

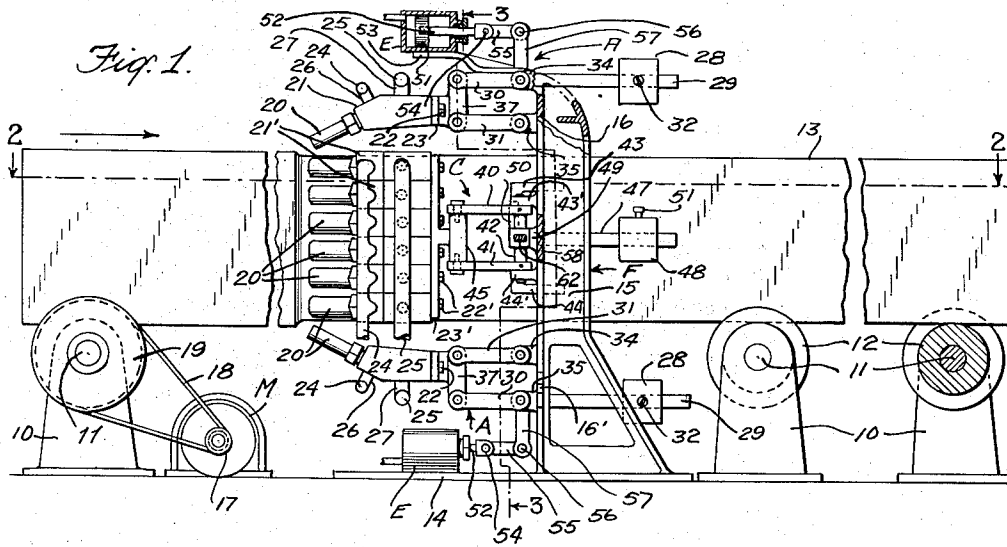
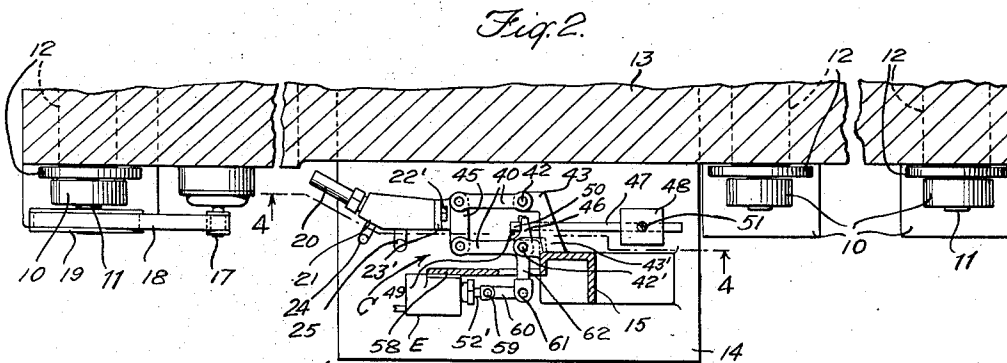
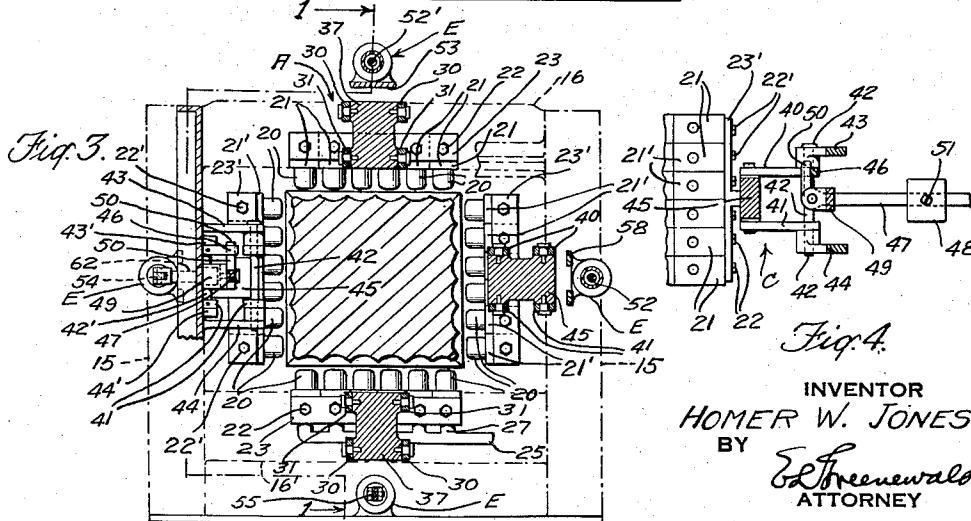
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APPARATUS FOR REMOVING METAL FROM THE SURFACES OF METALLIC BODIES

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My invention relates to apparatus for removing metal from the surfaces of metallic bodies, particularly bodies of ferrous metal having rectangular cross sections.

