No. 729,008. PATENTED MAY 26, 1903.

H. M. SUTTON & W. L. & E. G. STEELE.

ORE ROASTER.

APPLICATION FILED JULY 1, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

Fig. 1.

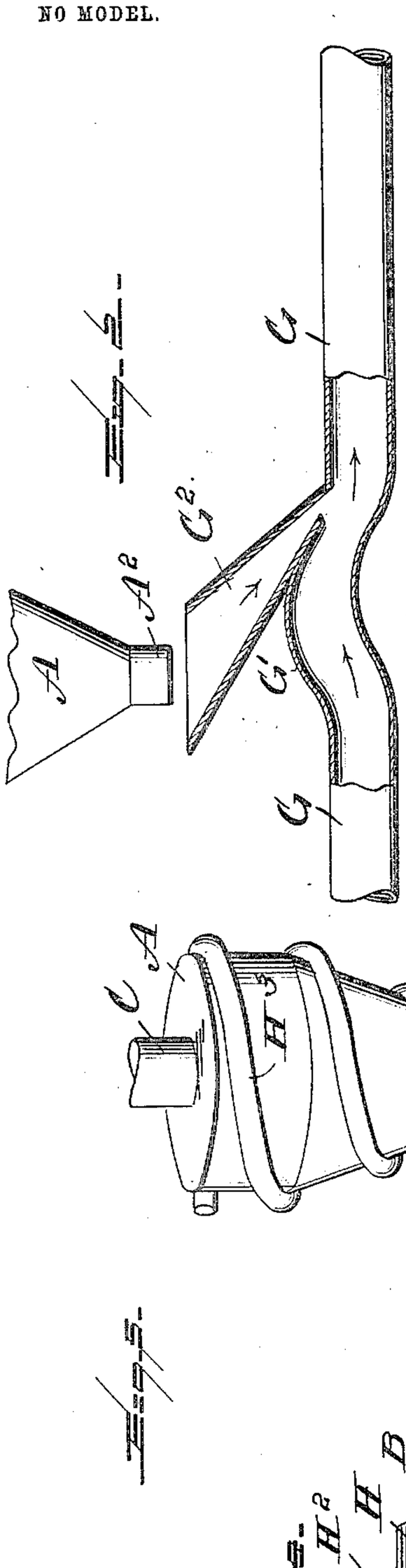

Fig. 2.

