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A. LIPPMAN, JR
LEVEL CONTROLLER

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2 Sheets-Sheet 2

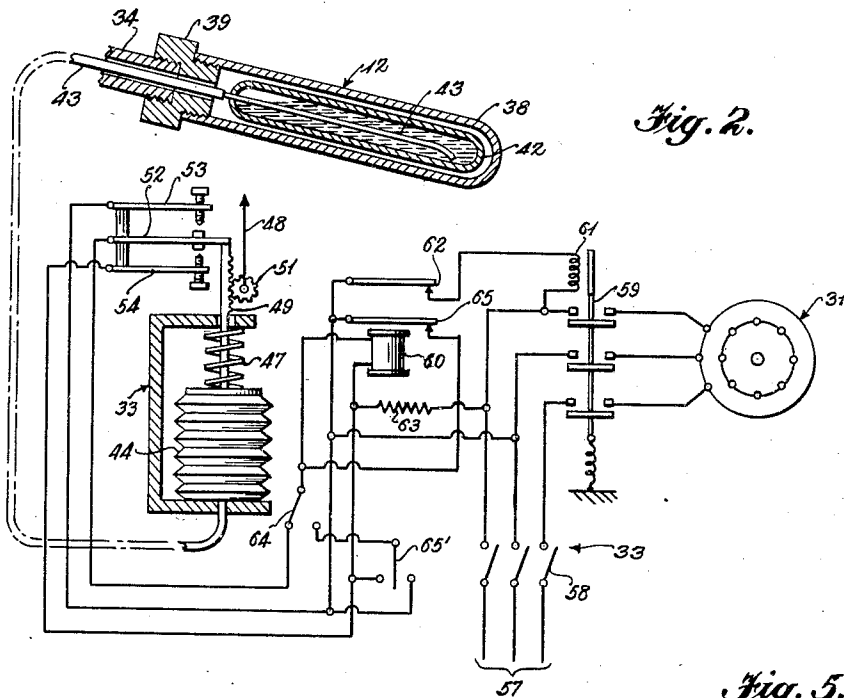


Fig. 2.

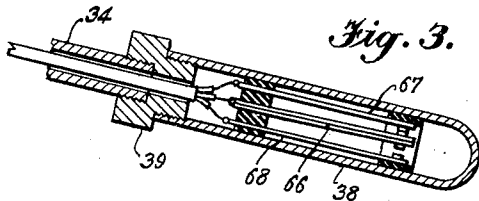


Fig. 3.

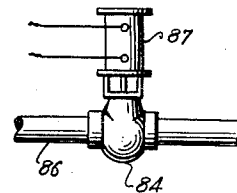


Fig. 5.

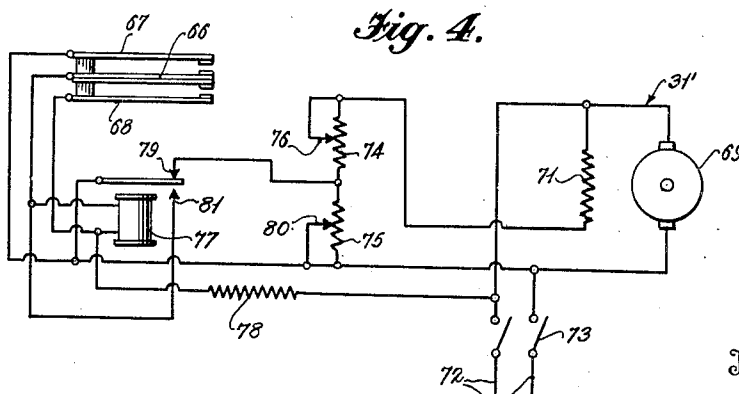


Fig. 4.

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UNITED STATES PATENT OFFICE

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LEVEL CONTROLLER

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2 Claims. (Cl. 23-278)

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This invention relates to a level controller and more particularly to a device and method for controlling the level of a liquid body of fuel during burning of the body of fuel.

The present invention is especially useful for the purpose of controlling the level of a pool of molten sulfur during burning of the sulfur and will be particularly described with respect thereto although the invention can be utilized wherever it is desired to control the level of a burning liquid body of fuel.

Many commercial processes require large quantities of sulfur dioxide. This sulfur dioxide is usually produced by burning sulfur in a rotary sulfur burner in which a body of molten sulfur is maintained and to which a solid, usually powdered, sulfur is fed. Although the need has long been apparent, no satisfactory method or device has heretofore been found which would control the sulfur level in sulfur burners. Such sulfur burners have, therefore, required the almost constant attention of an operator.

