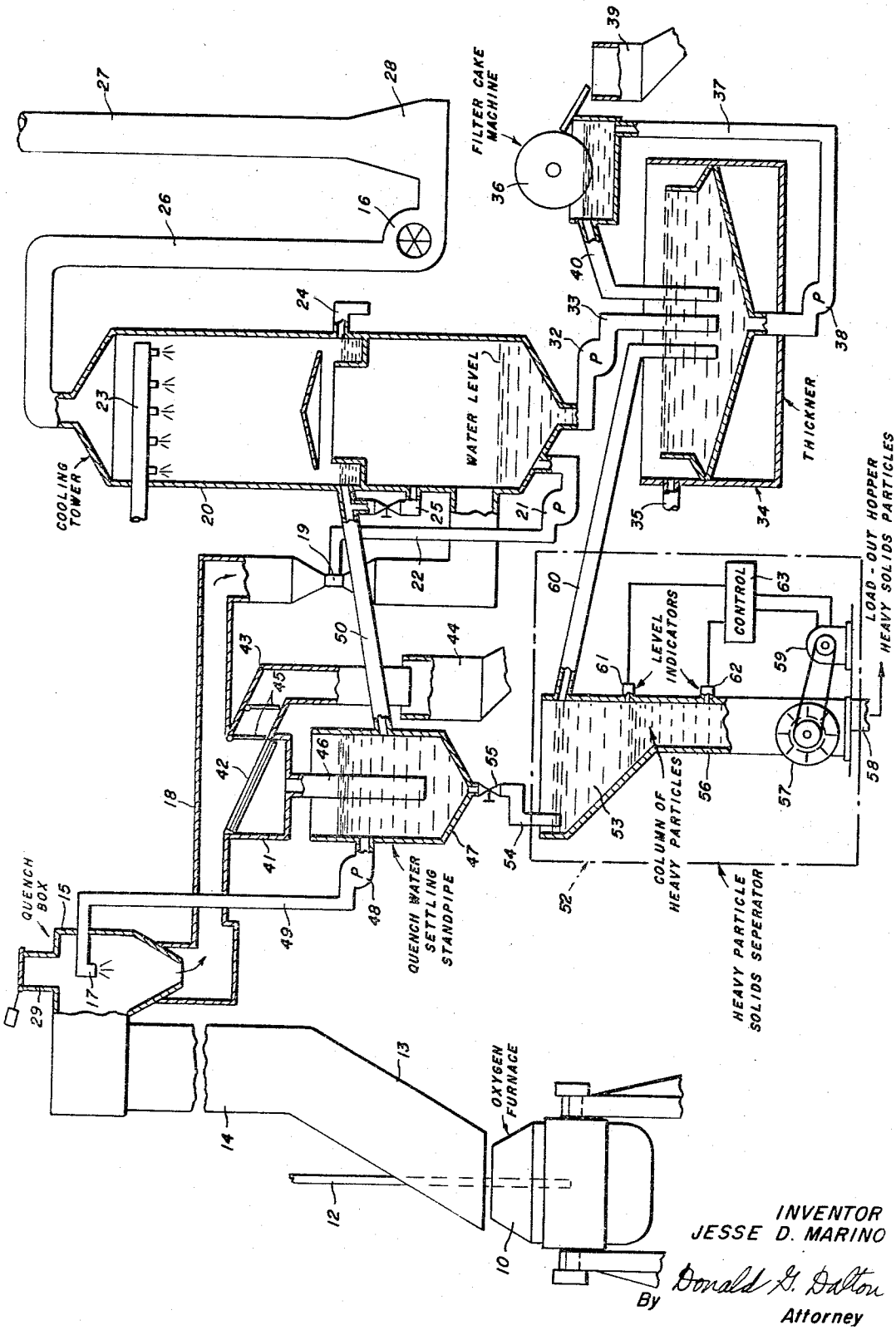
April 25, 1967 J. D. MARINO 3,315,443

METHOD AND APPARATUS FOR CLEANING EXHAUST GASES FROM OXYGEN STEELMAKING FURNACES

Filed Oct. 5, 1965



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United States Patent Office 3,315,443
Patented Apr. 25, 1967

3,315,443

METHOD AND APPARATUS FOR CLEANING EXHAUST GASES FROM OXYGEN STEELMAKING FURNACES

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Filed Oct. 5, 1965, Ser. No. 493,149
10 Claims. (Cl. 55—85)

This invention relates to an improved method and apparatus for cleaning exhaust gases from oxygen steelmaking furnaces.

In an oxygen steelmaking process, a stream of oxygen contacts molten iron in a furnace and oxidizes various impurities from the iron. The exhaust gases from the furnace are extremely hot and dirty and must be cooled and cleaned before they discharge into the atmosphere. The gases may be cleaned either in a precipitator or by wet-washing. One difficulty encountered in usual wet-washing systems with which I am familiar is that heavy particles recovered from the gases tend to plug parts of the equipment and otherwise interfere with its proper operation.

An object of the present invention is to provide an improved method and apparatus, operable in conjunction with an otherwise conventional wet-washing system, for handling and removing heavier particles from the water and preventing their interference with operation of the equipment.