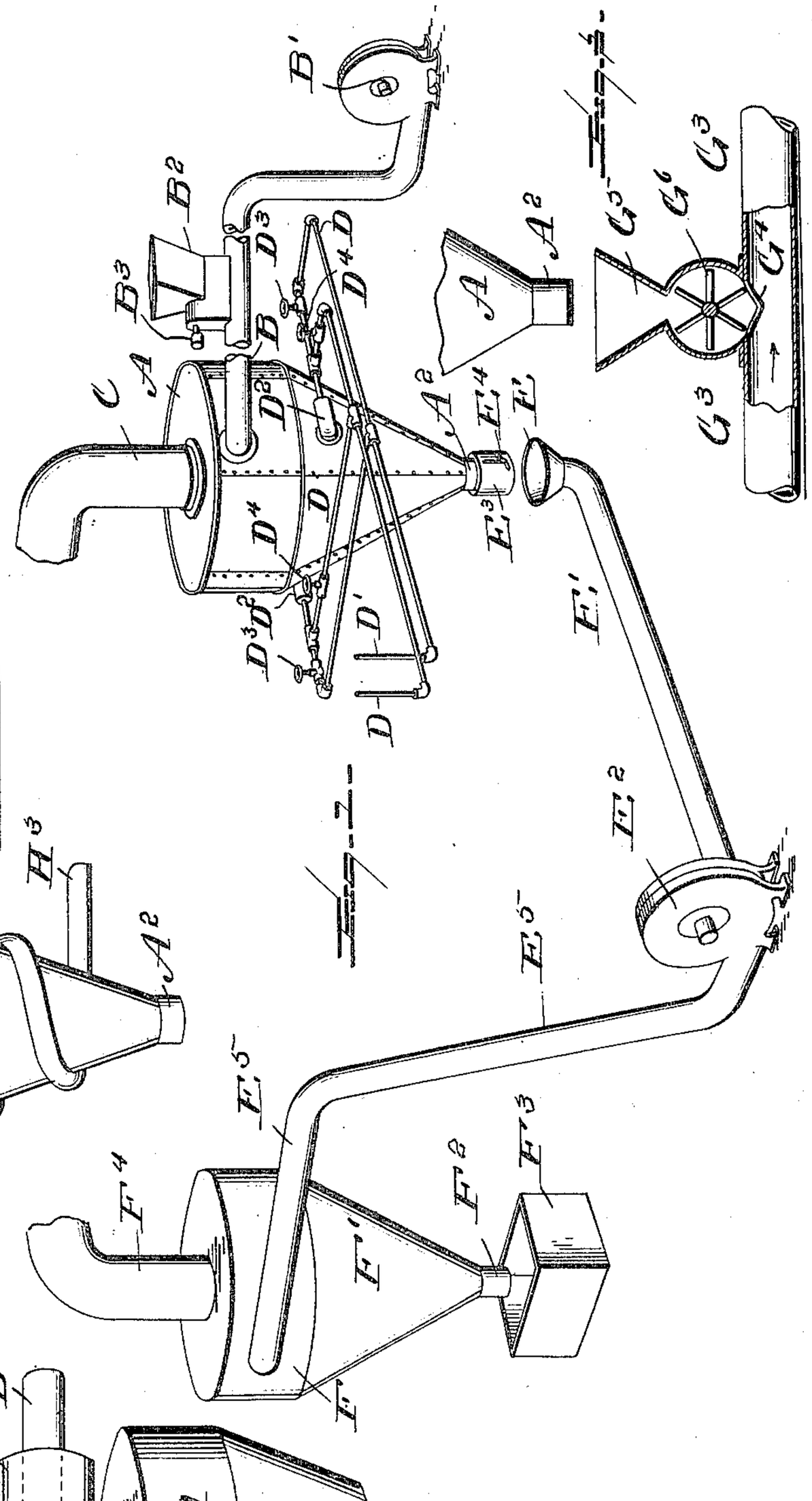

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

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