Aug. 8, 1939. H. R. PUFAHL ET AL 2,168,581

METHOD AND APPARATUS FOR THERMOCHEMICALLY REMOVING METAL FROM BODIES OF FERROUS METAL

Original Filed June 4, 1936

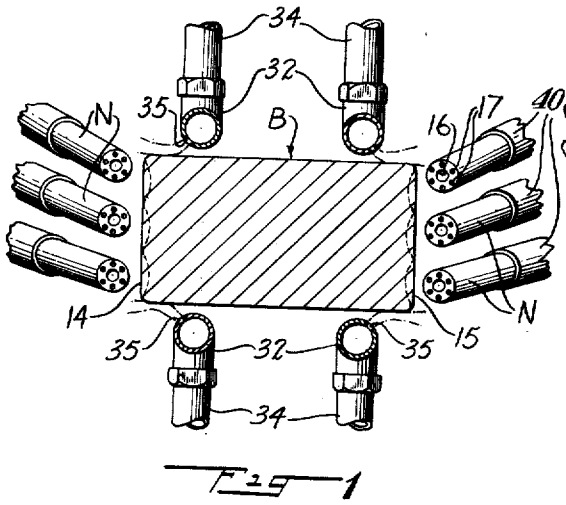


Fig 1

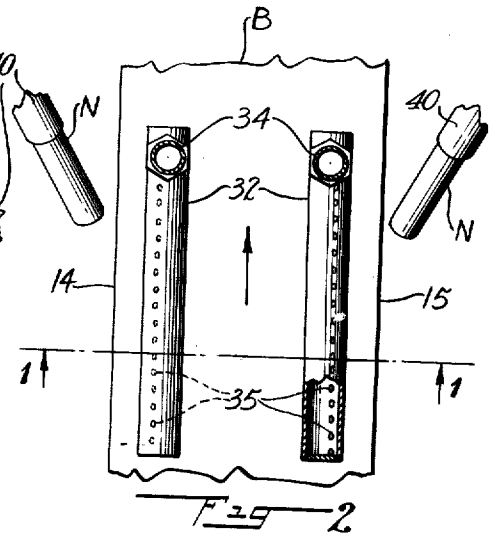


Fig 2

Fig 3

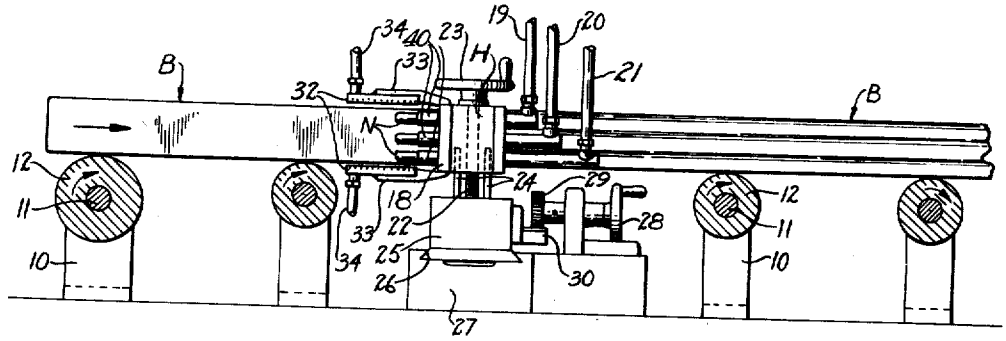


Fig 5

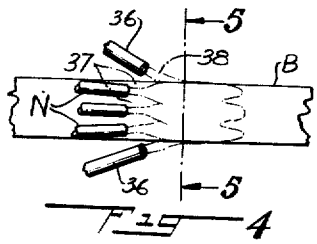
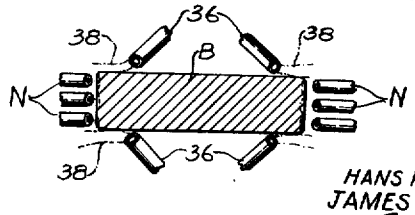


Fig 4



INVENTORS.
HANS R. PUFAHL
JAMES H. BUCKNAM.
BY E. E. Greenewald
ATTORNEY.

