May 1, 1962 R. A. CHURCH 3,032,323

AIR CONDITIONING SYSTEMS

Filed Dec. 3, 1956 3 Sheets-Sheet 1

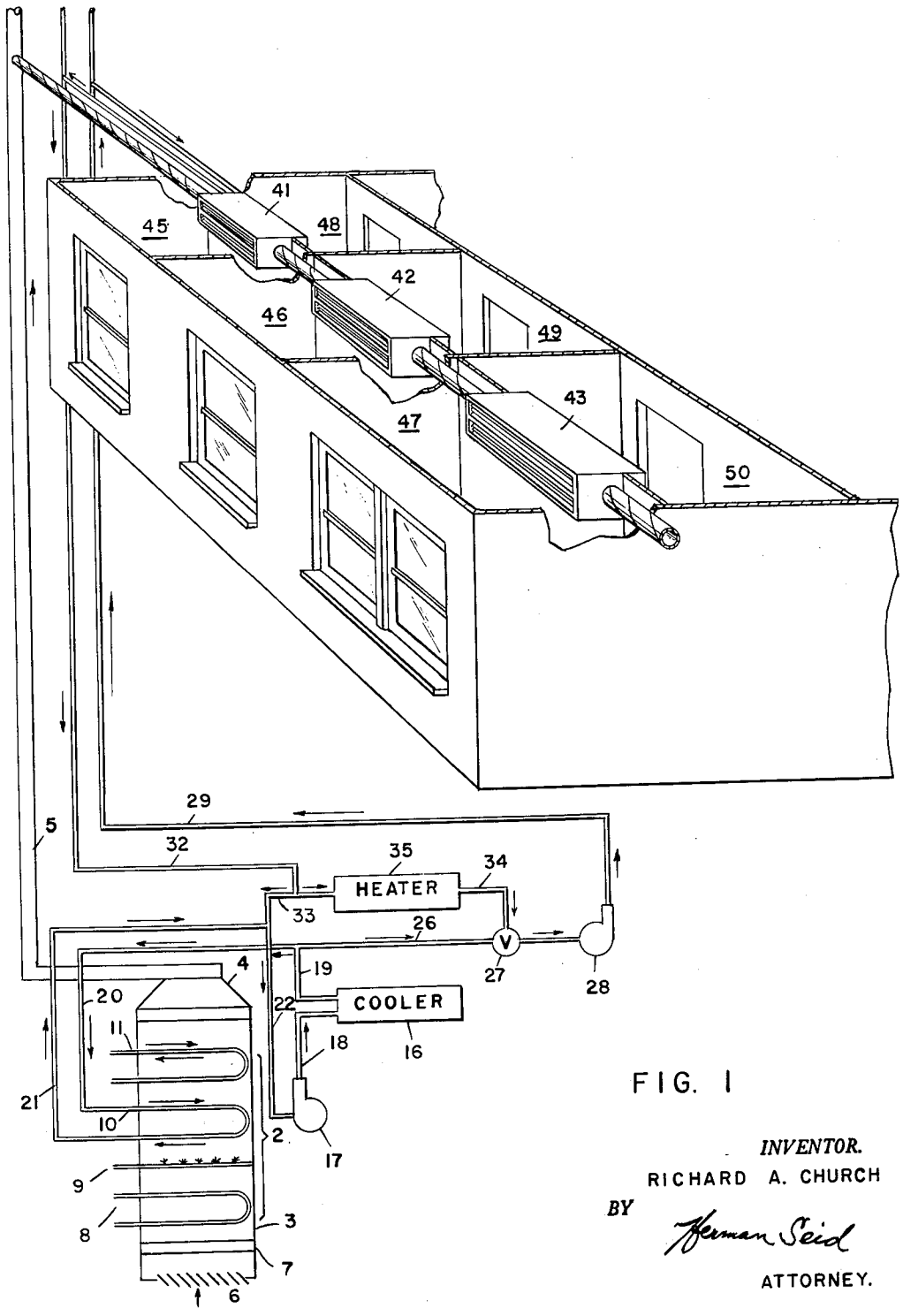


FIG. 1

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AIR CONDITIONING SYSTEMS

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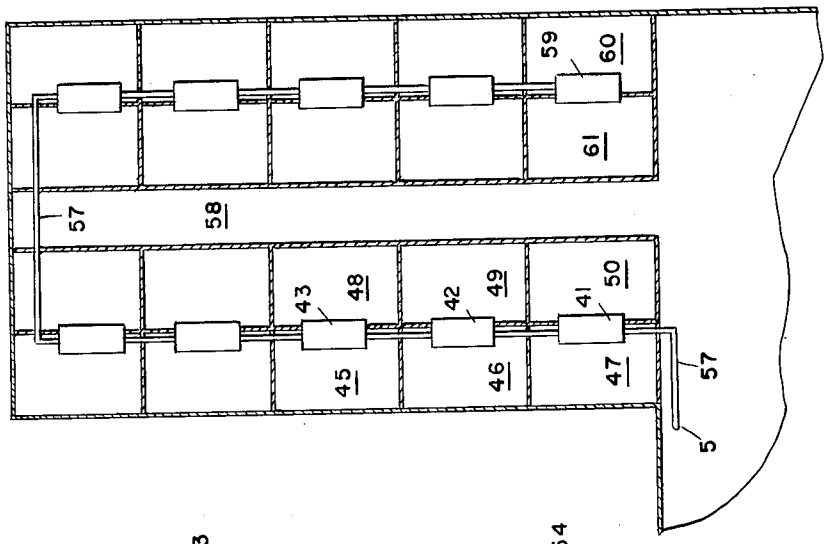


