

- [54] OXYGEN TRAP SCARFING APPARATUS
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Related U.S. Application Data

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[58] Field of Search. 148/9.5; 266/23 R, 266/23 H, 23 T

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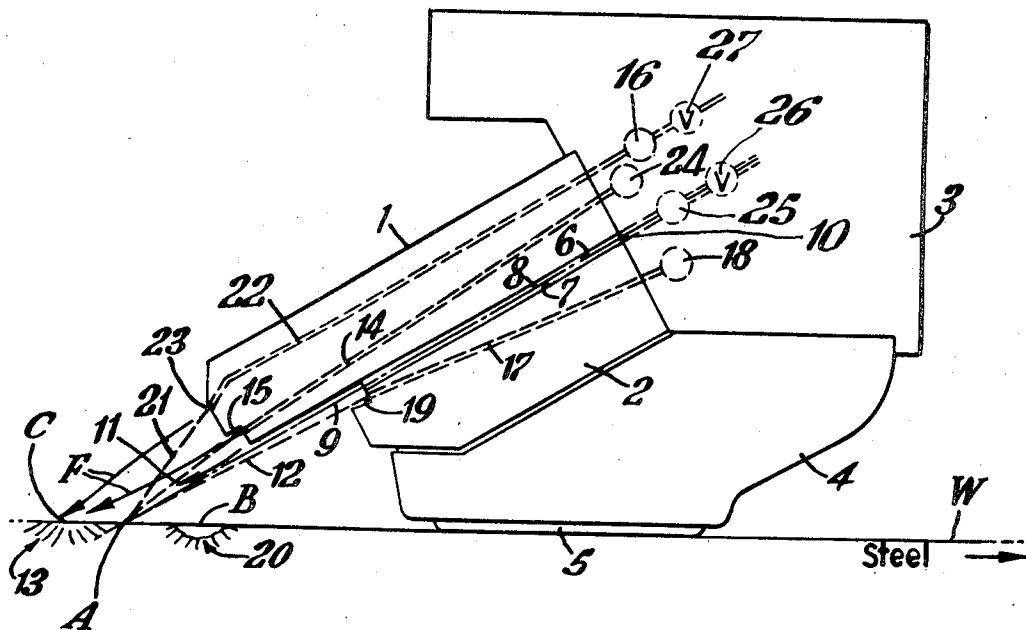
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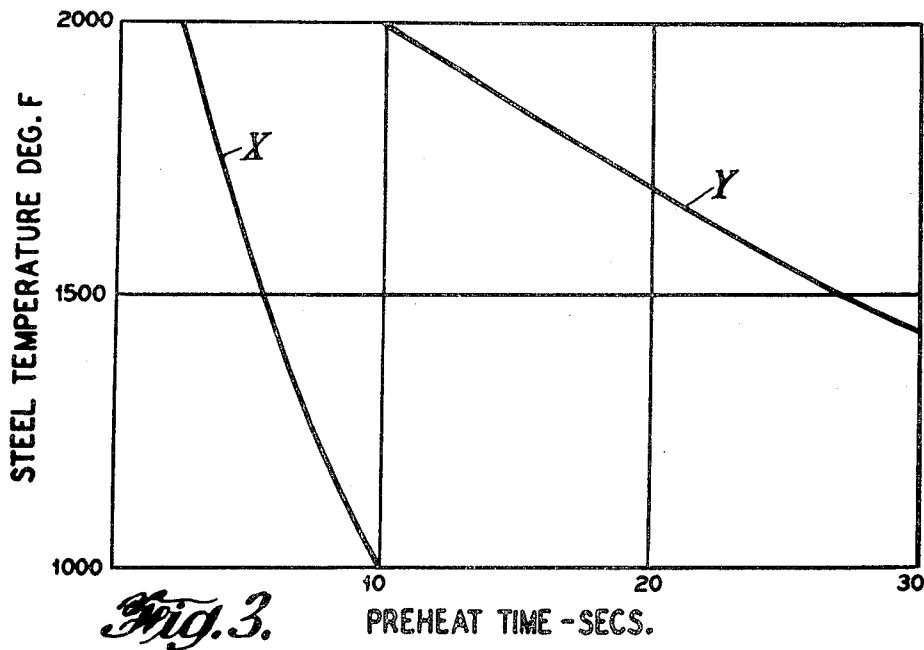
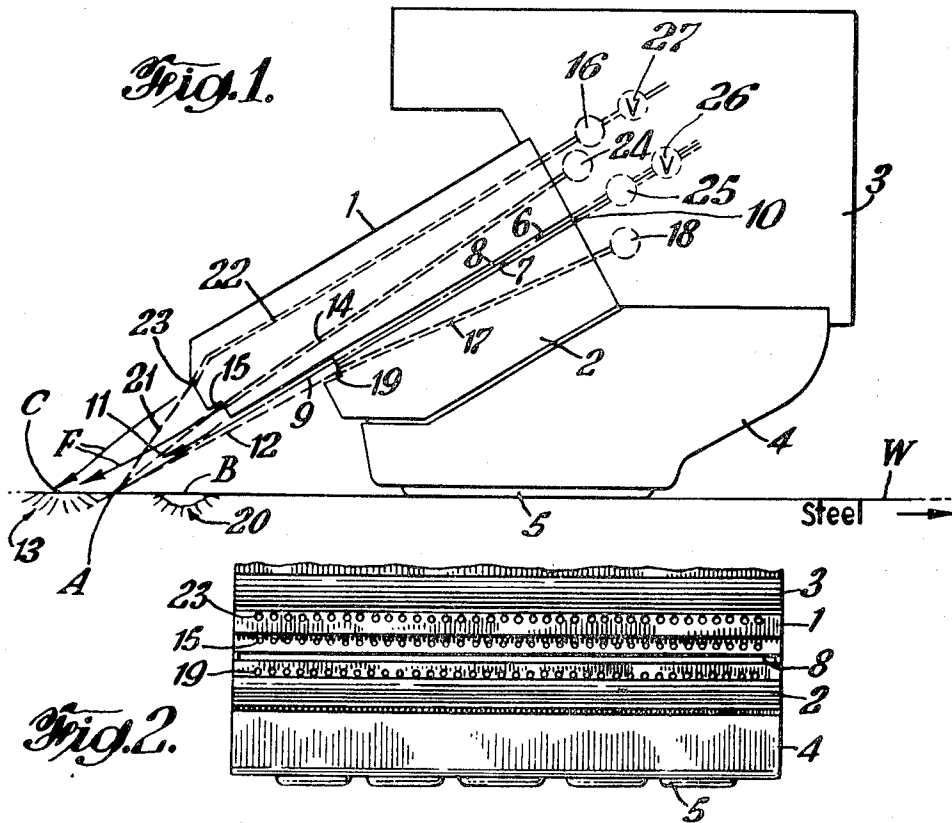
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[57] **ABSTRACT**

