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APPARATUS FOR DETERMINING THE CARBON CONTENT OF METALS

Filed Jan. 22, 1965

2 Sheets-Sheet 1

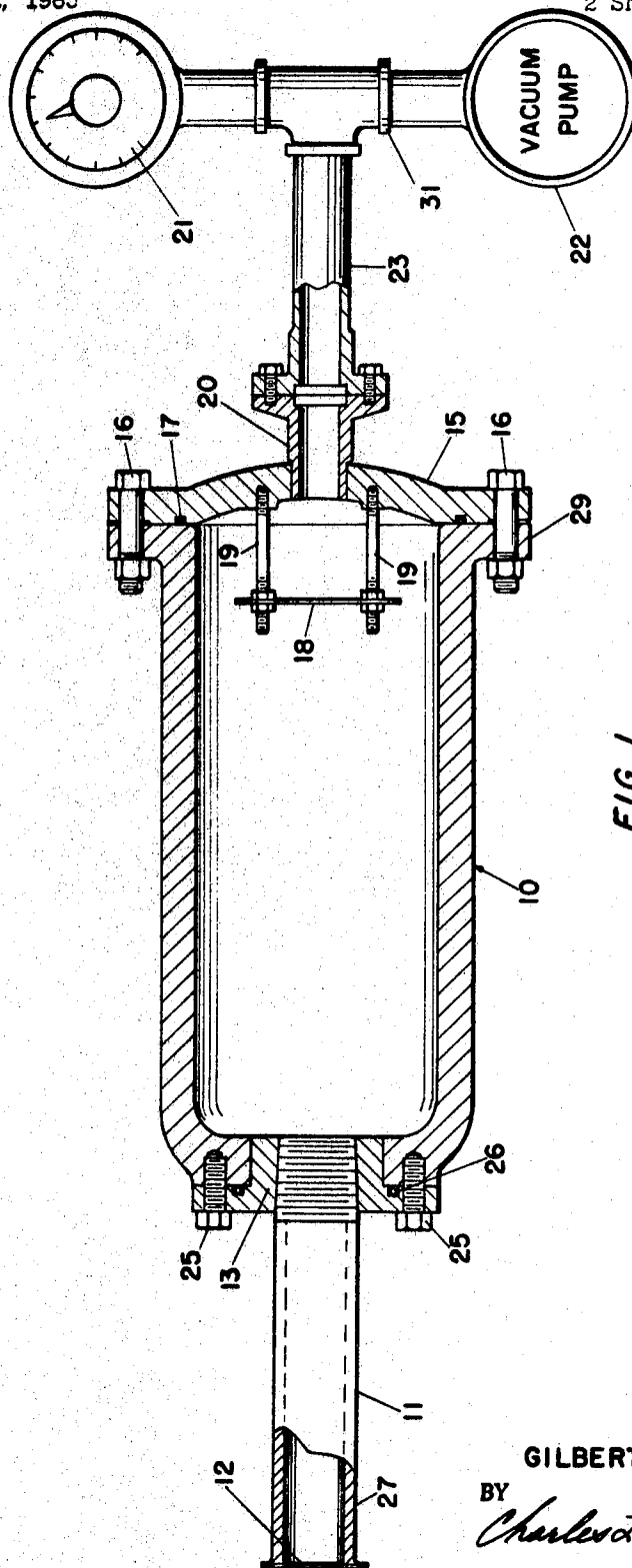


FIG. 1

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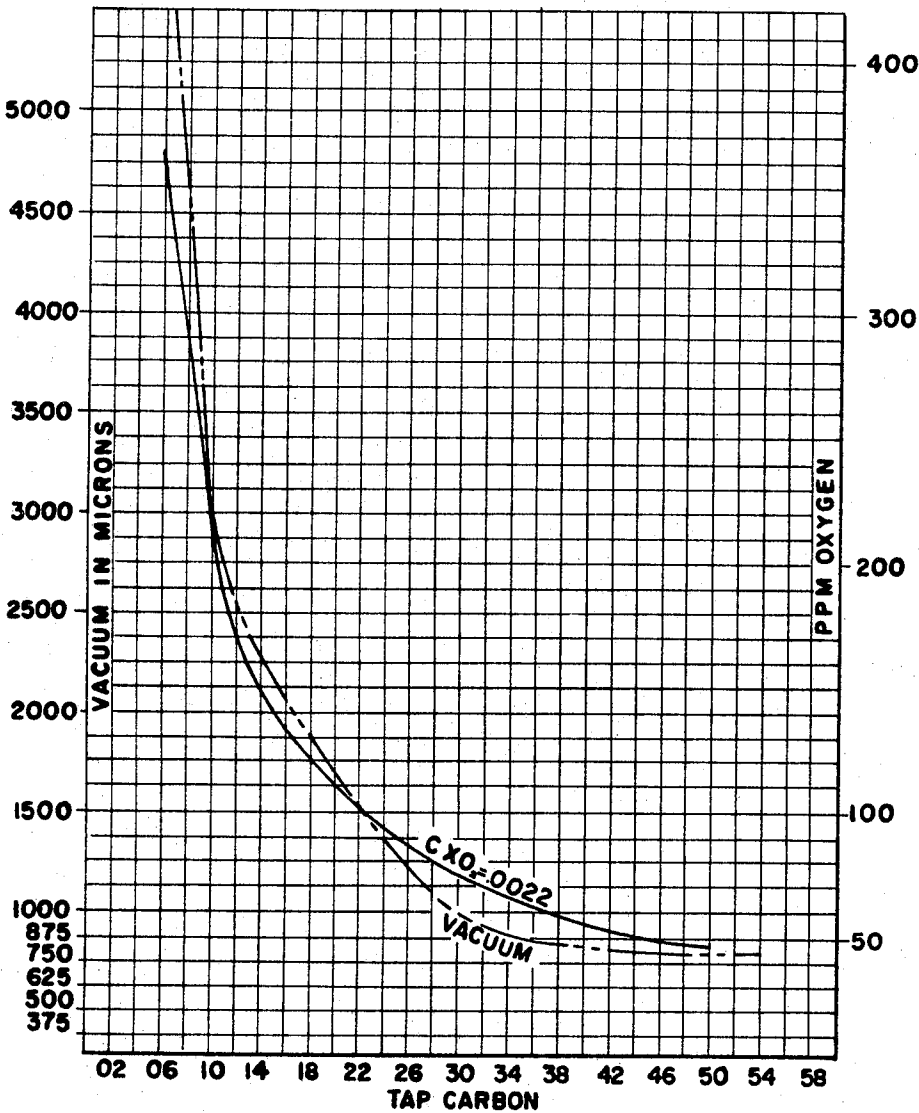


FIG. 2

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APPARATUS FOR DETERMINING THE
CARBON CONTENT OF METALS
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1 Claim. (Cl. 73-19)

ABSTRACT OF THE DISCLOSURE

The present invention involves apparatus for determining the carbon content in liquid nonoxidized steel wherein the molten steel is placed in a chamber under vacuum. The vacuum is measured before the steel is inserted and again after the steel is inserted and the difference between these two pressures is noted.

This invention relates to metallurgical processes and, more particularly, to an apparatus for determining the carbon to form carbon monoxide gas bubbles.

It is known that carbon dissolved in molten steel is many times more powerful as a deoxidizer at one millimeter of absolute pressure than it is at atmospheric pressure. Silicon has been used to deoxidize steel before it is poured. The purpose of deoxidization is to lower the dissolved oxygen in the steel to a point where it will not react with carbon to form carbon monoxide gas bubbles.

Silicon, or any other metallic deoxidizer, becomes stronger as the temperature drops. This continues up to the time the metal freezes. Silicon reacts with the dissolved oxygen in the steel to form SiO_2 . SiO_2 is a sand inclusion and rises toward the top of the molten steel as the metal has good fluidity. As the temperature drops and silicon gets stronger as a deoxidizer, the steel becomes less fluid and the remaining inclusions in the steel are trapped.

To determine the effects of silicon deoxidation, a heat of steel that had not been deoxidized was poured in vacuum and the carbon in the steel allowed to deoxidize it. It was discovered that the resulting steel was cleaner and low in dissolved oxygen.

It was also discovered while pouring this type of steel that for roughly the same pouring rate, the pressure in the vacuum tank varied with the carbon in the steel. This was because the dissolved oxygen in the steel depended on the carbon content of the steel. The lower the carbon, the higher the dissolved oxygen. Conversely, the higher the carbon, the lower the oxygen content. This accounts for more gas being formed at lower carbon content with resulting higher pressure in the tank.

