Cordage. The word «cordage» is used in a comprehensive sense to include all sizes and varieties of the article from binder twine to a cable 15 inches in circumference, though strictly speaking the term is hardly applicable to a rope that is less than half an inch in diameter.

The materials employed for rope making are various, embracing hemp, flax, manila, sisal, jute, and other vegetable fibres. Sisal from Yucatan and East Indian jute are largely used for the manufacture of cheaper grades of rope and for binder twine. Russian and American hemp are preferred for standing rigging, owing to their ability to absorb a great amount of tar. Manila hemp is more extensively used in the manufacture of cordage than any other material, as its great pliancy and strength adapt it to a multitude of uses. Manila hemp is obtained from a species of wild plantain belonging to the banana family and is a native of the Philippine Islands. Its stem has a height of from 15 to 20 feet, is of a dark-green color and very smooth on the surface. The fibre is round, silky-looking, white, lustrous, easily separated, stiff, very tenacious, and very light. Although not in itself very large, the fibre is composed of very fine and much elongated bast-cells. The length of the cells is about a quarter of an inch, and they are not, as commonly supposed, held together by an intercellular tissue or mucilaginous substance. The characteristic roughness possessed by manila fibre is due entirely to mechanical causes, such as, for instance, the laceration of a cell in the separation from the leaf-stalk, or the subsequent opening out of the ends of the cells. While the fibres are weak transversely, they have great strength in the direction of their length. The tensile strength of manila fibres will average over 30,000 pounds per square inch of section. The plantain is cut near the roots when from two to four years old, and the leaves cut off just below their expansion. The outer leaf is then stripped off, and the fibrous coats are left for a day or two in the shade to dry, and then divided lengthwise into strips three inches wide. They are then scraped by an instrument made of bamboo until only the fibres remain. Bundles of fibres are shaken into separate threads, after which they are washed, dried, and separated according to quality and shipped in bales. From 150 to 200 trees are required to produce 140 pounds of fibre.

Sisal hemp is the product of the agave, a large genus of fleshy-leaved plants found chiefly in Mexico and Yucatan. The fibre is yellowish-white, straight, smooth, and clean, and is about 25 per cent weaker than manila fibre. Much of the sisal hemp is prepared for export to the United States by machinery. Its consumption is fully as large as that of manila, and it is chiefly used for binder twines.

The preliminary treatment of the fibre after it arrives at the cordage mill is approximately the same whether it be manila or sisal, so that a description of the process on one fibre will practically answer for the other. In one of the largest plants in the United States, taken as an example, there are a number of buildings devoted to the manufacture of various classes of cordage, and the ropewalk is two blocks in length. The binder twine-mill is separate and is not run at all times of the year, as the work ceases in the spring, when the orders for twine have been filled; the rest of the plant runs throughout the year. The bales of manila hemp, averaging about 270 pounds each, are opened in the basement of the manila twine-mill, and after the material has been lightly shaken apart it is placed in layers which are sprinkled lightly with oil to soften and lubricate the fibres previous to their passage through the machinery. The first mechanical operation consists in passing the hemp over roughing cylinders bristling with sharp steel prongs or teeth, which straighten out the fibres and remove the tow and fine broken particles, dirt, or other foreign substances. It then passes to the breakers, which are large frames about 25 feet long, consisting of two endless chains studded with steel pins. The first chain runs slowly and feeds the fibres to the second, which runs much faster, the effect being to comb or straighten out the fibres and draw them into a «sliver» or ribbon. The hemp is then hoisted on elevators to the top of the building. Following this operation comes the passage of the hemp through the spreaders and drawing-frames. These machines are similar to the breakers, but are smaller and furnished with steel pins and teeth of gradually increasing fineness, which still further comb and straighten out the fibres, a number of slivers being put together behind each machine and drawn down to one sliver again at the end of each machine. This drawing is repeated a number of times with machines of various degrees of fineness, in order to make the sliver even, without which it would be impossible to spin fine, even yarn. The process is completed in a very fine drawing-frame called a «finisher,» and from this the material finally emerges in complete readiness for spinning, having been drawn into slivers, or small, soft ribbons, in readiness for the spinning-frames.

The small sliver is fed from one of the cans of the spinning jenny over the endless belt provided with needles, as in the breakers, spreaders, and finishers. These needles carrying the fibre move toward a conductor or «nipper,» carrying the sliver with it. The sliver is by this time exceedingly small, and is capable of passing through a small hole in the face-plate of the nipper, where it is compacted in passing through the orifice. A jaw is controlled by a spring which can be regulated so as to adjust the size of the feed. As it leaves this part of the machine the twisting begins. The speed is 1,500 revolutions per minute. The yarn is twisted in a direction called right-handed, and feeds through a pulley by passing through the head-block and moving face-plate, and is finally warped around grooved pulleys in order to give the necessary strain to pull the compacted fibres through the nipper. It is then wound on a bobbin to the amount of about 1,000 yards. A special mechanism traverses the bobbin in order that the yarn may be evenly wound. The attendants see that the sliver is regularly supplied and that any accidental breakages in the thread are repaired. The yarn is placed in small cars and sent to the various rope-making departments. If a rope is to be tarred, the yarns are run through copper tanks filled with heated tar. The yarns enter through holes in an iron plate and are drawn through the tank by machinery. As the yarns emerge, the superfluous tar is removed by means of pressing-rollers, and the yarn is wound on bobbins. If the yarn is to be used for binder twine, the sisal hemp is spun finer than manila, and after being spun the yarn, which is now on bobbins, is carried to the twine balling and packing room, where balling machines wind the yarn into balls of proper size.

