No. 865,333. PATENTED SEPT. 3, 1907.

A. M. DAY.

PROCESS OF SMELTING ORE AND CONVERTING MATTE.

APPLICATION FILED DEC. 28, 1905.

3 SHEETS—SHEET 1.

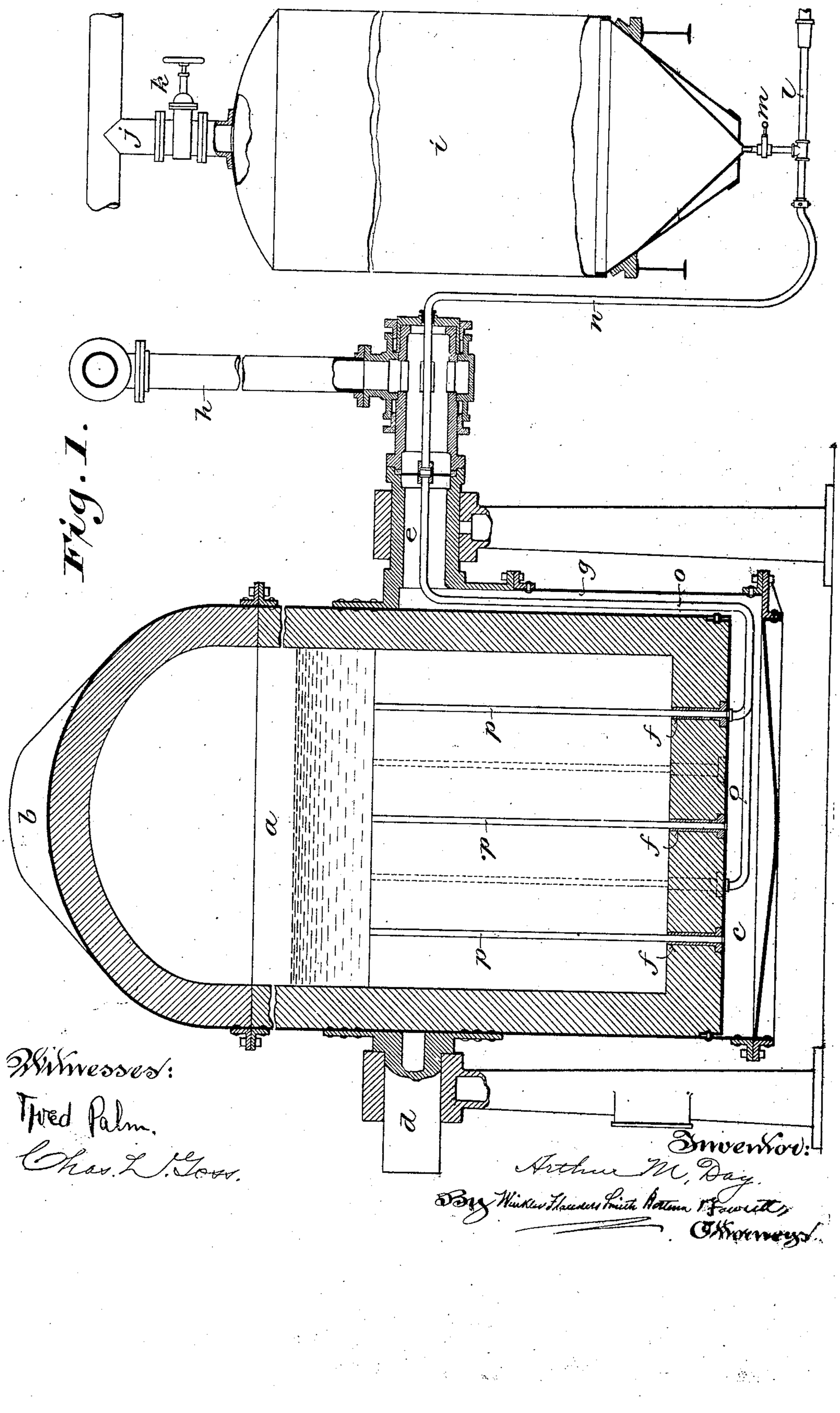

Fig. 1.

