Fig. 1

Fig. 5

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METHOD AND APPARATUS FOR DETERMINING AND/OR CONTROLLING CONSTITUENT POTENTIALS

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This invention relates to the method and apparatus for measuring and/or controlling the constituent potential of a gas, and more particularly of a heat treating gas.

When heat treating metals it is necessary that the metal be treated in a protective atmosphere. For example, in heat treating carbon steels, it is essential that the treating gas have a carbon potential which is in equilibrium with the carbon of the treated steel.

Heretofore, efforts have been made to determine the carbon potential of the treating gas by dew point indicators or by devices which measured the change in condition of an element disposed in the treating furnace. These methods have been difficult to carry out and have required costly and complicated equipment.

The present invention overcomes these difficulties by providing a method and apparatus whereby the constituent potential of the treating gas can be readily measured and/or controlled.

For the purpose of illustration, the invention will be described as controlling the carbon potential for a heat treating furnace. This is accomplished, according to the present invention, by drawing off a portion of the treating gas and feeding the same to a burner and there burning the gas in a flame and measuring the temperature of the flame which has a direct relation to the carbon potential of the gas. The temperature measurement can be used to indicate the carbon potential whereby manual control of the constituent gas can be effected. However, in most circumstances it is desirable to maintain the carbon potential automatically and this is achieved by utilizing the variation of the temperature of the flame to actuate a control for varying the proportion of the components of the gases making up the treating gas so as to maintain the carbon potential at the desired amount.

A feature of the invention resides in the fact that the gas is burned in a novel burner construction having a thermocouple mounted therein by which the temperature of the flame is taken at the base of the flame and the center of the flame is protected by a wall of flame therearound which prevents variations in the center flame.

In carrying out the present invention the drawn off gas can be taken from the generator in cases where the generator feeds but one treating furnace or if the generator feeds a plurality of treating furnaces, the treating gas is drawn off from the treating furnace and corrective adjustments of the carbon potential in the furnace are obtained by controlling a source of enriching gas which is provided for each furnace.

Other features and advantages of the invention will be apparent from the specification and claims when considered in connection with the drawings in which:

Figure 1 shows a diagrammatic layout of a heat treating system embodying the present invention.

Figure 2 shows a sectional view of the novel burner.

Figure 3 is a top view of the burner.

Figure 4 is a sectional view taken along lines 4—4 of Fig. 2.

Fig. 5 is a diagrammatic view showing another system embodying the present invention.

For the purpose of illustrating the invention, the drawings show the invention applied to the formation of an atmosphere for use in heat treating carbon steels.

As shown in Fig. 1, air and a gaseous fuel, preferably of the hydrocarbon type, such as natural gas, propane, butane or methene, are fed from supplies thereof through lines 10 and 11 respectively, mixed and fed into a gas generator 12. The gas generator can be of any desired type which breaks down the mixture into hydrogen, nitrogen, carbon monoxide, carbon dioxide and methane. One such generator is disclosed in my co-pending application Serial No. 507,651, filed May 11, 1955, now Patent No. 2,802,725, issued August 13, 1957. The generated gas is fed from the generator through line 13 into the heat treating furnace 14 so as to provide the required atmosphere in the furnace during the heat treating operation.

In heat treating steel, for example, it is essential that the carbon potential of the gas forming the treating atmosphere be maintained in equilibrium with the carbon of the steel in order to prevent variation in the carbon content of the steel. The present invention provides means whereby this can be readily accomplished.

As shown in Fig. 1, a portion of the resulting gas is drawn off from the line 13 leading to the furnace by a pump P and is fed through pressure regulating means 15 to be mixed with air fed at a constant rate from a supply line 16 by a similar pump P through a similar pressure regulating means 17. In the illustrated form of the invention the pressure regulating means comprises coarse regulators 18 which provide an initial drop and fine regulators 19 which control the pressure very accurately as the treating gas and the air are mixed. If desired, the pressure of the treating gas and air delivered to be mixed can be checked by suitable pressure gauges 20.

The treating gas and air, when mixed, are fed into a burner 21 so as to be burned therein in a flame 22. The temperature of the base of the flame is measured and determines the carbon potential since this temperature has been found to have a predetermined direct relationship to the carbon potential of the treating gas.

In carrying out the invention a novel burner construction is employed. As shown in Figs. 1 to 4, it comprises a T-shaped housing 23 having the mixed gas fed therein through a port 25 in one side thereof. Projecting from one end of the T is the burner member comprising a sleeve 24 having a flange 25 at one end. Projecting axially of the sleeve from the flange is a threaded portion 26 adapted to receive a threaded ring 27 having an intumid lip 27a to engage and clamp a ceramic disk 28 against a shoulder 29 on the end of the sleeve, a suitable gasket 30 being provided to effect a seal between the disk and sleeve. The bore 31 of the sleeve connects the housing with the manifold 32 under the disk.

