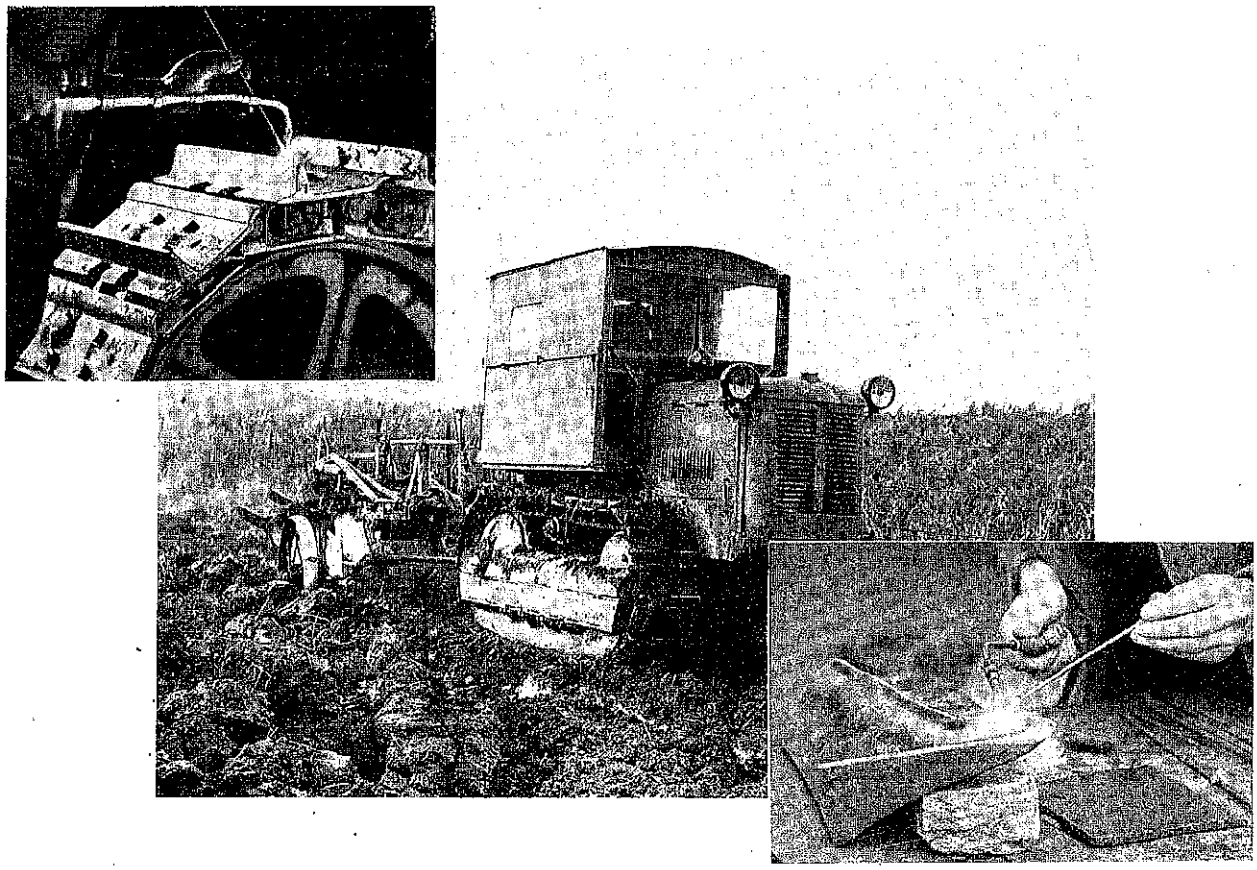
OXY-ACETYLENE WELDING

AND THE REPAIR OF

AGRICULTURAL MACHINERY



TECHNICAL INFORMATION BOOKLET No. 15

(FEBRUARY, 1948)

THE BRITISH OXYGEN Co LTD

HEAD OFFICE:

GROSVENOR HOUSE (6th Floor) · PARK LANE · LONDON · W·1

B.O.C. SERVICE

Customers are invited to make the fullest use of the efficient service provided by the Company for the supply of information and instruction. Application for assistance should be made through the nearest District Sales Office. The Company's principal instruction and demonstration centre is the Sales Technical Service Department situated at North Circular Road, Cricklewood, N.W.2. Comprehensive assistance in relation to every application of oxy-acetylene welding, cutting and other uses of industrial gases is placed at customers' disposal.
Some of the facilities provided by the B.O.C. Service organisation at Cricklewood are as follows :—

DEMONSTRATIONS

In addition to practical demonstrations of the use of the Company's products, there is a staff of experts in constant attendance who will be willing at any time to show customers or their operatives how any particular job should be carried out, what technique to adopt, what materials to use, what precautions to take, and what results to expect. Arrangements can also be made for the periodical visit of local service operators in any part of the country.
Demonstrations are also given to technical societies visiting the works by special arrangement.

TECHNICAL INFORMATION

Data sheets have been compiled covering a wide range of applications of the oxy-acetylene process. These give practical information in a clear and concise form for the operator.

LECTURES

The lecture theatre is equipped for showing films and slides, and in normal times regular lectures are given which are open to all who are interested in the Company's products and processes.

INSTRUCTION

One of the most important sections of the Service organisation is the welding and cutting instruction school which provides tuition for customers' operatives. Terms for instruction will be supplied on request. Films are shown to students to amplify the courses of instruction which are arranged, and there is an extensive library of instructional films and lantern slides which can be supplied on loan to technical schools, etc.

SHOWROOM

A representative selection of the equipment supplied by the Company is displayed in the showroom, together with specimens of work which have been produced by means of the oxy-acetylene, air-acetylene and kindred processes.

TESTING AND RESEARCH DEPARTMENTS

In addition to the comprehensive Service facilities outlined above, the Company maintains extensive laboratories which are well equipped with modern apparatus for metallography, X-ray examinations, chemical analysis and mechanical testing. A fully qualified staff, well experienced in all matters relating to welding materials and processes, is available, and all special enquiries and problems raised by customers can be referred to them by the B.O.C. Sales Service organisation.

OXY-ACETYLENE WELDING AND THE REPAIR OF AGRICULTURAL MACHINERY

The Farmer is fighting a never-ending battle against time and weather. In recent years he has been materially assisted by the extensive introduction of mechanical equipment to speed up his work, but this has in turn made him increasingly dependent on the serviceability of his machinery. For a large part of the year much of this machinery is lying idle, but during the period in which it is used it is absolutely essential to the farmer that it should be kept in operation with the fewest possible stoppages and delays; for in the continuous battle against the elements the loss of a few hours or days may mean the difference between a safely gathered harvest and a ruined crop.

But agricultural machinery is, by the nature of the job, subjected to very heavy wear, and is, through no fault in design or manufacture, liable to breakage. Two factors contribute to this: firstly owing to the fact that they are continuously working in earth and dirt, it is impossible to lubricate many of the parts which would in other machinery invariably run in oil or grease; secondly agricultural machinery consists largely of cast-iron, which is by nature comparatively brittle.

When spare parts were readily available the farmer's first thought was to buy a new part, and only if this could not be obtained would he consider repairing the old part. To-day, however, when replacements are uncertain, and often impossible, welding is playing an ever increasing part in the economics of agriculture. But even now the full possibilities of welding as applied to agricultural machinery are not always realised, and it is the object of this booklet to show that Oxy-Acetylene Welding has many more benefits to offer to the farmer, than merely that of being a stop gap when new parts are not available. For with full knowledge of the possibilities of Oxy-Acetylene Welding the farmer will realise that, not only can any piece of equipment from a pitchfork to a combine-harvester be repaired in a matter of hours, very often for less than the cost of a replacement, but that new equipment can be made to last much longer, and old, worn equipment be given a new lease of life. He will also understand that new equipment can very often be made up from scrap metal, again for a fraction of the cost of purchasing the new article, and in a fraction of the time required for its delivery.

It is, therefore, intended to explain in outline the various types of oxy-acetylene welding applicable to agriculture, and with the assistance of actual examples to show how these can be of real assistance to the farmer. It is not intended to give an exhaustive list of the possible applications of welding to the repairs of agricultural machinery, nor is it within the scope of this booklet to explain in detail the welding technique employed. The latter subject is dealt with at length in "The Oxy-Acetylene Welding Repair Manual" by Messrs. C. G. Bainbridge and F. Clark, listed at the back of this booklet; the former depends almost entirely on the ingenuity of the welder, for the scope of the oxy-acetylene welding blowpipe itself is virtually unlimited.

At the same time it must be stressed that welding is a skilled job. It is possible in the course of a few weeks to pick up the rudiments of the craft, but the production of the thoroughly efficient work, such as is essential in the case of agricultural machinery can only be guaranteed by considerable experience and constant practice. It is not, therefore, normally advisable for the farmer himself to undertake his own repairs, for it is unlikely that he will

have sufficient work to keep an operator properly in practice; and if an unskilled welder without all the proper equipment attempts to repair a complicated piece of machinery or intricate casting the results may well be disastrous. There are throughout the country firms of agricultural engineers, staffed by experienced welders, and provided with all the necessary equipment essential to successful welding, and the more extensive welding tasks should normally be undertaken by them; while simpler repair jobs in the field or workshops should, it is recommended, be entrusted to one of the fully trained welders who are now to be found in almost every agricultural district.

FUSION WELDING.

Fusion Welding consists of bringing the edges of the pieces to their melting point, and with the aid of a filler rod of similar metal, making the joint a homogeneous whole with the parent metal. As agricultural machinery is almost entirely constructed of steel, cast or malleable iron, discussion will be restricted to the fusion welding of these two metals.

Cast Iron.

There are three types of cast iron—grey cast iron, white cast iron, and malleable iron.

"Grey" and "White" cast iron are so named because of their respective colours when fractured. Grey cast iron has excellent all round mechanical properties and may be machined. White cast iron on the other hand is very hard and brittle. Malleable cast iron combines some of the properties of steel with some of those of cast iron. It comprises a layer of iron of low carbon content, in other words steel, around the outside of the casting which has all the malleability of steel without the low resistance to shock of cast iron.

