Jan. 16, 1962 W. J. FRITZ 3,016,981

METHOD AND APPARATUS FOR QUENCHING HIGH TEMPERATURE GASES

Filed May 20, 1960

2 Sheets-Sheet 1

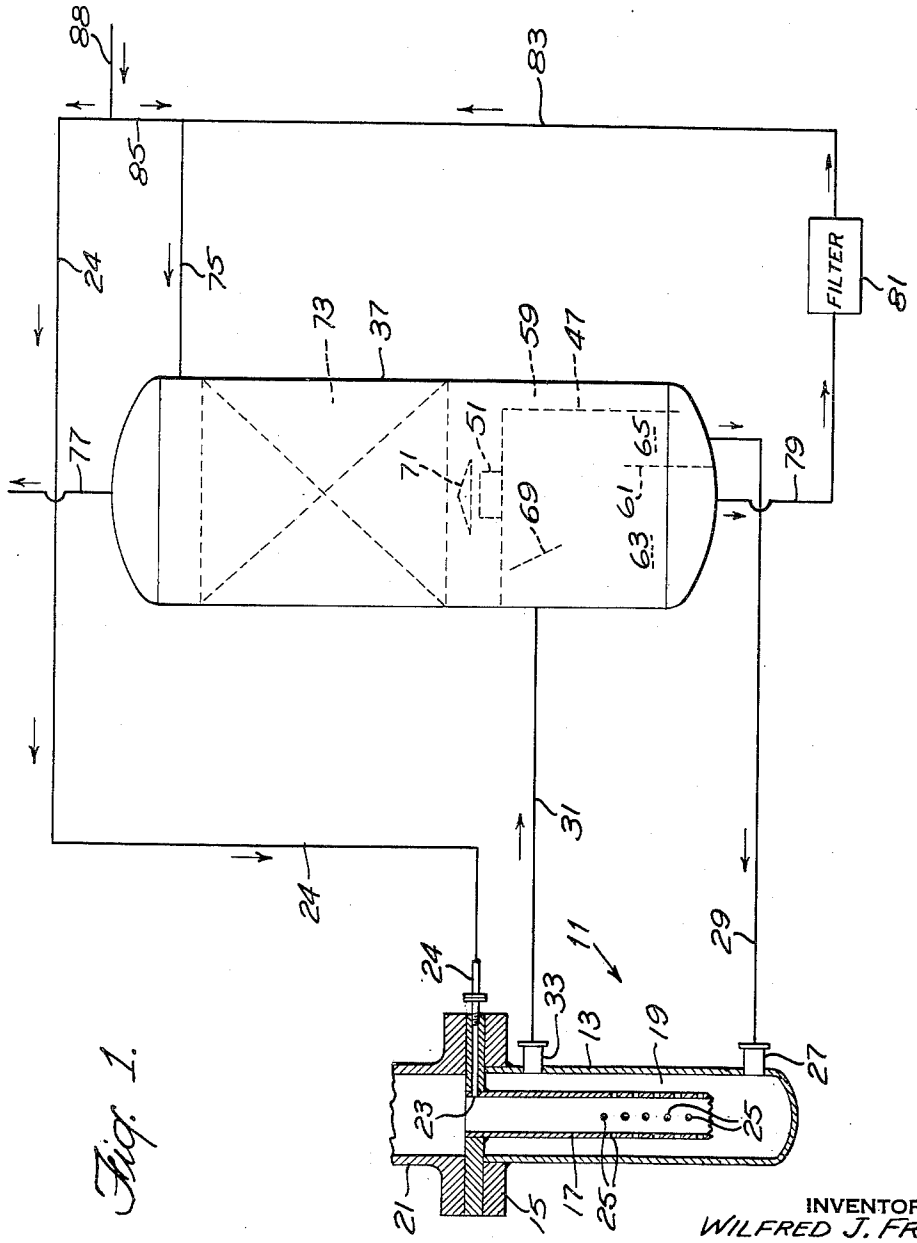

Fig. 1.

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Fig. 2.

