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SULPHUR-WATER-AIR SEPARATOR

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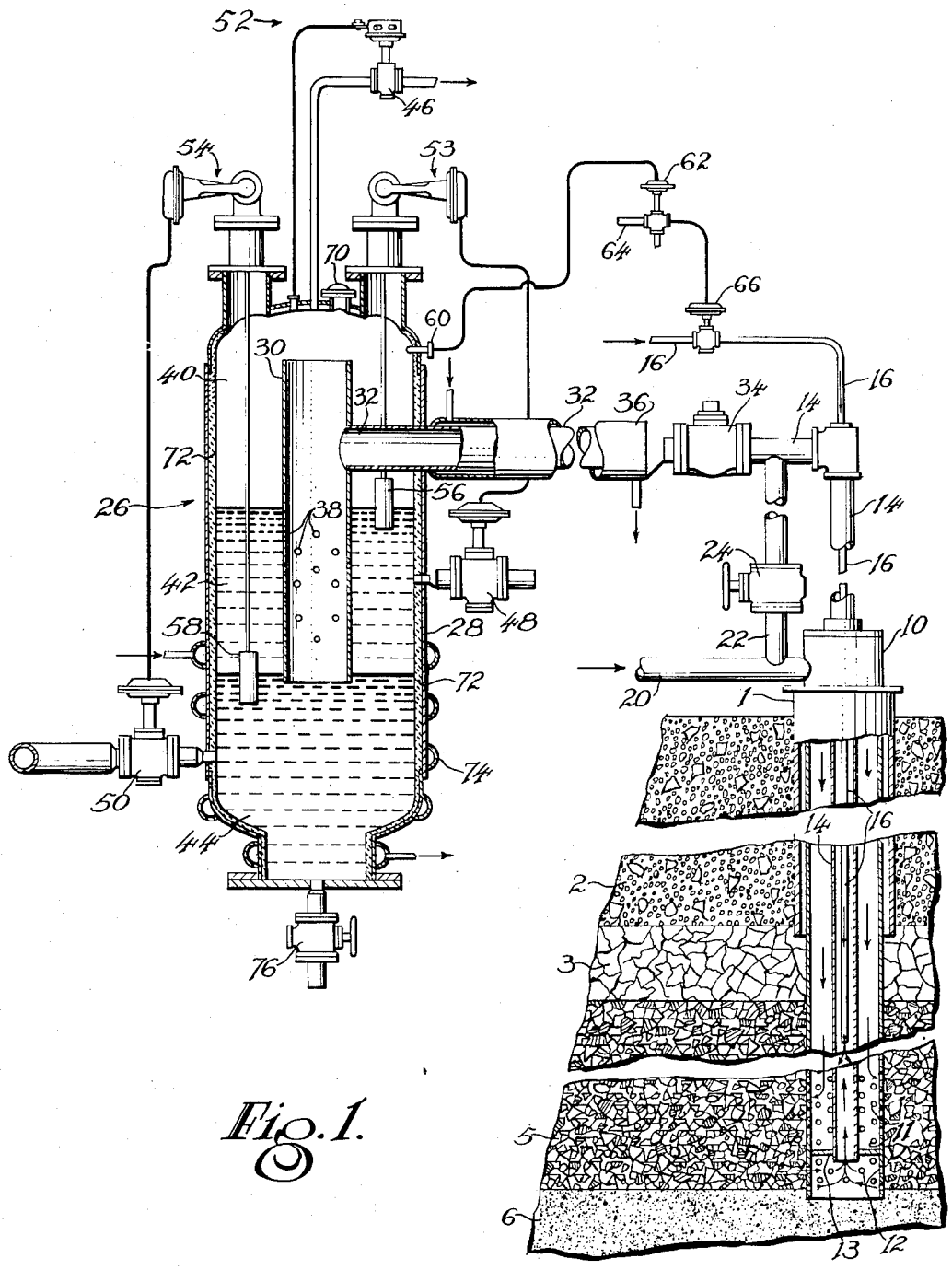


Fig. 1.

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SULPHUR-WATER-AIR SEPARATOR

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This invention relates to a new method and apparatus for improving the production of sulphur from mines and more particularly to a method and apparatus for continuously separating sulphur from the discharge of a Frasch process sulphur mine containing molten sulphur and gas (air), and also on occasions varying proportions of water.