"Grey" and "White" cast iron can be fusion welded, but malleable cast iron should under no circumstances be fusion welded as this will cause its favourable characteristics to be lost. Malleable cast iron can be distinguished from grey or white cast iron by the fracture which shows the outer skin clearly. It can also be distinguished by using a chisel on the surface : in the case of malleable iron a ductile chip can be formed whereas with ordinary cast iron the chip will be brittle and break off.

Preparation for Fusion Welding of Cast Iron.

The edges to be welded should be bevelled to an included angle of 90° on one side only for thicknesses up to $\frac{1}{2}$" and on both sides for greater thicknesses. This may be done by a hammer and chisel or by grinding.

Pre-heating is essential to the successful welding of cast iron for two reasons :—

(1) It is the only successful method of preventing cracks from appearing in the casting, either during or after welding.

(2) It ensures that the weld will cool down slowly, and so enable a strong, machinable deposit to be made, instead of a brittle deposit of white iron, which would result from rapid cooling.

Preheating.

The extent of pre-heating depends upon the type of article to be welded. Since one of the prime objects of pre-heating is to prevent strain, it is really only necessary to pre-heat at those points where the stresses are likely to be concentrated, and to make arrangements for the weld to cool down slowly. In practice, however, it is usually best to pre-heat the whole article and this can be done by the blowpipe itself for small jobs; for larger or more intricate structures, however, a pre-heating furnace is required, similar to the type shown in Figure 1.

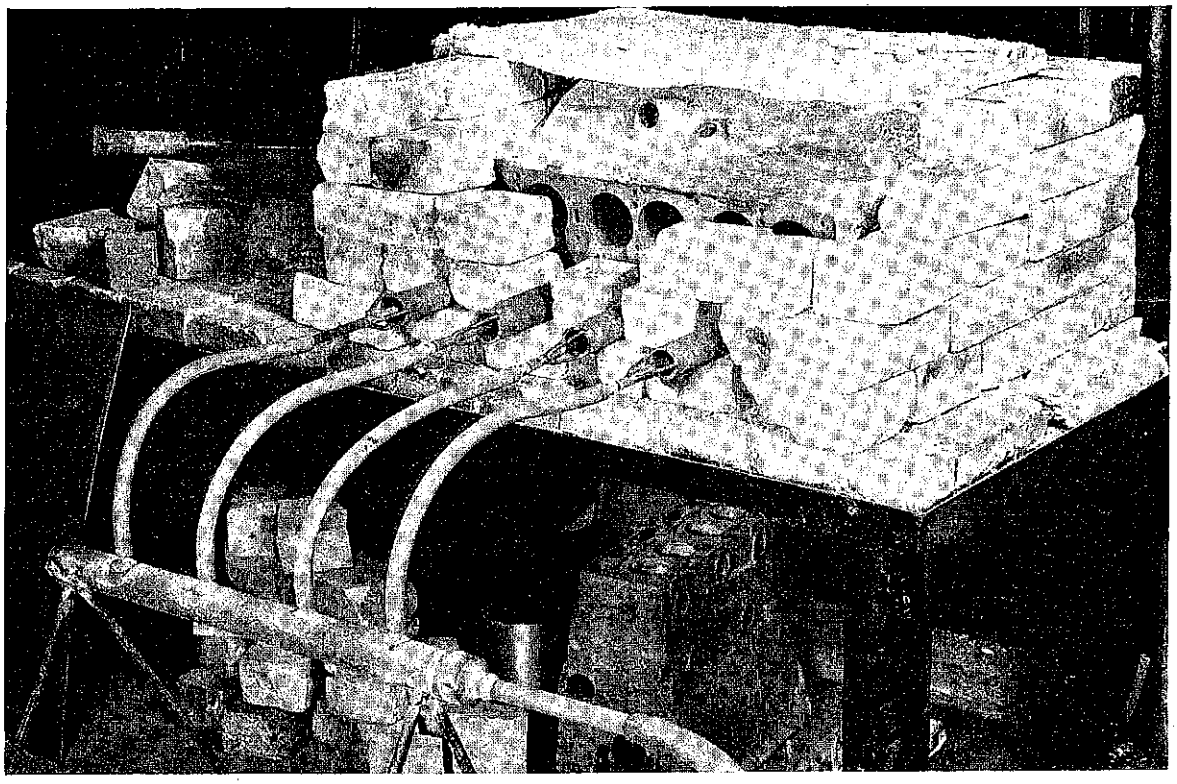


FIG. 1. PRE-HEATING FURNACE PARTIALLY BUILT UP FOR WELDING OF CAST-IRON CYLINDER BLOCK.

Cast Iron Welding Rods.

The British Oxygen Company, Ltd., produces three kinds of Welding Rod for the fusion welding of cast iron, each of which has been developed for a particular purpose. These are :—

Alda Super Silicon.
Alda Ferrotectic.
Alda Nicotectic.

Exhaustive tests have shown the strength of welds made with these rods, and when they are subjected to stress in excess of their strength the fracture invariably occurs in the parent metal and not in the weld itself.

Finishing the Weld.

When the weld has been completed it should be allowed to cool down as slowly as possible; if a pre-heating furnace has been used it should be allowed to cool down in here; if it is a small article it should be allowed to cool in a tub of ashes or cinders. Care must also be taken that there is no possible access for draughts or currents of air. Not only will rapid cooling affect the machinability of the weld, but it will probably cause fracture, either adjacent to the weld or in some other part of the casting.

These precautions outlined above, together with correct choice and manipulation of

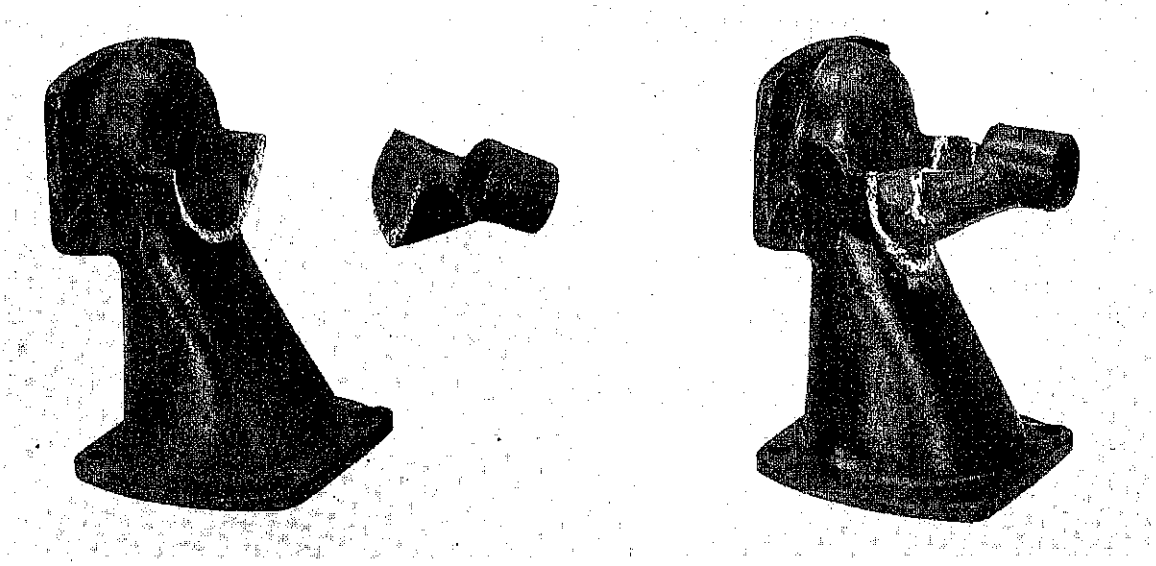


FIG. 2. BROKEN WATER PUMP CASTING OF A TRACTOR.

materials are essential to the successful fusion welding of cast iron. But if properly carried out fusion welding can be used for the repair of the most intricate castings, and the welded article will be entirely satisfactory for further service.

Examples of Fusion Welding of Cast Iron.

1. The water pump castings on tractor engines similar to that illustrated in Figures 2 and 3 are liable to breakage owing to rough usage. The casting illustrated was broken in two as a result of a knock. It was dismantled from the engine, repaired by fusion welding and back at work on the tractor within a few hours.

2. The axle brackets of ploughs are also susceptible to damage, and replacements are difficult to obtain. Their repair by fusion welding, however, is a straightforward job which can be carried out, with a pre-heating furnace, in a very short time. A typical example of a fractured axle bracket before and after welding is shown in Figure 4. The hole in this case can be preserved by the insertion of a carbon plug.

3. Figure 5 shows the Knotter Frame of an American type Reaper Binder. This had been shattered when the binder fell off a lorry, rendering the machine useless. Time was vital in this case as the machine was wanted for harvesting. The machine was dismantled and the broken parts taken to an agricultural engineer who, using both fusion welding and bronzewelding, repaired the Knotter Frame within twenty-four hours, so that the binder was at work again next day.

Steel.

