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AIR CONDITIONING SYSTEM AND APPARATUS

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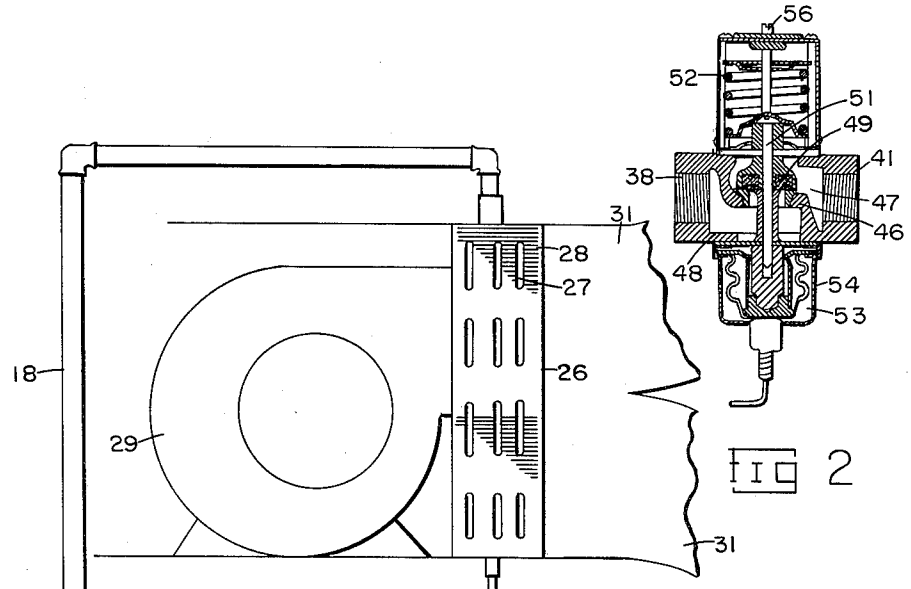


FIG 2

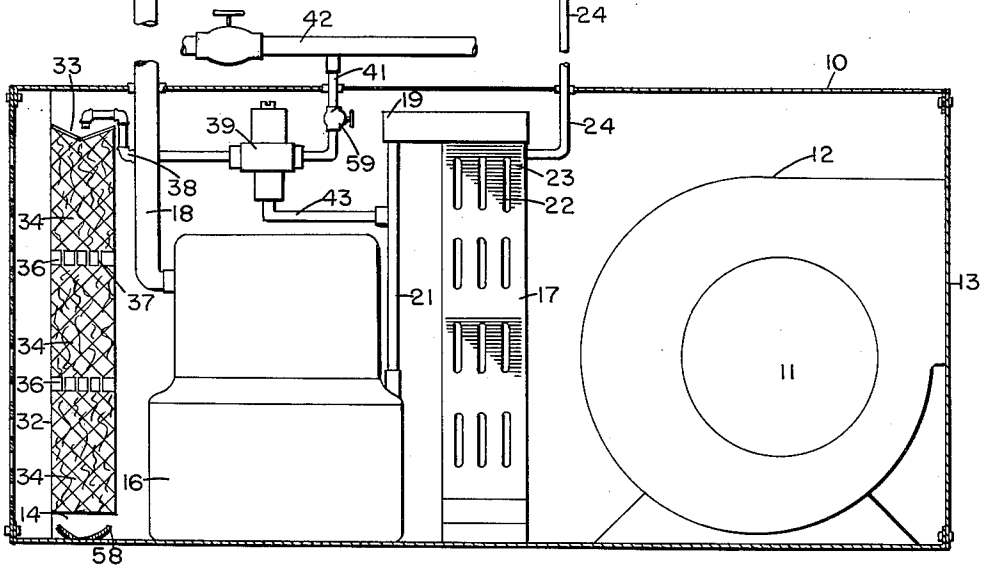


FIG 1

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AIR CONDITIONING SYSTEM AND APPARATUS

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My invention relates in general to air conditioning systems and more in particular to the selective cooling of the condenser portion of the system in response to pre-selected loading of the compressor.

Conventional refrigeration systems employing modern relatively low vapor pressure and high specific heat types of refrigerants operate on the principal of compressing the refrigerant to a liquid, passing the compressed refrigerant to a condenser coil, cooling the condenser coil to stabilize the refrigerant in liquid condition, delivering the liquid refrigerant to an expansion coil where it is evaporated and adsorbs heat from the coil and its surroundings, and returning the vaporous refrigerant to the input side of the compressor to complete the cycle. Air is passed over the expansion coil, commonly called the cooling coil in air conditioning parlance, and the air cooled by contact with the cooling coil is delivered continuously and by recirculation to the space to be cooled. Conventionally the condenser is cooled either by air or by means of liquid in a heat exchanger.

