No. 746,246. PATENTED DEC. 8, 1903.

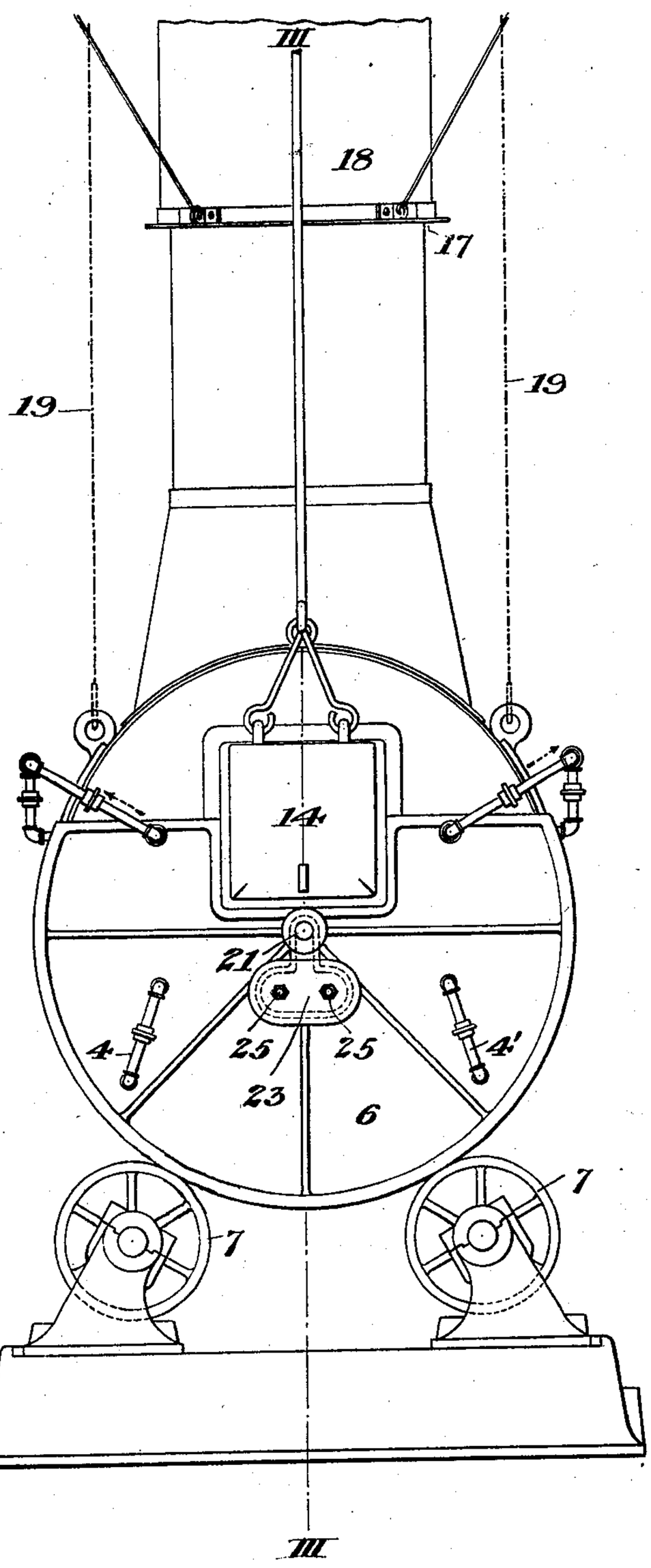
R. BAGGALEY.

REFINING COPPER.

APPLICATION FILED MAR. 28, 1903.

NO MODEL. 5 SHEETS—SHEET 1.

Fig. 1.



WITNESSES

E. W. Lindquist.

Geo. D. Rockwell.

