March 12, 1946. E. J. DILLMAN 2,396,559

AIR COOLING APPARATUS

Filed March 13, 1944

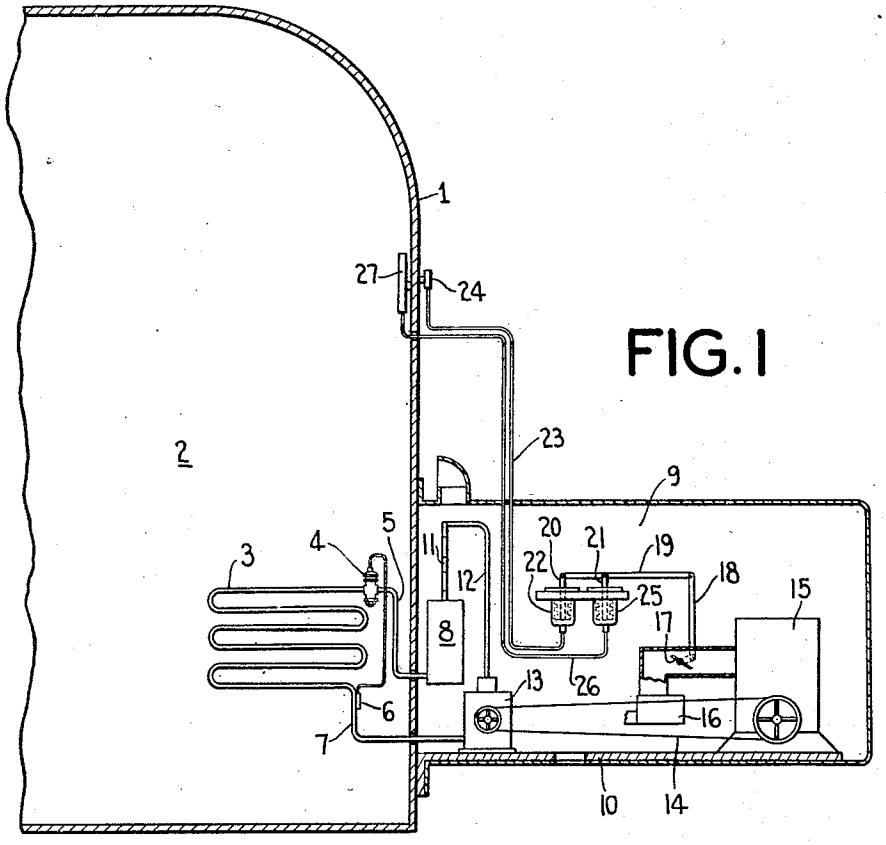
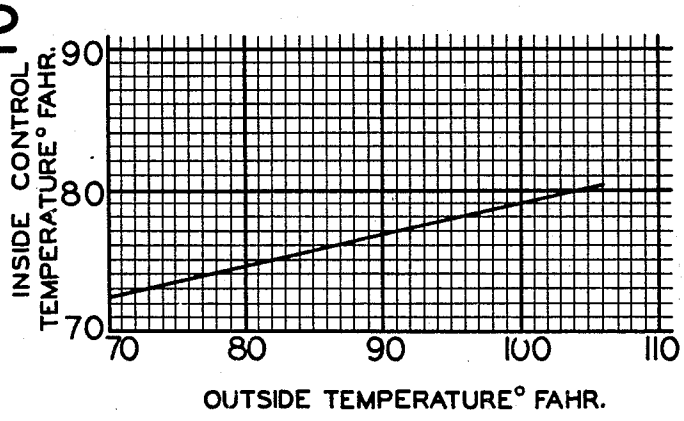


FIG. 1

FIG. 2



INVENTOR
Earnest J. Dillman
BY
Andrew K. Foulds
his ATTORNEY

Patented Mar. 12, 1946 2,396,559

UNITED STATES PATENT OFFICE

2,396,559

AIR-COOLING APPARATUS

Earnest J. Dillman, Detroit, Mich., assignor to Detroit Lubricator Company, Detroit, Mich., a corporation of Michigan

Application March 13, 1944, Serial No. 526,229

4 Claims. (Cl. 62—4)

This invention relates to new and useful improvements in apparatus for comfort cooling the space in a vehicle or automotive bus to be occupied by human beings.

An object of the invention is to cool the space in relation to the temperature of the outside air.

Another object is to provide means to control the speed of an internal combustion engine for driving the compressor of a continuously operating refrigerating apparatus so as to cool the space in accordance with the space temperature as related to external air temperature.