A further object is to provide an improved method and apparatus of the foregoing type in which the heavier particles are retained in a critically designed settling column ahead of the disposal equipment for the lighter particles.

In the drawing:

The single figure is a diagrammatic view of an oxygen steelmaking furnace and wet-washing equipment for the exhaust gases including my improved apparatus for handling the heavier particles.

The drawing shows a conventional oxygen steelmaking furnace **10**, a lance **12** for introducing oxygen thereto, and a hood **13** covering the furnace mouth. The furnace contains a charge of molten iron with which the oxygen reacts and causes hot gases (about 3500 F.) to be emitted at high velocity from the mouth into the hood. These gases carry many large and small liquid particles, including iron, slag and various metallic oxides. Most of these particles fall back into the furnace, but as much as about 40 pounds of particles per ton of steel continues on with the gases and must be removed by the gas-cleaning system.

The hot dirty gases leave the hood through a stack **14**, which leads to a quench box **15**. A fan **16** farther along in the system draws the gases through the stack and quench box and maintains this part of the system under a partial vacuum. Further oxidation takes place in the stack, and the temperature of the gases can reach a maximum of about 4000 F. The quench box contains a spray device **17** which directs water on the gases in sufficient quantity to lower their temperature to about 185 F., and thus solidify all liquid particles therein. The water also wets all the heavier particles and many lighter particles. The wetted particles drop out of the gas stream in the quench box. The water provides a flume of sufficient flow to carry away whatever solid particles drop out of the gas stream.

A conduit **18** carries gases from the quench box **15** through a venturi washer **19** into a cooling tower **20**, which contains water approximately to the level indicated in the drawing. As the gases leave the quench box, they still carry smaller lighter particles. A pump **21** directs water from the bottom of the cooling tower through a

pipe **22** into the venturi washer **19**, where the water collects the particles from the gases. The resulting sludge settles in the bottom of the pool of water in the cooling tower. Another spray device **23** in the top of the cooling tower provides cooling water to lower the vapor content of the gases. The cooling tower is equipped with a sealed overflow **24** and a water-level control **25**. Clean gases discharge from the cooling tower through a main **26**, which contains the aforementioned fan **16**, and out a stack **27** into the atmosphere. The base of stack **27** has a final moisture separator **28**. Preferably the top of the quench box **15** has an emergency stack **29**, which normally is closed but can be opened to discharge gases directly from the quench box if the subsequent equipment is not operating.

A pump **32** directs sludge from the bottom of the cooling tower **20** through a pipe **33** into a conventional thickener **34**, which has an overflow **35** for discharging excess clear water to the sewer. Underflow from the thickener is handled in a conventional filter-cake machine **36**. The latter is connected to the bottom of the thickener via a pipe **37**, which contains a pump **38**. The filter-cake machine dewaters the sludge from the thickener and directs it to a load-out hopper **39**. A return pipe **40** carries water from the filter-cake machine back to the thickener. Preferably the filter-cake machine operates only intermittently when the sludge becomes sufficiently concentrated that the solids can be removed economically from the system. During periods when the filter-cake machine is out of operation, pump **38** continues to run to prevent plugging of the outlet at the base of the thickener.

Water from the quench box **15** discharges into a scupper **41** which is equipped with a scalping screen **42**. The screen catches the largest particles and foreign bodies which sometimes drop into the quench box and would plug or damage subsequent equipment. Material caught on the screen discharges through a chute **43** into a load-out hopper **44**. Chute **43** is equipped with sealing flaps **45**. Water and solids which pass through the scalping screen **42** discharges from the scupper **41** through a vertical pipe **46** into a quench-water settling standpipe **47**. A pump **48** recirculates the quench water from the standpipe through a pipe **49** to the spray device **17** in the quench box **15**. A pipe **50** supplies make-up water to the standpipe from the cooling tower **20**.

All the structure and operation thus far described are conventional, and hence are not shown nor described in greater detail. Prior to my invention the practice was to pump water-borne solids directly from the bottom of standpipe **47** to the thickener **34** or to pass these solids through a cyclone between the standpipe and thickener to remove heavier particles. Neither practice was successful, as heavier particles plug the thickener, filter-cake machine, or cyclone. With the cyclone further processing, such as a drag conveyor, is necessary to separate the heavy particles from the carry-over water. The usual practice of operating the filter-cake machine **36** intermittently and the pump **38** continuously is successful in preventing plugging only when the solids in the thickener **34** do not vary greatly in size and specific gravity. In the present application heavier particles segregate at the center of the thickener and at the base of the filter-cake machine and cause an acute plugging problem.

In accordance with my invention, I interpose a heavy-particle separator **52** between the standpipe **47** and the thickener **34**. The separator **52** includes a relatively long narrow settling tank **53**, to one end of which water-borne solids feed from the standpipe through a pipe **54**. Preferably the head of solids and water in the standpipe is sufficient to feed these materials into the tank, and the pipe **54** contains a valve **55** only for control purposes. How-

ever, I can replace this valve with a pump if needed. A column **56** extends downwardly from tank **53** spaced from the location at which the solids enter. The tank is relatively shallow and its bottom slopes downwardly toward the column **56**. Heavier particles among the solids drop out of suspension and collect in the column. I mount a rotary feeder **57** at the bottom of the column to withdraw particles, as hereinafter explained. The feeder directs these particles to another load-out hopper **58**. The feeder has a drive motor **59**. Water and lighter particles overflow from the settling tank into a pipe **60** which carries them to the thickener **34**.