INVENTOR

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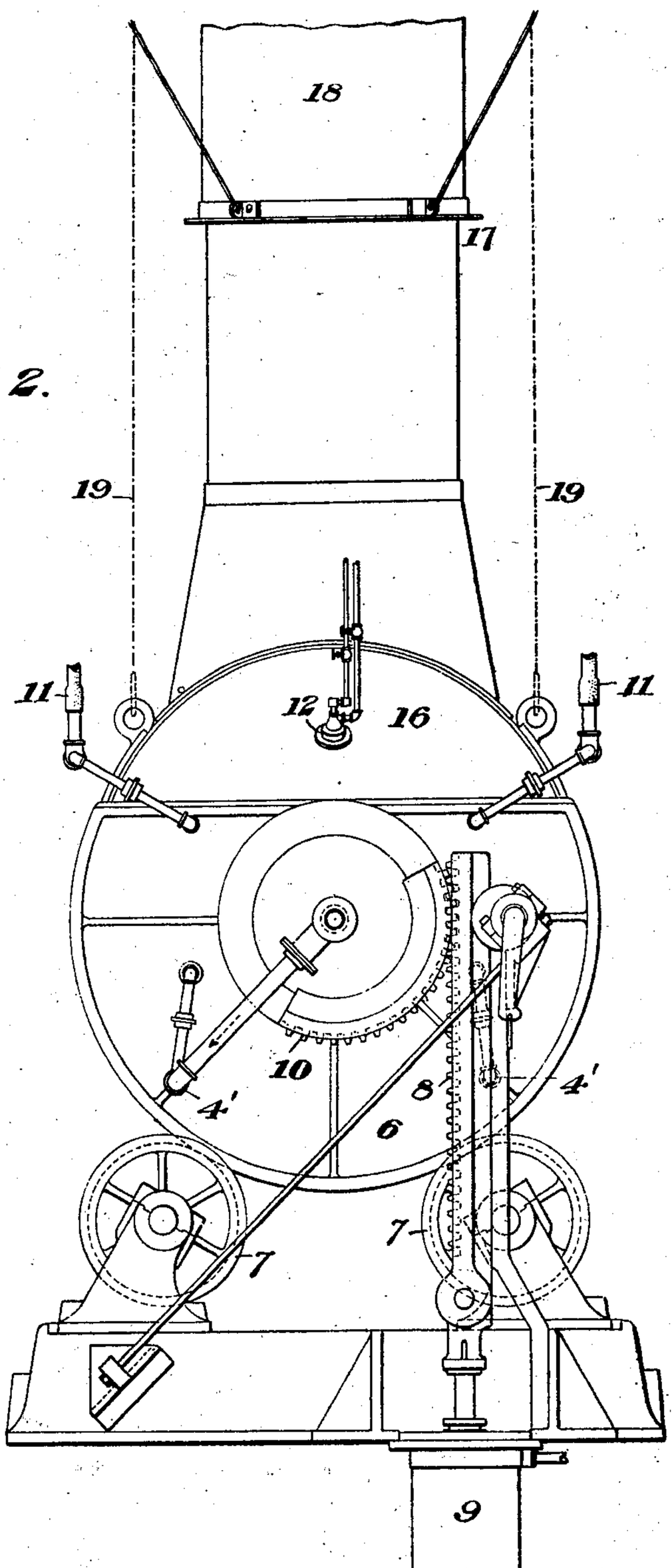
NO MODEL. 5 SHEETS—SHEET 2.

Fig. 2.



