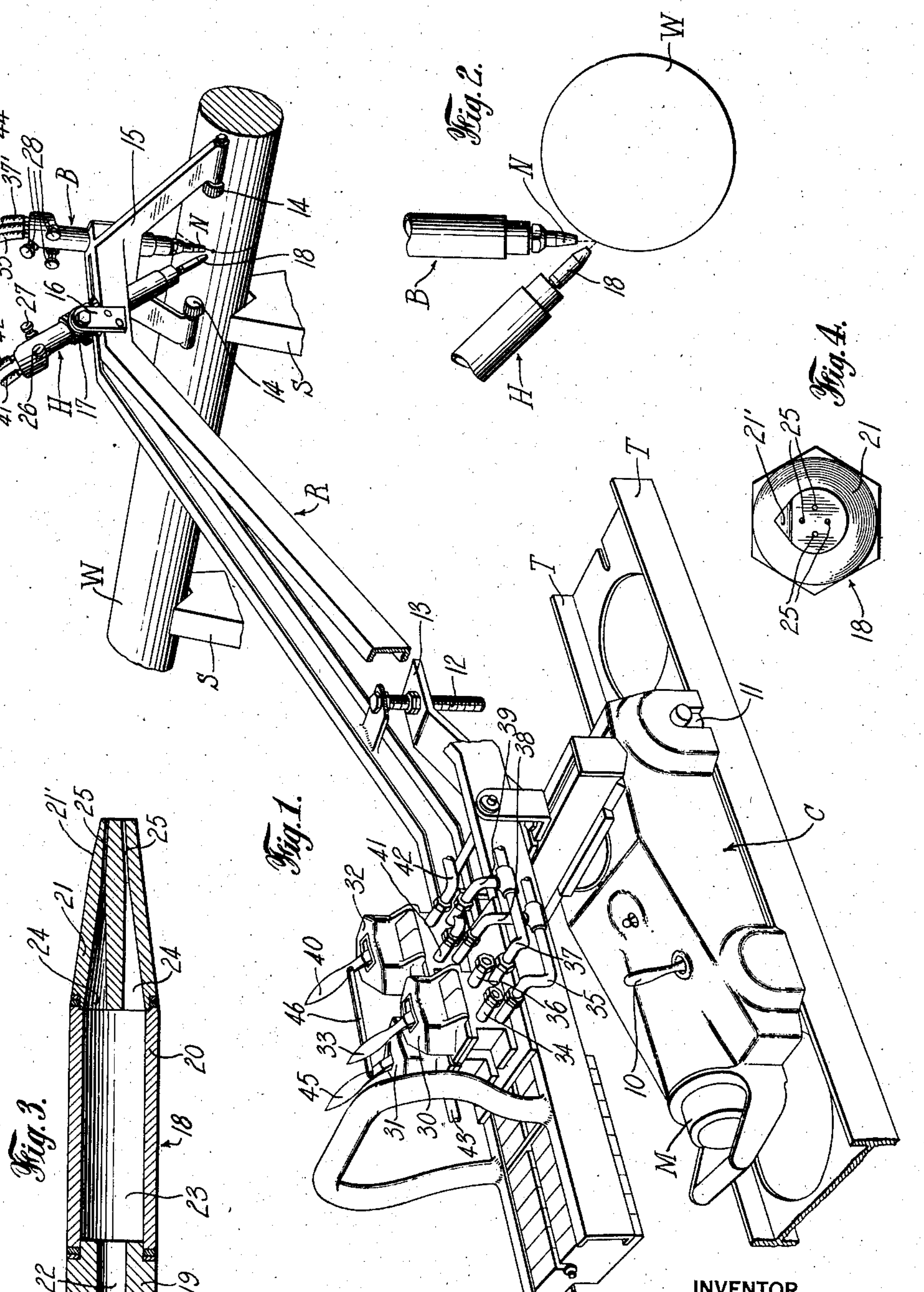
July 14, 1942. E. P. JONES 2,289,968

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

Filed April 2, 1940 2 Sheets-Sheet 1



INVENTOR
EVERETT P. JONES
BY
E. L. Groenewald
ATTORNEY

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

Filed April 2, 1940 2 Sheets-Sheet 2

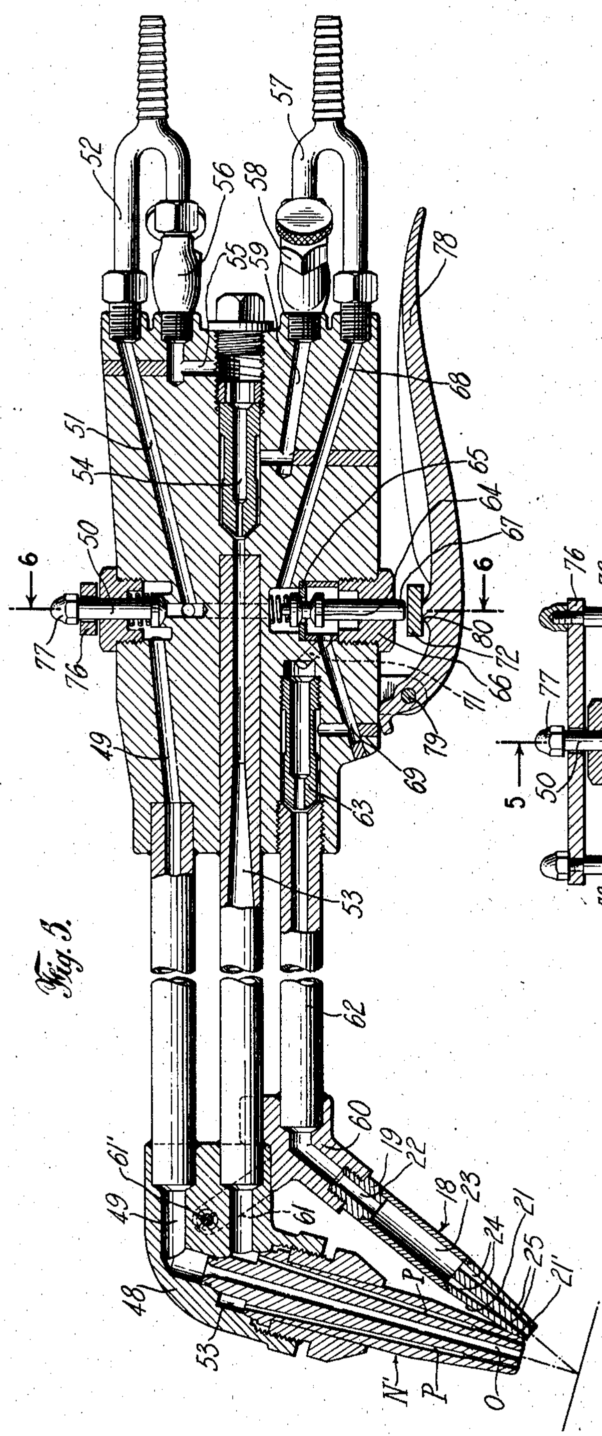


Fig. 3.

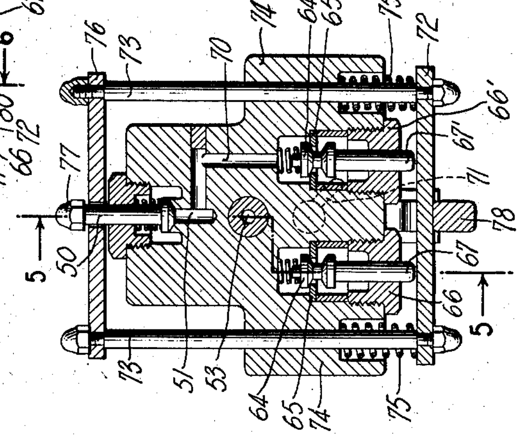


Fig. 6.

INVENTOR
EVERETT P. JONES
BY
E. L. Greenewald
ATTORNEY

Patented July 14, 1942 2,289,968

UNITED STATES PATENT OFFICE

2,289,968

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

Everett P. Jones, Elizabeth, N. J., assignor to The Linde Air Products Company, a corporation of Ohio

Application April 2, 1940, Serial No. 327,444

14 Claims. (Cl. 148—9)

This invention relates to a method of and apparatus for thermo-chemically removing metal from ferrous metal bodies, and more particularly to a method and apparatus for rapidly severing ferrous metal bars, especially round bars, with a cutting blowpipe.

Heretofore, it has been the practice to remove metal from ferrous metal bodies with a blowpipe having a nozzle provided with a central orifice producing an oxidizing gas stream of suitable character which reacts with or consumes portions of metal of the body against which the stream is projected which portions must be at an ignition temperature. In addition to the oxidizing gas orifice it is customary to provide in the nozzle, separate, annularly positioned, mixed gas passages having orifices adjacent the oxidizing gas orifice for producing one or more heating flames. Means are customarily provided for separately controlling the flow of oxidizing gas to the cutting orifice and the flow of an oxidizing gas and a fuel gas to the heating flame orifices of the nozzle.