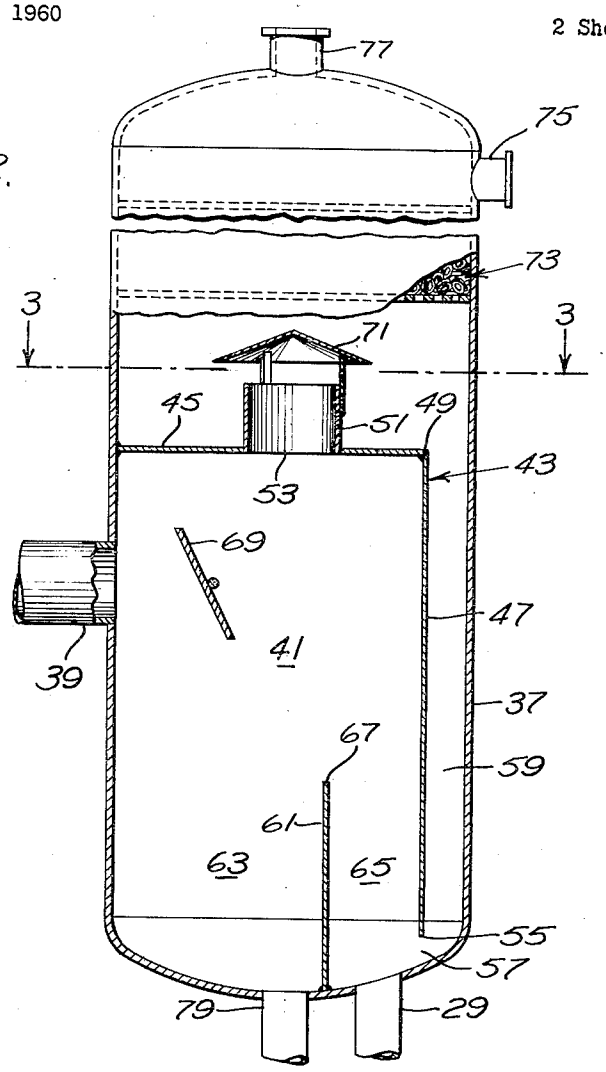
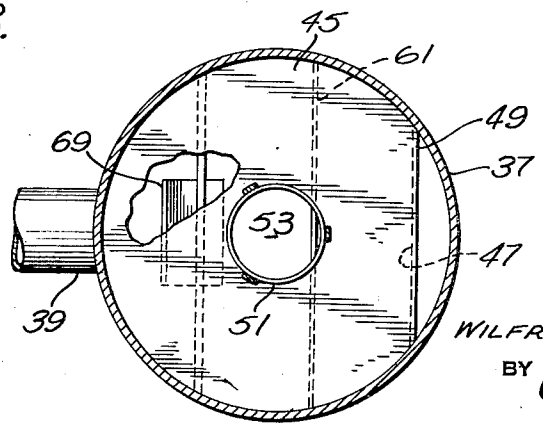


Fig. 3.



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3,016,981
METHOD AND APPARATUS FOR QUENCHING HIGH TEMPERATURE GASES

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13 Claims. (Cl. 183—27)

The present invention relates to the quenching of high temperature gases and more particularly to methods and apparatus for removing soot from high temperature gases quenched by the direct liquid contacting of the gas.

Many chemical reactions, particularly those involving combustion require the rapid cooling or quenching of the gaseous reaction products. For example, rapid cooling of high temperature effluent gases from a pressurized synthesis-gas generator in which a reaction involving the partial combustion of natural gas with oxygen is necesary. The same requirement exists for rapid cooling of high-temperature effluent gases from a pressurized gas generator in which fuel oil, coal, or other carbonaceous material is reacted wtih oxygen, oxygen enriched air, or air. Such cooling is frequently accomplished by the direct injection of a volatile liquid into the hot product gases of the chemical reaction. The temperature of the effluent gases is thus quickly lowered due to the rapid transfer of heat from the gases into the liquid, with the resultant vaporization of all or a portion of the liquid medium.

A highly effective apparatus for the quenching of high temperature gases is described and claimed in U.S. Patent No. 2,744,730 issued May 8, 1956 to Gilbert S. Merritt, and in which patent a hydrocarbon fuel and gaseous oxygen are burned to carbon monoxide and hydrocarbon in the combustion chamber of a reactor. The products of combustion are directed into a quench vessel which contains a body of circulating liquid, and cooling is accomplished by the vaporization of part of the liquid. A reservoir of quenching liquid is provided so as to permit continuation of the quenching operation for a reasonable period of time after stoppage or reduction of the normal quench liquid glow to the quench vessel. The patented apparatus provides a continuous internal circulation of liquid by means of a gas-lift effect which permits establishment of high liquid-to-gas ratios with effective gas and liquid contact.

