

justed, requiring a peculiar temper. The slips for the handles require great care in fitting. It is stated that a three-bladed knife passes through the finisher's hands a hundred times.

The manufacture of butcher and shoe knives is large in the state of New York. The state census gives it at 35,000 per annum, and these have a wide reputation.

The manufacture of forks is said to be one of the most unhealthy of the mechanical arts. It has been estimated that the destruction of life in it is greater than in any other pursuit, by reason of the fine dust evolved in the process of grinding, and which fills the atmosphere of the rooms, and invades the lungs of the operators. This takes place in the finishing. The forks are hammered out of square steel rods three-eighths of an inch thick. The tang and shank are roughly shaped at the end of the steel rod, and are then cut off, with about an inch of the square steel besides. This is drawn out flat for the prongs, and the tang and shank are then shaped by the dies. The other end, heated to a white heat, is laid in a steel die upon an anvil, another die attached to the under face of a heavy block of metal, is allowed to fall upon it to a height of seven or eight feet. The prongs are thus shaped, and all but a thin film of steel removed from between them. This is cleared out by a machine called a fly press. A number of forks are collected together, and annealed by heating and allowing them to cool slowly. They are now sufficiently soft to be easily shaped by the file, and by bending. They are then heated to redness and suddenly cooled, by which the hardness is restored. The process of hardening renders all steel brittle, and it is intended to remove this by tempering. The higher the heat when the metal is hardened the softer and stronger will be the steel. A lower degree of heat gives more hardness and also more brittleness. The temper is indicated in the color, and temperature which produces that color follows a regular scale. Thus 430° of heat gives a very pale straw color, suitable for the temper of lancets. Higher degrees of heat gives darker shades of yellow, suitable for razors, penknives, and chisels; until at 500° the color is brown yellow, adapted to axes and plane irons. Twenty degrees higher the yellow has a purple tinge, seen in table knives. Thirty degrees higher the dark color of a watch spring is obtained. Again twenty degrees the dark blue of saws is visible. At 630° the color has a tinge of green, and the steel is too soft for instruments. This color is supposed to be produced by the action of the oxygen of the air upon the carbon of the steel, and protects the metal from rust in some degree.

One of the most necessary tools for a new and agricultural country is the ax. The remains of all lost races generally disclose, in some rude form, that useful instrument; and the modern nations of Europe present it in an improved metallic form. The Spanish ax, which has no head, is made by hammering out the bar and turning it into a loop to make the eye. The manufacture of the ax has, however, like its use, been carried to its highest perfection in the United States. An American ax has a fame co-extensive with an American backwoodsman, who alone of all the nations that visit this continent is fitted to struggle with the mighty forests with which the country was covered. While the American pioneer, ax in hand, boldly buries himself in the forest to clear and subdue it, the European rather keeps to the plains as more easily managed. The experience in the use of the ax, and the various uses to which it is applied, have combined to produce great varieties, all of which have undergone considerable improvements. Formerly, the operator depended upon the rude forges and limited skill of blacksmiths to supply axes. With the improvements that suggest themselves, special factories sprang up, and the largest factory of the kind in the world is in New England. There, 1,200 tons of iron and 200 tons of cast steel are by machinery wrought annually into tools. In the most recent process hammered bar iron is heated to a red heat, cut off the requisite length, and the eye, which is to receive the handle, punched through it. It is then re-heated and pressed between concave dies until it assumes the proper shape. It is now heated and grooved upon the edge to receive the piece of steel which forms the sharp edge. To make the steel adhere to the iron borax is used. This acts as a soap to clean the metal in order that it may adhere. At a white heat it is welded and drawn out to a proper edge by trip hammers. The next process is hammering off the tool by hand, restoring the shape lost in drawing out; it is then ground to form a finer edge. Afterwards it is ground upon finer stones, and made ready for the temperer. The ax is now hung upon a revolving wheel in a furnace over a small coal fire, at a peculiar red heat. It is cooled successively in salt and fresh water, and then tempered in another furnace, where the heat is regulated by a thermometer. It is then polished to a high finish, which will show every flaw and enable it to resist rust. It is then stamped, and the head blackened with a mixture of turpentine and asphaltum.

The manufacture of scythes has reached a high state of perfection in the Western States, and the patterns have been imitated to a great extent in Europe.

The manufacture of surgical instruments has become large in the cities, mostly in Philadelphia, where the manufacture has acquired great celebrity. The ingenuity and skill with which an infinite variety of instruments is adapted to the purpose of operations upon the living fibers of the body are marvellous in their way. The quantities supplied to the West and South are large.

WHEN the head of a cold chisel has been battered, so that the steel "rags" over the edge, the edges of the head should always be ground off. The "ragging" is very hard and flinty, and apt to fly at the blow of the hammer, and a particle lodged in the holding hand, is an uncomfortable companion.

