May 6, 1952 R. T. BRAUN 2,595,447

METHOD OF VAPORIZING AND BURNING SULFUR

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FIG. 1.

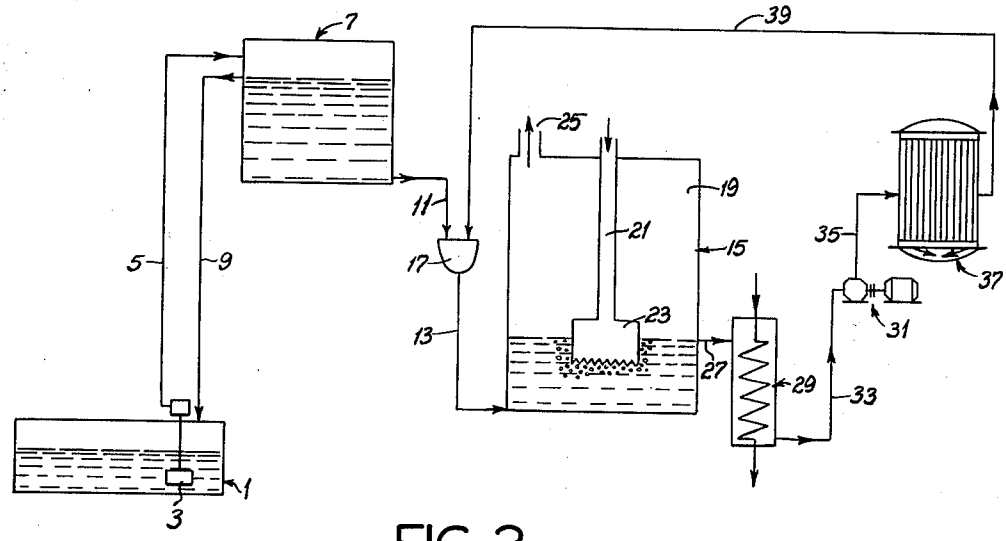

FIG. 2.

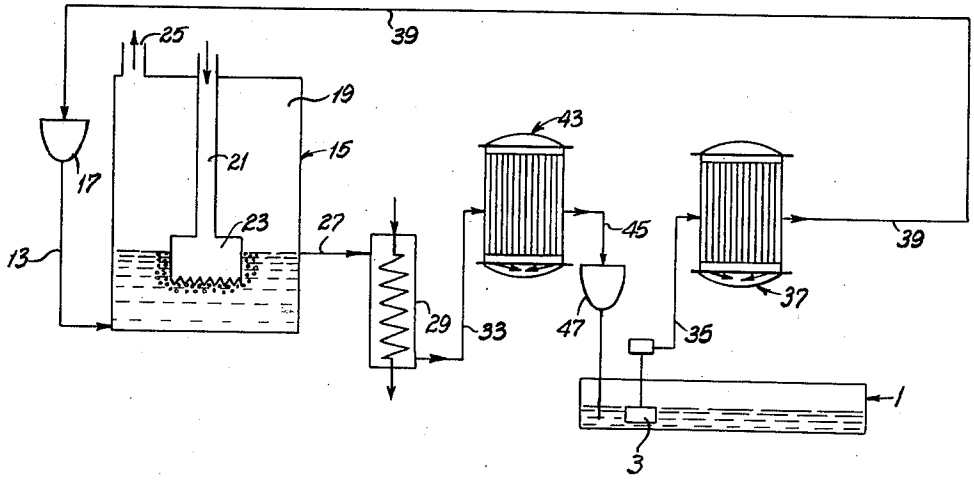

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FIG. 3.