Another object is to control the speed of the engine in accordance with a differential between the temperatures inside and outside of the space as the outside temperature increases, but at a less rate than the rate of increase of the external or outdoor temperature.

The invention consists in the cooperative relation of parts and the control of the refrigerating or cooling system effected thereby to be more fully described hereinafter and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawing to be taken as a part of this specification, there is fully and clearly illustrated a preferred embodiment of the invention, in which drawing:

Figure 1 is a diagrammatic view of a cooling apparatus and its controlling means as applied to a bus and embodying the invention, and

Fig. 2 is a temperature chart showing the relation of temperatures within and outside of the bus, as maintained by the control means of Fig. 1.

Referring to the drawing by characters of reference, 1 designates the body of a bus having a space 2 to be occupied by the bus passengers and within which is positioned an air cooling coil or refrigerant medium evaporator 3 forming the low side of a refrigerating apparatus. The supply of refrigerant medium to the evaporator 3 is controlled by the usual thermostatic expansion valve 4 intercalated in the refrigerant medium liquid line 5 and having a temperature responsive control bulb 6 clamped to the refrigerant medium return or suction line 7. The liquid line 5 is fed from a tank or receiver 8 positioned external of the space 2 and mounted within the housed space 9 of a supporting structure 10. The receiver 8 is fed from a condenser 11 contained in the space 9 and connected by a feed line 12 to the outlet of a compressor 13 which has its inlet connected to the return line 7. The compressor 13 is driven by belt or other gearing 14 from an internal combustion engine 15 having a carburetor 16. The supply of fuel mixture from the carburetor 16 to the engine 15 is controlled by a throttle valve 17 operated by a link 18 pivotally connected to a lever 19 which is pivotally connected to thermostatically operated thrust members 20, 21. The thrust member 20 is operable by the movable wall, such as a metal bellows, of an expansible, contractible chambered member 22 connected by a capillary tube 23 to a bulb element 24. The bulb element 24, tube 23 and the expansible, contractible chamber in member 22 are charged solid with a temperature responsive expansible liquid such, for example, as kerosene, so that the rod 20 will be moved in accordance with temperature change to which the bulb element 24 is subjected. The rod 21 is operable by the movable wall, such as a metal bellows, of an expansible, contractible chambered element 25 connected by a capillary tube 26 to a bulb element 27 mounted within the space 2 adjacent the external location of the bulb element 24, so that the bulb elements 24 and 27 are in side by side relation separated by the bus wall and so that the capillary tubes 23 and 26 will be of substantially equal length. The bulb element 27, tube 26 and the expansible, contractible chamber of the member 25 are charged solid with the same temperature responsive liquid as in the element 24, namely kerosene. The volumetric capacity of the bulb element 27 is so related to the volumetric capacity of the bulb 24 that when the tubes 23 and 26 and the chambered members 22 and 25 are of equal capacity, the relative expansion of the liquids in these bulb elements will give the curve shown by the chart of Fig. 2, that is, the volumes of the elements 24 and 27 will be proportional to the ordinate and the abscissa respectively of the tangent of the temperature curve. The tubes 23 and 26 are maintained in close proximity to each other throughout their lengths so that they will be subjected equally to any changes of temperature and also to the same temperatures so that the valve 17 will be controlled substantially solely by the differential of expansion of the liquids in the bulb elements 24 and 27. The thrust members 20 and 21 are connected relatively close to each other to the lever 19 so that a temperature change of say 3° F. at the bulb element 27 will move the throttle valve 17 from full open to full closed position or vice versa. The bulb element 24 then operates to control the range or to determine the temperature setting at which the bulb element 27 operates the throttle valve 17.

The operation of this apparatus is as follows: With the refrigerating apparatus in operation, the compressor 13 being driven by the engine 15 and the expansion valve 4 maintaining the evaporator 3 refrigerated throughout its length, the throttle valve 17 will be automatically adjusted to regulate the engine speed and therefore the speed of the compressor 13 and resulting low side or evaporator pressure. If the temperature within the space 2 due to increase in the number of passengers increases, then the bulb element 27 responding to the temperature increase will rotate the lever 19 on the rod 20 as a fulcrum and move

