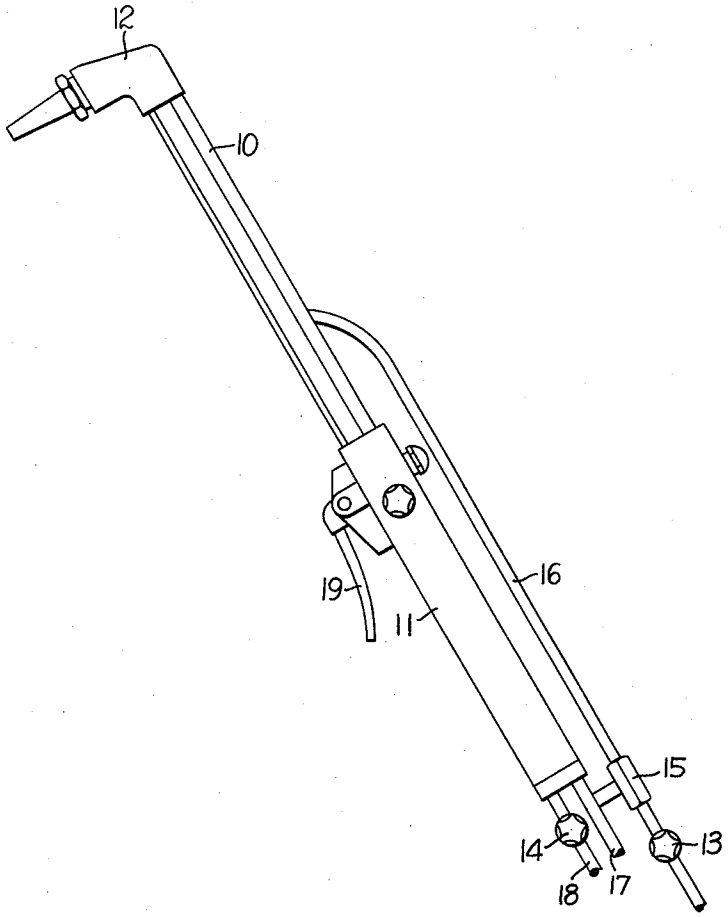
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METHOD OF CUTTING MANGANESE STEEL

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METHOD OF CUTTING MANGANESE STEEL

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This invention relates generally to the oxygen cutting of manganese steel, and more particularly to a new method of cutting manganese steel with an oxy-fuel torch.

Manganese steels having 8 to 12% manganese and other such alloy steels are quite difficult to cut thermochemically with an oxy-fuel torch. These steels oxidize too readily and uncontrollably so that the oxides which are formed during oxy-fuel cutting do not easily flow from the kerf. Although it is possible to cut manganese steel with a regular oxy-fuel torch, the process is rather slow and considerable difficulty is encountered. For example, starting the cut may be difficult, and once started the cutting action is often not continuous, and difficulty is encountered in restarting the cut. Further, numerous minor explosions are likely to occur accompanied by violent upward ejections of hot slag. Once severance is achieved, the kerf is usually wide and irregular with its surface severely gouged and pitted. These gouges and pits are usually so severe that each resultant kerf face may have as much as one inch of waste material which must be ground off if a flat edge face is desired. Thus by thermochemical cutting, as much as two inches of material are wasted along the entire length of the cut.

I have found that these manganese steels can be cut quickly, easily and continuously with a resulting narrow and smooth kerf, without the difficulty of starting if sulfur dioxide gas is added to the cutting oxygen in an oxy-fuel cutting torch. The torch must be designed so that both oxygen and sulfur dioxide gas are fed simultaneously to the workpiece during the cutting operation. The sulfur dioxide gas in combination with the cutting oxygen facilitates the removal of the slag from the reaction zone by increasing the fluidity of the slag, provides a beneficial temperature reduction, and minimizes the violent reaction of the oxygen alone upon the hot manganese steel. Therefore, the cutting is made smooth and continuous with the slag, largely FeO, Fe_3O_4 and FeS, flowing readily from the kerf bottom as the cut progresses. The kerf is quite narrow at about ⅛ inch which minimizes waste, and the finished cuts are of good quality with the surfaces plane, having shallow drag lines and free from gouges and pits.

Therefore, it is a primary object of this invention to provide a method whereby manganese steel may be cut easily and quickly by thermochemical means without the usual attendant difficulties as starting, noncontinuity and violent ejections of hot slag.