Steel is the most readily weldable of all metals, but as it is also one of the strongest and most resistant to hard treatment, there

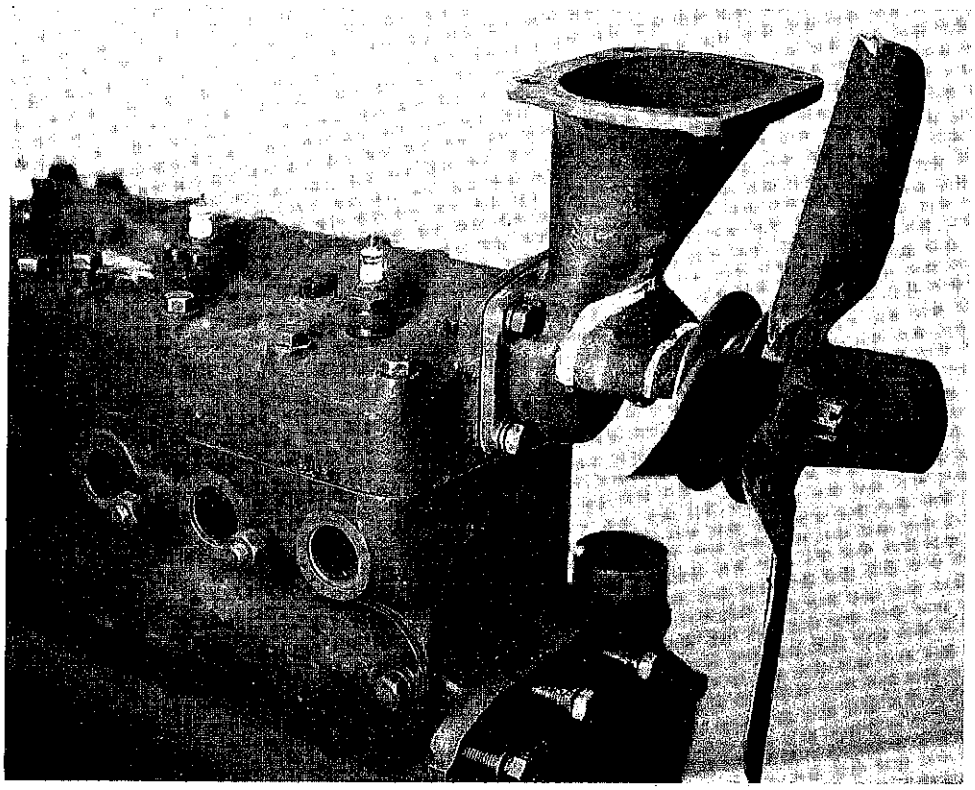


FIG. 3. TRACTOR ENGINE WATER PUMP CASTING REPAIRED BY FUSION WELDING.

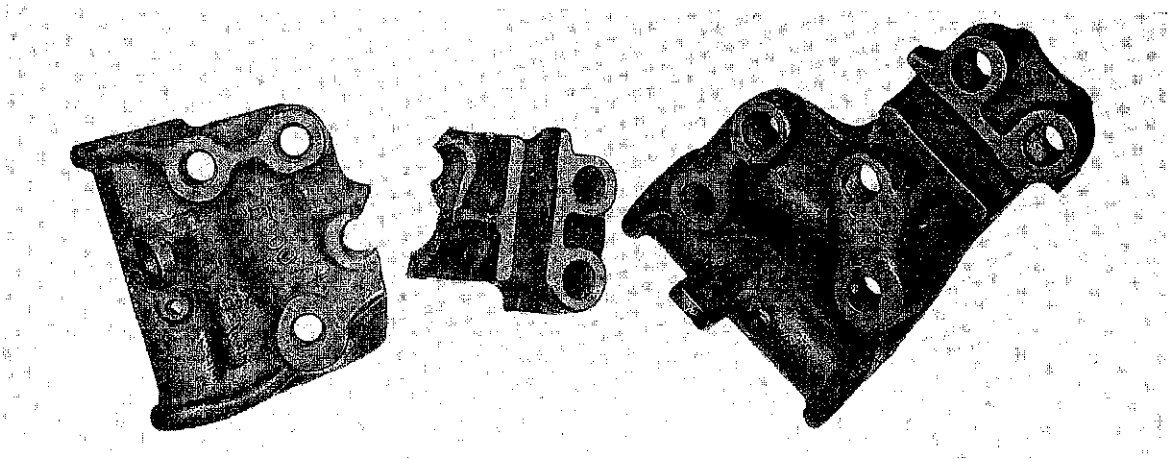


FIG. 4. FRACTURED CAST IRON AXLE BRACKET OF PLOUGH BEFORE AND AFTER FUSION WELDING.

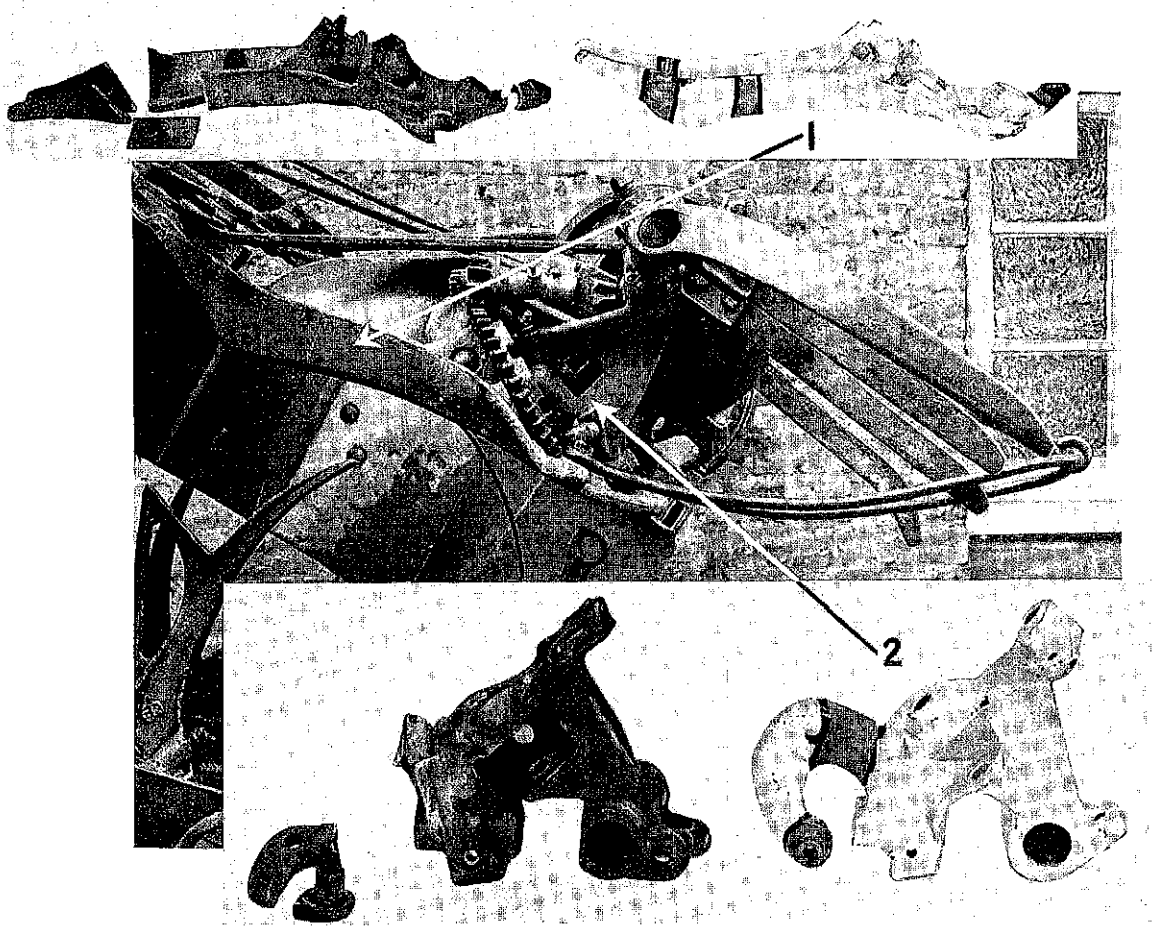


FIG. 5. THE SHATTERED CAST-IRON PARTS OF A REAPER BINDER KNOTTER FRAME.
THESE WERE REPAIRED BY FUSION WELDING AND BRONZEWELDING.

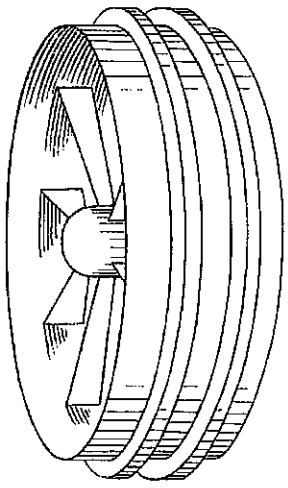
is not a great demand for welding repairs to the steel parts in agricultural machinery. Apart from simple repair work, however, the welding of steel has other important applications as far as agricultural equipment is concerned, the chief of which are the rebuilding of worn parts and the fabrication of new equipment from steel sheet or scrap with the assistance of the oxygen cutter.

Welding in the Repair and Rebuilding of Steel Parts.

The repair of broken steel parts by welding is a straightforward business, presenting no difficulties to the skilled operator, and the farmer need have no fears that any steel article which suffers damage cannot be successfully repaired.

When equipment breaks and the broken part is lost, a new part can very often be made by cutting a piece out to shape from steel plate and welding it into place. When equipment wears down to such an extent that it is no longer usable the worn part can be conveniently cut out by the cutting blowpipe and a new section, having been cut to shape can be welded in. A good example of the possibilities of welding when coupled with ingenuity on the part of the operator, is provided in the case of the idler wheels of a certain make of track-type tractor. The tracks on this type are carried by idler wheels having two parallel rims, as shown in Figure 6. These rims wear out quickly, and instead of being flat at the top are worn to a point. Replacement is expensive and not always possible, and any way the rest of the wheel is still perfectly serviceable. They can, however, be repaired in the following manner. The rims are removed either by the oxy-acetylene cutting blowpipe or grinding. A piece of mild steel strip is cut to the appropriate length, and is welded round the wheel to form a new rim, being bent in place by the heat from the blowpipe. A layer of Wear Resisting Alloy Steel or Stellite—(see pages 21-25) is then deposited on this new rim with the blowpipe, with the result that it will last, perhaps, ten times longer than the original rim.

THE IDLER WHEEL SHOWING RIMS BEFORE WEAR.



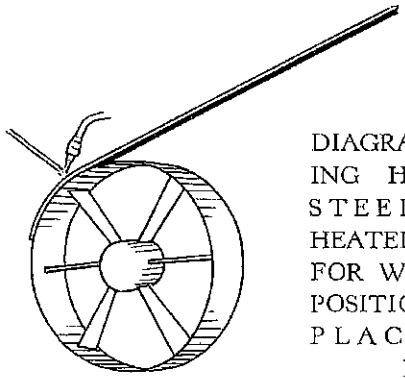


DIAGRAM SHOWING HOW MILD STEEL BAR IS HEATED TO SHAPE FOR WELDING IN POSITION TO REPLACE WORN RIMS

FIG. 6.

Further examples of this type of repair are shown in Figures 7 to 11.

If the growser plates of tractor tracks become worn new plates can easily be cut from mild steel and welded into place, and the broken frames or steel tractor wheels can be similarly replaced.

Welded Fabrication of Agricultural Equipment.

