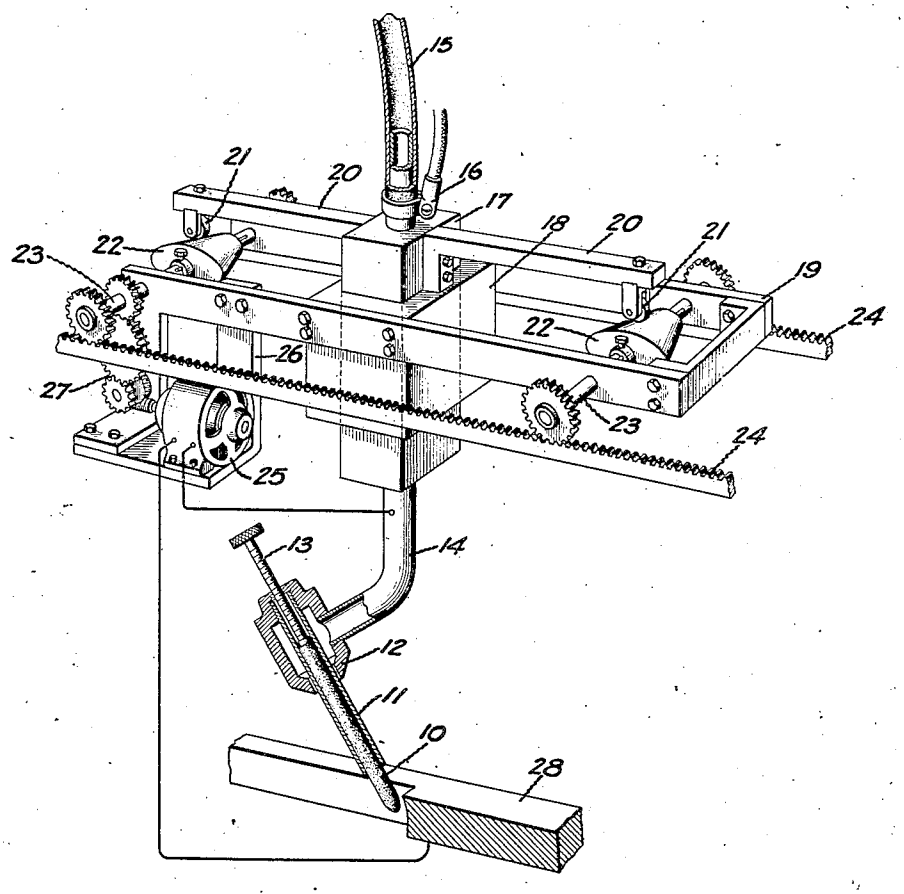
Feb. 4, 1930. P. P. ALEXANDER 1,746,208

ELECTRIC ARC CUTTING

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ELECTRIC-ARC CUTTING

Application filed August 26, 1925, Serial No. 52,663. Renewed October 8, 1927.

My invention relates to the cutting of metals by means of the electric arc.

An object of my invention is to provide an improved process and an improved apparatus utilizing an arc of relatively high potential and great heating capacity to cut metals. Although not limited thereto my invention finds particular application to the cutting of cast iron and non-ferrous metals.

The arc voltage using a carbon electrode in air is on the average of 37 volts and the current values used are high, in some cases as high as 1500 amperes. The width of the groove cut depends on the size of the electrode which in turn depends on the value of the current used. As the cutting is essentially a melting process the speed is determined by the amount of metal to be removed and the energy supplied for that purpose.

As pointed out in my application, Serial No. 758,082, filed December 26, 1924, for methods and apparatus for electric arc welding, and assigned to the same assignee as the present application, the voltage of the arc in a hydrogen atmosphere is greatly in excess of that of the corresponding arc in air. The high normal voltage of such an arc makes it possible to secure a much greater heating effect with this arc in the hydrogen atmosphere than in air for the same current and with this high arc voltage and a high current value the energy available by the employment of such an arc is tremendous. Furthermore, the arc in hydrogen has its largest fall of potential in the gaseous layer next to the positive crater; that is a large proportion of the energy is produced at the exact place where it is needed when the work to be cut is made the positive side of the circuit.

