July 7, 1959 J. R. HARNISH 2,893,218

AIR CONDITIONING SYSTEMS

Filed Feb. 21, 1958 3 Sheets-Sheet 1

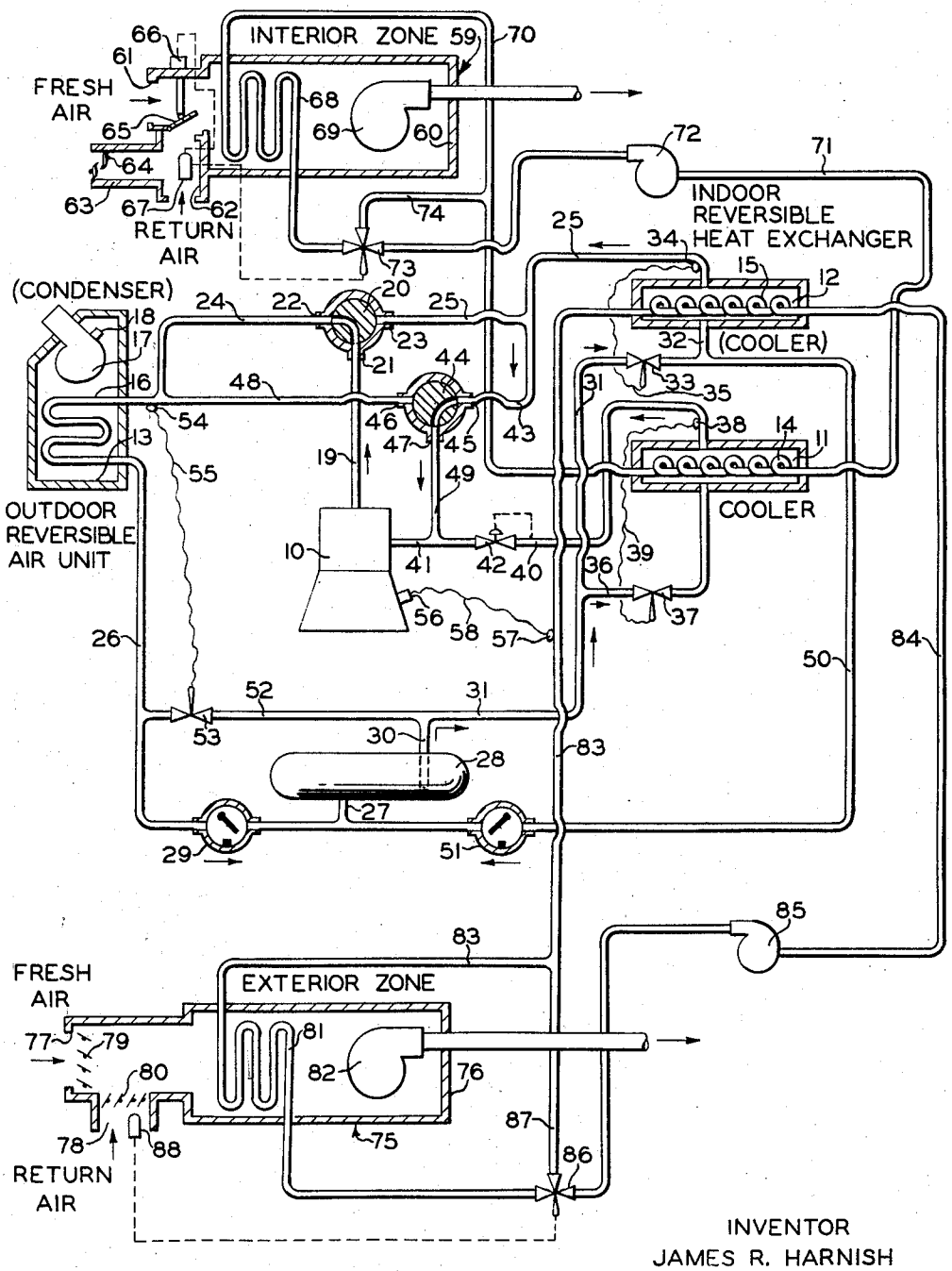


FIG. 1

INVENTOR
JAMES R. HARNISH
BY
ATTORNEY

July 7, 1959 J. R. HARNISH 2,893,218

AIR CONDITIONING SYSTEMS

Filed Feb. 21, 1958 3 Sheets-Sheet 2

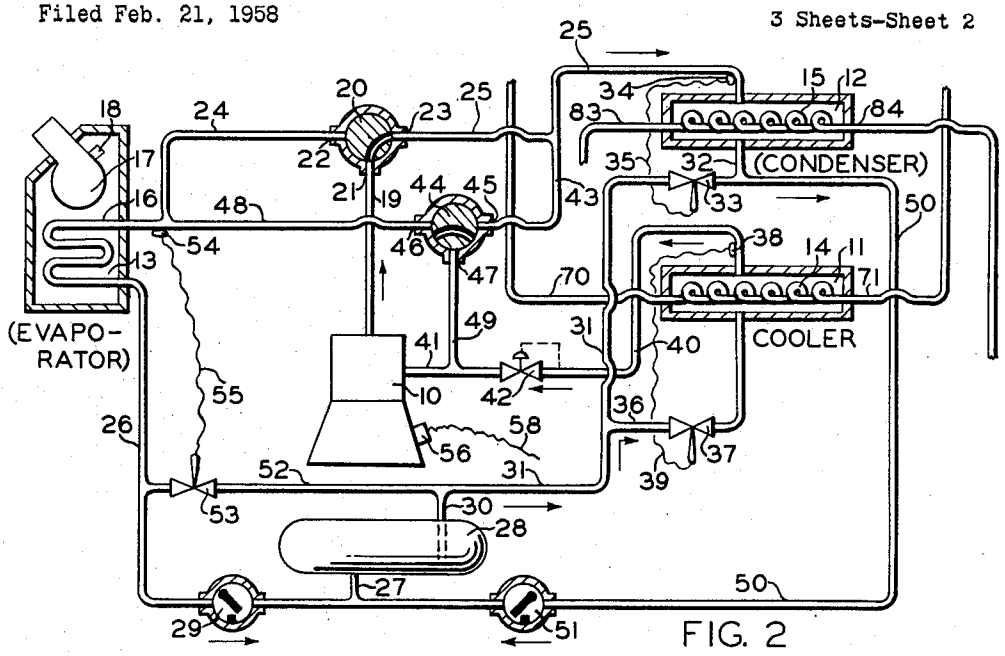


FIG. 2

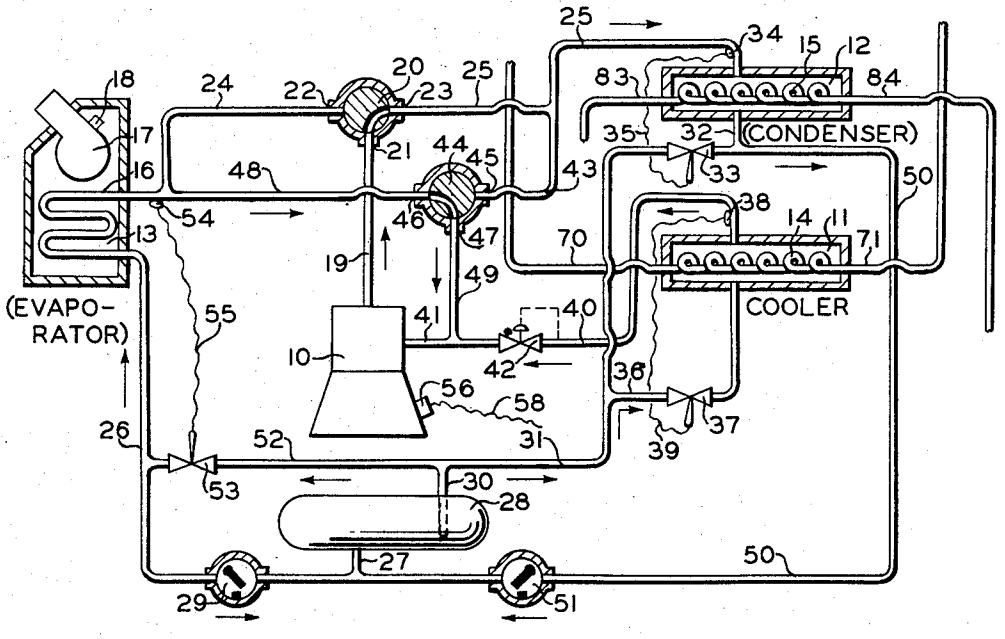


FIG. 3

INVENTOR
JAMES R. HARNISH
BY
Sidney N. Rosenfeld
ATTORNEY

July 7, 1959 J. R. HARNISH 2,893,218

AIR CONDITIONING SYSTEMS

Filed Feb. 21, 1958 3 Sheets-Sheet 3