The quenching apparatus of the above-mentioned Merritt patent operates effectively and to a great advantage in those instances where the effluents of the reaction contain small amounts of soot. The separated liquid recycled from the reservoir to the quench vessel did not contain objectionable quantities of soot, and soot concentration in said liquid was maintained at low value by merely blowing down small amounts of the soot-liquid mixture. Any soot entrained in the gases leaving the reservoir space was removed in a scrubber prior to being utilized in process equipment further down-stream. In the production of synthesis gas, the concentration of soot in the liquid in the quench apparatus should preferably be kept at a low value. It has been found that when fuel oil is reacted with the gaseous oxygen, large amounts of soot are formed as a result of such reaction, and consequently the soot concentration in the quench liquid may rise to an objectionable value. It has been observed in an extreme case that soot concentration can build up to a point at which the soot-liquid mixture will "set-up" and thereby arrest circulation. It has been observed that suspensions of soot in water become thixotropic when the soot cencentration becomes too high. Increasing viscosity as the soot concentration becomes

too high. Increasing viscosity as the soot concentration rises, will inhibit circulation of the unevaporated liquid, preventing proper cooling of the gas and removal of soot from the quench vessel. In severe cases, reduction of circulation may take place to the point where severe overheating of the quench vessel will occur.

It is an object of the present invention to provide novel methods and apparatus for removing soot from quenched high-temperature gases, and for reducing the level of concentration of soot in liquid recycled for quenching such gases.

The present invention therefore contemplates novel methods and apparatus wherein the mixture of quenched gases containing soot and unevaporated quench liquid is separated into a gas stream containing a small quantity of entrained soot and a liquid stream containing a large amount of soot. The gas stream is conducted through vapor-liquid contact means while part of the liquid stream is recycled to the quench apparatus and part passes to filtration equipment where substantially all of the soot is removed. The substantially soot-free liquid from the filter then is passed into the vapor-liquid contact means in countercurrent contact with the gas stream to scrub the soot particles therefrom and render the gases free of soot. The liquid leaving the vapor-liquid contact means contains the soot scrubbed from the gas stream and is collected for recycling to a quench vessel wherein high temperature gases containing soot are continuously introduced for quenching.

The invention will be understood from the following description when considered in connection with the accompanying drawings forming a part thereof and in which:

FIG. 1 is a flow diagram of the present invention and shows a diagrammatic view, more or less, of the apparatus therefor,

FIG. 2 is an elevational view, in section, of the scrubber vessel of FIG. 1, and

FIG. 3 is a plan view, in section, taken along the line 3—3 of FIG. 2.

Like characters of reference refer to the same or to similar parts throughout the several views.

Referring to the drawings, the apparatus of the present invention, as illustrated, comprises a substantially vertical quench vessel 11 having an outer vertical cylindrical casing or tube 13 mounted at the top thereof in a flange 15, within which outer tube is disposed a substantially vertical and concentrically arranged inner tube 17. Inner tube 17 extends downwardly within outer tube 13 to a point short of the bottom thereof and has its outer periphery in spaced relationship with the inner periphery of tube 13 to form a substantially vertical annular passage 19 therebetween. The upper portion of inner tube 17 is in communication with a reactor vessel 21 (partly shown) and is provided with a liquid inlet 23 in the side thereof through which liquid is introduced therein from a conduit 24. The lower portion of tube 17 is provided with a plurality of outlet perforations or apertures 25 to discharge a vapor and liquid mixture therefrom into passage 19. The bottom of outer tube 13 as shown is preferably open.

The lower portion of quench vessel 11 has a liquid inlet 27 which has connected thereto one end of a quench liquid conduit 29 (shown diagrammatically in FIG. 1) which supplies quench liquid as for example water to the vessel. A conduit 31 is connected to outlet 33 in the upper portion of quench vessel 11 to convey from the vessel a gas-liquid mixture as will be presently described.

The structure described up to this point is substantially identical to that disclosed in the mentioned Merritt patent and in operation of such structure hot effluent and high

pressure gases or vapor from a combustion reaction of a carbonaceous material, as for example, fuel oil and oxygen, flow downwardly from reactor vessel 21 into the upper end of tube 17. Cooling liquid is introduced through inlet 23 from conduit 24 to cool flange 15 and the hot effluent gases and liquid contact one another in tube 17. The liquid evaporates and the gas thereafter passes downwardly into the lower portion of tube 17 and out of the lower portion of the tube through perforations 25 into the annular passage 19 between tubes 13 and 17. Perforations 25 permit uniform distribution of the mixture into passage 19. The higher upstream pressure of the incoming effluent gases from the reactor 21 causes the incoming gas and liquid to form a gas-liquid phase or mixture which occupies the larger part of passage 19 during the whole time of operation of the apparatus. Intimate gas-liquid mixing and contacting takes place in passage 19 with part of the heat content in the original high temperature effluent gas being transferred to the liquid to thereby flash a portion of the liquid from a liquid state to a gaseous state to lower gas temperature. The gas-liquid mixture thereafter flows upwardly in passage 19 and out thereof through tube 31 in the upper portion of tube 13.