Patented Aug. 8, 1939 2,168,581

UNITED STATES PATENT OFFICE

2,168,581

METHOD AND APPARATUS FOR THERMO-CHEMICALLY REMOVING METAL FROM BODIES OF FERROUS METAL

Hans R. Pufahl, Chicago, Ill., and James H. Bucknam, Cranford, N. J., assignors to The Linde Air Products Company, a corporation of Ohio

Application June 4, 1936, Serial No. 83,518
Renewed January 5, 1939

19 Claims. (Cl. 148—9)

This invention relates to a method of and apparatus for thermo-chemically removing metal from bodies of ferrous metal and more particularly to a method of and apparatus for counteracting the accumulation of the products of a thermo-chemical metal consuming reaction on surfaces of a body adjacent the places from which metal is removed.

In many industrial applications it is desirable to partially or completely desurface bodies of ferrous metal, and this is particularly true in steel mill operations during the manufacture of steel billets, bars, slabs, blooms, and other semi-finished shapes from steel ingots. During the customary rolling operations effected at elevated temperatures, defects and seams appear on the surfaces of the semi-finished shapes, and, in order to reduce the number of rejects of finished products produced, it is desirable to desurface the semi-finished shapes to remove surface defects and seams as well as to expose seams which are beneath the surface.

Within recent years bodies of ferrous metal have been efficiently and economically desurfaced by progressively applying oxidizing gas streams to surfaces thereof which are at their ignition or kindling temperature. In removing surface metal in this manner to provide substantially clean surfaces having no defects or seams, it has been found that the surfaces being desurfaced are impaired for subsequent rolling operations. The metal so removed is in the form of slag, comprising, for example, either completely oxidized metal or a mixture of oxidized and molten metal, which may flow or be sprayed onto adjacent surfaces of the metal body being desurfaced, where it collects and adheres in quantities generally sufficient to be detrimental. Although a considerable portion of the slag is completely removed, that which adheres upon cooling becomes in many instances welded at least in spots to the surfaces. This is objectionable because the adhering material is rolled into the surfaces during subsequent rolling operations. Such adherence is particularly severe when desurfacing billets while at normal rolling temperatures, the adhesive tendencies being then much greater. Further, it is impossible to desurface the entire peripheral surfaces of metallic bodies in two passes without having removed metal collecting on one or more surfaces of the bodies after the final pass or desurfacing operation.

The principal object of this invention is to provide a method of and apparatus for counteracting the adherence of slag on surface regions of a ferrous metal body on which the slag produced by a thermo-chemical metal consuming reaction tend to accumulate. Other objects of this invention are to provide a method of removing metal from bodies of ferrous metal with oxidizing gas whereby the surfaces adjacent to the area being acted upon are maintained clean and free of slag; to deflect the slag and the impelling component of the oxidizing gas in a manner which avoids or counteracts the tendency of the slag to flow over an adjacent area of the body being desurfaced; to control the shape and extent of the reaction zone acting on the surface so as to confine the same entirely to the area to be acted upon; and to provide apparatus for carrying out the method of desurfacing with the slag deflected in the manner indicated.

The above and further objects and novel features of this invention will become apparent from the following description and the accompanying drawing, in which:

Fig. 1 is a fragmentary sectional view of the apparatus shown in Fig. 3, taken at line 1—1 of Fig. 2, to illustrate one manner of carrying out the present method for preventing any removed material from collecting on the top and bottom surfaces of a billet when desurfacing opposing vertical sides of the same;

Fig. 2 is a plan view of the portion of the apparatus shown in Fig. 1;

Fig. 3 is a side view of apparatus embodying this invention;

Fig. 4 is a fragmentary side view of a ferrous body illustrating another manner of maintaining the top and bottom surfaces thereof free and clean of removed metal while the side walls are being desurfaced; and

Fig. 5 is a sectional view taken at line 5—5 of Fig. 4.