FIG. 3

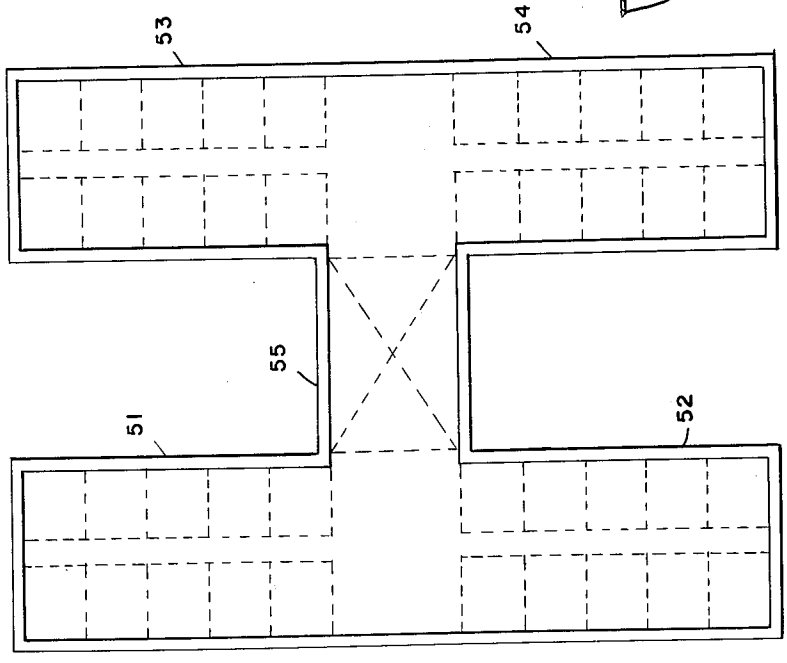


FIG. 2

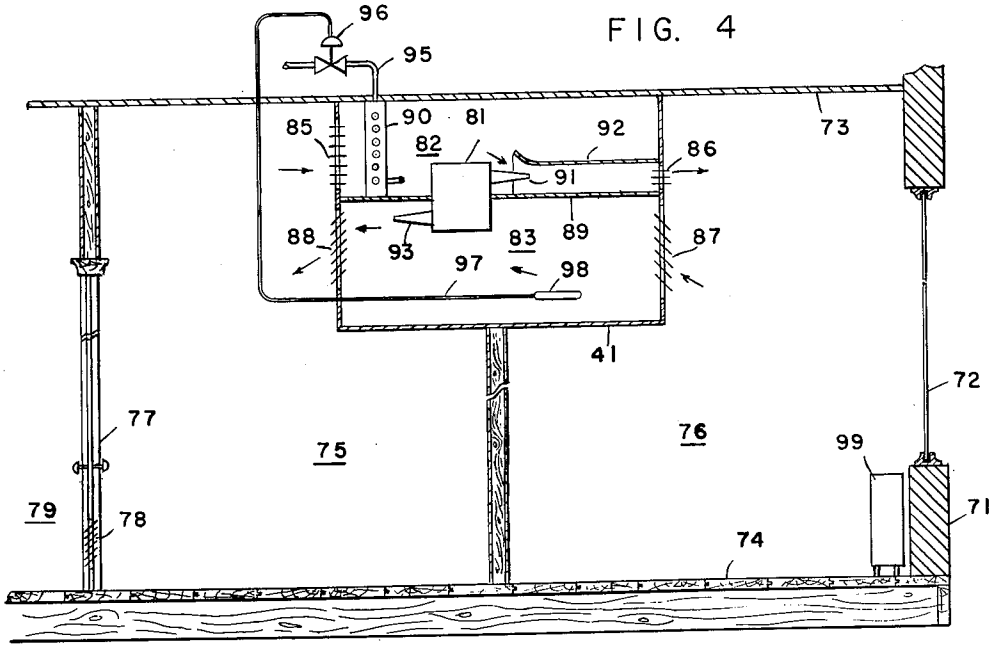
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AIR CONDITIONING SYSTEMS

Filed Dec. 3, 1956 3 Sheets-Sheet 3

FIG. 4



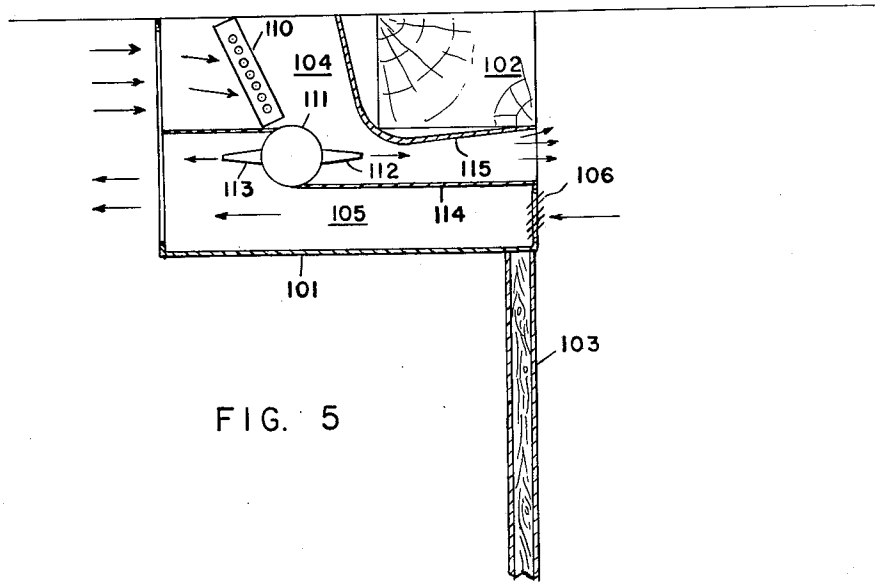


FIG. 5

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3,032,323

AIR CONDITIONING SYSTEMS

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Filed Dec. 3, 1956, Ser. No. 625,956
12 Claims. (Cl. 257—313)

This invention relates to air conditioning systems and more particularly to improved air conditioning systems which may utilize units of the induction type in a manner whereby two spaces having specific requirements may be comfort conditioned at a cost greatly reduced over other systems which normally require a plurality of units to supply the same requirements. This invention also relates to a method of air conditioning a plurality of spaces in an economical manner whereby the temperature condition of one space is utilized to condition one or more other spaces.

In Carrier Patent No. 2,363,294, granted November 21, 1944 there is disclosed an air conditioning system for multi-room buildings which contemplates a supply of conditioned air from a central station at high velocity and static pressure through small conduits to units placed in rooms being conditioned. Each room unit includes a heat exchanger through which cold or hot water may be passed depending upon the temperature conditions exteriorly of the building. The stream of conditioned primary air (cold or warm) from the central station is discharged to the unit at a velocity such as to induce a secondary stream of air into the unit through the heat exchanger to mix therewith. The mixture of streams is then discharged into the room to cool or heat the same.