5 It has generally been the practice heretofore to employ heavy machine tools, such as planing, shaping, milling, and chipping machines, for removing or cutting metal from the surfaces of metallic bodies. Such machines are not entirely
10 satisfactory, because they remove metal at a very slow rate. Further, they are expensive, and their operating costs are high because power is required both for relatively moving the cutting tool and the metallic body and for carrying out
15 a cutting operation. In such machines, also, the greater the hardness of metal the greater is the amount of power required to make a cut.

Within the last few years the objections of heavy machine tools have been avoided by em-
20 ploying blowpipes having nozzles particularly adaptable for removing surface metal from metallic bodies. These nozzles are constructed so as to permit the passage of comparatively large volume of oxidizing gas at a relatively low velocity in such a manner that surface metal is re-
25 moved and cuts or grooves are produced having gradually sloping sides. By making cuts in this manner, the sloping sides thereof which have fins will tend to flatten out and will not fold over and be rolled into the metallic body upon further
30 rolling thereof.

In removing surface metal in steel mill operations it has been the practice for an inspector to draw chalk marks around the defects and seams
35 on the surfaces of a semi-finished shape. An operator employing a blowpipe of the character just described then removes the defects marked on the top surface of the metallic body and, after such defects are removed, the metallic body is
40 turned or rotated to present other surfaces to the operator in order to enable him to remove easily the defects in the metallic body.

It has not been entirely satisfactory to remove metal from the surfaces of metallic bodies when
45 different surfaces of a bar or slab or successive portions of the peripheral surface of a round billet are presented to form a top surface, because in this position there is a tendency generally for fin material to remain on each side of
50 a cut, e. g., a groove or channel so cut in the surface. The formation of fins is due to the washing effect of the slag as it is forced out of such cut and over the surface of the work by the force of the oxidizing gas stream. The slag
55 may comprise both oxidized 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.

I have found that the amount of fin material formed can be reduced considerably by applying
5 the oxidizing gas streams so as to impinge simultaneously on regions extending entirely across a surface to be removed, such as the top, side walls and bottom of a metallic body. By this method, the oxidized and fused or molten metal is forced
10 out of a cut by the force of the oxidizing gas stream and falls away from the cut by the force of gravity. When surface metal is removed in this manner, a substantially smaller amount of fin material is produced on the sides of a cut
15 and a desirable corner formation results. Since it is desirable to utilize the force of gravity for reducing the amount of fin material produced on the sides of a cut, my method is particularly
20 adaptable for simultaneously removing surface metal from all sides of a multi-sided metallic body or for removing surface metal from the entire peripheral surface of a round metallic body. In such cases the fin material will be greatest
25 where the force of gravity is least effective in carrying away the metal removed by the oxidizing gas stream.

An object of my invention, therefore, is to remove metal simultaneously from opposite sur-
30 faces of metallic bodies with an oxidizing gas stream in such a manner that the force of gravity can be utilized for carrying away the metal removed.

Another object of my invention is to remove surface metal simultaneously from all sides or
35 the entire peripheral surface of a metallic body by applying oxidizing gas streams against the metallic body along a zone extending about the entire perimeter thereof, and by moving the oxidizing gas streams and metallic body relatively
40 to each other.

A further object of my invention is to provide an improved apparatus for removing metal or defects from the surfaces of metallic bodies
45 with oxidizing gas streams.

A further object of my invention is to provide apparatus for effectively removing surface metal with an oxidizing gas stream from the top, sides
50 and bottom of a metallic body.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the various features of novelty which characterize my invention are pointed out with particularity in the claims an-
55

nexed to and forming a part of this specification. In the drawing:

Fig. 1 is a side elevation, partly in section, of apparatus embodying the principles of my invention for removing metal from the surfaces of the side walls and top and bottom of a metallic body, the grooves formed by the removal of the metal being omitted for clearness;

Fig. 2 is a fragmentary sectional view taken on line 2—2 of Fig. 1 to illustrate more clearly the portion of the apparatus for removing surface metal from a side wall of the metallic body;

Fig. 3 is a sectional view taken on line 3—3 of Fig. 1; and

Fig. 4 is a sectional view taken on line 4—4 of Fig. 2.

Referring to the drawing, the apparatus for removing surface metal in accordance with the principles of my invention may comprise a plurality of pedestals 10 having shafts 11 journaled thereon to which are secured rollers 12 to provide a conveyor for supporting and moving a number of metallic bodies, such as a rectangular shaped billet 13 in the direction of their lengths, through an opening formed in a frame F for supporting the cutting gas apparatus. The frame structure F may comprise a base 14 and vertical side members 15 to which are secured upper and lower transverse members 16 and 16', respectively.

The billets 13 may be moved in any suitable manner, and as shown a variable speed driving motor M having a pulley 17 secured to the shaft thereof drives a belt 18 which is connected to a pulley 19 secured to one end of a shaft 11 for driving a roller 12. Although only one roller 12 is shown as driven, it is to be understood that other rollers 12 may be driven in a similar manner to insure a continuous movement of a number of billets 13 toward and away from the frame structure F.

