LOCKWOOD'S TECHNICAL MANUALS

ALUMINIUM REPAIRING

WILLIAM H. H. PLATT

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THE REPAIRING OF ALUMINIUM SHEET AND CASTINGS AND ATTACHING OF COPPER, BRASS AND STEEL TO ALUMINIUM BY TINNING, SWEATING, AND BURNING PROCESSES, WITH SHEET IRON JIGS EXPLANATIONS AND ILLUSTRATIONS SHOWING THE METHODS TO BE ADOPTED IN WORKING THESE PROCESSES UNDER THEIR DIFFERENT HEADINGS

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ILLUSTRATIONS

ALUMINIUM REPAIRING

Composition of Alloys.

	Tin.	Zinc.	Aluminium Sheet Scrap.
No. 1 Alloy Sweating Process	2	1	$\frac{1}{2}$

Melt and run into thin strips for use on small jobs, tinning, sweating, loading and filling of bolt holes, cracks, or breaks, of carburettors and small castings, and for attaching of copper, brass and steel tube, sheet aluminium, joints and attachments, etc.

	Tin	Zinc.	Aluminium Scrap, Sheet or Castings.
No. 2 Alloy Burning Process	2	1	2 to 3

Melt in metal pot, in the above proportions, when required for use on repairs to broken castings, such as radiator tops and bottoms, flanges, side standards, gear cases, etc.

Notes.

The composition of these alloys will be found to be as cheap as any alloy used, and as strong as any casting already made. I have used them with great success in all work that has come my way, from a small aluminium trinket and repairing an aluminium saucepan with a copper bottom to motor car gear case, radiator repairs, and aero engine cases and attachments.

Treatment of Castings subject to Oil, Grease, etc.

Before explaining my methods of doing repair work with such alloys, it will be convenient to describe my method of treating castings that have been subjected to lubricating oil or grease prior to repairs with No. 1 and 2 alloys. I heat the part locally that has to be repaired, so as to burn off the oil or grease, which leaves a brown or black deposit (carbon) on the surface of the aluminium. After cooling off a little, I then file or scrape this deposit away and thoroughly clean and tin the surface of the joint, break, or around a hole, and also a small distance away from the part. Care must be taken to get under the film of oxide that forms during the application of heat before one commences to load or fill up the part under repair.

Tinning Process.

(The tinning treatment and loading of surfaces of aluminium sheet work and castings to be repaired with No. 1 alloy under the sweating process is as follows, no flux being necessary.) On commencing the work of tinning or sweating with the above alloy, the parts are first cleaned with a file end or scraper to remove any dirt. The blowpipe or lamp that is used is then lighted and started up, care being taken not to use a smoky flame during the process. If the article to be repaired is a small one, it can be held in the flame with a pair of pliers, and a little of the metal alloy strip is melted on the part. If it be too big to hold with the pliers, it can be rested in a convenient position on a bench or fastened lightly in a vice. The flame is played lightly on the part required, adding or melting a small portion of strip metal alloy No. 1. While applying the heat of the flame to the article, any suitable kind of scraper is used on the small portion of strip metal already added, by lightly scraping and teasing the strip metal and the parts to be tinned, constantly moving the end of the scraper over the surface to remove the superficial coating of oxide that forms during the application of heat. A small portion of the strip alloy is added in sufficient quantity as required for the surface under repair—inside if a hole, and a small distance around on either side, and inside if a crack, as far as the scraper will enter, and in sheet work all along the edge before making the joint (whether butt, lap, or scarfed, or chamfered edge), to allow a good surface to be made for more metal strip to be added as the work progresses. The proper use of the scraper is an essential part of the work of tinning in laying the foundation for a body of metal. The constant light scraping and teasing with the scraper end assists the molten alloy to take and run, and it will be found that this metal will follow the scraper while operating and at the same time will lift the coating of oxide to be removed later. This is applied in all cases when using No. 1 alloy, either on sheet or castings. When the tinning process is satisfactorily done, add more metal to load up the job sufficiently, and use a spatula or other suitable instrument to dress the metal to any curves or shape required. The flame of the lamp or blowpipe should be lowered while loading up. The lowering of the flame allows the metal to get into a semi-molten condition, so that it can be moved about much the same as a plumber wipes a joint. When there is sufficient metal on the job, and it has been got to the required shape or curves, the flame can be lowered still more, and the lamp or blowpipe placed at a suitable distance away from the article, to allow the latter to cool gradually in the heat from the lowered flame. Any film or particles of oxide that collect in patches before finishing off should be removed by lightly and quickly drawing the side edge of the spatula across the surface before it commences to cool. Care must be taken while conducting the work not to leave any beading of the molten metal while tinning at the outer edges of the part treated either of metal or oxide, and, to prevent this, scrape from the outer edge the centre of tinned surfaces, and it will be found in loading up the joint at the finish the metal alloy will be left clear and clean. Cooling off in the heat from the lowered flame is advised, as draughts or sudden cooling tend to cause a fracture in castings, and also as the metal cools shrinkage takes place, and more metal may have to be added before the job is allowed to cool off completely.

Burning Process.

(I shall now explain the burning process with the use of No. 2 alloy. No flux is required, and no previous tinning, as in the case of repairs with No. 1 alloy.) This method is used on larger jobs, for repairing broken castings, new parts or attachments to existing castings. With this method jigs, preferably of sheet iron, are used, with the reinforcement of parts with fireclay, these jigs being shaped according to the work, and the jigs being washed with fireclay and water before fixing to articles prior to treatment, to prevent the molten metal from adhering to the sheet iron.

The operator should have an open fire and a five-pint blow-lamp, or gas blowpipe at his disposal. Sufficient metal of No. 2 alloy is put in the melting-pot to do the job, and placed on the fire to melt. The blowpipe flame is opened on the job at the edges where the repairs are required, the flame being directed downwards to melt the broken edge of the flange or other part; and when it is perceived the edges are beginning to fall away into the jig in a semi-molten condition, a poker or rod is used to help it to break, and a little of the alloy is added from the pot, the two metals being fed together with the aid of the poker end, and the flame of the lamp or blowpipe. The alloy from the melting-pot is then filled up to the top of the jig. The molten metal is fed right on the face of the flange or other part with the poker end, and when this is done from one end of the break to the other end, and you have sufficient metal over and above the surrounding surfaces, the flame of the lamp or blow-pipe can be lowered and placed at a little distance away. The job is allowed to cool down in the heat from the flame (which must be directed towards the job), and not in the heat of the flame itself.

Trowels or Spatulas.

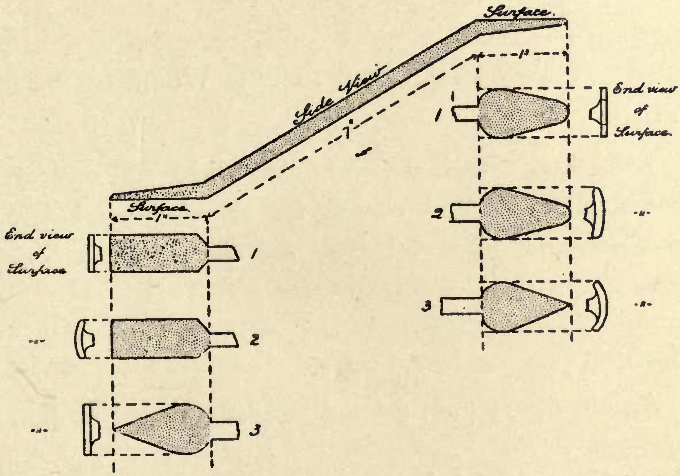


PLATE No. I.

When the job is cooling contraction sets in, and if it has not been properly loaded with metal, a little metal strip of No. 1 alloy is added to take up shrinkage, and to save bringing the whole up to melting-point again with the aid of the flame. Then the job is allowed to cool down gradually; when cold, the jig is taken asunder, and the surplus metal dressed off with a file or by machinery.

Tools required in this Work.

Files.

Rasp half round, dreadnought, rough and smooth flat half round and round, for cleaning up before and dressing off metal after finishing. Also emery cloth.

Scrapers.

An old file or two, ground to suit end or side job.

Trowels or Spatulas.

Mild steel rod, about 9″ long, $\frac{5}{16}$″ diameter, flattened out at both ends, bent and curved at both ends as per sketches, for use on small jobs with No. 1 alloy sweating process. These three types will be found very useful. Also a vice and pair of pliers.

(*See* Plate No. I.)

Pokers.

Say two pieces of iron rod $\frac{1}{8}''$ and $\frac{5}{16}''$ diameter, about 18″ long, flattened out at one end, for use when running or burning big jobs with No. 2 alloy in the feeding of metal to take up shrinkage, the length of which saves the hands from getting burnt while using blowpipe or lamp.

Blow-Lamps.

One $\frac{1}{2}$ pint and one 1 pint, petroleum or benzine, for use on small jobs with No. 1 alloy, re-tinning and sweating, etc. One 4 or 5 pint lamp to be used on larger jobs with No. 2 alloy in repairing of broken castings, new parts or attachments to existing castings, as will be mentioned later under Burning Process with No. 2 alloy.

Blowpipe Coal Gas.

Where gas mains from town supply and power for a blower or fan are available in workshops undertaking aluminium repairs, a blowpipe will be found a great advantage in this work for its portability, lightness in handling, and regulation of the flame, large or small, according to the nature of work under repairs.

Fires.

Where an open fire with blower is available in a workshop is another advantage, both in drying jobs that require fireclay for fixing up before treatment, and also for assisting in keeping jigs heated while the article is under treatment ; also for melting alloy No. 2, to be added while burning on any new piece or portion required. These points will be explained under headings as they occur.

Chisels.

The use of large chisels for dressing off metal are not advisable, small chisels with a cutting edge about $\frac{3}{8}''$ will be found sufficient for any job undertaken.

Jigs.

