

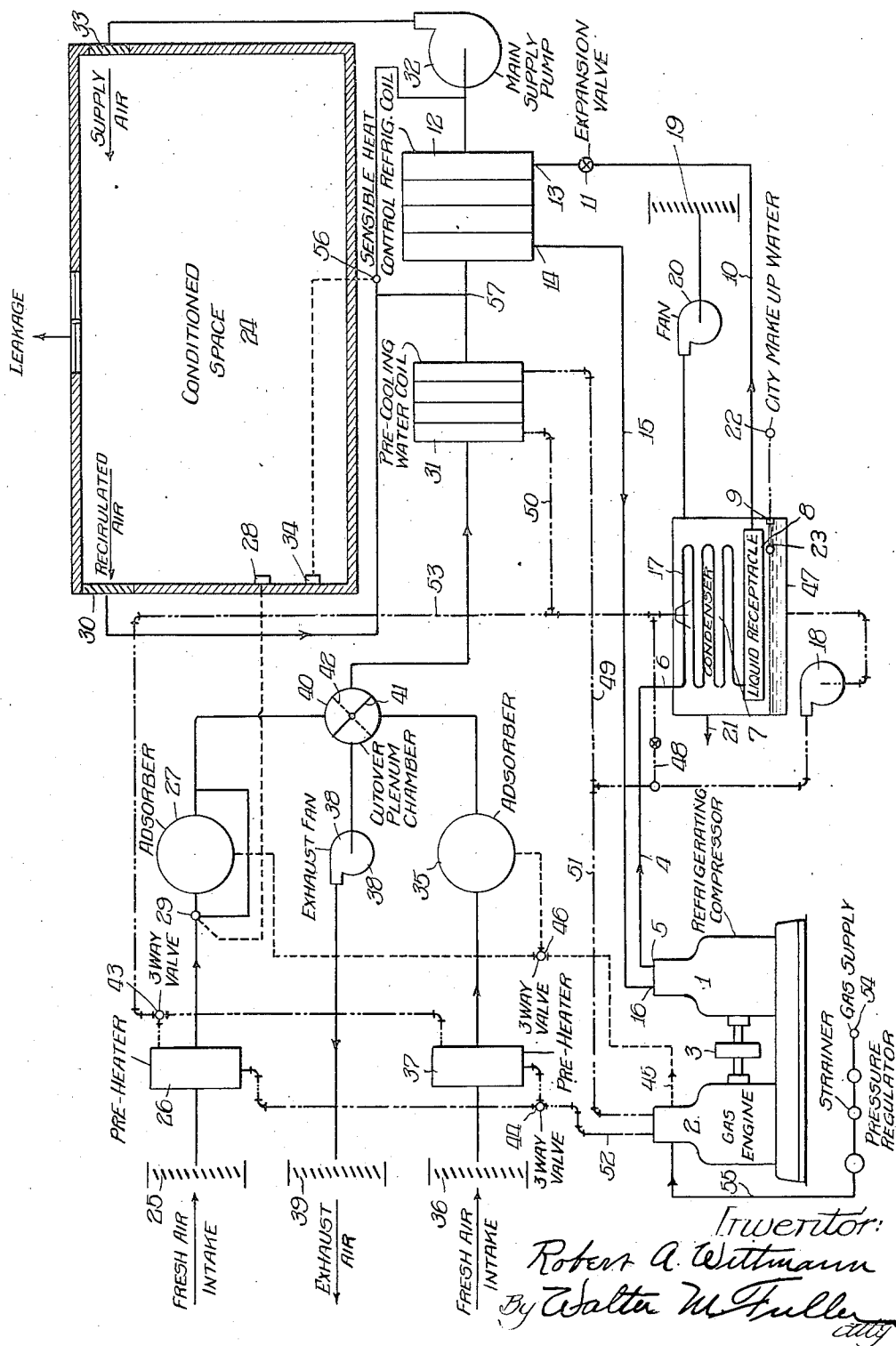
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ECONOMIZING AIR CONDITIONING CYCLE