In the apparatus shown, the oxidizing gas stream applying devices are arranged to apply the oxidizing gas so as to impinge against a zone of surface extending entirely across all four faces of the billet 13 and comprise gangs of blowpipes or torches 21 having nozzles 20 disposed at an acute angle to the direction in which the applied streams advance over the surfaces of the top, bottom, and side faces. Each nozzle 20 is adapted for applying heating jets and/or oxidizing gas streams obliquely against a surface of the billet 13 to remove metal therefrom as the billet is moved relatively to the nozzles. In this arrangement, effects resulting from the application of an oxygen stream and high temperature heat on one face of the billet are compensated for by the effects produced by similarly applying oxygen and high temperature heat to the opposite face of the billet.

In removing surface metal with oxidizing gas streams, a portion of the metal is preferably removed in an oxidized form and another portion is removed in the form of molten metal which is blown away with the oxidized metal by the oxidizing gas streams. To remove metal a portion at least of the surface must be raised to an ignition or kindling temperature before the oxidizing gas stream is applied thereto. The entire metallic body can be raised to an ignition temperature, as in a furnace, or successive portions of the surface metal can be progressively raised to an ignition temperature prior to the application of the oxidizing gas stream, as by the blowpipe nozzles 20.

The blowpipe nozzles 20 are so constructed that they will permit the passage of a comparatively large volume of oxidizing gas at a relatively low velocity, and may comprise a central passage for an oxidizing gas to provide an oxidizing gas stream. A plurality of passages surrounding the central passage may be provided for a combustible gas to produce a heating flame to raise the metal to be removed to an ignition temperature. Suitable nozzles of the character indicated are disclosed in my copending application Serial No. 695,571, filed October 28, 1933.

As shown in the drawing, a plurality or gang of nozzles 20 are arranged adjacent to each other and inclined relatively to the top, bottom, and side surfaces of the billet 13 to apply oxidizing gas streams obliquely against and lengthwise of said surfaces for removing metal in a single pass from the entire peripheral surface of the billet. The nozzles 20 are threadedly secured to nozzle heads or torches 21 having an oxidizing gas passage and a combustible gas passage communicating with similar passages in the nozzles 20. The nozzles disposed at the top and bottom of the billet 13 are arranged adjacent to each other by securing their respective nozzle heads 21 by cap screws 22 to bars 23, and the nozzles at the sides of the billet are similarly arranged by securing their respective nozzle heads by cap screws 22' to bars 23'. The outside nozzles 20 may be arranged sufficiently near the corners of the bar or billet so that the oxidizing gas streams will flow over such corners. In this manner, the surfaces of the corners are removed and the corners may be more or less convexly rounded.

The oxidizing gas, such as oxygen or a mixture of oxygen and air, and a combustible gas, such as a mixture of oxygen and acetylene, may be delivered from a suitable source of supply through flexible conduits (not shown) to manifolds 24 and 25 having connections 26 and 27, respectively, communicating with the oxidizing and combustible gas passages in the heads 21 and 21'.

In removing a shallow layer of surface metal by moving the billet 13 with respect to the nozzles 20, it may be desirable under certain conditions to permit the tips of the nozzles to rest or ride on the newly-exposed surface; and under other conditions it may be desirable to maintain the tips of the nozzles spaced from the surface, as will be hereinafter explained.

When a layer of surface metal is removed with the tips of the nozzles riding on the newly-exposed surface, it is desirable that the tips of the nozzles only bear lightly on the surface of the work, so as to minimize the friction and chattering between the nozzles and the work. For this reason, the groups of nozzles 20 and heads 21 disposed at the top and bottom surfaces of the billet 13 are counterbalanced in a suitable manner, so that the top and bottom groups of nozzles 20 will bear lightly and yieldingly follow the channel formed. The groups of nozzles disposed at the sides of the billet 13 are arranged to be urged likewise toward the side surfaces in such a manner that the nozzles will bear lightly and yieldingly follow the channels formed.

Referring to the group of nozzles 20 and heads 21 disposed adjacent the top and bottom surfaces of the billet 13, in order to prevent the entire weight of these nozzles and heads from riding on the newly-exposed surface, they are counterbalanced by mechanism comprising a weight

28 which is slidably mounted at one end of a lever arm 29. The weight 28 counterbalances the weight of these nozzles 20 and heads 21 through a parallel linkage A comprising a pair of horizontal links 30 arranged in the same horizontal plane in spaced and parallel relation, and a second similarly arranged pair of horizontal links 31 below and in the same vertical planes as the links 30, as shown in Figs. 1 and 3. The links 30 and 31 are pivotally connected at one end thereof to projections 34 and 35, respectively, which may be attached to or formed integral with the upper and lower transverse members 16 and 16', respectively, of the frame structure F. The opposite ends of the links 30 and 31 are pivotally connected to the upper and lower ends and to the opposite sides of a block 37 which serves as a vertical link in the parallel linkage A, and which may be formed integral with the bar 23 to which the nozzle heads 21 are secured. The lever arm 29 forms an extension of one of the horizontal links 30, and by properly positioning the weight 28 thereon by a set screw 32, the weight of the nozzles 20 and heads 21 can be readily counterbalanced, so that the tips of the nozzles 20 will bear lightly on the newly-exposed surface of the billet as the nozzles 20 and billet are moved relatively to each other.