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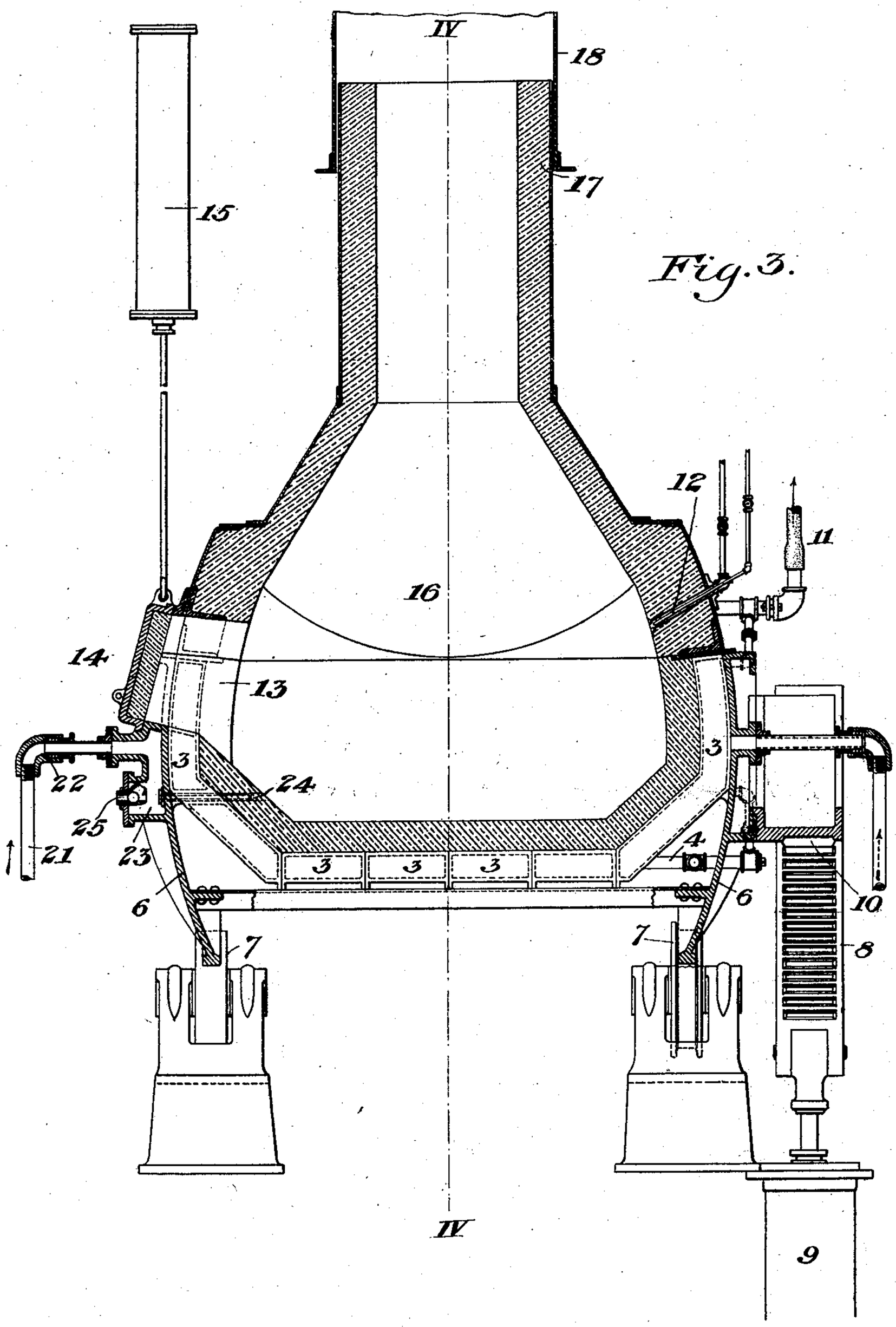
NO MODEL. 5 SHEETS—SHEET 3.

Fig. 3.



