THE MANUFACTURE OF OLIVE OIL IN CALIFORNIA.

For a number of years past, the olive tree has been cultivated with varying success throughout the Southern States, and especially on the islands on the coast of Georgia and Florida and along the sea board of North Carolina. The quality of the product, however, not being the best, its manufacture has never assumed proportions of any magnitude, nor has it been able to compete with the oil imported from Europe.

A writer in the *Overland Monthly* publishes the information that the culture of the olive tree and the manufacture of oil from its fruit is gradually becoming a leading industry in California. The character of the climate, and the soil of the valley of Santa Barbara and of the foot hills of Santa Inez, for sixty miles along the coast, are adapted to the production of the finest varieties of oil. It is predicted that this portion of the State will eventually be numbered among the most celebrated oil districts of the world.

The olive is propagated almost entirely by cuttings taken from the sprouts and branches of mature trees at the time of pruning. The cuttings are generally from ten to fifteen inches long and from half an inch to three or four inches thick; the thickest are the best. These are placed in a perpendicular position in a bed of good soil, six, eight, or ten inches apart, their tops level with the surface. The earth is pressed closely around them, and their ends are slightly covered to protect them from the drying influence of the sun. Here they remain, throwing out leaves and branches, until April or May, when, with as little disturbance as possible of the roots, they are taken up and, after being trimmed to a single sprout, are set out in the orchard, in rows about twenty-five feet apart each way. The ground between the trees may be cultivated for several years, with little or no detriment to the young trees. When the olives are to be gathered, cloths are spread under the trees and the berries are pulled from their branches by hand and thrown upon the ground, or are beaten off with a long rod. If they are intended for making oil, they are carried to a dry room or loft and scattered upon the floor, or, where this is not convenient, a drying frame is made—consisting of broad shelves one above another, and sliding in and out as the drawers of a bureau—and the berries are spread upon the shelves. By this exposure to a dry, in-door atmosphere, the berries ripen further, their watery juices are evaporated, the oil is released and, when the skins have been broken, flows more readily under pressure. A slight mold may gather upon the berries during the few days that they remain here, but not sufficient to have an injurious effect upon the oil, or it may be prevented entirely by stirring the berries daily.

The process of extracting the oil, as practiced in Santa Barbara, is simple, even to mediæval rudeness. A large, broad stone wheel is held by an arm from a center post, and, by a horse attached to this arm, is made to traverse a circular bed of solid stone. The berries are thrown upon this stone bed, and are shoveled constantly in the line of the moving wheel until they are considerably macerated, but not thoroughly or until the stones are broken. This process finished, the pulp is wrapped in coarse cloths or gunny sacks, and placed under a rude, home-made screw or lever press. The oil and juices, as they ooze through the cloth or sacks, flow into a small tank, and, as they increase, are distributed into other vessels, from the surface of which the oil is afterwards skimmed. The oil flowing from this first pressure is that known as "virgin oil," and commands the highest price from connoisseurs of the table. Without further preparation the oil is now ready for use, except that, in order that any intrusive matter may be separated from the body of the oil and collected at the bottom of the oil cask or jar previous to bottling, it is set away for a time to rest. At the Mission of Santa Barbara, the oil is stored in huge antique pottery jars, that, ranged round the room, remind one of the celebrated scene of the jars in the story of "The Forty Thieves." The "second class oil" is the result of a second and more thorough crushing of the berries, in which even the stones are broken, and of a subsequent subjection of the pulp to the press. The berries are sometimes submitted even to a third process of crushing, and, previous to pressure, are brought to a boiling heat in huge copper kettles. The oil thus obtained is of an inferior quality, and is sold for use as a lubricator and also as an ingredient in the manufacture of castile and fancy toilet soaps, and for other purposes for which it is superior to animal oil. The residue of the berries is then returned to the orchard and scattered under the trees, and, possessing the qualities of a rich and rapid fertilizer, may be said to be yielded to us again revivified and luscious in the richer fruitage of succeeding years.

The tree, at five years of age, returns a slight recompense for care; and at seven an orchard should afford an average yield of about twenty gallons of berries to a tree. If there are seventy trees to an acre, there should be obtained from it one thousand four hundred gallons of berries. From twenty gallons of berries may be extracted three gallons of oil; and, if properly manufactured, olive oil will command $4 to $5 a gallon at wholesale. Thus, an average yield of olives, derived from an orchard covering one acre of land, will produce about $800 worth of oil. After deducting the entire cost of production and manufacture, a net profit may be anticipated of at least $2 per gallon; and thus, one acre, containing seventy trees, yielding an average of twenty gallons of berries, or the equivalent of three gallons of oil, each, will afford a surplus above all expenses of about $400 a year.

