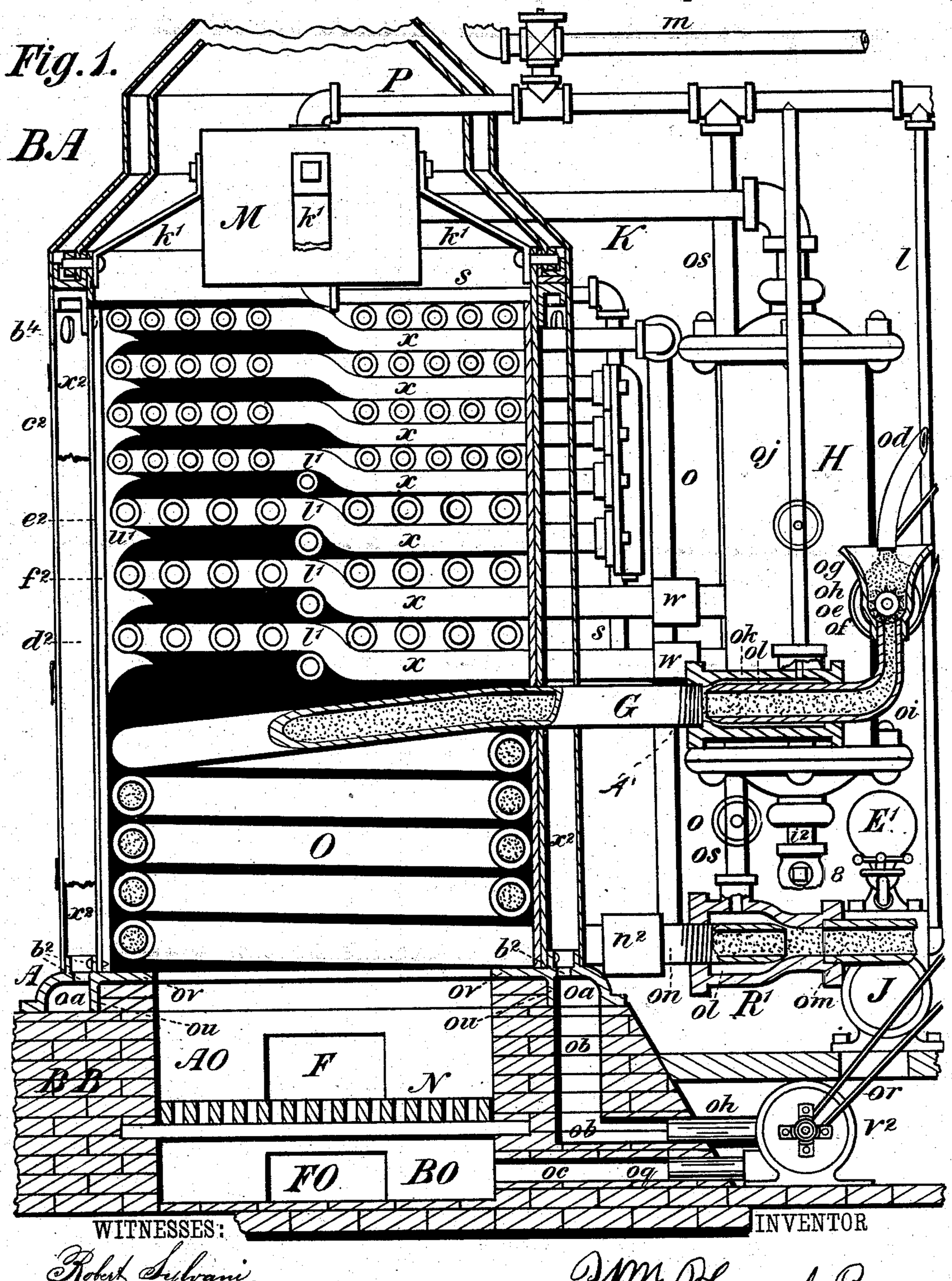
(No Model.) 2 Sheets—Sheet 1.

