March 11, 1947. C. R. BEEBE 2,417,345

CUPOLA

Filed Aug. 1, 1945

Fig. 1

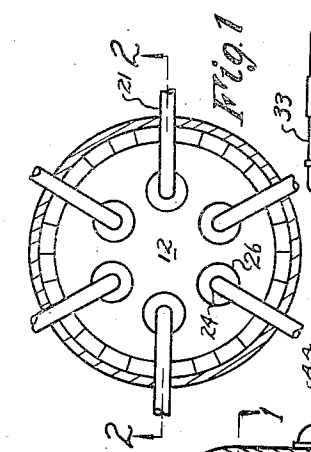


Fig. 2

INVENTOR.
CLAUD R. BEEBE
BY
Gray and Smith
ATTORNEYS.

Patented Mar. 11, 1947

2,417,345

UNITED STATES PATENT OFFICE

2,417,345

CUPOLA

Claud R. Beebe, Inkster, Mich.

Application August 1, 1945, Serial No. 608,273

3 Claims. (Cl. 266—41)

1

The present invention relates to improvements in a cupola construction and more particularly to improvements in a cupola construction adapted by way of example to the melting of rock or slag for the manufacture of mineral wool. The invention, however, is not limited in its use to this particular field, but may be used in any field in which high temperatures are to be developed in a cupola to smelt, roast, sinter, refine or melt ores, ore bearing rock, glass, slag and the like.

In cupolas used in high temperature furnace smelting, sintering or refining operations, the charge of fuel and material to be melted is charged into the cupola and air under pressure is supplied at the zone of combustion through tuyères which extend through the cupola from the air bustle pipe to the zone of combustion. Prior to the present invention the life of conventional types of tuyères in this type of service was very limited because of the failure of the materials from which the tuyères were constructed when subjected to the high temperatures incident to their use.

It is an object of the present invention to provide an improved cupola construction in which a novel form of tuyère is provided to supply air to the zone of combustion in the cupola, the tuyères being characterized particularly in having a relatively long life in service.

It is a further object of the present invention to provide a novel cupola construction which is particularly adapted for use in high temperature operations, and in which its novel construction gives it a long service life under difficult operating conditions.

It is another object of the present invention to provide a novel cupola construction in which the refractory lining is uniformly cooled and air is supplied to the zone of combustion through a plurality of jacketed tuyères, each of which is cooled by a fluid coolant.

It is a further object of the present invention to provide a cupola construction in which a plurality of vertically extending jacketed tuyères are employed to discharge a supply of preheated air into the charge in the cupola at the zone of combustion in the cupola, thereby confining the zone of greatest temperature in the cupola to a limited region adjacent the refractory lining thereof.

It is a further object of the present invention to provide a cupola construction in which the water used in cooling the jacket surrounding the refractory lining of the cupola and in cooling the tuyères is supplied from a supply source through supply conduit systems in which the circulation of the water is accomplished by the thermo-siphon effect resulting from the method of feeding the water to the jacket and to the tuyères and of returning it to the supply tanks.

2

It is a further object of the present invention to provide a cupola construction in which a heat exchanging air bustle is provided above the water jacket of the cupola to provide for cooling the upper portion of the cupola and preheating the air which is supplied to the tuyères.

Other objects of this invetnion will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In the drawings:

Fig. 1 is a view showing the tuyère arrangement and construction in top plan and showing a section of a cupola embodying the present invention, the view being taken substantially on the line 1—1 of Fig. 2 looking in the direction of the arrows.

Fig. 2 is a fragmentary enlarged side elevation partially in section taken substantially on the line 2—2 of Fig. 1 looking in the direction of the arrows, and showing a cupola construction embodying the present invention and its associated accessory units for supplying air to the bustle and water to the cupola water jacket and to the tuyère jackets.

