H. B. HOVLAND.

APPARATUS FOR TREATING ORES AND OTHER MATERIALS UNDER PRESSURE.

APPLICATION FILED MAY 27, 1915.

1,164,187.

Patented Dec. 14, 1915.

3 SHEETS—SHEET 1.

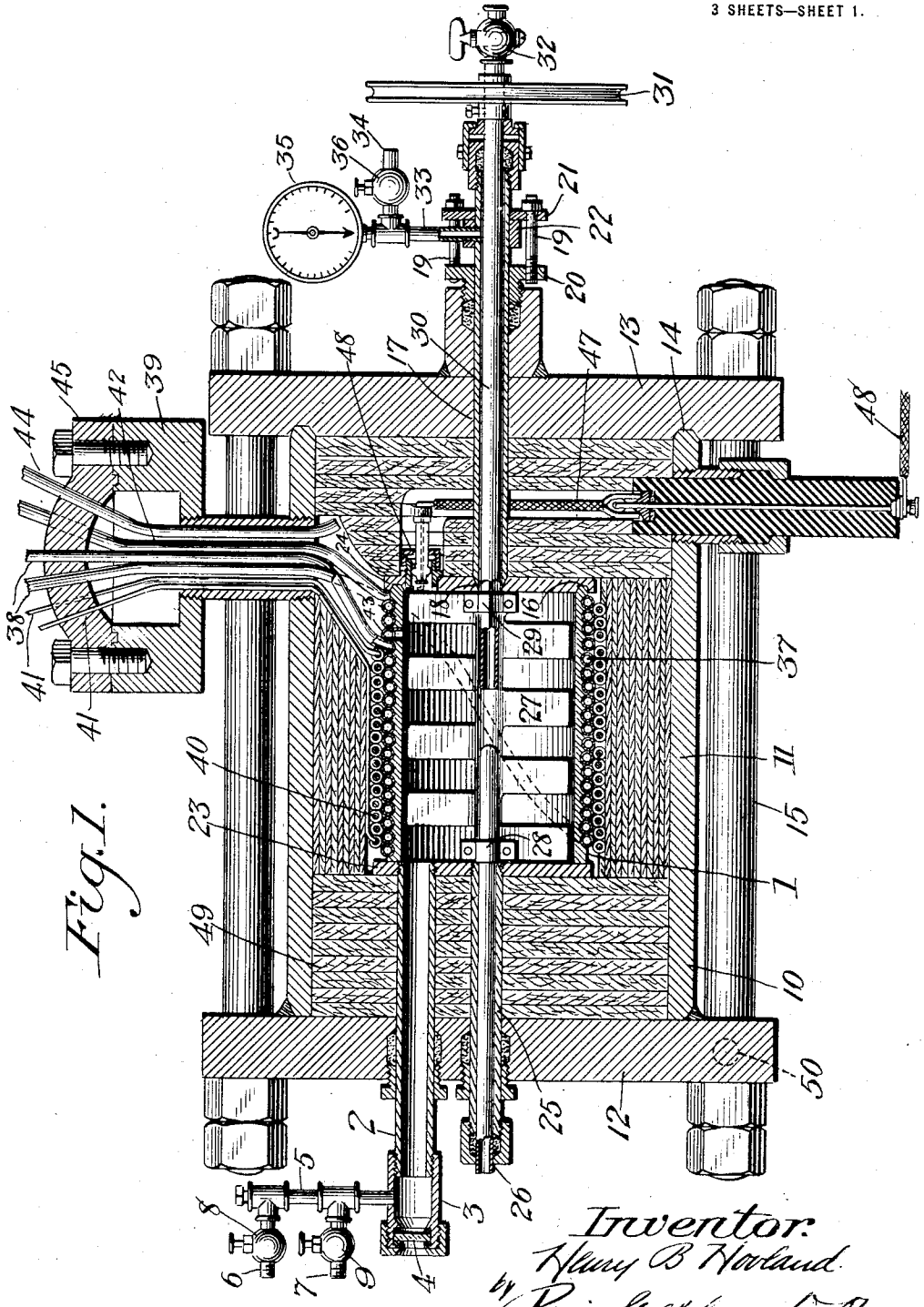


Fig. 1.

