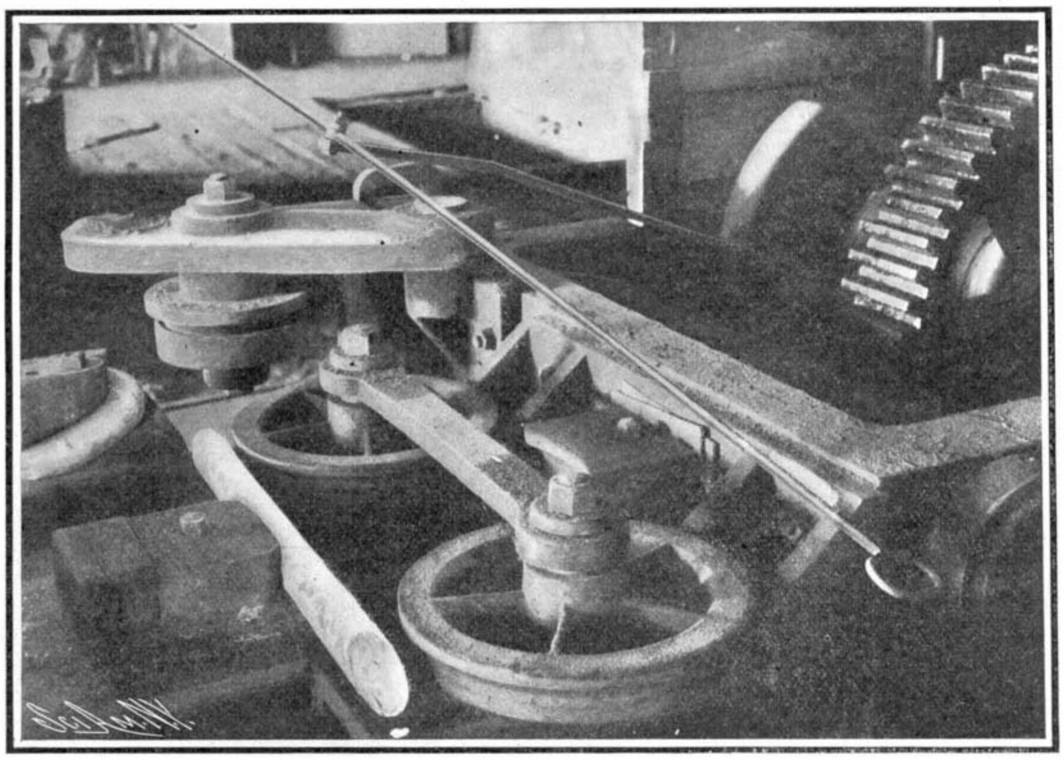
CHAIN MAKING.

In spite of the general supplanting of hand labor by machinery in the various branches of iron and steel manufacture, we meet here and there with an industry in which the skilled mechanic is still able to hold his own, and turn out a product which not the most ingenious machinery can equal, much less supplant. There are not many such cases, it is true, but they exist, and conspicuous among them is the art of chain-making. In the present article, we speak of machine-made cable, it is true; but the term is to be given only a restricted application; for although the links may be cut by one machine, bent into shape in another, and welded under a power-driven hammer, the operation is nevertheless dependent for its success upon the deft skill with which these mechanical tools are manipulated.

The permanence of the traditional methods of chain-making is further suggested by the fact that iron, and not steel, is the material from which it is fabricated. The survival of the older material and the older method in this age of steel and labor-saving machinery is due to the special conditions under which chain is used, and the exacting requirements of its service. A mention of a few of the uses to which chain cable is put impresses one at once with the severity of the service, and the unusual qualities which are required. Thus we find it employed in sling chains in the rough work of quarrying, for lifting heavy weights in building construction, in foundries and machine shops, or at the docks in loading and unloading vessels; while to the lumberman it is absolutely indispensable. In such work the strains are severe and sudden, the links of the chain being subjected to repeated jar and wrench due to the slipping or dropping of the material which is being hauled and lifted. We find it also performing the most important and delicate work of hauling a costly yacht or merchant vessel up a marine railway; while last, and most important of all, is its use as a ship's cable, where, in times of stress, a vessel costing hundreds of thousands of dollars, together with priceless human lives, may depend upon the sound quality of the iron and the fidelity with which the smith has welded the chain, link by link, on his anvil.