Before explaining in detail the present invention it is to be understood that the invention is not limited in the application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring to the drawings:

A cupola embodying the present invention is indicated generally by the numeral 10 and comprises a hood 11 leading to a stack (not shown) and a combustion zone 12 provided with a refractory lining 13 of any desired refractory material, such for example as high temperature fire brick or the like. A water jacket 14 surrounds the lower portion of the combustion zone 10 and aids in dissipating heat from the refractory lining 13. Water is supplied to the jacket 14 by the water supply pipe 15 leading to the supply tank 16. Water is heated and rises in the water jacket 14 and is returned from the top of the jacket 14

through the water-return line 17 to the supply tank 16. Steam and vapor is vented from the supply tank 16 through a vent 18. The water level in the tank 16 is maintained by water introduced through a water feed line 19. The supply of feed water may be maintained in the tank 16 by a manual control (not shown) or it may be maintained by any suitable type of automatic means such as a conventional float control valve or a metering valve, both of which constructions are well known to those skilled in the art and hence are not here shown. The tank 16 is drained through a suitable drain sillcock 9.

Immediately above the water jacket 14 is an air bustle 20 which acts as a heat exchanging member between the top portion of the refractory lining 13 and the air supplied to the bustle 20 by an air supply duct 21 communicating with a power driven blower 22. The air is introduced from the duct 21 to the bottom of the bustle 20 and rises while it is heated in the bustle 20. The heated air is drawn from the top of the bustle 20 through a plurality of air supply ducts 21, leading to the tops of a plurality of vertically extending tuyères 24, each having an angularly cut air discharge end 25 terminating adjacent the combustion zone 12. As shown, the shortest side of the angularly cut discharge ends 25 is located toward the center of the combustion chamber 12. This assists in directing the air inwardly of the combustion chamber 12 and away from the refractory 13. The tuyères 24 are protected against rapid deterioration due to the heat generated within the cupola by a water jacket 26 surrounding the bottom portion of each tuyère 24 and extending over the portions thereof subjected to the highest temperatures during operation of the cupola. Each of the water jackets 26 around the tuyères 24 is supplied with water from a water supply tank 27 through a connection 40 with a header 41 from which a water supply connection 28 leads to each of said water jackets 26. The connections 28 lead from the header 41 and enter the bottom of the water jackets 26 at an angle so as to discharge the water upwardly into the water jackets 26 and thus to initiate the upward flow of water therethrough. The bottom plate 46 on each water jacket is welded to the body thereof at an angle corresponding to the angle of the water supply connection 28 and assists in directing the water upwardly in the water jackets 26. This also eliminates any pockets in which steam might otherwise form in the bottoms of the water jackets 26. A return line 29 is provided from each water jacket 26 at a point removed from the top thereof, and leads the heated water to the header 42 from which a return line 43 leads back to the tank 27. Steam developed in the water jackets 26 is collected in the steam head provided in each water jacket 26 above the point of connection with the return line 29. The steam is led from the tops of the water jackets 26 through steam return lines 30 extending from the head portion of each of the water jackets 26 to the header 44 from which the return line 45 leads to the top of the tank 27. The steam together with the vapors given off from the returned hot water in the tank 27 are accumulated in the top portion of the tank and are then taken off through a steam line 31 connected to a water separator 32 where condensed water is removed from the steam. The steam is then led into a main steam line 33 leading to a boiler (not shown) where it may be superheated if desired. A steam line 34 leads from the main steam line 33 to a blow cap, of conventional construction and hence not shown, which may be utilized in the event that the cupola construction of the present invention is used in the manufacture of mineral wool. The water level in the tank 27 is maintained by feed water supplied from the feed water supply line 35. The level of the water in the tank 27 may be regulated manually by the operator or it may be controlled automatically through any desired conventional type of float control valve or metering valve, both of which are well known to those skilled in the art and hence not shown on the drawings.

Sediment in the tank 27 may be drained therefrom through a drain valve 36.

The arrangement of the tuyères 24 and the water jackets 26 in a circle spaced from the center of the cupola is a particularly desirable arrangement for it permits ready charging of the cupola from the top through the hood 11 and provides a clear center space into which the charged stock will first fall and then flow toward the circumference of the combustion zone 12. The tuyère arrangement also serves to divide the charge vertically and to assist in supporting the main weight of the charge while permitting the charge to flow outwardly toward the refractory lining 13 in the plurality of spaced paths between the tuyères.

