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BY A. P. C.

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LOW-PRESSURE STEAM HEATINGS FOR VEHICLES
Filed Jan. 16, 1941

Serial No.
374,611
2 Sheets-Sheet 1

Fig. 1

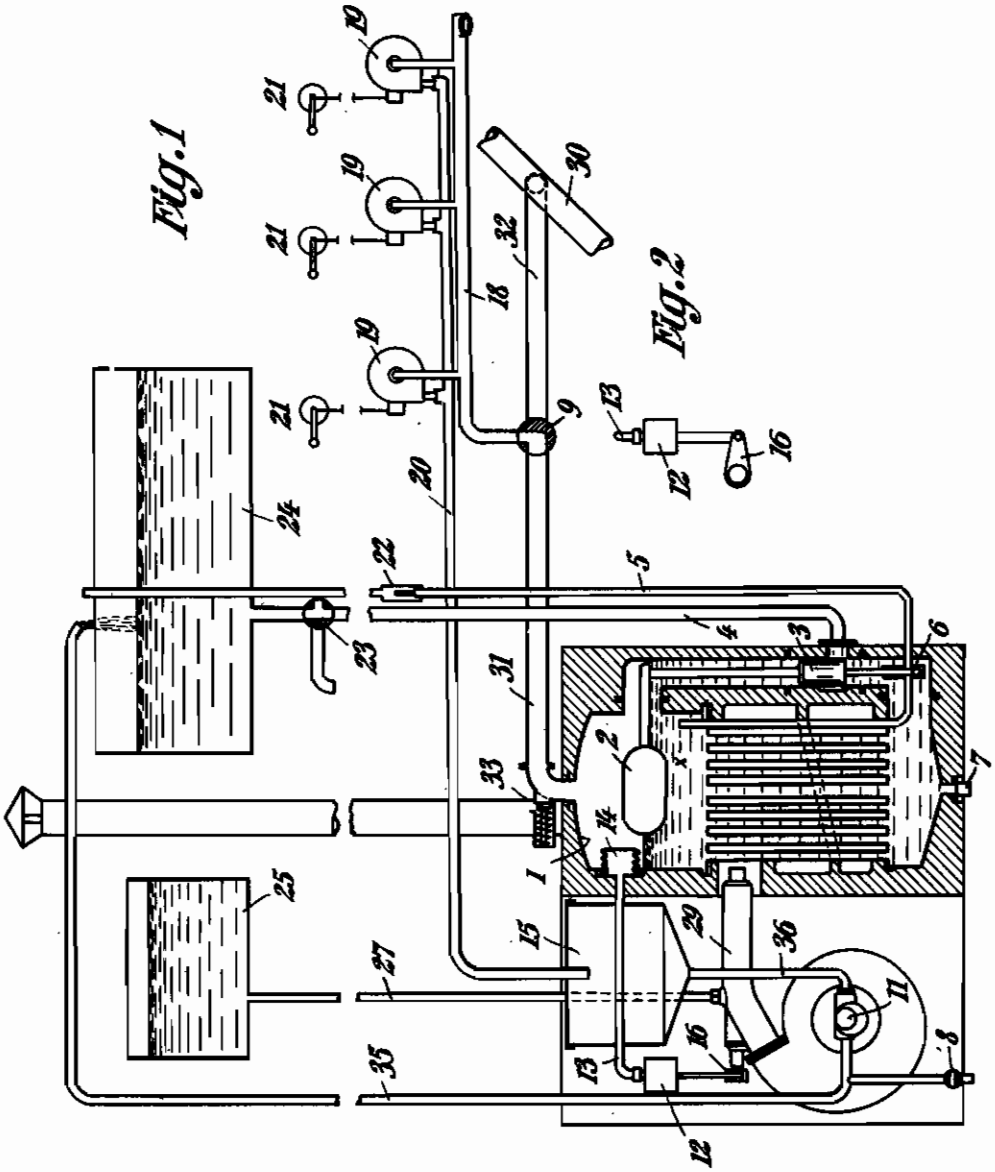

Fig. 2

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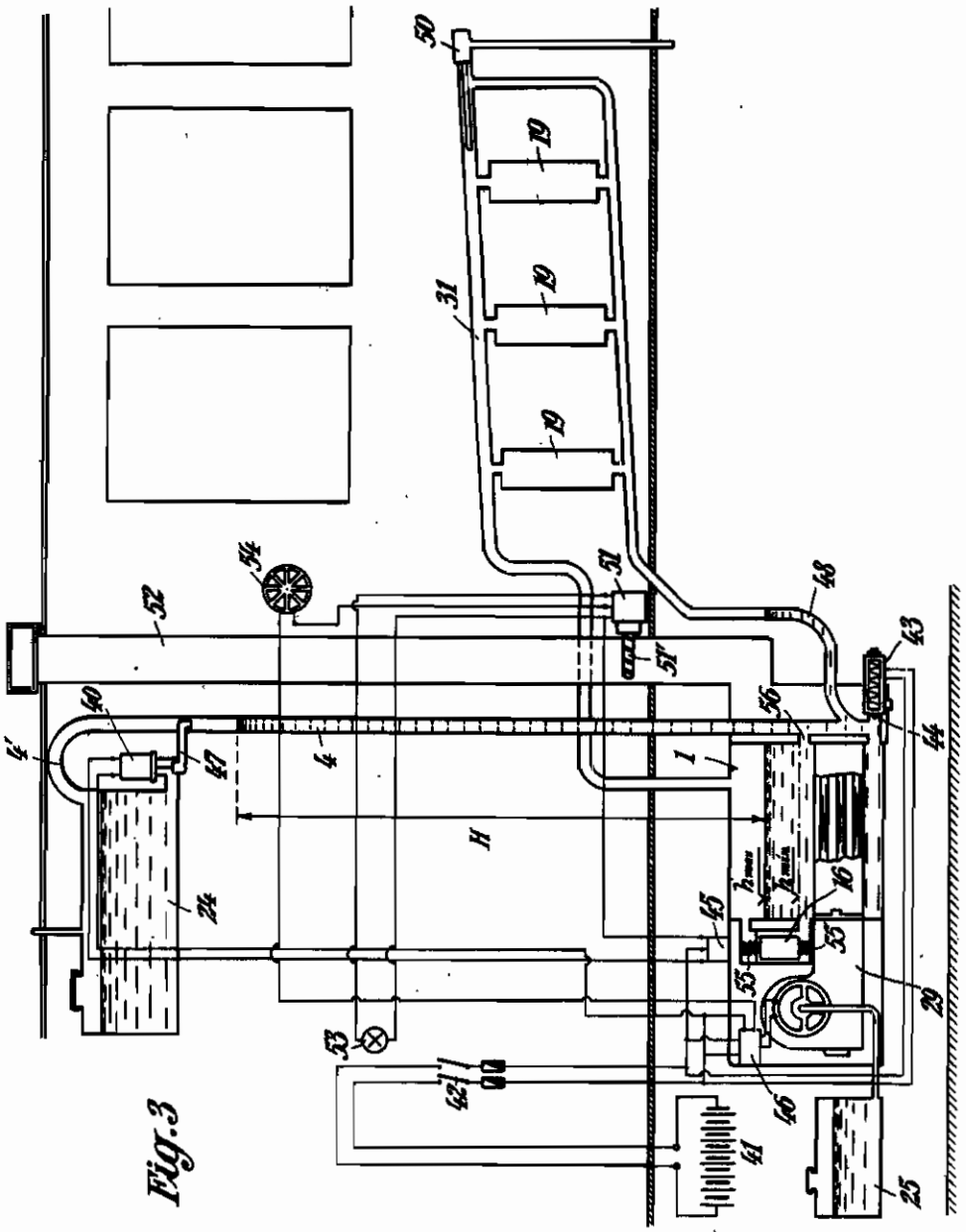

Fig. 3

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ALIEN PROPERTY CUSTODIAN

LOW-PRESSURE STEAM HEATINGS FOR VEHICLES

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The present invention relates to low-pressure steam heatings for vehicles provided with an own steam generator.

To be practically usable and to ensure safety during operation, a low-pressure steam heating for vehicles provided with an own steam generator requires a manufacture thoroughly considering not only the constructional conditions of the vehicle, but also the operative requirements, for instance most simple construction and payment of as least attention as possible.