The disk 28, as shown in Fig. 3, is provided around its periphery with small apertures 33 and has an enlarged aperture 34 at the center. Thus, it will be seen that as the mixture of gas and air is fed into the housing it will pass through the bore 31 in the sleeve and out through the central aperture 34 and peripheral apertures 33 so as to burn with a center flame 35 and a protecting wall of flame 36 therearound which stabilizes and prevents air currents from varying the center flame. Further, if desired, a suitable glass chimney A can be provided to protect the flame 22.

For best results it has been discovered that the temperature of the center flame should be measured at the base thereof. In order to accomplish this, the housing has mounted therein a thermocouple 37 mounted in a fixture 38 connected to a nipple 39 threaded in the other end of the housing with the thermocouple extending...
through the bore 31 and having the end 37a projecting into the base of the central flame 35 so as to accurately record the temperature thereof. In order to center the thermocouple in the aperture 34, centering screws 40, shown in Fig. 4, are provided in the sleeve 24.

The leads 41, 42 from the thermocouples are connected to a universal adjustable controlling type of potentiometer or bridge device 43 having an indicator 43a cooperating with a scale 43b to indicate the temperature of the base of the flame. If desired, a movable reference pointer 44 can be mounted on the device 43 to show the adjustment of the device for the proper carbon potential. By suitable calibration the scale 43b can be utilized to give a direct reading of the carbon potential. With this arrangement the carbon potential can be readily determined and set at the required amount and any variations therefrom can be readily detected and indicated.

In order to correct for variations in the carbon potential, the proportion of the fuel gas and air fed into the generator may be varied. While either the air or gas may be varied, in the illustrated form of the invention the proportion is changed by providing an auxiliary fuel gas supply 45 having a valve 46 therein whereby more or less gas can be fed to the mixture.

While the valve 46 may be actuated manually, it is preferred to provide a remote controlled valve connected to the controlling device 43 for automatically maintaining the carbon potential at the required amount. In the illustrated form of the invention, the valve is an electrically controlled valve which may be actuated by means of solenoid motors and is connected to the control device by leads 47, 48 so that the auxiliary supply can be controlled in accordance with the actuation of the bridge circuit or potentiometer by the thermocouple as required. Thus, it will be seen that any variation in the carbon potential of the generated gas will be immediately detected by the variation in the temperature of the base of the flame and will, through the thermocouple, potentiometer and/or bridge, control the valve 46 to add more gas should the potential be below normal, or cut back the gas should the potential be above normal. The device provides a very accurate and sensitive determination of the carbon potential of the gas and quickly and accurately corrects any variation or deviation from the required amount.

Instead of taking the sample of treating gas from the generator, as shown in Fig. 1, the sample can be taken from the furnace as shown in Fig. 5. This lends itself well to systems wherein one generator is employed to supply a plurality of furnaces, each of which may require a different carbon potential. In this form of the invention, the fuel and gas are so proportioned and fed to the gas generator 12 so as to produce a treating gas having a minimum carbon potential. The generated gas is then fed through lines 13a to each of the furnaces 14. In the line 13b to each furnace is connected a supply 48a of enriching gas which is controlled by means of a control valve 46a. A constituent potential control means of the present invention is connected to each furnace and a portion of the atmosphere of the furnace is drawn off by the pump P, mixed with a constant volume of air and burned as described above. The temperature of the base of the flame is measured and utilized to control the valve 46a to supply the required amount of enriching gas to bring the carbon potential to the required amount for the particular furnace and to maintain it at said required amount.

While the foregoing description has been concerned with a heat treating atmosphere having a predetermined carbon potential, it is to be understood that the invention can be utilized to determine and/or maintain the constituent potential of any combustible heat treating gas having a hydrogen component therein. Furthermore, although the constituent potential detecting means of the present invention has been described herein as detecting and/or controlling the constituent potential of the atmosphere to be used in the heat treating furnace, it is to be understood that the device can also be used to determine and/or control constituent potentials wherever combustible gas is used.

Variations and modifications may be made within the scope of the claims and portions of the improvements may be used without others.

I claim:

1. Means for measuring the constituent potential of a combustible gas comprising a burner, means feeding the gas to the burner to be burned therein with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame, the temperature in the center of the base of the flame varying with the composition of the gas and means connected to the thermocouple for indicating the constituent potential of the gas and variations therein.

2. Means for measuring the constituent potential of a combustible heat treating gas comprising a burner, means feeding a portion of the treating gas to the burner to be burned therein with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame, the temperature in the center of the base of the flame varying with the composition of the gas and means connected to the thermocouple for indicating the constituent potential of the gas and variations therein.

3. Means for measuring the constituent potential of a combustible heat treating gas comprising a burner having a ceramic head provided with a central aperture and a plurality of apertures around the periphery, means feeding the treating gas to the burner to flow through the apertures and be burned with a flame, a thermocouple carried by the burner and disposed in the central aperture in position in the center of the base of the flame to measure the temperature of the base of the flame, the temperature in the center of the base of the flame varying with the composition of the gas and means connected to the thermocouple for indicating the constituent potential of the gas and variations therein.

