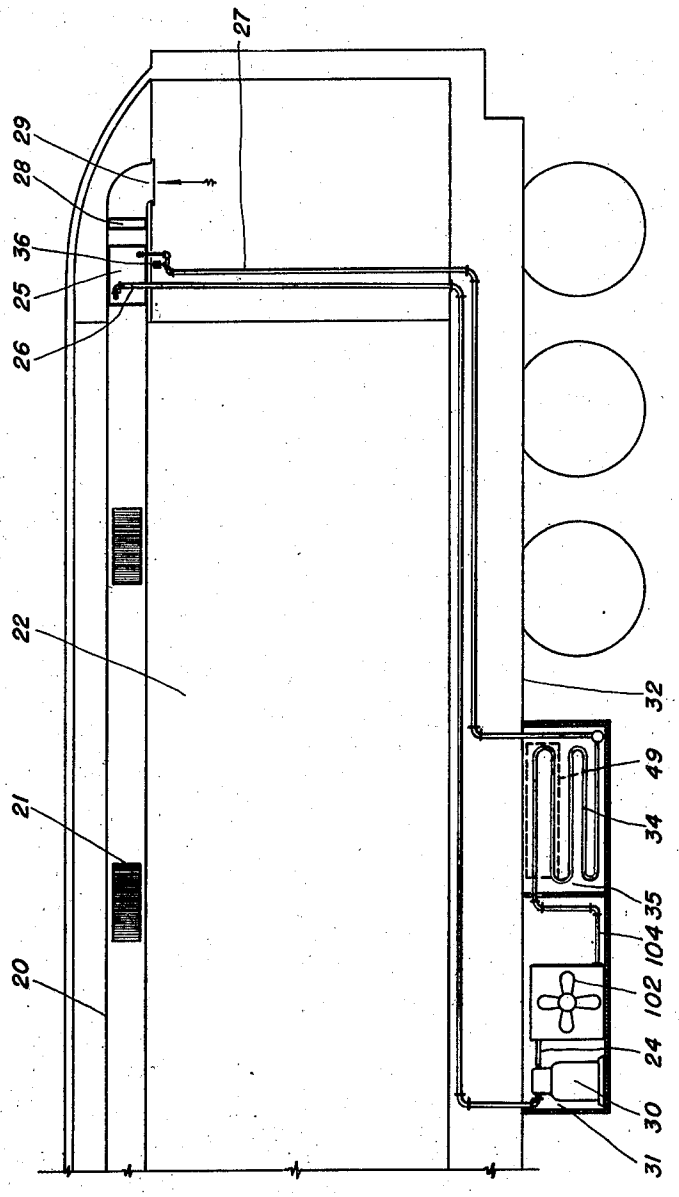
Sept. 6, 1938. R. H. ANDEREGG 2,128,890

AIR CONDITIONING APPARATUS

Filed Dec. 14, 1936 3 Sheets-Sheet 1

Fig. 1



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Fig. 2

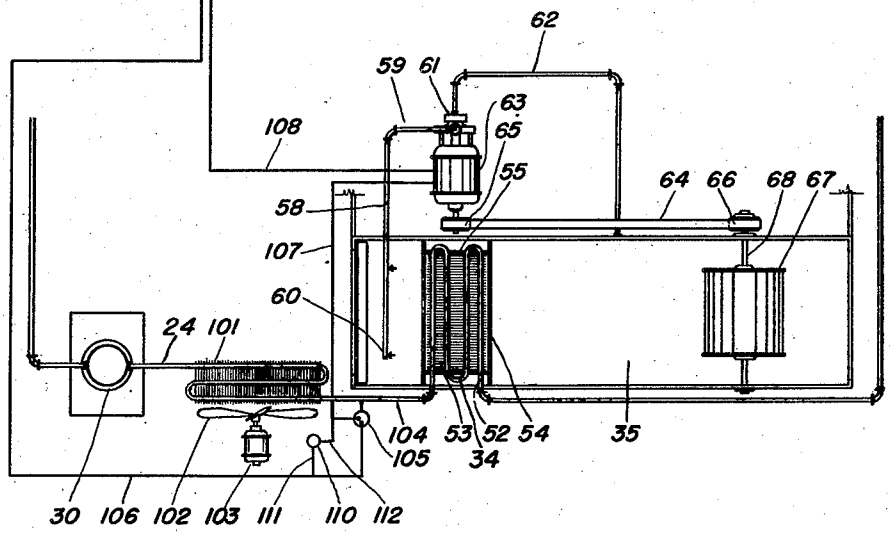
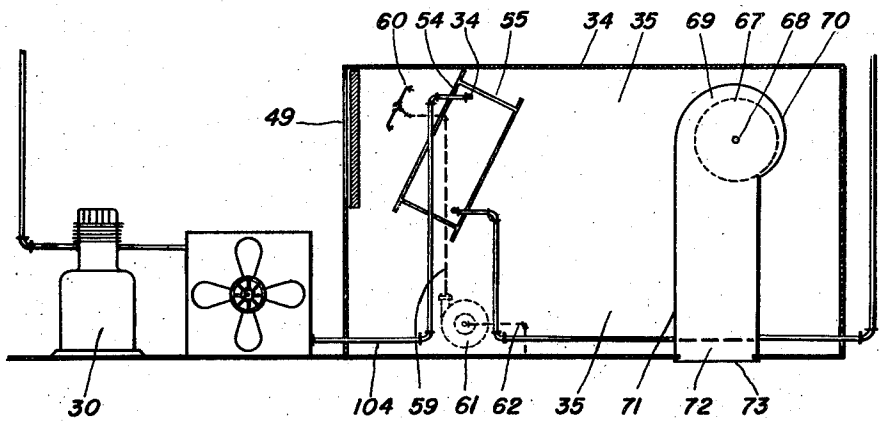


Fig. 3



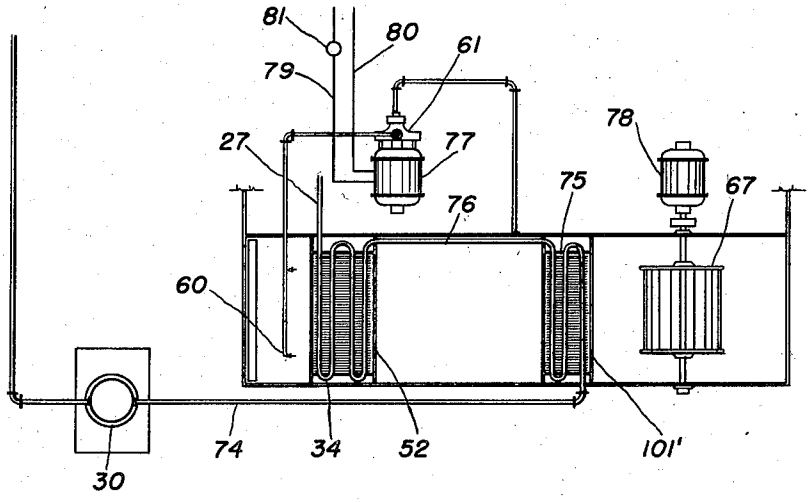
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Fig. 4



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UNITED STATES PATENT OFFICE

2,128,890

AIR CONDITIONING APPARATUS

Ruben H. Anderegg, La Crosse, Wis., assignor, by direct and mesne assignments, of one-half to The Trane Company, La Crosse, Wis., and one-half to Waukesha Motor Company, Waukesha, Wis.

Application December 14, 1936, Serial No. 115,780

14 Claims. (Cl. 62—6)

The present invention relates generally to apparatus for use in conditioning or cooling air. More particularly the invention relates to that type of apparatus which is used on a vehicle such as a railway passenger car, and comprises a compressor under the body of the vehicle, an evaporator in an air circulating system in the vehicle body, an expansion valve at the inlet side of the evaporator, a high pressure refrigerant line leading from the compressor to the expansion valve and including an air cooled condenser for the refrigerant and a receiver between the condenser and the expansion valve, and a low pressure refrigerant line leading from the outlet side of the evaporator back to the compressor.