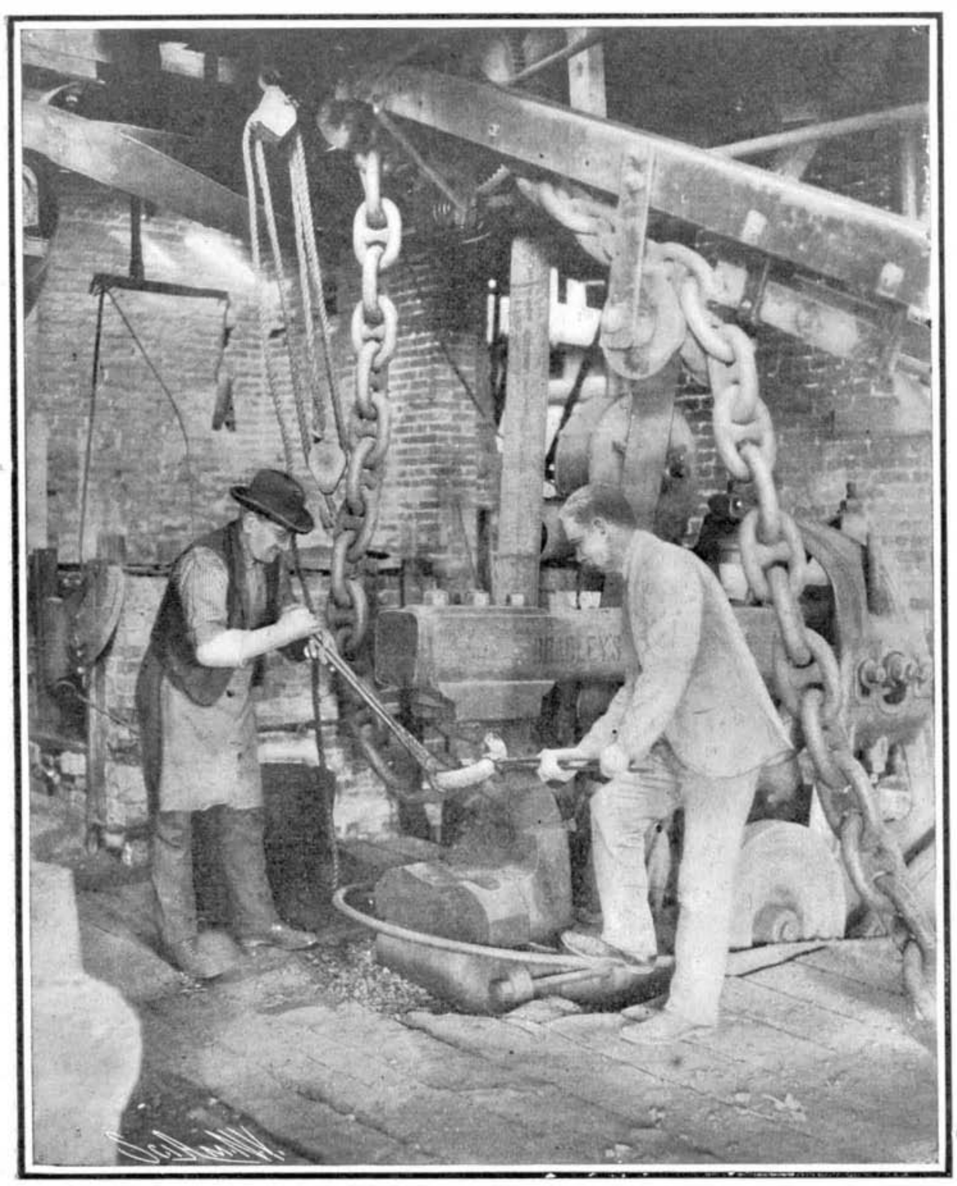
We have chosen for our description of chain making the American Chain Cable Works, of Troy, New York, largely for the reason that in this establishment are made large quantities of ships' cables for the United States government, and particularly for the lightships of the United States lighthouse service.



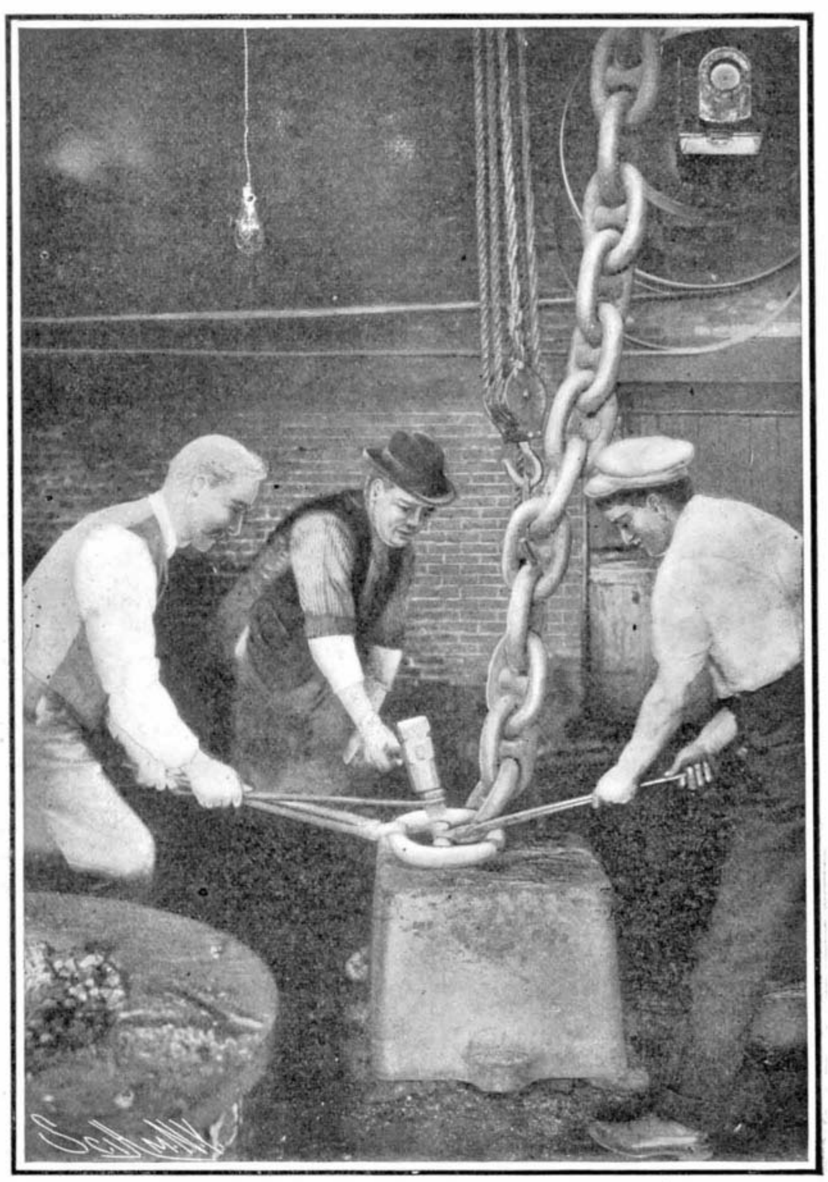
Hydraulic Machine for Forming the Links.

