July 26, 1938. W. J. JACOBSSON ET AL 2,125,182

METHOD OF FLAME MACHINING

Original Filed Dec. 4, 1934

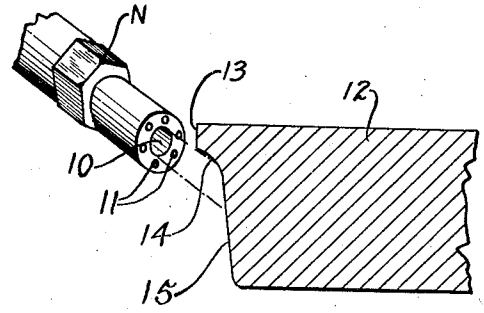


fig 1

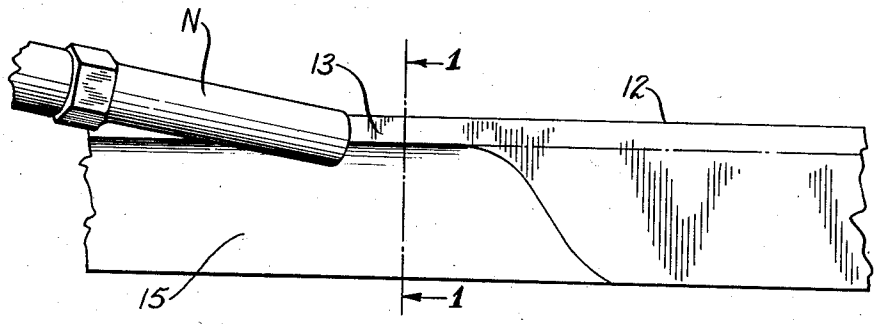


fig 2

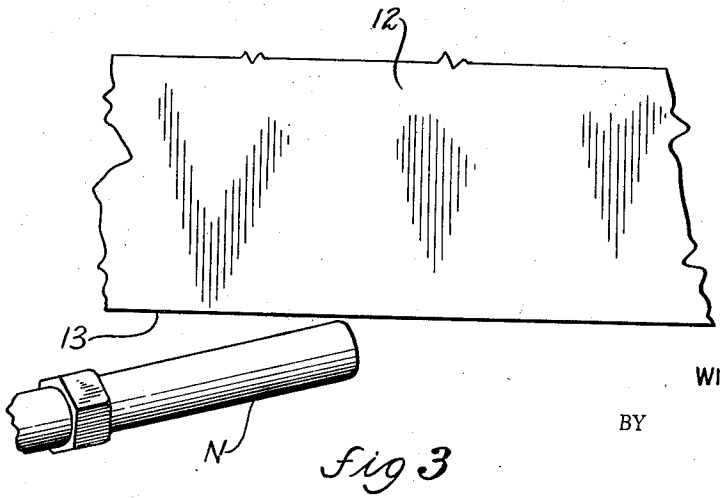


fig 3

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Patented July 26, 1938 2,125,182

UNITED STATES PATENT OFFICE

2,125,182

METHOD OF FLAME MACHINING

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Application December 4, 1934, Serial No. 756,000
Renewed April 23, 1938

14 Claims. (Cl. 148—9)

This invention relates to a method of flame machining in which metal at an ignition or kindling temperature is removed from the surface of a metallic body by progressively applying an oxidizing gas stream on successive portions of such surface.

In many instances it is desirable to remove metal from only a portion of a metallic surface to produce a cut which slopes inward from an uncut portion of the surface and extends to an extreme edge of the metallic body. This is particularly true when it is desired to produce cuts at the edges of plates or other structural shapes which are subsequently united by welding. Such cuts or bevels may take the shape of a half U so that, when two plates having such cuts are arranged with the beveled edges adjacent to each other, a U-shaped groove is provided that is suitable for welding.

Ordinarily there is a tendency for fin material to remain at the edges of a cut. The formation of these fins is due to the washing effect of the slag as it is forced out of a cut and over the surface of the metallic body by the force of the oxidizing gas stream. The slag may comprise both oxidized metal and fused or molten metal, and the latter has a tendency to freeze on the sides of a cut and is exceedingly difficult to remove.

In order to provide cuts of the character above described, which are smooth and of uniform shape with substantially no fin material formed at the edges of a cut, we provide an improved method of flame machining whereby an oxidizing gas stream is progressively applied on successive surface portions, the axis of the oxidizing gas stream being at an acute angle to the surface and inclined in a direction away from an uncut portion of the surface. Preferably the oxidizing gas stream is applied on the lower portion of the edge surface of a substantially horizontal metallic plate, the oxidizing gas stream being slightly inclined downwardly and at an acute angle to the edge surface in the direction of the successive surface portions from which metal is to be removed, and relatively moving the gas stream and the surface. By inclining the oxidizing gas stream away from the uncut portion of the edge surface, all of the slag is effectively swept sideways of the cut and off the newly exposed surface that is produced.