While this system is the most satisfactory heretofore developed for air conditioning multi-room buildings, it is somewhat expensive in installation, especially in existing buildings. Since practically all new office buildings, hotels, et cetera, are air conditioned, lack of air conditioning places a non-conditioned building structure of this type in an extremely difficult competitive position for most tenants or guests prefer and are willing to pay a premium for air conditioned quarters. In order to render existing structures competitive, various solutions have been advanced such as the use of self-contained units and also window air conditioning units. However, it has been found that such units are unsatisfactory since they do not perform adequately and are noisy and expensive to maintain in use. Central station systems appear to be the most practicable means for solving the problem of air conditioning existing building structures so that they can compete with new structures of the same type. In many cases, unfortunately, space, cost and construction considerations make such a solution impracticable.

The Ashley patent application, Serial Number 559,061, filed January 13, 1956 discloses an improved system wherein the number of conduits and water lines to the various induction units in the system are minimized. It is believed a system of this type has made a great stride toward decreasing the installation difficulties and costs of this type of system. It will be appreciated that certain types of structures have unique problems which require methods of approach not suggested by the Carrier patent nor the Ashley application. A building of this type is the building constructed during the 20's and early 30's which has a general H cross section. In this type of building, the occupants use the four wings and the connecting section of the H is utilized for service facilities such as elevators, water lines, et cetera.

In providing a building of this type with air conditioning the various ducts and water lines are passed up through the service area of the H shape building and then spread out into the various wings of the building.

The problem with such a building arises when it is considered that each wing of the building comprises a corridor having a double depth of rooms on either side of the corridor extending along the length of the wing. In systems such as the Carrier and Ashley systems, no problem arises with conditioning the exterior zones of the building, however, the interior rooms of such a building and also the corridor of the building provide a severe problem which is not readily solved. Normally to condition the corridor and the interior rooms, further ductwork, water lines and a greater number of units are required. It will be immediately recognized that such added construction would be carried out at prohibitive cost making the existing and older structure require rentals to support such expenditures far exceeding the cost of existing air conditioned buildings.

The chief object of the present invention is to provide an air conditioning system of the induction type and also a method of air conditioning in which a single unit may be utilized to comfort condition more than one space.

An object of the invention is to provide an air conditioning system of the induction type adapted to supplement existing heating facilities in the space to be comfort conditioned.

A further object is to provide an air conditioning system utilizing an induction type unit in which a single unit may condition a plurality of spaces in an economical manner whereby the temperature of the air in the first space is utilized to condition the air in the other spaces.

A further object is to provide an air conditioning system whereby air is conditioned and passed from an interior zone into an exterior zone and wherein air from the exterior zone is passed from said zone and mixed with a source of primary air and passed into an interior zone to comfort condition said zones.

A still further object is to provide a method of air conditioning two spaces in which air from an interior zone is conditioned and mixed with a source of primary air and passed into an exterior zone to comfort condition said exterior zone, passing air from the exterior zone, mixing said air with a source of primary air and passing said mixture of air into an interior zone to comfort condition said interior zone, whereby the temperature condition of the exterior zone is effectively utilized to comfort condition said interior zone. Other objects will be readily perceived from the following description.

This invention relates to an air conditioning system for multi-room building structures which comprise a plurality of interior and exterior zones. Air is passed from the interior zone and is conditioned by a heat exchange process with a conditioning medium; the air is then mixed with a source of primary air and passed into an exterior zone to comfort condition this exterior zone. The air in the exterior zone is passed from said zone and mixed with a source of primary air and urged into the interior zone to comfort said interior zone. The interior zone is maintained at a slightly higher temperature than the exterior zone so that the temperature of the air in said exterior zone will largely determine the conditioned result of the air within said interior zone. This system further utilizes means to control the air passing from the exterior space by controlling the heat exchange process of the air passing from the interior zone to the exterior zone in heat exchange relation with the conditioning medium.

This invention also relates to a method of comfort conditioning a plurality of interior and exterior zones in which air is passed from the interior zone into heat exchange relation with a conditioning medium; mixing this conditioned air with a source of primary air and inducing this mixture of conditioned and primary air into the exterior zone to condition said zone and maintain said zone at a first temperature; passing the air from

the exterior zone and mixing it with a source of primary air, passing said mixture of primary air and air of the exterior zone into the interior zone to comfort condition said interior zone at a second temperature which is slightly higher than the first temperature and also sensing the temperature of the air passing from the exterior zone and controlling the heat exchange process between the conditioning medium and the air passing from the interior zone to the exterior zone in response thereto.