While the arrangement of equipment in a system may vary extensively, it has become a common practice in relatively small air conditioning systems suitable for homes to mount the compressor and condenser in a separate unit outside the home and to utilize ambient air for cooling the condenser, the air being passed over the condenser coil by a blower commonly mounted in the outside unit. It is known that there is a loss of efficiency and some increase in operating costs when ambient air is used for cooling the condenser and there have been several approaches to the solution of this problem. A common approach of several manufacturers is to attempt to balance up the different factors and equilibria involved to increase efficiency in the environment in which the system is operated, including for example operating the system at a somewhat higher back pressure on the input side of the compressor and increasing the volume of air passed over the condenser coil. The use of refrigerated air to cool the condenser coil has also been suggested, but since the employment of refrigerated air for this purpose represents a loss to the air cooling portion of the system, over-all efficiency is not improved. Most recently water has been sprayed on or near the condenser coils for the purpose of supplementing the cooling action of a normal air cooled condenser system, and while efficiency of the system and reduced operating costs have resulted from this supplementary water spray procedure, water scaling of surfaces also occurs and extensive cleaning and/or replacement of parts becomes necessary in anywhere from one to three years.

The principal object of my present invention is the production of an improved air conditioning system.

Another object is to improve the efficiency of a normal air cooled compressor and condenser system.

Still another object is to supplement the cooling action of ambient air by water evaporation when ambient conditions result in the placing of a predetermined load on the refrigerant compressor.

Still another object is to utilize water to supplement the cooling action of ambient air in such a way as to avoid the objectionable features of supplementary water cooling as used in the prior art.

In accordance with the main features of my invention,

I provide an absorbent pad through which ambient cooling air passes on its way to the condenser and delivers a relatively small amount of water to such pad in response to a predetermined rise in pressure on the outlet side of the compressor and between the compressor and the condenser. Water is delivered to the pad from an ordinary water supply line only when the load placed on the compressor reaches a predetermined level. The system of the present invention can be built into the usual compressor, condensor, blower unit of household refrigerating systems, or it may be applied to an existing system already in operation. In either case efficiency of the system as evidenced by reduced power costs is greatly increased with the deleterious deposit of scale such as occurs in systems of the prior art heretofore employed.

In the drawings,

FIG. 1 is a composite view showing the system of my present invention, some of the parts being shown structurally and some schematically;

FIG. 2 is a sectional view of one type of pressure responsive water control valve which may be used in the system.

Referring now to the drawings, the numeral 10 identifies a usual type of housing substantially imperforate so that air drawn through the intake 11 of a blower 12 and delivered through a discharge opening 13 passes through the intake side 14 past a compressor 16 and over a condenser coil 17. Normally a blower of the type shown has an intake 11 at both sides thereof. It should be understood that the installation shown is completely illustrative as any type of blower and air movement system may be used in which the air is either drawn across the condenser as indicated in the drawing or blown across the condenser as occurs in some types of installations.

In the form shown, the compressor 16 draws vaporous refrigerant through a line 18 and delivers it to a header 19 of the condenser through a high pressure line 21. The condenser has a series of copper tubes 22 provided with fins 23 to provide an increased heat exchange surface, all of which structure is conventional and may be of any usual construction. The condensed refrigerant is delivered through a tube 24 to a cooling coil 26 which also has a series of tubes 27 and fins 28. A blower 29 draws room air from the usual return register (not shown) and delivers it over the coils and fins of the cooling coil through a duct system 31 back to the room space being refrigerated. The expanded vaporous refrigerant passes from the cooling coil 26 to the line 18 to complete the refrigerant cycle.

At the air intake side of the housing or casing 10 I provide an evaporator 32 having a shallow trough 33 at its top and a plurality of absorbent pads 34 separated by transverse strips 36 which may be porous asbestos or any suitable strip running the full width of the evaporator. In the drawings I show small openings 37 in the water retaining and spreader strips 34 to indicate slow gravity movement of water through such strips. The absorbent pads 36 may be any suitable material providing a relatively large evaporative surface which is wetted relatively quickly by water and may comprise any of the usual pad materials employed in ordinary evaporative coolers such as excelsior treated to increase its water absorption and decrease fungicidal action.