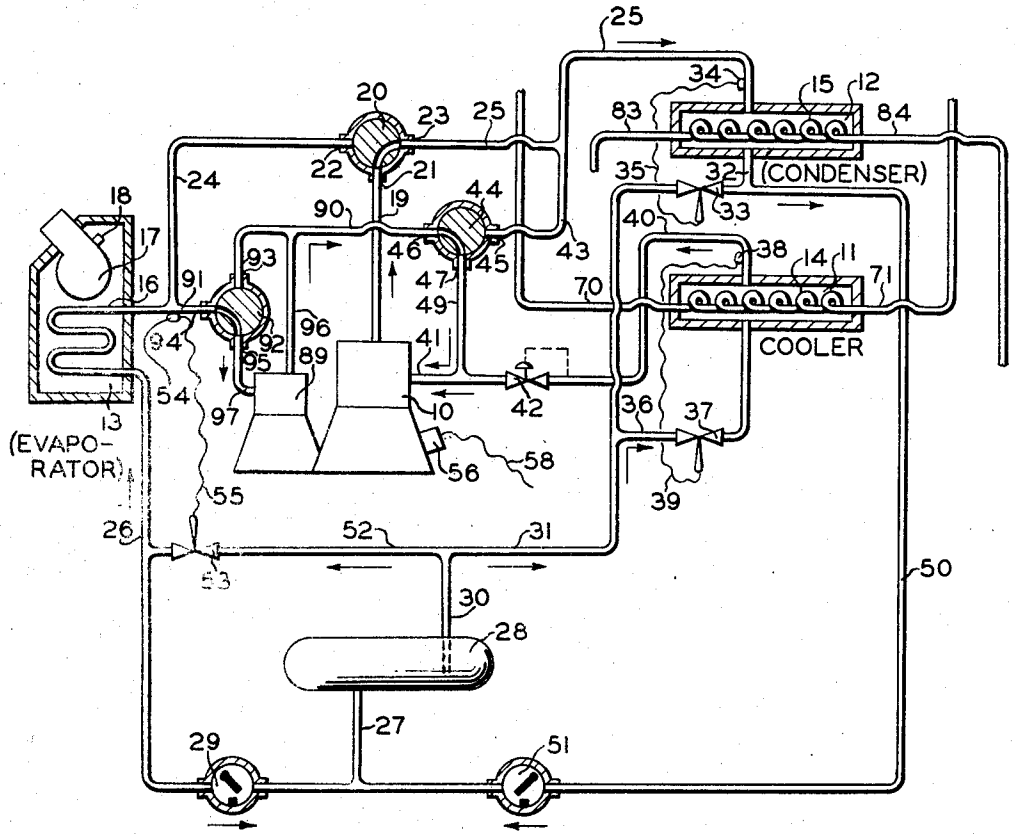


FIG. 4

INVENTOR
JAMES R. HARNISH
BY
Sidney N. Rosenfeld
ATTORNEY

United States Patent Office

2,893,218

Patented July 7, 1959

2,893,218

AIR CONDITIONING SYSTEMS

James R. Harnish, York, Pa., assignor to Borg-Warner Corporation, Chicago, Ill., a corporation of Illinois

Application February 21, 1958, Serial No. 716,653

15 Claims. (Cl. 62—180)

This invention relates to air conditioning systems for year-round conditioning of multi-room buildings and particularly to that type of system utilizing a reversible refrigerating apparatus.