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ECONOMIZING AIR-CONDITIONING CYCLE

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The present new and improved air-conditioning cycle is provided for the purpose of maintaining a relatively-constant, predetermined, dry-bulb-thermometer temperature and relative humidity in a room or rooms, regardless of size, and, in order to accomplish this favorable result, it is necessary to cool and dehumidify a volume of air so that the heat gain and moisture pick-up in this conditioned space will just maintain the desired condition, from which it is evident that the air entering the room or rooms will have to be colder and less humid than that of the room or rooms themselves.

Likewise, for maintaining a pleasant and comfortable atmosphere, it is advisable to supply a constant volume of fresh air from out-of-doors.

There are a considerable number of ways in which this desirable outcome may be accomplished, but the majority of these systems are expensive to operate, and, accordingly, it is one purpose of this invention to provide an air-conditioning cycle whereby an ice or refrigerating machine, driven by a gas-engine, provides the sensible cooling or maintains the dry-bulb-thermometer temperature, and the relative humidity is kept by dehumidifying with a suitable adsorptive material, reactivated by the waste-heat from the gas-engine.

The utilization of such normally unproductive or unprofitable heat for revitalizing the adsorptive agent increases the efficiency of the overall plant to the extent of the latent heat load of the air-conditioning equipment which in some installations is as high as 50% to 60% of the total load.

In addition to obtaining free or substantially expenseless dehumidification, the load on the ice or refrigerating machine is entirely sensible cooling, thereby eliminating the necessity of operating at a suction gas temperature below the dew-point temperature of the air.

In normal practice, it is necessary to operate at a suction gas temperature of the refrigerant of 45° Fahrenheit, while with the new and improved cycle of this invention, it is possible to operate at a suction gas temperature of 60° Fahrenheit, with a resultant increase in the capacity output of the refrigerating-compressor as high as 28% and a decrease in the horse-power per ton of refrigeration of 62%.

The complete cycle of the novel and improved air-conditioning plant is shown diagrammatically in the single figure of the drawing presented to enable those familiar with the art to understand the various relations between the connections of

the air, water, gas and refrigerant, and the relationship of one to the other, or others.

In this apparatus, the refrigerating-compressor 1, which may be of the reciprocatory or rotary type, and which can use any one of the many well-known refrigerants, is driven, either direct-connected, as at 3, or belt-driven, by means of a gas-engine 2, whereby the refrigerant is compressed by the compressor 1 and discharged at a relatively-high pressure into the discharge-line 4 at the point 5, such refrigerating medium flowing through such conduit 4 and entering the condenser 7 at the point 6, this condenser, which may be any one of several types, being preferably of the evaporative-condenser style, wherein the refrigerant flows inside of a series of pipes 17 and the heat is removed by the proper proportion of air and water flowing around the outside of such pipes, the water referred to being used continuously over and over again and circulated by an appropriate pump 18 of suitable design.

The air which is continuously supplied in fresh condition, is taken from out-of-doors, or from any space in the building not conditioned, at 19, and by means of a fan 20 is blown over the condenser-coils 17 and discharged out-of-doors at 21.

Such water as is evaporated into this air is supplied in the same proportions from a source of supply 22, as for instance the city water-main, and its admission to the condenser is controlled by means of a common, ball-float-operated water-valve 23.

In this condenser 7, the refrigerating agent is cooled and converted from a gas at high pressure into a liquid at the same high pressure, which is accumulated in the receiver or reservoir 8 at the lower portion of the condenser and which leaves such receiver at the point 9 and flows through a liquid line 10 to an expansion-valve 11 of the ordinary type where the pressure is reduced from the discharge pressure to the suction pressure with a resulting drop in temperature, this cold liquid entering the direct-expansion, sensible-heat-control, refrigerating-coils 12 at the point 13, and in these coils heat from the air is absorbed by the liquid refrigerant which boils into a gas at the same cold temperature (assuming no superheat).

