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PROCESS OF DESEAMING BLOOMS, BILLETS, SHEET BARS, AND THE LIKE

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The present invention relates to a process of desaming blooms, billets, sheet bars and the like, and more particularly to a process of desaming nickel and nickel alloy blooms, billets, sheet bars, and the like by means of an electric arc.

In working ingots into commercial shapes such as sheets and bars, surface defects occur which must be removed in order to obtain a satisfactory and acceptable surface finish on the final product. The removal of defects such as seams, splits, cracks, etc., has been a slow, laborious and expensive process involving, as a rule, the use of manually operated pneumatic chipping hammers. It was necessary to remove the metal around the defect in such a manner that, in further rolling, the metal surrounding the removed portion would not lap over and the groove or depression formed would roll out smooth. In recent years, oxy-acetylene desaming of steel billets has been tried and found to save considerable time and expense. When applied to non-ferrous metals such as nickel and nickel alloys, however, oxy-acetylene desaming has not been commercially practicable and the art has been forced to deseam non-ferrous blooms, billets, sheet bars, and the like by the slow and laborious chipping method.

While the reasons why oxy-acetylene desaming of non-ferrous metals and alloys is impracticable have not been completely determined, contributing factors are the differences in heats of formation and melting points of the metallic oxides formed and the rates of reaction between the oxygen and the metal or alloy. Gas cutting of ferrous metals is a process of preheating the material to be cut to its kindling or ignition temperature and then rapidly oxidizing it by means of a closely regulated jet or stream of oxygen issuing from a cutting blow-pipe. The process is primarily a chemical one based upon the remarkable chemical affinity of oxygen for ferrous metals when raised to the kindling temperature. Due to this high chemical affinity, the rate of reaction between the oxygen and the ferrous metal is rapid. The oxide of iron formed in the cutting process is the black, magnetic oxide Fe_3O_4 which has a molecular heat of formation of approximately 271,000 gram calories. This oxide is non-adherent and readily washed out of the groove or kerf by the gas stream along with about 30 to 40% of the total metal removed in molten but uncombined form. Non-ferrous metals, on the other hand, do not have rates of reaction comparable with that of ferrous metals

and in general the molecular heats of formation are considerably less. In the case of nickel and copper, for example, the molecular heats of formation are about 61,500 gram calories for NiO , 43,800 gram calories for Cu_2O and 37,700 gram calories for CuO , respectively. The melting point of the nickel oxide is about 1650°C . as compared with about 1550°C . for iron oxide. The nickel oxide, moreover, instead of being non-adherent and readily washed out of the cut, adheres tenaciously to the metal and resists removal by the stream of oxygen. Other factors, for example, thermal conductivity, may also play an important role. Regardless of the scientific explanation for the phenomena, the fact remains that attempts to deseam non-ferrous blooms, billets, sheet bars, and the like by using an oxy-acetylene flame have resulted in failure. In the case of nickel and nickel alloys, for example, the metal that melts merely balls up and does not yield a cut satisfactory for desaming.

I have discovered a process for desaming billets, blooms, and the like, by means of an electric arc by which seams, splits, cracks, and similar defects can be removed from metals and alloys, including nickel and nickel alloys, in a rapid, satisfactory and comparatively inexpensive manner.

It is an object of the present invention to provide a process for desaming blooms, billets, sheet bars, and the like, in a rapid and satisfactory manner by means of an electric arc.

It is another object of the invention to provide a process of removing seams, splits, cracks, and similar defects from the surface of blooms, billets, sheet bars, etc., made of nickel and nickel alloys by means of an electric arc.

Further objects and advantages of the present invention will become apparent from the following description.

Generally speaking, the process of the present invention involves the steps of melting the metal surrounding a defect on the surface of a bloom, billet, sheet bar, etc., by means of the heat developed by an electric arc, and removing the molten metal whereby the defect is eliminated. In case the seam, crack, split or other defect is comparatively long, the arc is moved along the same at the proper speed to melt and remove the metal at either side of the defect progressively. The speed is determined by the current density, the depth of the defect, compositions of metal, etc. For best results the depth of the groove formed should be less than the width and there should be no undercuts. A groove with a

somewhat arcuate bottom has given good results.