Each group of nozzles 20 disposed at a side of the billet 13 may be maintained in contact with a side surface thereof by a parallel linkage C biased to move the nozzles 20 toward the billet 13. Each linkage C comprises a pair of upper horizontal links 40 arranged in the same horizontal plane and in spaced and parallel relation, and a second similarly arranged pair of lower horizontal links 41 below and in the same vertical planes as the links 40. The links 40 and 41 nearest the billet 13 are secured at one end thereof to a vertical pin 42 which is pivotally mounted on brackets 43 and 44 attached to the vertical side members 15 of the frame structure F, and the outer links 40 and 41 are secured at one end thereof to a vertical pin 42' which is pivotally mounted on projections 43' and 44' attached to the vertical side members 15 of the frame structure F. The opposite ends of the links 40 and 41 are pivotally connected to the top and bottom of a block 45 which serves as the vertical link of the linkage C and which may be formed integral with the bar 23' to which the nozzle heads 21 at the side of the billet 13 are secured.

To cause the linkage C to swing toward the side of the billet 13 so that the tips of the nozzles 20 will contact the side surface thereof, the end of the upper and outermost link 40, which is secured to the pin 42', is provided with a right angle extension 46 extending toward the billet 13; the link 40 and its projection 46 forming a bellcrank, as shown in Fig. 2. In the space between the upper links 40 and lower links 41, a lever arm 47 having a weight 48 slidably mounted thereon, is pivotally connected at one end thereof to a projection 49 attached to a vertical side member 15 of the frame structure F, as most clearly shown in Fig. 4. The pivotally connected end of the lever arm 47 is provided with an upward extending extension 50, the upper end of which is adapted to contact the extension 46 of the upper and outermost link 40 and cause the linkage C to swing on the pivotally mounted pins 42 and 42' toward the billet 13. By properly positioning the weight on the lever arm 47 by a set screw 51, the moment of force of the weight and lever arm can be so adjusted that the nozzles 20 will be

moved by the linkage C to contact the surface of the billet 13 with the tips of the nozzles bearing lightly on the newly-exposed surface as the billet is moved with respect to the nozzles. In a similar manner the group of nozzles 20 disposed at the opposite side of the billet 13 are biased toward the other side surface of the billet to remove surface metal with the tips of the nozzles riding on the new surface produced.

To increase the flexibility of the apparatus, suitable means is provided for maintaining the tips of the nozzles 20 spaced from the top, bottom, and side surfaces of the billet 13. This may be accomplished automatically, as for example by providing cylinders E adapted to be connected to a suitable source (not shown) of compressed air or equivalent motive fluid, and having therein movable pistons 51 connected to piston rods 52 extending through an opening in the end wall of the cylinders.

As shown in Fig. 1, the air cylinder E at the top of the frame structure F is mounted on a plate 53 attached to the upper transverse frame member 16. The end of the piston rod 52 is pivotally connected at 54 to one end of a link 55, the opposite end of which is pivotally connected at 56 to the upper end of a link 57 forming a right angle extension of one of the horizontal links 30 of the linkage A. The horizontal link 30 and its extension 57 form a bellcrank for converting the straight line motion of the piston rod 52 to an angular motion of the linkage A. When the piston 51 is caused to move to the right by admitting air under pressure into the cylinder E, the bellcrank, which is pivotally mounted on the projection 34, will turn to the right and swing the linkage A and nozzles 20 carried thereby upward against the movement of force of the lever arm 29 and weight 28. The distance of the tips of the nozzles 20 from the top surface of the billet can be readily controlled by regulating the pressure of the air in the cylinder E.

A cylinder E is mounted on the base 14 of the frame structure F, and the piston therein is connected to the lower linkage A in the same manner as described above for moving the lower group of nozzles 20 away from the lower surface of the billet and for adjusting the lower nozzles in reference thereto.

The linkages C at the sides of the billet 13 are likewise pivotally connected to the pistons in cylinders E for maintaining the tips of the nozzles 20 spaced from the side surfaces of the billet. As shown in Fig. 2, the cylinder E is mounted on a plate 58 attached to the side member 15 of the frame structure F. The piston rod 52' is pivotally connected at 59 to one end of a link 60, the opposite end of which is pivotally connected at 61 to the outer end of a link 62 forming a right angle extension of one of the upper horizontal links 40 of the linkage C. The outer link 40 and its extension 62 form a bellcrank for converting the straight line motion of the piston rod 52 into an angular motion of the linkage C; and, as explained above in connection with the linkage A, the pressure of air in the cylinders E at the sides of the billet can be controlled so as to regulate the distance of the tips of the nozzles 20 from the side surfaces of the billet.

In the event it is desired to remove surface metal from round billets the nozzles 20 may be arranged on a circular head adapted to encompass the billet so that the nozzles converge on the axis of the billet and form an acute angle therewith of between 10° and 35°. The head may be

made in a plurality of sections and operated by linkage mechanism similar to that shown in the drawing.