Water is delivered to the trough 33 through a pipe 38 leading to a pressure responsive valve 39, the water supply being through a relatively small pipe 41 leading to an ordinary water line 42 furnishing water to the home. The pressure responsive expansion valve 39 is connected by a tube 43 to the line 21 running from the pressure side of the compressor to the condenser 17. The pressure responsive valve 39 may be of any suitable common type. In FIG. 2 one such type which I have employed success-

fully has a seat 46 between an intake chamber 47 and an outlet chamber 48 which connect to lines 41 and 38 respectively, normally closed by a valve 49 on a stem 51 biased downwardly by a spring 52. The stem 51 extends downwardly into a diaphragm chamber 53 sealed by a diaphragm 54 so constructed and arranged that pressure on the outside of the diaphragm through line 43 will raise the diaphragm assembly and lift the valve stem and valve. The compression of spring 52 may be controlled by exterior adjusting nut 56 so that the valve may be adjusted to open in response to a predetermined pressure within the limits of its design. Since, as will be explained, the pressure responsive valve should open when the compressor is operating at a predetermined pressure, for example about 200 pounds per square inch, the valve should be selected to be effective between limits including the selected range to which the valve is to be responsive.

In operating the system of my present invention, there are advantages both from the standpoint of operating efficiency as evidenced by reduction in power consumption of about 40% when the water evaporative pad system including the pressure responsive valve 39 is added to an existing system, and from the standpoint of revised engineering of the entire system in a new installation giving rise to still increased savings. Since air conditioning systems vary somewhat in their design as well as operating costs in various parts of the country, the advantages and functions of the present invention will be described by reference to climatic conditions usually encountered in southern Arizona.

In the desert and semi-desert areas of the southwest, ambient temperatures may vary during a refrigerating season between 50° and 115° or 120°, considering both the diurnal and nocturnal variations. The rule of thumb for air cooled relatively small (one to five tons for example) air conditioning systems is to employ two square feet of condenser per compressor horsepower based on the use of a condenser coil which is three tubes deep and is provided with ten fins per square inch. Conventionally, also, a cooling coil will be provided having one square foot of area for each two square feet of condenser area, with the cooling coil also being three tubes deep and having ten fins per lineal inch. This relationship is illustrative and of course may vary somewhat from installation to installation. Such a system usually operates at seventy to eighty pounds back pressure as measured at the intake side of the compressor and up to 425 pounds per square inch at the discharge side of the compressor between the compressor and condenser coil. When the evaporator pad 32 is employed, it is preferably about one to one and one-half inches in thickness so that air will readily pass through it without overloading the blower 11, and it preferably has an area approximately equal to the area of the condenser. These dimensions for the evaporative pad 32 may of course vary somewhat with the available space, particularly in an already installed system. If it is necessary to restrict the over-all area of the pad 32 it can be made somewhat thicker so that it will still supply the same required evaporative surface. If now into the system as described the pressure responsive valve 39 is introduced, installed as shown in the drawing and adjust to open at 200 pounds pressure, the back pressure on the system will normally drop to about sixty to sixty-five pounds per square inch, and the pressure at the discharge side of the compressor will normally drop to the 180 to 260 pound range depending upon the ambient temperature.

The water delivered to the trough 33 should be just sufficient to moisten the entire pad surface, allowing only a very small amount of excess, or possibly none at all during the period of maximum ambient temperature and lowest relative humidity. Any excess non-evaporated water drops to a drain board 58 where it is allowed to run off, and since it is always small in amount no problem of drainage occurs. The pipe 41 is normally dimensioned, taking into consideration the normal water pressure, so

that approximately the required amount of water will always flow through the pipe 41. I may, however, provide a separate water control valve 59, which is normally adjusted to the water flow requirements and then remains untouched.

The markedly reduced pressure in the system as described hereinabove results in decreased operating costs because of the smaller pressure against which the compressor must pump to liquify the refrigerant. When the air temperature is for example 110° the ambient temperature within the unit itself in which the compressor and condenser are housed may be as high as 140° or even 150° depending upon the location of the unit. This relatively higher temperature is due to absorption of heat from the sun's rays as well as to the generation of heat because of the work being performed by the compressor. When the ambient temperature is high and the humidity is low, the incoming air passing over the compressor and condenser may be as low as 80° so that the cooling action of the air is markedly increased. It is of course known that the higher the temperature of a gas, the greater the pressure required to condense it. I have found, however, that the operating result of the system of the present invention does not appear to be entirely a function of ambient temperature gradient. High ambient temperature coupled with relatively high humidity is not uncommon, but normally markedly high temperatures are not accompanied by correspondingly high humidities. In other words, when the humidity is up, the ambient temperature is usually somewhat lower than when the relative humidity is down. While I am unable to explain the observed facts fully, I have found by actual test that even during relatively high humidity periods in the southwest when evaporative coolers will not efficiently cool a living space, the system of the present invention still functions with marked increase in efficiency as constrasted with systems of the prior art.

