FLAME CLEANING

BY

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The Author of this Paper is a member of the Staff of Messrs. British Oxygen Gases Limited. The Company has consented to allow certain of its members to cover aspects of gas-welding and allied processes which seem to the Editor to be of interest and value to naval officers in the day-to-day performance of their duties. It is hoped to publish further Papers in later issues.

Steel making, like many other processes has, in its evolution undergone various changes. New methods of production, new techniques in processing or finishing have brought into being steels with a variety of analyses and specifications for a multitude of purposes. It is possibly due to these changes, from wrought iron to acid steel, and later to the increased use of basic steel, that one sometimes hears the cry ' Steel's not what it used to be '. Whatever the relative merits of this statement, it is an established fact that all steel tends to revert to the stable form akin to the ore from which it was produced. Corrosion is the ' natural ' method by which this reversion takes place.

There has been a growing interest in recent years in the causes and prevention of corrosion. This interest has no doubt been stimulated by the difficulty of obtaining replacements, by economic considerations and by the requirements of technical efficiency. Much has been written on the subject of corrosion and it is not proposed to devote more than a brief reference to it here. It is a well-known fact that mill scale is potentially cathodic to steel, and that on a steel surface there are potentially anodic and cathodic areas due to the presence of alloying elements or to stresses caused by defects or by hot working, such as forming to shape. Whatever the cause, these potentially anodic and cathodic areas exist and, in the presence of an electrolyte such as sea water, will cause electrical currents to flow resulting in the corrosion of the metal. Stated simply, the theory is that ferrous ions leave the metal and combine with negatively charged hydroxyl ions and are deposited at the anode to form hydrated iron oxide (rust).

Tests have shown that sea water has a greater electrical conductivity than either tap water or distilled water ; any steel therefore which is exposed to the former will corrode more than steel exposed to either of the latter two electrolytes.

It is a well established practice to ' weather ' new steel by exposing it to the atmosphere for periods of six months and upwards to remove the mill scale which is formed during the rolling part of its manufacture. If this mill scale were impermeable to moisture and if it were possible to maintain it intact, then it would, itself, provide an excellent protective coating. Unfortunately, neither of these qualities obtains.

If there exists a small area where the mill scale has been damaged, by weathering or by mechanical means, corrosion of the exposed steel will be severe. This is because of the large area of cathodic mill scale in comparison with the small anodic area of exposed steel. This concentration being at the relatively small anode is the cause of pitting. Where there is a general detachment of mill scale