It is in the field of fabrication that the fullest scope is given to the imagination and ingenuity of the welder, for in the welding and cutting blowpipes he possesses two tools which are capable of almost unlimited application in work on steel. At least one farmer has even constructed a large barn entirely by welding out of material purchased from various sources. While illustrating the true versatility of oxy-acetylene welding, this particular example is not, however, generally to be recommended, as the results of inexpert design and construction will not always be as successful as this, which has already stood up to severe tests of weather, including extremely heavy snowfalls.

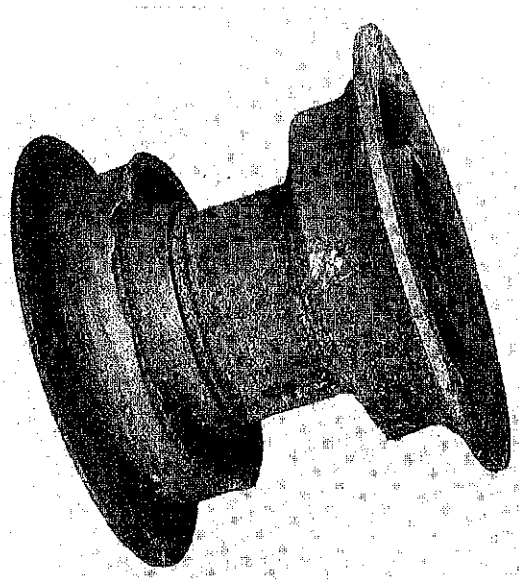


FIG. 7. DIESEL CATERPILLAR 50 TRACK ROLLER SHOWING CHIPPED PIECE AND WEAR.

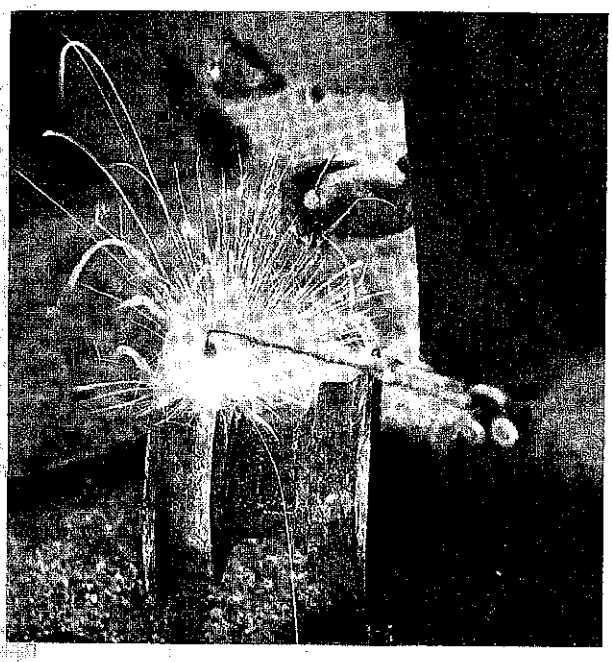


FIG. 8. WELDING ¾" BAR IN POSITION ON DIESEL CATERPILLAR 50 TRACK ROLLER.

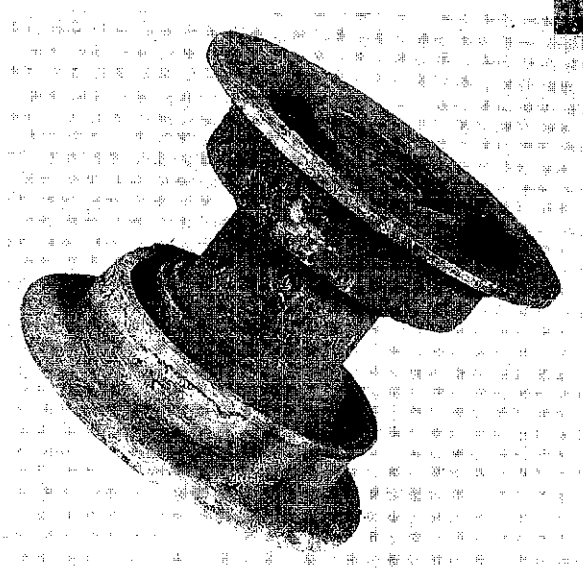


FIG. 9. MILD STEEL BAR WELDED IN TO REPLACE CHIP IN DIESEL CATERPILLAR 50 TRACK ROLLER.

REPAIR TO DIESEL CATERPILLAR 50 TRACK ROLLER.

A piece was chipped off this track roller and the face was deeply worn. To replace the chipped piece a length of ¾" square Mild Steel Bar was welded into position, and the whole side was built up with Wear Resisting Alloy Steel Rod. It is common for these rollers to be worn on one side of the face only: this is caused by the sprocket being slightly out of line.

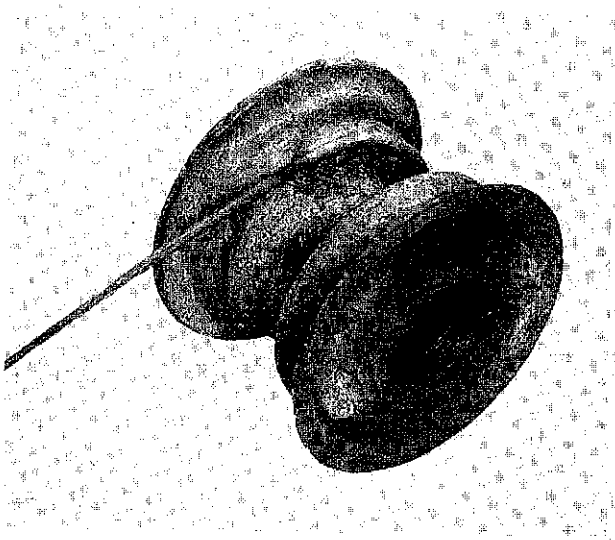


FIG. 10. WORN TRACK ROLLER SHOWING ¼″ MILD STEEL ROD PARTIALLY WELDED IN POSITION.

FIGS. 10 AND 11. REBUILDING OF WORN TRUCK ROLLER.

This track roller was worn on one side only—too thin for immediate building up: this wear is clearly shown in Figure 10. A piece of ¼″ Mild Steel Rod was tacked and welded on to the worn edge and final welding runs were laid down on this backing to build up the worn surface in two stages.

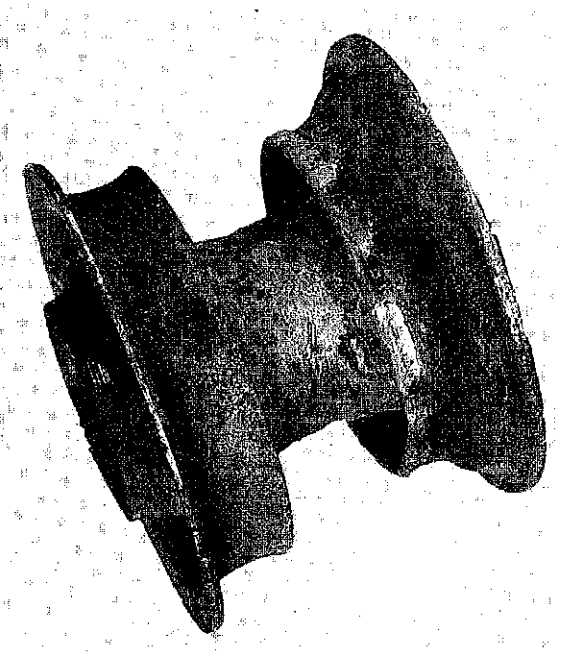


FIG. 11. TRACK ROLLER WITH ¼″ MILD STEEL ROD WELDED ON TO THE WORN EDGE.

Figure 12 shows a set of gates which were made up from scrap tubing purchased from Government sources and fabricated by oxy-acetylene welding. These 12 ft. gates were made up and put in place in one day for the cost of a few shillings. The farmer in question wanted 12 ft. gates to replace his narrower wooden gates in order to make it easier for his tractors to turn in and out of the road to the fields. Not only are they cheaper than wooden gates, they are also considerably lighter. This farmer has already had several sets of gates made up to this pattern and also a length of fencing, and is so satisfied that he proposes to replace all his farm gates by steel ones made up in this fashion.

Another example of the versatility of gas welding is shown in Figure 13. This trailer was made up from an old petrol tanker purchased from Government sources: the petrol tank was removed and pieces of angle-iron were cut to length by the hand-cutter and welded into place to form the sides of the platform. The traverse of the front wheels

FIG. 12. FARM GATES FABRICATED BY OXY-ACETYLENE WELDING. MILD STEEL TUBING WAS USED FOR THESE GATES.

of the trailer was restricted, owing to the position of the springs, but this was altered to give a 360 traverse and the draw bar was lowered to prevent the wheels being pulled into the ground, by cutting out a piece of $\frac{1}{2}$" mild steel plate to shape with the oxy-acetylene hand cutter, cutting the necessary holes for the fastening of the draw bar (again with the oxy-acetylene hand cutter) and welding it into place.

BRONZEWELDING.

Long before the days of the oxy-acetylene blowpipe it was known that a continuous metal-to-metal joint could be obtained by the use of certain low melting point alloys, which produced a sound but relatively weak bond. With the advent of the oxy-acetylene flame fusion welding became possible, enabling joints to be produced "in situ" without general heating, of a strength equal to that of the parent metal. For certain purposes, however, the high temperature necessary for fusion welding produces complications in the way of expansion, distortion, or as in the case of malleable cast iron, the loss of certain characteristic properties, or the burning off of protective coverings. These drawbacks have been overcome by the development of bronzewelding.

