

- [54] **COMBINATION REFRIGERATION AND EVAPORATIVE COOLING AIR CONDITIONER**
- [76] Inventor: **William H. Goettl**, 4717 N. Granite Reef Rd., Scottsdale, Ariz. 85251
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- [51] Int. Cl. **F28d 5/00**
- [58] Field of Search **62/311, 314, 332, 309, 62/171; 261/140 R**

- [56] **References Cited**
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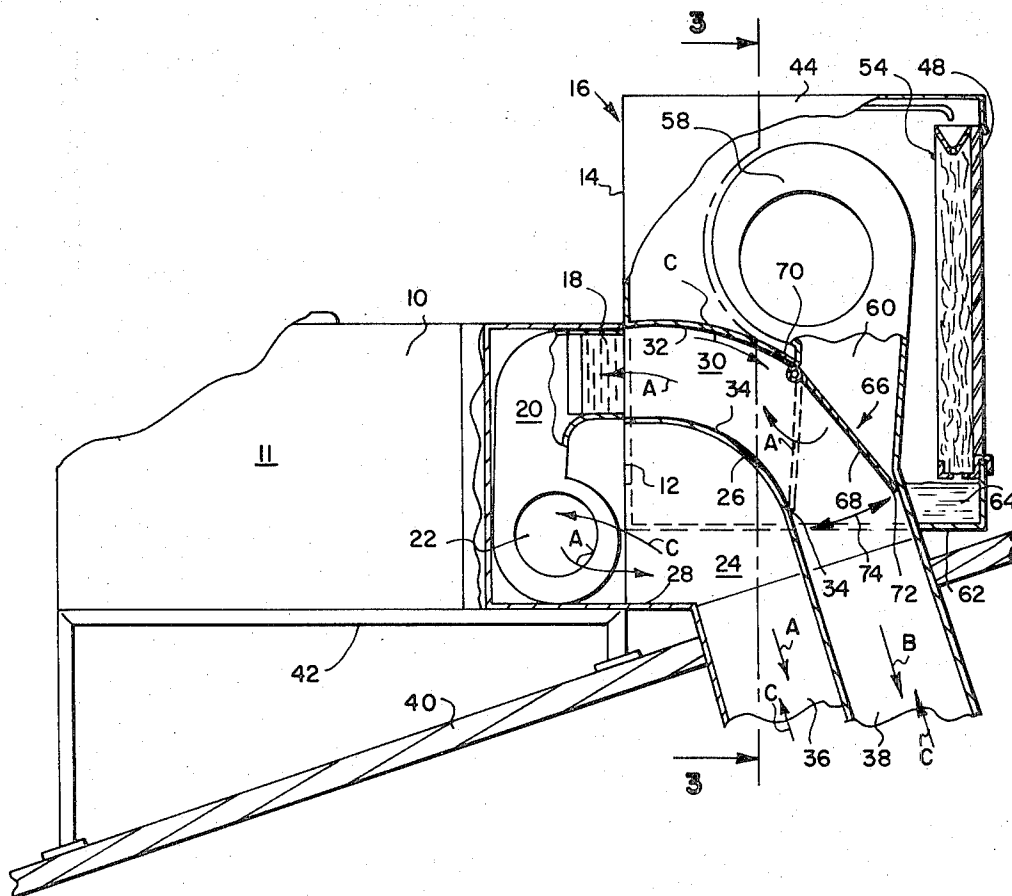
Primary Examiner—William J. Wye