The present method may be effectively carried out in practice in the manner shown in the accompanying drawing, in which:

Fig. 1 is a sectional view, taken at line 1—1 of Fig. 2, to illustrate the relative position of a nozzle with respect to the edge of a metallic plate from which metal is removed to produce a half U-shaped cut;

Fig. 2 is a side view of the nozzle and plate shown in Fig. 1 to illustrate the downward inclination of the nozzle as it is moved parallel to the edge of the plate; and

Fig. 3 is a plan view of the nozzle and plate shown in Fig. 1 to illustrate the application of the oxidizing gas stream at an acute angle to the edge surface of the plate.

To remove surface metal it must be heated to an ignition or kindling temperature before the oxidizing gas stream is applied thereto. The entire metallic body may be heated to an ignition temperature, as in a furnace, or an electric arc or high-temperature heating flame may be utilized to heat successive portions of the surface metal to an ignition temperature prior to the application of the oxidizing gas stream. We preferably employ a single nozzle N to provide an oxidizing gas stream and a plurality of high-temperature heating flames. The blowpipe nozzle N may have a central passage 10 for an oxidizing gas, such as oxygen or a mixture of oxygen and air, to provide an oxidizing gas stream. A plurality of passages 11 surrounding the central passage 10 may be provided for a combustible gas, such as a mixture of oxygen and acetylene, to produce heating flames to heat the metal to be removed to an ignition temperature. Nozzles of this character are described and claimed in W. S. Walker and W. J. Jacobsson application, Serial No. 536,254, filed May 9, 1931.

The nozzle N may be moved relatively to the edge of the plate 12 in any suitable manner. In order to produce straight cuts a self-propelled carriage is preferably used. Such a carriage may be driven on the surface of the plate 12 and guided by a rail mounted thereon, the carriage having an arm secured thereto which extends beyond the edge of the plate. On this arm may be mounted a downwardly extending bracket to which the nozzle N can be adjustably secured. Apparatus of this character is described and claimed in J. H. Bucknam and H. J. Miller application, Serial No. 1,470 filed January 12, 1935.

In order to remove surface metal according to the present method, the nozzle N is positioned at the edge surface of a substantially horizontal plate 12 so that its longitudinal axis is slightly inclined downwardly and also at an acute angle to the surface. The oxidizing gas stream discharged from the tip of the nozzle is applied ad-

jacent the uncut portion 13 of the surface and substantially in the direction of the successive surface portions from which metal is to be removed.

The combustible gas issuing from the passages 11 heats the metal directly ahead of the nozzle to an ignition temperature, and the oxidizing gas contacting the heated metal causes the same to ignite and burn. Upon striking the edge of the plate 12 at an acute angle, the gas stream produces the curved portion 14 of the cut. The oxidizing gas stream is deflected by the curved portion 14 it produces, and sweeps over the lower portion of the heated surface to the extreme lower edge of the plate to produce the substantially straight portion 15 of the cut, which is at an acute angle to the uncut portion 13 at the edge of the plate, as shown in Fig. 1.

This burning or oxidation of surface metal just described takes place progressively as each successive portion of heated surface metal comes in contact with the oxidizing gas stream. By producing a cut in this manner at the vertical edge of the plate 12 with the oxidizing gas stream slightly inclined downwardly and away from the uncut portion of the edge surface, the metal removed is effectively carried away so that the newly exposed surface produced is exceptionally smooth and of uniform shape with no accumulation of slag or fin material at the extreme lower edge of the cut. In addition, by removing metal from an initially exposed vertical surface, the force of gravity is utilized to aid the oxidizing gas stream in carrying the removed metal from the cut surface.

Although the surface metal removed can be reduced completely to an oxidized form, considerable economy can be effected in the amount of oxidizing gas used by removing a substantial portion of the surface without completely oxidizing it. The metal removed comprising a mixture of oxidized metal and molten metal has been termed a "slag"; and such slag blown ahead of or sideways of a cut as it is being made, is reduced substantially to a non-adherent granular state.

