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A. WRONSKI.

METALLURGICAL FURNACE AND PROCESS.

No. 572,393. Patented Dec. 1, 1896.

Fig. 1.

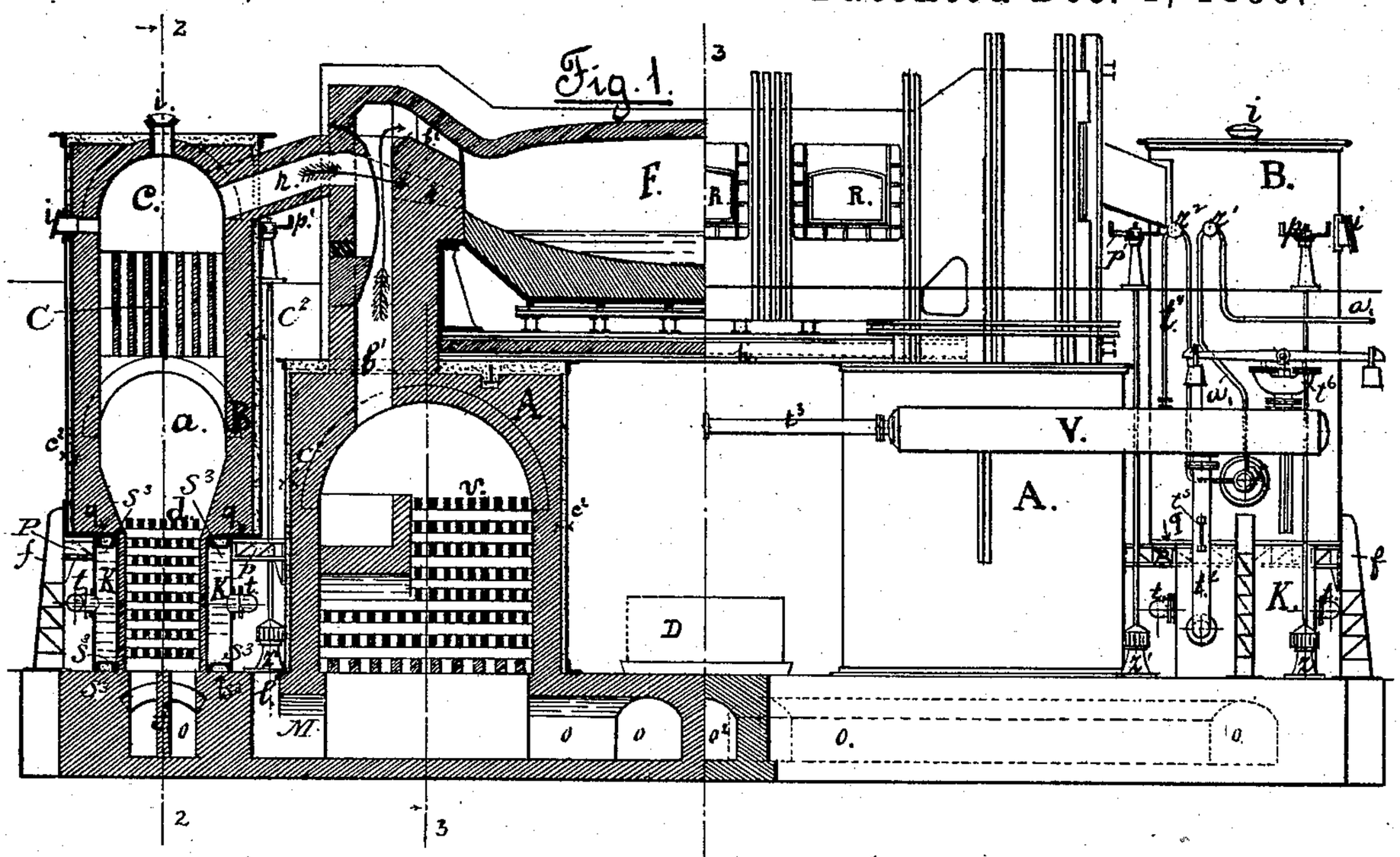


Fig. 2.