Quality of Iron for Chain Making.—The iron used is a specially rolled grade, of high tensile strength and great ductility, the object being to secure a chain which, on the application of a sudden stress—as, for instance, when a ship is riding at anchor in a heavy seaway—will stretch and so resist the strain gradually, instead of snapping, as would be liable to happen with material of higher tensile strength but small ductility or power of elongation. Chain of from 5-16 inch up to 2 inches diameter is forged by hand, and above 2 inches it is forged with the assistance of machinery.

Hand-Made Chain.—In the smaller sizes the whole operation of chain making is done by a single smith without any helper. The length of completed chain is hung upon a hook or some convenient support near the anvil, and the operation of forging the link proceeds as follows: In his fire the smith will have two or three short rods of the required diameter, and as one is heated to, say, a cherry red, he withdraws it, cuts off the desired length for one link, gives it a couple of blows to form the welding scarf, bends it through say about 130 degrees, hooks it into the end of the completed chain, and brings the ends together for welding. He then raises the link to a welding heat in his fire, places the abutting ends over what is known as the bick-iron, gives it a few taps to insure a good weld, brings over a "dolly" (which is hinged at the outer end of his anvil and when brought over registers above the bick-iron), and with half a dozen blows on the dolly, accompanied with a dexterous movement of the link, the weld is completed and the link smoothed up to a neat finish. The rapidity with which the smiths do this work is very remarkable. Thus, in the case of a 7-16-inch chain, with thirty links to the yard, an expert smith will cut off from the iron bar, scarf, bend up into shape, and weld the links, at the rate of 18 yards in a day of nine working hours, which is two yards per hour, or one link per minute. We present an illustration showing a smith and his two helpers (it takes three men to hand-forge the larger chains) forging a 1¼-inch ship cable. The iron is cut to about one-foot lengths, and several of these are being heated in the fire at the same time. The operation is as follows, the various steps succeeding each other with great rapidity: First, the helper to the right of the anvil withdraws the heated piece, drops one end into an eye at the end of the anvil, and bearing down upon the tongs, bends the piece over to an angle of about 45 degrees. The smith then takes it in his tongs, and with a few taps of the sledge it is bent around as shown in our illustration. It is heated again, passed through the end of the chain by the smith, laid flat on the anvil and the welding scarfs are put on with a few



Bringing Scarfed Ends of Link Together Ready for Welding.



Inserting the Stud in Heavy Stud Chain.

MANUFACTURE OF HEAVY MACHINE-MADE CABLE.

blows of the sledge. The link is now raised to a welding heat, welded by a few blows by the helpers, laid over the bick-iron (which will be noticed in our engraving projecting from the anvil toward the smith), the hinged dolly is brought over, and a few rapid blows on the dolly, while the smith turns the link to and fro, serve to bring the weld up to a smooth finish. The link is now laid on edge; a single blow from the sledge brings it into shape, and with a final tap or two of the smith's hammer the link is finished. At this forge as many as thirty-five links will be added to a heavy chain of this size in one hour, or say about one every two minutes.

MACHINE-MADE CHAIN.—In the heavier sizes of chain of over 2 inches diameter, it becomes necessary to call in the aid of machinery in shearing the iron into lengths for the links and in bending the links into shape. The scarfs are produced by shearing the iron at an angle of 60 degrees with the axis of the bar, all cuts being taken with the inclination in the same direction, so that when the links are formed up the scarfs will lap in the desired relative position. The iron is then heated and placed in a hydraulic bending machine, where it is formed against a block into a rough U-shape at the first stroke, and then rolled into the oval link form on another block adjoining the first. These operations are shown in the accompanying engraving. The scarfed ends are left wide enough apart to allow of the link being hooked onto the end of the chain which is being forged. The scarfed ends are now brought down snugly into contact under an automatic quick-acting hammer, and the link is heated and then welded up under the same hammer. Most of the ship cable has a cast-iron stud inserted in each link. The ends of the stud are hollow, to match the round of the chain, and when the link has been hammered down snugly into place, it is impossible for the stud to be displaced. Indeed, the pull upon the cable, by tending to straighten it out, causes the link to tighten upon the stud and hold it the more securely in place. Cables are made in standard lengths of 15 fathoms or 90 feet, and any greater length is obtained by shackling several of the 15-fathom lengths together, the average length of a ship's cable being about 90 fathoms, or 540 feet. The life of such a cable is about ten years. This, however, depends upon the judgment of the insurance company.