Because of the high voltage great energy may be derived with low current values and thus one generator may be used both for welding and cutting. If the necessary high striking voltage of about 120 volts for an arc in a hydrogen atmosphere be obtained by the insertion of a properly predetermined reactance in the circuit any suitable source of current may be used, for example a generator such as shown in Letters Patent to Bergman, No. 1,340,004 wound for about 80 volts on open circuit has been found to give satisfactory operation. The minimum arc voltage in hydrogen is about 40 volts, but it is to be understood that arc voltages greatly in excess of this may be used where a suitable supply circuit is used. The arc voltage depends upon the arc length. I have successfully used arc voltages in excess of 75 volts and higher voltages may be used if desired.

My invention is to be distinguished from cutting arrangements and processes wherein the heating effect of an arc is supplemented by the chemical reaction of combustion of gases such for example as oxygen and hydrogen. In accordance with my invention the gaseous medium is not oxidizing but actively reducing in its nature. The gas need be supplied in relatively small quantities. The method of cutting may be such as to allow a free flow of the melted metal from the cut or section but preferably the gaseous medium is supplied in the form of a blast which removes the molten metal.

The cost of hydrogen per cubic foot is at the present time from two and one half to three times lower than that of oxygen or acetylene. In large industrial plants hydrogen is available as a by-product. In such a case its cost is only one twentieth that of acetylene. The reducing gaseous medium need not be pure hydrogen but I deem it preferable to use a medium which contains or is decomposed in the arc to produce a considerable percentage of hydrogen. For example, I have found illuminating gas may be used. Illuminating gas contains around 30 to 40% of hydrogen and a somewhat smaller amount of carbon monoxide. The hydrocarbons and carbon dioxide of illuminating gas are decomposed and recombined when the arc is confined in the kerf with the further liberation of hydrogen. The presence of carbon monoxide in substantial proportions tends to lower the arc voltage for any given arc length but the arc voltage may be kept as high as desired by holding a longer arc. When such a gas as illuminating gas is used its cost is almost negligible when compared with the cost of the usual cutting gases and thus the cost of my gas arc cutting process using illu-

minating gas will be comparable to or lower than that of the previous gas cutting means and it is much more satisfactory for cast iron and non-ferrous metals.

By my process I have cut cast iron and steel plates of one and two inches in thickness with a current of 130 amperes at speeds of 30 and 40 feet per hour and the edges of the cuts have been clean and sharp and compare favorably with the cuts made with the oxy-hydrogen torch. The reducing gas flame protects the metal during the operation and the edges are not oxidized as is the case in oxy-hydrogen or oxy-acetylene cutting where the basic principle of the process rests upon the oxidization and burning of the metal. Furthermore, since the gas flame entirely surrounds the electrode its consumption is greatly lessened.

Aside from these advantages of low cost of operation, the possibility of using a single standard generator as above pointed out for both welding and cutting purposes is a great advantage. At the present time cutting by the carbon arc necessitates machines capable of developing from 600 to 1000 amperes or more.

The single figure of the drawing illustrates an automatic machine for carrying out my invention. In the figure, 10 is a graphite or carbon electrode which is mounted in sliding engagement within a tube 11 located in the face of the nozzle 12. The electrode 10 may be adjusted in the tube 11 by means of a screw 13. The end of the tube 11 is enameled to prevent accidental short circuiting of the arc when the electrode is in a deep narrow cut.

A heavy copper tube 14 conducts the gas and the current simultaneously to the nozzle 12. Gas is supplied to the tube by a pipe 15 and one terminal of the source of welding current is connected at 16 to this tube. Tube 14 slides in the steel block 17 so that the height of the electrode above the work can be adjusted. The block 17 slides freely within a sleeve 18 which is supported by a carriage 19. Block 17 is also provided with arms 20 carrying at their extremities cam followers 21. These cam followers are forced into engagement by gravity with cams 22 adjustably located by means of splined joints to axles 23 of the carriage 19.