The use of jigs or moulds of sheet iron for single jobs or for repetition work is advisable and important, as they mean a saving of time, and a little forethought given to the job in hand will repay the worker for the trouble taken. No work with No. 2 alloy can be carried out without a jig of some kind, made to conform to the contour of the article. You will find that in some cases jigs both for the inside and the outside will be necessary to preserve the contour. I will explain later how to make jigs and set them up, whether for a single job or for repetition work. They are made of 20 to 24 gauge sheet iron, and in some cases $\frac{1}{8}''$ plate, and may with care be used many times over. The fact of the material being so thin and easy to bend to shape makes the job of jig-making interesting in itself. Often these jigs require the addition of fireclay to form a mould.

Clamps.

A couple of screw clamps will be found very handy in the fixing of jigs on to articles for repairs. Existing bolt holes in castings can very often be utilized for the holding of jigs in place while working.

Crucibles and Iron Ladles.

Small crucibles of plumbago are very useful for melting the alloys, but every workman cannot have one by him. The alternative is a small cast iron melting-pot for the fire, and a wrought iron ladle for use when adding molten alloy during the burning process. Remember always to heat the ladle before putting it in the melting-pot. The ladle and pot of iron require treatment with fireclay before melting these alloys, and should be treated regularly, to preserve and to lengthen the life of pot and ladle. This will be dealt with under heading Fireclay.

Fireclay.

When treating cast-iron pots and hand-ladles before melting the alloys, wash the pots or ladles round inside and out with fireclay and water to prevent the metals attacking the iron, as will happen if they are used constantly with the alloys for this work. They should be dried first before melting the metal. When using fireclay frequently with jigs as a mould, mix the fireclay into a stiff mass with water, and press it into the parts required, to form the shape in the fireclay for the metal alloy to be run in. After the operator has attained the shape required, place the whole object near a fire to dry gradually (not quickly) of all moisture before commencing the work of burning with lamp or blow pipe and No. 2 alloy. Avoid the use of quick drying, as it leaves the fireclay cracked, though this can be remedied by applying a soft mixture of fireclay and water with a brush over the cracks until they are filled up. When dry, it is ready to commence.

Notes.

With regard to coal-gas and oxygen drawn from cylinders for blowpipe on burning process, I would advise any operator intending to use oxy-coal-gas for burning process to first get instructions from the makers themselves upon the working of blowpipes supplied from trade cylinders.

The tinning treatment appears vague (when I state that no flux is necessary), especially to workmen conversant with tinning and soldering other metals, and accustomed to using a flux such as hydrochloric acid for zinc, iron and steel, along with sal-ammoniac (chloride of ammonium) or killed spirits for soldering of tin, brass and copper articles. The process I have explained is, however, absolutely satisfactory. Tinning any article first and mastering the method with regard to teasing and scratching will give the operator who undertakes this work absolute confidence and ability to do almost any job that comes his way, after perusing the instructions I have given, and even without experience gained by working practice. When the part has been tinned correctly, he has a foundation on which to build a body of metal to complete his work. Intense heat in air gives aluminium a superficial coating of oxide, which can be removed by following directions given under Tinning treatment.

I wish at this stage to compare oxy-acety-welding and my processes of burning broken aluminium castings one with the other. I consider that on the whole these compare very favourably with other methods employed.

In the case of oxy-acety-welding it is advised and necessary to preheat the article previous to welding and to reheat again after the welding is finished, and to place the finished job in hot sand or a muffle to cool off. I will take for examples and comparison the radiator tops, side standards, and gear-case ends, that I have illustrated in Sketches X, Y, Z.

The welder commences to preheat the whole article, and when sufficiently heated he gets his oxy-acety-blowpipe on the job and starts up.

The welding of aluminium needs some experience on the part of the individual worker. As the heat of the oxy-acety-blowpipe is playing on the job, it makes a bath of molten metal in the immediate vicinity of the flame cone. At the same time the metal is oxidizing and the use of flux is absolutely necessary to disperse the oxide so that the metal will unite. While the article is under the oxy-acety flame there is an intense heat concentrated on a small area or bath of say 2″ in diameter, and as the work progresses one part is commencing to cool behind the blowpipe and the portion in front is heating up to melting-point as the break is traversed. At the same time the effect of the preheating is gradually being lost in those parts of the metal away from the place where the weld is being made. Consequently, outside this area strains are set up which are relieved by reheating after the weld is made, and thereafter cooling off in muffle or hot sand.

I will now deal with my process of burning these castings with the help of sheet iron jigs, gas blowpipe, or blow-lamp. The jig is placed in position and the flame is directed on the part that is enveloped in the jig. The flame distributes its heat in the following manner: The centre of reducing flame is concentrated directly on the part that requires repairs; the outer extremities of the flame provide sufficient heat for the jig and article. The temperature is increased until the melting-point is attained at the broken part in the reducing portion of the flame.

When the melting-point has been attained at the broken edges and the metal commences to fall away in a semi-molten condition, it becomes absolutely molten on coming in contact with the heated jig, and at this stage the molten alloy No. 2 is added from the melting-pot to fill the jig up. When the edges of the article and the alloy are running fluid together and united and the jig is filled up with metal, there is no need to reheat the job, as the heat that the whole has been subjected to during the process permeates the entire article. The temperature is allowed to rise until the metals have become molten, when the flame is lowered and the article is allowed to cool down gradually in the heat from the flame, but not in the flame itself. This, in my opinion, heats the air around and about the job sufficiently, whether there are draughts or not, and will prevent sudden contraction of the metal, which would tend to cause a fracture. During this process the use of flux is not necessary. In taking up shrinkage as the metal alloy cools it makes no difference if you have to add a little strip metal No. 1 with aid of lamp and blowpipe, and does not alter the strength of joint made, while it saves bringing the whole object up to melting-point again.

Making of Joints used on Sheet Aluminium.

Butt joints (Figs. 1 and 2) used when sheet aluminium articles are joined together, either edge to surface (Fig. 1) or edge to end (as in Fig. 2). First make the shape required, then take apart and clean the edges of any grease or dirt with scraper or end of file. When this has been done, take the small blow-lamp, or use the flame of a small blow-pipe, and apply heat to the edges already cleaned. Add a little metal strip No. 1. Use a small clean flame. It must not be smoky or too fierce. Use your old file to tease the metal strip on to the edges or surfaces required to meet each other, and see

Fig 1&2 Butt Joints
Fig 3&4 Lap Joints Straight Joint Fig 3 Bottoms Fig 4.
Fig 5 Thinned or Scarfed Joint for Cylindrical Articles as Fig 6
Fig 7 Coupling piece for Rubber Tube
Fig 8 Sleeve for repairing Aluminium Small Bore Tube

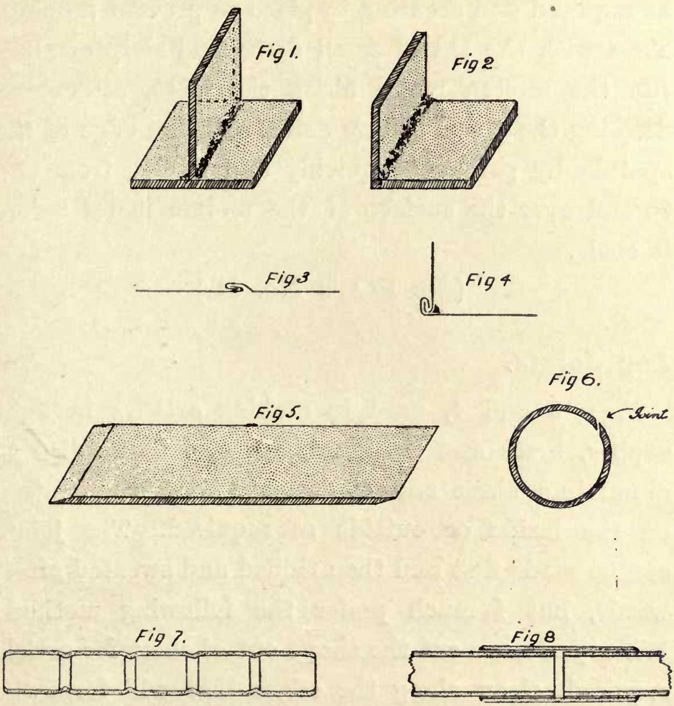


PLATE No. II.

that all parts are dealt with as you travel along, say about $\frac{3}{8}$ of an inch either side of where the joint will be made, leaving no part undone or any beading of the metal or oxide at the outer edges which may form during the application of heat. Allow the articles to cool off when; cold, placing them together as required and securing in place to prevent moving. Then with the aid of small flame and strip of alloy run the molten metal along the joint, afterwards dressing the metal of any oxide with the edge of the spatula by passing it quickly and lightly from end to end over the surface of the molten metal before it cools.

(*See* PLATE NO. II.)

Lap Joints.

Figs. 3 and 4, used in making articles in light copper, brass and tin sheet, can also be applied to aluminium sheet and made watertight by sweating on the inside or outside as required. The joints can be made first and then tinned and sweated afterwards, but I much prefer the following method: When you have cut the shape out of sheet for article required, clean along the edges that will form the joint with scraper file or card wire, and tin these edges first with alloy strip No. 1. This will give the operator confidence after the joints are made to know he has a clean surface to deal with. All that is required now is to heat the joint along and melt the strip metal on the joint. Train it along with spatula while in a molten state. The operator will find that this is very quickly done. While the alloy is still running fluid, pass the edge of spatula quickly and lightly over the surface from end to end of joint to remove any film or particle of oxide that has fallen and also any surplus metal off the joint.

Thinned or Scarfed Edge Joints.