In a refrigerating apparatus of this type an air cooled condenser is employed instead of an evaporative condenser because it is lighter, requires practically no servicing, and is not affected by freezing atmospheric conditions or temperatures such, for example, as may be encountered when the vehicle with which the apparatus is associated travels over mountains. In practice it has been found that an air cooled condenser, although it embodies the aforementioned advantages and is sufficiently efficient for practical operating purposes at normal temperatures, that is, temperatures less than 100° F., is not efficient at temperatures in excess of 100° F. like, for example, those that are encountered during the hot summer season or in desert areas, and also that in such excess temperatures the capacity of the apparatus drops materially.

One object of the invention is to provide a refrigerating apparatus of the aforementioned type which is more efficient and practical than previously designed apparatus of the same general character by reason of the fact that it includes in addition to the air cooled condenser in the high pressure refrigerant line, a small self-contained evaporative condenser which may be brought into play during the summer months or when excess temperatures are encountered and operates when in use to increase the capacity of the apparatus as a whole.

Another object of the invention is to provide a refrigerating apparatus of the last mentioned character in which the evaporative condenser is controlled automatically so that it operates only during periods when refrigerant pressures are higher than normal due to higher atmospheric conditions or greater load.

Another object of my invention is an air conditioning apparatus which can use lower head pressures in the condenser means.

Another object of my invention is an improvement in extracting heat from the condenser side of a heat cycle to reduce the load on the compressor.

Another object of my invention is to secure better control in cooling the refrigerant or refrigerating liquid after it leaves the compressor.

Another object of my invention is to secure economy in cost of operation and installation of the apparatus designed for cooling the refrigerant.

Another object of my invention is to make said apparatus lighter and less expensive than apparatus formerly used for cooling the refrigerant.

The foregoing and many other specific features of my invention are set forth in the following specification, where I describe what I consider the preferred embodiments of my invention. These are illustrated in the accompanying drawings where—

Figure 1 is a longitudinal cross section of a portion of a railway car showing diagrammatically the arrangement of the air conditioning equipment.

Figure 2 is a cross section of the apparatus designed to compress and cool the refrigerant or refrigerating liquid.

Figure 3 is a vertical elevation of the apparatus shown in Figure 2, partly in section.

Figure 4 is a cross section similar to Figure 2, designed to show a modified form of my invention.

Referring to Figures 1 to 4, inclusive, **20** is a duct system for conveying conditioning air to outlets **21** into the car compartment **22** to be cooled. The cooling coils **25** are mounted in the top of the car and are connected with a source of cold or cooling cycle by means of the pipes **26** and **27**. **28** is a filter interposed in the air inlet **29**. **30** is a compressor mounted in the compartment **31**, supported from the bottom **32** of the car. **24** is the liquid line from the compressor **30** to the cooling coil **101**, which is constructed with a serpentine coil and fins mounted thereon. This coil is cooled by air propelled by the fan **102**, operated by the motor **103**. From the coil **101** the liquid passes through the line **104** to a second coil **34**, contained in the compartment **35**, which is a conventional fin and tube type coil comprising tubes **52** and fins **53**.

The heat exchange tube and fins are protected from injury by the supporting casings **54** and **55**. Sprays **60** are in communication with the water pump **61** through the line **59**. A water pump is direct connected to and operated by the motor **63**,

and also, by means of the belt 64 and pulleys 65 and 66, rotates the shaft on which is mounted the fan 67.

The suction inlet 69 above the water line in the compartment 35 draws the air through the inlet 49, past the sprays 60, through the coil 34; then through the fan housing 70; thence downward through a duct 71 leading downward through the compartment 35 to the outlet 72, so that air is discharged toward the road-bed. The air outlet is protected by a screen 73 preventing the entrance of foreign material.

