Sept. 27, 1938. R. F. MULLEN 2,131,635

STEAM HEATER FOR AUTOMOBILES

Filed March 7, 1934 2 Sheets-Sheet 1

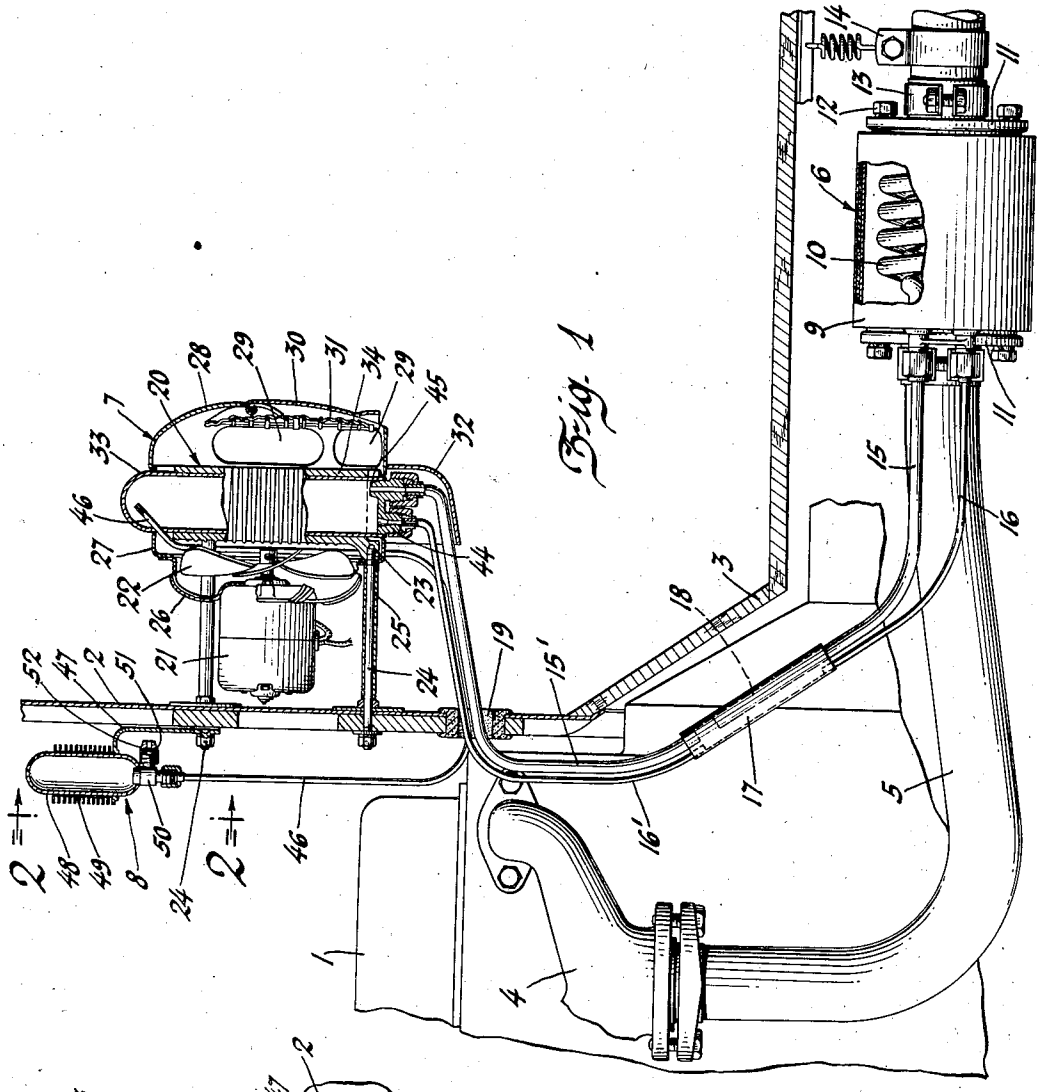


Fig. 1

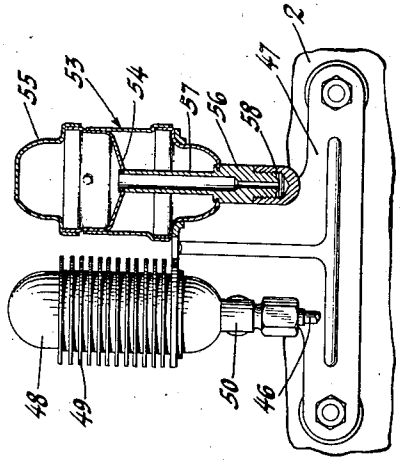


Fig. 2

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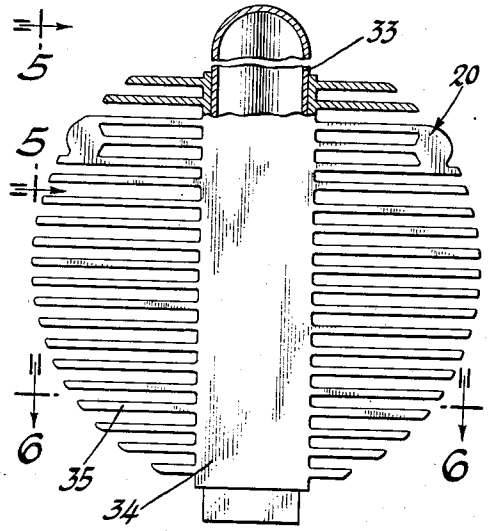


Fig. 3

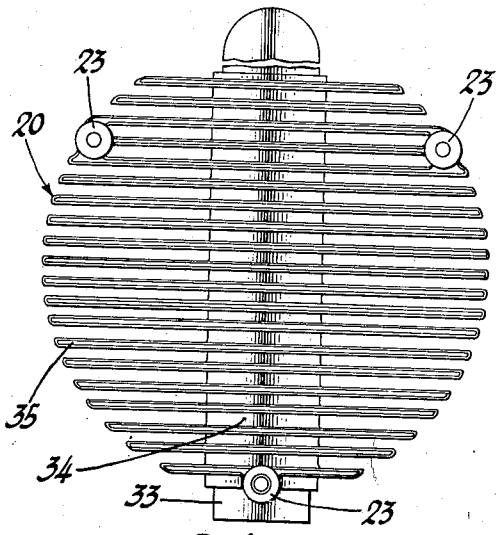


Fig. 4

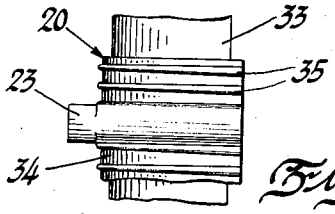


Fig. 5

