

[54] AIR CONDITIONING APPARATUS

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[58] Field of Search 165/22, 27; 62/196

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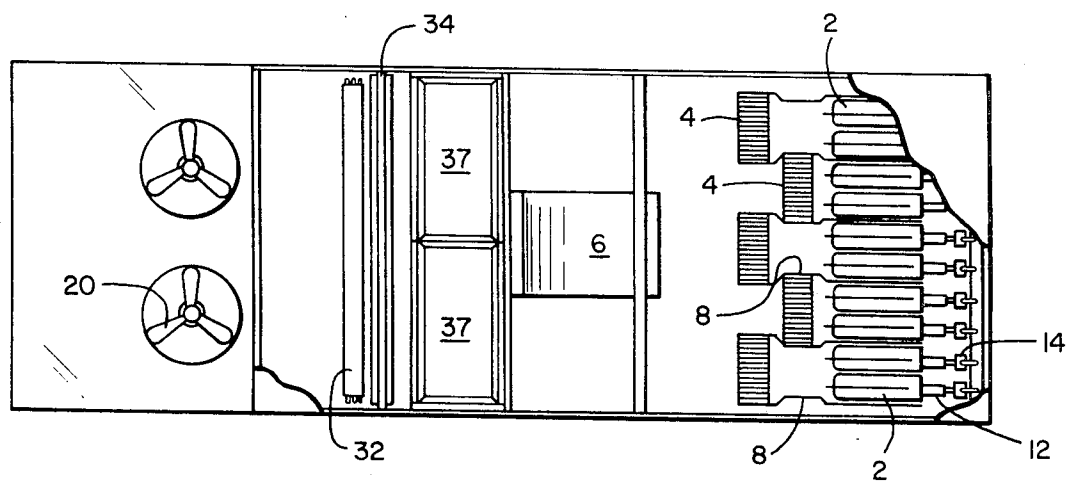
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[57] **ABSTRACT**

An air conditioning apparatus including refrigeration means and heating means for selectively heating and cooling a plurality of zones, the apparatus being provided with separate heating means and separate refrigerant evaporator coils for each zone served thereby. High pressure, hot refrigerant vapor from the refrigerant compressor may be passed through a common refrigerant coil in heat exchange relation with liquid refrigerant from the refrigerant condenser to provide a load on the compressor when the refrigeration system is energized and the load imposed thereon by the separate evaporator coils is below the safe minimal compressor load. When desired, outside air may be introduced into the system through the common refrigerant coil, the air being cooled and dehumidified by the common refrigerant coil before passage to the individual zones.