In the practice of the present invention, a stratum of metal is thermo-chemically removed progressively from successive portions of a ferrous metal body by applying one or more oxidizing gas streams so as to impinge upon a surface when the surface has been heated to the oxygen ignition temperature in a manner well known to the art. In order to control the resulting slag in a manner which prevents adherence on an adjacent surface, a gaseous blast is applied in conjunction with the oxidizing gas stream to provide a current which directs the flow of or counteracts the adherence of slag in the manner desired.

Referring to the embodiment of the invention illustrated in the drawing and particularly to

Fig. 3, the apparatus for desurfacing may comprise a plurality of pedestals 10 having shafts 11 journaled thereon to which are secured rollers 12 for supporting and moving a number of metallic bodies, such as rectangular-shaped billets B, only one of which is shown. The rollers 12 may be driven in any suitable manner, such as the gear drive common in rolling mill practice, to insure a continuous movement of a number of billets B. In steel mill operations the rollers 12 may comprise a part of the conveyor system of a rolling mill, and the apparatus shown may be disposed at one side of or between two stands of rolls where the billets are subjected to a number of draughts to reduce their cross-sectional area.

A plurality of nozzles N of a character adapted for applying oxidizing gas with a velocity suitable for a wide surface metal removing or desurfacing operation are here shown as arranged closely adjacent to each other at the side walls 14 and 15 of the billet B for delivering the gas in a plurality of streams which merge to provide in effect a single gas stream which extends across a major portion of or across the entire width of a vertical surface. Each nozzle N has a central passage 16 for delivering a comparatively large volume of oxidizing gas, such as oxygen or a mixture of oxygen and air, which will be discharged from the nozzle orifice substantially at atmospheric pressure and at a volocity between 200 and 1000 feet per second. A plurality of passages 17 surround the central passage 16 for delivering a combustible gas mixture, such as a mixture of oxygen and acetylene, to provide high temperature heating flames. The nozzles N are arranged at an acute angle, preferably between 10 to 35 degrees to the side walls, so that the individual gas streams delivered thereby are applied to the surfaces in the direction the desurfacing is to be effected.

Each nozzle is connected to a blowpipe 40 which in turn is secured to a manifold block 18 having passages communicating with passages in the blowpipe. The oxygen and acetylene, which form a combustible gas mixture in the blow-pipes 40, may be delivered to the manifold 18 through flexible conduits 19 and 20, respectively, and oxygen for effecting the thermo-chemical removal of metal may be delivered to the manifold 18 through a separate conduit 21, the flexible conduits being connected to suitable sources of supply (not shown) of oxygen and acetylene.

The nozzles N are preferably adjustable vertically and also adjustable toward and away from the side walls of the billet. The manner in which one group of nozzles N may be supported is shown in Fig. 3, and it should be understood that the group of nozzles N adjacent the opposing side wall of the billet may be supported in a similar manner. The manifold head 18 may be secured to a support H which is vertically adjustable and axially movable along a lead screw 22 by turning a handwheel 23, the support H being guided by vertical rods 24 secured to a block 25 and extending into openings in the support. The block 25 is movable toward and away from the billet B in a guideway 26 formed in a base 27, and its position may be adjusted by a handwheel 28 adapted to drive a pinion 29 which engages a toothed rack 30 secured to the block 25.