Since the oxidizing gas stream preferably is applied directly and progressively to the initially exposed substantially vertical edge surface between the upper and lower margins of said surface and downwardly obliquely across the remainder of said surface, said stream does not attack or affect the portion 13 of the initially exposed edge surface but leaves the portion 13 intact and removes surface metal only between the portion 13 and the lower margin of the edge surface, thus providing an edge suitably shaped and prepared for welding the same to a similarly shaped edge.

Flame machining according to the above described method has been successfully carried out in practice with oxidizing gas velocities ranging from 200 to 1,000 feet per second. In most applications, however, the pressure of the oxidizing gas is adjusted to produce an oxidizing gas stream having a velocity between 550 and 750 feet per second. The velocities of the oxidizing gas stream just given are the calculated velocities of the gas discharged from the nozzles, based on the assumption that a measured quantity of gas discharged in a given time has a temperature of 70° F. and is at atmospheric pressure.

The present method of flame machining is particularly useful in preparing the edges of relatively thick metal plates for welding. The finished surface, flame machined as described, carries a very thin coating of iron oxides after the loose magnetic oxide has been removed from the surface. The thickness of this iron oxide film is substantially equal to a wave length of light, and beneath such oxide film there is a thin layer of metal containing carbon in an amount greater than that of the original metal before the flame machining operation. In this manner the flame machined surface is so conditioned and improved that subsequent welding of two plates having such surfaces is considerably facilitated, and the resulting welded joint has a strength and uniformity superior to joints heretofore produced in this field of welding.

The shape of the cut produced is dependent upon the velocity of the oxidizing gas stream and its rate of movement with respect to the surface of a metallic body, and the particular angle at which the gas stream is applied on the surface. Generally the velocity of the gas stream and its rate of movement with respect to the surface are selected to obtain maximum gas economy. By varying the angle at which the gas stream is applied on the surface, cuts having a predetermined sectional contour can be produced. It will therefore be understood that the present method of flame machining is not limited to the particular shaped cut illustrated and described herein.

We claim:

1. A method of flame machining in which metal at an ignition temperature is removed from the lower portion of a substantially vertical and initially exposed surface of a metallic body, such metal being removed to produce a cut having one edge thereof sloping inward and downward from an uncut portion of said surface, which comprises directing against said surface adjacent the uncut portion thereof a relatively low-velocity large-volume oxidizing gas stream inclined downwardly across and at an acute angle lengthwise of said surface; said stream being directed toward the successive surface portions from which metal is to be removed; and applying said gas stream progressively against successive portions of said surface.

2. A method of removing metal from a substantially vertical and initially exposed surface of a metallic body to produce a cut having one edge thereof sloping inward from an uncut portion of said surface, such cut extending to the extreme lower edge of said body, which comprises applying at least one heating flame against said surface to heat the same to an ignition temperature; applying against said heated surface adjacent the uncut portion thereof a relatively low-velocity large-volume oxidizing gas stream inclined downwardly across and at an acute angle lengthwise of said surface; said stream being directed toward the successive surface portions from which metal is to be removed; and relatively moving said oxidizing gas stream and the metallic body; said oxidizing gas stream having sufficient velocity to at least partially oxidize successive portions of the surface metal at an ignition temperature and blow the same, in the form of a slag, ahead of said oxidizing gas stream and off the newly exposed surface produced.

3. A method of removing metal from a substantially vertical and initially exposed surface of a metallic body to produce a cut sloping inward from an uncut portion of said surface and extending to the extreme lower edge of said body, which comprises applying a gaseous heating flame on

such surface metal to heat the same to a temperature at which it will ignite when an oxidizing stream is applied thereon; applying on said heated surface adjacent the uncut portion thereof a relatively low-velocity large-volume oxidizing gas stream inclined downwardly across and at an acute angle lengthwise of said surface; said stream being directed toward the successive surface portions from which metal is to be removed; and relatively moving said heating flame and said gas stream with respect to said surface.

4. A method of removing metal at an ignition temperature from a substantially vertical and initially exposed surface of a metallic body to produce a cut sloping inward from an uncut portion of said surface and extending to the extreme lower edge of said body, which comprises applying against said surface adjacent the uncut portion thereof an oxidizing gas stream having a velocity of between 200 and 1,000 feet per second; and relatively moving said gas stream and said surface; said gas stream being inclined downwardly across and at an acute angle lengthwise of said surface, and directed toward the successive surface portions from which metal is to be removed during such relative movement.