Rope making is accomplished in various ways and is all done by machinery. The yarn is twisted into strands by means of machines called «formers,» and the strands are twisted into rope by means of machines called «layers.» If the rope is to be of moderate size, not exceeding an inch in diameter, the formers and layers are combined in one machine. The large machines are very impressive on account of their great size and the rapidity with which the finished product is turned out. In the Farmer machine there are many bobbins, which are arranged in three frames, each of which revolves independently around its own axis, and they are all carried around while in motion by a large frame which supports all three smaller frames. The threads from the various bobbins are passed through apertures in an iron plate, and the motion of each small frame serves to twist the yarn drawn from the bobbins into a strand. The three strands pass upward through a «top» at the upper portion of the machine. As the strands come together they are twisted to form a rope by the movement of the entire machine carrying the three sets of bobbins, which are each rotating separately. The result is a finished rope. The new rope is rotated around several pulleys in order that the proper pull may be obtained to draw the rope tightly through the «top,» and it is then wound on one of the reels. This rope can, of course, be used for any purpose and can be made of large size. For well-drilling and other purposes where rope of great strength but little flexibility is required, cables are used. Cables vary from 1,400 feet in length up, and usually measure from 1⅞ to 2½ inches in diameter. They are composed of three manila ropes instead of strands, and the ropes are twisted together with a very hard «lay,» so that they will not untwist when used for drilling, and so that they will resist wear in the continuous rubbing against the side of the casing and the walls of the well. Owing to their length and construction, cables are always made on machines and not in a ropewalk. On one of the machines in the factory under consideration it is possible to make cables 15 inches in circumference. The reel containing the rope that has just been made is now placed on a cable-making machine. The principle of cable making is the same as rope making, only that actual ropes are used instead of strands. Each reel is turned around on a horizontal plane by means of gears, while it is paying out its rope. The entire machine carrying the three reels is turned simultaneously on a horizontal plane, the ropes are rove around various pulleys, and finally, as they pass through a «top» at the upper part of the machine, they are twisted together to form the cable, and then, after being rove around grooved sheaves to obtain the necessary pull, are reeled up by a power reel. When a sufficient length of cable is obtained, it is ready for shipment. In this plant there is a large horizontal rope and drilling cable-laying machine, but the principle does not differ materially from the vertical machine.

Ropes of considerable size, towing lines, and ships' cables of the largest dimensions are made on the ropewalk, which is 1,100 feet long and passes under one cross street. The yarn is rewound on larger bobbins, and the number used depends on the size of the rope. These bobbins are put on a framework of wood located near one end of the ropewalk, and the ends of the yarn are passed through holes in an iron gauge-plate, known as the face-plate. It then passes through cast-iron tubes, and the yarn is fastened on hooks of the forming machine, which consists of a truck which travels on a track the entire length of the walk. There are as many hooks as there are strands. As the former moves away from the face-plate it draws the yarn with it, and at the same time each hook revolves by means of gears, twisting the yarn left-handed into a strand. The machine is actuated by a cable which lies along the floor of the ropewalk. The cable passes over a large wheel at the left and serves to operate the mechanism which turns the hooks, and at the same time winds up a cable attached to the end of a ropewalk, thus making its motion positive. When the forming machine has reached the upper end of the ropewalk, the strands, each 1,100 feet in length, are completed. They are now taken and laid over on the other side of the walk, and the strands are then ready to be «laid» or made into rope. Two laying-machines are required, one at each end of the walk, and are known as the «upper» and «lower» machines. They also give the rope what is known as a fore turn and an aft turn. As many of these strands as are required for the rope are stretched to full length and are attached to hooks on the laying-machine. The upper machine has several hooks, but only one is used. All the strands are fastened to this hook, and they turn left-handed in laying, and the lower machine has as many hooks as there are likely to be strands, and operates in the opposite direction. The strands are meantime placed in the grooves of a conical wooden block called a «top,» through which is passed an iron bar which is fastened to an upright post of a car called a «top sled.» Pieces of rope called «tails» are fastened on the bar and wound around the rope to be laid. They help regulate the lay and assist in giving the rope a finish-gloss. The top having been mitred between the strands as closely as possible to the top, the sled is gradually forced along as the twisting proceeds in a right-handed direction. The lower machine keeps all the strands from untwisting. The top sled finally arrives at the lower end of the walk, with the full length of the completed rope behind it. It is then compactly coiled by a reeling machine, covered with burlap, and shipped to its destination.