The attached drawings illustrate a preferred embodiment of the invention, in which

FIGURE 1 is a view partly diagrammatic, partly perspective, illustrating the air conditioning system of the present invention;

FIGURE 2 is a plan view illustrating the use of the present invention in an H cross-section building;

FIGURE 3 is an enlarged plan view of a wing of the building shown in FIGURE 2;

FIGURE 4 is a cross-sectional view of an interior and exterior zone air conditioned by the present invention; and

FIGURE 5 is a cross-sectional view of a modification of the system shown in FIGURE 4.

Referring to the drawings, in FIGURE 1 there is shown the air conditioning system of the present invention. This system comprises suitable air conditioning apparatus placed in a central station **2**, such apparatus being contained in a casing **3**. The apparatus may be disposed in any suitable place in the basement, on the roof, or in a storage space of a building served thereby. A fan **4** is provided to draw air within casing **3**, the air being conditioned in any desired manner during its passage through casing **3**, and then to discharge the conditioned air at relatively high static pressure and high velocity into a primary air conduit such as riser **5**.

The air conditioning apparatus illustrated at **2** may be of any desired type and it is understood that the present invention is not limited with respect to the apparatus illustrated. As illustrated, apparatus **2** includes a plurality of dampers **6** through which air is drawn into casing **3** from the exterior of the building, a filter **7**, a preheating coil **8** through which steam may be passed to preheat air drawn into casing **3**, sprays **9**, a dehumidification or cooling coil **10** and a reheating coil **11**. In such apparatus, primary air is suitably conditioned in accordance with the requirements of the areas to be conditioned.

Conditioned primary air is forced through riser **5** by fan **4** to the various wings of the building structure being conditioned. The conditioned primary air is discharged at relatively high velocity into induction units and serves to induce a constant flow of secondary air within the units from the areas being conditioned.

Heat exchange medium, such as water, varied in temperature in accordance with conditions existing exteriorly of the building is supplied to the heat exchange members of the room units. A cooler **16** is provided forming part of a refrigeration system (not shown) to furnish cold water to the room unit heat exchange members and to the cooling coil **10** of the central station apparatus **2**. A pump **17** passes water through line **18** to cooler **16**, water being cooled therein and supplied through line **19** and line **20** to cooling coil **10**, water returning to the pump from cooling coil **10** through line **21** and line **22**.

Pump **17** also aids in supplying cold water for the heat exchange members of the induction units. The water passes through line **19** and line **26**, a three-way valve **27** being placed in line **26** for a purpose hereinafter described, to secondary pump **28** which forwards the water through riser line **29** and run-out line **30** to the heat exchange members in the induction units. Water supplied to the heat exchange members is returned through return line **32**, line **33**, line **22**, pump **17** and line **18** to cooler **16**.

During the heating season, when it is desired to supply hot water to the heat exchange members, three-way valve **27** is manipulated to close line **26** and to open line **34** connecting heater **35** with pump **28**. The heated water then passes from pump **28** through line **29** to the heat exchange members and returns to heater **35** through line **32** and **36**. The heater **35** may be the existing furnace in the building normally utilized to supply heating medium to the existing heat exchangers in the various rooms of the biulding. During the heating season it will be remembered that the room units provided by this system may supplement the heating facilities already existing in the building.

Referring to FIGURE 1, there are shown in perspective three exterior rooms **45**, **46** and **47** and three interior rooms **48**, **49** and **50**. Lying between these rooms are the units **41**, **42** and **43** which are operatively connected to the riser **5** and the water lines **29** and **32**. It will be noted that each of these units services an exterior and an interior room.

Referring to FIGURE 2 there is shown an H-shaped building which is the general plan of buildings erected during the 20's and early 30's. This is the type of building for which the present invention is particularly adapted. This building comprises four wings **51**, **52**, **53** and **54**. These wings are normally occupied by guests or tenants and the central portion **55** of the building is utilized for service facilities such as elevators, electrical, heating and water facilities. In applying the present invention, air conduits and water lines extend upwardly through this area.