In protecting the tuyères 24 from rapid deterioration due to the heat in the combustion zone, I have found it preferable to use heated water as the cooling medium for such water will absorb a substantial amount of heat in being converted to steam and will prevent the thermal shock which is noted when cold water is used and which is an added cause for the rapid deterioration of the tuyères. I have also observed that in using hot water as the heat absorbing fluid, there is less tendency for the molten slag in the cupola to ball up and adhere to the walls of the tuyère water jacket than is the case where cold water is supplied to the tuyères.

The tuyère water jackets 26 each act as a steam generator. The water is supplied thereto through the lines 28 under pressures sufficiently high to insure its flow against such steam pressures as may be built up in the head of the water jackets 26. It is preferable to use water heated to its maximum temperature before changing to steam at the pressures employed in the water tank and the water lines. This temperature is preferably in excess of 212° F. in all instances.

From the foregoing it will be seen that the cupola construction herein disclosed provides an efficient method for the heat exchange between the refractory lining 13 in the combustion zone 12 and the water jacket 14 adjacent thereto. This provides a uniform cooling of the refractory 13 adjacent the zones of greatest temperature therein. The provision of the air bustle 20 also provides a heat exchange between the top portion of the refractory 13 and the air which is circulated through the bustle 20 which is utilized to support the combustion in the combustion zone. This construction utilizes the heat units otherwise lost by radiation to heat the pre-heated air supplied to the tuyères 24.

The use of the preheated air in the tuyères 24 has been found to provide a desirable means for regulating the temperatures and controlling the combustion in the combustion zone 12 since it provides a more constant velocity to the air and hence less fluctuation in the amount of air supplied to the combustion than is the case where

air at atmospheric temperatures is supplied. Air at atmospheric temperatures varies in velocity and hence in amounts supplied as the atmospheric temperatures vary.

The cupola construction of the present invention is particularly economical in use. The steam generated in the water jackets 26 surrounding the tuyères is carried away at relatively high temperatures and is sufficient in temperature and in quantity to permit of its use for power in a plant in which the cupola construction is installed. In addition the cupola embodying the present invention has been found to have a long life in service as the refractory 13 is uniformly cooled as herein disclosed and the tuyères 24 are protected against deterioration by the high heat developed in the combustion chamber.

It will be noted also that the cupola construction of the present invention is simple to construct and operate for it is not necessary to provide for water pumps to supply the water either to the water jacket 14 or to the tuyère water jackets 26. There is a positive circulation of the water through the water jackets 14 and 26 by its thermo-siphon action. In all instances where steam is generated, it is led out of the system so that there are no steam back pressures in the water jackets which otherwise would prevent the ready circulation of the water therethrough.

In operation it is to be noted that the spacing and placement of the tuyères 24 permits a ready top charging of the cupola which provides a uniform feeding of the charge stock through the zone of combustion and hence this arrangement simplifies the charging of the cupola and its operation.

It will be seen also that the cupola construction of the present invention, while novel in many of its features and in its operation, is readily constructed of standard parts with a maximum utilization of the materials employed.

Two separate but interconnected water feeding systems are shown. One supplying the water jacket 14 surrounding the lower portion of the refractory 13 and the other supplying the water jackets 26 of the tuyères 25. The water in the water jackets 14 is under no steam pressure while that in the tuyère water jackets is under steam pressures. Water is admitted to the tank 16 at approximately atmospheric pressures and is heated by its passage through the water jacket 14 after which it is pumped out of the line 8 to the feed water line 35 of the tank 27. Thus the water jacket 14 serves to heat the feed water for the tank 27. This constant circulation of the water through the jacket 14 prevents the water from boiling in the jacket 14 and the generation of steam therein.