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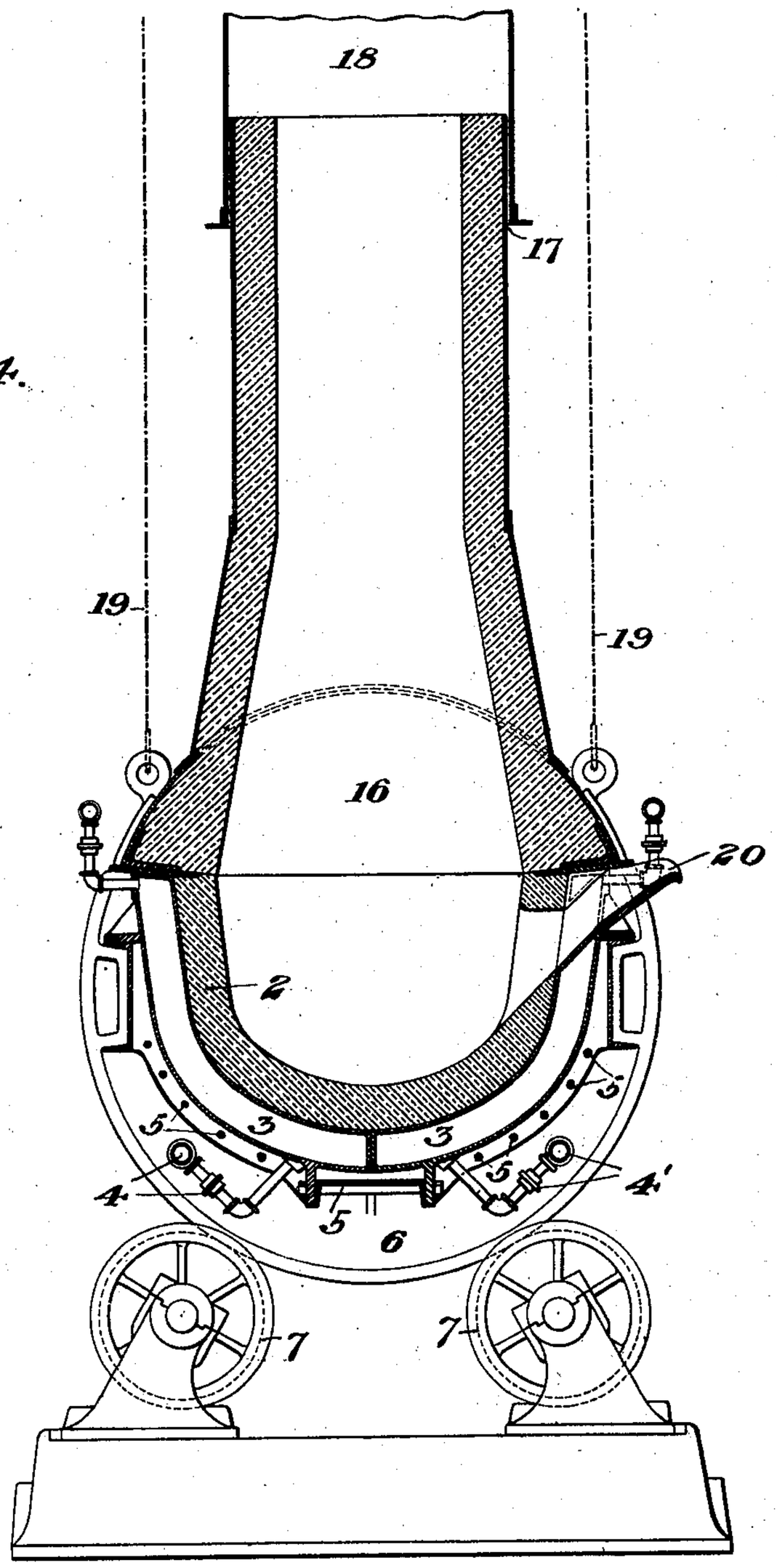
NO MODEL. 5 SHEETS—SHEET 4.

Fig. 4.



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NO MODEL. 5 SHEETS—SHEET 5.

Fig. 5.