In rotary sulfur burners, a film of sulfur is carried around on the inner surface of the rotor and this sulfur burns as a result of contact with air drawn into the sulfur burner. Burning also takes place directly from the upper surface of the pool of molten sulfur. If the sulfur level falls, the burning area is increased and the temperature in the burner rises to an extent which may damage the apparatus. Furthermore, the molten sulfur becomes very viscous or semi-solid when the rise in temperature becomes excessive. This is due to evaporation or combustion of most of the sulfur to leave a mixture of sulfur and bituminous matter in the burner. Such bituminous matter is almost always present in sulfur burners and is chiefly responsible for the semi-solidity of the residue in the burner. This residue adheres to the shell of the burner and is carried around therewith, producing an eccentric load so that the rotor slips on the trunnion instead of revolving. A time consuming operation of gradually burning out the residue and manually cleaning out the ash must then be carried out. If, on the other hand, the sulfur level becomes too high, molten sulfur will flow out of the ends of the sulfur burner, liberating copious sulfur dioxide fumes into the atmosphere and also producing fire hazards.

Ordinary float level controllers were found not to be applicable because of the high temperatures and the high viscosity or stickiness of the molten sulfur. Also, the sulfur ordinarily burned in sulfur burners contains a small amount of bituminous matter which deposits a black carbonaceous sub-

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stance interfering with the operation of a float. It is difficult to mount a float in the rotating burner without interfering with the sulfur feed or the air supply and also the rotation of the burner produces a wave action in the surface of the pool of molten sulfur which causes a float to continuously oscillate making it difficult to utilize such a float as a control element.

In accordance with the present invention a temperature responsive element is supported in the burner so as to be positioned substantially at the surface of the body of burning molten sulfur. That is to say, the temperature responsive element is exposed partly to the burning gases above the sulfur while being protected from the total heat of these gases by being partly submerged in the sulfur. It has been found that the temperature of the burning gases above the sulfur is very much higher than the temperature of the molten sulfur so that slight differences in the level of the sulfur produce major changes in the temperature of the temperature responsive element. This temperature differential can be employed to control the rate of sulfur fed to the burner such that the sulfur level can be very accurately maintained at the desired level.

It is therefore an object of the present invention to provide an improved device for controlling the level of liquid fuel during burning thereof.

Another object of the invention is to provide a device for controlling the level of a burning liquid body of fuel in which a temperature responsive element is positioned partly in the liquid fuel substantially at the upper surface thereof.

Another object of the invention is to provide an improved feed control mechanism for burners in which a temperature responsive element is partially submerged in a burning body of liquid fuel and employed to control the rate of fuel feed to said body.

Another object of the invention is to provide a temperature responsive level control for rotary sulfur burners.

Another object is to provide an improved method of controlling the liquid level of a burning body of liquid fuel.

A further object of the invention is to provide a method of controlling the liquid level of a burning body of liquid fuel by employing the difference in temperature between the liquid fuel itself and the burning gases above said fuel.

A still further object of the invention is to provide an improved method of controlling the sulfur level in a sulfur burner.

Other objects and advantages of the invention

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will appear in the following description of preferred embodiments thereof shown in the attached drawings in which:

Figure 1 is an elevation, partly in vertical section, of a sulfur burner and feeding device therefor incorporating the present invention;

Figure 2 is a diagrammatic view showing the details of a suitable control system;

Figure 3 is a fragmentary sectional view showing a modified type of temperature responsive element;

Figure 4 is a schematic diagram showing a control circuit suitable for employment with the temperature responsive element of Figure 3; and

Figure 5 is a fragmentary view showing a modified type of fuel control mechanism.

Referring more particularly to Figure 1 of the drawings, 10 indicates, in general, a rotary sulfur burner, 11 indicates, in general, a feed mechanism therefor and 12 indicates a temperature responsive element positioned in the sulfur burner 10.