In the Frasch process of mining sulphur, a well is drilled into the sulphur bearing formation, and four concentric pipes are placed in the hole. The outer pipe is a ten-inch-wide protective casing. The next pipe, an eight-inch, extends into a caprock to the bottom of the sulphur deposit therein, the lower end of which is perforated with small holes. A four-inch pipe extends to within a short distance of the bottom. A one and one quarter-inch pipe carrying compressed air and reaching to within 200 feet of the bottom is in the center.

Superheated water, raised to about 330 degrees Fahrenheit under pressure, is forced down the space between the eight-inch and four-inch pipes and flows out the holes into the sulphur deposit. The sulphur melts and sinks to the bottom of the well. It is then forced several hundred feet up the four-inch pipe by the pressure of the water above in the rock formation. Compressed air forced down the smallest pipe lifts the sulphur to the surface, where it is discharged into steam-heated vats at central points called relay stations.

The rate of withdrawal of sulphur must be closely regulated so that the bottom of the well is "sealed" with molten sulphur, for if the rate is too high, the level of the pool falls and water enters the sulphur withdrawal line. Since this water is at a temperature of about 300° F., reduction of the pressure on the mixture of water and sulphur in the discharge line causes the water to flash to steam, thereby extracting heat from the sulphur and forming a mixture of air, water, steam, solid sulphur and liquid sulphur. This is known as "blowing."

The variations in mine formations and difficulties in operation of the sulphur wells make it impossible to avoid the presence on occasions of varying amounts of water in the fluid stream. Heretofore, only a low grade of sulphur could be recovered from such water-containing streams, and the recovery of this sulphur involved diversion of the stream into a cooling and settling basin known as a "blow box." The expense of recovery in this way has been very high.

Accordingly, it is an object of this invention to provide a method, together with apparatus for practicing it, capable of efficiently separating molten sulphur from the air used in lifting the same and from any water which may unavoidably be present due to blowing or due to leakage of water through the sulphur-conducting pipe in the well.

It is another object of the invention to provide a method and apparatus which not only effects the efficient recovery of sulphur from the fluid streams flowing from the wells, but also permits the adoption of improved techniques in mining and handling the separated sulphur.

A further object of the invention is to provide a method and apparatus for separating sulphur of high grade from water-containing, molten sulphur-air streams flowing from sulphur wells.

Still another object of the invention is to provide a method and apparatus by which the rate of production from a mine may be increased without adding to the cost of sulphur.

Yet another object of the invention is to provide a method and apparatus in which the efficient recovery of sulphur from fluid streams cannot be seriously interfered with by fire.

It has now been found that it is possible to bring about a highly advantageous separation of sulphur from a fluid stream flowing from a sulphur mine and containing sulphur and gas, and also varying proportions of water either intermittently or continuously, by passing such a stream into a columnar separation zone in which it will undergo at least a partial gravimetric separation of its constituents and simultaneously discharging separated gas upwardly from the separation zone, settling sulphur from the same zone and, when present, collecting separated water in a liquid body separate from the settled sulphur. By performing these operations in an enclosed space in which separated constituents are collected in supernatant layers, it is possible to raise the separation of sulphur to a high degree of perfection.

It has also been found that a separation of the nature described can be maintained continuously with high efficiency by carrying out the operations in a pressure vessel under conditions of high temperature at which the sulphur content of the incoming fluid stream is kept molten, and under a suitable superatmospheric pressure. Indeed, the constituents of the inflowing fluid stream can be separated conveniently at a temperature approximating the temperature at which the stream flows from the well. Under these conditions, the separated water and sulphur in the pressure vessel can be excluded from objectionable contact with air, the formation of water-sulphur emulsions and solid sulphur froth particles can be largely or entirely avoided, and the freezing of sulphur in the separator as well as other obstruction of it by the sulphur content can be prevented.

Another important feature of the invention resides in conducting the water separated in the columnar separation zone away from that zone at a location above the layer of settled sulphur that collects in the bottom of the separator or pressure vessel so that the actively flowing water and settled sulphur do not intermix in such a manner as would promote the formation of objectionable sulphur-water emulsions.

