

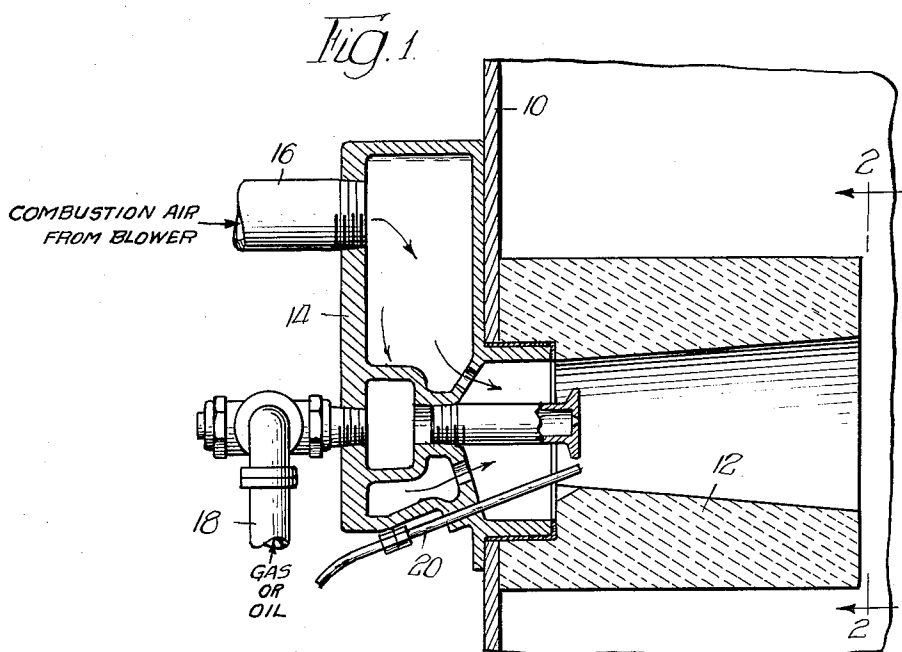
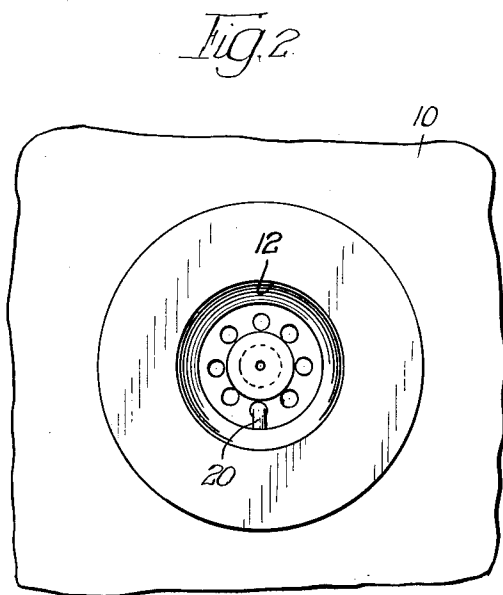
March 8, 1966

B. G. HARMON

3,239,391

SCALE FREE FLAME HEATING OF STEEL

Filed July 8, 1963



INVENTOR.

Benjamin G. Harmon,

BY

Sabin C. Bronson
att'y.

1

3,239,391

SCALE FREE FLAME HEATING OF STEEL

Benjamin G. Harmon, 904 Elmwood Ave., Evanston, Ill.

Filed July 8, 1963, Ser. No. 293,502

4 Claims. (Cl. 148—16)

The invention relates to the heating of steel, and is a method of scale free flame heating of steel such as slabs, plates, blooms, billets, bars, etc., for hot rolling, forging, extrusion, normalizing, annealing and heat treating.

The invention is an improvement over the method of scale free heating shown and described in Patent No. 2,723,927, dated November 15, 1955.

It is particularly applicable to gas or oil fired furnaces wherein the products of combustion directly contact the work being heated.