In carrying out the deseaming process of the present invention satisfactory results have been obtained using carbon and graphite electrodes.

The diameter of the electrode will depend somewhat upon the size of the defect to be removed, the current density employed and the speed of removal desired. In general an electrode diameter varying from about $\frac{1}{2}$ " up to about 2" has been found satisfactory, with about 1" as a convenient size for removing most defects. Ordinarily a graphite electrode is preferable because of its higher electrical conductivity.

The electrode is electrically connected to one terminal of a suitable source of electric current and the bloom, billet, sheet bar, or the like, from which the defects are to be removed is electrically connected with the other terminal of the current source. While both alternating and direct current may be used, best results have been obtained with direct current, and with the electrode connected to the negative terminal of the current source. It has been found advantageous to connect only one end of the bloom, billet, sheet bar, or the like to the positive terminal. Thus, when the positive side is grounded one end of the bloom should be insulated from ground, for example by setting it on a block of insulation such as wood, rubber, paper, etc.

The current may vary from about 300 amperes to about 3000 amperes. Good results have been obtained in the range of about 1500 to about 2500 amperes. Generally speaking, amperage of about 2500 is preferred. The voltage will usually not exceed about 30 volts, a satisfactory range being about 20 to about 30 volts and preferably about 25 volts. Under these conditions defects have been removed at the rate of about 5' to 10' per minute when a groove about $\frac{1}{8}$ " deep was formed and at about 20' per minute when the defects did not go deeper than about $\frac{1}{8}$ ". The depth of the cut is proportional to the speed of the electrode, provided the current is constant. Voltages considerably in excess of 30 volts may be used in order to create greater power and pressure, thereby facilitating and improving the deseaming action, when compatible with increased cost of generating current under these conditions.

Ordinarily it is unnecessary to use any fluxes or to use a gas stream to blow the molten metal from the groove. The arc develops adequate heat that need not be supplemented, for example, by atomic hydrogen. Similarly metal electrodes are ordinarily to be avoided as they tend to deposit metal on the bloom, billet or sheet bar rather than to remove it. The deseaming of the blooms, etc., appears to be entirely a process of removing the metal in which the defect occurs and not to involve the welding of the seam.

While the process of the present invention is applicable to metals and alloys generally when blooms, billets, sheet bars, and the like, have to be deseamed, it is particularly useful for non-ferrous metals such as nickel and nickel alloys which cannot be satisfactorily deseamed by the oxy-acetylene torch. Satisfactory results have been obtained on various grades of nickel, on nickel copper alloys of the type sold under the trade-mark "Monel" and on nickel-chromium-iron alloys of the type sold under the trade-mark "Inconel" when treated in accordance with the foregoing principles. The deseamed billets, blooms and sheet bars were hot rolled and then

cold rolled to gauge, and yielded satisfactory and acceptable surface finish.

I claim:

1. The process of deseaming blooms, billets, sheet bars, and the like made of nickel and nickel alloys comprising connecting one end of the bloom, billet, sheet bar and the like containing a surface defect to the positive terminal of a source of direct electric current; insulating the other end of the bloom, billet, sheet bar and the like; connecting the negative terminal of said source of direct electric current to a carbon electrode having a diameter of about an inch; striking an arc between the electrode and the bloom, billet, sheet bar and the like; moving said electrode along a surface defect to be removed while controlling the current in excess of about 1500 amperes and not exceeding about 2500 amperes and controlling the voltage within the range of about 20 volts to about 30 volts to cause the metal about said defect to become molten and to be automatically removed as a result of the electric forces generated in the molten metal incident to the passage of current therethrough, thereby producing a groove adjacent to the surface defect in the bloom, billet, sheet bar and the like; and correlating the speed of the electrode along the defect with the current and the depth of the defect to produce an arcuate groove in the metal having a depth at least equal to the depth of the defect to be removed and a width in excess of the depth whereby a grooved bloom, billet, sheet bar and the like free from surface defects is obtained which, when worked, provides an acceptable product having a surface free from seams, splits, cracks and other surface defects.

