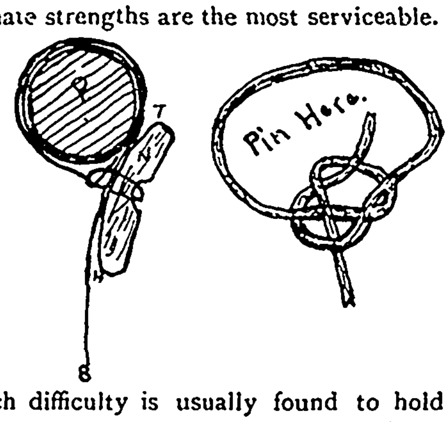
be well to glance for a moment at the method of manufacture of the more ordinary kinds. In making the strand of the rope, the proper number of yarns are passed through a register plate, and from that into a tube into which they fit very tightly. This bundle of yarns is then fastened to the forming machine which travels backward down the walk, pulling the yarn through the tube and at the same time twisting the bundle of yarns into what is called a strand. The angle of this twist is in all cases as nearly as possible 37°. Three of these strands, having been hauled the whole length of the walk, are thrown over upon the laying track and each hooked on to a separate spindle of the laying machines which stand at each end of the walk. One machine is stationary and the other travels a little when the twist goes into the rope. This is on account of the rope shortening as it gets twisted. To prevent this machine moving too quickly, a brake is arranged to grip the rails. When the strands are thus hung upon the machines, at each end of the walk, each strand on its own spindle, and the brake in position, both machines are started so as to put more twist into the strand. This turn or twist of course reduces the length and the twist is regulated by the amount the strand is shortened. If 100 fathoms of rope is wanted with 6 per cent. of hard in it, 6 fathoms of hard is put into the strands, after the strands have first been formed at an angle of 37° as already mentioned. In other words, a strand, which has already been formed at an angle of 37°, is taken and twisted by these machines until it shortens say 6 per cent. of its original length; then we have a strand with 6 per cent. of "hard" in it. Generally speaking the hard ropes wear best, but are very difficult to handle in water. The soft ropes are much more pliable and easier to handle, but they do not stand wear as well as the harder qualities. The soft ropes are usually the stronger.

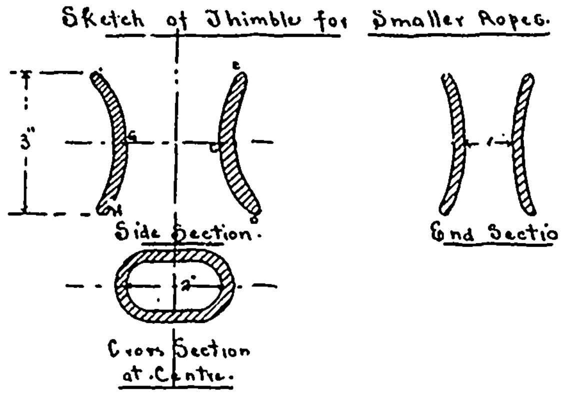
With this brief account of the process of manufacture we will now proceed to describe the testing of the ropes as carried out in the laboratory. At the very threshold the difficulty of holding the specimens was met. Wooden and iron specimens can be so formed that the portion gripped by the testing machine will be sufficiently strong to hold the specimen until fracture occurs in the test piece in the position desired. It is not so, however, with rope. Moreover, it is obvious that even where the rope is made fast round a pin of considerable diameter, some of the fibers will be strained greatly more than others, thus preventing the results obtained from being the ultimate strength of the material. It was this strength we desired to obtain, although it may seem that results gotten under conditions which obtain in actual practice might be more valuable. We desired comparable results and to this end the ultimate strengths are the most serviceable.

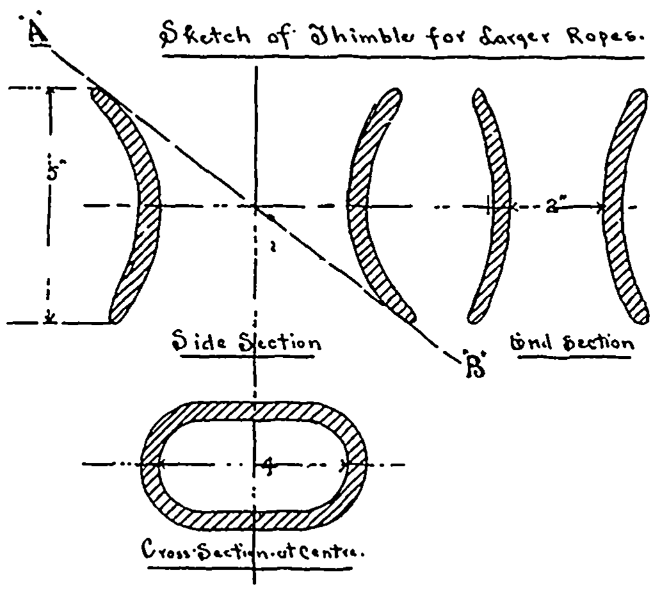


Much difficulty is usually found to hold ropes by means of knots when great stress is applied. By means of the "bowline" knot, a sketch of which is given, we overcame this trouble.

There was no slip nor give; but we soon saw that the strength of the rope was by no means fully developed. The rope failed invariably at the knot, so we were compelled to have recourse to some other contrivance. Splicing was, after consideration, rejected as requiring more time than we had at our disposal.

A contrivance as shown in the sketch below was tried





with some success. P is the pin of the testing machine; N is a block of hard wood. A groove is cut in this along the circular face, TH, in which the specimen to be tested, S, lies. The line, S, goes round the pin twice and is then taken to the block, N, and tied around it, also enclosing the rope, S. The friction of the rope on the pin so decreased the pull on the end tied round the block that the knot on the block never once failed to hold. On account of the difficulty encountered in holding the direction of the block parallel to that of the rope, the device was abandoned. We had the satisfaction, however, of seeing the specimens tested in this manner break in the free, straight portion and not at the fastening. Failure was a successful tutor. We began to clearly perceive the principles underlying a satisfactory holder, and we next tried an oval shaped thimble with flaring ends which were open. The idea was to obtain a holder which would not injure the fiber of the rope; which would not occasion any sharp bends in the strained portion, and at the same time would leave the specimen free to move in the direction of the stress. The thimbles answered very well indeed. The following is a description of them which, with the accompanying sketch, will clearly exemplify the method of working.

The thimbles were made of iron, the smaller about ¼ inch thick and the larger ⅜ inch thick. The dimensions were as shown on sketch. It will be noticed that the radius of curvature along the surface, CD, is the same as