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ELECTRIC DESEAMING

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Fig. 1.

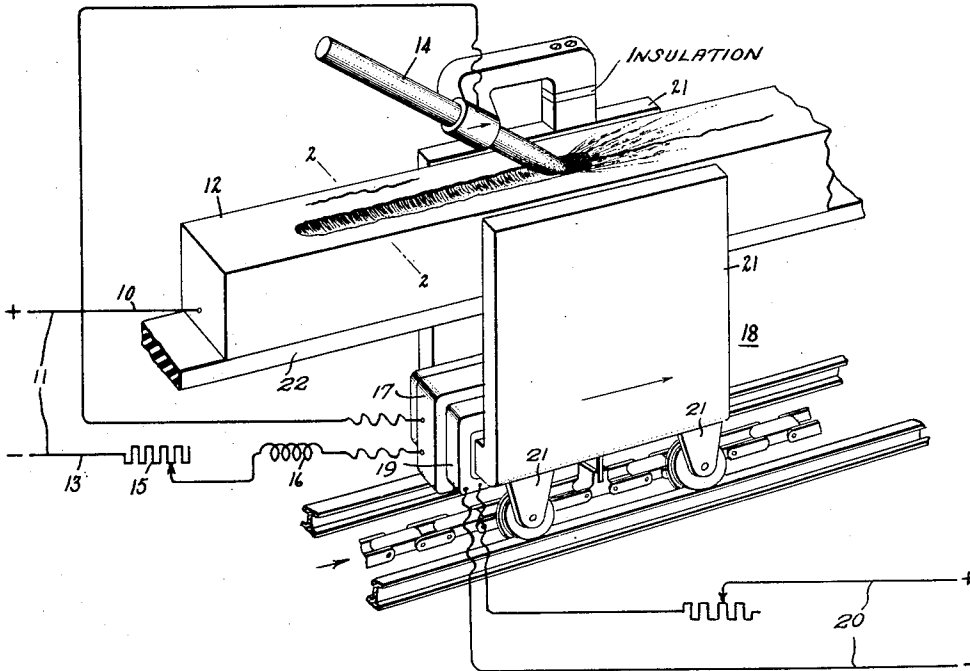
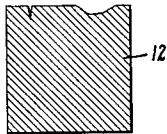


Fig. 2.



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ELECTRIC DESEAMING

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9 Claims. (Cl. 148—9)

My invention relates to the electric deseaming of billets, bars, slabs, and the like of steel, nickel, nickel alloys, and other metals. It may be also applied to the surface grooving of other articles.

Unless certain surface defects are removed from billets, bars, slabs, and the like, they are perpetuated during rolling and forging operations and appear as surface flaws in the finished product. These surface defects are variously identified and for convenience will be referred to as seams. Likewise, for convenience my invention will be described as applied to the deseaming of billets although it is to be understood that it is also applicable to any semi-finished piece of metal which is to be subjected to further rolling or forging operations.

It is an object of my invention to provide an electrical process particularly suited for removing seams from semi-finished pieces of metal.

It is a further object of my invention to provide apparatus for effecting the process of my invention.

Further objects of my invention will become apparent from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 diagrammatically represents my process as well as apparatus for effecting it; and Fig. 2 is a sectional view of the billet of Fig. 1 taken along lines 2—2 thereof.

According to my procedure the surface of a billet along a seam therein is progressively melted, preferably by an arc, and the molten metal is expelled magnetically as fast as it is formed to produce a groove which eliminates the seam. The molten metal is preferably expelled in a forward direction or diagonally in a forward direction relative to the direction of arc travel but it is apparent that it may be expelled in any direction. It is, of course, least desirable to expel the molten metal in a backward direction since this tends to fill the groove and destroy the clean cut which it is desirable to obtain. The depth and width of the groove is controlled by controlling the heating effect of the arc and the magnetic removal of metal produces a smooth, clean cut in the billet which is concave in shape and of such a nature as to be easily removed by subsequent rolling or forging operations.

The magnetic blow necessary for removing molten metal in accordance with my invention may be secured by properly positioning the arcing electrode relative to the billet and traversing

it along a seam in the proper direction relative to the point of connection of the source of arcing current to the billet. This magnetic blow may, however, be intensified by means of a magnet, preferably an electromagnet.

As illustrated in Fig. 1, the positive terminal 10 of a direct current source of supply 11 is connected to the left end of a billet 12 and the negative terminal 13 of this source of supply is connected to the electrode 14 through an adjustable resistance 15, an inductance 16, and the series coil 17 of an electromagnet 18. In order properly to direct the current flow in the billet, it is mounted upon an insulating support so that current must flow between the terminal connection 10 attached thereto, and the arc established between the electrode and the billet. As shown in Fig. 1, the deseaming operation progresses from left to right and the electrode is inclined away from the direction of arc travel which is away from the point of connection of the source of supply with the billet. The flow of current through the billet and the electrode when thus positioned relative to one another produces in back of the electrode a concentrated magnetic field which, when acting on the current conducting molten metal produced by the arc, forcibly ejects it in a forward direction producing a clean cut in the billet. As illustrated in the drawing, small particles of molten metal are sprayed in a forward direction and usually a pool of molten metal forms ahead of the arc and flows along in the direction of arc travel with the rear end of the pool about $\frac{1}{8}$ to $\frac{1}{4}$ of an inch away from the tip of the electrode. The metal forcibly ejected from the arc crater in the work may be caught or deflected in order to prevent it from falling on the surface of the billet. Those particles that do fall on the surface of the billet may, however, be readily removed by means of a wire brush, scraper or the like.