The object of the invention is to inhibit the scaling and decarburizing of steel by a novel means.

The invention will be better understood from the following description, forming part of this application, when read in conjunction with the accompanying drawing, wherein:

FIGURE 1 is a vertical cross sectional view through a conventional burner for a furnace, and fuel and low pressure air supply for its combustion.

FIGURE 2 is an elevational view on the line 2—2 of FIGURE 1.

In the drawings a wall of the furnace casing is indicated at 10. This casing 10 has formed therein an opening into which the burner body 14 is installed and secured in place. Within this casing 10 is installed a hollow refractory burner block 12 into which the burner fires. The burner body is indicated at 14 with connections 16 for combustion air and 18 for oil or gas fuel. This is a conventional gas or oil fired burner for firing with low pressure air.

Instead of introducing a volatile compound of boron in liquid phase, as alkyl borates, i.e., methyl, ethyl or propyl borates, boron trichloride, including organic solvents in which these compounds are soluble, into the combustion air or the fuel for firing the burners, or directly into the furnace itself, as shown in Patent 2,723,927, such volatile compound of boron is introduced in very small, predetermined, meter quantities by volumetric pumps, one for each temperature control zone, through a small diameter stainless steel or other metal nozzle 20 capable of withstanding temperatures up to 2000° F. Such nozzles are of a length that when inserted through a hole created by drilling and tapping the body of each burner, the volatile compound of boron will be delivered, separately from the combustion air or fuel, to the refractory lined opening into which such burner fires, at point just before the combustion air meets the fuel, whether gas or oil.

While I have shown the nozzle 20 as discharging immediately under the fuel nozzle, equal results are accomplished if the discharge from this nozzle is located above, anywhere around this fuel nozzle, or if the tube 20 extends within and through the fuel nozzle itself or through the refractory lining of the burner opening to discharge coincidently with the discharge of the fuel nozzle.

This insures the combustion of this volatile compound of boron occurring along with the combustion of such fuel, whether gas or oil, and a very thorough mixing of the resulting molten particles of colloidal boric anhydride formed from the combustion of such compound with the products of combustion of the gas or oil, as they are discharged into the furnace from the refractory lined openings into which each burner fires.

When the molten boric anhydride particles land on the surfaces of the mill scale existing on the cold steel pieces being loaded into the furnace, they solidify, but

2

again become molten when the temperature of the mill scale reaches the melting point of the boric anhydride particles (850–1200° F.). The affinity of molten boric anhydride for iron oxide causes it to adhere to and flux with the iron oxide of the mill scale on the steel, inherently loosening and softening said scale. Such fluxing increases as the temperature rises. This forms a thin, semi-molten, and viscous film of ferrous or ferric borate slag on all surfaces of steel slabs, plates, blooms, billets, or bars being heated. This semi-molten, viscous film serves as an effective, protective barrier to the products of combustion of the gas or oil fuel reaching and scaling or decarburizing the steel beneath the mill scale that existed on the steel when it was loaded into the furnace. This inhibits the oxidation and decarburization of the steel heated to the high temperatures required for hot working or rolling, with minimum loss of weight, i.e., to be substantially scale free heated and also heated free from decarburization. This is accomplished with minimum consumption of the volatile compound of boron.

In addition, this semi-molten, viscous film on the steel inhibits the scaling of the steel while being unloaded from the furnace and transferred to the forging press, hammer, up setter, or rolls, for hot working or rolling. Also, until removed, this film serves as a partial lubricant to the forging dies, tools, and rolls, prolonging their lives.

It is also noted that this semi-molten film protects such steel products, regardless of the carbon and alloy constituents therein, from decarburization.

In addition to protecting steel slabs, blooms, plates, billets, and bars, from loss of weight by scaling while being heated for the time necessary to secure the plasticity required for hot forging, pressing, or rolling, the semi-molten, viscous film protects such steel from the loss of weight experienced during press, mill, or other delays. This enables billets to be sheared to shorter lengths and still be long enough for forging to specified dimensions, due to minimum loss of weight, even with prolonged heating, thereby reducing the loss of steel occasioned by having to shear all billets to sufficient length to insure that all forgings made from billets subjected to prolonged heating will be of specified dimensions.

