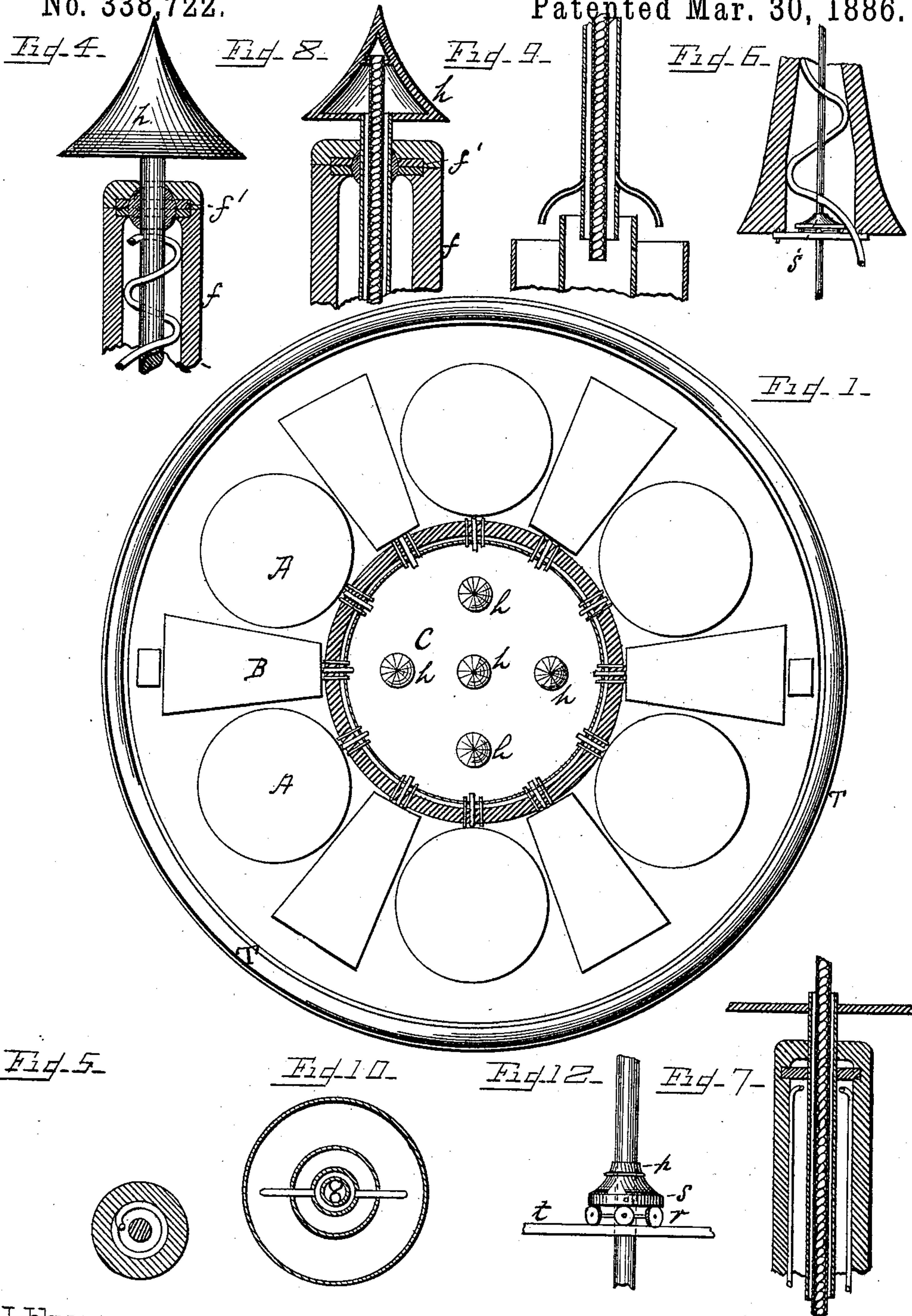


E. F. FALCONNET.

APPARATUS FOR THE MANUFACTURE OF IRON AND STEEL.

No. 338,722.

Patented Mar. 30, 1886.



Witnesses.

J. A. Faubus
H. B. Morison

Inventor.

Eugene F. Falconnet
By F. M. Ritter
att'y

(No Model.)

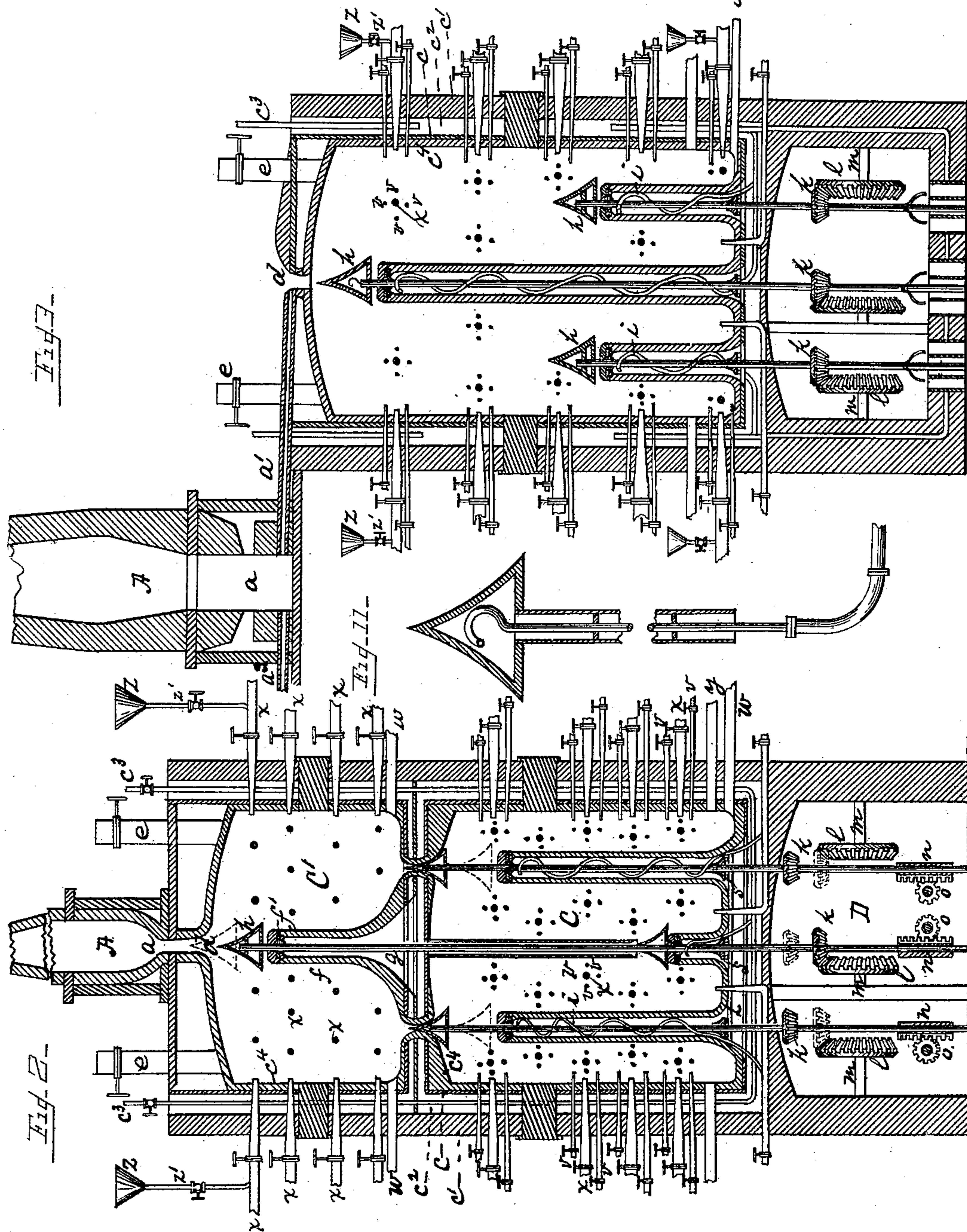
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Inventor

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UNITED STATES PATENT OFFICE.

EUGENE F. FALCONNET, OF NASHVILLE, TENNESSEE, ASSIGNOR OF ONE-HALF TO HENRY M. PIERCE, OF SAME PLACE.

APPARATUS FOR THE MANUFACTURE OF IRON AND STEEL.

SPECIFICATION forming part of Letters Patent No. 338,722, dated March 30, 1886.

Application filed May 18, 1885. Serial No. 165,879. (No model.)

To all whom it may concern:

Be it known that I, EUGENE F. FALCONNET, of Nashville, in the county of Davidson and State of Tennessee, have invented a certain new and useful Improvement in Apparatus for the Manufacture of Iron and Steel; and I hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, in which—

Figure 1 is a plan view of a plant and sectional view of the decarburizing-chamber for treating the molten metal as it comes from the blast-furnace. Fig. 2 is a vertical section of a portion of the blast-furnace and of the chambers for treating the molten metal—viz., an upper or desiliconizing and decarburizing chambers and a lower or recarburizing chamber. Fig. 3 is a similar section of a single chamber adapted to serve both purposes. Figs. 4, 5, 6, 7, 8, 9, 10, 11, and 12 are detail sectional views of revolving cones for spraying or whirling the molten metal, the pillars for supporting said cones, and means for causing a circulation of water for cooling the cones, pillars, and refining-chambers.

Like letters refer to like parts wherever they occur.

My present invention has for its object the provision of means whereby the molten metal directly from the blast-furnace may be desiliconized, decarburized, refined, and converted by a continuous process which will avoid the remelting of the metal and the attendant loss and labor incident to the methods now commonly practiced.

To this end the main feature of the invention consists in the construction of a closed chamber which receives the molten metal, and within which are arranged a series of revolving disks or cones which whirl the metal into showers or spray, into and through which air, gases, and basic or detergent substances are forced for the desiliconization, decarburization and refining of the metal. The minor features embrace the means by which the disks or cones are rotated, the cones and chamber cooled, the air, gas, and basic material introduced and the molten metal transferred from

chamber to chamber, all as will hereinafter more fully appear.

I will now proceed to describe my invention more fully, so that others skilled in the art to which it appertains may apply the same.

In the drawings, A indicates a blast-furnace in which the ore is charged and smelted in the usual manner. If a single blast-furnace, A, is used, it may be placed directly over the refining-chamber and its hearth *a* open directly into the chamber, as shown in Fig. 2, while if a continuously-operating plant is desired and several blast-furnaces are employed for smelting the ore they may be arranged in a circle around the refining-chamber with interposed hot-blast ovens B, as shown in Fig. 1, and one gutter or runner, *a'*, may lead from the furnace to the refining-chamber, and another gutter or runner, *a''*, may lead in the opposite direction (see Fig. 3) to a suitable sand floor or pig-molds. With such an arrangement or plant the manufacturer may produce the ordinary pig or refined metal at will.

C indicates the refining-chamber, which may have two compartments, one, C', in which the molten metal is desiliconized, decarburized, and refined by the air-blasts, &c., and another, C, in which it is recarburized, (see Fig. 2;) or it may have a single chamber adapted to both purposes, (see Fig. 3,) as will hereinafter appear. The same general construction exists in both cases, and described in detail is as follows: The refining-chamber C may be constructed in any suitable manner, preferably by employing the metallic shell or casing *c*, covered above by a fire-brick arch, and so enclosed by exterior walls, *c'*, as to form a water-space or water-jacket, *c''*, for the circulation of water entering by pipes *c'''*. The circulation of the water may be maintained by a hydrostatic column—elevated reservoirs—by a pump, or in any suitable manner. The interior of the refining and converting chambers C (or shell *c*) is provided with a lining, *c''''*, of any of the well-known refractory materials—such as ganister, mixtures of fire-clay, lime, silica, and asbestos—formed into paste with petroleum-tar or other suitable liquid, and hardened by heat, so as to form a smooth, hard, non-con-

ducting refractory lining, such as is required in this class of apparatus.

In the crown or top of the refining and converting chamber is one or more charging-holes, *d*, for the introduction of the molten metal, and this charging hole or holes may connect with the stack A by a gutter, or be located directly under the stack, as herein specified. Moreover, this port or opening *d* may be closed either by a separate stopper or by one of the revolving disks or cones of the refining-chamber. One or more valved flues, *e*, are also provided in the upper part of the refining-chamber to control and carry off the gases from the refining-chamber C, and these flues for the waste gases may lead to any point where it is desirable to utilize said gases.

M indicates man-holes for gaining admission to the chamber for repairs, &c.

Within the refining and converting chambers are erected or formed a series of pillars or posts, *f*, in which are journaled shafts *g*, surmounted by cones or disks *h*. The preferable arrangement of these pillars and cones is that shown in the drawings—that is to say, a central pillar and cone (which may also serve as a stopper for the charging-port *d*) and surrounding pillars and cones at a lower level—and in operation it is also preferable to revolve the central cone or disk in reverse direction to the lower surrounding disks or cones, as thereby the molten metal is better broken up or whirled and sprayed. These pillars or posts *f* are also hollow for the circulation of water, and may be formed of a metallic shell roughened and covered with a refractory covering of the character before specified; or they may be formed or molded from plastic refractory material and burned, as in the manufacture of fire-brick and like articles. In either case they should be provided with brasses or boxes *f'* above for the shafting of the disks or cones *h*.

In order to maintain a circulation of water in these posts or pillars, pipes *i* are arranged within the same so as to discharge at the upper end, (see details, Figs. 4, 5, 6,) and the water may be forced into and through said pipes *i* by hydrostatic pressure, (or a pump, as before specified,) and escaping from the open upper end of the pipe will drop back again through the pillars, thus protecting them from the intense heat.

Journaled in the pillars *f* are the shafts *g*, carrying the cones *h*. As these cones *h* can be readily renewed, they may be simple disks or cones of fire-clay or other refractory material, with ribbed or corrugated faces to swirl the molten metal. They may, however, be constructed as shown—that is to say, the cone *h* may be a hollow chamber communicating with its shaft *g*, and a circulation of water may be maintained therethrough by means of a central water-pipe and hydrostatic pressure, (see detail, Fig. 11,) by means of an Archimedean screw, (see details, Figs. 7, 8, 9, and 10,) with supply and waste tanks, or in any other well-known ways of obtaining a circulation of

water under similar circumstances. The shafts *g* extend through the bottom of refining and converting chambers into a lower or subterranean chamber, D, wherein is located the mechanism for rotating the shafts and disks, which may consist of bevel-gearing *k* on the shafts *g* and bevel driving-gear *l* on suitable power-shafts, *m*.

As before specified, these cones or swirling disks *h* may be used as stoppers for the charging-openings *d*, in which case they would require to be raised and lowered, to accomplish which the disk or cone-shaft *g* is set to move endwise through its bearings and through the carriage *s*, hereinafter described, and is provided with a rack, *n*, at its lower end, which gears with a power-pinion, *o*.

In order to support the cone-shafts *g* and permit of their being readily rotated, each shaft is provided with a collar, *p*, which supports it upon a carriage, *s*, (see Fig. 12,) through which the shaft passes loosely, and the carriage *s* is provided with anti-friction rollers *r*, resting upon a plate, *t*, secured in the enlarged base of the pillar or post *f*. This carriage *s* carries the entire weight of the shaft and its adjuncts, so that the beveled wheels below are relieved of all burden.

Having described the mechanism by which the molten metal is swirled or sprayed, I will next describe the means for injecting the air, gas, and basic material in the treatment of the molten spray. The bottom or hearth of the refining and converting chambers is so constructed that the metal will collect at the lowest point at the tapping-holes *w*, and at a suitable distance above the tapping-holes slag-ports *y* are provided. A series of valved air and gas pipes project into the refining-chamber through the walls thereof, at intervals all around the same, and at different heights or levels, so as to subject the molten spray to cross-jets of air and gas, which assist in the agitation as well as serve to refine the metal. For this purpose the air and gas pipes may, if desired, unite in a single tuyere or nozzle; but for the purposes of illustration I have shown these pipes arranged in clusters consisting of a central air-jet, X, and a series of surrounding gas-jets, V, and as a means of introducing pulverized basic material into the molten mass in the refining-chamber I have shown hoppers or funnels Z, connected with the air-pipes by valved pipes *z'*. The air and gas tuyeres *x* and *v* might also be placed in alternate rows, or the gas exclusively might be blown into the chamber in the upper part or in the lower part, as best suited, and the air alternately with the gas in the lower or upper part of the chamber, as under some circumstances it will be found desirable to subject the molten metal to air only or to gas only in one part or in the whole of the chamber.

Where it is preferred to first decarburize, desiliconize, and refine the metal in one chamber and then recarburize and further treat it in a second chamber, the upper chamber (see

C', Fig. 2) may be provided only with the air-jets X and the basic receptacles Z. The basic receptacles Z may be omitted in the chamber C, but where the decarburizing, purifying, refining, and converting processes are to be simultaneously carried on in a single chamber the construction adopted is that shown in the lower chamber, Fig. 2, or in the single chamber C, Fig. 3.

As a matter of preferred construction the blast-furnace may be elevated on a stone foundation to such height as will permit the refining-chamber C to be located above ground, the gear-chamber D being in such case the only subterranean part of the apparatus.

As a matter of convenience a track, T, (see Fig. 1,) may inclose the plant, and in order to utilize the waste gases from the converting-chamber C the waste-gas flues *e* may be made to deliver into the hot-blast ovens B.