When an air conditioning system is installed using the improvements of the present invention, I have found that the area of the cooling coil may also be increased thereby making it possible to utilize a lower horsepower unit to cool a given space. I have for example successfully employed a cooling coil identical with that described hereinabove in which the area was one and one-half square feet per compressor horsepower, and it appears possible to increase the cooling coil to as much as two square feet per compressor horsepower so that it will be substantially the same area as the condenser coil. Increase in the area of the cooling coil is accompanied by an increase in back pressure but the back pressure resulting is not greater than the back pressure at which systems of the prior art commonly operate. Moreover, it is possible even with an increased back pressure to still reduce the discharge pressure of the compressor of the present invention, although such discharge pressure will be somewhat higher than the discharge pressure maintained when the smaller cooling coil is used.

Regardless of the specific design of the system in which the present invention is used and the particular approach made to utilize the resulting efficiencies, there is no water scaling or other deleterious effect from the use of the water coolant. Because the water is used only intermittently and because only a small amount is employed, the total burden of hardness in the water is markedly reduced. While in evaporative coolers pads normally must be replaced or cleaned at least once or twice a year for suitable performance, the evaporative pads used in accordance with the present invention have a much longer useful life and require little or no attention. There is no added cost of power or consumption of already existing power in operating the system. While various known types of water evaporator air cooling units may be used in the practice of my invention, with or without water recirculation, I have found that for many reasons the best and simplest arrangement is the pad and tap water feed system shown.

I have shown and described one specific embodiment of

my invention in detail so that those skilled in the art may understand the manner of practicing the same, but the scope of the invention is defined by the claims.

I claim:

1. In an air conditioning system having a refrigerant compressor and air-cooled refrigerant condenser and means for delivering a stream of cooling air across the condense, an evaporative pad in the path of said air stream, a source of water under normal water system pressure and means for delivering water from said source to said pad in response to generation of a predetermined pressure in said compressor, whereby to pre-cool said stream of air by water evaporation.

2. In an air conditioning system having a refrigerant compressor with usual intake and discharge ports, an air-cooled refrigerant condenser, a connection between the compressor discharge and the condenser, a cooling coil, a connection between one side of the cooling coil and condenser, a connection between the cooling coil and intake side of the compressor, and means for passing a stream of ambient air into contact with the condenser, an evaporator pad in the path of said air stream, a source of water under normal water system pressure, and means for delivering water from said source to the evaporator pad in response to development of a predetermined refrigerant pressure in said connection between the compressor and condenser, whereby to pre-cool said stream by water evaporation before it contacts the condenser.

3. A system as defined in claim 2 wherein said water delivery means includes a pressure responsive water control valve, and a pressure control refrigerant line running from said valve to said connection between the compressor and condenser, said valve being adjusted to admit system water to the evaporator pad when the said refrigerant pressure reaches about two hundred pounds per square inch.

4. In an air-conditioning system, a refrigerant compressor and air-cooled refrigerant condenser unit including a casing having an air intake opening at one side and an air discharge opening at another side, a blower in the unit positioned to withdraw ambient air through said intake opening and exhaust it through the discharge opening to thus provide a stream of air moving through the casing, a refrigerant compressor and refrigerant condenser positioned in said air stream, an evaporating member at said intake opening, and means responsive to a predetermined pressure in the compressor to deliver water to said water evaporator member.

5. In an air conditioning system, a refrigerant compressor, an air cooled refrigerant condenser coil unit, means for continuously passing ambient air across said condenser coil to cool the same, a cooling coil having an outside area over which air to be cooled passes of at least one and one-half feet square for each horsepower of the compressor, and means for adiabatically reducing the sensible heat of said ambient cooling air passing over said condenser coil when the pressure between said compressor and condenser coil is above two hundred pounds per square inch, whereby the capacity of a cooling unit to cool a given space may be increased.

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