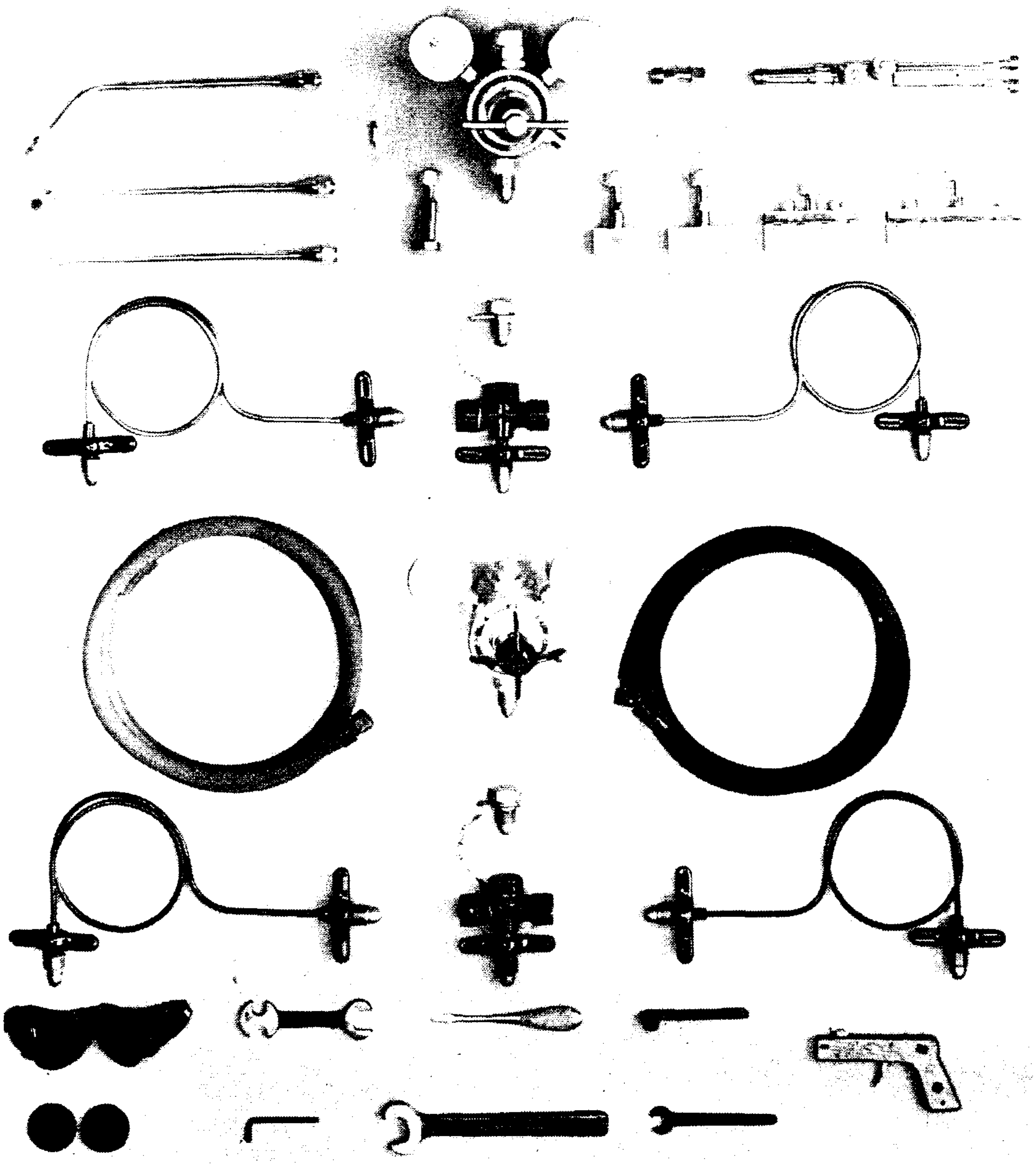

FIG. 1—FLAME CLEANING OUTFIT

and rusting takes place, the rust film is of uniform thickness. In weathering steel the detachment of mill scale is not uniform, so that those areas of steel first exposed are subject to the corrosive action and remain so until the weathering period is over and the protective coatings are applied.

The elimination of moisture and the removal of mill scale are most important factors. If the moisture is removed, there is no electrolyte to permit the flow of electrical currents and no resulting rust deposits in the anodic area. The removal of the mill scale is necessary to provide a smooth surface, and to ensure that, if moisture does get through the paint, there will be no pitting due to the cathodic nature of the scale. In the Flame Cleaning Process an answer is provided to both problems. Firstly, the heat of the flame drives out all moisture so that a clean dry and warm surface is presented for painting; and secondly, the application of the flame on the mill scale creates a differing expansion between the scale and the steel, thus loosening the scale so that it may fall away or easily be brushed off. Rusted surfaces also are successfully prepared for painting by this process. The flame, passing over the surface at

FIG. 2—DESCALING COKE CARS

the correct speed, robs the rust of its oxygen and leaves it as a grey powdery deposit. If the flame is passed over the surface too quickly, the rust retains its red colour, but if the passage of the flame is too slow, the metal overheats and ' blues '. On steel under $\frac{1}{4}$ in. thick this ' blueing ' is more easily produced than on the thicker material. The reduction in the speed of passing the flame over a gas holder sufficient to overheat and ' blue ' the metal, would have no such effect on thicker plate, e.g. on the side of a ship, due to the mass effect of the metal in the latter.

Whilst other methods of surface preparation such as pickling, grit blasting, chipping and wire brushing, etc., do not come within the scope of this article, it is perhaps relevant to point out that none of these alternative surface preparations have the property of warming the steel to such an extent as to remove all moisture. Furthermore, in the case of the pickling and blasting methods, heavy capital expenditure is involved, and severe limitations are imposed on the size, weight and shape of the article to be cleaned. So harsh are these limitations that site work is very often out of the question. Flame cleaning on the other hand, demands little capital outlay, is completely portable, does not demand highly paid, highly skilled operators, and is equally applicable to buoys or battleships.