Before steel can be cut or surface metal be removed by thermo-chemical reaction with oxygen, at least a small area of the metal to be removed must be heated to the kindling temperature which is approximately 2300° F. For such preheating the mixed gases forming preheating flames are turned on first and the flames are projected against the surface of the work until an area at the starting point is sufficiently heated. Such preheating requires an appreciable period of time with the customary forms of nozzles. When the preheat is obtained, the oxidizing gas is turned on and the blowpipe is moved along the surface of the work to form a kerf or a groove, as the case may be. During such movement it is found advantageous to continue the heating flames. The preheating flame necessary to accompany the oxygen stream for optimum efficiency in the consumption of gases and rate of cutting is relatively small. Therefore, if the blowpipe nozzle is designed to provide the most desirable size and intensity of preheat flame for carrying the cut, the flame will be relatively small and the time of preheating before starting the cut will be relatively long. If the preheating flame of the nozzle is made large in order to shorten the starting time, the flame will be too large during the cutting period and will result in excess consumption of gas and in cutting may cause an excessive melting down of the upper edges of the kerf.

Further difficulties result when cutting round bars with a customary cutting blowpipe. For cutting round bars the blowpipe is positioned with its longitudinal axis in a plane normal to the longitudinal axis of the bar. The axis of the blowpipe nozzle is generally also maintained vertical or substantially vertical. Thus, when starting the cut the preheating flames will not be normal to the surface at the starting point and therefore the rate of heat transfer from the flame to the work surface is relatively low and the time required for heating the spot to the kindling temperature is further increased. It is often the case that the preheating period is as long or longer than the actual cutting period. When manually cutting such bars, the operator can tilt the torch so that the flames are normal to the surface and when an ignition is obtained the blowpipe nozzle may be tilted back to the desired vertical position for making the cut. However, in cutting round bars with a machine propelled cutting torch, the torch usually is fixed in a vertical position. Attempts have been made to reduce the time of preheating to obtain an ignition by inserting a small portion of a ferrous metal rod in the heating flames and using the molten metal produced to obtain rapid ignition. The preheating period can be greatly reduced by such method. However, the deposit of molten metal may interfere with the oxygen stream so as to cause a gouge at the starting portion of the cut. The kerf produced will have a nick in the corner and therefore such cutting method will be unsatisfactory except for rough work.

A principal object of the present invention is to provide a method and apparatus for thermo-chemically removing metal from ferrous metal bodies which shall be rapid and efficient and economical to use.

Other objects of the invention are to provide a method of an apparatus for removing metal from ferrous metal bodies by an oxygen jet with increased rapidity by effecting a reduction in the time of starting the metal removing reaction; with increasing economy in the consumption of gases by employing only a relatively small heating flame during the metal removing step, and by employing a relatively high intensity preheating flame only during the preheating step; to provide an apparatus for carrying out such method of removing metal which includes a nozzle for producing high-intensity preheating flames cooperating with a relatively low intensity heating flame of the metal removing nozzle; to provide suitable means for controlling a supply of gases to the respective metal removing nozzle and the high-intensity preheating nozzle; to provide a blowpipe apparatus including a nozzle producing a high-intensity preheating flame; and to provide a blowpipe apparatus which will efficiently and rapidly sever ferrous metal bars, particularly round bars.

The manner in which these and still other objects are attained by the invention will be apparent from the following description having reference to the accompanying drawings in which:

Fig. 1 is a perspective view of an exemplary apparatus adapted to carry out the principles of this invention when applied to severing a round bar;

Fig. 2 is a diagrammatic view on an enlarged scale showing the relation between the cutting blowpipe and auxiliary preheating blowpipe with respect to the surface of the bar to be cut;

Fig. 3 is a longitudinal sectional view on an enlarged scale of a preferred form of high-intensity preheating nozzle;

Fig. 4 is an end view of the nozzle shown in Fig. 3;

Fig. 5 is a longitudinal sectional view of a hand-operated blowpipe embodying the principles of the invention; and

Fig. 6 is a view of a transverse section taken on the line 6—6 of Fig. 5.

In the preferred form of this invention a high-intensity auxiliary preheating nozzle is positioned at an angle with respect to and adjacent to a cutting nozzle which may be of the customary type or which preferably is arranged to provide a relatively low heating flame. The auxiliary preheating nozzle is arranged to project a concentrated heating flame substantially normally against the spot of the surface to which the heating flames of the cutting nozzle are directed substantially tangentially or at an acute angle. To make a cut the heating flame of the cutting nozzle is preferably ignited first, the blowpipe moved to the desired starting position, the gases are then supplied to the heating flame nozzle and the heating flames of both nozzles will be concentrated at the starting spot of the work surface. After a very short interval of time, the ignition temperature will be reached and the cutting oxygen will be turned on. Simultaneously with the turning on of the cutting oxygen to initiate the cutting reaction, the gases supplied to the auxiliary preheating nozzle will be shut off. The cutting nozzle will then be moved relatively along the work surface to produce the desired cut. When cutting a round bar the angular position of the auxiliary preheating nozzle is preferably arranged so that the high-intensity preheating flame will impinge substantially normally against the surface of the bar.

