THE MANUFACTURE OF COLD-DRAWN STEEL TUBES

Nearly two years ago we drew attention to a new and exceedingly remarkable process—the manufacture of steel tubes by cold drawing. At that time this process was so far in its infancy that it could hardly be considered as more than a scientific curiosity. The machinery erected at Willow-walk, Bermondsey, although sufficiently complete to demonstrate the fact that steel tubes could be made by boring out an ingot and passing it through dies, was still so far from perfection that it could not be regarded in any other light than as the embodiment of first, and, in a sense, crude ideas. But to active minds two years afford ample time for the production of great results, and at the moment we write an influential company has been established, and steel tubes are now manufactured under the patents of Messrs. Harding, Hawksworth, and Christophe, on an extended scale, by elaborate machinery; while the details of the process have been so far perfected that there is no reason to doubt that the cold-drawn steel tube manufacture will very soon occupy an important place in the trade of the country. Boiler tubes are now used annually by hundreds of tuns. Hollow shafting is not in demand solely because a demand could not hitherto be supplied at a moderate price. Lining tubes for ordnance, rifle barrels, surface condenser tubes, etc., are manufactured yearly in immense quantities; and it is certain that any sensible improvement on existing means of production will be fully appreciated by the public. We regard, indeed, the operations of the new company as being important in the fullest sense of the word, and we feel some pleasure in laying before our readers ample details of this, possibly the most remarkable invention in the art of working in metals which has been introduced for many years.

Nearly five years have elapsed since the first experiments were made with the view to produce cold-drawn steel tubes commercially. The credit of the first idea is due, we believe, to Mr. G. P. Harding and Mons. L. Christophe, who, while residing in Paris in 1851, had constant opportunities for observing the remarkable softness, toughness, and ductility of a peculiar steel manufactured by Mr. Hawksworth, of Linlithgow, N. B. This gentleman has for many years devoted his attention to the production of a very peculiar soft steel intended for the rolls of calico printing machines, on which, as is well known, the pattern or device is impressed by causing them to revolve under excessive pressure in contact with a very hard steel roll, on which the device is first engraved. After years of experiment, Mr. Hawksworth succeeded in making steel of a uniform quality which left nothing to be desired, and it is to this steel that the process under consideration is indebted for its development. It is true that tubes can now be drawn from almost any good steel; but this was not the case in the beginning, and it is possible that the numerous failures met with in the earliest stages of the invention would have proved sufficiently discouraging to lead to its abandonment had it not been for the peculiar facilities afforded by Mr. Hawksworth's steel. Prior to the year 1851, tubes had indeed been made cold from steel, but only as curiosities. The method of manufacture consisted in beating up a short tube from a circular steel disk into a cup shape, and then driving this cup once or twice through a die. In this way only short lengths could be procured at an immense expense. In a word, such tubes were, as we have said, curiosities and nothing more.

The first experiments in the new process were made at Paris by Messrs. Harding and Christophe, and the results were, upon the whole, so encouraging that these gentlemen, in company with Mr. Hawksworth, patented the machinery employed. The process itself is, perhaps, hardly a good subject for a patent. It is not so much a novel invention as the legitimate development of an old idea—that of drawing wire. That steel could be drawn into tubes constitutes a discovery, not an invention. Nevertheless, the history of this process affords a striking illustration of the amount of time, skill, energy, and capital required to bridge over the space intervening between an original idea and its commercial realization. No one can imagine that in this case the realization would ever have been effected but for the protection afforded by the patent laws. Even now the success of the process depends almost altogether on the machinery employed, and on delicate manipulations, the knowledge of which has only been acquired by dearly-bought experience. The earlier experiments conducted at Paris went little beyond affording proof that the manufacture of tubes on a large scale by the new process was possible, but all the operations were confined—and are still, as far as regards Paris—to the production of rifle barrels. Sufficient was done, however, to show that there was a good opening for the investment of capital. Machinery of a more powerful kind was therefore erected on temporary premises in Bermondsey in 1864; and after a time a company was formed under the title of the "Cold Drawn Steel Tube and Ordnance Company (Limited)." The premises of the old London Zinc Company, in Macclesfield street, City road, were taken, powerful machinery erected, and after many and unavoidable delays, the manufacture of steel tubes in quantities, as a commercial speculation, has at last been commenced, and we believe we are correct in stating that the new company is now in a position to execute very large orders. But it is not to be supposed that the machinery as now constructed is identical with that originally patented. On the contrary, many patents have been taken out, and various improvements have been introduced from time to time during the last five years.

The process of manufacturing steel tubes of equal diameter from end to end is exceedingly simple. A solid ingot of sufficient size is placed in a drilling machine and bored right through from both ends at once. The size of the ingot and the diameter of the hole depend on the kind of tube to be produced. A short and very thick steel pipe is thus produced, and this pipe is then threaded on a rod having an excessively hard steel acorn-shaped head. This rod or mandrel is secured to one head-stock of an hydraulic press. To a central frame work or head-stock a die is fixed, exactly within which stands the acorn-head of the mandrel. The end of the tube having been slightly tapered down is then introduced into the die aperture, and affixed to the crosshead of the moving ram by means to which we shall refer presently. The force pumps are then put in motion and the tube is drawn through the die, thereby having its external diameter reduced, while the acorn-head of the mandrel imparts a beautiful glossy surface to its interior. After a few passes through the dies, the tube is annealed, and then passed again, and so on until the required length and thinness is attained. In making tubes for surface condensers, for example, a bar of steel 2 feet long and 2 inches in diameter is taken; this is perforated from end to end with a $\frac{3}{4}$ inch hole, and then drawn out through a series of dies into a tube or tubes $\frac{1}{16}$ths of an inch in diameter, $\frac{1}{32}$d of an inch thick, and 60 feet long, weighing $\frac{1}{4}$ lb. per foot of length instead of 10$\frac{1}{2}$ lbs., the weight of the original bar; and so far is this severe manipulation from injuring the metal that such a tube will resist a bursting hydraulic pressure of 7,000 lbs. or more than three tuns per square inch. The change which takes place in the position of the molecules is very remarkable; and in the fact that this change is so radical, resides, strangely enough, one of the best aids to the commercial success of the process. Only a good steel will endure the first and second drawing, which embody the most severe test to which the metal is exposed. The least flaw is thus detected in the earliest stage of the process, and the ingot can therefore be rejected before much labor has been expended upon it. The first two passes through the dies accomplished, the production of the finished tube becomes a matter of certainty, as the metal is apparently so consolidated by the drawing that it becomes enabled to resist all the rough usage to which it is subsequently submitted; and it must be borne in mind that the strain to which the metal is exposed becomes gradually diminished in amount as the frictional surfaces and the thickness become less.

It is obvious that where large quantities of tubes are to be produced, drilling the ingots constitutes a very important department of the manufacture. Great difficulties have, we believe, been encountered in producing a machine which would drill a large number of ingots simultaneously, and from both ends, with sufficient accuracy. It is easy enough to drill from one end only, but this involved too much time. Ten ingots are drilled at one time, with such approximate accuracy as suffices for every purpose. The machine only requires the attendance of one man and a boy, and can turn out from ten to twenty ingots, each producing from 20 feet to 40 feet of tubing according to thickness in ten hours. At present it is principally employed in drilling ingots for rifle and musket barrels, a special branch of the company's operations, the consideration of which we shall reserve for a second paper. Ingots of large size are sometimes drilled separately, much in the ordinary way, calling for no very special mention, but they are mostly produced by casting hollow, or by punching and rolling.

The drilling effected, the tubes are next brought to the draw bench. There are two of these benches at Macclesfield street. The larger of the two consists of two pairs of hydraulic cylinders 13 inches diameter and 12 feet stroke; the four rams are attached to a very massive crosshead supported by slide bars; and the tube to be drawn is placed between one pair of cylinders and coupled to the center of the crosshead. The dies are all formed in segments and packed tightly around the tube and within the die-holder. The mandrel is placed at the same time within the tube to maintain its internal diameter, or to increase it, as may be desired. Power is communicated by a set of six-geared, two-inch pumps, capable of producing a pressure of three tuns per square inch, or 800 tuns on the pair of rams. The velocity at which the rams move is 15 inches per minute, and the motion is perfectly equable, steady, and without vibration The cylinders are fixed to strong cast-iron bed plates, and are heavily stayed both transversely and longitudinally. The die-holder is forged from a solid block of wrought iron, and has a sectional area at the weakest place of 160 square inches. The entire apparatus weighs 90 tuns, of which the cylinder, framing, etc , form 75 tuns, the rams and crosshead weighing 15 tuns. It constitutes, as a whole, possibly, the most powerful hydraulic machine ever devoted to manufacturing purposes, and, alike from its magnitude and design, it is well worthy of attention, even if we disregard the object for which it has been specially constructed. Although small tubes could be drawn by this press, it would be sheer waste of power to employ it for such a purpose. It is devoted to the production of hollow shafting, lining tubes for ordnance, etc., and will draw tubes from 3$\frac{1}{2}$ inches to 18 inches in external diameter, an overhead traveler being employed to move such heavy masses of metal. Smaller tubes are drawn by a second apparatus with a single pair of 11-inch rams and a stroke of 10 feet. Heavy flanges cast on the cylinder constituting the die-holders, half a dozen tubes may be drawn at once. —*London Engineer.*

Kangaroo on a Tread Mill.

In our Australian advices we find the following:—"A market gardener in the neighborhood of Portland has put a kangaroo, which he caught and tamed, to various uses. The animal stands nearly 6 feet high. The owner has tested its strength and capabilities in the following manner:—He had a large circle made of slabs an inch thick, with the outside diameter 20 feet, and with an inner one of 17 feet 6 inches. On the circular floor is nailed flat ridges and furrows, thus affording a floor for the kangaroo's feet, and a resting place about 3 feet long for his tail. It is fitted up with simple wheels in the center, like those of a horse chaff-cutting machine, and it is fixed on an incline. The kangaroo is kept fast to a frame work of post and rails, stuffed with hay and bagging, to prevent his legs and back from being bruised. An opening is left in the rear to give his tail full play. By continually springing up he sets the machine in motion. The animal works at about half a horse-power and turns a grinding stone, chaff-cutter, bean mill, turnip cutter, and a washing machine, and all at the same time. This simple contrivance also lifts water separately for irrigating the garden"—Of course it does, and we have no doubt astonishes the natives as well. Why not estimate the power of engines by the nominal kangaroo? It would convey quite as accurate an impression as the nominal horse.—*Engineer*