Chipping and wire brushing being slow and laborious soon tire the operator to such an extent that the degree of cleanliness achieved deteriorates appreciably as fatigue sets in. Furthermore, a study of the use of chipping tools may make one pose the question, ' Does the end justify the means ?' True the chipping hammer will remove scale, but in doing so it is prone to leave heavy indentations on the surface and by the cold-working effect produces fresh anodic and cathodic areas. In addition, the impact of the chipping hammer often leaves sharp edges on the surface of the steel. As it is extremely difficult to achieve the desired paint thickness on these sharp edges, the resultant lack of proper protection at these points leads to early failure of the paint.

FIG. 3—FLAME CLEANING THE SIDE OF A CARGO VESSEL AT MESSRS. JOHN BROWN LTD., OF CLYDEBANK

It is commonly believed by many that a good wire brushing is sufficient to prepare a rusted surface for painting. Closer examination of a surface so prepared, invariably reveals that a film of rust remains even after vigorous wire brushing ; especially does this apply to the pits and crevices. Not only is this rust hygroscopic, but it prevents intimate adhesion of the paint to the steel. In addition to its cleansing action, the flame warms the steel sufficiently to lower the viscosity of the paint enabling it to flow more readily into surface imperfections to form a sound mechanical bond in addition to the normal adhesive bond. The effect of painting on to a warm surface is of benefit where it is considered desirable to apply two coats of paint in one day. Those responsible for dry-docking dues or scaffolding arrangements will readily appreciate these advantages.

The equipment primarily consists of a blowpipe with a series of flat tip nozzles in widths of 2 in. to 6 in., and a round nozzle for rivet heads and awkward corners (FIGS. 1 and 2). From these nozzles a series of high velocity flames emerge to combine into one high temperature brush-like flame (FIG. 3). Flexible rubber tubing connects the blowpipe to the oxygen and acetylene regulators. For most oxy-acetylene applications the regulator is connected direct to the cylinder. Where, however, the acetylene draw-off rate exceeds one-fifth of a cylinder's capacity (as in the case of flame cleaning using the larger flat tips or the round nozzle) it is necessary to couple three cylinders together to ensure a continuous ample supply of gas to the blowpipe. Oxygen may be drawn off at a much higher rate, but in order to save change-over time, the coupling of three cylinders is more efficient (FIG. 4). Three-way valve adaptors with coupling arms, left hand for acetylene, right hand for oxygen, are a convenience. The coupling arms are made of copper for oxygen and steel for acetylene. (*N.B.* Copper should *not* be used for acetylene due to the risk of forming the explosive compound copper acetylide.)