In using conventional types of tuyères in cupola operations, it is necessary to shut down the operations periodically to clear the bottom of accumulated waste and unburned materials. If this is not done, the fire placement in the cupola is changed, due to the build-up of such materials on the bottom and the operation of the cupola is impaired. As contrasted with such conventional constructions, a cupola embodying the present invention may be operated for very long periods of time without requiring shut downs and rebuilding of the bottom. This is due to the downwardly directed blasts of air from the tuyères 25, which assures a distribution of air through the materials on the bottom so that full combustion is assured. This provides sufficient heat at the bottom of the cupola so that the charge stock on the bottom is melted and any waste or refuse, as for example molten iron which may form in the melting of slag and rock in the manufacture of mineral wool, can be removed from the cupola bottom by tapping the cupola without drawing the fire therefrom. Thus the present invention permits the continuous operation of the cupola throughout prolonged periods wihout requiring bottom changes.

I claim:

1. A cupola including a refractory lined combustion chamber, a water jacket surrounding the lower portion of said chamber, an air bustle surrounding the upper portion of said combustion chamber, a plurality of vertically extending water jacketed tuyères connected at their upper ends with said air bustle and having their lower ends open to discharge air into a zone of combustion in said combustion chamber, an air supply duct connected with the bottom of said bustle and communicating with a source of air under pressure, an air supply duct leading from the top of said bustle to each of said plurality of water jacketed tuyères, and a water circulating system for supplying water to said water jacket around said combustion chamber, and to the water jackets surrounding said tuyères, and including a water supply tank connected to the bottom portion of said water jacket surrounding said combustion chamber, and a second water supply tank having connections with the bottoms of each of the water jackets surrounding said tuyères and extending upwardly at an angle to the bottoms thereof, and a water return line leading from each of the said tuyère water jackets at a point removed from the top thereof, and a steam line leading from each of the said tuyère water jackets at a point adjacent the top thereof.

2. A cupola including a refractory lined combustion chamber, a water jacket surrounding the lower portion of said chamber, an air bustle surrounding the upper portion of said combustion chamber, a plurality of vertically extending water jacketed tuyères connected at their upper ends with said air bustle and having their lower ends open to discharge air into a zone of combustion in said combustion chamber, said tuyères being symmetrically spaced circumferentially of said cupola to provide an open centrally located space for charging said cupola from the top portion thereof, an air supply communicating with said bustle to supply air thereto and to said tuyères and a water circulating system for supplying water to said water jacket around said combustion chamber and to the water jackets surrounding said tuyères, and including a water supply tank connected to the bottom portion of said water jacket surrounding said combustion chamber and a second water supply tank having connections with the bottoms of each of the water jackets surrounding said tuyères and extending upwardly at an angle thereto and a water return line leading from each of the said tuyère water jackets at points removed from the top thereof, and a steam line leading from each of said tuyère water jackets at a point adjacent the top thereof.

3. A cupola including a refractory lined combustion chamber, a water jacket surrounding the lower portion of said chamber, an air bustle surrounding the upper portion of said combustion chamber, a plurality of vertically extending water jacketed tuyères connected at their upper ends with said air bustle and having their lower ends

open to discharge air into a zone of combustion in said combustion chamber, said tuyères being symmetrically spaced circumferentially of said cupola to provide an open centrally located space for charging said cupola from a point adjacent the top thereof, an air supply duct connected with the bottom of said bustle and communicating with a source of air under pressure, an air supply duct leading from the top of said bustle to each of said plurality of water jacketed tuyères, and a water circulating system for supplying water to said water jacket around said combustion chamber, and to the water jackets surrounding said tuyères, and including a water supply tank connected to the bottom portion of said water jacket surrounding said combustion chamber, and a second water supply tank having connections with the bottoms of each of the water jackets surrounding said tuyères, and extending upwardly on a line parallel to the angular plane of the bottom of said tuyère water jackets, a water return line leading from each of the said tuyère water jackets at a point removed from the top thereof and a steam line leading from each of said tuyère water jackets at a point adjacent the top thereof.

CLAUD R. BEEBE.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
277,638	Wendt	May 15, 1883
1,014,314	Marshall	Jan. 9, 1912
726,422	Garretson	Apr. 28, 1903
2,215,887	Seigle et al.	Sept. 24, 1940
1,910,724	Unden	May 23, 1933
1,925,519	Brewer et al.	Sept. 5, 1933