

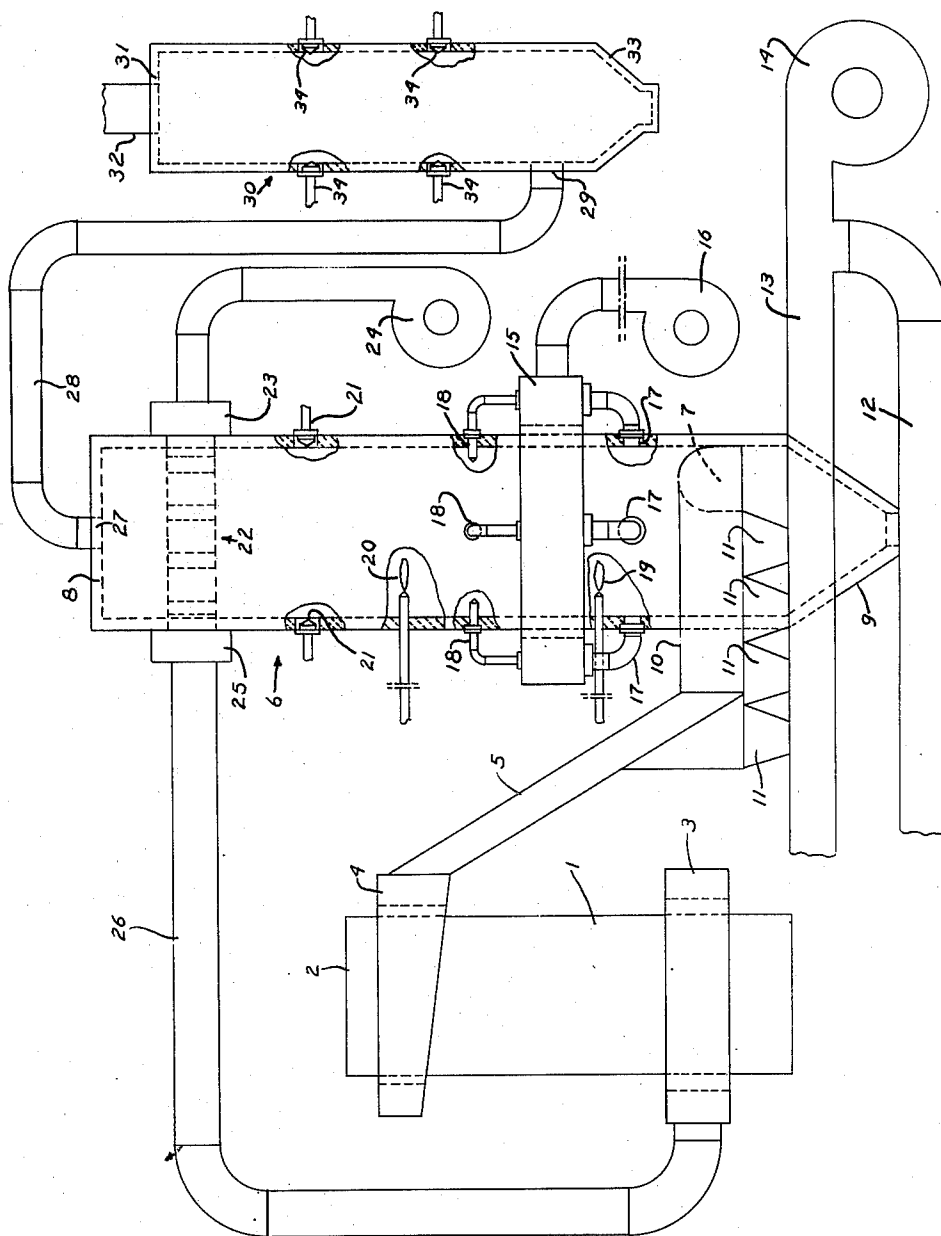
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T. TINKER

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CUPOLA GAS CONDITIONING APPARATUS AND PROCESS

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INVENTOR:

TOWNSEND TINKER

BY

Andrew K. Foulds

his ATTORNEY

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CUPOLA GAS CONDITIONING APPARATUS AND PROCESS

Townsend Tinker, Orchard Park, N. Y., assignor, by mesne assignments, to American Radiator & Standard Sanitary Corporation, New York, N. Y., a corporation of Delaware

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8 Claims. (Cl. 266—17)

This invention relates to new and useful improvements in iron melting cupolas and more particularly to apparatus and processes for conditioning the gases discharged from a cupola.