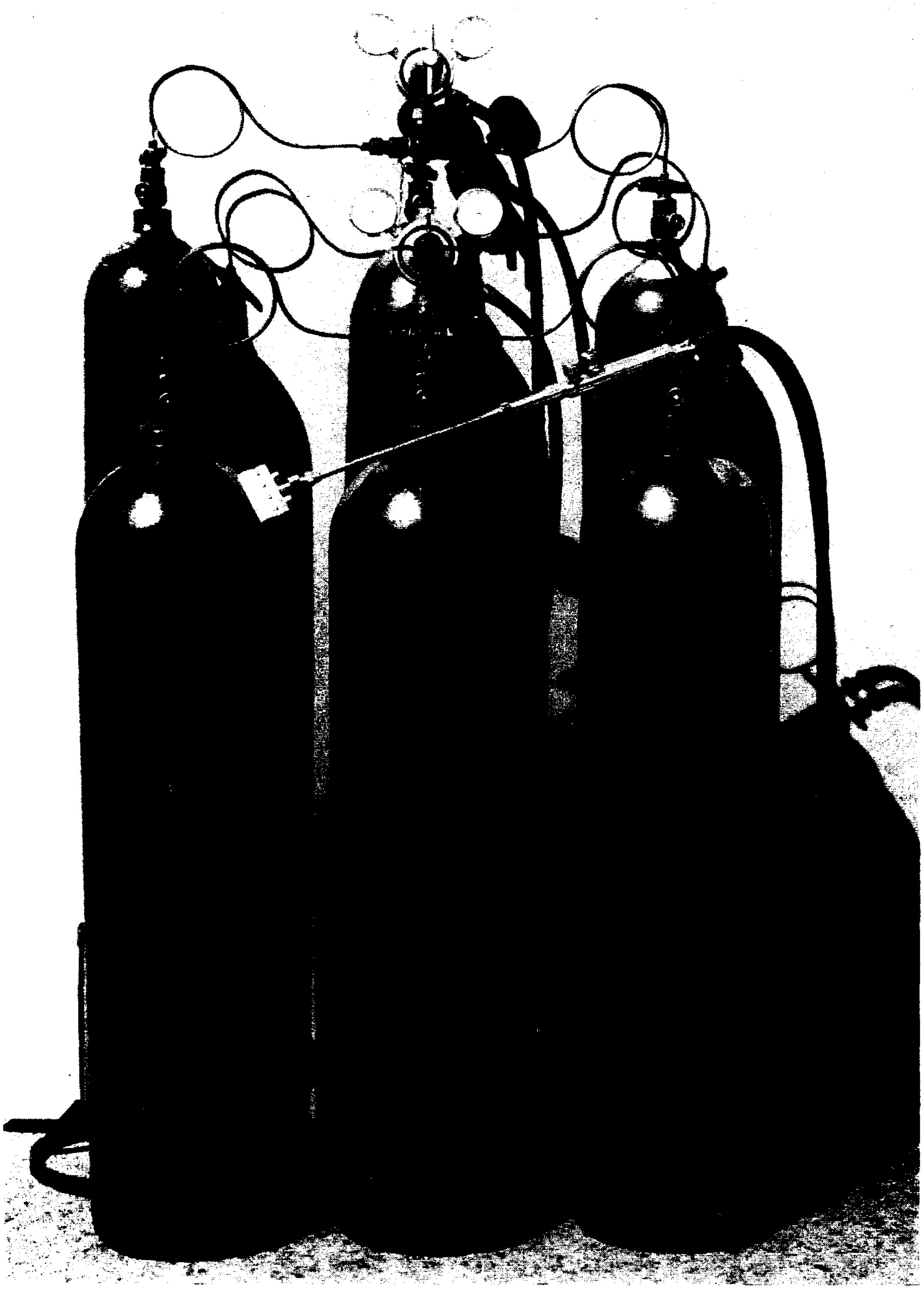

FIG. 4—COMPLETE EQUIPMENT FOR FLAME CLEANING, INCLUDING OXY-ACETYLENE BLOWPIPE AND OXYGEN AND ACETYLENE CYLINDERS

The flame is progressed over the work in a series of $\frac{1}{2}$ in. forward and $\frac{1}{4}$ in. backward movements. This has the effect of scrubbing the steel at a speed of 30 in. per minute which has been found to be the most efficient speed for the removal of mill scale and rust, and to achieve the desired temperature of 100 degrees F. It has been found by experience that this is about the maximum at which the hand may comfortably be held on the steel.

