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MEANS FOR CONTROLLING FUEL SUPPLY IN STEAM GENERATING SYSTEMS.

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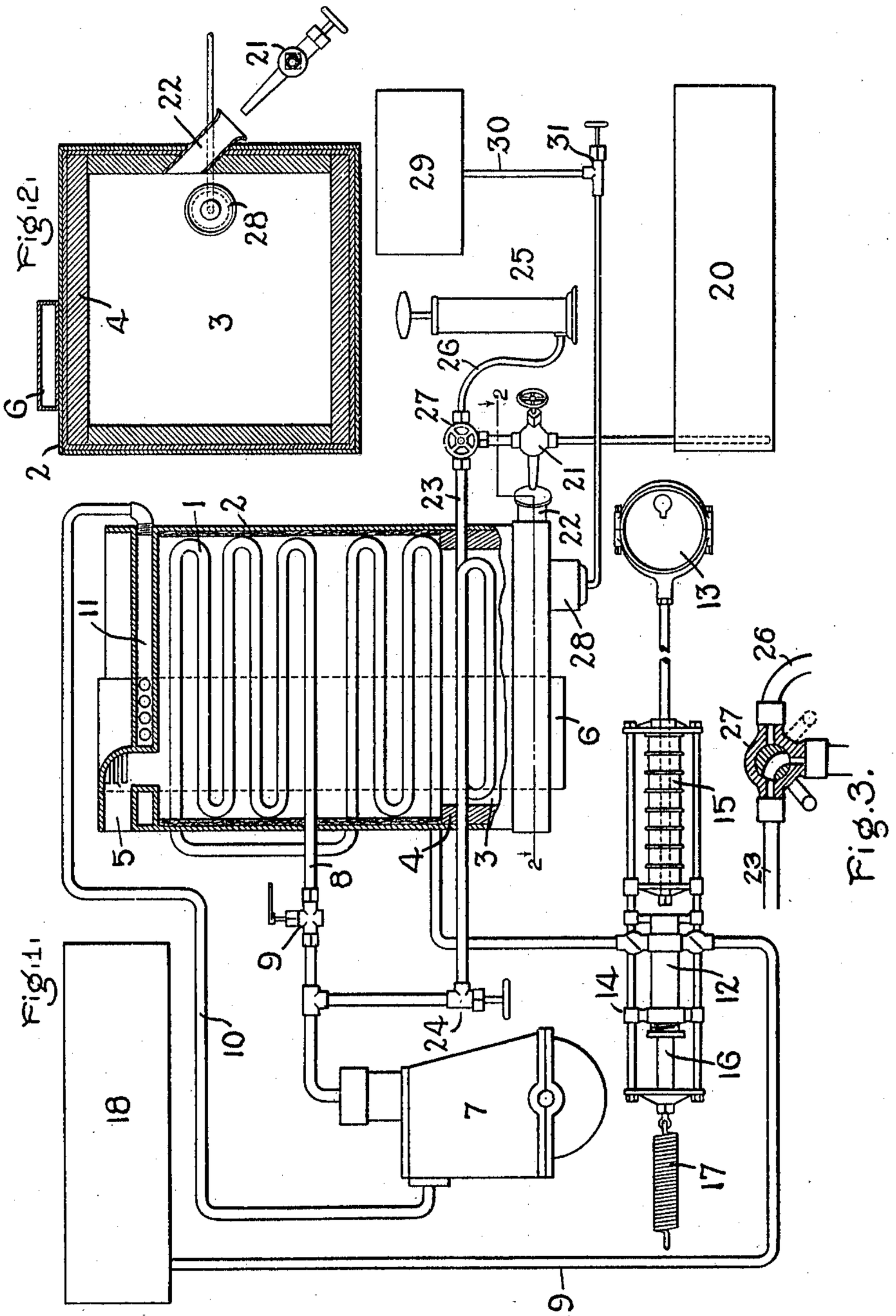

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MEANS FOR CONTROLLING FUEL-SUPPLY IN STEAM-GENERATING SYSTEMS.

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To all whom it may concern:

Be it known that I, HERMANN LEMP, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Means for Controlling Fuel-Supply in Steam-Generating Systems, of which the following is a specification.

In steam power systems, especially in those where the load on the engine is characteristically variable, as in steam automobiles, it is particularly desirable to provide, and I have heretofore provided, a system including automatic means whereby the heating energy supplied for the vaporization of the liquid delivered to the generator may be regulated as to quantity, by being diminished under conditions of light load with an attendant small demand for steam or vapor, while on the other hand, being increased under heavy loads where the demand for steam is relatively high, and such system is broadly set forth in my pending applications Serial No. 6,806, filed Feb. 28, 1900, and Serial No. 129,859, filed Nov. 3, 1902, and is not claimed therein. In its general aspect, the present invention employs this method of regulation, but it relates more particularly to a steam generating apparatus for producing superheated steam, wherein the fuel employed is supplied in liquid form to the combustion chamber and atomized therein preparatory to burning. In this connection kerosene is the most preferable of the liquid hydrocarbons. The factors which are conducive to complete combustion of atomized kerosene and which are necessary to give satisfactory results are the minuteness of the particles, proper temperature at which they are ignited, and their mixture in suitable proportions with oxygen. It is in connection with this manner of utilizing the fuel that my system of fuel regulation is applicable. Highly superheated steam is used for atomizing the liquid kerosene and for injecting it into the combustion chamber of the generator, and as the atomizing device is of the injector type, a sufficient quantity of oxygen is induced into the combustion chamber with the atomized kerosene to produce a rich combustible. The means for regulating the supply of fuel operates to vary the quantity of superheated steam that is to be supplied to the injector. In order that the regulation may be as close as possible to meet the demand for steam created by the engine under varying load conditions, the steam for atomizing the fuel is supplied from the engine side of the throttle in the live steam pipe that delivers the vapor or steam to the engine. On this side of the throttle the steam pressure varies through a wide range depending upon the demands of the engine, and according to the variations in the steam, as to pressure, the quantity of fuel to be atomized varies in direct ratio. Thus, as the throttle is opened wide it delivers a large quantity of steam to the engine, and a similar effect is set up at the end of the steam supply pipe at the atomizing device or injector, so that as steam of increased pressure and quantity passes to the atomizing device it atomizes a larger quantity of fuel and supplies more heating energy to the generator substantially at a time when acceleration of vapor generation is most desirable; while obviously the contrary condition prevails upon reducing the quantity of steam passing the throttle.

In the accompanying drawing, which illustrates an embodiment of my invention, Figure 1 is a diagrammatic representation of a steam power system showing my improved system of fuel regulation; Fig. 2 is a horizontal section of the combustion chamber, taken on line 2—2, Fig. 1, disclosing the cooperative relation of the atomizing device thereto and Fig. 3 is a section of the 3-way valve.

Referring to the drawings, 1 represents a steam boiler for the rapid generation of steam, comprising a continuous coil of pipe in which the liquid supplied thereto is gradually raised to the temperature of vaporization and is further superheated to a desired degree suitable for furnishing the power agent for the engine or motor. The generator, or in other words, the coil of pipe, is inclosed in a casing or shell 2, which is provided at its lower end with an open combustion chamber 3 lined with fire brick 4 or other refractory material, and at the upper end of the casing is formed a natural draft flue 5 and a down or forced draft flue 6. The superheated steam end of the generator leads to an engine 7 through a live steam pipe 8, and a two-way throttle valve 9 controls the quantity of steam delivered to the engine. The exhaust steam is conducted

away from the engine through an exhaust pipe 10 to a reheating chamber 11 in the top of the casing, and in this the steam is reheated to increase its pressure preparatory to its delivery into the down flue 6, for the purpose of creating a forced draft to aid the combustion of the fuel.

The liquid or water may be supplied to the generator in any approved manner, but as shown the supply is under the control of a variable stroke pump 12 which automatically regulates itself to deliver a varying quantity of liquid depending upon the condition of the steam as to pressure on the water end of the generating coil. Power is derived from an eccentric 13 which may be driven on the rear axle of the vehicle or other counter shaft in the power transmitting system connected with the engine, or it may be operated by an independent motor. Motion is imparted from the eccentric to a cross-head frame 14 with which it is connected, through an intermediate elastic connection or buffer 15 which moves the plunger 16 of the pump on its inward or discharge stroke, and a retractile spring 17 restores the plunger. The length of the stroke, and, therefore, the effective supply of liquid, is dependent upon the back pressure on the water side of the generator, the lost motion being taken up by the buffer when the stroke varies from the maximum. Accordingly the quantity of liquid supplied is automatically regulated, varying as the condition of the steam pressure in the generator varies. The supply of liquid is taken from a reservoir 18, through a supply pipe 19 which connects with the pump 12.

The fuel supply system comprises a source of fuel 20, connected with an atomizing device or injector 21, an injector tube 22 arranged in coöperative relation to the injector and to the interior of the combustion chamber, being inclined at an angle toward one of the walls so as to cause the jet of combustible mixture to impinge upon the wall opposite, from which the mixture will deflect around in the chamber and completely carburize and ignite. The steam side of the injector is connected with a steam supply pipe 23 which branches from the live steam pipe 8 between the engine and the throttle. This pipe 23 leads back to the generator casing where it takes the form of a superheating coil, so as to deliver steam to the injector in a highly heated state and at relatively greater pressure, so that the fuel becoming entrained with the steam is completely atomized or sprayed by the force of the pressure jet of steam. Any definite proportion of the whole steam supplied by the generator may be delivered through the pipe 23 by means of a valve or throttle 24 located in the pipe. Variations in the pressure of the steam at the throttle end of this pipe are communicated to the injector end which immediately responds thereto in varying the quantity of steam that is supplied to the injector, and consequently, to the same degree the quantity of fuel, as the latter is directly dependent upon the steam supply. The steam in passing through the injector or atomizer tends to create a vacuum, thereby causing the suction of fuel from its source, and discharges the fuel through the injector tube with considerable force and speed so that a certain quantity of air is also induced into the combustion chamber by the jet, and all combine to produce a rich mixture.

To carry out the atomizing process when the generator is inert and cannot deliver steam to the injector, a separate source of an atomizer medium may be employed, as air under pressure. To this end a hand pump 25 is provided and connection therefrom to the injector by coupling with the steam supply pipe 23 is made through an air supply pipe 26, and a three-way valve 27 is arranged at this point of connection, whereby either of the sources of atomizing agents, the steam or the air, can be operatively related to the injector or atomizing device. After the initial generation of vapor or steam in the generator by the air-atomized fuel, the air supply is preferably cut out of service and the steam performs the office of atomizing the fuel, and with much better results, due to the high heat that is given to the kerosene particles by the steam and the higher pulverizing force of the steam, so that a superior mixture is obtained.

A pilot burner 28 is furnished for the purpose of starting combustion in the combustion chamber at the initial time of starting or during subsequent times of starting, as when the engine is temporarily shut down and the supply of steam interrupted by the closure of the throttle. The pilot is situated in the combustion chamber adjacent the discharge end of the injector tube and where the fuel mixture will be certainly ignited. After combustion in the chamber is established the pilot plays a minor part, for the state of combustion is maintained continuous as long as the supply is not shut down by closing the throttle. The pilot may then be extinguished by stopping the supply of fuel thereto. The fuel is supplied from a tank 29 under a suitable head, by reason of its elevated position, and a pipe 30 affords means of feeding the fuel, and a valve 31 provides for controlling the feed.

It will be noted that in the present system of fuel regulation the generation of steam or vapor may be automatically controlled so as to be quantitatively co-equal with the demand, and capable of delivering sufficient steam under all load conditions

within the steaming capacity of the generator.

In accordance with the provisions of the patent statutes I have described the principle of operation of my invention, together with the apparatus which I now consider to be the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new, and desire to secure by Letters Patent of the United States, is,—

1. The combination of a steam generator, a combustion chamber, an engine, a steam conduit between the generator and the engine having a throttle valve therein which delivers a continuous supply of steam at different pressures to the portion of the conduit between it and the engine, a fuel atomizing device, a source of fuel for supplying the device, a steam supply pipe for the atomizing device leading from said conduit at a point between the throttle valve and the engine, means for superheating the steam delivered through said supply pipe to the device and a valve in said supply pipe for adjusting the proportion of steam supplied to the atomizing device relatively to the quantity delivered to the engine.

2. The combination of a steam generator, a combustion chamber, an engine, a live steam pipe between the generator and the engine having a two-way throttle valve therein which delivers a continuous supply of steam at different pressures to the portion of the pipe between it and the engine, an atomizing device for supplying atomized fuel to the combustion chamber, a source of liquid fuel connected therewith, means for supplying steam to the atomizing device from a point in the steam pipe on the engine side of the throttle valve so that the quantity of steam supplied to said device varies as the supply of steam to the engine varies, and means for superheating the steam delivered to the atomizing device.

3. The combination of a steam generator, a combustion chamber, an engine, a live steam pipe connecting the generator and the engine having a two-way throttle valve therein which delivers a continuous supply of steam at different pressures to the portion of the pipe between it and the engine, a source of liquid fuel, an atomizing device adapted to receive fuel from said source and to inject atomized fuel into the combustion chamber, a steam supply pipe connected with the live steam pipe between the throttle valve and the engine, and a superheating coil in the combustion chamber connected with the steam supply pipe and adapted to supply superheated steam to the atomizing device.

4. The combination of a steam generator, a combustion chamber, an engine, a live steam pipe connecting the generator and the engine having a two-way throttle valve therein which delivers a continuous supply of steam at different pressures to the portion of the pipe between it and the engine, a source of liquid fuel, an atomizing device adapted to receive fuel from the source and to inject atomized fuel into the combustion chamber, a steam supply pipe connected with the live steam pipe between the throttle valve and the engine, a superheating coil in the combustion chamber connected with the steam supply pipe and adapted to supply superheated steam to the atomizing device in quantities varying directly as the steam on the engine side of the throttle varies, and means in the steam supply pipe for adjusting the proportion of steam supplied to the atomizing device relatively to the quantity delivered to the engine.

5. The combination of a steam generator, a combustion chamber, a source of liquid fuel, an atomizing device connected therewith, means for supplying air to the atomizing device to deliver atomized fuel to the combustion chamber for the initial generation of steam, an engine, a live steam pipe between the engine and generator, a throttle therein, means for supplying steam to the atomizing device from the live steam pipe on the engine side of the throttle in a quantity variable directly as the supply to the engine varies, and means for connecting the steam supplying means to the atomizing device and simultaneously disconnecting the air supplying means.

6. The combination of a steam generator, a combustion chamber, a source of liquid fuel, an atomizing device connected therewith, an injector tube disposed in coöperative relation to the atomizing device and combustion chamber, means for supplying air to the atomizing device for spraying fuel through the injector tube into the combustion chamber for the initial generation of steam, an engine, a live steam pipe between the engine and generator, a throttle therein, means for supplying steam to the atomizing device from the live steam pipe on the engine side of the throttle subject to variation as to the quantity of steam delivered to the engine, and a three-way valve for controlling the coöperative relation between the means for supplying air and the means for supplying steam to the atomizing device.

7. The combination of a steam generator, a combustion chamber, an engine, a live steam pipe between the generator and the engine, a two-way throttle valve in said pipe which delivers a continuous supply of steam at different pressures to the portion of the pipe between it and the engine, means for supplying atomized fuel to the combustion chamber, and a conduit leading from the

portion of the live steam pipe between the throttle valve and the engine for supplying steam to the atomizing means which conduit is controlled by the throttle valve so that the supply of atomized fuel varies directly with the steam supply to the engine.

8. In combination, a rapid steam generator, an engine receiving superheated vapor therefrom, a conduit between the generator and the engine, a two-way throttle valve in the conduit for controlling the supply of vapor to the engine which delivers a continuous supply of steam at different pressures to the section of the conduit between it and the engine, a heater for the generator, an atomizer for supplying atomized fuel to the heater, means connected to said conduit which receives superheated vapor from the engine side of the throttle, further superheats it and delivers it to the atomizer for atomizing the fuel, and a valve in said connection for proportioning the supply of vapor to the atomizer relatively to the quantity delivered to the engine.

9. In combination, a rapid steam generator, an engine receiving superheated steam therefrom, a conduit between the generator and the engine, a two-way throttle valve in the conduit controlling the supply of steam to the engine which delivers a continuous supply of steam at different pressures to the section of the conduit between it and the engine, a combustion chamber, an atomizer for discharging fuel into the chamber, a superheater in said chamber which is connected at one end to the conduit between the throttle valve and the engine and at the other end to the atomizer, and a valve in the connection between the conduit and the superheater.

10. In combination, a steam generator, an engine supplied with steam therefrom, a closed combustion chamber for the generator, an atomizer for delivering atomized fuel to the chamber, a steam supply connection leading to the atomizer, a valve in said connection, a two-way throttle valve for controlling the supply of steam to the engine and to the atomizer connection to vary the supply of fuel to the chamber correspondingly with the demand for steam by the engine, which throttle delivers a continuous supply of steam at different pressures to the engine and atomizer connection, and means for superheating the steam supplied to the atomizer.

In witness whereof I have hereunto set my hand this tenth day of November 1903.

HERMANN LEMP.

Witnesses:

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