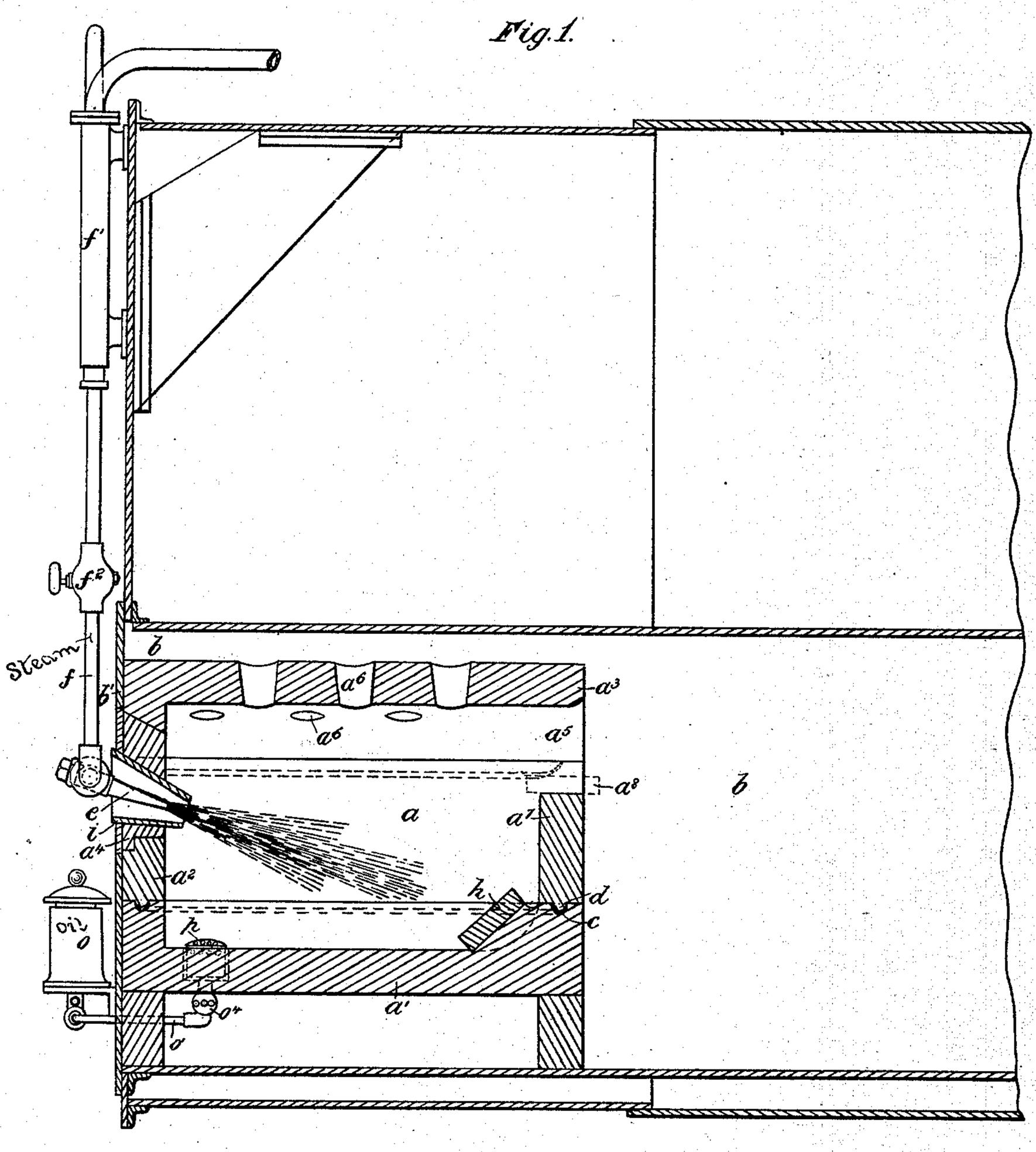
(No Model.) 6 Sheets—Sheet 1.

J. H. SELWYN.

FURNACE FOR THE COMBUSTION OF LIQUID FUEL.

No. 326,161. Patented Sept. 15, 1885.

Fig. 1.



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FURNACE FOR THE COMBUSTION OF LIQUID FUEL.

No. 326,161. Patented Sept. 15, 1885.

Fig. 2.