By providing apertures in the side walls of an upright hollow member forming the columnar zone, the water separated from the fluid in the zone may be passed laterally outward into the supernatant water layer. It is also possible to adjust the height of the hollow member so that the separated water in whole or in part flows over the top end thereof.

Still another important feature of the invention resides in extending the lower end of the columnar zone into the settled sulphur layer collected at the bottom of the pressure vessel, so that sulphur being settled from the fluid in the columnar zone may pass directly into the sulphur layer, thus preventing the formation of water-sulphur emulsions that would arise from the agitation induced by passage through a portion of the supernatant layer.

A further important feature of the invention resides in conducting water separated in the columnar zone into a considerable body or layer of water maintained within the enclosed space or pressure vessel over a layer of settled sulphur maintained therein, so that sulphur particles suspended or otherwise carried by the separated water can settle from the water layer into the sulphur layer before the water is discharged from the separator.

The invention also provides means for automatically discharging fluids from the supernatant layers in the pressure vessel such that a constant superatmospheric pressure (variable if desired) and constant liquid levels are maintained in the pressure vessel. An automatic pressure valve has been provided for a gas outlet which permits the outward flow of gas whenever the pressure exceeds a predetermined amount. Valves in the sulphur layer and water layer outlet conduits are controlled by liquid level responsive means including floats which act to open and close the respective valves as the upper surfaces of the sulphur layer and the water rise above and fall below predetermined levels. The level at which the sulphur layer outlet discharges is located above the lower end of the hollow member such that sulphur settling out of the fluid in the columnar zone passes directly into the sulphur layer.

It has also been found that the separating rate of the new method and apparatus can be enhanced by effecting a partial stratification of the constituents of the fluid stream into supernatant layers before it is received in the columnar zone. This operation can be simply carried out by initially passing the fluid stream from the pipe leading from the well through a horizontal chamber of increased diameter connected to the upright hollow member within the pressure vessel.

It has also been found possible to reduce to a minimum the interference caused by fires in the separator. This has been accomplished by installing a temperature responsive means in the enclosed space or pressure vessel, which is effective upon a rise in temperature in the enclosed space to interrupt automatically the air injection into the upcoming sulphur stream. By this method, the source of air on which such a fire would feed is cut off and the fire is quickly extinguished through smothering before any material damage occurs to the apparatus.

The operation of the improved method and a suitable apparatus for carrying it out may best be understood from a consideration of the accompanying drawing, which illustrates diagrammatically and in cross-section a preferred manner of practicing the invention.

Referring to the drawing in greater detail, a sulphur well is shown as including a protective pipe **1** extending downward through an unconsolidated formation **2** into the upper surface of a barren caprock **3**. The protective pipe encompasses the upper end of a pipe **10** extending down through caprock and through a sulphur bearing formation **5** beneath it into the upper surface of a barren rock **6**.

The pipe **10** has a plurality of apertures **11** above its lower end to provide for the flow of water laterally outward of the pipe and has an additional series of holes **12** substantially at the bottom to provide for the inward flow of molten sulphur, the two groups of holes being separated by a plate or plug **13**. Disposed interiorly of the outer pipe **10** is a pipe **14** for conducting molten sulphur from the pool in the sulphur bearing formation **5** and the chamber below the plate **13** to the surface, which pipe terminates below the plate **13**. Mounted interiorly of the pipe **14** is a pipe **16** for the injection of air into the upcoming molten sulphur stream. The external pipe **10** is connected to a hot water inlet pipe **20** having a branch pipe **22** and valve **24** whereby water may temporarily be permitted to flow into the pipe **14** and into the well.

The sulphur conduit **14** at its sulphur discharge end is connected to a separator, generally indicated at **26**, which includes a pressure vessel **28** containing a vertical hollow or columnar member **30** communicating with a horizontal chamber **32** connected to the molten sulphur conduit **14** through valve **34**, said chamber being of larger diameter than the pipe **14**. The horizontal chamber **32** has a steam jacket **36** to prevent the molten sulphur from solidifying. The fluid stream containing molten sulphur, air and any water leaking into the sulphur stream passes through the horizontal chamber **32** where it undergoes a partial stratification into its constituents, after which it is discharged into the vertical hollow member **30** in which it undergoes a further gravimetric separation and from which the separated gas is discharged through the open upper end while the sulphur for the most part is settled through the open bottom end, and any water present flows through apertures **38** formed in the side wall of the hollow member **30** and/or over the upper end of the hollow member.