It has been found desirable in the operation of iron melting cupolas to condition the gases discharged from cupolas to remove foreign matter therefrom and to burn out the excess CO in the gases and utilize the heat generated thereby for heating incoming blast air.

It is therefore one of the objects of this invention to provide a new and improved apparatus for conditioning and recovering heat from cupola exhaust gases.

Another object of this invention is to provide a new and improved apparatus for conditioning cupola exhaust gases and disposing of foreign matter separated therefrom.

Another object is to provide a new and improved apparatus for conditioning cupola exhaust gases, burning out the excess CO therein, limiting the temperature of combustion products, and reclaiming waste heat for heating blast air for the cupola.

Another object is to provide a new and improved process for conditioning and recovering waste energy from cupola exhaust gases.

Other objects will become apparent from time to time throughout the specification and claims as hereinafter related.

This invention comprises the new and improved construction and arrangement of this conditioning apparatus and the new and improved method of conditioning cupola waste gases which will be described more fully hereinafter and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawing, to be taken as a part of this specification, there is clearly and fully illustrated a preferred embodiment of this invention, in which drawing:

The figure shown is a more or less diagrammatic view of this cupola conditioning apparatus which discloses the arrangement and interconnection of the various parts and which illustrates both the apparatus and method claimed.

Referring to the drawing by numerals of reference, there is disclosed a cupola conditioning system comprising an iron melting cupola 1 preferably arranged for "closed charging." The cupola 1 is supplied with blast air through an air inlet bustle 3 and discharges exhaust gases through an off-take bustle 4. The cupola 1 is connected by a duct 5 to a vertical processing cylinder 6. The duct 5 extends from the cupola off-take bustle 4 and enters the cylinder 6 through a tangential inlet opening 7. The processing cylinder 6 is hollow and provides a continuous chamber throughout its entire vertical length and has a closed top end 8 and a tapered bottom end 9 forming a collection hopper. All portions of the duct 5 which do not slope downward toward the processing cylinder 6, such as the horizontal duct section 10, are provided with a plurality of hoppers 11 underlying their entire length. The hoppers 9 and 11 are arranged for discharge into refuse disposal ducts 12 and 13 which transmit refuse to a remote disposal point, not shown, under the influence

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of fluid circulating means such as a high capacity fluid pump or blower 14. The processing cylinder 6 is provided with an air inlet bustle 15 which is supplied with air by a blower 16. The bustle 15 has a plurality of large low-velocity air inlet connections 17 to the cylinder 6 and a plurality of small high-velocity air inlet jets 18 spaced above the inlets 17. The cylinder 6 is also provided with constantly burning gas pilots 19 and 20, respectively, for ignition of the gas and air mixture in the cylinder. The upper middle portion of the processing cylinder 6 is provided with a plurality of water sprays 21 for limiting the temperature of combustion products in the upper portion of the chamber. The upper portion of the cylinder 6 is provided with a heat exchanger 22 having an inlet 23 connected to a high capacity blower 24. The heat exchanger 22 has an outlet 25 connected by a duct 26 to the cupola bustle 3. The top end 8 of the cylinder 6 has an outlet 27 connected by a duct 28 to the inlet 29 at the lower end of a collection cylinder 30. The cylinder 30 has a closed top end 31 having an outlet 32 discharging to atmosphere. The cylinder 30 has a tapered bottom end 33 providing a collection hopper for waste foreign particles. The cylinder 30 is also provided with a plurality of sprays 34 for separating fine dust particles from the cupola gases before they are discharged to atmosphere.