Olive culture is so simple that any one of ordinary intelligence may engage in it. The process of manufacturing the oil is an entirely different business, and belongs separate and apart from the cultivation of the olive. In time, it will not be expected, as now, that each grower shall be manufacturer also. As soon as the supply of olives in a neighborhood is sufficient to warrant the erection of suitable machinery for expressing the oil, every requisite for the purpose will be at hand. The olive grower's labors for the season will end with the deposit of his berries at the oil manufactory; and, according to the custom of the olive districts of Europe, one half the oil from his berries will subsequently be returned to him, ready for use and for market.

A large part of the oil sold in this country, and purporting to be olive oil of European manufacture, is the product of adulteration and imitation. It is generally manufactured in this country, and is composed principally of animal oil, though mustard seed oil and other inferior vegetable oils also form materials for its adulteration. Every housewife knows that olive oil purchased from the grocer, when exposed to a cold atmosphere, sometimes thickens and turns white or opaque in the lower part of the bottle; and every one familiar with the nature of olive oil knows that it retains its perfect transparency and uniform oily consistence under any temperature. Animal oil condenses under the influence of cold; but vegetable oil does not. This difference has been well noted on the shelves of stores where the genuine and the adulterated oil have been ranged for sale, side by side. The genuine oil glows clear beneath the glass in all weathers; the adulterated oil turns flaky with the cold, and the lard goes down with the fall of the winter's thermometer. It is an advantage, also, of the genuine "virgin oil," obtained by home manufacture, that it retains its perfect sweetness longer than any other oil. "Virgin oil," made at the Santa Barbara Mission four years ago, is to-day in possession of the nice delicacy of its first flavor when fresh from the berries.

IRON AS A MATERIAL OF CONSTRUCTION.*

There are three great divisions under which the material called iron is usually classified—malleable or wrought iron, steel, and cast iron; and of these there are endless varieties both as to quality and character.

Iron is never found in a chemically pure state, but always in combination with foreign substances, which it is the business of the manufacturer to get rid of as far as possible, as it is the presence of these impurities which deteriorates the metal. The ore, which is an oxide of iron, is first heated in a blast furnace with limestone and coal or coke, the carbon from the latter combining with the oxygen of the ore and allowing the molten metal to flow away, together with a "slag" composed of the earthy matters in the ore united with the limestone. The slag, being light, can be drawn off from the top of the molten metal, which is afterwards run out of the bottom of the furnace into furrows made in sand, and broken up into convenient lengths called "pigs."

Chemically pure iron, even if it could be obtained, would be much too soft for purposes of construction, and it is therefore necessary that a small quantity of carbon should be always combined with the metal to render it hard and strong; the proportion in which carbon combines with iron varies from $\frac{1}{4}$ per cent to 6 per cent. In order that iron may be malleable, or readily worked by the hammer, it must not contain more than $\frac{1}{2}$ per cent of carbon; and from this proportion up to 2 per cent of carbon in combination gives us steel. If more than 2 per cent of carbon is present, we obtain cast iron, the brittleness of which increases with the proportion of carbon with which it is impregnated, 6 per cent being the highest that it is possible to combine with it.

The minerals silicon, sulphur, and phosphorus are found combined in greater or less proportion with all iron, and these impurities must be got rid of as far as possible, since their presence tends to weaken the metal.

Malleable iron is obtained from the "pig" by the process of "puddling," or exposing the molten metal to the action of the air, by which the greater part of the carbon is carried off, the metal being stirred until the above named impurities are got rid of, and a spongy character is imparted to it. The iron is then removed from the furnace to the squeezer, or hammer, by which the remainder of the slag is forced out, and the metal can then be placed between rollers and drawn out into flat bars. When bars or beams of large size are required, the puddled bars are piled up together, heated to a welding temperature, and passed several times through grooved rollers, the size of the groove diminishing each time until the required shape and size is obtained. By this means bars of any required section and length can be obtained.

CAST IRON.

Cast iron is obtained by merely remelting the pigs, and pouring the metal into sand molds made to any required form. The quality of the metal is improved by frequent meltings, which remove the impurities, and for good work a third melting should be used; the strength is also increased the longer it is kept in a state of fusion. It is desirable to mix the pigs from different ores, as well as those obtained from different meltings.

To obtain great hardness, the castings must be chilled or cooled rapidly, the surface metal which cools first being always harder and closer in texture than the interior, where the castings are of large size.

The tensile strength of cast iron, or its power to resist a direct strain applied to stretch it in the direction of its length, is small as compared with its crushing strength, as well as with that of malleable iron; 7 tuns being about the average force that will break a bar 1 in. square, although some bars, that had been carefully prepared and kept in a state of fusion for several hours, bore double this amount of strain It is in its resistance to crushing that the great value of cast iron as a building material lies; experiments upon a large number of cylinders, $\frac{3}{4}$ in. diameter and $1\frac{1}{2}$ in. high, gave the crushing strength per square inch from 27 tuns to 54 tuns, or an average of 38 tuns, the specimens shortening from $\frac{1}{10}$ to $\frac{1}{20}$ of their length before crushing; the ultimate tensile strength was found to be about $\frac{1}{6}$ of the crushing, the elongation being about $\frac{1}{600}$ of the length.