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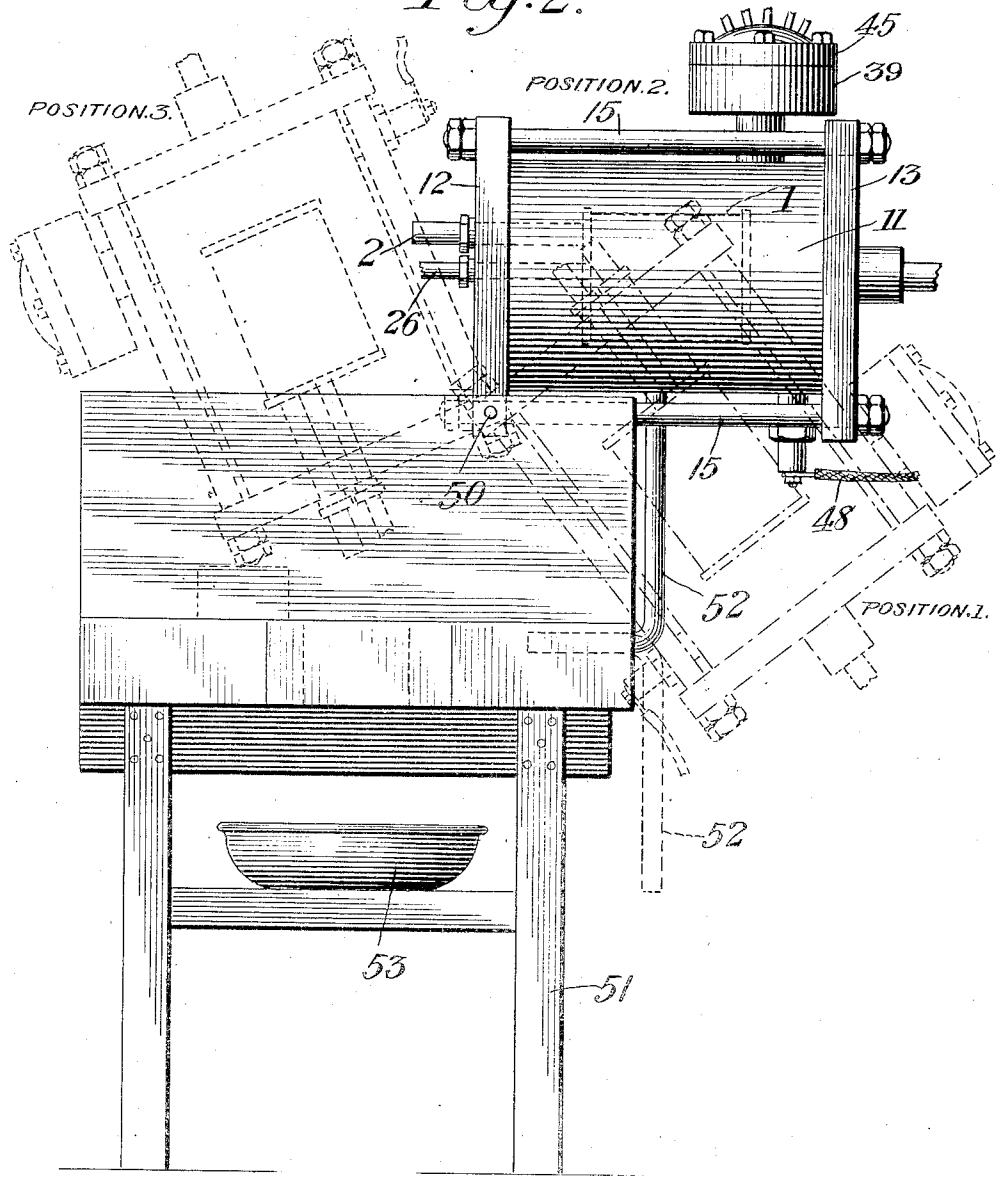
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3 SHEETS—SHEET 2.

Fig. 2.