Figs. 5 and 6, which are made by using the cross-paned hammer to thin the edge of sheets that meet each other so that the joint will be the same thickness as the sheet metal when finished. This type of joint (usually made by coppersmiths for brazing) can be used on the stouter gauges of aluminium sheet, as in the case of a cylindrical article (Fig. 6), and can be sweated together. When made, this joint will stand a little hammering and working, and even if it splits it can be sweated again and again during working. I have found this joint answer the purpose of making up connecting pieces for insertion into rubber tubes for petrol, as in Fig. 7, and also in the joining of a sleeve to repair broken aluminium tubes, as in Fig. 8. For the tinning and loading of this joint follow instructions given under Tinning and Loading Surfaces of Aluminium. When you have tinned the edges of the sheet with the alloy, allow the shape to cool before putting it together, and if it requires holding in place, pass a wire around and secure with a twist and proceed to sweat the strip alloy through the joint. It will run through of its own accord when you apply heat and metal, whether from inside or outside. As soon as you observe the metal running through, lower the flame of lamp or blowpipe slightly, and draw the heat away from the article a little. Take hold of spatula and dress the molten metal on both sides to take off surplus metal and any oxide that has formed. The action of dressing the spatula prevents drops of metal from adhering to the side opposite to that on which the operator is working, leaving a good even joint, and will save filing after cooling down. As I have stated previously, this joint will stand working and also pressure.

Cast Aluminium Pipes. Broken Lugs of Flanges, their Repair with No. 2 Alloy and Jig required.

The common causes of a fracture in the flanges of aluminium pipes at bolt holes are uneven fitting

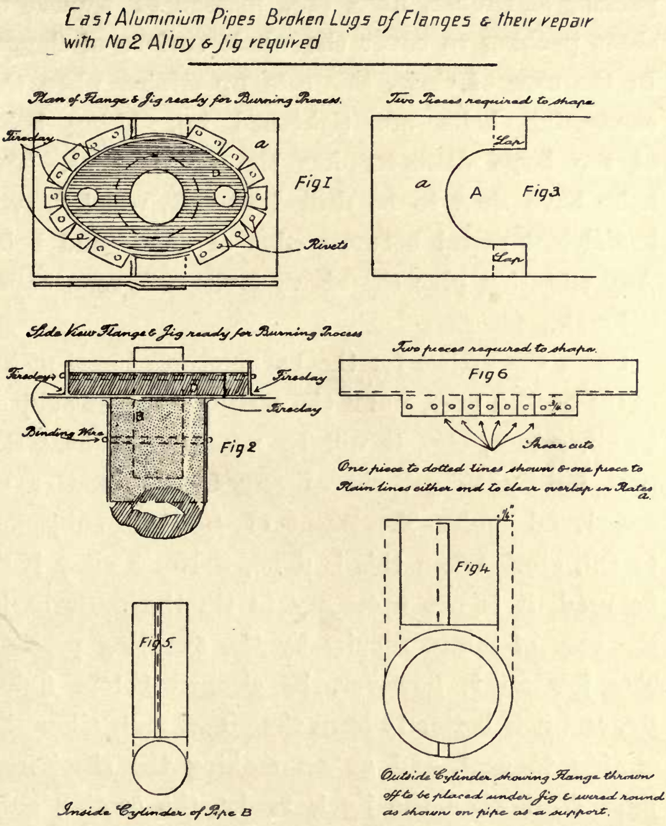

Cast Aluminium Pipes Broken Lugs of Flanges & their repair with No 2 Alloy & Jig required
Plan of Flange & Jig ready for Burning Process.
Fireclay
a
Fig I
Rivets
Two Pieces required to shape
Lap
a
A
Fig3
Lap
Side View Flange & Jig ready for Burning Process
Fireclay
Fireclay
Fireclay
B
B
Binding Wire
Fig 2
Two pieces required to shape.
Fig 6
Shear cuts
One piece to dotted lines shown & one piece to Plain lines either end to clear overlap in Plates a.
Fig4
Fig 5.
Inside Cylinder of Pipe B
Outside Cylinder showing Flange thrown off to be placed under Jig & wired round as shown on pipe as a support.

PLATE No. III.

face to face when making joints and using a ring packing of rubber, fibre, etc., instead of a piece of sheet packing to cover the whole surface of flange. In the case of rings, this sets up strains when the connecting bolts are tightened up. Using bolts of too large diameter has the same effect. The holes have then to be drilled to suit, which leaves insufficient metal between edge of flange and hole. Any vibration plus the above faults will soon cause a break.

Clean the article for the burning on of new metal at the broken part, and if the casting has been subject to oil, grease, etc., it will be necessary to heat the part locally to get rid of any foreign matter as mentioned under Treatment of Castings subjected to Oil, etc. When this is done, if No. 2 alloy is to be used, it is not necessary to tin the parts as in the case of minor repairs by the sweating process. The job must, however, be cleaned before fixing jig, and it is better to burn the oil off first, allow the casting to cool, and go on making the sheet iron jig. Then when the jig is ready, the casting only requires scraping or filing to clean it up for fixing the jig and burning repairs.

(*See* Plate No. III.)

Making of Jig for Oval Flange, Figs. 1 and 2.

Two pieces of sheet iron cut as per sketch A, Fig. 3, larger than the size of flange D, Fig. 1, cut away at A, Fig. 3, to suit outside diameter of pipe, the ends being left long enough, as shown in Fig. 3, to overlap when placed in position behind flange, as in sketches 1 and 2.

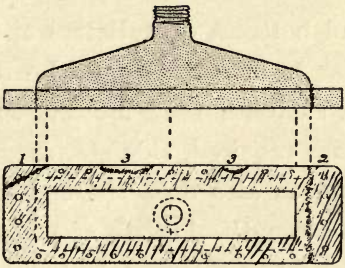
One piece of sheet iron (Fig. 4) about 2″ wide and longer than the circumference of the outside diameter of pipe (B, Fig. 2), so as to overlap at ends when placed around the pipe behind flange like a ferrule, with one end beaten over about ¼″ by stretching with cross pane of a hammer. This ¼″ flange when in position on pipe B supports the plates and behind the flange, as shown in Fig. 2.

One piece of sheet iron, Fig. 5, about 2½″ wide and longer than the circumference of the inside diameter of pipe B (Fig. 2). This forms a cylinder when made up, and is placed inside the pipe to preserve the inside diameter when the metal is running fluid.

Two strips of sheet iron (Fig. 6) cut a ¼ of an inch wider than the thickness of flange D, Fig. 2, and bent to suit the shape of end of flange D, Fig. 1, around the outer edge, with shear cuts made as in sketch Fig. 6, and punched for riveting to plates shown in A, Figs. 3 and 1. The resulting lugs made by the shear cuts are bent outwards at right angles, as shown in Fig. 1. Holes are then marked on plates (A, Fig. 1). Punch these and then rivet the separate plates together in half sections. When coupled together they make the outer jig or mould of flange. Now as to fixing of flange up with jig before commencing the burning process, take the inside (Fig. 5) and wash it on the outside with fireclay and water; then press it into the aluminium pipe. It should be a tight fit, and leave about $\frac{3}{8}''$ standing up above the face of flange, as in Fig. 2. Next take outside ferrule and wash the inside with fireclay and water, and open sufficiently to go over the pipe if it will not slip on the other end. The top is the flanged end after this has been done. Take the two half sections and place in position round the flange with the ends overlapping, as shown in Figs. 1 and 2. Wire this top portion and also the ferrule round to keep them from moving, as shown in Fig. 2; mix a stiff mass of fireclay and press it round the part of jig flange and joints indicated. The whole job should then be fixed face of flange upwards and about 18″ off the floor, and made secure so that it will not move about or fall when working. It is now ready for the burning process as outlined under that heading.

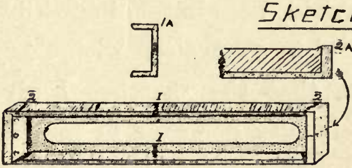
(*See* PLATE No. III.)

Sketch X



Radiator Tops & Bottom Repairs
1. *Broken flange at corner*
2. *Whole end flange repairs.*
3. *Broken away at bolt holes on flange*

Sketch Y



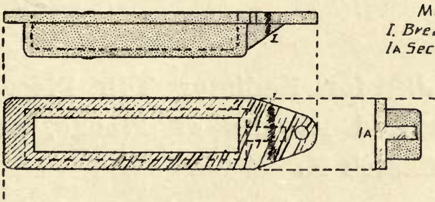
Radiator Side pieces or Standards.
1. *Break through centre*

1A *Section through I*

2. *Break near Flange.*

2A. *Section through flange at arrow*

Sketch Z



Motor Lorry Gear Case.

I. *Break through Strengthening Rib.*

1A *Section through I*

Plate No. IV.

Repairs to Motor Aluminium Radiator, Tops and Bottoms, Side Standards and Gear Cases.

The flanges of tops and bottoms of radiators and gear cases are very similar to one another, so I will deal with a top in the sketches that follow. As to making the jigs that are required, side standards require a new kind of jig, as also does the end of a gear case, which has a strengthening rib of metal at one end. There are so many different makes of these articles that it would be almost impossible to collect the data required in connection with every type. I hope, therefore, that the sketches I give here will explain and help any operator in making jigs for the different types as occasion may require. I will take them as they occur in the Sketches X, Y, Z.

Making up of Jig for Radiator Top Piece, Corner or End Repairs of Flange, as shown in Sketch X.

One strip of sheet iron about 8″ long and 3½″ wide and cut as shown at A, Fig. 1. Bend the strip at B B measurement, for the distance between lines B B is the inside of top at C, Fig. 2. The lugs at each end are bent over, as at A A, Figs. 1

and 2, to cover bolt holes on face of flange, the holes are then marked off and punched, and the inner section of jig is ready to be secured in place later.