The operation of the apparatus illustrated in the drawing is substantially as follows: It will be assumed that the billet 13 or other work is mounted on the rollers 12 and in proper alignment, with the right hand end of the billet 13 adjacent the tips of the nozzles 20; that the positions of the counterweights 28 and 48 on the lever arms 29 and 27, respectively, have been adjusted so that the nozzles 20 will bear lightly on the bottom of the cut; that the source of compressed air is not connected to the cylinders E and that the pistons therein will move freely; and that the manifolds 25 are supplied with a mixture of oxygen and acetylene, respectively.

With the above assumed conditions, the combustible gas issuing from the tips of the nozzles 20 is ignited so that the heating flames will be applied to the entire peripheral surface of the billet at the right hand end thereof. As soon as the portions of the peripheral surface at the end of the billet have reached an ignition temperature, oxygen is supplied to the manifolds 24 and the motor M is connected to a suitable supply of electrical energy (not shown) to drive the billet 13 from left to right, as indicated by the arrow shown in Fig. 1. The oxidizing gas streams issuing from the orifices of the nozzles 20 are applied at an acute angle to the surfaces of the billet 13 and will oxidize the surface metal at the right hand end thereof which has been raised to an ignition temperature by the heating flames; and this oxidized metal, along with molten metal, will be blown ahead of the nozzles 20 in the form of a slag by the force of the oxidizing streams. The several oxygen streams issuing from the four groups of nozzles 20 thus effect superficial metal combustion along a relatively wide transverse zone of each surface of the billet 13 and, during the movement of the billet relatively to the nozzles 20, the volume, velocity, and angle of impingement of the oxygen streams as well as the rate of such movement are so correlated as to maintain such superficial metal combustion on successive surface zones from one end of the billet to its opposite end, to produce continuous and uniform thermo-chemical removal of a wide shallow layer of metal from each of the surfaces of the billet throughout the entire length of the latter.

The tips of the nozzles 20 may rest on the bottom of the cut started at the right hand end of the billet 13, whereupon the latter is moved relatively fast on the rollers 12, the heating flames of the nozzles 20, together with the molten metal and oxides blown ahead of the nozzles, raising successive surface portions to an ignition temperature; and the oxidizing gas streams oxidizing the successive surface portions which have been raised to an ignition temperature. During the entire operation, oxidized and molten metal are blown ahead of the cut by the force of the oxidizing gas streams; while at the sides and bottom of the billet such oxidized and molten metal are effectively carried away by the force of gravity to fall clear of the nozzle supporting mechanism which holds the nozzles offset a substantial distance from the supporting frame.

In the description of the operation of the apparatus, it has been stated that the oxidizing gas streams blow away oxidized and molten surface metal, and this mixture of oxidized and molten surface metal has been termed a "slag".

Although the surface metal removed can be reduced completely to an oxidized form, it has neither been desirable nor necessary to do so in practice. For example, it has been calculated that approximately 4% cubic feet of oxygen are required to oxidize completely one pound of an ordinary grade of low carbon steel containing about .2% carbon. In actual practice it has been possible to remove a pound of this steel with approximately 2 cubic feet of oxygen. It is therefore apparent that a portion of the surface metal removed is in an oxidized state, and that the remaining portion is in a partially oxidized state and in an unoxidized state or molten form. By removing a substantial portion of surface metal without completely oxidizing the same, considerable economy can be effected in the amount of oxidizing gas required to remove metal from the surfaces of metallic bodies.

Although the removed metal or slag blown ahead is reduced substantially to a non-adherent state, there is a tendency for the molten metal forming part of the slag to freeze on the sides of the channel and form fins. By properly controlling and correlating the variable factors, such as the acute angle of the nozzles with respect to the work, the velocity of the oxidizing gas, and the rate of relative movement of the nozzles and the work, the amount of fin material formed can be controlled and the efficiency of the process regulated by the mutual spacing of the oxidizing gas streams and the adjustment of the distance of the nozzles from the work. As stated above, however, it is generally not desirable to completely oxidize the metal removed in order to remove surface metal as economically as possible. It has been found that fin material formed on the sides of a cut when the slag is not completely oxidized is extremely small when the force of gravity can be utilized to carry away the slag from the surface of the work. For this reason, it is a distinct advantage to remove surface metal from the sides and bottom of a metallic body, and at the same time remove such metal with a minimum consumption of oxidizing gas. Where metal is to be removed from a single side or portion of a peripheral surface of a body it can be so arranged that the force of gravity can be effectively utilized to carry away the metal removed. In cases where metal is to be removed from all sides or the entire peripheral surface of a metallic body, it is preferable to remove the surface metal in a single pass of the nozzles relative to the metallic body. In such cases the force of gravity will carry away removed metal from a considerable portion of the peripheral surface of the metallic body.

In normal production work the new surfaces produced are sufficiently smooth for all practical purposes. In certain instances, however, it is desirable to produce particularly smooth surfaces. In order to make channels which are particularly smooth, the nozzles 20 are adjusted so that their tips will be spaced from the bottom surfaces of the channels produced. This is accomplished by connecting the cylinders E to a source of compressed air so that the linkages A, B, and C will swing the nozzles 20 away from the top, bottom and side surfaces of the billet 13 against the moments of force of the lever arms 20 and weights associated with the linkages. By varying the pressure of the air supplied to the cylinders E through a suitable pressure regulating valve or similar device, the distance of the tips of the nozzles 20 from the surfaces of the billet can

be readily controlled. Although smoother cuts are obtained when the tips of the nozzles are spaced from the bottom of a cut, it is considerably more economical to remove metal with the nozzles riding upon the newly-exposed surface, because in the latter case less oxidizing gas is required to remove a pound of metal, other factors remaining substantially the same.

The air cylinders E may also be employed to swing the nozzles 20 away from the surfaces of the work to start a cut at an end or at a point intermediate the ends of the work, or to align the nozzles with respect to the work before starting a cut.

It has been stated that the nozzles 20 are of such a type that they will permit the passage of a comparatively large volume of oxidizing gas at a relatively low velocity. In practice it has been determined that the best results under average conditions are obtained in most cases when the pressure of the oxidizing gas is adjusted to produce an oxidizing gas stream having a velocity between 550 and 750 feet per second. However, higher or lower oxidizing gas stream velocities may be used to suit different conditions and results desired. The velocities of the oxidizing gas streams stated herein 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 degrees F. and is at atmospheric pressure.

The depth of the grooves or channels and the height of the ridges between them may be made more or less pronounced than illustrated herein to suit the working conditions. The depth and width of a channel are affected by the velocity of the oxidizing gas stream, both the depth and width increasing with an increase in the velocity of the oxidizing gas stream. The nozzles employed in the present apparatus are capable of producing individual cuts or grooves about 1½ inches in width and ½ inch in depth when the discharge velocity of the oxygen is about 585 feet per second and the rate of movement of the nozzles with respect to the surface is about 6 feet per minute. Cuts of such relatively wide width are clearly shown in Fig. 3. The depth and width of a cut or channel, therefore, can be partially controlled by varying the velocity of the oxidizing gas stream.

In the drawing the nozzles 20 are shown at an acute angle of approximately 25 degrees with respect to the work. Satisfactory cuts have been made with nozzles at acute angles varying from 10 to 35 degrees with respect to the surface of the work. Although the nozzle heads 21 are shown fixedly secured to the bars 21' and 21'', it may be desirable to provide means for varying the acute angle of the nozzles with respect to the work, and to provide suitable indicating means for setting the nozzles at a particular acute angle. Although the depth of a cut does not change appreciably with a change in the angle of the nozzle with respect to the work, a marked increase in the width of a cut is obtained with an increase in the angle at which the nozzle is set. Since wider cuts are obtained when the nozzles are set at the higher angles, the amount of metal that can be removed per pound of oxidizing gas can be increased by increasing the acute angle of the nozzles with respect to the work.

At very low speeds satisfactory cuts are not obtained. This in part is caused by the metal slag piling up ahead of the nozzle. In order to avoid the undue reaction of the oxidizing gas stream

on the surface of the work, it is moved relatively to the work at a speed sufficient to prevent the oxidizing gas stream being applied for too long a time at any particular portion of the surface of the work. By way of example, satisfactory cuts have been made on cold metal by moving nozzles relatively to the work at speeds varying from 4 to 90 feet per minute, i. e., at a uniform rate of speed higher than the maximum speed conventionally employed for severing a steel body by means of an oxygen jet. For example, when using well known high-velocity oxygen jets for cutting or severing mild or structural steel at room temperature, conventional machine cutting speeds for propelling the cutting nozzle or blow-pipe relatively to the steel body vary from about 2.4 inches per minute for steel of 12 inches thickness to 32 inches per minute for steel of one-eighth inch thickness.

Removing surface metal in the manner described above is particularly advantageous in steel mill operations where semi-finished steel shapes are at an elevated red heat temperature, such as 1600° F. or higher, for example, after a rolling operation which reduces the cross section of the semi-finished shapes and elongates them. When machine tools and chipping tools are employed to remove surface metal, it is necessary to allow the bars and billets to cool before surface metal can be removed with appreciable accuracy. With my improved apparatus, surface metal can immediately be removed from bars and billets that are at an elevated red heat temperature during rolling operations. Although the work may be sufficiently heated after a rolling operation for an oxidizing gas stream to remove surface metal therefrom when applied thereto, it is desirable in some instances to apply heating flames even on the heated work so as to increase the speed of metal removal and to remove a greater amount of surface metal per cubic foot of oxidizing gas.

It has also been observed that relatively hard metals, such as steels having high amounts of combined carbon, respond more readily to the action of oxidizing gas streams than metals of lower hardness, such as the low carbon steels. Since the harder metals respond more readily to the action of an oxidizing gas stream than metals of lower hardness, the cost of removing surface metal does not increase with the hardness of the metal cut, as is the case with the heavy machine tools heretofore used where the amount of power required to make a cut increases with the hardness of the metal.

While I have shown a particular embodiment of my invention in which surface metal is removed from all sides of a rectangular metallic body, it will be apparent that modifications can be made for removing surface metal from any multi-sided or round metallic body, and that certain features can be used independently of others without departing from the spirit and scope of my invention.