The intensity of the magnetic field in back of the arcing terminal of the electrode may be controlled by controlling its inclination relative to the billet. I prefer to incline the electrode at an angle of from 30° to 45°. I also prefer to intensify the magnetic field resulting from the relative position of the electrode and billet by also using an electromagnet 18 which generates a magnetic field transverse to the longitudinal axis of the electrode and its path of travel along the billet. By providing this electromagnet with a series winding, the magnetic blow will vary directly with variations in arc current and the

consequent variations in the rate of producing molten metal by the heating effect of the arc. The electromagnet may also be provided with another coil 19 excited from a source of supply 20 in a manner to produce a field in the same direction as that produced by its above referred to series coil 17.

The use of an electromagnet is particularly desirable where due to the physical dimensions of a billet it is not possible to localize the direction of current flow to or from the arcing terminal of the electrode. The electromagnet may also be used to control the direction of discharge of molten metal from beneath the arcing terminal of the electrode without altering the position of the electrode relative to the billet. As pointed out above, a discharge in a forward diagonal direction is particularly useful and this may be accomplished by placing the magnet diagonally to the direction of electrode travel.

In the arrangement illustrated in Fig. 1, the magnet 18 is provided with pole pieces 21 which direct its flux across the arc. This electromagnet may be positioned above or below the work and the billet may be passed under, over, or between its pole pieces so long as the arrangement will produce the desired field of force at the arc crater in the billet. The electrode 14 and magnet 18 may be moved as a unit relative to the billet 12 as shown by the arrows on the electrode support and magnet. This may be accomplished by hand, or preferably by means of a travel carriage 21 which is movable relative to the billet or a support 22 upon which the billet is located.

Graphite electrodes are preferably used because of their current-carrying capacity. Carbon electrodes or water-cooled metal electrodes may be used. Means should also be provided for cooling the electrode holder and the electromagnet and its exciting windings.

The electrode may be controlled manually although I prefer to provide an automatic means for striking and maintaining the arc as well as for traversing the arc relative to the billet. It is very desirable that the arc length be maintained substantially constant in order to produce the best operating conditions.

The depth of the cut in the billet may be controlled by controlling the speed of travel, the arc current, and the size of electrode. Current values from 1800 to 2500 amperes, and arc voltages from 20 to 45 volts have been successfully used with graphite electrodes of one-inch in diameter and travel speeds of from 10 to 18 feet per minute. The cuts thus produced are approximately $\frac{1}{4}$ -inch deep and about $\frac{3}{4}$ -inch wide when operating on billets of Monel, Inconel, and nickel.

When a manual operation is performed, the arcing terminal of the graphite electrode may be rested on the work during the deseaming operation. When operating in this manner, it is quite likely that successive conductive engagements between the work and the electrode are formed which subsequently result in arcs when the metal of the billet is melted and blown away by the magnetic field employed. It is preferable, however, to perform the operation by automatic means which accurately controls the spacing of the arcing terminal of the electrode relative to the work and thus maintains an arc length of predetermined length.

Either alternating current or direct current may be used. Direct current is considered preferable because by connecting the positive terminal of such a source to the billet, the major portion

of the heating effect of the arc is located at the arc crater in the work.

It is to be understood that the deseaming procedure above described is a procedure for removing metal. As fast as metal is melted beneath the electrode, it is forced out, preferably in a forward direction, in order to produce a clean cut. If the magnetic field employed for removing the molten metal is not strong enough, it is not possible to produce a clean cut. No attempt is made to weld the seam or float out impurities as in a welding operation. When employing my procedure, it is possible to remove a layer of metal from over a deep seam leaving the bottom portion of the seam entirely unfused after the passage of the electrode. It is thus possible by visual examination to determine whether sufficient metal has been removed from the billet to eliminate the seam therefrom. The surface of the groove produced by my procedure evidences the usual cooling ridges common to arc deposited metal and because of this the above explanation has been given so that the procedure will not be confused with a welding procedure. The cooling ridges above referred to are illustrated in Fig. 1 of the drawing. This figure, as well as Fig. 2, illustrates the nature of the seams above considered and the groove produced by my deseaming process. Because the groove is shallow and does not have steep edges or porous portions, it may be completely eliminated by subsequent rolling or forging operations.