9 Claims, 3 Drawing Figures



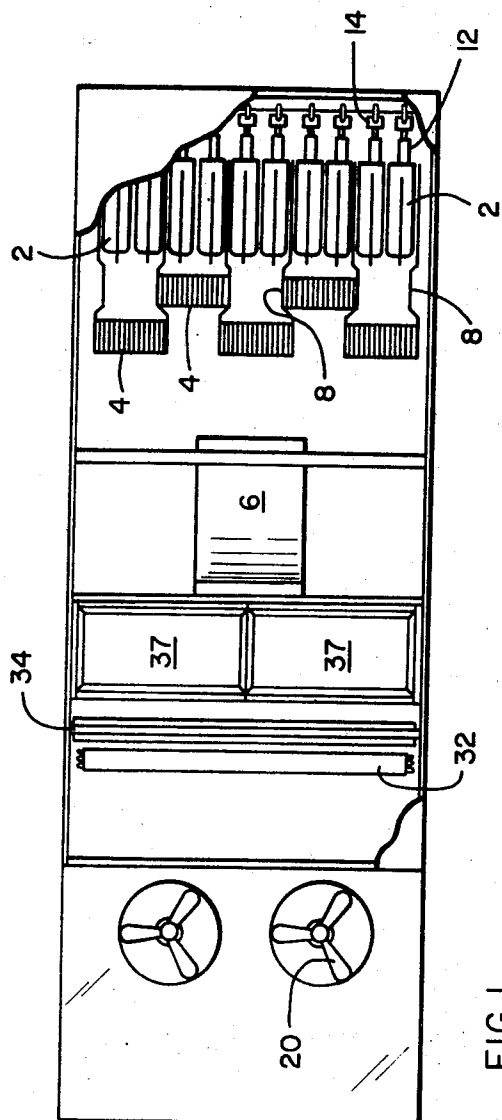


FIG. 1

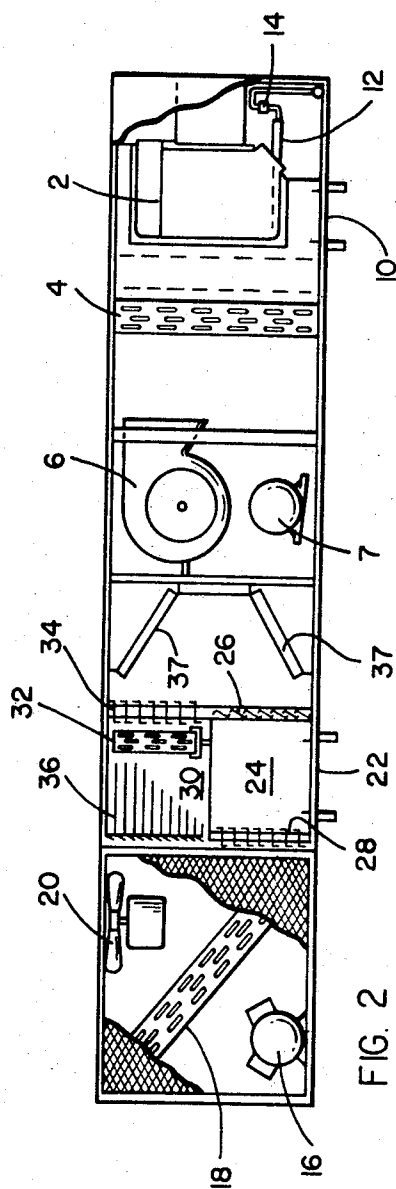


FIG. 2

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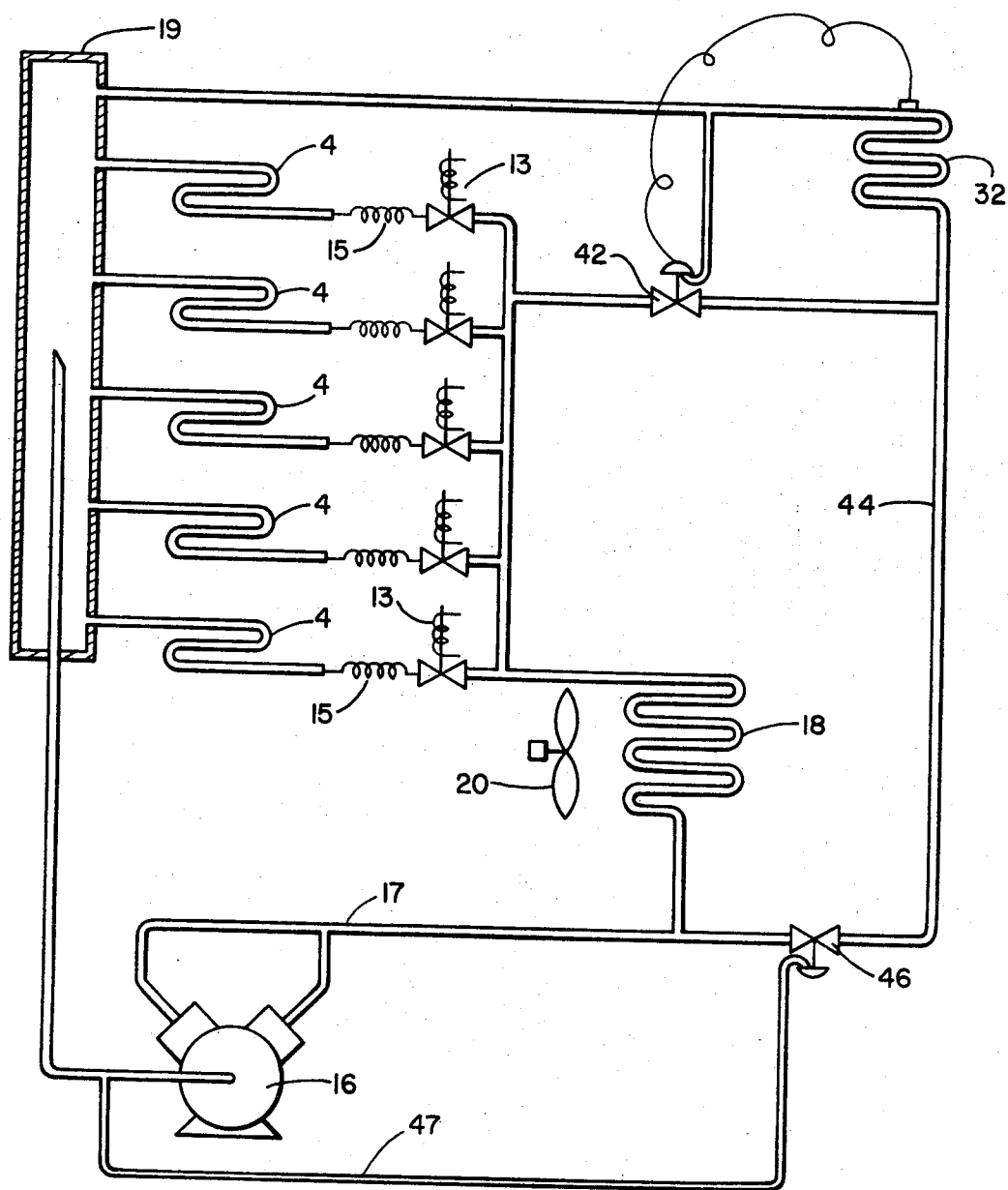