As indicated hereinbefore the combustion of oxygen and carbonaceous material results in the formation of soot particles which if allowed to remain in the system eventually reduce the quench liquid circulation to a point wherein the system becomes inoperative. It is the purpose of the present invention to provide effective novel methods and apparatus for removing soot from the quench gases and to maintain a low concentration of soot in the quench liquid recycled to the quench vessel. To this end a substantially vertically disposed cylindrical scrubber vessel 37 is provided with a vapor-liquid inlet 39 (FIG. 2) having the other end of conduit 31 connected thereto for introducing the vapor-liquid mixture containing soot particles into the vessel 37. Inlet 39 is in communication with a separation chamber 41 defined by baffle means 43 which comprises a horizontal plate or tray 45 and a vertical plate 47. Plate 45 is generally circular but has a cut-out portion which forms a straight edge 49. The peripheral edge of plate 45 is secured to the wall of vessel 37 by any suitable means as for example by welding, and along its straight edge 49 is spaced from the wall of the vessel. Plate 45 is provided with an upstanding cylindrical member 51 which encompasses a vapor outlet 53 for separation chamber 41. Vertical plate 47 has an upper edge which is secured to straight edge 49 of plate 45 and side edges secured to the vessel wall (FIG. 3); the lower edge 55 of plate 47 being spaced a slight distance from the bottom of vessel 37 to form a passageway 57. From the construction described above, it will be seen that separation chamber 41 is substantially fluid-tight except for vapor outlet 53 and passageway 57. Plate 47 along its surface remote from chamber 41 is spaced from the adjoining vessel wall to form a downcomer passage 59, for a purpose to be presently described.

A vertical partition 61 is provided in the bottom of vessel 37 and in separation chamber 41 to form a pair of quench liquid compartments 63 and 65. As best seen in FIG. 2 the lower edge of partition 61 is secured to the bottom of vessel 37 and the vertical edges of said partition are secured to the wall of the vessel (FIG. 3) while an upper edge 67 is unsecured. An inclined deflection member 69 is provided in separation chamber 41 and in the path of entry of the gas-liquid mixture into the chamber for intercepting the incoming mixture. The vapor-liquid mixture upon entering vessel 37 separates by gravity into a stream of gas containing entrained soot particles and a stream of liquid containing a large quantity of soot. Separation of the mixture into the two streams is aided, in part, by deflection member 69 but the primary function of the deflection member is to assure the deflection of the liquid stream into liquid collection

compartment 63. It should be understood, however, that the utilization of deflection member 69 is not essential although it serves to assure positive deflection of the liquid stream into compartment 63. The separated gas stream with the entrained soot leaves the separation chamber through vapor outlet 53 and member 51 and is deflected in its flow upwardly by a cap member 71, whence the gas stream passes through vapor and liquid contact means, generally designated by the numeral 73. Vapor-liquid contact means 73 consists of suitable packing as for example Raschig rings, which provide a large surface for contact with a downwardly flowing scrubbing liquid introduced into the top of vapor-liquid contact means 73 by a conduit 75 from a source to be described hereinafter. The gases in passing through the vapor-liquid contact means have the entrained soot particles scrubbed out of it and the clean gases flow out of the top of the vessel 37 by way of a conduit 77 for use in process equipment (not shown). The scrubbing liquid together with the soot particles separated from the gases flow out of the contact means and onto horizontal plate 45, the downwardly flowing liquid being prevented from entering separation chamber 41 by cap 71 and cylindrical member 51. The scrubbing liquid then flows off plate 45 and passes through downcomer 59 and passageway 57 for collection in compartment 65. Quench liquid conduit 29 has its other end in communication with compartment 65 whereby the liquid in the latter is conducted to quench vessel 11. The liquid in compartment 63 contains a substantial amount of soot and the same is conducted by a conduit 79 to filtration equipment 81 shown diagrammatically in FIG. 1. The liquid passing through filtration equipment 81 has substantially all of the soot removed therefrom and the soot-free liquid flows upwardly through a conduit 83 which is connected to conduit 75. The soot-free liquid then flows through conduit 75, whence it enters vessel 37 above the vapor-liquid contact means 73 as indicated above. Since some of the liquid in quench vessel 11 vaporizes, part of the make-up liquid for the system is provided through a conduit 85 connected to the juncture of conduits 75 and 83 at one end and at its other end to a conduit 88 in communication with a source of fluid (not shown). The conduit 24 also is connected to said source of liquid and provides the remainder of the make-up liquid partly supplied through said conduit. The liquid in conduit 24 also serves to cool flange 15 which is subjected to the high temperature gases emanating from reactor 21.