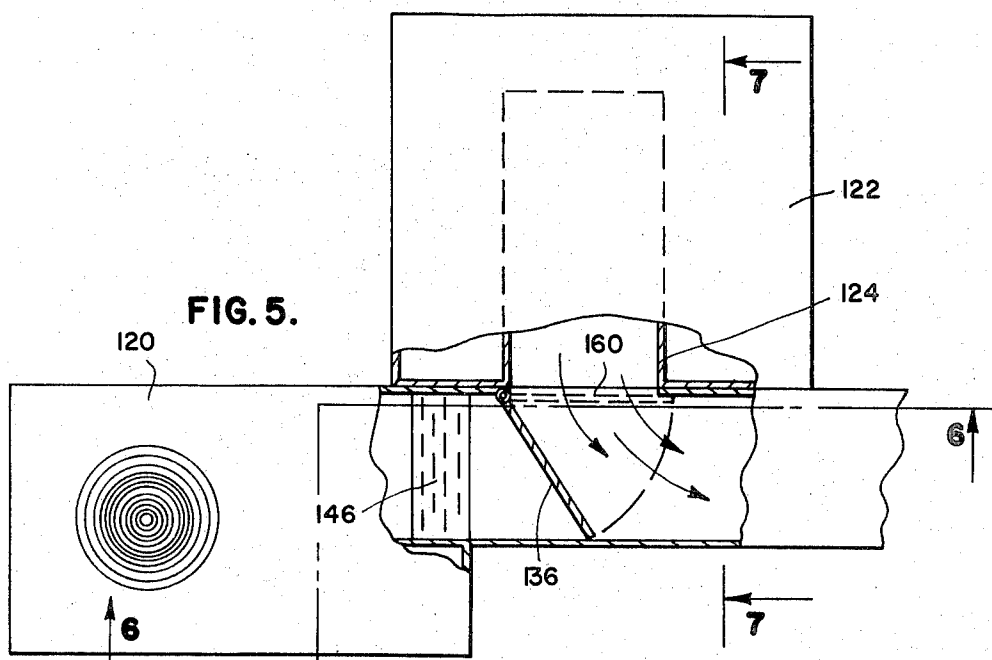
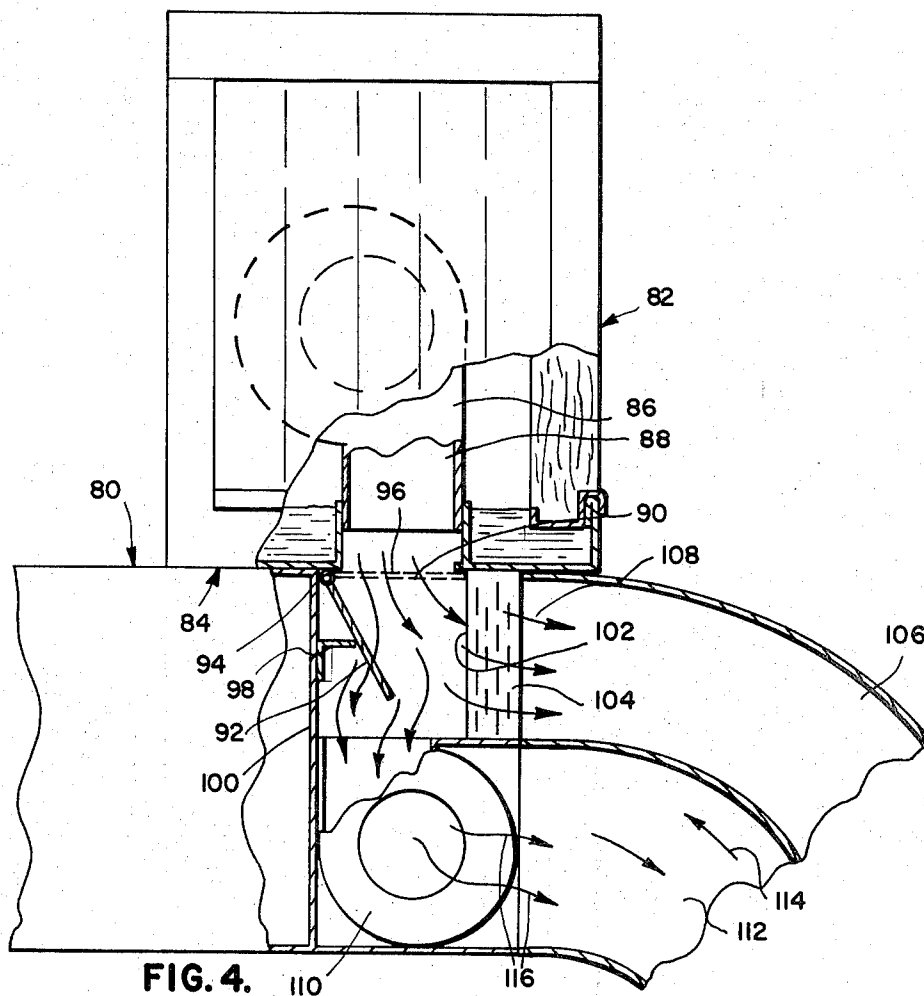
- [57] **ABSTRACT**
- The disclosure relates to a compact and unitary as-

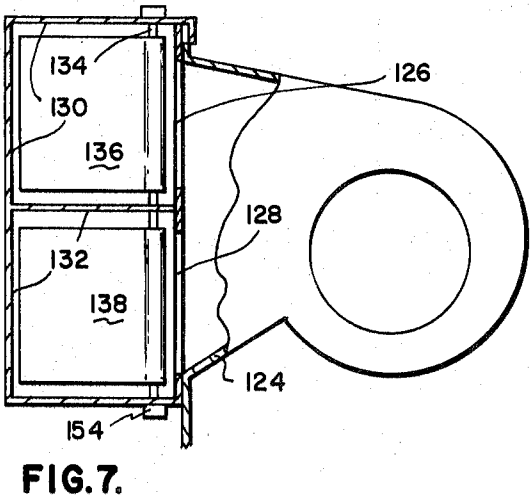
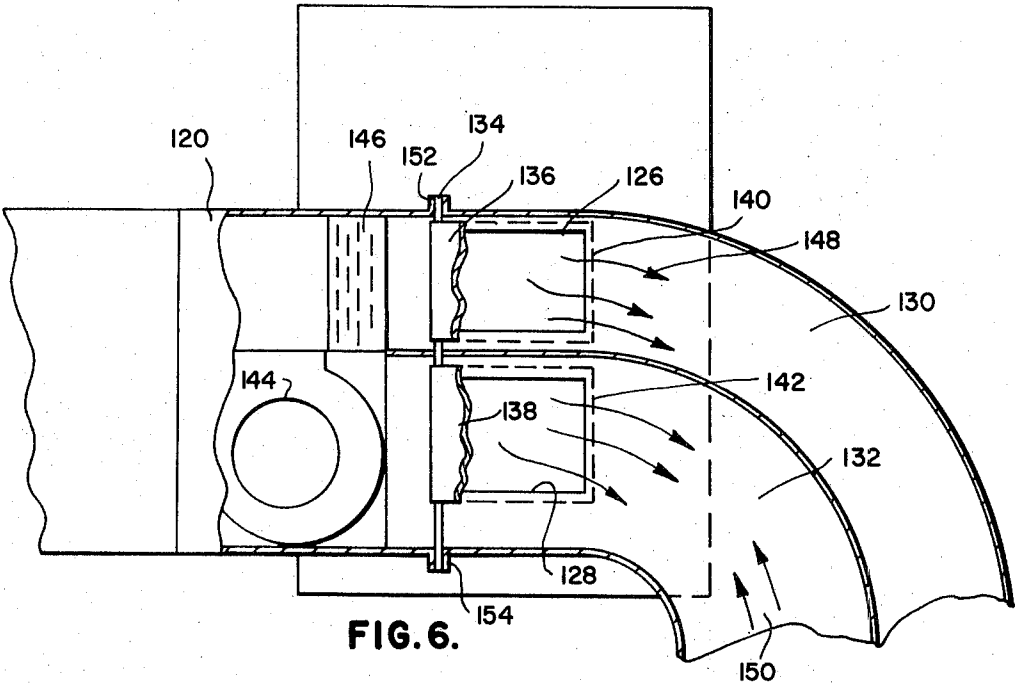
sembly of a refrigeration air conditioner and an evaporative cooler air conditioner wherein damper means is arranged with relation to the delivery and return duct assembly of the refrigeration air conditioner so that evaporative cooled air may be delivered from the evaporative cooler, through both the delivery and return ducts of the refrigeration air conditioning system when the refrigeration air conditioner is not energized, and whereby the energization of the refrigeration air conditioner and deenergization of the evaporative cooler causes said damper automatically to be shifted to close off the blower outlet opening of the evaporative cooler so that normal refrigeration air conditioning may be accomplished by the refrigeration air conditioner. The disclosure also relating to several species of the invention which all relate to the use of the aforementioned delivery and return ducts for concurrent delivery of evaporative cooled air therethrough.

The system is unitary and adapted to be mounted on the upper side of a building roof so that all of the equipment, including the damper mechanism may be above the roof.

8 Claims, 7 Drawing Figures







COMBINATION REFRIGERATION AND EVAPORATIVE COOLING AIR CONDITIONER

BACKGROUND OF THE INVENTION

For many years, the air conditioning industry in substantially arid regions has recognized the advantages of refrigerated air conditioning as compared to evaporative cooling and many of the companies installing air conditioning have primarily considered the installation of refrigeration.

It has been well known that evaporative coolers are very effective during periods when the relative humidity is low and evaporative coolers are relatively inexpensive to operate due to the relatively low power requirements, all of which generally saves energy and cost of operation to the owner.

In many areas the weather includes certain periods in which the relative humidity is quite low and during such periods evaporative cooling is entirely satisfactory. However, in the same areas and during other seasons of the year humidity becomes very high and at the same time, the ambient temperature is high. Accordingly, during such periods refrigeration air conditioning is required due to the fact that evaporative coolers do not provide for the comfort necessary in air conditioned areas.

Accordingly, during low humidity periods it has been found that evaporative cooling is very satisfactory while it is not generally satisfactory during high humidity periods when refrigeration air conditioning is very effective. Accordingly, various attempts have been made to provide a compact and efficient combination air conditioner, including both refrigeration and evaporative cooling.

The prior art contains a variety of such arrangements, many of which are bulky and require various dampers or slide valves which may be installed in various areas of a building. Furthermore, various systems which have been designed primarily for refrigeration do not have sufficient cross-sectional area in the ducts to accommodate the volume flow required for effective evaporative cooling.

SUMMARY OF THE INVENTION

The present invention comprises a novel, compact and unitary assembly of a refrigeration air conditioner and an evaporative cooler air conditioner wherein a novel damper means is arranged with relation to the delivery and return duct assembly of the refrigeration air conditioner so that evaporative cooled air may be delivered from the evaporative cooler, through both the delivery and return ducts of the refrigeration air conditioning system when the refrigeration air conditioner is not energized, and whereby energization of the refrigeration air conditioner and deenergization of the evaporative cooler causes said damper automatically to be shifted to close off the blower outlet opening of the evaporative cooler so that normal refrigeration air conditioning may be accomplished by the refrigeration air conditioner.

One species of the invention comprises a duct and damper assembly which is generally elbow shaped and extends from a generally upright side of the refrigeration air conditioner in a downwardly direction through a lower portion of the evaporative cooler and the refrigeration delivery duct of the elbow assembly is gen-

erally uppermost and communicating therewith is an outlet of a blower of the evaporative cooler with a damper at the juncture of the outlet and the refrigeration delivery duct, the damper being pivoted to the upper wall of the refrigeration delivery duct and adapted to swing free at its lower edge so as to alternately close the evaporative cooler blower and to partially close the delivery duct between the blower and the refrigerant evaporator of the refrigeration system so that when the damper is open relative to the evaporative cooler blower. Evaporatively cooled air may pass into the delivery duct toward a room and also in the opposite direction through the delivery duct backwardly through the refrigerant evaporator of the refrigeration air conditioner and through its respective blower and into the return duct and then in a direction toward the room, thereby allowing evaporatively cooled air to be delivered through both the delivery and return ducts of the refrigeration air conditioner system.

The combination air conditioner of the invention is adapted to be mounted on top of a building roof with all of its components thereabove and to communicate with return and delivery ducts which are interior ducts in the building. The evaporative cooler is provided with a water-containing sump partially surrounding the elbow shaped duct assembly which comprises the delivery and return ducts of the refrigeration air conditioner and a generally upright side of the evaporative cooler adjacent to a respective upright side of the refrigeration air conditioners, is disposed at the connection of the delivery and return ducts of the refrigeration air conditioner and the evaporative cooler in its remaining generally upright walls is provided with evaporative cooling pads which are substantially conventional evaporative cooler pads.

Other species of the invention comprise various mechanical arrangements of the blower outlet damper with relation to the delivery and return ducts of the refrigeration air conditioning system so as to permit the evaporative cooler to deliver evaporative cooled air through both the return and delivery ducts and to provide automatic operation of the damper so that it will open when the evaporative cooler is energized and closed when the refrigeration air conditioning is energized as desired.

Operation of the combination air conditioner of the invention may automatically take place with energization of the evaporative cooler blower and concurrent deenergization of the refrigeration air conditioner, or refrigeration cooling may take place automatically by energization of the refrigeration air conditioner and deenergization of the blower of the evaporative cooler and a damper in the delivery duct of the refrigeration air conditioner system is automatically opened with respect to the outlet of the evaporative cooler blower when it is energized and the damper is automatically closed relative to the outlet of the evaporative cooler blower when the refrigeration air conditioner is energized. The combination air conditioner of the invention provides for many advantages such as the economy of evaporative cooler operation during periods of low humidity and also the convenience of having refrigeration readily available without delay when atmospheric conditions become substantially humid and generally such that evaporative cooling is not efficient.

Accordingly, it is an object of the present invention to provide a novel combination refrigeration and evap-

orative cooling air conditioner which provides for the saving of power and energy as compared to the year-round use of conventional refrigeration air conditioning system.

Another object of the invention is to provide a novel, compact combination refrigeration and evaporative cooling air conditioner wherein a novel, generally elbow shaped duct assembly comprises a delivery and return duct means for a refrigeration air conditioner which is shared by an evaporative cooler due to a novel damper arrangement which automatically swings open or closed in either of two directions, depending upon which of the units is being operated, namely, the refrigeration air conditioner or the evaporative cooler.

Additionally, it is an object of the present invention to provide a novel combination refrigeration and evaporative cooling air conditioner wherein a damper operating between an evaporative cooler blower outlet and a refrigeration delivery duct, is so arranged that the damper allows flow of evaporatively cooled air to move in both directions in the delivery duct so that air flows directly from the evaporative cooler blower to an interior duct of a room, and also in the opposite direction toward the refrigeration evaporator and through it and into the conventional return duct so that evaporatively cooled air is delivered through both the refrigeration delivery duct and return duct to a room thereby providing substantial capacity for air flow of the evaporative cooler, the requirements of which are greater than that of the refrigeration air conditioner alone.

An additional object of the invention is to provide a variety of species of the invention for accomplishing automatic operation of a damper to allow the evaporative cooler of the invention to deliver evaporative cooled air through both the return and delivery ducts of the refrigeration air conditioner and to provide for automatic operation of the damper so that either evaporative cooling or refrigeration may be accomplished by energizing and deenergizing the respective units and whereby the damper will respond accordingly and automatically.

Further objects and advantages of the invention may be apparent from the following specification, appended claims and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a combination refrigeration and evaporative cooling air conditioner;

FIG. 2 is an enlarged side-elevation view of said air conditioner on a roof and showing portions thereof broken away and in section to amplify the illustration;

FIG. 3 is a vertical sectional view taken from the line 3—3 of FIG. 2;

FIG. 4 is a view similar to FIG. 2 showing a modification of the invention with the evaporative cooler mounted up on top of the refrigeration air conditioner;

FIG. 5 is a top or plan view of a further modification of the invention showing portions broken away and en-sectioned to amplify the illustration;

FIG. 6 is a fragmentary section of view taken from line 6—6 of FIG. 5; and

FIG. 7 is a fragmentary section of view taken from line 7—7 of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in FIG. 1, a substantially conventional re-

frigeration air conditioner **10** is provided with a substantially upright side **12** contiguous with a respective upright side **14** of a substantially conventional evaporative cooler **16**.

The refrigeration air conditioner **10** at its upright side **12** is provided with a refrigerant evaporator **18** which is a substantially conventional evaporator consisting of tubular refrigerant conduits with heat conductive fins thereon.

This evaporator **18** communicates with an outlet duct **20** of a blower **22**, the inlet of which communicates with a return duct **24**.

The return duct is defined by a wall **26** at its upper portion and a wall **28** disposed at its lower portion.

The refrigerant evaporator **18** communicates with a delivery duct **30** having an upper wall **32**. The delivery duct **30** is provided with a lower wall **34** which is the opposite side of the intermediate wall **26**, which is the upper wall of the return duct **24**.

The return duct **24** communicates with an interior return duct **36** and the delivery duct **30** communicates with an interior delivery duct **38**. These interior delivery ducts **36** and **38** communicate with the interior of a room below a roof **40** on which the air conditioner is mounted by a conventional mounting frame **42**.

The evaporative cooler **16** is provided with a housing **44** having three sides **46**, **48** and **50** in which respective evaporative cooler pads **52**, **54** and **56** are mounted. These are substantially conventional evaporative cooler pads assembly. And these sides comprise three sides of the evaporative cooler housing **16** in addition to the fourth side **14** which is contiguous with the substantially upright side **12** of the refrigeration air conditioner **10**.

The evaporative cooler **16** is provided with a blower **58** of the conventional centrifugal type, and the blower is provided with a downwardly directed delivery outlet **60** which is directed toward a bottom or lower portion **62** of the evaporative cooler **16** wherein a sump pan **64** partially surrounds the generally elbow whaped duct assembly which comprises the delivery and return ducts **30** and **24** respectively.

At a lower portion of the delivery outlet **60** the blower is provided with a blower outlet opening **66** which is adapted to be opened or closed by a pivoted damper **68**. The damper **68** is hinged at **70** to the upper, inner portion of the delivery duct wall **32**. The damper **68** is provided with free swinging lower edge **72** adapted to move in opposite directions as indicated by arrows **74** either into closed position with respect to the blower outlet **66** or into engagement with the generally lower wall **34** of the delivery duct **30** which is uppermost in the assembly comprising the generally elbow shaped assembly of the delivery and return ducts for the refrigeration air conditioner.

The damper **68**, shown in FIG. 3 of the drawings, is provided with opposite edges **76** and **78** spaced from side wall portions **80** and **82** respectively of the delivery duct **30** so that air may flow around the damper **68** when in the broken line position shown in FIG. 2 of the drawings, and pass in the direction of an arrow A in FIG. 1 toward the evaporator **18** and in this position the damper also allows air to flow in the delivery duct **30** in the direction of an arrow B, all as will be hereinafter described in detail.

As shown in FIG. 3, it will be seen that the lower edge as well as the side edges **76** and **78** of the damper **68**

overlie the evaporative cooler blower delivery 66 so that when the damper is in the solid line position shown in FIG. 2, the delivery opening 66 is fully enclosed.

In the closed position, as shown by solid lines in FIG. 2 of the drawings, the damper 68 thus shuts off flow of air from the blower 58 and under such conditions, the blower 58 is deenergized and the blower 22 is energized. In this mode of operation, arrows C represent flow passing upwardly from a room through the return duct 24 and through the blower 22 and the refrigerant evaporator 18 and into the delivery duct 30 such that the arrows C indicate a continuous flow through the return duct 24 toward the evaporator 18 and through it and then back through the delivery duct 30 and into a room.

Under this mode of operation, air pressure delivered by the blower 22 holds the damper 68 closed against the outlet opening 66 of the evaporative cooler blower 58.

When the refrigeration air conditioner is deenergized the blower 22 thereof remains in static condition and when the evaporative cooler blower 58 is concurrently energized, it forces the damper 68 into the broken line position as shown in FIG. 2 of the drawings, whereupon evaporatively cooled air from the evaporative cooler pads 52, 54 and 56 passes through the blower 58 downwardly through the outlet opening 56 and through the delivery duct as indicated by the arrow B and also around opposite edges 76 and 78 of the damper 68 and through the refrigerant evaporant 18 and its respective blower 22 and downwardly through the delivery duct 24 to a room, all as indicated by the arrows A. In the forgoing manner the damper 68, when open, permits the blower to communicate concurrently with both the delivery and return ducts.

Accordingly, it will be understood that the volume requirements of evaporative cooler air flow from the blower 58 are met by using both of the delivery and return ducts 30 and 24 respectively due to the fact that the damper allows part of the evaporatively cooled air to pass through the refrigerant evaporant 18 and the blower 22 and into the return duct 24 so that air from the evaporative cooler blower 58 passes through both the delivery and return ducts 30 and 24 and into a respective room below the roof 40.

The disposition of the generally elbow shaped duct assembly comprising the delivery duct 30 and the return duct 34 disposed within a portion of the evaporative cooler 16, permits the adjacent generally upright sides 12 and 14 of the air conditioner and evaporative cooler 10 and 16 respectively to be secured together in a unitary and compact relationship and readily adapted for installation above a roof 40 so as to contain all of the means required for automatic operation of either of the units alternately to provide for evaporative coolings or refrigeration as desired.

The evaporative cooler 16, when in operation serves very efficiently during low humidity condition, while the refrigeration air conditioner 10 serves efficiently during relatively high humidity ambient conditions. Accordingly, the function of the combination air conditioner since such air conditioners cost a great deal more to operate from a power standpoint than to conventional evaporative coolers.

The compactness of the invention may be appreciated due to the fact that the elbow shaped duct assembly passes outward and downward through the evapo-

orative cooler and the compact damper arrangement provided by the damper 86 in the return duct 30 provides a means by which air flow from either of the air conditioning units may operate the damper in its respective direction and this may be accomplished by simply utilizing a switch which concurrently energizes blower 58 and deenergizes the blower 22 or vice versa, depending on whether evaporative cooling is required or whether refrigeration is required.

It will be understood that the refrigeration air conditioner is provided with an air-to-air cooled condenser which receives air through a grill 11 as shown in FIG. 1 of the drawings, and exhausts air to atmosphere through an outlet 13. This refrigerant air conditioner also provides a conventional refrigerant compressor in circuit with the evaporator 18 and the usual condenser which is disposed in a location next to the grill 11 hereinbefore described.

In the modification as shown in FIG. 4, a refrigeration air conditioner 80 is similar to the hereinbefore described refrigeration air conditioner 10 and an evaporative cooler 82 is similar to the hereinbefore described evaporative cooler 16.

the evaporative cooler 82, however, has evaporative cooler pads on all four sides and the bottom of the evaporative cooler rests on top of the refrigeration air conditioner 80 and is secure thereof.

The evaporative cooler 82 is provided with a blower 86 having a downwardly directed delivery outlet duct portion 88 which communicates with an opening 90 in the upper side of refrigeration air conditioner 80. A damper 92 is pivoted at 94 to swing into a closed broken line position 96 or into the solid line position shown in FIG. 4 against a stop 98 carried by a wall 100 internally of the refrigeration air conditioner 80.

The opening 90 is disposed at and communicating with an inner side 102 of a refrigerant evaporative 104 which is similar to the hereinbefore described evaporator 18.

A delivery duct 106 communicates with the evaporator 104 to receive refrigerated air from the evaporator in the direction of the arrows 108 which air is driven by a blower 110 adapted to receive air through a delivery duct 112 in the direction of arrows 114.

In operation when the evaporative cooler blower 86 is energized, evaporatively cooled air is forced downwardly causing the damper to open against the stop 98 and allowing air to flow downwardly and through a refrigerant evaporative 104 and into the delivery duct 106 in accordance with the flow disposed by arrows 108. Concurrently evaporative cooled air flows downwardly around the damper 92 and through the blower 110 and proceeds into the delivery duct in the direction of arrows 116, whereby evaporative cooled air may be delivered through both the delivery and return ducts 106 and 116 respectively when the evaporative cooler 82 is energized and when the refrigeration air conditioner is deenergized.

Conversely when the evaporative cooler 82 is deenergized and the refrigeration air conditioner 82 energizes the blower 110 forces air through the return duct 112 in the direction of the arrows 14 and delivers air upwardly forcing the damper 92 to enclosed broken line position 96 and forcing air through the refrigerant evaporator from the side 102 and into the delivery duct 106 whereby refrigerated air is delivered through the duct 106 and air is returned from the respective room

as indicated by arrows 114 through the return duct 112.

The species shown in FIG. 4 provides for concurrent communication of the evaporative cooler blower with both the delivery and return ducts which communicate with the refrigeration air conditioner A.

In the modification of the invention as shown in FIGS. 5, 6 and 7 a refrigeration air conditioner 120 is similar to the refrigeration air conditioners 10 and 80 and an evaporative cooler 122 is similar to the hereinbefore described evaporative coolers 16 and 82. The evaporative cooler 122 is provided with a side delivery blower having a delivery duct 124 adapted to deliver evaporative cooled air. This duct 124 as shown in FIG. 7 is substantially horizontal duct flared to communicate with respective openings 126 and 128 in delivery and return ducts 130 and 132 respectively as shown in FIG. 6 of the drawings. A shaft 134 extends downwardly through the delivery and return ducts 130 and 132 and carries a pair of damper members 136 and 138 which are fixed to the shaft 134 and cooperate respectively with the blower outlet openings 126 and 128. These dampers 136 and 138 are movable from the solid line position shown in FIGS. 5 and 6 to broken line positions 140 and 142 respectively to overly and cover the respective openings 126 and 128.

In operation when the refrigeration air conditioner 128 is energized, air is forced from the respective air conditioner blower 144 shown in FIG. 6 through the refrigerant evaporator 146 and into the delivery duct 130 in the direction of arrows 148. Air returns through the return duct 132 in the direction of arrows 150 and when the refrigeration air conditioner 120 is deenergized and the evaporative cooler blower is energized evaporative cooled air is delivered through the blower duct 124 which forces the dampers 136 and 138 fixed to the shaft 134 to pivot in bearings 152 and 154 to the solid line position as shown in FIG. 5 of the drawings so that evaporative cooled air is delivered directly from the blower through the side openings 126 and 128 and into both the delivery and return ducts 130 and 132 concurrently. According to this particular species of the invention evaporatively cooled air does not flow through the refrigerant evaporator 146 or the respective blower 144.

It will be appreciated that when the blower 144 is energized and the blower 124 is deenergized that flow of refrigerated air will cause the damper 136 to swing close to a broken line position 160 shown in FIG. 5 of the drawings. Inasmuch as the damper 138 is also fixed to the shaft 134, it will also close before substantial flow through the return duct 132 occurs according to arrows 150.

All of the dampers namely the damper 168, the damper 92 and the dampers 136 and 138 may have conventional magnetic holding devices for holding them in close position relative to the evaporative cooler blower outlets if desired and which magnets are capable of being overcome by force of air passing from the evaporative cooler blower when it is energized.

It will be obvious to those skilled in the art that various modifications may be resorted to without departing from the spirit of the invention.

I claim:

1. In a combination air conditioner adapted to be installed on top of a building roof; an evaporative cooler; a refrigeration air conditioner adjacent to said evapora-

tive cooler; said refrigeration air conditioner having a refrigerant evaporator; said refrigeration air conditioner having first means for forcing air through said refrigerant evaporator; a refrigerated air delivery duct extending from said refrigerant evaporator to receive refrigerated air therefrom; an air return duct adjacent to said delivery duct; said return duct communicating with said first means; said first means disposed to force air from said return duct and through said refrigerant evaporator and into said delivery duct; a blower in said evaporative cooler; said blower provided with a delivery opening communicating with the interiors of both of said ducts; and a pivoted damper pivotally disposed to swing into an open or closed position relative to said blower delivery opening; said damper alternately pivotal into an open or closed position relative to said delivery ducts to thereby permit said blower to deliver evaporatively cooled air concurrently through said delivery duct and said return duct.

2. The invention defined in claim 1 wherein said delivery duct is disposed uppermost in said duct assembly; said delivery duct having upper and lower wall portions; said damper pivoted at said upper wall portion of said delivery duct; said damper being pivoted at a respective said of said blower delivery opening.

3. The invention as defined in claim 2 wherein said delivery duct is provided with opposite side walls; said damper having opposite edges spaced from said opposite side walls to allow flow of evaporatively cooled air into said delivery duct toward said evaporator when said damper is in said closed position relative to said delivery duct to thereby permit evaporatively cooled air to flow progressively through said evaporator said first means and said return duct; said damper when in open position relative to said blower delivery opening having its free edge opposite to said pivoted portion thereof; said free edge movable to said lower wall portion of said delivery duct to allow evaporatively cooled air to move from said blower delivery opening and into said delivery duct extending downwardly therebelow whereby evaporatively cooled air may be delivered to a room through both said delivery and return ducts.

4. The invention as defined in claim 3 wherein said damper is responsive to air flow from said first means when said blower is deenergized whereby said damper is forced closed by air from said first means thereby closing said blower delivery opening and refrigerated air is then delivered from evaporator through said delivery duct and returned to said evaporator through said return duct.

5. The invention as defined in claim 1 wherein said evaporative cooler and said air conditioner are fixed together in a unitary assembly; support means carrying said unitary assembly; a roof supporting said support means; interior delivery and return duct means below said roof; said interior return and delivery duct means communicating through said roof with said first mentioned return and delivery ducts of said elbow shaped duct assembly.

6. The invention as defined in claim 1 wherein said evaporative cooler is provided with evaporator cooler pads; said cooler having sides, other than said upright sides, in which said evaporator cooler pads are disposed; said evaporator cooler having a sump portion near said bottom thereof said sump portion adapted to contain water therein; said sump portion disposed in

partially surrounding relation to said elbow shaped duct assembly.

7. The invention as defined in claim 1 wherein said evaporative cooler is mounted on top of said refrigeration air conditioner; said blower of said evaporative cooler having a delivery opening communicating with said refrigerant evaporator of said refrigeration air conditioner and adapted to force evaporative cooled air therethrough and into said delivery duct and concurrently adapted to force air through said first means and into said return duct; and a damper pivotally mounted in relation to said delivery opening of said evaporative cooler for swinging into closed position relative to when first means of said refrigeration air conditioner is energized, said damper being freely pivotal to an open position by air forced through said evaporative cooler blower when it is energized and when said refrigeration air conditioner is deenergized.

8. The invention as defined in claim 1 wherein said evaporative cooler is provided with a side delivery blower opening communicating with openings in sides of said delivery and return ducts; and pivotal damper means coupled together and adapted to swing open and close relative to said openings in the sides of said ducts whereby evaporative cooled air from said blower of said evaporative cooler may be delivered directly into said ducts for concurrent delivery of evaporatively cooled air through both said delivery and return ducts and whereby the damper means is forced closed relative to the delivery opening of the evaporative cooler blower when said first means is energized for forcing air through said refrigerant evaporator to deliver refrigerated air through the delivery duct and allow air to return through said return duct to said first means.

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