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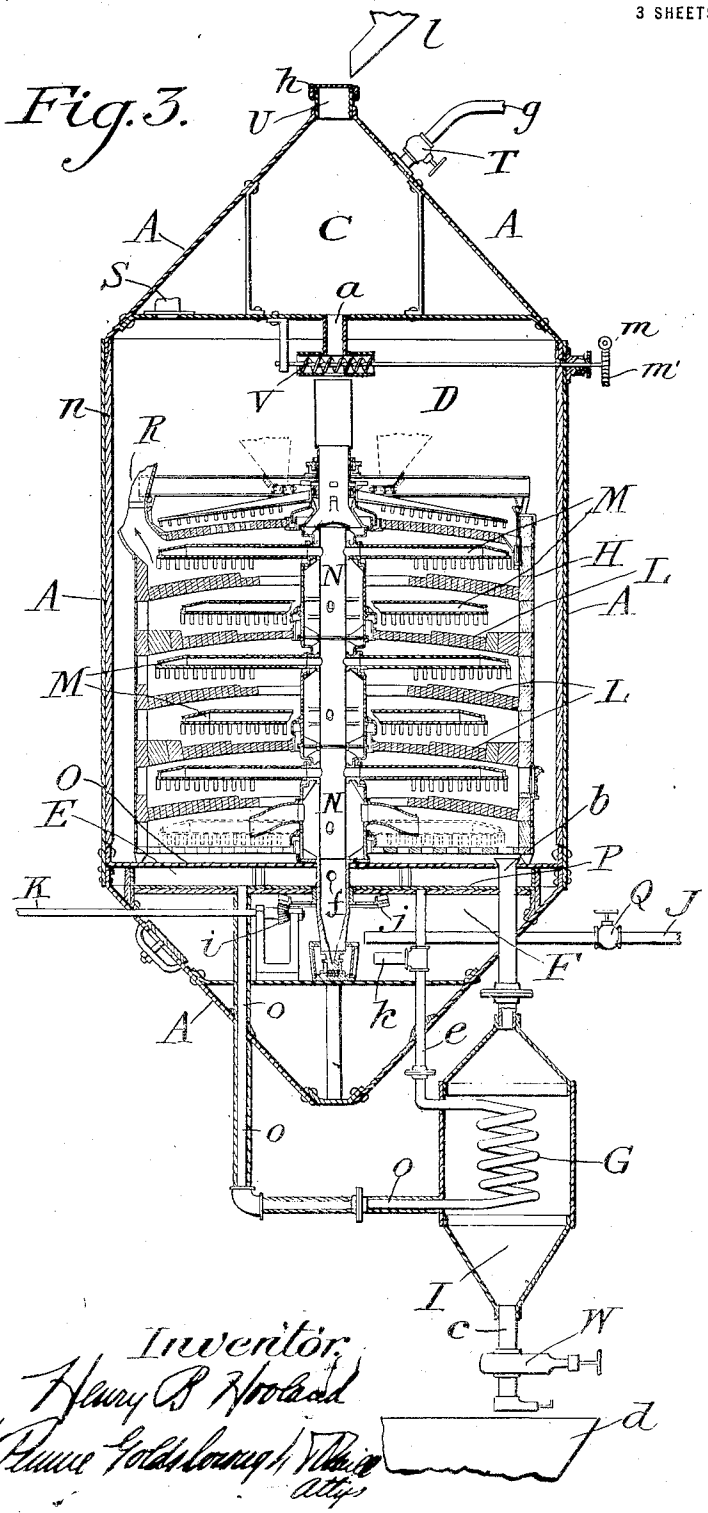
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3 SHEETS—SHEET 3.

Fig. 3.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR TREATING ORES AND OTHER MATERIALS UNDER PRESSURE.

1,164,187. Specification of Letters Patent. Patented Dec. 14, 1915.

Application filed May 27, 1915. Serial No. 30,749.

To all whom it may concern:

Be it known that I, HENRY B. HOVLAND, a citizen of the United States, residing at Duluth, county of St. Louis, and State of Minnesota, have invented certain new and useful Improvements in Apparatus for Treating Ores and other Materials Under Pressure; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to apparatus for sulfating ores and similar materials, and has for its object to provide apparatus which is especially adapted for dry sulfating under superatmospheric pressure in the manner disclosed in the co-pending application of George B. Frankforter and myself, Serial No. 28,308, filed May 15, 1915.