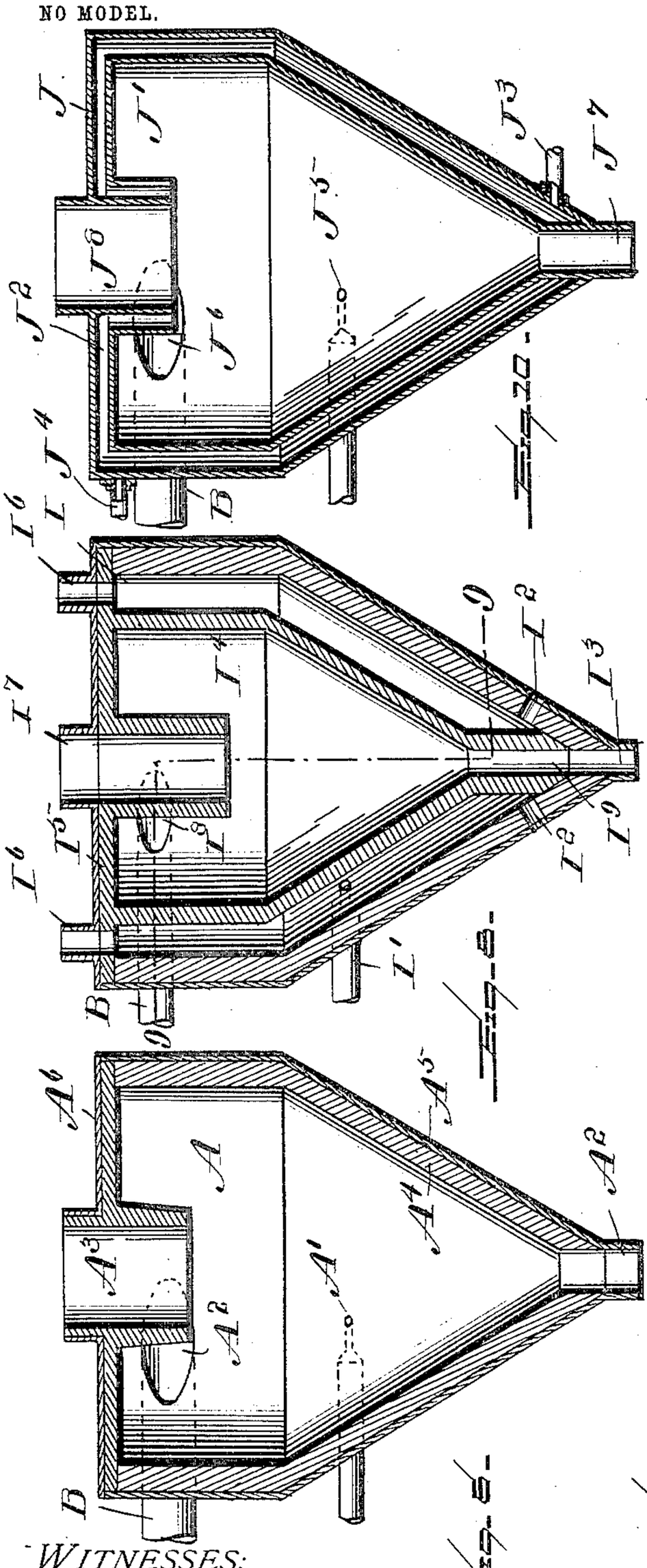
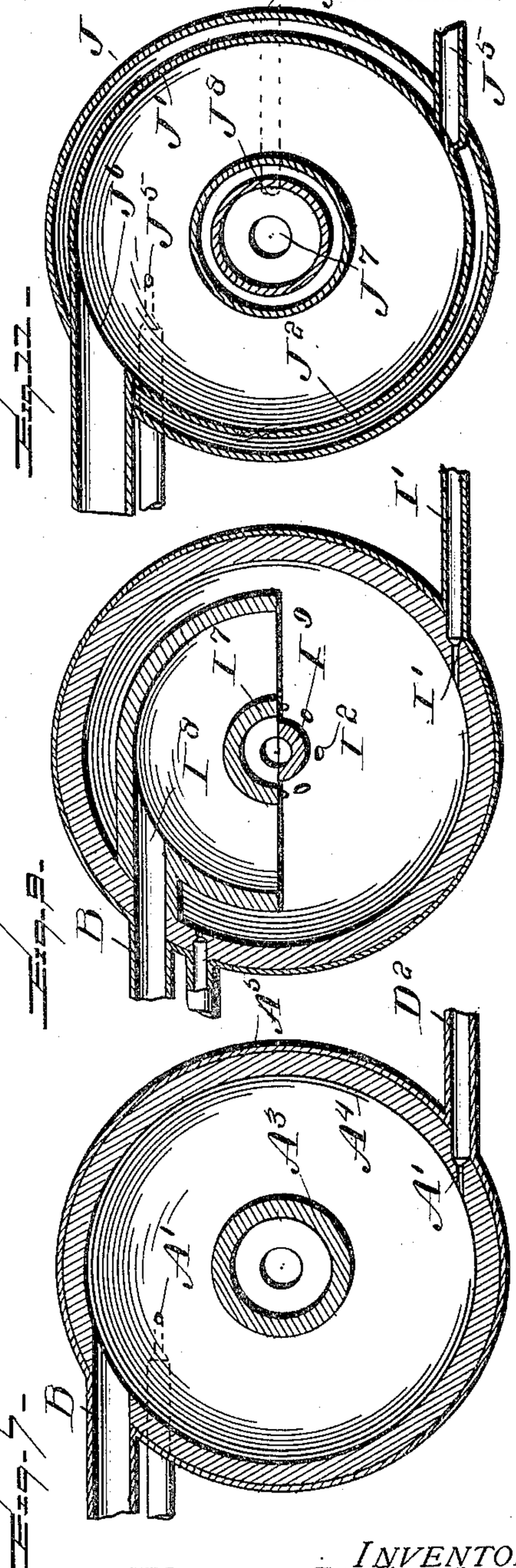
NO MODEL. 2 SHEETS—SHEET 2.





