(No Model.) 4 Sheets—Sheet 1.

T. WALKER & J. F. CARTER.

ORE ROASTING FURNACE.

No. 516,781. Patented Mar. 20, 1894.

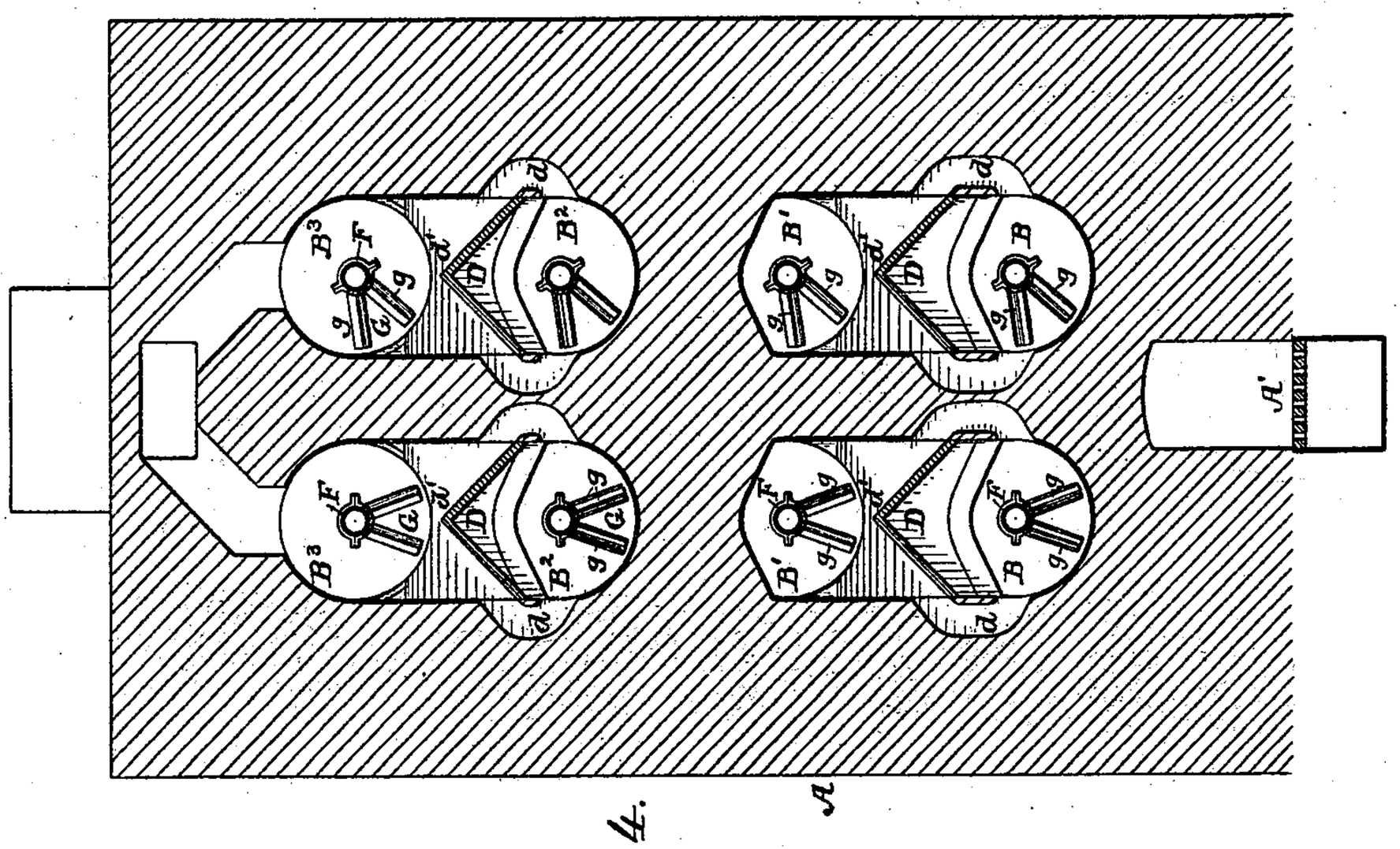

FIG. 4.