Referring to FIGURE 3 there is shown an enlarged plan view of a wing of this building. The riser **5** extends upwardly in the service area **55** and a branch line **57** extends therefrom. It will be noted that this particular wing consists of a central corridor **58** having a double depth of rooms on either side thereof. Between each pair of interior and exterior rooms there is located a suitable air conditioning unit, the details of which will be described fully hereinafter. These units are placed in series and extend first down one side of the wing terminating at the end of the wing, passing over the corridor into the second side of the wing and terminating at the other side of the building. For example, units **41**, **42** and **43** service exterior zones **45**, **46** and **47** and interior zones **48**, **49** and **50**. All these units are connected by the conduit **57** and attendant water lines. The line of units terminates on the opposite side of the corridor in the rooms **61** and **60**, opposite the rooms **47** and **50** and the last unit on the conduit **57** is the unit **59**.

From FIGURES 2 and 3 it can be readily seen that an existing building of this particular cross-section can be readily conditioned by a minimum number of units and a minimum length of water and air lines since a single line services a plurality of units and the units service more than one space.

Referring to FIGURE 4 there is shown a sectional view in elevation of one of the compartments illustrated in FIGURES 1 and 3 employing the present invention. This figure indicates in section, the building in which the wall **71** is an exterior wall exposed to the outdoors and having a window **72**. The section is defined by ceiling **73** and a floor **74** and a partition which divides the space into two rooms **75** and **76** with a door **77** having louvers **78** connecting the room **75** with the corridor **79**. Located within this space is a unit **41** which is in communication with both rooms **75** and **76**.

This unit has located therein a suitable conduit **81** and further consists of a casing which defines a first passage **82** and a second passage **83**. These passages form means of communication between the rooms **75** and **76**. The

first passage 82 has an inlet louver 85 and outlet louver 86 and the second passage 83 has an inlet louver 87 and an outlet louver 88. These two passages are separated by a partition 89.

Located in the first passage 82 adjacent the louvers 85 is a suitable heat exchange member 90. Following this heat exchange member is a set of nozzles 91 which originate from the conduit 81. These nozzles 91 are directed into a passage formed by the partitions 89 and 92 which form a suitable venturi. Originating from the conduit is a second set of nozzles 93 which are located in the second passage 83 and are directed toward the louvers 88.

A supply of conditioning medium is passed to the heat exchange member through the line 95 and this supply is controlled by a suitable control valve 96 which is connected through the line 97 to a suitable sensing bulb 98 located in the second passage 83 adjacent the louvers 87.

As has been previously mentioned this type of installation is well suited for conversion installations in existing buildings. In FIGURE 4 is will be noted that below the window 72 there is located a suitable radiator 99 which is a normal part of the heating system of the existing facilities of the building. Normally during the cooling season the unit 41 will be utilized alone to comfort condition the spaces 75 and 76. However, during the winter season when heating is required, it is possible that the heat exchanger 90 may not be adequate to supply the full requirements of the spaces and will be mostly used for ventilation purposes and the radiator 99 will carry out the heating function as it did prior to the installation of the present air conditioning system.

Referring to FIGURE 5 there is shown a modification of the unit illustrated in FIGURE 4. This unit 101 consists of a casing which is fitted about the support member 102 of the building and one end of which terminates in the wall 103. This particular unit has two passages 104 and 105 which have suitable louvers 106, if desired. Located within the unit is a heat exchange member 110 similar to the one illustrated in FIGURE 4. This heat exchange member 110 is angularly disposed with respect to the air stream passing through the passage 104. Located adjacent this heat exchange member is a circular plenum 111 which may be fabricated of spiral conduit having suitable nozzles 112 and 113 extending therefrom. The nozzles 112 extend into the first passage 104 and the second set of nozzles 113 extend into the passage 105. It will be noted that the partition 114, which defines the passages 104 and 105, is offset to accommodate the circular plenum. Downstream from the nozzles 112 is a suitable partition member 115 which is formed about the structural member 102 in such a manner as to form a venturi effect or ejecting air from the first passage into the exterior zone.

Similar controls as those utilized in the embodiment of FIGURE 4 may be employed in this embodiment of the invention.

It will be noted that functionally the first and second embodiments are similar with the exception of the orientation of the partition members defining the first and second passages, the orientation of the heat exchange member and the cross-sectional shape of the plenum which supplies the primary air. The second embodiment furthermore provides means for accommodating a structural member without impeding the air flow within the unit.