In operation, the mixture of quenched gases containing entrained soot and quench liquid flows out of the top of quench vessel 11 through outlet 33 and is conducted by conduit 31 to separation chamber 41 of scrubber vessel 37, where the mixture separates into a stream of gas containing a small amount of entrained soot particles and a stream of liquid containing a large amount of soot particles. The quench gases flow out of separation chamber 41 through vapor outlet 53 and into vapor liquid contact means 73 while the soot-rich liquid collects in compartment 63. The liquid in compartment 63 then flows through conduit 79 to filtration equipment 81 where substantially all of the soot is removed and the soot-free liquid flows through conduits 83 and 75, whence it is introduced into the top of scrubber vessel 37. The soot-free liquid in vessel 37 flows downwardly through vapor-liquid contact means 73 in countercurrent contact with the quench gas containing entrained soot to remove same. The soot-free gas leaves vessel 37 through conduit 77 while the scrubbing liquid with the scrubbed soot particles flows through downcomer passage 59 and passageway 57, whence it is collected in liquid compartment 65. The liquid in compartment 65 is then conducted to the bottom of quench vessel 11 by conduit 29 for quenching of the gases entering the vessel from reactor 21.

The structure of the present invention has been described hereinabove under a condition of operation where-

in the primary purpose thereof is to provide an optimum soot-free condition of the quench liquid conducted back to the quench vessel 13 via conduit 29. Accordingly, the liquid levels in both compartments 63 and 65 were maintained below edge 67 of partition 61 so as to prevent a flow of liquid containing soot into compartment 65 which contains relatively clean liquid. In practice, it may be desired to provide a liquid level in chamber 41 which is above edge 67 of partition 61 in order that some of the soot containing liquid entering chamber 41 from conduit 39 also enters compartment 65 for flow through conduit 29 to quench vessel 13. In such event the soot concentration in the liquid conducted to vessel 13 would have a slightly higher soot concentration than that described hereinabove, but plant operation or economic conditions may not require an optimum minimum soot concentration in the quench liquid. It will be understood that the amount of quench liquid necessary for quenching purposes is quite large and if some of the necessary quench liquid could be soot containing liquid, less liquid from compartment 63 need pass through the filter 81 and, accordingly, the size of the filter, which may be quite expensive, may be reduced.

The present invention also contemplates methods of operation or structure wherein the filtering action or filter 81 may be dispensed with. Most applications of the present invention require, under governing laws or ordinances of the area in which the plant may be located, that the contaminated liquids such as the soot containing liquid from conduit 79, not be permitted to flow into waste disposal systems. In addition, the economics of the particular plants may dictate that the quench liquid from the quench vessel be recirculated because of the great expense entailed in continually introducing fresh liquid or water into the plant. However, there may be situations where governing regulations do not forbid the discharge of contaminated liquids into waste disposal systems and the expense of fresh water is not excessive. In such event, filter 81 and conduit 83 may be omitted and conduit 79 may be connected to waste while all of the required water for quenching process may be obtained from conduit 88.

Inasmuch as various modifications may be made in the form of the invention herein disclosed and in the steps of the method and the location of the parts of the apparatus without departing from the principles thereof, it will be understood that the invention is not to be limited excepting by the scope of the appended claims.

What is claimed is:

1. A method for removing soot from a gas in a quenching operation and for reducing the soot concentration of a continuously recycled liquid utilized to quench the gas, comprising the steps of, quenching incoming gas containing soot with a liquid by intimately contacting the gas with a confined liquid whereby a gas-liquid stream containing soot is produced, separating the gas-liquid stream in a separating zone into a gas stream containing an amount of soot and a liquid stream also containing an amount of soot, providing a substantially clean scrubbing liquid, scrubbing said gas with said scrubbing liquid to thereby provide a substantially soot-free gas, maintaining said scrubbing liquid substantially separate from said liquid stream, and recycling said scrubbing liquid to quench said incoming gas containing soot.