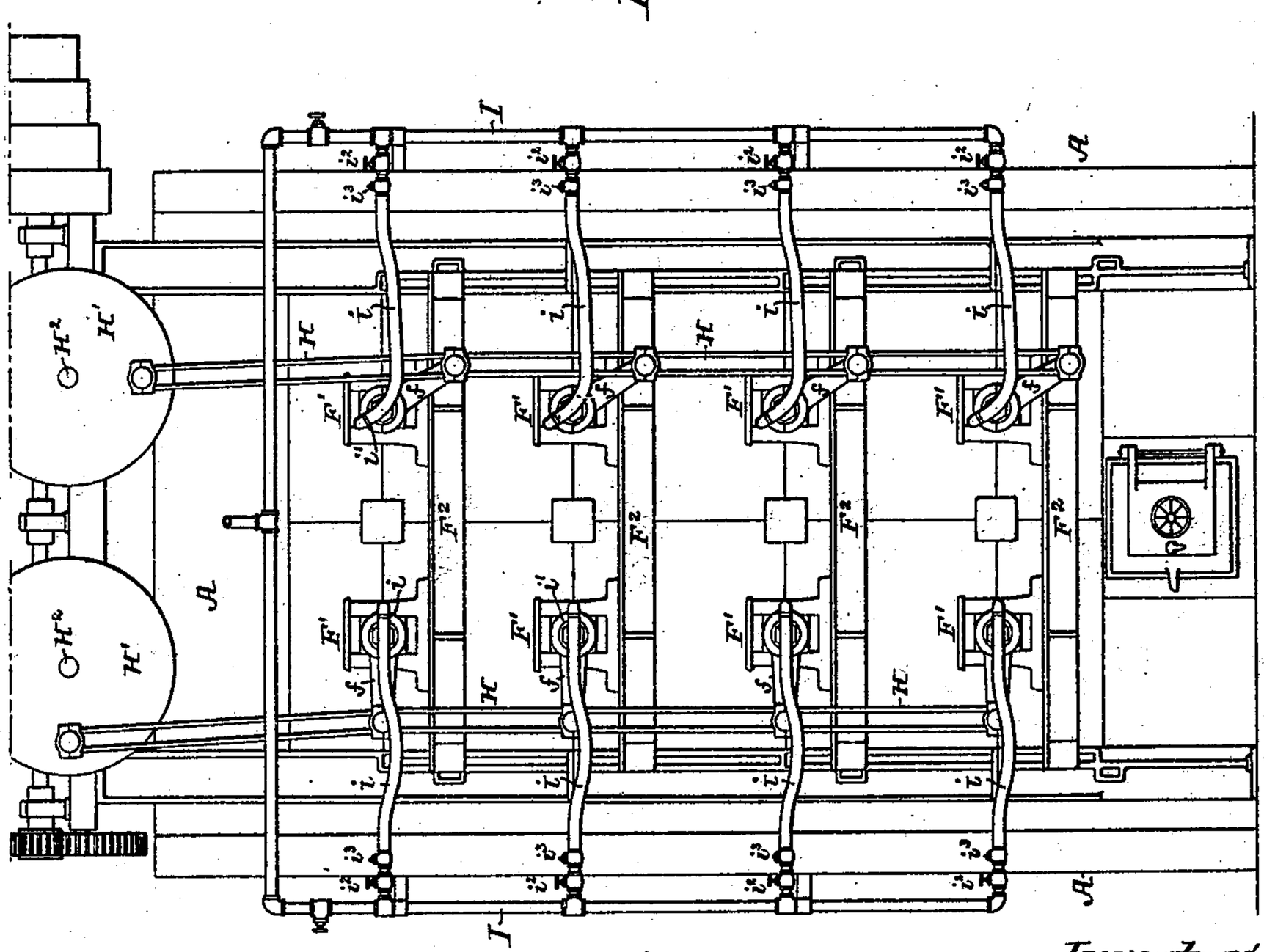

FIG. 1.

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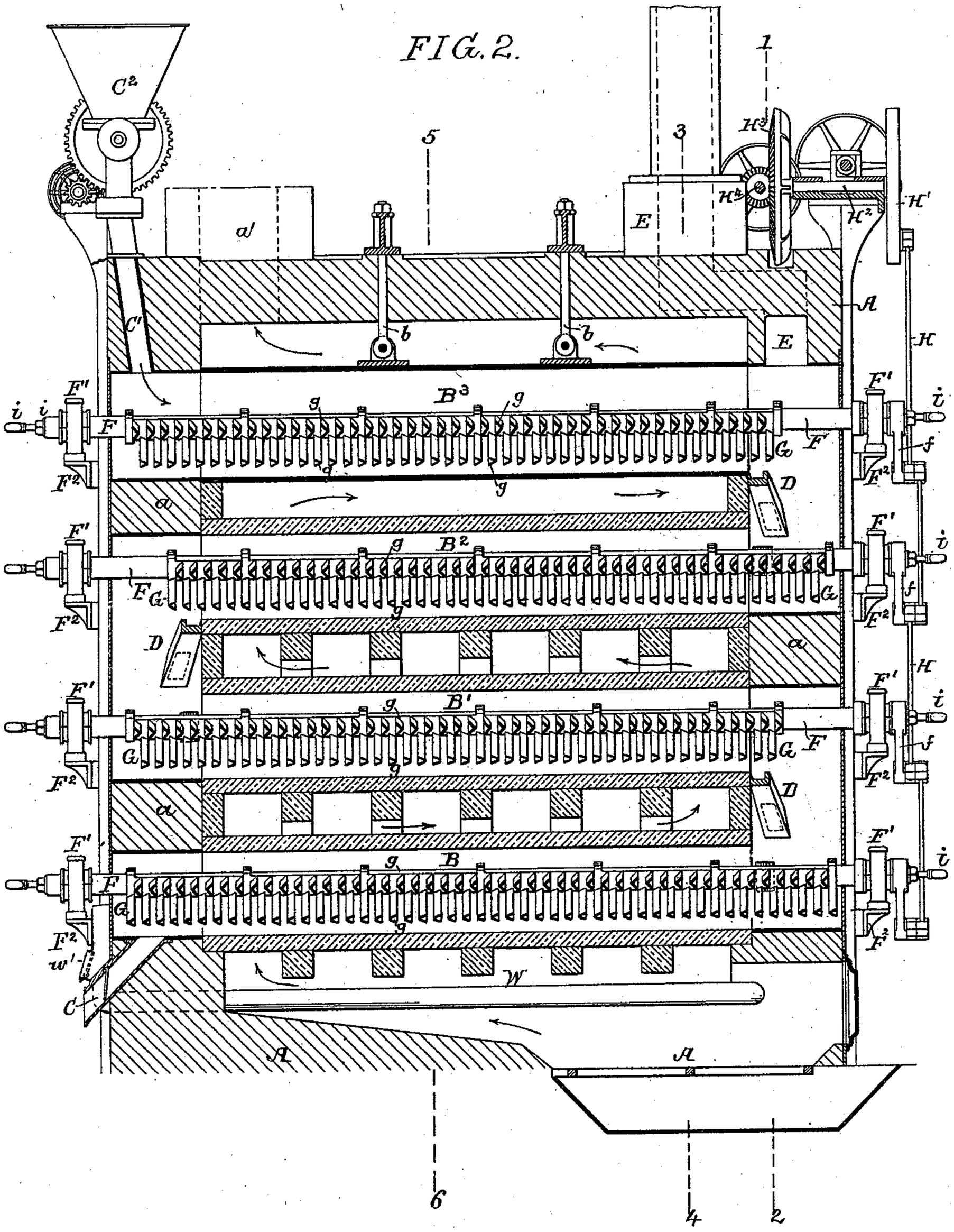
FIG. 2.



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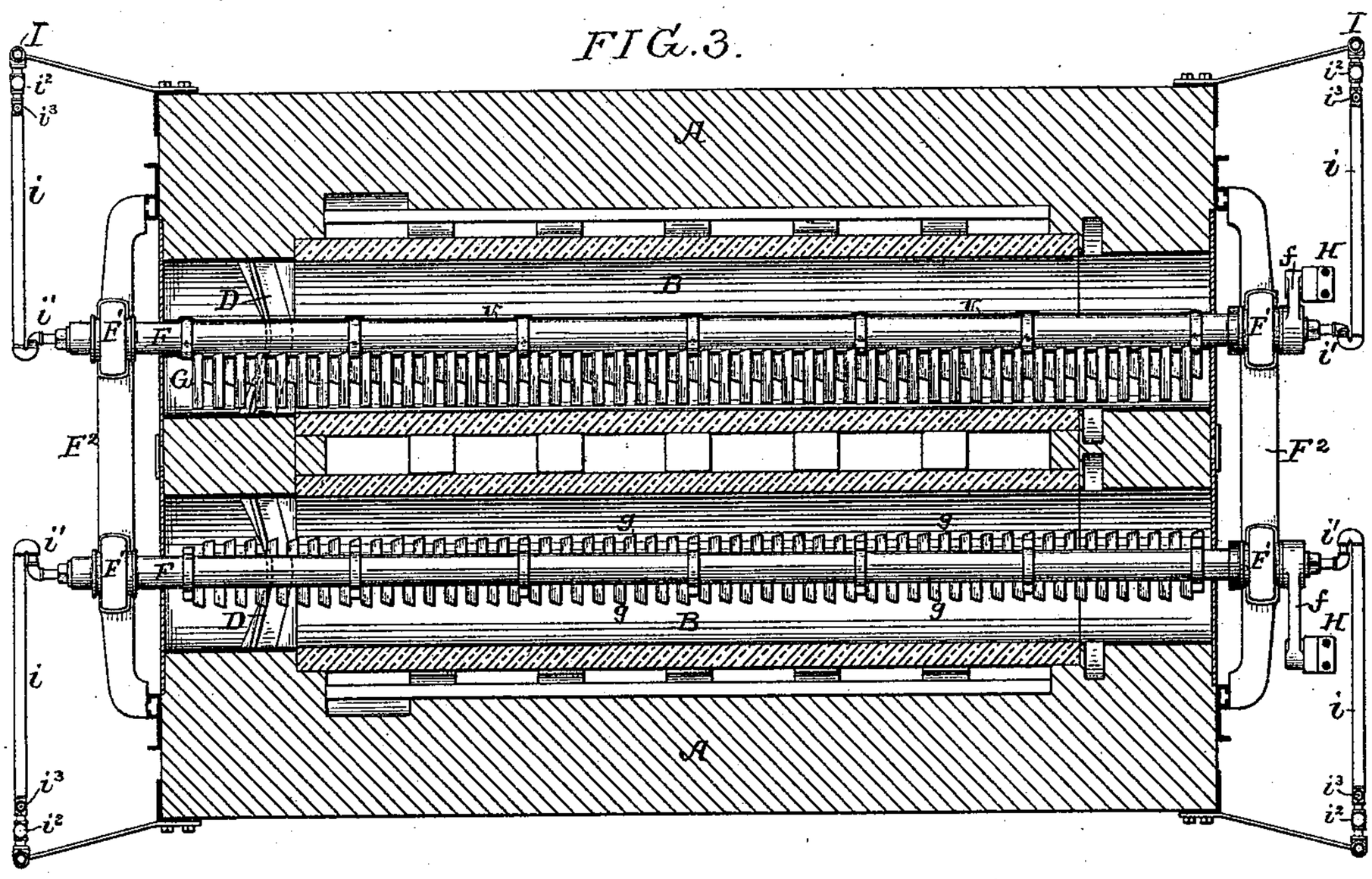
ORE ROASTING FURNACE.

No. 516,781 Patented Mar. 20, 1894.

FIG. 3.



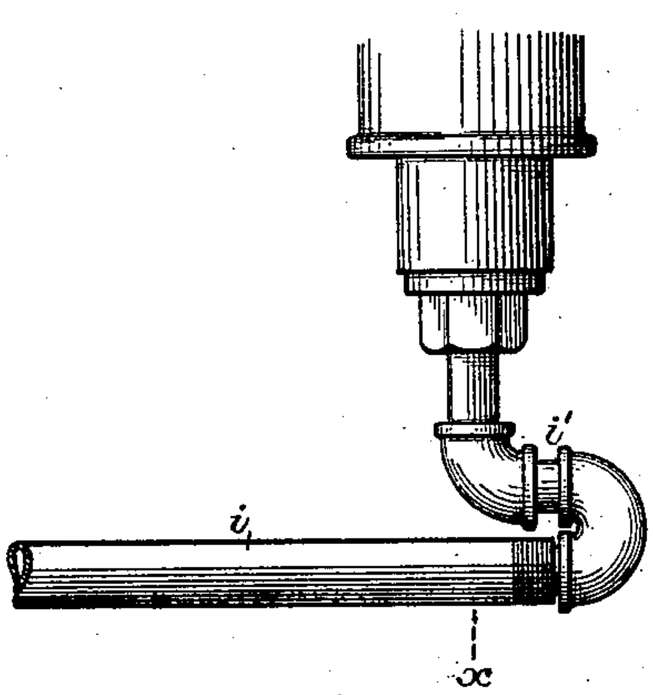


FIG. 7.

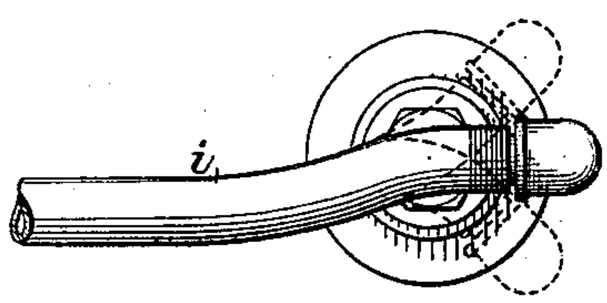
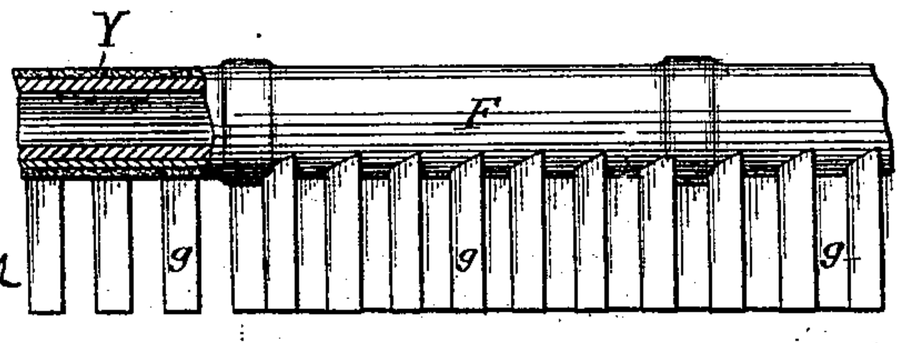


FIG. 8.

FIG. 9.



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(No Model.) 4 Sheets—Sheet 4.

T. WALKER & J. F. CARTER.

ORE ROASTING FURNACE.