62 represents a water supply pipe connected to the pump 61 and to the bottom of the compartment 35, which is water-tight and is filled with water to a pre-determined level. The motor 63 which controls the operation of the pump 61 and the fan 67 is operated by electricity through the lines 108, 107 and 106.

Interposed in the electric line 107 is a pressure switch 105 responsive to the pressure in the liquid line 104. This switch upon reaching a predetermined pressure will close and complete the circuit in lines 106 and 107, causing the motor 63 to operate. The lines 106 and 107 are also connected by the lines 111 and 112 with a thermostat interposed therein, responsive to outside air so that upon the air reaching a predetermined temperature the switch 110 will close, causing the motor 63 to operate. Thus, the operation of the motor 63 is dependent both on the outside air and on the pressure in the liquid return from the compressor.

It may be thus observed that while the fan 102 will operate generally while the whole apparatus is in service and the compressor not running (the connections therefor not shown), that the auxiliary cooler will be only put into service when either the pressure in the return line calls for lower pressures or by the outside air temperature rising. In the latter case the cooling effect of the outside air over the cooling coil 101 is decreased by the reduction of difference of temperature between the outside air and the liquid in the coil 101, and it becomes necessary to put into service the auxiliary sub-cooler. Thus, the auxiliary cooler may be smaller and of less weight than the type of cooler which consists entirely of wetted surface and apparatus necessary to produce that wetted surface.

A modified form of my invention is shown in Figure 4 in which the liquid passes from the compressor 30 through the line 74 to the cooling coil 101' in supporting casing 75, which coil is similar to the cooling coil 101 in Figure 2. From the cooling coil 101' the liquid is passed through the pipes 76 to the cooling coil 34 and thence back to the evaporator through the pipe 27. The air passing over the coil 34 is moistened by means of sprays 60, which spray water into the air in advance of the coils and also upon the coils, producing a wetted surface of the fins. The pump 61 is operated by the motor 77 and the fan 67 is operated by the motor 78. In the apparatus shown in Figure 4 the air is drawn by the fan 67 over the coil 34, which is wetted, and thence over the coil 101', which is dry.

Thus, at times during the operation of this apparatus the air emitting from the coil 34 will be cooler than outside air and sufficiently cool to pre-cool the liquid passing through the coil 101'; and after the liquid is cooled in the coil 101', it goes to the coil 34 and further cooled down by the wetted fin surface.

Under both the constructions shown in Figure 2 and Figure 4, the total weight of the apparatus needed to cool the liquid is considerably reduced over an apparatus having a coil only wetted by water due to the fact that additional storage space is required for water and an additional amount of water is required to be used, and the whole apparatus required is lighter than is required with an apparatus using only water.

When the temperature outside is low, the apparatus is designed to shut off the sprays so that all of the air passes coils 34 and coils 101' as dry coils, and the apparatus is also designed so that when the outside temperature rises above a predetermined point that the motor 77 will start, causing the sprays to wet the coil 34, which is necessary when the outside temperatures go above 95 deg. F. The motor 77 is connected to a source of power through two electric lines 79 and 80, and in the line 79 there is a thermostat 81 responsive to the outdoor temperature. This thermostat could also be made responsive to the indoor temperature or responsive to the pressure of the gas in the line 74 and secure the same results.

While I have described the foregoing preferred embodiments of my invention, I contemplate that many changes may be made without departing from the scope or spirit of my invention.

I claim:

1. In an air conditioning apparatus, the combination of a heat exchange cycle with the evaporator side of said cycle situated within a compartment to condition the air therein, a compressor in said cycle delivering gas under pressure to the condenser side of said cycle, separate cooling coils interposed in said condenser side to cool said gas, means to cool one of said coils with untreated air, a second means to cool the other of said coils with treated air, means to put said second means into operation upon the pressure in said condenser side reaching a pre-determined amount.

