SOLDERING AND BRAZING.

To describe in detail the various operations of hard and soft soldering as adapted to various classes of work would demand much more space than could possibly be spared in this work. A clear idea of the general principles and practice involved therein will, however, be given. While there is much both in principle and practice which is common to both methods, for the sake of clearness it will be better to keep the treatment of the two distinct and separate.

Soldering in its generally understood sense signifies the close union of metallic surfaces by means of a thin film of molten metal or alloy run between the surfaces. There are two main classes of soldering, conveniently distinguished by the terms hard and soft, the first-named being known as brazing. Hard soldering is of the strongest character, requiring a high temperature, namely, a good red heat, visible in daylight, soft soldering is usually done at a temperature below that of melting lead. The hard solders are chiefly alloys of copper, and are known as spelter. Silver solders, used by the jewelers, also come under this class. The soft solders are mainly alloys of tin and lead. The proportion in which the metals are mixed to form soldering alloys are various, such variations being rendered necessary in order that a soldering alloy shall always have a lower melting point than that of the metal or

alloy which it has to unite, and also in some cases to obtain as nearly as possible uniformity of color and strength between the two. Many a job has been spoiled by the use of an unsuitable solder, the work melting at the same time, or before the solder, and many a job strong in itself is rendered weak by the use of a solder too weak for it. In all cases the solder should be selected in order that it may melt at a temperature considerably below that of the materials which it has to unite, and the necessary knowledge may in some cases be obtained either directly from tables, or by experiment, in the manner to be noted presently. Moreover, the harder metals and alloys should always be united with hard solders, and the softer ones with soft solders, and then the seams will be of about equal strength with the other parts.

It is practicable to obtain a most extensive range of solders with melting points from below that of boiling water, up to those suited for copper and iron goods. The lowest melting points occur in what are termed the bismuth solders, the highest in the spelter and silver solders. An alloy of three of lead, five of tin, and three of bismuth, melts at 202 degrees Fahrenheit, one containing equal parts of lead, tin, and bismuth, at 254 degrees Fahrenheit, one containing four of lead, four of tin, and one of bismuth, at 320 degrees Fahrenheit. Such solders, and others with various melting points, are used chiefly for white metal work. Tin and lead mixed in various proportions form the most useful range of soft solders, their melting points ranging from about 380 degrees Fahrenheit to 558 degrees Fahrenheit. The commonest alloy is two of tin and one of lead, melting at 340 degrees Fahrenheit, one of tin and

two of lead is plumber's solder, melting at 441 degrees Fahrenheit.

It is absolutely necessary to the intimate and perfect union of all soldered work, that metal shall unite to metal. That is, the presence of any dirt or oxide in the joint will effectually prevent a perfect union of the surfaces in contact. During the brief period of the raising of the temperature of the work to the melting point of the solder, some film of oxide will almost invariably form unless means be taken to prevent it. So that before a perfect joint can be made two precautions are necessary. One is to clean the surfaces first, the next is to keep them clean, until the solder is fused and run in. To effect the latter, a flux is used both to protect the cleaned surfaces from the action of the air, and also to dissolve any oxide which may form on the already cleaned surface. The selection of suitable fluxes is necessary to the making of a perfect joint.

The metals and alloys which are united by soft soldering are chiefly copper and its alloys, as brass, and gun metal, lead and tin, and alloys of the same, as the white metals and tinned iron and zinc. Copper, brass, and their alloys, are, however, more frequently united by hard soldering or brazing. When united with soft solder, the alloy used is about two parts of tin to one of lead, the ordinary tinsmith's solder. Tinned iron, or what is commonly called sheet tin, is united with the same solder, two of tin, one of lead, and chloride of zinc for a flux. Lead is united with a similar solder, or with others containing larger proportions of lead, but the flux used is tallow. White metal is united with solder containing two of tin and one of lead, and

with chloride of zinc, or resin as flux, zinc with the same solder, and flux.

The bulk of soft soldering is done with the copper-bit, or by means of sweating on, or by wiping. The copper-bit, sometimes erroneously termed a soldering iron, is a convenient reservoir of heat for melting the solder while in contact with the work. Before using it is tinned, that is, heated to a low red, filed bright, and rubbed first with salammoniac, and then upon a piece of tin or of solder, to coat the surface, after which it is wiped with rag, or tow.

The edges to be soldered are scraped clean, and brought together, and protected with powdered resin, or with chloride of zinc, or other flux. Then the strip of solder being held in the left hand, and the copper-bit in the right, the two are brought into contact, and drawn along the edges of the work. The solder is thereby melted in small quantity, and is worked and spread and smoothed along the joint with the copper-bit. The bit must not be made too hot, or it will render the solder too fluid, and repel it.

The sweated joint is generally adopted for broad surfaces, and not for narrow edges. The surfaces are cleaned, and a thin layer of tin or of solder is spread over each, with the copper-bit. The two tinned surfaces are then brought together, and raised to a temperature sufficiently high to melt the films of metal, and cause them to unite.

The wiped joints are used for lead pipe. The melted solder is poured round the jointed pipes in quantity, and is smoothed to a rounding form with special irons, and with a well-greased pad of thick cloth.

The tinning of copper cooking utensils is akin to

soldering, and is done to prevent the formation of oxide, which is poisonous. Stew pans, tea-kettles, and similar copper articles, are treated in this way. Previous to tinning, the inside of the vessel is washed with muriatic acid to remove all dirt. All trace of the acid is then removed by scouring with clean, sharp sand, and common salt, and washed in clean water. The inside is rubbed over with soldering fluid, or with sal-ammoniac, and the outside is coated with a solution of whiting to protect the vessel from the fire, over which it is now heated. Melted block tin is poured in, and rubbed over the inside of the vessel with a wad of salammoniac. When all parts are coated the superfluous tin is poured off, and the inside wiped smoothly with a wisp of tow held in a gloved hand in the case of an open vessel, or wrapped round a wire if the vessel has a narrow mouth. Washing in clean water follows to remove any salammoniac remaining, and the article is dried in sawdust. Finally, the inside is polished with a rag and whiting, and the outside with a rag and crocus.

In hard soldering, or brazing, the parts to be united have to be raised to so high a temperature that the copper-bit is of no use, but the heat of a coke or charcoal fire, or in some cases of the air-blast, is employed. Moreover, since the work takes some time to execute, and because it is raised to so high a temperature, it is usual to secure the parts with soft iron wire, called binding wire. The flux used is borax, a compound which dissolves almost all oxides and earthy impurities that are likely to form on the joint. The hard or spelter solders mostly contain zinc, and the eye partly judges of the completion of the joint by the blue

flame which accompanies the volatilization of the zinc. The spelter is granulated, and the borax is pounded fine. The two are mixed, and applied together, or separately, and sprinkled or spread along the joint. The heat is applied very gradually in order that the ebullition or boiling up of the borax, due to driving off of its water of crystallization by the heat, shall not displace the spelter from the joint. Afterwards the heat is increased, and at a low red the borax fuses, and at a bright red the solder fuses, and runs quickly into the joint. After covering or charging a joint with borax first and spelter afterwards, the water in the borax is slowly dried off, and if any borax has spread beyond the joint, this should be wiped off to prevent the spelter spreading farther than is necessary.