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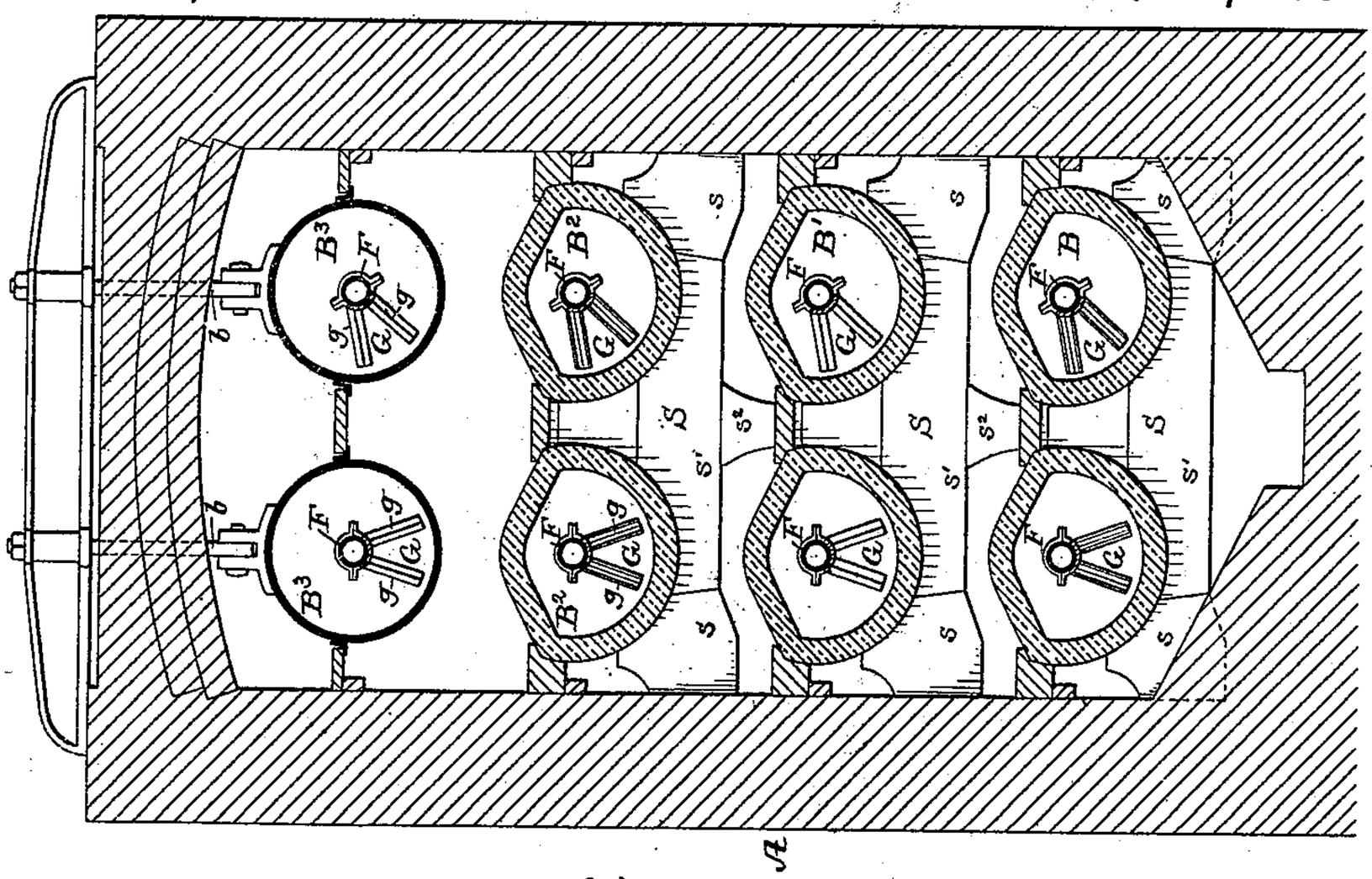

FIG. 6.

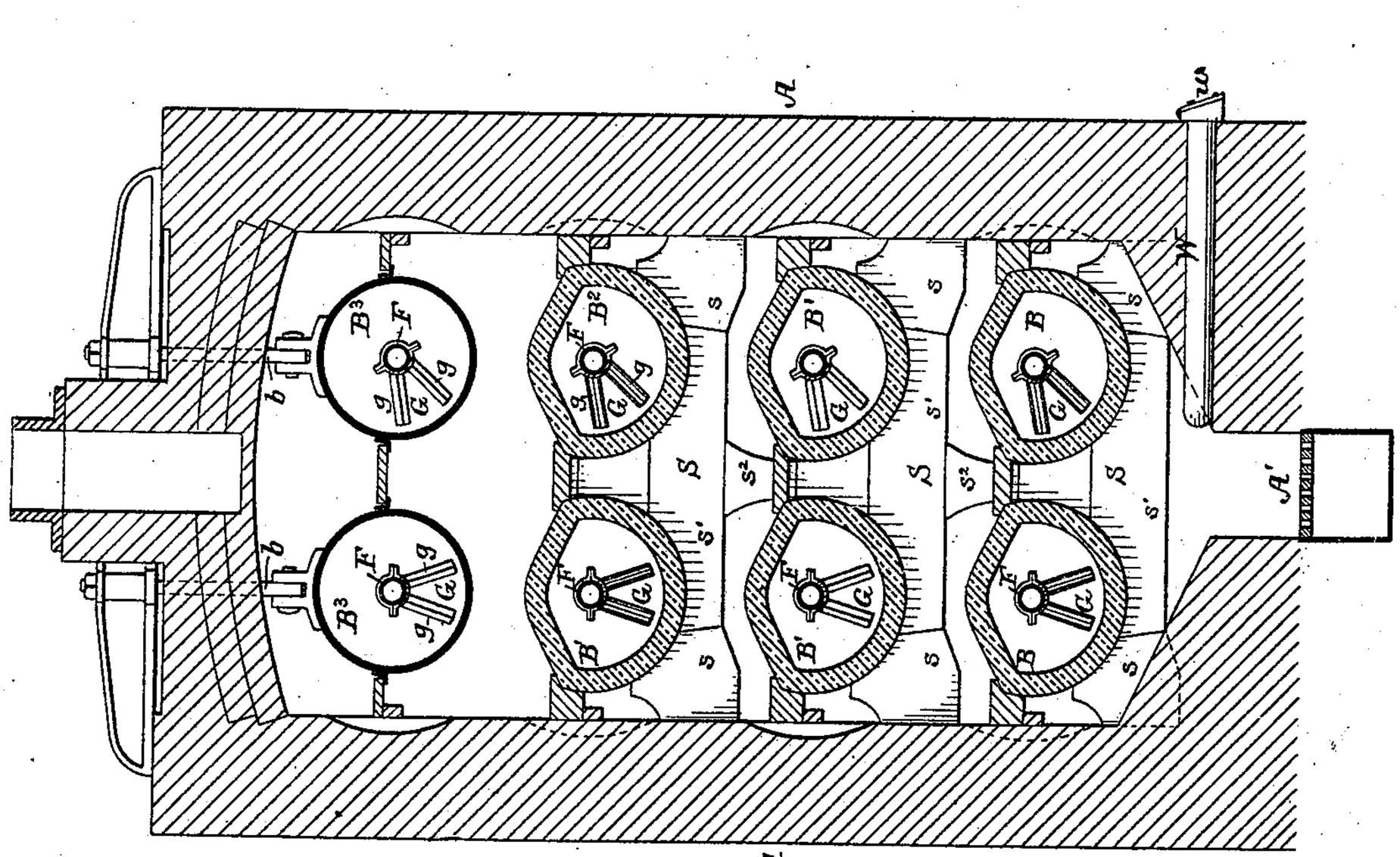

FIG. 5.

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UNITED STATES PATENT OFFICE.

THOMAS WALKER AND JOHN F. CARTER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNORS TO JOHN A. BARHAM AND JOSEPH A. VINCENT, OF SAME PLACE.

ORE-ROASTING FURNACE.

SPECIFICATION forming part of Letters Patent No. 516,781, dated March 20, 1894.

Application filed December 14, 1892. Serial No. 455,165. (No model.)

To all whom it may concern:

Be it known that we, THOMAS WALKER and JOHN FORSYTH CARTER, citizens of the United States, and residents of Philadelphia, Pennsylvania, have invented certain Improvements in Ore-Roasting Furnaces, of which the following is a specification.

Our invention relates to certain improvements in ore roasting furnaces set forth in Letters Patent No. 280,102, of June 26, 1883, and No. 311,052, of January 20, 1885; the object of our present invention being to prevent dusting, and to improve the operation of the furnace.

In the accompanying drawings:—Figure 1, is a face view of a furnace constructed in accordance with our invention. Fig. 2, is a longitudinal sectional view. Fig. 3, is a sectional plan view. Fig. 4, is a transverse section on the line 1—2, Fig. 2. Fig. 5, is a transverse sectional view on the line 3—4, Fig. 2. Fig. 6, is a transverse sectional view on the line 5—6, Fig. 2. Figs. 7, 8, and 9, are views of details of our invention.

To rapidly and thoroughly oxidize ores it is desirable first, to pass the finely divided ore through the retorts in the furnace in thin layers, keeping it in constant motion both laterally and longitudinally, so that the best possible results will be obtained; and we have found that it is not only desirable, but essential, that the ore should pass from one retort to another in such a manner as to avoid dusting. We have found by a series of experiments, that the most practical method for passing the ore from one retort to another is through a system of inclined planes or chutes; thus the ore slides practically from one retort to the other, and consequently it is thus prevented from dusting, and further, it is essential in roasting furnaces, to pass the fumes through the several retorts in such a manner that they will pass over the ore, and not through the body of ore. This we accomplish by so delivering the stream of ore to one side of the channel, and allowing the fumes to pass in a direct course from one retort to the other. We have also found that better results can be obtained in vibrating the rakes or stirring blades than by the method described in the Carter patent above mentioned, that is rotating the blades, as the agitation caused by the vibration of the blades is sufficient, and does not allow the ore to drop through the fumes in their passage through the retort. We have so constructed the coupling for the water supply of the several tubular shafts, that they can be readily coupled, and are flexible, so that they will not interfere in any manner with the operation of the furnace.

We will now describe the construction of the furnace.

A is the main body of the furnace, which is preferably made of brick and supports the several sets of retorts B, B′, B^2, B^3; the lower retorts B, B′, B^2 are preferably made of fire clay, while the upper retorts B^3 may be made of metal. The retorts are independently supported in the furnace. One retort does not support the one above it as in ordinary furnaces. We provide saddles or arches for each retort. These saddles S may be a single piece of fire clay, but in double furnaces as shown in the drawings, the saddles are composed of two end blocks *s* which project from the side walls of the furnace, and support a key block *s*′. These saddles are arranged at intervals throughout the length of each retort, and are recessed to receive the retorts; and in double furnaces we mount posts s^2 between the key blocks to give additional support for saddles or arches. The retorts are free to expand and contract, being simply placed upon the saddle, and not confined, consequently each retort can have a certain amount of independent movement without interfering with the other retorts of the furnace, and furthermore any one of the retorts can be removed should a crack or break occur, without interfering with the other retorts. The upper retorts when made of iron may be supported by rods *b* hung from the roof of the furnace as shown in Fig. 2. The retorts proper stop at the inner walls of the structure, but passages are formed in the front and back walls, and partitions *a* are so built as to form a cir-

cuitous passage for the ore and fumes shown in Fig. 2. The ore enters the furnace from a hopper C^2 through a passage C'. Suitable ore feeding mechanism is arranged in the hopper; the mechanism shown is what is termed screw feeding mechanism, by which the ore in given quantities is fed to the furnace. This mechanism is common in ore roasting furnaces of this class, and is particularly shown and described in the patent of January 20, 1885, mentioned above. Other mechanism may be used without departing from our invention. The ore enters the upper retort, and is fed through this retort, and then flows into the retort below it until it discharges through the outlet passage C. The fumes are carried in the opposite direction, and over the ore to the fume outlet E. In this furnace we only provide one outlet E for the escape of the fumes or gases, this outlet being in the upper portion of the furnace, and communicates with the upper retort, so that the fumes will pass through the series of retorts before they escape through the stack or into a fume chamber. While the several retorts communicate one with the other at one end for the passage of vapor or gases, the ore is passed down the inclined planes D to openings which communicate with passages *d* in the walls of the furnace, the outlets *d'* of these passages being as near as practicable to the bottom of the retort, the ore following a curved incline passing into the side walls of the chamber and out into the retort below, as clearly shown in the drawings; thus the ore is carried from an upper retort to a lower retort without dusting and without coming in contact with the gases or vapors, as there is sufficient flue space beyond the inclined chutes D to allow the vapor to pass up from one retort to the other without coming in contact in anywise with the ore. The furnace grate A' is situated centrally below the two sets of retorts, and the products of combustion pass around and over the retorts in a zig-zag course to the outlet *a'* in the upper portion of the furnace.

Passing through each retort is a shaft F provided with a protective covering Y of suitable material which is supported by suitable bearings F' mounted on brackets F^2, adjustably secured to the front and rear of the furnace, as shown in the drawings. On this shaft are mounted the agitating and conveying blades G which are made up of a series of sections, each section having two sets of blades *g* which have their faces inclined in such a manner as to feed the ore from one end of the retort to the other; the blades being so arranged that the ore will be carried from the upper portion of the furnace, through the series of retorts, to the outlet at the bottom of the furnace.

On the front end of each shaft F is secured an arm *f* which is coupled to a connecting rod H connecting the several shafts in the retorts in a vertical line together. In the present instance there are two connecting rods, one for the shafts of the retorts on one side of the furnace, and the other for the shafts of the retorts on the opposite side of the furnace; these connecting rods are attached at their upper ends to disks or cranks H'. These disks are mounted on shafts H^2 having bevel wheels H^3 which mesh with pinions *h* on the shaft H^4. The shaft H^4 is provided with belt wheels through which it is driven from any suitable motor. Thus the blades are vibrated slowly within the retorts, and the ore is constantly agitated, and at the same time moved forward.

Each shaft F is hollow and is coupled to a water pipe I. There are two main pipes in the present instance, one situated on each side of the furnace at the front, and one pipe communicates with the shafts on its side of the furnace, and the other pipe communicates with the shafts on its side of the furnace. The connections are preferably of rubber hose looped sufficiently to allow for the movement of the shaft, and each flexible connection *i* is coupled to its shaft by a goose-neck *i'*, so as to make the movement as short as possible. This goose-neck as shown in Figs. 7 and 8, extends back of the center line *x* of the pipe, and at this point it is coupled to the flexible tube *i*, thus preventing the abrupt bending of the connecting hose or tube. Each flexible connection *i* may be provided with a valve to cut off that particular section when it is required to shut down for repairs, and a check valve i^3 is also provided to prevent the water from being forced back by the heat of the retorts. Each shaft in this instance has an independent water supply, and the water does not pass from one shaft to the other, as in the apparatus described in the patent of 1885 mentioned above.

By making the lower retorts comparatively flat on top, we are enabled to decrease the height of the furnace, and by making the upper retort or retorts of metal, which are not as highly heated as the other retorts, we are enabled to economize in the construction of the furnace.

It will be understood that other constructions or modifications of the inclined planes may be used without departing from our invention, the main idea of which is to carry the ore from one retort to the other without dropping the ore through the fumes.

In applications filed by us on May 23, 1893, Serial Nos. 475,281 and 475,282, we have described modifications of our device embodying the main feature of our invention.

