

[54] METHOD OF MELTING METAL

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abandoned, which is a continuation of Ser. No.  
658,472, Aug. 4, 1967, abandoned.

**Foreign Application Priority Data**

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[52] U.S. Cl. 75/43, 75/42

[51] Int. Cl. C21b 11/02, C21b 13/02

[58] Field of Search 75/43, 42

[56]

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**FOREIGN PATENTS OR APPLICATIONS**

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[57]

**ABSTRACT**

Metals are melted in a gas cupola furnace by introducing a hydrocarbon such as natural gas to the high temperature regions of the furnace, preferably after preheating the hydrocarbon.

**4 Claims, 3 Drawing Figures**

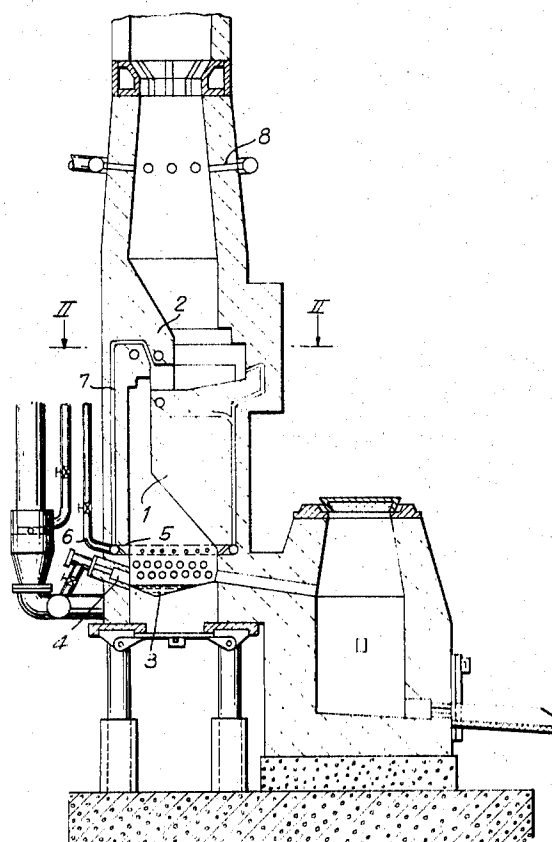


FIG. 1

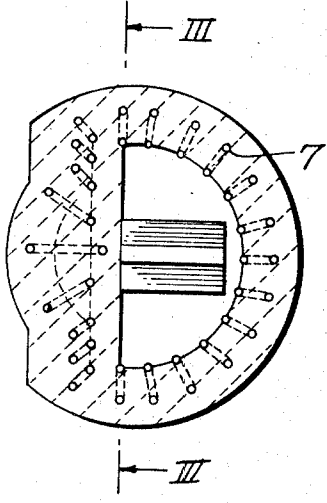
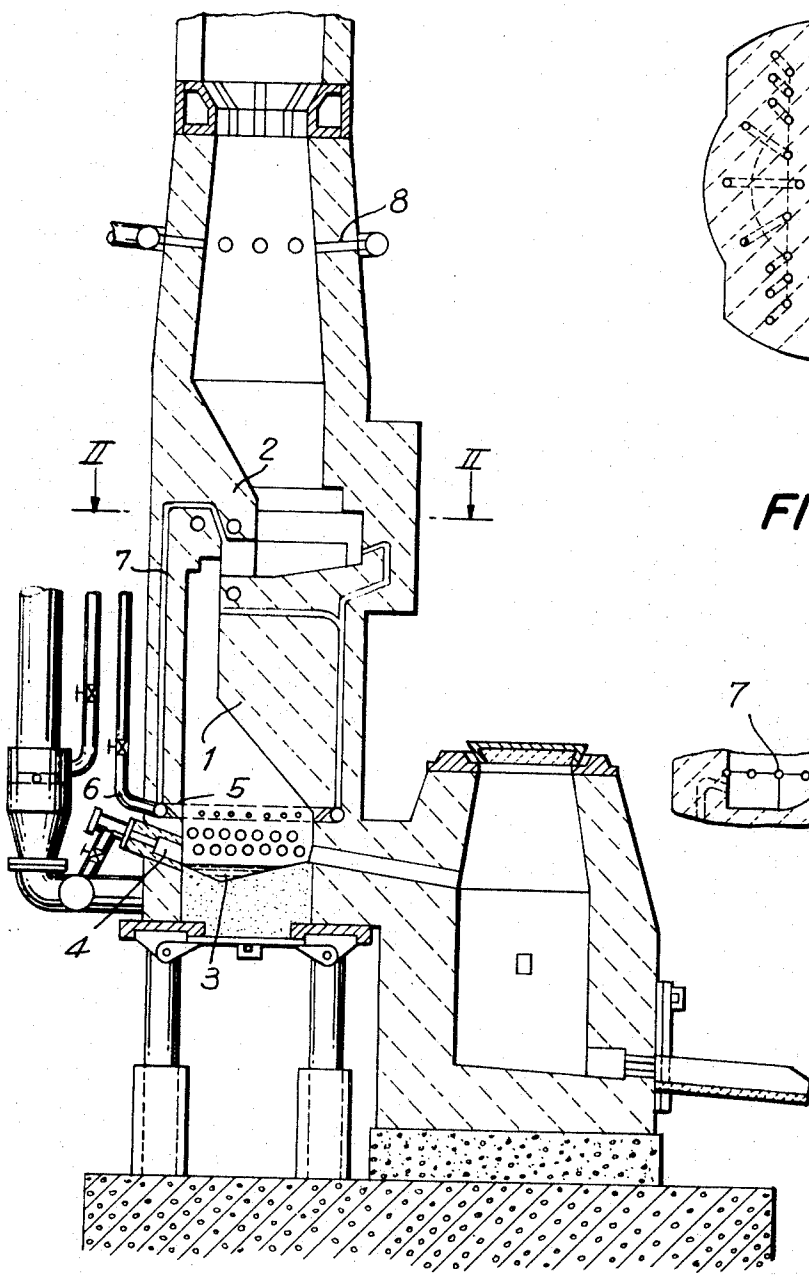


