

April 5, 1955

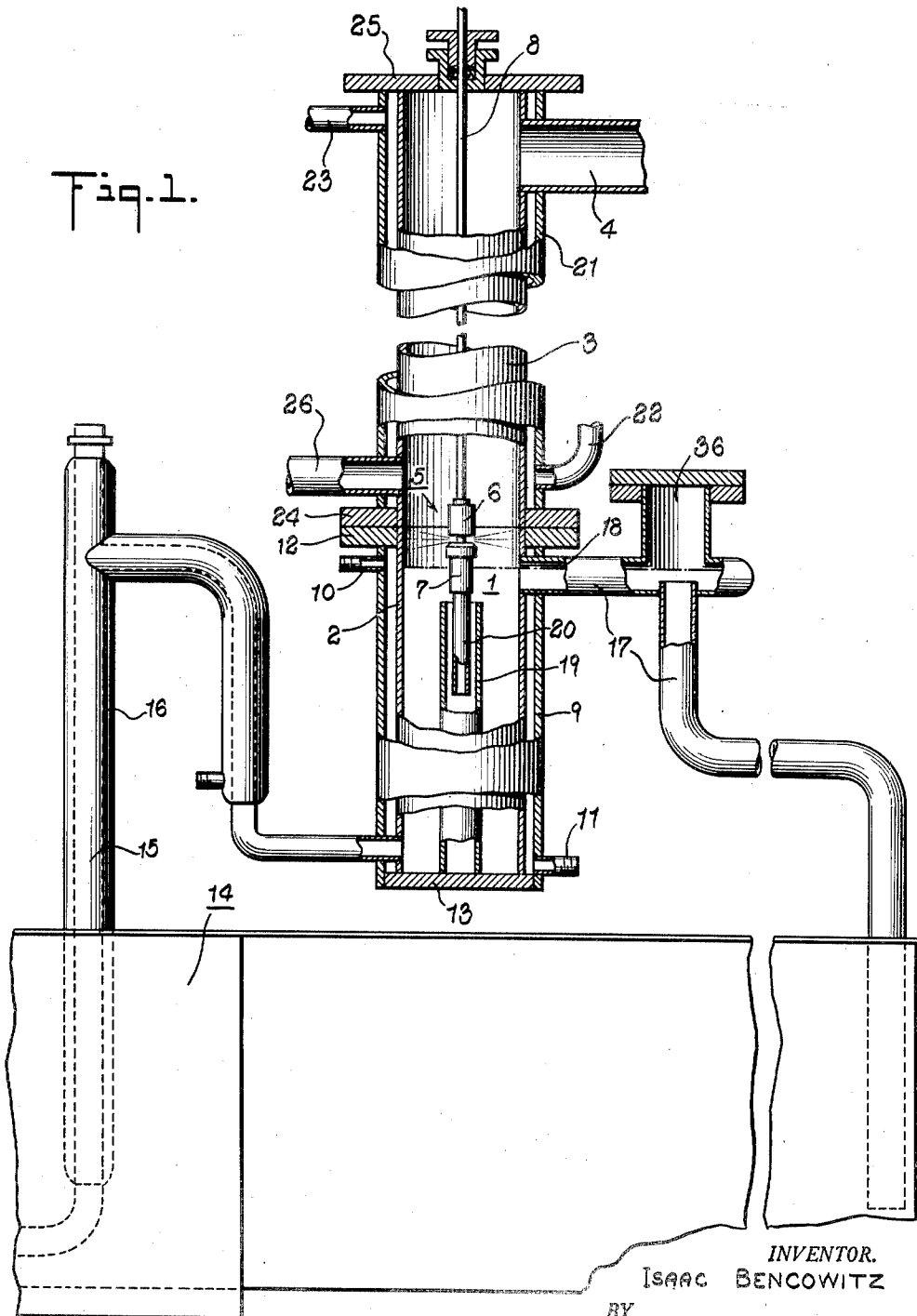
I. BENCOWITZ
SULPHUR ATOMIZER AND BURNER