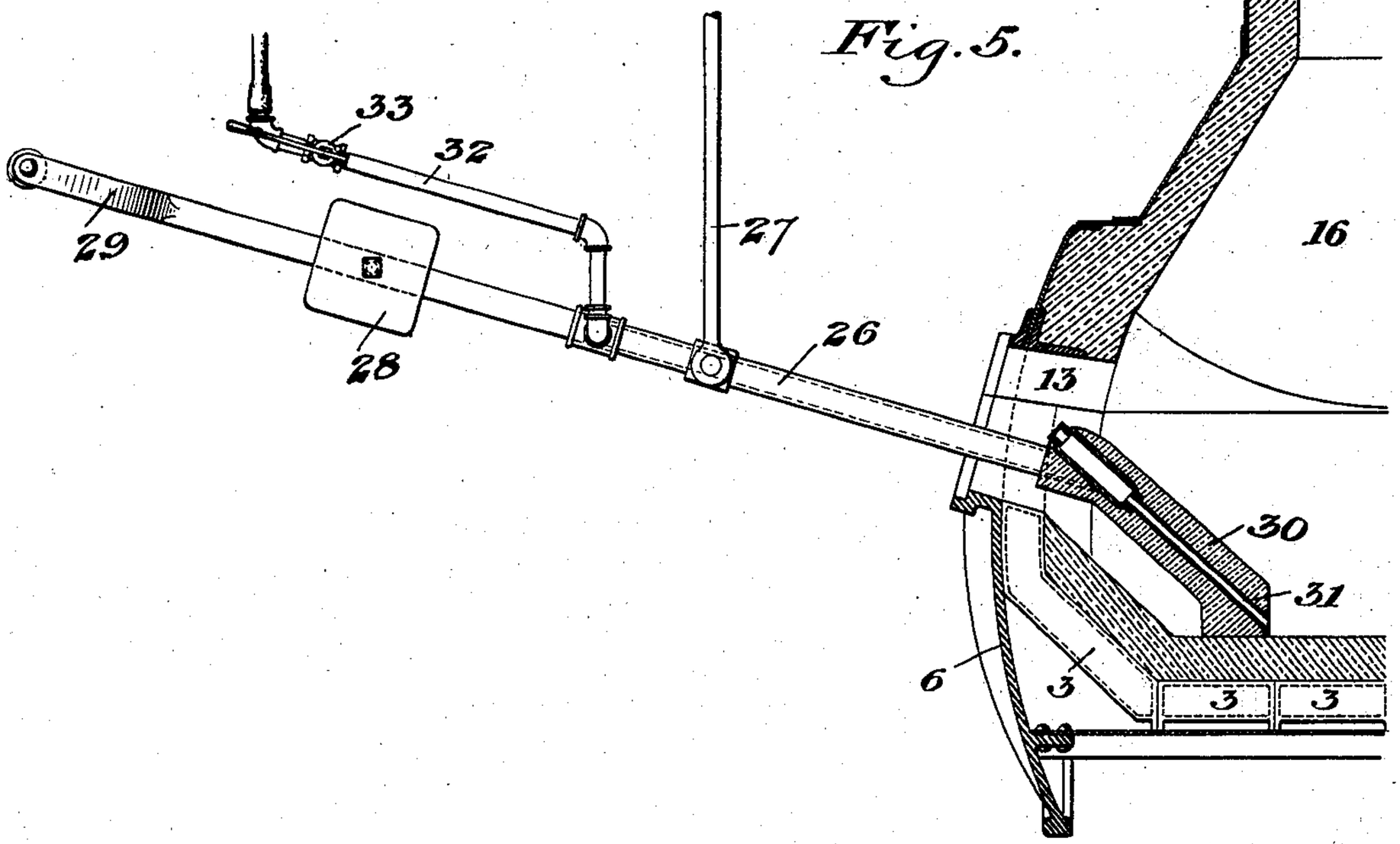
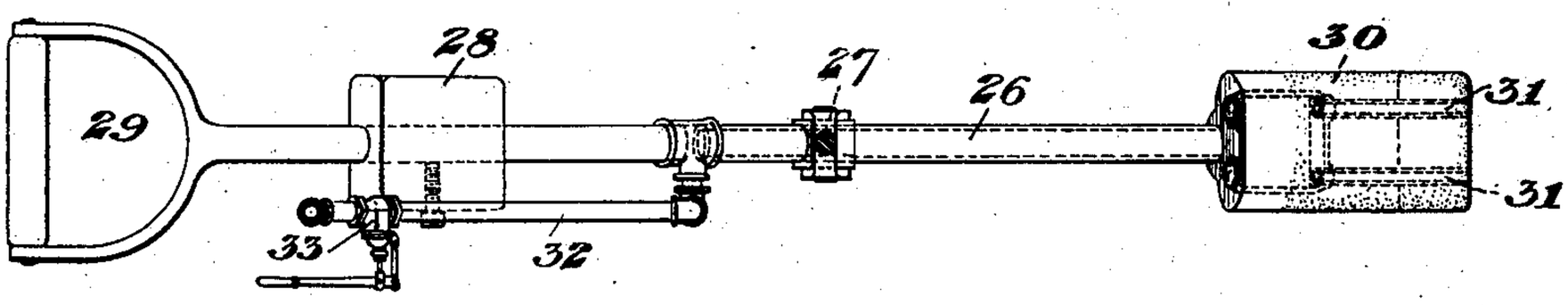


Fig. 6.



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UNITED STATES PATENT OFFICE.

RALPH BAGGALEY, OF PITTSBURG, PENNSYLVANIA.

REFINING COPPER.

SPECIFICATION forming part of Letters Patent No. 746,246, dated December 8, 1903.

Application filed March 28, 1903. Serial No. 149,985. (No specimens.)

To all whom it may concern:

Be it known that I, RALPH BAGGALEY, of Pittsburg, Allegheny county, Pennsylvania, have invented a new and useful Method of Refining Copper, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figures 1 and 2 show in elevation the opposite ends of an apparatus suitable for the practice of my invention. Fig. 3 is a vertical section on the line III III of Fig. 1. Fig. 4 is a vertical section on the line IV IV of Fig. 3. Fig. 5 is a sectional view showing a modified apparatus, and Fig. 6 is a plan view of the means shown in Fig. 5 for introducing the hydrocarbon gases.