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No. 729,008. Patented May 26, 1903.

UNITED STATES PATENT OFFICE.

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ORE-ROASTER.

SPECIFICATION forming part of Letters Patent No. 729,008, dated May 26, 1903.

Application filed July 1, 1902. Serial No. 114,021. (No model.)

To all whom it may concern:

Be it known that we, HENRY M. SUTTON, WALTER L. STEELE, and EDWIN G. STEELE, citizens of the United States, residing at Dallas, in the county of Dallas, State of Texas, have invented certain new and useful Improvements in Ore-Roasters, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to ore-roasters, and particularly to a structure wherein the ore to be roasted or treated is carried in a centrifugal path through a heated receptacle.

The invention has for an object to provide an apparatus for roasting ore in which the ore is suspended in a current of air moving in a rotary path and entirely surrounded by the same, whereby the fusing of the more readily fusible constituents of the ore is prevented and much better results in the concentration secured.

A further object is to provide a roasting apparatus in which the current of air conveying the ore is carried in a spirally centrifugal path through a roasting-chamber.

Another object of the invention is to provide improved means for feeding and delivering ore to and from the roasting-chamber and also for introducing into said chamber tangentially a liquid fuel.

Other and further objects and advantages of the invention will be hereinafter set forth, and the novel features thereof defined by the appended claims.

In the drawings, Figure 1 is a perspective of a roasting apparatus embodying this invention. Fig. 2 is a modified form of the receiving device at the discharge from the roaster. Fig. 3 is a further modification of a similar device. Fig. 4 is a perspective of a device for heating the air before introduction into the roaster. Fig. 5 is a modified form of a similar apparatus. Fig. 6 is a vertical section through the roasting-chamber; Fig. 7, a horizontal section thereof. Fig. 8 is a vertical section of a modified form of roasting-chamber in which the ore does not come in contact with the flame. Fig. 9 is a horizontal section therethrough on the line 9 9 of Fig. 8. Fig. 10 is a further modified form of the roasting-chamber, showing the same provided with a water-jacket; and Fig. 11, a horizontal section thereof.

Like letters of reference refer to like parts in the several figures of the drawings.

The letter A designates a roasting-chamber, preferably of a circular conical formation, as herein disclosed, and connected to which is a feed-pipe B, through which the ore to be treated is fed into the roaster by means of a fan B′ or other suitable blast device and which pipe is provided with a feed-hopper B^2, from which the ore is fed by the rotatable feeder B^3 of any desired construction to feed the ore to the furnace in predetermined quantities. The roaster A is also provided at its upper portion with an air and gas outlet C, which may be carried to any suitable dust-collector, or to a reduction apparatus if it is desirable to save the fumes caused by the combustion of the ore. At the sides of the roaster an air or steam pipe D and an oil-pipe D′ are extended to feed the fuel to the burners D^2, located at the openings A′ in the roaster A, and by this means the necessary pressure is obtained to atomize the oil and produce the centrifugal movement within the roaster. Suitable regulating-valves D^3 and D^4 are provided upon the steam and oil pipes, respectively. At the lower portion of the roaster a discharge-opening A^2 is provided and beneath the same a suitable receptacle E, communicating with the discharge-pipe E′, into which a suction of cold air is drawn by means of the fan E^2, the amount of this suction being regulated by the sliding sleeve E^3, carried by the discharge from the roaster. This sleeve is adapted to be secured at any position by means of the clamp-screw E^4. The ore after passing into the pipe E′ is taken up at once by the suction from the fan E^2 and blown or blasted through the pipe E^5, which may be of any desired length—for instance, one hundred feet or more—in order to thoroughly cool the ore while it is being conveyed to the point desired. This cooling-pipe communicates at its opposite end with a separator F, preferably provided with a conical lower portion F′, having a discharge-spout F^2, disposed above a suitable receptacle F^3, while the pressure of air is permitted to escape through the pipe F^4 at the upper por-

