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AIR-CONDITIONING SYSTEM

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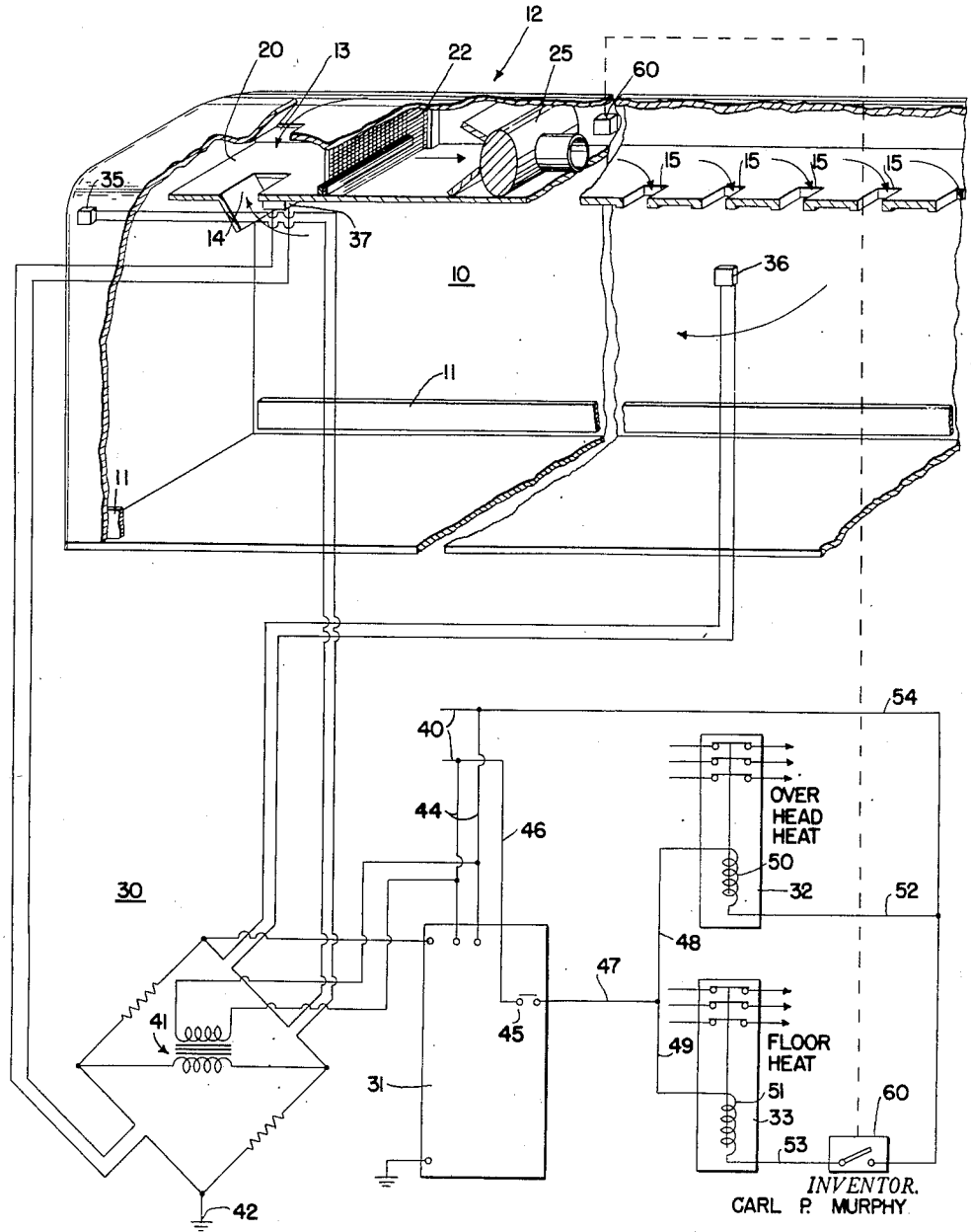

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AIR-CONDITIONING SYSTEM

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My invention relates to air-conditioning systems and more particularly to improved heating or air-conditioning systems of the type found in buses and railway cars wherein the supply of energy for the changing of the temperature of the air-conditioning medium is electrical.