With this object in view, the invention consists in providing a container forming a reaction chamber for holding the material to be treated. The container is inclosed by an external jacket or casing capable of withstanding superatmospheric pressures. The container is provided with means for admitting and discharging the treated material and with means for admitting fluid-reacting constituents, such as sulfurous acid and air under superatmospheric pressure, an agitator being provided in the container for agitating its contents during the treatment by the reacting constituents. If the container is made gas-tight, the space between the container and the outer casing is preferably supplied with fluid under superatmospheric pressure to at least balance the internal pressure of the container, but if the container is not made gas-tight, it is obvious that the pressure medium, such as the sulfurous acid and air under superatmospheric pressure supplied to the container, will also increase the pressure in the outer casing, and the pressure on the outer walls of the container will, therefore, equal the pressure on the inner walls thereof. When the desired pressure has been obtained in the apparatus to promote the chemical reactions, a suitable bleeder valve associated either with the container or the outside casing may be partially opened to permit bleeding of the gaseous contents of the apparatus and the admittance of fresh fluid reacting constituents. In some instances, it may be desirable to supply certain other appurtenances, hereinafter described.

The invention is illustrated in the accompanying drawings, in which:—

Figure 1 is a vertical section of the container and its associated parts when constructed for laboratory use; Fig. 2 is a side elevation showing the apparatus disclosed in Fig. 1 pivotally mounted upon a supporting structure; and Fig. 3 is a vertical section of an apparatus involving the same general principles of operation as that shown in Figs. 1 and 2, but constructed for commercial purposes.

Referring to Figs. 1 and 2, it will be seen that the apparatus, when constructed for laboratory purposes, comprises a container 1 forming at its interior, a reaction chamber to which the charge may be introduced and discharged by means of a pipe section 2 having a removable closure 3 in the form of a sleeve, one end of which is closed by means of a sight-glass 4. Communicating with the interior of the sleeve 3 is an upstanding pipe section 5 having the branch conduits 6 and 7 controlled by the valves 8 and 9, respectively.

The container 1 is inclosed by an outer casing 10 capable of withstanding relatively high internal pressures. For this reason, the casing 10 comprises a strong cylindrical body portion 11 welded at one end to an end plate 12, and at its opposite end is provided with a closure plate 13 held firmly seated on the peripheral edge 14 of the body portion 11, by means of the bolts 15 passing through the two plates 12 and 13. Likewise the container comprises a cylindrical body portion welded at one end to an end plate 23 and at its other end may be closed by a plate 24 seated upon the peripheral edge 16 of the cylindrical body portion of the container. If it is desired to render the container 1 gas-tight, the plate 24 may be forced into tight seating engagement with the cylindrical body portion of the container by means of a hollow tube or trunnion 17 having a beveled extremity coöperating with a correspondingly formed seat 18 provided in the plate 24. The tube or trunnion 17 passes outwardly through the end plate 13 of the outer casing and has an end thrust imparted thereto by means of the draw bolts 19 having threaded engagement with a stationary part of the appara-

tus, such as shown at 20 and coöperating with the disk 21 which is moved laterally when the bolts are actuated. The disk 21 abuts against a sleeve 22 rigidly secured to the trunnion 17, so that by tightening the bolts 19, the disk 21 imparts an end thrust to the trunnion 17 and holds the plate 24 seated. A second hollow trunnion 25 is secured to the end plate 23 of the container and passes outwardly through the end plate 12 of the outer casing. A pyrometer tube 26 may be inserted through the hollow trunnion 25 for determining the temperature in the reaction chamber.

Mounted in the container 1 is a rotatable rabble or agitator indicated at 27, and mounted at one end upon the extremity of the pyrometer tube 26, as indicated at 28. The other end of the rabble is secured at 29 to the extremity of a hollow tube 30 passing through the trunnion 17 to a point where it is connected with a driving pulley 31. The passage in the hollow tube 30 is controlled by means of a valve 32. The tube 30 fits loosely in the hollow trunnion 17, so as to leave a space between the inner wall of the trunnion and the outer wall of the tube. This space is utilized for supplying the fluid-reacting constituents to the reaction chamber, which constituents are admitted to the hollow trunnion 17 through an upstanding pipe section 33 in communication with a branch conduit 34, and a combined pressure and vacuum gage 35. The branch conduit 34 is controlled by means of a valve 36.