The carriage 19 is arranged to move on rack rails 24 and is positively driven by a motor 25 mounted on a bracket 26 secured to the carriage by a gear train 27 which drives one of the axles of the carriage. The motor 25 may be a constant speed motor or as shown in the drawing it may have its terminals connected across the arc in which case the speed of cutting will be regulated automatically. If the arc length is shortened by the metal not being removed at a rate corresponding to the speed of propulsion of the carriage the voltage impressed on motor 25 will be lessened and the carriage slowed in its travel so that the energy in the arc may remove more metal. This will then lengthen the arc. If the arc on the other hand is too long then the carriage will be advanced at a more rapid rate along the line of section because of the increased value of potential impressed on the motor. Thus the speed of the carriage will be proportional to the arc length which is determined by the rate of removal of metal.

As the motor advances the carriage along the rack rails the rotary movement of the cams 22 secured to the axles 23 of the carriage causes the block 17 by means of arms 20 and the cam followers 21 to oscillate thereby oscillating the electrode vertically in the plane of the kerf.

When operating the machine it is preferable to keep the arc between the electrode 10 and the work 28 within the kerf, since if the arc be brought to the surface of the work there is a tendency for it to wander about over the surface of the work and produce a rough and irregular kerf.

The application of Irving Langmuir, Serial No. 729,185, filed July 30, 1924, for heating process and apparatus, assigned to the same assignee as the present application, discloses and claims method and apparatus for producing atomic hydrogen and carrying it over to the work where it is recombined, liberating heat. Whether or not heating of the work by the recombination of dissociated hydrogen may under certain circumstances be present to some extent when my invention is used, I make no claim to such subject matter since the Langmuir invention is earlier than my invention.

While I have described and illustrated an apparatus particularly adapted for carrying out my process where a certain class of work is to be cut, it is apparent that for many classes of work a hand tool may be preferable. It will also be apparent to those skilled in the art that as far as the broader aspects of my apparatus are concerned it is immaterial whether the machine operates on rails over the work or rolls directly upon the work or remains stationary while the work moves. I therefore, aim in the appended claims to cover all such modifications and variations of my process and apparatus as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. The method of cutting metals by the electric arc which comprises maintaining a cutting arc between an electrode and the work constituting the other electrode and supplying a blast of a reducing gaseous medium containing hydrogen to envelop the arc and remove the molten metal.

2. The method of cutting metal work by the electric arc which comprises maintaining a cutting arc within the kerf in the work between a negative electrode and the work constituting the positive electrode and supplying a blast of illuminating gas to envelop the arc and remove molten metal.

3. A gas arc cutting machine wherein the arc is between an electrode and the work, comprising means for producing relative movement between the arc and the work along the section to be cut, means for oscillating the electrode in the plane of the cut, and means for supplying a blast of gaseous medium to envelop the arc and remove molten metal.

4. A gas arc cutting machine wherein the arc is between an electrode and the work, comprising means for producing relative movement between the arc and the work along the section to be cut, means for oscillating the electrode in the plane of the cut and within the kerf, means for supplying a blast of gaseous medium to envelop the arc and remove molten metal, and means for controlling the rate of movement along the work in response to an electrical characteristic of the arc which varies with the arc length.

5. A gas arc cutting device comprising a gas delivery nozzle, an electrode mounted in said nozzle, a support for said nozzle, and means for vertically oscillating said nozzle relatively to the work.

6. An arc cutting machine wherein an arc is maintained between a substantially non-consuming electrode and the work comprising means for producing relative movement between the arc and the work along the section to be cut, means for oscillating the electrode in the plane of the cut, and means for controlling the rate of movement along the work in response to an electrical characteristic of the arc which varies with the arc length.

7. The method of cutting metals by the electric arc which comprises maintaining a cutting arc between a negative electrode and the work constituting the positive eletrode and supplying a reducing gaseous medium containing hydrogen about the arc and molten metal.

In witness whereof I have hereunto set my hand this 12th day of August, 1925.

PETER P. ALEXANDER.