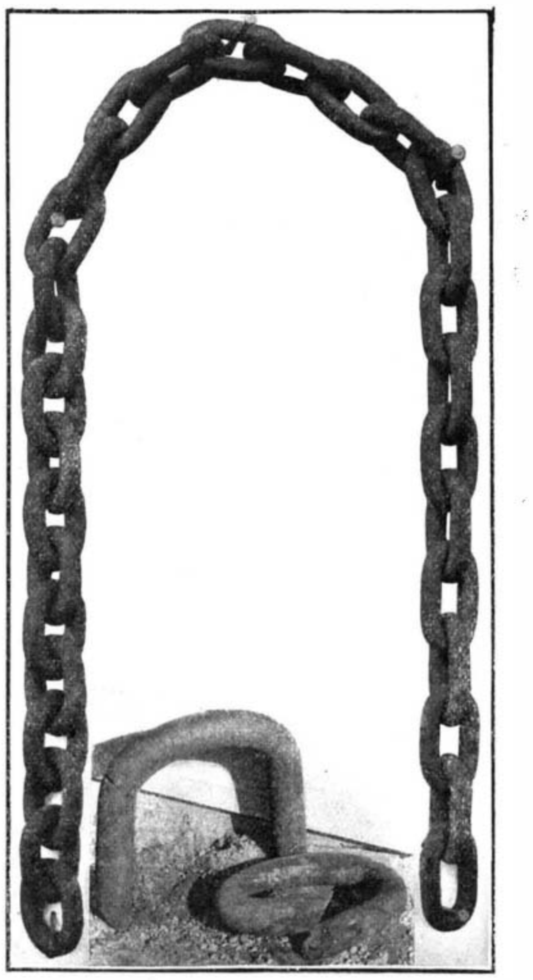
TESTING.—In the case of all cables built for government lightships, one shackle and one swivel are tested to destruction, as are also two sample pieces of the chain, each five links in length. The peculiarly ductile qualities of the Burden iron from which most of the chain at this works is manufactured, is shown in the accompanying illustration, where the right-hand portion of the chain, including ten links, stretched without fracture until the ten links were equal in length to twelve links of the untested chain.

BLACKING.—When the 15-fathom length is completed, it is placed in an iron box and heated by steam, and then drawn through a vat of boiling tar, known as the "tar kettle." Here it receives a thorough coating, after which it is drawn out upon an iron grating, where the surplus tar is allowed to drain off, leaving a heavy protective coat upon the cable.

In conclusion it should be noted that although each link of a chain consists of two thicknesses of bar, it must not be presumed that a chain possesses double the strength of a single bar; actually there is a reduction of three-tenths in the strength due to the formation into links, so that the chain has but about seven-tenths of the united strength of two bars of the same diameter of iron. Moreover, as the strength per square inch of a heavy bar is not so great as that of a smaller diameter iron, there is further reduction to be made on this account. Thus, if a bar of ordinary rolled iron shows a breaking strength of twenty tons per square inch, the breaking strength will decrease to 19 tons up to 2 inches, and 18 tons per inch up to 3 inches diameter of rod. Consequently, the breaking strength of chain made of 1-inch iron will be about 50,000 pounds, and the breaking strength of 2-inch chain about 190,000 pounds.

Slag Portland Cement.