FIG. 2

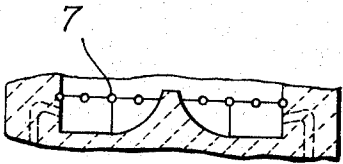


FIG. 3

## METHOD OF MELTING METAL

This is a continuation of application Ser. No. 29,773, filed Apr. 28, 1970 and now abandoned; which was a streamlined continuation of application Ser. No. 658,472, filed Aug. 4, 1967, and now abandoned.

The present invention relates to the field of metallurgy, and more particularly to methods of melting metals.

There is known in the prior art a method of melting metal in a gas cupola furnace as disclosed in U.S.S.R. Author's Certificate No. 167613, Class 31a, 1/01.

The shaft of this cupola furnace is provided with two shoulders: a lower shoulder for maintaining the column of charge materials and an upper shoulder for preventing the charge from falling into the lower part of the cupola furnace. The melting and superheating of metal are effected in the cupola furnace shaft as a result of the combustion of a gaseous fuel in the lower part thereof. This cupola furnace makes it possible to carry into effect the operations of melting and superheating of metal directly in the shaft, which enables liquid metal to be obtained at a temperature sufficient for casting thin-walled articles. The productive capacity of the gas cupola furnace is thereby higher than that of a coke cupola furnace of the same size, the former being simpler as to its construction and requiring a smaller floor space.

The process of melting metal in this cupola furnace, however, does not readily lend itself to adjusting the composition of the furnace gas atmosphere. When carrying out a melt in this cupola furnace, the furnace atmosphere is of an oxidizing character, since the combustion products contain large amounts of  $\text{CO}_2$  and  $\text{H}_2\text{O}$  capable of oxidizing metal and its impurities at a high temperature. In practice, however, it is often necessary to carry out a non-oxidizing or reducing process in the cupola furnace. This proves to be especially necessary when a large amount of rusty, oxidized metal with a well developed surface is incorporated in the charge, or oxidized chips and cuttings, or else when ore is to be added to the charge, and when the required ferro-alloys and deoxidizers are not available.

An object of the present invention is to eliminate the above-mentioned disadvantages. Other objects and advantages of the invention will become more fully apparent from the description given hereinbelow.

The objects of the invention are achieved by the provision of a method of melting metals in a gas cupola furnace, involving the introduction of a hydrocarbon, for example, natural gas, into the high-temperature region of the cupola furnace.

It is preferable to preheat the hydrocarbons prior to feeding the same into the working space of the cupola furnace.

The nature of the present invention will become more fully apparent from a consideration of the following description of a method of melting metal in a gas cupola furnace constructed according to the invention, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a longitudinal section of the gas cupola furnace for effecting the method of melting according to the invention;

FIG. 2 is a cross-sectional view of the same cupola furnace, taken along line II—II of FIG. 1; and

FIG. 3 is a cross-sectional view of the same cupola furnace, taken along line III—III of FIG. 2.

The shaft of the gas cupola furnace is provided with two shoulders, namely, a lower shoulder 1 (FIG. 1) for maintaining the column of charge materials and an upper shoulder 2 for preventing the charge from falling into the lower part of the cupola furnace shaft wherein is the chamber for the superheating of metal.

The bottom of the lower part of the superheating chamber is provided with a basin 3 adapted to contain liquid metal during the melting process and serving for the superheating thereof. A plurality of tunnels 4 for the combustion of gas are uniformly disposed in the shaft lining over the basin throughout the periphery of the shaft. Gas and air can be preheated in special arrangements.