As shown in the drawings, the sulfur burner 10 includes an elongated cylindrical body 13 having frusto-conical ends 14 and 16. The sulfur burner is provided with annular members 17 resting upon pairs of rollers 18, the rollers 18 being driven in any suitable manner (not shown) to rotate the burner 10 about its horizontal axis. Sulfur, usually in powder form, is fed into the burner by means of a chute 19 from the feed mechanism 11 into a molten pool of sulfur in the lower portion of the burner, the average sulfur level being indicated by the dash line 21. Air enters the burner through the inlet member 22 adjacent the feed mechanism 11 and a mixture of gases including sulfur dioxide and vaporized sulfur is discharged from the other end of the burner through the discharge member 23. Complete combustion is ordinarily not produced in the sulfur burner and a gap 24 is left between the discharge member 23 and a flue 26 connected to a supplemental combustion chamber (not shown). A draft is produced in the supplemental combustion chamber by known means (not shown) so that additional air enters through the gap 24 to mix with the gases withdrawn from the sulfur burner to complete the combustion in the auxiliary combustion chamber. The body or rotor 13 of the burner is provided with an outer covering of heat insulation 26' and the interior is provided with a plurality of longitudinally extending fins 27 suitably secured thereto by any suitable means such as riveting.

The feed mechanism 11 includes a hopper 27' for the powdered sulfur and a screw conveyor 28 having a casing 29 discharging into the chute 19. The screw conveyor 28 may be driven from an electric motor 31 through a suitable speed reducing device 32. The starting and stopping of the motor 31 or the speed of this motor may be controlled in response to the temperature of the element 12 by means of a controller indicated at 33 in Figure 1, the temperature responsive element 12 being connected to the controller 33 through a suitable conduit or pipe 34 and the controller 33 being connected to the motor 31 and a source of electric power through suitable conduits 36 and 37.

The details of a suitable type of temperature responsive element 12 as well as controller 33 are shown in Figure 2. The temperature responsive element may include a corrosion resisting metallic tubular member 38 preferably having one end integrally closed and its other end closed by

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means of a reducer 39. The pipe 34, which may be of reduced diameter, may be threaded into the reducer 39, the reducer 39 and pipe 34 also being preferably made of corrosion resistant material. Thus, stainless steel has been found to be a suitable material for the tubular member 38, reducer 39 and pipe 34.

The tubular member 38 may contain a commercially available sealed thermo-bulb 42 having a tube 43 extending thereinto and also containing a liquid which volatilizes within the operating range of the device. The tube 43 extends through a bore in the plug 39 and through the pipe 34 and may be connected to an expandable element such as a Sylphon bellows 44 in the controller 33. As shown in Figure 1 the pipe 34 may constitute a support for the temperature responsive element 12. For example, this pipe may extend outwardly through the inlet member 22 of the rotary sulfur burner and be secured to any suitable support such as a base member 46 for the screw conveyor housing 29. An increase in temperature of the temperature responsive element 12, including the bulb 42 and its contents, increases the pressure in said bulb as well as in the bellows 44. Thus, the bellows 44 expands against the action of a spring 47 as the temperature of the bulb 42 increases, this expansion being a function of the temperature of the bulb 42. Expansion of the bellows 44 may be imparted in any suitable manner to a temperature indicating needle 48, for example, through a rack 49 connected to the bellows 44 and a pinion 51 carrying the needle 48. The expansion of the bellows 44 may also be employed to actuate spring contact member 52, suitably supported to be engaged by the end of the rack 49 and spring biased toward the rack 49. Adjustable spring contact members 53 and 54 may be engaged by the contact member 52 in its upper and lower positions, respectively, to form a control for the motor 31.

As shown in Figure 2, the motor 31 may be a conventional induction motor having its stator winding connected to a three phase alternating current line 57 through a manual switch 58 and a solenoid contactor 59. The contactor 59 may be of the normal open type which is actuated to closed position by an operating coil 61, the operating coil 61 being energized for actuating the contactor from one phase of the line 57 under control of a relay 60. That is to say, coil 61 is connected across one phase of the line 57 in series with normally open contacts 62 of relay 60. The contact members 52 and 53 may be employed to close the relay 60, this relay being connected across one phase of the line 57 in series with a resistor 63, a switch 64 and the contacts of contact members 52 and 53. It will be apparent that an increase in temperature of the temperature responsive bulb 42 will cause expansion of bellows 44 to close the contacts of contact members 52 and 53 thus energizing relay 60 to close its contacts 62 which in turn causes actuation of the contactor 59 to closed position. That is to say, the motor 31 operates to feed additional sulfur into the burner whenever the temperature of the temperature responsive bulb 42 increases to a predetermined temperature determined by the position of adjustable contact member 53. Energization of relay 60 also closes normally open contacts 65 of the relay 60 to complete a holding circuit for the relay 60 so that the relay remains energized after contact between contact members 52 and 53 is broken. Upon decrease