W. F. BROWNE.

PROCESS OF AND APPARATUS FOR DESULPHURIZING ORES.

No. 284,177. Patented Sept. 4, 1883.

Fig. 1.



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INVENTOR

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

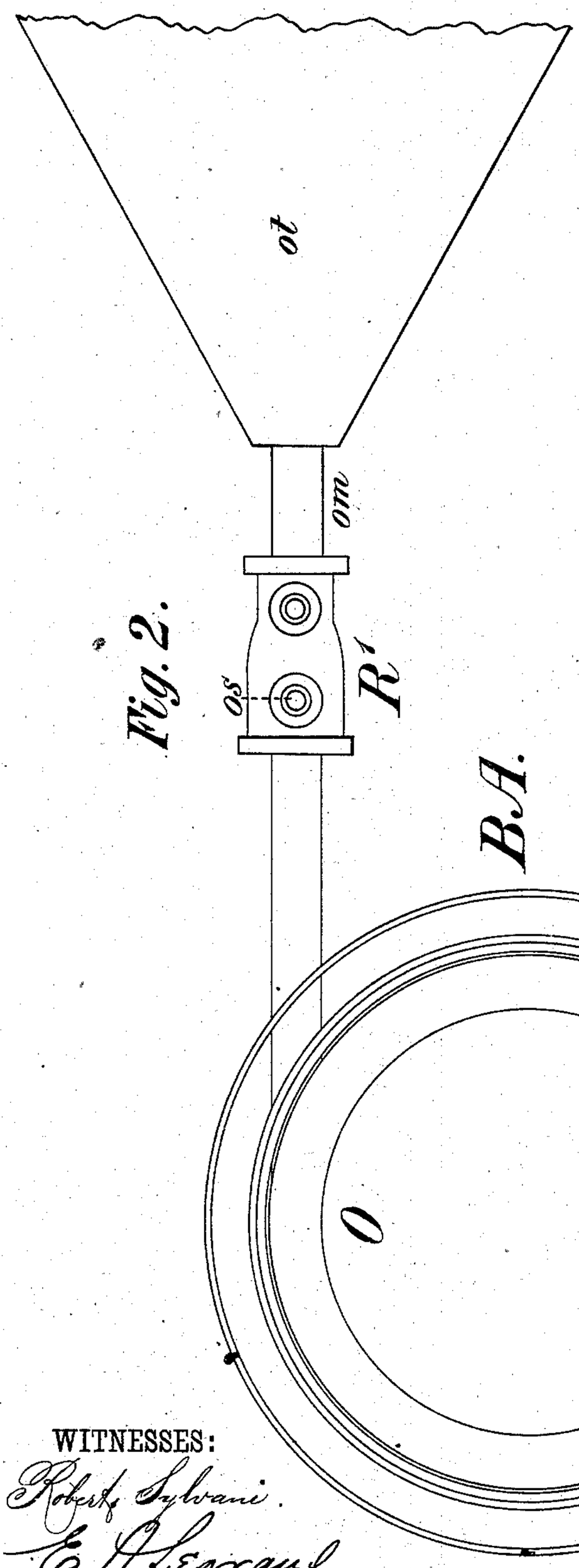

Fig. 3.

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WILLIAM FRANK BROWNE, OF NEW YORK, N. Y.

PROCESS OF AND APPARATUS FOR DESULPHURIZING ORES.

SPECIFICATION forming part of Letters Patent No. 284,177, dated September 4, 1883.

Application filed January 28, 1882. (No model.)

To all whom it may concern:

Be it known that I, WM. FRANK BROWNE, of the city, county, and State of New York, have invented certain new and useful Improvements in Process of and Apparatus for Desulphurizing Ores; and I do hereby declare that the following is a clear and full description thereof, reference being had to the accompanying drawings, which form a part of this specification.

This invention relates to devices and apparatus for desulphurizing ores, and has for its object the combination of a desulphurizing apparatus with a high-pressure-steam generator, the one being essential to the successful operation of the other.