Referring to the drawings, and particularly to Figs. 1 and 2, a cutting blowpipe B is moved mechanically with respect to a bar W which is to be severed. The machine shown for moving the blowpipe comprises a boom R at the end of which is supported the blowpipe B in a substantially vertical position above the work W. The boom R extends transversely of the work W and is rockably supported on top of a carriage C, the carriage C being motor driven and moving along a horizontal track T which may be supported on the floor in a position transverse to the axis of the work W and lower than such axis. The carriage C is provided with a gear-shift lever 10 which, when shifted forward, engages the motor M in the carriage C with the wheels 11 of the carriage to move the carriage in the forward direction toward the work W. When the lever 10 is in the vertical position the motor M is disconnected from the wheels of the carriage and when the lever 10 is pulled backward the carriage C will move backward. The height of the blowpipe B is adjusted so that the end of its nozzle N will be slightly above the axis of the work W when the machine is retracted away from the work W. Such level is adjusted by the stop screw 12 cooperating with the bracket 13. The nozzle N is maintained a substantially constant distance from the surface of the work W by a pair of guide rollers 14 that engage the surface and are mounted at the lower ends of downwardly projecting arms 15 at the end of the boom R.

For providing a high-intensity preheating flame there is also mounted adjacent the blowpipe end of the boom R an auxiliary blowpipe H. The blowpipe H is adjustably mounted on a projection 16 secured to the boom R and has a holder 17 arranged to provide longitudinal adjustment of the blowpipe H. The blowpipe H is positioned such that its nozzle 18 is adjacent to the nozzle N and the main axis of the nozzle 18 is directed to intersect the work surface substantially at the point of intersection of the axis of the nozzle N with the work surface. The axis of the nozzle 18 is preferably more nearly normal to the portion of the work surface impinged than the axis of the nozzle N.

It is known that the rate of heat transfer from a high-velocity flame to a work surface is more rapid than the rate of heat transfer when customarily low-velocity flames are employed. It is preferable, therefore, but not essential in carrying out the method of this invention, to employ an auxiliary preheating nozzle which will provide a heating flame of relatively high velocity and high intensity. A preferred form of the nozzle 18 is illustrated in Figs. 3 and 4. The nozzle 18 comprises a head portion 19 adapted to be secured to the stem or lower end of the blowpipe H, a body portion 20, and a tip portion 21. The head portion 19 has a relatively large axial passage 22 therethrough. In the body portion 20 is an enlarged chamber 23 and through the tip 21 there are a plurality of passages 24 conecting the chamber 23 to a coresponding number of orifices 25. In the preferred embodiment as shown in Fig. 4, four orifices 25 and passages 24 are employed. The passages 24 preferably converge toward the orifices and the orifices 25 preferably converge toward the main axis of the nozzle in order to produce a group of extra long, high-velocity preheating flames that converge toward a point. The inner cones of the flames do not extend quite to the point of convergence and the nozzle is so positioned that the point of convergence is approximately at the point on the surface of the bar intersected by the axis of the main nozzle N. The blowpipe H may be of the customary type adapted to mix oxidizing and fuel gas and pass the mixture to the nozzle 18.

To produce the desired high-intensity convergent heating flames, the gases must be supplied to the nozzle 18 at the proper pressure and volume. The proportion of the gases is adjusted by valves 26 and 27 at the upper end of the blowpipe H. Similar valves for regulating the supply of gases to the cutting blowpipe B in the customary manner are provided at 28, there being three valves, one for heating oxygen, the second for fuel gas, and the third for cutting oxygen.

Suitable means for controlling the supply of gases in the proper sequence to the blowpipes B and H is provided. On the rear portion of the boom R are mounted three sets of lever-operated valves 30, 31, and 32. The valve 30 has an operating handle 33 which, when in the rearward position shown closes two valve elements in the valve 30. One valve element in valve 30 controls the flow of fuel gas from a supply connection 34 to a discharge conduit 35. The other valve element in valve 30 controls the flow of oxidizing gas from the supply connection 36 to the discharge conduit 37. Conduits 35 and 37, respectively, are supported along the boom R and connect with the respective fuel gas and heating oxygen inlets of blowpipe B indicated at 35′ and 37′, respectively. Branch conduits 38 and 39 are connected between conduits 35 and 37 to valve elements in the valve 32 which has an operating handle 40. The valve elements in valve 32 discharge fuel gas and heating oxygen, respectively, through conduits 41′ and 42′ which connect with the inlet connections of the blowpipe H at 41 and 42. Valve 31 has a single valve element therein which controls the flow of cutting oxygen from a supply connection 43 to a discharge conduit 44 that is supported along boom R and connects with the upper end of the blowpipe B. Valve 31 has an operating handle 45 that is preferably connected with valve handle 40 of valve 32 by a link 46 so that the valves will operate simultaneously. Valves 31 and 32 are so arranged that when the handles 45 and 40 are rearwardly directed in the position shown, the valve element in valve 31 will be closed, while the valve elements in valve 32 will be open, and vice versa.