Atmospheric air is admitted into the furnace preferably through a hollow cast iron pipe W set in the wall in close proximity to the fire box, as shown in Figs. 2 and 5, and this pipe has an admission valve or damper *w* at one end, and is connected to the lower retorts at the opposite end. At this end is a cold air valve *w'*, on operating which cold air

can be admitted to the retorts, and the hot air from the pipe cut off.

The action of the furnace on the ore under treatment is as follows: Owing to the finely divided state of the ore entering the furnace, many surfaces are presented; under the action of the heat the sulphur in the ore is oxidized forming gases containing sulphur and oxygen, the oxygen in the air admitted into the furnace, combining with the iron forming oxide of iron $Fe_2 O_3$, and keeping up the combustion. The surface area of ore presented to the action of the heat and air in the eight retorts of the furnace illustrated, is about two hundred and forty square feet; this surface changes at every oscillation of the shafts to which are attached the rakes, vanes, or stirrers. Owing to the action as above stated very rapid desulphurization and oxidation follow. The function of the rakes or vanes is to move the ore from one end of the retort to the other. In doing this it spreads the ore on the bottom of the retort in a thin layer, and at the same time presents new surfaces to the action of the heat and air. The ore in going through this furnace as ordinarily constructed, moves a distance of about forty-eight feet, through four different degrees of temperature—the highest being in the last or lowest retort, and the lowest temperature in the uppermost retort.

We claim as our invention—

1. In an ore roasting furnace, the combination of a series of retorts one mounted above the other, fume passages forming communication between the several retorts, and inclined planes in these passages extending from one retort to a retort below so that the ore as it passes from one retort to another will pass down the inclined plane without dusting, the fumes passing through the retorts in the opposite direction, substantially as described.

2. The combination in an ore roasting furnace, of a series of retorts mounted one above another, agitating mechanism in each retort, and means for feeding the ore through the retorts, passages forming communications between the retorts, inclined planes in said passages upon which the ore is carried from one retort to the other, and a flue or flues communicating with the upper retorts by which the fumes are carried through the retorts to the outlet, the ore being directed clear of the fumes as it passes from one retort to the other, substantially as described.

3. The combination in an ore roasting furnace, of the body portion, a series of retorts mounted therein, the front and rear walls of said body portion having fume passages communicating with the retorts, inclined planes in said passages for the delivery of ore from one retort to another, shafts in each retort, agitating blades mounted on said shafts, with mechanism for vibrating the same, substantially as described.

4. The combination in an ore roasting furnace, of the body portion, a series of retorts, the front and rear walls of the body portion having passages therein for the escape of fumes from one retort to another and to the outlet, with inclined planes extending from the lower surface of one retort to and through the side walls of the said passages and to the retort below, whereby the ore is carried from one retort to another without dusting and without coming in direct contact with the fumes, substantially as described.

5. The combination in an ore roasting furnace, of a series of retorts, a hollow shaft in each retort, blades on said shafts, mechanism for operating the shafts, with a main water pipe and coupling pipe for each hollow shaft communicating with the said water pipe, said coupling being looped sufficiently to allow for the vibrating movement of the shafts, substantially as described.

6. The combination in an ore roasting furnace, of the combustion chamber, a series of retorts mounted therein, mechanism for traversing the ore through the said retorts a hot air pipe in the combustion chamber connected at one end to the lower retort, a valve *w* at the inlet end of said pipe, and a valve *w'* at the opposite end to cut off the hot air supply to the retorts, and to admit cold air, substantially as described.

7. The combination in an ore roasting furnace of the retorts, a shaft in each retort, mechanism for vibrating said shafts, with two sets of blades carried by said shaft, each blade being V-shaped in cross section, whereby as the shaft is vibrated the material is not only gently moved laterally but also longitudinally in one direction, substantially as described.

8. The combination in an ore roasting furnace, of the series of retorts one mounted above another, said retorts being closed at each end to the atmosphere, vertical passages arranged alternately at each end of the furnace and communicating with the several retorts so that the fumes will pass through one retort then up and through another and so on to the outlet, with inclined planes in said passages, feeding mechanism in each retort for the ore under treatment so that the ore may pass through the retorts in a direction opposite to that of the fumes and pass from one retort to the other without dusting, substantially as described.

9. The combination in an ore roasting furnace, of the body portion forming a combustion chamber, a fire pot at the base of the furnace, a series of retorts mounted one above the other in said combustion chamber, the lower retorts being made of fire clay, and the upper retort or retorts being made of cast iron, substantially as described.

10. The combination in an ore roasting furnace, of two or more retorts, one receiving material from another, in its passage through the furnace, agitating and feeding mechanism in each retort, fume passages, with a pas-

sage forming a communication between the two retorts, inclined planes in said passage whereby the material is carried from one retort to the other without dusting, substantially as described.

11. The combination in a furnace of the hollow shaft, a retort, a water supply pipe, a goose-neck coupling attached to the side hollow shaft and extending away from the water supply pipe and to the goose-neck back of the center line of the hollow shaft, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

THOMAS WALKER.
JOHN F. CARTER.

Witnesses:
HENRY HOWSON,
JOSEPH H. KLEIN.