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in temperature of bulb 42 to a predetermined temperature, contact member 52 engages contact member 54 to short circuit the relay 60, since contact members 52 and 54 are connected directly across the operating coil of relay 60. This de-energizes relay 60 to open holding contacts 65 and also contacts 62 to de-energize contactor coil 61 thus allowing contactor 59 to open and stop the motor 31. The resistor 63 prevents short circuiting of the line 57 when the relay is short circuited. The switch 64 may be employed to convert the system to manual control by switch 65' during starting of the operation or at any desired time. Thus actuation of switch 64 to its right position in Figure 2 substitutes manual control switch 65' for contact members 52, 53 and 54.

The control system of Figure 2 thus produces intermittent feeding of the sulfur burner, the rate of feeding due to operation of motor 31 being greater than the rate of burning of sulfur in the sulfur burner. Even with such an intermittent operating feed, it has been found possible to control the level of sulfur in the sulfur burner within plus or minus $\frac{1}{4}$ inch or better, which is a more accurate control than necessary for sulfur burners. That is to say, it has been found that the temperature of the body of molten sulfur is of the order of 400° to 580° F. whereas the temperature of the burning gases above the sulfur are of the order of 750° to 900° F. A very slight difference in level, therefore, produces extremely large changes in temperature of the temperature responsive element when this element is positioned substantially at the surface of the burning body of molten sulfur. An adjustment such that the feed is started when the temperature of the temperature responsive element increases to approximately 600° F. and is stopped when the temperature decreases to approximately 525° F. has been found to produce satisfactory results and hold the sulfur level within plus or minus $\frac{1}{2}$ inch. This provided relatively long periods of feed and also relatively long periods when feeding did not take place, thus eliminating rapidly recurring stopping and starting of the motor 31. A narrower temperature control range, for example, 630° F. to start the feed and 600° F. to stop the feed can obviously be employed if closer control of the level, for example, plus or minus $\frac{1}{4}$ inch, is desired.

An alternative form of temperature responsive element is shown in Figure 3 and may include the closed tubular element 38, reducer 39 and pipe 34. A bimetallic element 66 may be suitably supported in the tubular member 38 so as to be insulated therefrom and to make contact with a contact member 67 when the temperature of the bimetallic element increases to a predetermined temperature and alternatively to make contact with a contact member 68 when the temperature decreases to a predetermined temperature. The pipe 34 may form a conduit for suitably insulated wires connected to the bimetallic element 66 and contact members 67 and 68. A circuit for producing a variable rate of feed of the fuel is shown in Figure 4 utilizing the bimetallic element 66 and contact members 67 and 68 of Figure 3. In this system a variable speed motor such as a direct current shunt motor 31' having an armature 69 and field 71 may be employed, the motor being energized from a direct current line 72 through a switch 73. The field 71 may be connected across the line 72 in series with rheostats 74 and 75. A variable tap 76 on the rheostat 74 may be employed to set the low speed operation of the motor 31'.

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The bimetallic element 66 and contact member 67 may be connected across the line 72 in series with a relay 77 and a resistor 78 so that engagement of bimetallic element 66 with contact member 67 energizes the relay 77. Normally closed contacts 79 of the relay 77 may be employed to shunt the rheostat 75, a variable tap 80 being employed to set the high speed operation of the motor 31'. A holding circuit for the relay 77 is completed when normally open contacts 81 of the relay 77 are closed due to energization of the relay so that the relay remains closed after bimetallic element 66 disengages contact member 67. Engagement of the bimetallic element with contact member 68, however, short circuits relay 77 to open contacts 81 and close contacts 79, the resistor 78 preventing short circuiting of the line 72.

When the bimetallic element 66 is out of contact with the contact element 67 and the relay de-energized, the contacts 79 of relay 77 are closed such that the field 71 of the motor 31' is energized through a relatively low resistance and the motor runs at a low speed. This low speed can be adjusted by varying the adjustable tap 76 on the rheostat 74 so that the level of the sulfur in the burner decreases at the low rate of feed. When the bimetallic element 66 engages the contact element 67 due to decreased sulfur level and increased temperature of the bimetallic element, the relay 77 is actuated to open contact 79 to decrease the excitation of the field 71 and increase the speed of the motor. The high speed of the motor may be adjusted by adjusting tap 80 of the rheostat 75 to overfeed the burner 10 so that the level of the sulfur tends to increase under high speed operation of the motor. As the sulfur level increases, the temperature of the bimetallic element 66 decreases to cause the same to engage contact member 68 and thus cause opening of relay contacts 79 to decrease the speed of the motor and the feeding rate so that the sulfur level again falls.

It will be apparent that the contact members 52, 53 and 54 with their associated temperature responsive bulb 42 and bellows 44 of Figure 2 may replace the bimetallic element 66 and contact members 67 and 68 in the circuit of Figure 4 or that the bimetallic element 66 and the contact members 67 and 68 may replace contact members 52, 53 and 54 and their associated temperature responsive bulb 42 and bellows 44 in the circuit of Figure 2. In order to simplify the diagram of Figure 4, switch 64 for converting the circuit to manual operation and manual control switch 65' of Figure 2 are not shown in Figure 4 but may be obviously connected into the circuit of Figure 4 in the same manner as in Figure 2.

While the level control apparatus of the present invention has been described particularly with respect to sulfur burner level control, it will be apparent that a motor such as the motors 31 and 31' may drive a pump for liquid fuel being fed into a pool of burning liquid fuel, utilizing a temperature responsive element 12 positioned adjacent the surface of the burning fuel to control the operation of the motor and thus the operation of the pump. Furthermore, as shown in Figure 5, a solenoid valve 84 may be positioned in a liquid fuel line 86 through which liquid fuel is supplied under pressure to a body of burning liquid fuel. The valve 84 is opened by the operating coil 87 when the liquid level falls to increase the temperature of the temperature responsive element 75 12 and closed upon decrease in temperature of

this element. That is to say, the solenoid coil may be substituted for the contactor coil 61 of Figure 2. The present invention is thus applicable to the feeding of either a solid or liquid fuel into a body of fuel which remains in liquid state during burning in order to control the level of such fuel. It will also be apparent that various other temperature responsive elements and control circuits therefor can be employed in utilizing the principles of the present invention.

For example, a further modification of a feed control particularly suitable for sulfur burners but which is also applicable to feeding of other types of fuel to a liquid pool of molten fuel is shown in Figure 6. The system of Figure 6 provides a continuous feed of fuel to the pool at approximately the burning rate of the fuel, the rate of feeding fuel increasing when the level of the fuel in the burner drops and decreasing when this level rises. This system may employ a motor 31 such as that shown in Figures 1 and 2 as well as a speed reducer 32 and a screw conveyor 28 for delivering the sulfur to the burner. A variable speed device 88 is also provided and is preferably positioned between the motor 31 and the speed reducer 32. Such variable speed devices are well known and need not be described in detail. For example, the well known "Reeves" type of variable speed drive employing a belt engaging one or more variable diameter pulleys (not shown) is commercially available and suitable for use in the present invention. Such devices are provided with means for varying the diameter of the pulleys which may, for example, include a rotatable shaft 89 provided with a pinion 91.

In accordance with the present invention, the pinion 91 may mesh with a rack 92 secured to one end of a bellows 93 connected to a fluid containing bulb enclosed in a casing to form a temperature responsive element 12 such as shown in Figure 1. The bellows 93 can be constructed to develop substantial power and may be employed to directly drive the pinion 91 of the speed control shaft 89 through the rack 92 although it is apparent that any known or suitable power amplifying follow-up mechanism (not shown) can be employed between the pinion 91 and the shaft 89. By positioning the temperature responsive element 12 as shown in Figure 1, the speed of the feed device 28 can be made a function of the temperature of the element 12 such that the rate of fuel feed increases as the sulfur level in the burner decreases and vice versa, this rate being at all times substantially equal to the rate of fuel combustion. The level in the burner is thereby maintained substantially constant by a continuous fuel feeding device.

