WELDING BY THE ELECTRIC ARC.

By J. F. Lincoln.

An arc welder is essentially an apparatus for transforming electric current at high voltage to a low voltage work current with heavy amperage. In a paper read before the American Foundrymen's Association recently, Mr. J. F. Lincoln described briefly a number of types of welder that have more or less satisfactorily established a place for themselves in commercial use.

The changing of the current which is necessary for the best application of the arc is first the reduction of the voltage to a value somewhere between 30 and 60 and then some kind of arrangement so that this voltage will be reduced as the current increases. In other words, as the resistance of the arc decreases on account of increasing current, the amount of current that flows must not increase to a point which will burn the weld or give varying results. That is, the welder must have a dropping characteristic so that as the current flow increases the voltage will drop, and drop considerably.

The first types of arc welder were of resistance units, either a water rheostat or grid resistance which placed sufficient resistance in the circuit so as to reduce the voltage to the proper point for use in the arc. This is a very satisfactory method for arc welding and the only disadvantage is that about 65 per cent. of a 110-volt current and 85 per cent. of a 220-volt current is wasted in the resistance. Another bad feature is the fact that it is rather difficult to handle large currents through resistance in a satisfactory manner on account of the burning-out of the resistance units.

Another type consisted of a motor-generator set, the only possible advantage of which over the resistance method being some current saving. There are many devices of this kind which give a satisfactory arc and save some of the current which was lost in the resistance type. With the motor-generator set it is necessary to keep a considerable amount of resistance in circuit in order to act as a ballast, or to limit the amount of current when only a small amount is required.

The usual application of the electric arc in welding is made by forming an arc between a carbon electrode and the piece to be welded. Since the piece which is welded is the positive electrode, practically all the heat of the arc is liberated here, very little being released at the negative carbon electrode. Into this arc is passed the filling metal which rapidly melts off and drops on to the positive electrode, kept at a welding temperature by the arc. In this way a weld which is perfect can be made because both the filler and the piece to be welded can be kept at a temperature at which the metal is fluid; 95 per cent. of all arc welding is done in this way.

There is another application for the electric arc, however, which is used to some extent in certain classes of work where the weld must be made overhead or on the side of a piece into which the molten metal cannot be dropped. For this application an electrode of metal is used, this electrode itself being the filler. As the arc is established the metal electrode slowly melts off, sticking on to the part already heated by the arc.

This metal electrode work is apt to be unsatisfactory unless carefully done, on account of the fact that the metal welded on must be heated to a welding temperature and the point it touches must also be heated to the same temperature.

In a general way, the statement is true that the weld is equally as strong as the original piece, providing that the original piece is of the same quality and kind of metal as the filler used. This statement, however, does not fully comprehend the difficulties in the way of getting a weld which is as strong as the original piece. A steel casting can be repaired by the use of the arc welder and a weld can be made the strength of which will exceed 60,000 lbs., which is as strong as the average steel casting. The strength of the weld is practically constant when properly made and is approximately 60,000 lbs. per sq. in. Whether it is stronger or weaker than the original piece depends on the strength of the section.

In the cutting of steel, the electric arc has another application. It is used extensively for cutting sheets, boiler-plate, etc. This work can be done cheaply and efficiently when compared with punch press, cold saw, or any other method of cutting.

MODERN METHODS IN THE MANUFACTURE OF PORTLAND CEMENT.

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The subject matter of this paper has had the close attention of the engineering profession during recent years, in view of the important functions which this material exercises in almost all constructional work. More especially is this the case where the engineer has to combat the mighty forces of nature, which are continually acting on such constructions, more particularly in connection with hydraulic and marine work, such as docks, harbors, breakwaters, water reservoirs, etc., where the combination of forces is such that only the most skilful design, coupled with the use of the highest quality of the most suitable material, can insure success.

To the engineering profession is largely due the credit for the improvement in the quality and adaptability of the material which is the subject of our discussion. By collaboration of their varied experiences in the use of Portland cement, aided by the technical knowledge of the manufacturers, improvements have been introducd into manufacturing processes, which have wholly, or almost entirely, removed the defects which existed in the early days of the manufacture.

Specifications have been drafted as the result of the combined experiences of engineers in all branches of the profession, which have gone far to raise the standard of quality, and to insure uniformity of this most important material of construction.

The general principles governing the manufacture of Portland cement are well known to the profession. It will therefore only be necessary to refer shortly to the usual methods of manufacture, devoting the space at our disposal more particularly to those processes upon the proper conduct of which depends the ultimate quality and reliability of the material produced.

Need of Uniformity in Quality.—Portland cement is now being manufactured in all parts of the world from a variety of raw materials all having as their base some form of calcium carbonate, which, together with suitable argilaceous materials, form the principal ingredients of manufacture. These materials must be perfectly amalgamated and combined chemically in fixed and defiant proportions, the limits of which are not so wide as is generally supposed. Nature

* Notes on a paper delivered to the Canadian Society of Civil Engineers, Vancouver Branch, on May 26th, 1913.