The devices being of substantially the character hereinbefore described will be employed as follows: From the hearth or crucible of blast-furnace A the fluid metal is tapped into and through port *d* upon the revolving cone *h*, which whirls it off into sheet or spray form in the upper part of refining-chamber C, where it is met and traversed by cross-currents of air and gas charged with basic material, as in Fig. 3, and falling upon the lower row of cones is again broken into spray and whirled, being met by further cross-currents of air, gas, &c. The molten metal thus purified, refined, and converted collects in the bottom of the refining-chamber C, where it can be further treated by blasts through pipes *d'*, if desired, and whence it is drawn through tap *w* into ingot-molds or into other chambers for any further treatment that may be deemed desirable.

Where it is proposed to decarburize, desilicize, and treat with basic materials prior to recarburizing and refining by carbonic oxide, hydrocarbon, and other gases, and the upper chamber, C', Fig. 2, is used, the molten metal, when whirled and sprayed by the disk or cone *h*, is subjected only to air-blasts charged with pulverized basic substances—such as iron oxide, ground magnesium, limestone, &c.—which will suffice to desilicize, decarburize, desulphurize, and dephosphorize the molten metal, after which it is drawn into chamber C and treated with gas, or air and gas, for conversion.

I do not herein claim the process of dephosphorizing, desulphurizing, and refining metal by subjecting it while in the form of molten spray to the action of air-currents charged with fine basic substances for refining and converting the metal, as the same forms the subject-matter of case Serial No. 165,880, filed of even date herewith.

I am aware that in the production of solid castings a centrifugal pan, disk, or table surrounded by a channel for the reception of the molten metal and arranged in a closed or vacuum chamber having an outlet for gases and an inlet for air and gas for the preliminary

heating of the apparatus has been devised to free the metal of occluded gases, and do not herein claim such devices, as they are not adapted to refine the metal, which must be subjected to jets of air, or air and gas, charged with basic material; but,

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In apparatus for treating molten metal, the combination, with a refining-chamber provided with a series of tuyeres, of one or more revoluble spraying disks or cones arranged in said chamber, substantially as and for the purposes specified.

2. In apparatus for treating molten metal, the combination, with the refining-chamber, of one or more revoluble spraying disks or cones, and a series of tuyeres arranged at intervals and at different levels around the refining-chamber, substantially as and for the purposes specified.

3. In apparatus for treating molten metal, the combination, with the refining-chamber, of one or more revoluble spraying-disks, a series of tuyeres arranged around and delivering into the refining-chamber, and basic receptacles connected with and delivering into the blast pipes or tuyeres, substantially as and for the purposes specified.

4. In apparatus for refining metal, the combination, with the refining-chamber, of two or more revoluble spraying cones or disks arranged on different levels within the refining-chamber, substantially as and for the purposes specified.

5. In apparatus for refining metal, the combination, with the refining-chamber, of two or more revoluble spraying disks or cones arranged on different levels within the refining-chamber and geared to revolve in reverse direction, substantially as and for the purposes specified.

6. In apparatus for refining and converting metal, the combination, with the refining-chamber, of one or more revoluble spraying cones or disks, and a series of air and gas tuyeres arranged around and delivering into the refining and converting chamber at intervals above the bottom thereof, substantially as and for the purposes specified.

7. In apparatus for treating molten metal, a refining-chamber having a hollow water-cooled pillar, and a rotating cone or disk shaft journaled in the pillar, substantially as and for the purposes specified.

8. In apparatus for treating molten metal, the combination of the water-jacketed refining-chamber provided with water-cooled pillars, and cone or disk shafts journaled in said pillars, and the subterranean gear-chamber provided with the gearing for rotating and raising the cone-shafts, substantially as and for the purposes specified.

9. In apparatus for refining and converting molten metal, the combination of an upper and a lower communicating chamber, each

provided with revoluble spraying cones and disks, and tuyeres delivering through the side walls of the chambers at different levels, substantially as and for the purposes specified.

- 5 10. In an apparatus for refining molten metal, the combination, with a refining-chamber having a hollow water-cooled pillar, of a hollow water-cooled revoluble disk and disk-shaft journaled in the pillar of the refining-

chamber, substantially as and for the purposes so specified.

In testimony whereof I affix my signature, in presence of two witnesses, this 5th day of May, 1885.

EUGENE F. FALCONNET.

Witnesses:

W. D. TALBOT,
GEO. E. PURVIS.