Operation

In operation, the cupola 1 is supplied with blast air from the fan 24 which has been heated in passing through the heat exchanger 22 and which enters the cupola through the inlet bustle 3. In the cupola 1, the coal or coke is burned under the influence of the blast air to provide the necessary heat for melting the iron charge. The combustion in the cupola, however, is never complete and, as a result, a small quantity of CO is discharged with the N₂ from the air and the CO₂ formed in combustion. The cupola exhaust gases are discharged through an off-take bustle 4 and generally carry with them a fairly large quantity of foreign particles from the cupola. The heavier foreign particles in the cupola exhaust gases will drop out while passing through the duct 5 to the processing cylinder 6. These heavier particles fall into the plurality of hoppers 11 which underlie the sections of the duct 5 which do not slope toward the processing cylinder 6. As the cupola exhaust gases enter the processing cylinder 6, they are given a high rotary motion by reason of their entering through the tangential inlet 7. This high rotary motion of the gases will cause the larger particles of foreign matter remaining in the gas stream to be separated therefrom by centrifugal force. The foreign particles which are so separated fall into the hopper 9 at the lower end of the cylinder 6. The hoppers 9 and 11 are arranged to discharge into refuse disposal ducts 12 and 13 which are supplied with high-velocity air from a blower 14. The ducts 9 and 11 are preferably arranged to discharge into the ducts 12 and 13 whenever a predetermined weight of foreign particles has accumulated in the hoppers. This automatic dumping of the hoppers 9 and 11 can be accomplished by a spring loaded closure at the bottom ends thereof or by any other suitable weight responsive mechanism. The cupola gases which have entered the cylinder 6 through the tangential inlet 7 pass upward through the cylinder with a spiral motion. As these gases pass the large air inlets 17, they are supplied with a quantity of low-velocity air which is introduced by the blower 16 through the air inlet bustle 15. The gas and air mixture is ignited as it passes the constantly burning gas pilot 19. As this mixture of burning gas and air passes upward, it is supplied with further quantities of combustion air through the high-velocity air inlet jets 18. This arrangement of low-velocity and high-velocity air

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inlets is necessary to burn low-grade gases of this character in a relatively short combustion chamber and is described more fully in my co-pending application, Serial No. 287,889, filed May 15, 1952. The burning gas mixture continues upward in its movement past the second pilot burner 20 which assists in igniting any of the gas and air mixture which has not already begun to burn. As the gases pass upward beyond the middle or combustion chamber portion of the processing cylinder 6, they pass a plurality of water sprays 21 which are described more fully in my co-pending applications, Serial No. 280,759, now U. S. Patent No. 2,678,236, issued May 11, 1954, and No. 287,888. The water sprays 21 are operable to introduce water into the combustion products and limit the temperature thereof to a predetermined safe value. The combustion products resulting from the combustion of cupola gases and the air introduced through the inlets 17 and 18 continue upward past the heat exchanger 22 where a portion of their heat is given up to heat the blast air for the cupola which is supplied by the blower 24. At this point in the apparatus, the gases still carry some very fine foreign particles which were not separated in the hoppers 9 or 11. The gases, therefore, are directed outward through the outlet 27 and duct 28 to the inlet 29 of a water spray dust separator cylinder 30. The gases entering the cylinder 30 pass upward past a plurality of high-pressure, high-velocity water sprays 34 which are operable to further reduce the gas temperature and which are operable to remove the finer foreign particles therefrom. The sprays 34 are preferably a high-velocity, high-pressure type sprays which are operable to break the water into extremely fine particles. In fact, it has been found that when the water spray is broken into individual particles of a size on the order of 100 microns or less in diameter, a very high degree of cleaning of the gases is possible. The gases which are then discharged from the outlet 32 have been cleaned to a high degree and have had reclaimed a substantial quantity of the waste energy therefrom. The finer foreign particles which are separated by the water sprays 34 are collected in the hopper portion 33 of the cylinder 30 where they may be removed periodically.