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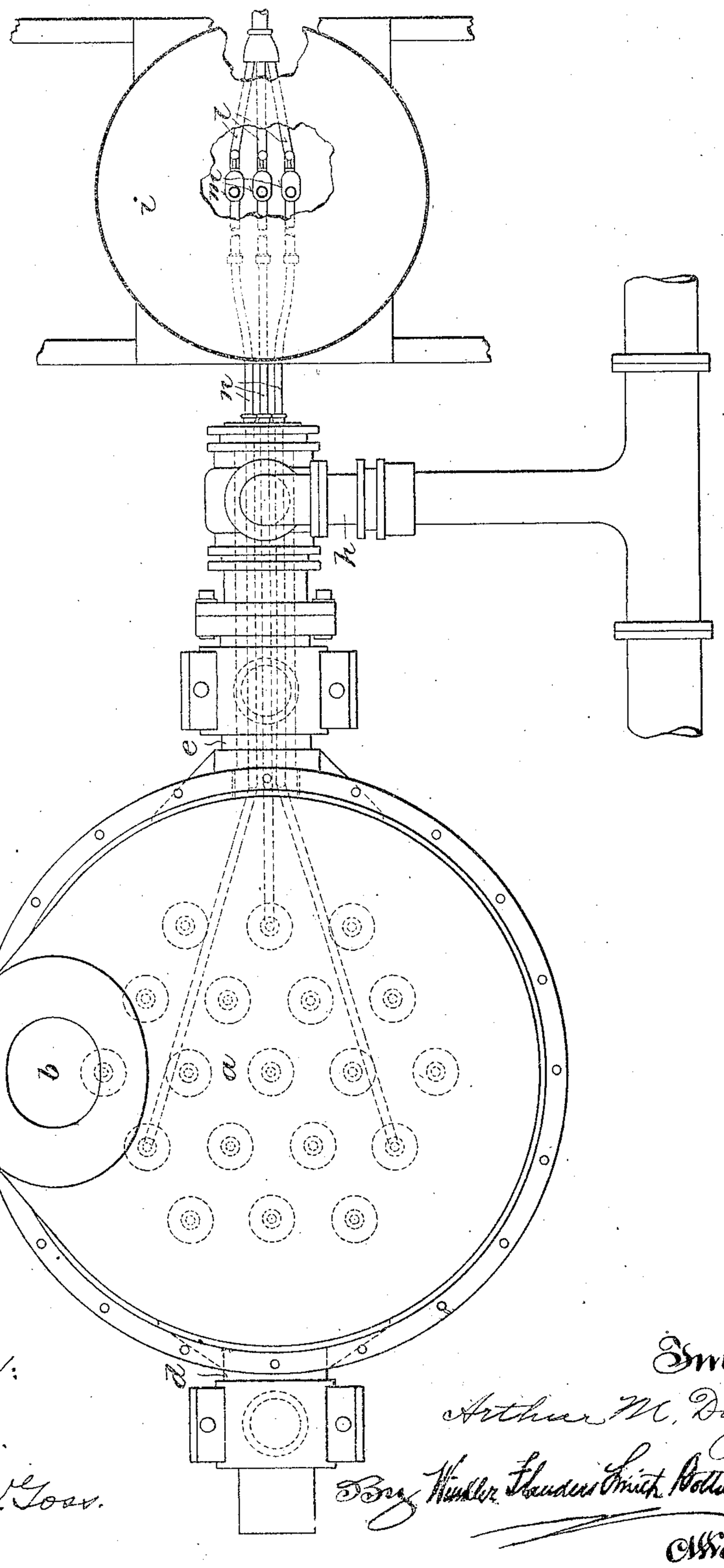
3 SHEETS—SHEET 2.

Fig. 2.



