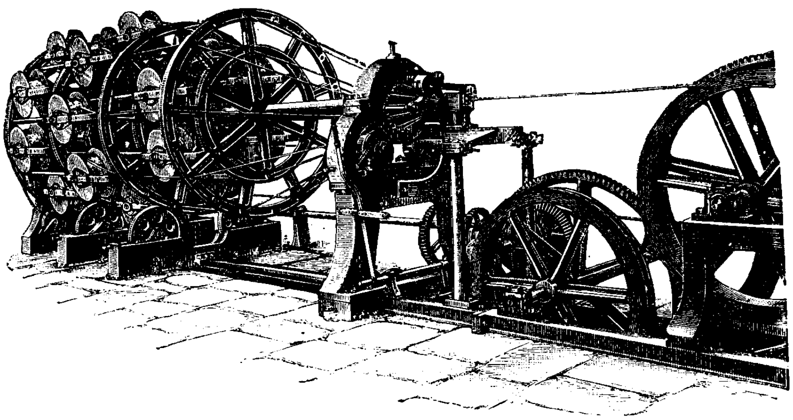

FIG. 13.—Wire-stranding machine.

draw-off drums. The hempen or wire core is drawn in centrally from the back of the machine through the tubular horizontal shaft, and as the machine revolves and draws in the core, the wires are twisted spirally round the same. The tandem grouping or arrangement of the bob-

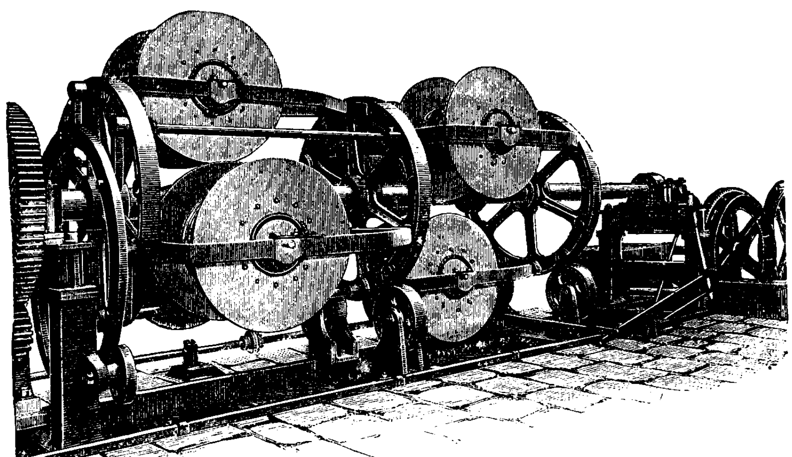

FIG. 14.—Wire-rope closing machine.

bins is worthy of notice, and consequent easy angle at which the wires are concentrated at the nozzle plate, and drawn through the closing die. In this manner the strands are twisted up without bending or straining the component wires, whilst any undue slack arising from any unequal running of the bobbins is ingeniously pushed back from the aforesaid die. The bobbins mounted in the flyers, or fork-shaped frames, are controlled by an eccentric motion at the back of the machine, as shown in the closing machine, Fig. 14, so that whilst the circular carrying frame revolves, they are always maintained in a vertical attitude, in order to prevent any individual twisting of the wires. Each bobbin is mounted on an independent transverse axis, and provided with a tension band and adjusting screw, so that they may be set to pay the wire out uniformly. The draw-off drum at the opposite end of the machine is driven by a train of gearing actuated by a spur-wheel fixed on the revolving portion of the machine, and proportioned to drive the said drum at a determined peripheral speed, in order to obtain a required length of lay in the strand. In other words, as the revolving portion of the machine makes one complete revolution, the draw-off drum receives an angular movement, dependent upon the proportion of lay desired, the variation of lays being obtained by the employment of "change wheels." The finished strands are wound upon reels or bobbins, and are afterward placed in the flyers of the closing or rope-making machines, such as represented at Fig. 14, before referred to. This only differs from the stranding machine explained inasmuch that the bobbins are usually confined to six in number, and that they are loaded with strands in lieu of wires. Closing machines are, however, run at lower speeds —*e.g.*, from 30 to 50 revolutions per minute—whilst those for stranding are run up to from 75 to 150 revolutions, and some even up to 300 revolutions per minute.