tion of the separator. This pipe F^4 may be extended to a dust-collector if it is desirable to save any of the extremely fine material which may escape with the expanding air.

In Fig. 2 a modified form of the receiving device at the discharge of A^2 from the roaster is shown and comprises a pipe G, through which an air-blast passes, provided with an upwardly-curved portion G', with which a feed-hopper G^2 communicates, so as to feed hot ore into the traveling current of air and also create a suction through the hopper G^2. A further modification of the same device is shown in Fig. 3, where the pipe G^3, extending to the separator, is provided with an opening G^4 in its upper portion, having above the same a hopper G^5 and a rotary feeding device G^6, by which the ore may be introduced into the traveling current of air without permitting any escape of the air through the hopper.

Under some conditions it is desirable to heat the air which is fed into the furnace with the ore, and for this purpose a device is shown in Fig. 4, in which the feed-pipe B passes through a heating-drum H, connected, by means of the pipe H', with the outlet from the upper portion of the roaster and having a discharge H^2, which may be connected to the pipe C, if so desired. A further modification is shown in Fig. 5, in which the air-pipe H^3 for the feeding apparatus is coiled about the exterior of the roaster, so that the air passing therethrough will be heated by the escaping heat from the roaster.

The several devices heretofore described are adapted for use in connection with the roaster; but the invention is not in any wise confined thereto, as they are illustrated to show a desirable form of apparatus.

The roaster may be likewise modified in construction, and in Figs. 6 and 7 the chamber A is shown as tapering at its lower portion and provided with burner-inlets A' at opposite sides and in different horizontal planes. A single inlet or fuel-burner may be used or the number may be multiplied, depending upon the degree of heat found necessary in the treatment of the different classes of ore. At the upper portion of the chamber A the ore-inlet A^2 is provided, and in the top A^6 a flanged discharge-opening A^3 for the air and gases is formed and communicates with the pipe C, as shown in Fig. 1. The chamber is lined throughout with fire-brick or other suitable refractory material A^4 and provided with an exterior casing A^5, of metal or other suitable material.

In Figs. 8 and 9 a modified form of the roaster adapted to roast or dry ores without the material coming in contact with the flame is shown. The outer chamber I in this form is lined with refractory material and provided with the burner-openings I', extending tangentially thereto at the tapering or conical lower portion of the chamber, which portion is also provided with air-inlets I^2 and with the discharge-spout I^3. Within the chamber I an ore-chamber I^4 is provided of substantially the same configuration, although of less diameter, so as to leave a fuel-space between the two chambers. The chamber I^4 is closed at its top I^5, and the space between the inner and outer chambers is provided at its upper portion with openings I^6 for the escape of products of combustion, while the inner chamber is provided at its upper portion with an opening I^7 for the escape of gases and air when expanded by the heat of the inner chamber. The feed-pipe B for the fuel is extended into the inner chamber, as shown at I^8, and this chamber is provided at its lower portion with a discharge-neck I^9, communicating with the spout I^3 of the inner chamber. In this modification an inner cone or chamber is used, the outer cone being substantially the same as in Figs. 6 and 7 and the flames being forced to circulate around the outside of the inner cone in the fuel-space there provided. This inner cone or chamber is constructed of refractory material and being entirely surrounded by the flames can be raised to any temperature required. The ore when blown into the inner chamber through the pipe B closely hugs the hot inside walls of this chamber in its rotary downward or spiral movement until discharged at the lower portion of this chamber.

In Figs. 10 and 11 a further modification is shown, which is substantially similar to that shown in Figs. 6 and 7, wherein the walls of the outer chamber or cone J and the inner chamber or cone J' are formed of metal and provide a water space or jacket J^2 between the same, which is provided with suitable feed and outlet connections J^3 and J^4 for the purpose of maintaining a circulation therein. The burner J^5 extends within the inner chamber, as does also the ore-inlet J^6 from the feed-pipe B, while the lower portion of both chambers terminate in the discharge-pipe J^7, and the upper portion of the inner chamber is provided with the discharge J^8 for fumes and gases from the heated ore.

The operation of the furnace is as follows: The crushed ore after passing through the feeder is carried by the blast of air, which may be either hot or cold, as desired, and blown into the furnace suspended in this current of air. The furnace is lined with suitable refractory materials and provided with openings, as shown, through which one or more flames are blown. These heating-flames may be atomized fuel-oil blown from an ordinary fuel-oil burner or any ordinary blow-pipe flame burning a liquid fuel. If desired, ordinary coal may be blown into the furnace in a fine divided state through the proper burners. These flames entering the furnace on a tangent with the inner wall of the same immediately assume a circular motion conforming to the inner walls of the furnace, which motion is further assisted by the air-blast entering through the ore-inlet. The pressure back of the flames, together with the

air-blast carrying the ore, causes the flames to completely encircle the interior of the furnace many times, practically covering the walls thereof with a layer of flame and raising the temperature of said walls to a dull-red heat or higher, if necessary. The ore being blown into the furnace on a tangent with the inner walls the same as the flames, assumes at once the same circular motion and travels through the flames along the hot walls of the furnace on its way to the ore-outlet at the bottom. The air-blast as it enters the furnace with the ore suspended therein immediately expands, the expansion being caused by the greater diameter or area of the outlet-pipe than the inlet-pipe, whereby the air-pressure is reduced and the ore previously held in suspension is released or precipitated, taking at once the rotary motion imparted to it by the tangential arrangement of the feed-pipe to the interior contour of the furnace and the ore by its gravity being centrifugally held close to the walls in direct contact with the flames traversing the same by the centrifugal motion imparted by the circulation. The particles of ore circulate in each passage around the furnace at a slightly lower level and in a substantially spiral path caused by the specific gravity of the particles and the gradual loss of momentum until they pass out at the ore-discharge. It will thus be seen that the length of time required for the ore to pass through the furnace will depend upon the specific gravity of the particles and the momentum imparted to the air-blast, so that, if desired, these particles can be made to travel several hundred feet through the flame and over the hot walls of the furnace before being discharged therefrom. It will also be noted that certain classes of ore require only a very slight roast or heat, in which case a single burner is used, while on other ores probably eight or ten burners may be necessary, thus providing a flame-opening at short distances apart around the circumference of the furnace, each opening being slightly lower than the preceding one, so as to completely fill the interior of the furnace with circulating flame.

Among the advantages secured by this roaster is the strictly automatic operation requiring no attention other than to keep it supplied with ore and fuel, the furnace having no moving parts whatever and the only moving parts in the entire apparatus being the driving-fans and the automatic feeding device if used. As fuel-oil is burned, the amount thereof can be regulated so as to accomplish the exact degree of heat desired at any time, and the ore being in actual contact with the flame any combustible matter therein—such as sulfur, arsenic, &c.—is oxidized and full combustible value of the ore realized. The ore is conveyed to the furnace suspended in an air-blast, and each particle thereof is at all times entirely surrounded by the air, thus producing strong oxidizing conditions which can be increased by using the heated air. It will also be seen that the simplicity of the furnace is such that the parts can be easily replaced or repairs made, and the absence of any moving members in the heated parts forms an economically constructed and operated roasting device. If desirable, the gases formed by the operation of roasting can be collected as they pass out of the top of the furnace and by-products then secured by any of the well-known reduction processes.

This furnace is especially adapted to roasting ore requiring the addition of chemicals to produce the results required, as the material is fed into the furnace in a fine divided state and a complete mixture of the ore and chemical may be made before roasting, so that both are blown into the furnace at the same time.

In addition to the foregoing advantages it should be stated that heretofore in this art there has been no effectual method of preventing the fusing of the more readily fusible constituents of the ore. This fusing causes a considerable loss either of values or on account of small particles adhering to the values, thus raising the percentage of gangue in the subsequent concentration, thereby lowering the value thereof. To explain, suppose a zinc ore containing pyrites is being roasted, the double object of a roasting being to reduce the percentage of sulfur in the mass and to render the pyrites magnetic for subsequent magnetic treatment. The pyrites in this ore having a much lower fusing-point than zinc, fuses in an ordinary furnace and settles down in the mass, adhering to the particles of the zinc content. The iron being magnetic is removed by a subsequent magnetic treatment, and the adhering particles of zinc thus carried out are lost, while they lower the value of the iron concentrates, as explained above. In this furnace each particle of ore being suspended in air and entirely surrounded by the same, it is obvious that any fusing of the pyrites, if such did occur, would not cause the loss and difficulty just referred to.

The furnace may be used as both an oxidizing and reducing roaster, depending upon the amount of oxygen admitted to the furnace as compared with the amount of fuel being consumed, and it is also possible to reduce the carbonate ore to the metallic state simply by the proper regulation of the ore blast and burners.

It will be obvious that changes may be made in the various features of construction hereinbefore described without departing from the spirit of the invention, one of the essential features of which is the method and apparatus whereby the ore particles are suspended and surrounded by a moving body of air when subjected to the roasting heat and also the other features of construction defined by the appended claims.

Having described our invention and set forth its merits, what we claim, and desire to secure by Letters Patent, is—

1. In an ore-roaster, means for creating a current of air, means for introducing ore into said current, a heating-chamber, means for imparting a rotary motion to said current within the said chamber, means for heating the air and ore, and means for effecting an expansion of the air to precipitate the ore within said chamber; substantially as specified.

2. In an ore-roaster, means for creating a current of air, means for introducing ore into said current, a heating-chamber for the air and ore having curved walls against which the air and ore are tangentially projected, and means for effecting an expansion of the air to precipitate the ore within said chamber; substantially as specified.

3. In an ore-roaster, means for creating a current of air, means for introducing ore into said current, a heating-chamber for heating the air and ore having curved walls against which the air and ore are tangentially projected provided with a burner-opening disposed at a tangent to the inner wall of said chamber, and means for effecting an expansion of the air to precipitate the ore within said chamber; substantially as specified.

4. In an ore-roaster, means for creating a current of air, means for introducing ore into said current, means for heating the air and ore having curved walls against which the air and ore are tangentially projected provided with a burner-opening disposed at a tangent to the inner wall of said heating means; a discharge at the lower portion of said heating means, a hopper beneath said discharge communicating with a conducting-pipe, means for producing a current of air in said pipe, and a separating-chamber adapted to receive the material from said pipe and permit an expansion of the air-current; substantially as specified.

5. In an ore-roaster, means for creating a current of air, means for introducing ore into said current, means for heating the air and ore having curved walls against which the air and ore are tangentially projected provided with a burner-opening disposed at a tangent to the inner wall of said heating means, a discharge at the lower portion of said heating means, a hopper beneath said discharge communicating with a conducting-pipe, means for producing a current of air in said pipe, a separating-chamber adapted to receive the material from said pipe and permit an expansion of the air-current, a conducting-pipe extending from the upper portion of the heating means, and a feed-pipe adapted to introduce fuel into the feeding-current for the roaster; substantially as specified.

6. In an ore-roaster, means for creating a current of air, a feed-hopper for introducing ore into said current, means for heating the air and ore having curved walls against which the air and ore are tangentially projected provided with a burner-opening disposed at a tangent to the inner wall of said heating means, a discharge at the lower portion of said heating means, a hopper beneath said discharge communicating with a conducting-pipe, means for producing a current of air in said pipe; a separating-chamber adapted to receive the material from said pipe and permit an expansion of the air-current, a conducting-pipe extending from the upper portion of the heating means, a fan-motor adapted to introduce air into the feeding-current for the separator, and means for heating the air fed to said heating means; substantially as specified.

7. In an ore-roaster, a conical heating-chamber, a feed-pipe communicating therewith at a tangent to the inner wall thereof, a blast device for creating a current of air through said feed-pipe, an ore-feeding device in communication with said pipe, a fluid-pressure burner communicating with said conical chamber at a tangent to the inner wall thereof, and a discharge-spout at the lower portion of said chamber; substantially as specified.

8. In an ore-roaster, a conical heating-chamber, a feed-pipe communicating therewith at a tangent to the inner wall thereof, a blast device for creating a current of air through said feed-pipe, an ore-feeding device in communication with said pipe, a fluid-pressure burner communicating with said conical chamber at a tangent to the inner wall thereof, a discharge-spout at the lower portion of said chamber, a conducting-pipe beneath said spout, an adjustable sleeve carried by said spout, a separator, a cooling-pipe extending thereto, means between said conducting and cooling pipes for producing a suction in the former and a blast in the latter, an ore-discharge at the lower portion of said separator, and an air-discharge at the upper portion thereof; substantially as specified.

9. In an ore-roaster, a heating-chamber having a conical lower portion, an inlet at the upper portion of said chamber for ore and air arranged tangentially to the inner wall thereof, an air-outlet at the upper portion of said chamber of greater area than said inlet and a burner-opening arranged tangentially to the wall of said chamber; substantially as specified.

10. In an ore-roaster, a heating-chamber having a conical lower portion, an inlet at the upper portion of said chamber for ore and air arranged tangentially to the inner wall thereof, a burner-opening arranged tangentially to the wall of said chamber, an outlet at the upper portion of the chamber for gases of greater area than said inlet, and a discharge-spout at the lower portion of the chamber for the heated ore; substantially as specified.

11. In an ore-roaster, a heating-chamber having a conical lower portion, an inlet at the upper portion of said chamber for ore and air

arranged tangentially to the inner wall thereof, a burner-opening arranged tangentially to the wall of the chamber, an outlet at the upper portion of the chamber for gases of greater area than said inlet, a discharge-spout at the lower portion of the chamber for the heated ore, a refractory lining to said chamber, and means for introducing the ore and air under pressure against the curved inner wall of the chamber and the fuel against a similar wall in the same direction as the feed of ore; substantially as specified.

12. In an ore-roaster, a heating-chamber having a curved inner wall at its upper portion and a conical wall beneath the same, an air-outlet at the upper portion of said chamber, and means for introducing fuel and ore tangentially into contact with said walls whereby a downward spiral movement is given to the contents of the furnace and the walls thereof heated by the contact with the fuel thereof; substantially as specified,

13. In an ore-roaster, a heating-chamber having a conical lower portion and a refractory lining, a discharge-spout at the lower portion thereof, an outlet at the upper portion above said discharge, a tangentially-disposed inlet for air and ore of less area than said outlet, and tangentially-disposed burners at the conical portion of said chamber arranged in different horizontal planes; substantially as specified.

In testimony whereof we affix our signatures in presence of two witnesses.

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Witnesses:
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