One piece of sheet iron about 10″ long and $4\frac{1}{2}$″ wide marked off and cut as in sketch Fig. 5. Bend this piece at E E at right angles, as shown in Fig. 6. Measurement for distance E E is the outside measurement of top at D, Fig. 3, underneath flange. One piece of sheet iron marked off and cut according to the following instructions: Take Fig. 7, E E, as base lines, and E J length of sides similar to E J, Fig. 6, with $\frac{1}{2}$″ left on inside these lines and cut diagonally at G, Fig. 7, into the corners. This inside edge is turned down to rivet on to Fig. 6 when the shapes are placed together, Fig. 6 to fit inside Fig. 7. The outer edges F F F are arrived at in the following manner: The sides are the space of flange at K K, Fig. 3, the end is the length of flange as at L, Fig. 4, and an extra $\frac{5}{8}$″ is left on all round the outside edge for turning up, first making cuts at the two corners G, Fig. 7. These corners are then riveted to hold the turned-up edges together, as at M, Fig. 8. When the shapes of Figs. 6 and 7 are placed together and riveted, they form the outer mould, Fig. 8, which is then placed in position at the end and outside of flange of radiator top, as in Figs. 9, 10 and 11. After this mould or jig is placed in position, mark off holes to correspond to the holes in flange and to meet the holes of the inner section, and punch. Where the edges of Figs. 6 and 7 join in the outer mould at H H H, dress the projecting edge over by lightly hammering to make a good job of the joint and so that no molten metal will run between later.

(*See* PLATE NO. V.)

Fixing of Jigs on to End of Flange where Repairs are required.

Fig. 1 goes inside of radiator top, the turned-down portions at the ends A A laying over one or two holes. Fig. 8 goes outside the end of flange, and the surface K K K lies under corresponding holes to Fig. 1 inside jig. Couple up inside jig, flange of radiator, and outside jig with bolts and nuts, and it will appear as in Figs. 9, 10, 11. When all is made tight, press a stiff paste of fireclay and water all round the spaces between jigs and radiator top, outside and underneath, as shown in Figs 10 and 11, to prevent any molten metal running between jig and casting when the metal alloy is being run on top.

Making of Jig for Radiator Top or Cover whole end & corner repairs of flanges

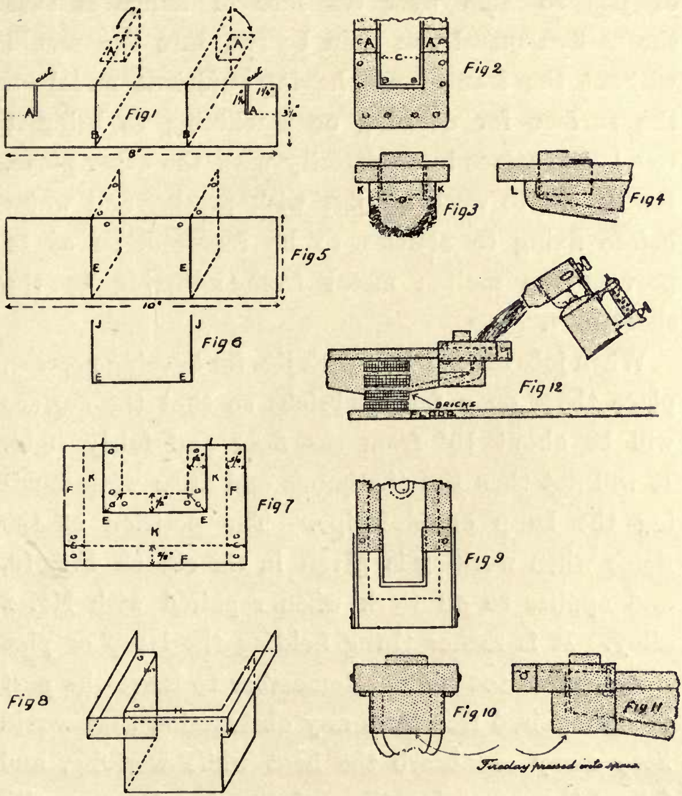


PLATE No. V.

This jig, when made, can be used several times before it is scrapped both for a corner, or whole, end flange repairs. The reason I leave the top edges of jigs so high over the face of flange is that the molten metal can then be run into the mould without the fear of not having sufficient metal on the surface for dressing or machining to bring it to a level surface in conformity with the other parts. Remember to wash all jigs with fireclay and water before fixing to articles to be repaired, so as to prevent the molten metal from adhering to the sheet iron.

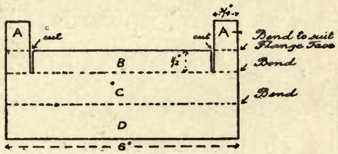
When jobs are fixed up with jigs for burning process, place them on a few firebricks so that the surface will be about 18″ from the floor and fairly rigid. It will not then tire the hands and arms while holding the lamp or blowpipe. The position of the flame when working is given in the sketch Fig. 12, and applies to all work when repaired with No. 2 alloy. It is rather tiring holding the lamp or pipe if the job is too high. Remember to leave the part to be repaired free from any obstruction that would keep away or absorb the heat while working, and follow the general outline of Burning Process with No. 2 Alloy.

(*See* PLATE NO. V.)

Filling in a portion of flange broken away at bolt holes & shape of Jig required for side repairs of Straight Flanges.

Outside Pattern for Flange Repairs

Fig 13



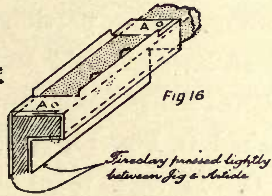


Fig 16

Inside Pattern for Flange Repairs

Fig 14

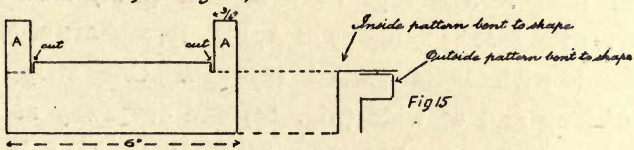


Fig 15

Fig 17

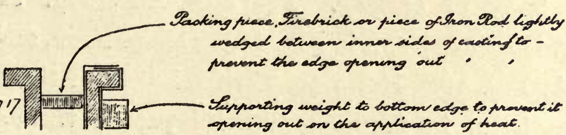


Fig 16 Showing method of fixing up

Fig 17 Showing Packing & Support of bottom edges, Inside & Outside

Plate No. VI.

Filling in a Portion of Flange broken at Bolt Holes and Shape of Jigs required for Side Repairs of Straight Flanges.

One strip of sheet iron about 6″ long and 4½″ wide, cut as in sketch Fig. 13, and marked off for bending. The portion marked B is bent along dotted lines at right angles to C and upwards. The width of flange underneath, say ¾″, is left, and portion marked D, Fig. 13, is now bent down at right angles to C. It then takes the shape shown in Fig. 15, outside pattern, and is placed in position on outside of flange. The lugs at each end (A A) are bent over the face of flange as at A, Fig. 16, and are secured later with bolts passed through. One strip cut 6″ long and 4″ wide (Fig. 14) and cut away at top edge similar to Fig. 13. Place in position inside the body of casting. The lugs A A, Fig. 14, are then bent as shown in Fig. 15, inside pattern, and also at A, Fig. 16. Holes are then marked on these lugs from holes in flange and bolts passed through to hold the ends of jigs in place, as shown in Fig. 16. Remember to wash the surfaces that go to the casting with fireclay, and fix up, as shown in Fig. 17, with a piece of firebrick or iron rod inside and a weight outside. Press a stiff paste of fireclay along bottom edges, and the job is ready for the burning process with No. 2 alloy.

(*See* Plate No. VI.)

Radiator Side Pieces or Standards   Repairs to Break at either side or both

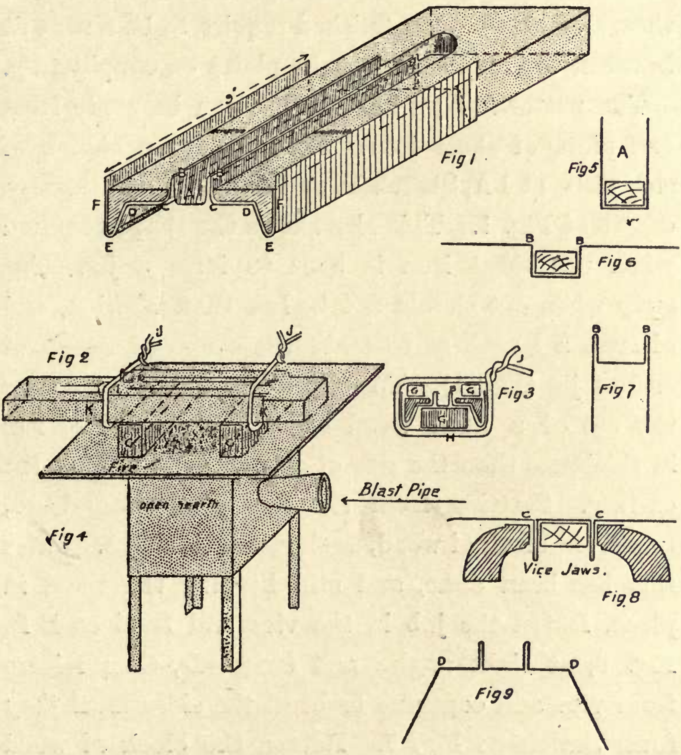


PLATE No. VII.

Radiator Side Pieces or Standards. Sketch Y.

Before commencing the repair of a side piece broken through centre as shown at 1, Sketch Y, I would advise the taking of measurements from end to end, as these side pieces when finished require to be a neat fit between top and bottom tube plates on coupling up.

The pattern of jig for this job can be made from one piece of sheet iron. First, I give a sketch of side piece at 1 A, Sketch Y, and also a section through centre of Fig. 1. This also shows the shape required when the sheet iron is bent to form a jig. The strip when cut should not be less than 9″ wide, and of such a length as to make the shape as shown at end of jig (Fig. 1). To help in the making I advise the use of a hard wood block 9″ long and ¼″ less in thickness than the size of gap at A, Fig. 1, on the casting. Starting from the centre of sheet bend, round the block of wood, as shown at A, Fig. 5. After this has been done, and still keeping the wood in place, fasten the job in the vice and bend at B B, Fig. 6, at right angles and outwards, then release from vice and continue to bend the sides until they form the shape Fig. 7. Return the block of wood to the gap A, reverse the job and place in vice again. Bend the sheet at C C outwards, and taking careful measurements from C to D either side, bend downwards.

(*See* PLATE NO. VII.)

Mark off at E each side and bend upwards, as shown from E to F, and you have the shape required for jig shown at end of Fig. 1. This mould or jig when made will suit a Leyland radiator side piece, and the sketches of side view and end, Figs. 2 and 3, will help to explain the fixing up for the burning process.

G G G are pieces of firebrick at each end of jig, as shown in Fig. 3. The bottom piece lies flat on the underpart of jig and projects below the edges of the recessed portion of casting as shown at each side, Fig. 3. The two top portions lie flat on the surface either side of gap and stand above the top edges of jig at B, Fig. 1. The $\frac{1}{8}''$ binding wire is bent round the firebricks and jig at both ends and holds the jig, casting, and bricks in position, with a twist at J, Figs. 2 and 3, and compresses the whole together.

After this has been done, press a stiff paste of fireclay all round the ends at K K, Fig. 2, to prevent molten metal from running between jig and casting when burning. Then place the whole over a fire, the centre of the jig and casting over the centre of fire so that the heat is directly under the break. Place the job on two firebricks as shown in Figs. 2 and 4, G G as supports or rests, so that the heat from the fire will assist as a bottom heat for the jig. You do not want a big fire when operating, as you have the flame of the blowpipe or lamp going on top, and the heat from this flame with very little assistance from the fire will be found sufficient. For Burning Process follow instructions given under that heading, and when the job is ready for cooling down, cover the fire underneath the jig with a small piece of sheet iron. Place between the firebricks and allow to cool right out in this way, so that you will have a gradual cooling down in the heat from the fire. When the fire has died down and the metal is set or solid you can remove the job and lay aside until cold; then take apart and dress off.

(*See* PLATE No. VII.)

Repairs to Radiator Side Piece at End, as shown in Sketch Y 2. Break near Flange.

A break or crack near either end necessitating a new part being burnt on and jig required.

The sheet-iron jig for this particular job assumes a box-like shape and is cut in three pieces, two pieces being riveted together, and the third piece clamped when fixing up for burning process, as shown in Fig. 4.

The inside mould consists of two portions cut as follows: The measurements for Fig. 2 are A, Figs. 1 and 2 for width at top inside; B B, Figs. 1 and 2,

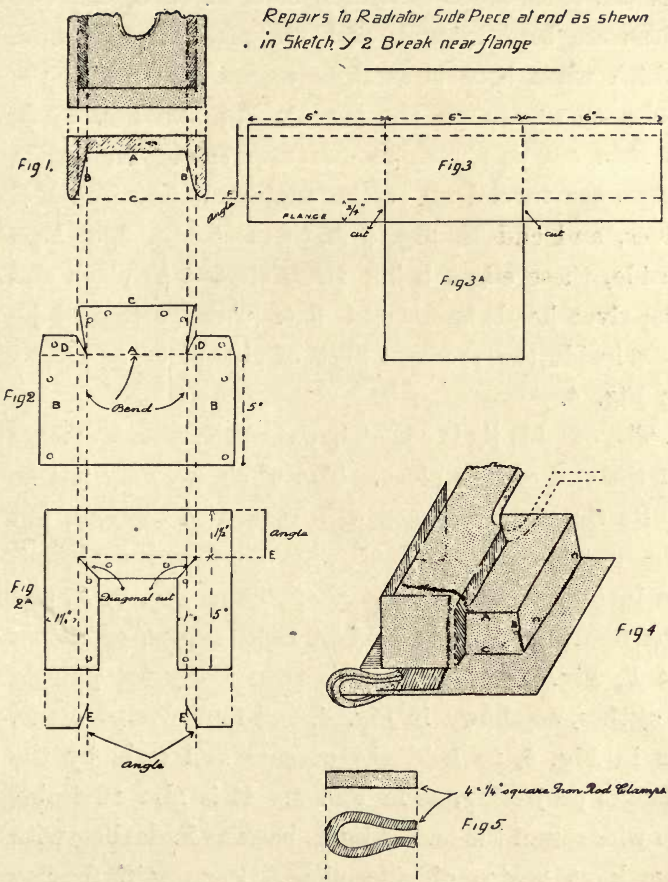


PLATE No. VIII.

for depth; C, Figs. 1 and 2, for width at bottom. As the sides slope outwards from A to C, the two sides are bent inwards and are riveted on to end, which when bent is at right angles to A, with the holes as shown on the lap D, Fig. 2. Fig. 2, A, is then cut as shown to measurements. The inside edges are turned up to the angles as shown at E E sides, and end E, Fig. 2 A, to meet Fig. 2, and go inside, these edges being then riveted in place and the rivet heads hammered flat. This portion of jig goes inside the recessed part of side piece, as shown in Fig. 4.

The outside jig is one strip cut to the measurements of the end of side piece. The 6″ shown may not be quite the right distance with regard to the end, but the outside sizes of 6″ will be found sufficient, as in Fig. 3, and bent to shape as in Fig. 3, A, and the flange $\frac{3}{4}$″ is thrown off at right angles, as shown at F, Fig. 3. The whole is then ready for putting together, as shown in Fig. 4, and four clamps made, as in Fig. 5, to hold the corners and ends by the flanges projecting, as in Fig. 4. It is also advisable to wire round the end of jig at back as in dealing with break at centre of side piece. Press stiff fireclay and water in between all joints of jig and see that you have the right length over all end to end before commencing the burning process. Rest the whole

Repairing Motor Lorry Gear Case, the end having broken away

Details of Jig required

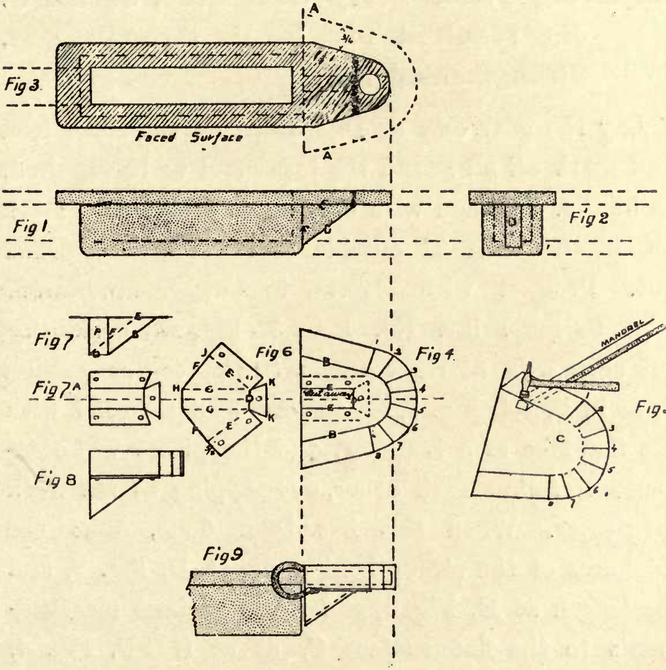


PLATE NO. IX.

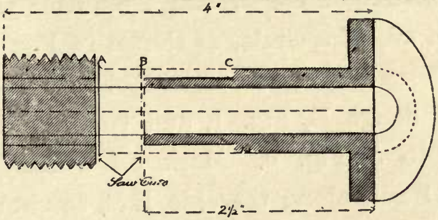
article on a couple of fire-bricks, and it is ready to commence.

(*See* Plate No. VIII.)

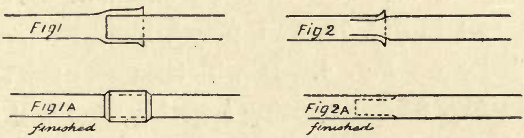
Repairing Motor Lorry Gear Case, Sketch Z. Jig required for break through End, Strengthening Rib.

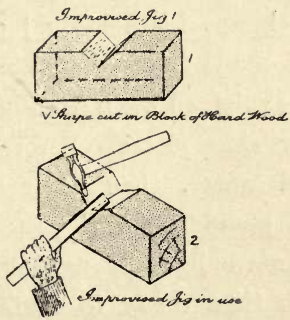
Lay the gear case surface down on the sheet iron and mark off all round the taper end to be repaired, as in Fig. 3; then with compasses or dividers mark off another line $\frac{3}{4}''$ outside and cut this segment out. Proceed with shears to cut from outside edge to inner line No. 1 to 8, Fig. 4. Bend this cut edge over at right angles to flat centre portion C, as in sketch Fig. 5, on the end of a mandrel with the flat face of a hammer, and the pieces will commence to follow each other, overlapping as the work progresses. When this has been done, take the thickness of the strengthening rib at D, Fig. 2, and the length at E, Fig, 1, and transfer these measurements to the flat surface C, as at E E D, Fig. 4. Cut this piece out so that it will fit underneath the taper end of gear case up to the body at F, Fig. 1. Another shape has to be cut and made to fit the rib D, Fig. 2, and takes the lines as at 6–7–7*a*. Take again the width of rib D, Fig. 2, and the length at

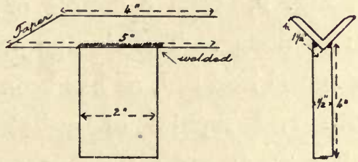
Shortening a Cast Aluminium pipe or connecting a flange or boss to the end for a thread or with a thread already made



Making a Socket Joint in Aluminium tube Fig 1 & 1A
" " Flush " " " " " 2 & 2A







Permanent Jig useful when reducing diameter of small tube consists of a piece of Angle-cut as per sketch & one piece of Flat-iron 2" x ½" welded where shown for hold--ing in Vice when in use.

PLATE No. X.

G, Fig. 1, and transfer these measurements to a piece of sheet iron as in Fig. 6, D G G. Take the length of E, Fig. 1, with compasses, and from each side of D describe an arc of a circle, as shown in Fig. 6; then take the length of F from end of rib G to the underside of flange E, Fig. 1, and transfer this length from H to J, Fig. 6. Mark off a line $\frac{5}{8}''$ outside end at D and along the side E E, as shown in Fig. 6. Cut this piece out and make cuts also at K K and proceed to bend the pattern as shown at G, Fig. 7; then throw off flange at D and E E, as shown in Fig. 7*a*, and punch holes to correspond to holes on Fig. 4. It will then assume the shape as in Fig. 8 after riveting together, and will be ready to place in position, to be secured, as shown in Fig. 9, with a couple of clamps for holding jig on to flange. The clamps are made from $\frac{1}{4}''$ square or round iron rod, as has been explained when dealing with end repairs of radiator side pieces. Before using wash with fireclay and water, then fix up and place clamps in position, pressing a stiff paste of fireclay in the joints between jig and casting at J and O, Fig. 9. You are then ready to commence the burning process explained previously.

(*See* Plate No. IX.)

Shortening a Cast Aluminium Pipe, or connecting a Flange or Boss to the End, for a Thread or with a Thread already made.

Regarding alterations to existing castings, it is sometimes necessary to alter a cast pipe length, which is done by the sweating process with No. 1 alloy. I will take the cast aluminium pipe in the sketch with flange one end and a threaded boss at the other. Suppose that this pipe 4″ long has to be shortened 1½″, bringing the length down to 2½″ from 4″. Cut the boss end right off where marked, A. Then cut piece off pipe at dotted lines B, which will leave the length of pipe and flange 2½″ over all. Take the length of boss, say 1,″ mark off on the free end of pipe 1″ as at C, and reduce the outside of this pipe to half the thickness of metal. Then bore or drill the boss end out to fit the reduced end of pipe loosely, and it is ready to commence tinning, prior to sweating together with No. 1 alloy, providing that you have no oil or grease to contend with. Commence to tin the inside of the boss and the outside of pipe up to the shoulder at C, and also at the end of boss which meets this shoulder, and a short distance on the outside circumference of original pipe. For the tinning with No. 1 alloy look up the instructions given under Tinning and Loading Surfaces of Aluminium. While both articles are still hot, place the pipe end into the boss, and lightly fasten the pipe in the vice, boss end up. Melt the strip alloy on to the joint, and heat the boss with the aid of lamp or blowpipe from the top, so that the molten metal will run through the joint of boss and pipe. When the metal commences to run through, press the boss right up to the shoulder C, and allow the job to cool off; then dress off with file and emery cloth at the joint and face of boss, and the job will be found a good one.

Bending of Aluminium Tube.

To many persons aluminium tube presents difficulties in bending, and I hope the following remarks will be found instructive. Get sand free from stones and heat it on a piece of sheet iron, to the exclusion of any dampness, and while the sand is drying plug one end of tube with a wooden plug, then fill the tube with the hot sand and tap the tube gently with a flat piece of wood to allow the sand to settle down, and repeat this action until the tube is full. Then plug this end also, remembering that if a long length of tube is being filled it requires supporting, otherwise it might get an awkward bend or kink when moving about, as the hot sand anneals the aluminium; it is fairly soft even when cold. When bending aluminium tube I advise the use of a soft wood block rounded off at one end to suit the radius of inside curve of bend required, and a thin piece of soft wood to back the tube when holding in vice, which must not be held tight, as the metal soon takes a flat, and in some cases it is almost impossible to get the dent or flat out again, particularly if it occurs between two bends.

Making Socket Joints in Aluminium Tubing.

The sketches I have shown will help in the making of socket and flush joints for the repair or piecing up of aluminium tube. Fig. 1 is a socket joint for use when the reduction of the bore is not desired.

Fig. 2 is a flush joint outside, but one which reduces the bore, though the outside can be dressed off to correspond with the other parts after sweating together. To expand the tube for a socket (Fig. 1) get a piece of round mild steel rod that will enter the bore and fasten in a vice, leaving about $1\frac{1}{2}''$ out at end of jaws. Place the tube end on this part and lightly hammer, say, for a length of $1''$ all round, and the tube will stretch and expand under the repeated blows of the hammer. When you have got the required diameter for other end to fit inside, round it up nicely and commence to throw a lip off at the end of the enlarged portion, say from $\frac{1}{8}''$ to $\frac{3}{16}''$, to make shoulder for the strip alloy to rest on when sweating together; clean the inside of socket and lip and the outside of tube end that meets it and tin with No. 1 alloy. While both parts are still hot insert one into the other and place in an upright position (taking care, if you have any bends on the separate parts, to place them at their proper angles) and sweat together, with the aid of lamp or blowpipe and strip of metal. A small clean flame and a spatula will help. See that the metal runs right in the joint, but do not keep the flame on the job all the time, as it might so heat the tube that it would break into or cause the metal to run through the joint and into the pipe below the joint. Play the flame on and off as may be required. After you have loaded the lip, allow the job to cool off, then dress the lip down with file and emery cloth, and the joint will appear as in Fig. 1, A.

Fig. 2 is a flush joint when finished, but there is one drawback to this kind of joint, owing to the reduction of the bore, as shown in Figs. 2 and 2*a*.

To reduce the portion of tube for the joint in Fig. 2 from, say, $\frac{1}{2}''$ to $1''$ in length, according to the size of tube under treatment, I show sketches of an improvised jig (or I should say "tool") for the work;

but in the case where repetition work is the order, I have given a sketch for a permanent tool also. I take as the improvised tool a block of wood, cut as shown in Fig. 1. Fasten this hard wood block in the vice, and using the cross pane of hammer, as shown in Fig. 2, lightly hammer on the tube (commencing about $\frac{1}{2}''$ in small bore up to $1''$ in larger bore from the end). This will cause the reduction of the part struck. Follow round and round, coming nearer to the end after each course, you will find the tube reduced in diameter, as in Fig. 2. When sufficiently reduced to enter the second piece, lay on one side and commence to throw a lip off on the end of the second piece, as shown, Fig. 2, for the metal to rest on to make the joint. Clean the inside of this portion and the outside of reduced portion for the length of the joint required and tin as mentioned previously, and while hot insert one into the other and sweat together, remembering to place any bends at their proper angles. Dress off when cold, and the joint should appear as in sketch 2 A.

The sketch of the permanent tool for this class of work consists of a piece of angle iron to the sizes given and cut away on the slope and a piece of strip on flat iron welded where shown for holding in vice when using.

Reducing the Size of Hole in a Boss that has become too big through Use and which requires Machining afterwards.

I will take for example an aluminium magneto drive cover of an Hispano Suiza aero engine, very many of which I repaired in the manner I am about to explain. These were machined afterwards, and were absolutely perfect when finished.

The sketches I give of this particular article and the method I used in making the jig can be applied to other similar work, as in the case of a boss to be attached to an existing cast pipe for a branch connection, etc. The jigs are made as follows :—

Two sheet iron half plates $\frac{1}{8}''$ thick (A A, Fig. 1) and cut as in sketch Fig. 3. The projecting pieces B B are then bent as shown to form a hinge, as at B, Fig. 1, and the side view, Fig. 3. They are then placed together, and a short piece of iron rod inserted into each side. When the hinge is made, fit these plates on to the magneto drive cover, over the boss at the angle shown, loosely as in Fig. 1, A A B, to allow of an outer mould or case to fit over the boss and inside the curves of the two plates A A, Figs. 1 and 8.

To make this outer mould, take the outside circumference of boss, Fig. 8, plus $\frac{3}{8}''$ at end for lap as sketch Fig. 4 of pattern shows, then take the depth of the boss at sides D and front and back E outside Fig. 1. Transfer the length on to strip, Fig. 4, as shown, allowing $\frac{1}{8}''$ to $\frac{5}{8}''$ along the straight edge as extra depth to let the top edge stand above the boss, as shown in Figs. 1 and 9. Cut shape out of 20 wire gauge sheet iron, as in the case of a shape for a branch piece or saddle. The curves as shown can be sketched freehand. After the pattern is cut out bend it round a mandrel or round bar of iron until the ends overlap, as shown in Figs. 5 and *5a*, then where the dotted lines are shown at Fig 4, F, on each curve, edge this portion with the cross pane of a hammer and the edge of the mandrel at the square end by stretching, and it will lie over so as to rest on the body when placed in position round the boss, as shown in Fig. 1, and also Figs. 5 and *5a*. It is then ready to place in position later.

Now, whatever the diameter of hole is required inside the boss, make due allowance for machining afterwards. The natural method is to make the inside mould on the small side to allow of more metal being run between inner and outer mould. This inner mould or cylinder is made the full depth of D, Fig. 1. The circumference which must be on the small side is taken, and an allowance of about $\frac{3}{8}''$ for overlapping ends. The circumference will therefore constitute the length, and D, Fig. 1, the depth or width of sheet iron 20 wire gauge required for the inner mould to be cut and bent, as in Figs. 6 and 7.

(*See* PLATES NOS. XI AND XII.)

At this stage I wish to say that when I made my permanent jigs I had a welding plant (oxy-acety) at my disposal, and it enabled me to make a strong joint at the portions of plates A A, Fig. 3, inside the curves to which I attached the outer mould in half sections, split at D with an overlap at each side. Consequently the jig working on the hinges B, Fig. 1, could be placed on the job immediately it was required. As I have not dealt with the oxy-acety welding of jigs described in this book, I will mention here that where a welding plant is available it is advisable to have parts welded, especially where there is a chance of repetition work being carried on, though in the first case in every job I undertook that required a jig I made them by the methods I have described previously. I found them very satisfactory, and the reason I have explained the making of jigs without welding is that many persons who are interested in the repair of aluminium may not be conversant with the working of sheet metals.

Now as to fixing the magnetic drive cover and jig together preparatory to the burning process,

Reducing a hole in a boss of an Aluminium casting & Jig required
The example taken Magneta Drive cover Hispano Suiza Aero Engine,

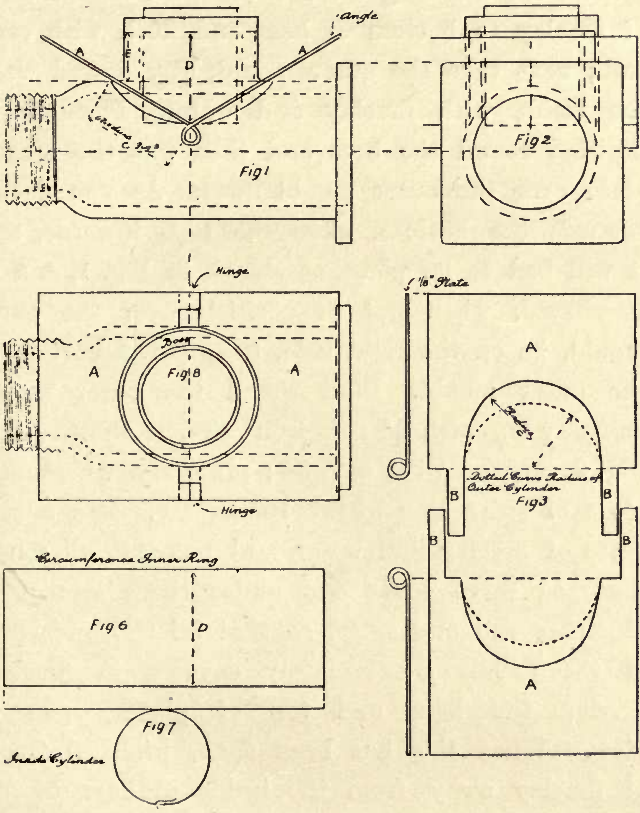
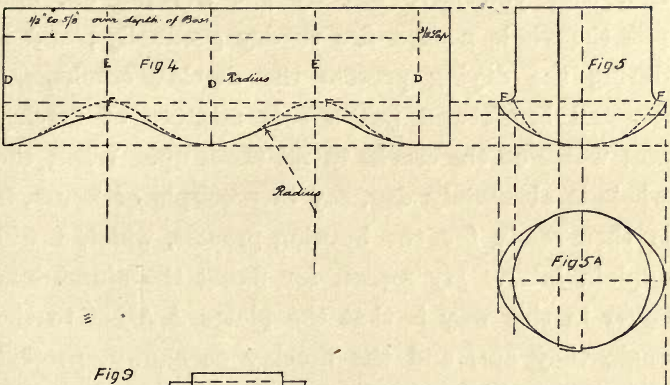
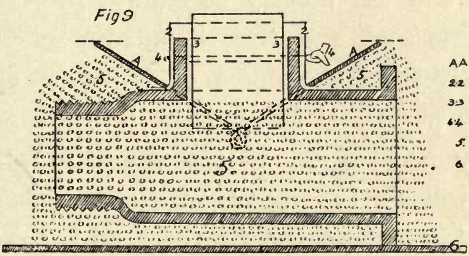


PLATE No. XI.

I will explain this with the help of the accompanying sketches.

First fill the mag drive cover with a stiff mass of fireclay to bottom of boss and flush with each end; next take the outer mould, Fig. 5, and wash the inside with fireclay and water. Place it in position round the boss and then put the hinged plate over the outer mould open. As you got it towards the bottom, close the tops inwards, and it will bed to its place, as shown in Fig. 1, A A B. It should, when put in position over the outer mould, be on the tight side, to grip the bottom of the outer mould. Bind round the outer mould half-way up with $\frac{1}{8}''$ soft iron wire, as shown at 4, Fig. 9, secured with a twist; place the whole on a piece of sheet iron about 10″ square. Mix a stiff paste of fireclay and water and put this all round the mag drive cover and under the plates A A at either end and sides, so that all the underpart of the article is absolutely covered in fireclay, leaving the boss and top of plates open to view. When this has been done, wipe all traces of fireclay away from the inside of boss to the bottom and leave this part hollow. Take the inner cylinder and press it into the fireclay right in the centre and leave it standing alone, the top edge of boss say about $\frac{3}{8}''$ to $\frac{1}{2}''$, as in





Explanation of Fig 9.

AA *Hinged plates*
2.2 *Outer ring or mould*
3.3 *Inner ring in fireclay*
4.4 *Binding wire*
5. *Fireclay*
6. *Sheet Iron about 10' square*

PLATE No. XII.

the sketch Fig. 9, which will explain all that is required.

When this has been done take hold of the sheet iron that you have already got the job on, and put the whole near a fire to dry gradually; and if during the drying process the fireclay cracks, get a small brush and put a soft mixture of fireclay and water on the cracks to fill them up. When the whole is absolutely dry, say in a couple of hours, it is then ready for the burning process, which I will explain later. My reason for fixing the aluminium cover in this way is that the plates A A set to the angle they are, and the fireclay as shown, protect the flange at one end and the threaded portion at the other, diverting the flame of blowpipe or lamp from these parts and keeping the heat where it is absolutely necessary. If the operator will study Fig. 9, he will see that when the flame is playing on the top portion of boss and jig the heat is concentrated all round the boss, and this is what is required, while the centre part, being left hollow, allows the heat to keep the inner mould hot right to the bottom. This, when the molten alloy is added, is a great asset, as it can be kept in a molten state between inner and outer moulds until the job is finished.

Next prepare the melting-pot and ladle for melting the alloy, wash the inside and outside with fireclay and water and dry off, then put into pot sufficient of No. 2 alloy, tin zinc and aluminium 2–2–3, to do the job, and put the pot on the fire to melt while you are heating the whole of the mag drive cover, enclosed with jig and fireclay.

Place the whole job already on the sheet iron about 18″ off the floor on firebricks, or anything of like height that will not burn, so as not to tire the arms while holding the lamp or blowpipe. Open the flame out on the top of the inner mould, with the flame directed downwards to melt the top edges of the boss between the moulds of sheet iron, not forgetting to keep an eye on the metal alloy in the pot on the fire. Keep the flame going on the job until you perceive the top edge of boss beginning to fall away in a semi-molten condition, and at this stage take the poker and use the end lightly and help the edges to break away. Lay aside the poker for awhile and take a little of the molten alloy from the pot on the fire with the ladle and pour in the space between the inner and outer mould and return the ladle to the side of the fire to keep hot. Open the flame of blowpipe or lamp out as hard as it will go, and with the aid of poker again, puddle the alloy and molten metal of the casting together, lightly and quickly traversing all round the ring of the now molten metal. When it is running fluid lay aside the poker and fill up the space between the inner and outer moulds to the top of the jig, and then run the poker end lightly round the ring of molten metal, and any foreign matter or oxide that has formed during this process will rise to the surface and can be removed by passing the poker horizontally across the top of jig, which action will cause the oxide or scum to form in front of poker and be pushed right off the job. Lower the flame of the lamp or pipe a little and look for the shrinkage which will take place, adding a little more metal if required from the pot or the metal strip No. 1. It makes no difference which is used. Use the flame again; then when there are no more signs of settling down, lower the flame a little and allow the job to cool in the heat from the flame, by placing the lamp or pipe a short distance away and securing, with the heat directed towards the object. After about ten minutes or quarter of an hour, lower the flame still more just to allow of a current of heated air to surround the article, and after about another ten minutes has passed put the flame out and let the job cool right out. When it is cold, and the jig is taken asunder and the fireclay is cleaned from outside and inside, you should find that it is a good job.

Notes.

When you commence to take the fireclay from the inside of the cover you may find that a little metal has run down inside between body of article and fireclay. This will break away if you will take a small chisel and insert it between the metal and inner side of body and put a thin piece of wood between body and chisel to prevent marking the article or cutting it on the inside. Tap the chisel lightly, and the spare metal will commence to break away to the bottom of the repaired boss, as this metal cannot adhere to any part of the body inside, owing not only to the fireclay coating which is dried on the metal, but also the oxide that forms during the application. This forms a projecting surface for the surfaces not in contact with the reducing flame of lamp, and if the metal does run between it is only a shell and easily broken.

To remove Paint or Oil from Aluminium in Addition to the Heat Treatment previously described.

A small bath or bucket of hot water and caustic soda will remove paint, etc., from either sheet or castings. Wash well in hot clean water afterwards, but take care not to touch either hands or clothes with the solution, or it will burn the skin or rot the clothes. Dipping articles in this way is best done by securing the jobs with iron wire to hold them until washed off. I found that caustic soda is inclined to blacken aluminium slightly, but the blackened portion can be cleaned with scraper or file before tinning, etc.

Hydrochloric acid or spirits of salts, as it is most generally known, is not advised as a cleaning agent, as it dissolves the aluminium, but it may be used with other metals which are to be attached to aluminium, as I shall explain later.

Sulphuric acid also dissolves aluminium.

Nitric acid attacks aluminium slowly when heated. I have mentioned these three acids as they are very commonly used in workshops. I wish to warn operators against their use in connection with aluminium. They serve no good purpose, and are very dangerous to meddle with, unless thoroughly understood. I have dealt with them because anyone accustomed to ordinary soldering commencing to experiment in the repair of aluminium is inclined to go right for the acids as a starting-point, knowing that killed spirits and other fluxes are used for soldering other metals, with very disappointing results.

Filling of Bolt Holes and also Holes in Castings that have been tapped, which have become too big through Ordinary Wear and Tear, with No. 1 Alloy Sweating Process.

First drill the hole out a size or two larger with a file to clear the thread right out or to round up any irregularities there may be. Then take the sharp edge off round the hole at both ends or at one end as the case may be. If the article has been subjected to oil, grease, etc., remove by heating locally as mentioned previously, then clean with file or scraper for a small distance round the edges of hole and inside. Remove any burnt refuse, and commence to tin all the parts already cleaned, so that after the tinning is satisfactorily done a body of metal alloy can be built up on the top of hole.

Before you commence to load up with alloy, place a small piece of sheet iron on the under side of hole and melt the strip so that it will run through from the top side. When sufficient has been melted on the top to form a small body of metal over and above the surface surrounding the hole, dress this metal on the top side with the spatula and allow it to cool until it acts, then turn over and continue the loading on the reverse side if necessary. It is advisable to leave a pad of metal on both sides to be dressed flush with surrounding parts when cold with a file and emery cloth. For tinning and loading refer to that heading under Sweating Process.

On filling Articles with Fireclay.

