HOW TO BRONZE WELD CYLINDER BLOCKS

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation

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How to Bronze-Weld Cylinder Blocks

BRONZE-WELDING, by the oxy-acetylene process, is the method generally used for the repair of cast-iron cylinder blocks. In many cases it can be done without removing the block from the car and without preheating or re-grinding it.

To apply this welding method correctly, and to avoid the possibility of spoiling a valuable block, the beginner should make a careful preliminary study of the procedure and have some practice in making this type of weld on pieces of scrap metal. The procedure generally recommended is to obtain a scrap block (6 or 8 cylinder if possible) and make several test welds on this before attempting to make bronze welded joints on a block that is to be used again.

Bronze-welding jobs have in some instances turned out unsatisfactorily from the fact that the repair in question was the first attempted by the operator, who, instead of "knowing his metal," made the joint without any previous practice or experience. There are a number of very necessary precautions to be taken in this work and these should be followed closely.

After obtaining a discarded cylinder block and making several test welds, the sections around the joint can be broken out with a hammer and examined to see whether proper adhesion and soundness of metal have been obtained. In this way the welder can experiment with tip sizes, amount of flux, methods of chipping or grinding, metal temperatures, and other variable conditions. It is a vital matter for these details to be settled before attempting to make final joints in cast-iron parts by bronze-welding.

Preparation for Bronze Welding

The subject of dismantling is the first to be considered. If possible, the block should be removed, laid on a flat surface such as a welding table where it is easily handled and bronze-welded. If necessary, bronze-welding can also be performed on cylinder blocks in place, but usually considerable preparation to the engine and parts is necessary before the job can be undertaken. The cylinder head can almost always be removed and, whenever possible, this should be done.

Remove the head by taking off the spark plugs and wires and unscrewing the bolts which fasten the head to the block proper. The head can be then taken off and put aside. If the break is in the cylinder head it can be welded conveniently on the welding table.

Cracks in cylinder blocks are of several types. Perhaps the easiest to repair are cracks which occur in the water jacket in. the head. In addition, cracks occur in the corners of the block, in the cylinder wall toward the center of the block, in the bottom part of the block, and at times in the cast iron arms which appear on some makes of engine. For the latter type of break, it is always necessary to take the block out of the car because even though no preheating is done, it would be impossible to support the block in line when it is under strain.

Welding a Cylinder Block in Place

If the block is left in place in the car, special care should be taken to protect all other parts of the machinery from damage which might be caused by the oxy-acetylene flame. Precautions should also be taken beforehand to prevent any possibility of marring the wood of the car or of injuring the vital parts of the engine. Asbestos fibre cement is very handy in protecting parts from the effect of the blowpipe flame. A stiff paste can be made up from asbestos cement and water and can be generously used to cover any parts which may need protection. This paste should be used on painted surfaces or on solder so that these materials will not be harmed by heat of welding.

All gasoline should be thoroughly drained from the gas line, vacuum tank and carburetor; all wiring, oil, and gas lines and other parts of the ignition and lubrication systems should be carefully protected. Asbestos paper should be used to cover up the parts which should be protected from the heat of the blowpipe, and so eliminate the necessity of removing them from the car.

The water circulation system should be drained well below the level of the crack, and the cooling system vented so that no pressure will be built up if the overflow pipe becomes clogged. It is advisable to run the car for a few minutes with the cooling system empty in order to preheat the casting slightly. This should be done carefully so that the engine is not injured by overheating.

Chipping

Chipping should be performed whether the block is in place in the car or whether it is removed and repaired on the welding table. When

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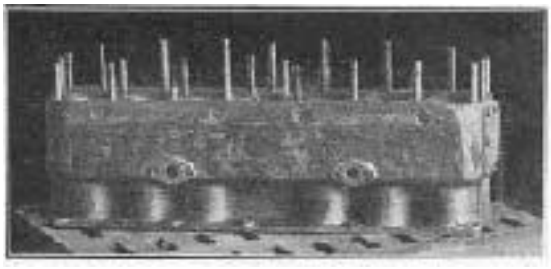

Fig.1-Crack marked out with chalk

the block can be removed from the car it should be set upon a level surface, Fig. 1, and the crack carefully marked out for chipping. For this work a diamond point chisel is best, and it should be sharp enough so that the edges of the vee will be clean and will take the bronze easily. Every crack should be chipped out carefully to within about 1-16 in. from the bottom. (Fig. 2.) There is no harm in chipping through be cause the hole will be filled up with bronze afterward. The vee should extend well beyond the visible end of the crack. (Fig. 3.)