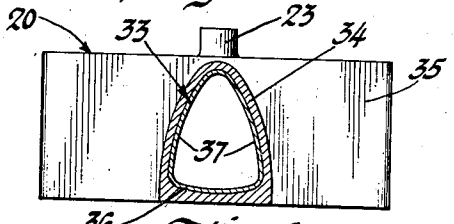


Fig. 6.

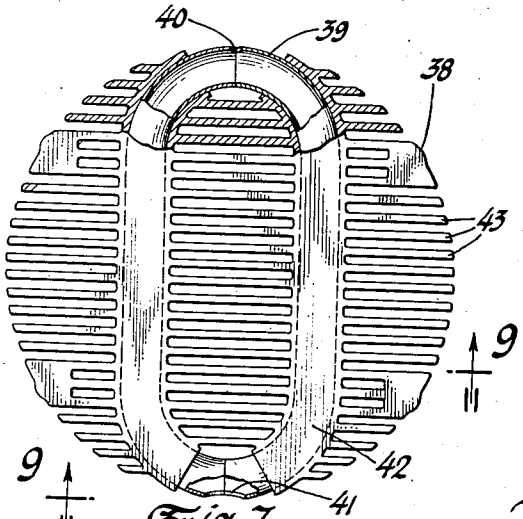


Fig. 7

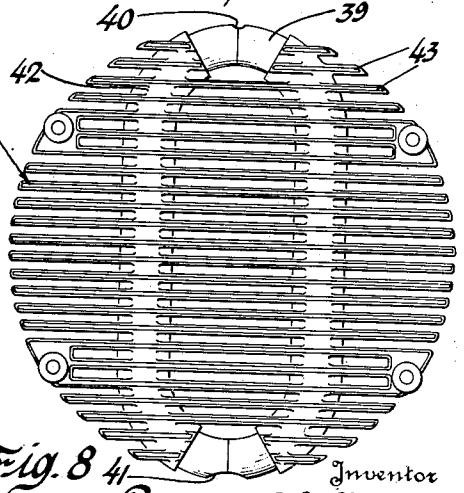


Fig. 8

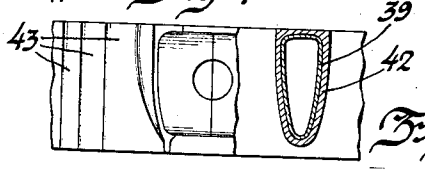


Fig. 9

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UNITED STATES PATENT OFFICE

2,131,635

STEAM HEATER FOR AUTOMOBILES

Raymond F. Mullen, Rochester, N. Y., assignor to General Motors Corporation, Rochester, N. Y., a corporation of Delaware

Application March 7, 1934, Serial No. 714,365

3 Claims. (Cl. 237—12.3)

This invention relates generally to an improved heating system for motor vehicles in which the waste heat from the exhaust gases of the internal combustion engine is utilized to generate steam which is supplied to one or more radiators in the vehicle from which heat is dissipated and the steam condensed by heat radiation and the condensate returned to the steam generator.

One object of this invention is to provide a simple control which will automatically regulate the quantity of steam generated by automatically varying the amount of liquid available at the steam generator so as to maintain a fairly constant pressure irrespective of changes in exhaust gas temperature which may vary from 350° F. at low car speeds to 1400° at higher car speeds.

A further object is to provide this pressure control in a system which is always completely closed so that there can be no loss of vapor or liquid from the system except for leaks which may develop by reason of loose or faulty connections, and a convenient means is provided to supply only the exact amount of liquid required for proper operation at the time of installation or to refill the system whenever required by reason of leakage.

A still further object is to so design the system as to provide for the return of substantially all liquid to the steam generator when the heating system is not in use where this liquid may freeze without injury to the system with the connecting lines between this steam generator and radiator so constructed and arranged as to facilitate and cause the proper circulation whenever the system may be again operated, or in other words, immediately upon starting the engine which furnishes its exhaust heat to the steam generator.

Many novel features of this invention, such as, for instance, the radiator construction and the other details of the various parts which have been found to be of particular advantage in the system will appear from the following detailed description of the structure and operation of the system which is illustrated by way of example in the accompanying drawings, in which:

Fig. 1 is a side elevation with parts in section of the entire system as applied to an automotive vehicle.

Fig. 2 is an enlarged fragmentary front view with parts in section viewed in the direction of the line 2—2 of Fig. 1.

Fig. 3 is an enlarged front elevation, partly in section, of the radiator appearing in Fig. 1.

Fig. 4 is a rear elevation of the radiator shown in Fig. 3.

Figs. 5 and 6 are detailed views taken respectively, on line 5—5 and line 6—6 of Fig. 3.

Fig. 7 is a front elevation, partly in section, of a modified form of radiator.

Fig. 8 is a rear elevation of the radiator shown in Fig. 7.

Fig. 9 is a bottom view, partly in section, taken on line 9—9 of Fig. 7.

Referring first to Fig. 1, there has been shown diagrammatically only those parts of the usual automotive vehicle which are essential for an understanding of the application of the present heating system. The internal combustion engine is indicated generally at 1 in the engine compartment which is separated from the body compartment in the usual manner by the dash 2 and floor boards 3. This engine includes the usual exhaust manifold 4 and exhaust pipe 5 and is preferably provided with the usual cooling radiator and fan (not shown) and in this and other respects may be generally similar to standard practice.

The principal parts of the heating system shown in Fig. 1 consist of a steam generator or boiler unit indicated generally at 6, a heater unit indicated generally at 7, and a pressure control unit indicated generally at 8. The details of these parts and the connections therebetween will next be described and followed by a description of the various functions of these parts and the operation of the entire system.

The boiler unit 6 which is more fully described and claimed in a copending application, S. N. 714,366, filed March 7, 1934, now Patent No. 2,048,882, granted July 28, 1936, consists primarily of a casing 9 which is preferably interposed in a horizontal portion of the exhaust pipe 5, and a coiled tube 10 within the casing 9 in the path of the exhaust gases. The casing 9 may be readily installed in the usual exhaust pipe by cutting and removing a portion thereof of slightly greater length than the casing, sliding the clamping collars 11 over the ends of the adjacent exhaust pipe sections, then placing the casing between these sections and securing the collars to the end walls of the casing (which have central openings for passage of exhaust gases from one exhaust pipe section to the other) by means such as bolts 12, and finally tightening the split sleeve portions of the collars around the exhaust pipe sections by the contractible bands 13 fitted on these split sleeve portions. A support 14 for the exhaust pipe is preferably located at a point near the boiler.