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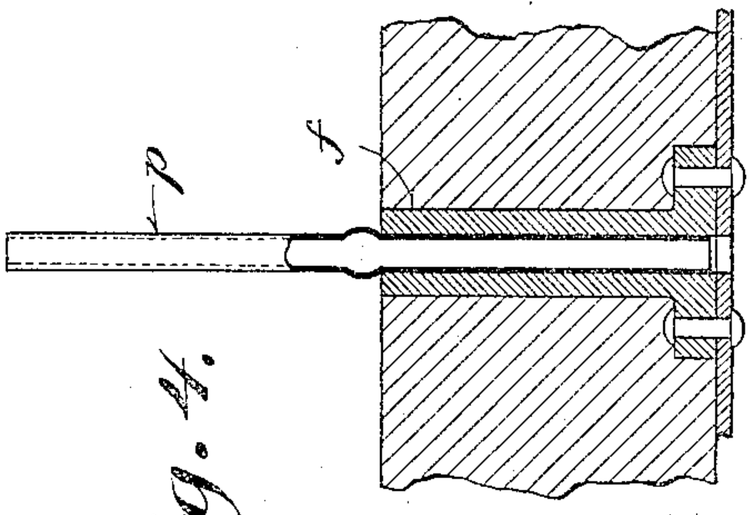

Fig. 4.

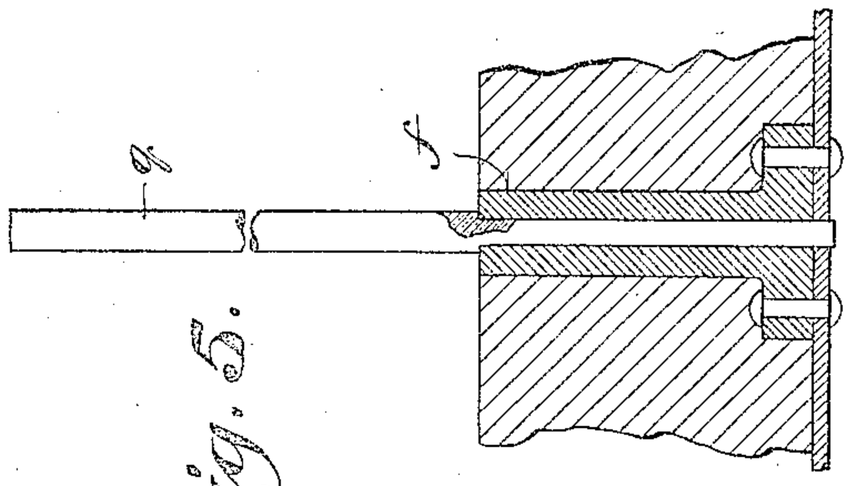

Fig. 5.