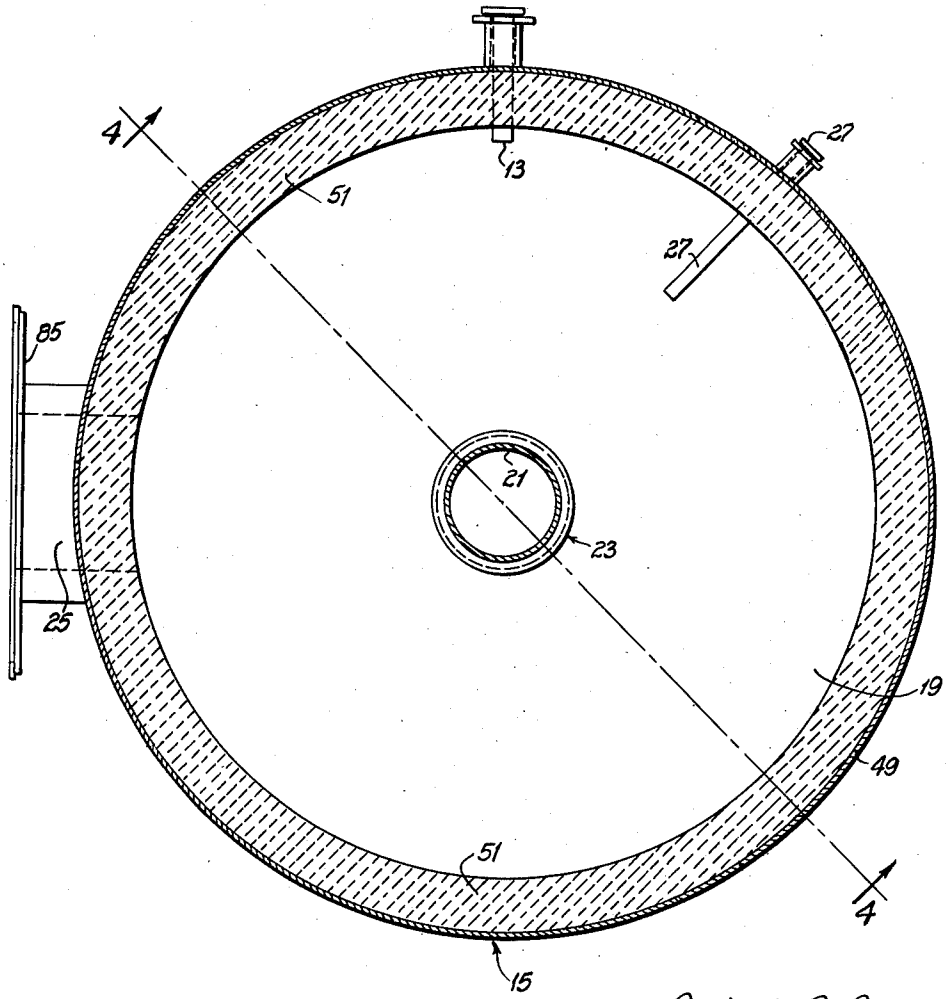

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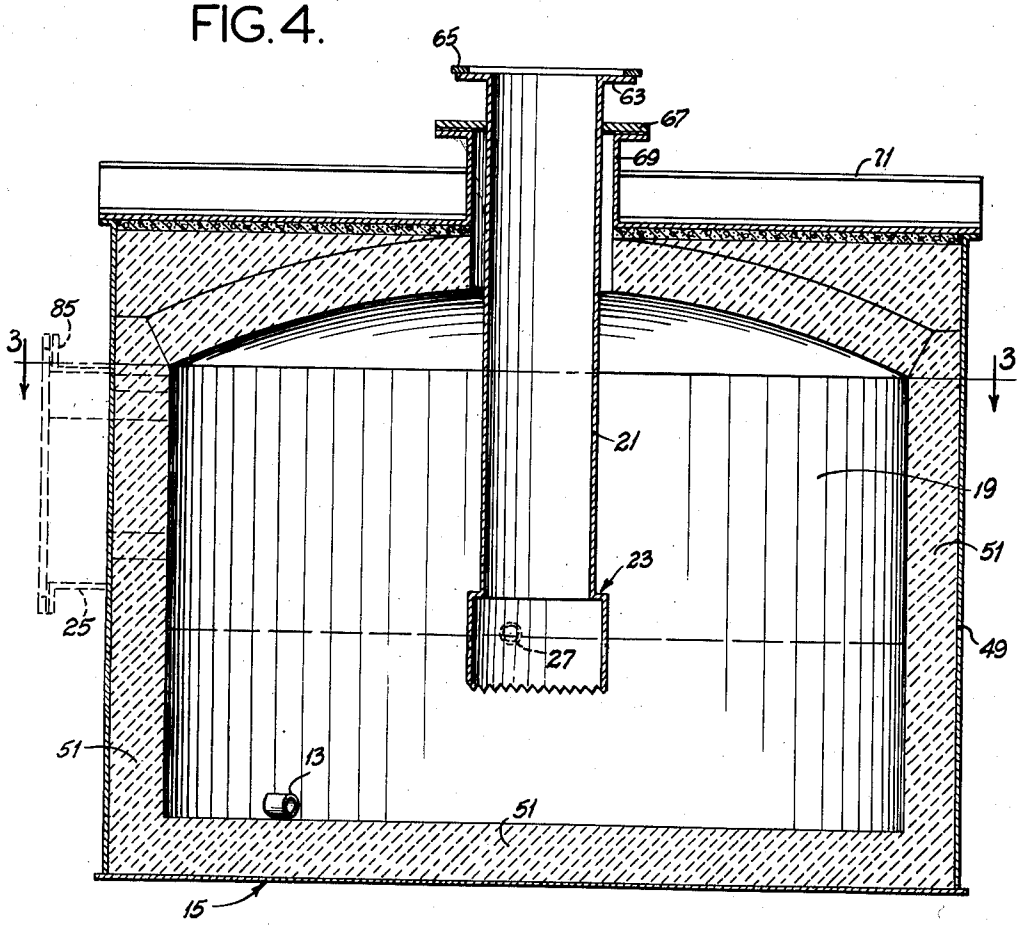
FIG. 4.



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METHOD OF VAPORIZING AND BURNING SULFUR

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6 Claims. (Cl. 23—179)

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This invention relates to sulfur burners and more particularly to continuous sulfur vaporizer and burner systems.

Among the several objects of this invention are the provision of sulfur vaporizer and burner systems for producing gas containing sulfur dioxide and vapor phase sulfur relatively free from impurities; the provision of systems of the type referred to which give increased yields of sulfur dioxide and vapor phase sulfur; the provision of sulfur vaporizer and burner systems which render possible closer control of effluent gas concentrations, and the provision of sulfur vaporizer and burner systems of the class described which effect a substantial increase in operating efficiency and unit production. Other objects will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, steps and sequence of steps, features of construction and manipulation, and arrangements of parts which will be exemplified in the structures and methods hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which several of the various possible embodiments of the invention are illustrated:

Fig. 1 is a flow diagram of a sulfur vaporizer and burner system of the present invention;

Fig. 2 is a flow diagram of an alternative embodiment of a sulfur vaporizer and burner system of the present invention;

Fig. 3 is a horizontal sectional view taken along line 3—3 on Fig. 4; and

Fig. 4 is a vertical cross section taken along line 4—4 on Fig. 3.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

Commercial grade sulfur, such as that obtained by the Frasch process, normally contains inorganic and organic impurities. These impurities, although usually present in only small percentages, are sufficient to contaminate effluent gases from sulfur burner systems, often to such a degree as to render these gases undesirable for many purposes. Increasing amounts of impurities in the body of molten sulfur due to the removal of vaporized sulfur cause greater quantities of the contaminants to be carried in the effluent gases. One of the primary uses of sulful dioxide is in the conversion of sulfur dioxide to sulfur trioxide in the contact process for

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manufacturing sulfuric acid. It is of importance in this process as well as in many other processes that the gases be subtantially dust and impurity free.

Various methods have been utilized in the past for production of a purified effluent gas from sulfur burners, including purifying the gaseous reaction products or purifying the sulfur that will later be vaporized and burned. There are numerous difficulties with these methods and the apparatus utilized to effect them. One expedient frequently used to obtain effluent gases of high purity is to shut down from time to time and manually clean out the apparatus. Another is to draw off periodically and discard the sulfur then in the vaporizer burner. Both procedures are uneconomical because the impure sulfur so withdrawn or cleaned out normally contains 90% or more sulfur. However, burning sulfur even with such a small proportion of impurities present is impossible without seriously contaminating the gaseous reaction products and in a relatively short time destroying the efficiency of a contact catalyst or increasing the resistance of the system to gas flow.

In accordance with the present invention a sulfur burner system has been devised which efficiently produces effluent gas of high purity. Intermittent manual clean-out operations, hot gas filters and other purification arrangements are eliminated, together with the expense associated therewith. It has been found that by continuously withdrawing at or near the surface of a body of molten sulfur a small portion of the sulfur being vaporized and burned, purifying this portion and returning this purified portion to the body of molten sulfur after purification, the percentage of impurities in the molten sulfur body may be conveniently maintained below a level which will unduly contaminate the effluent gas.

Referring now to Fig. 1, there is indicated generally at numeral 1 a sulfur melting pit. Solid sulfur may be charged into this pit either continuously or intermittently. Melted sulfur from pit 1 is forced by means of a pump 3 through a pipe 5 to a constant head feed tank 7. An overflow line 9 also connects tank 7 with pit 1. A feed line 11 serves to drain molten sulfur from the bottom of tank 7, through a pipe 13 to a sulfur vaporizer and burner unit 15 controlled by means of a feed control unit 17.

Sulfur vaporizer and burner unit 15 includes a volatilization chamber 19 of any conventional heat and sulfur resistant material such as brick; an air duct 21 having one extremity, which may

carry an injector head 23, submerged beneath the surface of the body of molten sulfur contained in the lower portion of chamber 19; an outlet 25 for gaseous reaction products leading to a conventional type combustion chamber (not shown); and, an outlet pipe 27. Pipe 27, located at the liquid level within chamber 19 serves to carry molten sulfur from unit 15 to a cooler 29. Any suitable cooling medium such as low pressure steam or molten sulfur from the sulfur pit 1 may be passed, if desired, through cooler 29 to cool the hot, molten, impurity-laden sulfur below the temperature range of high viscosity. The cooled and impure molten sulfur is sent by a pump 31 and pipes 33 and 35 to a purifier unit 37. This purifier may be of any customary type which will separate impurities from molten sulfur. It is preferred, however, to use a removable leaf type filter, such as manufactured by the Niagara Filter Corporation. A steam jacketed pipe 39 interconnects filter 37 and vaporizer unit 15 via feed control unit 17.

The operation is as follows:

Solid sulfur in any convenient shape or size is fed into tank 1 either intermittently or continuously, manually or mechanically. Tank 1 is maintained by any conventional heating arrangement at a temperature high enough to keep the sulfur liquid. The sulfur is transferred from pit 1 through line 5 to feed tank 7 by action of pump 3. The level of molten sulfur in tank 7 is maintained substantially constant at a predetermined level. The sulfur in tank 7 is maintained fluid by a sufficient supply of heat thereto. The amount of molten sulfur drained from tank 7 to unit 15 is effectively and simply controlled by control unit 17, which may be, for example, a valve.

The molten sulfur enters unit 15 through pipe 13 which may be positioned at any convenient height in the side wall of chamber 19. It is preferred, however, that pipe 13 enter chamber 19 at the bottom level of the chamber. Air under pressure is transmitted through duct 21 and dispersed through the foraminous undersurface of the injector head 23 into the top portion of the sulfur body, thus forming air bubbles which course upwardly through the sulfur toward the surface. The gaseous reaction products, including sulfur dioxide and vapor phase sulfur, are conducted out of unit 15 through outlet 25. This effluent gas comprising vapor phase sulfur and sulfur dioxide is fed into the customary type of combustion chamber (not shown) wherein the vapor phase sulfur is subjected to oxidation to convert it to sulfur dioxide.

Pump 31 continuously removes a portion of molten sulfur from the top surface of the sulfur mass in unit 15. The sulfur thus withdrawn is conducted through sulfur cooler 29 and filter 37 where impurities are removed. Purified sulfur is then carried through pipe 39 to unit 15, the flow thereof being easily and accurately controlled by feed control 17.

The removal of impure molten sulfur from the surface of the molten sulfur mass prevents the increase of impurities at the burning surface. Without removal of impure sulfur from unit 15 the amount of contaminants left behind when the molten sulfur vaporizes would rapidly increase and would be entrained in the gaseous effluent. The action of the air bubbles coursing upwardly through the sulfur mass tends to carry these impurities to the surface where their presence in the surface film or froth enhances the probability of their being carried into the vapor space of chamber 15 and thus out exit 25. The lighter impurities also tend to accumulate at the burning surface of the sulfur. By removal of the contaminated molten sulfur from the burning surface this area will be kept substantially pure. The effluent gas may be oxidized in a sulfur burner of any customary type (not shown) and sent to a catalyst converter (such as a vanadium pentoxide type) for conversion to sulfur trioxide and then to sulfuric acid in a contact type sulfuric acid plant, without the intermediate use of gas filters.

Fig. 2 represents an alternative embodiment of a sulfur vaporizer and burner system of the present invention. In this arrangement a portion of the contaminated molten sulfur is removed from the surface of the molten sulfur mass and thereafter cooled in cooler 29 as in the Fig. 1 system. However, the contaminants are removed by means of another purifying unit 43, similar to unit 37 described above, and the purified sulfur instead of being directly returned to vaporizer 15 is sent to melting pit 1 through a pipe 45 and a control unit 47 such as, for example, a valve. In this embodiment all the sulfur fed to the vaporizer 15 is filtered by purifier 37 immediately before introduction to chamber 19 through pipe 13. This eliminates any need for balancing two molten sulfur streams to unit 17. Pump 31 may be omitted in this system as well as the tank 7. Filter 43 may be omitted if desired and the impure sulfur fed directly from pipe 33 to control unit 47. The gaseous effluent containing vapor phase sulfur and sulfur dioxide is then oxidized by a sulfur burner of any customary type (not shown) which is connected to unit 15 by means of outlet 25.

Referring now more particularly to Figs. 3 and 4, there is indicated at numeral 15 the vaporizer and burner unit comprising a chamber 12, a steel shell 49 and a refractory lining 51. Air duct 21 is provided at its upper end with a flange 63 and a gasket 65 adapted to connect with an air blower unit (not shown) of any customary design. A collar 67 is affixed to duct 21 intermediate the foraminous injector head 23 and flange 63. A flange 69 affixed to shell 49 supports the duct assembly 21 on its upper surface. The roof of vaporizer 15 is reinforced by beams 71.

Pipe 27, projects into the interior of chamber 19. Inlet pipe 13 projects into chamber 19 at the bottom level thereof. Gas outlet 25 is provided with a flange 85 adapted to be connected by exterior ducts (not shown) to a sulfur burner (not shown) as described above.

The operation is as follows:

Molten sulfur is introduced into chamber 19 and its level is maintained constant at the elevation of pipe 27 by means of control 17. Air is forced downward through duct 21 and introduced into the molten sulfur body through injector head 23. The effluent gas containing vapor phase sulfur and sulfur dioxide is conducted out of the vapor space of chamber 19 through exit 25, and contaminated sulfur is removed from the molten sulfur surface by pipe 27.

Organic as well as inorganic impurities in the molten sulfur body in unit 15 are thus maintained at a concentration where the gaseous sulfur dioxide and vapor phase sulfur effluent from outlet 25 is substantially free from contaminants which would otherwise be present. By use of the sulfur burner and vaporizer systems of the present invention the amount of the impurities or contaminants present in the vaporizer and burner unit 15 are maintained below a level of approxi-

mately 0.1%. The effluent gas may be further oxidized in the customary way to convert vapor phase sulfur to sulfur dioxide. This sulfur dioxide gas is of such purity that a hot gas filter may be dispensed with entirely and the gas stream used as the feed for a contact sulfuric acid plant.

The systems of the present invention also increase the overall efficiency due to the elimination of periodic shut downs. Moreover, loss of sulfur discarded in the purification step is minimized, a saving in power is obtained due to the elimination of the hot gas filter and the elimination of plugging of the filter and catalyst beds by solid contaminants in the gases, and closer control is secured over vaporizing and burning of sulfur as well as over effluent gas concentration.

It is to be understood that arrangements other than those shown in the drawings for maintaining the molten sulfur in vaporizer unit 15 at any desired constant level may be employed. Further, it is to be noted that purifying units other than leaf type filters may be employed.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above constructions and methods without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. The method of vaporizing and burning sulfur comprising bubbling air into an upper portion of a mass of molten sulfur in a volatilization chamber, continuously removing gaseous effluent comprising vapor phase sulfur and sulfur dioxide therefrom, said air aiding in the carrying of impurities in said sulfur mass to the surface thereof, continuously removing a portion of said molten sulfur from the surface of said sulfur mass, purifying said portion out of gaseous communication with said chamber, and returning said purified portion to said molten sulfur mass.

2. The method of vaporizing and burning sulfur comprising bubbling air through an upper portion of a mass of molten sulfur in a volatilization chamber, continuously removing the gaseous effluent comprising vapor phase sulfur and sulfur dioxide therefrom, said air aiding in the carrying of impurities in said sulfur mass to the upper portion of said sulfur mass, continuously removing a fraction of the upper molten sulfur portion, purifying said fraction by filtration out of gaseous communication with said chamber, and returning said purified portion to said molten sulfur mass.

3. The method of vaporizing and burning sulfur comprising feeding molten sulfur into a lower portion of a mass of molten sulfur in a volatilization chamber, bubbling air through an upper portion of said sulfur mass, removing the gaseous effluent comprising vapor phase sulfur and sulfur dioxide therefrom, said air aiding in the carrying of impurites in said sulfur mass to the upper portion of the sulfur mass, continuously removing a fraction of the upper molten sulfur portion, purifying said fraction

out of gaseous communication with said chamber, and returning said purified portion to said molten sulfur mass.

4. The method of vaporizing and burning sulfur comprising continuously feeding molten sulfur into a lower portion of a mass of molten sulfur in a volatilization chamber, continuously bubbling air through an upper portion of said sulfur mass, continuously removing the gaseous vapor phase sulfur and sulfur dioxide effluent therefrom, said air aiding in the carrying of impurities in said sulfur mass to the upper portion of said sulfur mass, continuously removing a fraction of the upper molten sulfur portion from the surface thereof, cooling said fraction below the temperature range at which molten sulfur is highly viscous, continuously purifying said fraction by filtration out of gaseous communication with said chamber, combining said purified portion with said molten sulfur feed, and returning this molten sulfur mixture to the lower portion of said molten sulfur mass.

5. The method of vaporizing and burning sulfur comprising bubbling air into the upper portion of a mass of molten sulfur in a volatilization chamber, removing the gaseous effluent comprising vapor phase sulfur and sulfur dioxide therefrom, said air aiding in the carrying of impurities in said sulfur mass to the surface thereof, continuously removing a portion of said molten sulfur from the surface of said molten sulfur mass, combining said portion with a second source of molten sulfur, purifying this molten sulfur mixture out of gaseous communication with said chamber, and returning said mixture to said mass of molten sulfur.

6. The method of vaporizing and burning sulfur comprising bubbling air into an upper portion of a mass of sulfur in a volatilization chamber, removing the gaseous vapor phase sulfur and sulfur dioxide effluent therefrom, said air aiding in the carrying of impurities in said sulfur mass to the surface thereof, continuously removing a fraction of the upper molten sulfur portion from the surface thereof, cooling said fraction below the temperature range at which molten sulfur is highly viscous, purifying said fraction out of gaseous communication with said chamber, combining said purified portion with a second source of molten sulfur, purifying this molten sulfur mixture, and returning said mixture to the lower portion of said molten sulfur mass.

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