the acetylene and oxygen in their correct proportions, and to project a flame of absolute stability. Flexible tubing, of sufficient length to allow the operator to reach all parts of the work, connects the blowpipe with the gas reservoirs.

One or more welding tables—which are usually of iron, with a top of fire bricks—and an oven are always necessary items of the welder's outfit, the purposes of the latter being, first, to pre-heat the work for a reason we shall see later, and, secondly, for "annealing" after the welding has been done. The process of annealing consists of subjecting the article welded to a high heat throughout, and subsequently allowing it to cool off at a certain rate; and its object is to reduce any brittleness of the metal caused by the internal strains induced by the welding or any previous treatment.

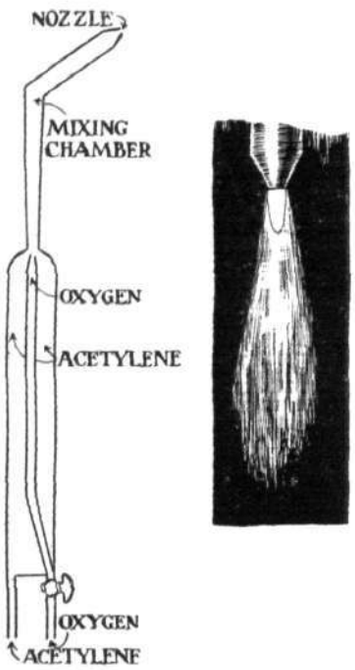
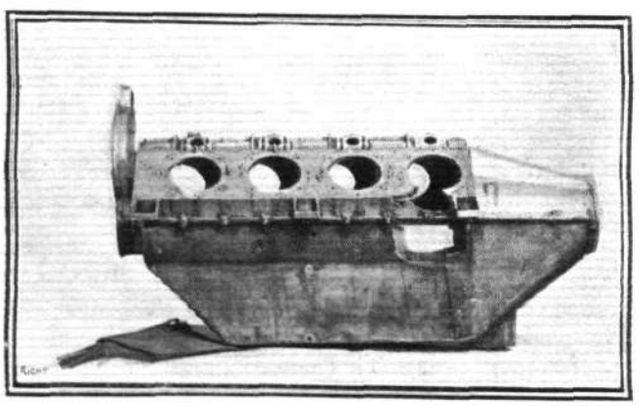


Diagram of a blowpipe for autogenous welding, and on the right the shape of the flame produced.

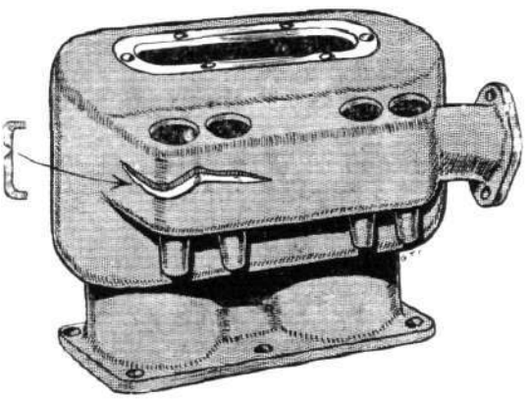
Turning from the plant to the exercise of the welder's art, it must be pointed out that, in this as in most other accomplishments, although practically anyone can make some sort of a job after a few hours' practice, it takes years of constant practice and thought to become a really good welder. In proof of that it is merely necessary to reiterate the fact that it is only within the last few years that the art itself has advanced to a degree where a thoroughly dependable job was possible.

Keeping this fact in view, the apparent simplicity of the operation when witnessing a repair being executed is as misleading as it is astonishing. As an illustration the process of repairing the aero-engine crankcase shown in one of the illustrations may be followed. The crankcase is made of aluminium, but the process will be similar in the case of other metals, though the temperatures and the composition of the flux and welding-rod will differ. It may be mentioned here incidentally that practically all the industrial metals and alloys are amenable to the welding treatment, though in some few cases the art has not even yet progressed sufficiently to ensure a perfect union in all cases. It is not so long since aluminium was one of these unsatisfactory materials, but the special difficulty in this case is now fully overcome, and as a matter of fact it is now perhaps one of the best "patients," as a good welded join in this metal can be made of even greater strength than the main body of the casting.



The above photograph shows the aluminium crankcase of an eight-cylinder Curtiss aeroplane engine badly damaged as the result of an accident. It will be seen that both sides have been knocked out as well as a part of the cylinder holding down base, all of which parts are missing. The crankcase was sent to Barimars in the condition shown, and the welding department of this firm were able to make a perfectly satisfactory repair to the casting.

In repairing the crankcase in question, the first thing done is to cut out from sheet aluminium of the requisite thickness pieces approximately filling the holes to be stopped. Then comes into play the first indication of the operator's skill: all contiguous edges to be joined have to be carefully bevelled off so that when in position no holes or excess thickness are produced at the bottom of the bevel, but the whole forms a kind of trough in which the molten welding rod combines with the molten metal of the work and forms a pool. The object of so bevelling is to enable the blowpipe to reach the whole of the surface to be treated, and thus to make sure of



The sketch shows a cylinder casting that has become cracked, and the edges of the crack bevelled preparatory to welding.

melting the metal, and so ensure an unbroken join, throughout its thickness. Also, by enlarging the line of join in this way, the consequences of too great a localisation of defects are avoided. After this, the bevelled faces and immediate surroundings have to be thoroughly cleaned until the metal is bright.

The next step in the procedure calls for no little experience, especially where, as in this case, "the work" (by which term, it should be explained, is always meant the whole of the unit for treatment or repair) is of a complicated pattern. It consists of arranging and adjusting the parts to be joined so that during the welding they remain perfectly in position in spite of the disturbing and distorting effects of local expansion and contraction. For other reasons also, this matter of allowing for these phenomena is of vital importance, and is one of the most serious considerations of the expert welder, for, at the least, it may very readily give rise to internal stresses in the welded join that seriously impair its strength, while the effect may be so severe as to cause the join to break or crack when cooling. The avoidance of this possibility depends on the experience and skill of the operator to a vast extent, and is in some cases guarded against by bringing the main body of the work to a very high temperature either in