AN IMPROVED ELECTRIC WELDER.

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Welding is one of the most important and at the same time one of the most difficult operations in the manufacture and use of metals.

Until the recent introduction of welding by electricity, little progress was made in the art during the past thousand years, yet reliable welds were more and more needed as the manufacture of metals and alloys improved and higher working stresses were demanded.

Welding is the operation of uniting two or more pieces of metal by heating the surfaces required to be joined, and forcing them together either by hammering or other pressure while the metal surfaces are in the plastic state. A perfect weld might be defined as one in which the metal at and near the weld remains equal in strength and ductility to those parts of the metal which have not been heated.

In the ordinary process of welding two pieces of iron, the smith heats the ends in a fire until, so far as he is able to judge, the temperature has become somewhat higher than the correct welding point. The ends are then placed together, treated with a flux—such as borax—which melts and quickly covers the heated surface, thus preventing the further access of air, and, at the same time, reduces the oxide scale already formed to a liquid state; the smith then hammers the two ends together, his aim being to force out from the surfaces in contact all the burnt iron and all the flux, and also to produce a smooth round surface. The strength of the weld depends almost entirely upon the skill which has been exercised in bringing the metal to just the right temperature, and in hammering out all the burnt metal and flux.

The welding of brass, copper, and some other metals is impracticable by the old hand method, since copper would need to be raised to a very high temperature, as compared with iron, and it is then highly oxidizable, and liable to form a scale difficult to treat by any flux; it also passes quickly from the solid to the molten state, and is brittle near the welding temperature; while with brass it is difficult to avoid volatilization of the zinc before the copper constituent has been raised to the necessary temperature, and further, this alloy also becomes very brittle near the welding temperature. Heretofore such metals and alloys have been united by brazing or soldering—operations which require considerable skill, and are expensive in the matter of solder, fluxes, heating appliances, and labor charges.

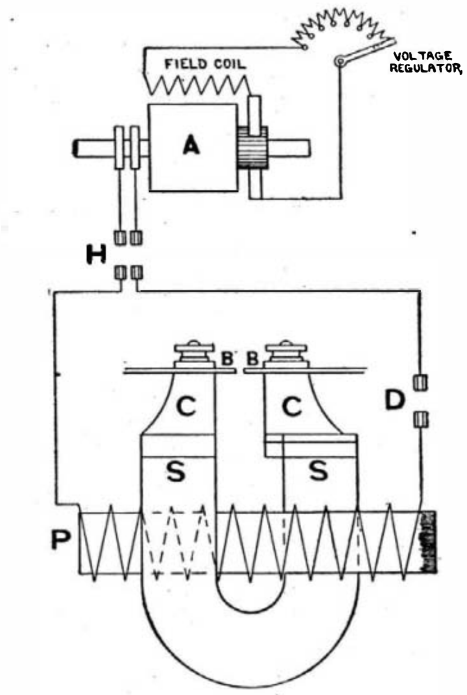
These metals and alloys can, however, readily be welded electrically, and, under certain conditions, a good weld can be made between two entirely different metals and alloys without difficulty. Welding by electricity is, in fact, capable of producing such astonishing results that it has revolutionized many manufacturing operations, doing away with highly skilled labor, increasing enormously the rate of production, while the final result is that more reliable work can be turned out at a fraction of the previous cost. The system adopted and the machines employed must, however, be suitable for the particular class of work to be done.

The Prescott welder shown in the illustrations is especially designed for welding wire and rods of comparatively small cross section, that is, it will weld wire of the smallest sizes up to rods of the following maximum sizes: iron and steel, ¾ inch in diameter; brass, 9/16 inch in diameter; and copper, ⅜ inch in diameter. Bars and strips of metal of any shape or section can also be welded, provided the sectional area does not materially exceed that of the equivalent areas for rods as given below.