The pressure vessel **28** collects the fluids being discharged by the hollow member **30** in supernatant layers in zones **40**, **42** and **44**, respectively, of gas, water, and sulphur. Outlets are provided in the side wall of the vessel **28** to communicate with each of these zones and these include a valve controlled outlet **46** for the gas layer, a valve controlled outlet **48** for the water layer and a valve controlled outlet **50** for the sulphur layer. Whenever the fluid stream containing molten sulphur and gas is lacking in water, the water gradually evaporates from the vessel and the gas layer occupies zones **40** and **42**.

An automatic pressure responsive means **52** is provided to control the flow of gas through the gas layer outlet valve **46** so as to maintain a constant superatmospheric pressure in the pressure vessel **28**, which pressure is built up by the forceful discharge of the fluid stream into the vessel. The gas layer is maintained under a superatmospheric pressure sufficient to prevent boiling of water at the temperature of molten sulphur. The maintenance of this pressure prevents the formation of sulphur-water emulsions and solid sulphur froth particles, and prevents cooling and solidification of the sulphur in the sulphur layer. The automatic pressure responsive means may be of any suitable type but is preferably of the diaphragm type.

The flow of liquid from the water layer, if present, and the sulphur layer is automatically controlled through a liquid level responsive means connected to the respective valved outlets **48** and **50** and these may be of any commercial type provided with floats. The liquid level responsive means **53** for the water layer is mounted on the top of the pressure vessel and includes a float **56** extending approximately one-third of the distance downward into the pressure vessel. The liquid level responsive means **53** acts to open and close the valved outlet **48** as the float **56** rises above and falls below a predetermined level between the upper and lower ends of the hollow member.

The liquid level responsive means **54** for the sulphur layer outlet includes a float **58** extending approximately to the lower end of the hollow member **30**, which acts to open and close the sulphur layer outlet valve **50** as the surface of the sulphur layer rises above and falls below a predetermined level slightly above the lower end of the hollow member **30**.

The pressure vessel is provided with a temperature sensitive means operative automatically to cut off the injection of air into the upcoming sulphur stream upon the occurrence of a fire in the vessel. A temperature bulb **60** is mounted in the upper portion of the pressure vessel, and protrudes into the upper zone **40** therein. This bulb **60** communicates with a three-way pilot valve **62** interposed in an air supply duct **64** communicating with a control valve **66** in the air injection pipe **16**. Upon an abnormal rise of temperature in the gas layer zone of the separator due to fire, the temperature bulb **60** effects movement of the pilot valve **62** so as to cause the control valve **66** to stop the air flow in the injection pipe **16**. The lack of air will quickly extinguish the fire in the separator.

Since the sulphur separator **26** may be subjected to sudden increases in pressure beyond the capacity of the gas outlet **46** which would tend to rupture the pressure vessel, a safety valve to prevent such excessive pressure is provided which may take the form of a rupture diaphragm **70** mounted in the top of the pressure vessel, or alternatively, a steam-jacketed relief valve (not shown) similarly mounted.

The interior surface of the pressure vessel 28 has been provided with a lining 72 to insulate it and to protect the interior surface against corrosion. An efficient material of this type has been found to be Lumnite cement, though other high temperature Portland cements have also been satisfactorily employed.

In order to insure that the sulphur in the pressure vessel will retain its molten state it has usually been found desirable to provide for the heating of the pressure vessel, as by a steam blister coil 74, formed on the exterior surface of the pressure vessel.

The lower end of the pressure vessel is provided with a drain valve 76 to permit the discharge of the fluids in the separator when repair and maintenance are necessary.