CAST-IRON WORKING IN SCOTLAND.

We condense from the *Ironmonger* some interesting information respecting the manufacture of cast-iron wares at the Carron Iron Works in Scotland. These works were established in 1759, by Dr. Roebuck, who employed James Watt to erect a large steam engine, which was merely used to pump back into a reservoir the water that had passed over the water wheels, and so enable it to be used again and again to drive the machinery, instead of applying the engine direct for that purpose.

It appears that the Carron Company employs about 2,000 men and boys, who are well cared for and contented, and there is no trouble with them in the way of strikes or trade disputes, which is not to be wondered at as the Company takes a deep interest in all that concerns the welfare of the operatives, who have benefit societies, the most important one of which has been in operation for several years, and holds an interest in the Company.

THE PROCESS OF MOLDING.

Take, for example, a three-legged pot, the patterns for which consist of nine pieces, two for the body, three for the feet, and two for each of the ears. The body pieces have been formed by taking a completed pot, denuding it of feet and ears. These pieces the molder takes, and placing the severed edges together, lays them down on his bench with the bottom upward. He then incloses the pattern in a circular casing, which he fills up with sand. The sand is rammed down all round and over the pattern, care being taken during the process to insert the feet pieces, and also a wooden plug to form a "gate" through which to pour the metal. The molder then turns the box over and fills the inside of the pot with sand. The next part of the operation is to take out the pattern and leave open and entire the space it occupies. The advantage of having the casing and pattern in sections now becomes manifest. The upper section of the casing is unfastened and taken off, when it is seen that the sand bears an impression of the bottom of the pot. The side pieces are in like manner removed, leaving the body pattern clear. The latter is carefully lifted off, one half at a time, exposing the "core" or globular mass of sand which represents the interior of the pot. The whole surface of the sand is next thickly dusted with ground charcoal, and rubbed quite smooth—a process which makes the iron take a finer "skin" than it would otherwise do. The feet and ear pieces having been withdrawn, all that is now necessary is to put the casing together again, fasten it tight up, and prepare the "gate" by pulling out the plug and rounding off the edges of the hole. So compact does the sand become that the completed mold may be moved about freely without sustaining injury. An expert hand can mold a pot of the largest size in from fifteen to twenty minutes. After a certain number of molds have been prepared, the workmen proceed to "cast" them. The molten metal is carried from the furnaces in huge ladles, and appears to be as fluid as water. When it is poured into the mold, gas is at once generated, which finds its way through the sand, and issuing from the joints of the casing, become ignited, and burns with a beautiful purple flame. Were this gas not allowed to escape, the mold would burst, and the consequences to the workmen would be most disastrous. It is a curious fact, that while a few drops of water would ruin a mold, the boiling metal may be poured in from a height of a couple of feet without disturbing a particle of the sand.

When the metal has cooled sufficiently, it is dug out of the sand and taken to the dressing shops, where roughnesses are removed. Articles cast in several pieces are then carried to the fitting shops, where they are put together. Kettles and stew pans, which are to be tinned, are first annealed, and then passed to turners, who put a smooth and bright surface on the inside. The tinning is then done, the handles put on, the outsides japanned, and the completed goods removed to the warehouse. Portions of many of the articles are of malleable iron—such as the handles of kettles and pans; and in the making of these a large number of smiths are employed. The division of labor system is extensively applied in the works, and the result is that the men in the various departments display extraordinary expertness. When a boy enters on his apprenticeship, he chooses, or has chosen for him, the branch of work that he is to follow, and to that he adheres. Let us suppose that a boy selects pot molding. After some preliminary training he is intrusted with the making of pots of the smallest size. As he advances in years, so does the size of his pots increase; and by the time that gray hairs come, he finds his hands employed upon vessels so capacious that each might contain a dozen of those he made in his early days. This is one of the peculiarities of life at Carron; and though it looks as if designed to remind the men of the flight of time and the growth of years upon them, it is simply the result of promotion by seniority. The mold for a small pot requires nearly as much time to make as that for a large one; but there is a difference of price in favor of the latter, and these the older hands claim the privilege of making. Another peculiarity of the pot-making branch is the mode of payment, which is this: a man agrees to make a certain number of pots for half a crown, and he is allowed one shilling of premium on every hundred that he produces. Taken altogether, the men employed in molding make higher wages than those in the other departments, and it is no unusual thing for one of them to receive even as much as £3 for a week's work; but the general wages of the class may be set down at about twenty-five shillings for sixty hours' work.

ARTISTIC WORKS IN CAST IRON.

The Carron Company has devoted much attention to the production of cast iron goods of an artistic kind. When any new article is to be produced, a drawing of it is first made,

and from that a modeler forms a pattern in wood, wax, or plaster. From the pattern a cast is taken in tin, a metal which takes a smooth surface, and from the tin copy, which is nicely chased up, the molder makes the impression in sand from which the iron is cast. A smoother surface is thus given to the iron than would be the case were a wood pattern used. In all cases, the details of the pattern are sharpened in the iron, after casting, by filing. Though no model seems to be too difficult for the molder to make in one piece, yet, as a matter of convenience, most articles of any size or complexity are made in several pieces. In the molding shop, in which the ornamental castings are made, we had an opportunity of seeing sand molding of the most difficult kind; but the operations of the workmen would require to be seen to be understood. A specimen of work from this shop was shown at the Exhibition of 1862, along with a variety of other castings, and excited a good deal of interest, as showing the capabilities of the sand-molding process. It was a small figure of a stag browsing; and, in order to cast it in one piece, the mold had to be made in upwards of one hundred parts, each part being simply a clod of moist sand, held together by compression.

CAPABILITIES OF CAST IRON.

It would appear that the capabilities of cast iron have not yet been fully developed by the ironfounders of the country. At the Paris Exhibition were shown specimens of Berlin castings in iron, which, by their delicacy and beauty of outline, attracted considerable attention. Some specimens of the same kind of work may also be seen in the Edinburgh Industrial Museum. The minutest details are sharply defined, and the entire surface has a bronze-like smoothness. It has been generally believed that this kind of work was made by mixing with the iron some metalloid, which has the effect of giving to the metal more fluidity and density; but this, we believe, is not the case. The specimens are made of iron alone, and are the result of the laborious researches and experiments of M. Schott, the manager of Count Stolberg's works in Brunswick. "His attention," it is stated, "was first directed to the importance of procuring the finest quality of molding sand, and to prevent, as far as possible, the accumulation of air in the mold which is drawn in during the process of pouring the liquid metal". His sand is made by mixing burned clay with pulverized sandstone, having a maximum porosity. It has also the fineness of grain which is essential in producing a delicate mold. An incident is related which illustrates the importance of this in this branch of the art. M. Schott, in explaining the subject to some friends who were dining with him, sent a folded napkin from the table to the foundery, and shortly after showed them a casting which correctly represented the indentations produced by the finely woven thread of the fabric. The most important part of the process, however, is the preparation of the metal. M. Schott made a series of experiments to determine the melting point of different kinds of pig iron; and, by mixing several in proper proportions, he has been enabled to vary the melting point at will. It will surprise even practical ironfounders to learn that his experiments proved that the melting point of different samples of charcoal iron, made at his own blast furnaces, varied more than 800° Fah. Charcoal iron generally melts at 700° higher temperature than coke iron. The contraction, on cooling, is greatest in the charcoal iron, and, in most cases, it has the greatest density when solid. In examining various specimens of casting, M. Schott brought to his aid the microscope, and was thus enabled to detect certain differences which chemical analysis had failed to explain. The iron ore used by him is not different from that found in many other places. It is reduced in a series of small charcoal furnaces in the vicinity of the mines, which are situated in Northern Germany, near the town of Brunswick.

Modern Naval Warfare.

MR. A. L. HOLLEY of Harrisburg, Pa., who is thoroughly acquainted with the subject, has published in *Engineering* a lengthy article in which he claims for the Messrs. Stevens of Hoboken, that they were the originators of many, if not most of the improvements in modern naval warfare. He sums up their claims that the Messrs. Stevens, father and son, either originated, or first developed, the following important features of modern naval warfare. Twin screw, 1805; armor plating, 1812; inclined armor, 1812 and 1841; training guns by rotating the vessel, 1812 and 1862; engines and screws below water in war vessels, 1841; large engines to work expansively at ordinary times, and with maximum power in action, 1841; concentrated fuel (working to petroleum?), 1841; iron hulls for war vessels, 1841; wrought-iron rifled gun, 1841; the Armstrong lead-coated elongated shot, 1841; concentrated protection, a central battery, a belt of armor at the water line, and a shell proof deck, 1843 to 1854; protecting the hull by immersion to fighting draft, by means of water let into compartments for the purpose, 1843 to 1854; wrought iron engine framing, and a wrought-iron ship of 420 feet length, 1843 to 1854; loading a gun below deck by steam power, 1862.

As to the later inventions of Mr. Stevens, we can testify to the correctness of Mr. Holley's assertion, his plans having been repeatedly presented to this office by the venerable surviving inventor.

TRADES UNIONS ON TRIAL.—The case of Mr. Henry B. Dawson, against the Bricklayer's Union in Westchester county, N. Y., for conspiracy in preventing his son from obtaining employment, has so far resulted in a finding of a bill by the grand jury, the defendants having carried the case up to a higher court. The decision will be looked forward to with interest.