Bronzewelding makes use of the concentrated heat of the oxy-acetylene flame to localise the area brought to welding temperature and to achieve perfect control of the parent metal. It also takes advantage of the fact that copper-zinc and copper-zinc-nickel alloys will make a sound bond on copper, steel and cast iron

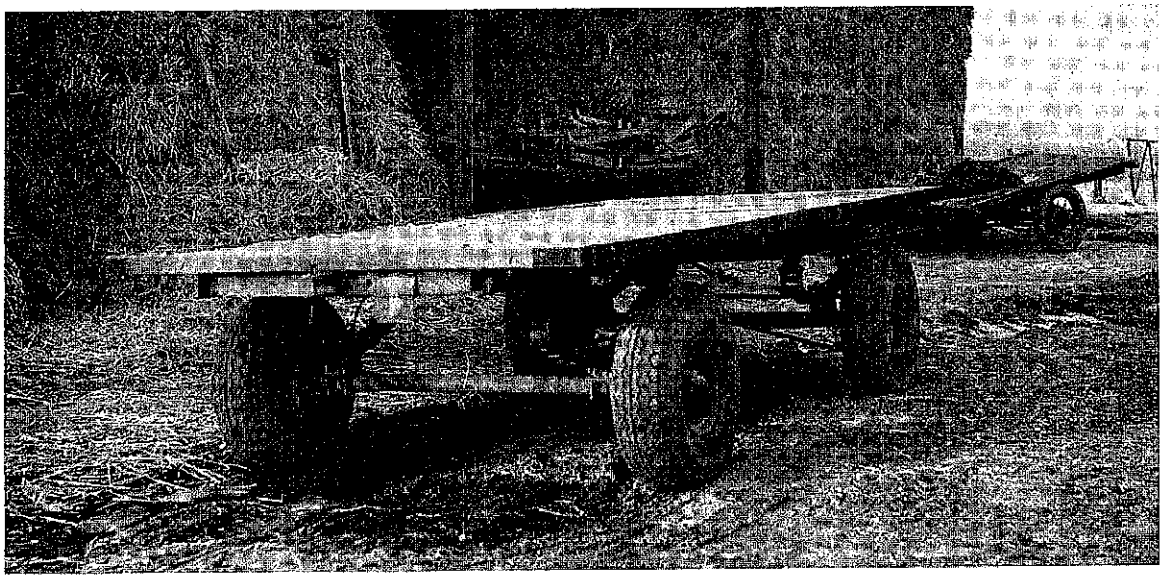


FIG. 13. AN EX-R.A.F. PETROL TANKER CONVERTED INTO A FARM TRAILER WITH THE ASSISTANCE OF OXY-ACETYLENE WELDING AND HAND CUTTING.

at temperatures of 800°—900°C., i.e., well below the melting point of these metals. In this way high tensile joints are produced on a wide variety of metals with a minimum of heat.

For bronzewelding, special filler rods are used which have progressed a long way from the brazing spelters on which they are based. By the scientific balance of special ingredients these rods will deposit metal of high tensile strength and produce a thoroughly sound bond. The British Oxygen Company Ltd., produces three such rods, and also special fluxes, which are graded according to the duty for which they are intended, and the metal to which they are to be applied. These rods are :—

Brazotectic (Silicon Bronze) : Recommended for the bronzewelding of brass and copper sheet, galvanized iron, etc.

Brazotectic (Nickel Bronze) : Recommended for the bronzewelding of steel or malleable iron where the highest mechanical strength is required, for gear teeth, etc.

Brazotectic (Manganese Bronze) : Recommended for the general bronzewelding of cast or malleable iron, also for the building up of worn surfaces. Particularly useful for the repair of cast iron frames, lugs, brackets, gear teeth, etc., on site.

If bronzewelding is properly carried out, the resulting joint will be found to be equal to, and in the case of cast iron greater than, that of the parent metal. The overall strength of the bronzewelded joint is, of course, entirely dependent on the soundness of the bond between the bronze and the parent metal, and to ensure a sound joint it is absolutely essential that the metal to be welded be thoroughly clean. This can be achieved by the grinding or filing not only of the edges to be welded, but of the metal in the immediate neighbourhood of the weld. The joint between the bronze and the parent metal has a very high shear strength, and full advantage must be taken of this in order to obtain the maximum strength from the weld ; this means that an excess of bronze must be left on top of the weld, and in no circumstances should this be ground off.

The lower temperatures required for bronzewelding result in an economy of gas consumed, a reduction in the amount of preheating required, and a lessening of contraction stresses in the joint. These advantages, together with the fact that cast and malleable iron, steel and galvanised iron can all be readily and satisfactorily joined by this method, often in situ and without the need for dismantling which might have been required had fusion welding been used, combine to make bronzewelding the most useful application of welding to the farmer and agricultural engineer, both for the repair of broken parts, and for the rebuilding of surfaces subject to excessive wear.

Bronzewelding Steel.

Bronzewelding is often made use of for steel in cases where it is necessary to avoid putting more than the minimum of heat into the work. It is very useful for certain jobs in thin sheet where fusion welding has been found to produce excessive distortion, and it can also be used to advantage where a thin portion is to be joined to a thick, or where a repair job is to be carried out in situ and the spread of heat would cause difficulties. It is also recommended for joining steel to cast iron. Two examples will show the possibilities of this last application.

A cast iron tractor sump casing was fractured by a piston failure and a piece approximately 4″ by 6″ was missing. The edges of the fracture were cleaned and bevelled and a piece of mild steel plate was cut out with the hand cutter to replace the lost piece from the sump. The casing was then pre-heated to a suitable temperature and the steel plate was bronzewelded into position. The casting was then allowed to cool down slowly and a perfect joint resulted.

The inner shoe of the cutter bar of a grass mower was broken, and the fractured part lost. Once again the cast iron main part of the shoe was ground to a regular shape, and a piece of mild steel, cut to shape by the oxy-acetylene hand cutter, was bronzewelded into place with the result shown in Figure 14.

Bronzewelding Cast Iron.

Bronzewelding of cast iron is chiefly used for the repair of broken castings and the rebuilding of such parts as broken gear teeth, and there are few articles in any sphere of industry too large or too complicated to be repaired by this process.

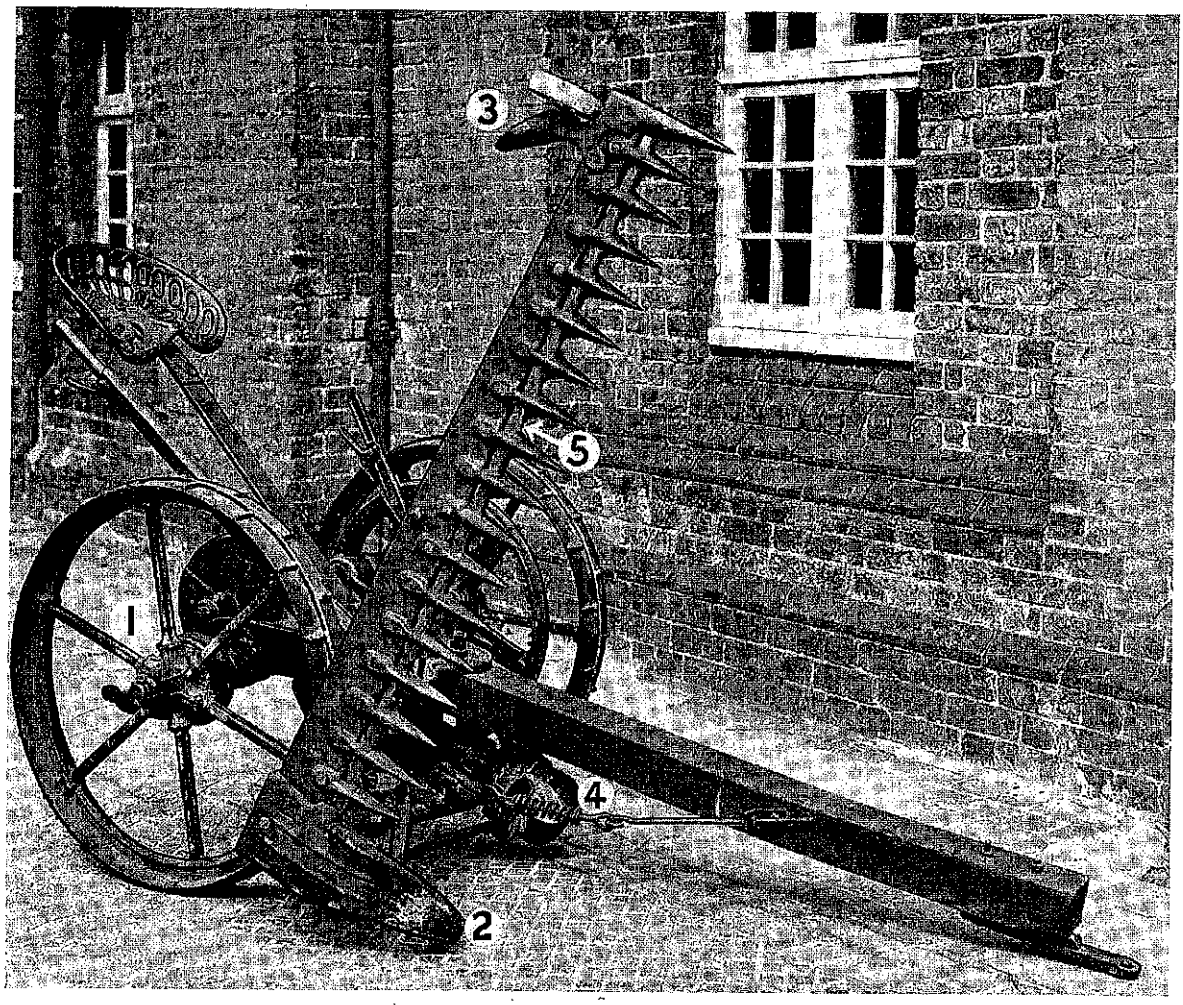


FIG. 14. BRONZEWELDING REPAIRS TO GRASS MOWER.

(1). MAIN WHEEL SPOKE ENDS WELDED TO BOSS.
(2). CUTTER BAR INNER SHOE WITH MILD STEEL REINFORCEMENT
(3). CUTTER BAR OUTER SHOE REPAIR TO SWATHBOARD BRACKET.
(4). FLY-WHEEL GUARD REPAIRED.
(5). CUTTER BAR FINGER WINGS BUILT UP.

As has already been said, owing to the lower temperature involved in bronze-welding it is often possible to carry out a repair without dismantling the machinery. The experienced welder will be able to decide whether it is necessary to dismantle the part, but if it is, the casting should be heated carefully to a uniform temperature of about 450°C, and on completion of the job it must be allowed to cool down slowly again in the furnace.