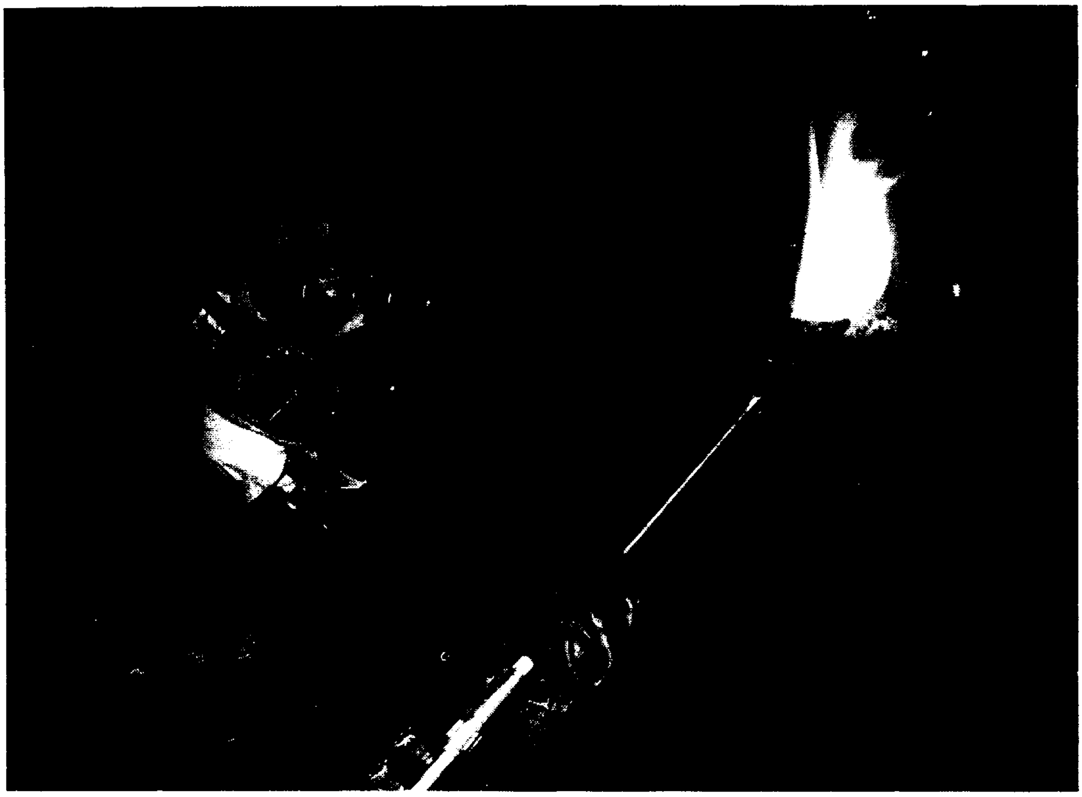

FIG. 5—USE OF RESPIRATOR IN FLAME CLEANING AND DESCALING (SIEBE-GORMAN, MARK IV)

After a few square yards have been cleaned, they are wire brushed, dusted and painted. Good team work ensures a continuity of operation so that all paint is applied to a warm, clean and dry surface. It is advisable to clean as many yards as can be painted in the same day. Should it be necessary to leave unpainted a flame cleaned area overnight, it is recommended that this area be given one quick pass to remove any moisture and to warm the steel before painting.

Old painted surfaces can be cleaned to bare metal by the use of this process with a slightly modified technique. In this, the first pass is made by drawnig the flame slowly backward over the surface to char the paint. The surface is then wire brushed and cleaned with the flame in the usual manner of $\frac{1}{2}$ in. forward and $\frac{1}{4}$ in. backward movements. The flame is drawn backwards in the first pass to prevent the nozzle orifices becoming blocked with molten paint.

When burning off old paint, the fumes produced can be noxious ; under outdoor conditions, however, the prevailing wind is usually sufficient to disperse these fumes and carry them away from the operator. When working in a confined space, either a filter-pad type of respirator (FIG. 5) or, if there is insufficient ventilation, a compressed air respirator (FIG. 6) is recommended.

The choice of paint demands and receives more attention than it used to do. By the use of exposure racks in various parts of the world, and under a variety of service conditions and by the use of devices designed to accelerate the effects of the elements, paint research staffs have been able to formulate paints designed to give maximum service life under various conditions, whether they be marine, normal weathering or in chemically laden atmospheres. Priming coats, in many cases chosen because they are rust inhibitive, are not necessarily impervious to moisture ; they should therefore be covered with the undercoat and finishing coat as soon as possible after the previous coat has thoroughly dried.

Fig. 6—Siebe-Gorman Compressed Air Type Respirator

In many cases small scale trial areas were flame cleaned and compared with identically painted areas which had been cleaned by traditional methods. Subsequent to a trial of this nature, one large tanker operating company decided to flame clean the starboard of a ship and to scrape and wire brush the port side. After a period of three years in service there was a considerable difference in the appearance of the two sides, especially above the water line. The flame cleaned side was relatively smooth, while the other side was quite rough with appreciable lifting of patches of scale. Over several years the quantity of paint used for maintenance was three times greater on the non-flame-cleaned side. Furthermore, many plates on the non-flame-cleaned side had to be chipped to bare metal and painted, yet on the flame-cleaned side no descaling was necessary after five years.

The three main considerations in the painting of ships are :—

(i) Protection against corrosion

(ii) The maintenance of a smooth surface to afford minimum resistance to the passage of the ship through the water

(iii) The preservation of a good appearance.

The importance of (i) and (iii) are self-apparent and though superficially the effect of a roughened underwater skin may appear to be of minor importance, a closer examination of the fact will discount this. It has been stated that in the case of many tankers having a service speed of 11½ knots, this roughening has been responsible for the loss of half a knot after the first five years and about one knot after 10 years of the ship's life. Operating costs over this period have been estimated to increase by 7½ per cent ; a considerable figure !

This experience with the hulls of ships tends to demonstrate the value of flame cleaning which is equally applicable to the smaller areas and objects with which the serving officer is probably more frequently concerned, and which absorb so many man-hours of maintenance labour. It is, at any rate, well worth remembering that the eradication of water and the proper adhesion of the preservatives used may well free personnel for the more directly useful and certainly less uninspiring work of engine maintenance.

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