In operation, it will be assumed that the work W is horizontally positioned on a suitable support S; that the height of the boom R has been adjusted so that the end of the blowpipe nozzle N will be at the desired level slightly higher than the axis of the work W; that the valves 28 have been properly adjusted so that when the gases are flowing the preheating flame of the desired relatively low intensity will be produced by nozzle N; that the valves 26 and 27 of the blowpipe H are adjusted so that when the gases are flowing the nozzle 18 will produce a relatively large high-intensity preheating flame; that the blowpipe nozzle 18 is properly positioned as shown with respect to the nozzle N; that the motor M of the carriage C is energized; and the lever 10 is in the neutral vertical position. The operator will position the machine along the track T until the rollers 14 engage the surface of the bar W. The operator will then move the handle 33 forward thus supplying oxidizing gas and fuel gas directly to the blowpipe B and also to the blowpipe H through the open valve elements in valve 32. If the work W is sufficiently heated, for example, if it is at a rolling temperature, the gases on contacting with the surface of the work will be ignited. If the work W is not sufficiently heated, other means, such as a pilot flame may be provided for effecting ignition. When the operator observes that the work has been heated to an ignition temperature, or by previous experience awaits for the relatively short interval of time which will provide an adequate preheat, the operator will move valve handle 45 forward thus opening the valve element in valve 31 to supply cutting oxygen to the cutting orifice of the nozzle N. At the same time valve handle 40 will be shifted forward, thus closing the valve elements in the valve 32 which shuts off the gas supplied to the blowpipe H. The valve handle 33 is left in the forward position so that the heating flames produced by nozzle N continue to burn. The oxygen stream impinging on the highly heated portion of the work surface W immediately under the nozzle will thermo-chemically combine with the metal of the bar and form a kerf through the bar. Immediately after or simultaneously with the forward movement of the handle 45, the operator will shift the lever 10 forward and start the carriage moving in the forward direction at a desired cutting speed. The blowpipe B will be carried transversely across the work W and maintained at a substantially constant distance from the surface by the rollers 14. When the kerf is completed the operator will pull levers 33, 45, and 10 rearwardly thus shutting off all the gases and causing the carriage C to reverse and retract the blowpipe. If desired, the carriage C may be pulled back manually by putting the lever 10 in the vertical or neutral position.

When cutting cold, round, steel bars with the customary machine cutting torch, it has been found that the preheating time will range from about 25 seconds for 4 inch diameter bars to 120 seconds for 8 inch diameter bars. However, by employing the auxiliary high-intensity preheating nozzle 18, all other conditions being the same, the preheating time is reduced to approximately 4 to 6 seconds, depending on the diameter of the bar.

The principles of the invention may also be employed in a hand-operated blowpipe which may be of a type suitable for kerf cutting or of a type suitable for removing surface metal, such as deseaming, depending mainly upon the character of the nozzle N′ employed. The blowpipe has the customary nozzle N′ which is secured to the blowpipe head 48, the oxygen orifice O of the nozzle N′ being supplied with cutting oxygen through a passage 49 that is controlled by a cutting valve 50. The cutting oxygen is supplied to the valve 50 through a passage 51 leading from a connection 52 at the rear of the blowpipe. The mixed heating gases are supplied to the heating gas passages P of the nozzle N′ through a passage 53 which receives the gases from a mixer element 54 of a type which is customarily employed. Oxidizing gas is supplied to the mixer 54 by a passage 55 controlled by a valve 56 interposed between the passage 55 and the connection 52. Fuel gas is supplied from a connection 57 through a valve 58 and a passage 59. The above-described elements of the blowpipe shown in Fig. 5 are those customarily employed in cutting or desurfacing blowpipes. To provide an auxiliary high-intensity heating flame, the nozzle 18 is mounted closely adjacent to the nozzle N′ and arranged so that the axes of the two nozzles will intersect at a point approximately at the level of the work surface. To permit close nozzle spacing, the tip 21 of the nozzle 18 is cut away on one side as shown at 21′ in Fig. 4, and the cut-away portion is placed adjacent the nozzle N. The nozzle 18 is secured to a head 60 which may be fastened to the head 48 by suitable means such as by providing a pair of extensions 61 on either side of the head 48 and securing them by a bolt 61′ passing through both extensions and the head 48. The head 60 is connected with the body of the blowpipe by a mixing tube 62 which receives mixed gas from a mixer 63 in the body of the blowpipe. The mixer 63 may also be of the customary type and similar to the mixer 54 except that the gas passages therethrough are preferably larger in order to provide a greater flow of mixed gas.