Another object of this invention is to provide a method for cutting manganese steel whereby the kerf is straight, narrow and smooth, thus eliminating the usual wide, irregular, gouged and pitted kerf.

These and other objects and advantages shall become apparent from a full understanding of the following description, especially when read in conjunction with the following drawing which is a plane view of the cutting torch as modified to practice my invention.

In the practice of my invention a flame cutting torch must be modified to permit the passage of the sulfur dioxide gas with the cutting oxygen. Thus, two cutting gases must be supplied. It is further necessary that a valve or some regulating means be provided so that the ratio of the two gases can be controlled. The modification used is not material so long as the sulfur dioxide gas is fed to the cutting zone along with the cutting oxygen. However, I have found it necessary to modify the torch

in such a manner that the sulfur dioxide gas is not admitted simultaneously with the cutting oxygen when the cutting oxygen lever is first depressed. For best results it is desirable that the cutting oxygen be introduced to the cutting zone first before the sulfur dioxide is introduced.

The torch I modified was of the Airco 9500 series and is illustrated as modified in the figure. First a ¼ inch hole was drilled into the cutting oxygen tube **10** at a forward angle on the top side about one-third of the way between the torch handle **11** and the cutting tip elbow **12**. A stainless steel needle valve **13** (Matheson #103 N.P.T. male) was mounted adjacent to the standard valve **14** by means of a hexagonal bushing **15** attached to the torch handle **11**. A ¼ inch stainless steel tube **16** was attached to the forward end of the bushing **15**. The forward end of the stainless steel tube **16** was bent down so that it fit over the angular ¼" hole drilled into the cutting oxygen tube **10** and there brazed to prevent leakage.

The following procedure is one which may be employed in cutting manganese steel with the modified torch described above. It should be understood however that the following procedure is only illustrative of procedures that may be followed.

The first consideration is that the cutting area must be well ventilated because of the use of the noxious sulfur dioxide gas. If cutting is to be conducted indoors it should be done under an exhaust hood, and it may even be necessary that the operator use an appropriate mask.

To commence the work, the oxygen and acetylene supply lines are connected to the torch in the usual manner at **17** and **18** respectively. A hose from a sulfur dioxide supply is connected to the inlet on the needle valve **13**. Because of the corrosiveness of the sulfur dioxide gas, I have found it desirable to use Teflon (T.M. Du Pont) hoses and gaskets for the sulfur dioxide supply line. With the torch properly connected the oxygen valves and the acetylene valve are opened, the gas at the tip is ignited and adjusted to a neutral or slightly carburizing flame. The usual procedures for ordinary oxy-acetylene cutting are then followed to start the cut. That is, the flame is pointed downward to locally heat the top edge of the workpiece at the point where cutting is to start. The torch thus blasts downward on the upper corner of the starting face and parallel across the side surface beneath the corner. When localized melting occurs at the upper corner, the cutting oxygen lever **19** is depressed and the oxygen jet causes some oxidation in the molten iron on the top edge. The oxides then run down the side surface preheating a thin line to promote further oxidation. Up to this point of course, the preceding procedure is that ordinarily followed in oxy-fuel cutting. After the cutting oxygen lever **19** is depressed and the cut started, the sulfur dioxide needle valve **13** is opened to allow a flow of about four to seven liters per minute. The cut is then finished by advancing the torch slowly along the line to be cut in accordance with the usual cutting procedures. For best results it is of course desirable that machine cutting be used so that the rate of travel is controlled.

Now to examine the preceding procedure in detail it is noted that many of the variables are left to the personal preference of the operator, such as size and type of cutting torch and cutting tip and so on.

The various gas pressures may be varied to some extent without much effect. The usual oxygen pressures in the 30 to 50 p.s.i.g. range are all satisfactory, although pressures in the 50 p.s.i.g. range usually produce more favorable results. The most critical pressure is that of the sulfur dioxide which must be at about 40 to 45 p.s.i.g. However, marketed sulfur dioxide cylinders only have an initial pressure of 35 p.s.i.g. at 70° F., so it is necessary to heat the cylinder in order to attain and maintain 40

to 45 p.s.i.g. Furthermore, since the pressure of the oxygen at the torch is greater than the pressure of the sulfur dioxide, it is necessary that a check valve be placed on the sulfur dioxide supply line to prevent feedback of oxygen into the sulfur dioxide cylinder.