It has been found essential to introduce the volatile boron compound separately into the refractory openings into which the burners fire for the following reasons:

(1) Introduction of this compound into the burners with the combustion air resulted in precipitation of boric acid within the openings in the burner bodies, clogging them up and interfering with their deliveries of heat required. This was found to be due to the effect of moisture in the combustion air, causing boric acid to be precipitated and deposited within the burner bodies, clogging them up and preventing their deliveries of the heat required.

(2) Introduction of this compound into the gas, also resulted in some precipitation of the boric acid but not as much as was experienced when the volatile boron compound was introduced with the combustion air.

(3) The introduction of the volatile boron compound separately into the refractory linings of the burners avoided all precipitation of boric acid and gave good scale free heating results, and also because such introduction into each burner would give more uniform distribution of the particles of boric anhydride require for scale free heating and also for heating without surface decarburization and at minimum expense for its introduction in this manner.

I claim:

1. An improved method of heating hot rolled steel having mill scale thereon with minimum loss of weight and surface decarburization, comprising loading said steel while cold into a gas or oil fired furnace, introducing into

3

refractory lined burner openings of said furnace, separately from the fuel and combustion air, a volatile compound of boron which ignites forming boric anhydride mist which mixes with the products of combustion and air in flight through said refractory lined burner openings leading into the furnace, and deposits boric anhydride particles on the surfaces of the mill scale on said steel and adheres thereto, and fluxes with the iron oxide thereof when the temperature of the mill scale rises to the melting temperature of the boric anhydride particles (850–1200° F.) forming an effective and protective semi-molten, viscous film of ferrous or ferric borate slag on the mill scale, preventing the products of combustion from penetrating said film and reaching and scaling and decarburizing the steel beneath the mill scale.

2. An improved method of heating steel in direct contact with gaseous products of combustion in a furnace having refractory lined burner openings into which conventional fuel burners fire, said method comprising introducing through each burner into said burner openings separately from the fuel and combustion air a volatile compound of boron in liquid phase which ignites, forming colloidal boric anhydride which mixes with the products of combustion of the fuel and is carried thereby through the burner opening and into the furnace, whereby boric anhydride particles are deposited on the surface of mill scale on said steel, adhering thereto and fluxing with the iron oxide thereof when the temperature of said scale rises to the melting temperature of the boric anhydride particles forming a semimolten film thereon and preventing further scaling and decarburizing of the steel.

4

3. A method of heating steel in direct contact with gaseous products of combustion in a furnace for hot forming said steel, which method comprises introducing into refractory burner blocks into which burners fire in heating furnaces, separately from the introduction of the fuel, and combustion air, a volatile compound of boron in liquid phase which ignites in said burner blocks forming colloidal boric anhydride which thoroughly mixes with the products of combustion of the fuel and travels therewith to the surfaces of the steel being heated forming a film thereon inhibiting scaling and decarburizing of the steel.

4. The method set forth in claim 3 wherein said film changes the character of any scale on said steel due to prior heating, loosening said scale from the steel and reducing its hardness so that it is softer than the heated steel, whereby said scale is not rolled or forged into the steel but crushed to a powder that serves as a nonabrasive semi-molten lubricant to the rolls or dies.

References Cited by the Examiner

UNITED STATES PATENTS

2,100,843	11/1937	Fischer	263—15
2,181,093	11/1939	Ness	148—16.7
2,402,013	6/1946	Billeter et al.	148—16
2,723,927	11/1955	Tour	148—16.7
2,848,207	8/1958	Rusciano	263—15
2,992,147	7/1961	Hayes	148—16

DAVID L. RECK, *Primary Examiner*.

HYLAND BIZOT, *Examiner*.