A bronzewelded joint on cast iron when properly carried out has excellent mechanical properties, and the perfect bond between the bronze and the cast iron may be seen from the micrograph in Figure 15. Such a joint has extremely high tensile strength and when tested to destruction will fracture in the parent metal outside the weld.

FIG. 15. BRONZEWELDED CAST-IRON, SHOWING PENETRATION OF BRONZE WELD METAL INTO CAST-IRON — × 200.

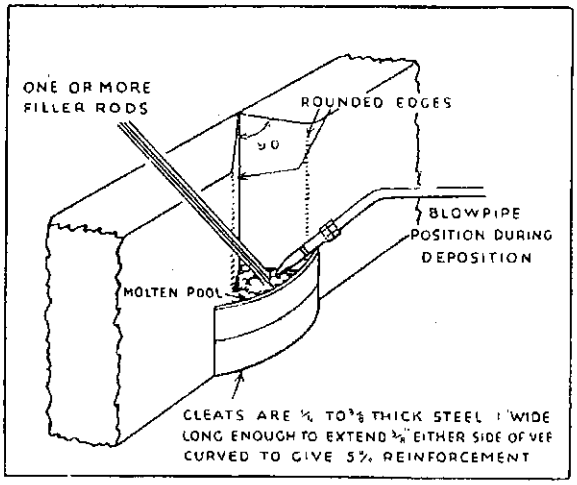


FIG. 16. CLEAT METHOD OF BRONZEWELDING.

Heavy sections may be vertically bronze-welded by the cleat method. The metal is deposited into a series of cups formed by steel cleats placed across the welding vee. These control the metal so that a larger blow-pipe can be used, increasing the speed of working on sections of 1" and over, where otherwise it is hard to avoid spilling the molten bronze; they also add to the strength (Figure 16). There is little likelihood of bronzewelding being required on cast iron of this thickness in agricultural machinery, but this will serve to illustrate that there is also little likelihood of there being any piece of agricultural machinery that cannot be easily repaired by bronzewelding.

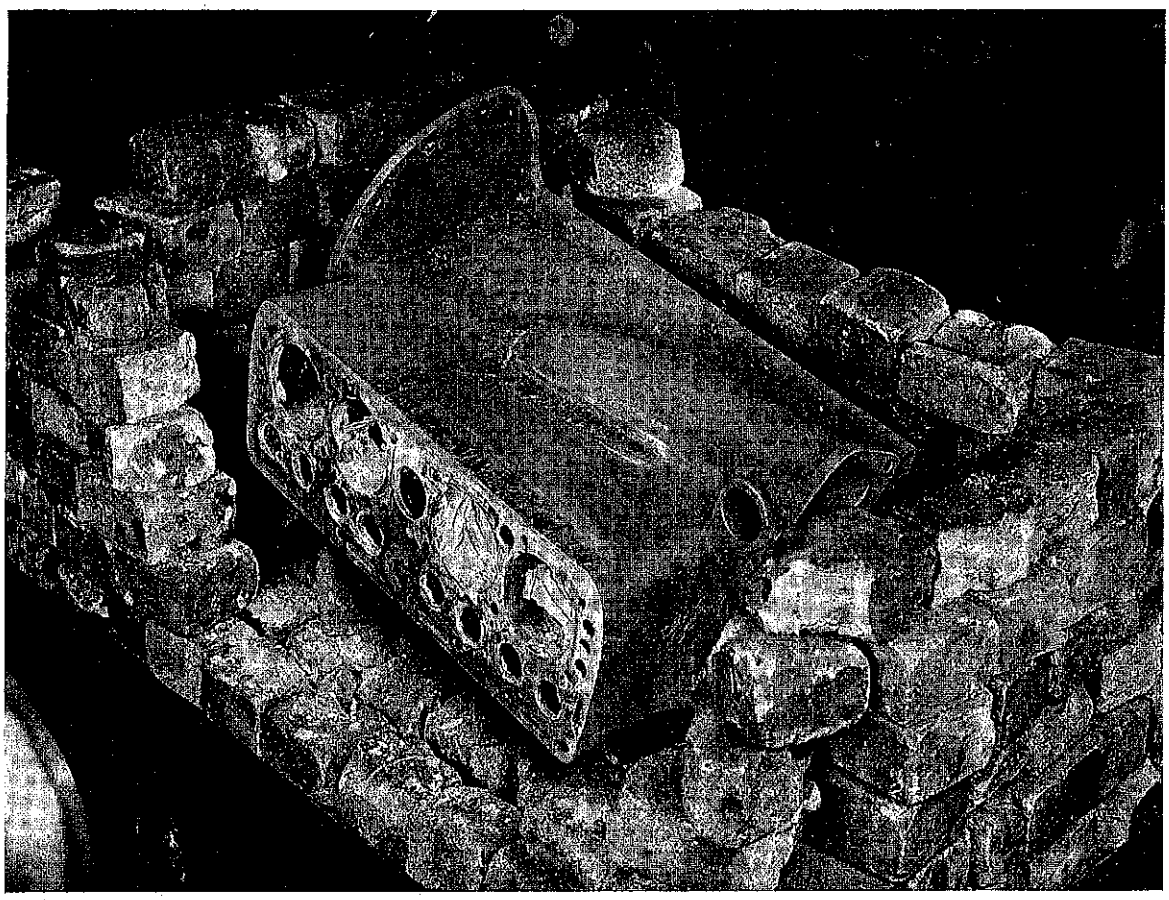


FIG. 17. CRACKED TRACTOR CYLINDER BLOCK REPAIRED BY BRONZEWELDING.

Bronzewelding is also recommended for joining galvanised sheet, and should be used for the repair of feeding troughs, drinking bowls, etc. The fact that bronzewelding is carried out at a lower temperature avoids burning off the galvanising which results from fusion welding, and so if the weld is properly carried out, the corrosion resisting properties of the sheet will not be impaired.

Examples of the use of bronzewelding in the repair of agricultural machinery are very numerous, and there can be few farmers who have not at some time or another had a broken part made fully serviceable again by this method. One of the most frequent applications of bronzewelding is in the repair of cracked cylinder blocks of all types (Figure 17), while Figure 14 shows some of the cast iron parts on a grass mower, all of which are more or less susceptible to breakage, which have, at one time or another, been repaired by bronzewelding over a period of years.

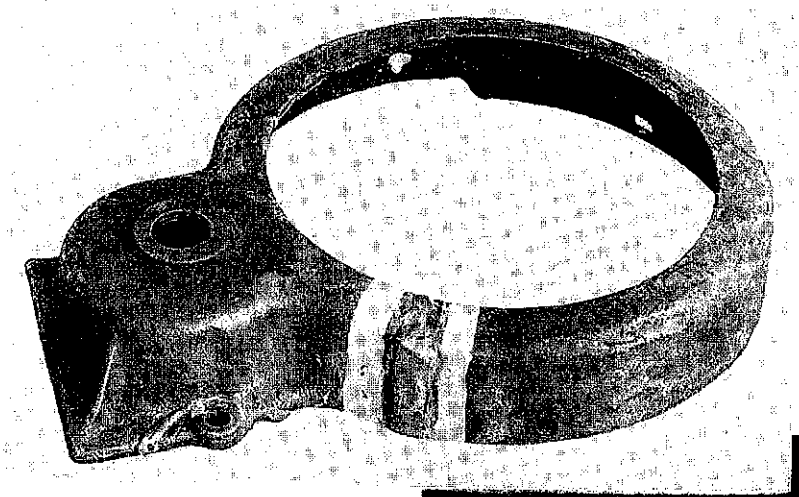


FIG. 18. GEAR WHEEL COVER OF AMERICAN TYPE REAPER BINDER REPAIRED BY BRONZE-WELDING.

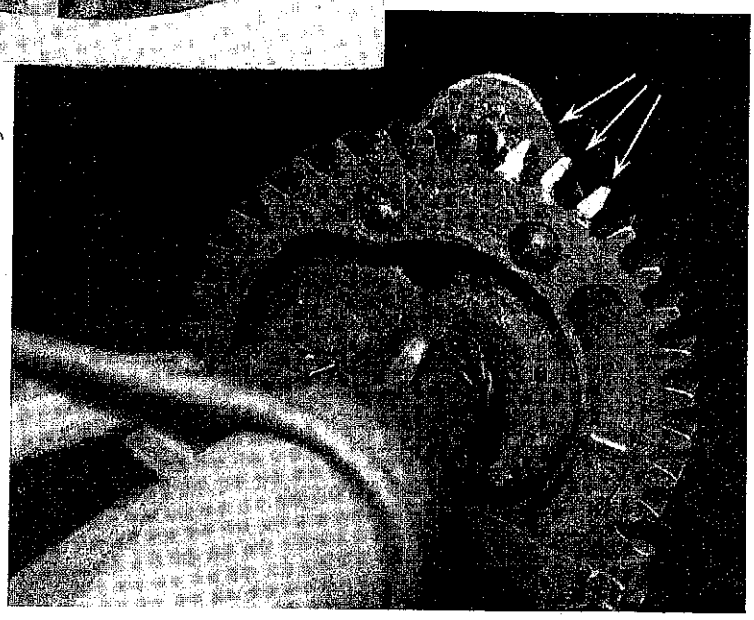


FIG. 19. THREE BROKEN TEETH ON KNOTTER GEAR WHEEL OF AMERICAN TYPE REAPER BINDER REBUILT BY BRONZEWELDING.

THIS URGENT REPAIR WAS CARRIED OUT IN UNDER ONE HOUR. THE TEETH WERE REPAIRED IN 1944 AND HAVE BEEN IN SERVICE EVER SINCE WITHOUT CAUSING ANY FURTHER TROUBLE.

Another reaper binder of the type already illustrated in Figure 5 was twice put back into service after breakages, thanks to bronze-welding. On one occasion the cast iron cover of the gear-wheel of the knotter was fractured. For a short time an attempt was made to continue harvesting without the cover, but this proved impossible, and so the cover, having been dismantled was repaired by bronzewelding, pre-heating being supplied by the blowpipe itself (Figure 18). On another occasion three teeth were torn off this gear wheel, and the machine was, of course, put completely out of action; to dismantle the gear-wheel and replace it with a new one would have taken twenty-four hours, even if a wheel had been available, a serious delay in the middle of the harvest; but by bringing an oxy-acetylene welding plant out into the field, and (after removing

the gear cover), building up the three teeth by bronzewelding and subsequently filing them down to shape, the whole job was done and the machine was at work again in one hour. (Figure 19).