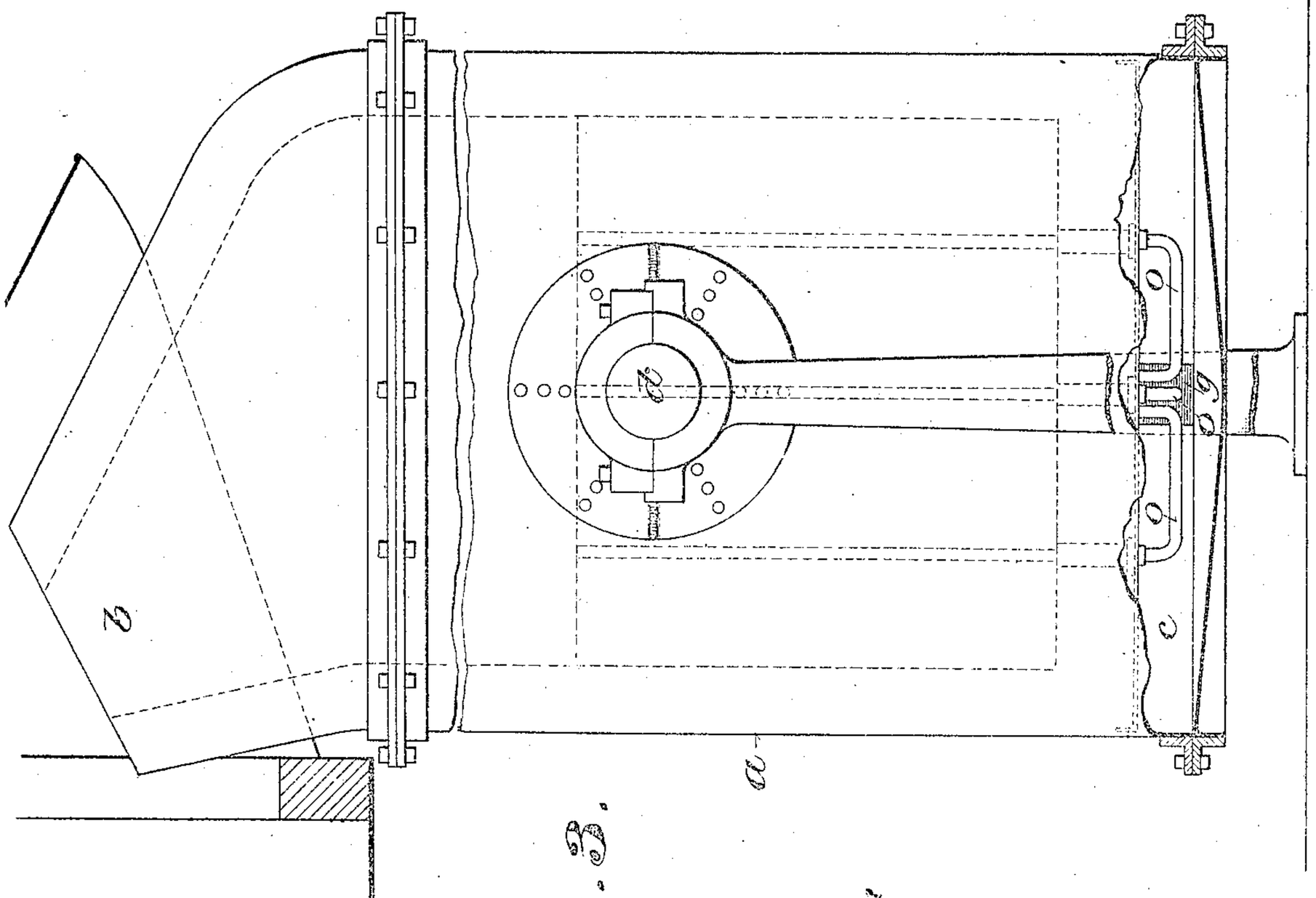

Fig. 3.

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UNITED STATES PATENT OFFICE.

ARTHUR M. DAY, OF BINGHAM CANYON, UTAH.

PROCESS OF SMELTING ORE AND CONVERTING MATTE.

No. 865,333. Specification of Letters Patent. Patented Sept. 3, 1907.

Original application filed April 19, 1905, Serial No. 256,484. Divided and this application filed December 28, 1905. Serial No. 293,556.

To all whom it may concern:

Be it known that I, ARTHUR M. DAY, a citizen of the United States, residing at Bingham Canyon, in the county of Salt Lake and State of Utah, have invented certain new and useful Improvements in Processes of Smelting Ore and Converting Matte, of which the following is a specification, reference being had to the accompanying drawing, forming a part thereof.

This application is a division of my application Serial No. 256,484, filed April 19, 1905.

The main objects of the present invention are by the injection into the charge of ore or matte of powdered silica or other silicious material in a fluent form with an air blast, to keep the twyers open without drifting, according to the usual practice; to admit of the employment of fire brick linings in place of the silicious linings commonly used in converting matte; and to prevent the obstruction of the air supply or blast passages with the silica or silicious material.

The invention consists essentially in the injection of powdered silica, silicious ore or other silicious material in a fluent form into a charge of ore or molten bath of matte, as hereinafter particularly described and set forth in the claims.

In the accompanying drawing illustrating apparatus suitable for performing this process, like characters designate the same parts in the several figures.

Figure 1 is a vertical longitudinal section and partial elevation of the apparatus; Fig. 2 is a plan view of the same; Fig. 3 is a side elevation as viewed from the left with reference to Fig. 1 of the smelting vessel or converter bowl; Fig. 4 is a detail sectional view on an enlarged scale of one form of twyer extension used in connection with the apparatus for smelting ore; and Fig. 5 is a similar view showing means for forming twyer extensions for this purpose in another way.

a designates a smelting vessel or converter bowl which is made of boiler plate or sheet metal lined with fire brick and formed at the top with a nozzle *b* and at the bottom with a wind box or air chamber *c*. On opposite sides it is provided with trunnions *d* and *e*, which are adapted to turn in suitable supporting bearings.

Suitable means are provided for turning the smelting vessel or converter bowl *a* on its trunnions for the purpose of drawing off slag from time to time, and ultimately the matte or metal produced by the smelting or converting operations.

A number of twyers *f*, extend upwardly through the bottom of the vessel or bowl *a* from the wind box or air chamber *c*.

The trunnion *e* is made hollow and is connected with the wind box by a passage *g* at one side of the vessel *a*, and a compressed air supply pipe *h* is detachably connected with said trunnion in communication with the wind box *c* through the passage *g*.

The apparatus comprises one or more closed reservoirs *i*, each of which is connected at the top with a compressed air supply pipe *j* provided with a valve *k*. At the bottom, which is preferably funnel shaped, each reservoir is connected with one or more auxiliary air blast or compressed air supply pipes *l*, each of its connections with said pipes being provided with a valve *m*. Each of the pipes *l* is detachably connected by a hose or flexible pipe *n* with a pipe *o* leading through the trunnion *e*, main blast passage *g* and wind box *c* to one of the twyers *f*, to which it is attached.

With such apparatus the process constituting the present invention is carried out as follows: For smelting ore the twyers *f* are provided with fusible tubular extensions *p*, as shown in Fig. 4, which extend from the bottom of the vessel *a* to the top of the charge, or with some kinds of ore the twyer extensions may be formed by tamping the ore around rods *q* which are temporarily inserted in the twyers *f*, as shown in Fig. 5, and withdrawn when the vessel is completely charged, thus leaving openings or passages through the ore from the twyers to the surface of the charge. One of the reservoirs *i* is filled or supplied with powdered silica, silicious ore or other silicious material in a fluent form, while another may be supplied with fuel such as powdered coal or coke or with oil, and still another with a flux such as powdered lime stone or iron ore. The vessel *a* having been charged with the ore to be smelted, as for instance, with crude copper sulfid ore, the charge is dried sufficiently on top to prevent explosions. Compressed air is then turned on from the main supply pipe through the main blast passage *g* into the wind box *c* and the twyers *f* in communication therewith. The vessel *a* is now tilted into a convenient position to receive through the nozzle *b*, molten matte or other material containing sufficient heat to start the smelting operation. Said vessel being then turned back into an upright position, the molten matte or other substance flows over and covers the top of the charge, and the air supplied through the twyers under sufficient pressure to prevent the matte or other substance from flowing into them, comes in contact therewith, producing intense heat at that point. The smelting operation thus begins at the top of the charge and progresses gradually downward until the entire charge has been melted. As the operation proceeds, the smelting vessel is turned down and the molten slag accumulating at the surface is drawn off from time to time through the nozzle *b* to avoid material increase of the resistance to the passage of the air through the charge and consequent abatement of the smelting operation. As the melting level progresses downward the

twyer extensions are melted off and the air is delivered to the top of the ore next to the molten covering. When it is feasible, the ore is mixed so as to produce a self-fluxing charge, but when this is not practicable, the flux required to properly fuse the charge is supplied from one of the receptacles *i* by opening one or more of the associated valves *m*, thereby admitting the powdered flux into one or more of the blast pipes *l*, from which it is carried with the air blast through the connections hereinbefore described to one or more of the twyers and delivered at the top of the charge of ore below the molten covering, where the greatest heat is produced and maintained. The oxidation of the sulfur and iron or other combustible substances contained in the ore, ordinarily produces sufficient heat to smelt the ore, the operation having been started by the covering of molten matte or other substance. In case however, the ore does not contain sufficient fuel to maintain the required degree of heat, powdered coal or coke or oil is supplied as required from one of the receptacles *i* in the manner above stated, this additional fuel supply being regulated by the adjustment of the associated valve or valves *m* and delivered by the twyer extensions to the charge where fusion is taking place most actively. To keep all the twyers open, a small quantity of powdered silica, silicious ore or other silicious material in a fluent form is supplied from one of the receptacles *i* to one or more of the twyers. The silica or other silicious material injected into the charge while it is being agitated by the air blast, is diffused through the entire charge and brought into contact with the iron which is contained in the charge and with which it combines and forms a fluid slag. The chemical reaction which thus takes place throughout the entire molten portion of the charge while the demand of the iron for silica is being satisfied, operate to keep the twyers open. In this way drifting or thrusting rods or bars through the twyers from time to time to keep them clear, an operation that is inconvenient and difficult, particularly in connection with an upright smelting vessel having twyers in the bottom as herein shown and described, is avoided.

With apparatus such as herein shown and described, having several separate connections between each of the receptacles *i* and certain of the twyers, powdered or fluent material from any one of the receptacles can be supplied to the smelting vessel through any or all of the several auxiliary air blast connections, of one kind of material can be supplied through two or said connections while another kind is supplied from another receptacle through the third connection, or three different kinds of material can be supplied simultaneously from the several receptacles, but one connection being used with each receptacle.

With the auxiliary blast pipes leading through the main blast passage to and connecting with some of the twyers, a positive and accurately regulated supply of silica or silicious material may be delivered in a powdered or fluent form into the charge in the smelting vessel separately and independently of the main and auxiliary air supply connections with other twyers, and in this way the lodging of such material in and the clogging of the air blast passages, are avoided.

For the conversion of matte, as for example of copper matte, into pig copper, the twyer extensions are not required, the air with the silica or the silicious or other material in a powdered or fluent form, being delivered directly from the twyers *f* into the lower part of the smelting vessel or converter bowl *a*. This may be done in the same vessel after the smelting operation hereinbefore described has been completed, molten matte from other smelters being supplied to complete the charge, or the matte may be transferred from the vessel in which the crude ore has been smelted, to another like or similar apparatus for converting it into pig copper or other metal.

In the conversion of the matte into copper or other metal, the twyers are kept open the same as in smelting ore, by introducing powdered silica, silicious ore or other silicious material in a fluent form through one or more of the twyers, and the silica or other silicious material in this case serves the additional purpose of combining with iron contained in the matte and thereby liberating the copper.

The method employed in this process of injecting powdered silica or other silicious material in a fluent form into the charge, admits of the use of ordinary fire brick or clay linings in the smelting vessel or converter bowl, and thereby does away with the destructible silicious linings which are commonly employed in converters and are a source of trouble, expense and danger, since being rapidly consumed, they require frequent renewal, and since if the molten charge breaks through the lining, it will immediately melt and destroy the metal shell of the smelter or converter.

In place of a single main air supply connection common to a number of twyers, as herein shown, each of the several twyers may have a separate air blast connection and all or any desired number of the twyers may be connected with one or more reservoirs containing powdered silica or silicious ore and other material or materials in a fluent form such as may be required or desirable in addition to the silica or silicious material for the smelting and converting operations in the treatment of various kinds of ore and matte.

Various modifications in the manner of performing the process and in the apparatus therefor may be made, without departing from the principle and intended scope of the invention.

I claim:

1. The process of smelting ore and converting matte, consisting in forcing air into the charge and injecting powdered silica or silicious material in a fluent form through one or more twyers with an air blast separate and distinct from the air supply to either twyers, substantially as described.

2. The process of smelting ore and keeping the twyers open, consisting in covering the charge of ore with a molten substance containing sufficient heat to start fusion of the charge, supplying air to the charge at or near the melting level as fusion progresses downward, and injecting powdered silica or silicious material in a fluent form with an air blast delivered at or near the melting level through one or more twyers separate from the air supply to other twyers, substantially as described.

In witness whereof I hereto affix my signature in presence of two witnesses.

ARTHUR M. DAY.

Witnesses:
ERNST J. MULLER,
JOSEPH DEDERICK.