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2 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

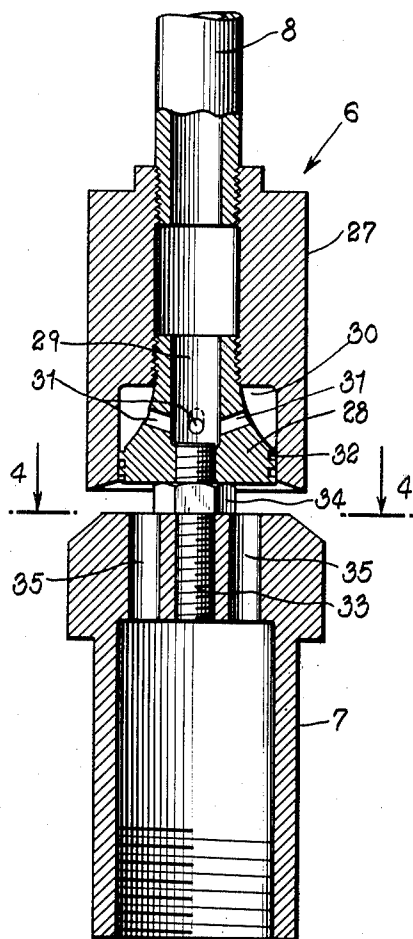
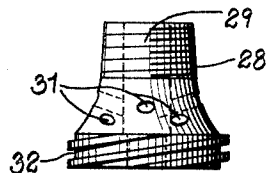


Fig. 3.

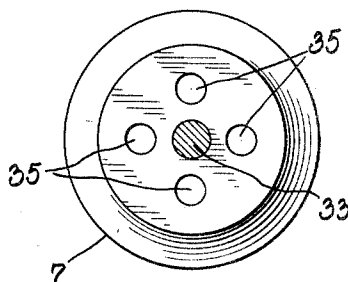


Fig. 4.

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SULPHUR ATOMIZER AND BURNER

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9 Claims. (Cl. 23—278)

The present invention comprises certain novel structural arrangements for apparatus for burning sulphur, as in the manufacture of sulphuric acid, by first atomizing sulphur derived from a molten sulphur bath and then causing combustion to occur. It contemplates particularly features which give rise to highly efficient combustion and which give to the apparatus a structural and operational simplicity making unnecessary any need for elaborate and costly equipment or delicate controls.

The full nature of the invention will better be understood by reference to the following description of one illustrative embodiment thereof which is depicted graphically in the annexed drawings in which the Fig. 1 is a somewhat schematic view partly in cross section of a system for burning sulphur; the Fig. 2 is a cross sectional view of a novel atomizer construction forming an inventive part of the system illustrated in Fig. 1; while the Figs. 3 and 4 are respectively a perspective view of an air distributor used in the construction of Fig. 2 and a top plan view of a sulphur director illustrated in the Fig. 2, the Fig. 4 being viewed as along the line 4—4 of Fig. 2.

Referring to the drawings, and particularly to the Fig. 1, the system there shown operates to atomize molten sulphur in a sulphur bath 1 by means of an air vortex established just above the surface of the bath, and to burn the atomized sulphur. Conditions are such that efficient combustion of the atomized sulphur will occur and the hot gases and sublimed sulphur will be conveyed upwardly through a riser for distribution to any subsequent processing channels. To this end there may be provided a cylindrical container 2 for the molten sulphur, a cylindrical riser 3 for directing the combustion products upwardly to any suitable outlet duct 4 which leads to any suitable further processing equipment (not shown), and an atomizer 5 comprising the nozzle 6 and the cylindrical sulphur pick up tube or director 7, the details of which will be described below. The atomizer is energized by compressed air from a suitable source (not shown) which may, for example, be connected to the inlet pipe 8 by which the atomizer is both supported and supplied.

As indicated better in Fig. 2, the sulphur director 7 has a lower open end which is adapted to be immersed below the surface of the bath 1 so that sulphur from the bath may be sucked up and directed upwardly within the director 7 to its upper open end and thence into the vicinity of the nozzle 6. As will be indicated in greater detail below, the nozzle 6 is so constructed that it will, when energized, establish a vortex of air in the general region of the annular space between juxtaposed faces of the nozzle 6 and the director 7 and, in general, just above the surface of the bath 1. This vortex tends to establish pressure conditions which suck sulphur from that portion of bath 1 which is within director 7 upwardly within the director so that the sulphur is drawn into the turbulence of the vortex for efficient atomization. Combustion, initiated by suitable means (not shown), may take place in a combustion chamber defined generally by the surface of the riser 3 and will give rise to convection currents, which may be assisted by the low and high air pressure flow to be described below, causing the combustion products to flow upwardly within the riser 3 and out of the duct 4.

For maintaining the bath 1 in a molten condition but at a temperature suitable to prevent the viscous condition characteristic of sulphur, there may be provided around the container 2 a concentric jacket 9 having an

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inlet duct 10 and an outlet duct 11 so that steam or other heating medium may be introduced into the annular chamber between the jacket 9 and the container 2. It is noted that this annular chamber is closed at its ends by suitable end members 12 and 13 suitably connected to the container 2 and the jacket 9. For the purpose of supplying the container 2 with a supply of sulphur for the bath 1, there may be provided the following means which permit a continuous or discontinuous flow of molten sulphur in a circuit through the interior of the container 2. A suitable storage vat 14 acting as a reservoir of sulphur is connected with a duct 15 which, as indicated, leads to the interior of the container 2. Suitable pumping means (not shown) may be provided for forcing molten sulphur from the vat 14 into the interior of the container 2. The duct 15 may be jacketed with a suitable steam jacket 16 for maintaining the flowing sulphur at a proper temperature. If the rate of supply of the molten sulphur to the container 2 by these means is greater than the rate at which the sulphur can be consumed by combustion within the combustion chamber within riser 3, the overflow may pass out of the container 2 through an overflow duct 17 which returns the excess to the vat 14. A typical level of the bath 1 under these conditions of operation is indicated by the fluid surface line 18. Control of the level 18 may be effected by adjusting the height of the upper end of the vertical section of duct 17. This arrangement has the merit that scum or like matter which might tend to inhibit combustion and operation may be continuously removed by flow back to the vat 14. Access of the molten sulphur to the interior portions of the director 7 of the atomizer is conveniently permitted by the construction comprising the tube 19 into which a smaller tube 20 projects, the tube 20 being affixed to the lower end of the director 7 in direct communication with its interior.

In order that the temperature within the combustion chamber may be regulated, e. g., prevented from becoming excessive, there may be provided the concentric jacket 21 which surrounds the riser 3 in a manner similar to that in which the jacket 9 surrounds the container 2. Jacket 21 is illustrated as being provided with suitable inlet duct 22 and outlet duct 23 for the circulation of a cooling medium such as water in the annular space between riser 3 and jacket 21. The latter space is confined in a manner similar to that of the space between container 2 and jacket 9 by the end members 24 and 25. In order to facilitate the movement of the combustion products out of the combustion chamber and into the duct 4, there may be connected to the riser 3 an inlet duct 26 through which air, preferably at a relatively low pressure, may be introduced into the combustion chamber. Preferably duct 26 is arranged such that the air is injected tangentially into the cylindrical combustion chamber. It is to be understood that the compressed air supplied to the atomizer through the inlet pipe 8 will also assist in this process. As indicated, the pipe 8 is sealed through the member 25 by suitable means. The pipe 8 also acts as a support for the atomizer 5.