Generally, in air conditioning a multi-room building, it will be found that portions of the building, such as an interior zone, will require year-round cooling while the exterior zone, or perimeter portion of the building, will require cooling during a portion of the year and heating during the remainder of the year. It will be apparent that during that time of the year that the exterior zone requires heating, operating economies can be effected if the heat removed from the interior zone were made available for heating the exterior zone. Such systems are well known and have heretofore been proposed.

It is also well known that a reversible refrigerating apparatus may be utilized to both heat and cool a building. Operated normally, the refrigerating apparatus removes heat from the interior of the building and dissipates it to the exterior. When heating of the building is required, the apparatus may be reversed operating as a heat pump and picking up heat from outside air. In heating with such a reversible refrigerating apparatus and particularly that type utilizing outside air as a heat source, a primary disadvantage is that as the outside temperature drops and heating requirements increase, the available heat decreases. While this disadvantage is not present in that type of reversible refrigerating apparatus using water as a heat source, generally speaking, sufficient water is not available for the purpose and outside air must be relied on.

I propose an air conditioning system combining the advantages of the above two systems. Although it is subject somewhat to the disadvantage of a conventional heat pump system in that heat must be picked up from the outside air, this is alleviated to a great degree since complete advantage is taken of the internal heat available. Outside air is used as a heat source only to the extent that there is insufficient heat available from the interior zones. The higher the internal heat load of the building in relation to the heat requirements of the exterior zone, the more efficient the system becomes.

It is an object of the invention, therefore, to provide an air conditioning system for multi-room buildings having an interior zone comprising a refrigerating system for cooling the interior zone and operable to utilize heat removed therefrom for heating the exterior zone and also operable for removing heat from outside air to aid in heating the exterior zone when there is insufficient heat removed from the interior zone for providing the total heat requirements of the exterior zone.

It is a further object of the invention to provide a refrigerating system for heating a building and comprising a cooler, an indoor heat-exchanger and an outdoor air unit, and means for operating the indoor heat-exchanger as a condenser and for operating the outdoor air unit as a refrigerant evaporator in parallel with the cooler.

A still further object of the invention is to provide a

reversible refrigerating system for conditioning a building comprising a cooler, an indoor reversible heat-exchanger and an outdoor reversible air unit, all connected in a closed refrigerant circuit, and means for operating the indoor reversible heat-exchanger as a cooler or condenser and for operating the outdoor reversible air unit as a condenser or evaporator. When the indoor heat-exchanger operates as a cooler, the outdoor heat-exchanger operates as a condenser. When the indoor heat-exchanger operates as a condenser, the outdoor heat-exchanger is either inoperative or operative as a refrigerant evaporator to pick up heat from outside air.

Yet another object is to provide a reversible refrigerating system of the type just above-mentioned, wherein compression means are provided operable to compress refrigerant flowing from the cooler to the indoor heat-exchanger (when functioning as a condenser) in a single stage of compression, and operable to compress refrigerant flowing from the outdoor air unit (when functioning as an evaporator) to the indoor heat-exchanger (when functioning as a condenser) in plural stages of compression.

In carrying out the invention, separate air treating units are provided for the interior and exterior zones. Each unit includes a heat-exchange coil and a fan. A mixture of recirculated air and fresh air flows over the heat-exchange coils and then is delivered by each fan to its respective zone. A refrigerating apparatus is provided including a water cooler, an indoor, reversible heat-exchanger operable either as a water cooler or a water-cooled condenser, and an outdoor air unit operable as a refrigerant condenser or evaporator. Water chilled in the water cooler is connected in a closed circuit with the heat-exchange coil in the interior zone air treating unit. Water chilled or heated in the indoor, reversible heat-exchanger is connected in a closed circuit with the heat-exchange coil in the exterior zone air treating unit. During that time of the year that both zones require cooling, the indoor, reversible heat-exchanger operates as a water cooler and the two coolers then operate in parallel. One cooler absorbs heat from water circulated through the interior zone air treating unit coil and the other absorbs heat from water circulated through the exterior zone air treating unit coil. Both reject this heat to the outdoor air unit operating as a condenser.

At such times of the year as the exterior zone requires heating and sufficient heat is available for this purpose from the interior zone, then the outdoor air unit is shut down and the indoor, reversible heat-exchanger operates as a condenser. The cooler is then utilized to absorb heat from the water circulated in the closed circuit including the interior zone air treating unit coil, which heat is then rejected to the indoor, reversible heat-exchanger functioning as a condenser. The water circulated in the closed circuit, including the exterior zone air treating unit coil, absorbs the heat picked up by the cooler and rejected to the indoor, reversible heat-exchanger by the compressor. This heat is dissipated to the air passing over the exterior zone air treating unit coil for heating the air.

During such times of the year that there is insufficient heat available from the interior zone to heat the exterior zone, then the outside air unit operates as an evaporator in parallel with the cooler. Both the cooler and the evaporator then reject their heat to the indoor, reversible heat-exchanger, which still functions as a condenser. As before, the water circulated in the closed circuit including the exterior zone air treating unit coil, absorbs the heat and dissipates it to the air flowing over the coil to heat the air.