5. A method of preparing a plate or other structural shape for welding by removing surface metal at an ignition temperature from a portion of an initially exposed edge surface to produce a cut sloping inward from an uncut portion of said surface and extending to an extreme edge of said plate, which comprises directing a relatively low-velocity large-volume oxidizing gas stream downwardly across and at an acute angle lengthwise of said surface and in the direction of the successive surface portions from which metal is to be removed; and progressively applying said oxidizing gas stream across successive portions of said surface so that the removed metal is blown ahead of and sideways of the cut as it is being made.

6. A method of preparing a plate or other structural shape for welding by removing surface metal at an ignition temperature from a portion of an initially exposed edge surface to produce a cut sloping inward from an uncut portion of said surface and extending to an extreme edge of said plate, which comprises progressively applying against and transversely of successive portions of such surface an oxidizing gas stream having a velocity between 200 and 1,000 feet per second, said oxidizing gas stream being applied at an acute angle lengthwise of said surface and directed toward the successive portions from which metal is to be removed so as to blow the metal removed ahead of and sideways of the cut as it is being made.

7. A method of providing a predetermined sectional contour along an initially exposed edge surface of a metal plate which comprises supporting said plate in a substantially horizontal position; and simultaneously and progressively applying to and downwardly across said edge surface kindling heat and a relatively low-velocity large-volume oxidizing gas stream, the axis of said oxidizing stream being at an acute angle lengthwise of said edge and directed toward the successive surface portions from which metal is to be removed.

8. A method of providing a predetermined sectional contour along an initially exposed edge surface of a metal plate which comprises supporting said plate in a substantially horizontal position; and simultaneously and progressively applying to and downwardly across said edge surface kindling heat and a relatively low-velocity large-volume oxidizing gas stream, said oxidizing gas stream being applied below the top surface of said plate, positioned at an acute angle lengthwise of said edge surface, and directed toward the successive surface portions from which metal is to be removed so as to undercut said plate and leave an uncut portion of said edge surface adjacent to the top surface of said plate.

9. A method of preparing an exposed edge of a metal plate or shape for welding which comprises applying a relatively low-velocity large-volume oxidizing gas stream directly to successive portions of the surface of said edge between the margins of said surface while such portions are at an ignition temperature, said stream being inclined relatively to the plane of said surface and also inclined relatively to the margins of said surface, whereby said stream does not attack a portion of the original surface of said edge adjacent one margin thereof but flows across said surface and removes surface metal from the remainder of said edge to the other margin of said surface.

10. A method of removing surface metal from an exposed surface of a metal plate or shape which comprises applying a relatively low-velocity large-volume oxidizing gas stream directly against successive portions of said surface between the margins thereof while such portions are at an ignition temperature, said stream being applied at an acute angle lengthwise of said surface at a distance from one of said margins and obliquely across the remainder of said surface and the other of said margins, whereby a portion of said exposed surface remains intact and metal is removed from the remainder of said surface.

11. A method of preparing an initially exposed edge of a plate or shape for welding which comprises applying a relatively low-velocity large-volume oxidizing gas stream directly to successive portions of the surface of said edge between the margins of said surface while such portions are at an ignition temperature, said stream being applied at an acute angle lengthwise of said surface at a distance from one of said margins and obliquely across the remainder of said surface and the other of said margins, whereby a portion of said surface remains intact and metal is removed from the remainder of said surface.

12. A method of preparing an initially exposed edge of a plate or shape for welding which comprises disposing said edge in a substantially vertical position, and applying a relatively low-velocity large-volume oxidizing gas stream directly against successive portions of the surface of said edge below the upper margin of said surface and throughout the entire length of said plate while such portions are at an ignition temperature, said stream being applied at an acute angle lengthwise of said surface and downwardly obliquely across the remainder of said surface and the lower margin thereof, whereby a portion of such initially exposed edge surface adjacent the upper margin remains intact and metal is removed from the remainder of said surface, the thickness of such removed metal increasing toward said lower margin.

13. A method of preparing the edge of a metal plate for welding which comprises progressively and concurrently advancing a high-temperature heating flame and a relatively low-velocity oxidizing jet longitudinally of said edge throughout the entire length of said plate while applying said flame and said jet obliquely against said edge along a path below the upper face of said plate

and also downwardly toward the lower margin of said edge, whereby an initial portion of said edge remains intact and metal is progressively removed from a portion of said edge between such intact portion and said lower margin.

14. A method of preparing metal plates and the like for welding which comprises concurrently moving a high-temperature heating flame and a relatively low-velocity oxidizing jet longitudinally throughout the entire length of an edge of said plate; directing said oxidizing jet against said edge at a point below the top margin and downwardly across the lower margin thereof, at an acute angle lengthwise of said edge, and in the direction of the movement of said flame and oxidizing jet.

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