4. Means for controlling the constituent potential of a combustible heat treating gas comprising a burner, means feeding a portion of the treating gas at a constant pressure and rate to the burner, means feeding air at a constant pressure and rate to the burner, said burner mixing said air and gas and burning it with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame, the temperature in the center of the base of the flame varying with the composition of the gas and means connected to the thermocouple for controlling the composition of the gas and maintaining the constituent potential of the gas uniform.

5. Means for measuring the constituent potential of a combustible heat treating gas comprising a generator for generating the treating gas, means feeding the gas from component gases, a burner, means feeding a portion of the generated gas at a constant pressure and rate to the burner, means feeding air at a constant pressure and rate to the burner, said burner mixing said air and gas and burning it with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame at the base thereof, the temperature in the center of the base of the flame varying with the composition of the gas and means connected to the thermocouple for controlling the composition of the gas and maintaining the constituent potential of the gas uniform.

6. Means for measuring the constituent potential of a combustible treating gas in a heat treating furnace comprising a burner, means feeding the portion of the treating gas from the furnace at a constant pressure and rate to the burner, means feeding air at a constant pressure and rate to the burner, said burner mixing air and gas and burning it with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame, the temperature
in the center of the base of the flame varying with the composition of the treating gas, and means connected to the thermocouple for controlling the composition of the treating gas in the furnace to maintain the constituent potential of the treating gas uniform.

7. In a heat treating system, a gas generator; means feeding air and a gas to the generator to be generated into a combustible treating gas having a predetermined carbon potential, and means feeding said treating gas to a furnace to provide a required heat treating atmosphere therein; and means for controlling the constituent potential of the combustible treating gas comprising a burner, means feeding a portion of the treating gas to the burner to be burned therein with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame, the temperature in the center of the base of the flame varying with the composition of the treating gas, and means connected to the thermocouple for controlling the composition of the treating gas to maintain the constituent potential of the gas uniform.

8. In a heat treating system, a gas generator means for converting air and a hydrocarbon fuel into a combustible treating gas having a predetermined carbon potential, and means to feed said treating gas to a furnace to provide a required heat treating atmosphere therein, means for controlling the temperature of the flame, the temperature in the center of the base of the flame varying with the composition of the treating gas, and means connected to the thermocouple for controlling the air-fuel ratio for varying the composition of the treating gas to maintain the carbon potential of the gas uniform.

9. In a heat treating system, a gas generator, means including valve means feeding air and a hydrocarbon fuel to the generator to be generated into a combustible treating gas having a predetermined carbon potential, and means to feed said treating gas to a furnace to provide a required heat treating atmosphere therein, means for controlling the carbon potential of the combustible treating gas comprising a burner, means feeding a portion of the treating gas to the burner to be burned therein with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame, the temperature in the center of the base of the flame varying with the composition of the treating gas, and means connected to the thermocouple for controlling the valve means for varying the composition of the treating gas to maintain the carbon potential of the gas uniform.

10. In a heat treating system, a gas generator, means feeding air and a hydrocarbon fuel to the generator to be generated into a combustible treating gas having a predetermined carbon potential, means including a feeding line for feeding said treating gas to a furnace to provide a required heat treating atmosphere therein, means for controlling the carbon potential of the combustible treating gas comprising a burner, means feeding a portion of the treating gas in the furnace to the burner to be burned therein with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame, the temperature in the center of the base of the flame varying with the composition of the treating gas, and means connected to the thermocouple for controlling the means for supplying the enriching hydrocarbon to the feed line, and means connected to the thermocouple for controlling the flow of enriching hydrocarbon into the feed line to vary the composition of the treating gas in the furnace and maintain the constituent potential of the treating gas uniform.

11. In a heat treating system, a gas generator, means including means feeding air and a hydrocarbon fuel to the generator to be generated into a combustible heat treating gas having a minimum carbon potential, and means to feed said treating gas to a furnace to provide a required heat treating atmosphere therein, separate means for supplying an enriching gas to increase the carbon potential of the heat treating atmosphere in the furnace, means for controlling the carbon potential of the treating atmosphere comprising a burner, means feeding a portion of the treating gas to the burner to be burned therein with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame, the temperature in the center of the base of the flame varying with the composition of the treating gas, and means connected to the thermocouple for controlling the means for supplying the enriching gas for varying the composition of the treating gas to maintain the carbon potential of the gas uniform.

12. In a heat treating system, a gas generator means including valve means feeding air and a hydrocarbon fuel to the generator to be generated into a combustible treating gas having a minimum carbon potential, and means to feed said treating gas to a plurality of heat treating furnaces to provide a required heat treating atmosphere therein, separate means for supplying an enriching gas to each of the furnaces to increase the carbon potential of the heat treating atmosphere in the furnace, means for controlling the carbon potential of the combustible treating gas in each furnace comprising a burner, means feeding a portion of the treating gas from the furnace to the burner to be burned therein with a flame, a thermocouple at the burner and disposed in the center of the base of the flame to measure the temperature of the flame, the temperature in the center of the base of the flame varying with the composition of the treating gas, and means connected to the thermocouple for controlling the means for supplying the enriching gas for varying the composition of the treating gas to maintain the carbon potential of the gas uniform in the furnace.

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