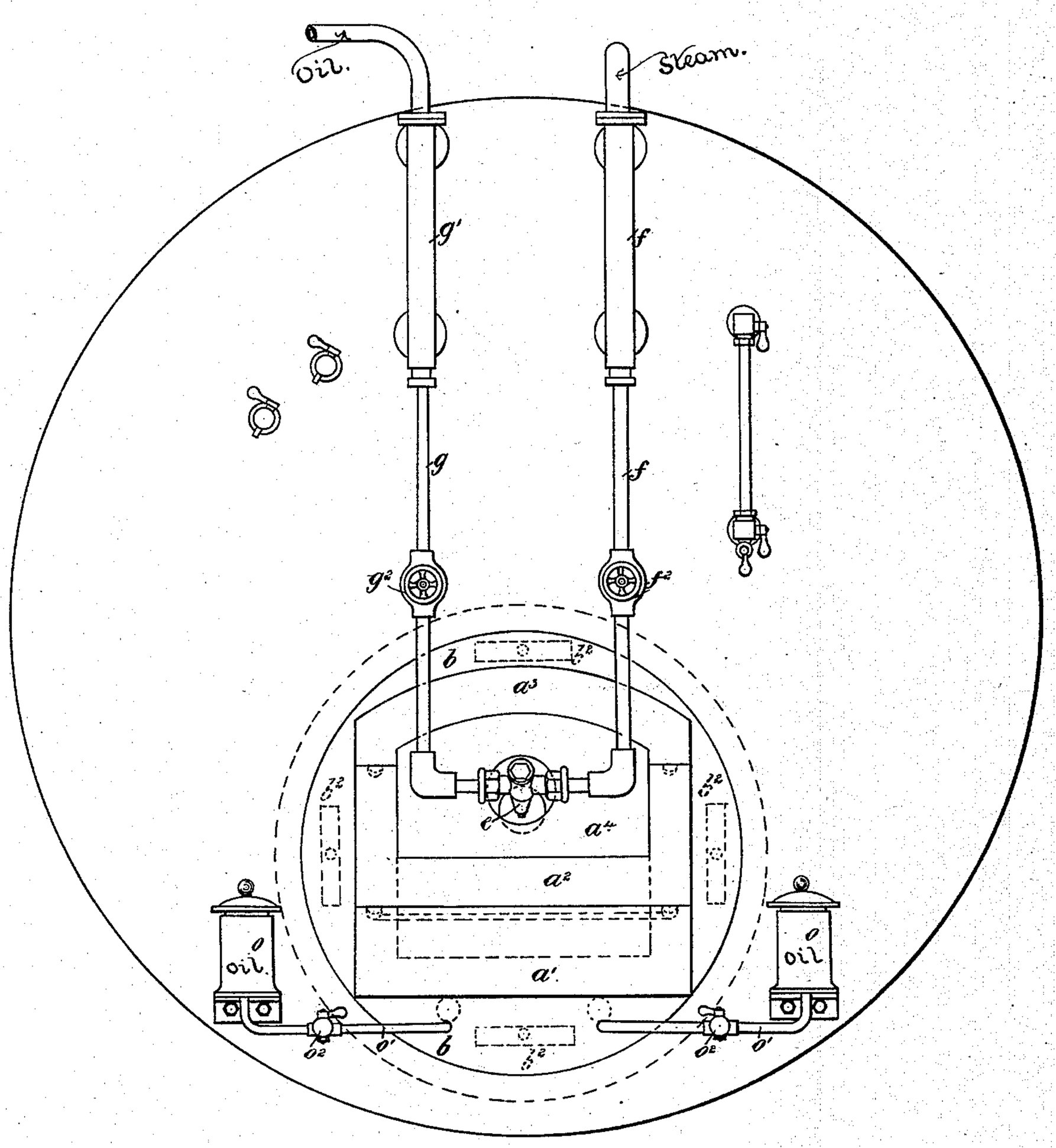

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Fig. 4.

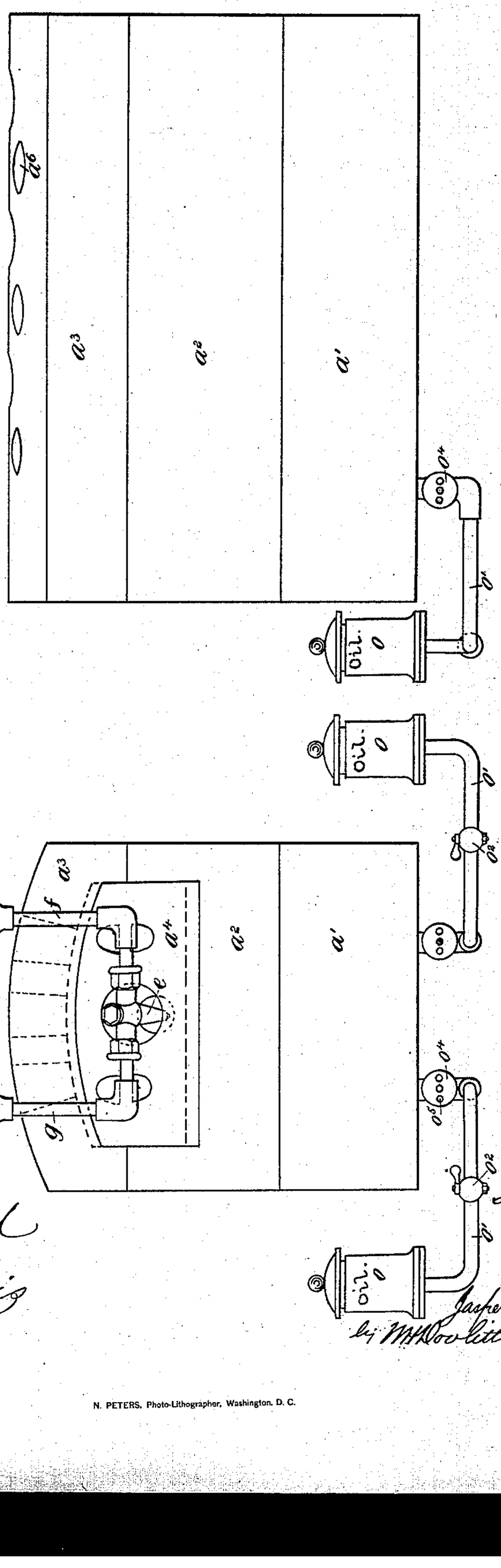

Fig. 3.

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FURNACE FOR THE COMBUSTION OF LIQUID FUEL.

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Fig. 6.

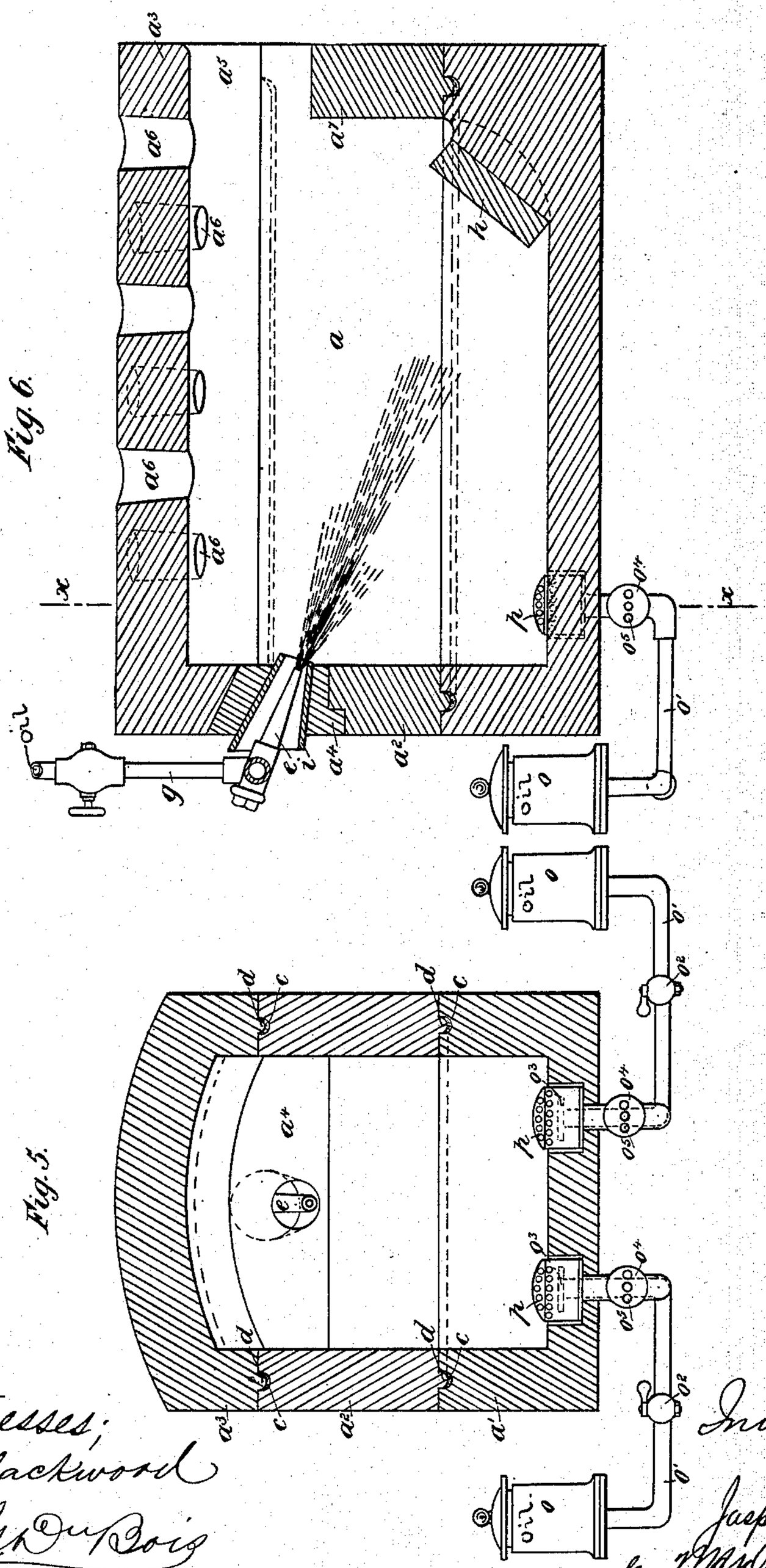

Fig. 5.

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Fig. 10.

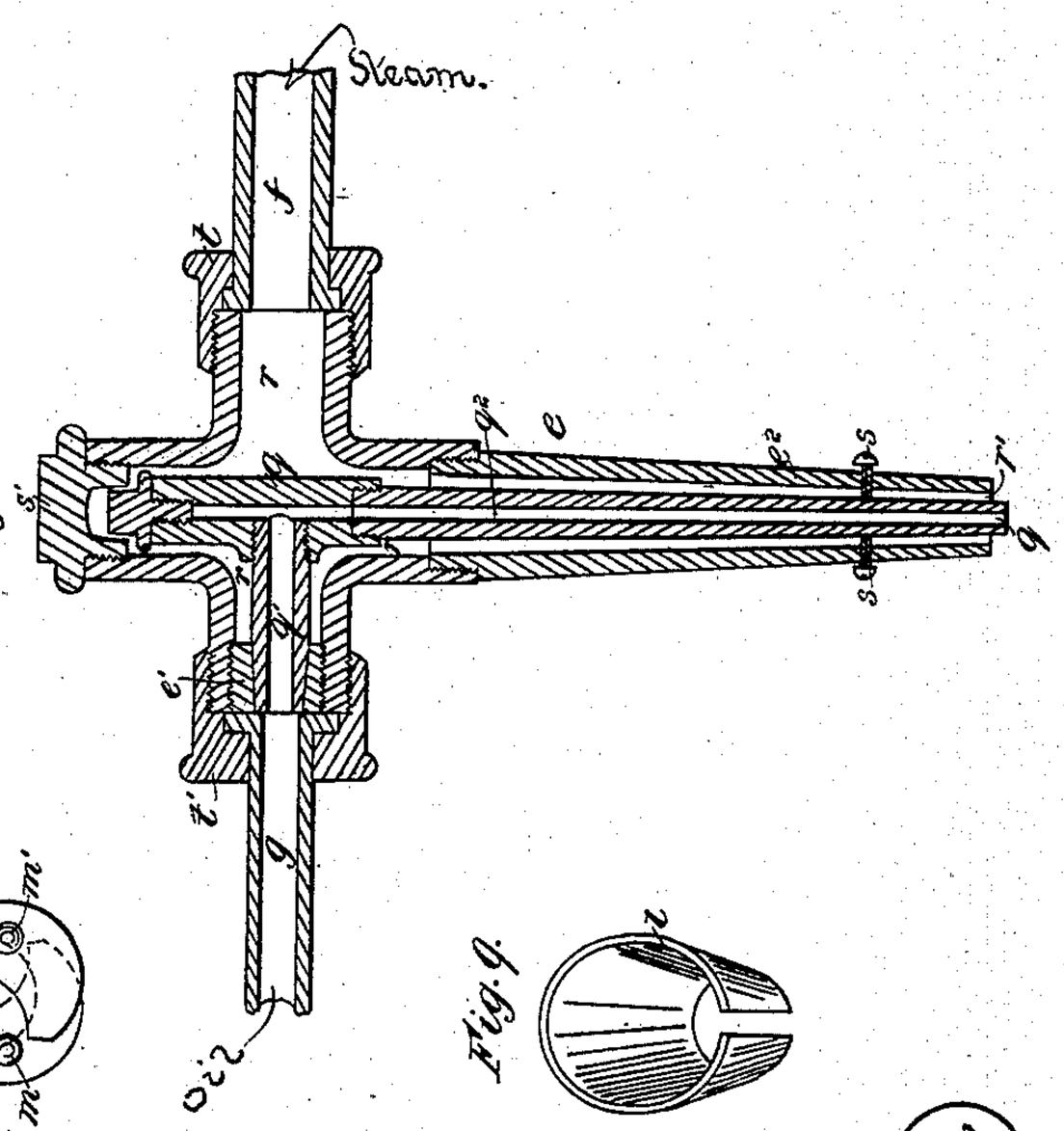


Fig. 8.

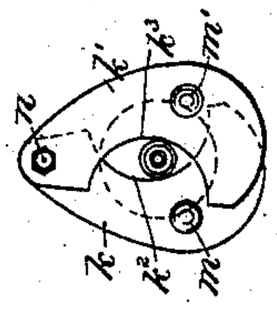
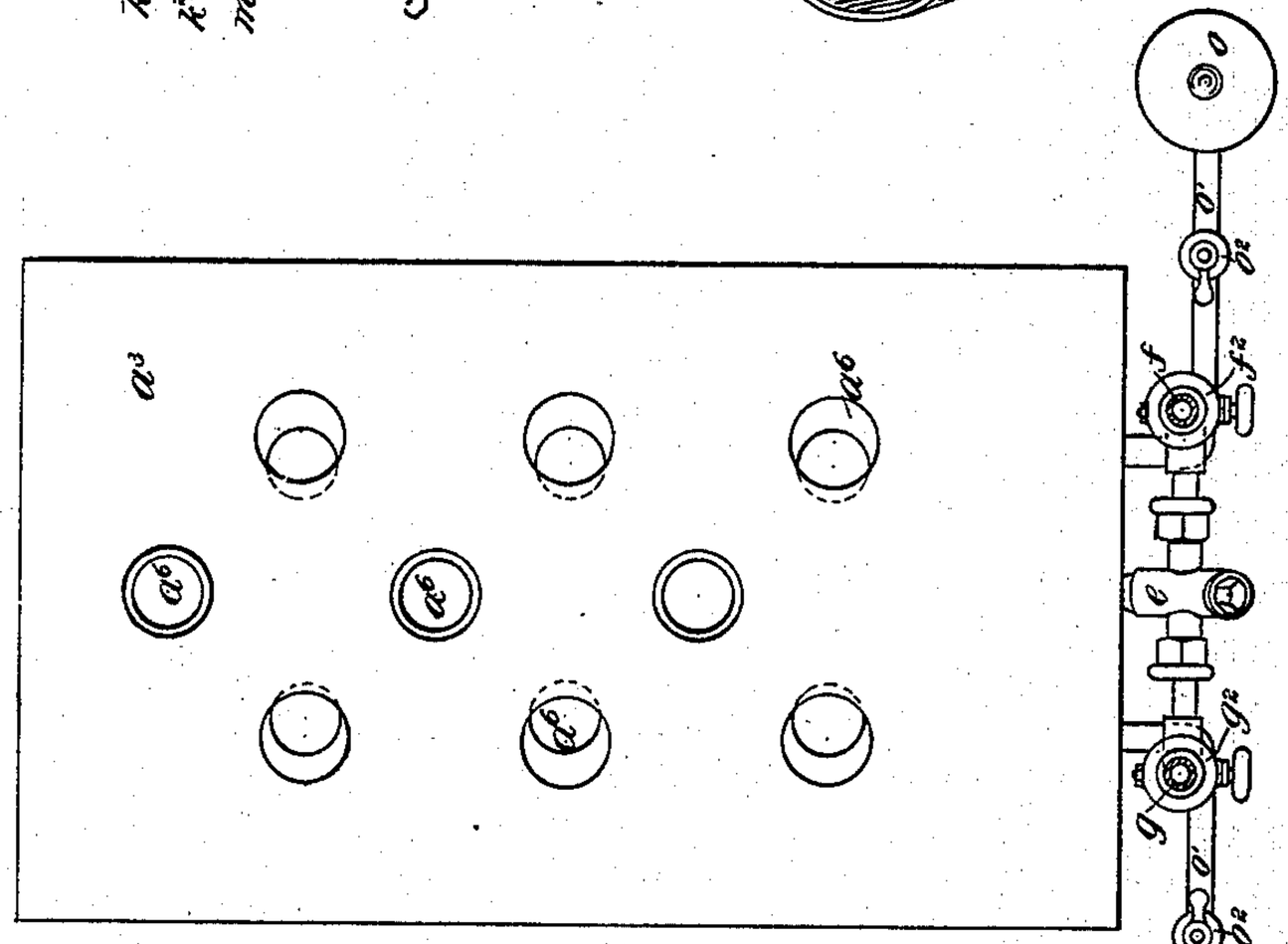


Fig. 9.

Fig. 7.



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FURNACE FOR THE COMBUSTION OF LIQUID FUEL.

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Fig 11.

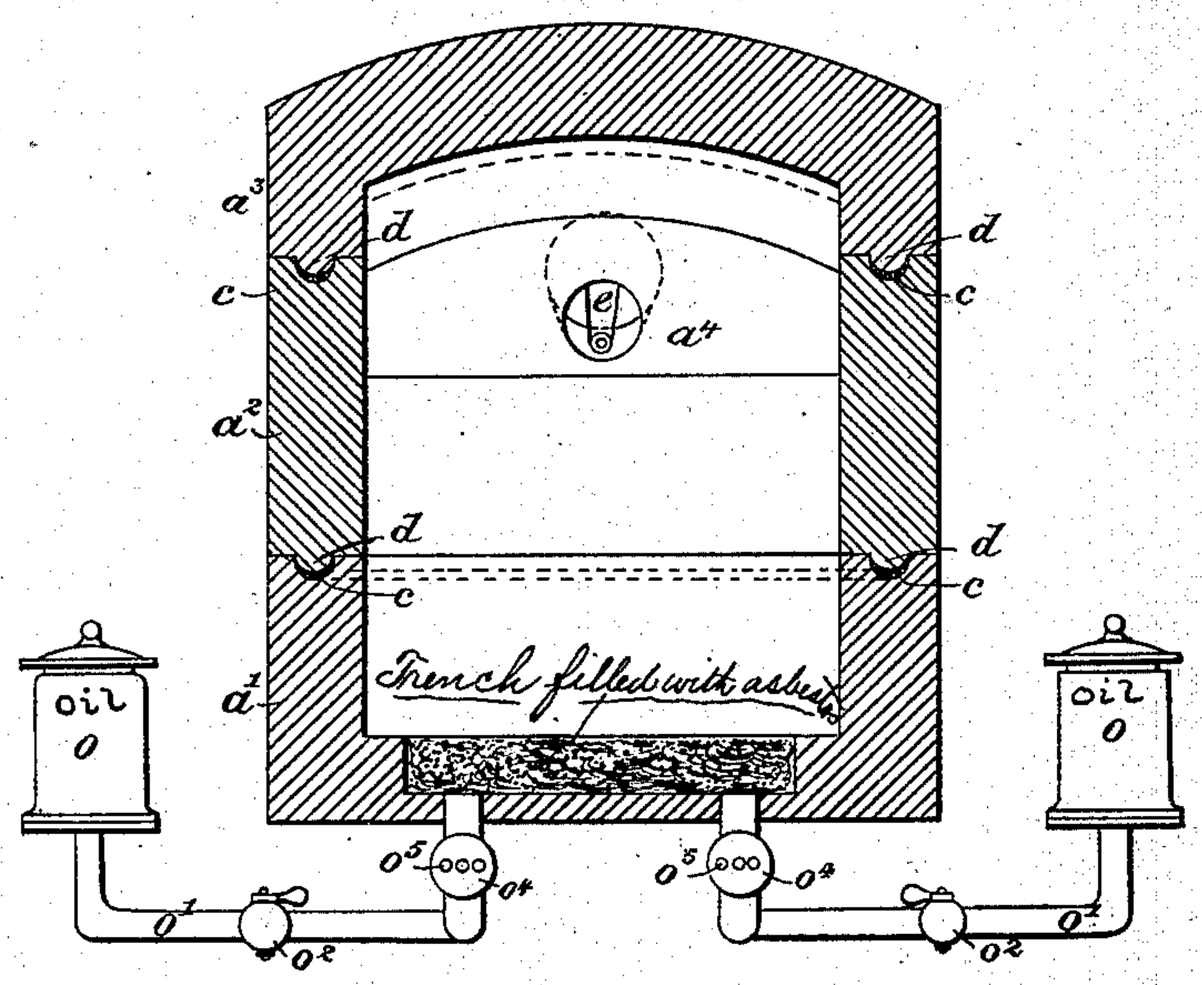
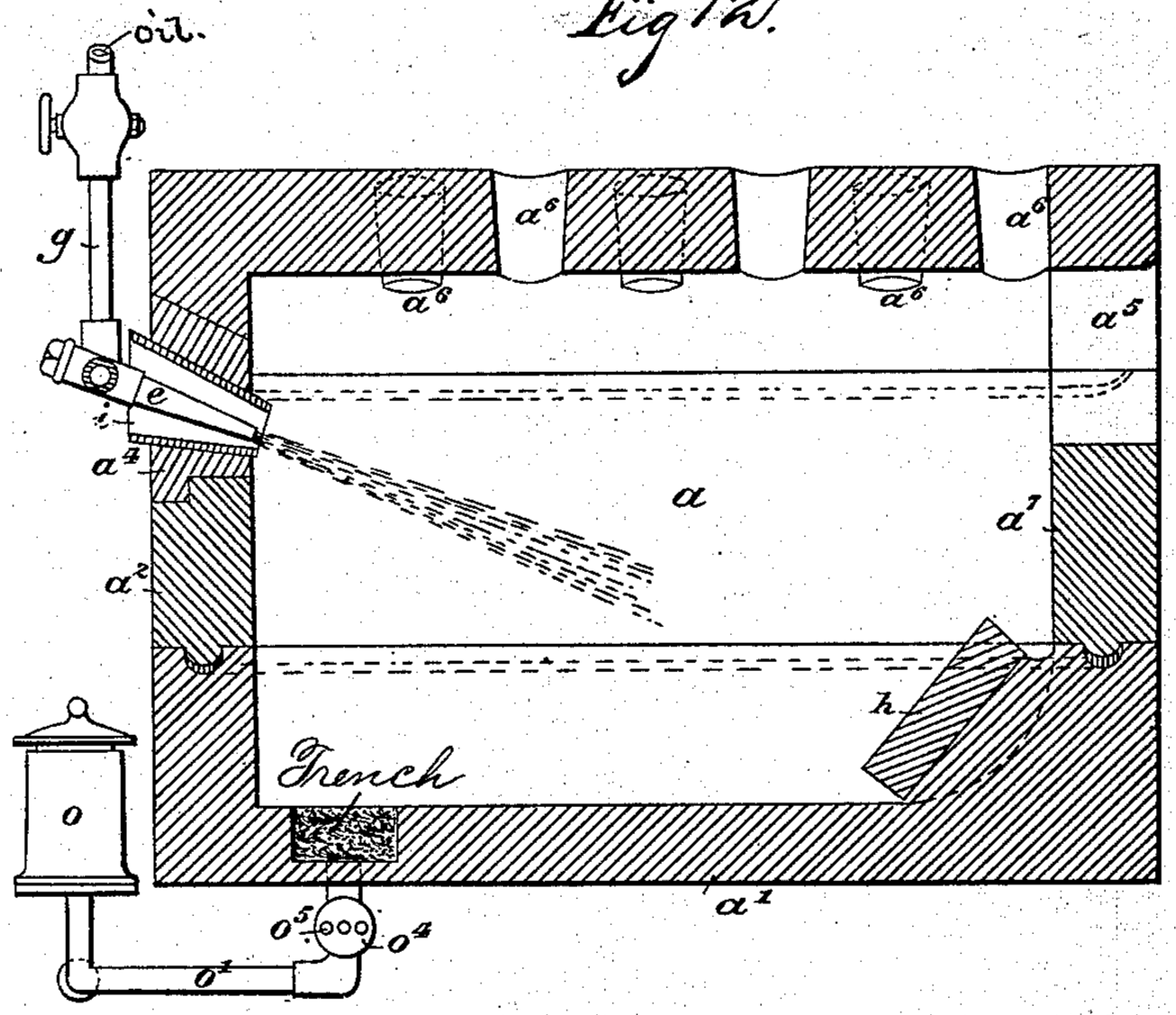


Fig 12.



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UNITED STATES PATENT OFFICE.

JASPER HENRY SELWYN, OF GLOUCESTER CRESCENT, HYDE PARK, COUNTY OF MIDDLESEX, ENGLAND.

FURNACE FOR THE COMBUSTION OF LIQUID FUEL.

SPECIFICATION forming part of Letters Patent No. 326,161, dated September 15, 1885.

Application filed March 29, 1884. (No model.) Patented in England August 24, 1883, No. 4,108, and January 25, 1884, No. 2,160; in France February 22, 1884, No. 160,494; in Belgium February 22, 1884, No. 64,243; in Germany March 1, 1884, No. 30,269; in Italy March 31, 1884, XXXIII, 46; in Austria-Hungary November 11, 1884, No. 10,263, and in India November 18, 1884, No. 128.

To all whom it may concern:

Be it known that I, JASPER HENRY SELWYN, a subject of the Queen of Great Britain and Ireland, residing at Gloucester Crescent, Hyde Park, in the county of Middlesex, Kingdom of Great Britain and Ireland, have invented new and useful Improvements in and Pertaining to Furnaces for the Combustion of Liquid Fuel, (for which I have obtained a patent in Great Britain, No. 4,108, bearing date August 24, 1883,) of which the following is a a specification.

My invention relates to that kind of liquid-fuel furnace wherein the fuel is injected in the form of spray by steam (preferably by superheated steam) into a combustion-chamber containing a slab or dash brick against which the fuel is projected, a regulated supply of air being admitted to support combustion.

According to my invention the furnace or combustion-chamber is so constructed of fire-resisting material—such as fire-clay—as to admit of expansion and contraction without admission of air at the joints, and to resist displacement by movement such as a combustion-chamber would be liable to when used on board ship, or in any other situation where subject to vibration or other movements. For this purpose it is built up of sections. Various constructions may be adopted. According to one arrangement the sections are provided at the edges with grooves or recesses and projections, the latter entering the former, and the joints being made good without mortar by the use of dry fire-proof material, which may conveniently be in the form of powder so applied as to insure an air-tight condition of the joints. This air-tight condition of the joints is of importance, because it will enable the air-supply to be regulated in the manner and for the purpose stated below. In connection with the furnace or combustion chamber, as above referred to, I employ an injector apparatus constructed with compound nozzles, in which some suitable gaseous body or bodies—such as steam or air, or both—is or are made use of to project the oil into the furnace or combustion-chamber, as is well understood, and in order that such injector may be readily moved out of the way to allow of access to the front of the furnace or combustion-chamber, I provide in connection therewith a special arrangement of pipe or pipes for conveying the gaseous body or bodies and oil to the injector, this arrangement being such as to admit of a sliding or telescopic action. By this arrangement the injector may be readily moved into position or be raised clear of the furnace or combustion-chamber, when requisite—as, for instance, while firing with coal or ordinary fuel to raise steam. I admit air in such proportion that when the process is in full action carbon in the solid state is continuously formed (burned away by admission of more air, if necessary) in the furnace or combustion-chamber from a portion of the hydrocarbon used. To this end I provide means whereby the air-supply is at all times under control, and is caused to enter the combustion-chamber in the form of an annulus or ring, the cross-sectional area of which is regulated, according to one arrangement, by a plate of any suitable material—such as asbestus card or platinum, or steel bent into the form of a hollow truncated cone, but not united at the edges. This plate is introduced between the injector and a conical opening through which the injector projects into the combustion-chamber. Thus there is produced imperfect combustion, so that some of the carbon is deposited in the form of coke and insures the evolution of hydrogen from the steam.

It will be evident that by a careful regulation of the air-supply carbon may be continuously dropped or formed from the hydrocarbon blown in, and thus fulfill the condition necessary to effect separation of steam into carbonic oxide, carbonic acid, and hydrogen—*i. e.*, about twenty per cent. carbonic oxide, twenty per cent. carbonic acid, and sixty per cent. hydrogen, more or less, as is well understood. There might, however, be circumstances under which it would become difficult, especially on board ships, to secure the constant deposition of carbon in the manner above stated, and I have discovered that such difficulty can be obviated by burning the liquid hydrocarbon in the furnace in conjunction with water, gas, or steam in the presence of a

substance containing both carbon and iron. For this purpose I employ plumbago or graphite, (known also as "black-lead" or "amorphous carbon,") which I find to be a material peculiarly adapted for use in and for the construction of such furnaces, as it contains both carbon and iron. The proportions of these constituents vary according to the quality of the material. Where fire-clay or other fire-resisting material is used in the construction of the furnace, as above described, the plumbago or graphite may be introduced into the furnace in any convenient form. For example, it may be in the shape of bricks, linings, or balls, so as to fulfill the above-mentioned purpose of effecting the decomposition of the steam with which the hydrocarbon oil is blown in, and to permit reactions in the furnace (at that temperature which is obtained by burning hydrogen gas—viz., say about 3,776° Fahrenheit) such as may give the greatest quantity of gas for heating purposes. Iron being also present, the quantity of hydrogen produced is, as will be well understood, still further increased beyond the proportions above recited. Thus four equivalents of water plus three equivalents of iron equal or yield one equivalent of magnetic oxide of iron, and free hydrogen is thereby produced, which contributes to the combustion.

In connection with the furnace or combustion-chamber I provide means—such as bird-fountains—whereby a flame or flames is or are maintained when the supply of oil to the injector is temporarily interrupted, thereby obviating risk of accidental explosion.

It will be evident that a furnace or combustion chamber according to my invention may be provided with more than one injector or apparatus for feeding fuel thereto, if desired; also, that such furnaces may be employed for various purposes where it is required to apply heat, and especially where it is requisite the heat should be long continued and equable—as, for example, in the manufacture of vitreous substances.

Figure 1 of the accompanying drawings shows in longitudinal vertical section the front part of an ordinary single-flued Cornish boiler with my improved liquid-fuel furnace applied thereto. Fig. 2 is a front elevation of the same with the front tube-plate removed. Fig. 3 is a front elevation of the combustion-chamber with its injector and bird-fountain oil-feeding apparatus. Fig. 4 is a side elevation of the combustion-chamber. Fig. 5 is a vertical section in the line *x x*, Fig. 6. Fig. 6 is a longitudinal vertical section, and Fig. 7 is a plan. Fig. 8 shows an arrangement of pivoted plates whereby the size of the orifice or air-space around the injector may be regulated, and Fig. 9 is a perspective view of a movable and elastic hollow truncated cone or bent plate for the same purpose. Fig. 10 is a central longitudinal section of the injector to an enlarged scale, and Figs. 11 and 12 views of a slight modification.

The furnace or combustion-chamber *a*, which, in the example illustrated, is placed in the front end of the flue *b* of the boiler, is constructed of fire-resisting material—such as fire-clay—and is built up of three sections, a' a^2 a^3. The edges of these sections where they abut against or join one another are provided with grooves or recesses *c* and projections or fillets *d*, the projections of one taking into the recesses of the other next to it, and the joints being made air-tight by the introduction of dry fire-proof material, as before described. By this construction expansion and contraction of the combustion-chamber is provided for without any admission of air thereto at the joints.

e is the injector, which, by means of steam supplied by the pipe *f*, projects the oil supplied by the pipe *g* into the furnace *a* and onto the dash brick or slab *h*. This dash brick or slab may with advantage be a block of plumbago or graphite. The arrangement of the pipes *f* and *g* is such as to allow of moving the injector *e* out of the way, so as to permit of access to the front of the furnace *a*. For this purpose the pipes *f* and *g* are carried by other pipes, f' g', fixed to the front plate of the boiler. In these pipes f' g', the pipes *f* *g*, respectively, slide telescopically when the injector is pushed upward, which can be readily done when it is required to move the injector from its place in front of the furnace. The space between *f* and f' and the space between *g* and g' are provided with packing to prevent leakage, but so as to allow of the telescopic movement of *f* and *g*.

f^2 g^2 represent valves or cocks applied to the pipes *f* and *g*, by means of which the supply of steam and liquid hydrocarbon may be regulated as required. The air necessary for combustion enters the furnaces, as already stated, in the form of an annulus or ring. The cross-sectional area of the annular stream is regulated by a plate, *i*, made of any suitable material, such as asbestus card or platinum, or steel bent into the form of a hollow truncated cone, Fig. 9, but not united at the edges. This truncated cone *i* is placed in a conical opening formed in the movable part a^4, carried in the front portion of the furnace, through which the nozzle of the injector projects. The plate *i* is pulled outward or pushed inward according to whether the area of the air-space around the nozzle of the injector is required to be increased or diminished; or the arrangement shown in Fig. 8 may be used instead of the truncated cone *i*. In this arrangement two plates, *k* k', curved on their inner edges at k^2 k^3, and provided with handles *m* m', are pivoted on a screwed bolt, *n*, by means of which the plates are secured to the front plate, b', of the boiler-flue *b* in such a manner as to more or less close the air-opening in the removable part a^4, as may be desired. The front tube-plate, b', may be provided with air-valves b^2 (shown in dotted lines in Fig. 2) of any suitable construction.

The object of such air-valves is to admit oxygen for combustion, if required, to the boiler-flue outside the chamber *a*. By the means described the air-supply may be so regulated that imperfect combustion of the liquid hydrocarbon shall take place, whereby solid carbon will be continuously formed for the purpose of effecting the combustion of the hydrogen resulting from the decomposition of the steam in the combustion-chamber, as above stated.

The combustion-chamber *a* has an opening, a^5, in its back wall and a series of openings, a^6, in its top, through all of which products of combustion may escape into the boiler-flue or to act upon any other desired heating-surface. The back wall or bridge, a^7, may be more or less protected from the action of the products of combustion in the combustion-chamber *a* by placing thereon bricks a^8 of any suitable refractory material, as shown in dotted lines in Fig. 1.

o o represent liquid-hydrocarbon reservoirs or vessels acting on the well-known principle of the bird-fountain, whereby a flame or flames may be maintained constantly in the combustion-chamber *a*, even though the supply of oil to the injector be temporarily interrupted or the injector be raised clear of the furnace. These reservoirs or vessels *o* are provided each with a pipe, *o'*, and valve o^2, by means of which liquid hydrocarbon may be conducted to a burner at o^3. An exterior casing, o^4, of any suitable material and provided with air-holes o^5, surrounds a portion of each of the pipes *o'*, whereby air is fed to the burners at o^3, (see Fig. 5,) as in the well-known Bunsen burner. The combustion of the liquid hydrocarbon is thus effected.

p p are dome-shaped covers or vessels of refractory material, provided with holes through which flame issues into the combustion-chamber *a*. These covers or vessels are placed over the burners at o^3, and in holes or recesses formed in the bed of the combustion-chamber *a*.