One method of determining how far the crack extends is to rub oil over the surface at the end of the crack and wipe off all excess oil with a piece of waste. If chalk is rubbed on the surface after this operation, it will absorb the oil from the crack, and the outline of the crack can be easily seen by the line of oil in the chalk mark.

Fig. 2-With diamond point chisel and hammer

A portable electric grinder can sometimes be used for this work. The vee should be at an angle of about 45 deg. After the vee has been chipped out, the sides of the adjacent metal can be roughened with a chisel or preferably with a file.

If a portable grinder is used for veeing out the crack, the metal should be ground bright 1/2 in. on each side of the crack. This will clean the metal and give a good surface for the bronze to adhere to. After chipping and filing has been completed, the vee should be thoroughly brushed with a wire brush (Fig. 4), and, if possible, washed with a little gasoline to make sure that all grease and dirt is removed from the walls before starting the welding.

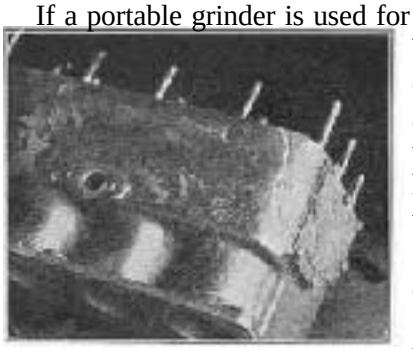

Fig. 3-The vee is chipped out

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Welding Equipment

A good quality bronze rod specially manufactured for this type of work should be used. Oxweld No. 25M Bronze Rod is particularly well adapted for this type of work. Brazo flux, made specially for. bronze-welding, should be freely used on the first attempts. The operator will gradually determine the required amount of flux necessary for this particular type of bronze-welded repair.

Heat Control

Much of the success obtained by this method of welding depends upon the proper location and control of the welding flame and the heat which it supplies. A slightly oxidizing flame is best used for bronze welding. It is better to use a slightly smaller tip than would ordinarily be used for the thickness of metal involved. Thus, where ordinarily a No.5 tip would be used, a No.3 tip might be selected for bronze-welding. This is done to prevent any possible overheating and cracking of the metal.

Fig. 4-Cleaning the vee with a wire brush

The blowpipe flame should be played on the metal around the break, bringing it gradually up to the welding heat. To complete this gradual heating the flame should be directed also for some distance around the break in order to expand the metal slowly so that the other parts of the block away from the break will absorb a part of the contraction when the casting and weld are cooling. The heat is finally concentrated on the end of the crack where welding is to begin.

Location of Cracks

If the break extends into the valve ports, or to any other edge of the casting, the progress of the weld should be toward this point. In other cases, the progress of the weld should be from the ends of the crack toward the middle and should also progress from any small branch cracks toward a central point.

Start the welding operation well beyond the visible ends of the crack or break (Fig. 5), because sometimes the fracture extends much further along on the inner surface of the block, and if not properly welded, the parts will break again at a slight strain.

Special care should be taken to align parts. At times the block can be left in place for some of the welding operation and then removed for the completion of the weld. In cars which have supporting lugs of cast iron, it is necessary to remove the engine from the frame before breaks in these members can be repaired. The metal in these supporting arms is usually fairly thick and for this reason should be chipped out on both sides to form a double vee for the welding operation.

The Welding Operation

The metal in the vicinity of the cracks is first heated gradually as explained until it just barely commences to glow. Some welders make a practice of testing the heat of the metal with water or saliva; if it bubbles or boils, the metal is hot enough to start welding. The knack of securing best results in bronze-welding consists in keeping the metal at this uniform heat, allowing it to get neither too hot nor too cool.

Fig. 5-Starting to weld

If the metal should become too hot, the bronze-weld metal will boil and form into drops which will roll off as fast as the rod is added, and when the metal appears to be joined, it will be found that no bond has been obtained. If the casting is too cool, the bronze-weld metal will be deposited but will not form a strong bond with the edges of the vee as it should.

Good "tinning" is most important. Tinning is a term used to indicate the action of the bronze which produces results similar to those obtained from the tinning operation in ordinary soldering. When molten bronze is applied to a clean, fluxed surface heated to the proper temperature, a thin layer of bronze will flow and spread out over the metal a little ahead of the main deposit. The flow will be free and natural like water spreading over a clean, damp surface, and will not have

the appearance of water on a greasy surface. The edge of the molten bronze will not round out like a bubble of mercury, but will tend to spread out over the heated metal.

The end of the rod is introduced into the flame while the casting is being heated, and the hot end is dipped in the flux. (Fig. 6.) This will cause flux to adhere to the rod. (Fig. 7.) The flux is then applied to the heated ,spot. If the metal is at the proper temperature, the end of the rod will flow away and produce the tinning coating.