The American consul-general at Coburg, Germany, reports: Portland cement has been made from blast furnace slag for several years in various cement works in Germany, Luxemburg, and Belgium, and has yielded very satisfactory results, especially in regard to quality. Negotiations are being carried on with some blast-furnace works with a view to the introduction of the slag-cement industry into England, Austria, and France. In some respects a blast works has a considerable advantage over other Portland cement factories because the motive power from the cement works can be supplied by a blast-furnace gas motor with electric transmission, the rubber or waste coke from the blast furnaces can be utilized in the cement kiln, and the principal raw materials—namely, the granulated slag and the limestone—are close at hand. Besides, there are other minor advantages. Portland slag cement has also some advantages over natural Portland cement; for while the yield from the raw materials when the former is used is about eighty per cent, the yield when the ordinary raw materials are used is seldom more than sixty per cent. As the cost of production per ton of raw materials is nearly equal in both cases, a saving of about twenty per cent in fuel, labor, etc., is effected in the case of slag cement. Besides, this Portland slag cement is more trustworthy and more regular, and its manufacture can be more easily controlled than that of the so-called natural Portland cement, because the raw material—namely, the blast-furnace slag—is, as a rule, a regular product whose chemical composition is easily controlled; consequently, any alterations which are liable to take place are known beforehand, and precautions can accordingly be taken in time. This is not the case when the natural raw materials are used. Some recent tests with Portland cement from blast-furnace slag, made in the municipal laboratory at Vienna, showed that mortar composed of three parts of sand with one part of this cement gave the following results: 1. After seven days' hardening—Tensile strength, 383 pounds per square inch; strength of compression, 3,880 pounds per square inch. 2. After twenty-eight days' hardening—Tensile strength, 551 pounds per square inch; strength of compression, 5,411 pounds per square inch.



The ten links to the right stretched to the extent of two links in ten without fracture. Of the two detached links, the fractured one, a piece of commercial iron, failed in a bend of 90 degrees; the other, of special Burden iron, was bent as shown, without fracture.

THE ACTION OF CHAIN IRON UNDER TEST.

Both masonry and concrete are occasionally employed in American mines, but are more common in Europe. It has been found that concrete is often advisable at the collar of shafts, either inclined or vertical. Steel is also used in mine support to a limited extent. In shafts it might be employed to advantage, and would prove a perfect protection against fire. Under heavy pressure steel would probably prove a dangerous substitute for timber, as it would give little warning of collapse; and if it gave way under the strain, accident would come without warning, whereas in workings supported by timbers there is always sufficient indication of approaching disaster—sufficient in most cases for men to escape, if not to prevent collapse. Filling is the only safe course to pursue, as no timber will support heavy ground perpetually.—Mining and Scientific Press.

The term "limestone dike" is a misnomer. Dikes are intrusive—injected in molten condition from below. Sedimentary beds, such as limestone, quartzite, sandstone, shale, etc., are not dikes. These latter are sometimes called reefs. Eruptive rocks are also intruded in flat sheets in horizontal formations. These are called sills. Should the formation be uplifted subsequently these sills might be mistaken for dikes, or dikes thrust upward into rock strata standing at a high angle might be mistaken for sills if earth movements caused the inclosing formation to assume a recumbent position. In studying the stratigraphy of rock masses, care must be taken not to mistake slaty cleavage for lines of sedimentation. The former is induced by pressure and movement, the latter by deposition of the rock material in water. Cleavage planes and lines of sedimentation may coincide.—Mining and Scientific Press.

What is believed to be the first iron casting made in the territory now included in the United States, is preserved in Lynn, Mass. Its history is well authenticated. It is a cooking-pot, weighing a little over two pounds. It was made about 1642, near Lynn, where a small blast furnace was built in that year. This furnace used charcoal for fuel, with bog ore found in the meadows along the Saugus River, and oyster-shells as flux. The furnace was operated until 1688, with some intermissions.

This smith and his two helpers are forging 1¼-inch ship's cable at the rate of 35 links in one hour.

THE MANUFACTURE OF CABLE BY HAND.