It should be noted that the diameter of the boiler casing 9 is somewhat greater than that

of the exhaust pipe so that the boiler tube 10 does not cause excessive back pressure in the exhaust line, and that the tube 10 is preferably formed into a double coil to provide a large surface contact with the exhaust gases. The ends of the tube 10 are extended through one end wall of the casing 9 to provide terminals for the connection of the steam supply conduit section 15 and condensate return conduit section 16 which extend to the radiator of the heater unit 7.

As will be apparent from Fig. 1, the steam supply conduit is of greater diameter than the condensate return conduit and these conduits extend upwardly and are jointed together between the boiler and radiator terminals by a tube 17 in communication with both conduits. The conduit section 15 extends almost to the upper end of this tube as indicated by dotted lines at 18, whereas the conduit section 16 opens into this tube at its extreme lower end for a purpose which will be set forth hereinafter. From the upper end of the connecting tube 17, the steam supply conduit section 15' and the condensate return conduit section 16' extend upwardly and through a single opening 19 in the dash 2 for connection to the radiator terminals.

The heater unit 7 is shown as mounted on the dash 2 within the body compartment and consists generally of a finned radiator 20 for the heating medium with an electric motor 21 driving fan 22 for creating a forced circulation of air through the finned radiator. The radiator 20 is provided with threaded bosses 23 on its rear side towards the fan to receive mounting bolts 24 with spacing sleeves 25, and the motor and fan may be secured to the radiator as a unit by the grille 26.

The radiator 20 is further provided with a casing 27 on which is secured a deflector assembly at the front of the radiator which includes an upper shroud portion 28, peripheral outlets such as 29, and an adjustable deflector portion 30 pivoted horizontally to the lower edge of the shroud portion. The connection of the deflector assembly to the radiator casing is preferably such as to permit an initial mounting at different circumferential positions so that more heated air may be directed diagonally to one side than the other if desired by reason of locating the heater unit to either side of the center of the dash. A wire mesh guard 31 may be placed directly behind the adjustable deflector portion 30, and a sheet metal guard 32 provided to shield the connections of the conduits 15' and 16' to the radiator 20.

The radiator 20 has been specifically designed to safely withstand the maximum steam pressures developed in the heating system and provide a large radiating surface and air passages to insure an efficient heat transfer with forced air circulation. Referring more particularly to Figs. 3 to 6, inclusive, the radiator 20 comprises a single, substantially triangular, vertical duct or liner 33 which is surrounded for the greater portion of its length by a cast body 34 formed with parallel radiating fins 35 extending horizontally from opposite sides and of varying length to outline the circular periphery of the radiator. The cast body 34 is preferably an aluminum silicon alloy which has high heat absorbing and conducting properties but a fairly low dissipation when not in a forced draft. Such an alloy is, however, slightly porous at the temperatures and pressures developed in the system so that it is not suitable as a duct for the heating medium which is constituted by the liner 33 preferably of copper which offers slight resistance to heat passage if in close contact with the heat radiating body 34.

Although the aluminum body and fins might be die cast and the copper duct or liner press fitted therein, it has been found that a more intimate contact is obtained by casting the body directly on the liner, and the particular cross section of the liner shown in the drawings has been designed to facilitate the casting operation and insure a perfect bond of the two metals so that heat is readily conducted through to the radiating fins. As mentioned hereabove, the duct or liner 33 is substantially triangular in cross section and on reference to Fig. 6, it will be seen that it is constituted by a front wall 36 at the front of the radiator with side walls 37 converging to the rounded apex at the rear side of the radiator. By reason of this decrease in cross section from one side of the radiator to the other, it is possible to cast the body and fins about the duct or liner with a single mold which may be withdrawn in one direction from the rear of the radiator, and to further facilitate the withdrawal of the mold it will be noted from Fig. 5 that each of the radiating fins 35 decreases in thickness towards the rear of the radiator.