The bronze should be thoroughly tinned in the scarf of the vee and on the shoulder of the casting metal nearby. It is very important that the bottom of the vee should be well tinned and filled with bronze. The walls of the vee and the metal adjacent to the edges are tinned first so that after the bronze is added this inner layer of weld metal will be firmly bonded to the cast iron. After tinning a short section of the vee, the bronze-weld metal is built up until it fills the vee and spreads over the surface of the block about 1/4 in. on each side of the section which had been chipped out.

The rod should be brought into the flame approximately in line with the joint. (Fig. 8.) The blowpipe should be held in such a way that the flame after striking the weld reflects so that it preheats the joint at
some distance ahead of the puddle. .

The puddle is gradually moved forward; the welder uses the swinging motion of the blowpipe and rod, characteristic of all ripple welding, the motion of the blowpipe and rod being opposite to each other. The inner cone of the flame should be kept about 1/8 or 1/4 in. away from the surface of the puddle and sufficient flux should be frequently applied so that a layer of molten flux will precede the bronze. The vee

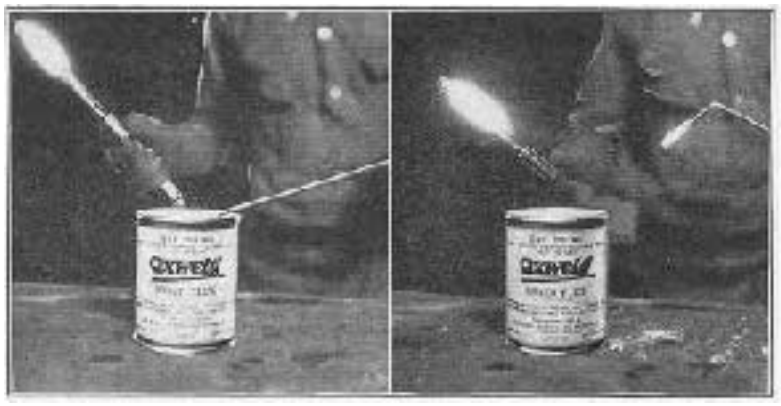

Fig. 6-Dip the rod in and *Fig. 7-the flux will adhere*

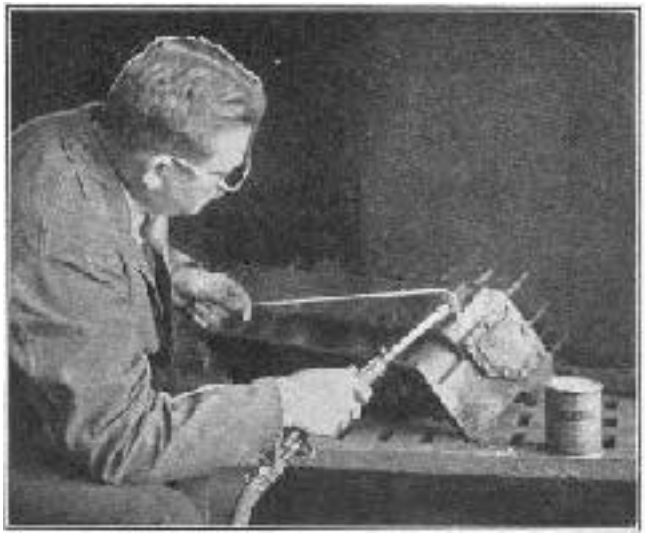

Fig. 8-The finishing touches

should be completely filled as the weld progresses to avoid delay in going back to touch up previous work. The proper welding speed will be indicated by the speed of the tinning film. The bronze should never be flowed in faster than tinning progresses.

Flux should be used freely throughout the operation so that any impurities or bubbles of gas in the weld metal will be forced to come to the surface and then escape. Bright spots on the metal in the puddle indicate the presence of oxides or impurities and should be worked out with the welding flame or with flux. Too much flux is not only wasteful but prevents proper making of the joint. Use just enough to secure a good adhesion between the added metal and the cast iron or the previous layer of bronze.