To this end the invention consists in means for inducing and exhausting a current of finely-pulverized ores through a coil of pipe or conduit by means of a volume of high-pressure steam injected into the induction end of said coil and another volume at the eduction end of the coil, whereby a combined impelling and expelling force is brought to bear in the same direction upon the current of ores passing through the coil for the purpose of desulphurizing the ores, as will be more fully hereinafter described.

This invention further consists in the construction and arrangement of the impelling and expelling devices, the feeding device, the separating-chamber, and other details, as will more fully hereinafter appear.

Figure 1 is a vertical section of a steam-generating and desulphurizing apparatus. Fig. 2 is a horizontal section of the combined steam and desulphurizing apparatus, showing the conduit in which the ore is desulphurized, the injector and ejector for forcing and drawing the ore through the conduit, and the receptacle into which the ore is discharged.

The general construction of the steam-generating apparatus (shown in Fig. 1) is similar to one for which an application for Letters Patent was filed August 16, 1881.

The steam-generating apparatus B A consists of an outer and inner shell, c^2 and e^2, secured to the base A. The interior shell is lined with a coating of asbestus cement, f^2, or with some other material of an analogous nature.

The combustion-chamber is provided with a suitable number of coiled pipes or conduits, x, which are preferably made spiral in form and in horizontal planes, and when grouped together, as shown, they form a coiled sectional steam-generator, which is capable of sustaining a very high pressure, and especially so when the sections are made from double-extra lap-welded pipe.

The two ends of the pipes which form the sections x project parallel to each other through the outer and inner shells, c^2 and e^2, where they are provided with suitable regulation or special gas-pipe fittings, whereby a free circulation is obtained through the series of sections x. The water from which the steam is generated is forced into the upper section through connecting-pipe o' by steam-pump E′ J. This water is now forced through the spiral turns of the upper section, from whence it is discharged into the next section below, through which it is forced into the next lower section, and so on through the series, until finally discharged into the separator or chamber H in the form of highly-heated steam under a corresponding high pressure. This pressure should be at least two hundred and fifty pounds, thereby containing nearly 410° of sensible heat, which is of the utmost importance when employed as a desulphurizing agent.

The steam is discharged from the separator or chamber H through pipe K into dome M, from whence it is conducted through suitable pipe-connections to the place or places required. Steam from the pump is conducted from the dome through pipe P and connecting-pipe l. A safety device is attached to pipe P. This device is provided with pipe m, for conducting steam to a motor or other places of use. The ore-conduit O should be made from double-extra lap-welded pipe of from one hundred and fifty to two hundred and fifty feet long. The internal diameter of the pipe should be from two to three inches. However, greater or less diameter can be used; but for practical work the pipe which is but two to three inches in diameter will be the most economical.

The length of pipes which compose the coil must be joined together into one continuous length of pipe by welding their ends together. Great care should be exercised while forming the joints, in order to preserve an even and uniform bore when welding the two ends to-

gether. Should obstructions or unevenness occur at the welds, they would obstruct the ore and be liable to effect agglomeration, which might, in time, clog the pipe; and also these lengths of pipe should never be connected by right and left couplings, for at each joint an annular recess would be formed of about one-fourth of an inch in depth, which would fill with ore, and if agglomeration did not take place the end of the pipe receiving the current of ore would be soon worn away by the cutting or abrasion of the silica contained therein. After the lengths of pipe are welded together, until the required pipe for forming the coil is obtained, it is then heated and bent into a circular or helical coil of a suitable diameter, which, to a certain degree, will depend upon the diameter of the pipe. Thus a pipe two and one-half inches in internal diameter should be bent or coiled within a circle the circumference of which should not be less than fifteen feet. This coil can be made in the form of the frustum of a cone and of any length required; and, furthermore, the turns of the coil can be made to fit a fire-box which is polygonal in form by bending the pipe at the angles of the box and leaving it straight on the faces thereof; but coils which contain straight runs and angles—either right, obtuse, or acute—are objectionable, as the circular form offers the least obstruction or resistance, and it is the one in which an even flow of ore can be maintained, and in which the abrasion of the internal surface will be equalized throughout the entire length of the coil when used in the following manner:

The ore is carried through the coil by impelling and exhausting forces, by means of which the ore can be kept in a comminuted state, and which cannot be done as effectually as when but one force is employed, for the reason that all bodies when projected by an impelling force tend to move in straight lines and never out of that course, unless interrupted by some counter force, and when so interrupted the resultant course will be in accordance with the two forces. Therefore when the ore is projected through the coil by an impelling force the ore tends to move in a straight line, but being limited in its course by the walls of the pipe it is projected against the exterior inner circumference, against which it abrades the entire length of the pipe on its passage through the same. In consequence of this abrasion the pipe will soon be worn away unless a counter force is employed, whereby the resultant course of the ore, caused by the two forces, can be changed to the center of the pipe. If only the drawing or exhausting force is employed, the ore will be projected or drawn against the interior inner circumference of the coil, thereby wearing it away in undue time; but when the two forces act simultaneously the axis of the resultant course will be at or near the center of the coil, whereby any undue abrasion of the coil is obviated, and the ore held in suspension, and no agglomeration of the particles will occur during its transit through the same, in consequence of which the ore and steam will be intimately mingled, and when highly heated, or heated to about 850° Fahrenheit, the volatile portion of the ores will be separated and the highly-heated steam will be decomposed and form fixed gases, some of which can be condensed by well-known means, while the precious metals, the oxides, and pulverized rock will be precipitated into properly-constructed receptacles for further treatment.

The impelling and exhausting forces above mentioned are of great importance and should be employed on all occasions, or whenever ore is to be desulphurized or oxidized in a coiled conduit; but the ore can be drawn through by the exhausting force, which would be far better and more reliable than when forced through by the impelling force, as when only the impelling force is employed the ore would be driven against the outer interior diameter of the coil, and will pass through the same in a compact form.

Another serious objection to the impelling force when used alone is in consequence of the ore being thrown upon the inner exterior circumference of the pipe, so that by the specific gravity and cohesion of the particles of ore upon themselves and upon the pipe they will become retarded and agglomerated, while the steam will flow on through the unobstructed portion of the pipe, and by a constant influx of ore, with a decreasing velocity in consequence of the friction, aggregation must take place, and the pipe soon becomes filled and the ore so impacted that it is impossible to remove it by the aid of steam, however great the pressure thereof.

The devices for impelling and exhausting the ore through the coil O consists of an injector, *o k*, and ejector R′, which are connected to the two ends of the coil. The injector is connected to the end A′, while the ejector is connected to a nipple, *o n*, and the nipple to the coil by the right-and-left coupling n^2. The injector is connected with the steam-pipe *o j*, while the ejector is connected with the steam-pipe *o s*. Both of these pipes communicate with the dome M by means of pipe P. The dome is held in position by braces *k*′. The steam-generating coils are supported in the shell by a rack, *w*′, upon one side of the furnace, and upon the opposite side by the inner projecting end of the coils, and at right angles to these two points of support by a series of cross-pipes, *l*′, which are shown only in section. These pipes project through the two opposite sides of the shell, where they are connected by proper fittings, which will admit of a free circulation of water through the same. These cross-pipes will, when water is circulating through them, prevent the coiled section *x* from sagging down when very high heat is required. Whatever condensation of steam occurs in the dome will return to the separator H by way of drain-pipe *s*. This condensation can be

discharged from the separator through pipe i^2 on opening plug-cock 8.

The coiled sections of steam-pipe can be increased to any number required, or until all of the heat is absorbed by the water on its passage downward through the series, and it is found that nearly all of the heat is utilized when twenty of the sections are used and only natural draft employed. Nearly one-half of the shell surrounding the combustion-chamber, from the base A to above the upper coil or section, is made into two doors, which swing outward upon hinges and expose the whole series of coils or sections, whereby they can be removed by disconnecting their ends from the fittings. If the sections are damaged, they can be readily removed and replaced by new sections. The coil O can be readily removed by disconnecting the ends and opening the doors.