In these air-conditioning systems of this type, the electric heaters are located inside the occupied space usually at the floor beneath the windows and also in an overhead compartment. The floor heaters are meant to handle the transmission heat losses of the car and the overhead heaters handle the ventilation heat. The overhead heaters heat up a mixture of outside and return air (the outside air is somewhere between 25 and 50 percent of the total depending upon the design). The air is circulated across the overhead heaters by a blower in the overhead compartment. The heated air is then supplied to the car space through diffusers in the ceiling and this air should be at or slightly above space temperature. The most economical way to control the floor and overhead heaters is from a space or return air thermostat cycling the floor and overhead heaters simultaneously.

If the percentage of outdoor air used can be assumed to be always constant, it is a simple matter to size the overhead heaters. However, it is almost impossible to predict accurately what the transmission heat loss of the car will be. The heat loss is usually calculated under design conditions of maximum speeds, maximum wind, the minimum outdoor temperature and then, to allow for errors, a safety factor is used. This means that under almost all conditions, the floor heat is oversized. This also means, then, that if the floor and overhead heat are operated simultaneously, the floor heat will provide more than its proper portion of heat to the car and the car thermostat will be satisfied even though the overhead discharge temperature is below space temperature. Overhead air delivered to the space below the space temperature is uncomfortable to the passengers.

The purpose of this invention is to remedy the above condition. This is done by using a thermostat in the overhead duct set at or slightly above space temperature. If the overhead discharge temperature falls below the setting of this thermostat, the thermostat disables the floor heat and this means that the overhead heat must handle both the transmission and ventilation heat losses if it is to satisfy the space thermostat. The overhead discharge temperature will, of course, have to rise above the setting of the discharge thermostat in order to do this. When the overhead temperature does rise above the thermostat setting, the floor heat is again allowed to cycle with the overhead heat.

It is therefore an object of this invention to provide an improved railway car or vehicle heating system for a space within which space temperature and ventilation air temperature are maintained at a desired temperature level for comfort of the occupants thereof.

It is further an object of this invention to provide an improved electric car heating system in which passenger comfort is assured by preventing ventilation air temperature from falling below a predetermined level despite outside weather and travel conditions.

It is further an object of this invention to provide an improved space heating system wherein a main heat exchanger for the heat space supplies the heat loss from the space and a second heat exchanger is utilized for heating ventilation air circulated in the space with the heat exchangers controlled from a controller responding to space temperature and with provision for rendering the main heat exchanger inoperative upon the decrease in ventilation air temperature.

These and other objects of this invention will become apparent from the attached description together with a drawing.

An improved air-conditioning apparatus is shown herein in connection with a transportation vehicle such as a railway car or bus having an electric heating system. In my improved apparatus, the main heat exchangers are shown schematically as panels **11** positioned along the sides of the car and will be hereafter described as floor level heaters. Positioned in the upper portion of the car and separated therefrom is a ventilation channel or duct indicated generally at **12** having an air intake **13** communicating to the outside of the car and a return air duct or vent **14** through which ventilation air is returned to the duct. Positioned along the extent of the car are vent-like openings or registers **15** through which ventilation air after conditioning is forced into the car. Return ventilation air and fresh air from the outside of the car enter the duct passage at a mixing section indicated at **20** in which is positioned a second heat exchanger **22** through which the ventilation air must pass and be modified in temperature. Also included in the duct is a circulator or blower **25** which forces the ventilation air out through the registers of overhead duct and into the space and at the same time draws return air through the vent **14** and fresh air through the vent **13** past the heat exchanger for ventilation and circulation purposes.