Bronze should be deposited at the lowest temperature at which it will readily flow. The weld should be carried through to completion in one operation if possible. The welding operation should finish as near

.as possible to the middle of the crack unless the end of the crack extends to the edge of the casting, in which case the weld will end at that point. Where breaks are jagged and have cracks which run out at different directions, it will be necessary to stop welding as the central meeting point of these cracks is approached. If welding is interrupted and the puddle chills, care must be taken to make it molten again before any new bronze is applied. When the welds of a group of

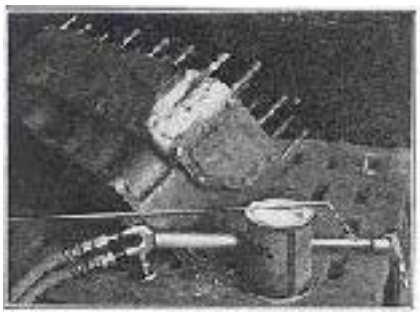

Fig. 9-The weld completed

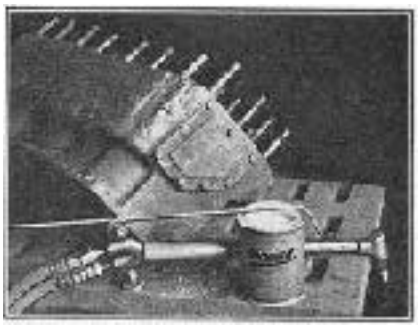

Fig. 10-After brushing off excess fiux

cracks approach the central point where the welding is to end, the deposited bronze in adjoining cracks should be remelted for an inch or more and allowed to flow down into the advancing puddle. It is a good idea to heat the vicinity of this final point for some distance around it after the welding is finished, so that any cooling strains in the various individual cracks may be relieved during the cooling of the entire central portion.

Slow cooling is advantageous for bronze-welded parts. Even a sheet of asbestos wrapped around the welds will help to reduce the cooling.

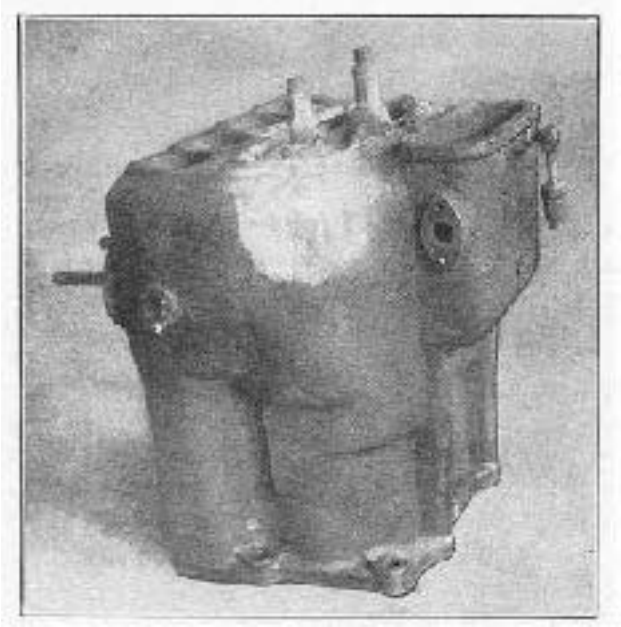

Fig. II-Extra weld metal ground off

rate. The block should not be subjected to any stress until completely cooled.

When the weld is finished (Fig. 9) it should be brushed with a wire brush to remove any excess flux which may have adhered to the metal, and also to remove the soot and deposit from the welding operation.

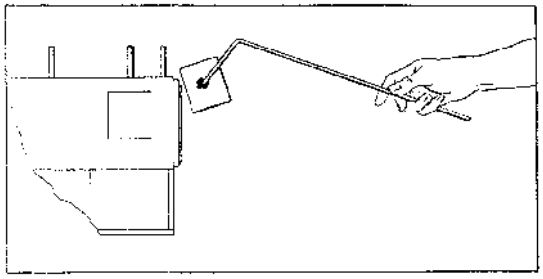

Fig. 12--Method *of holding patch for tacking*

The appearance of the finished weld may not seem to be very neat when compared with the smooth side of the casting. (Fig. 10.) This rough appearance can easily be remedied by grinding or filing if desirable, although it is probably preferable to leave as much of the reinforcement in place as possible. Fig. 11 shows a completed repair in a cylinder block from a large truck engine. The weld has been ground off smooth and, except for its different color, cannot be distinguished from the casting metal.

In instances where a piece has been broken out of a cylinder, the broken piece should be lined up and vees should be chipped out as for a single crack. A backing-up bar or plate used with C-clamps can sometimes be used to hold the broken parts in line, especially where pieces are broken from the edges. The same welding procedure should be carried out, except that tack welding will be necessary to hold parts in place for the first time. A welding rod can be used to hold the pieces in place while tack-welding is being done as shown in the sketch, Fig. 12. When pieces have been tack-welded, it is necessary, in the final welding work, to melt out and reweld all the tack welds. This will insure perfect penetration and adhesion of the weld metal and a uniformly strong joint will result.

The usefulness of bronze-welding as a method of repair is not limited to cylinder blocks. Many other automotive parts can be repaired by this method, including cast-iron manifolds, flywheel guards and all parts which are made from malleable iron.

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