This cold refrigerating medium leaves the coils 12 as a gas at the point 14 and flows through a suction line 15, entering the compressor 1 at the point 16, this cycle being continuously repeated with a resulting continuous production of refrigeration, the purpose of this part of the plant

being to supply refrigeration for the removal of the sensible heat from the air, which has already been dehydrated as hereinafter described, with the compressor operating at a high-suction pressure with a resultant saving of power and increase of capacity, and, at the same time, utilizing the waste heat from the gas-engine to reactivate the adsorbers and thereby increasing the general efficiency of the system as presented in detail below.

The dehumidification part of the apparatus may be described as follows:

Fresh air is taken from outside of the room 24 to be conditioned through grilles or louvers 25 and it passes through preheating-coils 26, not then in use for this particular phase of the operation, and then it flows into the adsorber 27 which is filled with an adsorbent material, such as silica-gel, activated-alumina, or lamisilite, it being a well-known fact that, when air passes through a bed of such material, the air is fully or partially dehumidified, and, in this instance, the exact amount of moisture removed can be controlled by a humidistat 28 in the room which governs a damper 29 controlling the amount of air passing through the adsorber 27.

This dehumidified air then passes over a set of water-cooled cooling-coils 31 where the sensible heat generated in the adsorber 27 and some of the heat originally in the outdoor air is removed, this dehumidified and partially-cooled air then mixing at 57 with the recirculated air 30 from the conditioned space or room 24 and passing through the direct-expansion cooling-coils 12 where it is reduced to the necessary temperature to maintain a predetermined temperature in the room 24.

This cooled and dehumidified air then flows to a fan 32 by which it is blown into the room or rooms 24 through the inlet or admission grille or grilles 33.

The dry-bulb-thermometer temperature in the room 24 is controlled by a thermostat 34 which operates a by-pass damper 56 to by-pass some of the air around the coil 12 or such control may be brought about by many other methods now in common practice.

In this cycle, there are two adsorbers, 27 and 35, and while one for example 27, is dehumidifying the air, the other 35, is being reactivated or reenergized.

Fresh air taken from the outside through the grille or louver 36 passes through preheating-coils 37 where the air temperature is increased to about 180° Fahrenheit, this heat being extracted from the water leaving the cooling-jacket of the gas-engine 2 hereinafter more fully described.

Such preheated air is then heated to about 250° Fahrenheit by the exhaust-gases from the engine 2, this being accomplished by mixing the exhaust-gases directly with the air or by means of a heat-transfer surface.

Such heated air then flows through the adsorber 35 driving the water or moisture from the adsorbent material into the air, and this air is then picked up by the action of an exhaust-fan 38 and discharged outdoors through the exhaust-louvers 39.

The operation is so arranged that one adsorber 27 is dehumidifying while the other adsorber is being reactivated, and when one adsorber is saturated, the other adsorber is cut in to dehumidify and reactivation of the first one starts, this shift from one to the other being accomplished by a cut-over plenum-chamber 40, and when ad-

sorber 27 is dehumidifying, the damper is in position as shown in full line at 41, and when adsorber 35 is dehumidifying, the damper is in a position shown in dotted line as illustrated at 42.

When adsorber 27 is dehumidifying, three-way valves 43 and 44 are so arranged that the hot water from the engine water-jacket passes through the preheating-coil 37, and, when adsorber 35 is dehumidifying, three-way valves 43 and 44 are adjusted so that the hot water passes 10 through the preheating-coil 26.

The exhaust-gases leave the gas-engine 2 at the point 45 and, when adsorber 27 is dehumidifying, the three-way valve or damper 46 directs the hot gases to adsorber 35, and, likewise when 15 adsorber 35 is dehumidifying, the hot gases are directed to adsorber 27 for reactivation.