the throttle valve 17 toward open position, thereby decreasing the temperature in the evaporator 3 to counteract the temperature increase in the space 2. Decrease of temperature in the space 2 will correspondingly rotate the lever 19 in the reverse direction to decrease the speed of the engine 15 and therefore of the compressor 13 so that the rate of heat absorption by the evaporator 3 will be reduced. The bulb element 24 will also function to operate the lever 19 but, being of smaller capacity, will act to a lesser degree than the bulb 27 such that upon decrease in external temperature the throttle valve 17 will be moved toward open position by the lever 19 fulcruming on the rod 21. When there is an increase in outside temperature, the liquid in bulb element 24 will exert its expansion pressure to move the throttle valve 17 toward closed position, so that the inside bus temperature will be permitted to increase in order to maintain the straight line temperature differential. Accordingly, the bulb elements 24 and 27 will act, as outside temperature increases, to maintain a predetermined increasing temperature differential between the interior and the exterior of the space 2, balancing the speed of the engine 15 in relation to the differential at a given outside temperature, and accordingly balancing the rate of heat absorption by the evaporator 3.

What is claimed and is desired to be secured by Letters Patent of the United States is:

1. A cooling apparatus for buses comprising a bus body having an enclosed space for human occupancy, a supporting structure external of said space, a refrigerating apparatus having a condenser and compressor mounted on said supporting structure and having a refrigerant medium evaporator positioned in said space, an internal combustion engine geared to and for driving said compressor and mounted on said structure, a throttle valve controlling the speed of said engine, and differential temperature responsive means controlling said throttle valve in accordance with a desired difference between the temperatures within and external of said space, said responsive means being so proportioned and related to each other that the temperature in said space increases at a less rate than the rate of temperature increase external of said space.

2. A cooling apparatus for buses comprising a bus body having an enclosed space for human occupancy, a supporting structure external of said space, a refrigerating apparatus having a condenser and compressor mounted on said supporting structure and having a refrigerant medium evaporator positioned in said space, an internal combustion engine geared to and for driving said compressor and mounted on said structure, a throttle valve controlling the speed of said engine, a pair of chambered members each having a movable wall, thrust rods movable one by each of said walls, a lever pivotally connected to and supported by said rods and operatively connected to said valve, each of said rods serving as a fulcrum for operation of said lever by the other of said rods, capillary tubes connected one to each chambered member and each having a bulb element, said chambered members, tubes and elements being charged solid with an expansible liquid, one of said bulb elements being positioned in said space and having a greater volumetric capacity than the other of said elements, and said other element being mounted external of said space so that said throttle valve is moved toward open position in accordance with an increasing differential between the temperatures within and external of said space as the temperature external of said space increases.

3. A cooling apparatus for buses comprising a bus body having an enclosed space for human occupancy, a supporting structure external of said space, a refrigerating apparatus having a condenser and compressor mounted on said supporting structure and having a refrigerant medium evaporator positioned in said space, an internal combustion engine geared to and for driving said compressor and mounted on said structure, a throttle valve controlling the speed of said engine, a pair of chambered members each having a movable wall, thrust rods movable one by each of said walls, a lever pivotally connected to and supported by said rods and operatively connected to said valve, each of said rods serving as a fulcrum for operation of said lever by the other of said rods, capillary tubes connected one to each chambered member and each having a bulb element, said chambered members, tubes and elements being charged solid with an expansible liquid, one of said bulb elements being positioned in said space and having a greater volumetric capacity than the other of said elements, said other element being mounted external of said space so that said throttle valve is moved toward open position in accordance with an increasing differential between the temperature within and the temperature external of said space as the temperature external of said space increases, and said capillary tubes being of substantially equal length and extending in close proximity to each other from said bulb elements to said chambered members so that the expansion of the liquid in said tubes will be substantially equal.

4. A cooling apparatus for buses comprising a bus body having an enclosed space for human occupancy, a refrigerating apparatus having a refrigerant medium evaporator positioned in said space and having a compressor and a condenser operatively connected together and to said evaporator, means for driving said compressor at a variable speed, a pair of chambered members each having a movable wall, thrust rods movable one by each of said walls, means controlling the speed of said driving means, a lever pivotally connected to and supported by said rods and operatively connected to said controlling means, capillary tubes connected one to each of said chambered members and each tube having a bulb element, said chambered members, tubes and elements being filled with expansible medium, one of said bulb elements being positioned in said space and having a greater volumetric capacity than the other of said elements, the said other of said elements being mounted external to said space so that said controlling means is operated to increase the speed of said driving means in accordance with an increasing differential between the temperature within and the temperature external to said space as the temperature external to said space increases, and said capillary tubes being of substantially equal length and extending in close proximity to each other from said elements to said chambered members so that the total linear expansion of the expansible mediums in said tubes will be substantially equal.

EARNEST J. DILLMAN.