From the foregoing description, it is seen that there is provided herein both a novel apparatus and a novel process for the conditioning of cupola exhaust gases. In the apparatus there is disclosed a continuous single processing chamber in which foreign particles are removed and which is provided with a refuse disposal arrangement for the foreign particles so removed. The processing apparatus is also provided with means to burn the cupola gases to reclaim waste heat therefrom, means to limit the temperature of combustion products, and a heat exchange means for heating blast air for the cupola. The apparatus is also provided with a final separator for removing the finer dust particles from the cupola gases. As a process, it is seen that there is disclosed a novel method of conditioning cupola gases which includes separation of larger foreign particles, combustion of cupola gases for reclaiming heat therefrom, the limitation of temperature of combustion products, and the final separation of the finer dust particles from said gases.

While there has been described only one embodiment of this invention, it will be obvious to those skilled in the art that other embodiments are possible which are the equivalent of this apparatus and which would be capable of performing the desired conditioning process without departing from the scope and intent of this invention as defined in the appended claims.

Having thus described the invention, what is claimed and is desired to be secured by Letters Patent of the United States is:

1. An apparatus for processing gases from an iron melting cupola, comprising a vertical cupola having an air inlet bustle and a gas off-take bustle, a vertical processing unit comprising a hollow elongated cylinder

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having closed top and bottom ends, said cylinder having a tapered bottom end providing a hopper for collection of the heavier particles of foreign matter carried in said gases, a tangential inlet to said cylinder at the bottom end therefor and above said hopper, a duct connecting said bustle to said tangential inlet, the tangential inflow of gas into said cylinder being operable to effect a centrifugal separation of heavy foreign matter carried therein for collection in said hopper, means for supplying air to the middle portion of said cylinder for combustion of said gases, means for igniting the gas and air mixture in said middle portion, water sprays in the upper middle portion of said cylinder for limiting the temperature of combustion products, a heat exchanger in the top portion of said cylinder positioned in the path of combustion products, an outlet from the top of said cylinder, air supply means discharging air through said heat exchanger, and a duct connected to conduct heated air from said heat exchanger to said cupola inlet bustle.

2. An apparatus for processing gases from an iron melting cupola, comprising a vertical cupola having an air inlet bustle and a gas off-take bustle, a vertical processing unit comprising a hollow elongated cylinder having closed top and bottom ends, said cylinder having a tapered bottom end providing a hopper for collection of the heavier particles of foreign matter carried in said gases, a tangential inlet to said cylinder at the bottom end thereof and above said hopper, a duct connecting said bustle to said tangential inlet, the tangential inflow of gas into said cylinder being operable to effect a centrifugal separation of heavy foreign matter carried therein for collection in said hopper, means for supplying air to the middle portion of said cylinder for combustion of said gases, means for igniting the gas and air mixture in said middle portion, water sprays in the upper middle portion of said cylinder for limiting the temperature of combustion products, a heat exchanger in the top portion of said cylinder positioned in the path of combustion products, an outlet from the top of said cylinder, air supply means discharging air through said heat exchanger, a duct connected to conduct heated air from said heat exchanger to said cupola inlet bustle, and means for removing waste foreign particles from said hopper.

3. An apparatus for processing gases from an iron melting cupola, comprising a vertical cupola having an air inlet bustle and a gas off-take bustle, a vertically processing unit comprising a hollow elongated cylinder having closed top and bottom ends, said cylinder having a tapered bottom end providing a hopper for collection of the heavier particles of foreign matter carried in said gases, a tangential inlet to said cylinder at the bottom end thereof and above said hopper, a duct connecting said bustle to said tangential inlet, the tangential inflow of gas into said cylinder being operable to effect a centrifugal separation of heavy foreign matter carried therein for collection in said hopper, means for supplying air to the middle portion of said cylinder for combustion of said gases; said air supply means including a plurality of inlets for introduction of air at a low velocity and a plurality of high velocity air inlet jets, said jets being spaced vertically above said inlets; a constantly burning pilot for igniting the gas and air mixture in said middle portion, water sprays in the upper middle portion of said cylinder for limiting the temperature of combustion products, a heat exchanger in the top portion of said cylinder positioned in the path of combustion products, an outlet from the top of said cylinder, air supply means discharging air through said heat exchanger, a duct connected to conduct heated air from said heat exchanger to said cupola inlet bustle, a refuse disposal duct connected to the bottom of said hopper, and fluid circulating means connected to said duct and operable to evacuate said hopper.