When this data is plotted on a curve, one curve shows the theoretical carbon oxygen equilibrium line. The other curve shows the actual pressure and the carbon content of the steel. The curves run closely together. From this chart, it appears that holding a known amount of liquid un-deoxidized steel under vacuum and using a very sensitive vacuum gauge, the carbon in the steel can be read from the pressure.

It is, accordingly, an object of the present invention to provide an improved device for determining the carbon content of steel.

Another object of the invention is to provide an improved device for determining the presence of an amount of a gasified chemical in a molten metal.

With the above and other objects in view, the present invention consists of the combination and arrangement of parts hereinafter more fully described, illustrated in the accompanying drawing and more particularly pointed out in the appended claim, it being understood that changes may be made in the form, size, proportions, and minor details of construction without departing from the spirit or sacrificing any of the advantages of the invention.

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In the drawing:

FIG. 1 is a longitudinal cross sectional view of a device for determining the carbon content of steel; and

FIG. 2 is a curve showing the relationship of the vacuum to the carbon-oxygen equilibrium line.

Now with more particular reference to the drawing, in the device shown in FIG. 1, the chamber 10 is shown which may be made of aluminum or other suitable metal. The chamber 10 is closed at one end by the closure 13 which is attached thereto by suitable studs 25. An O-ring seal 26 forms a seal. The center of the closure 13 is threaded and adapted to receive the immersion tube 11 which may be made of suitable material; for example, steel, and it may be provided with a cardboard sleeve 27 around it to prolong its life. The distal end of immersion tube 11 is sealed by the steel disk 12 which may be in the form of an extremely thin steel diaphragm welded to the end of immersion tube 11 to close and seal the end thereof.

The upper end of the chamber 10 is closed by means of the head 15 which is secured to the outwardly directed flange 29 by means of bolts 16 and a suitable O-ring seal 17 is provided to form an air tight connection.

The head 15 has a threaded opening which receives the nipple 20 that is attached to the pipe 23 and the pipe 23 is connected to the T 31 which is, in turn, connected to the vacuum pump 22 and to the vacuum gauge 21.

A suitable baffle plate 18 is provided to prevent interference with the vacuum pump 22 and the vacuum gauge 21. The baffle plate 18 is attached to the head 15 by means of studs 19.

To use the device, the vacuum pump 22 is started and the pressure inside the chamber 10 is reduced to a value of, for instance, less than one mm. of mercury. The pressure at this point is then read on the vacuum gauge 21. The immersion tube 11 is then immersed into a molten bath of steel that is to be analyzed. The bath will melt the steel disk 12 and allow molten metal to flow up into the tube 11.

As the metal flows into the tube 11, the carbon in the steel combines with the dissolved oxygen in the steel at the reduced pressure to form a gas, either carbon monoxide or a lower oxide of carbon. The release of this gas raises the pressure in the chamber. This pressure is measured by the vacuum gauge. The reading of the vacuum gauge can be used as a measure of the carbon in the steel sample by comparing it to the carbon-oxygen equilibrium curve. Carbon and oxygen in the steel at 2912 degrees Fahrenheit are in equilibrium as expressed by the formula $C \times \text{CO}_2 = .0022$. This indicates that as the carbon in the steel goes from high to low, the dissolved oxygen goes from low to high. At a vacuum of approximately one millimeter of mercury, the deoxidizing power of carbon is one hundred times more powerful than at atmospheric pressure.

In actual practice, the vacuum pressure, while pouring un-deoxidized steel at approximately sixteen thousand pounds per minute, follows a curve very close to the carbon oxygen equilibrium curve, as shown in FIG. 2. From the foregoing, it is clear that the above described instrument can be used to give a very quick reading of the carbon content of steel before it is deoxidized.

The foregoing specification sets forth the invention in its preferred practical forms but it is understood that the structure shown is capable of modification within a range of equivalents without departing from the invention which is to be understood is broadly novel as is commensurate with the appended claim.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An apparatus for determining the carbon content of steel comprising

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a chamber having an elongated tube connected to the lower end thereof,
a closing means closing the lower end of said tube,
said closing means being meltable at the temperature below the temperature of molten steel,
means to evacuate said chamber,
and means to measure the pressure in said chamber,
said chamber being adapted to be evacuated and said tube being adapted to be immersed in molten steel whereby said closing means is melted and said molten steel enters said chamber whereby the pressure of gas escaping from said steel in said chamber may be determined from said measuring means.

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