The flow rate of the sulfur dioxide should be in the range of 3.9 to 7.0 liters per minute. Flow rates below 3.9 liters per minute will result in progressively poorer cuts, while quantities in excess of 7.0 liters per minute are of doubtful value. The cutting oxygen flow rate is too great to be measured with ordinary meters; however, calculations show a good average cutting oxygen flow rate to be about 150 cubic feet per hour.

As noted above it is usually desirable that the cutting oxygen lever be depressed shortly before the sulfur dioxide valve is opened. If the two gases are first admitted simultaneously, a washing action may take place on the side surface. Such a washing action is characterized by a wide area of the steel being washed away at a temperature below its melting point due to reaction with the sulfur dioxide. Thus, the sharp line score should be started before the sulfur dioxide valve is opened, so as to contain the thermochemical reaction within the kerf.

Other fuels will also work in place of the acetylene, such as hydrogen, butane, propane and so on. However, the acetylene was used because of convenience and availability.

It is apparent then that the specific best conditions will vary somewhat depending upon the circumstances. In order to more clearly illustrate this invention, however, the following table shows the conditions I found to be most favorable for cutting a two inch manganese steel plate:

Table

Torch tip	Airco 144–4.
Flame	Slightly carburizing.
Acetylene pressure	3 p.s.i.g.
Oxygen pressure	50 p.s.i.g.
Sulfur dioxide pressure	40 p.s.i.g.
Cutting oxygen flow	150 cu. ft. per hour.
Sulfur dioxide flow	5.8 liters per minute.
Travel speed	4 inches per minute.

Microexamination of surfaces cut in accordance with this teaching has shown that the heat affected zone is very slight. Such heat affected zones for manganese steels ranged from about 0.001 to 0.007 inch. By way of comparison many cuts made with ordinary oxy-fuel methods have shown heat affected zones up to 0.120 inch.

Tests were also conducted using sulfur dioxide as a flux for cutting other alloy steels and cast irons. Here only limited success was achieved in improving the results of cutting ordinary cast iron. Cast iron has a slow rate of combustion and its removal by thermochemical means is largely a matter of melting and erosion. The sulfur dioxide flux did improve the cutting of cast iron, although not to any great degree as reported above for the manganese steel alloys.

Although ordinary low alloy steels are readily cut by ordinary oxy-fuel torches, the use of sulfur dioxide flux does improve in some cases the cutting by facilitating slag removal and leaving smoother surfaces. This is especially true for cutting extremely thick pieces where the slag may not flow readily from the kerf.

Having now particularly described and ascertained the nature of my said invention and the manner in which it is to be performed, I declare that what I claim is:

1. The method of thermochemically cutting an alloy steel member containing 8 to 12 percent manganese which comprises:
   (*a*) projecting a stream of cutting oxygen against the edge of said member to be cut while the edge portion of the member is at the melting temperature, and
   (*b*) introducing sulfur dioxide gas into the cutting oxygen stream at a flow rate of about 3.9 to 7.0 liters per minute.

2. The method of thermochemically cutting an alloy steel member containing 8 to 12 percent manganese which comprises:
   (*a*) projecting an oxy-fuel flame against the outer edge surface of said member until localized melting occurs,
   (*b*) projecting a jet of cutting oxygen against said molten metal along with the said flame until oxidation of the molten metal is initiated and the kerf started,
   (*c*) thereafter introducing sulfur dioxide gas into said cutting oxygen jet at a flow rate of about 3.9 to 7.0 liters per minute, and
   (*d*) moving said flame and said cutting oxygen and sulfur dioxide jet along the line to be cut.

3. The method of claim 2 wherein said sulfur dioxide flow rate is about 5.8 liters per minute.

4. In the thermochemical cutting of 8 to 12 percent manganese steel alloy wherein a stream of oxygen is projected against the alloy steel to be cut while the metal is at its melting temperature, in combintion therewith, the improvement comprising: projecting sulfur dioxide gas along with the cutting oxygen at a flow rate of about 3.9 to 7.0 liters per minute.

5. In the thermochemical cutting of 8 to 12 percent manganese steel alloy wherein said alloy is locally heated to its melting temperature with an oxy-fuel flame, and thereafter subjected to a stream of cutting oxygen to cause the molten metal to oxidize and flow down the starting surface preheating a thin line which oxidizes to score a kerf into the surface of the alloy, in combination therewith, the improvement comprising: projecting sulfur dioxide gas against the alloy surface in a mixture with the cutting oxygen stream at a flow rate of about 3.9 to 7.0 liters per minute.

6. The method of claim 5 wherein the flow rate of the sulfur dioxide is about 5.8 liters per minute.

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