If, in some plants, the dehumidification requirements are severe, an auxiliary heating means can be provided to supplement the deficit 20 of heat of the gases of the engine-exhaust.

The water-cycle is as follows:—The water-pump 18 takes water from the pan 47 at the bottom of the condenser 7 and discharges it to three points; pipe 48 delivering the necessary 25 volume of water over the condenser-coils 17 for the purpose of liquefying the refrigerant, the water at the pump suction being maintained at the wet-bulb-thermometer temperature of the air being blown through the condenser by fan 30 20; pipe 49 delivering the necessary water to the precooling-coil 31, this water being returned to the condenser through pipe 50; pipe 51 delivering the required volume of water to the cooling-jacket of the engine, where the temperature of 35 such water is increased to about 190° to 200° Fahrenheit, such hot water flowing out of the engine-jacket through pipe 52 to the preheating-coils, either 37 or 26, depending upon which unit is being reactivated, this, of course, preheating 40 the air for reactivation, this water now, at about 120° Fahrenheit, being returned to the evaporative-condenser 7 by means of a pipe 53 and it is cooled to the wet-bulb-thermometer temperature of the air. 45

The gas-supply to the engine 2 comes from the gas-main 54 and flows through pipe 55 to the carburetor of the engine.

Whereas the system illustrated and described in detail refers to a gas-engine, it is to be understood that the invention broadly covers the use 50 of steam, gas, vapor or other style of engine, the waste heat therefrom being employed for the purpose indicated.

By means of employment of the principles herein outlined, it will be obvious that this new invention uses a portion of the waste energy of the cooling-system to effect the reactivation of the dehydration means; or, stated somewhat differently, the invention involves the employment 60 of the cooling system economically to obtain free dehydration.

The invention, as defined in the appended claims, which should be construed as broadly as permissible by the state of the prior art, is susceptible of various modifications and changes of 65 structure and mode of operation without departure from the heart and essence of the invention and without the loss or sacrifice of any of its material benefits and advantages. 70

The term dehumidify has been used in the sense of complete or partial removal of the moisture in the air and not necessarily in the limited meaning of elimination of all moisture.

Whereas hereinbefore the appliances 27 and 75

35 have been referred to as adsorbers, it is to be understood that, if preferred, they may be absorbers, the functions of the two means being comparable.

5 I claim:

1. In an air-cooling and dehumidifying system, the combination of means to dehumidify the air to be cooled, a refrigerant-compressor, a condenser receiving the refrigerant from said compressor, means to permit expansion of the refrigerant discharged from said condenser, means to cool the dehumidified air by such expansion of the refrigerant, a heat-actuated prime-mover operating said compressor, and means employing
10 air heated by waste heat from said prime-mover to reactivate said dehumidifying means.
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2. In an air-cooling and dehumidifying system, the combination of means to dehumidify the air to be cooled, a refrigerant-compressor, a condenser receiving the refrigerant from said compressor, means to permit expansion of said refrigerant discharged from said condenser, means to cool the dehumidified air by such expansion of the refrigerant, a heat-actuated prime-mover
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operating said compressor, means to reactivate said dehumidifying-means by air heated by waste-heat from said prime-mover, and means to pre-heat said reactivating air by waste heat from said prime-mover.

3. The system presented in claim 2 in which said prime-mover is a water-cooled internal-combustion engine, said preheating-means is heated by heat extracted from the cooling-water of said engine, and said reactivating-means is heated by heat derived from the exhaust-gases of said engine.
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4. The structure presented in claim 2 in which said dehumidifying means comprises a plurality of adsorbers and means to render said adsorbers active singly, in which said waste-heat reactivates said adsorbers while they are inactive, and in which said prime-mover is a water-cooled internal-combustion engine, said preheating means is heated by heat extracted from the cooling water of said engine, and said reactivating-means is heated by heat derived from the exhaust-gases of said engine.
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