There is provided between the layers of the refractory lining of the superheating chamber, above the burner tunnels 4, an annular collector 5, to which natural gas (or some other reducing gas) is furnished by pipe 6, which gas may be preheated for effecting the thermal cracking. A plurality of pipes 7 of small diameter are connected to the annular collector 5, said pipes passing through the lining and emerging above the upper row of the burner tunnels 4, on the periphery between the lower end of the upper shoulders, and on the periphery of a semi-annular internal cavity. Provided in the upper part of the cupola furnace are pipes 8 for supplying air to effect complete combustion of the exit gases.

The gas cupola furnace operates in the following manner, carrying into effect the method of melting according to the invention.

Before starting of the melt, the gas cupola furnace is preheated for raising the temperature of the superheating chamber to a temperature on the order of  $1,600^\circ\text{C}$ . Then a charge, composed of metal, metal oxides and fluxes, is charged into the furnace shaft. While the metal charge passes between the shoulders into the shaft, hot gases melt the metal charge, which flows dropwise and falls from the shoulder 1 into the basin, filling it thereby with molten metal. Slag also collects in the basin, but it is continuously drained into a forehearth from the metal surface. In such a manner, the surface of metal is permanently kept clean of slag, which thus does not interfere with the superheating of the metal. The drops of metal, falling as it were in a rain, from the shoulder 1 into the basin, agitate the molten metal therein, which results in obtaining a "fluidized" bed of molten metal completely clean of the slag. The "boiling" action of the metal bath contributes to a better superheating of the molten metal. Directed onto the "boiling" surface of molten metal are great number of flames having a temperature of about  $1,700^\circ\text{C}$ , creating over the metal surface a continuous layer of hot gases with an air excess factor of 0.90 to 0.98. Above the burner tunnels, the composition of the gaseous phase in the superheating chamber is varied by supplying natural gas through the pipes 7 from the collector 5. The coefficient air excess factor here is maintained within a range of from 0.6 to 0.7. A still greater volume of natural gas is supplied into the melting zone, said gas being subjected to thermal cracking when passing along the pipes 7 provided in the hot lining of the cupola furnace. The air excess factor in the melting zone is maintained approximately within a range of 0.4 to 0.5. The gaseous phase contains soot carbon and free carbon, which are capable of reducing metal from its oxides. When passing through the melting zone and

shaft, the reducing gases and soot carbon cause the reduction of metal from its oxides; saturation of the metal with carbon is also possible thereby. The reducing gases and soot carbon, which have not reacted with metal oxides, burn completely in the upper part of the shaft where the air excess factor is increased approximately to 1.1 by supplying secondary air into the furnace shaft through pipes 8. Heat evolved thereby is utilized for preheating the charge materials, and may also be employed for preheating air and natural gas to be consumed during the melting. The superheated metal (both molten and reduced from the oxides) is fed from the basin into the forehearth, whence it is tapped as required.

The method of melting metal according to the invention allows the use of cheap materials in the charge, including such that are remelted only in a blast furnace, i.e., oxidized chips and cuttings, and ore, which contributes to an increase in the economical efficiency of the process.

The term "excess air factor" as employed above is used in the art to characterize the minimum amount of air, determined by calculation, which is required for the complete combustion of a unit of mass or volume of a given fuel. The quantity of air actually required for the combustion of fuel is greater than the theoretical amount, and the air excess factor  $\alpha$  is expressed by the ratio

$$\alpha = A_{act}/A_{th}$$

wherein

$A_{act}$  = Actual consumption of air

$A_{th}$  = Theoretical minimum amount of air required.

This term is found in numerous publications contain-

ing information on the combustion of fuel.

We claim:

1. A method for use with a gas cupola furnace having a refractory lining defining a generally vertical shaft in which a melting zone is superposed over a super-heated chamber and in which vertically spaced horizontally staggered shoulders are interposed between the said zone and chamber while allowing communication therebetween, said furnace further including a basin beneath said chamber for collecting molten metal; said method comprising charging a metal into said melting zone and heating the furnace to melt said metal so that the latter flows between said shoulders and falls dropwise into said basin wherein the molten metal is collected, directing flames against the molten metal in said basin thereby creating over the molten metal a layer of hot gases, introducing part of a hydrocarbon reducing gas into said superheating chamber above said flames and passing the remainder of the reducing gas through the refractory lining into the melting zone whereby said remainder is subjected to thermal cracking on the way to said melting zone and whereby the composition of said layer is controlled.

2. A method as claimed in claim 1 wherein said layer is provided with an excess air factor of about 0.90 to 0.98.

3. A method as claimed in claim 2 wherein by the introduction of said reducing gas into said superheating chamber, an excess air factor is maintained at about 0.6 to 0.7.

4. A method as claimed in claim 3 wherein an excess air factor of about 0.4 to 0.5 is maintained in the melting zone.

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