Considering the operation of the embodiment illustrated in FIGURE 4, suitable louvers have been provided for the first and second passages in the unit 41. The purpose of these members is to separate the incoming and outgoing air as they pass through the unit. Air is drawn from the room 75 through the louvers 85. This air passes through the heat exchange member 90 which is supplied with cooling medium in amounts determined by the air passing through the second passage 83. This air is induced into the first passage 82 by means of the primary

air issuing from the nozzles 91 which extend from the sources of primary air within the plenum 81. This air is urged into the venturi created by the members 92 and 89 and draws air from the second room and mixes therewith. This mixture of primary air and secondary air is then injected into the first room 76 where it is diffused into the room. Air from the exterior space 76 is drawn through the louvers 87, into the second passage 83. The temperature of the air passing through the second passage is sensed by the bulb 98 which is connected by the line 97 to the control valve 96. This control valve regulates the amount of heat exchange medium supplied to the heat exchange member 90 and controls thereby the temperature in the rooms 76 and 75. The nozzle 93 located in the second passage urges the air to pass through the second passage and discharge the same into the second room 75. This nozzle also provides a source of ventilating and conditioning air for space 75.

The present system envisions an arrangement wherein the exterior rooms normally encounter a greater load than the interior rooms. Generally the exterior rooms are occupied by a number of people and are subjected to greater heat loads from within the rooms and also to exterior heat loads, and therefore require a greater cooling effort. The present invention contemplates that the exterior rooms will normally operate at a slightly lower temperature during the summer than the interior rooms.

It will be immediately recognized that since the exterior room 76 generally has the greater load the heat exchange member 90 has been provided to accommodate this load by being placed in the first passage. The interior room 75 usually has a much lower load and the air passed through the second passage mixed with additional air from the primary air supply will adequately handle the requirements of the interior room. It will be again noted that a temperature gradient exists between the interior and exterior rooms. The exterior room will normally be at a temperature of, for example, 1 to 2 degrees lower than the temperature of the interior room. This differential will be sufficient to maintain the temperature of the interior room because of the lesser load due to the fewer people and lights therein and also to a great extent to the absence of transmission losses through any of the walls. The air as it is discharged from the unit 41 through the louvers 88 diffuses into the room 75. Air from this space is passed back into the unit by passing through the louvers 85 of the first passage 82. A portion of the air introduced into this room 75 may pass into the corridor through the louvers 78 in the door 77.

The unit illustrated in FIGURE 5 functions in a similar manner and such a unit may be more feasible in certain installations particularly where a structural member is located in the partition between interior and exterior rooms. This modification is simple and economical since the plenum is fabricated of inexpensive spiral conduit. This particular embodiment may be controlled in a manner similar to that of FIGURE 4.

The present invention presents a solution to the problem of comfort conditioning existing installations of the type described so that two spaces are conditioned by a single unit, which is mounted above the floor so as not to take up valuable floor space. The unit functions in a manner wherein the conditioned air of the exterior space conditions the air in the interior space at a nominal cost and enables existing non-conditioned buildings to be in a competitive situation with respect to similar new air conditioned structures.

While I have described preferred embodiments of this invention, it will be understood the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. In an air conditioning system for a multi-room building structure, the combination of a first area to be

conditioned, a second area to be conditioned, means defining a passage between the first and second areas, a supplemental air conditioning unit in said passage, means defining a second passage between said areas, means to supply primary air to said first and second passages, nozzle means operatively associated with said supply means to discharge primary air in said first passage in a predetermined direction thereby inducing a stream of secondary air from the second area into the passage through said supplemental unit to mix with the primary air, the mixture being discharged in said first area, and second nozzle means operatively associated with said supply means to discharge primary air in said second passage in a predetermined direction thereby inducing a stream of tertiary air from the first area into the second passage to mix therewith, the mixture being discharged in said second area.

2. In an air conditioning system, a plurality of rooms, a plurality of units, each unit discharging into two rooms, a conduit extending between and through at least a pair of said units, at least one of said units comprising a first passage and a second passage, each extending between the first and second rooms, a first and second set of nozzles attached to said conduit, a source of primary air connected to said conduit, a supplemental conditioning unit in the first passage said first set of nozzles extending into the first passage to induce air from the second room through said supplemental unit into the first room, said second set of nozzles extending into the second passage to induce air from the first room to the second room.

3. In an air conditioning unit for use in multi-room building structures, the combination of a casing forming a first air passage and a second air passage, a supplemental conditioning unit in said first passage, a plenum member in said casing adapted to be connected to a source of primary air, nozzle means connected to said plenum to discharge primary air in said first passage in a predetermined direction to induce secondary air into the passage from a first area being treated and through said supplemental unit for admixture with the discharge primary air, and second nozzle means connected to said plenum to discharge primary air in said second passage in a predetermined direction to induce tertiary air into the passage from a second area being treated for admixture with the discharged primary air.

4. An air conditioning unit according to claim 3 in which the supplemental conditioning unit comprises a heat exchange member located in said first air passage.

5. An air conditioning unit according to claim 4 in which the heat exchange member has a circuit therein through which is conducted conditioning medium, said flow of conditioning medium being made responsive to a condition of air passing through the second air passage of the unit.

6. In a method of air conditioning, the steps which consist in discharging a stream of primary air to induce a stream of secondary air from an area being conditioned, placing the secondary air in heat exchange relation with conditioning medium, mixing the streams of air and discharging the mixture into a second area being conditioned; discharging a second stream of primary air to induce a stream of tertiary air from the second area being conditioned, mixing the streams of air and discharging the mixture into the first area being conditioned.

7. In a method of air conditioning two spaces at different temperatures in which air is passed from a first space to a second space, and from a second space to a first space, the steps which consist of passing air from the second space into heat exchange relation with a conditioning medium, controlling said heat exchange relation in response to the condition of air passing from the first to the second space, mixing air from said heat exchange process with air from a primary source of conditioned air, and then passing the stream of air into the first space to comfort condition said space, passing air from said first space, mixing said air so drawn from said first space with primary conditioned air, and then passing said air into the second space to comfort condition said second space.

8. In an air conditioning system for a multi-room building structure, the combination of a first area to be conditioned, a second area to be conditioned, means defining a passage between the first and second areas, means defining a second passage between said areas, means to supply primary air to said first and second passages, nozzle means operatively associated with said supply means to discharge primary air in said first passage in a predetermined direction thereby inducing a stream of secondary air from the second area into the passage to mix therewith, the mixture being discharged in said first area, second nozzle means operatively associated with said supply means to discharge primary air in said second passage in a predetermined direction thereby inducing a stream of tertiary air from the first area into the second passage to mix therewith, the mixture being discharged in said second area, a heat exchange member placed in the first passage, and means to pass a conditioning medium through said member in heat exchange relation with secondary air induced into the first passage.

9. An air conditioning system according to claim 8 in which means are provided to regulate passage of conditioning medium through the heat exchange member responsive to a condition of tertiary air entering the second passage.

10. In an air conditioning system, a plurality of rooms, a plurality of units, each unit discharging into two rooms, a conduit extending between and through at least a pair of said units, at least one of said units comprising a first passage and a second passage, each extending between the first and second rooms, a first and second set of nozzles attached to said conduit, a source of primary air connected to said conduit, said first set of nozzles extending into the first passage to induce air from the second room into the first room, said second set of nozzles extending into the second passage to induce air from the first room to the second room and a heat exchange member placed in the path of air passing through the first passage, said heat exchange member being controlled by the condition of air passing through said second passage.

11. An air conditioning system according to claim 10 in which a heat exchange member having a circuit therein for heat exchange medium is placed in the path of the air in the first passage, said flow of heat exchange medium being responsive to a condition of air in the second passage.

12. In an air conditioning system, a first room, a second room, a heat exchanger having a heat conditioning fluid, first means for inducing an air supply from the second room into heat exchange relation with the heat exchanger and into the first room, said first means including a source of primary air which induces the air from the second room and mixes therewith as it passes into the first room as a single stream of conditioned air, and second means for passing the air from the first room into the second room, the second means including a stream of primary air which induces and mixes with the air from the first room and passes into the second room.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,032,323

May 1, 1962

Richard A. Church

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 21, for "is" read -- it --; line 53, for "or" read -- for --.

Signed and sealed this 2nd day of October 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents