June 11, 1946. M. M. SMITH ET AL 2,401,890

HEAT PUMP

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Fig. 1

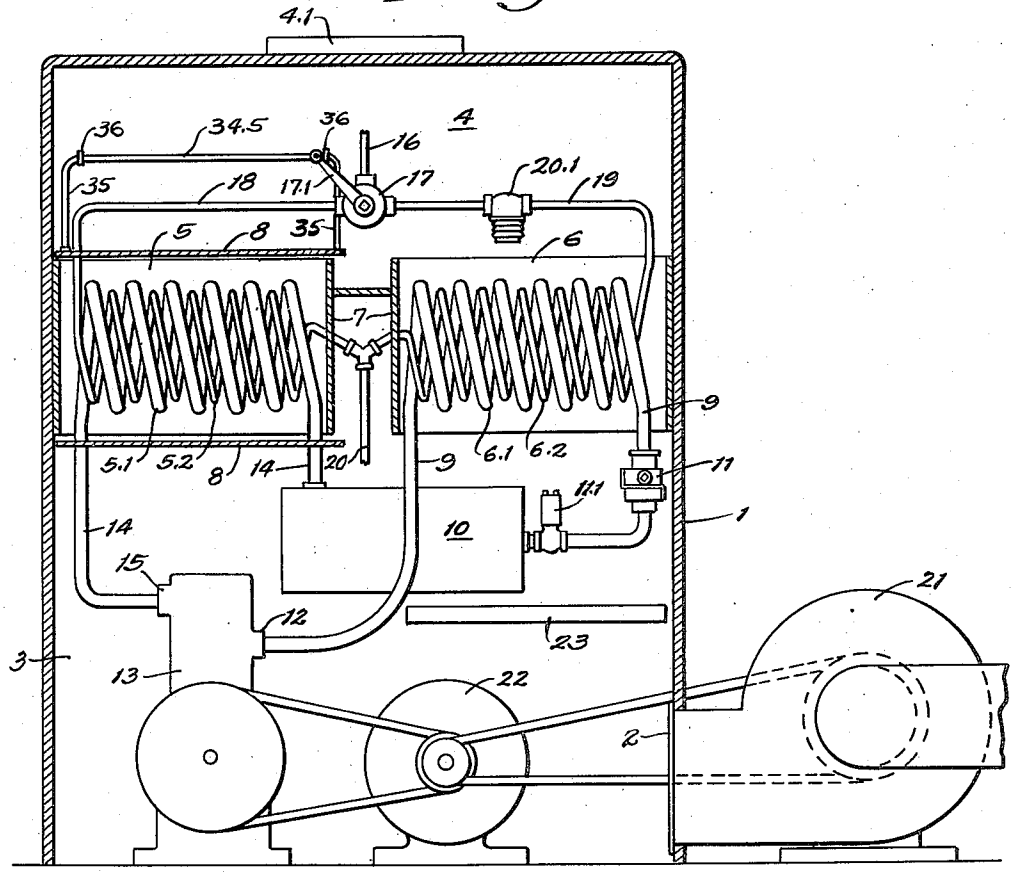


Fig. 4

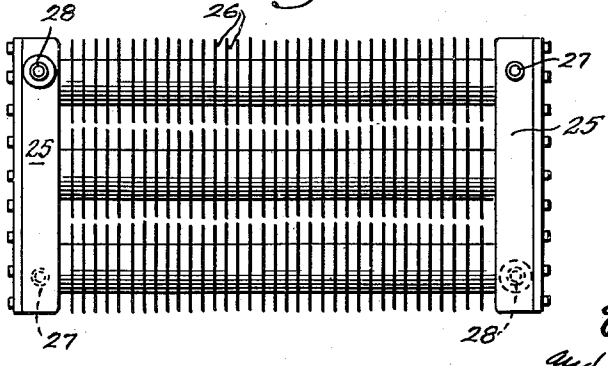
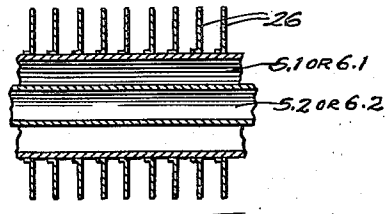


Fig. 5



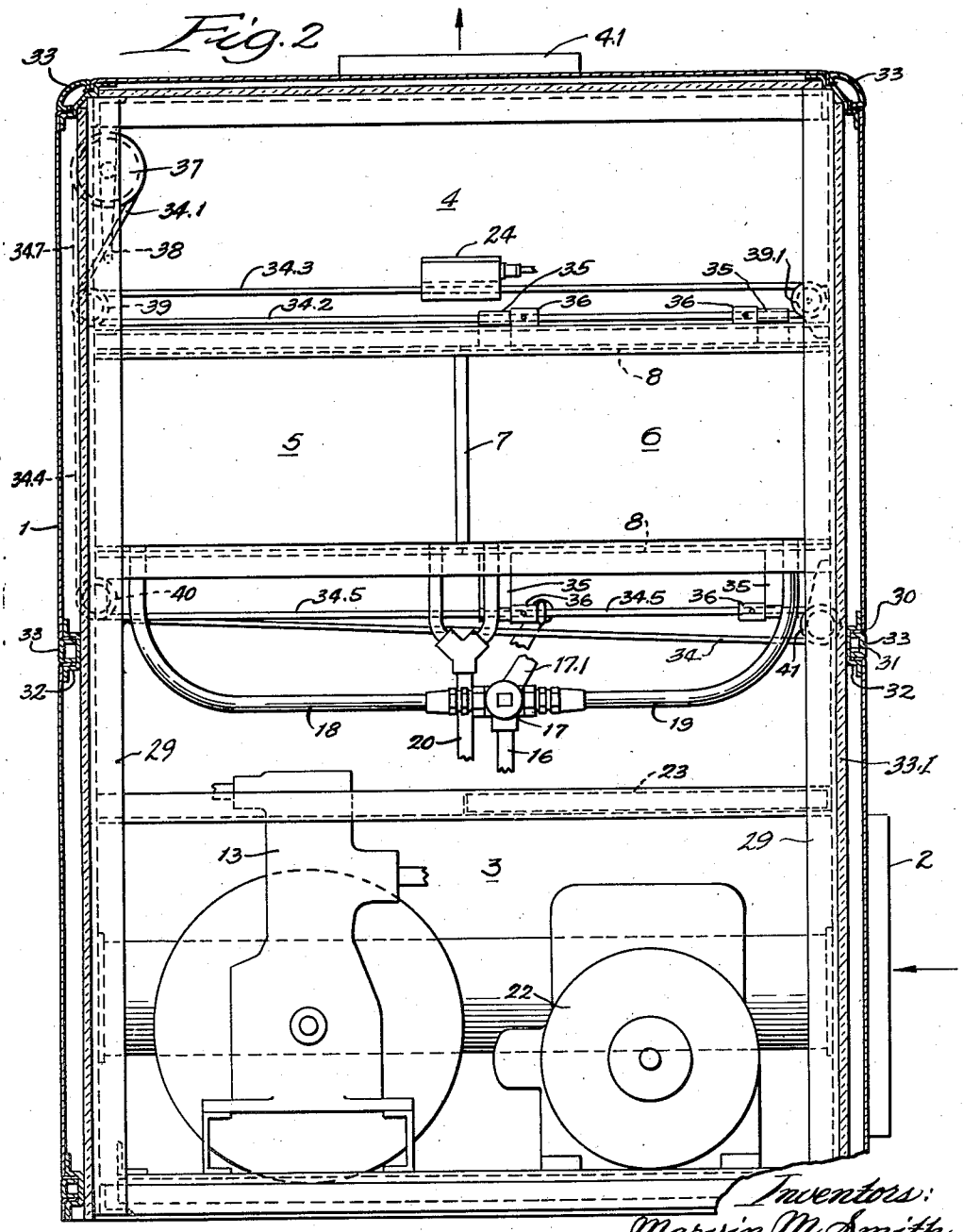
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HEAT PUMP

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Fig. 2



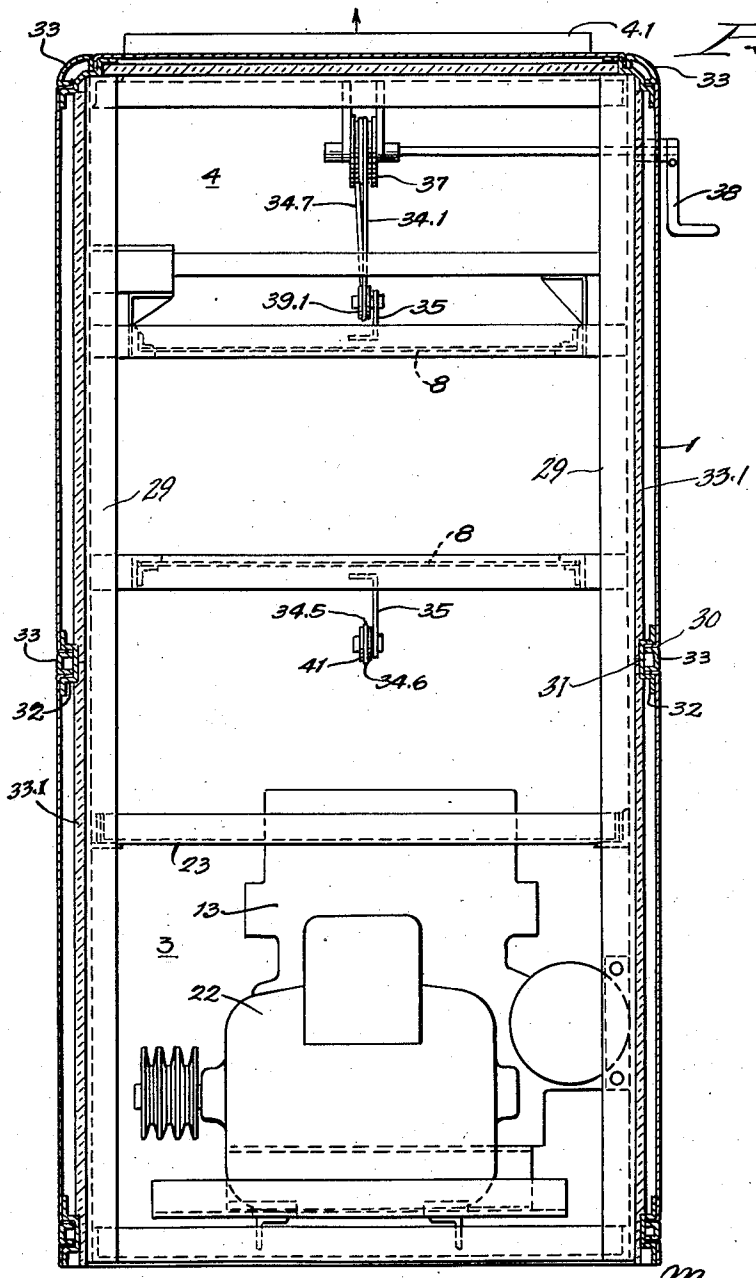
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Fig. 3



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Patented June 11, 1946 2,401,890

UNITED STATES PATENT OFFICE

2,401,890

HEAT PUMP

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Application January 25, 1945, Serial No. 574,478

9 Claims. (Cl. 62—129)

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The main objects of this invention are to provide a simple and improved form of heat pump for all-year air conditioning; to provide an improved arrangement of and housing for the elements of a refrigerating machine for this purpose; to provide an improved assemblage of operating units in such machines whereby the adjustment from summer to winter operation and vice-versa can be accomplished with minimal attention by the user; and to provide an improved simple and compact housing structure suitable for factory production of the complete machine, requiring merely the addition of service connections for installation at its destination.

A specific illustrative embodiment of this invention is shown in the accompanying drawings, in which:

Figure 1 is a schematic diagram of the machine and its housing.

Fig. 2 is a front elevation with front wall of the housing removed and the side walls in section and indicating schematically the functional arrangement of its interior.

Fig. 3 is a side elevation of the same with the near wall removed, and the side walls in section.

Fig. 4 is an elevation of a heat exchanger coil, suitable for circulating the refrigerant in heat transferring relation to both water and air.

Fig. 5 is a sectional detail showing the concentric arrangement of water and refrigerant passages in the heat transfer coil of Fig. 4.

This invention relates primarily to an adaptation of the principles of the refrigerating machine and to certain desirable improvements in the structure and arrangement of parts, whereby the same can be made a practical commodity of commerce as a portable heat pump for all-year air conditioning of houses and other uses.

In the form shown, the housing 1 is a rectangular shell with an air inlet 2 leading to a lower chamber 3 and an air outlet 4.1 at its upper part leading to an upper air chamber 4.

The heat exchangers which constitute the condenser 5 and the evaporator 6 are arranged side by side or end to end so as to substantially fill a transverse zone between the chambers 3 and 4.

This heat exchanger zone in the drawings is horizontal and is subdivided into two air ducts by a vertical partition 7 separating the condenser 5 from the evaporator 6. A pair of slidable horizontal partitions or baffles 8 coact with the partition 7 and the housing or other walls to completely enclose and isolate one of the heat exchangers and direct the air flow through the other. These baffles 3 are shiftable across the

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housing to provide for cooling or heating of the air stream as will hereinafter appear.

The refrigerant circulating system is hermetically sealed and comprises a suction line of piping 9, connecting the receiver 10 through the expansion valve 11 and a thermostatically controlled regulating valve 11.1 to the refrigerant coil 6.1 of the evaporator 6 and with the intake port 12 of the compressor 13, and a pressure line of piping 14, connecting the outlet port 15 of the compressor 13 with the refrigerant coil 5.1 of the condenser 5 and with the receiver 10.

The thermostatically controlled solenoid valve 11.1 regulates the flow of refrigerant to suit the demand, as may be indicated by a distant thermostat at some suitable place in the space that is to be conditioned.

The refrigerant system is purposely indicated by showing in the drawings only its most essential elements, and omitting many details and refinements of present-day practice which have no direct bearing on the disclosure of present invention.

In the form shown, the heat pump is arranged to utilize, in the heating season, water as the heat source and the air of the house as the dump for heat of the refrigerant cycle; and in the cooling season, the house air becomes the heat source and water is utilized as the dump for the heat of the refrigerating cycle.

The water system comprises a service pipe 16 from a water source, such as a city main or well, a three-way inlet valve 17, branch pipes 18 and 19 leading to condenser water-coil 5.2 and evaporator water-coil 6.2 respectively, and a discharge pipe 20 to which the outlet ends of the water-coils 5.2 and 6.2 are connected and which leads to a drain. A thermostatically controlled valve 20.1 controls the flow of water in the water-coil 6.2 to prevent freezing.

The air system comprises suitable ducts to and from the parts of the house to be heated and a blower 21 at the inlet 2 for forcing a circulation of air. The blower 21 and compressor 13 may have a common motor 22 or be separately driven. A water pan 23 collects any water that may drip from the evaporator by reason of condensation of moisture in the air and also serves as a baffle to direct the incoming air over the motor and compressor to cool them and utilize their waste heat during the heating season. A humidifier 24 may be located in the compartment 4 for moistening the air in the heating season.

The heat exchanger coils are shown in Fig. 1 as

separate water and refrigerant coils for clearness of diagrammatically illustrating the relation and continuity of the air, water and refrigerant circuits, but in practice these coils are more intimately associated. As shown in Figs. 4 and 5, these exchangers are made up of banks of refrigerant tubes with water tubes inside them in concentric relation and these tubes are connected in zig-zag relation at their ends by appropriate headers 25 to preserve the continuity of each kind of passage and the segregation of the water from the refrigerant. The outer walls of the refrigerant tubes have transverse fins 26 for efficient transfer of heat between the refrigerant and the air stream. The headers are each suitably ported, as at 27 and 28, for pipe connection.

The housing 1, as shown in Figs. 2 and 3, is made up of sheet metal or other material enclosing a rigid skeleton frame 29 which carries the load. The sheet metal shell of housing 1 may be made of flat panels with offset marginal flanges 30 clamped into channels 31 of frame bars 32 by channel-shaped filler strips 33. The walls of the housing are insulated by an inner layer of insulating material 33.1.

The positioning of the baffles 8 is controlled, as indicated in Figs. 2 and 3, by a system of belts or cables 34 attached to lugs 35 on the baffles 8, by means of stop buttons 36 fixed on the cable 34. The cable 34 is driven by a drum 37 having a crank 38. The cable is wound around several turns about the drum and flight 34.1 of the cable passes to pulley 39, flight 34.2 extends to pulley 39.1, flight 34.3 passes to a second pulley at 39, flight 34.4 leads to one of two pulleys 40, flight 34.5 leads to pulley 41, and returns as flight 34.6 to a second pulley 40, and finally flight 34.7 leads back to the drum 37.

The three-way valve 17 can be turned to supply water either to the condenser 5 or to the evaporator 6 and may have its handle 17.1 of lever form and be positioned so that the shifting of baffles 8 from summer to winter position and vice versa will automatically reverse the valve 17. As shown in Fig. 2, the valve lever 17.1 has an eye at its end and the cable 34 has stop buttons 36 suitably spaced to accomplish this shifting with appropriate lost motion. In the diagram of Fig. 1, the cable is not shown, but is represented functionally in the form of a traveler rod having the same relation to the lever arm 17.1 of the valve 17 and to the baffle 8 and its parts are numbered to correspond with parts of like function in Fig. 1.

The operation of the device shown is as follows:

Except as to parts of the mechanism and equipment having direct bearing on the present invention, it should be understood that many details of a commercial embodiment of the heat pump are omitted from the drawings and this description. For example, it should be understood that apparatus of this kind is controlled by thermostatic appliances such that the space which is to be conditioned will be maintained at nearly constant conditions, particularly as to temperature regulation by the user. Such apparatus would, of course, include means for starting and stopping the motor, fan and compressor and valve means for cutting off and controlling the flow of water at times when the motor is not operating. Many refinements of details of the refrigerating system which are embodied in commercial applications are also omitted for like reasons.

When the parts are in the position shown in Fig. 1, the fan 21 draws air from the space that is to be conditioned and forces the air to flow through the housing 1 and be returned from the outlet 4.1 to said space. Since this air current is excluded from the condenser 5, it will pass over the evaporator and be cooled thereby. Any condensation of moisture due to this cooling of the air will be collected and drained away by the drip pan 23.

When the motor drives the compressor 13, refrigerant will be drawn from the receiver 10 through the expansion valve 11 where it is expanded so as to cool the evaporator coil 6.1 and will then flow to the compressor 13 where it is compressed, raising its temperature; then the compressed refrigerant vapor passes through the coil 5.1 of the condenser, being condensed by the transfer of its heat to the water coil 5.2 and finally returned to the receiver 10. The water enters from the pipe 16 and is directed by the three-way valve 17 to the pipe 18 and condenser coil 5.2 and after taking up the heat that is dumped into it in the condenser, this water is drained away by the pipe 20.

When the baffle plates 8 are shifted to the right of Fig. 1 across the partition 7 and into contact with the right-hand wall of the housing 1, the air flow will be directed through the condenser duct and will be excluded from the evaporator. Under these circumstances the air pump will function as a heater since the air will then serve as a dump for the heat of the condenser and as a cooling medium for the refrigerant and will carry its heat to the space to be heated.

When the baffle plates 8 are shifted to the right of Fig. 1, the element 34.5 will slide through the swiveled eye at the end of the lever 17.1 of the valve 17 until it is engaged by the left-hand button 36 and swung to the position for directing the flow of water from pipe 16 to pipe 19 and evaporator coil 6.2 where heat is extracted from this water by the cold refrigerant coil 6.1 of the evaporator and after passage through the compressor and evaporator coil, this heat is elevated in temperature and delivered to the air current at the condenser and then carried to the space that is conditioned.

It will thus be seen that in the apparatus shown, the refrigerant cycle is the same for both the heating and cooling seasons and that to change it from the function of heating the air to that of cooling the air and vice-versa, the operator need only turn the crank 38 in the direction it is free to move and rotate it until it is stopped by the engagement of the baffle plates with the opposite wall of the housing. The matter of starting and stopping the mechanism according to the needs of the space to be conditioned is then controlled by thermostatic devices, not shown, the operation of which, however, is well understood.

Although but one specific embodiment of this invention is herein shown and described, it will be understood that numerous details of the structure shown may be altered or omitted without departing from the spirit of the invention as defined by the following claims.

We claim:

1. A heat pump, comprising a condenser, an evaporator, an air duct surrounding said condenser and evaporator, means for forcing air through said duct, a partition separating said condenser and evaporator, a pair of baffle plates shiftable edgewise across said duct at opposite

ends of said partition and shaped to expose either one of said condenser or said evaporator to the flow of air in said duct while isolating the other from such flow of air, and means adapted alternatively to extract heat from said condenser or to supply heat to said evaporator when cut off from the air flow by said baffle means.

2. In a heat pump, an air duct, means providing a sealed refrigerant circuit comprising a refrigerant coil in said air duct, a water coil in heat transferring relation to said refrigerant coil, movable baffle means controlling the exposure of said refrigerant coil to the air flow in said air duct, a valve controlling said water-coil, and means interconnecting said valve and baffle means whereby said refrigerant coil will be alternately exposed solely to the air flow in said duct or to a water flow in said water-coil.

3. In a heat pump, a housing having an air inlet and an air outlet, a refrigerant conduit comprising a condenser and an evaporator in substantial alinement with each other across said housing between said air inlet and air outlet, a partition separating said condenser and evaporator, shiftable baffle means coacting with said partition and adapted in one position to direct the air flow in said housing across said condenser and exclude it from said evaporator and in another position to direct the air flow across said evaporator and exclude it from said condenser, and means adapted alternatively to extract heat from said condenser or to supply heat to said evaporator when cut off from the air flow by said baffle means.

4. In a heat pump, a housing having an air inlet and an air outlet, a refrigerant conduit comprising a condenser and an evaporator in substantial alinement with each other across said housing between said air inlet and air outlet, a partition separating said condenser and evaporator, and shiftable baffle means at both ends of said partition and adapted in one position to direct the air flow in said housing across said condenser and exclude it from said evaporator and in another position to direct the air flow across said evaporator and exclude it from said condenser, means adapted alternatively to extract heat from said condenser or to supply heat to said evaporator when cut off from the air flow by said baffle means, and a single operating member for shifting said baffling means from one of said positions to the other and correspondingly controlling said alternative heat extracting and supplying means.

5. In a heat pump, a housing having an air inlet and an air outlet, a refrigerant conduit comprising a condenser and an evaporator in substantial alinement with each other across said housing between said air inlet and air outlet, and shiftable baffle means adapted in one position to direct the air flow in said housing across said condenser and exclude it from said evaporator and in another position to direct the air flow across said evaporator and exclude it from said condenser, said evaporator and condenser each comprising a refrigerant coil and a water coil in heat exchange relation with each other, and valve means adapted in one position to supply water to one said water coil and exclude it from the other water coil and in another position to cut off said one water coil and supply the other.

6. In a heat pump, a housing having an air inlet and an air outlet, a refrigerant conduit comprising a condenser and an evaporator in substantial alinement with each other across said housing between said air inlet and air outlet, and shiftable baffle means adapted in one position to direct the air flow in said housing across said condenser and exclude it from said evaporator and in another position to direct the air flow across said evaporator and exclude it from said condenser, said evaporator and condenser each comprising a refrigerant coil and a water coil in heat exchange relation with each other, and valve means adapted in one position to supply water to one said water coil and exclude it from the other water coil and in another position to cut off said one water coil and supply the other, and a single operating member for shifting said baffling means from one of said positions to the other and simultaneously controlling said valve means to supply water to the evaporator or condenser when and only when the same is excluded from the air flow by said baffling means.

7. In a heat pump, a housing having an air inlet and an air outlet, a refrigerant conduit comprising a condenser and an evaporator in substantial alinement with each other across said housing between said air inlet and air outlet, a partition separating said condenser and evaporator, a pair of baffle panels coacting with said partition and housing to cut off the air flow at one side of said partition, said baffle panels being shiftable across said partition, adapted in one position to direct the air flow in said housing across said condenser and exclude it from said evaporator and in another position to direct the air flow across said evaporator and exclude it from said condenser, and means adapted alternatively to extract heat from said condenser or to supply heat to said evaporator when cut off from the air flow by said baffle means.

8. In a heat pump, a housing having an air inlet and an air outlet, a refrigerant conduit comprising a condenser and an evaporator in substantial alinement with each other across said housing between said air inlet and air outlet, a partition separating said condenser and evaporator, a pair of baffle panels coacting with said partition and housing to cut off the air flow at one side of said partition, said baffle panels being shiftable across said partition, adapted in one position to direct the air flow in said housing across said condenser and exclude it from said evaporator and in another position to direct the air flow across said evaporator and exclude it from said condenser, said evaporator and condenser each comprising a refrigerant coil and a water coil in heat exchange relation with each other, and valve means adapted in one position to supply water to one said water coil and exclude it from the other water coil and in another position to cut off said one water coil and supply the other, and a single operating member for shifting said baffle panels from one of said positions to the other and simultaneously controlling said valve means to supply water to the evaporator or condenser when and only when the same is excluded from the air flow by said baffle panels.

9. In a heat pump, a housing having an air inlet and an air outlet, a refrigerant conduit comprising a condenser and an evaporator in substantial alinement with each other across said housing between said air inlet and air outlet, a partition separating said condenser and evaporator, a pair of baffle panels coacting with said partition and housing to cut off the air flow at one side of said partition, said baffle panels being

shiftable across said partition, adapted in one position to direct the air flow in said housing across said condenser and exclude it from said evaporator and in another position to direct the air flow across said evaporator and exclude it from said condenser, said evaporator and condenser each comprising a refrigerant coil comprising water passages completely surrounded by

refrigerant passages, and valve means arranged to supply water to the water passages of said evaporator and cut off the supply of water from the water passages of said condenser and vice versa.

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