2. The process of deseaming blooms, billets, sheet bars, and the like made of nickel and nickel alloys comprising connecting one end of the bloom, billet, sheet bar and the like containing a surface defect to the positive terminal of a source of direct electric current; insulating the other end of the bloom, billet, sheet bar and the like; connecting the negative terminal of said source of direct electric current to a non-metallic electrode having a diameter of about an inch; striking an arc between the electrode and the bloom, billet, sheet bar and the like; moving said electrode along a surface defect to be removed while controlling the current within the range of about 1500 amperes to about 2500 amperes to cause the metal about said defect to become molten and to be automatically removed as a result of the electric forces generated in the molten metal incident to the passage of current therethrough, thereby producing a groove adjacent to the surface defect in the bloom, billet, sheet bar and the like; and correlating the speed of the electrode along the defect with the current and the depth of the defect to produce a groove in the metal having a depth at least equal to the depth of the defect to be removed and a width in excess of the depth whereby a grooved bloom, billet, sheet bar and the like free from surface defects is obtained which, when worked, provides an acceptable product having a surface free from seams, splits, cracks and other surface defects.

3. The process of deseaming blooms, billets, sheet bars and the like made of nickel and nickel alloys comprising connecting one end of the bloom, billet, sheet bar and the like containing a surface defect to the positive terminal of a source of direct electric current; insulating the other end of the bloom, billet, sheet bar and the

like; connecting the negative terminal of said source of direct electric current to a carbon electrode having a diameter of about one-half inch to about two inches; striking an arc between the electrode and the bloom, billet, sheet bar and the like; moving said electrode along a surface defect to be removed while controlling the current in excess of about 300 amperes and not exceeding about 3000 amperes to cause metal about said defect to become molten and to be automatically and instantaneously removed as a result of the electric forces generated in the molten metal incident to the passage of current therethrough, thereby producing a groove adjacent to the surface defect in the bloom, billet, sheet bar and the like; and correlating the speed of the electrode along the defect with the current and the depth of the defect to produce a groove in the metal having a depth at least equal to the depth of the defect to be removed and a width in excess of the depth whereby a grooved bloom, billet, sheet bar and the like free from surface defects is obtained which, when worked, provides an acceptable product having a surface free from seams, splits, cracks and other surface defects.

4. The process of deseaming blooms, billets, sheet bars and the like made of nickel and nickel alloys comprising connecting one end of the bloom, billet, sheet bar and the like containing a surface defect to the positive terminal of a source of direct electric current; insulating the other end of the bloom, billet, sheet bar and the like; connecting the negative terminal of said source of direct electric current to a non-metallic electrode having a diameter of about one-half to about two inches; striking an arc between the electrode and the bloom, billet, sheet bar and the like; moving said electrode along a surface defect to be removed while controlling the current in excess of about 300 amperes and up to about 3000 amperes to cause metal about said defect not only to become molten but to be automatically and instantaneously removed as a result of the electric forces generated in the molten metal incident to the passage of current therethrough, thereby producing a groove adjacent to the surface defect in the bloom, billet, sheet bar and the like; and correlating the speed of the electrode along the defect with the current and the depth of the defect to produce a groove in the metal having a depth at least equal to the depth of the defect to be removed whereby a grooved bloom, billet, sheet bar and the like free from surface defects is obtained which, when worked, provides an acceptable product having a surface free from seams, splits, cracks and other surface defects.

5. The process of deseaming blooms, billets, sheet bars and the like made of nickel and nickel alloys comprising connecting the bloom, billet, sheet bar and the like containing a surface defect to the positive terminal of a source of direct electric current; connecting the negative terminal of said source of direct electric current to a non-metallic electrode having a diameter of about one-half inch to about two inches; striking an arc between the electrode and the bloom, billet, sheet bar and the like; moving said electrode along a surface defect to be removed while controlling the current in excess of about 300 amperes and up to about 3000 amperes to cause metal about said defect not only to become molten but to be automatically and instantaneously removed as a result of the electric forces generated in the molten metal incident to the passage of current therethrough, thereby producing a groove adja-

cent to the surface defect in the bloom, billet, sheet bar and the like; and correlating the speed of the electrode along the defect with the current and the depth of the defect to produce a groove in the metal having a depth at least equal to the depth of the defect to be removed and a width in excess of the depth whereby a grooved bloom, billet, sheet bar and the like free from surface defects is obtained which, when worked, provides an acceptable product having a surface free from seams, splits, cracks and other surface defects.

6. The process of deseaming blooms, billets, sheet bars and the like made of nickel and nickel alloys comprising connecting one terminal of a source of direct electric current to the bloom, billet, sheet bar and the like containing a surface defect; connecting the other terminal of said source of direct electric current to a non-metallic electrode having a diameter of about one-half inch to about two inches; striking an arc between the electrode and the bloom, billet, sheet bar and the like; moving said electrode along a surface defect to be removed while controlling the current in excess of about 1500 amperes to cause metal about said defect to become molten and to be automatically and instantaneously removed as a result of the electric forces generated in the molten metal incident to the passage of current therethrough, thereby producing a groove adjacent to the surface defect in the bloom, billet, sheet bar and the like; and correlating the speed of the electrode along the defect with the current and the depth of the defect to produce a groove in the metal having a depth at least equal to the depth of the defect to be removed and a width in excess of the depth, whereby a grooved bloom, billet, sheet bar and the like free from surface defects is obtained which, when worked, provides an acceptable product having a surface free from seams, splits, cracks and other surface defects.

7. The process of deseaming blooms, billets, sheet bars and the like made of nickel and nickel alloys comprising connecting one terminal of a source of electric current to the bloom, billet, sheet bar and the like containing a surface defect; connecting the other terminal of said source of electric current to a non-metallic electrode; striking an arc between the electrode and the bloom, billet, sheet bar and the like; moving said electrode along a surface defect to be removed while controlling the current in excess of about 300 amperes to cause metal about said defect to become molten and to be automatically removed as a result of the electric forces generated in the molten metal incident to the passage of current therethrough, thereby producing a groove adjacent to the surface defect in the bloom, billet, sheet bar and the like; and correlating the speed of the electrode along the defect with the current and the depth of the defect to produce a groove in the metal having a depth at least equal to the depth of the defect to be removed whereby a grooved bloom, billet, sheet bar and the like free from surface defects is obtained which, when worked, provides an acceptable product having a surface free from seams, splits, cracks and other surface defects.

8. The process of deseaming blooms, billets, sheet bars, and the like made of nickel and nickel alloys comprising striking an arc between the bloom, billet, sheet bar and the like containing a surface defect, and an electrode; moving said electrode along a surface defect to be removed while controlling the current in excess of about

1500 amperes to cause metal about said defect to become molten and to be automatically removed as a result of electric forces generated in the molten metal incident to the passage of current therethrough, thereby producing a groove adjacent to the surface defect in the bloom, billet, sheet bar and the like; and correlating the speed of the electrode along the defect with the current and the depth of the defect to produce a groove in the metal having a depth at least equal to the depth of the defect to be removed and a width in excess of the depth whereby a grooved bloom, billet, sheet bar and the like free from surface defects is obtained which, when worked, provides an acceptable product having a surface free from seams, splits, cracks and other surface defects.

9. The process of descaling blooms, billets, sheet bars, and the like, made of nickel and nickel alloys comprising striking an arc between the bloom, billet, sheet bar and the like containing

a surface defect, and an electrode; moving said electrode along a surface defect to be removed while controlling the current in excess of about 300 amperes to cause metal about said defect to become molten and to be automatically removed as a result of electric forces generated in the molten metal incident to the passage of current therethrough, thereby producing a groove adjacent to the surface defect in the bloom, billet, sheet bar and the like; and correlating the speed of the electrode along the defect with the current and the depth of the defect to produce a groove in the metal having a depth at least equal to the depth of the defect to be removed whereby a grooved bloom, billet, sheet bar and the like free from surface defects is obtained which, when worked, provides an acceptable product having a surface free from seams, splits, cracks and other surface defects.

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