By virtue of the substantially triangular duct or liner 33 and the varying cross section of the radiating fins which might be said to taper rearwardly or towards the fan 22, the air passages around the body 34 and between the radiating fins 35 decrease in size towards the front or outlet side of the radiator so as to set up a resistance to the free passage of air and increase the heat transfer by insuring good contact with the radiating surfaces. The walls 36 and 37 of the duct or liner 33 are slightly bulged outwardly and all corners rounded to insure a perfect bond with the cast body since it was found that if these walls were straight and the corners too abrupt there would be a tendency for the walls of the liner to collapse to some extent and draw away from the body during the casting operation.

The modified form of radiator 38 shown in Figs. 7 to 9, inclusive, differs principally from that above described in the provision of a copper duct or liner 39 which is substantially oval, and may be conveniently formed by half sections with the curved abutting ends at the top and bottom united by silver soldering. Except for portions of this duct or liner which are exposed at the top and bottom with openings 40 and 41 for conduit connections, the same is enclosed by the aluminum body 42 provided with radiating fins 43 which may be cast directly on the duct or liner. It will be noted that this duct or liner 39 is substantially triangular in cross section and the radiating fins 43 also decrease in cross section towards the rear side of the radiator 38 to facilitate the casting operation and obtain an efficient heat transfer as has been heretofore described with reference to the radiator 20 to Figs. 3 to 6, inclusive.

Referring again to the showing in Fig. 1, the lower end of the radiator duct or liner 33 receives the cap or cover 44 which is preferably secured thereto by silver solder. This cap 44 is provided with screw threaded terminals for the connection of the conduit sections 15' and 16' with passages which place these conduits in communication with the interior of the radiator. For a purpose which will be noted hereinafter, the cap 44 has an upward extension 45 within the radi-

ator about the passage which communicates with the steam supply conduit section 15'.

The upper end of the radiator duct or liner 33 is closed except for a small opening above the cast body 34 and the relatively small conduit 46 extends through this opening and is secured therein by means such as silver solder. This conduit 46 is extended into the radiator so as to communicate therewith adjacent the extreme upper end of the radiator, and extends downwardly within the radiator casing, then rearwardly through the opening 19 in the dash and upwardly within the engine compartment to a terminal connection with the control unit 8.

The control unit 8 is supported on the dash within the engine compartment above the horizontal plane of the radiator 20 by means such as the bracket 47 carried by the heater mounting bolts 24, and includes a closed control chamber 48 with radiating fins 49. The chamber 48 is provided at its bottom with a fitting 50 having a screw threaded lower end for the terminal connection to the conduit 46 with a vertical passage to place this conduit in communication with the interior of the chamber. The fitting 50 is also formed with a lateral passage which leads from the vertical passage to an outlet which is normally closed by the fuse plug 51 secured over this outlet by the threaded sleeve or hollow nut 52.

Referring to Fig. 2, the bracket 47 also serves as a support for a filler assembly 53 which includes a casing with a separate chamber 54 of predetermined volume with a removable cover 55. A fitting 56 at the bottom of the casing is provided with a hollow upward extension 57 secured to the bottom of the chamber 54 and with a screw threaded terminal which is adapted to receive either the plug nut 58 or have the conduit 46 secured thereto after removing this plug nut to place the chamber 54 and the passage through the fitting 56 in communication with the heating system.

With reference to the operation of the heating system above described, it is desired to first note that distilled water has been found to be the most satisfactory heating medium in a system which is entirely closed to the atmosphere since apparently the standard anti-freeze solutions are subject to decomposition at high temperatures, and in some instances, generate a fixed gas which is not completely absorbed and produces a cumulative rise in pressure which cannot be readily controlled. Since water is subject to freezing the system has been so designed as to operate with only a small amount of this heating medium and the installation of the system is such that this water will drain back to the boiler when the engine is not in operation where it may freeze and expand without injury to the system and be available to be immediately thawed out and generate steam whenever the engine is started.

In a completely closed system such as disclosed herein it will be apparent that the operation as well as the pressure control of the system depends upon the relative volumes of the various parts and the amount of heating medium in the system so that sufficient liquid is available to obtain satisfactory pressure and heat transfer at low engine speeds and exhaust temperatures, and the proper amount of this liquid withdrawn from circulation or prevented from returning to the boiler at high engine speeds and exhaust temperatures to regulate the amount of liquid available for steam generation and prevent the generation of excessive pressures in the system.