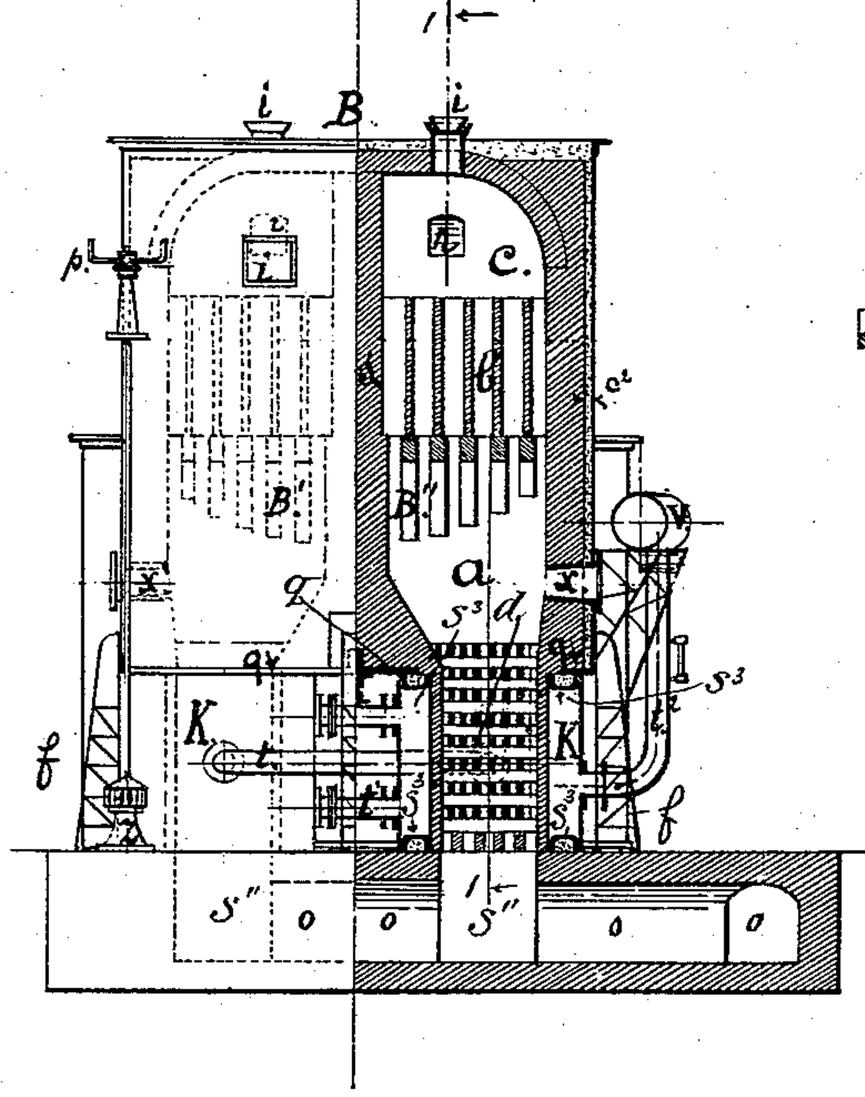
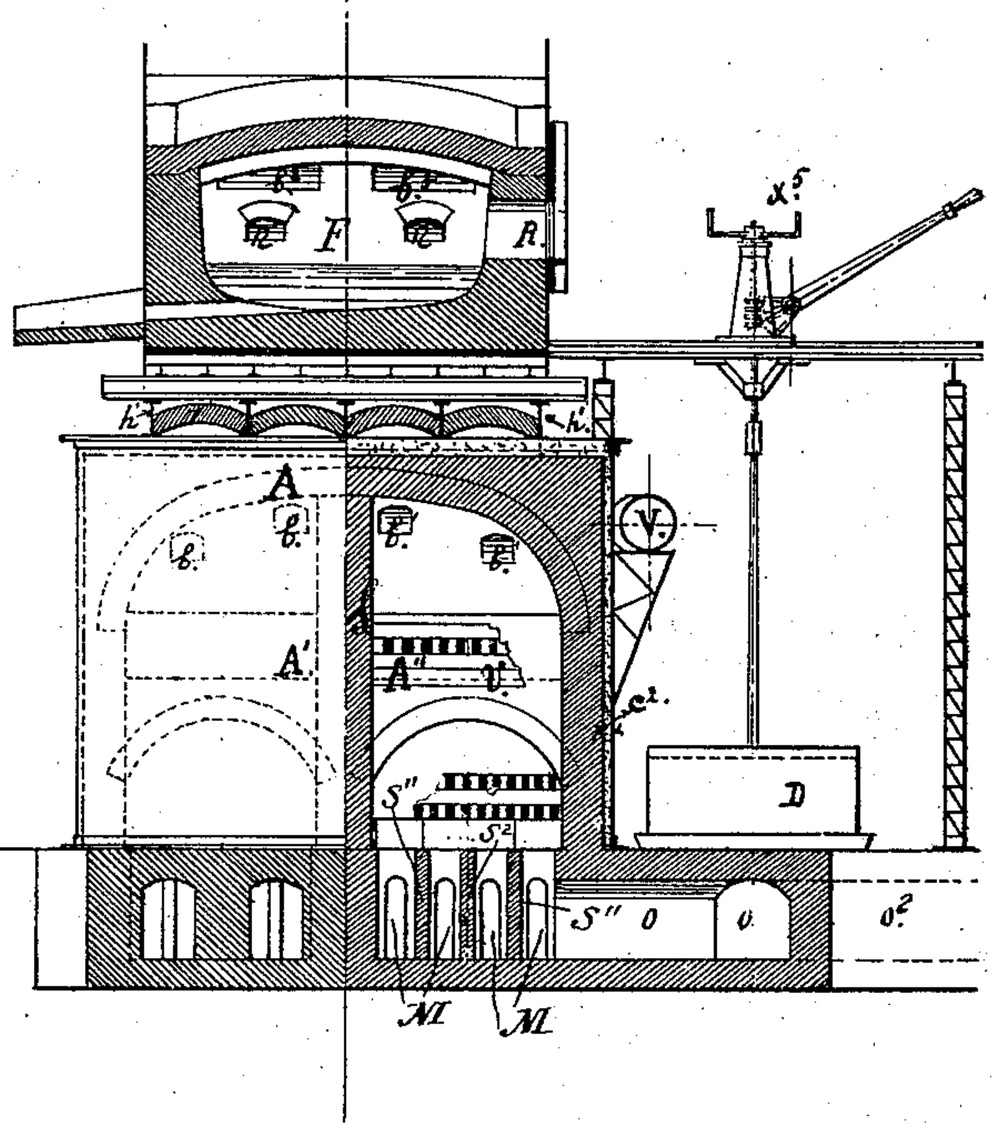


Fig. 3.



Witnesses

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A. WRONSKI.

METALLURGICAL FURNACE AND PROCESS.

No. 572,393. Patented Dec. 1, 1896.

Fig. 1a

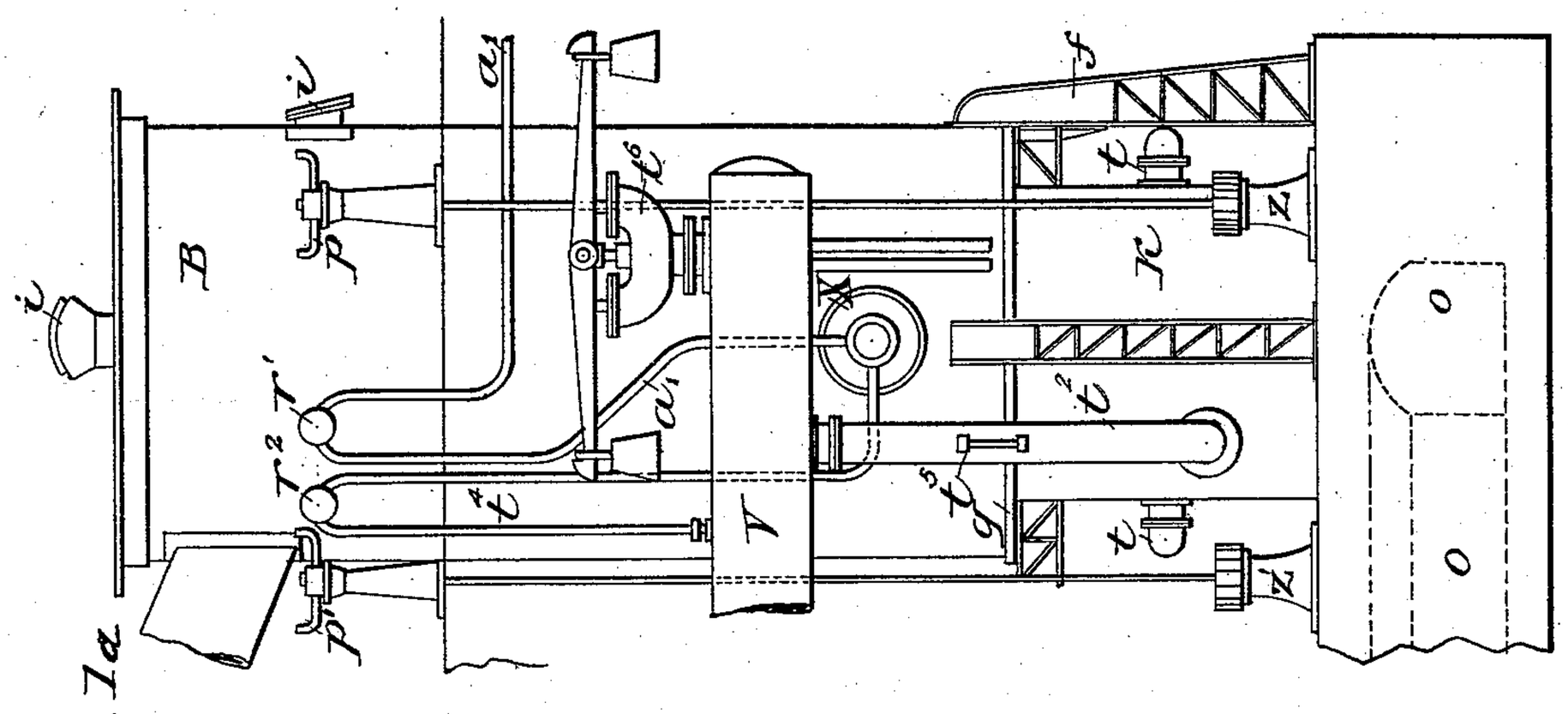
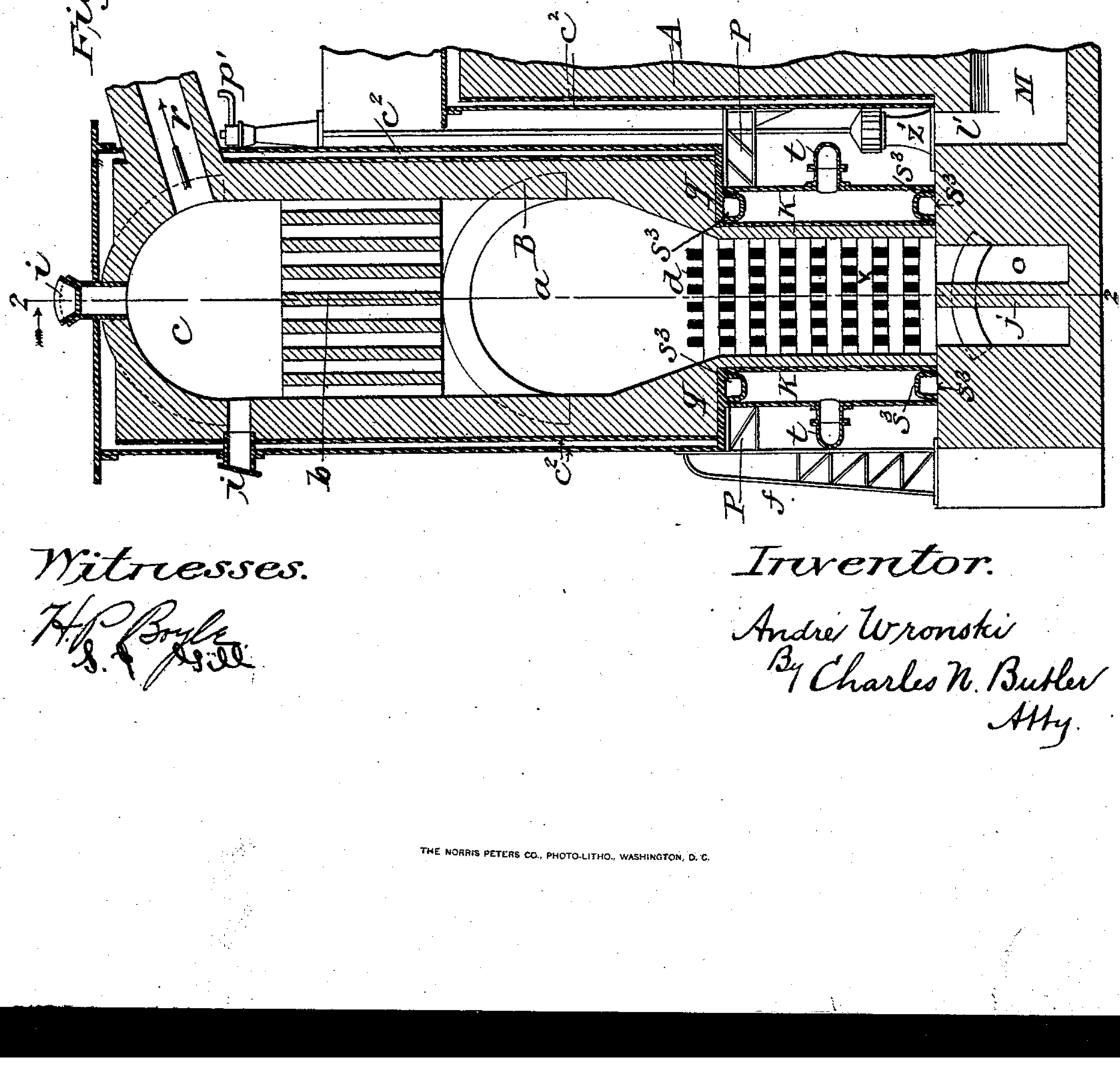


Fig. 1



Witnesses.

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(No Model.) 5 Sheets—Sheet 3.

A. WRONSKI.

METALLURGICAL FURNACE AND PROCESS.

No. 572,393. Patented Dec. 1, 1896.

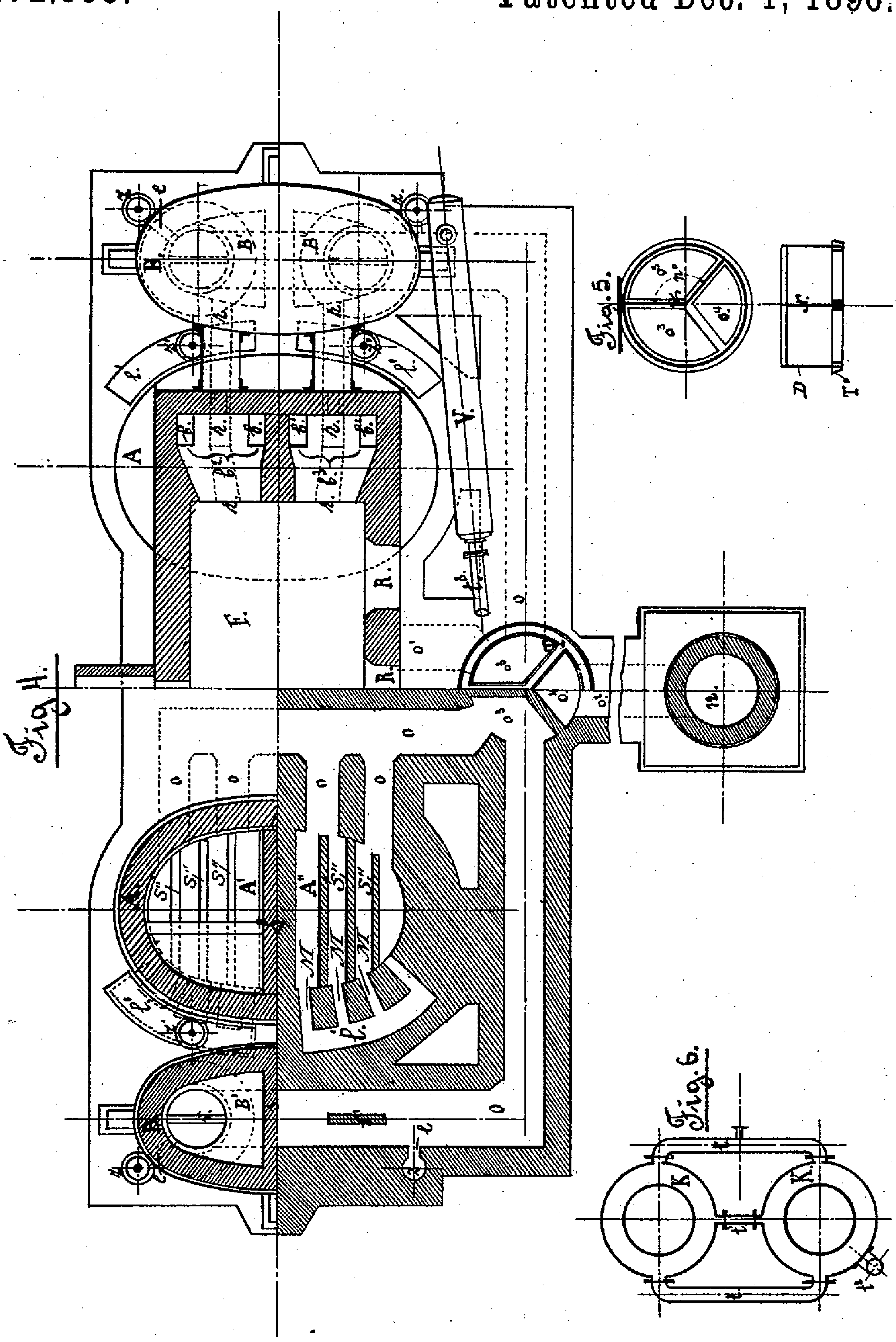

Fig. 4.

Fig. 5.

Fig. 6.

Witnesses

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(No Model.) 5 Sheets—Sheet 4.

A. WRONSKI.

METALLURGICAL FURNACE AND PROCESS.

No. 572,393. Patented Dec. 1, 1896.

Fig. 7.

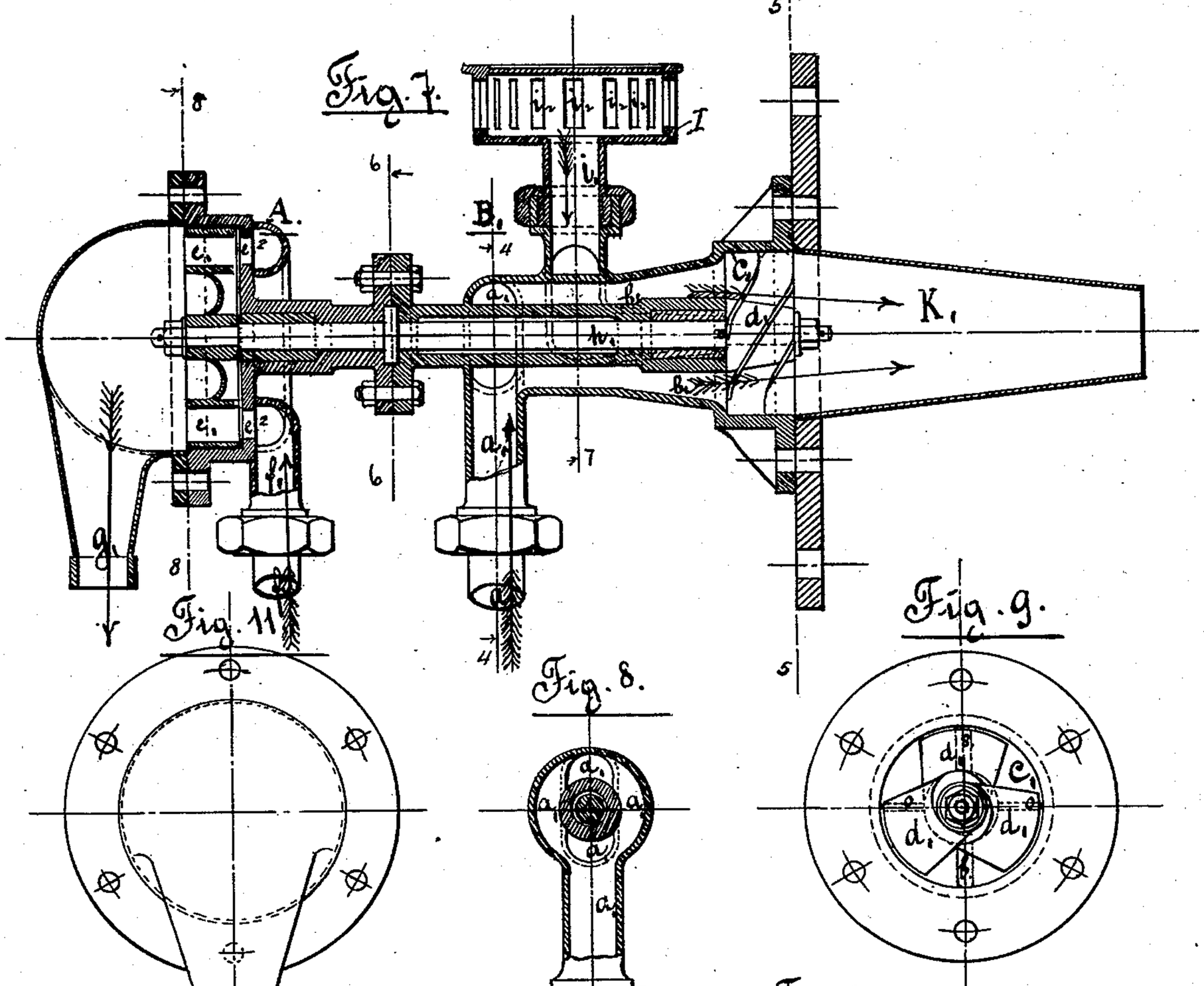


Fig. 11.

Fig. 8.

Fig. 9.

Fig. 10.

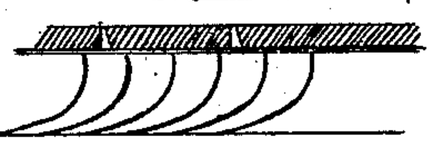


Fig. 14.

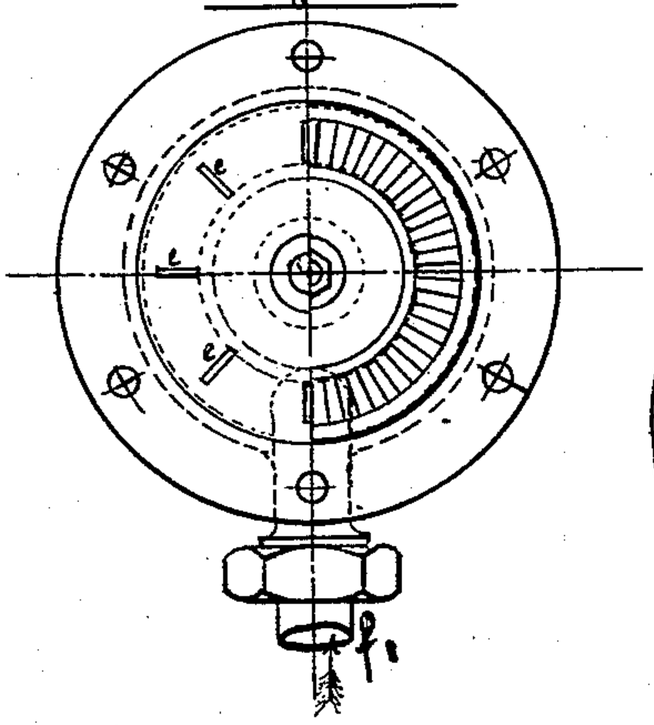


Fig. 12.

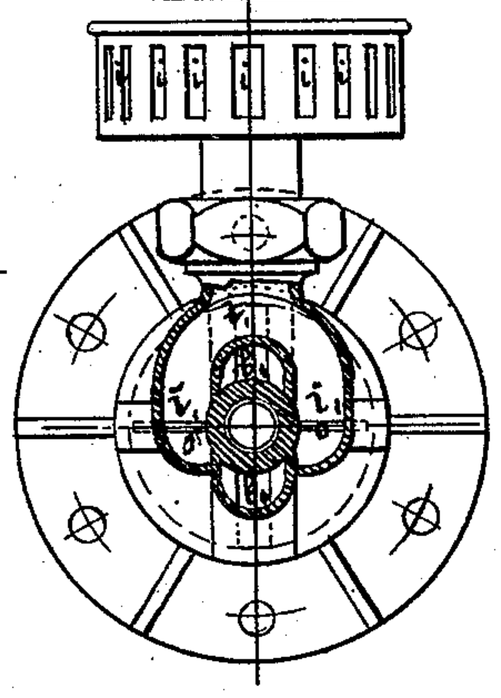
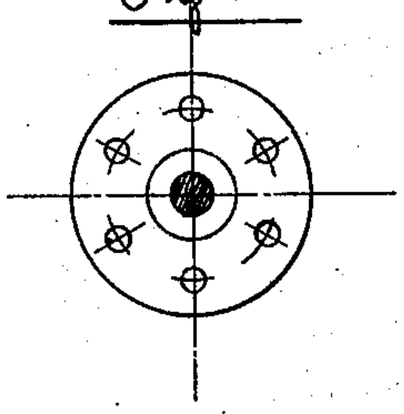


Fig. 13.



Witnesses

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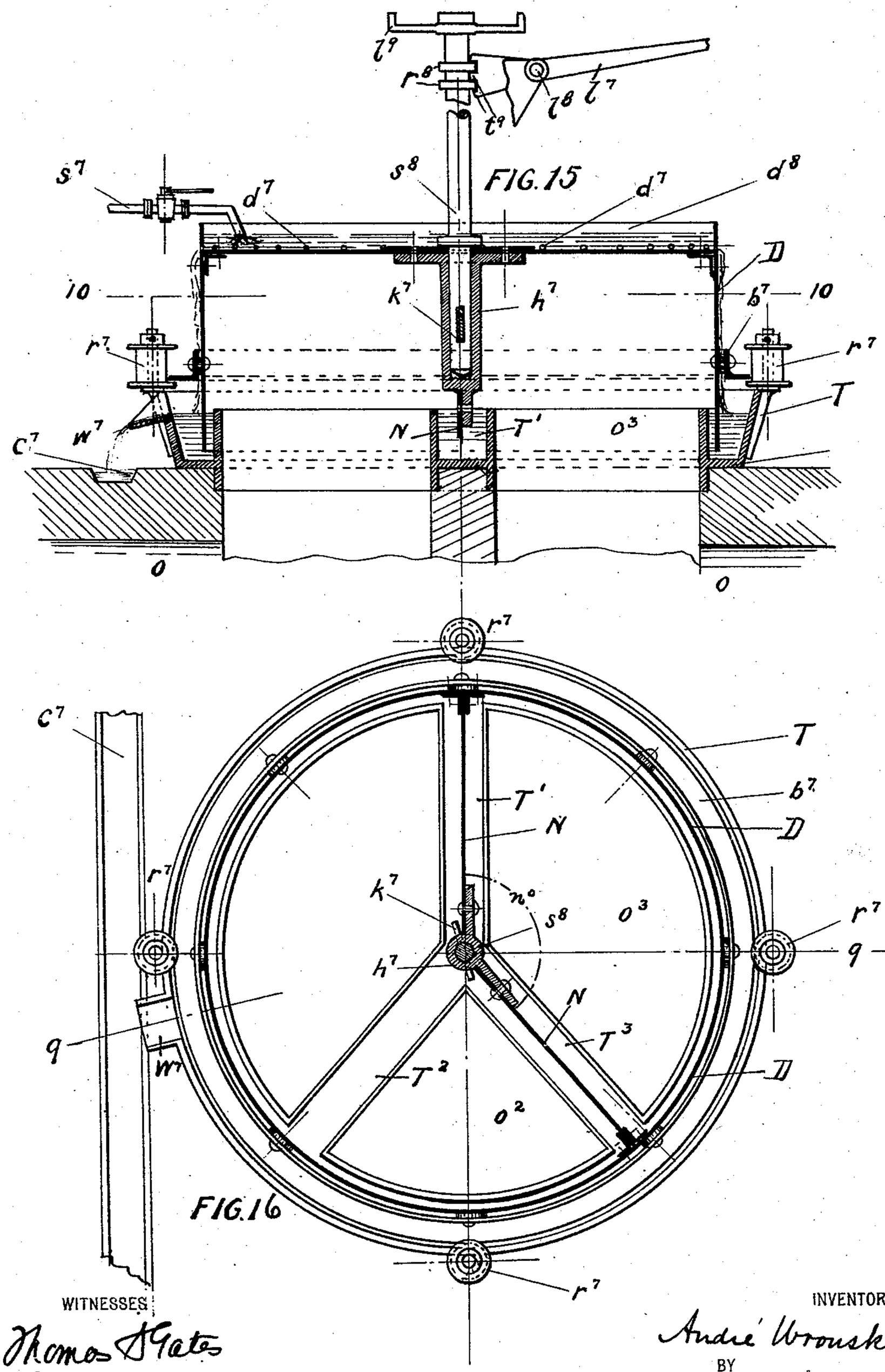
METALLURGICAL FURNACE AND PROCESS.

No. 572,393. Patented Dec. 1, 1896.



UNITED STATES PATENT OFFICE.

ANDRÉ WRONSKI, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-THIRD TO JOSEPH JAMES DE KINDER, OF SAME PLACE.

METALLURGICAL FURNACE AND PROCESS.

SPECIFICATION forming part of Letters Patent No. 572,393, dated December 1, 1896.

Application filed April 6, 1896. Serial No. 586,450. (No model.)

To all whom it may concern:

Be it known that I, ANDRÉ WRONSKI, a citizen of Russia, residing in the city of Philadelphia, State of Pennsylvania, have invented a new and useful Improvement in Naphtha-Furnaces for Metallurgical Operations and Glass Industries and the Process Involved in the Same, of which the following is a specification.

My invention has for its object the construction of a furnace for metallurgical operations and glass industries wherein naphtha or the residuum of naphtha is utilized as fuel with the application of hot air by the Siemens process; and it consists of, first, a gas-generating apparatus comprising a chamber for the vaporization of naphtha, a regenerator for transforming the vapor into gas, a room for collecting the gas, and a room for heating the air; second, a specially-constructed centrifugal "pulverizateur" or injector for injecting the naphtha into the gas-generator; third, the application of boilers to the Siemens-Martin furnace to be heated by the gases already utilized in the furnace to effect the formation of vapor; fourth, the regeneration (by suitable mechanism and the division of the hot-air apparatus) of the air and gases which may enter freely on each side of the furnace and the proper disposition of the orifices for the entrance of the gases and the air.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 is a front elevation of my apparatus, the left half being in vertical section, taken on the line 1 1 of Fig. 2. Fig. 1ª is an enlarged view of the ends of the apparatus as illustrated in Fig. 1, showing a vertical section and a front elevation of the gas-generating apparatus. Fig. 2 is an end elevation, partially in section, taken on the line 2 2 of Fig. 1. Fig. 3 is a vertical section on the line 3 3 of Fig. 1. Fig. 4 is a sectional plan view. Fig. 5 shows a plan view and sectional elevation of the drum or valve mechanism for controlling the escape to the chimney. Fig. 6 is a plan view of the boilers and their connections. Fig. 7 is a sectional view of the pulverizateur or injector. Fig. 8 is a partial sectional view taken on the line 4 4 of Fig. 7. Fig. 9 is a sectional view taken on the line 5 5 of Fig. 7. Fig. 10 is a partial sectional view of the helical blades of the winged wheel for driving the injector and the ports leading thereto. Fig. 11 is a left end view of the mechanism shown in Fig. 7. Fig. 12 is a sectional view taken on the line 4 7 of Fig. 7. Fig. 13 is a view on the line 6 6 of Fig. 7. Fig. 14 is a view on the line 8 8 of Fig. 7. Fig. 15 is a vertical central section of the drum or valve for controlling the escape to the chimney, taken on the line 9 9 of Fig. 16; and Fig. 16 is a horizontal sectional view of the drum, taken on the line 10 10 of Fig. 15.

Referring to Figs. 1, 2, 3, and 4, it will be seen that each side of the furnace comprises in its formation a gas-generating apparatus B, a hot-air apparatus A, and vertical boilers K, the gas-generating apparatus and the hot-air apparatus communicating with the furnace proper, F, and with the compartment D, which controls the escape of the utilized gases to the chimney *n*. The furnace F is placed on the horizontal beams *h'*, which are joined with the covering of each of the hot-air apparatuses.

The mixture of naphtha and its liquids is injected, by the aid of my specially-constructed pulverizateur or injector, through the orifices X X′ on the left of the furnace, Figs. 1 and 2, into the chamber *a* of the gas-generating apparatus B, by which the liquid naphtha is transformed into vapor.

The vapors formed in the chamber *a* rise and pass through the regenerator *b*, which has been heated to a temperature of about 1,400° and are thus transformed into gas containing hydrocarburet, (C_nH_{2n} and C_nH_{2n+2},) which, in contact with a certain quantity of air, is decomposed into carbon, (C,) hydrogen, (H,) carbonic acid, (CO_2,) and vapor of water (H_2O.)

The gas in decomposing receives from the lower part of the apparatus *d* a certain quantity of hot air which is sufficient to allow the hydrogen to separate from the gas and ignite with the formation of hydrous oxid, (H_2O_2.) Carbonic acid (CO_2) in contact with carbon (C) is transformed into carbonic oxid, (CO.) This last reaction takes place only in the regenerator *b*, a special construction of the gas-generating apparatus B. The principal com-

pounds H_2O_2, CO, and C, leaving the regenerator *b*, are chemically reunited in the chamber *c*, from which they pass, by the inclined orifices *r r*, into the furnace F, where they are brought into contact with a new quantity of air which enters by the orifices *b' b' b² b²* after having been heated in the hot-air apparatus A, Figs. 1 and 3. Complete combustion of the gases is thus effected with evolution of CO_2, H_2O, and N, the last evolving from the air. The burned gases having effected their function of melting the products placed in the furnace through the three doors R R R, Figs. 1 and 3, pass out by the opposite orifices on the right of the furnace, which are similar in location and construction to those on the left. A portion of these escaping gases passes through the orifices *r r* on the right of the furnace and heats the regenerator *b* in the gas-generating apparatus B. Then descending, these gases heat the volume of bricks in the compartment *d* and give up the remainder of their heat to heating the two boilers K K. The other portion of these gases passes through the orifices *b² b² b' b'* on the right into the hot-air apparatus *a*, then descending communicate their heat to the volume of bricks *v*, Figs. 1 and 3. These two portions of burned or waste gases escape from the compartments A and B through the passage *o* on the right, with which they communicate and which leads to the chimney *n* through the drum or valve D. It will be understood that the mechanism on the right is a duplication of that on the left and designated by the same letters. Each of these two gas-generating apparatuses B B is divided by a vertical refractory partition *s* into two compartments B' B'', which are respectively composed of, first, a chamber to receive the injection of naphtha through the openings X X' and transform the liquid of naphtha into vapor; second, a regenerator to transform the vapors of naphtha into gas in decomposing them into hydrocarburets; third, a chamber for collecting the decomposed gases, and, fourth, a lower hot-air apparatus for use in the decomposition of gas into H_2O_2 and CO, and at the same time for the production of steam by means of the boilers K K. The function of each of these several features of the apparatus has been previously described in detail.

Each of the two compartments B' B'' receives a quantity of air which is determined by its register *z*, revolved by a lever *p* and controlling the air-passage *l*, leading to each of the said compartments. As each of these compartments is provided with an air-conduit controlled by a register and as an injector for naphtha is placed at each of the orifices X X' and the naphtha-passages *a*, controlled by cocks *r'*, the quantity of gas required on either side of the apparatus may thus be regulated as required.

Each compartment of the gas-generator has under its body two cylindrical boilers K K, Figs. 1, 2, and 6, connected by the pipes *t t' t' t'*, in which hot water circulates. The object of substituting two boilers for one is to diminish the diameter of the boiler and at the same time the thickness of the sheet-iron, as well as to facilitate their removal in case of necessity. These boilers communicate by vertical pipes *t² t²*, Figs. 1 and 2, with two horizontal steam-collectors V, which in their turn are connected by a pipe *t³*. The pipes *t²* are supplied with water-gages *t⁵*. Each collector has a double safety-valve *t⁶*, acting under a maximum pressure of five atmospheres. A pipe *t⁴*, controlled by a cock *r²*, Fig. 1, connects the collectors V with the injector at X and supplies the quantity of steam which is required in the injector for effecting the speed or velocity of its action.

Each of the large hot-air apparatuses A A, Figs. 1, 3, and 4, is divided into two compartments A' A'', each of which receives the quantity of air necessary for heating it. This air enters by the conduits *l' l'*, each of which has its register *z'* revolved by means of a lever *p'*, Figs. 1 and 4. Air enters through the registers *z'* and passes through the conduits *l'* and the apertures M, Figs. 1, 3, and 4, thence between the partitions *s''*, Figs. 3 and 4, which serve to support the volume of bricks *v*, Figs. 1 and 3, by which it is heated, and passes thence through the orifices *b' b²* to the furnace F. Each of the compartments A' A'' is thus provided with means whereby the requisite quantity of air for the furnace may be supplied. It will thus be seen that the operator will be able to oxidate at will the metals which are in the furnaces, as well as to regulate at will the temperature on either side of the furnace at any stage of the process, which is of the first consequence, as the charge thrown into the furnace is frequently irregular and the doors are always the cause of cooling on one side. This ability to regulate the temperature affords means for protecting the vault from premature burning.

The burned or waste gases on passing out of the furnace are borne through the apparatus A B on the right, as heretofore explained, where they give up their heat, which is later utilized in vaporizing the injection of liquid naphtha. They then escape through the conduits *o o* and the iron drum D, which is kept constantly cooled by water, which flows from a pipe *s⁷* upon the top of the drum, and, passing over its edges or through openings *d⁷*, formed in the rim *d⁸*, descends to the circular channel T, flowing thence through the communicating radial channels T' T² T³, the overflow escaping through a waste-weir W⁷ and a canal C⁷. The object of this construction is to keep the drum cool and to provide a hermetical seal. This drum is divided into two parts by a partition N, bent at an angle of *n⁰*, which separates the conduits *o o* leading from the left of the furnace from the conduits *o o* leading from the right, the said partition being adapted to revolve with the drum and

alternately open the escape from the respective conduits *o o* through the passage o^2 and the chimney *n*, Figs. 4 and 5, thus permitting the waste product to pass out. The lower edge of the drum lies in the circular channel T, and is kept constantly immersed in the water circulating in this channel. The lower edge of the partition N lies normally immersed in water in the radial channels T′ T^2 or T′ T^3, depending upon which of the two passages for waste products is desired to be open. To cut off the escape from the left passage *o* to the chimney and to open that from the right, the drum is lifted sufficiently to permit the partition to clear the channels T′ T^2 T^3, and is then swung to the left through an angle of n^0 and lowered, immersing the lower edge of the partition N, which had formerly occupied the channels T′ T^3, in the water in the channels T′ T^2, thus opening the escape-passage $o\,o^3$ on the right to the passage o^2 and the chimney *n* and closing that on the left. The drum is encircled by an angle-bar b^7, secured thereto, which with the flanged rollers d^7, secured to fixed supports, serve to guide the movements of the drum. The drum is operated through a shaft s^8, secured by a key k^7 to a hub h^7, which is secured to the drum and serves to support the partition. A lever l^7, fulcrumed on a fixed support at l^8, has its short arm provided with teeth l^9, which engage rings r^8, formed on the shaft, so that when this lever is depressed the drum will be elevated until the angle b^7 is engaged by the upper flanges of the rollers r^7, which permits the partition to clear the channels T′ T^2 T^3 and the drum to be revolved by the lever d^9, fixed on the shaft. When the drum has been revolved to the new position, it is lowered until the angle rests on the lower flanges of the rollers r^7, as shown in Fig. 15, and the partition lies in the channels T′ T^2. It will be evident that the drum is not elevated sufficiently to withdraw its lower edge from the water, in which it is kept constantly immersed.

The hot-air apparatus A A is elliptical in form and its refractory walls are joined by a partition S, Figs. 3 and 4, which effects its division into two compartments and affords resistance. The elliptical wall is equipped with a sheet-iron covering, and between the wall and this covering is a space c^2, which is filled with wood-ashes to prevent the entrance of air into the apparatus in case of cracks in the walls, which cracks frequently occur as a result of the unequal expansion due to change of temperature in the apparatus, particularly when the walls are thick. These ashes also serve to prevent the escape of heat. The partition dividing the gas-generating apparatus B B into the compartments B′ B″ is in like manner covered with sheet-iron at a determined distance therefrom and the intervening space filled with wood-ashes, as before, for the purpose described.

The gas-generating apparatus is supported by columns *f*. A steel plate *g*, formed in two pieces *g′ g′*, is laid on a cross-beam P′, one end of which is connected with the column *f* and the other end with the covering of the adjacent hot-air apparatus. The plate *g* supports directly the brick body of the gas-generating apparatus.

The bricks of the regenerator *b* are arranged in tubular form in order that slight resistance may be offered to the entrance of the gaseous vapors into the collector *c*.

Each of the collectors *c* is provided with orifices *i i*, in which are fitted safety-doors as vents in case of an explosion of gas, in which event the doors open immediately, thus protecting the vault from injury.

The inner part of the boilers K K has a layer of bricks, which absorbs heat and transmits it to the boiler. At the same time these bricks increase the endurance of the boilers, as the sheet-iron is thus protected from the sulfurous gases escaping from the furnace. The heat absorbed by the bricks is sufficient to heat the boilers.

Between the boilers K K and the foundations supporting them asbestos rings s^3 are firmly bound, and rings of asbestos s^3 are in like manner bound between the top of each boiler and the steel plate *g*, thus forming a hermetical seal and preventing the least escape of gas from the gas-generating apparatus.

The naphtha is injected into the compartments B′ B″ of the gas-generator B through the orifices X X′, Figs. 1 and 2, by a centrifugal injector. The body of this injector, Fig. 7, is formed of bronze and is provided with a round inlet *a′* for the admission of naphtha, which passes from this inlet through the passages *b′ b′*, the drum *c′*, and the nozzle K′, which fits the inlet-port X of the gas-generator B. A quantity of air enters by the orifices *i′* and passes through the two conduits i^2 i^2, Figs. 7 and 12, through the drum *c′* and the nozzle K′, the air being regulated by the drum I, Figs. 7 and 12. A wheel *d′* with helical blades or wings is caused to revolve rapidly in the drum *c′*, the function of this mechanism being the proper mingling of the air and naphtha and its injection into the gas-generator, Figs. 7 and 9. The wheel *d′* is fixed on one end of a revolving shaft *h′*, and upon the opposite end of this shaft is secured a second winged wheel *e′*, Figs. 7, 10, and 14. Steam from the pipe t^4 enters by the conduit *f′* and passes through the ports e^2. The winged wheel *e′* is thus caused to rotate and, through the shaft *h′*, rotates the wheel *d′*, which effects the desired mingling of the air and naphtha and its injection into the furnace, as previously described.

From the foregoing description it will be understood that air from the conduit *i′* and naphtha from the conduit *a′* are driven by the winged wheel *c′* into the compartment *a* of the gas-generating apparatus B, where an access of air unites with it through the registers *z*, the conduit *l*, and the compartment *d*

of heated bricks. This volume of mingled naphtha and air in the form of vapor passes thence through the heated regenerator *b* to the chamber *c*, at which stage it has been transformed into gases with the reactions, as previously explained. The gases escaping from the chamber *c* by the passages *r r* to the furnace F are there mingled with access of air, (through the registers *z'*, conduits *l'*, apertures M, the volume of heated bricks *v* of the hot-air apparatus A, and conduits *b'* and b^2,) which leads to the complete combustion of the gases and the melting of the furnace charge. The burned gases escape thence through the opposite passages, giving up their energy in heating the regenerator, bricks and boilers and compartments of the gas-generating apparatus, and the hot-air apparatus, and escape through the passages *o* o^3 o^4 o^2 and the chimney *n*. The gas-generator and hot-air apparatus, which has acted as an escape and been heated by the waste gases, now receive injections of naphtha and air, and the operation is repeated in the reverse direction.

This system of heating by naphtha applies to all the Siemens-Martin furnaces now operating with oil, gases, wood, &c. In such cases I have merely to adapt the gas-generator of such furnaces to the plan of my gas-generator. I am, however, obliged in such case to take the steam necessary for the vaporization of the naphtha from a boiler which does not belong to the existing furnace.

Instead of employing steam for operating the centrifugal wheel of the injector a dynamo or other motor may be substituted therefor.

In case of necessity an ordinary form of injector may be used, when vapor mingled directly with the naphtha will of itself force the residuum of naphtha into the chamber *a* of the gas-generator B. In some cases it may be found expedient to dispense with the partitions *s* and S of the gas-generator and the hot-air apparatus and using one injector instead of two.

Various changes may be made in the apparatus without departing from the spirit of my invention, and I do not wish to be understood as limiting myself to the specific mechanism shown and described.

Having thus described my invention, I claim as new—

1. In a regenerative furnace, the process which consists in effecting a mixture of naphtha and air in desired proportions and injecting the mixture in the form of vapor into the receiving-compartment of a gas-generator, then effecting a mixture of the injection with a current of heated air in desired proportions and conducting this product through a regenerator, thus decomposing the vapor into gases, then conducting these gases and a determined quantity of air from a hot-air apparatus into the reducing-compartment of the furnace and thus effecting the complete combustion of the gases, then conducting the burned gases through a second similar gas-generating apparatus and hot-air apparatus and utilizing their energy in heating the said second apparatus, substantially as shown and described.

2. In a regenerative furnace, a gas-generating apparatus having a fuel-receiving chamber, and an injector for charging the same with hydrocarbon vapors, a heating-chamber provided with an inlet for air and an outlet for waste products with means for controlling the said passages and boilers heated from the said chamber, a regenerator for transforming the said vapors and air into gases, and a gas-chamber provided with explosion-doors, in combination with a hot-air apparatus having an inlet for a current of air and means for regulating and heating the same, and an outlet for waste products, substantially as shown and described.

3. In a regenerative furnace, in combination, a gas-generating apparatus having a fuel-receiving chamber, an injector for charging the said chamber with hydrocarbon vapors, a heating-chamber provided with an inlet for air and boilers heated from the same, a steam-collector communicating with the said boilers and also connected with the injector, mechanism whereby steam from the collector operates the injector and means for controlling the communication between the said injector and collector, substantially as shown and described.

4. In a regenerative furnace, in combination, a gas-generating apparatus having a fuel-chamber, an injector for charging the said chamber with hydrocarbon vapors, a heating-chamber provided with an inlet for air and boilers heated from the same, a steam-collector communicating with the said boilers and also with the injector, mechanism whereby steam from the collector operates the injector means for controlling the communication between the collector and the injector, and a regenerator and gas-chamber communicating with said fuel-chamber, substantially as shown and described.

5. In a regenerative furnace an injector having a journaled shaft, a winged wheel fixed thereon, a conduit for liquid and a second conduit for air leading to the said winged wheel, a second winged wheel fixed on the said journaled shaft, and means for rotating the said second wheel, substantially as shown and described.

6. In a regenerative furnace an injector having a journaled shaft, a winged wheel fixed thereon, a conduit for liquid and a second conduit for air leading to said winged wheel, a second winged wheel fixed on the said shaft, a steam-collector, and a conduit connecting the steam-condenser with the second winged wheel, substantially as shown and described.

7. In a regenerative furnace an injector having a journaled shaft, a winged wheel fixed thereon, a conduit for liquid leading

thereto, and a second conduit having adjustable ports for the admission of air communicating therewith, a second winged wheel fixed on the said shaft, a steam-condenser, and a conduit having a cock, therein connecting the steam-collector with the second winged wheel, substantially as shown and described.

8. In a regenerative furnace, a reduction-compartment, a gas-generating apparatus divided by a partition and having on each side of said partition an inlet for air and an outlet for waste products, a heating-chamber, a fuel-receiving chamber, a regenerator and a gas-chamber communicating with the said reduction-compartment, a hot-air apparatus divided by a partition and having on each side of said partition an inlet for air and an outlet for waste products, and a passage communicating with the reduction-compartment, in combination with a second similar gas-generating apparatus and hot-air apparatus communicating with the said reduction-compartment, substantially as shown and described.

9. In a regenerative furnace, a reduction-compartment, a gas-chamber communicating with said reduction-compartment, a regenerator communicating with said gas-chamber, a fuel-receiving chamber communicating with said regenerator, an air-heating chamber communicating with said fuel-receiving chamber, an inlet for air leading to said air-heating chamber, an outlet for waste products leading from said air-heating chamber, a second air-heating apparatus communicating with the said reduction-compartment, an inlet for air leading to said second air-heating apparatus, and an outlet for waste products leading from said second air-heating apparatus, in combination with a second similar gas-generating apparatus and hot-air apparatus communicating with said reduction-compartment.

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Witnesses:
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