In wrought iron construction the joints should be as few as possible. The plates and bars should be made of the greatest possible length, but not to exceed such a size and weight as to increase the cost of rolling them. The joints can be made by placing the various parts so that one piece shall lap over another and the two be rivetted together. In this case the rivets will be in "single shear," that is, in pulling the two pieces of iron apart, each rivet will be sheared, or cut through, only once, whilst, if the pieces of metal butt against each other and have a joint plate or bar on each side and rivetted, the rivets will be in "double shear," that is, each rivet must be sheared, or cut through, in two places before the joint will break. Therefore, this kind of joint requires only half the number of rivets that there in the lap joint. It is this butt joint which is generally made in girder work, for the very evident reason that, although two joint strips or plates are required—one on each side of the abutting plates—only half the number of rivets are necessary to make an equally strong joint as the "lap joint." Where several plates or bars have to be joined at the same place, as is sometimes the case in the flanges of girders when composed of several thicknesses, where they all butt in the same plane, the joint plates of necessity extend some distance on either side of the joints, so as to have room for the proper number of rivets. In this case, the rivets should be placed as near to each other as possible without injuring the strength of the plates. Otherwise, if they are too far apart, the first row of rivets will have a much greater strain than the second row, the second row a greater strain than the third, and so on to the last row, which will have the least amount of strain. In fact, this will be the case no matter how near each row is to the other, but the difference will not be so great. It is the elasticity of the metal which causes this difference of strain on the rivets. A joint plate might be so long that the first row of rivets would actually be sheared before the last row had any strain upon them worth speaking of. Therefore, for two reasons the joint plates should be as short as possible—first, to get as nearly as possible an equal strain on all the rivets, and, secondly, to have the least amount of weight in them.

The rivets should in all cases be so arranged that the holes, if drilled, would not decrease the strength of the bars, or useful sectional area, more than by one hole. And the sectional area of the shearing parts of the rivets on each side of the joint should never be less than the sectional area, *minus* the rivet holes, of the bar or plate to be joined. It has been proved by experiment that the ultimate resistance to shearing is proportional to the sectional area of the bar torn asunder, and that the ultimate resistance of any bar to a shearing strain is very nearly the same as the ultimate resistance of the same bar to a tensile strain. Therefore, if the sectional area of the shearing parts of the rivets on each side of the joint is equal to to the useful sectional area of each bar to be joined, there will be the same strength in the rivets as in the joined plates or bars. In most cases it is advisable to have some excess in the sectional area of the rivets, to allow for bad workmanship. Sometimes the rivet holes in several pieces of metal are not fair with each other, and when the rivet is driven in hot, it accomodates itself to the irregular hole, and forms a bad rivet, having lost a portion of its shearing area. A still greater excess should be allowed in the case of rivets that pass through a greater number of pieces, for the holes are more likely to be irregular. The excess to be allowed depends very much upon the quality of the workmanship in the construction. If the holes are carefully drilled the excess to be allowed may be much less than when the holes are punched.

In addition to the shearing strength of the rivets, some strength may be calculated upon from the friction that is produced by the rivetting and cooling of the rivets; this additional strength can only be calculated upon, as an addition, when it is quite certain that the rivet holes are completely filled by the rivets.

Experiments shew that a three-quarter inch rivet properly rivetted in three plates or bars, the centre one having a slotted hole, will take five tons to overcome the friction of the heads of the rivet and make the centre plate slip between the other two, and the friction given by a $\frac{7}{8}$-inch rivet will not be overcome with less than 7 tons. This extra force from friction is no addition to the shearing strength of the rivets, unless the rivet holes are well filled up. There is no doubt this friction adds much to the rigidity of built wrought iron girders, and has something to do with the deflection being no more than if all the joints were welded. Good rivetting will bring all the plates into close contact, and besides adding to the stiffness of the work by friction, it prevents anything more than a superficial coating of oxide between the faces rivetted together.

No doubt machine rivetting is the best for giving the greatest friction, and filling the rivet holes most perfectly; and it certainly injures the rivets less than the succession of blows given by hand rivetting. In hand rivetting many of the blows are given when the rivet is comparatively cold, and have, therefore, a tendency to destroy the quality of the iron in the head; and, again, hand blows cannot force the metal into the body of the rivet hole in any way to be compared to machine rivetting. A machine rivetted boiler is generally tighter under pressure than a hand rivetted boiler, showing the plates are in closer contact, and better able to resist corrosion by being rivetted with machinery. —*Mechanics' Magazine.*

## WELDING METALS.

Of all the proporties of iron, it need scarcely be said that the comparative ease with which two similar parts are welded together, or *soudés*, as the French say, is the most valuable. We believe that no other metal exists so readily to be united by means of a high temperature of the points of contact, and the impact of blows or sudden pressure. A mere sight of the operation, conducted by a skilful smith, is always interesting, even when of daily-life occurence. In welding two round bars together for instance, the ends are upset or made thicker; and each end is bevelled of in a plane diagonally to the axis of the bar. The two ends are then raised to a welding heat—the temperature of which, by the bye, is as yet quite undetermined—and some