The apparatus is operated as follows:

In starting the well operation, hot water under pressure and at a temperature of 275–330° F. is injected from pipe 20 downwards in the space formed between the outer pipe 10 and the sulphur conduit 14 and is also forced through pipe 22 and valve 24 and through the sulphur conduit 14 into the mine, valve 34 having been closed. When a sufficient amount of sulphur has been melted around the well to begin recovery operations, the valve 24 is closed, valve 34 is opened and air is injected into the sulphur conduit 14 from the lower end of the pipe 16 to assist the flow of sulphur and water upwards in the pipe 14. The upflowing fluid stream passes through the valve 34 into the enlarged horizontal chamber 32 where a reduced velocity effects a partial stratification of the fluid stream into gas and sulphur layers and a water layer when such liquid is present. The partially stratified fluid stream then passes into the vertical hollow member 30 wherein it undergoes a further gravimetric separation, the gas discharging upwardly from the upper end thereof, the sulphur settling downward from the lower end thereof, and the water passing laterally outward through the apertures 38 and/or over the upper end of the hollow member. When the gas pressure exceeds the predetermined amount necessary to prevent boiling of the water at the temperature of the molten sulphur in the vessel, the automatic pressure responsive means 52 permits flow of gas through the control valve 46 and a constant superatmospheric pressure is maintained in the vessel. As the sulphur layer surface exceeds a predetermined level above the lower end of the hollow member 30, the float 58 of the liquid level responsive means 54 actuates the valve 50 and brings about the discharge of molten sulphur from the pressure vessel with the aid of the superatmospheric pressure of the gas layer 40 until the level of the sulphur layer falls to its predetermined level. The liquid level responsive means 53 opens and closes the valved outlet 48 when the surface of the water layer moves the float 56 above and back to its predetermined level. A conduit (not shown) may be provided to carry away the water to a point of disposal.

It will be observed that in normal operation sulphur settling from the lower end of the hollow member 30 passes directly into the sulphur layer 44, thus avoiding any contact with the water layer, if present, and the consequent formation of an emulsion with water. Any water leaving the hollow member 30 does not pass through the sulphur layer and thus also does not form an emulsion with the sulphur. By restricting the flow of separated gas from the pressure vessel, the water in the vessel is prevented from boiling although it is at the temperature of the molten sulphur. Due to these controls, the formation of water-sulphur emulsions and solid sulphur froth particles is largely or entirely avoided and heat loss is prevented.

It will be further observed that the operation of the separator is independent of the amount of water present in the fluid stream. When no water is present, the sulphur is effectively separated from the air or gas. When water suddenly appears in the sulphur-air stream due to blowing or leakage, the apparatus in the sulphur-air stream due to blowing or leakage, the apparatus automatically adjusts itself thereto and separates the water as well as the gas in the manner hereinbefore described. When no water is present in the separator, the water layer is merely replaced by an enlargement of the gas layer.

By the use of this invention, a sulphur-water-air separator can be installed at each well head in a sulphur field for completely automatic operation, and the sulphur produced by the several separators can be metered and then discharged into a common collecting line that takes the sulphur to a single relay station for the entire field. This effects a considerable saving in sulphur line initial cost and maintenance over the old type of field installation wherein after separating part of the air from the air-sulphur stream at each well head it was still necessary to conduct the remainder of the discharge from each well by separate piping to its respective air-sulphur separator at one of a number of relay stations for close supervision to enable diversion of the stream into a "blowbox" should water appear, and also for the metering of the produced sulphur before it could be discharged into a common sulphur collector.

Since excessive care for avoiding blowing does not have to be exercised, the use of this invention permits the injection of more heat through the medium of hot water to melt the sulphur, thus enabling wells to produce at higher sulphur rates and cutting down the time necessary to establish efficient new wells. Through the use of the improved method and apparatus it is possible to operate wells that heretofore have been economically unsound because of excessive water in the molten sulphur.

The improved method and apparatus eliminates to a considerable extent the violent surging well pressures to which low production rate wells having small sulphur pools formerly were subject. At low production rates violent surging of sulphur flow occurs due to the nature of the air lift resulting in varying pressures at the well head which tend to increase the violence. By maintaining a constant pressure at the well head, this violence is reduced, and there is less likelihood of the "seal" at the bottom of the well being broken.

While there has been described specific procedure and apparatus for carrying out the invention, together with some of the variations which may be made in the form of the apparatus and the manner of operation, other modifications within the spirit of the invention will be apparent to a person skilled in the art. It is, therefore, desired that the invention be accorded a scope fully commensurate with the spirit of the specification and the requirements of the claims without restriction to non-essential details.

Under some conditions it may be preferable to locate the separator at the relay instead of on the well head, with the sulphur wells not normally connected to the separator. As wells are blowing or sealing, they can be shifted to the separator, and the formation of off-grade sulphur eliminated.