The heat exchanger **22** hereinafter to be defined as the overhead or ventilation air heater as well as the floor level heaters **11** are adapted to be connected to a common power supply for energization purposes. The heating elements are of fixed impedance or resistance values and because such units are normally simultaneously connected in an on-off manner to a fixed voltage and current supply, the heat output of the same will be relatively fixed. Control of these heaters, as shown by the drawing, is from the bridge type network indicated at **30** which controllably energized an amplifier relay indicated in block form at **31**, which is of the type shown in the A. P. Upton Patent 2,432,534, the amplifier relay **31** controlling contactor **32**, **33** which connects the heaters to the source of power. Bridge network **30** could use any number of sensing devices desired and is shown herein as including an outside air thermostat **35**, a space thermostat **36** both of which are connected to series in one leg of the bridge network with a return air stat at **37** being connected in the opposite leg of the bridge network, which includes in addition fixed resistors in a conventional manner in the remaining legs of the bridge. While we have shown the bridge to include a number of different sensing elements of the resistance type, a single space thermostat of the resistance type may be utilized for this purpose.

The bridge **30** is energized from an alternating current source of power indicated at **40** through a transformer **41** which is connected to diametrically opposite points on the bridge with the remaining junctions being connected to the amplifying relay and a ground connection to provide an output circuit for the bridge to the input of the amplifying relay. Relay **31** is also energized from the source **40** through conductors indicated at **44**. The

contacts of the maplifying relay, indicated at **45** are included in the energizing circuit for the contactors **32, 33**, which are shown as connected to the source of power **40** through a conductor **46, 47** to conductors **48, 49** and coils **50, 51** respectively of the contactors **32, 33** to conductors **52, 53** and **54** to the source of power **40**. Included in the conductor **53** connected with the floor heat contactor is a switch element **60** designed to be positioned in the duct **20** near the discharge side of the circulator to sense ventilation air temperature beyond the exchanger as ventilation air is being discharged into the space to be conditioned. The temperature responsive switch **60** is set at a predetermined ventilation air temperature and is designed to open the energization circuit of the floor heat contactor thereby disconnecting the floor heat exchanger **11** from the source of power whenever ventilation air temperature drops below a predetermined set value.

Thus with the bridge elements of the bridge network **30** calling for heat upon a decrease of outside, space or return air temperatures, the relay **31** will be energized, connecting the contactors **32, 33** and hence the heat exchangers **11** and **22** simultaneously to the source of power for energization purposes. Should ventilation air temperature be below the set point of stat **60**, stat **60** is set to operate and open the contactor for the floor heat exchanger thereby energizing only ventilation heater **22** to bring the ventilation air up to the desired temperature before the space thermostat is satisfied after which the stat **60** will close reconnecting the floor heat exchanger or heater to the source of power, until the space temperature setting is reached and no longer calling for operation of the relay **31**. By disconnecting the floor heat exchanger from the source of power and connecting only the overhead or ventilating air heat exchanger to the source of power, the ventilating heater will rapidly heat the ventilation air after which the floor heat exchangers may be reconnected to bring about the desired space temperature in the car.

In considering this invention it should be kept in mind that this description is to be considered as illustrative only and the scope of the invention should be determined only by the appended claims.

I claim as my invention:

1. A railway car heating apparatus comprising, a floor level electric heating unit, an overhead duct including an intake passage, a return passage and a plurality of discharge passages into the interior of said car, an overhead electric heating unit positioned in said duct for heating the intake and return air for ventilation purposes, means for circulating the ventilation air in said duct to said car, temperature responsive means positioned in said car and responsive to an indication of the air temperature within said car, means for connecting said overhead and floor level electric heating units to a source of power, means including said temeprature responsive means for controlling said conecting means, and means responsive to the temperature of the ventilation air positioned in said duct and connected in circuit with said floor level electric heating unit to disconnect said floor level heating unit from said energizing source upon a drop in temperature of the ventilating air.