2. A method for removing soot from a gas in a quenching operation and for reducing the soot concentration of a continuously recycled liquid utilized to quench the gas, the steps comprising, quenching a gas containing soot with a liquid in a quenching zone by intimately contacting the gas with a confined liquid whereby a gas-liquid stream containing soot is produced, conducting the gas-liquid stream to a separation zone to separate the gas-liquid stream into a gas stream containing an amount of soot and a stream of liquid also containing an amount of soot, flowing the gas stream to a vapor-liquid contact zone, removing soot from said liquid stream to provide a substantially clean scrubbing liquid, flowing the soot-free scrubbing liquid into the vapor-liquid contact zone countercurrent to the gas stream to remove the soot therefrom, maintaining said scrubbing liquid substantially separate from said soot-containing stream of liquid, and recycling said scrubbing liquid from the vapor-liquid contact zone to the quenching zone.

3. A method for removing soot from a gas in a quenching operation and for reducing the soot concentration of a continuously recycled liquid utilized to quench the gas, the steps comprising, quenching a gas containing soot with a liquid in a quenching zone by intimately contacting the gas with the liquid whereby a gas-liquid stream containing soot is produced, conducting the gas-liquid stream to a separation zone to separate the gas-liquid stream into an ascending gas stream containing an amount of soot and a descending second stream of liquid also containing an amount of soot, flowing the gas stream upwardly through a vapor-liquid contact zone, collecting the liquid stream containing soot in a first collection zone, conducting the liquid from said first collection zone to a filtration zone to remove the soot from the liquid and to provide a substantially soot-free scrubbing liquid, passing said substantially soot-free scrubbing liquid from the filtration zone downwardly through the vapor-liquid contact zone in countercurrent contact with the gas stream to remove soot from the latter, collecting the scrubbing liquid containing soot from the vapor-liquid contact zone in a second collection zone, maintaining said scrubbing liquid substantially separate from said liquid stream, and recycling the scrubbing liquid containing soot from the second collection zone to the quenching zone.

4. A method for removing soot from a gas in a quenching operation and for reducing the soot concentration of a continuously recycled liquid utilized to quench the gas, the steps comprising, quenching a gas containing soot with a liquid in a quenching zone by intimately contacting the gas with a body of liquid whereby a gas-liquid stream containing soot is produced, conducting the gas-liquid stream to a separation zone to separate the gas-liquid stream into an ascending gas stream containing an amount of soot and a descending second stream of liquid also containing an amount of soot, flowing the gas stream upwardly through a vapor-liquid contact zone, collecting the liquid stream containing soot in a first collection zone, conducting the liquid from said first collection zone to a filtration zone to remove the soot from the liquid and to provide a substantially soot-free scrubbing liquid, passing said substantially soot-free scrubbing liquid from the filtration zone downwardly through the vapor-liquid contact zone in countercurrent contact with the gas stream to remove soot from the latter, collecting the scrubbing liquid containing soot from the vapor-liquid contact zone in a second collection zone, maintaining said scrubbing liquid substantially separate from said liquid stream, passing a small portion of the liquid in said first collection zone to said second collection zone in admixture with said soot-free liquid, and recycling the mixture of liquids from the second collection zone to the quenching zone.

5. A method for removing soot from a gas in a quenching operation and for reducing the soot concentration of a continuously recycled liquid utilized to quench the gas, the steps comprising, quenching a gas containing soot with a liquid in a quenching zone by intimately contacting the gas with a body of liquid whereby a gas-liquid stream containing soot is produced, conducting the gas-liquid stream to a separation zone to separate the gas-liquid stream into an ascending gas stream containing an amount of soot and a descending second stream of liquid also containing an amount of soot, flowing the gas stream upwardly through a vapor-liquid contact zone, collecting the liquid stream containing soot in a first collection zone, conducting the liquid from said first collection zone to a filtration zone to remove the soot from the liquid and to provide a sub-

stantially soot-free scrubbing liquid, passing said substantially soot-free scrubbing liquid from the filtration zone downwardly through the vapor-liquid contact zone in countercurrent contact with the gas stream to remove soot from the latter, adding soot-free liquid from a source of liquid in admixture with the substantially soot-free scrubbing liquid from the filtration zone prior to said last-mentioned liquid flowing to the vapor-liquid contact zone, collecting the liquid containing soot from the vapor-liquid contact zone in a second collection zone, maintaining said scrubbing liquid substantially separate from said liquid stream, and recycling the liquid containing soot from the second collection zone to the quenching zone.