To control the supply of oxidizing and fuel gas to the mixer 63 at the proper time, two control valves are provided. The fuel gas supply is controlled by a valve 64 having upper and lower valve elements both of which are seatable alternately on a valve seat 65 disposed between them. The valve seat 65 is retained in place against a shoulder by the sleeve-like extension of a valve cap 66 through which the stem 67 of the valve passes. If desired, a suitable packing may be arranged about the valve stem 67 in the cap 66 to prevent leakage of gas when the valve is opened. For controlling the flow of heating oxygen to the mixer 63 a similar valve 64' is provided. The chamber over the valve seat 65 is connected by a passage 68 with the fuel gas connection 57 and the chamber below the valve seat 65 is connected with the space around the mixer 63 by a passage 69. Similarly, the chamber above the valve seat 65' is connected with the oxidizing gas inlet passage 51 by a passage 70, and the chamber below the valve seat 65' is connected with the passage through the mixer 63 by a passage 71. The valve stems 67 and 67' are arranged to contact with a cross bar 72 secured to the ends of a pair of vertical rods 73. The rods 73 pass slidably through projections 74 of the body of the blowpipe and springs 75 are provided acting between the bar 72 and the projections 74 to urge the rods 73 downwardly. The upper ends of the rods 73 are connected by a cross bar 76 which has a central hole therethrough through which the stem of the cutting valve 50 passes. A head 77 is secured to the end of the stem of valve 50, in order that the valve 50 may be opened when the cross bar 76 moves upwardly.

To operate the valves, a hand lever 78 is pivotally secured at 79 to the body of the blowpipe and passes under the bar 72 having a portion 80 contacting with the cross bar 72. Thus, when the lever 78 is pressed upwardly halfway it will force the bar 72 upwardly against the springs 75. This will press the valve stems 67 and 67' upwardly sufficiently to unseat the upper valve elements of the valves 64 and 64' from the valve seats 65 and 65' and thus permit gas to flow through the valves to the mixer 63, the mixed gas then discharging from the nozzle 18. Further upward movement of the lever 78 will press the lower valve elements of the valves 64 and 64' against the valve seats 65 and 65' to shut off the gas supply of nozzle 18, and at the same time the cross bar 76 will contact with and lift the head 77 to open the cutting valve 50. The gas flow to the auxiliary nozzle 18 will thus be shut off when the cutting valve 50 is open and operation of the blowpipe will thus be quite convenient. The oxygen and fuel-gas supply hoses will be connected to connections 52 and 57, respectively.

With the gases supplied at the proper pressure the valves 56 and 58 are adjusted to supply oxygen and fuel gas to the mixer 54 in the proper proportion to provide a normal relatively low heating flame to issue from the heating flame orifices P of the nozzle N'. With the proper pressure of oxygen and fuel gas, the proportions of the mixer 63 are such that the desired high-intensity heating flame will issue from the nozzle 18 when the valves 64 and 64' are open. Thus, to start a cut the operator directs the nozzles N' and 18 at the spot where the kerf is to begin, and having ignited the heating flames issuing from the nozzle N' the operator will depress the lever 78 part way to start the flow of gas to the high-intensity heating nozzle 18. After a very short interval of time the operator presses the handle 78 all the way and this action will open the cutting valve 50 and shut off the supply of heating gas to the nozzle 18. The operator then begins moving the blowpipe nozzle N' along the surface of the work to remove surface metal or to cut a kerf according to the type of nozzle being employed. It will be seen that when using the present method of cutting steel bars and particularly cold, round, steel bars there will be no undesirable gouging at the start of a cut and it has been observed that after the cut has been completed the only way that the position of the start of such cut can be ascertained is by the fact that the starting portion of the cut appears slightly smoother than the rest of the cut.

It will be understood, that fuel gas other than acetylene may be employed and that oxygen or mixtures containing oxygen may be employed for the combustion supporting and metal removing gas streams. The particular embodiments herein described and illustrated in the drawings are presented to indicate how the invention may be applied. Other forms differing in detail but not in principle, will of course suggest themselves to those skilled in the art. Certain features of the invention may be used independently of the others and other uses of the nozzle may be found without departing from the spirit and scope of the invention as defined in the claims.

