March 3, 1953 E. B. MILLER 2,629,895

METHOD OF AND APPARATUS FOR MAKING FLAKE SULFUR

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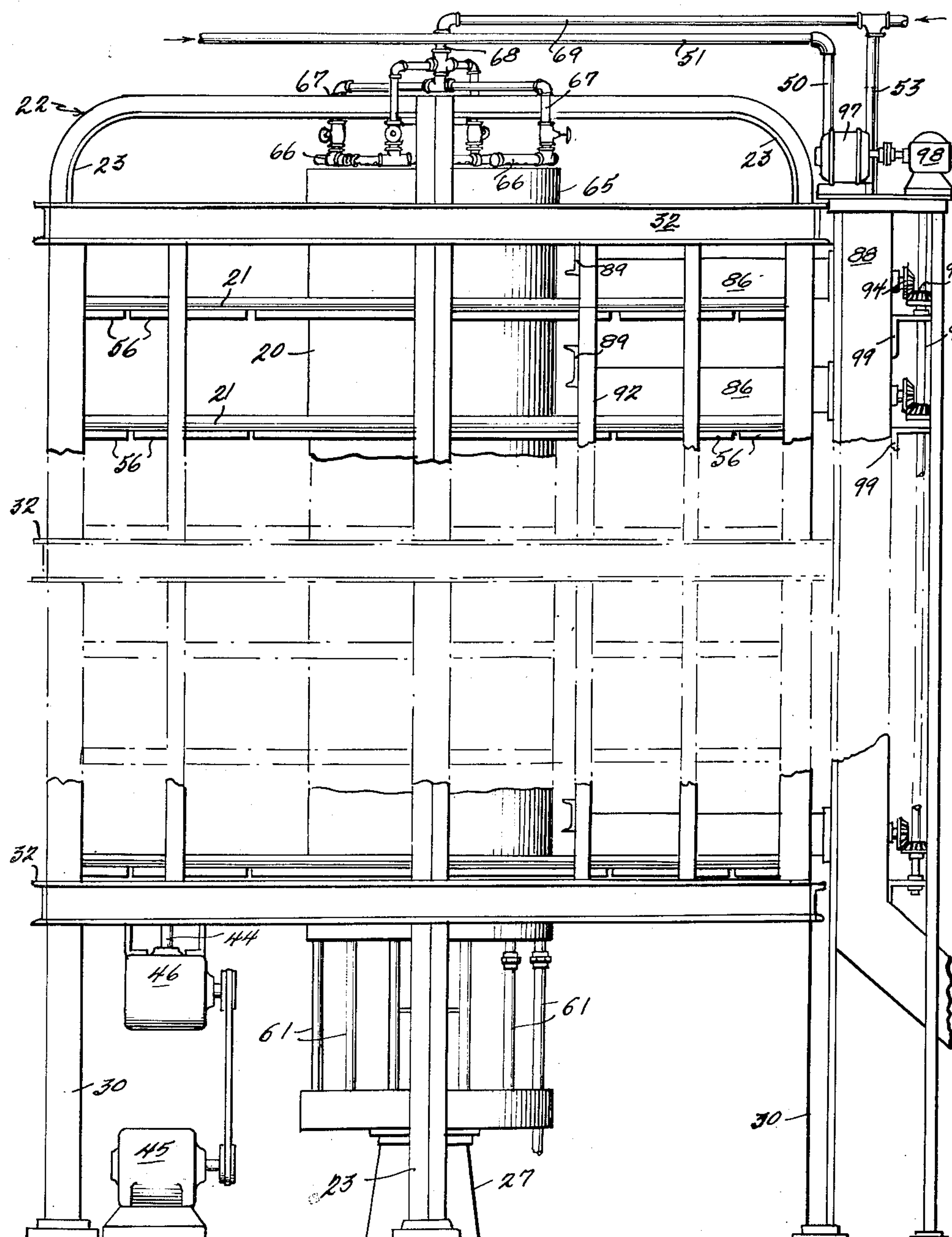


FIG. 1.

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FIG. 2.

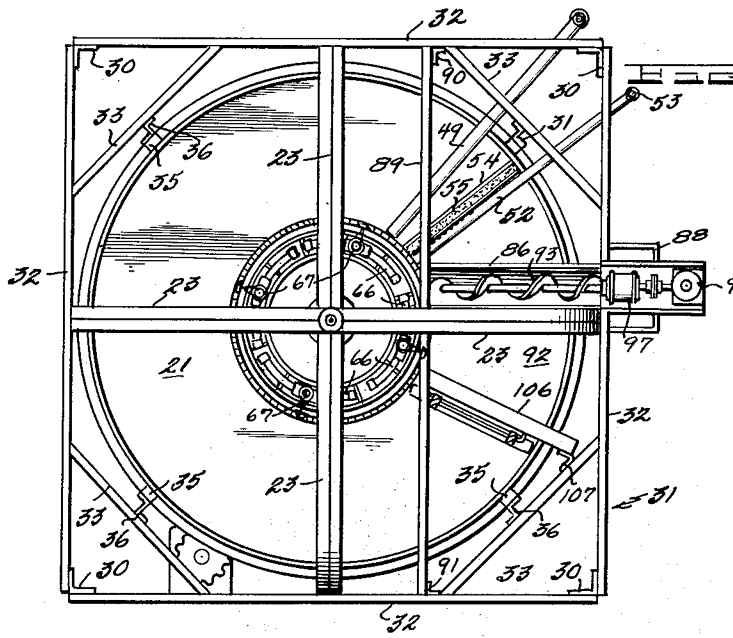


FIG. 9.

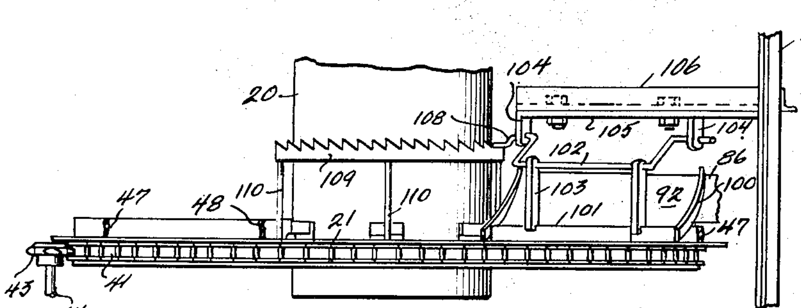


FIG. 10.

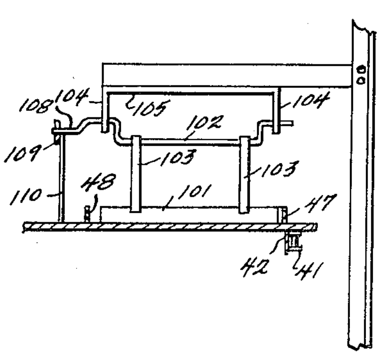


FIG. 11.

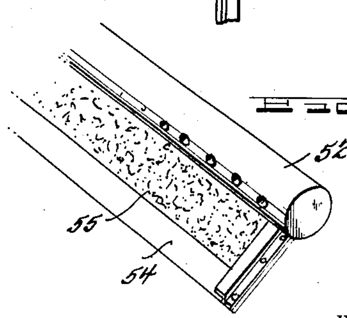


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FIG. 3.

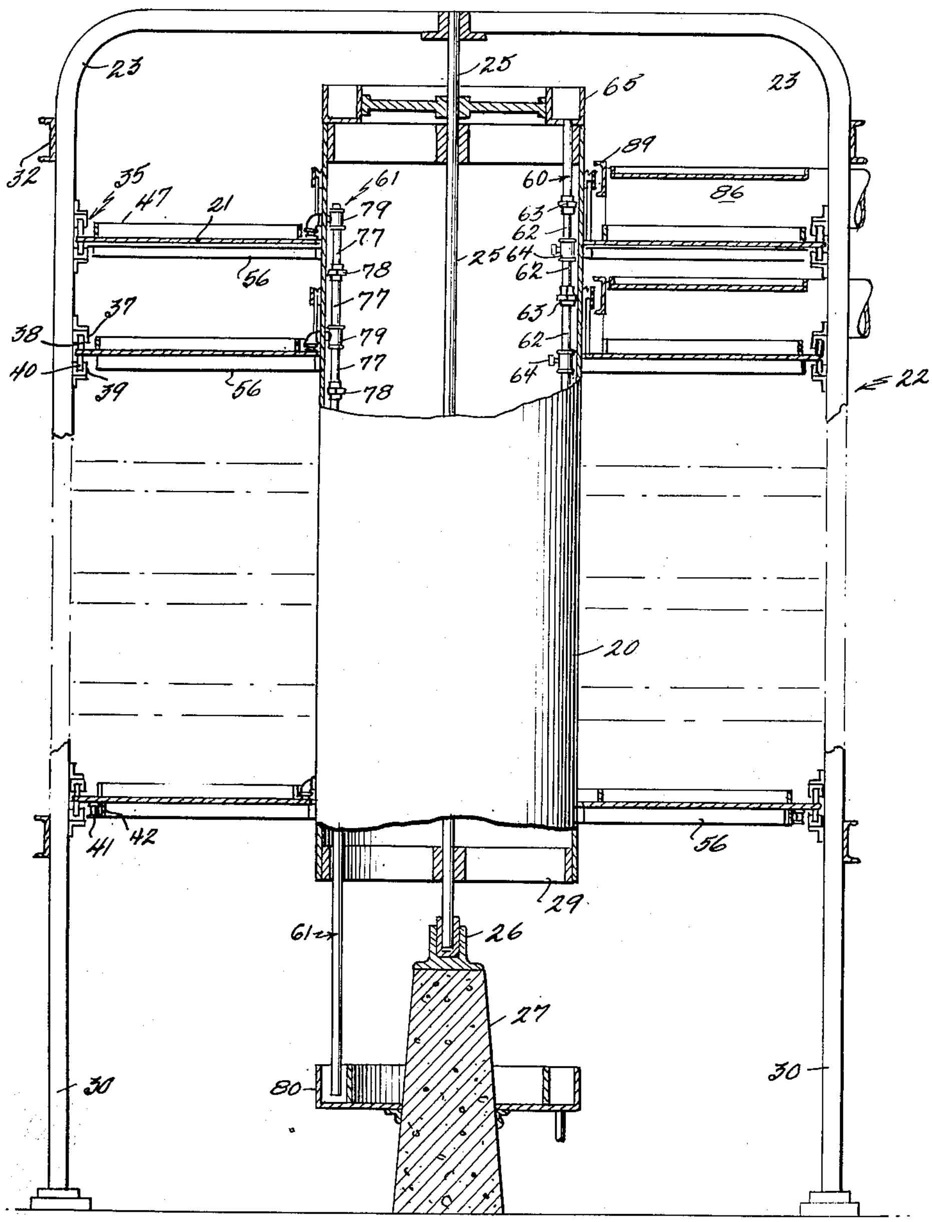


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FIG. 4.

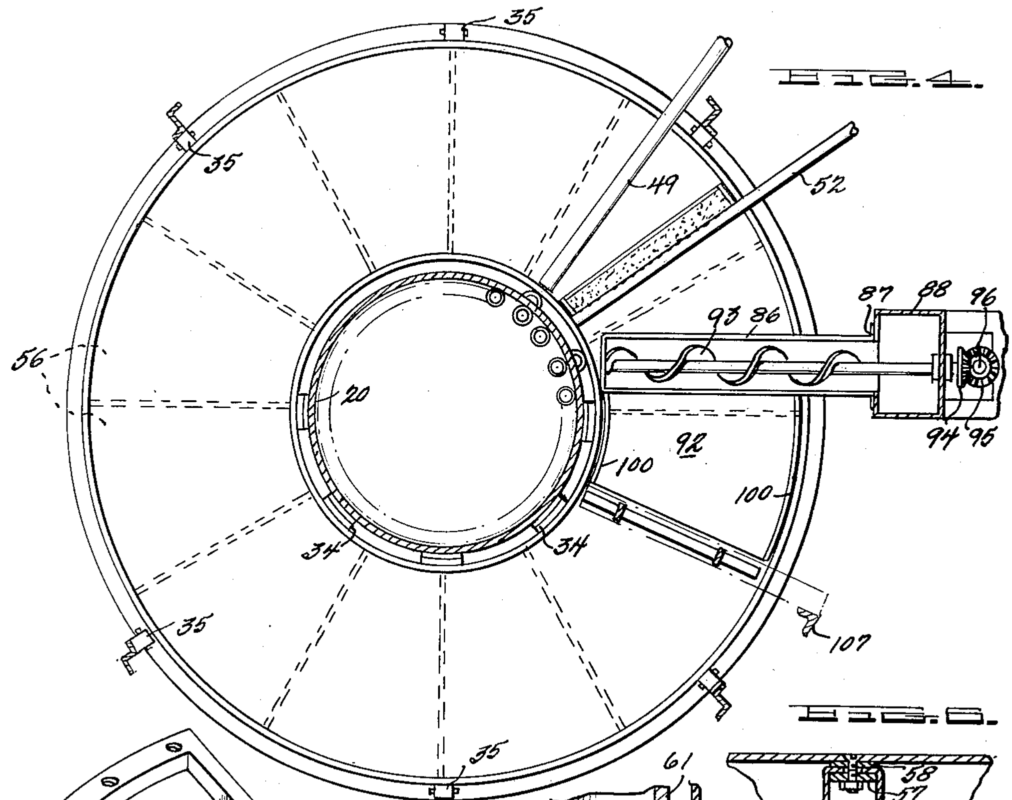



FIG. 5.

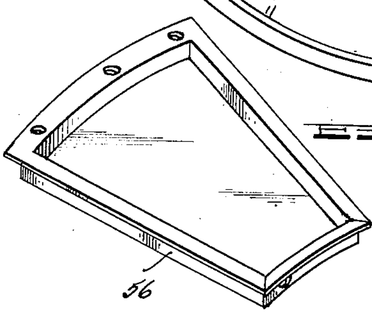



FIG. 6.

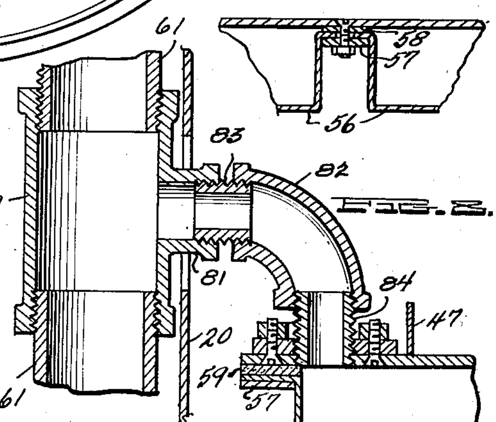
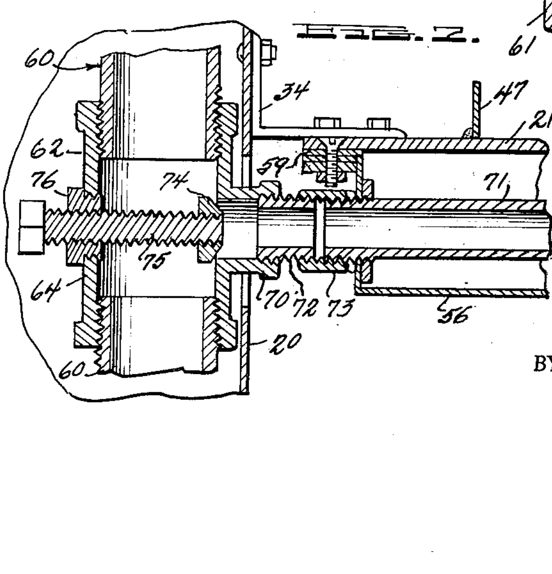



FIG. 8.



FIG. 7.

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Patented Mar. 3, 1953 2,629,895

# UNITED STATES PATENT OFFICE

2,629,895

## METHOD OF AND APPARATUS FOR MAKING FLAKE SULFUR

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Original application March 12, 1951, Serial No. 215,178. Divided and this application March 12, 1951, Serial No. 215,180

6 Claims. (Cl. 18—1)

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This invention relates to the treatment of sulphur and has more particular reference to a method of and apparatus for solidifying and flaking liquid sulphur.

One object of the present invention is to provide a novel method of and improved apparatus for the solidifying and flaking of liquid sulphur.

Another object of the present invention is to provide improved apparatus for continuously converting liquid sulphur into sulphur flakes.

Another object of the present invention is to provide apparatus, as characterized above, including a plurality of rotatable water-jacketed annular plates; means for depositing a layer of liquid sulphur superimposed upon a film of water on the upper surfaces of the plates; and means for cracking and removing the layers of deposited sulphur after they have solidified.

Other objects and advantages of the invention will appear in the following specification when considered in connection with the accompanying drawings, wherein:

Fig. 1 is an elevational view, with parts omitted, of a sulphur flaking machine constructed in accordance with the present invention;

Fig. 2 is a plan view of the machine shown in Fig. 1;

Fig. 3 is an elevational view, partly in section, and with parts omitted for clarity, of the machine shown in Fig. 1;

Fig. 4 is a horizontal sectional view, with parts omitted, taken on the line 4—4 of Fig. 1;

Fig. 5 is a perspective view of a water jacketing pan;

Fig. 6 is a detail view showing how the water jacketing pans are secured to the annular plates;

Fig. 7 is a vertical sectional detail view showing the manner in which an inlet water connection is made to the pan;

Fig. 8 is a vertical sectional detail view showing the manner in which an outlet water connection is made to the pan;

Fig. 9 is an elevational detail view showing the manner in which a breaker is mounted;

Fig. 10 is an elevational detail view showing the breaker bar; and

Fig. 11 is a fragmentary perspective detail view showing the construction of a water spray pipe.

This application is a division of my co-pending application, Ser. No. 215,178, filed March 12, 1951, for Method for the Recovery of Elemental Sulphur in Liquid Form From Gases Containing Hydrogen Sulphide, and the Conversion of the Liquid Sulphur into Solidified Flakes.

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The aforesaid co-pending application involves a system for recovering elemental sulphur in liquid form from gases containing hydrogen sulphide, and the conversion of the liquid sulphur into solidified flakes.

The system includes a sulphur flaking apparatus for converting the recovered liquid sulphur into solidified sulphur flakes.

The present invention is drawn to the novel method of and the particular apparatus for converting liquid sulphur into solidified flakes as disclosed in said co-pending application.

Referring now to the drawings, there is shown in Figs. 1, 2 and 3, one embodiment of apparatus and the arrangement thereof for carrying out the method of this invention. As there shown, a vertical rotatable open-ended cylindrical member **20** having a plurality of axially spaced annular plates **21** secured thereto, is mounted within a suitable structural frame, indicated generally at **22**. The structural frame is formed of structural steel members and is shown as including four vertical frame members **23** having their upper end portions bent over the top of the cylindrical member and secured to a plate carrying an upper vertical guide bearing **24** for a vertical shaft **25** extending centrally of the cylinder **20** and having a lower step bearing **26** mounted on a concrete foundation block **27**. Upper and lower radial arms **28**, **29** connect the shaft to the cylinder. The structural frame **22** also includes four vertical frame members **30** and three vertical spaced horizontal bracing frames **31**, each formed by four structural channel members **32** having their ends secured to the vertical frame members **30**, and having an angle brace **33** extending across each corner (see Fig. 2).

The diameters of the circular openings in the annular plates **21** are larger than the diameter of the cylinder **20** and the inner peripheral edge portions of the plates are secured to the cylinder, as by a plurality of circumferentially spaced L-shaped members **34** having their legs suitably secured to the cylinder and the respective plates (see Figs. 4 and 7). The outer peripheral edge portions of the annular plates are supported by a plurality of roller assemblies **35** carried by four vertical frame members **36** each of which is secured to the three vertically spaced angle braces **33** in each corner of the structural frame assembly (see Fig. 2), and by the vertical frame members **23** (see Fig. 3).

Each of the roller assemblies is identical in construction and, as best seen in Fig. 3, comprises an upper inverted U-shaped member **37** having a roller 38 journalled therein and a lower U-shaped member 39 having a roller 40 journalled therein. The members 37 and 39 are secured to the respective frame member on which they are mounted in spaced apart relation, as by means of brackets which may be welded or bolted to the frame member.

Rotation of the cylinder and the annular plates is effected as by means of a sprocket chain 41 carried by a depending ring member 42 secured to the bottom outer edge of the bottom plate 21 (see Figs. 9 and 10). The sprocket chain meshes with a sprocket 43 mounted on the upper end of a shaft 44 driven by a motor 45 through suitable reduction gearing 46 (see Figs. 1 and 9.)

Each of the annular plates 21 is provided with an upstanding annular flange 47 adjacent its outer periphery and an upstanding annular flange 48 adjacent its inner periphery (see Figs. 3 and 10). The surfaces of the plates between the inner and outer upstanding flanges are designed to have liquid sulphur deposited thereon as the plates are rotated by means of a plurality of perforated horizontally extending branch conduits 49 connected to a vertically extending header or conduit 50 which is connected to a pipe line 51 which delivers liquid sulphur from a source of supply, not shown (see Figs. 1 and 2). All of the liquid sulphur pipe lines and conduits may be steam jacketed, if desired.

In order to prevent the liquid sulphur from sticking to the plates, a plurality of horizontally extending perforated branch water conduits 52 are provided. Each of the branch conduits extends across one of the plates 21 and is positioned ahead of the branch conduit 49 which deposits liquid sulphur on the plate, so that a water film may be deposited on the plate as it rotates, before the sulphur is deposited. The branch water conduits are connected to a vertical water header 53 which is connected to a source of water supply, not shown (see Figs. 1 and 2).

In order to insure that a continuous thin film of water is deposited on the plates 21 and to prevent any possible flow of liquid sulphur to pass back of the perforated branch conduits 52, each of the conduits 52 is shown as having secured thereto a downwardly and forwardly extending generally rectangular metal lip 54 having a felt pad 55 suitably secured to the upper portion of its surface just below the row of perforations in the pipe (see Fig. 11).

While the thin layers of deposited liquid sulphur may be solidified by air cooling, additional means for cooling the sulphur may be provided. In the particular embodiment of the invention illustrated, additional cooling means are provided by water jacketing the bottoms of the portions of the plates 21 on which the sulphur is deposited. Each of the plates 21 is water jacketed in the same manner and, as shown, a plurality of pans 56 (see Figs. 1, 3, 4 and 5) are secured to the under surfaces of the plates. Each pan is substantially trapezoidal in shape and its upstanding walls are provided with a laterally extending flange around their upper edges. The pans are removably secured to the under sides of the plates 21, as by means of radially extending steel strips 57 bolted to the under surfaces of the plates and securing the flanges of adjacent pans between itself and the plates. Cork gaskets 58 may be inserted between the flanges and the steel plates, if desired (see Fig. 6). The flanges along the inner and outer walls of the pans are secured to the under side of the plates 21, as by bolting, with an intervening gasket strip 59 to make it water-tight (see Figs. 7 and 8).



Mounted within the cylinder 20 are a plurality of water inlet pipes 60 and water outlet pipes 61. Each of the inlet pipes 60 is made up of a series of short pipe sections 62, union couplings 63, and valve T fittings 64 connected together so that each valve T fitting is positioned to be connected to one of the pans of the series of pans under each of the annular plates 21, and the union couplings are positioned on opposite sides of the valved T fittings to facilitate the connection or disconnection of the T fitting to its respective pan (see Fig. 3). Each of the inlet pipes 60 is fixedly connected at its upper end to a compartment in an annular compartmentized open top trough 65 which is secured to the shaft 25 and rotates with the cylinder 20. Water is supplied to the compartmentized trough 65 by means of a plurality of arcuate perforated pipes 66 (four such being shown), each of which is positioned to supply water to a series of compartments in the trough. Each arcuate pipe 66 is connected to a valved down-comer pipe 67. The down-comer pipes 67 are connected to a single down-comer pipe 68 carried by a pipe 69 which is connected to the source of water supply (not shown). The construction and arrangement are such that each separate series or group of compartments in the trough 65 will have a separate controlled water supply, thus permitting control of the rate of flow of the water through the pipes 60 and thereby permitting control of the temperature of the cooling pans (see Fig. 1).

The manner in which each water inlet pipe 60 is connected to each of its respective pans is identical and the details thereof are shown in Fig. 7. As there shown, the valved T fitting 64 has its stem or lateral branch 70 projecting through an opening formed in the cylinder 20 and connected to a spur tube 71 in the pan, as by means of nipple 72 and a coupling 73, respectively. A gasket may be positioned between the coupling and the wall of the pan and a lock nut may be threaded on the spur tube, if desired, all as shown in Fig. 7. The inner peripheral edge of the T fitting stem forms a seat for a valve disc 74 mounted on the end of a threaded valve stem 75 screwed in a cap or plug member 76, which, in turn, is screwed in the side wall of the T fitting opposite the stem branch. The flow of water into the pan may be controlled by adjusting the valve disc relative to its seat.

Each of the water outlet pipes 61 is made up of a series of short pipe sections 77, union couplings 78, and T fittings 79, connected together so that each T fitting is positioned to be connected to one of the pans of the series of pans under each of the annular plates 21 and the union couplings are positioned on opposite sides of the T fittings to facilitate the connection or disconnection of the T fitting to its respective pan (see Fig. 3). Each of the outlet pipes 61 has its bottom pipe section projecting downwardly into an open top annular trough 80 fixedly mounted on the concrete support 28. The annular trough 80 may be provided with a drain pipe and a plurality of the bottom pipe sections of the outlet pipes 61 may be provided with couplings to facilitate their removal to permit access to the interior of the drum 20, all as shown in Fig. 1.

The manner in which each water outlet pipe 61 is connected to each of its respective pans is identical, and the details thereof are shown in

Fig. 8. As there shown, the T fitting 79 has its stem or lateral branch 81 projecting through an opening formed in the cylinder 20 and connected to an elbow fitting 82 by means of a nipple 83. The elbow fitting 82 is connected to a nipple 84 which extends through a disc flange bolted onto the upper surface of the plate 21 adjacent its inner edge, and is threaded into an opening formed in the plate 21, all as shown in Fig. 8.

Suitable means are provided for scooping up the deposited layers of sulphur on the annular plates 21 after they have solidified. In the particular embodiment of the invention illustrated, such means are shown as comprising a plurality of troughs 86, each having its open outer end 87 connected to discharge into a vertical chute 88 and its closed inner end secured to a channel bar 89 which extends between and is secured at its ends to upright angle frame members 90, 91 (see Figs. 1 and 2). Each of the troughs 86 is positioned to extend inwardly over one of the annular plates 21 and each has a ramp 92 extending downwardly into engagement with the upper surface of the plate and positioned to scoop the sulphur up into the trough, and a screw conveyor 93 having its inner end journalled in a suitable bearing formed on the closed inner end of the trough and its outer end portion journalled in a suitable bearing formed in the outer side wall of the vertical chute 88 and carrying a bevelled gear 94 which meshes with a bevelled gear 95 fixedly mounted on a vertical shaft 96. The vertical shaft 96 drives all of the screw conveyors and, in turn, is driven, as by means of a motor 97, through reduction gearing 98. The vertical shaft 96 may be mounted in vertically spaced bracket bearings 99 suitably secured to the outside wall of the chute 88 (see Figs. 1, 2 and 4). The ramp or scoop 92 is provided with upright flanges 100 along its longitudinal side edges and fits between the outer and inner flanges on the plate 21 (see Fig. 9).

Suitable means are provided for breaking up the solidified layer of sulphur on each of the plates 21 before it is scooped up into the trough associated with the plate. Each of these means is identical in construction and the details thereof are shown in Figs. 9 and 10. As there shown, a heavy breaker bar 101 is pivotally suspended from a U-shaped crank shaft 102, as by means of a spaced pair of arms 103. The crank shaft 102 is journalled in the depending legs 104 of an inverted U-shaped bracket member 105. The member 105 is secured to a bracket arm 106 connected at one end to an upright structural angle member 107 which, in turn, is secured to the tiered cross brace members 33 in one corner of the structural frame (see Fig. 2). The arm 106 extends across the plate 21 in position to place the breaker bar 101 adjacent the bottom of the ramp or scoop 92 (see Figs. 2 and 9). The inner end of the crank shaft 102, as viewed in Figs. 9 and 10, has a crank 108 formed thereon and positioned to extend across and be engaged by the teeth of a rotating ratchet or cam ring 109. The ratchet or cam ring is shown as encircling the cylinder 20 and as being mounted on a plurality of circumferentially spaced vertical rods 110 secured to the inner end portion of the plates 21 (see Figs. 9 and 10). The inclined upper surfaces of the teeth of the ratchet ring engage the crank 108 on the end of the crank shaft 102 as the ratchet ring rotates and causes an alternate rising and falling of the breaker bar 101, which results in breaking the solidified sulphur into small pieces or flakes before it passes up the ramp or scoop 92 into the trough 86.

The operation of the device is believed obvious. As the cylinder 20 and the annular plates 21 are rotated (in a counterclockwise direction as viewed in Fig. 2), a thin film of water is deposited on the upper surface of each of the plates 21 by the branch water pipes 52, and a layer of liquid sulphur is deposited on top of the film of water by the branch sulphur pipes 49. The thickness of the layer of sulphur is determined by the speed of rotation of the plates and the rate of flow of the liquid sulphur. As the plates rotate, the layers of liquid sulphur thereon are solidified by the air and by the water jackets beneath the plates. As the solidified layers of sulphur approach the ramps or scoops, they are broken into small pieces or flakes by the constant rising and falling of the breaker bar 101. The broken pieces or flakes of sulphur pass up the ramps into the troughs 86 from which they are removed by the screw conveyors and dumped into the vertical chute 88. The sulphur flakes fall through the chute 88 into the bottom of a vertical conveyor (not shown) which lifts them into a storage hopper (not shown). The sulphur flaking machine may be made of any suitable material, such as structural steel. However, all the parts thereof which come into contact with the liquid sulphur are preferably made of stainless steel.

From the foregoing description, it will be apparent that there has been provided a novel method of and improved apparatus for the conversion of liquid sulphur into sulphur flakes.

Obviously, the invention is not restricted to the particular embodiment thereof herein shown and described. Moreover, it is not indispensible that all of the features of the invention be used conjointly, since they may be employed advantageously in various combinations and sub-combinations.

What is claimed is:

1. In the formation of sulphur flakes from molten sulphur involving the depositing of a layer of molten sulphur on a previously wetted surface of a moving carrier, the cooling of the sulphur layer to solidify it and the subsequent breaking up of the solidified layer into flakes, the improvement which comprises continuously rotating an annular metal carrier having a flat upper surface about a vertical axis; continuously applying a film of water on the upper surface of said carrier at one point in its path of travel; continuously depositing a thin layer of molten sulphur on the water film at another point in the path of travel of the carrier adjacent to the point where the water film is applied; continuously directing a stream of cooling water against the entire bottom surface of said carrier as it rotates, whereby the deposited layer of sulphur will be solidified due to the extraction of heat therefrom; and continuously breaking up and removing the solidified layer of sulphur at a third point in the path of travel of said carrier.

2. Apparatus for the conversion of liquid sulphur into solidified flakes which comprises at least one rotatable metal plate having a flat upper surface; means for rotating said plate about a vertical axis; means including a conduit for depositing a film of water on said plate at one point in its path of travel; means including a conduit for depositing a layer of liquid sulphur on the water film formed on said member at another and adjacent point in its path of travel; heat exchanging

means mounted on the bottom of said movable plate for cooling and solidifying the liquid sulphur thereon; and means for breaking up and removing the solidified sulphur from said plate at a third point in its path of travel.

3. Apparatus for the conversion of liquid sulphur into solidified flakes which comprises at least one rotatable annular flat metal plate; a perforated pipe extending radially of said plate at one point for depositing a film of water thereon as the plate rotates; a perforated pipe extending radially of said plate at a point spaced from said first point for depositing a layer of liquid sulphur on the water film formed on the rotating plate; cooling means including conduits and water jacketing pans mounted on the bottom of said plate for cooling and solidifying the liquid sulphur; and means including a breaker bar and scoop for cracking the solidified layer of sulphur into flakes and removing the flakes from the plate as it rotates.

4. Apparatus for the conversion of liquid sulphur into solidified flakes which comprises a vertical rotatable cylinder having a plurality of axially spaced annular radially extending metal plates secured thereto; means including a water header having a plurality of branch perforated pipes each extending radially of one of said plates for sprinkling a film of water thereon as the cylinder rotates; means including a liquid sulphur header having a plurality of branch perforated pipes each extending radially of one of said plates and spaced from the corresponding water branch pipe for depositing a layer of liquid sulphur on the water film formed on the plate as it rotates; means including pipes and water jacketing pans mounted on the bottoms of said plates for cooling and solidifying the layers of liquid sulphur deposited thereon; and means mounted above each plate for breaking up and removing the solidified layer of sulphur therefrom as the plate rotates.



5. Apparatus, as set forth in claim 4, wherein the means for breaking up and removing the solidified layer of sulphur from each plate comprises a breaker bar pivotally mounted for a rising and falling engagement with the plate, a scoop having a screw conveyor mounted therein, and a vertical conduit connected to each scoop to receive the broken up flakes of sulphur.

6. Apparatus, as set forth in claim 4, wherein each of the perforated pipes for sprinkling water is provided with a generally rectangular downwardly and forwardly depending metal lip having a felt pad secured thereto to insure that a continuous film of water is deposited on the plate and prevent back flow of the sulphur thereon.

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