Gearbox selector forks are often made of aluminium bronze. They cannot, therefore, be repaired with the standard bronzewelding rods or flux, or the normal bronzewelding technique. A special aluminium bronze welding rod and flux (ALDA Aluminium Bronze) are available for this purpose, and these should be used in conjunction with an excess acetylene flame.

Special care must be taken with this material to ensure that the edges to be welded are clean, but even so welding may be somewhat difficult, and the resulting weld will not have quite the same neat appearance as is obtained with ordinary bronzes. It is desirable to overbuild the worn part considerably to allow for trimming.

Rebuilding of worn Surfaces by Bronzewelding.

The front axles of certain types of tractor wear down with use and are liable to break. Bronzewelding is frequently used for the repair of these on breakage, and it is also used to build up the worn surface, thus avoiding the necessity for a replacement when the wear becomes excessive; for when this has worn down, it can in turn be built up again by further bronzewelding. Other parts which are suitable for rebuilding by bronzewelding when worn are, for instance, the steering quadrants of tractors, the engaging sections of hay rake drive plates, worn cycle bar guides and guards of reapers, the throws in the shaker shafts of threshing machines and sprockets and gears of spreaders, to name but a few.

When Bronzewelding is used for the rebuilding of worn steel shafts Brazotectic Nickel Bronze Rod is recommended. But it is important to remember that where the shaft works in a brass bush this procedure should not be adopted. In this case a 3½% Nickel Steel Rod should be used.

But while it will thus be appreciated that bronzewelding is capable of very wide application, and while it is agreed that it is a popular method of repair among welding engineers, because of its ease and economy of operation it must be stressed that, particularly in the case of cast iron it is extremely important that bronzewelding should be carried out in accordance with certain very clear principles, and with the proper equipment. An inexperienced welder, or an ill-equipped operator, however great his skill, will not be able to make a successful bronzewelding repair on an intricate casting. But there are firms who specialise in the repair of cast iron structures and who have the full equipment and experience necessary for such work. If difficult repairs are left in their hands the farmer will find that almost any piece of cast iron equipment can be put back into operation to give fully satisfactory service for an indefinite period.

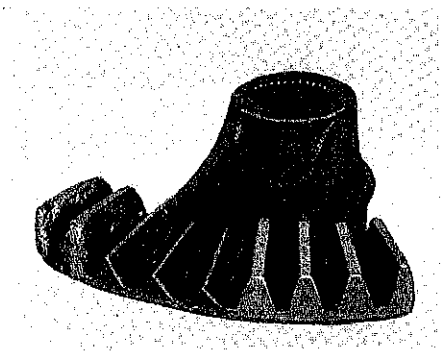


FIG. 20. THE WORN TEETH OF A TRACTOR'S STEERING QUADRANT REBUILT BY BRONZEWELDING. TEETH ON RIGHT HAVE BEEN REBUILT AND FILED TO SHAPE. THOSE ON LEFT HAVE NOT YET BEEN GROUND. THOSE IN CENTRE SHOW WEAR PRIOR TO REBUILDING.

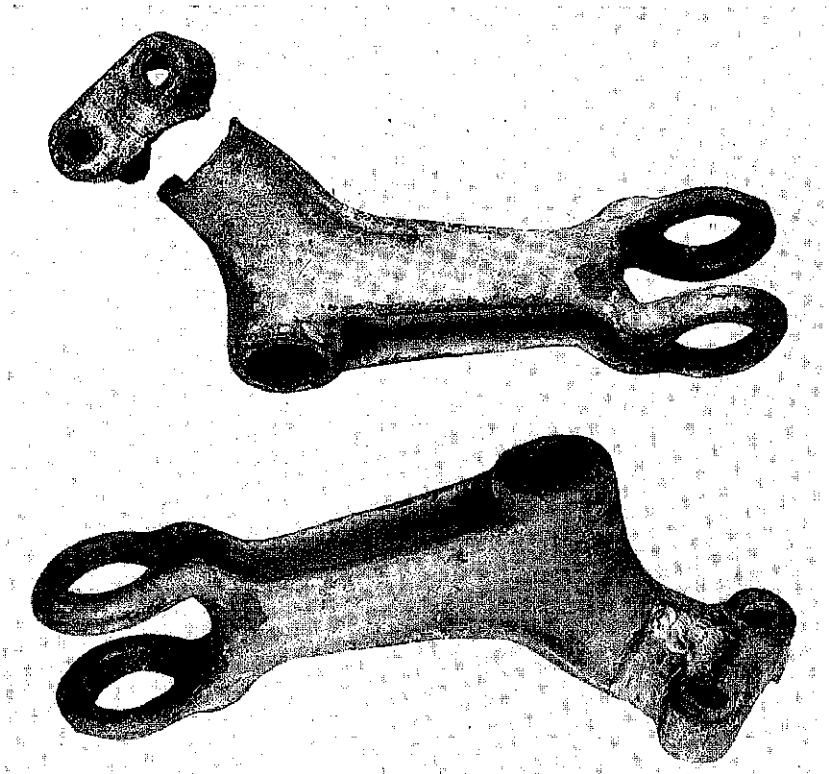


FIG. 21. BRONZEWELDING REPAIR TO THE ARM ON THE FURROW AXLE FOR THE FURROW LIFT OF A PLOUGH.

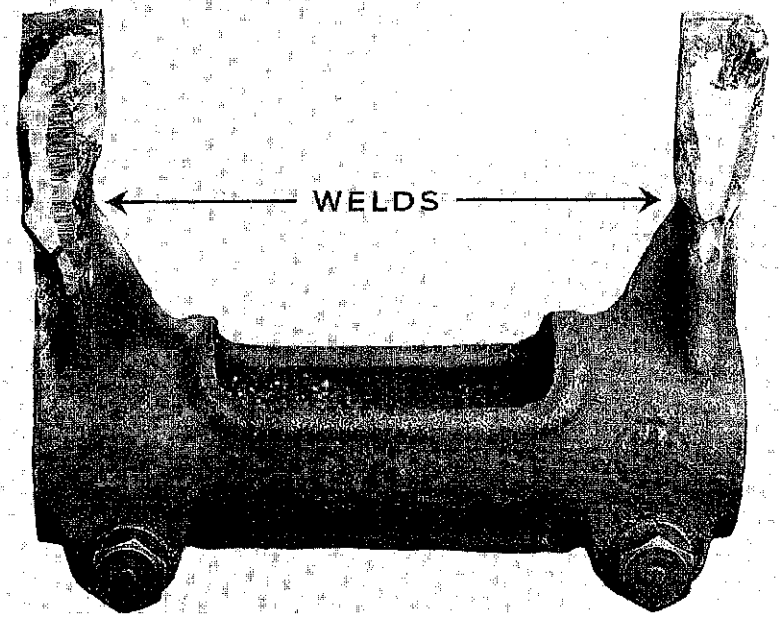


FIG. 22.
STEERING CLUTCH RELEASE OF AMERICAN TYPE TRACTOR AFTER REPAIR BY BRONZE-WELDING.

HARD FACING OF SURFACES SUBJECT TO EXCESSIVE WEAR.

If the methods to be described in this section are used on new equipment, its life will be extended very considerably before signs of wear are shown, but they can equally well be applied to old and already worn equipment, thus giving it a new lease of life and returning it to its former efficiency.

Mention has already been made of the fact that owing to the severe conditions under which it works, and owing to the enforced lack of lubrication on many parts, farm equipment is subjected to very heavy wear. This can be overcome and the service life of the equipment materially extended by the deposition of Hard Facing Materials onto the wearing parts, by the oxy-acetylene blowpipe. It should be noted, however, that in the case of equipment already excessively worn it is not economical to build up the whole of the worn portion with high grade and expensive surfacing metals : a lower grade wearing impact-resisting metal may be used for building up to approximately the original shape, on top of which a thin layer of Hard Facing Material should be deposited.

Two principal welding rods are recommended by The British Oxygen Co., Ltd., for use as Hard Facing Materials namely, Stellite and Wear Resisting Alloy Steel.

1. Stellite.

This material is a mixture of tungsten and other carbides carried in a matrix of cobalt. Stellite is extremely resistant to corrosion and abrasion and retains these properties at red heat. Three grades of Stellite are normally used, Grades 1, 6 and 12. Grade 1 is the hardest but most brittle and Grade 6 is the toughest. Grade 12 is recommended for the

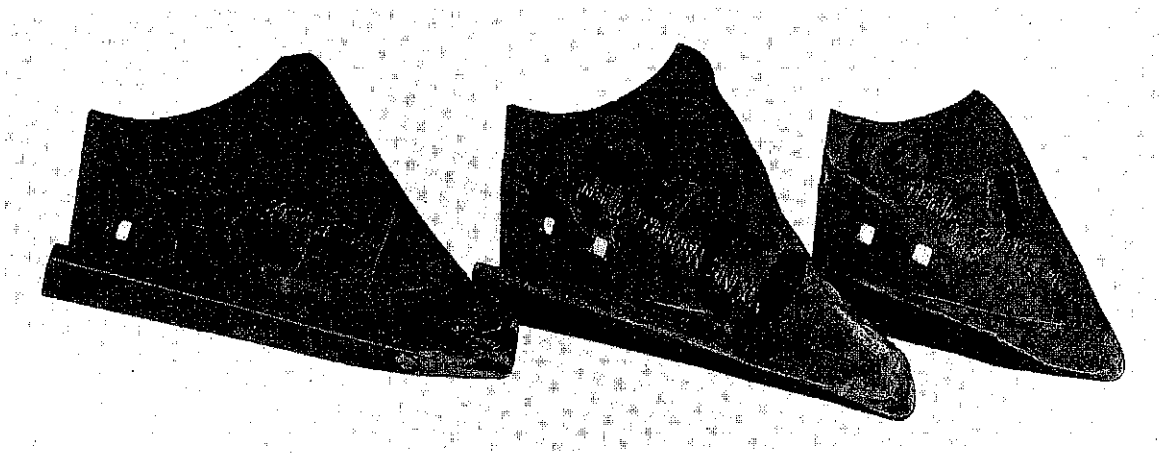


FIG. 23. STELLITING OF STEEL PLOUGHSHARES FROM M.M. PLOUGH.