When articles require to be reinforced with fireclay, mix it into a stiff mass with water and press the substance into any nook or crevice inside or out as may be required; then take a piece of thin wire and probe into the fireclay in several places, so as to make air passages for the vapour to escape when drying the job before the Burning Process is commenced.

It will often be noticed that when hot metal has been run into jobs filled with fireclay and allowed to cool, that some of the molten metal has found its way between the fireclay and casting. This shell of metal is very easily removed with a small chisel or hammer, not forgetting to put a thin piece of wood between the chisel and casting to prevent cutting or marking, and this shell will break away very easily, as I have explained previously when dealing with mag drive cover.

Repairing an Aluminium Saucepan (putting in a New Bottom with Aluminium or Copper Sheet).

Cut the old bottom out and dress off the edge all round, then throw a lip $\frac{3}{16}''$ off all round at right angles to the sides with a tinsmith's jenny, if in possession of one; if not, with a hammer, the cross pane of which should be fairly broad. This is to stretch the edge of the metal so that it will not crack; when this has been done, cut the circle of sheet aluminium or copper (whichever is going to be used) about 20 or 22 W G, $\frac{3}{8}''$ larger than the diameter of the edged pan bottom. Then throw up all round this circle a $\frac{3}{16}''$ edge so that it will go over the bottom of saucepan with a jenny, or if not with a wooden mallet and the round end of a mandrel or a half-moon stake.

Dealing with the Case of an Aluminium Bottom.

Clean the edges of the saucepan with a piece of card wire or emery cloth inside and out and for a distance of, say, $\frac{3}{16}''$ to $\frac{1}{4}''$ up the sides. Then clean the edge all round the aluminium bottom about $\frac{1}{2}''$ from the edge thrown up inside and out and tin the cleaned parts with No. 1 alloy and scraper, as mentioned previously. When tinned, scrape off all particles of oxide or foreign matter that may have collected on the edges and allow to cool off. When cold put the saucepan into the edged bottom and heat the edge of bottom once on to the edge of the sides. When it lies flat, place the pan on the end of a mandrel and beat this remaining edge over again on the sides, as in Fig. 4, under heading Lap Joints. Then, when this is laid over all round, proceed to sweat strip alloy No. 1 inside the corner all round the joint with the aid of flame and end of spatula. This will make the joint quite smooth all round. While holding the pan in the heat of the flame of lamp or blowpipe outside, which should not be held too long in one spot, neither should the flame be too big, the pan should be rotated in the flame slowly while the sweating process is being carried on. When traversed all round, allow to cool.

I will now take the case of a Copper bottom. After it has been edged up all round and cleaned on both sides, you will require a strip of ingot tin and killed spirits of salts. When tinned all over, wipe off all surplus metal with a piece of clean rag and plunge the bottom in a pail of hot clean water to remove all traces of acids from the job.

If sal-ammoniac is used, as is always advisable in the case of cooking vessels being repaired, wash the already cleaned copper bottom with cold water and sprinkle a little of the pulverized sal-ammoniac all over. Then heat up and apply strip of ingot tin, and when tinned wipe all surplus tin off and plunge into hot clean water to remove the substances left by the tinning.

After the copper has been tinned, whether killed spirits or sal-ammoniac has been used, and the acids and other foreign substances have been washed in hot water, you will have to retin all round the inner edges, for a distance of $\frac{1}{2}''$ inside the turned-up portion, with strip alloy No. 1. Do not allow this metal to come in contact with any acids or any acids to come into contact with the job or metal after the tinning is finished in the first case.

When using the alloy strip you will find that it will need very little assistance from scraper to make it flow all round the previously tinned bottom. Clean all surplus metal from the corner after the flame is traversed around the edge, and allow to cool down.

When the bottom has cooled and the edge of the saucepan is tinned, put the bottom on and beat the edge of the bottom over on the lip of the sides; then continue to beat this edge over again, as in Fig. 4 (Lap Joints). Proceed to sweat the strip alloy all round the inside joint, dressing with the end of spatula as the metal is molten and rotating the pan in the flame, which should play outside. Do not keep the flame in one place too long, and after the whole joint has been traversed around, allow the pan to cool out. Fill up with clean cold water and bring this to the boil to remove from the inside all traces of foreign matter which may have collected. It is then ready for use.

Withdrawing Steel Liner from an Aluminium Casting such as an Internal Combustion Engine Cylinder, whether the Liner has been pressed in or the Outer Casing of Aluminium has been shrunk on.

Taking this as an example, the method is as follows: Place the cylinder on a couple of firebricks a few inches off the floor and end up. Light the lamp or blowpipe and direct the flame on the outer casing and travel all round as evenly as possible (remembering not to play the flame too long in one spot) until the whole is sufficiently heated and rather too hot for holding with the hands. This is about the heat that will turn a piece of white paper brown or black when placed on the aluminium, and I may mention here that this test is generally used when annealing or softening aluminium or zinc sheet in working up articles in these metals.

When the outer case has been tested for heat as mentioned, lower the flame and take the cylinder up with a piece of sacking, placing the whole in a vice, the sacking being left round so as to prevent the casing from getting damaged in the vice jaws.

Lightly secure so that it will not fall out of vice, and with a pair of tongs or pliers grip the lip of the liner and try to withdraw it from the casing. If it will not move, take it out of vice and heat again and replace in vice with the sacking still round. Take a chisel with a thin cutting edge and insert between the lip of liner and the outer case, and lightly tap the chisel with a hammer to get a start. It should not be necessary to use a chisel in every case, for if the outer case is heated correctly the liner should slip out easily and quickly, but on occasions it will stick at the start, and on other occasions it will stick half-way out. When a start has been made, the application of a little oil after heating at the joint of liner and case will help considerably. I have also used a piece of sacking previously damped (but not running with water) and placed inside the liner. This will assist when run round inside, as the cold water on the sack will cause the liner to contract and come away quickly. Where it is the case that the liner sticks, it will generally be found to be a case of slight rusting on the outside of the liner. A little oil will assist in its removal, but as a rule you should not have any trouble in this respect unless the cylinder has been laid on one side for a considerable length of time in a damp place.

Inserting a Brass Bush in an Aluminium Casting, applicable to the Machined Parts and in Cases where the Brass Bushes already in Place have become loose in working.

Take the bush out by pressing or drive it out with a small piece of hard wood and a hammer, previously placing a hard wood block with a hole sufficiently large for the bush to pass through behind the casting. When the bush is out, clean the hole of any dirt, grease, or oil by heating locally, as mentioned previously, and while the aluminium article is cooling down take the brass bush, whether an old one or a new one is to be used, and tin the outside and the edges with ingot tin and killed spirits. Allow it to cool off after washing away in hot clean water all traces of foreign matter; then reheat and retin with strip alloy, mentioned in previous article, without the use of any acids, afterwards scraping off any surplus metal to finish.

Then take up the casting and clean off any deposit from around and inside the hole and tin these parts with alloy No. 1, as mentioned under Tinning Treatment of Castings, etc. As the tinning progresses clean up behind the flame any surplus metal or oxide, and while this is in progress slightly warm the bush and place it in position. Put a piece of wood on the top of the bush and tap it smartly into its allotted place. When this has been done melt a little metal strip around the division between bush and casting and allow to cool; then turn over and see if the reverse side is all right; if not, melt a little strip metal on this side also. Scrape off any oxide or surplus metal and allow the job to cool down in the heat from the flame or blowpipe or lamp. When cold, dress off the edges with file or scraper.

General Remarks.

With regard to alloys mentioned in this book and the uses of sheet iron jigs and the reinforcement of parts with fireclay in the repair of aluminium castings, I have aimed at two objects—to offer a solution of the difficulties commonly met with in repairing aluminium castings, and to suggest methods which do this work effectively, thereby avoiding the necessity of replacing costly parts. It has often been remarked on that no satisfactory solder has been made for aluminium repair work. This is largely because the copper bit, commonly used in soldering other metals, cannot be employed with any success. I have not used the expression "soldering" aluminium in the above explanations as it would convey a wrong impression, suggesting to everyone accustomed to soldering other metals that the copper bit and fluxes were employed with aluminium also. When I first tried my hand, I naturally used the copper bit. The results were very disappointing. I found not only that I could not keep the heat to successfully melt the metal alloy to tin the surfaces for repair, but that the copper bit was being attacked both by the zinc and aluminium which pitted the end. The result was a combining of the zinc, aluminium and copper, to the formation of a very brittle brass end, owing to the amount of heat required to bring the copper bit to a temperature sufficient to melt the metal alloy. When this melted it was all oxidized, and would not take on any surface. Consequently the copper bit was useless for any other work until the end had been cut off and drawn out afresh.

With regard to sweating and burning with the use of jigs, I have found the methods which I have explained absolutely satisfactory. In the case of castings which have been repaired by these processes it has been found that in cases where these are subjected to pressure of oil under working conditions, they will stand upwards of 100 lb. per square inch, as for example in the case of aero engines. Moreover, if repairs to crank cases and sumps of these engines had not been satisfactory, the testing of the engines before actual use in the field would immediately have revealed any defect in the repaired part, as under working conditions these engines develop considerable oil pressure, heat and vibration. Any crack or break in the repaired part, therefore, would allow the oil to force its way through. Where a man's life depended on the running of the engine, it is safe to say that if any repaired part had shown any defects on test the article would have been scrapped without hesitation.

Whatever may be the composition of any casting, the operator may proceed with confidence, as anyone can make a successful repair by following the instructions I have given, always remembering that in loading up after sweating, where a jig of sheet iron is used for the burning process, you have a surplus of metal on the repaired part which can be left on for strengthening or can be machined or dressed off with files, etc., as desired.

Economy and effectiveness are always the main considerations when repairs are required, and my object in writing this brief treatise has been to put into the hands of those who may desire it sufficient practical information to enable them to execute these repairs soundly and cheaply, without the necessity of replacing the defective parts.

I trust that the foregoing instructions will be found useful and give the confidence necessary in undertaking the repair of aluminium and the other metals commonly used with it.

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