2. A railway car heating apparatus comprising, a floor level heating unit, an overhead duct including an intake passage, a return passage and a plurality of discharge passages into the interior of said car, an overhead heating unit positioned in said duct for heating the intake and return air for ventilation purposes, means for circulating the ventilation air in said duct to said car, temperature responsive means positioned in said car and responsive to an indication of the temperature air within said car, means for connecting said overhead and floor level heating units to a source of energy, means including said temperature responsive means for controlling

said connecting means, means responsive to the temperature of the ventilation air positioned in said duct, means connecting said last named temperature responsive means with said floor level heating unit to prevent the energization of said floor level heating upon a drop in temperature of said ventilation air.

3. In a heating system in combination with a space to be heated, a floor level heating unit for supplying major heat loss from said space, an air circulation passage above said space having an inlet leading from the space and outlets leading to said space, a duct leading from without said space into said passage which together with the inlets to the passage supply the ventilating air for said space, a blower forcing the ventilation air through said passage and through said outlets to said space, a ventilating air heating unit positioned in said duct for heating the ventilation air, means responsive to an indication of temperature of said space for controlling the operation of said floor level and said ventilating heating units, and second thermostatic means positioned in said passage and responsive to the temperature of the ventilation air for controlling the operation of said floor level heating unit independently of said ventilating air heating unit.

4. In a heating system in combination with a space to be heated, a floor level electric heating unit for supplying major heat loss from said space, an air circulation passage above said space having an inlet leading from the space and outlets leading to said space, a duct leading from without said space into said passage which together with the inlet to the passage supplies the ventilating air for said space, a blower forcing the ventilation air through said passage and through said outlets to said space, a ventilating electric air heating unit positioned in said duct for heating the ventilation air, means responsive to an indication of temperature of said space for controlling the energization of said floor level and said ventilating heating units, thermostatic switch positioned in said passage and responsive to the temperature of the ventilation air, and means connecting said switch means to said floor level electric heating unit to de-energibe the floor level heating unit upon a decrease in temperature of the ventilation air.

5. In a heating system in combination with a space to be heated, a floor level electric unit for supplying major heat loss from said space, an air circulation passage above said space having an inlet leading from the space and outlets leading to said space, a duct leading from without said space into said passage which together with the inlets to the passage supply the ventilating air for said space, a blower forcing the ventilation air through said passage and through said outlets to said space, a ventilating air electric heating unit positioned in said duct for heating the ventilation air, means operative upon a decrease in temperature of said space below a predetermined level for controlling the energization of said floor level and said ventilating electric heating unit, and temperature responsive switch means positioned in said passage and responsive to the temperature of the ventilation air and connected in circuit with said temperature controlling means for de-energizing said floor level electric heating unit upon a decrease in temperature of said ventilation air.

6. In a heating system in combination with a space to be heated, an air circulation passage having inlets leading from said space and outlets leading into said space, means for circulating air through said passage and into said space positioned in said passage, a main heat exchanger for said space, a second heat exchanger positioned in said passage to heat the air circulated therein, a source of heat producing energy adapted to be connected to said main and second heat exchangers, means operative upon an indication of a need for heat in said space for connecting said main and second heat exchangers to said source of heat producing energy, and means responsive to the temperature of the air circulated in said passage for disconnecting said main heat exchanger from said source of heat

producing energy upon a decrease in temperature with the circulated air in said passage.

7. In a heating system in combination with a space to be heated, an air circulation passage having inlets leading from said space and outlets leading into said space, means in said passage for circulating the air through said outlets, a main heat exchanger for said space, a second heat exchanger positioned in said passage to heat the air circulated therein, a source of heat producing energy, means for connecting said source of heat producing energy to said main and second heat exchangers, temperature responsive means responsive to the temperature of said space and connected to said connecting means for controlling the operation of the same, and means responsive to the temperature of the air circulated in said passage and connected to said connecting means for disconnecting said main heat exchanger from said source of heat energy upon the decrease in temperature of the circulated air.

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