In order to cool the reaction container, if it becomes too hot, a coil 37 is wound upon the container, the ends 38 of the coil being passed upwardly through the outlet box 39. If the temperature of the container is not sufficient, the container may be heated by means of an electric coil 40 wound upon the convolutions of the cooling coil 37, and having extremital portions 41 also passing upwardly through the outlet box 39. If a quantity of steam is desired in the reaction chamber, it may be admitted through a pipe section 42 wound several times around the extremity of the container 1 and communicating with the interior of the container by means of the inlet 43. Water introduced by means of the pipe 42, in encircling the container 1, will be converted into steam and admitted to the container 1 through the inlet 43. A pipe section 44 passing upwardly through the outlet boxes 39, and communicating with the space between the container 1 and the outside casing 11, serves to admit to this space, a pressure medium, such as nitrogen, when it is desirable to make the container gas-tight and to supply a pressure medium to the casing 11 to counter-balance the pressure in the container. The extremities of all of the pipes and also the extremities of the electric coil 40 should pass through the cover 45 of the outlet box 39 in a gas-tight manner.

In order to augment the reaction, an electric arc producing plug 46 may be positioned in one wall of the container 1 and may be supplied with electric current by means of the electrical conductors 47 and 48. If so desired, the space between the container 1 and the outer casing 11 may be filled with heat-insulating material, such as asbestos, indicated at 49, and which, if so desired, may be laminated, as clearly shown in Fig. 1.

The apparatus above described is preferably pivotally mounted as at 50 upon a suitable supporting structure 51 and is normally held in its working position, indicated as "Position 2", in Fig. 2, by means of a prop 52. This prop is capable of dropping to the dotted line position shown in Fig. 2 to permit the apparatus to swing about its pivotal connection to the dot and dash line position, indicated as "Position 1." This corresponds to the filling position as the material to be treated may be readily introduced into the reaction chamber through the pipe section 2. In the position designated as "Position 3", the material may be readily discharged through the pipe section 2 into a receiving receptacle 53.

In operation, the ore or other material to be treated is comminuted and introduced in a dry condition into the reaction chamber through the pipe section 2, while the apparatus is in "Position 1", (Fig. 2), the sleeve 3 being first removed and after introduction of the material, replaced. The apparatus is then moved to "Position 2", or its working position, and the rabble 27 rotated slowly by means of the pulley 31. If the container 1 is constructed in a gas-tight manner, all of the valves are then closed and nitrogen is introduced through the pipe 44 until a pressure is attained in the space between the casing and the container equal to or somewhat higher than the treatment pressure in the reaction chamber. This pressure may be in the vicinity of 150 lbs. to the square inch, and is for the purpose of counter-balancing the pressure in the reaction chamber. It is obvious, however, that if the container 1 is not constructed in a gas-tight manner, the fluid constituents admitted to the container 1 under pressure will not only increase the pressure in the container, but also in the space between the container and the casing. The pressure will, therefore, be the same outside of the container as inside of the same, and the admittance of the pressure medium through the pipe 44 may then be dispensed with. The fluid reacting constituents, such for instance as sulfurous acid and air under a pressure of approximately 100 lbs. to the

square inch, are then passed through the valve 36 until the pressure in the reaction chamber reaches 100 lbs. to the square inch. The chemical reaction immediately starts, and if the heat developed thereby is not sufficient, an electric current may be passed through the heating coil 40 to bring the temperature to the required degree. On the other hand, if the temperature exceeds the required degree, cooling water, air or other fluid may be passed through the coil 37. After the reaction starts and the temperature reaches the desired degree, the bleeder valve 9 is partially opened to permit bleeding of the gaseous contents of the apparatus, and to permit a continual introduction of fresh sulfurous acid and air at a constant pressure of 100 lbs. to the square inch, the pipe 34 is connected to a tank, or other means capable of continually supplying the sulfurous acid and air under a constant pressure. The arc producing plug 46 acts as a catalyzer to augment the chemical reactions.