The invention consists of the novel constructions, arrangements and devices to be hereinafter described and claimed for carrying out the above-stated objects and

such other objects as will appear from the following description of preferred embodiments of the invention described with reference to the accompanying drawings, in which:

Fig. 1 is a schematic representation of an air conditioning system according to the invention;

Fig. 2 is a schematic representation of the refrigerating apparatus as shown in Fig. 1, but on an intermediate cycle of operation;

Fig. 3 is a view similar to Fig. 2 showing the winter cycle of operation; and

Fig. 4 is a view comparable to Fig. 3 showing a modification thereof.

Like numerals refer to like parts throughout the several views.

Turning now to Fig. 1, the refrigerating apparatus comprises a compressor **10**, a water cooler **11**, an indoor, reversible heat-exchanger **12** functioning as a water cooler or a water-cooled condenser, and an outdoor air unit **13** functioning as a refrigerant evaporator or condenser. Hereinafter, the heat-exchanger **12** will be denoted a cooler or condenser depending on its then function, and the outdoor air unit **13** will be denoted an evaporator or condenser depending on its function. It will be appreciated that when the heat-exchanger **12** functions as a cooler the air unit **13** functions as a condenser. Conversely, when the heat-exchanger **12** functions as a condenser, the air unit **13** functions as an evaporator when in operation. Cooler **11** includes a water coil **14** therein and the heat-exchanger **12** includes a water coil **15** therein. The outdoor air unit **13** includes a refrigerant coil **16** and a fan **17**. A switch **18** is provided for controlling the operation of fan **17**.

A hot gas line **19** leads from the discharge of compressor **10** and connects to a three-way valve **20** including junctions **21**, **22** and **23**, with line **19** being received in junction **21**. The second junction **22** of three-way valve **20** receives a line **24**, which is connected to one end of refrigerant coil **16**. The third junction **23** of three-way valve **20** receives a line **25**, which communicates with the heat-exchanger **12**.

The other end of refrigerant coil **16** is connected to a line **26** which joins a line **27** leading into the inlet of a refrigerant receiver **28**. Flow through line **26** is controlled by a one-way valve **29**. An outlet line **30** leads from receiver **28** and joins with a line **31**. Line **31** is connected to a line **32** communicating with the heat-exchanger **12**. Refrigerant flow through line **31** en route to heat-exchanger **12** is controlled by a conventional expansion valve **33**. Expansion valve **33** includes a bulb **34** located on line **25** adjacent heat-exchanger **12**. Bulb **34** is connected to valve **33** by way of a capillary **35**, all as is old and well-known in the art.

A line **36** including an expansion valve **37** extends between line **31** and cooler **11**. Expansion valve **37** has a bulb **38** attached thereto by way of a capillary **39** for controlling flow of liquid refrigerant through line **36**. A line **40** extends from cooler **11** to a line **41** leading to the inlet of compressor **10** with the aforementioned bulb **38** being located on line **40** immediately adjacent cooler **11**. Line **40** includes a suction pressure regulating valve **42**.

A line **43** leads from the line **25**, which extends between valve **20** and heat-exchanger **12**. Line **43** is connected to a three-way valve **44** including junctions **45**, **46** and **47**, with line **43** being received in junction **45**. Junction **46** receives a line **48** which terminates in line **24**. Junction **47** receives a line **49** which connects with line **41**.

A line **50** extends between lines **32** and **27** for receiving liquid refrigerant from heat-exchanger **12** when operating as a condenser. Line **50** includes a one-way valve **51** for controlling the flow of refrigerant therethrough. A line **52** leads from the juncture of lines **30** and **31** to line **26** for the flow of liquid refrigerant from receiver **28** to the outdoor air unit **13** when the latter operates as an evaporator. Line **52** includes a thermostatic expansion valve **53**. Expansion valve **53** comprises a bulb **54** located on refrigerant coil **16** adjacent one end thereof. Bulb **54** is connected to valve **53** by way of the customary capillary **55**.

A capacity controller **56** is provided for compressor **10** and includes a bulb **57** connected thereto by way of a capillary **58**. All of the various bulbs and capillaries recited contain a volatile fluid so chosen that it will develop a suitable pressure at the desired temperature of the refrigerant flowing within the various lines. The pressure thus developed in the bulb is transmitted through the capillary tube to actuate the various expansion valves or capacity controller, as the case may be.

An air treating unit **59** is provided for properly conditioning air delivered to the interior zone of the building. Air treating unit **59** comprises a casing **60** having a fresh air inlet **61** and a return air inlet **62**. Return air inlet **62** is provided with a recirculated air outlet **63** leading to the exterior of the building with flow through outlet **63** being controlled by damper mechanism **64**. A damper **65** is provided to properly proportion flow of air through fresh air inlet **61** and return air inlet **62**. Damper **65** is so positioned that the flow of fresh air can never be completely cut off, thereby always providing for the minimum ventilation requirements, except during those times that the building may be unoccupied. The proper positioning of damper **65** is effected by way of a damper control mechanism **66** controlled by a thermostat **67** located in the return air stream.

Air treating unit **59** includes a water coil **68** and a fan **69** of suitable capacity for drawing a mixture of fresh and return air through casing **60** and over coil **68** for delivery to the interior zone. The outlet of coil **68** is connected by a line **70** to the inlet of coil **14** located in cooler **11**. The inlet of coil **68** is connected to the outlet of coil **14** by way of a line **71** having a pump **72** and a modulating valve **73** therein. Modulating valve **73** has a bypass line **74** connected thereto for bypassing water around coil **68** and into line **70**. The operation of modulating valve **73** is controlled by the aforementioned thermostat **67**.

An air treating unit **75** is provided for properly conditioning the air supply to the exterior zone. Unit **75** includes a casing **76** having a fresh air inlet **77** and a return air inlet **78** controlled by suitable dampers **79** and **80** respectively. Air treating unit **75** comprises further a water coil **81** and a fan **82**. Fan **82** is sized to provide for the proper flow of fresh air and return air through casing **76** and over water coil **81** for delivery to the exterior zone rooms. Coil **81** has the outlet thereof connected by way of a line **83** to the inlet of coil **15** in heat-exchanger **12**. Bulb **57**, which effects the proper positioning of controller **56** is located on line **83**. A line **84** joins the inlet of coil **81** with the outlet of coil **15**. Line **84** includes a pump **85** and a modulating valve **86**. A bypass line **87** is provided from modulating valve **86** to return line **83** for bypassing water around coil **81**, depending on the position of valve **86**. Valve **86** is controlled by a thermostat **88** located in the return air stream.

In those buildings located in extremely cold climates, it might be desirable to provide for multi-stage compression in order to efficiently remove heat from the outside air. This can be accomplished very simply as is shown in Fig. 4 by providing a booster compressor **89**. Line **48**, as shown in Figs. 1–3 is replaced by lines **90** and **91** interconnected by a three-way valve **92** having junctions **93**, **94** and **95**. Line **90** is connected with junction **93** and line **91** is connected with junction **94**. The discharge of compressor **89** is connected to line **90** by way of a hot gas line **96** and the inlet to the compressor is connected by way of a line **97** to junction **95** of three-way valve **92**.

Operation

The system operates on three different cycles of operation: summer, winter and intermediate.

The summer cycle is that time of year when cooling is required in both the interior and exterior zones of the building. The winter cycle is that time of year wherein the outside air temperature is such that the total heat rejected from the interior zone is less than the heating requirements of the exterior zone. During the winter cycle the heat available from the internal zone must then be supplemented by heat picked up from the outside air. The intermediate cycle of operation is that time of the year when the exterior zone requires heating, with sufficient heat being available for that purpose from the interior zone.

Turning now to Fig. 1, the operation on the summer cycle will be described. Valves **20** and **44** are set as shown. Indoor reversible heat-exchanger **12** is operating as a water cooler and outdoor air unit **13** is functioning as a refrigerant condenser. Cooler **11** is in operation to chill water flowing through coil **14**. Hot gaseous refrigerant compressed by compressor **10** flows through line **19** and is then directed by a valve **20** into line **24**. From line **24** the hot gas flows through coil **16** wherein it has its heat removed by the outside air flowing thereover under the influence of fan **17**. The now condensed refrigerant liquid exits coil **16** by way of line **26** flowing past one-way valve **29** and through line **27** into receiver **28**. The liquid refrigerant then exits receiver **28** by way of lines **30** and **31**, with part continuing on to cooler **12** via line **32** and part flowing through line **36** to cooler **11**. The refrigerant liquid has its pressure and corresponding temperature reduced in flowing through expansion valves **33** and **37** respectively. The cold refrigerant liquid within coolers **11** and **12** then removes the heat from the water flowing through coils **14** and **15** respectively, becoming vaporized thereby. The gas leaves cooler **11** by way of line **40** flowing thence into line **41** back to the inlet of compressor **10**. Refrigerant gas within cooler **12** exits therefrom by way of line **25** flowing thence into line **43**. From line **43** it is directed by valve **44** into line **49** from whence it merges with the gas from cooler **11** in line **41** to complete the cycle.

The suction pressure regulating valve **42** maintains a constant suction pressure within cooler **11** to provide a supply of chilled water therefrom at a fairly constant temperature and to insure that no freeze ups occur in cooler **11** under light loads, all as is customary in the refrigerating art.

Water chilled in cooler **11** is pumped by pump **72** through coil **68** and thence through line **70** back to the inlet of coil **14** to complete the chilled water cycle. Modulating valve **73**, under the control of thermostat **67** permits only so much water to flow through coil **68** as is needed to cool down the air flowing thereover to the desired temperature. The remainder of the water is bypassed around coil **68** by way of line **74**. Damper **65** is in a position to allow flow of fresh air into air treating unit **59** only in sufficient quantities to satisfy ventilation requirements. The mixture of fresh and recirculated air properly conditioned in flowing over coil **68** is then delivered by fan **69** to the various rooms in the interior zone served thereby.

The chilled water in coil **15** is pumped through coil **81** in the exterior zone air treating unit under the influence of pump **85**. Air flowing through air treating unit **75** under the influence of fan **82** has its heat removed by the chilled water flowing through coil **81** and is then delivered by fan **82** to the exterior zone rooms. Modulating valve **86** permits only sufficient water to flow through coil **81** as will satisfy the requirements of thermostat **88**. Dampers **79** and **80** are positioned to allow only sufficient fresh air flow to satisfy ventilation requirements.

As the outside air temperature drops, the system goes on the intermediate cycle, as is shown in Fig. 2. Three-way valve **20** is rotated to communicate lines **19** and **25** and three-way valve **44** is positioned so that there can be no flow therethrough. Fan **17** in the outdoor air unit **13** is inoperative under the control of switch **18** and the outdoor air unit is therefore also inoperative. Refrigerant compressed by compressor **10** flows through line **19** and is then directed by three-way valve **20** into line **25** whence it flows into heat-exchanger **12** now functioning as a water-cooled refrigerant condenser. The refrigerant gives up its heat to the water flowing through coil **15** becoming condensed thereby. The now liquid refrigerant leaves condenser **12** by way of lines **32** and **50**, flowing past one-way valve **51** and through line **27** into receiver **28**. The liquid refrigerant in receiver **28** exits therefrom by way of line **30** and then flows via lines **31** and **36** into cooler **11**. In its passage through line **36**, the refrigerant flows through expansion valve **37** whereby its pressure and corresponding temperature are reduced. The cold refrigerant liquid within cooler **11** then serves to remove heat from the water flowing through coil **14**, becoming vaporized thereby. The gas then flows through lines **40** and **41** back to the inlet of compressor **10** to complete the cycle.

Heated water flowing through coil **15** of condenser **12** is then utilized in coil **81** of the exterior zone air treating unit **75** to heat air flowing thereover under the influence of fan **82** for delivery to the exterior zone in order to provide the necessary heating.

Chilled water flowing through coil **14** of water cooler **11** then flows through coil **68** in the interior zone air treating unit **59** to cool air flowing thereover under the influence of fan **69**. The properly cooled air will then be delivered by the fan to the various rooms of the interior zone.

Compressor **10** has its capacity reduced by controller **56** to a point where the refrigerating apparatus only removes sufficient heat from the interior zone to just satisfy the heating requirement of the exterior zone. Suction pressure regulating valve **42** will insure that no freeze ups occur during this period of operation.

It will be borne in mind that down to the temperature at which the system goes on the winter cycle, there will be more heat rejected from the interior zone than is needed by the exterior zone. The system, of course, goes on the winter cycle when the heat rejected from the interior zone just balances the heat required by the exterior zone. Below this temperature the requirements of the exterior will be greater than can be supplied solely by the interior zone. Bulb **57** operates to maintain a desired temperature of the heated water flowing through line **83**. Should the temperature of the water rise, indicating that too much heat has been absorbed by cooler **11** and rejected by compressor **10** to condenser **12** for absorption by the water flowing through coil **15**, then controller **56** operates to reduce the capacity of compressor **10**. Any well known capacity reduction device can be utilized; for example, the compressor unloading device disclosed in Patent No. 2,526,922. Should the temperature of the water flowing through line **83** drop, then controller **56** operates to increase the capacity of compressor **10**.

Any additional cooling required in the interior zone, because of the reduction in capacity of compressor **10**, will be supplied by increasing the quantity of fresh, cold air allowed to pass through air treating unit **59** en route to the interior zone rooms. With valve **73** open to permit full flow of chilled water through coil **68**, should this be insufficient to provide adequate cooling, then thermostat **67** will operate on damper control mechanism **66** to reposition damper **65** to permit a greater quantity of cold air to flow through the air treating unit to provide the additional cooling.

It will be apparent that when a greater than normal quantity of fresh air is brought into the interior zone of the building, under the circumstances as set out just above, some means must be provided for exhausting excess air from the building. This is taken care of by

the recirculated air outlet 63. Dampers 64 are of the spring balanced type and when the pressure within outlet 63 builds up sufficiently to force dampers 64 open, the excess air exits the building. A positive exhaust fan (not shown) may also be provided for this purpose.

As the outside air temperature continues to drop, it eventually reaches a point where the system goes on the winter cycle, as shown in Fig. 3 and to which reference is had. Valve 20 is set to provide communication between lines 19 and 25 and valve 44 is set to provide communication between lines 49 and 48. Switch 18 is actuated to place fan 17 into operation and the outdoor air unit is therefore operative as a refrigerant evaporator. Refrigerant compressed by compressor 10 flows through line 19 whence it is directed by valve 20 into line 25. From line 25 the gas flows through heat-exchanger 12 functioning as a refrigerant condenser, giving up its heat to the water flowing through coil 15 and becoming condensed thereby. The refrigerant liquid leaves heat-exchanger 12 by way of line 32 and flows through line 50 past one-way valve 51 and through line 27 into receiver 28. The liquid, on leaving receiver 28 takes two paths. One part flows into lines 31 and 36 and through cooler 11, as in the intermediate cycle of operation. The remainder flows through lines 52 and 26 into coil 16. In flowing through line 52 the liquid has its pressure and corresponding temperature reduced by thermostatic expansion valve 53. The cold liquid in flowing through coil 16 absorbs heat from outdoor air flowing thereover under the influence of fan 17 becoming vaporized thereby. The gas leaves coil 16 by way of line 24 flowing thence into line 48. From line 48 the gas is directed by three-way valve 44 into line 49 whence it merges in line 41 with the gas from cooler 11.

Heat picked up in the outdoor air unit supplements heat available from the internal zone to provide for the requirements of the exterior zone. The water flow through coil 68 in the interior zone air treating unit 59 and through coil 81 of the exterior zone air treating unit 75 is identical to that of the intermediate cycle. However, damper 65 is again positioned to permit only sufficient outside air to pass through air treating unit 59 to satisfy the ventilation requirements of the interior zone.

In the system disclosed in Fig. 4, operation on the summer and intermediate cycles is identical to the Fig. 1 system. For this purpose, valve 92, as seen in Fig. 4, is set to a position communicating lines 90 and 91, which lines then become the equivalent of line 48 in the Fig. 1 system. This takes compressor 89 out of operation, since valve 92 shuts off all communication to it.

On the winter cycle, however, valves 92, 44 and 20 are set as shown in Fig. 4, and the system operates as follows: refrigerant compressed by compressor 10 flows through line 19 whence it is directed by valve 20 into line 25. From line 25 the gas flows through heat-exchanger 12, functioning as a refrigerant condenser, giving up its heat to the water flowing through coil 15 and becoming condensed thereby. The refrigerant liquid leaves heat-exchanger 12 by way of line 32 and flows through line 50 past one-way valve 51 and through line 27 into receiver 28. The liquid, on leaving receiver 28, takes two paths; one part through lines 31 and 36 and through cooler 11, and one part through lines 52 and 26 into coil 16. In flowing through expansion valves 37 and 53, the liquid has its pressure and corresponding temperature reduced to a point where it can pick up heat from the chilled water flowing through coil 14 or the outdoor air flowing over coil 16, the liquid becoming vaporized in both cases. The gas leaves cooler 11 by way of line 40 flowing thence into line 41 and back to the inlet of compressor 10. Up to this point the operation of the Fig. 4 system is identical to that disclosed in Fig. 3. The difference lies in the fact that gas leaving coil 16 flows into line 91 whence it is directed by valve 92 into line 97 and the inlet of compressor 89. The gas has its pressure increased in passing through compressor 89 to the suction pressure of compressor 10. The gas discharges from compressor 89 by way of line 96 whence it flows into line 90. From line 90 the gas is directed by valve 44 into line 49 whence it flows into line 41 to merge with the gas flowing from cooler 11 to complete the cycle.

The use of booster compressor 89 allows a lower pressure to be maintained within coil 16 and a correspondingly lower refrigerant temperature. This permits a correspondingly greater transfer of heat between the refrigerant within the coil 16 and the air passing thereover. At the same time, the efficiency of the refrigerating apparatus is increased due to the removal of heat from the interior system at a high temperature level with only supplementary heat supplied from the low temperature level.

It will be understood that the term "water," as used in the specification and claims, is used in a generic sense as denoting any heat-exchange medium suitable for the purpose.

I wish it to be understood that my invention is not to be limited to the specific constructions and arrangements shown and described, except only insofar as the claims may be so limited, as it will be apparent to those skilled in the art that changes may be made without departing from the principles of the invention.

What is claimed is:

1. An air conditioning system for multi-room buildings having an interior zone and an exterior zone comprising an air treating unit, including a water coil, for said interior zone; an air treating unit, including a water coil, for said exterior zone; means for delivering air treated in said units to the respective zone rooms; a refrigerating system comprising a water cooler, an indoor reversible heat-exchanger and an outdoor reversible air unit connected in a closed refrigerant circuit; means connecting said interior zone unit water coil in a closed water circuit with said water cooler; means connecting said exterior zone unit water coil in a closed water circuit with said indoor reversible heat-exchanger; and means for operating said indoor reversible heat-exchanger as a water cooler and said outdoor reversible air unit as a condenser or for alternatively operating said indoor reversible heat-exchanger as a condenser and said outdoor reversible air unit as an evaporator.

2. An air conditioning system for multi-room buildings having an interior zone and an exterior zone comprising an air treating unit, including a water coil, for said interior zone; an air treating unit, including a water coil, for said exterior zone; means for delivering air treated in said units to the respective zone rooms; a refrigerating system comprising a water cooler, an indoor reversible heat-exchanger and an outdoor reversible air unit connected in a closed refrigerant circuit; means connecting said interior zone unit water coil in a closed water circuit with said water cooler; means connecting said exterior zone unit water coil in a closed water circuit with said indoor reversible heat-exchanger; means for operating said indoor reversible heat-exchanger as a water cooler in parallel with said aforementioned water cooler and for operating said outdoor reversible air unit as a condenser; and alternative means for operating said indoor reversible heat-exchanger as a condenser and for operating said outdoor reversible air unit as an evaporator in parallel with said water cooler.

3. An air conditioning system for multi-room buildings having an interior zone and an exterior zone comprising an air treating unit, including a water coil, for said interior zone; an air treating unit, including a water coil, for said exterior zone; means for delivering air treated in said units to the respective zone rooms; a refrigerating system comprising a water cooler, an indoor reversible heat-exchanger and an outdoor reversible air unit connected in a closed refrigerant circuit; means

connecting said interior zone unit water coil in a closed water circuit with said water cooler; means connecting said exterior zone unit water coil in a closed water circuit with said indoor reversible heat-exchanger; means for operating said indoor reversible heat-exchanger as a water cooler in parallel with said aforementioned cooler and for operating said outdoor reversible air unit as a condenser; first alternative means for operating said indoor reversible heat-exchanger as a condenser for said water cooler with said outdoor reversible air unit being inoperative; and second alternative means for operating said indoor reversible heat-exchanger as a condenser and for operating said outdoor reversible air unit as an evaporator in parallel with said water cooler.

4. An air conditioning system for multi-room buildings having an interior zone and an exterior zone comprising an air treating unit, including a water coil, for said interior zone; an air treating unit, including a water coil, for said exterior zone; means for delivering air treated in said units to the respective zone rooms; a refrigerating system comprising refrigerant compression means, a water cooler, an indoor reversible heat-exchanger and an outdoor reversible air unit connected in a closed refrigerant circuit; means connecting said interior zone unit water coil in a closed water circuit with said water cooler; means connecting said exterior zone unit water coil in a closed water circuit with said indoor reversible heat-exchanger; means for operating said indoor reversible heat-exchanger as a water cooler in parallel with said aforementioned water cooler, for operating said outdoor reversible air unit as a condenser, and for operating said compression means to compress refrigerant flowing from said coolers to said condenser in one stage of compression; and means for operating said indoor reversible heat-exchanger as a condenser, for operating said outdoor reversible air unit as an evaporator in parallel with said water cooler, and for operating said compression means to compress refrigerant flowing from said water cooler to said condenser in one stage of compression and to compress refrigerant flowing from said evaporator to said condenser in plural stages of compression.

5. A reversible refrigerating system for conditioning heat-exchange medium for a building having concurrent heating and cooling loads comprising compression means, a cooler, an indoor reversible heat-exchanger and an outdoor reversible air unit; means connecting said components in a closed refrigerating circuit; means for directing refrigerant flow from said compression means through said outdoor reversible air unit and thence in parallel through said cooler and said indoor reversible heat-exchanger for return to said compression means, or for alternatively directing refrigerant flow from said compression means through said indoor reversible heat-exchanger and thence in parallel through said cooler and said outdoor reversible air unit for return to said compression means; and means for flowing said heat-exchange medium in heat-exchange relation with said cooler and said indoor reversible heat-exchanger.

6. A reversible refrigerating system for conditioning heat-exchange medium for a building having concurrent heating and cooling loads comprising compression means, a cooler, an indoor reversible heat-exchanger and an outdoor reversible air unit; means connecting said components in a closed refrigerating circuit; means for directing refrigerant from said compression means through said outdoor reversible air unit and thence in parallel through said cooler and said indoor reversible heat-exchanger for return to said compression means; first alternative means for directing refrigerant flow from said compression means through said indoor reversible heat-exchanger and thence through said cooler for return to said compression means; second alternative means for directing refrigerant flow from said compression means through said indoor reversible heat exchanger and thence in parallel through said cooler and said outdoor reversible air unit for return to said compression means; and means for flowing said heat-exchange medium in heat-exchange relation with said cooler and said indoor reversible heat-exchanger.

7. A reversible refrigerating system for conditioning heat-exchange medium for a building having concurrent heating and cooling loads comprising compression means, a cooler, an indoor reversible heat-exchanger and an outdoor reversible air unit; means connecting said components in a closed refrigerating circuit; means for directing refrigerant flow from said compression means through said outdoor reversible air unit and thence in parallel through said cooler and said indoor reversible heat-exchanger for return to said compression means; means for alternatively directing refrigerant flow from said compression means through said indoor reversible heat-exchanger and thence in parallel through said cooler and said outdoor reversible air unit for return to said compression means, and for operating said compression means to compress refrigerant flowing from said outdoor reversible air unit to said compression means in plural stages of compression; and means for flowing said heat-exchange medium in heat-exchange relation with said cooler and said reversible indoor heat-exchanger.

8. A refrigerating system for cooling and heating heat-exchange medium for a building having concurrent heating and cooling loads comprising compression means, a cooler, an indoor heat-exchanger and an outdoor air unit; means connecting said components in a closed refrigerating circuit; means for directing refrigerant flow from said compression means through said indoor heat-exchanger and thence in parallel through said cooler and said outdoor air unit for return to said compression means; and means for flowing heat-exchange medium in heat-exchange relation with said cooler and said indoor heat-exchanger.

9. A refrigerating system for cooling and heating heat-exchange medium for a building having concurrent heating and cooling loads comprising compression means, a cooler, an indoor heat-exchanger and an outdoor air unit; means connecting said components in a closed refrigerating circuit; means for directing refrigerant flow from said compression means through said indoor heat-exchanger and thence in parallel through said cooler and said outdoor air unit for return to said compression means, and for operating said compression means to compress said refrigerant flowing from said outdoor air unit to said compression means in plural stages of compression and to compress said refrigerant flowing from said cooler to said compression means in a single stage of compression; and means for flowing said heat-exchange medium in heat-exchange relation with said cooler and said indoor heat-exchanger.

10. A refrigerating system for cooling the interior zone and heating the exterior zone of a building comprising compression means, a cooler, an indoor heat-exchanger and an outdoor air unit; means connecting said components in a closed refrigerating circuit; means for directing refrigerant flow from said compression means through said indoor heat-exchanger and thence in parallel through said cooler and said outdoor air unit for return to said compression means; means for passing a heat-exchange medium in heat-exchange relation with said indoor heat-exchanger for heating said medium; means for passing a heat-exchange medium in heat-exchange relationship with said cooler for chilling said medium; and means for flowing chilled medium in heat-exchange relation with interior zone air and for flowing heated medium in heat-exchange relation with exterior zone air.

11. An air conditioning system for multi-room buildings having an interior zone requiring cooling and an exterior zone requiring heating comprising an air treating unit, including a water coil, for said interior zone; an air treating unit, including a water coil, for said exterior

zone; means for delivering air treated in said units to the respective zone rooms; a refrigerating system comprising compression means, a water cooler, an indoor heat-exchanger and an outdoor air unit connected in a closed refrigerant circuit; means connecting said interior zone unit water coil in a closed water circuit with said water cooler; means connecting said exterior zone unit water coil in a closed water circuit with said indoor heat-exchanger; means for directing flow of refrigerant from said compression means through said indoor heat-exchanger and thence through said cooler for return to said compression means when the heat rejection from said interior zone is greater than the heating load of said exterior zone, said outdoor air unit being inoperative; and means for directing flow of refrigerant from said compression means through said indoor heat-exchanger and thence in parallel through said cooler and said outdoor air unit when the heat rejection from said interior zone is less than the heat load of said exterior zone.

12. The system as set out in claim 11 including means for controlling the capacity of said compression means to a point where the heat rejection from said interior zone just equals the heating load of said exterior zone.

13. The system as set out in claim 12 including means for supplying fresh air to said interior and exterior zones, and means for varying the supply of fresh air to said interior zone when said capacity controlling means is operative.

14. An air conditioning system for supplying heated and chilled air to multi-room buildings having concurrent heating and cooling loads comprising a first air treating unit, including a water coil, for supplying said heated air; a second air treating unit, including a water coil, for supplying said chilled air; means for delivering air treated in said units to the respective rooms; a refrigerating system comprising compression means, a water cooler and a condenser connected in a closed refrigerant circuit; means connecting said first air treating unit water coil in a closed water circuit with said condenser; means connecting said second air treating unit water coil in a closed water circuit with said water cooler; means for directing flow of refrigerant from said compression means through said condenser and thence through said water cooler for return to said compression means; means for supplying outside air to said second air treating unit for delivery to said rooms; means for varying the quantities of outside air supplied to said second air treating unit; and means for varying the capacity of said compression means.

15. The air conditioning system of claim 14 wherein said refrigerating system further includes an outdoor air unit connected in said closed refrigerant circuit; and means for directing flow of refrigerant from said compression means through said condenser and thence in parallel through said cooler and said outdoor air unit when the heat rejection from said building is less than the heat requirements thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

2,100,867	Olson	Nov. 30, 1937
2,292,335	Durbin	Aug. 4, 1942
2,722,107	Gay	Nov. 1, 1955