I claim:

1. A method of severing a ferrous metal bar which comprises directing a relatively low-intensity heating flame substantially tangentially against a curved surface portion at one side of the bar; directing against said surface portion a separate relatively high-intensity heating flame, said high-intensity heating flame being disposed at an angle to the direction of flow of said low-intensity heating flame, and in a direction substantially normal to said surface portion; when said surface portion reaches an ignition temperature, entirely interrupting said high-intensity heating flame and simultaneously applying a stream of oxidizing gas against said heated surface portion; continuing said low-intensity heating flame; and simultaneously moving said oxidizing gas stream and said low-intensity heating flame transversely across said bar to form a kerf therethrough.

2. A method of removing metal from a ferrous metal body which comprises applying at least one low-intensity heating flame at an acute angle against a surface portion of the metal to be removed; applying substantially normally against said surface portion a plurality of separate relatively high-intensity convergent heating flames, said high-intensity heating flames converging toward the same area of said surface portion and being disposed in symmetrical relation about a common axis which is disposed at an angle with respect to the axis of said low-intensity heating flame; when said surface portion reaches an ignition temperature, entirely interrupting said high-intensity heating flames and simultaneously applying a stream of oxidizing gas against said heated surface portion; and simultaneously moving said oxidizing gas stream and said low-intensity heating flame along the surface of said body for removing portions of metal therefrom.

3. A method of severing a round ferrous metal bar supported horizontally which comprises directing a relatively low-intensity heating flame downwardly and substantially tangentially

against a curved surface portion at one side of the bar; directing substantially normally against said surface portion a separate relatively high-intensity heating flame, said high-intensity heating flame being directed substantially in the plane of the cut to be made and at an angle to the direction of flow of said low-intensity heating flame; when said surface portion reaches an ignition temperature, entirely interrupting said high-intensity heating flame and simultaneously applying a stream of oxidizing gas downwardly against said heated surface portion; continuing said low-intensity heating flame; and simultaneously moving said oxidizing gas stream and said low-intensity heating flame tranversely across said bar while maintaining said stream in said plane to form a kerf through said bar substantially free from undesirable gouges.

4. Apparatus for severing a ferrous metal bar which comprises a cutting blowpipe adapted to apply a low-intensity heating flame and a vertical stream of cutting oxygen initially against a lateral surface portion of said bar; mechanism for supporting and moving said blowpipe above and transversely across said bar; an auxiliary blowpipe adapted to produce a separate relatively high-intensity heating flame, said auxiliary blowpipe being disposed adjacent said cutting blowpipe and positioned to direct said high-intensity heating flame substantially normally against the lateral surface portion impinged by said low-intensity heating flame; and valve means for controlling the supply of mixed gas to said cutting blowpipe and to said auxiliary blowpipe and the supply of cutting oxygen to said cutting blowpipe, said valve means being operable to supply said heating gas to both blowpipes and to discontinue the flow of said heating gas only to the auxiliary blowpipe when supplying cutting oxygen to said cutting blowpipe.

5. Blowpipe apparatus according to claim 4 in which said auxiliary blowpipe is provided with nozzle means constructed and arranged for producing a group of convergent high-velocity high-intensity heating flames.

6. Blowpipe apparatus according to claim 4 in which said valve means includes conduit means for conducting cutting oxygen to said cutting blowpipe; a valve having an operating element controlling said cutting oxygen conduit; a duplex valve having operating elements controlling the supply of oxidizing gas and fuel gas to said auxiliary blowpipe; means interconnecting the operating element of said cutting oxygen valve with the operating elements of said duplex valve for closing said duplex valve when said cutting valve is opened; and a second duplex valve operative to control the supply of oxidizing gas and fuel gas to both said cutting blowpipe and said first-mentioned duplex valve.

7. Apparatus for removing metal from a ferrous metal body which comprises main nozzle means for applying a heating flame substantially tangentially against a portion of the surface of said body and for applying an oxidizing gas stream against said surface portion; an auxiliary nozzle mounted closely adjacent to said main nozzle, said auxiliary nozzle being adapted to apply a relatively high-intensity heating flame substantially normally to the surface portion impinged by said main nozzle; conduit means for supplying a mixed fuel and oxidizing gas to the heating flame means of said main nozzle; conduit means for supplying oxidizing gas to the oxidizing-gas passage of said main nozzle; a cutting valve controlling said oxidizing gas passage; means for supplying mixed oxidizing and fuel gas to said auxiliary nozzle; and valve means controlling the supply of oxidizing and fuel gas to said auxiliary nozzle and operable to interrupt quickly the supply of said gases thereto substantially simultaneously with the opening of said cutting valve.

8. Apparatus for removing metal from a ferrous metal body which comprises main nozzle means for applying a heating flame against a portion of the surface of said body and for applying an oxidizing gas stream at an acute angle against said surface portion; an auxiliary nozzle mounted closely adjacent to said main nozzle, said auxiliary nozzle being adapted to apply a relatively high-intensity heating flame substantially normally to the surface portion impinged by said main nozzle; conduit means for supplying a mixed fuel and oxidizing gas to the heating flame means of said main nozzle; conduit means for supplying oxidizing gas to the oxidizing-gas passage of said main nozzle; a cutting valve controlling said oxidizing gas passage; means for supplying mixed oxidizing and fuel gas to said auxiliary nozzle; and valve means controlling the supply of oxidizing and fuel gas to said auxiliary nozzle and operable to interrupt quickly the supply of said gases thereto independently of the supply of mixed fuel and oxidizing gas to the heating flame means of said main nozzle.

9. Blowpipe apparatus for removing metal from a ferrous metal body which comprises a main nozzle having an axial cutting oxygen orifice therethrough and heating flame orifices adjacent to said cutting orifice; an auxiliary nozzle mounted closely adjacent to and at an angle to said main nozzle, said auxiliary nozzle being constructed to apply a high-intensity heating flame substantially normally against the surface portion of the body initially impinged substantially tangentially by oxygen discharged by said main nozzle; conduit means supplying mixed fuel and oxidizing gas to the heating flame orifices of said main nozzle; conduit means supplying cutting oxygen to the cutting oxygen orifice of said main nozzle; a cutting valve controlling flow through said cutting oxygen conduit; a mixer for mixing oxidizing gas and fuel gas and supplying such mixed gas to said auxiliary nozzle; a pair of valves controlling the supply of oxidizing gas and fuel gas to said mixer; and means for simultaneously operating said pair of valves, said operating means being constructed and arranged to open said pair of valves independently of said cutting valve and to close said pair of valves substantially simultaneously with the opening of said cutting valve.

10. Blowpipe apparatus according to claim 9 in which said auxiliary nozzle is provided with a plurality of converging heating flame orifices for providing high-velocity heating flames which converge and merge on the surface of said body.

11. Blowpipe apparatus for removing metal from a metal body which comprises means for projecting a stream of oxygen at an acute angle against a surface of such body; means for applying a heating flame to the surface area impinged by said cutting oxygen; means for applying an auxiliary high-velocity heating flame substantially normally against said surface area; passage means supplying cutting oxygen to said cutting oxygen stream; a cutting valve controlling said cutting oxygen passage; means for sup-

plying mixed fuel and oxidizing gas to said relatively low heating flame; a mixer for mixing oxidizing and fuel gas and supplying such mixed gas to said auxiliary high-velocity heating flame means; a pair of valves controlling the supply of oxidizing gas and fuel gas to said mixer; means for simultaneously operating said pair of valves, said operating means being constructed and arranged to open said pair of valves independently of said cutting valve and to close said pair of valves substantially simultaneously with the opening of said cutting valve.

12. In the art of removing metal from a ferrous metal body having a curved side surface, the method of quickly heating a spot on said curved side surface of the ferrous metal body to its ignition temperature solely for starting a thermo-chemical metal removal operation with a downwardly discharged substantially vertical stream of oxidizing gas surrounded by oxy-acetylene preheating jets of low velocity, which comprises applying to said spot a plurality of inclined high-velocity and high-intensity oxy-acetylene flames which converge at said spot, said flames being disposed in symmetrical relation about a common axis which is disposed at an acute angle with respect to the axis of said oxidizing gas stream and substantially normal to said curved surface, the inner cones of said flames being spaced slightly from the point of convergence of said flames, and entirely discontinuing said flames immediately after said spot has reached its ignition temperature for thermo-chemical reaction with said oxidizing gas stream which is initiated upon the discontinuance of said high-intensity and high-velocity flames.

13. Blowpipe apparatus which comprises means including a stem for supplying a mixed gas containing combustible gas, such as acetylene, and combustion-supporting gas, such as oxygen; and means connected to said stem for producing converging high-velocity and high-intensity heating flames with said mixed gas, comprising a nozzle including a head secured to said stem and having a relatively large axial mixed-gas inlet passage therethrough, a body having an enlarged mixed-gas chamber, and an otherwise imperforate tip having a plurality of gradually tapered passages connecting said chamber to a corresponding number of relatively long outlet orifices, said passages converging toward said orifices and said orifices converging toward the main axis of the nozzle in order to produce, when the jets of mixed gas discharged thereby are ignited, a group of extra long, high-velocity flames that converge toward an intensely hot common point.

14. Blowpipe apparatus according to claim 13 in which the construction and arrangement is such that the inner cones of the flames do not extend quite to the common point of convergence and the nozzle is so positioned in use that the common point of convergence is approximately at the surface of the work to be heated.

EVERETT P. JONES.