Referring now more particularly to the Figs. 2, 3 and 4, the atomizer 5 is constructed in the following manner. Affixed to the lower end of the pipe 8 is an adapter or cup-like cylindrical collar 27 and concentrically within this collar is an air flow distributor 28 which is shown in perspective in the Fig. 3. The distributor 28 is affixed as by threads to the internal surface of the collar 27 and is provided with a central channel 29 by which the high pressure air may be supplied to the annular chamber 30 between the distributor 28 and the collar 27 through a plurality of ducts 31 extending radially through the distributor. The lower outer surface of the distributor 28 is provided with a plurality of spiral grooves 32 which define with the inner surface of the collar 27 a plurality of spiral channels since the lands forming the sides of the grooves engage the inner surface of the collar 28. These spiral channels terminate in openings in the lower face of the nozzle 6, which openings are preferably uniformly spaced around the periphery. In a typical construction, four such grooves were provided so that four such openings equally spaced 90° apart were presented in the lower face of the nozzle. Because of the spiral direction of

the channels, air coming out of these openings will tend to move tangentially of the various cylindrical members or generally across radii thereof. The air will then circulate in a vortex or cylindrical rotating motion coaxially about the structure of the atomizer and tend to establish low pressure between the nozzle and director so as to suck up the sulphur.

The director 7 is supported by and spaced from the nozzle 6 by means of the threaded bolt 33 and nut 34. Bolt 33 engages within the distributor 28 and thus closes the lower end of the duct 29; it also engages in the center of the upper surface of the director 7. In order to provide communication between the center of the director 7 and the volume directly under the nozzle so that sulphur may be sucked up into the aforementioned vortex, a plurality of openings or channels 35 is provided. As indicated, the outer upper edge of the director 7 is beveled at a suitable angle, for example, from 40° to 20° from the horizontal.

As an example of a practical burner of the type described, the following dimensions for the various parts are indicated. The riser 3 and the container 2 comprised pipes eight inches in diameter, the jackets 9 and 21 were pipes ten inches in diameter, pipe 8 was three-eighths of an inch in diameter, tube 19 was two inches in diameter as was also the duct 17, the duct 4 was four inches in diameter, inlet 26 was two inches in diameter and the remaining elements associated within the jackets 9 and 21 were approximately proportionate to these dimensions on the scale of the drawing. From 25 to 75 lbs. per square inch gauge pressure was supplied to pipe 8.

In operation combustion may be initiated suitably. For example, a gas torch may be temporarily introduced through inlet duct 26 or even into the overflow weir 36, in which case, the natural draft of the combustion chamber, tends to suck the flame into the apparatus. The low pressure air is then introduced approximately into the plane of the flame and the high pressure air introduced through the pipe 8. The various operating conditions are preferably so adjusted that the sulphur bath 1 will remain in a molten state and not become viscous. It has been found that for best efficiency and capacity for a burner of the dimensions previously indicated, the distance of the air jet from the nozzle 6 from the level of the sulphur in the bath 1 should be of the order of one inch. Preferably, the construction of the nozzle 6 is such that the circulating air leaving the openings in its lower surface is directed generally toward the wall of the riser 3.

It will be apparent that the invention presents a simplified, effective and easily controlled burner for the purpose indicated. The construction is such that there is little opportunity for clogging and plugging of the apparatus by the sulphur. Sulphur may be burned continuously and efficiently in controllable quantities. Variations in the pressure and the volume of the air flow can be used as a control means for regulating the rate of burning and the volume of sulphur consumed.

It is to be understood, of course, that the specifications indicated above are for the most part illustrative only and that numerous variations and modifications falling within the true scope of the invention will occur to those skilled in the art.

What is claimed is:

1. Apparatus for burning sulphur comprising a container for a bath of molten sulphur, a riser above said container for directing combustion products away from the surface of the bath, and a sulphur atomizer within the container and riser comprising a sulphur director comprising a vertical passage having an open lower end adapted to be immersed below the surface of the bath within the container and an open upper end through which sulphur from the bath is directed toward the hereinafter mentioned nozzle, said director having an upwardly-facing horizontal face surrounding the open upper end of said passage and adapted to be disposed above the surface of said bath and container and in said riser, and an air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director and including channels terminating at said downwardly-facing end face and directed outwardly and tangentially to a cylinder having its axis at the axis of said director for directing air jets outwardly toward the container and riser between said faces to establish a vortex above and adjacent the upper end of the director.

2. Apparatus for burning sulphur comprising a con-

tainer for a bath of molten sulphur, a riser above said container for directing combustion products away from the surface of the bath, and a sulphur atomizer within the container and riser comprising a sulphur director comprising a vertical passage having an open lower end adapted to be immersed below the surface of the bath within the container and an open upper end through which sulphur from the bath is directed toward the hereinafter mentioned nozzle, said director having an upwardly-facing horizontal face surrounding the open upper end of said passage and adapted to be disposed above the surface of said bath and container and in said riser, and an air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director and including spiral air channels opening outwardly and tangentially of a cylinder having its axis at the axis of said director in the lower face of the nozzle and directed between said faces for directing air jets outwardly toward the container and riser to establish a vortex above and adjacent the upper end of the face on the director.

3. Apparatus for burning sulphur comprising a cylindrical container for a bath of molten sulphur, a cylindrical riser above said container for directing combustion products away from the surface of the bath, and a sulphur atomizer within the container and riser comprising a cylindrical sulphur director comprising a vertical passage having an open lower end adapted to be immersed below the surface of the bath within the container and an open upper end through which sulphur from the bath is directed toward the hereinafter mentioned nozzle, said director having an upwardly-facing horizontal face surrounding the open upper end of said passage and adapted to be disposed above the surface of said bath and container and in said riser, and a cylindrical air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director, the nozzle comprising a cup-like collar with its open end facing the face on the upper end of the director, a pipe for supplying air to the inside of the collar, and a cylindrical distributor fitting into the open end of the collar and defining therewith downwardly extending spiral channels connecting with the inside of the collar and opening in the face of the nozzle and directed between said faces for directing air jets outwardly toward the container and riser in directions crossing radii thereof to establish a vortex above and adjacent the upper end of the director.

4. Apparatus for burning sulphur comprising a container for a bath of molten sulphur, means for supplying molten sulphur to the container and an overflow duct for removing surface scum therefrom, a riser above said container for directing combustion products away from the surface of the bath, and a sulphur atomizer within the container and riser comprising a sulphur director comprising a vertical passage having an open lower end adapted to be immersed below the surface of the bath within the container and an open upper end through which sulphur from the bath is directed toward the hereinafter mentioned nozzle, said director having an upwardly-facing horizontal face surrounding the open upper end of said passage and adapted to be disposed above the surface of said bath and container and in said riser, an air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director and including channels terminating at said downwardly-facing end face and directed outwardly and tangentially to a cylinder having its axis at the axis of said director for directing air jets outwardly toward the container and riser between said faces to establish a vortex above and adjacent the upper end of the director, and means for delivering air under pressure to said nozzle.

5. Apparatus for burning sulphur comprising a container for a bath of molten sulphur, means for supplying molten sulphur to the container and an overflow duct for removing surface scum therefrom, a riser above said container for directing combustion products away from the surface of the bath, and a sulphur atomizer within the container and riser comprising a sulphur director comprising a vertical passage having an open lower end adapted to be immersed below the surface of the bath within the container and an open upper end through which sulphur from the bath is directed toward the hereinafter mentioned nozzle, said director having an upwardly-facing horizontal face surrounding the open upper end of said passage and adapted to be disposed above the surface of said bath and container and in said riser, an air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director and including channels terminating at said downwardly-facing end face and directed outwardly and tangentially to a cylinder having its axis at the axis of said director for directing air jets outwardly toward the container and riser between said faces to establish a vortex above and adjacent the upper end of the director, and means for delivering air under pressure to said nozzle.

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surface of said bath and container and in said riser, an air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director and including spiral air channels opening outwardly and tangentially of a cylinder having its axis at the axis of said director in the lower face of the nozzle and directed between said faces for directing air jets outwardly toward the container and riser to establish a vortex above and adjacent the upper end of the face on the director, and means for delivering air under pressure within said riser and to said nozzle.

6. Apparatus for burning sulphur comprising a cylindrical container for a bath of molten sulphur, a duct entering the bottom of said container and means connected thereto for supplying molten sulphur to the container, an overflow duct for limiting the level of said bath and removing surface scum therefrom, a cylindrical riser above said container for directing combustion products away from the surface of the bath, and a sulphur atomizer within the container and riser comprising a cylindrical sulphur director comprising a vertical passage having an open lower end adapted to be immersed below the surface of the bath within the container and an open upper end through which sulphur from the bath is directed toward the hereinafter mentioned nozzle, said director having an upwardly-facing horizontal face surrounding the open upper end of said passage and adapted to be disposed above the surface of said bath and container and in said riser, and a cylindrical air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director, the nozzle comprising a cup-like collar with its open end facing the face on the upper end of the director, a pipe for supplying air to the inside of the collar, and a cylindrical distributor fitting into the open end of the collar and defining therewith downwardly extending spiral channels connecting with the inside of the collar and opening in the face of the nozzle and directed between said faces for directing air jets outwardly toward the container and riser in directions crossing radii thereof to establish a vortex above and adjacent the upper end of the director, said apparatus including means for injecting air at relatively low pressure into said riser near said nozzle, and means for supplying air at relatively high pressure to said pipe.

7. An atomizer for atomizing molten sulphur comprising a sulphur director comprising a vertical passage having an open lower end adapted to be immersed below the surface of a body of molten sulphur and an open upper end through which sulphur may be directed toward the hereinafter mentioned nozzle, said director having an upwardly-facing horizontal face surrounding the open upper end of said passage and adapted to be disposed above the surface of said bath, and an air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director and including channels terminating at said downwardly-facing end face and directed outwardly and tangentially to a cylinder having its axis at the axis of said director for directing air

jets outwardly from the axis of the director between said faces to establish a vortex above and adjacent the upper end of the director.

8. An atomizer for atomizing molten sulphur comprising a sulphur director comprising a vertical passage having an open lower end adapted to be immersed below the surface of a body of molten sulphur and an open upper end through which sulphur may be directed toward the hereinafter mentioned nozzle, said director having an upwardly-facing horizontal face surrounding the open upper end of said passage and adapted to be disposed above the surface of said bath, and an air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director and including spiral air channels opening outwardly and tangentially of a cylinder having its axis at the axis of said director in the lower face of the nozzle and directed between said faces for directing air jets outwardly from the axis of the director to establish a vortex above and adjacent the upper end of the face on the director.

9. An atomizer for atomizing molten sulphur comprising a cylindrical sulphur director comprising a vertical passage having an open lower end adapted to be immersed below the surface of a body of molten sulphur and an open upper end through which sulphur may be directed toward the hereinafter mentioned nozzle, said director having an upwardly-facing horizontal face surrounding the open upper end of said passage and adapted to be disposed above the surface of said bath, and a cylindrical air pressure nozzle having a downwardly-facing end face juxtaposed to and spaced from the face on the upper end of the director, the nozzle comprising a cup-like collar with its open end facing the face on the upper end of the director, a pipe for supplying air to the inside of the collar, and a cylindrical distributor fitting into the open end of the collar and defining therewith downwardly extending spiral channels connecting with the inside of the collar and opening in the face of the nozzle and directed between said faces for directing air jets outwardly from the axis of the director and crossing radii thereof to establish a vortex above and adjacent the upper end of the director.

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