The time required for scarfing the surface of a metal body is decreased by shortening the preheating time. This is accomplished by directing a row of "trap" oxygen streams from ports located above the upper pre-heat fuel gas ports so that the oxygen streams form a plane which intersects the surface of the metal body in such way as to form a wedge shaped pocket to confine the burning preheating gases. This results in faster puddle formation and causes the puddle to be formed at a location just ahead of the projected converging point of the fuel and oxygen gas streams, rather than in back of the converging point where it would be formed by prior art methods.

2 Claims, 3 Drawing Figures





OXYGEN TRAP SCARFING APPARATUS

This is a continuation of copending application Ser. No. 836,233 filed June 25, 1969, now U.S. Pat. No. 3,647,570 issued Mar. 7, 1972.

BACKGROUND

This invention relates to the thermochemical conditioning of ferrous metal bodies, commonly referred to as scarfing; and more particularly to apparatus capable of decreasing the time required for a complete scarfing cycle with post-mixed, fuel-oxygen preheat gas scarfing units by decreasing the time required for preheating the metal workpiece to be scarfed. The present invention is applicable to scarfing of hot as well as cold metal workpieces.

According to present post-mixed scarfing practice, as exemplified by U.S. Pat. No. 3,231,431, a scarfing reaction is caused to take place by first raising the temperature of the metal surface to be scarfed to the ignition temperature of the metal in an oxygen atmosphere. This temperature, which may be lower than the melting point of the metal in air, is referred to as the "reaction temperature." When the reaction temperature is reached, a puddle of molten metal is formed. The metal is removed — that is, the thermochemical scarfing reaction is caused to take place — by impinging a stream of oxygen on the puddle. In other words, in order to initiate a scarfing reaction a puddle must be formed before the scarfing oxygen stream can be turned on for the thermochemical scarfing reaction to begin.

A complete scarfing cycle consists of four steps. First, the workpiece is positioned in register with the scarfing machine. Second, the scarfing units are closed, either automatically or manually, around all the sides of the workpiece which are to be scarfed. Third, preheating of the workpiece is caused to take place by means of fuel-oxygen preheat flames so that a puddle of molten metal is formed on the stationary workpiece; and fourth, the scarfing reaction is carried out by initiating the flow of scarfing oxygen and setting the workpiece in motion. For example, when scarfing a 30 foot slab at 2,000°F, positioning takes about 3 seconds, closing about 5 seconds, preheating about 10 seconds, and scarfing the length of the slab about 20 seconds. Thus, the total scarfing cycle for the 30 foot slab requires approximately 38 seconds.

The time required for a complete scarfing cycle results in a scarfing rate or speed that is in some cases slower than the rate at which steel is rolled in a conventional mill. It is therefore desirable to decrease the time required to complete a scarfing cycle in order that the scarfing operation keep up with the production of the mill. Reduction in scarfing time may obviously be accomplished by reducing the time required for any of the above mentioned four steps which take place during a complete scarfing cycle. Since positioning and closing require a total of only about 8 seconds, the amount of improvement possible in these two steps is relatively small. Consequently, the logical steps to shorten in order to improve the speed of a scarfing cycle are the preheating and/or scarfing steps.

The seemingly simple expedient of increasing the flows of fuel and oxygen to decrease preheating time and increase scarfing speed, does not work. If greater than normal quantities of either fuel or oxygen are supplied, preheating time fails to improve. For example, if

more fuel gas than conventionally used is provided, it tends to pinch off the supply of oxygen to the workpiece with a consequent decrease in heating capacity, thereby slowing down the preheating reaction. Similarly, increasing the preheating oxygen decreases the heating potential of the upper preheat flames by placing an intervening layer of cold oxygen between the upper preheat flames and the workpiece. Additionally, the increased oxygen acts as a cooling medium which draws heat from the workpiece. The simultaneous and proportional increase in both preheat fuel gas and oxygen offers little improvement, since the excess amounts of oxygen and fuel cannot be mixed and burned efficiently in a post-mixed system.

THE DRAWINGS

In the drawings:

FIG. 1 is a side elevation of a scarfing unit according to the present invention which is provided with a row of "trap" oxygen orifice ports located in the upper preheat block above the row of preheat fuel gas ports.

FIG. 2 is a front elevation of the scarfing unit shown in FIG. 1.

FIG. 3 is a graph comparing the preheat times obtained by the use of the "trap" oxygen stream in accordance with the present invention as compared to a scarfing unit without such "trap" oxygen streams.