2. In an air conditioning apparatus, the combination of a heat exchange cycle with the evaporator side of said cycle situated within a compartment to condition the air therein, a compressor in said cycle delivering gas under pressure to the condenser side of said cycle, separate cooling coils interposed in said condenser side to cool said gas, means to cool one of said coils with untreated air, a second means to cool the other of said coils with treated air, means to put second means into operation when the temperature of said untreated air reaches a pre-determined amount.

3. In an air conditioning apparatus, the combination of a heat exchange cycle with the evaporator side of said cycle situated within a compartment to condition the air therein, a compressor in said cycle delivering gas under pressure to the condenser side of said cycle, separate cooling coils interposed in said condenser side to cool said gas, means to cool one of said coils with untreated air, a second means to cool the other of said coils with treated air, said second means comprising a fan and passing an air stream over said coils, water sprays in the path of said air stream, a conduit with a water pump interposed therein between said sprays and a source of water supply, power means to operate said pump and fan responsive to the pressure in said condenser side.

4. In an air conditioning apparatus, the combination of a heat exchange cycle with the evaporator side of said cycle situated within a com-

partment to condition the air therein, a compressor in said cycle delivering gas under pressure to the condenser side of said cycle, separate cooling coils interposed in said condenser side to cool said gas, means to cool one of said coils with untreated air, a second means to cool the other of said coils with treated air, said second means comprising a fan and passing an air stream over said coils, water sprays in the path of said air stream, a conduit with a water pump interposed therein between said sprays and a source of water supply, power means to operate said pump and fan responsive to temperature of outside untreated air.

5. In an air conditioning apparatus, the combination of a heat exchange cycle with the evaporator side of said cycle situated within a compartment to condition the air therein, a compressor in said cycle delivering gas under pressure to the condenser side of said cycle, separate cooling coils interposed in said condenser side to cool said gas, means to cool one of said coils with untreated air, a second means to cool the other of said coils with treated air, a pressure switch interposed in said condenser side adapted to put the last named means into operation when the pressure in said condenser side reaches a predetermined amount.

6. In an air conditioning apparatus, the combination of a heat exchange cycle with the evaporator side of said cycle situated within a compartment to condition the air therein, a compressor in said cycle delivering gas under pressure to the condenser side of said cycle, separate cooling coils interposed in said condenser side to cool said gas, means to cool one of said coils with untreated air, a second means to cool the other of said coils with treated air, a thermostat responsive to outside air temperature adapted to put the last named means into operation when said temperature reaches a pre-determined amount.

7. In an air conditioning apparatus, the combination of a heat exchange cycle with the evaporator side of said cycle situated within a compartment to condition the air therein, a compressor in said cycle delivering gas under pressure to the condenser side of said cycle, separate cooling coils interposed in said condenser side to cool said gas, means to cool one of said coils with untreated air, a second means to cool the other of said coils with treated air, and means to control the operation of the last named means responsive to said untreated air and the pressure within said condenser side.

8. In a refrigerating apparatus comprising a refrigerant compressor, an evaporator with an expansion valve at the inlet side thereof, and high and low pressure refrigerant lines leading from the compressor to the valve and from the evaporator to the compressor respectively, the combination of an air cooled condenser in the high pressure line for condensing the refrigerant compressed by the compressor, an evaporative condenser in said high pressure line for assisting the air cooled condenser in condensing said refrigerant, and means whereby the evaporative condenser is rendered operative when atmospheric and load conditions are such that the condensing capacity of the air cooled condenser is insufficient for efficient operation of the apparatus and is rendered inoperative when atmospheric and load conditions are such that the condensing capacity of said air cooled condenser is sufficient for efficient operation of the apparatus.

9. In a refrigerating apparatus comprising a refrigerant compressor, an evaporator with an expansion valve at the inlet side thereof, and high and low pressure refrigerant lines leading from the compressor to the valve and from the evaporator to the compressor respectively, the combination of an air cooled condenser in the high pressure line for condensing the refrigerant compressed by the compressor, an evaporative condenser in said high pressure line for assisting the air cooled condenser in condensing said refrigerant, and means operative in response to changes in the pressure of the refrigerant in said high pressure line for controlling the operation of said evaporative condenser.