The purpose of my invention is to provide means for the refining of copper and to effect very rapidly and by mechanical means a refining operation which heretofore has required many hours and has been accomplished only by difficult and expensive hand labor.

The invention consists in refining molten copper by oxidizing and removing its impurities and then forcing into it a reducing-gas which is generated outside the refining furnace or vessel and prior to its introduction into the copper.

The refining of copper as practiced from ancient times at Swansea, Wales, consists in treatment in a reverberatory furnace and by "flapping" the molten copper into the air with a suitable hand-tool in order that the rapidly-passing air-current through the furnace may oxidize the various impurities—such, for instance, as arsenic, antimony, bismuth, selenium, tellurium, &c. Since the application of the Bessemer converter to the treatment of copper, or since the year 1880, this stage of the refining process has been more cheaply accomplished in the converter by driving air underneath and through the molten bath instead of allowing it to flow over the surface of such bath, as is the case in the reverberatory furnace.

The purification of copper consists simply in bringing oxygen into contact with it while molten. As the impurities above referred to are more rapidly oxidized than copper, gold, silver, nickel, cobalt, &c., they are consumed and expelled before those metals have been seriously attacked by the oxygen, so that the latter remain in a practically pure state after the treatment described has been completed. Some of the impurities cling to the copper with great resistance—as, for instance, antimony and bismuth—and as even one-half per centum of either of these has the effect of injuring or destroying the ductility of the copper, particularly when cold, and inasmuch as the market price of the copper is injuriously affected if it contains even an appreciable percentage of such impurities it is of great importance that they be completely oxidized and expelled. It is impossible, however, to carry the oxidation to this extent without at the same time producing a small percentage of suboxid in the copper itself. Such suboxid does not float on the surface of the copper, as is the case with the oxidized impurities, but the surface of the molten copper remains clean and pure and bright and the suboxid is absorbed by and becomes an integral part of the copper itself.

Copper contaminated with suboxid is brittle, and its ductility is injured or destroyed, particularly when cold, so that when rolled it acts in many respects like copper containing appreciable percentages of objectionable impurities, such as antimony or bismuth. For these reasons copper that contains even a small percentage of suboxid must be re-treated while in the molten state in order to restore its ductility. This work has been done wherever copper has been produced by a process which consists in submerging poles of green wood, preferably hard wood, in the molten copper, the heat of which generates from the wood great volumes of hydrocarbon gases, which rise through the copper and exert a refining and a purifying influence upon it, expelling all the suboxid and restoring the ductility and value of the metal.

The objections to the poling method are many and they are serious. Some of them are as follows: The workmen command very high wages. The copper at this stage has a great tendency to chill on the bottom and the sides of the furnace. The losses of metal by saturation of the masonry of the present refining-furnaces are enormous. The copper is difficult to tap and to keep flowing when tapped owing to its tendency to chill. It is

often necessary to drive with sledges and steel bars through from eight to twelve inches of pure solidified copper in order to open the tap-hole, and the process of tapping causes many burns and sacrifices many eyes among the workmen. To produce satisfactory results, the process must be carried on with large charges, varying from eight to fifty tons, and such large charges require from three to four hours time or more in which to treat them. The process often requires, in addition to the men who fire and tap the furnace, three high-priced workmen at one time to submerge and to handle the large green poles or trunks of trees which are used in large furnaces. As the charge approaches the proper "pitch" it is extremely difficult to stop the process at the exact point desired. When the butt-end of a tree is submerged in the bath, the fumes and hydrocarbon gases produced by the heat are enormous, and as the trees are of different dimensions and contain different percentages of moisture it is impossible to regulate these things to the exact point where the perfect pitch of the copper is reached and is not exceeded. Of course samples and test pigs are continuously taken; but with the utmost care "overpoling," as it is called in the trade, is almost inevitable. Such overpoling produces in the copper almost the same effect as insufficient poling. It reduces or destroys its ductility when cold. Fresh green poles are sometimes difficult and expensive to obtain and to retain in the green state until required for use, and only a small percentage of each pole can be used effectively.

At many establishments the copper is ladled out of the refining-furnaces by hand. To so ladle out a charge of from ten to twelve tons and to cast it into the ordinary sixteen-pound ingots of commerce requires four men from three and one-half to four hours. It requires somewhat less time for four workmen to ladle the same tonnage into two-hundred-pound anodes, such as are usually made for the separation of the contained precious metals at the electrolytic works. Of course one man cannot lift more than fifty pounds in a ladle. Hence to pour a two hundred-pound anode the work must be regulated so that an even stream is constantly running into the mold until the casting is completed. The charge in a single furnace is often forty to fifty tons, and to ladle this tonnage by hand requires time and labor. While this work is being done, owing to the great time required the copper is constantly changing in pitch, so that one force of workmen is required to do the ladling, while a separate force is required to hold the copper at the proper temper, a most intricate and difficult piece of work.

In my improved method of refining copper in lieu of the present poling process I am able to eliminate the expenses, dangers, and difficulties above enumerated.

One man can tilt and operate the furnace readily by machinery. Losses of saturation are impossible owing to the use of a water-cooled lining. The usual expenses, delays, and dangers of the tap-hole are eliminated, because I can tilt and right my furnace at will by machinery to accomplish the act of pouring the metal, and its spout is always open and clean, because it drains itself. Should any copper be splashed up into it, the incandescence of the interior of the furnace will quickly melt it and cause it to return by gravity into the furnace.

The reducing-gas which I employ is derived, preferably, from an auxiliary gas-producing plant, in the kilns of which I make fixed ligneous hydrocarbon gases and charcoal very cheaply and in a continuous process out of any description of waste wood, slabs, sawdust, the trunks and branches of trees, the underbrush and waste materials of the forest, or indeed of ligneous material of any description. I may pump such gas by a suitable pump, first, into an ordinary gasometer, where it can be stored and used as desired, or I may pump it directly through suitable twyers into the furnace, where at a pressure of six pounds to the square inch it is forced underneath and into the molten copper. It is desirable to deliver these gases at the temperature at which they are taken from the kiln, as this will materially increase the efficiency of the process. The gases may be delivered beneath the molten copper through ordinary conveying twyers at the end or sides of the furnace and similar in many respects to the twyers now used for admitting the bessemerizing blast into the ordinary converter, or they may be delivered through a hand-pipe attached to a pliable hose, through which the hydrocarbon gases may be forced by an air-pump from the kilns or gasometer. For this purpose I may use a large overhead swinging hand-pipe, which may be inserted into the furnace through the end door, its refractory tip being submerged in the molten copper to any desired extent. When such refractory tip is moved by the operator backward and forward through the molten bath, it will distribute the purifying-gases thoroughly through every portion of the charge under treatment. Exactly uniform and predetermined quantities of refining hydrocarbon gases can thus be delivered into the copper and without any waste whatever of the material from which the gases are made. The operator is free to take frequent and continuous test samples as the bath approaches the critical point, and when the exact pitch has been finally reached he can instantly shut off the supply by means of a hand-cock provided for the purpose, and thus prevent overpoling.

The molten copper while in the furnace undergoing treatment is preferably kept covered with a thick layer of powdered charcoal in order to prevent it from absorbing additional oxygen from the atmosphere.

A suitable test sample of refined copper on cooling will indicate its exact pitch. If this is correct, the surface will remain smooth and level. If it is underdone—*i. e.*, if it still contains suboxid—the surface will sink. If it is overpoled, the surface will expand and will show a tendency to form arborescences.

When the test samples have shown that the charge is thoroughly refined and that the pitch is exactly right, the furnace is tilted by the operator through the use of machinery, and the refined copper is poured from the furnace into a ladle that is also provided with a covering of charcoal, whence the copper is immediately poured into pigs or slabs.

I am aware that in brass foundries where castings of pure copper have been made it has been the custom to spray or smear the molds with oil in order that when the molten copper is poured its heat will generate sufficient quantities of hydrocarbon gases from such oil to counteract the tendency of the casting to absorb oxygen, the effect of which would be to produce blow-holes and imperfect spots in such castings.

I am also aware that in foundries where pure copper castings are made it has been the custom to make the cores of sand mixed with sawdust. The heat of the molten copper when the casting is poured generates hydrocarbon gases from the sawdust and produces similar effect on the casting as is produced when oil is used on the mold.

I am also aware of a British patent granted in 1892, the object of which was to overcome the difficulties of the poling process by introducing with air liquids or solids, easily decomposed or vaporized into a reducing gas or gases, through or into the middle or lower part of the molten metal to be deoxidized. The agents described as suitable for this purpose were hydrocarbons in either liquid or solid state, (paraffin, petroleum, and the lighter oils.) This process is different from my invention in which precreated gases are forced into the metal, because it is impracticable to force petroleum and the lighter oils or solids in the form of paraffin where a pressure of six pounds to the square inch is required to accomplish the act without producing an explosion, which would defeat the end sought, and the air by which they were proposed to be introduced would oxidize the metal, and thus aggravate the difficulty sought to be cured.

In none of the prior processes above mentioned is gas, generated before its introduction into the copper independently of the heat of the copper, forced through the copper, and in none of them could the operation be kept under control, so as to secure accurate results in the final treatment of molten copper.

In the drawings the body of the furnace is shown as composed of a refractory lining 2, inclosed within hollow water-jackets 3 3, made in sections and provided with water-pipes 4 4′, by which cooling streams of water may be caused to flow through them. The water-jacketed sections are held together by bolts 5, passing through flanges on the sections. The furnace is supported by a strong metal shell 6 of circular outline and is adapted to be rotated and tipped, preferably by being mounted on rollers 7 7, and provided with a rack 8, reciprocated by a cylinder 9 or other suitable motor, the rack being in gear with a segmental pinion 10 on the furnace-shell. To permit of rotation of the furnace, the water-outlet pipes 4 are provided with flexible connections 11, and the water-inlet pipe 4′ extends from the axis of the converter-shell and is swiveled thereto, as shown in Fig. 2. At the end or ends of the furnace, preferably extending through the roof-section thereof, is a burner-pipe 12 for the introduction of gas or oil by which the furnace may be heated, and at the other end of the furnace is a working opening 13, adapted to be closed by a door 14, which may be operated by a cylinder or motor 15. The roof-section 16 of the furnace is preferably connected telescopically, as at 17, with a stack 18, and lifting devices 19 are provided by which it may be raised preparatory to tipping the furnace.

20 is the discharging-spout of the furnace.

21 is the pipe by which the hydrocarbon gas is supplied. It has a swivel-joint 22 at the axial line of the furnace and communicates with a box or chamber 23, from which twyers 24 lead into the interior of the furnace below the level intended for the surface of the molten copper therein. Valve-controlled openings 25 may be provided for the purpose of inserting rods into the twyers to close them while the furnace is being charged with metal and before the gas is admitted.

The furnace is charged through the opening 13 with the molten copper to be refined, the impurities of which have been removed by oxidation, as above explained, and heat is supplied thereto by the burner 12. The refining is accomplished, as above stated, by introducing gas through the pipe 21 and twyers and is continued until the proper pitch is reached, whereupon the furnace may be tilted and the copper discharged into a ladle for casting into molds, as desired.

In Figs. 5 and 6 I show a modification of the means for introducing gas into the molten copper. This device consists of a pipe 26, which may be supported by a hanger 27 and provided with a counterweight 28 and an operating-handle 29. The end of this pipe which is to be introduced into the furnace terminates in a refractory nozzle 30, having gas-passages 31 extending therethrough and communicating with the pipe 26, which derives its supply of gas from a pipe 32, controlled by a valve 33. The gas-passages 31 preferably extend from end to end of the nozzle, having removable stoppers at their upper ends to enable them to be cleaned.

The tool thus described is introduced through the working door of the furnace, its nozzle is submerged beneath the molten copper, and it is worked back and forth by the operator, so as to distribute the hydrocarbon gas thoroughly through the bath.

In case the supply of gas for any reason should be interrupted poles of wood may be inserted through the working door for treating the copper by poling in the manner heretofore commonly practiced in the art.

Without limiting myself to the apparatus above described, which may be modified in various ways, I claim—

1. A step in the process of refining copper, which consists in forcing through the copper when molten, and after oxidation and removal of its impurities, reducing-gas generated independently of the heat of the copper and prior to its introduction thereinto; substantially as described.

2. A step in the process of refining copper, which consists in forcing through the copper when molten, and after oxidation and removal of its impurities, a regulated stream of reducing-gas generated independently of the heat of the copper and prior to its introduction thereinto, and continuing the introduction of the gas until the copper has been brought to such pitch that it will remain substantially level when cast in a test-mold; substantially as described.

In testimony whereof I have hereunto set my hand.

RALPH BAGGALEY.

Witnesses:
GEO. B. BLEMING,
JOHN MILLER.