LEFT : STELLITED SHARE AFTER PLOUGHING SOME 25 ACRES OF LAND.
CENTRE : NEW STELLITED SHARE BEFORE USE.
RIGHT : UNTREATED SHARE WHICH PLOUGHED THE SAME ACREAGE AS ONE IN CENTRE.
N.B. THE ONE IN THE CENTRE CAN BE RE-SHARPENED AND RE-STELLITED.

treatment of surfaces which are subjected not only to abrasion but also to shock. All grades should be provided with a well supported bed of either steel or cast iron. The deposit should be thin, generally 1/16" being sufficient.

Grade 1 is recommended for such articles as ploughshares, mill grinder plates and teeth, rocker arms, cams, etc.

Grade 6 is suitable for wood cutting tools, valve seats, etc.

Grade 12 is recommended for knives for cutting metal, tractor caterpillars, hammers, shovels, etc.

The normal life of a steel ploughshare is strictly limited, and under conditions of hard ground considerable signs of wear may be evident after ploughing as little as 5 acres. If a layer of stellite is deposited on the cutting edge of the steel share, however, little wear will be seen after ploughing 25 acres. It is recommended that the share should be used for two or three hours and that it should then be removed for the Stellite to be deposited as shown in Figure 24.

The advantages of extending the life of a ploughshare need no explaining to the farmer at the present time when ploughshares are in short supply. Moreover even after the stellited share has started to show signs of wear it can be removed again for the deposition of another layer of Stellite. This can be done several times before the share becomes otherwise unserviceable, so that its life may be extended many times at a very low total cost. It should however be noted that for technical and economical reasons the Stelliting of cast iron ploughshares is not recommended.

The growser plates of track type tractors wear down very quickly, especially if the machine has to do any road work, thus considerably reducing their efficiency.

And again as soon as signs of wear appear another layer of stellite can be deposited. A layer of stellite is also deposited on top of the

FIG. 24. DEPOSITING STELLITE ON THE WEARING SURFACES OF A STEEL PLOUGHSHARE.

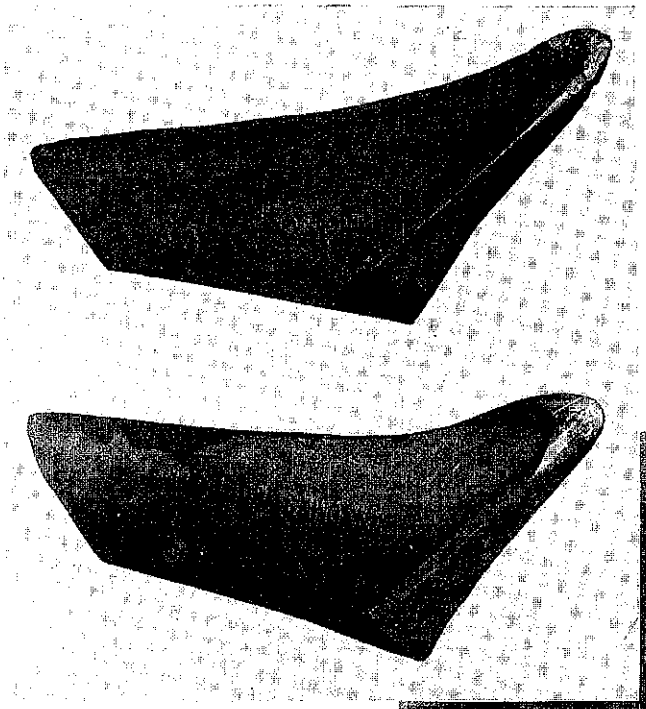


FIG. 25. THE TOP STEEL PLOUGHSHARE HAS BEEN STELLITED ON THE TOP AND ALONG THE LEADING EDGE. THE BOTTOM SHARE HAS NOT BEEN TREATED AND WEAR IS PLAINLY VISIBLE.

FIG. 26. DEPOSITING STELLITE ON THE GROWSER PLATES OF TRACTOR TRACKS.

rims of the idler wheels mentioned in page 9, and wear on these is now virtually eliminated.

A revealing test has been carried out by a Canterbury farmer in the use of Stellite in lucerne pulverizing hammers.

The standard swing hammers are capable of good work for about 30 tons of lucerne meal before being seriously affected by wear. But hammers which have been Stellited have done 500 tons and are still working, and when loss of efficiency begins to be noticeable they can be removed for the deposition of another layer of Stellite.

The use of Stellite should be seriously considered in the case of all farm equipment which is subjected to heavy wear, and unless the article is very cheap and readily obtainable it will be found that Stellite is an economical proposition. Its use is recommended on such items as plough discs, the points of cultivators, valves and valve seats of tractors, pickends, shovels, subsoil teeth, wire cutter blades, etc., etc.

2. Wear Resisting Alloy Steel.

Wear Resisting Alloy Steel Rod is a work hardening steel with good wearing properties. (That is to say that it is self-hardening with use). It is widely used for building up worn railway crossings and on much equipment in heavy industry that is subject to heavy impacts. Deposits may be put down up to $\frac{1}{4}$" in thickness, and should be hammered when red hot; it can also be shaped by the blacksmiths "flatter" when hot, which is important since the metal can only be ground when cold, as it work-hardens immediately under a file.

This rod is used where greater depths or areas have to be built up than is recommended for Stellite, or where such hard wearing properties as those possessed by Stellite are not essential.

It is recommended for building up the sprocket wheels of caterpillar tractors, the teeth of which wear down very quickly unless given some hard surfacing treatment; for the rollers of caterpillars tracks; towing shackles; ploughshares (as an alternative to Stellite), etc., etc.

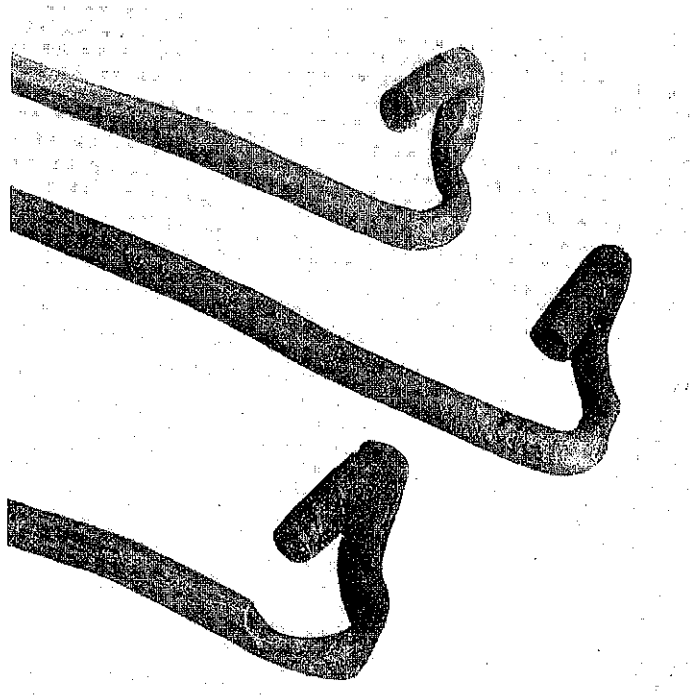


FIG. 27. RE-BUILDING OF POTATO DIGGER CHAIN RODS WITH W.R.A.S. ROD.
TOP : NEW ROD.
CENTRE : AFTER REBUILDING WITH W.R.A.S.
BOTTOM : THE UNTREATED WORN ROD.

Figure 27 shows how Wear Resisting Alloy Steel may be applied to the case of potato-diggers. The ends of the shaker-chain rod links wear down very quickly but they can be pre-heated and built up with W.R.A.S. rod to their former shape. It is important that they should be reheated after welding and allowed to cool slowly, as otherwise they will be brittle, and liable to breakage. To build up a complete worn chain necessitates about 180 individual welds; this can be done in a few hours, and at a fraction of the cost of a new chain. The rebuilt rods will have a considerably longer life than previously and can moreover be built up again, on beginning to wear. When rebuilding these links it is important to ensure that the deposited metal does not stand proud of the original arm, as otherwise the interlocking arms ride off and jam the machine.

Repairs to Non-Ferrous Metals.

A fully trained welder equipped with the proper apparatus can undertake repairs in other metals, such as copper, brass, aluminium, magnesium, etc., as readily as he can repair those metals already described. There is very little farm equipment made of the non-ferrous lighter metals, however, since by its nature it is not so well able to stand up to the hard treatment required of agricultural machinery. It should, however, be borne in mind by all concerned with the maintenance of agricultural machinery, that, in the event of breakage to any non-ferrous articles, oxy-acetylene welding can be of equal assistance as in the repair of the heavier ferrous metals. For instance while most of the heavier tractors have cast iron carburettors, which can be repaired as described above in the event of damage, certain of the lighter tractors are equipped with carburettors made of zinc-base die castings. This is because they are equipped with motor car engines. But since they are subjected to much rougher treatment than that usually encountered by an ordinary motor car, they are quite frequently broken or cracked. These castings can be satisfactorily welded by a fully trained operator with comparative ease.

Conclusion.

This booklet is not intended as an exhaustive list of all the items of farm equipment which can be repaired and rebuilt by Welding. But it is hoped that it will serve as a guide to show the farmer the very wide field in which oxy-acetylene Welding, backed up by the service and research organisation of The British Oxygen Co., Ltd., and the skill of the agricultural engineer, is able to assist in keeping agricultural machinery and equipment of all kinds in full working order.

Finally, it should always be remembered that, although welding may be relied upon to help the farmer out in an emergency, many such emergencies can be avoided if machinery is sent to the agricultural engineer for overhaul and maintenance during the season in which it is idle. Welding is quick, but should never be hurried, and if work can be carried out without one eye on the clock, the welder will be able to ensure a repair with which he, as a craftsman, will be fully satisfied.

This booklet was prepared with the co-operation of :—

The Rural Industries Bureau.

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