We claim:

1. In a process for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, the steps comprising continuously delivering the fluid stream into a columnar separation zone, maintaining the fluid in said zone at a temperature at which the sulphur is molten and under superatmospheric pressure sufficient to prevent boiling of the water content, continuously separating gas from the fluid in the columnar zone and discharging it upwardly therefrom, continuously separating sulphur from the fluid in the columnar zone and discharging it downwardly therefrom, and continuously conducting any water separated from the fluid in the columnar zone out of said zone.

2. In a process for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, the steps comprising continuously delivering the fluid stream into a columnar separation zone,

maintaining the fluid in said zone at a temperature at which the sulphur is molten and under superatmospheric pressure sufficient to prevent boiling of the water content, continuously separating gas from the fluid in the columnar zone and discharging it upwardly therefrom, continuously separating sulphur from the fluid in the columnar zone and discharging it therefrom downwardly in a condition substantially free of water, continuously conducting any separated water with entrained sulphur out of said zone directly into a water layer between adjacent fluid layers respectively containing separated gas and separated sulphur, and settling sulphur from said water layer into the layer containing separated sulphur.

3. In a process for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, the steps which comprise conducting the stream into a columnar separation zone within an enclosed collection area, maintaining the fluid in said area at a temperature at which the sulphur is molten and under superatmospheric pressure sufficient to prevent boiling of the water content, separating the constituents of the stream in said columnar zone by settling, and conducting the separated constituents from the columnar zone into corresponding supernatant layers within said area.

4. In a process for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, the steps which comprise conducting the stream under pressure into a columnar separation zone within an enclosed collection area, maintaining the fluid in said area at a temperature at which the sulphur is molten and under superatmospheric pressure sufficient to prevent boiling of the water content, gravimetrically separating constituents of the stream in said zone, conducting separated constituents from the columnar zone into corresponding supernatant layers within said area, discharging gas from the gas layer so as to maintain a substantially constant superatmospheric pressure within said collection area, discharging sulphur from the molten sulphur layer so as to maintain the upper surface of the same at a predetermined level above the lower end of the columnar zone, and discharging water from the water layer whenever the water rises to a predetermined level in said area.

5. In a process for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, the steps which comprise partially stratifying the fluid stream, further separating constituents of the partially stratified fluid by passing it continuously into a columnar separation zone, maintaining the fluid in said zone at a temperature at which the sulphur is molten and under superatmospheric pressure sufficient to prevent boiling of the water content, continuously discharging gas separated from the fluid in said zone upwardly from the zone, continuously discharging sulphur separated from the fluid in said zone downwardly from the zone, and continuously conducting any water separated from the fluid in the columnar zone out of said zone.

6. In a process for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, the steps comprising partially stratifying the fluid stream, further separating constituents of the partially stratified fluid by passing it continuously into a columnar separation zone, maintaining the fluid in said zone at a temperature at which the sulphur is molten and under superatmospheric pressure sufficient to prevent boiling of the water content, continuously discharging gas separated from the fluid in said zone upwardly from said zone, continuously discharging sulphur separated from the fluid in said zone downwardly from the zone, conducting any water present in the separated fluid out of said zone, collecting the discharged constituents in corresponding supernatant layers, and further separating sulphur out of the water layer when present by settling it into the sulphur layer.

7. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes also water, the combination comprising, means defining a columnar zone for separating the constituents of the stream, means associated with said columnar zone means for continuously delivering the fluid stream into said columnar zone, said columnar zone having (1) means for continuously discharging upwardly gas separated from fluid in said zone, (2) means for continuously discharging downwardly sulphur separated from the fluid in said zone, and (3) means for continuously conducting any water separated from the fluid in said columnar zone out of said zone, means for heating the contents of said zone and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said zone at a level preventing vaporization of water therein.

8. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, the combination comprising, means defining a columnar separation zone for separating the constituents of the stream, means associated with said columnar zone means for continuously delivering the fluid stream into said columnar zone, said columnar zone having (1) means for continuously discharging upwardly gas separated from the fluid in said zone, (2) means for continuously discharging downwardly sulphur separated from the fluid in said zone, and (3) means for continuously conducting any water separated from the fluid in said columnar zone out of said zone, means for heating the contents of said zone and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said zone at a level preventing vaporization of water therein, and means associated with said columnar zone means for collecting the discharged constituents in supernatant layers respectively of gas, water, and sulphur and enabling the settling of any sulphur in the supernatant water layer thereout into the sulphur layer.

9. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, the combination comprising, means defining a columnar separation zone for separating the constituents of the stream, means associated with said columnar zone means for continuously delivering the fluid stream into said columnar zone, said columnar zone having (1) means for continuously discharging upwardly gas separated from the fluid in said zone, (2) means for continuously discharging downwardly sulphur separated from the fluid in said zone, and (3) means for continuously conducting any water separated from the fluid in said columnar zone out of said zone, means associated with said columnar zone means for collecting the discharged constituents in supernatant layers respectively of gas, water, and sulphur and enabling the settling of any sulphur in the supernatant water layer thereout into the sulphur layer, means for maintaining the sulphur in said apparatus at molten temperatures means associated with the collecting means for automatically discharging gas from the gas layer so as to maintain a substantially constant superatmospheric pressure within said collecting means, means associated with the collecting means for discharging sulphur from the molten sulphur layer so as to maintain the upper surface of the same at a predetermined level above the lower end of the columnar zone, and means associated with said collecting means for discharging water from the water layer whenever the water rises to a predetermined level in said collecting means.

10. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes also water, means to partially stratify the fluid stream, means defining a columnar zone associated with said stratifying means for continuously receiving and separating constituents of the partially stratified fluid, said columnar zone having (1) means for continuously

discharging upwardly gas separated from the fluid in said zone, (2) means for continuously discharging downwardly sulphur separated from the fluid in said zone, and (3) means for conducting any water separated from the fluid in said columnar zone out of said zone, means for heating the contents of said zone and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said zone at a level preventing vaporization of water therein, and means associated with said columnar zone means for collecting the discharged constituents in supernatant layers respectively of gas, water and sulphur and enabling the settling of any sulphur in the supernatant water layer thereout into the sulphur layer.

11. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes also water, means to partially stratify the fluid stream, means defining a columnar zone associated with said stratifying means for continuously receiving and separating constituents of the partially stratified fluid, said columnar zone having (1) means for continuously discharging upwardly gas separated from the fluid in said zone, (2) means for continuously discharging downwardly sulphur separated from the fluid in said zone, and (3) means for conducting any water separated from the fluid in said columnar zone out of said zone, means associated with said columnar zone means for collecting the discharged constituents in supernatant layers respectively of gas, water, and sulphur and enabling the settling of any sulphur in the supernatant water layer thereout into the sulphur layer, means for maintaining the sulphur in said apparatus at molten temperatures, means associated with the collecting means for automatically discharging gas from the gas layer so as to maintain a substantially constant superatmospheric pressure within said collecting means, means associated with the collecting means for discharging sulphur from the molten sulphur layer so as to maintain the upper surface of the same at a predetermined level above the lower end of the columnar zone, and means associated with said collecting means for discharging water from the water layer whenever the water rises to a predetermined level in said collecting means.

12. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, an upright hollow member to receive the fluid stream and induce gravimetric separation of its constituents, said hollow member being open at both ends, an inlet conduit connected to said member, a pressure vessel surrounding the hollow member and directly communicating with said open ends, said vessel serving to collect separated sulphur, gas and any water present in corresponding supernatant layers, and a plurality of vertically spaced outlets from said vessel including at least one outlet to communicate with each of said layers, means for heating the contents of said vessel and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said vessel at a level preventing vaporization of water therein.

13. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, an upright open-ended hollow member to receive the fluid stream and induce gravimetric separation of its constituents, an inlet conduit connected to said member, a pressure vessel surrounding and directly communicating with the hollow member and to collect the separated sulphur, gas and any water present in supernatant layers, and a plurality of vertically spaced outlets from said vessel including at least one outlet to communicate with each of said layers, the water layer outlet being spaced above the lower end of said hollow member such that the upper surface of the sulphur layer may be maintained above the lower end of the hollow member, means for heating the contents of said vessel and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said vessel at a level preventing vaporization of water therein.

14. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, an upright open-ended hollow member to receive the fluid stream and induce gravimetric separation of its constituents, an inlet conduit connected to said member, a pressure vessel surrounding the hollow member and in direct communication therewith and to collect the separated constituents in zones containing respectively sulphur, water if present, and gas, and a plurality of vertically spaced outlets from said vessel including at least one outlet to communicate with each of said zones, said hollow member being so positioned in the vessel that its lower end extends into the sulphur zone and terminates above the bottom of said vessel, means for heating the contents of said vessel and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said vessel at a level preventing vaporization of water therein.

15. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, an upright open-ended hollow member to receive the fluid stream and induce gravimetric separation of its constituents, an inlet conduit connected to said member, a pressure vessel surrounding and directly communicating with the hollow member, said vessel serving to collect separated sulphur, water if present, and gas in supernatant layers, and a plurality of vertically spaced outlets from said vessel including at least one outlet to communicate with each of said layers, the gas layer outlet being provided with an automatic pressure relief valve to control the flow therethrough so as to maintain a constant superatmospheric pressure in the vessel, means for heating the contents of said vessel and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said vessel at a level preventing vaporization of water therein.

16. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, an upright open-ended hollow member to receive the fluid stream and induce gravimetric separation of its constituents, an inlet conduit connected to said member, a pressure vessel surrounding and directly communicating with the hollow member, said vessel serving to collect separated sulphur, water if present, and gas in supernatant layers, a plurality of vertically spaced outlets from said vessel including at least one outlet to communicate with each of said layers, and liquid level responsive means associated with the interior of said vessel to control the flow from the sulphur layer outlet so as to maintain the sulphur layer surface above the lower edge of the hollow member, means for heating the contents of said vessel and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said vessel at a level preventing vaporization of water therein.

17. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, an upright open-ended hollow member to receive the fluid stream and induce gravimetric separation of its constituents, an inlet conduit connected to said member, a pressure vessel surrounding and directly communicating with the hollow member, said vessel serving to collect separated sulphur, water if present, and gas in supernatant layers, a plurality of vertically spaced outlets from said vessel including at least one outlet to communicate with each of said layers, a valve for each of said outlets, means responsive to the sulphur layer surface level in said vessel to control the flow from the sulphur layer outlet, means responsive to the water layer surface level to control the flow from the water layer outlet, and means responsive to the gas pressure in said vessel to control the flow from the gas layer outlet so as to maintain a constant superatmospheric pressure within said vessel, means for heating the contents of said vessel and for maintaining the sulphur in molten

condition, and means for maintaining superatmospheric pressure in said vessel at a level preventing vaporization of water therein.

18. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, an upright open-ended hollow member to receive the fluid stream and induce gravimetric separation of its constituents, an inlet conduit connected to said member, a pressure vessel surrounding and directly communicating with the hollow member wherein separated sulphur, gas and any water present in supernatant layers are collected, a plurality of vertically spaced outlets from said vessel including at least one outlet to communicate with each of said layers, the water layer outlet being spaced above the lower end of said hollow member so that the upper surface of the sulphur layer may be maintained above the lower end of the hollow member, a valve for each of said outlets, liquid level responsive means including a float extending down from the top of the vessel for opening and closing the sulphur layer valve as the sulphur layer surface rises above and falls below a predetermined level above the lower end of the hollow member, liquid level responsive means including a float extending down from the top of the vessel for opening and closing the water layer valve as the upper water layer surface rises above and falls below a predetermined level, and a means responsive to the gas pressure in said vessel to control the flow from the gas layer outlet so as to maintain a constant superatmospheric pressure within said vessel, means for heating the contents of said vessel and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said vessel at a level preventing vaporization of water therein.

19. In an apparatus for continuously separating sulphur from a fluid stream containing molten sulphur, gas and sometimes water, a generally horizontal chamber for conducting said fluid stream while effecting a partial separation of the constituents into supernatant layers, an upright hollow member having open ends directly communicating with the area surrounding said member, said member being associated with said horizontal chamber to receive the partially separated fluid stream and induce further gravimetric separation of its constituents, a pressure vessel completely encompassing the hollow member thereby providing a zone for collecting the separated sulphur, water if present, and gas in supernatant layers as the said components leave said hollow member, and a plurality of vertically spaced outlets from said vessel including at least one outlet to communicate with each of said layers, means for heating the contents of said vessel and for maintaining the sulphur in molten condition, and means for maintaining superatmospheric pressure in said vessel at a level preventing vaporization of water therein.

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