To accomplish surface metal removal as here proposed, the metal is preferably locally heated to the oxygen ignition or kindling temperature before the oxidizing gas is applied thereto. This may be accomplished in any convenient manner; for example, the entire body may be heated to or above the desired ignition temperature in a furnace, or the portions of the surface metal impinged by the oxidizing gas stream may be locally heated at the time or a little before the instant of oxidizing gas impingement by suitable means, for example, by a high temperature heating flame or by an electric arc. With the nozzles N in their adjusted position, as shown in Figs. 1 and 2, and the billet B traveling in the direction indicated by the arrow in Fig. 3, heating flames and relatively wide oxidizing gas streams are applied on the surfaces 14 and 15 of the billet. The combustible gas mixture issuing from the passages 17 heats or assists to maintain the metal directly ahead of the nozzles at an ignition temperature, and the oxidizing gas contacting the heated metal reacts thermo-chemically therewith and causes the same to ignite and burn. This burning or oxidation of surface metal takes place progressively as successive portions of heated surface metal are subjected to the influence of the oxidizing gas, a reaction zone or "puddle" being constantly maintained at the point of impingement of the gas stream on the surface. In this manner, a plurality of contiguous channels are produced having gradually sloping sides, as best indicated in dotted lines at the side walls 14 and 15 in Fig. 1. It should be understood, however, that when the billets B are at a sufficiently elevated temperature, it is not necessary to apply additional heat to the surfaces, although it is frequently desirable to do so in order to increase the speed of desurfacing.

The oxidizing gas streams force away the highly heated oxidized and molten surface metal from the reaction zone, and this mixture has been termed a "slag". Although surface metal can be reduced completely to an oxidized form, it has been found in practice that only a portion of the surface metal removed need be oxidized, the heat developed removing the remainder in the molten form, thus effecting considerable economy in the amount of oxidizing gas required to remove a given amount of metal. The proportion of metal in the molten state contained in the slag becomes particularly high when the billet is at relatively high temperature and such superheated metal readily melts surfaces it may come in contact with adjacent the area being desurfaced, becoming welded thereto upon cooling. By the present invention the slag is controlled by means of gaseous blasts to flow over only the surface area which is to be desurfaced so as to confine the region of contact of slag on base metal to within desired limits.

To make certain that the channels extend to the extreme edges of the surfaces 14 and 15, the nozzles N are properly positioned with respect to the corners of the billet B. With this positioning of the nozzles the removed metal tends to be forced over the edges of the billet to collect on the top and bottom surfaces thereof. This is due to the fact that the oxidizing gas streams are deflected by impingement on the reaction zone so that portions flow toward the surfaces adjacent to the area to be desurfaced which in this case are the top and bottom surfaces, although it is contemplated that an adjacent surface may be another area of the same surface adjacent the area acted upon.

Accordingly to maintain the top and bottom surfaces of the billets B clean during the desurfacing operation on the surfaces 14 and 15, a gaseous blast is directed on the top and bottom

surfaces to prevent the flow of slag thereon. These gaseous blasts are applied in such a manner that the portions or components of the oxidizing gas streams tending to flow over the edges of the billet are deflected, so that no removed metal is forced over to collect on the surfaces adjoining those being desurfaced.

One manner of carrying out this method of control is effected by providing manifolds 32 disposed lengthwise of the billet B adjacent the top and bottom surfaces thereof. The manifolds 32 are adjustably secured to brackets 33 mounted on the heads 18, the brackets being angularly adjustable in horizontal planes. Each manifold 32 is connected through a flexible conduit 34 to a source of supply of gas, such as air or oxygen or a mixture thereof, and is provided with a plurality of spaced and aligned openings 35 to produce a gaseous blast of sheet-like form which extends longitudinally of the billet B and is directed at an acute angle toward an edge thereof adjacent the region where desurfacing is being effected. The pressure of the source of gas connected to the manifolds 32 is preferably so adjusted that the force of the gaseous blast produced is sufficient to counteract or overcome the tendency of the slag to flow beyond the limits desired. As shown in Figs. 2 and 3, the gaseous blast of sheet-like form extends ahead of and to the rear of the tips of the nozzles N, so that the top and bottom surfaces of the billets are effectively maintained clean and free of slag during the desurfacing operation.

Instead of employing manifolds 32 to control slag, single nozzles 36 may also be effectively utilized, as shown in Figs. 4 and 5. The nozzles 36 may be inclined at an acute angle in the same direction as the nozzles N, as shown in Fig. 4, and also inclined toward the edges of the billet B, as shown in Fig. 5. The spreading of the oxidizing gas streams after impingement is indicated at 37 in Fig. 4, and the nozzles 36 are so positioned that the gaseous blasts 38 delivered thereby meet, the outside blasts forming portions or components normally tending to flow over the edges of the billet. When single nozzles of the character just described are employed, the size of the gaseous blast and its point of application may be determined so that the removed metal is effectively prevented from collecting on surfaces adjacent to those being deseamed.

In view of the foregoing, it will be apparent that the thermo-chemical removal of portions of metallic bodies can be effectively and expiditiously carried out without impairing the condition of other surfaces thereof. Thus in steel mill operations, semi-finished shapes can be subjected to further rolling directly after a desurfacing operation according to the principles of this invention has been completed. When two opposing surfaces have previously been desurfaced, the subsequent desurfacing of the adjacent two surfaces will not impair the condition of the surfaces first desurfaced when slag adherence thereon is prevented.

It has previously been pointed out that the slag controlling gas blast may be an oxidizing gas or oxygen. Since the slag contains also molten iron and is very hot, it is evident that the oxygen of the blast will tend to more completely oxidize the portions of slag onto which it comes into contact. This action is beneficial because the more completely oxidized slag does not adhere tenaciously to the metal surface after it solidifies while the molten metal content of a less completely oxidized slag will freeze to such adjacent surface.

Referring to Figs. 1, and 5, it will be apparent that the tendency of slag to adhere to the lower surface of a body is much greater because the slag and molten metal flows by gravity toward the lower corner. This tendency is also increased when the cutting gas stream or streams are applied so that the cutting gas flows downwardly toward the lower surface as in cutting a kerf.

While particular embodiments have been shown and described, it will be apparent that modifications may be made, and that the invention can be practiced when the shapes of the metallic bodies are cylindrical as well as rectangular in shape, and where it is desired to control the shape of the reaction zone within desired limits as it passes over the surface, without departing from the spirit and scope of this invention.

What is claimed is:

1. A method of removing metal from the surface of a body of ferrous metal, which comprises progressively applying an oxidizing gas stream to successive portions of a surface so as to remove a layer of surface metal therefrom, the surface metal to which said gas stream is applied being substantially at an ignition temperature, and, during the application of said gas stream, applying a gaseous blast against a surface area adjacent to that from which the layer of surface metal is being removed so as to prevent removed metal from collecting on such area.

2. A method of desurfacing a body of ferrous metal substantially rectangular in cross section, which comprises progressively applying oxidizing gas streams to successive portions of two opposite surfaces of said body so as to remove surface metal therefrom, the surface metal to which said gas streams are applied being substantially at an ignition temperature, and, during the application of said gas streams, applying gaseous blasts against the surfaces adjacent to those from which surface metal is being removed so as to prevent removed metal from collecting on such adjacent surfaces.

3. A method of desurfacing a body of ferrous metal, which comprises progressively applying an oxidizing gas stream to successive portions of a surface so as to remove metal therefrom, the surface metal to which said gas stream is applied being substantially at an ignition temperature, and, during the application of said gas stream, applying an air blast against a surface of the body adjacent to that from which surface metal is being removed, said air blast being directed obliquely against said adjacent surface and toward the portion of the surface from which metal is being removed so as to prevent removed metal from collecting on said adjacent surface.

4. A method of desurfacing a body of ferrous metal substantially rectangular in cross section, which comprises progressively applying oxidizing gas streams to two opposite surfaces so as to remove surface metal therefrom, the surface metal to which said gas streams are applied being substantially at an ignition temperature, and, during the application of said gas streams, applying air blasts against the surfaces adjacent to those from which surface metal is being removed, said air blasts being directed at an acute angle to said adjacent surfaces and toward the portions of the surfaces from which metal is being removed so

as to prevent removed metal from collecting on said adjacent surfaces.

5. A method of removing metal from the surface of a body of ferrous metal, which comprises progressively applying an oxidizing gas stream to successive surface portions so as to at least partially oxidize surface metal and remove the same in the form of a slag, the surface metal to which said gas stream is applied being substantially at an ignition temperature, said gas stream having a component tending to force slag over an adjacent surface of the body, and, during the application of said gas stream and adjacent the immediate region where it impinges on the surface, applying a gaseous blast of sheet-like form against said adjacent surface, said gaseous blast being directed toward the surface from which metal is being removed so as to deflect away from said adjacent surface the component of said gas stream tending to force slag over said adjacent surface.

6. A method of removing metal from the surface of a body of ferrous metal, which comprises progressively applying a high temperature heating flame and an oxidizing gas stream simultaneously against successive portions of a surface so as to remove a desired area of surface metal therefrom, said gas stream having a component tending to force removed metal over an adjacent surface of the body, and, during the application of said gas stream, deflecting away from said adjacent surface the component of said gas stream tending to flow over said adjacent surface so as to maintain the same clean and free of removed metal.

7. In apparatus for desurfacing bodies of ferrous metal, the combination with means for supporting such a body, of means for delivering an oxidizing gas stream obliquely against a surface of the body to remove metal therefrom by a high temperature reaction producing a fluid slag, means for relatively moving said gas delivering means and the body, and means disposed near a surface of the body adjacent to that upon which the gas stream is delivered adapted to deflect portions of slag away from such adjacent surface and maintain the latter substantially clean and free of removed metal during a desurfacing operation.

8. In apparatus for desurfacing bodies of ferrous metal rectangular in cross section, the combination with means for supporting such a body, of means for delivering oxidizing gas streams obliquely against opposite surfaces of the body to remove metal therefrom by a high temperature reaction producing a fluid slag, means for relatively moving said gas delivering means and the body, and means disposed near the surfaces adjacent to those against which the gas streams are delivered adapted to deflect slag away from such adjacent surfaces and maintain such adjacent surfaces clean and free of removed metal during a desurfacing operation.

9. In apparatus for removing metal from the surface of a body of ferrous metal, the combination with means for supporting such a body, of means for delivering an oxidizing gas stream obliquely against a surface area of the body to maintain a reaction zone removing metal therefrom, means for relatively moving said gas delivering means and the body, and means disposed near said reaction zone for applying a gaseous blast against a surface area of said body adjacent to said reaction zone and for directing said blast so as to prevent removed metal from collecting on such adjacent surface.

10. In apparatus for desurfacing bodies of ferrous metal, the combination with means for supporting such a body, of means including a gang of nozzles for delivering against a surface of a body an oxidizing gas stream to remove metal therefrom, means for relatively moving said gang of nozzles and the body, and means including a manifold having a plurality of spaced openings for delivering a gaseous blast of sheet-like form against a surface of the body adjacent to that against which the gas stream is delivered to prevent removed metal from collecting on such adjacent surface.

11. In apparatus for desurfacing bodies of ferrous metal rectangular in cross section, the combination with means for supporting such a body, of means for delivering an oxidizing gas stream across an entire surface of the body to remove a layer of metal therefrom, means for relatively moving said gas delivering means and the body, said gas stream having components tending to flow over the edges of the surface against which it is delivered and force slag over the adjacent surfaces at right angles thereto, and means to deflect away from said adjacent surfaces the components of said gas stream tending to force slag over the edges of the surface to which it is applied to maintain the adjacent surfaces clean and free of removed metal during a desurfacing operation.

12. Apparatus for removing metal from a surface of a body of ferrous metal, such apparatus comprising, in combination, nozzle means for delivering an oxidizing gas stream obliquely against a surface area of said body to remove metal from said surface, and gas blast delivering means connected to said nozzle means to move in unison therewith and so positioned relatively thereto that the blast delivering means is adapted to apply a gas blast obliquely against a surface of said body adjacent said surface area and toward the latter, thereby counteracting accumulation and adherence of slag or molten metal on such adjacent surface.

13. Apparatus for removing surface metal from a body of ferrous metal which comprises the combination of nozzle means for delivering an oxidizing gas stream at an acute angle against a surface of the body to maintain a high temperature reaction zone removing metal therefrom when moved relatively to said surface and toward surface metal to be removed, and for delivering high temperature heating flames adjacent said oxidizing gas stream and toward said reaction zone so as to assist said surface removal; and means connected with said nozzle means to move in unison therewith for providing and directing an air blast at a different acute angle against surface metal immediately adjacent said reaction zone and inclined toward said reaction zone to counteract the tendency of slag to flow out of said zone toward said adjacent surface and thereby maintain the same free of deposited slag.

14. A method of thermo-chemically removing metal from a body of ferrous metal which comprises progressively applying an oxidizing gas stream to successive portions of said body to effect a thermo-chemical reaction along a path producing a molten slag, the metal to which said gas stream is applied being substantially at an ignition temperature; and during the application of said gas stream and while the slag being produced is still molten, applying a gaseous blast

obliquely against a surface area of said body onto which said molten slag tends to flow, said blast being directed toward said molten slag so as to counteract adherence of slag or molten metal on such surface.

15. A method of thermo-chemically removing metal from a body of ferrous metal which comprises progressively applying an oxidizing gas stream to successive portions of said body along a path to effect a thermo-chemical metal consuming reaction producing a molten slag, the metal to which said gas stream is applied being substantially at an ignition temperature; and during the application of said oxidizing gas stream, and while said slag is still molten, applying a blast of oxygen obliquely against a surface area of said body on which said fluid slag tends to flow, said blast being directed to impinge against said molten slag so as to counteract adherence of slag or molten metal contained in said slag on such surface area.

16. A method of thermo-chemically removing metal from a ferrous metal body which comprises applying a highly oxidizing gas stream against successive portions of said body to effect a metal consuming reaction producing a fluid slag, said portions being at or above the oxygen ignition temperature and said oxidizing gas flowing downwardly toward a lower surface of said body whereby said fluid slag tends to adhere on said lower surface; and counteracting such adherence of slag by applying against such slag while it is hot a stream of oxidizing gas.

17. A method of thermo-chemically removing metal from a body of ferrous metal which comprises progressively applying an oxidizing gas stream to successive portions of a surface area, said portions being at or about the oxygen ignition temperature for effecting a metal consuming reaction producing a fluid slag, said slag tending to flow away from the point of impingement of said stream and onto an adjacent surface area; and counteracting the adherence of such slag on said adjacent surface by applying against such slag while it is hot a stream of oxidizing gas.

18. Apparatus for thermo-chemically removing metal from a body of ferrous metal, such apparatus comprising, in combination, a nozzle means for delivering an oxidizing gas stream against a heated surface area of said body to effect a thermo-chemical reaction removing metal therefrom; and gas blast delivering means connected to said nozzle means to move in unison therewith and so positioned relatively thereto that the blast delivering means is adapted to apply a gas blast obliquely against a surface of said body immediately adjacent said surface area and toward the latter, thereby counteracting accumulation and adherence of slag or molten metal on such adjacent surface.

19. Apparatus for thermo-chemically removing metal from a body of ferrous metal, such apparatus comprising, in combination, nozzle means for delivering an oxidizing gas stream against a heated surface area of said body to effect a thermo-chemical metal consuming reaction producing a fluid slag; means for relatively moving said nozzle means and said body in a direction substantially parallel to said surface; and gas blast delivering means connected to move simultaneously with said nozzle means, and so positioned relatively thereto that the blast delivering means is adapted to apply a gas blast obliquely against a surface of said body on which said slag tends to flow and directed toward said slag to counteract accumulation and adherence of slag or molten metal on such adjacent surface.

HANS R. PUFAHL.
JAMES H. BUCKNAM.

CERTIFICATE OF CORRECTION.

Patent No. 2,168,581. August 8, 1939.

HANS R. PUFAHL, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 30, after the word "surfaces" insert the words adjacent to the surfaces; page 2, first column, line 30, for "volocity" read velocity; page 5, second column, line 8, claim 18, strike out "a" before "nozzle; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of September, A. D. 1939.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

obliquely against a surface area of said body onto which said molten slag tends to flow, said blast being directed toward said molten slag so as to counteract adherence of slag or molten metal on such surface.

15. A method of thermo-chemically removing metal from a body of ferrous metal which comprises progressively applying an oxidizing gas stream to successive portions of said body along a path to effect a thermo-chemical metal consuming reaction producing a molten slag, the metal to which said gas stream is applied being substantially at an ignition temperature; and during the application of said oxidizing gas stream, and while said slag is still molten, applying a blast of oxygen obliquely against a surface area of said body on which said fluid slag tends to flow, said blast being directed to impinge against said molten slag so as to counteract adherence of slag or molten metal contained in said slag on such surface area.

16. A method of thermo-chemically removing metal from a ferrous metal body which comprises applying a highly oxidizing gas stream against successive portions of said body to effect a metal consuming reaction producing a fluid slag, said portions being at or above the oxygen ignition temperature and said oxidizing gas flowing downwardly toward a lower surface of said body whereby said fluid slag tends to adhere on said lower surface; and counteracting such adherence of slag by applying against such slag while it is hot a stream of oxidizing gas.

17. A method of thermo-chemically removing metal from a body of ferrous metal which comprises progressively applying an oxidizing gas stream to successive portions of a surface area, said portions being at or about the oxygen ignition temperature for effecting a metal consuming reaction producing a fluid slag, said slag tending to flow away from the point of impingement of said stream and onto an adjacent surface area; and counteracting the adherence of such slag on said adjacent surface by applying against such slag while it is hot a stream of oxidizing gas.

18. Apparatus for thermo-chemically removing metal from a body of ferrous metal, such apparatus comprising, in combination, a nozzle means for delivering an oxidizing gas stream against a heated surface area of said body to effect a thermo-chemical reaction removing metal therefrom; and gas blast delivering means connected to said nozzle means to move in unison therewith and so positioned relatively thereto that the blast delivering means is adapted to apply a gas blast obliquely against a surface of said body immediately adjacent said surface area and toward the latter, thereby counteracting accumulation and adherence of slag or molten metal on such adjacent surface.

19. Apparatus for thermo-chemically removing metal from a body of ferrous metal, such apparatus comprising, in combination, nozzle means for delivering an oxidizing gas stream against a heated surface area of said body to effect a thermo-chemical metal consuming reaction producing a fluid slag; means for relatively moving said nozzle means and said body in a direction substantially parallel to said surface; and gas blast delivering means connected to move simultaneously with said nozzle means, and so positioned relatively thereto that the blast delivering means is adapted to apply a gas blast obliquely against a surface of said body on which said slag tends to flow and directed toward said slag to counteract accumulation and adherence of slag or molten metal on such adjacent surface.

HANS R. PUFAHL.
JAMES H. BUCKNAM.

CERTIFICATE OF CORRECTION.

Patent No. 2,168,581. August 8, 1939.

HANS R. PUFAHL, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 30, after the word "surfaces" insert the words adjacent to the surfaces; page 2, first column, line 30, for "volocity" read velocity; page 5, second column, line 8, claim 18, strike out "a" before "nozzle; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of September, A. D. 1939.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)