In accordance with the prior art, in order to maximize heat input into the workpiece at the reaction zone, the upper and lower preheat fuel gas streams 11 and 12 in FIG. 1, as well as the scarfing oxygen stream 9 emanating from the central slot 8, are all directed so that their straight line projections converge at point A on the surface of the workpiece W. However, due to the aerodynamics of the system, caused by the flow of hot reacting gases and cooling from the surrounding area, as well as the pressure drop caused by the flow of high velocity gases, the puddle 20 forms not at the point A, but rather in back of it by several inches at point B. Consequently, it has been necessary, in accordance with prior art practice, as shown for example in U.S. Pat. No. 3,322,578, to back up the scarfing unit or the workpiece (in a direction opposite to the arrow) by several inches before the scarfing oxygen stream was turned on, so that when it was turned on, the scarfing oxygen stream would impinge upon the puddle rather than ahead of it. This backing up of either the scarfing unit or workpiece between preheating and starting of the scarfing reaction has been responsible in part for the excessive time required for preheating.

OBJECTS

It is the primary object of this invention to decrease the time required for a complete scarfing cycle.

It is another object of this invention to decrease the time required to preheat the workpiece prior to initiation of the scarfing reaction.

It is still another object to avoid the necessity for backing up the scarfing unit or workpiece before scarfing oxygen is turned on.

SUMMARY OF THE INVENTION

These and other objects, which will become apparent from the detailed disclosure and claims to follow are achieved by the present invention, which comprises a continuous slot, post-mixed fuel-oxygen scarfing apparatus wherein said slot is formed between an upper pre-

heat block and a lower preheat block which are in spaced relation to one another, wherein means are provided for controllably discharging a sheet-like stream of oxidizing gas through said slot for reacting with a metal surface to be scarfed as well as for burning pre-heat fuel gas, and wherein said scarfing apparatus is provided with a row of ports communicating with supply passages for discharging a plurality of parallel streams of preheat fuel gas from at least the upper pre-heat block to converge with said stream of oxidizing gas, the improvement comprising: a row of oxygen ports located in said upper preheat block above said row of fuel gas ports communicating with oxygen supply passages, means for controlling the flow of oxygen through said oxygen supply passages independently of the flow of said sheet-like stream of oxidizing gas, said row of oxygen ports being capable of discharging a plurality of parallel streams of oxygen gas which form a sheet-like oxygen gas curtain, said oxygen ports being directed at the converging points of the straight line projections of the oxidizing gas and fuel gas streams so as to cause the oxygen curtain streams emanating therefrom to form a wedge shaped pocket between the planes formed by said curtain oxygen stream and the surface of said metal body, thereby confining the fuel and oxidizing gases discharged from their respective ports.

DETAILED DESCRIPTION OF THE INVENTION

The oxygen curtain or plane above the preheat fuel gas streams formed by the "trap" oxygen streams causes a wedge shaped pocket to be formed between itself and the surface of the metal being scarfed. The oxygen curtain is formed by a parallel row of oxygen ports 23 located above the row of upper preheat block fuel gas ports 15. High velocity fuel gas from both upper and lower preheat blocks 1 and 2 is directed into the pocket, becoming trapped in the pocket and consequently forced to mix intimately with the oxygen 9 emanating from the continuous slot 8. This permits considerable improvement to be made in preheat time by increasing the flows of fuel and oxygen that can be adequately mixed for combustion while precisely fixing the location of the puddle at the point where it is desired.

The oxygen curtain provides a two-fold effect; first, it acts as a physical barrier to contain or trap the fuel and oxygen preheat gases causing them to burn in place; and second it permits an increase in the total amount of oxygen, thereby causing a hotter flame to be produced. The combination of these two effects improved heat transfer to the workpiece and concentrates the heat at a particular spot.

An unexpected but very beneficial result of this invention is that the molten puddle is formed not at point B behind point A, but rather at point C forward of point A. As a result of the fact that point C is just ahead of the projection of the scarfing oxygen stream 9, backing up of the workpiece or scarfing unit prior to starting of the cutting oxygen flow is eliminated. This, in turn, provides additional beneficial results in the speed of preheating.

Reference to FIGS. 1 and 2 will show that the scarfing unit is comprised of an upper preheat block 1, a lower preheat block 2, a head 3 and a shoe 4 which rides on skids 6. The lower surface 6 of upper preheat block 1 and the upper surface 7 of lower preheat block 2 form a continuous slot passage 8 for the oxygen

stream 9. The rear end 10 of oxygen passage 8 communicates with an oxygen supply manifold 25, to which the supply of oxygen is controlled by valve 26. During preheating, passage 8 is used to provide oxygen for combustion of the upper and lower preheat fuel gas streams 11 and 12. After the puddle 13 has been formed, the oxygen flow in stream 9 is increased to provide sufficient oxygen for the scarfing reaction. Upper preheat block 1 is provided with a plurality of preheat fuel gas passages 14 which terminate at the front face of the preheat block 1 in a row of fuel gas ports 15. Gas passages 14 communicate with a fuel gas header 24 located in head 3 from which they receive their supply of fuel gas. Natural gas is the preferred fuel gas; however, other fuel gases may also be employed such as, for example, methane, propane or coke oven gas. Lower preheat block 2 contains a plurality of fuel gas passages 17 which communicate with and receive a supply of fuel gas from header 18 located in head 3. Passages 17 terminate at the front face of the lower preheat block 2 in a row of lower preheat fuel gas ports 19. Both the upper preheat fuel gas ports 15 and the lower preheat fuel gas ports 19 are directed so that the straight line projections of the gas streams 11 and 12 emanating therefrom will converge with the straight line projection of the sheet-like stream of oxygen 9 at the converging point A on the surface of the metal workpiece W. Due to the aerodynamic effect of the hot gas streams as previously explained, the puddle 20 is formed upon the surface of the workpiece W at point B by prior art methods, i.e., without the use of the "trap" oxygen stream 21.

In accordance with the present invention, the upper preheat block 1 is provided with a plurality of oxygen passages 22 which terminate at the front face of said preheat block in a row of "trap" oxygen ports 23. Oxygen is supplied to passages 22 from an oxygen header 16 located in head 3. The "trap" oxygen streams 21 emanating from ports 23 are also directed to converge with the fuel gas stream projections 11 and 12 and oxygen stream projection 9 at point A. The plane formed by the plurality of "trap" oxygen streams 21 forms a wedge shaped pocket between itself and the surface of the workpiece W to confine the preheating gas streams 11 and 12 and the oxygen stream 9 thereby improving heat transfer to workpiece W and concentration of the heat within the wedge shaped pocket formed thereby. It has been found that when the "trap" oxygen stream 21 is used, the puddle 13 is formed at point C just ahead of converging point A, rather than at point B where it would have been formed without the use of the "trap" oxygen streams. This is apparently caused by the change in the flow dynamics of the system resulting from use of the "trap" oxygen streams. In other words, due to the aerodynamics of the system, the streams of fuel gas and oxygen do not follow the straight lined projections 9, 11, 12 and 21, but rather follow a path indicated generally by flow lines F. Consequently, when the scarfing reaction is to begin, after puddle 13 has been formed at point C, the oxygen stream 9 is simply increased to the flow rate required for scarfing by adjustment of valve 27 or other conventional flow control means, and the workpiece W is then set in motion toward the right as indicated by the direction of the arrow, without the need for backing up the workpiece or scarfing unit. This would have been necessary had the puddle been formed at point B, in order that the scarfing reaction might begin by having the scarfing oxygen

stream 9 impinge upon the puddle. After the preheat step has been completed, and the scarfing reaction started, the "trap" oxygen flow may be kept on, shut off completely, or lowered just to "bleed" slightly in order to prevent ports 23 from becoming plugged by the splatter of molten metal and slag. This can be effected by adjustment of valve 26 or other conventional flow control means. Keeping the "trap" oxygen on at full flow rates during the scarfing step has not been found to produce any beneficial results.

FIG. 3 is a graph comparing preheating time using a post-mixed fuel-oxygen scarfing unit of the prior art with a unit in accordance with the present invention containing a row of "trap" oxygen ports above the upper preheat fuel gas ports to provide the oxygen curtain of the present invention. The flow rates of preheat fuel gas (natural gas) were approximately 3,500 C.F.H. in both cases. The total amount of oxygen was likewise the same in both cases, i.e., about 7,500 C.F.H. However, the distribution of the oxygen was different. In the case of the prior art scarfing unit, all of the oxygen was discharged through the center slot, while in the case of the scarfing unit of the present invention, approximately half of the oxygen was discharged through the center slot and the other half through the "trap" oxygen ports. It can be seen from the graph that preheating time depends upon the temperature of the steel work surface and that the hotter the work surface, the shorter the preheating time. Curve X shows the results obtained in using a scarfing unit of the present invention, while curve Y shows the results obtained using a standard post-mixed scarfing unit of the prior art. Comparison of curves X and Y shows that at steel temperature of 2,000°F, it required only about 3 seconds to preheat the workpiece in accordance with the present invention, whereas it required 10 seconds to preheat the workpiece with the prior art unit. This constitutes a reduction of about 7 seconds, or better than a three fold improvement. A similar result can be observed at 1,500°F where it required about 5 seconds to preheat in accordance with the present invention, whereas it required about 27 seconds with the prior art unit.

The significance of the faster preheat time obtained in accordance with this invention is that it improves the preheating time at 2,000°F, for example, by about 7 seconds, thereby cutting the scarfing cycle described pre-

viously from 38 seconds to about 30 seconds. This is an improvement of over 20 percent in the scarfing cycle and is sufficient to enable the scarfing machine to keep up with a higher production rate than was formerly possible. It should be noted that the present invention also provides a saving in preheating time by elimination of the need for backing up the workpiece or scarfing unit prior to initiation of the scarfing oxygen reaction, in addition to the shortening of the preheating time as shown in FIG. 3.

What is claimed is:

1. In a continuous slot, post-mixed fuel-oxygen scarfing apparatus wherein said slot is formed between an upper preheat block and a lower preheat block which are in spaced relation to one another, wherein means are provided for controllably discharging a sheet-like stream of oxidizing gas through said slot for reacting with a metal surface to be scarfed as well as for burning preheat fuel gas, and wherein said scarfing apparatus is provided with a row of ports communicating with supply passages for discharging a plurality of parallel streams of preheat fuel gas from at least the upper preheat block to converge with said stream of oxidizing gas, the improvement comprising: a row of oxygen ports located in said upper preheat block above said row of fuel gas ports communicating with oxygen supply passages, means for controlling the flow of oxygen through said oxygen supply passages independently of the flow of said sheet-like stream of oxidizing gas, said row of oxygen ports being capable of discharging a plurality of parallel streams of oxygen gas which form a sheet-like oxygen gas curtain, said oxygen ports being directed at the converging point of the straight line projections of the oxidizing gas and fuel gas streams so as to cause the oxygen curtain streams emanating therefrom to form a wedge shaped pocket between the planes formed by said curtain oxygen stream and the surface of said metal body, thereby confining the fuel and oxidizing gases discharged from their respective ports.

2. The scarfing apparatus of claim 1 wherein said lower preheat block also is provided with a row of ports communicating with supply passages for discharging a plurality of parallel streams of preheat fuel gas.

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Disclaimer

3,752,460.—*Thomas James Lytle*, West Orange, N.J. OXYGEN TRAP SCARFING APPARATUS. Patent dated Aug. 14, 1973. Disclaimer filed June 6, 1973, by the assignee, *Union Carbide Corporation*.

Hereby disclaims the portion of the term of the patent subsequent to Mar. 7, 1989.

[*Official Gazette October 23, 1973.*]