4. An apparatus for processing gases from an iron melting cupola, comprising a vertical cupola having an air inlet bustle and a gas off-take bustle, a vertical process-

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ing unit comprising a hollow elongated cylinder having closed top and bottom ends, said cylinder having a tapered bottom end providing a hopper for collection of the heavier particles of foreign matter carried in said gases, a tangential inlet to said cylinder at the bottom end thereof and above said hopper, a duct connecting said bustle to said tangential inlet, the tangential inflow of gas into said cylinder being operable to effect a centrifugal separation of heavy foreign matter carried therein for collection in said hopper, said duct having a plurality of tapered hoppers underlying all sections thereof which do not slope downward in the direction of gas flow, means for supplying air to the middle portion of said cylinder for combustion of said gases, means for igniting the gas and air mixture in said middle portion, water sprays in the upper middle portion of said cylinder for limiting the temperature of combustion products, a heat exchanger in the top portion of said cylinder positioned in the path of combustion products, an outlet from the top of said cylinder, air supply means discharging air through said heat exchanger, and a duct connected to conduct heated air from said heat exchanger to said cupola inlet bustle.

5. An apparatus for processing gases from an iron melting cupola, comprising a vertical cupola having an air inlet bustle and a gas off-take bustle, a vertical processing unit comprising a hollow elongated cylinder having closed top and bottom ends, said cylinder having a tapered bottom end providing a hopper for collection of the heavier particles of foreign matter carried in said gases, a tangential inlet to said cylinder at the bottom end thereof and above said hopper, a duct connecting said bustle to said tangential inlet, the tangential inflow of gas into said cylinder being operable to effect a centrifugal separation of heavy foreign matter carried therein for collection in said hopper, means for supplying air to the middle portion of said cylinder for combustion of said gases, means for igniting the gas and air mixture in said middle portion, water sprays in the upper middle portion of said cylinder for limiting the temperature of combustion products, a heat exchanger in the top portion of said cylinder positioned in the path of combustion products, an outlet from the top of said cylinder, air supply means discharging air through said heat exchanger,

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a duct connected to conduct heated air from said heat exchanger to said cupola inlet bustle, and means connected to said cylinder top outlet for separating the finer foreign particles from said combustion products.

6. A method of processing gases from an iron melting cupola comprising the steps of mechanically separating larger foreign particles in said gases, burning at least some of the combustible CO in said gases, passing the combustion products in heat exchange relation with blast air for the cupola, and limiting the temperature of combustion by introducing water into the combustion products prior to the passage of said combustion products into said heat exchange relation.

7. A method of processing gases from an iron melting cupola comprising the steps of mechanically separating larger foreign particles in said gases, burning at least some of the combustible CO in said gases, passing the combustion products in heat exchange relation with blast air for the cupola, limiting the temperature of combustion by introducing water into the combustion products prior to the passage of said combustion products into said heat exchange relation, and mechanically separating the finer foreign particles in said gases.

8. A method of processing gases from an iron melting cupola comprising the steps of centrifugally separating larger foreign particles in said gases, burning at least some of the combustible CO in said gases, passing the combustion products in heat exchange relation with blast air for the cupola, limiting the temperature of combustion by introducing water into the combustion products prior to the passage of said combustion products into said heat exchange relation, and separating the finer foreign particles from said gases by subjecting the same to a very fine water spray.

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