Means may be provided for adjusting the current supplied to the arc as well as for stabilizing its operation. In the system above described, the adjustable resistance 15 constitutes a means for adjusting the current strength and the inductance 16 together with the series winding 17 on the electromagnet 18 acts to stabilize the action of the arc. Likewise, means may be provided for controlling the blowing effect of the electromagnet. This may be a mechanical arrangement although preferably the blow is controlled by controlling the amount of current flowing through the winding or windings of the electromagnet.

Various improvements and modifications of the arrangement illustrated in Fig. 1 will occur to those skilled in the art, and I, therefore, aim to cover by the following claims all such variations and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of deseaming a billet which comprises maintaining between an electrode and said billet an arc of sufficient intensity to render molten the surface portions of said billet, traversing said arc along a seam in said billet, establishing at said arc a magnetic field which is transverse to the longitudinal axis of said electrode and its path of travel along said seam in said billet and which combines with the magnetic field resulting from the flow of arc current through said billet and said electrode to produce a resultant magnetic field of sufficient strength forcefully to expel from the arc crater in said billet current conducting molten metal as fast as it is formed by said arc, and controlling through the agency of said magnetic field the direction and force of discharge of molten metal from the arc crater in said billet.

2. The method of deseaming a billet which comprises connecting the terminals of a source of arcing current to said billet and to an electrode, maintaining an arc between said elec-

trode and said billet, traversing said arc along a defective portion of said billet in a direction away from the terminal connection with said billet, and inclining said electrode away from the direction of arc travel at an angle of from 30° to 45° with said billet to expel from the arc crater in said billet the current conducting metal rendered molten by said arc.

3. The method of deseaming a billet which comprises connecting the terminals of a source of arcing current to said billet and to an electrode, maintaining an arc between said electrode and said billet, traversing said arc along a defective portion of said billet in a direction away from the terminal connection with said billet, inclining said electrode away from the direction of arc travel to generate a magnetic blowing effect on the current conducting metal rendered molten by said arc, and intensifying said magnetic blowing effect by an additional magnetic field which is transverse to the longitudinal axis of said electrode and its path of travel along said billet to obtain complete removal of the molten metal beneath the arcing terminal of said electrode.

4. Apparatus for deseaming a billet comprising an electrode, means for traversing said electrode and said billet relatively to one another, means for maintaining an arc between said electrode and said billet, and magnetic means for generating a magnetic field which is transverse to the longitudinal axis of said electrode and its path of travel along said billet and which intensifies the magnetic effect of arc current flow through said billet and said electrode and produces a resultant magnetic field which immediately expels from the arc crater in the surface of said billet the current conducting globules of molten metal formed by said arc.

5. Apparatus for deseaming a billet comprising an electrode, means for traversing said electrode and said billet relatively to one another, means for maintaining an arc between said electrode and said billet, and magnetic means acting independently of the direction of current flow through said billet and said electrode for generating a magnetic field transverse to the longitudinal axis of said electrode and its path of travel along said billet and immediately expelling from the arc crater in the surface of said billet and in the direction of arc travel the current conducting globules of molten metal formed by said arc.

6. Apparatus for deseaming a billet comprising an electrode, a source of current connected to said electrode and said billet, means for holding said electrode in arcing engagement with said billet and inclined backward at an angle of from 30° to 45° with said billet toward the connection

of said billet with said source, and means for traversing the arcing terminal of said electrode over said billet away from the connection of said billet with said source.

7. Apparatus for deseaming a billet comprising an electrode, a source of current connected to said electrode and said billet, means for holding said electrode in arcing engagement with said billet and inclined backward toward the connection of said billet with said source, means for traversing the arcing terminal of said electrode over said billet away from the connection of said billet with said source, magnetic means for generating a field transverse to the longitudinal axis of said electrode and its path of travel along said billet, intensifying the magnetic field resulting from the flow of current through said billet and said electrode and expelling current conducting molten metal from beneath the arcing terminal of said electrode, and means for adjusting the magnitude of said magnetic field produced by said magnetic means.

8. Apparatus for deseaming a billet comprising an electrode, a source of current connected to said electrode and said billet, means for holding said electrode in arcing engagement with said billet and inclined backward toward the connection of said billet with said source, means for traversing the arcing terminal of said electrode over said billet away from the connection of said billet with said source, and magnetic means for generating a magnetic field transverse to the longitudinal axis of said electrode and its path of travel along said billet and propelling current conducting molten metal from beneath the arcing terminal of said electrode in the direction of electrode travel.

9. Apparatus for deseaming a billet comprising an electrode, a source of current connected to said electrode and said billet, means for holding said electrode in arcing engagement with said billet and inclined backward toward the connection of said billet with said source, means for traversing the arcing terminal of said electrode over said billet away from the connection of said billet with said source, and magnetic means for generating a magnetic field transverse to the longitudinal axis of said electrode and its path of travel along said billet, intensifying the magnetic field resulting from the flow of current through said billet and said electrode and expelling current conducting molten metal from beneath the arcing terminal of said electrode in the direction of electrode travel, said magnetic means being excited in accordance with the flow of current through said billet and said electrode.

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