10. In a refrigerating apparatus comprising a refrigerant compressor, an evaporator with an expansion valve at the inlet side thereof, and high and low pressure refrigerant lines leading from the compressor to the valve and from the evaporator to the compressor respectively, the combination of an air cooled condenser in the high pressure line for condensing the refrigerant compressed by the compressor, an evaporative condenser in said high pressure line adapted to cool the condensed refrigerant and including a water pump and an electric motor for driving the pump, and control means for the evaporative condenser consisting of a switch for the electric motor and a device for closing the switch when atmospheric and load conditions are such that the air condensing capacity of the air cooled condenser is insufficient for efficient operation of the apparatus and for opening the switch and rendering the evaporative condenser inoperative when atmospheric and load conditions are such that the condensing capacity of the air cooled condenser is sufficient for efficient operation of the apparatus.

11. In a refrigerating apparatus comprising a refrigerant compressor, an evaporator with an expansion valve at the inlet side thereof, and high and low pressure refrigerant lines leading from the compressor to the valve and from the evaporator to the compressor respectively, the combination of an air cooled condenser in the high pressure line for condensing the refrigerant compressed by the compressor, an evaporative condenser in said high pressure line adapted to assist the air cooled condenser in condensing said refrigerant and including a water pump and an electric motor for driving the pump, and control means for the evaporative condenser consisting of a switch for the motor and a device for closing the switch and rendering said evaporative condenser operative when the pressure of the refrigerant in the high pressure line reaches a predetermined point and opening said switch and rendering said evaporative condenser inoperative when the pressure of the refrigerant in said high pressure line drops below said point.

12. In a refrigerating apparatus comprising a refrigerant compressor, an evaporator with expansion means at the inlet side thereof, and high and low pressure refrigerant lines leading from the compressor to the valve and from the evaporator to the compressor respectively, the combination of an air-cooled coil type condenser in the high pressure line for condensing the refrigerant compressed by the compressor, fan means for circulating air around the coils of the air cooled condenser, a self-contained evaporative condenser in said high pressure line independent of, and positioned in spaced relation with respect to, said air cooled coil type condenser and adapted

when operative to assist said last mentioned condenser in condensing the refrigerant and including a water pump, a blower, and an electric motor for driving the pump and blower, and control means for the evaporative condenser including a switch for said electric motor.

13. In a refrigerating apparatus comprising a refrigerant compressor, an evaporator with an expansion valve at the inlet side thereof, and high and low refrigerant lines leading from the compressor to the valve and from the evaporator to the compressor respectively, the combination of an air cooled condenser in the high pressure line for condensing the refrigerant compressed by the compressor, an independent self-contained evaporative condenser in said high pressure line adapted to be operated when high atmospheric and load conditions are encountered and of such capacity that when operating under such conditions it coacts with the air cooled condenser to provide sufficient condensing capacity for efficient operation of the apparatus, and means for controlling said evaporative condenser so as to render it operative or inoperative.

14. In combination with a wheeled vehicle having a body with a space therein, a refrigerating apparatus for conditioning the air in said space comprising a refrigerant compressor mounted beneath the bottom of the body, an evaporator arranged to cool the air in said space and having an expansion valve at the inlet side thereof, high and low pressure refrigerant lines leading from the compressor to the valve and from the evaporator to the compressor respectively, an air cooled refrigerant condenser connected to and forming a part of the high pressure line and mounted beneath the bottom of the vehicle and adjacent to the compressor, a self-contained exaporative condenser in the high pressure line and independent of the air cooled condenser, mounted beneath said bottom of the vehicle body and in spaced relation with respect to said air cooled refrigerant condenser and adapted when operative to assist the latter condenser in condensing the refrigerant, and means for controlling the operation of said evaporative condenser.

RUBEN H. ANDEREGG.