In order to guard against abnormal operation of the burner such as caused by a failure of the draft, failure of fuel supply to the feed device, failure of motor 31, etc., provision may be made for stopping the motor 31 when the fuel level in the burner becomes abnormally high and for sounding an alarm when this level becomes abnormally low. For example, variable speed devices such as the device 88 operate through a limited range of speed variation such that failure of the fuel supply will eventually cause lowering of the fuel level in the burner to produce an excessive temperature in the burner which may damage the apparatus as explained above. Lowering of the level of the sulfur below the desired level will cause expansion of the bellows 93 until extending member 94 on the rack 92 engages

and closes a pair of normally open contacts 96. The contacts 96 may be arranged to be closed prior to the production of temperatures which will damage the apparatus and may be connected in a series circuit containing an alarm such as a siren 97 and a source of electric power shown as a battery 98 and a switch 99 for disabling the alarm. A separate source of electric power is preferred for another cause of a low fuel level in the burner could be a failure of power to the motor 31.

An abnormally high level of fuel in the burner and even overflowing of fuel might be caused by a failure of the draft for the burner. A high fuel level will cause lowering of the temperature of the temperature responsive element 12 and contraction of the bellows 93 resulting in closing of normally open contacts 101 by the member 94 prior to overflowing of fuel. The contacts 101 are shunted across the operating coil 102 of the normally open contactor 103 for the motor 31 such that closing of the contacts 101 short circuits the coil 102 to cause opening of the contactor to stop the motor 31 until the fuel level falls. The coil 102 may be energized from one phase of the line 104 through a resistor 106 to prevent short circuiting of the line and also a switch 107 providing for manual starting and stopping of the motor 31. It will be apparent that a suitable alarm (not shown) similar to the alarm 97 may also be provided for abnormally high fuel level so as to be operated by contacts closed by expansion of the bellows 93.

As a specific example of the present invention a rotary sulfur burner of the type shown in Fig. 1 was operated over an extended period of time with a control system similar to that shown in Fig. 2. The rotor of the burner was provided with a heat insulated shell 4 ft. in diameter and 10 ft. long and was provided with fins on the interior and with 20 inch flue and inlet openings. The rotor was rotated at a speed of 2 R. P. M. The temperature responsive element 12 was placed 1½ inches below the overflow level of the rotor and the rate of fuel feed when the motor 31 was running was between 5000 to 6000 lbs. per hour although the burning rate averaged approximately 1400 lbs. per hour but varied considerably as the draft was varied. This high rate of fuel feed provided for rapid increase of fuel level when the temperature increased to a predetermined point due to decrease of fuel level. It was found that, depending upon the draft induced, the temperature of the sulfur pool varied between 400° F. and 580° F. while the temperature of the vapors adjacent the upper surface of the sulfur varied between 750 to 900° F. For close control of the sulfur level the "feed-on" contacts were set for 630° F. and the "feed-off" contacts were set for 600° F. With these settings the sulfur level remained within plus or minus ¼ inch indefinitely without attention.

This is closer control than necessary and the "feed-on" contacts can be adjusted to close at a higher temperature, for example 660° F., and if the maximum draft is such that the maximum temperature of the sulfur bath can not reach the maximum figure of 580° above given, the "feed-off" contacts can be adjusted to close at a lower temperature. For example, with a low maximum draft in which the temperature of the bath did not exceed 400° F., satisfactory operation with the level maintained between plus or minus ½ inch was obtained by a "feed-on" setting of 600° F. and "feed-off" at 425° F. The critical factors

are that the "feed-off" setting must not be lower than the maximum temperature the bath can attain and is preferably at least 20° F. and preferably 50° F. higher than said maximum temperature as a safety factor. Also the "feed-on" setting must not be higher than the maximum temperature which the vapors can attain immediately adjacent the upper surface of the bath and is preferably substantially below such maximum temperature. Best results are obtained when the operating range between "feed-on" and "feed-off" is of the order of 30 to 60° F. In intermittent feed systems, such as shown in Fig. 2, it has been found desirable to provide a sulfur feed which is 3½ to 4½ times the average rate of fuel consumption and the same is true of the higher fuel feed rate of the system of Fig. 4. The most common difficulty is a decrease in the fuel feed due to poor flowing damp-sulfur supplied to the hopper of the feed device so that high sulfur feed compensates therefor.

The system of Fig. 4 more accurately maintains the sulfur level, as a low speed feed is at all times operating somewhat below the average rate of sulfur consumption and the high speed feed operates at infrequent intervals to compensate for a gradually decreasing sulfur level. The system of Fig. 6 gives the most accurate control of sulfur level and the feed is continuous at approximately the rate of fuel consumption. In this system the variable speed mechanism preferably has a greater range of control in the direction of high feed rates than in the direction of low feed rates as the most common difficulty is a decrease in sulfur feed as explained above.

The average rate of sulfur consumption of 1400 lbs. per hour given in the specific example is much higher than that ordinarily obtained with sulfur burners of the same size which ordinarily average about 800 lbs. per hour under most favorable conditions. Accurately controlling the sulfur level so as to operate at optimum burning conditions is a contributing factor to this higher rate, but two other factors also contribute to this higher burning rate.

It has always been considered necessary to leave the rotor of a sulfur burner uninsulated in order to dissipate heat therefrom. It has been found that the rotor may be heat insulated without reaching excessive temperatures as more heat is then employed in vaporizing sulfur which is later burned in the auxiliary combustion chamber above discussed.

Another factor is the provision of internal fins in the rotor. Prior art burners have had a substantially smooth interior and extensive trouble has been encountered with the formation of a coating of bituminous matter on the surface of the sulfur, interfering with sulfur vaporization and combustion. Also large lumps of such bituminous material would form in the bath and build up to an extent obstructing the operation of the burner. This required periodic cleaning resulting in loss of time, loss of sulfur, liberation of fumes, etc. In fact, sulfur burners were operated with a constant overflow to continuously discharge the bituminous film. This resulted in a substantial sulfur loss of the order of one ton per day in addition to the liberation of sulfur fumes. The fins in the burner of the present invention churn up the surface of the bath to break up the film thereon. Also the fins lift and convey bituminous matter along with

sulfur directly into the hotter gas stream and a portion thereof drops in small particles from the fins through the center of the gas stream. This, in addition to the fact that the heat insulation on the burner increases somewhat the temperature in the burner, causes substantially complete combustion of the bituminous matter and discharge of resultant ash with the gas stream. The fins do not cause any substantial restriction of the cross section of the burner and a speed of 2 to 3 R. P. M. of the rotor is sufficient to keep the fins always covered with a film of sulfur so that they are protected from excessive heat from the burning gases. This also provides an increased burning surface to increase the rate of sulfur consumption. With the level control of the present invention, the heat insulation of the rotor, and the provision of internal fins, average burning rates of as high as 1800 lbs. per hour have been maintained over long periods of time for a sulfur burner of the above given dimensions as opposed to 800 lbs. per hour for prior art sulfur burners.

While I have disclosed the preferred embodiments of my invention, it is understood that the details thereof may be varied within the scope of the following claims.

I claim:

1. In combination in a sulfur burner a hollow generally cylindrical burner body constructed to hold a pool of fluid sulfur of extensive surface upon which combustion of the sulfur is maintained, said body being mounted for continuous rotation on a generally horizontal axis and having heads with central openings limiting the level of the pool, one of said openings being an inlet opening and the other being an outlet opening, feeding means for delivering sulfur into the body through said inlet openings, a thermostat comprising an element responsive to the attainment by it of a predetermined temperature disposed within the chamber and lying partly below and partly above a predetermined plane which represents the desired level of the pool determined by said outlet opening, and a fixed support for said thermostat extending from outside said burner body through one of said openings independently of the walls of the burner body, and means under the control of the temperature responsive element for controlling the operation of the feeding means to introduce more sulfur when the temperature responsive element is exposed to greater heating by lowering of the level of the burning pool and attains said predetermined temperature.

2. In a burner apparatus including a receptacle rotatable on a generally horizontal axis and having an inlet opening at one end of the receptacle and an axial outlet opening at the opposite end of the receptacle and adapted to contain a pool of burning liquid, the products of combustion passing out through said outlet opening, and controllable fuel feeding mechanism for feeding fuel to said pool through said inlet opening, the improvement which comprises a temperature responsive device fixedly held independently of said receptacle, and adjusted to a position partly above and partly below a predetermined plane which represents the desired level of the pool of liquid fuel, and control mechanism actuated by said temperature responsive device for controlling the fuel feeding mechanism to increase the supply of fuel in said receptacle when the temperature of said temper-

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ature responsive device rises above a predetermined value.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date	10
885,891	Tromblee	Apr. 28, 1908	

Number
934,700
1,397,724
1,624,294
5 1,949,933
2,255,126
2,261,585
2,269,800

12

Name	Date
Stebbins	Sept. 21, 1909
Crandon	Nov. 22, 1921
Wallace	Apr. 12, 1927
Frantz	Mar. 6, 1934
Middleton	Sept. 9, 1941
Lockrae	Nov. 4, 1941
Wetzel	Jan. 13, 1942