6. In apparatus of the class described, a quench vessel including a reservoir of liquid for quenching high temperature gases containing soot, means in said vessel for causing intimate mixing of a quench liquid while the liquid is confined in said reservoir with the gases to provide a stream of liquid and gas, separating means in communication with the quench vessel to receive said stream and to separate it into a gas stream containing soot and a liquid stream containing a relatively higher amount of soot, vapor-liquid contact means for receiving the gas stream, collection means for receiving the liquid stream containing soot, filtration means connected to said collection means for receiving the liquid stream and removing substantially all of the soot therefrom to provide a soot-free scrubbing liquid, means communicating the filtration means with the vapor-liquid contact means to provide for contact of the soot-free scrubbing liquid with the gas stream to effect removal of the soot from the gas, and means connected to receive the last-mentioned liquid and including means for maintaining said scrubbing liquid substantially separate from said soot-containing liquid stream for recycling same back to the quench vessel for quenching the high temperature gases therein.

7. In an apparatus of the class described, a quench vessel containing a gas inlet for receiving and quenching high temperature gases containing soot, a liquid inlet for said quench vessel for receiving a quench liquid, means in said quench vessel for causing intimate mixing of said liquid with said gas to be quenched, an outlet for said vessel for discharging a mixture of gas and liquid containing soot, a scrubber vessel having an inlet connected to receive said mixture from the quench vessel outlet, baffle means in said vessel forming a separation chamber and a pair of liquid collection compartments, said separation chamber being arranged to receive said gas-liquid mixture and providing for gravity separation of said mixture into a gas stream having an amount of soot and a liquid stream also containing soot, one of said collection compartments being in communication with said separation chamber to receive said liquid stream for collection therein, vapor-liquid contact means arranged in said scrubber vessel for receiving said gas stream, conduit means in communication with the scrubber vessel for introducing soot-free liquid in countercurrent contact with the gas containing soot to remove the latter therefrom, outlet means in said scrubber vessel for discharging soot-free gas therefrom, means communicating the vapor-liquid contact means with said other collection compartment for conducting to the latter the liquid from the vapor-liquid contact means, and means communicating said other collection compartment with the liquid inlet in said quench vessel to recycle the liquid from said other collection compartment to the quench vessel.

8. In apparatus of the class described, a quench vessel containing a gas inlet for receiving and quenching high temperature gases containing soot, a liquid inlet for said quench vessel for receiving a quench liquid, means in said quench vessel for causing intimate mixing of said liquid with said gas to be quenched, an outlet for said vessel for discharging a mixture of gas and liquid containing soot, a scrubber vessel having an inlet connected to receive said mixture from the quench vessel outlet, baffle means in said vessel forming a separation chamber and a pair of liquid collection compartments, said separation chamber being arranged to receive said gas-liquid mixture and providing for gravity separation of said mixture into a gas stream having an amount of soot and a liquid stream containing soot, one of said collection compartments being in communication with said separation chamber to receive said liquid stream for collection therein, vapor-liquid contact means arranged in said scrubber vessel for receiving said gas stream, filtration means connected to receive said liquid from said one collection compartment for removing soot from said liquid to provide a substantially soot-free liquid, means communicating the filtration means with the vapor-liquid contact means to conduct the soot-free liquid to the latter in countercurrent contact with the gas containing soot to remove the latter therefrom, outlet means in said scrubber vessel for discharging soot-free gas therefrom, means communicating the vapor-liquid contact means with said other collection compartment for conducting to the latter the liquid from the vapor-liquid contact means, and means communicating said other collection compartment with the liquid inlet in said quench vessel to recycle the liquid from said other collection compartment to the quench vessel.

9. In apparatus of the class described, a quench vessel containing a gas inlet for receiving and quenching high temperature gases containing soot, a liquid inlet for said quench vessel for receiving a quench liquid, means in said quench vessel for causing intimate mixing of said liquid with said gas to be quenched, an outlet for said vessel for discharging a mixture of gas and liquid containing soot, a scrubber vessel vertically disposed and having an inlet connected to receive said mixture from the quench vessel outlet, baffle means in said scrubber vessel forming a separation chamber and a pair of liquid collection compartments in the bottom of the vessel, said separation chamber being arranged to receive said gas-liquid mixture and providing for gravity separation of said mixture into a gas stream containing an amount of soot and a liquid stream also containing soot, one of said collection compartments being in communication with said separation chamber to receive said liquid stream for collection therein, vapor-liquid contact means in said scrubber vessel and above said baffle means for receiving said gas stream for upward flow therethrough, filtration means connected to receive said liquid from said one collection compartment for removing soot therefrom to provide a substantially soot-free liquid, conduit means connecting the filtration means with the upper portion of the scrubber vessel above the vapor-liquid contact means to provide for passage of the soot-free liquid to the vessel and for flow downwardly through and in countercurrent contact with the gas stream ascending in the vapor-liquid contact means to remove soot from said gas, outlet means in said scrubber vessel for discharging soot-free gas therefrom, means communicating the vapor-liquid contact means with said other collection compartment for conducting to the latter the liquid from the vapor-liquid contact means, and means communicating said other collection compartment with the liquid inlet of said quench vessel to recycle the liquid from said other collection compartment to the quench vessel.