I claim:

1. Apparatus for simultaneously thermo-chemically removing a layer of metal from each surface of two opposite longitudinal sides of a ferrous metal body of rectangular cross-section, such as a steel billet, such apparatus comprising, in combination, nozzle means for simultaneously delivering a low-velocity voluminous stream of oxidizing gas obliquely against each of such surfaces to effect superficial metal combustion along zones extending across said surfaces; and mechanism for effecting continuous relative motion

of said nozzle means and said body lengthwise of said surfaces; the volume, velocity, and angle of impingement of such streams and the rate of such relative motion being so correlated as to maintain such combustion of superficial metal on each of said surfaces during such movement to produce continuous thermochemical removal of layers of metal from both of said longitudinal sides by a single pass of said body relatively to said nozzle means.

2. Apparatus for simultaneously thermo-chemically removing a layer of metal from each surface of two opposite longitudinal sides of a ferrous metal body of rectangular cross-section, such as a steel billet, which comprises, in combination, two spaced groups of nozzles for severally delivering high temperature flames and relatively low-velocity voluminous oxygen streams obliquely against such surfaces to effect superficial metal combustion along zones extending across said surfaces during the movement of said body between and relatively to said groups of nozzles; means whereby said groups of nozzles are movable toward and away from one another and toward and away from such body between said groups of nozzles; and mechanism for effecting continuous movement of said body in the direction of its length between and relatively to said groups of nozzles to maintain such superficial metal combustion on each of said surfaces and effect continuous thermo-chemical removal of a layer of metal from each of said longitudinal sides of said body during a single pass of said body relatively to said groups of nozzles.

3. Apparatus for simultaneously thermo-chemically removing a layer of metal from each of the four longitudinal sides of a ferrous metal body of rectangular cross-section, such as a steel billet, which comprises, in combination, blowpipe nozzle means constructed and arranged to be positioned in an outline substantially similar to the periphery of said body and adapted to deliver high temperature flames and relatively low-velocity voluminous oxygen streams obliquely against each of said sides of said body to effect superficial metal combustion along zones extending across each of said sides during the movement of said body relatively to said nozzle means and through the space defined by the latter; means operable to adjust said nozzle means toward and away from said body while the same is disposed in said space; and mechanism for effecting continuous movement of said body in the direction of its length and through said space relatively to said nozzles means to maintain such superficial metal combustion on said sides and effect continuous thermo-chemical removal of a layer of metal from each of said four sides during a single pass of said body relatively to said nozzle means.

4. Apparatus for surfacing metal bodies comprising a base, means for supporting a row of bodies to be surfaced, means for causing relative movement of the base and said bodies in the direction that the row of bodies extends, an arm carried by the base, and means on the arm for supporting a plurality of torches in position to surface the bodies successively during said relative movement.

5. Apparatus for surfacing ferrous metal bodies according to claim 4, including means for yieldably urging said torches toward the surface of the bodies being surfaced, and means for maintaining the nozzles of said torches positioned relatively close to said surface.

6. Apparatus for surfacing ferrous metal bodies according to claim 4, including means for counterbalancing a substantial portion of the weight of such torch-supporting means and torches.

7. Apparatus for surfacing ferrous metal bodies according to claim 4, in which said torches are provided with nozzle means for delivering relatively wide streams of oxidizing gas obliquely against and lengthwise of a plurality of surfaces of said bodies and are movable toward and from the operating position, and control means is provided for moving said nozzle means toward and from the operating position.

8. In apparatus for desurfacing bodies of ferrous metal while at an elevated temperature substantially that of red heat, the combination with a conveyor of a steel mill, of a supporting frame stationarily disposed with respect to said conveyor, means associated with said conveyor for feeding and guiding said bodies past said frame, means associated with said frame for delivering a relatively voluminous amount of oxidizing gas at low velocity upon a side of said body during said passage, whereby surface removal may be effected, and fluid-actuated means for maintaining said oxidizing gas delivering means in a predetermined operating position with respect to the side of said body being removed.

9. In apparatus for desurfacing metallic bodies of rectangular cross section, the combination with means for movably supporting the body in a position to be operated upon, of a frame stationarily disposed with respect to said supporting means, a gang comprising a plurality of blowpipe nozzles adjustably mounted closely adjacent to each other on said frame on opposite sides of the body to be desurfaced and arranged to ride on the new surface produced, said blowpipe nozzles being inclined at acute angles to the direction of advance and provided with separate passages for oxidizing gas and heating gas, means associated with the blowpipe nozzles for holding the same in positions for impinging adjoining oxidizing gas streams upon said surface at contiguous points extending substantially across the entire width, said gangs being offset from said frame a distance sufficient to permit the slag which forms to fall away under the influence of gravity, and means for effecting movement of said body upon said support between said gangs of blowpipe nozzles at a desired rate.

10. In apparatus for desurfacing metallic bodies of rectangular cross section, the combination with means for movably supporting the body in a position to be operated upon, of a frame stationarily disposed with respect to said supporting means, gang of blowpipe nozzles adjustably mounted on each of two opposite sides of said frame, means associated with said frame for yieldingly holding said gangs in desired positions with respect to the surfaces to be removed, said blowpipe nozzles being constantly inclined at acute angles to the direction of advance over the surfaces to be removed and provided with separate passages for oxidizing gas and heating gas, means associated with said blowpipe nozzles for holding the same in positions for impinging oxidizing gas streams upon said surface at points extending substantially across the entire width, said gangs being offset from said frame a distance sufficient to permit the slag which forms to fall away under the influence of gravity, and means for effecting movement of said body upon said support so as to pass at will

between said gangs of blowpipe nozzles at a desired rate.

11. In apparatus for desurfacing metallic bodies of rectangular cross section, the combination with means for movably supporting the body in a position to be operated upon, of a frame stationarily disposed with respect to said supporting means, a gang of blowpipe nozzles adjustably mounted on each of opposite sides of said frame, means associated with said mounting for yieldingly holding said blowpipe nozzles in positions to ride on the new surface produced, means associated with said holding means for automatically moving said nozzles into and out of said positions, said blowpipe nozzles each being inclined at an acute angle to the direction in which it advances over the surface being removed and provided with separate passages for oxidizing gas and heating gas, means associated with the blowpipe nozzles for holding the same in positions for impinging oxidizing gas streams upon said surface at contiguous points extending substantially across the entire width, said gangs being offset from said frame a distance sufficient to permit the slag which forms to fall away under the influence of gravity, and means for effecting movement of said body upon said support so as to pass at will between said gangs of blowpipe nozzles at a desired rate.

12. In apparatus for progressively removing successive portions of surface metal from a metallic body, the combination of a frame; means for applying an oxidizing gas stream on the metallic body including a blowpipe nozzle movably mounted on said frame and having the longitudinal axis thereof adapted to be inclined at an acute angle to the surface of the metallic body and in the direction of the successive surface portions from which metal is to be removed; fluid-actuated means for maintaining the tip of said blowpipe nozzle spaced from the surface of the metallic body; and means for relatively moving said blowpipe nozzle and the metallic body.

13. In apparatus for progressively removing successive portions of surface metal from a metallic body, the combination of a frame; means for applying an oxidizing gas stream on the metallic body including a blowpipe nozzle adjustably mounted on said frame for movement toward and away from said body and having the longitudinal axis thereof adapted to be inclined at an acute angle to the surface of the metallic body and in the direction of the successive surface portions from which metal is to be removed; means associated with said blowpipe nozzle whereby the tip thereof will bear lightly against the surface of the metallic body; fluid-actuated means for maintaining the tip of the said blow-

pipe nozzle spaced from the surface; and means for relatively moving said blowpipe nozzle and the metallic body.

14. In apparatus for progressively removing successive portions of surface metal from a metallic body, the combination of a frame; means for applying an oxidizing gas stream on the metallic body including a blowpipe nozzle having the longitudinal axis thereof arranged at an acute angle to the surface of the metallic body and in the direction of the successive surface portions from which metal is to be removed; means including a linkage carried by said frame for supporting said blowpipe nozzle; means associated with said linkage whereby the tip of said nozzle will bear lightly against the surface of the metallic body; fluid-actuated means for maintaining the tip of said nozzle spaced from the surface; and means for relatively moving said blowpipe nozzle and the metallic body.

15. In apparatus for progressively removing successive portions of surface metal from a metallic body, the combination of a frame; means carried by said frame and movable relatively thereto for applying an oxidizing gas stream at an acute angle to the surface of the metallic body and in the direction of the successive portions from which metal is to be removed; means for counterbalancing at least a portion of the weight of said oxidizing gas stream applying means; fluid-actuated means associated with said oxidizing gas stream applying means whereby the latter is maintained in desired relation with respect to the surface of the metallic body; and means for relatively moving said oxidizing gas stream applying means and the metallic body.

16. In apparatus for desurfacing metal bodies by the removal of surface metal from the entire peripheral surface of a metallic body, the combination with means for supporting said body in a position to be operated upon of a frame; a plurality of groups of blowpipe nozzles disposed closely adjacent to each other and adapted to extend about the entire perimeter of the body and pivotally mounted on said frame to have motion to and from the surfaces of said body; said blowpipe nozzles having the longitudinal axes thereof inclined at an acute angle to the surface of the metallic body and in the direction of the successive surface portions from which metal is to be removed; means associated with said pivotal mounting for yieldingly holding said groups of blowpipe nozzles in desired positions; and means for relatively moving said groups of blowpipe nozzles and the metallic body.

HOMER W. JONES.

CERTIFICATE OF CORRECTION.

Patent No. 2,125,174.

July 26, 1938.

HOMER W. JONES.

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 23, after the word "of" insert the article a; page 2, first column, line 24, after "lengths" strike out the comma and insert the same after the reference numeral "13" in same line; page 6, second column, line 57, claim 10, before "gang" insert a; page 7, second column, line 42, claim 16, after "upon" insert a semicolon; 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 13th day of September, A. D. 1938.

Henry Van Arsdale

(Seal)

Acting Commissioner of Patents.