FIG. 3

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AIR CONDITIONING APPARATUS

BACKGROUND OF THE INVENTION

Self-contained air conditioning units such as roof-top units have become increasingly popular in recent years. These units are ordinarily installed on the roof of a building for air conditioning the building. In many installations, it is necessary to individually control the temperature in a plurality of zones within a building served by a single self-contained air conditioning unit. This has heretofore been accomplished by providing a large evaporator coil and a large heating element in the unit and by means of suitable dampers, providing heated or cooled air to the individual zones. However, this requires operation of both the refrigeration system and the heating system even though only one of a plurality of zones might require cooling while the other zones require heating or if only one zone might require heating while the other zones require cooling. Extremely uneconomical operation results. For example, in a unit capable of providing 120,000 British thermal units per hour (BTUH.) of cooling and 300,000 British thermal units per hour (BTUH.) of heating, the 300,000 BTUH. heating element may be energized to satisfy one zone which might have a 50,000 BTUH. heating load.

To obviate these problems, a self-contained air conditioning unit having a plurality of heating elements and a plurality of refrigerant evaporator coils may be provided. However, to provide a minimal first cost, it is desirable to employ a common compressor-condenser circuit to supply the plurality of evaporator coils. While a multiple compressor arrangement employing compressor cylinder unloaders may be employed to provide variable refrigeration capacity in response to the refrigeration load on the apparatus, it may not be practical to provide a compressor-condenser circuit having a minimum capacity equal to the minimum refrigeration load that might be imposed thereon.

SUMMARY OF THE INVENTION

This invention relates to an air conditioning apparatus for use with a plurality of zones including fan means for circulating air through the apparatus before passage thereof to the individual zones, a refrigeration system for cooling the air circulating through the apparatus including a compressor, a refrigerant condenser adapted to receive high pressure refrigerant from the compressor, a plurality of evaporator circuits, means for controlling the flow of refrigerant from the condenser to the individual evaporator circuits in response to the temperature of the zones served thereby, and heat exchange means operably associated with the refrigeration system for passage of refrigerant therethrough from the high pressure side of the refrigeration system to provide a load on the compressor which, in conjunction with the load imposed on the compressor by the evaporator circuits, is at least equal to the minimum capacity of the compressor.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of an air conditioning apparatus with portions of the cover broken away to illustrate internal components;

FIG. 2 is a view partly in section and partly in elevation of the apparatus of FIG. 1; and

FIG. 3 is a schematic view of the refrigeration circuit utilized in the apparatus illustrated in FIGS. 1 and 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, there is illustrated an air conditioning apparatus adapted to serve a plurality of zones in a building. To provide individual temperature control in each zone without the use of dampers, damper actuators, etc., a plurality of direct-fired heat exchangers 2 for heating air and a plurality of refrigerant evaporator coils 4 are provided. While direct-fired heat exchangers are disclosed, it should be understood that electric resistance elements or other heating means could be utilized in place of the direct-fired heat exchangers. A fan 6 and fan motor 7 are provided to circulate air over the evaporator coils and heat exchangers. The unit illustrated is adapted to serve up to five individual zones. To accomplish this, baffles 8 are located to provide five separate air passages downstream from fan 6. Each of the passages contains a single refrigerant evaporator coil 4 and two direct-fired heat exchangers 2. While a single evaporator coil and two direct-fired heat exchangers are illustrated in each air passage, it should be understood that any desired number of evaporator coils 4 and heat exchangers 2 could be located in each passage formed by baffles 8. Each of the individual air passages is provided with a discharge opening 10, only one of which is visible in FIG. 2.

The conditioned air from each discharge opening 10 may be supplied to the individual zone to be served thereby. While it is contemplated that each passage containing an evaporator coil 4 and two heat exchangers 2 will serve one zone, it is to be understood that a number of discharge openings may be connected to a common duct to serve a zone requiring a greater heating and cooling capacity than could be provided by a single evaporator coil and two heat exchangers.

Each heat exchanger 2 is provided with a fuel burner 12 and fuel valve 14 which are adapted for energization by thermostatic control means, not shown, located in the zone served thereby.

Referring to FIG. 3, each evaporator coil is provided with refrigerant flow control means including a solenoid valve 13 and capillary 15, each solenoid valve being controlled by the thermostatic control means located in the zone served thereby.

A refrigerant compressor 16 and condenser 18 are provided and suitably connected to evaporator coils 4 to provide liquid refrigerant thereto. An accumulator 19 is provided between the evaporator coils and the compressor to prevent passage of liquid refrigerant to the compressor. Fan means 20 are provided to circulate ambient air over condenser 18 to condense the refrigerant therein.

Air from the individual zones is returned to the apparatus through opening 22 into a chamber 24. The chamber 24 is provided with dampers 26 and 28. A second chamber 30 is provided with a heat exchanger 32 as hereinafter explained, and a damper 34 is also provided. To provide fresh air to the individual zones, dampers 28 and 34 are opened to allow fan 6 to draw fresh air through outside air grille 36, heat exchanger 32, and damper 34 for passage over heat exchangers 2 and evaporator coils 4. Filters 37 are provided to filter the air supplied to fan 6.

Due to the restriction to air flow created by condenser 18, when dampers 28 are open, the fan 20 draws air from the individual zones through opening 22 and damper 28 and exhausts the air from the apparatus.

If it is desired to recirculate the air from the individual zones, dampers 28 and 34 may be closed and damper 26 may be opened so that fan 6 draws air from chamber 24 rather than through grille 36, heat exchanger 32 and dampers 34. It should be understood that the dampers 26, 28 and 34 may be modulated to provide any desired mixture of recirculated and fresh air to the individual zones rather than 100 percent fresh air or 100 percent recirculated air as described.

The heat exchanger 32 is important for operation of the air conditioning apparatus at less than capacity. Referring to FIG. 3, when one or more zones are being cooled by the apparatus, liquid refrigerant may be provided to heat exchanger 32 through thermal expansion valve 42 to pre-cool and dehumidify the fresh air drawn in through grille 36.

If only one of the evaporator coils 4 is energized, the load on the compressor may be below the safe minimum compressor loading, causing excessively low suction pressures and insufficient refrigerant flow to the compressor. To prevent this problem, heat exchanger 32 is also connected to the compressor discharge through line 44. When compressor suction pressure decreases to the minimal desired pressure, the pressure in a line 47 leading from the compressor inlet decreases accordingly, and effects the opening of a bypass valve 46 disposed between compressor line 17 and line 44. The opening of valve 46 allows hot gas to pass to the heat exchanger to increase the suction pressure and prevent freeze up of the evaporator coils 4 and 32. The thermal expansion valve 42 feeding liquid refrigerant to heat exchanger 32 will open to automatically provide sufficient liquid refrigerant flow to the heat exchanger to cool the hot refrigerant gas from the compressor. This will increase suction pressure and the quantity of refrigerant supplied to the compressor to prevent low suction pressure and the resultant evaporator coil freeze up and provide sufficient refrigerant flow through the compressor for cooling purposes.

Thus, an air conditioning unit is provided which is capable of simultaneously satisfying both a heating load and a cooling load while preventing excessively low suction pressures when a minimal cooling load is imposed thereon.

While we have described a preferred embodiment of our invention it is to be understood that the invention is not limited thereto, but may be otherwise embodied within the scope of the following claims.

We claim:

1. An air conditioning apparatus adapted to treat a plurality of zones, said apparatus comprising:
 - A. a housing
 - B. first fan means disposed within said housing for forcing air therethrough before passage thereof to the individual zones;
 - C. a refrigeration system within said housing for cooling the air forced therethrough, said refrigeration system including:
 1. refrigerant compression means;
 2. a refrigerant condenser adapted to condense high pressure refrigerant vapor from said compression means;

3. a plurality of evaporator circuits receiving refrigerant from said condenser, each circuit being adapted to serve an individual zone; and
 4. means for controlling the flow of refrigerant from the condenser to the individual evaporator circuits;
 - D. a plurality of separate heating means disposed within said housing serving separate zones;
 - E. baffle means forming a plurality of passages within said housing, each passage containing at least one of said evaporator circuits and at least one of said heating means for passage of air thereover from said first fan means, each of the air passages being adapted for communication with a zone served by the apparatus; and
 - F. damper means adapted to regulate the proportion of air returned from the individual zones and the proportion of outside air supplied to said first fan means.
2. An air conditioning apparatus according to claim 1 further including an outside air inlet formed in said housing;
 - a heat exchange coil disposed between said outside air inlet and said first fan means; and,
 - means for passing refrigerant from said condenser through said heat exchange coil in heat exchange relation with outside air passed thereover for cooling and dehumidifying the outside air before passage thereof to said first fan means.
 3. An air conditioning apparatus according to claim 1 and further including:
 - second fan means for circulating outside air over said condenser to condense refrigerant therein; and
 - means forming a mixing chamber in said housing, said mixing chamber being supplied with return air from the zones served by the apparatus; and wherein said damper means includes:
 - a first damper disposed between said mixing chamber and said first fan means for regulating the quantity of return air supplied to said fan means;
 - a second damper for communicating said mixing chamber with said second fan means, said second damper being located for passage of air from said mixing chamber to a location downstream from said condenser and upstream from said second fan means for drawing return air from said mixing chamber and exhausting the return air to atmosphere;
 - an outside air inlet formed in said housing; and
 - a third damper disposed between said air inlet and said first fan means, said third damper regulating the amount of outside air supplied to said first fan means.
 4. An air conditioning apparatus according to claim 3 further including a heat exchange coil disposed between said outside air inlet and said first fan means; and means for passing refrigerant from said condenser through said heat exchange coil in heat exchange relation with outside air passed thereover for cooling and dehumidifying the outside air before passage thereof to said first fan means.
 5. An air conditioning apparatus for use with a plurality of zones, said apparatus comprising:
 - A. a housing;
 - B. fan means for forcing air through said housing before passage thereof to the individual zones;

- C. a refrigeration system for cooling the air forced through the apparatus, said refrigeration system including:
1. compression means;
 - 2 a refrigerant condenser adapted to receive high pressure refrigerant from said compression means;
 3. a plurality of evaporator circuits receiving refrigerant from said condenser and transmitting refrigerant to said compression means; and
 4. means for controlling the flow of refrigerant from said condenser to the individual evaporator circuits and;
- D. heat exchange means operatively associated with said refrigeration system for passage of refrigerant therethrough from the high pressure side of the refrigeration system to provide a load on said compression means which, in conjunction with the load imposed on said compression means by said evaporator circuits, is at least equal to the minimum capacity of said compression means.
6. An air conditioning apparatus according to claim 5 further including means for introducing outside air into said system across said heat exchange means; and refrigerant expansion means for regulating flow of refrigerant from said condenser to said heat exchange means.
7. An air conditioning apparatus according to claim 6 further including valve means adapted to regulate flow of refrigerant vapor from said compression means to said heat exchange means to increase the load on said heat exchange means so that the load imposed

thereby on said compression means is at least equal to the minimum capacity of said compression means.

8. An air conditioning apparatus according to claim 5 further including refrigerant expansion means for regulating the flow of refrigerant from said condenser to said heat exchange means, and valve means adapted to regulate flow of refrigerant vapor from said compression means to said heat exchange means to provide a minimum load on said compression means.

9. An air conditioning apparatus including:

- A. a compressor for compensating hot gaseous refrigerant;
- B. a condenser operatively connected to said compressor for condensing refrigerant received from said compressor;
- C. evaporator means for absorbing heat from the space surrounding said evaporator, said evaporator receiving refrigerant from said condenser for transfer to said compressor; and
- D. means for maintaining a minimum load on said compressor said means comprising:
 1. heat exchange means for normally receiving refrigerant flow from said condenser;
 2. means actuable for transmitting refrigerant from the discharge side of said compressor to said heat exchange means to provide a load on said compressor; and
 3. means responsive to minimum load conditions on said compressor for actuating said transmitting means.

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