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H. LEMP.

FUEL REGULATING SYSTEM FOR STEAM GENERATORS.

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Fig. 1.

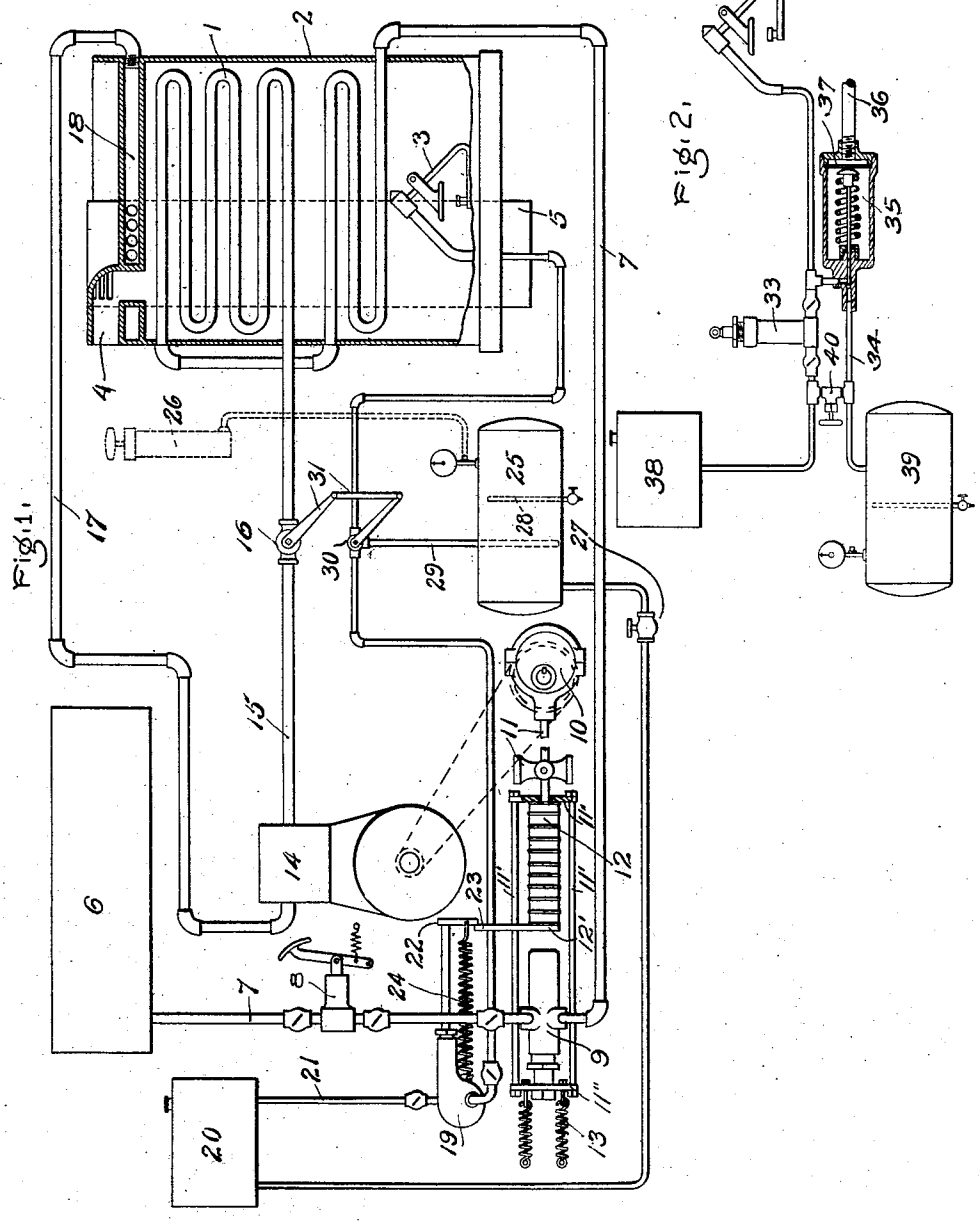


Fig. 2.

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FUEL-REGULATION SYSTEM FOR STEAM-GENERATORS.

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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 Fuel-Regulation Systems for Steam-Generators, of which the following is a specification.

In automobile steam generating apparatus in which liquid fuel is used as the heating agent it is the usual practice to provide means whereby the steam generator and the fuel vaporizer of the burner may be maintained at a suitable temperature at times when the vehicle is standing and the system is temporarily using no power, in order to have the apparatus in immediate readiness for service. An auxiliary burner, commonly termed a pilot, is generally employed for this purpose, and the heat of its flame serves to maintain steam in the generator, and also to keep the fuel vaporizer sufficiently hot to effectually vaporize the fuel when the supply is opened, or in other words, the auxiliary burner is analogous in its function to the banking of the fire in ordinary boiler firing practice.

My invention relates to a system of fuel regulation embodying this two-burner idea, and for which the supply of fuel is regulated by the throttle that controls the delivery of steam to the engine. The throttle operates to open or close the main supply of fuel to the burner simultaneously as it opens or closes the supply of steam to the engine, and in direct continuity with the closing of the main supply the auxiliary supply of fuel is opened, or vice versa, so that the separate supplies thus hold a reciprocal relation to each other.

In some systems there is a perceptible tendency for the vapor pressure of the burner to persist a certain period after the power is shut down, and thus furnish more vapor than is demanded. Obviously at this time when the power system is idle the forced draft flue is not operating and the volume of air in the natural draft flue is not sufficient to support a complete and clean combustion of the fuel, and consequently as soon as the vehicle stops, the exhaust products of combustion emit obnoxious odors. This same state of affairs exists while operating at light load as when the vehicle is moving at low speed on a level road and demanding very little propelling power, or in coasting down hill, where the quantity of steam is likewise practically negligible. With ordinary appliances however the pressure on the burner could not change rapidly enough to meet these conditions so that the quantity of fuel supplied to the burner remains for a time largely in excess of the requirements and as a result the exhaust products become sooty and odorous. It is apparent therefore that to provide a device for correcting these objections, which may be operated by the throttle and act therewith with equal promptness, is highly desirable and convenient. To provide such a device is the object of the present invention and to carry it into practice a single burner is employed, but the fuel is supplied thereto in different quantities so as to produce the main working flame or the pilot or auxiliary flame, whichever may be desired. These two different supplies of fuel, for convenience, shall be distinguished hereinafter as the main fuel supply and the auxiliary supply. The two supplies of fuel are so regulated as to hold a reciprocal relation to each other and one can be thrown into service simultaneously and in direct continuity with the cutting of the other out of service, and the control of both is dependent upon the action of the throttle. The main supply operates in uniformity with the throttle so as to open and close when the throttle opens and closes, thereby regulating the fuel so as to prevent the quantity from exceeding what the conditions of service demand.

The flow of fuel from the auxiliary reservoir does not follow immediately upon closing the main fuel supply, because of the difference in pressures on the burner and auxiliary supply reservoir. The pressure on the burner at the time the apparatus is shut down is considerably higher than that of the reservoir, and as a consequence of opening the auxiliary supply at the time the apparatus is shut down a quick relief is afforded for the pressure on the burner, and this sets up a momentary flow to the reservoir from the burner and the connected pipes, until the relative pressures are equalized, after which the auxiliary supply takes place under the initial pressure of the reservoir. This is an important feature of the system as it permits the burner pressure to be reduced simulta-

neously with the stopping of the forced draft, thereby preventing combustion with a sooty flame every time the apparatus is shut down.

The supplies of fuel are delivered from separate reservoirs, one of which is at atmospheric and the other under a higher air pressure. A force pump for the main supply of fuel is employed and the auxiliary supply is maintained by the initial air-pressure on the fuel in its reservoir.

In order to obtain the continuity with which the change is effected from the main to the auxiliary supply of fuel, or vice versa, simultaneously with the closing of the throttle, two methods may be employed: First, the throttle may be mechanically connected with a valve which functions in such a manner as to cut off the main fuel supply and at the same time open the auxiliary supply as the throttle closes or vice versa, in one and the same operation; this obviates the necessity of operating two sets of levers, namely the one controlling the delivery of steam to the engine, and the other the supply of fuel to the burner, thereby preventing confusion in manipulation as would likely be the case with a multiplicity of operating levers; second, the live steam pipe on the engine side of the throttle may be provided with a branch which communicates with a pressure controlled needle valve that is adapted to control a by-pass or connection from the pressure fuel reservoir. This needle valve is automatically operated by being subjected to the pressure of the steam when the throttle valve is open, and is therefore held in closed position at such times, whereas when the steam pressure lowers by closure of the throttle, the needle valve opens automatically to permit the auxiliary supply of fuel from the pressure reservoir to take the place of the main supply for supporting the pilot flame.

In the accompanying drawing, which illustrates one embodiment of my invention, Figure 1 represents diagrammatically a steam power system employing a boiler with my improved fuel regulation; and Fig. 2 a modified form of regulator in which the auxiliary fuel supply is under the control of the steam pressure on the engine side of the throttle.

Referring to the drawing, 1 represents a steam generator of any suitable type for producing superheated steam, which is inclosed in a casing 2 and heated by a burner 3 beneath the generator in co-operative relation thereto. The casing is provided with a natural draft or up flue 4 and a forced draft or down flue 5 by means of which the necessary volume of air for supporting combustion, either while the vehicle is stationary or in operation, is produced.

The supply of liquid to the steam or other vapor generator is taken from a reservoir 6 and is supplied through a supply pipe 7 to the generator, a foot or hand pump 8 being employed for the initial feed of liquid while a power driven variable stroke pump 9 is adapted to supply the liquid to the generator after the power system is in operation. This latter pump is driven by two co-acting motors. One motor comprises an eccentric 10 and a yielding connection between the same and the pump piston. The connection, in the present case, is a crosshead and connecting rod construction 11, a frame formed of side rods 11′ on opposite sides of the pump and end pieces or abutments 11″, and an elastic member 12 between the connecting rod and the frame. The connecting rod passes loosely through the adjacent cross-piece and projects into the frame. The elastic member 12 is mounted on the projecting end of the connecting rod, and consists preferably of annular rubber buffers assembled on the rod and spaced apart by metal washers. The buffers are confined between a plate 12′ on the end of the connecting rod and the cross-piece of the frame, which form abutments. The other cross-piece is rigidly attached to the pump plunger so that any movement of the frame is imparted to the plunger. The motor just described is capable of actuating the plunger only in one direction and is unable to return it, by reason of the loose connection between the connecting rod 11 and the adjacent cross-piece, thus constituting a lost-motion connection. It is the function of the second motor to return the plunger after being actuated by the first motor. The second motor comprises an extension spring or springs 13, fixed at one end and secured to the frame at the other, so that they are placed under tension by the operation of the other motor.

The motors are so arranged that the discharge stroke of the pump is performed by the first motor and the suction stroke by the second. The tension of the elastic member is adjusted so that the pump may deliver water to the generator at a predetermined pressure, and when for any reason the pressure on the generator tends to increase, the elastic member yields to a greater or less extent, thereby varying the stroke of the pump to maintain the effective supply of water at constant or substantially constant pressure. By this arrangement the supply of liquid to the generator may vary automatically in accordance with the pressure of the water side of the generator, and it therefore varies directly with the demand for steam. The generator supplies steam to an engine 14 through a live steam pipe 15 which is under control of a throttle or regulator valve 16. The exhaust side of the engine is connected by a pipe 17 to the reheating chamber 18 located at the top of the boiler casing 2, and therein the exhaust steam is superheated before discharging into the down flue 5 to create a forced draft.

In Fig. 1 two reservoirs for fuel are employed, one being the source from which the main supply to the burner is drawn and the other being the source from which the auxiliary supply is taken. The main supply of fuel is delivered to the burner 3 by a fuel pump 19, from a source of fuel under atmosphere pressure in a reservoir 20. This pump is situated in a supply pipe 21 between the reservoir and burner and is also of the variable stroke type whereby its effective supply may be automatically varied according to the pressure on the burner. The plunger of the pump 19 is provided with a finger 22 which loosely engages with a corresponding finger 23 on the plate 12′ of the connecting rod of the motor of the liquid pump, so that the fuel pump may be operated on its suction stroke by the said rod, and a spring 24 connected to the pump plunger at one end and fixed at the other to the pump cylinder, serves to perform the discharge stroke. With this arrangement the pump tends to deliver fuel to the burner at a certain pressure and if the pressure on the burner tends to increase the fingers 22 and 23 will disconnect and the spring 24 will yield and vary the stroke of the pump to such an extent that the quantity of fuel delivered thereby will be sufficient to enable the pressure to be maintained substantially constant on the burner. For the purpose of supplying the burner while the steam generator is idle a pressure reservoir or accumulator 25 is suitably provided and the fuel therein is placed under air pressure by means of a hand pump 26, shown in dotted lines, and the pressure most suitable for this purpose is about ten pounds per square inch. This reservoir is preferably supplied or filled from the reservoir 20 through a connecting pipe controlled by a stop cock 27. A drip or level pipe 28 is provided in the pressure reservoir and extends at its upper end adjacent to the top of the reservoir so as to determine the height of the fuel to afford space for the desired head of air. This reservoir 25 is connected with the fuel supply pipe 21 by means of a branch 29, and at the point of juncture thereof with the supply pipe a three-way valve 30, forming a fuel controller or regulator, is provided for controlling communication between the burner and the separate reservoirs. This is preferably arranged in close proximity to the throttle valve and they are both mechanically connected by an arrangement of levers 31, so that by operating the throttle the three-way valve 30 will be operated at the same time. The valve 30 is operatively connected with the throttle in such a manner that by simultaneously closing the latter the main supply of fuel from the pump will be cut off and communication be opened between the pressure reservoir 25 and the burner for establishing the auxiliary supply. The pressure in the reservoir 25 is just sufficient to supply enough oil to the burner to support a pilot flame, without smoke or odor, for effectually maintaining the steam in the generator in a state of vaporization.

When the throttle is closed the exhaust from the engine is stopped and consequently the forced draft ceases to operate. At this time the pressure on the burner is substantially at normal working pressure and this should be immediately reduced so that the natural draft can support a perfect combustion, otherwise the fuel would burn with considerable smoke and odor. As the opening of the auxiliary supply is simultaneous with the cessation of the forced draft, the existing pressure on the burner may be relieved to the auxiliary reservoir, in accordance with the relative difference of pressure. When the pressures are equalized the fuel for the pilot flame will be received from the auxiliary reservoir. This relief of pressure from the burner in case of repeated stops at short intervals, as in city service, might tend to raise the initial pressure in the reservoir above that desired. When this condition occurs a portion of the contents of the reservoir may be drawn off, as by opening the valve in the gravity feed connection between the main and auxiliary reservoir thereby causing fuel to escape due to the pressure of the latter reservoir being higher than that in the former.

This arrangement of a single controller for the delivery of steam to the engine and the supply of fuel to the burner relieves care from the mind of the operator by not having to attend to these controlling devices separately, and it also provides a uniformity of regulation. It will be observed, further, that by closing or opening the throttle the main supply of fuel is affected correspondingly, so that the fuel supply varies directly as the demand for the steam varies and thus affords more economy in operation.

According to the modified form of regulator for the fuel, Fig. 2, the changing from the main supply to the auxiliary supply, or vice versa, while not being mechanically controlled by the throttle, is, nevertheless, dependent upon the operation of the throttle. In other words, the pressure of the engine side of the throttle is utilized to control the auxiliary feed from the pressure reservoir or accumulator 25. In operation, as the main supply and the auxiliary supply hold a reciprocal relation, and as the main supply is open while the throttle is open, it follows that when the throttle is closed the auxiliary supply of fuel will be opened and the main supply will be closed. In Fig. 2, as in Fig. 1, separate fuel reservoirs are employed, namely, a reservoir 38 at atmospheric pressure for the main supply of fuel, and a pressure reservoir 39 which is placed under any suitable initial

air pressure and from which the auxiliary supply is delivered. In a pipe connection between the reservoirs is arranged a stop cock 40 by means of which fuel may be supplied to the pressure reservoir from the reservoir 38 for initially filling the same. The main supply is taken from the reservoir 38 and service pressure is imparted to it by means of a suitable power pump 33. The auxiliary supply flows from the tank or reservoir 39 through the pipe 34 which is controlled by a needle valve 35 adapted to be acted upon by the steam pressure on the engine side of the throttle. For this purpose the live steam pipe is tapped at a suitable point adjacent the throttle by means of a steam pipe 36 which communicates with the pressure chamber 37 of the needle valve.

It will be noted that according to the system of fuel control as described the change from the main supply to the auxiliary supply takes place in direct continuity, as when temporarily cutting down the steam supply for stopping the vehicle; also when traveling on level grades at low speed when the demand for steam is practically reduced to a minimum, the throttle and at the same time the main fuel supply to the burner may be progressively closed; and still further, in case of coasting, when the throttle is closed entirely the main supply will be correspondingly closed and the auxiliary supply simultaneously thrown into service, in this way keeping a flame continually burning for maintaining the steam and for restarting the main burner.

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 represent 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, an engine, a throttle controlling the delivery of steam to the engine, a burner in co-operative relation to the generator, main and auxiliary sources of liquid fuel supply, a conduit leading from each source to the burner, and means controlled by the throttle for opening and closing the main and the auxiliary supply conduits to the burner reciprocally.

2. The combination of a steam generator, a throttle controlling the delivery of steam therefrom, a burner for heating the generator, separate fuel supply tanks or reservoirs, and means controlled by the throttle for varying the quantity of fuel supplied from one of the tanks to the burner as the operative position of the throttle varies and for supplying a substantially constant quantity of fuel from the other tank when the throttle is closed.

3. The combination of a steam generator, an engine, a throttle between them, a burner for heating the generator, means for supplying fuel to the burner for supporting a main flame, means for supplying fuel to the burner for supporting a pilot flame, means for opening one supply while closing the other, and a connection between the throttle and the last mentioned means which opens the supply for the main flame and closes the supply for the pilot flame simultaneously with the opening of the throttle.

4. The combination of a generator, an engine, a throttle, a burner, separate means for supplying fuel thereto in different quantities, and a device mechanically connected with and operated by the throttle for simultaneously opening one of said supply means and closing the other as the throttle controls the delivery of steam to the engine.

5. The combination of a generator, an engine, a throttle, a burner, separate sources of fuel supply at different pressures, supply connections between the same and the burner, a valve controlling the relation of the separate sources of fuel to the burner, and means positively connecting said valve with the throttle.

6. In combination, a burner, two tanks, conduits therefrom to supply fuel to the burner at different pressures, and means which positively and simultaneously opens one conduit and closes the other.

7. In combination, a burner, a conduit for supplying fuel to the burner at low pressure, a conduit for supplying fuel to the burner at high pressure, a fuel controller for positively opening one conduit while closing the other, an engine, and a regulator for the engine which is operatively connected to the fuel controller.

8. In combination, a vapor generator, an engine deriving its motive energy therefrom, a throttle for controlling the delivery of motive fluid to the engine, a burner for the generator, a pump tending under all conditions of speed to supply fuel at a definite constant pressure to the burner, and means for interrupting the supply from the pump simultaneously with the closing of the throttle, the said means being adapted to admit fuel to the burner at a different pressure.

9. In combination, a generator, an engine, a throttle for controlling the delivery of motive fluid from the generator to the engine, a burner for the generator, a fuel pump driven by the engine for supplying fuel to the burner at a high constant pressure, said pump comprising means for limiting the pressure, means for supplying fuel at a low pressure to the burner, and devices co-operating with the throttle to interrupt the supply of high pres-

sure fuel to the burner and to admit fuel under low pressure to the burner as the delivery of motive fluid to the engine is interrupted.

10. In combination, a burner, a main fuel supply pipe connected to the burner, an auxiliary supply pipe for supplying fuel to the burner at a definite pressure, means for opening either supply pipe and closing the other, a pump in the main supply pipe for delivering fuel at a relatively higher pressure, and an automatic variable stroke mechanism for the pump.

11. In combination, a burner, a main fuel supply pipe and an auxiliary fuel supply pipe connected to the burner, a pump in the main supply pipe, actuating means for the pump provided with devices for automatically maintaining the main supply of fuel at constant pressure, and means for closing the main fuel supply pipe and simultaneously opening the auxiliary fuel supply pipe or vice versa.

12. In combination, a burner, a main fuel supply tank, an auxiliary fuel supply tank under air pressure, connections between the tanks and burner, a valved connection between the tanks, a pump for supplying fuel to the burner from the main tank, an automatic regulator for the pump which tends to maintain the main fuel supply at constant pressure, and means for simultaneously interrupting the main fuel supply and opening the auxiliary fuel supply to the burner or vice versa.

13. In combination, a steam generator and engine, a throttle for controlling the delivery of steam to the engine, a burner for the generator, means for delivering an auxiliary supply of fuel to the burner, means for delivering a main supply of fuel to the burner, a regulator for the latter means which tends to maintain the main supply at a constant pressure, and means which simultaneously opens the main fuel supply and closes the auxiliary fuel supply when the steam throttle opens or vice versa.

14. In a supply system, the combination of a burner, a main tank at atmospheric pressure, an auxiliary tank under air pressure, separate supply connections between the tanks and burner, and a controlled connection between the auxiliary tank and the main tank.

15. In a fuel supply system, the combination of a burner, a main tank at atmospheric pressure, an auxiliary tank arranged below the level of the main tank and adapted to be placed under air pressure, and a controlled connection between the tanks which permits fuel to flow from the main tank to the auxiliary tank under gravity or to flow from the auxiliary tank to the main tank under air pressure in the former.

16. In a fuel supply system, the combination of a burner, a main tank at atmospheric pressure connected therewith, an auxiliary tank under air pressure also connected with the burner, means for placing the auxiliary tank under pressure, means for relieving the air pressure from the auxiliary tank, and a controlled connection between the tanks which permits fuel to flow from the main to the auxiliary tank when the latter is at atmospheric pressure or to flow from the auxiliary to the main tank when the former is under air pressure.

17. In a fuel supply system, the combination of a main supply tank at substantially atmospheric pressure, an auxiliary tank under a higher pressure, a burner connected with the tanks, a pump between the main supply tank and the burner, and a controlled connection for relieving the pressure on the burner by discharging fuel into the auxiliary tank.

18. In a supply system, the combination of a burner, a main source of liquid fuel at substantially atmospheric pressure, a second source of fuel which is located below the level of the first, means for subjecting the second source to an initial air pressure, a connection between the sources through which fuel feeds by gravity from the first to the second source, a valve normally closing the said connection, means for relieving the pressure on the second source when it is desired to replenish it from the main source, a connection arranged to supply fuel from the main source to the burner, and a fuel pump in said connection.

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

HERMANN LEMP.

Witnesses:

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