The present system has been so proportioned as to use only about ¾ ounce of water and the automatic control functions to regulate the amount of liquid in effective circulation dependent upon the heat radiation from the radiator and the exhaust gas temperature at the boiler so as to normally maintain a predetermined pressure of approximately 150 lbs., which may be defined as the pressure control point of the system. At relatively low car speeds such a pressure is not immediately obtained and with sudden increases in car speed the pressure may exceed this momentarily, but with steady driving at any speeds above 25 or 30 miles an hour, the pressure is uniformly maintained at this control point.

In normal operation, referring to Fig. 1, when the engine is started, the exhaust gases coming in contact with the boiler tube 10 quickly heat the small amount of water therein (first thawing this water if frozen) and generate steam which passes through the steam supply conduit sections 15 and 15' to the radiator 20 where it is condensed by heat radiation and the condensate returns to the boiler through the conduit sections 16' and 16 which are of smaller cross section than the steam supply conduit sections to set up a resistance so as to maintain proper circulation at all times. If outside air temperatures are very low, there is a possibility that a small amount of liquid might be frozen in the small return conduit, and with extremely low temperatures the steam may be of sufficiently low temperature when it reaches the radiator that the condensate may actually freeze in the small return conduit or in the bottom of the radiator and prevent any return of condensate to the boiler and the system would become inoperative. To obviate this possibility, the conduits are connected together by the tube 17 between the boiler and radiator so that an initial circulation may be set up between this tube and the boiler and the positive circulation of steam and condensate in the conduits established by the extension 18 of the conduit section 15 within the tube 17 so that any condensate therein will return to the boiler through the conduit section 16. Then, as the steam temperature and pressure and amount of steam being generated increase sufficiently to overcome the cooling action of the conduit sections 15' and 16' and radiator 20, a circulation will be set up through these conduits and the radiator, and the upward extension 45 within the radiator will serve to admit steam to the radiator above the bottom of the radiator and cause the condensate to return through the conduit section 16' to the tube 17 from which it is returned to the boiler through the conduit section 16. It should be noted that the extension 45 also functions as an overflow in the bottom of the radiator to prevent a sudden surge of condensate down the steam supply conduit section 15' during sudden or momentary appreciable decrease in speed, and the tube 17 functions at all times to separate the steam and condensate to insure positive circulation.

It will be obvious that with the exhaust temperatures which are available for steam generation, more steam will be generated on continued operation at normal speeds or at relatively high speeds than can be condensed in the radiator 20 and to prevent excessive pressures being generated under such conditions, the automatic con-

trol has been provided to regulate the amount of liquid available for steam generation as has been mentioned hereabove, and which functions as follows:

As the steam generated in the boiler passes through the steam supply conduit and fills the radiator **20**, the air in these portions of the system is forced into the conduit **46** and into the control chamber **48**. As the generation of steam continues, this air is compressed in the control chamber in advance of the steam which when it enters the control chamber is condensed by reason of the radiating fins **49** and the location of this chamber in the engine compartment where it is cooled by air from the engine cooling fan. The exact amount of steam which may enter and be condensed and retained within the control chamber will, of course, vary in accordance with the changes in amount of condensation in the radiator **20** and exhaust gas temperatures, but the pressure in the system will never greatly exceed that for which it is designed, as has been heretofore noted, when the pressure of both the compressed air and liquid in the control chamber and the steam in the radiator will be at the so-called pressure control point, and the amount of liquid actually in circulation between the boiler and radiator will be only sufficient to maintain this predetermined pressure in the entire system. Then it will be apparent that whenever the pressure in the radiator falls below this predetermined pressure by reason of an increase in the amount of condensation in the radiator or a decrease in exhaust gas temperature, the higher air pressure above the liquid in the control chamber will force some of this liquid back to the radiator and increase the amount of liquid available for steam generation at the boiler.

With reference to the above description of the operation of the control chamber, it should be noted that the conduit **46** connecting this chamber with the upper end of the radiator is of relatively small cross section so as to keep the air always in advance of all vapor or condensate so that this air will be compressed to the proper extent and will function to return liquid to circulation in the manner set forth. The cross section of the conduit **46** is also of such size as to prevent any appreciable wall flow and therefore offer sufficient resistance to the passage of liquid to prevent the sudden return of all liquid in the control chamber to the radiator on merely a momentary drop in pressure in the radiator.