In hitherto known plants of this kind the steam generator was provided with automatically operating means for the regulation of the steam pressure and the water supply and, moreover, the heating plant connected to the boiler was provided with means for automatically regulating the current of the heating medium passing through and the temperatures of the heating surfaces. In most cases the boiler together with the furnace were mounted in a special compartment or in a space below the vehicle, the attention to be paid to the steam generating plant and its maintenance imposing special responsibility and troubles upon the personnel attending the train. The attention of the heating itself also required a certain carefulness of the personnel attending the train on starting and stopping the heating plant.

Now the object of the invention described below is to provide a low-pressure steam heating for vehicles having an own steam generating plant in which a maximum of simplicity is obtained and in which with regard to attention very slight requirements are imposed upon the personnel attending the train, whereby a high degree of reliability or safety of service is ensured.

To obtain the object aimed at, a steam generating plant, automatically controlled as far as the steam generation and the water supply are concerned, is used not only to provide the radiators with heating steam, but simultaneously also to control the temperature of the heating surfaces of the radiators connected to the steam generating plant. To this end the radiators are so connected to the steam space of the boiler of the steam generating plant that their interior spaces and the steam space of the boiler form a coherent space closed in itself in which the same steam pressure prevails at all places. Moreover, a device is provided at the boiler for automatically controlling this steam pressure and thereby also for automatically controlling the temperature of the heating surfaces of the radiators connected to the boiler. In this manner all special devices for the radiator are rendered superfluous which hitherto were required for controlling the steam supplied to the radiators and maintaining uniform the temperature of the heating surfaces of the radiators. By using suitable additional devices, depending on the temperatures prevailing in the compartments, and acting upon the control devices of the steam generating plant, such a construction of the heating plant allows a central regulation of the temperature of the individual compartments by the regulation of the steam generating plant.

To control the steam pressure in the boiler, an ascending-pipe known per se may be used leading from the water space of the boiler upwardly into the atmosphere and preferably discharging above the water level of a water storage tank. For a limited number of radiators the height of the ascending-pipe adapted to be used in the vehicle is sufficient to maintain any desired pressure in the boiler which is necessary for the supply of all the radiators with steam, so that in all the radiators the same steam pressure prevails as in the boiler and the temperature of the heating surfaces corresponding to this steam pressure is maintained.

As due to want of space in a vehicle, the boiler must be kept small and, therefore, the water storage in the boiler would very soon be spent, the invention provides, besides this steam pressure regulation and for its assistance, an automatic water supply for the boiler which consists of a water filling pipe system leading from the lower portion of the water space of a highly arranged storage tank and discharging into the water space of the boiler which pipe system is automatically closed by a closure member, preferably a float, and mechanical or electromagnetical means influenced by said float as soon as a predetermined height $h_{max.}$ of the water level of the boiler has been reached. This arrangement has the following effects: As soon as the water level of the boiler drops from the height $h_{max.}$ the water filling pipe system is opened by the above mentioned closure member and from the highly arranged tank water flows to the boiler until the predetermined height of the water level $h_{max.}$ is reached again. Hereby the pressure in the boiler never can rise above the height possible in the stand-pipe, because any increase of the steam pressure above this height is prevented by the fact, that by way of the stand-pipe water is pressed back into the highly arranged water tank. As hereby the water level drops and the above mentioned water-

pipe filling system is opened, cold water flows into the boiler after a corresponding slight drop of pressure obtained by discharging of steam, whereby not only the water in the boiler is supplemented, but also the necessary drop of pressure is accelerated. In this manner the same steam pressure is maintained in the boiler and simultaneously also in all the radiators connected to the boiler. Moreover, the temperature of the heating surfaces of the radiators is automatically regulated.

However, if a larger number of radiators is connected to the boiler, as is the case for instance with rail-cars with trailers, the radiators of which also are to be supplied with steam from the steam generating plant arranged upon the motor car, the steam pressure is no longer sufficient which is limited by the height of the column of water in the stand-pipe provided at the vehicle. With this pressure the same steam pressure as that prevailing in the boiler cannot be maintained in all the radiators.

To render the plant fit for use for this case also, a closure member for regulating the temperature of the heating surfaces to a height above the pressure limited by the height of the stand-pipe is provided in the pipe system leading from the boiler by way of the stand-pipe into the atmosphere which closure member is opened by the action of a float, as soon as the permissible minimum water level $h_{min.}$ is reached, but which is maintained closed as long as the water level of the boiler lies above this minimum height. Moreover, a pressure sensible control member is provided in the boiler which influences the boiler furnace in such a manner that the desired higher boiler pressure is maintained. A water filling pipe system leading from the water space of a highly located water storage tank and discharging into the water space of the boiler is provided in which a closure member is arranged which is so influenced by a float that it is opened as soon as the water level of the boiler drops to the predetermined minimum height $h_{min.}$ and which closes as soon as the highest water level $h_{max.}$ is reached. For this purpose for instance the same float may be employed which controls the above mentioned closure member arranged in the stand-pipe.

This arrangement allows the pressure sensible control member influencing the furnace to maintain a regulated steam pressure in the boiler as long as the closure member in the stand-pipe is closed and the water level in the boiler lies between the permissible limits $h_{max.}$ and $h_{min.}$ which steam pressure is higher than the column of water limited by the height of the stand-pipe. This steam pressure now determines the temperature of the heating surfaces of all the radiators connected which temperature is maintained uniform. However, if the water level of the boiler drops to the permissible minimum height $h_{min.}$, then the passage through the stand-pipe into the atmosphere is opened under the influence of the float mentioned above and first of all water is pressed by way of the stand-pipe into the highly located tank and finally steam also is blown into the atmosphere, so that the boiler pressure is lowered so far that by way of the open closure member in the water filling pipe system water may flow from the highly located tank into the boiler until the water level in the boiler has reached again the admissible maximum height $h_{max.}$ Now the pipe system leading by way of the stand-pipe into the atmosphere is closed again and the pressure controlled by the pressure sensible control member is again adjusted in the boiler and in the radiators.

Preferably, the pressure sensible control member is formed from a daphram box which by way of a liquid system and mechanical or electrical transfer members connected to this system more and more throttles the fuel supply to the furnace on increasing boiler pressure and finally closes the fuel supply on reaching the admissible maximum boiler pressure.

To obtain a quick drop of pressure in the boiler as soon as the water level of the boiler is lowered to the admissible minimum height $h_{min.}$, i. e. to obtain by way of the water filling pipe system opened at this time a quick refilling of the boiler up to the maximum water level $h_{max.}$ it is preferable to lead the above mentioned stand-pipe from the water level of the boiler indicating the minimum height of the water. On reaching the minimum water level and after pressing back into the highly located storage tank the water contained in the stand-pipe, boiler steam is discharged into the atmosphere and due to the quick drop of pressure accompanied thereby, the refilling operation may be accelerated. As the above mentioned pressing of water into the highly arranged tank by way of the stand-pipe causes at a corresponding boiler pressure a troublesome noise, it is advantageous to mount in the stand-pipe a throttling member, for instance a narrow, eventually helically wound small tube which offers a larger resistance at the passage of water than to the passage of steam, whereby, after opening of the closure member mounted in the stand-pipe, the noise due to the discharge of water is deadened.

To control the closure member provided in the boiler filling pipe system, a magnetic valve also may be used in accordance with the invention the circuit of which is so controlled by a float that this valve is closed as soon as the water level of the boiler reaches a predetermined maximum height $h_{max.}$ and is opened as soon as the water level of the boiler is dropped to the admissible minimum height $h_{min.}$

The filling operation occurs if the float has opened the boiler filling pipe system after dropping of the water level of the boiler to the height $h_{min.}$, and preferably electrical means may be actuated by the above mentioned float which stop the boiler furnace at this time, so that the steam generation is interrupted during the filling operation for accelerating the latter and for saving the boiler heating surface not in contact with water at this time. The arrangement then is such that the boiler furnace is operated again as soon as the water level of the boiler has reached again the predetermined height $h_{max.}$

In the accompanying drawings two heating arrangements according to the invention are shown by way of example.

In these drawings:

Fig. 1 shows a broken away more or less diagrammatic view of a low-pressure steam heating according to the invention,

Fig. 2 is a side elevation of a detail shown in Fig. 1, and

Fig. 3 shows more or less diagrammatically a modification of a low-pressure steam heating according to the invention.

In the heating plant shown in Fig. 1 a low-pressure steam boiler 1, embedded in refractory bricks, is mounted upon suitable beams of the vehicle, for instance below the floor. In the

height of the selected minimum water level, a U-shaped stand-pipe 5 extends downwardly and then leads from the water space of the boiler 1 upwardly until above the water level of the water tank 24 mounted below the roof of the vehicle. Moreover, from the water space of the boiler a second pipe 4 is led upwardly which discharges into the bottom of the highly arranged storage tank 24 and forms part of a filling pipe system for supplementing the water contents of the boiler. This pipe 4 of the boiler filling pipe system is controlled by a closure member 3, i. e. in the modification shown by a piston actuated by the float 2, in such a manner, that on reaching the maximum water level in the boiler 1 the piston closes the passage through the pipe 4. Therefore, water will flow from the higher located tank 24 by way of the pipe 4 into the boiler, as long as the maximum water level in the boiler 1 is not reached and the pressure prevailing in the boiler allows this. However, if the maximum water level is reached the pipe 4 is closed. Up to this time the difference in height of the water level in the highly located tank 24 with regard to the water level of the boiler determines the pressure in the boiler. If the boiler filling pipe system is closed, the boiler pressure is determined by the column of water in the stand-pipe 5, whereby the closure member, shown in Fig. 1 mounted in the pipe system leading from the boiler by way of the stand-pipe 5 into the atmosphere, i. e. the piston 6, is first of all to be supposed not to be present.

The boiler 1 is heated with heating oil, naphtha or any other suitable fuel. Fuel from the higher located fuel tank 25 is supplied to the burner 29 by way of a pipe 27. The necessary combustion air may eventually be supplied by a blower 10 which for instance may be electrically driven and be connected to the burner 29 by the pipe bend shown.

By way of the pipes 31, 18 the steam space of the boiler 1 is connected to the radiators 19 which, when the inlet valves are opened by the setting levers 21, are all maintained filled with steam of the same pressure as that of the boiler, whereby the temperature of their heating surfaces is maintained equal to the steam pressure controlled by the height of the stand-pipe 5.

During the period of time the heating is in operation, the piston 6, however, closes the passage leading from the boiler by way of the stand-pipe 5 into the atmosphere and a bellows 14, filled for instance with glycerine, is provided to regulate the steam pressure in the boiler 1. On being compressed the bellows 14 feeds glycerine by way of the pipe 13 to a spring loaded piston of the cylinder 12 which is moved thereby and swings the lever 16. In Fig. 2 of the drawings the cylinder 12 and the lever 16 are shown in detail and in side elevation. By this arrangement the burner is so controlled and the firing of the boiler 1 is so influenced that a predetermined pressure of sufficient height is maintained in the boiler which ensures the supply of all the radiators connected to the boiler with steam of the same pressure.

In the stand-pipe 5 a throttling member 22, for instance in the form of a helically wound small tube not shown in the drawings, may be inserted which offers less resistances to the passage of steam than to the passage of water. If the pressure in the boiler rises while the passage into the atmosphere by way of the stand-pipe 5 is open, i. e. of the piston 6 is drawn upwardly, water may be pressed up through the stand-pipe 5 and flow with dampened energy into the tank 24. If the water level in the boiler 1 is dropped to the predetermined minimum height, steam only is discharged by way of the stand-pipe 5 and nearly no resistance is offered by the throttling member 22 to the passage of this steam, so that pressure compensation with the atmosphere is quickly reached, and the re-filling operation with water from the higher located tank into the boiler is initiated as follows:

With a larger number of radiators connected, the maintenance of this state, however, would fail, because for this purpose the pressure limited by the maximum possible height of the stand-pipe would not be sufficient. For this purpose, the closure member 6, i. e. a piston, is arranged in the pipe system leading by way of the stand-pipe 5 from the boiler 1 into the atmosphere which piston in the modification shown is connected to the closure member 3 mounted in the boiler filling pipe system 4, in such a manner that on reaching the predetermined minimum water level in the boiler, the float 2 has drawn upwardly the piston 6 so far as to open the passage through the stand-pipe 5.

The drop of the water level is accompanied by a drop of the float 2 and an opening of the water supply from the tank 24 by way of the pipe 4 into the boiler 1, the slide 3 occupying its raised position. If the water level of the boiler is dropped to the predetermined minimum height $h_{min.}$, the above mentioned pressure compensation with the atmosphere is effected by way of the stand-pipe 5 and cold water begins to flow from the tank 24 to the boiler 1, whereby the development of steam in the boiler is reduced which accelerates the refilling operation.

If the permissible maximum water level is reached, the closure members 3 and 6 closed again and the steam pressure in the boiler is raised. Now, if this pressure has reached a predetermined height, the supply of oil to the burner is interrupted by the pressure control member 14 acting by way of the piston arranged in the cylinder 12 and the lever 16. In this manner the pressure in the boiler 1 and in the radiators 19 connected thereto is regulated by the pressure control member 14 to the predetermined height until the water level in the boiler is dropped again to the minimum height $h_{min.}$, whereupon the refilling operation described above is repeated and simultaneously the pressure in the boiler is reduced.

If due to the small number of radiators 19 connected to the boiler, a closure member 6 is not required in the passage leading from the boiler by way of the stand-pipe 5 into the atmosphere, then for regulating the pressure in the boiler and in the radiators the column of water in the stand-pipe 5 is sufficient, whereby for assisting this pressure regulation a corresponding control device for the firing may be provided in the form of a bellows or diaphragm box 14 which influences the burner 29. The regulating operations are effected as follows:

If the boiler pressure has reached a predetermined height, the supply of oil to the burner is interrupted by the pressure control 14 by way of the piston in the cylinder 12 and the lever 16, the burner, however, continuing to burn for several seconds. In this moment the water pressing upwardly in the stand-pipe 5 overcomes the resistance of the throttling member 22, and water flows into the tank 24. The float 2 drops. There-

by, in the manner already described, water is again discharged from the tank **24** into the boiler, the pressure drops, the lever **16** again effects opening of the fuel supply and the burner **29** is ignited by a pilot flame, whereupon this operation is repeated. If the water level in the boiler **1** drops below the predetermined minimum height, i. e. below the edge *x* of the stand-pipe **5**, then, after pressing of the water out of this tube into the tank **24**, steam flows into the atmosphere above the tank, whereby the pressure in the boiler quickly drops. Moreover, if the overpressure in the boiler should exceed the highest permissible limit, a safety valve **33** is opened which is provided in the steam drawing off pipe **31** of the boiler leading to the radiators **19**.

To increase the reliability of service of the heating plant which also depends on a sufficient quantity of water always being available in the higher located tank **24** for refilling the boiler, it is preferable to collect the condense water of the radiators **19** in a collecting tank **15**, and to provide a return feeding passage for this condense water from this tank to the boiler **1**. As shown in Fig. 1 this return feeding passage leads from a collecting tank **15** over a supply device **11**, driven by the motor driving the blower **10** also, and over the highly arranged water storage tank **24**, and then from the latter over the boiler filling pipe system **4** discharging into the water space of the boiler.

In this steam drawing off pipe **31** a closure member **9** is mounted for centrally closing or disconnecting all the radiators **19**. To obtain for a further safety of the heating plant an automatic discharge of water of the entire heating plant after disconnecting of the latter, the outlet valve **7**, provided at the bottom of the boiler **1**, and the outlet valve **8**, arranged at the lowest point of the water return feeding pipe system **35** may mechanically or electrically be connected to the above mentioned central closure member **9** in such a manner, that after closing the closure member **9** the above mentioned outlet valves **7** and **8** open. Then water flows off into the atmosphere from all parts of the heating plant filled with water, particularly also the water from the tank **24** by way of the boiler filling pipe system **4**, the boiler **1** and the outlet valve **7**, so that any danger of freezing in is automatically prevented. The flowing off of water from the tank **24** may be avoided by closing the valve **23** provided in the boiler filling pipe system **4**, if it is intended to have this water available as useful water for other purposes.

As it sometimes happens that the vehicle provided with this heating plant is to be arranged in a train which is drawn by a steam locomotive supplying the heating devices of all cars with steam, the closure member **9**, mounted in the steam draw off pipe of the heating plant, is, according to Fig. 1, formed as a two-way valve in such a manner, that this valve **9** in its position, closing the steam draw off pipe **31** towards the boiler **1**, connects the radiators **19** by way of the branch pipe **32** to the pipe **30** located below the vehicle and to the main steam pipe of the train by means of couplings.

The modification illustrated in Fig. 3 shows a low pressure steam heating of the same kind in which the upper end of the boiler filling pipe system leading from the highly located tank downwardly into the boiler **1**, is controlled at the tank **24** by a magnetically operated valve **40** the control circuit of which is subjected to the action of a float **16** in the boiler in such a manner, that, when the predetermined maximum water level is reached in the boiler, the control circuit is opened and the valve **40** is closed. As long as the control current flows the magnetically operated valve **40** is maintained open, and, if the boiler pressure allows, water may flow from the tank **24** into the boiler **1** by way of the boiler filling pipe system.

This filling pipe system leads from the tank **24** by way of the magnetic valve **40** and the short pipe **47** into the vertical pipe **4** the lower end of which discharges into the water space of the boiler near the bottom of the latter. The pipe **4** of this boiler filling pipe system, however, simultaneously forms a portion of the stand-pipe, designated **5** in Fig. 1, as about in the height of the predetermined minimum water level $h_{min.}$ the pipe socket **56** connected to the water space of the boiler leads to this pipe **4** the upper end of which is connected by a bend or elbow **4'** to the interior space of the tank **24** above its highest water level. This arrangement acts in exactly the same manner as the system of pipes **4** and **5** described in connection with the construction shown in Fig. 1.

The control current of the magnetically operated valve **40** is supplied from a battery **41** by way of a main switch **42**, an automatically acting auxiliary switch **46** and a bridge contact switch **45** which is so actuated by the float **16**, that on reaching the highest predetermined water level of the boiler the magnetic valve **40** is rendered currentless and closes the boiler filling pipe system **47**, **4**.

In dependence of the water level of the boiler, moreover the boiler furnace, i. e. the fuel supply to the burner **28**, also is controlled by the float **16**. The fuel supply from the tank **25** is effected by means of an electrically driven pump and the blower **10** which preferably is driven by the same motor as the pump. This control also is effected by means of a circuit supplied with current from the battery **41** over the main switch **42** and the auxiliary switch **46**, which circuit is opened by the float **16** if the maximum limit of the water level of the boiler $h_{max.}$ is reached, whereby the boiler firing is rendered operative.

The top and the bottom of the float **16** preferably are resiliently mounted by means of a spring member **55**, and during dropping of the water level of the boiler from $h_{max.}$ to $h_{min.}$ the member **55** performs a relatively small way of about 10 mm for instance only. The float **16**, in a manner known per se, acts, by means of a small piston, upon the contact bridge of the switch **45**.

By way of the auxiliary switch **46**, a time- and protection-switch **51** also is connected into the control circuit of the motor for the fuel supply pipe and the blower **10**. If the heating plant is set in operation, the time switch at first is closed. After a short period of time, i. e. after about a minute, however, the switch is opened and closes the circuit of the control current as soon as a temperature feeler **51'**, preferably an expansion- or bimetal-body, arranged in the chimney **52** of the firing, is heated. If the burner **25** is not ignited, the circuit of the motor for the firing is opened, so that the firing is rendered inoperative. Simultaneously a control lamp **53** is lighted which indicates this faulty or incorrect state. This may mean that either no fuel is present in the tank **25** or the nozzles of the burner **29** are contaminated or clogged.

To control the firing in dependence of the

height of the temperature of the heated space, a space temperature feeler **54** is arranged at a corresponding place in the space of the car which feeler also acts upon the circuit driving the motor for the burner **29** and the blower **10** in such a manner, that, on reaching a predetermined space temperature of about 20° C., the firing is rendered inoperative. If the temperature in the heated space drops again, for instance to 19° C., the circuit is closed again by means of the temperature feeler **54** and the burner is operated again. Hereby preferably an electric high voltage ignition is used having two electrodes located above the burner nozzle.

The automatic return of the water into the boiler **1** in the heating plant according to Fig. 3 is effected by leading the steam draw off pipe **31**, supplying the radiators **19** with steam, to a highest point at which a thermostatically controlled valve **50** is arranged which is closed on steam passing through it. When the plant is set in operation, first air is discharged through this valve **50** until steam begin to flow into the atmosphere and starts to heat the thermostat of the valve. After closing of the valve **50**, the boiler **1**, the steam draw off pipe **31** and the radiators **19** connected to the boiler as well as the condense water pipe **49** in which collects the water from the radiators form a coherent space closed in itself in which at all points the same pressure prevails. As the collecting pipe **49** discharges near the bottom of the boiler into the water space of the latter, the condense water formed in the radiators **19** always automatically returns into the water space of the boiler.

To obtain an automatic discharge or emptying of the part-s of the heating plant filled with water after the plant has been rendered inoperative, an electrically controlled valve **44**, for instance a thermostatically controlled valve, is arranged at the bottom of the boiler **1** the thermostat of which is heated by a heating coil which, by way of the main switch **42**, is supplied with current from the battery **41**. Therefore, as soon as the main switch **42** is closed, the heating coil is heated and the thermostat **43** closed the valve **44**. If by opening of the main switch **42** the heating plant is rendered inoperative, the thermostat **43** is cooled due to want of heating current, the valve **44** is opened and the water from the heating plant flows into the atmosphere. Hereby, however, the valve **40** closes due to want of its control current, and the water in the water tank **24** is retained for other purposes of use. If danger of freezing exists, a special emptying valve for the tank **24**, operated by the man attending the car is to be opened in this case which operation is known to him from the usual lavatories in railway cars.

In a very simple manner the heating plant may be set in operation. The tank **24** is filled with water and the switch **42** is closed. Of course, care is to be taken also that the tank **25** is filled with fuel. As soon as the main switch **42** is closed, the valve **40** is opened and water flows into the boiler **1** over the boiler filling pipe system **47, 4**. Of course, in the meantime some water also flows off by way of the still open discharge valve **44** into the atmosphere. However, this flow of water is stopped already after a short period of time as soon as the heating coil heats the thermostat **43** and the valve **44** is closed.

If now the boiler is filled with water to the height $h_{max.}$ the float **16** actuates the bridge contact switch **45** and opens the control circuit of the valve **40** so that the latter closes. Simultaneously by way of the auxiliary switch **46** the bridge contact switch **45** cuts in the control circuit of the burner motor. As soon as a sufficiently high steam pressure is present in the boiler **1**, steam is supplied to the radiators **19** by way of the pipe **31**. This steam by way of the valve **50** presses the air out of the heating system and finally closes the valve **50** by heating the appertaining thermostat. Now, the same pressure as in the boiler **1** is adjusted in the radiators **19** and in the condense water pipe **49**. With increasing pressure the column of water in the stand-pipe **4, 4** rises. By way of the pipe **49** the condense water which is formed in the radiators flows back to the water space of the boiler, whereby the water level in the pipe **49** adjusts itself to that of the boiler **1**.

If now the pressure in the boiler **1** is raised so high that water from the water space of the boiler is pressed upwardly by way of the stand-pipe **4, 4'** into the tank **24**, the water level in the boiler drops, the float drops and cuts out the control circuit of the burner motor and cuts in the circuit of the valve **40**, the burner is extinguished, the valve **40** is opened and cold water flows to the water space of the boiler and prevents further rise of the boiler pressure. If nevertheless the boiler pressure further rises, then on reaching a level below a predetermined minimum water level of the boiler $h_{min.}$, the steam is blown off by way of the connecting pipe **56** towards the water flowing off from the valve **40** by way of the pipe **4, 4'** until the proper boiler pressure and the corresponding water level are reached, whereupon the operation described is repeated.

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