In lieu of the arrangement illustrated, the oil for the constant flame may be fed to a trough formed in the bed of the combustion-chamber and having placed in it asbestus to serve as a wick, as illustrated in Figs. 11 and 12.

The form of injector I prefer to employ in my improved furnace is shown in Fig. 10, in which *f* is the pipe for supplying steam, and *g* the pipe for supplying the liquid hydrocarbon. A plug or ferrule, *e'*, screws into the open end of the injector, to which the pipe *g* is secured. The said plug or ferrule has a conical hole, which, when the plug or ferrule is screwed home, takes a steam-tight bearing upon a similarly-coned end on the branch pipe *q'* of the central oil-pipe, *q*, thus preventing steam under pressure escaping from the space *r*, and forcing back the supply of liquid hydrocarbon. Screws *s s*, in conjunction with a conical hole in the screw-cap *s'*, are employed to keep the oil-pipe *q* central within the nozzle of the injector.

The pipes *f* and *g* are secured to the injector by screw-caps *t t'*, as shown, or in any other convenient manner.

With this construction it results that the steam issues at *r'* from the injector in the form of an annulus or ring and surrounds the liquid hydrocarbon issuing from the central oil-pipe, *q*, at the same time inducing a current of air through the opening in the wall around the injector.

It is well known that when steam is blown in or over metals or carbonaceous material it is decomposed into its constituent gases and a recombination of those gases takes place in the presence of carbonaceous material, forming carbonic oxide, carbonic acid, and hydrogen.

I am also aware that others have proposed the use in hydrocarbon furnaces of carbonaceous materials, defining these to mean coal, coke, charcoal, and the like; but it must be evident that these, being highly combustible, would require frequent renewal and cannot be ranked with the material I employ, which is refractory, and, being composed of amorphous carbon and iron, is especially fitted for effecting the decomposition of steam while undergoing itself but little change in the furnace, unless a stream of oxygen gas be used.

I do not claim the use of the substance for furnaces generally, as I am aware that it has long been employed for such purposes. I claim its employment only when used in combination with hydrocarbon oils and with steam employed to blow in or atomize the oil, under which condition the steam can also be decomposed with much advantage to the total heat produced, which can be rendered available either when the regulation of the air-supply, as above described, does not operate to produce deposited carbon, from whatever cause, due to inattention or inaccuracy, when such regulation is rendered unnecessary—as, for instance, by using the graphite or plumbago in a furnace constructed of other refractory substances. The graphite or plumbago may be used for the purposes of my invention either after manufacture or in its native state, or mixed with other substance—such as clay or alumina—so long as the desired effect is produced—namely, decomposition of the steam without fusion of the graphite or plumbago at the temperature necessarily employed—*i. e.*, the heat of burning hydrogen.

I am aware of the patent to Russman, No. 269,720, for a furnace having the spaces between the convolutions of a coil filled with refractory material, and which also has an adjustable nozzle, an adjustable nozzle-support, and joint-tubes. I am also aware of Patent No. 68,708, showing a combustion-chamber built in sections, and of the joint in German Patent No. 6,414, of 1878; also, of the means for regulating the fuel and flame supply (not air) in Patent No. 263,198; also, of Patent No. 52,875, which shows that cast-iron has been used to absorb the oxygen and liberate the hydrogen of steam, so as to burn said gas in a furnace,

and I do not claim any of these features; but

What I do claim is—

1. In a furnace for generating heat by combustion of liquid fuel with steam, the combination, with the injector provided with compound nozzles for injecting liquid fuel to the combustion-chamber, of the telescopic pipes or tubes and the inclosing-pipes, within which the former have a telescopic action, whereby the said injector is readily moved clear of the opening in the furnace-wall, substantially as and for the purpose specified.

2. In a furnace for generating heat by combustion of liquid fuels with steam, in combination with the oil-pipe, the injector, the movable part a^4, provided with air-openings, and through which the injector projects, and the plate or plates placed in the said movable part, whereby when the said plate or plates are pulled outward or pushed inward the area of the air-space around the nozzle of the injector is increased or diminished; and the supply of steam and air thereby regulated, substantially as described.

3. A furnace for generating heat by combustion of hydrocarbon oils with steam, provided with a plumbago or graphite plate, brick, or lining placed within said furnace, said furnace being constructed of other refractory substances, in combination with steam and oil jets whereby the steam used to blow in the liquid fuel is decomposed, substantially as and for the purpose described.

4. In a furnace for generating heat by combustion of liquid fuels with steam, provided with the combustion-chamber *a*, in combination with means whereby the air is admitted thereto in the form of an annulus or ring, an adjustable injector for projecting the liquid fuel into said chamber, the dash brick or slab *h*, against which the fuel is projected, the dome-shaped covers *p p*, through which flame issues into the combustion-chamber, the liquid-hydrocarbon reservoirs provided with pipes and valves, casing and air-holes whereby the flame or flames may be maintained in said combustion-chamber, and the opening in the back wall of the combustion-chamber and the series of openings in its top, through which the products of combustion escape, substantially as described.

5. A furnace for generating heat by combustion of liquid fuels, provided with a plumbago or graphite plate, brick, or lining, in combination with a steam-jet, a liquid-fuel injector, a slab or dash brick against which the liquid fuel is projected, and the means, substantially as described, for regulating the air-space around the injector and for admitting the air to the furnace in the form of an annulus or ring, whereby the steam is decomposed and solid carbon is continuously formed and deposited, as herein set forth.

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