Commercially wrought iron, though essentially made direct from the ore, is usually made from cast iron by such removal of its carbon and silicon as to convert it into pasty particles, and by squeezing these together in a bath of cinder or slag into a coherent mass, which retains permanently an important quantity of that slag. The essential feature of wrought iron is the presence, in a finely divided and uniformly distributed state, of a quantity of silicate slag.

The chief advantage claimed for wrought iron is to resist corrosion to a greater degree than does steel. This is held to be due to the high degree of purity of the iron base and to the purely mechanical resistance to the progress of corrosive action offered by the slag veins. The exact degree of superiority has never been determined.

Identification of Wrought Iron and Steel Pipe. There is little difference in the appearance of wrought-iron and steel pipe but there are several tests which readily identify the materials. The fracture of wrought-iron pipe is ragged, dull gray, and fibrous. By hammering a piece of pipe flat the fracture can easily be observed. The fracture of steel is even, bright and crystalline. Wrought-iron pipe, when threads are cut on it, gives a crumbled chip, due to the fibrous structure. Steel pipe, when threaded, gives a long spiral chip. A microscopic examination of polished and etched specimens is an infallible test. The presence of slag in the wrought iron is unmistakable, while the steel is almost without slag.

Seamless Pipe. Steel pipe or *tubing* without the lap or butt weld is frequently used for high-pressure work. Its advantages are its somewhat greater strength, permitting the use of a thinner wall, and in the small sizes its freedom from the tendency of welded pipe to split at the weld occasionally when bent. Furthermore, the inherent physical properties of the steel used in its manufacture are somewhat better and a variety of combinations of carbon content and heat treatment are available.

Seamless pipe is made by either of two different processes, depending upon the size. The piercing process is used in the smaller sizes and the cupping process is sometimes used for tubing of 6 to 9 in. diameter.

Cast Ferrous Pipe. There are now available several types of cast ferrous metal pipe made of a good grade of cast iron with additions of nickel, chromium, etc. This pipe is available in sizes from 1½ in. to 6 in. and standard lengths of 5 or 6 ft with external and internal diameters closely approximating those of extra strong wrought pipe. Cast ferrous pipe may be had coupled, bevelled for welding or ends plain or grooved for the several types of couplings. It is readily cut, and threaded, as well as welded. The fact that it is readily welded enables the manufacturers to supply the pipe in any lengths practical for handling.

Alloy Metal Pipe. Steel pipe bearing a small alloy of copper is somewhat more resistant to corrosion than plain steel pipe. It is recommended usually for atmospheric corrosive conditions, *i.e.*, for corrosion caused by alternate exposure to air and water.

Non-Ferrous Pipe. A type of non-ferrous pipe is now marketed in which the weakness of threading the pipe is eliminated. Instead of threading the tubing, the ends are flared or expanded so as to fit against smooth-finished spherical or bevelled surfaces in the fittings, and are clamped there by a sleve nut screwed over the fitting, similar to a union. The tube

is thin enough to be bent readily, so that no elbow fittings are ordinarily required.

It may be run in building walls very much as BX cable is installed. This fact makes it particularly valuable for new installations or as replacements in existing buildings as it will save much cutting and patching. It is valuable, too, where flexible connections are required and limited space prohibits the usual construction in which several elbows are used, *e.g.*, as radiator runouts. This material is available in sizes of ⅜ in. to 2 in., and due to the ease with which it may be worked around obstructions and to the reduced number of fittings required, it often costs less to install than ordinary threaded pipe, and is of course more permanent.

Corrosion

The electrolytic theory of corrosion, as formulated in 1903 by Dr. Whitney, led to the development of certain protective methods for closed water systems, which are based on the removal of dissolved oxygen from the water. Careful experiments in various research laboratories have demonstrated that the amount of corrosion found in such systems is almost directly proportional to the amount of oxygen in solution, and varies with the temperature.

All reliable data on this subject indicate that the composition of the iron—*i.e.*, the varying amount of carbon, phosphorous, manganese, sulphur, silicon, oxides, slag and copper usually found in wrought iron and soft steel—makes very little difference in the amount or character of corrosion under water, although under atmospheric exposure the influence of composition is more marked.

In practice, oxygen removal has been accomplished in two ways, namely; by de-aerating the water mechanically; and by fixing the free oxygen by chemical combination. Suitable apparatus for this purpose is now on the market.

Another expedient sometimes resorted to in domestic supply systems is the use of zinc pockets in the supply line. An enlarged section is installed in the line and filled with pieces of zinc and the corrosive action of the water is expended on the zinc. As the zinc is consumed it must be renewed from time to time. The best way to deal with a corrosive water supply is to treat it at the source.

The introduction into piping systems of various chemical compounds, usually for forming a protective coating of thin deposit has apparently been rewarded with some success. Piping exposed to elements or buried in the ground is quite successfully protected by coatings of the asphaltic type, usually applied hot.

Pipe Welding

The application of welding on the job gives to the heating industry an improved method of joining pipes. Arc welding and oxy-acetylene welding are used with equal success in piping work. To date welded piping has been found practicable and less expensive than piping made with screwed or flanged joints on sizes down to 2 in. Smaller sizes are difficult to weld due to the thinness of the material.

Fittings often cause so much friction as to impair seriously the smooth