The transverse strength of cast iron beams is very variable, being greater in proportion in those of small size than in large castings. No sensible diminution of strength takes place in cast iron, if heated up to 600° Fahr., but beyond that temperature it gets rapidly weaker.

The ratio of the "working strength" of cast iron to its ultimate strength is as 1 to 3, or 1 to 4, for a stationary load, and 1 to 6 for a moving load, as in the case of a railway bridge. If the load is kept within the working limits, a beam of cast iron does not lose strength by a continuance, however long, or a repetition, however often, of the same load.

The average specific gravity of cast iron is 7·1, or it weighs 7,100 oz. or 443 lbs. per cubic foot. One cubic inch weighs $\frac{1}{4}$ lb, so that to find the weight in pounds of a casting, divide the number of cubic inches it contains by 4.

The great advantage of cast iron is that it can be made into any required shape; and when many copies of the same form are wanted, they can be supplied at a very moderate cost as compared with malleable iron. It has, however, the disadvantage of not being trustworthy, and is liable to unsoundness from unequal contraction in cooling, which causes some parts to be more dense than others; this can only be provided against by allowing an excess of strength in the castings. Its brittleness also unfits it for use where it would be subject to heavy concussions or sudden changes of load; this can, however, be obviated by a process of annealing, which produces

MALLEABLE CAST IRON.

The castings are first made in the usual way from soft and pure charcoal pig, and kept red hot for some days in powdered red hematite ore, by which most of the carbon is extracted, and the metal is converted into malleable iron; th expense, however, of this process prevents it from being use for any but small castings, of which a large number are required. Cast iron does not oxidize (rust) so readily as wrought iron when exposed to the weather, but the continued action of sea water is to convert it into a soft porous mass which readily crumbles to pieces.

WROUGHT IRON.

Wrought or malleable iron is the metal in its purest condition, and with the greatest proportion of carbon and other foreign matters removed in the process of manufacture When a wrought iron bar is broken by a tensile strain, applied in the direction of its length, it contracts in sectional area at some point before fracture, the amount of contraction depending on the quality of the metal, and being as much a 50 per cent in some specimens. The average resistance to fracture or tensile strength is about 25 tuns per square inch of original section, and no wrought iron ought ever to be allowed in a structure which will not stand at least 20 tun. per square inch.

When a compressive force is applied to wrought iron, it will stand about 9 tuns per square inch before any perceptible change takes place in the form, but beyond this it becomes distorted and yields like a lump of lead, its ultimate crushing strength being about 16 tuns per inch. The tensile strengt of rolled plates is 10 per cent less across the grain or direction of fiber than with it, and the ductility is about one half.

Wrought iron may be considered as perfectly elastic as long as the tensile strain does not exceed 10 tuns per square inch of section, the metal returning to its original shape and size when the strain is removed without any "set" or visible change of form; beyond this amount the extension becomes permanent, the limit of elasticity, which may safely be taken at about half the breaking weight, being passed. If a slight permanent set is produced when a load is first put on, this set will not be increased by any number of repetitions of that load, but each time the force is removed it will return to the form it assumed after the first loading, provided the limit of elasticity is not passed. For every tun of load per square inch up to 10 tuns, the extension is $\frac{1}{12500}$ of the length.

When wrought iron is subjected to a compressing strain, it is reduced $\frac{1}{10000}$ of its length for every tun per square inch up to 13 tuns, beyond which the amount of compression increases more rapidly; so that up to the limit within which this material ought to be strained in practice, whether in tension or compression, it may be assumed as perfectly elastic, the modulus being 10,000 tuns per square inch of section.

The toughness of wrought iron renders it useful for railways, machinery, armor defences, and wherever capability of resisting shocks and irregular strains is required; there is, however, great variety in the hardness of the metal, the soft irons being considered most valuable for withstanding heavy concussions or vibrations.

When a piece of wrought iron is broken suddenly, it generally presents a crystalline fracture, but if the force is applied gradually, the appearance is fibrous or silky; the fibers are, in fact, the crystals drawn out by the process of rolling or hammering. A crystalline fracture indicates hardness, while a fibrous fracture is a mark of softness and ductility; the finer and more uniform the crystals, the higher the quality of the metal. As might be expected from the process of manufacture, the specific gravity of wrought iron is highe than of cast, being usually taken at 7·68, a cubic foot weighing 480 lbs., and a plate 1 in. thick, 40 lbs. per foot super. A bar 1 in. square and 1 yard long weighs 10 lbs.; so that the

*Lectures at the Royal School of Naval Architecture. By William Pole, F.R.S.