new region, and a fundamental patent is often the basis for numerous and profitable improvements and additions.—*Scientific American.*

QUARRYING BY WIRE CORD.

What the band saw is to the frame saw, so much, and even more, is the continuous helicoidal wire cord to the reciprocating blades now used for sawing stone. Not that it is the blade in one case, or the cord in the other, that cuts the stone, both being merely the vehicles for carrying wet sand, which is the real cutting agent, just as it is in the case of deep grooves worn in iron plates along the towing path of a canal, apparently cut by the tow rope. The network of wires crossing one another in all directions, transmitting power from the engine on the surface to the very depths of the quarry, and in many cases also constituting the cutting tool, has very much the appearance of a telephone installation.

Each cord, about 7-32in. in diameter, consists of three mild steel wires, twisted to the pitch found most suitable in practice; and this twist imparts a rotary motion to the cord while travelling at the rate of 15 ft. or 16 ft. per second. The cord has its ends joined by a splice 5 ft. long (the ends of the wires breaking joint), so as to be continuous; and it may be of indefinite length, making several cuts simultaneously, but sufficient space being always left between each to permit of cooling.

The quarry has been worked since 1750, and for the last three years exclusively by wire cord, only thirty hands in summer, and twenty in winter, (all told, including smiths and foreman), being employed for the annual production of the quarry, viz., about 15,000 cubic feet of marble. This does not, however, include the lads who feed the cords down—a practice found preferable to self acting feed, on account of irregularities in the stone. It must be borne in mind that, in quarrying, especially valuable marble, the object is to extract as large a block as possible, and not, as in mining generally, to obtain the largest quantity of product. The sawing by wire cord, with its practically negligible waste, is an enormons improvement over the old system of picking out trenches round all the sides of a block; and, in the case of sawing a large mass into slabs, the wire cord does in a given time about ten times the amount of work performed by blades.

The process of quarrying by cord will, perhaps, be best described by taking the most unfavourable case—that in which the rock is untouched, having no free vertical side to start from, and which must, of course, occur once in all the beds into which stratified rocks are divided, or at each successive height of working in unstratified rocks. After the surface has been laid bare, it is necessary to sink at least three shafts, of 2 ft. 6 in. in diameter, to the natural parting, or desired depth of block, in order to introduce the pulley carriers for bringing the wire cord into play. At first, these shafts were sunk at the Traigneaux Quarry by hand labour with the pick or hammer and chisel, but now they are sunk entirely by mechanical means.

The constructor of the wire cord apparatus, M. Thonar, of Namur, has devised a perforator or trepanner, which makes an annular cut, like the diamond drill, leaving a core in the middle. It consists of a hollow cylinder of boiler plate, about 12 ft. high by 1 ft. 8 in. in diameter, shod at the bottom with an annular serrated steel cutter slightly thicker than the plate, so as to give the necessary clearance. The drill is mounted in a frame consisting of three uprights, and is made to revolve directly, at a speed of about 140 revolutions a minute, by a teledynamic cable working in a grooved pulley keyed on to the shaft. The power required is about 3½ h.p. for a descent of 1 in. per hour in marble. If the drill should become clogged, it is readily lifted out of the hole by a winch, which forms part of the apparatus. Sand and water are allowed to flow inside the perforator, and find their way down the clearance between it and the stone, through small holes in the cutter, rising to the surface again between the perforator and the rock. So greatly does the sand supplement the action of the teeth, that recently the cutter has been superseded by a plain collar of soft iron, with excellent cutting results and saving in first cost, besides having no teeth to sharpen. In the case of very hard rocks, the collar has been set with particles of emery amalgamated with metal—of which more hereafter— in the same manner that the crown of the diamond drill is set with "borts" or "carbonates." With a perforator 1 ft. 8 in. in diameter, it is necessary to sink three contiguous shafts and break down the intervening angles, in order to obtain the requisite space for the pulley carriers. This is not, however, "dead" work, as the cores are used as columns; and the diameter of the drill may be reduced to the size of columns most in demand, provided their number be correspondingly increased so as to obtain sufficient space. Let it be supposed that two shafts of a minimum diameter of 2 ft. 6 in. have been sunk by one method or another to receive the pulley carriers. Each of these latter consists of two uprights, carrying between them an upper and a lower grooved pulley, both normally in the same vertical plane; but the axis of the former is set out, and that of the latter is set in, with reference to the uprights, so as to give the necessary direction to the running wire cord. Moreover, the upper pulleys are capable of a slight horizontal travel, while the bearings of the lower ones slide in guides between the uprights, and are fed downwards by an endless screw, motion to which may be given automatically or by hand, as stated above. A pulley carrier being inserted in each of the two shafts, the cord is passed round the pulleys and set in motion, a suitable tension being maintained, as described below, and sharp sand and water being allowed to flow into the cut.

The writer observed, at the Traigneaux Quarry, the cut deepened to the extent of 4 in. per hour in a block of marble 8 ft. long, and was assured by the managing director that he had by this method cut Belgian porphyry and hard Bavarian granite blocks of about the same length at the rate of 1 in. per hour. At the Brussels Exhibition of last year, where the Société Anonyme Internationale du Fil Héliçoïdal had a complete installation, for which the first prize of progress was awarded by the International jury, still harder work was done. On this occasion, the same cord that cut a block of marble also cut a turret of concrete, composed of quartz pebbles from the bed of the Meuse.

To extract a triangular block of such size that it can be lifted by crane, one more shaft and two more cuts only are necessary; but if it be desired to extract a parallelopiped, four more shafts —six in all—must be sunk, and five vertical sides of the mass, but also to afford a 2 ft. space along one side for clearance. This 2 ft. space may be taken out by the pick if the stone should happen not to be very valuable, or the block may be lifted out by cranes. The spaces thus produced affords sufficient clearance for canting the mass over by means of wedges, crowbars, screwjacks, and winches or cranes. This is under the supposition that the rock has a natural bed or parting, down to which the saw cuts are carried; but in the case of an unstratified rock there is no alternative but to blast or pick out the clearance space, and run a nearly horizontal cut by wire cord under the mass to be extracted, while maintaining it in position by wedges, in order to prevent any pressure upon the cord. The cut is sufficiently inclined from the horizontal to permit of the sand and water flowing to the cord; and, in this