Not only can copper, brass, and other metals and alloys which are unweldable by any other process be welded, but in the case of iron and steel an unskilled man or youth after a little practice, can produce welds far superior to those turned out by a highly skilled smith. Thoroughly sound welds can be made in copper with the utmost ease, and it is an important fact that brass can be readily and simply welded. Still more important is the fact that brass can be welded without destroying the structure given to it by drawing or rolling, and the welds will stand all the rolling and drawing processes necessary to work the material down to the smaller sizes, as will be explained.

The system adopted in the construction of the welders is shown by the diagram, Fig. 1. *A* is an alternating-current dynamo, which can be connected by means of switches *H* and *D* to the primary coil *P* of the transformer. The secondary coil of this transformer consists of a massive single convolution *S S*, terminating externally in two large clamps *C C*, which grip the two rods or other pieces required to be welded together.

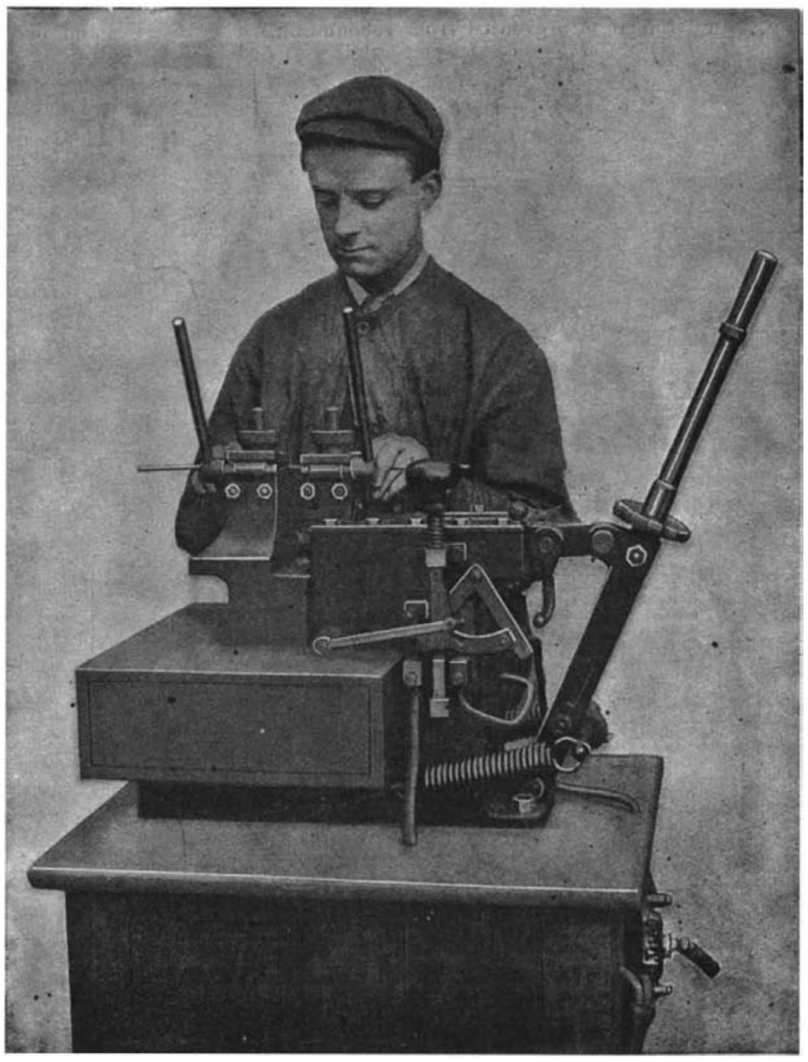
When the switches are closed the generator supplies a current of moderate strength at a pressure of, say, 100 volts to the primary coil *P* of the transformer. This current is transformed by electro-magnetic induction into a current of very low voltage but very great amperage, in the secondary coil *S*, and the heavy current so produced flows across the junction of the two



THE CONSTRUCTION OF THE WELDER.

pieces to be welded *B B*, their ends being kept in contact under moderate pressure.