The minimum dimensions of the settling tank **53** and column **56** are critical, although of course the optimum dimensions vary in different installations where the flow rates and the quantities and characteristics of the solids are different. The tank should provide sufficient retention time to allow the heavier patricles in the suspension to settle into the column. The column should have sufficient height that the bed of particles therein does not allow water to pass. In a typical installation where the volume of solids and water is about 300 gallons a minute, I have used successfully a tank 5 feet long and 2 feet wide. Typicaly the column may be 2 feet square and have a minimum of about 4 to 5 feet. In the illustration I equip the column with upper and lower level switches **61** and **62** which are connected with the drive motor **59** through a control **63**. When the height of bed in the column builds up to the level of the upper switch **61**, the switch operates to start the motor and drive the feeder **57** to remove particles from the bottom. When the height drops to the level of the lower switch **62**, the latter switch operates to stop the motor. Typically the upper switch **1** can be 9 feet above the bottom of the column and the lower switch **62** can be 5 feet thereabove. I have not shown the electrical connections, since they follow well-known principles.

Particles at the bottom of column **56** of course are wet, but they contain no loose water. The bed of particles in the column forms an effective barrier against leakage of water from tank **53**. Particles which remain in the water passing from the tank to the thickener **34** are sufficiently fine and of a character that they do not interfere with proper operation of the thickener.

While I have shown and described only a single embodiment of my invention, it is apparent that modifications may arise. Therefore, I do not wish to be limited to the disclosure set forth but only by the scope of the appended claims.

I claim:

1. In a wet-washing process for cleaning exhaust gases from an oxygen steelmaking furnace, which process includes quenching the gases with water to pick up in the water a portion of the particles carried by the gases, which portion includes all the heavier particles along with some lighter particles, transferring the water and particles picked up therein to a standpipe, recovering as a sludge another portion of the particles carried by the gases, which other portion is composed of lighter particles, and thickening said sludge, the combination therewith of a method of handling particles which go into said standpipe, said method comprising transferring water-borne particles from the bottom of said standpipe to a settling tank, retaining the water and particles in said tank until the heavier particles settle from the water and lighter particles forming a column of minimum height of about 4 feet of settled heavier particles from said tank, withdrawing heavier particles from the bottom of said column, and thickening the water and lighter particles from said tank to the exclusion of the heavier particles.

2. A method as defined in claim **1** in which particles are withdrawn from the bottom of said column when the height of the column reaches about 9 feet, and withdrawal of particles discontinues when the height of the column drops to about 5 feet.

3. A method as defined in claim **1** in which the water and particles from said standpipe feed to one end of said tank and flow along the length of the tank, and said column extends downwardly at a location spaced from that at which the water and particles feed into the tank.

4. A method as defined in claim **1** in which water and particles picked up therein pass through a scalping screen to exclude the largest particles and foreign bodies from said standpipe.

5. A method as defined in claim **1** in which the head of water and particles in said standpipe serves to feed them into said tank.

6. In a wet-washing system for cleaning exhaust gases from an oxygen steelmaking furnace, which system includes means for quenching the gases with water and thereby picking up in the water a portion of the particles carried by the gases, which portion includes all the heavier particles along with some lighter particles, a standpipe, means for transferring the water and particles picked up therein to said standpipe, means for recovering as a sludge another portion of the particles carried by the gases, which other portion is composed of lighter particles, and a thickener for the sludge, the combination therewith of an apparatus for handling particles which go into said standpipe, said apparatus comprising a settling tank, means for transferring water-borne particles from said standpipe to said tank, a column extending downwardly from said tank and having a minimum height of about 4 feet, said column receiving heavier particles which settle in said tank, means for withdrawing heavier particles from the bottom of said column, and means for transferring water and lighter particles from said tank to said thickener to the exclusion of the heavier particles.

7. An apparatus as defined in claim **6** further comprising spaced-apart means on said column for initiating withdrawal of particles when the height of the bed of particles in said column reaches about 9 feet and discontinuing withdrawal when the height drops to about 5 feet.

8. An apparatus as defined in claim **6** in which said tank is relatively long and narrow, the means for transferring particles to said tank feeds them at one end thereof, and said column extends downwardly from a location spaced from that at which particles feed to the tank.

9. An apparatus as defined in claim **6** further comprising a scalping screen ahead of said standpipe to exclude the largest particles and foreign bodies from said standpipe.

10. An apparatus as defined in claim **6** in which said standpipe provides a head of water and particles for feeding them into said tank.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,315,443 April 25, 1967

Jesse D. Marino

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 25, after "minimum" insert -- height --; line 33, for "switch 1" read -- switch 61 --.

Signed and sealed this 14th day of November 1967.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents