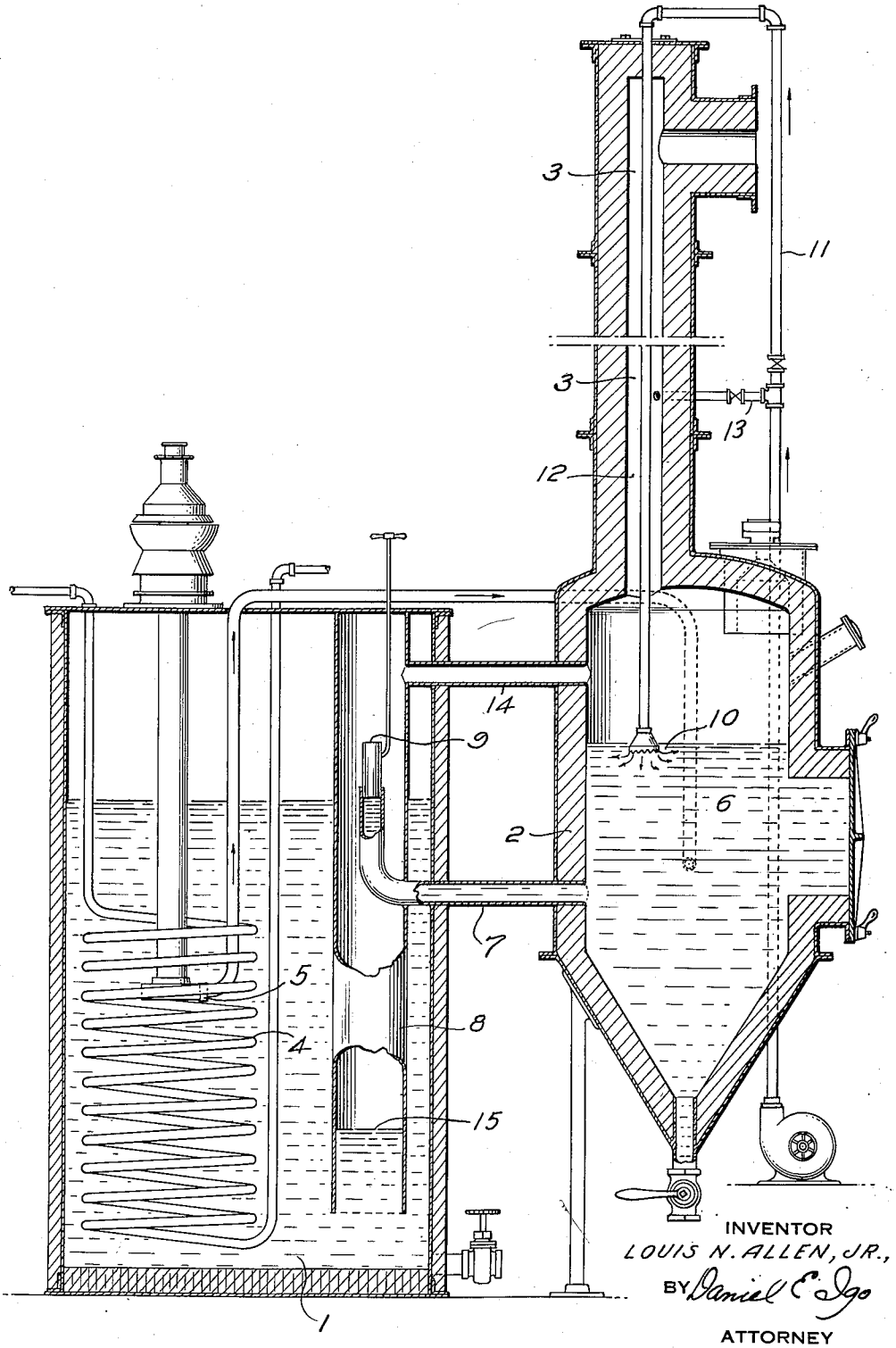
Dec. 16, 1952

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DIOXIDE AND SULFUR BURNER
Filed March 16, 1949

2,622,007



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Patented Dec. 16, 1952

2,622,007

UNITED STATES PATENT OFFICE

2,622,007

PROCESS FOR PRODUCING SULFUR DIOXIDE AND SULFUR BURNER

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Application March 16, 1949, Serial No. 81,690

3 Claims. (Cl. 23—179)

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This invention relates to a new and improved method and apparatus for the manufacture of sulfur dioxide and is particularly directed to sulfur burners and the method of burning sulfur for the production of said sulfur dioxide adapted for commercial utilization.

My invention has for its object to provide a new and improved method whereby sulfur may be burned with greater efficiency to produce sulfur dioxide than has been heretofore accomplished, as well as to provide an apparatus novel in construction and economical in operation for practicing this novel process. A further object is to provide a sulfur burner more simplified in design, so as to substantially reduce the volume of equipment required and take advantage of a more rapid rate of sulfur combustion facilitated by improved mixing of a combustion supporting gas and molten sulfur. A still further object of this invention is to make possible a sulfur burner that is more practical and economical when utilized in processes wherein three tons or less of sulfur are burned per 24 hours. These and other objects will be apparent from the hereinafter detailed description of my invention.

The foregoing objects are accomplished, according to this invention, by melting sulfur in a suitable melting vessel, transporting the molten sulfur to a combustion chamber and maintaining a constant level of molten sulfur in the said combustion chamber, continuously circulating the said molten sulfur between the melt vessel and the combustion chamber in order to utilize the sensible heat of the molten sulfur to provide the heat of fusion of the solid sulfur feed, partially buring and vaporizing the molten sulfur contained in said combustion chamber and subsequently burning the vaporized sulfur so produced.

Suitable apparatus for carrying out the process of this invention is illustrated in the accompanying drawing, which is a side elevation view in section of the subject apparatus. The illustrated sulfur burner consists generally of a melt vessel 1 wherein the raw sulfur is melted and a combustion chamber 2 wherein the molten sulfur is partially burned and vaporized, the vaporized sulfur being subsequently burned in a secondary combustion chamber 3 and a circulating means whereby the molten sulfur volume of the combustion chamber is circulated between said combustion chamber and the sulfur melt vessel, so that the heat of combustion of the sulfur is utilized to melt the raw sulfur feed of the melt tank by the sensible heat of the molten sulfur. By the utilization of the aforesaid sensible

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heat of sulfur a considerable economy is effected in this burner, in that an independent heat supply is not required, except for the original melting of the sulfur and starting up of this apparatus.

More specifically, my invention comprises melting a sufficient volume of sulfur in a sulfur melt vessel 1 by means of a steam heating coil 4 or any other suitable or equivalent means of melting the said sulfur so as to obtain a sufficient volume of molten sulfur, in order to transport the same to the primary combustion vessel, and to maintain in said primary combustion vessel a constant level of molten sulfur and to continuously circulate the molten sulfur between the sulfur melt vessel and the primary combustion chamber, in such a manner so as to utilize the heat of combustion of the sulfur through the sensible heat of the molten sulfur to supply the heat of fusion for the incoming raw sulfur feed. The said constant level of molten sulfur in the said combustion chamber must be such so as to allow a preheated primary combustion supporting gas supply to be fed slightly beneath the surface of the molten sulfur contained in the primary combustion chamber. The temperature of this molten sulfur prior to burning and during the establishment of the aforesaid sulfur volumes and levels should be within the range of 265° F. to 300° F. This temperature range should be maintained in order to obtain optimum or minimum molten sulfur viscosity in order to facilitate pumping and general circulation of the molten sulfur, as well as to prevent the polymerization of sulfur into a viscous mass which in turn would be extremely difficult and cumbersome to handle.

The molten sulfur is pumped or transported from the said melt vessel by means of a submerged sulfur pump 5 to the primary combustion chamber 6 which has been preheated by any suitable means, for example, a gas or oil flame, so as to maintain the sulfur in a molten condition. The molten sulfur volume level in the combustion chamber is maintained substantially constant as heretofore indicated. This substantially constant level in the combustion chamber is maintained and established by means of an overflow line 7 which connects the molten sulfur contained in the combustion chamber with the molten sulfur in the melt vessel. The said overflow line connects the said vessels in a horizontal manner and extends upward into the melt tank standpipe 8. The uppermost vertical end of said overflow line extending internally upward in said melt tank standpipe having an adjustable hollow concentric sleeve 9 which is capable of being manually ad-

justed in such a manner so as to control the height of the vertical section of the said overflow pipeline. The said height of the overflow line in turn controls the liquid sulfur level in the combustion chamber by means of adjusting the liquid sulfur level in the vertical section of said overflow line. The molten sulfur is then capable of being circulated continuously between the melt vessel and the combustion chamber by means of the aforesaid sulfur pump and adjustable overflow pipeline while maintaining a substantially constant level of molten sulfur volume in the combustion vessel.

The subject vessels may be constructed of any suitable material and lined with refractory and insulating material, the refractory material obviously being in contact with the molten sulfur.

Upon the establishment of the aforesaid molten sulfur level and circulation of sulfur between the melt vessels and the combustion chamber, a primary combustion supporting gas, obtained through any conventional means of supply, such as a centrifugal, rotary and the like, blower, is introduced into the molten sulfur of the combustion chamber 2 slightly below the surface of the said molten sulfur at (10). This primary gas supply is conducted to the said molten sulfur by means of a primary gas pipeline 11 which passes through a secondary sulfur vapor combustion zone or chamber 12 having therein sulfur vapor and sulfur dioxide produced by burning and vaporization of the molten sulfur surface by means of the said submerged primary combustion supporting gas. This manner of feeding or supplying the primary combustion supporting gas supply makes possible the preheating of the said primary gas supply which adds to the efficiency of the operation of this type of burner. It is essential for the successful operation of this sulfur burner that the said primary combustion supporting gas supply, which can be air, be preheated to at least 500° F. or the ignition point of the sulfur to be burned. The degree to which the primary air is heated will depend upon the temperature within the sulfur vapor combustion chamber or zone. The temperature in the vapor combustion zone will vary with the amount of sulfur dioxide produced; for example, where air is used to burn the sulfur and 8 per cent sulfur dioxide gas mixture is produced, the temperature in the vapor combustion zone or chamber will be approximately 1300° F., and when 12 per cent sulfur dioxide is produced, the vapor combustion chamber temperature will be approximately 1800° F. The primary combustion supporting gas should be introduced slightly below the surface of the molten sulfur contained in the said combustion chamber and at a temperature above the ignition temperature of sulfur. This procedure will accomplish submerged burning of the molten sulfur. The submerged burning of the molten sulfur in the combustion chamber produces heat of combustion which enables the said molten sulfur surface to be maintained at a temperature above the ignition temperature of sulfur, the ignition temperature of sulfur being approximately 502° F.

It has been found that in order to utilize the sensible heat of molten sulfur, to provide the heat of fusion of the solid sulfur feed, the molten sulfur must be circulated between the respective molten sulfur vessels in a ratio of approximately 15:1; i. e., approximately 15 parts of molten sulfur must be circulated between the molten sulfur vessels per one part of raw sulfur feed. This circulation is accomplished by the heretofore described sulfur pump and combustion chamber overflow pipelines having an adjustable concentric sleeve level control therein. The sulfur burner is in effect a self-sustaining unit from an operating heat consumption basis. The molten sulfur is circulated through the aforesaid overflow line 7 which takes molten sulfur from substantially below the surface level of the primary combustion chamber molten sulfur because the sulfur substantially below the molten sulfur surface is not as viscous as the molten sulfur at or slightly below the surface of this molten sulfur volume. The fact is that there exists a rather sharp temperature gradient over this molten sulfur volume contained in the primary combustion chamber because the sulfur at the surface of the molten sulfur volume is substantially above ignition temperature of sulfur, which causes to exist a rather viscous form of surface sulfur which acts as an insulator for the molten sulfur below the surface, which in turn will have a temperature of approximately 300° F.

The heretofore iterated procedure or steps have produced by burning the sulfur, sulfur dioxide and vaporized sulfur. In order to complete the combustion, the vaporized sulfur is burned by means of a secondary combustion supporting gas supply 13 which is introduced tangentially, or in any suitable direction, into the secondary vapor combustion chamber 12 to effect the burning of the sulfur vapor produced at the surface of the molten sulfur volume to sulfur dioxide.

My invention may be more specifically illustrated by the following specific example which specifically illustrates the operation of this burner. It should be understood that this example is merely a specific embodiment of the invention and said invention should not be limited thereby.

To start the sulfur burner, liquid sulfur is pumped into the combustion chamber of said burner from the sulfur melt tank. The liquid sulfur then overflows back through the overflow line to the sulfur melt tank. The liquid sulfur level within the combustion chamber is maintained at a level slightly above the bottom of the primary air line, as at 10.

Portions of the exterior of the combustion chamber are then preheated to a dull red heat by the use of auxiliary Premix City Gas Burners. After sufficient time for preheating has elapsed, 10–15 C. F. M. of primary air are bled into the combustion chamber. This primary air becomes heated to a temperature above 500° F., after which vaporization and burning of sulfur at the liquid sulfur surface commences.

Vaporization of the sulfur is induced by the sweeping action of the preheated primary air as it passes across the sulfur surface in said combustion chamber. As vaporization progresses, 10–15 C. F. M. of secondary air are added to the secondary combustion chamber, and burning of the vapor takes place in the heated portions of said combustion chamber. This serves to further preheat the incoming primary air. After initial vaporization and burning are well established, both the primary and secondary air volumes are increased to the normal operating levels of 30 and 67 C. F. M., respectively. The auxiliary gas burners are then shut off.

To produce 97 C. F. M. of 12 per cent sulfur dioxide gas in the effluent, 60 pounds per hour of raw sulfur are fed into the system. Level

adjustment of the sulfur level in the primary combustion chamber is made by hand operation of the steel connecting rod in the seal standpipe of the sulfur standpipe of the sulfur melt vessel.

The action of the sweeping primary air produces approximately 20 per cent sulfur dioxide gas in addition to the sulfur vapor. As the mixture of sulfur dioxide and sulfur vapor rises in the combustion chamber, secondary air mixes with this gas stream in a secondary combustion zone, creating turbulence, and burns the remaining sulfur vapor in the gas mixture. A 12 per cent sulfur dioxide gas is then produced. Temperatures in the range of 1500° F. to 1800° F. are obtained in the secondary combustion chamber. The effluent gas reaches a temperature of between 1150° F. and 1250° F. The gas pressure drop across the burner unit is approximately 12 inches of water. Changes in the secondary air rate also can be used to adjust the gas strength.

The temperature of the circulating sulfur was maintained between 300° F. and 320° F. In this specific example, a sulfur circulation rate of 50–100 pounds per minute was employed.

Shutting down of the burner merely requires stoppage of the primary and secondary air flows and sulfur circulation. The residual gases in the burner are then vented to the atmosphere.

It has been found that by the use of this sulfur burner approximately 19 per cent sulfur dioxide can be produced without subliming the sulfur when air is used as a combustion supporting gas.

In order to accomplish and operate a properly balanced burner, to constantly maintain the primary combustion supporting gas supply slightly below the surface of the molten sulfur in the combustion chamber, and in order to maintain a uniform and constant product gas composition, a constant level of molten sulfur must be maintained in the aforesaid sulfur combustion chamber. This constant level is maintained by means of the overflow pipeline 7 which connects the primary combustion chamber from a point substantially below the surface of the molten sulfur contained therein with the sulfur melt tank and extends horizontally to and into the said melt tank, and vertically in the standpipe 8 of the sulfur melt vessel, substantially as shown. The said vertical or upright section of the overflow pipeline being adapted with a concentric adjustable hollow sleeve 9 so as to adapt the overflow pipeline as a means for controlling the level in the said sulfur vessels on the basis of the U-tube principle. The standpipe 8 of the sulfur melt vessel is vented back to the combustion chamber by any suitable means, such as a pipeline 14 in order that the molten sulfur level in the combustion chamber will be independent of unit back pressure fluctuations to which this type of sulfur burner might be integrated.

The melt tank standpipe 8 operates so as to create a liquid sulfur seal against the atmospheric pressure of the sulfur melt vessel and the difference of the molten sulfur level 15 in the melt tank standpipe and the level of the molten sulfur in the melt tank, per se, which is open to atmospheric pressure, is equivalent to the back pressure against which this sulfur burner is required to deliver the sulfur dioxide product gas. This type of combination arrangement enables the production of a constant sulfur dioxide gas strength against a fluctuating unit back pressure of which this burner might be an integral part.

Any suitable combustion supporting gas will be adequate to operate this sulfur burner; air supplied by an conventional means with sufficient pressure to overcome the pressure drop of the system is preferred.

In actual practice it has been found that this sulfur burner presents a simplified and economical sulfur burner design, especially for use in conjunction with sulfur dioxide units consuming relatively small amounts of sulfur, that is, in the vicinity of three tons of sulfur burned per 24-hour day. This type of burner further presents the advantage of being able to utilize the heat of combustion of the sulfur that is burned and vaporized to melt the incoming raw sulfur feed.

It should be further pointed out that in the conventional type sulfur burner sulfur is burned in an air stream while flowing under laminar flow conditions, while in the sulfur burner of this invention the sulfur is burned in the combustion chamber under turbulent flow conditions, and consequently more intense combustion is accomplished due to the improved mixing of a combustion supporting gas and sulfur vapor, consequently resulting in a more efficient and economical sulfur burner.

It is apparent that many widely different variations and embodiments of this invention may be accomplished without departing from the scope and spirit thereof, consequently the scope of the subject invention is not to be construed as limited by the specific examples herein set forth, but instead by the scope of the hereinafter appended claims.

I claim:

1. A process of continuously producing sulfur dioxide of a predetermined constant strength by the vaporization of sulfur and the combustion of sulfur vapors, the steps comprising: adding raw sulfur to a sulfur melting zone, melting sulfur in the melting zone, conveying molten sulfur from the melting zone to a primary combustion zone, vaporizing molten sulfur in the primary combustion zone by introducing preheated primary air beneath the surface of the molten sulfur, burning the resulting vapors in a secondary combustion zone by introducing additional secondary air thereto, and continuously withdrawing molten sulfur directly from the primary combustion zone at a point substantially beneath the surface of the molten sulfur and discharging said withdrawn molten sulfur into the melting zone at a predetermined point through a seal of liquid sulfur, whereby a constant level of molten sulfur is maintained in the primary combustion zone and whereby the sensible heat of the withdrawn molten sulfur is utilized to melt the raw sulfur added to the melting zone.

2. A process as in claim 1 in which the primary air is preheated by passing the same in heat exchange relation with the products of combustion from the secondary combustion zone.

3. A sulfur burner comprising in combination, a sulfur melt vessel having disposed therein and as an integral part thereof a downwardly extending standpipe, a sulfur heating means in said vessel, a primary combustion chamber adapted to contain a volume of molten sulfur and having a condition for admitting a combustion supporting gas slightly beneath the surface of the molten sulfur therein, and a pump located within the sulfur melt vessel and connected on its discharge side to a pipe leading into said primary combustion chamber to supply sulfur thereto, said primary combustion chamber having a secondary

vapor combustion chamber connected to and communicating therewith for burning combustion chamber vapor, the said secondary vapor combustion chamber having a combustion supporting gas conduit for conducting said gas into the said secondary combustion chamber and a means for emitting the products of combustion from the burner; the said primary combustion chamber having an overflow and level control means comprising a horizontal connection between the said primary combustion chamber and the stand pipe of the sulfur melt vessel and extending upward and internally into the said stand pipe and having an adjustable hollow concentric sleeve contained in the said vertical section and

capable of being extended beyond the end of the said connecting pipe.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,904,512	Nordlander	Apr. 18, 1933
1,928,099	Gillett	Sept. 26, 1933
2,310,173	Chatelain	Feb. 2, 1943
2,445,112	Grace et al.	July 13, 1948