The electrical resistance in the secondary circuit being practically located at the two end surfaces, thus kept in contact, all the heat is developed at those surfaces, i. e. just where the weld is made, and the re-



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sulting increase in temperature by further augmenting the resistance at this point adds to the desired effect. A device is provided for regulating the pressure between the ends of the rods, since this pressure must be adjusted to the size of the rods and the plasticity of the metal at welding temperature. After a few seconds the metal begins to flow and the rods become perfectly united, the metal bulging out slightly around the joint, and at this stage the current is cut off by the switch *D*. The joint is now trimmed down by filing or by an emery wheel. The conditions for successful welding vary with different materials. With iron or steel it is necessary to keep the temperature below the melting point, to avoid injury to the mechanical properties of the metal, and consequently considerable pressure is required to make the weld. In the case of copper and brass, the pressure must be lighter; the metal is allowed to actually fuse at the junction, and the pressure should be only just sufficient to force out the burnt metal, the current being cut off at the moment the ends of the rods are forced together at the proper welding temperature. It is this forcing away of the burnt metal which enables such good results to be obtained with drawn brass rods.

The full equipment for electrical welding consists of a generator, switchboard, cable, transformer, clamps, operating lever, and automatic switch. Where suitable electric power is not at hand, a special self-exciting alternating-current generator is furnished. The switchboard is of the usual type, and a heavy cable is supplied to connect the generator, switchboard, and welder. In the transformer the main casting of the welder forms the core of the secondary coil, making the machine mechanically sound and electrically efficient.

The clamps for holding the work are massive in construction, in order to prevent temperature rises in the machine itself. For very large work a water-cooling arrangement is provided. The operating lever is so designed that the position of the movable clamp can be varied and the pressure adjusted on the ends of the pieces required to be welded. There is an automatic switch, which enables the current to be utilized at the instant it is required, and which automatically breaks the circuit when the critical temperature is reached.

The Charcot Antarctic Expedition.

At the time of the first French expedition, organized and conducted by the eminent explorer, Dr. Charcot, the circumstances were such that the preparations had to be made within a short time, and the resources which were placed at the explorer's disposition were quite small and insufficient. Nevertheless, the scientific results of this expedition were considerable. Encouraged by this first success, and stimulated by the conviction held by scientists of all countries that there is an immense amount of work to be done in the regions of the Antarctic which are so little known, Dr. Charcot, not long after his return to Paris, decided to organize a new expedition. The Académie des Sciences then charged a commission composed of MM. Mascart, Perrier, and Bouquet de la Grye, to draw up a report upon the results of the first expedition and upon the utility of a new one. Following the reading of this report, the Académie decided that it would be of great scientific value, and placed the project under the patronage of a commission composed of leading scientists, with instructions to lay out the scientific part of the programme for the new expedition. The work will bear upon the questions of geography, physics of the globe, including gravitation, magnetism, meteorology, atmospheric electricity, tides, etc., also astronomical work, zoology, palæontology, geology, bacteriology, and other branches. Data from the Antarctic regions are now wanting so as to be able to co-ordinate the observations upon physics of the globe and especially atmospheric electricity and meteorology taken at different points. It is hoped that this want will be supplied by expeditions such as the present one, and that by elucidating the problem of the existence of a permanent cyclonic or anti-cyclonic regime over the immense ice surface of the polar cap, we may be able to predict great atmospheric disturbances, to avoid or lessen cosmic disasters and to protect agriculture and navigation. On the same order of ideas, the knowledge of the densities of sea water, of ocean currents, habitat and migrations of fauna, will facilitate the fishing industries and whale hunting in these regions. The estimated cost of the expedition is $150,000. Private subscriptions will no doubt furnish one-fifth of this amount, and there will remain for the government the sum of $120,000. Half this credit will be needed during the present year for the preparatory work of the expedition, especially for building a special vessel which will be required. Upon the assent of the Minister of Public Instruction and the Minister of Finance, the government has just allotted a credit of $60,000 for the preliminary work.

The navigable dimensions of the Suez Canal are now practically double what they were twenty years ago, the superficies of the vertical profile having been considerably increased.