10. The apparatus of claim 9 wherein the pair of liquid collection compartments are in open communication with the separation chamber, and a deflection member is disposed in the separation chamber above the liquid collection compartments and in alignment with the inlet of said scrubber vessel, said deflection member being arranged in the path of entry of the gas and liquid mixture into the scrubber vessel from the quench vessel to direct the separated liquid into said one collection compartment.

11. In apparatus of the class described, a quench vessel containing a gas inlet for receiving and quenching high temperature gases containing soot, a liquid inlet for said quench vessel for receiving a quench liquid, means in said

quench vessel for causing intimate mixing of said liquid with said gas to be quenched, an outlet for said vessel for discharging a mixture of gas and liquid containing soot, a scrubber vessel vertically disposed and having an inlet connected to receive said mixture from the quench vessel outlet, baffle means disposed in the lower portion of the vessel and cooperating with the wall of said vessel to form a substantially fluid-tight vertically disposed separation chamber in communication with the vessel inlet to receive said gas-liquid mixture and providing for gravity separation of said mixture into a gas stream having an amount of soot and a liquid stream also containing soot, said baffle means having a vapor outlet at the top thereof to provide for discharge of separated gas containing soot and a pair of liquid collection compartments at the bottom thereof, one of said collection compartments being in communication with said liquid stream for collection therein, vapor-liquid contact means in said scrubber vessel above said separation chamber for receiving said gas stream discharged from said vapor outlet, cap means disposed over said vapor outlet to deflect passage of gas from said vapor outlet to said vapor-liquid contact means to prevent liquid from the latter from passing into said vapor outlet, filtration means connected to receive said liquid from said one collection compartment for removing soot from said liquid to provide a substantially soot-free liquid, conduit means communicating the filtration means with the vapor-liquid contact means to conduct the soot-free liquid to the latter in countercurrent contact with the gas containing soot to remove the latter therefrom, outlet means in said scrubber vessel for discharging soot-free gas therefrom, downcomer means communicating the vapor-liquid contact means with said other collection compartment for conducting to the latter the liquid from the vapor-liquid contact means, and conduit means communicating said other collection compartment with the liquid inlet of said quench vessel to recycle the liquid from said other collection compartment to the quench vessel.

12. The apparatus of claim 11 wherein the baffle means comprises a horizontally disposed plate forming the top of the separation chamber and secured along its perimeter to the wall of the vessel except at an edge portion thereof where it is spaced from the vessel, the baffle means further including a vertical plate secured at its upper edge to the spaced edge portion of the horizontal plate and along its vertical edges of the wall of said vessel and spaced at its bottom edge from the bottom of the vessel, said vertical plate being spaced along one side portion of the vessel wall to form the downcomer passage in communication with the vapor-liquid contact means, and a short vertical partition in said separation chamber spaced from and adjacent the other vertical side of the vertical plate and having its lower edge and side edges secured to the bottom and middle of the vessel respectively, said vertical partition forming a common wall of the pair of liquid collection compartments.

13. In apparatus of the class described, a quench vessel for quenching high temperature gases containing soot, means in said vessel for causing intimate mixing of a quench liquid with said gases to provide a stream of liquid and gas, separating means in communication with said quench vessel to receive said stream and to separate it into a gas stream containing soot and a liquid stream containing a relatively higher amount of soot, vapor-liquid contact means for receiving said gas stream, collection means for receiving said liquid stream containing soot, means for providing a soot-free scrubbing liquid to said contact means to effect removal of the soot from said gas stream, means to collect said scrubbing liquid and to maintain it substantially separate from said first mentioned liquid stream, and means to pass said scrubbing liquid to said quench vessel for quenching the high temperature gases admitted thereto.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,016,981 January 16, 1962

Wilfred J. Fritz

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 1, line 72, and column 2, line 1, strike out "Increasing viscosity as the soot concentration becomes too high.",

Signed and sealed this 17th day of July 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents