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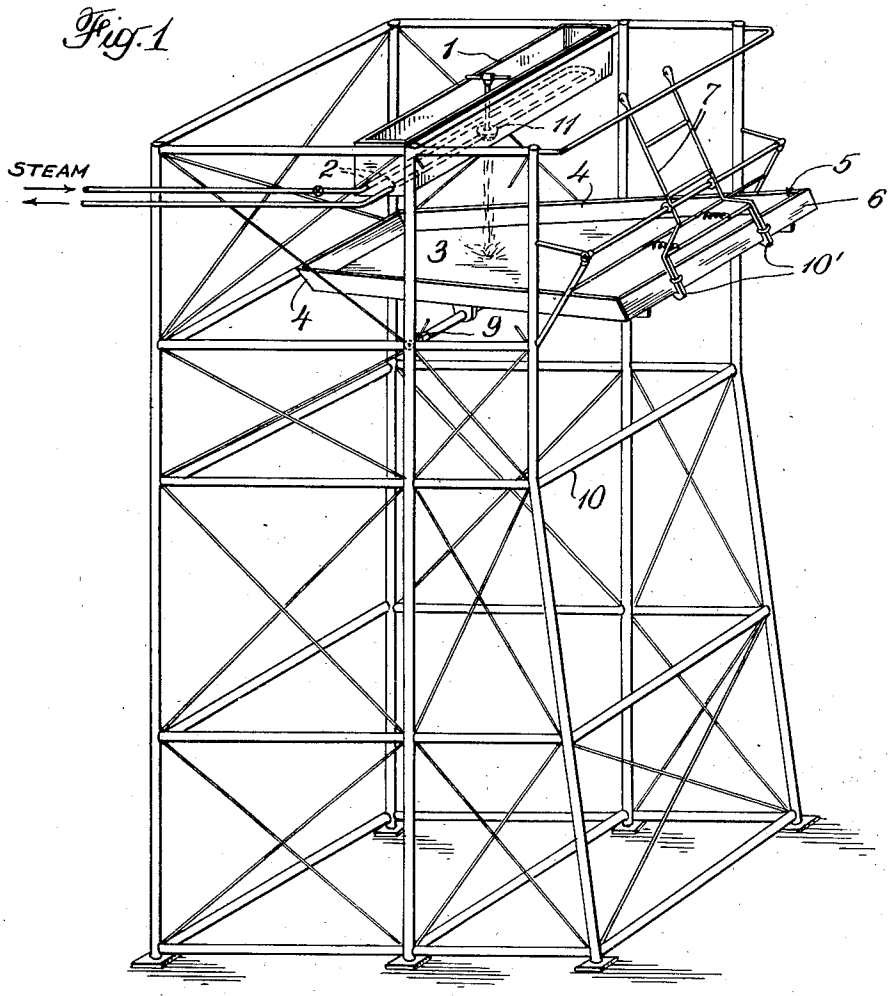
APPARATUS FOR SOLIDIFYING SULPHUR

Original Filed June 11, 1927

Fig. 1



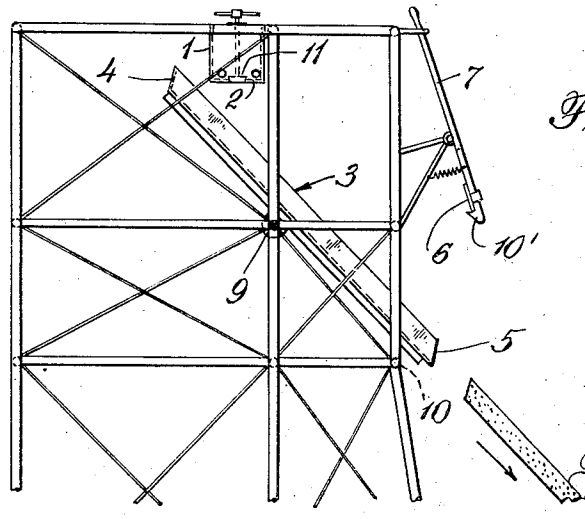


Fig. 2.

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UNITED STATES PATENT OFFICE

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APPARATUS FOR SOLIDIFYING SULPHUR

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Our invention relates to processes and appliances for cooling and solidifying various substances but is intended more particularly for use in cooling and solidifying molten sulphur.

The objects of the invention are fourfold. One object is to provide a process whereby molten sulphur may be reduced to a solid state previous to loading for shipment without the long delay incident to present methods. A second object is to provide a process whereby the cooled and solidified sulphur is delivered in a condition suitable for loading directly to cars for shipment without breaking down of the solidified mass as is commonly necessary with the present method. A third object of our invention is to provide apparatus by means of which the cooling and solidifying process may be carried on continuously and economically and on a scale commensurate with the large daily output of an actively producing mine operated by the underground fusion method. A fourth object is to provide a container for sulphur to be cooled, to which the sulphur will not adhere, and from which the cooled sulphur may be readily dropped out.

The process of cooling and solidifying sulphur which has generally been used heretofore at mines producing sulphur by the underground fusion method consists of pumping the molten sulphur into huge bins having vertical sides constructed of wood. Some of these great bins are as much as sixty feet wide, a hundred or more feet long, and forty to sixty feet high. The sulphur, after being discharged into the bins in a molten state, is allowed to cool and solidify. As the height of the sulphur in the bin increases the sides of the bin are from time to time extended upward until the desired height is reached. On account of the great size of the block of sulphur present when such a bin is full, and because of the high heat insulating value or low thermal conductivity of sulphur, it takes many days for the interior of such a huge block of sulphur to cool and solidify to a point where the bin may be opened up without danger from the still hot and unsolidified sulphur in the interior of the mass. This tendency for the sulphur to remain for long periods in a molten condition in the interior of the sulphur bin has resulted in serious accidents causing injury not only to property but to workmen employed in preparing the sulphur for loading.

After the bin has been filled to the desired height and sufficient time has elapsed for the sulphur therein to solidify and cool, the wood sides of the bin are stripped off holes are drilled into the solidified sulphur, explosives are placed in the holes and detonated. The blast breaks down a portion of the solidified sulphur but frequently many large lumps of sulphur must first be further reduced in size either by small blasts of explosive or by hand hammers before the sulphur is in condition for handling with a steam shovel or locomotive crane. The sulphur is then loaded into cars for shipment. It is when the side of one of these great masses of sulphur is blasted away that molten sulphur which has remained unsolidified in the interior of the mass may flow out and endanger the lives of workmen. The expense of constructing the bins, of the blasting down of the sulphur, of the subsequent breaking up of the large lumps, so that they may be rehandled, the long time required for cooling, the cost of rehandling into cars,—all these drawbacks inherent in the method now in common use are overcome by the process and apparatus which we have invented.

We are aware that many previous attempts have been made to solve this problem, and that there have been devised many ways for overcoming the above defects of the present commonly used method but these devices are cumbersome, expensive to construct and to maintain and so far as we are aware, have failed to replace the older method described above in a single instance.

Most of these devices have consisted of a conveyor of either the belt or pan type on which the molten sulphur is allowed to flow and is cooled while traveling upon the belt or within the pans of the conveyor. The size or length or number of the conveyors required to handle and cool, say, 1,000 tons of sulphur per day by these methods is so great that the cost of installation is prohibitive.

Another difficulty has been the tendency for the molten sulphur to adhere tenaciously to the surface against which it cools and many efforts have been made to overcome this trouble. With our process and apparatus there is no difficulty on this score. Our process consists essentially in placing the molten sulphur in large shallow trays to cool in the air and then dumping the large, relatively thin sheet of sulphur from the tray.

One of the marked advantages of our process lies in the simplicity of the apparatus. There are no continuously moving parts, no belts, no conveyors, no power required. The large area of sulphur in a relatively thin sheet exposed to the atmosphere, cools, slowly and steadily and produces a cake of sulphur possessing noticeable advantages over sulphur cooled in bins by the commonly used method. The cooled cake is highly crystalline in character. It is brittle and easily broken but when broken does not produce any appreciable quantity of dust. In fact, one of the valuable advantages possessed by sulphur cooled by our process lies in this freedom from dust of the broken up cakes. The lesser amount of dust present results in a lesser amount of acid being present in the sulphur as shipped. Acid is very objectionable in many manufacturing processes in which sulphur is used. The loss on handling is lessened and the fire hazard which arises largely from the presence of fine sulphur-dust is reduced. The product is therefore superior to anything now known in the raw and crude sulphur trade.

Obviously there are many forms of apparatus possible which would successfully carry out this process and we have shown in the drawings only one of these forms as illustrative of the type of apparatus which embodies the spirit of our invention.

In the accompanying drawing like symbols refer to the same or similar parts and arrows indicate direction of movement or rotation.

Figure 1 shows a perspective view of one unit or section of the complete apparatus with the cooling tray in position for filling. Figure 2 shows a portion of the apparatus including the cooling tray in position for discharging the sulphur.

In Figure 1, a trough 1 designed to receive and retain molten sulphur, is equipped with pipes 2 through which a heating fluid may be circulated to keep the surrounding sulphur in a molten condition. Below this trough are positioned a plurality of pans or trays 3, having upturned sides 4, 4, 4, but with one side 5, open. This open side of the pan is closed by means of a gate 6 which is held in position by any suitable means such as the arms 7, 7. The pans, 3, are pivotally attached to the framework of the supporting structure by means of the shaft rotatable in the bearings 9. A stop is provided at 10 which prevents the rotation of the pan beyond an angle of about 45° with the horizontal. A latch 10′ is provided for holding the pan 3 in a horizontal position while filling and cooling. In the trough are valves 11 by means of which molten sulphur may be discharged from the trough into the pans 3. The pans 3 are constructed of or alined with a material to which the sulphur will not adhere when cold. This material should also be highly resistant to the action of sulphur, either in the molten or solid state. A great deal of experimental investigation has been made of materials available for this purpose to find one suitable for the service. Much has been done by others to find a material suitable for small containers in which sulphur may be cooled but so far as we know no suitable material has been found to which sulphur would not at times adhere.

We find, however, that when the receptacle is quite large, i. e., many square feet in area, the relative contraction of the sulphur and the receptacle on cooling causes a freeing of the adhesion between the sulphur and the container which does not take place to a like extent in the case of smaller containers. We have found that pans or containers made of or lined with aluminum act in a very satisfactory manner in this respect and we prefer it to other materials for this purpose. This use of aluminum in the construction of the cooling trays has overcome the difficulty due to sticking of the sulphur to the container heretofore experienced in other forms of cooling devices for sulphur and is one of the features of our invention.

The pans 3 in our preferred embodiment are shown trapeziform in plan with the base of the trapezium as the open side of the tray. These trays should be relatively smooth on the inside and without sharp corners at the juncture of the bottom and sides. The tray 3, being in a substantially horizontal position and held by the latch 10′, is closed at its open end 5 by the close fitting gate 6. Sulphur is admitted to the tray from the trough 1 by opening the valve 11. When the molten sulphur has attained the desired depth in the tray the valve is closed and the molten sulphur is allowed to solidify and cool in the tray by the cooling action of the air. It has been found that in warm summer weather a layer of sulphur six inches thick will solidify and cool sufficiently for dumping from the tray in about four hours.

Upon the completion of the cooling period the latch 10′ is released and since the wide end of the tray with its sulphur content is heavier than the narrow end the tray tips to the position shown in Figure 2 and the end 5 of the tray is then open as the gate 6 is held stationary by the supports or brackets 7. The sulphur cake then slides from the tray into

whatever suitable receptacle may be provided to receive it. The fall of the cake of sulphur for even a few feet will provide sufficient momentum to cause the cake to break into many small pieces upon striking an obstruction.

Upon being released from its load of sulphur the tray 3 returns to its horizontal position and is caught and held by the latch 10′ in position and in readiness to receive another charge of molten sulphur.

It will be obvious that the trays 3 may be constructed with all four sides turned up instead of having one side left open to be closed by the gate 6, and that such a tray may be rotated 180°, or turned bottom side up, to dump its cooled contents. We do not intend to limit ourselves to trays of the form or shape described herein. We prefer a large shallow tray which will expose a relatively large surface area of sulphur to the cooling action of the air.

Having thus described our invention and the construction and operation of one form of apparatus embodying the spirit of the invention so that one skilled in the art may make and use it, we will now state what we claim as new and novel and on which we pray that Letters Patent be granted:

1. A receptacle for cooling and solidifying molten sulphur comprising a tray of aluminum of relatively smooth interior surface, rotatable about its support for discharging the solidified sulphur.

2. A receptacle for cooling and solidifying molten sulphur comprising a tray of aluminum of relatively smooth interior surface and open on one side for the discharge of the solidified sulphur.

3. The improvement in apparatus of the type described, for cooling and solidifying molten sulphur, consisting of a shallow tray having an inner surface of smoothly polished aluminum, mounted as described.

4. A tray for use in cooling and solidifying molten sulphur having a large area and relatively shallow depth, with inner surface of aluminum.

Signed at Freeport in the county of Brazoria and State of Texas this seventh day of March, A. D. 1927.

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