As a safety feature, the fusible plug **51** is provided and is of such material as will melt at a temperature of about 400° F. and place the system in communication with the atmosphere if this temperature is ever attained and thereby relieve the excessive pressure by exhausting the heating medium in which event the fusible plug would naturally have to be replaced before adding heating medium to the system as will be presently described. It should be noted that the use of a pressure responsive safety plug is impractical in view of the small area of the plug which would be in communication with the system and on which even considerable changes of pressure would have substantially no effect.

It will be noted that no means has been provided to shut off the operation of the heating system but such a means is not essential since very little heat is radiated unless the heater fan is in operation, and when it is desired to discontinue operation of the heating system, such as for summer driving, it is only necessary to disconnect the conduit **46** from the control chamber fitting **50** and run the engine for a few minutes to expel or boil all water from the system after which the conduit may be replaced on the fitting.

It has been heretofore pointed out that a predetermined amount of water is a requisite to proper operation of the present heating system, and the filler chamber **54** with the passage in fitting **56** is of such size as to hold only this amount of water. Before adding water to the system at the time of installation or after repairing leaky connections or replacing the fuse plug, the conduit **46** should be disconnected from the control chamber fitting **50** and the engine run for several minutes to boil off any water in the system. After shutting off the engine and permitting the system to cool for about ten minutes, the plug nut **58** is removed and the conduit **46** connected to the terminal on the fitting **56**. The cover **55** which prevents the accumulation of any dust or foreign matter in the filler chamber **54** may then be removed and the chamber filled with distilled water which will gradually run into the system through the restricted conduit **46**. If the system is entirely cool, this should take from three to five minutes, and if not cool, drainage will occur more readily if the connection of the steam supply conduit section **15'** to the radiator bottom cap **44** is loosened to relieve air pressure in the system. After filling, it is apparent that the conduit **46** should be transferred back to the control chamber fitting **50**, and the cover **55** and plug nut **58** replaced on the filler assembly.

It will be noted from Fig. 1 that the filler chamber is located at a higher elevation than the radiator so that practically all of the liquid will run into the radiator and then through the conduits to the boiler during the filling operation, and the very small amount of liquid which may be trapped in the conduit **46** during filling is forced into the system and displaced by air after the first cycle of operation of the heating system.

Instead of extending the conduit **46** downwardly within the radiator casing and through the opening **19** in the dash, it will be obvious that a further opening may be provided in the dash just below the control unit **8** for the conduit **46** which could then be connected to the upper end of the radiator and extend through this further opening for connection to the control chamber **48** or filler chamber **54** without extending below the connection to the radiator, thereby eliminating the liquid trap mentioned hereabove.

If desired, the system may be operated at pressures below those obtained by the relative volumes of the various parts and the predetermined amount of liquid for which the system may be designed as has been described hereabove, by removing a portion of the air from the system. This would be accomplished, after adding the proper amount of water to the system, by running the engine with the control conduit **46** disconnected from the control chamber **48** until the desired amount of air has been expelled and then connecting this conduit to the control chamber and thereby closing the system to the atmosphere before any steam escapes from the system.

Although the foregoing detailed description has related specifically to the construction and operation of the heating system shown in the drawings, it will be understood that the invention is not limited to this specific form but is susceptible of various modifications and alternative constructions which may fall within the spirit and

scope of the invention as expressed in the appended claims.

I claim:

1. In a steam heating system for motor vehicles, a pressure control and safety valve assembly mounted in the engine compartment and comprising a pressure control chamber adapted to normally prevent the generation of excessive pressure in said system, a fitting on said chamber with a terminal to provide for a detachable connection to the heating system to place the chamber in communication therewith, and an outlet in said fitting which is normally closed by a fusible plug.

2. In a steam heating system for motor vehicles, a pressure control and filler assembly including a supporting bracket adapted to be mounted in the engine compartment and comprising a pressure control chamber adapted to automatically regulate the pressure in said system and an adjacent filling chamber mounted on said supporting bracket and provided with terminals for the detachable connection of a conduit to place either of these chambers in communication with the system at will.

3. A steam heating system for motor vehicles comprising in combination with the vehicle engine and its exhaust pipe, a heating radiator in the body compartment of the vehicle mounted on the dash of the vehicle, a steam generator adapted to contain a vaporizable liquid and associated with said exhaust pipe so as to be heated by the exhaust gases passing therethrough, means connecting said generator to said radiator, and a pressure control chamber connected to said radiator and mounted on the dash of the vehicle in the engine compartment, and a single means to secure both said radiator and said control chamber to said vehicle dash on the opposite sides thereof.

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