The annular space x^2, between the outer and inner shell, is employed for heating the air prior to its entering the fire-box. The air is drawn into a series of holes, b^4, which extend around the top of the outer shell. The air passes through an annular row of holes, b^2, made in the base A, where it enters an annular chamber, *o a*. This chamber is formed by the vertical flange *o u*, the base A, and the masonry B B, forming the fire-box on which the generator rests. This annular chamber *o a* fits over or corresponds to a flue, *o b*, which is made in the masonry B B, and which is provided with an outlet into which an exhaust-pipe, *o h*, projects. This exhaust-pipe connects with a blower, V^2, which is for the purpose of exhausting or drawing the air through the holes b^4 down through the annular space x^2 into the annular chamber *o a*, thence through flue *o b* and pipe *o h* into the blower, from whence it is forced or discharged through pipe *o q* and flue *o c* into the ash-pit B O, thence between the grate-bars N into the furnace A O.

It will be observed that the walls of the furnace project inward from the inner shell to a distance corresponding to the internal diameter of the coil O. The flange *o v*, which is cast with the base A, projects inward for the purpose of covering the bricks and forming a support for the coil.

Fuel is fed to the fire-box through the door F, while the ashes are taken out through door F O. The pulverized ore is conducted through pipe *o d*, from whence it is discharged into hopper *o g*, wherein it comes in contact with the revolving toothed wheel *o h*, which prevents the ore from packing, and causes it to fall into pipe *o i*, from which it is blown and drawn into the coil O. The toothed wheel is revolved by means of belt *o f*, passing over pulley *o e*. The blower is also rotated by means of belt *o r*. If the ore is dry, it should be heated to a degree just below the melting-point of sulphur before being drawn or forced into the coil O, in consequence of which their can be no condensation when the steam and ore come in contact, which would be the case if the contact were made without preliminary heating; but in any event it will be better to dry and heat all of the ore prior to its entering the desulphurizing-coil; and, again, the ore should never be allowed to pass through the coil without either steam or water entering therewith, for without the aid of oxygen and hydrogen the pipe would fill up in a very short time, burn out, and be rendered useless. Of course the steam which is used in the ejector for exhausting and expelling the ore is useless, so far as a reagent is concerned. Therefore enough steam, which will vary according to the percentage of the volatilizable base properties contained in the ores, must be used for oxidizing and desulphurizing purposes. The higher the percentage of impurities in the ore the slower must be the feed, and also the velocity of its passage through the pipe, the velocity of which can be regulated by the exhausting device, but not by the impelling force.

This combined steam-generating and desulphurizing apparatus is intended to be employed about mines, where steam for motive power is employed for breaking and pulverizing ore, and other purposes for which steam is used about mines or reduction-works. The escaping heat from the desulphurizing-furnace is more than sufficient to generate all the steam required for crushing and pulverizing the ore. Therefore the apparatus herein shown and described will economize to the extent of the fuel required to generate the steam, which does the work of crushing and pulverizing said ore. This item of expense is of great importance when the high price of fuel in some localities is considered.

This combined apparatus can be made portable, when necessary, simply by dropping the base between the grate-bars and lengthening the shells, all of which is shown in the application referred to in the foregoing specification.

The operation of desulphurizing ores is as follows: Steam is at first generated in the coils *x* from the water, which is forced therein by the pump E′ J and discharged into the chamber or separator H, from whence it is conducted to the dome M. Thence it is conducted through pipes P *o s* and *o j* and discharged into the injector *o k* and ejector R′ in suitable proportions, as above mentioned, where, owing to the action of steam, the ore is caused to pass from pipe *o i* into and through the coil O, where, when highly heated, the sulphur and similar impurities become volatilized and discharged with the desulphurized ore by ejector R′ into a closed or open receiver, *o t*.

The receiver can be supplied with screens for the retention of the ores, while the gases are allowed free egress; and also the ore and gases can be discharged beneath the surface of water, which will retain the ore and allow the gases to escape.

All classes of desulphurized ores can be discharged directly beneath water, and thereby save any metals which might become volatilized by the high heat required. In desulphu-

rizing cinnabar the quicksilver would become volatilized and could be easily condensed and recovered when discharged below the surface of the water, and the same may be said of all other metals which volatilize at low temperatures.

One of the advantages derived from the use of the high-pressure-steam generator is that a very high pressure steam can be generated, which will be required to exhaust and force the ore through the highly-heated desulphurizing-coil, and a result obtained thereby which cannot be accomplished by steam from an ordinary steam-boiler, owing to the fact that it cannot resist the pressure of the generative force in the desulphurizing-coil, which can, however, be overcome by the high-pressure steam generated in the coiled sectional generator herein shown and described.

The heat of the steam which enters the coil with the ore should approximate nearly to the heat required to volatilize the sulphur, thereby absorbing but a very little more heat to effect the decomposition thereof in connection with the sulphurous and metalliferous vapors. Therefore by the use of the highly-heated steam a greater quantity of ore can be desulphurized in a given time than when done by the use of steam at the low pressure of forty to seventy pounds, which would contain heat of only 260° to 300°. Therefore, as the ordinary boiler now in use cannot sustain the high pressure required in my method of treating ores, and as these refractory ores cannot be properly treated without these high heats and pressure, I consider the steam-generator herein shown and described of great importance when taken in connection with a desulphurizing apparatus, and still more so when combined with said desulphurizing apparatus in a manner that it will utilize the heat which escapes from the desulphurizer, and which would be lost were it not for the steam-generating apparatus connected therewith, as shown and described.

I am aware that it is old to convey ores through an externally-heated pipe in conjunction with steam for the purpose of desulphurizing, and do not therefore claim such method, broadly.

What I claim, and desire to secure by Letters Patent, is—

1. In the desulphurization of ores by means of external heat in connection with steam, the method which consists in highly heating steam in the manner described and carrying the pulverized ore through an externally-heated conduit in conjunction with a current of air and dry or superheated steam, in the manner herein described.

2. In an apparatus for desulphurizing ores, the combination of a heating-chamber provided with a fire-box, a desulphurizing-coil placed above said fire-box, provided with a feeding device, a steam-injector at the induction end in front of the hopper, a coil, and an ejector at the discharge end of said coil for the purpose of inducing a current of air and steam through the desulphurizing-coil, as and for the purpose described.

3. In an apparatus for desulphurizing ores, the combination of a heating-chamber having a fire-box, with a coil-pipe steam-generator placed within said heating-chamber, and the connected desulphurizing-coil provided with a feeding device and a steam-injector at the induction end of said coil and an ejector at its discharge end, whereby a highly-heated current of steam and pulverized ore is forced through said coil in such manner that by the extreme heat from the furnace on the exterior of the coil and the extreme heat and pressure of the steam on the interior of the coil in direct contact with the ores a complete desulphurization of the ores is effected.

4. In a desulphurizing apparatus, the combination of the fire-box provided with air-flues, as described, of a base-plate placed upon said fire-box and forming an annular air-conduit therewith, of an inner and outer casing, the latter being provided with air-inlets, and of an exhausting and forcing device, all connected and arranged as described, whereby the air is heated in passing through said channels and is forced into the fire-box for the better combustion of the fuel.

5. In a desulphurizing apparatus, the coil-pipe steam-generator provided with a superheater, in combination with a desulphurizing helical coil arranged below said generator and immediately above the fire-place, substantially as described.

6. The combination, in a desulphurizing apparatus, of the heating-chamber and fire-box with a coiled-pipe steam-generator and a helical desulphurizing-coil arranged one above the other, the air-inclosing casing for the purpose of preventing radiation and to heat the air for the furnace, the hollow base provided with air-conduits for supplying air to the furnace, and the exhausting and forcing device for drawing the air from the hollow casing and forcing it to the fuel in the furnace and connections, as described.

WM. FRANK BROWNE.

Witnesses:
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J. L. MCDANIEL.