At suitable intervals, the charge may be tested by discharging a small portion thereof for analysis. This may be done either by closing the valve 36, reducing the pressure in the reaction chamber through the valve 9 to about 10 lbs. and opening the valve 32, to permit some of the charge as it is dropped over the open end of the tube 30 by the slowly revolving rabble 27, to be blown through the tube, or the pressure may be reduced in the reaction chamber and the apparatus tilted to position 3 to discharge some of the material into receptacle 53. Each time after the sample is obtained, the pressure is again increased, the current of gases through the chamber reëstablished, and the temperature brought up to and maintained at the desired degree. At the end of a certain period, a relatively large quantity of the sulfate is formed.

In some instances, it may be desirable to alternately reduce the pressure in the reaction chamber, and then increase it to the desired amount. This may be done by simply letting down the pressure to atmospheric pressure and reëstablishing it to the working pressure, or by connecting the branch pipe 6 with a vacuum pump and reducing the pressure through valve 8, and is for the purpose of permitting certain of the constituents to be broken up by the heat, as explained in the co-pending application of George B. Frankforter and myself, above referred to.

The apparatus above described has been found highly efficient for laboratory work, but for commercial purposes, the structure is preferably modified. A commercial apparatus is illustrated in Fig. 3, and comprises an outer casing A corresponding to the outer casing 10 of the form of the apparatus described above and capable of withstanding superatmospheric internal pressures. In the commercial form of the apparatus, the container for holding the ore or other material being treated takes the form of a furnace-container H, suitably supported within the outer casing A. The container H has positioned therein a plurality of superposed hearths L, from one to the other of which the material is successively fed by the rabbles M mounted upon the rotary shaft N.

The construction of the furnace comprising the hearths, rabbles and other appurtenances may be of the usual construction, so that the operation of the furnace need not be described in detail. It should be particularly noted, however, that the rotary shaft N is in communication by means of an opening *f* with a chamber E located below the furnace and formed between two plates O and P. Beneath the chamber E is a second chamber F, to which the fluid reacting constituents, such as sulfurous acid and air, are admitted through the pipe J controlled by means of a valve Q. The actuating mechanism for rotating the shaft N is positioned in the chamber F and comprises a rotary shaft K carrying a beveled pinion *i* meshing with a beveled gear *j* secured to said shaft N. The incoming fluid reacting constituents admitted to the chamber F, therefore, serve to cool the actuating mechanism. From the chamber F, the fluid reacting constituents pass through a branch conduit *k*, and then into a pipe *e*, which conducts the fluid reacting constituents to the chamber E through the piping *o*—*o*—*o*. From the chamber E, the fluid reacting constituents pass through the opening *f* into the interior of the shaft N and are distributed by means of the hollow rabble arms to the various hearths and escape from the furnace through an outlet R.

The fluid reacting constituents in being conducted from the chamber F to the chamber E are heated by being passed through a coil G positioned in the bin I. The hot material from the furnace is discharged through the conduit *b* into the bin I and in being held therein, serves to heat the fluid reacting constituents passing through the coil G. The fluid reacting constituents, after serving their purpose of sulfating the ore or other material held upon the furnace hearths, are discharged directly into the upper portion D of the casing A through the outlet R, and then pass through an opening S into the bin C, where they are permitted to escape through pipe *g* when bleeder valve T is opened.

The material to be treated may be introduced to the apparatus in any suitable manner, such as by removing cap *h* admitting the charge through feed opening U from the chute *l*, and then replacing cap *h*. The material is collected in the bin C and is grad-

ually fed to the furnace through an opening *a*, beneath which is positioned a feed screw V operated by any suitable mechanism, such as the worm *m* and worm wheel *m'*. The treated material may be discharged from the bin I through an outlet *c* into a bin *d*, a gate valve W being provided to control the discharge of material from the bin.

The operation of this form of the apparatus is as follows: The cap *h* is removed and dry ore, or other material to be sulfated, is introduced into the bin C. The actuating mechanism is then started and the interior of the casing A heated to the proper degree by the usual heating means comprising oil burners, hot air currents or the like. If desired, the common practice of mixing fuel with the treated material may be followed, in order to heat the furnace. The feed screw V is then operated and the material is fed to the right or left from the opening *a* depending upon the direction of rotation of the feed screw. The motion of the rabbles carry the material from hearth to hearth until the furnace has a working charge of material, at which time all of the material will have been removed from the bin C. The bin C is then refilled with material and all of the openings and valves associated with the outer casing are then closed and the fluid reacting constituents, such as sulfurous acid, and air or other gases, are admitted through the pipe J. The relatively cool current of these gases cools the actuating mechanism in the chamber F, and then passes through the pipe *e* into the chamber E, thence through the shaft N and rabbles to the chamber D, from which it escapes through the opening S into the bin C. When the desired super-atmospheric pressure is attained in the casing A, the valve T is partially opened to permit bleeding and the fluid reacting constituents are admitted through the pipe J from a tank or other source of supply capable of supplying the fluid reacting constituents under constant pressure. In this manner, the pressure in the casing will be kept constant and the treatment of the material on the hearths will take place under superatmospheric pressure, while a constant supply of fresh constituents is taking place. The hot material discharged into the bin I serves to preheat the fluid reacting constituents passing through the coil G, and the hot gases on their way from the furnace to the outlet *g* preheat the ore or other material in the bin C.

At suitable intervals, the treated material may be removed from the bin I by first closing valve Q, then fully opening the bleeder valve T, thereby letting down the pressure in the casing to atmospheric pressure, and then opening the valve W to permit the treated material to be discharged from the bin I into a bin or other receptacle *d*. The gate valve W is then again closed, the valve Q reopened, and the bleeder valve T partially closed to reëstablish the working pressure in the casing. The bin C may be refilled by closing the valve Q, and then removing the cap *h* to permit introduction of the material through the opening U. The cap *h* is then replaced and the valve Q reopened to reëstablish the working pressure.

In case relatively large units of roasting furnaces are used, it is obvious that the casing A will have to be made relatively large, and, therefore, will not withstand as high internal pressures as with smaller units of roasting furnaces. If it is necessary to use relatively large units, it may, therefore, be desirable to set the entire apparatus, including the outer casing A, into a gas-tight chamber in the earth having proper communication with the surface of the earth to permit introduction of the fluid reacting constituents and the charge, and to permit discharge of the gases and the treated material. The inclosure formed by the surrounding walls of the opening in the ground may then be supplied with fluid under pressure to counter-balance the internal pressure in the casing A. In this way, relatively high pressures may be used in the casing A without damage thereto just so the surrounding pressure is at least equal to that employed in the casing.

It will be noted from the foregoing description, that no matter whether the apparatus be constructed for laboratory or commercial purposes, it involves a container for supporting and holding the material treated, means for agitating the material, an outer casing capable of withstanding superatmospheric pressure, means for introducing the fluid reacting constituents to the apparatus, a bleeder valve, and means for introducing and discharging the material to and from the apparatus. In both forms of the apparatus, the fluid reacting constituents are permitted to pass into the container and there act upon the material under treatment, and they are permitted to gradually escape from the presence of the material through a bleeder valve associated with the apparatus, so that the material is treated under superatmospheric pressure while a constant supply of fresh fluid reacting constituents is taking place. In both forms of the apparatus, the outer casing constitutes a strong jacket for withstanding high pressures, thus relieving the inner container of this burden.

Both forms of the apparatus are highly efficient, especially when employed for carrying out a process for sulfating ore, such as that disclosed in the co-pending application of George B. Frankforter and myself, hereinbefore referred to. The time required for sulfating is greatly reduced and the per-

centage of sulfate formed is very high when the process is carried out in apparatus of the type herein disclosed.

Obviously numerous modifications and changes may be made in the details of construction, without departing from the spirit or scope of the invention, as defined in the accompanying claims.

What I claim is:—

1. Apparatus for treating ores and other material under predetermined pressure comprising an inclosure, a reaction container inclosed by the same and adapted to hold material to be treated, the material of the container being chosen regardless of its ability to withstand the pressure employed therein and the material of the inclosure being chosen without regard to the material treated but being designed to withstand the pressure employed in the apparatus, and agitating means for bringing the reacting constituents into contact with each other.

2. Apparatus for treating ores and other material under predetermined pressure comprising a casing, a reaction container inclosed by the same and adapted to hold material to be treated, the material of the container being chosen regardless of its ability to withstand the pressure employed therein and the material of the casing being chosen without regard to the material treated but being designed to withstand the pressure employed in the apparatus, and agitating means for bringing the reacting constituents into contact with each other.

3. Apparatus for treating ores and other material under predetermined pressure comprising a casing, a reaction container inclosed by the same and adapted to hold material to be treated, the material of the container being chosen regardless of its ability to withstand the pressure employed therein and the material of the casing being chosen without regard to the material treated but being designed to withstand the pressure employed in the apparatus, and an agitator positioned in said container and operable from a point outside of the casing.

4. Apparatus for treating ores and other material comprising a container, a casing inclosing the same and adapted to withstand relatively high internal pressures, means to admit and discharge material to and from the container, means to admit fluid reacting constituents to the container, an agitator within the container, and means to actuate the agitator from a point outside of the casing.

5. Apparatus for treating ores and other material under superatmospheric pressure, comprising a container, a casing inclosing the same adapted to withstand the maximum pressure employed in the apparatus, the container being designed to hold and confine all of the material being treated, means to admit the material to be treated to and discharge it from the container without opening the casing, and an agitator positioned in the container and operable from a point outside of the casing.

6. Apparatus of the kind described, comprising a container, a casing inclosing the same capable of withstanding superatmospheric internal pressures, means to admit material to and discharge it from the container, means to admit fluid under superatmospheric pressure to the container, means for cooling the contents of the container, and further means for heating the contents of the container.

7. Apparatus of the kind described, comprising a container, a casing inclosing the same capable of withstanding superatmospheric internal pressures, means to introduce material to and discharge it from the container, means to admit fluid reacting constituents under superatmospheric pressure to the container, and means to produce an electric arc in the container.

8. Apparatus of the kind described, comprising a container, means to introduce material to and discharge it from the container, means to admit fluid reacting constituents to the container, a casing inclosing the container capable of withstanding relatively high internal pressures, and a filling of heat-insulating material positioned in the space between the casing and the container.

9. Apparatus of the kind described, comprising a container, means to introduce material to and discharge it from the container, means to admit fluid reacting constituents under superatmospheric pressure to the container, a casing inclosing the container capable of withstanding relatively high internal pressures, a filling of heat-insulating material positioned in the space between the casing and the container, and means to admit fluid under superatmospheric pressure to the space between the container and the casing.

10. Apparatus of the kind described, comprising a container, a casing inclosing the same capable of withstanding relatively high internal pressures, means to admit material to and discharge it from the container, means to admit fluid reacting constituents to the container, means to agitate the contents of the container, and a cooling coil wound upon said container.

11. Apparatus of the kind described, comprising a container, a casing inclosing the same capable of withstanding relatively high internal pressures, means to admit material to and discharge it from said container, means to admit fluid reacting constituents to the container, and means to cool the contents of said container.

12. Apparatus of the kind described, comprising a container, a casing inclosing the

same capable of withstanding relatively high internal pressures, means to admit material to and discharge it from the container, means to admit fluid reacting constituents to the container, means to agitate the contents of the container, a cooling coil wound around said container, and a heating coil wound around said container.

13. Apparatus of the kind described comprising a container, means to admit fluid reacting constituents to the container, a gas-tight inclosure surrounding said container, means to admit the material to be treated to the container only, and while the latter is completely surrounded by the inclosure, and an agitator for agitating the contents of the container.

14. Apparatus of the kind described comprising a container, means to admit fluid reacting constituents to the container, a gas-tight inclosure surrounding said container, means to admit the material to be treated to the container only, and while the latter is completely surrounded by the inclosure, an agitator for agitating the contents of the container, and means to admit fluid under superatmospheric pressure to said inclosure.

15. Apparatus for treating ores and other materials comprising a container, a casing inclosing the same and adapted to withstand relatively high internal pressures, means to admit the material to be treated to the container only, and an agitator in said container.

In testimony whereof I affix my signature

HENRY B. HOVLAND.