# United States Patent [19]

**Doherty**

[11] **3,833,057**

[45] **Sept. 3, 1974**


[54] **INDUCED AIR COOLING AND HEATING SYSTEM**


[76] Inventor: **Robert P. Doherty,** 1709 W. 8th St., Los Angeles, Calif. 90017



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[21] Appl. No.: **262,575**

[52] **U.S. Cl.** ..... **165/123,** 165/22, 165/54, 165/55

[51] **Int. Cl.** ..... **F24f 3/02**

[58] **Field of Search** ..... 165/123, 22



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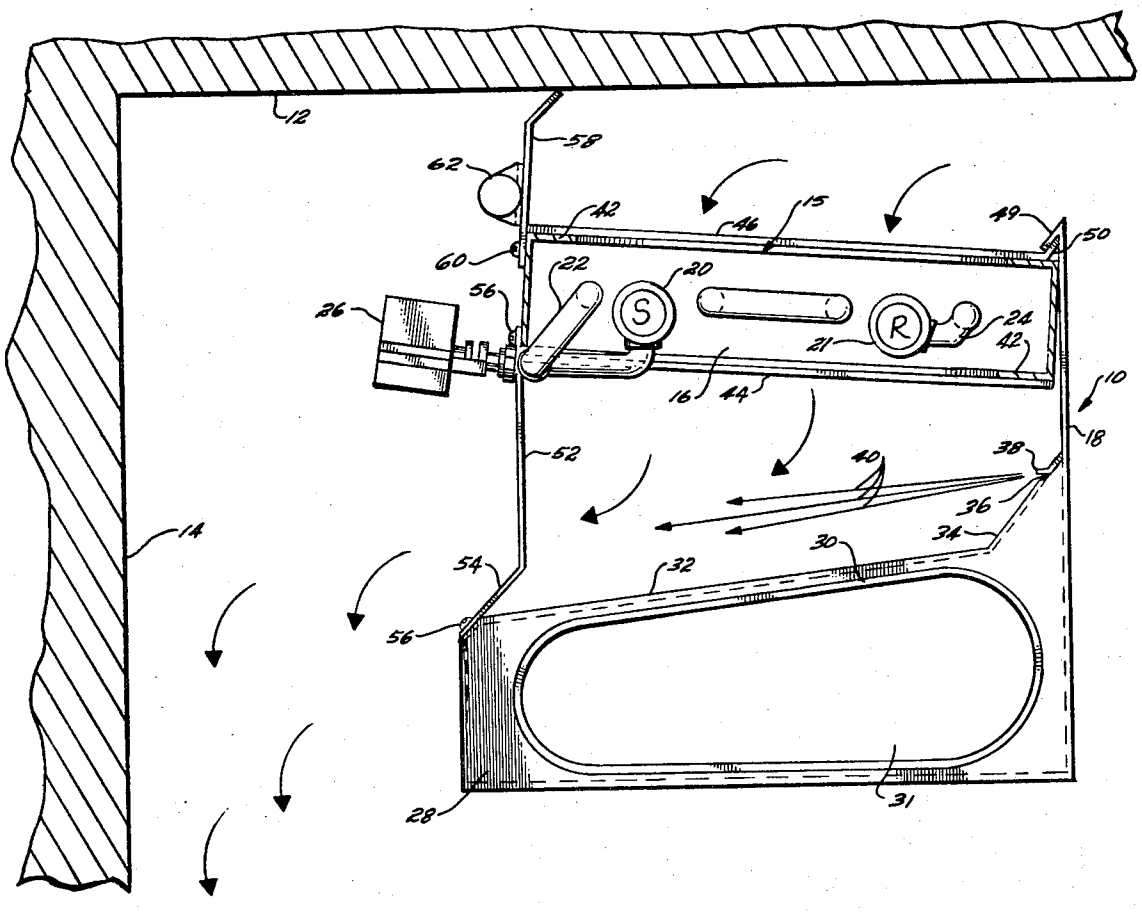
*Assistant Examiner*—S. J. Richter
*Attorney, Agent, or Firm*—Christie, Parker & Hale



[57] **ABSTRACT**

A system for heating and cooling multiple rooms includes a separate induced air heat transfer unit mounted adjacent to the ceiling in each room. Each unit includes a tubular cooling coil, a series of longitudinally spaced apart flat heat transfer fins mounted on the cooling coil, and an elongated, tubular plenum extending below the cooling coil. During the cooling cycle, chilled water is circulated through the cooling coil, and tempered air, i.e., fresh air which has been dehumidified below dew point, and preheated slightly above dew point (52°F.) in a remote central plant, is forced through the plenum. The tempered air is dispersed through slotted openings spaced along the length of the plenum to stimulate the natural convective flow of cool room air through the heat transfer unit. The supply and return pipes for the cooling coil in each room extend through the heat transfer fins and are coupled with a chiller in the central plant to provide continuous circulation of chilled water through the cooling coils. During the heating cycle, water circulation through the cooling coils is stopped, and tempered air is preheated in the central plant and forced through the openings in the plenum.


**18 Claims, 8 Drawing Figures**



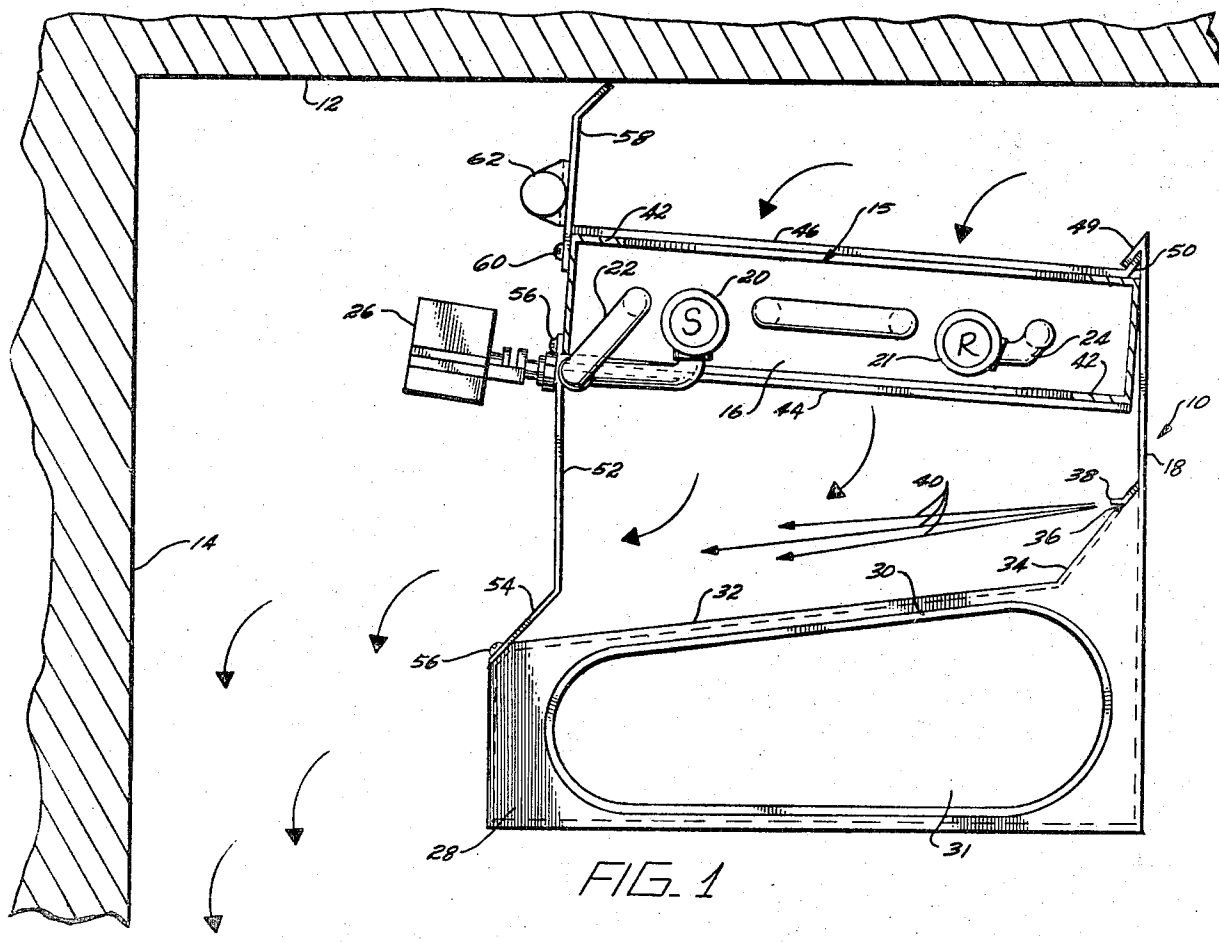



FIG. 1

FIG. 5

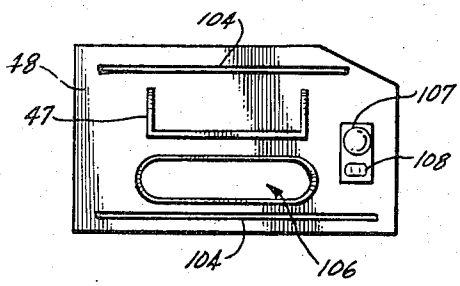
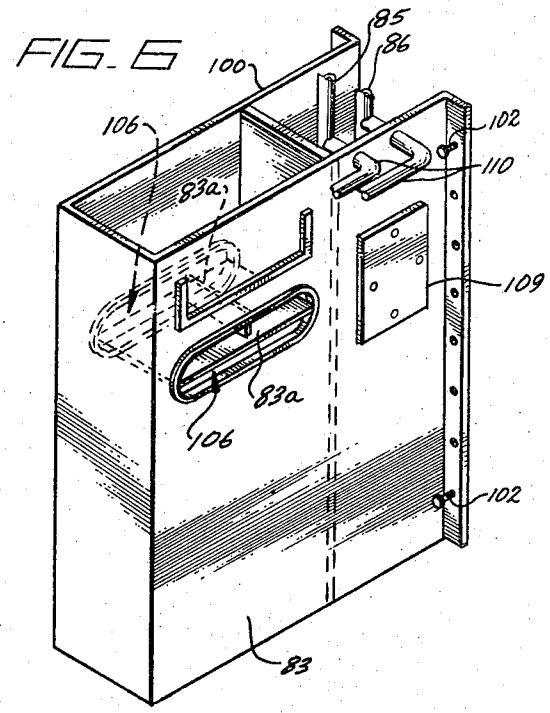



FIG. 6



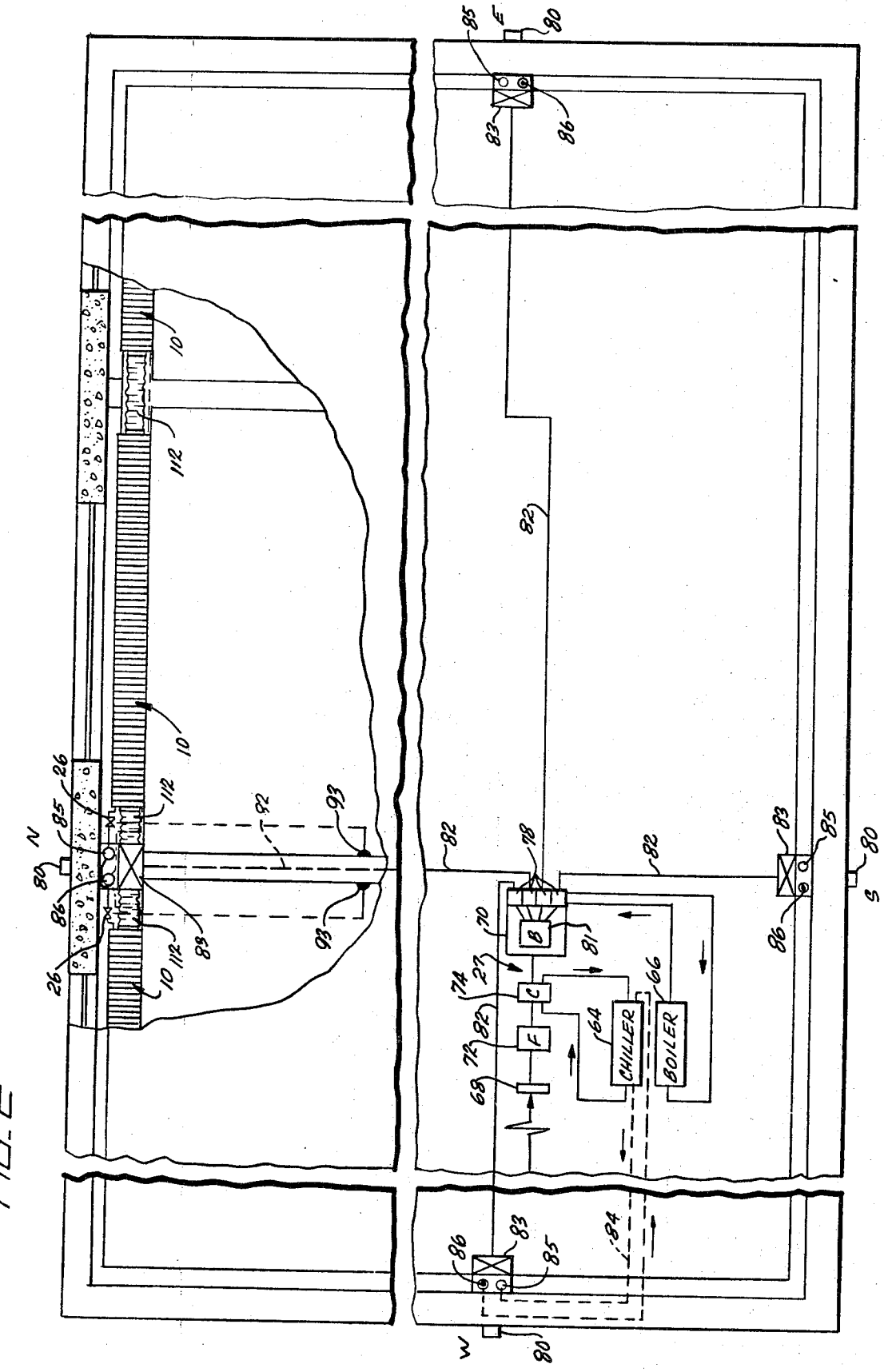
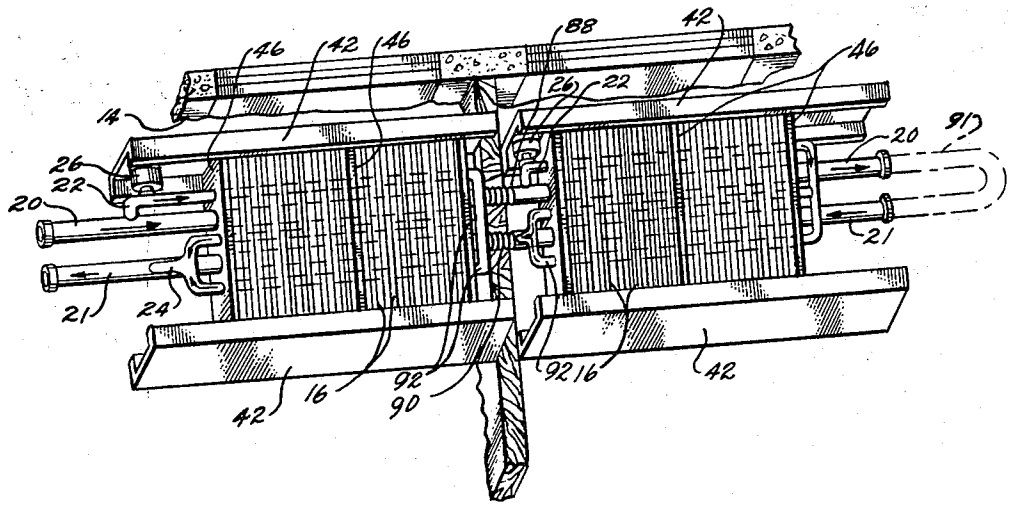



FIG. 2

FIG. 3


46
42
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88
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FIG. 4

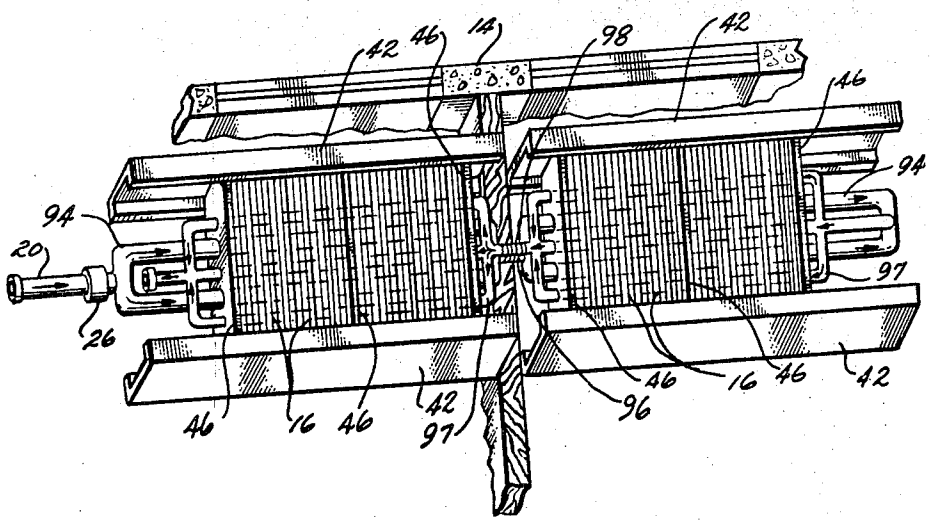
42
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FIG. 7

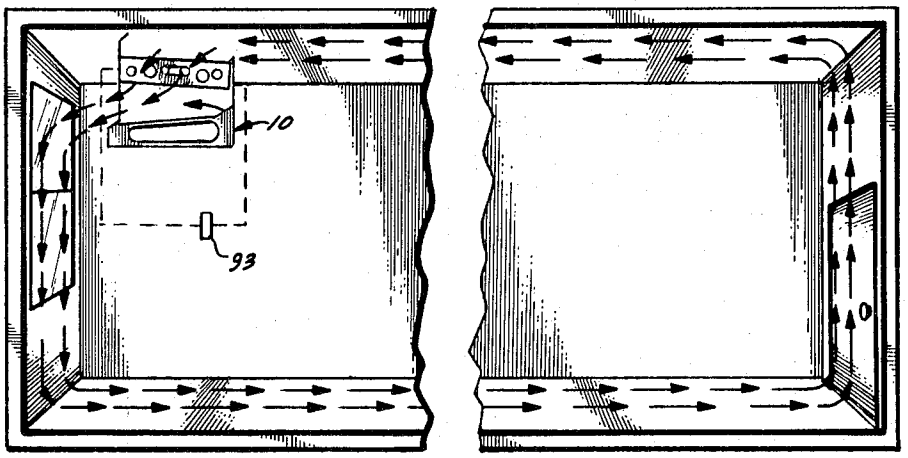
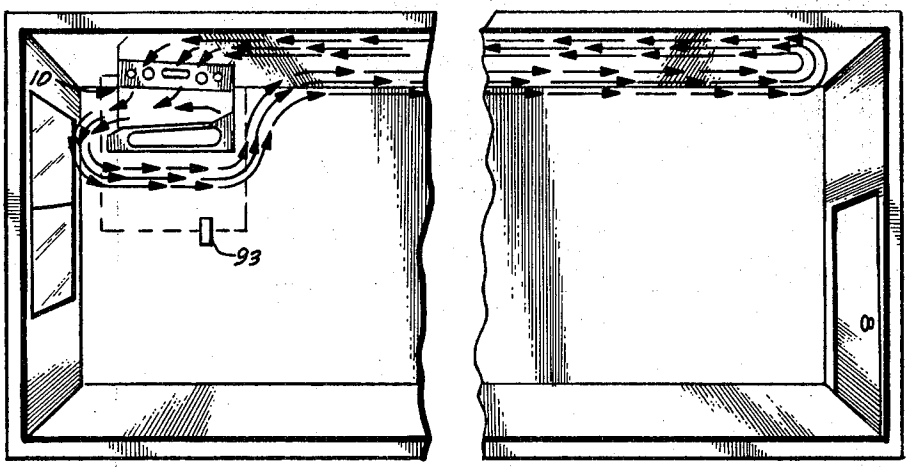



FIG. 8



# INDUCED AIR COOLING AND HEATING SYSTEM

## BACKGROUND OF THE INVENTION

This invention relates to air conditioning systems, and more particularly to an induced air system for cooling and heating rooms in buildings such as hotels, hospitals, convalescent homes, apartments, and the like.

In recent years, air conditioning units of the "valance" type have come into use as an alternative to forced-air air conditioning units. A typical valance unit is disclosed in U.S. Pat. No. 3,628,599 to Edwards. A valance unit generally includes a tubular heating coil for conducting heated fluid, a separate tubular cooling coil for conducting cooling fluid, and a series of longitudinally spaced apart, flat heat transfer fins mounted on both coils.

The valance unit is mounted in close proximity to the ceiling, and usually extends the length of the room. During operation, the unit produces a gentle convective flow of heated or cooled air throughout the room. The advantage of the valance unit over forced-air systems is that it is both noiseless and draft-free, and it requires no high pressure nozzles, or moving parts such as fans, electric motors, and the like.

However, prior art valance units have several disadvantages. Since a valance unit works only on natural convection, heating or cooling occurs at a relatively slow rate. Room air passing through the unit is cooled below its dew point, causing moisture to condense on the heat transfer fins. Thus, each unit requires special condensate collection trays and drain plumbing, which increases the cost of the unit. Moreover, a separate fresh air supply is required for each room. Thus, piping and ductwork costs are involved in installing the ductwork for each fresh air supply, and also for installing supply and return lines for delivering the hot and cold water to each unit.

## SUMMARY OF THE INVENTION

This invention provides an induced air room heating and cooling unit which is noiseless, draft-free, and relatively free from moving parts, and which also cools and heats faster than prior art valance units, and can be manufactured and installed at a substantially lower cost than valance units.

Briefly, the induced air system includes a plurality of spaced apart, elongated heat transfer tubes for circulation of a cooling fluid. A supporting framework holds the tubes in a fixed position between the side walls and adjacent to the ceiling of an enclosure. An elongated, tubular tempered air plenum mounted on the supporting framework extends in the same general direction as the heat transfer tubes and is closely spaced from the tubes. Tempered air is forced through the plenum under relatively low pressure, and out through slotted openings spaced along the length of the plenum. The low-velocity flow of tempered air induced into the flow pattern of room air stimulates the natural convective flow of air through the heat transfer tubes to assure proper circulation of room air through the system.

Preferably, the tempered air is dehumidified fresh air which has been precooled and preheated in a central plant and then circulated through the tempered air plenum. Fresh air in the central plant is drawn through a cooling coil which cools the air below its dew point, and then is drawn through a reheating coil which reheats it to approximately 52°F., i.e., just above the dew point temperature. Thus, the tempered air forced through the plenum and into the room is above condensation temperature, which eliminates the need for drain pans, drain connections, drain piping, and the like. Moreover, since the fresh air supplied to the induced air unit is tempered, or preconditioned, it is unnecessary to provide both hot water and cold water lines to the induced air unit. For example, only chilled water is provided to the unit, and the tempered fresh air is able to handle any heating load imposed on the system, together with a portion of any cooling load imposed on the system.

Since the tempered outside air is fed to the induced air unit directly for mixing with room air, a separate fresh air duct for each room is eliminated. Thus, installation time is reduced, and the overall building ductwork is simplified.

In a preferred form of the invention, the induced air unit includes a series of flat heat transfer fins mounted on conventional supply and return conduits for the cooling fluid, together with branch piping for circulating the fluid through the heat transfer unit. This piping arrangement eliminates the need for supplying each room with separate water supply and return lines, and thereby reduces the plumbing and installation costs when compared with conventional valance systems.

## BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention will be more fully understood by referring to the following detailed description and the accompanying drawings, in which:

FIG. **1** is an elevation view, partly in section, showing an induced air heating and cooling unit mounted in a room;

FIG. **2** is a plan elevation view of a building having a central plant on the roof of the building where tempered air is generated, the view being partly broken away to show a typical floor which receives the tempered air from the central plant;

FIG. **3** is a perspective view, partly in section, showing the induced air unit arranged for individually controlling cooling in two adjoining rooms;

FIG. **4** is a perspective view showing the induced air unit arranged for uniformly controlling cooling in a series of adjoining rooms;

FIG. **5** is an elevation view showing a wall bracket adapted for connection to the induced air unit;

FIG. **6** is a perspective view showing a factory prefabricated vertical duct and pipe column adapted for connection to the induced air unit;

FIG. **7** is a perspective view showing the flow path of cold air generated by the induced air unit; and

FIG. **8** is a perspective view showing the flow path of heated air generated by the induced air unit.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, an elongated induced air heating and cooling unit **10** is attached parallel to a ceiling **12** of a room. The unit extends the length of the room and is located about **6** inches in front of an outside wall **14** of the room. The induced air unit includes a heat transfer unit **15** comprising a series of longitudinally spaced apart, substantially rectangular, smooth, flat aluminum heat transfer fins **16** mounted in an upwardly opening

U-shaped galvanized support frame **18.** The fins are placed about one-fourth inch apart to allow debris, such as lint, to flow through them.

A plurality of longitudinally extending, parallel, elongated fluid conducting pipes pass through the fins. The piping for each room can be varied, as will be described in detail below. FIG. **1** shows one arrangement, which includes an enlarged main fluid supply conduit **20,** an enlarged main fluid return conduit **21,** and copper branch piping **22** and **24** coupled to the supply conduit and return conduit, respectively. A motorized valve **26** is coupled between supply conduit **20** and an inlet (not shown in FIG. **1**) from a chilled water supply (described in detail below) in a central plant **27** (see FIG. **2**).

An elongated tubular enclosure **28** made of galvanized metal is housed in the bottom of support frame **18** below heat transfer unit **15.** The enclosure extends the length of the room and is referred to hereafter as a tempered air plenum. The plenum has a separate oval-shaped flanged opening **30** at each end for circulating, through a hollow interior **31** of the plenum, a continuous supply of tempered air (to be described below) generated in central plant **27.**

The top wall of the plenum has a relatively long, slightly inclined portion **32** covering a major portion of the plenum interior, and a relatively short, steeply inclined portion **34** at the front edge of the unit. A series of longitudinally spaced apart, slotted openings **36** extend through the steeply angled portion **34** of the top wall. The slotted openings are spaced uniformly to extend the length of the room. The openings preferably are 3/16 inch wide, 3 inches long, and are spaced every 3 inches along the length of the plenum. Each opening has a flanged top or air flow deflecting means **38** protruding above it so that air forced through the interior of the plenum is induced to flow in a substantially horizontal direction (represented by arrows **40** in FIG. **1**) toward outside wall **14** and through the space between heat transfer unit **15** and the plenum.

The heat transfer unit is supported by two parallel, longitudinally extending, L-shaped channel bars **42** (shown in FIGS. **1, 3,** and **4**) fitted around opposite ends of the heat transfer fins and extending the length of the room. The channel bars are joined together in a rigid support structure by several longitudinally spaced apart, elongated, metal lower cross-braces or straps **44** extending below the heat transfer fins, and similar cross-braces **46** above the fins. The ends of channel bars **42** rest on upwardly opening, U-shaped lips **47** of two opposed wall brackets **48** (see FIG. **5**) mounted on the walls at opposite ends of the induced air unit.

The top of support frame **18** has an angled lip **49** which fits over a matching angled lip **50** at the front end of each upper cross-brace **46.** A vertically disposed hanger plate **52** has a downwardly and rearwardly angled lip **54** secured to the rear edge of the tempered air plenum by longitudinally spaced apart self-tapping screws **56.** The top of the hanger plate is secured to the bottom of the heat transfer unit support structure to anchor the plenum below the unit. A vertically adjustable, elongated diverter plate **58** is secured at its bottom to the top of the heat transfer unit support structure by several longitudinally spaced apart self-tapping screws **60.** The top of the diverter plate is held tightly against the ceiling to divert the passage of air through the heat transfer unit. An ultra-violet light **62** is secured to the rear edge of the diverter plate to provide germ-free radiation in the area between the diverter plate and rear wall **14.**

The induced air unit shown in FIG. **1** can be covered with appropriate finishing (not shown) to give it a neat appearance. Alternately, the unit can be concealed in a space between the ceiling and floor above. In the latter instance, a large downwardly opening box-like galvanized plenum (not shown) is disposed over the unit to provide a flow path for air to one side of the unit and away from the other side of the unit. Slotted linear diffuser plates (not shown) in the ceiling on one side of the unit direct air from the room through the unit. Air leaving the unit flows through the opposite side of the box, and out through a second set of diffuser plates (not shown) in the ceiling on the other side of the unit.

The induced air system of this invention is basically a perimeter system. It is designed for buildings having reversing sensible heat characteristics, in which cooling may be required in one room and heating in another. The induced air units receive tempered air and chilled water from central plant **27,** which is located remotely from the units, preferably on the roof of the building.

Referring to FIG. **2,** the central plant includes a chiller **64** for cold water and a boiler **66** for hot water. Outside air is drawn in through an air intake **68** of an air handler **70** at a quantity to meet or exceed local ventilation requirements. The air passes through a filter **72,** and is then drawn through a cooling coil **74** which cools the air below its dew point (condensing temperature) to dehumidify it. Cooling coil **74** receives a continuous supply of chilled water circulated through it from chiller **64.** A set of preheat coils **78,** which receive heated water from boiler **66,** reheat the dehumidified, cool air to at least 52°F., i.e., above dew point, to generate "tempered air", i.e., air which has been dehumidified and preheated above the temperature at which condensate forms. The tempered air can be heated by heating coils **78** to substantially higher temperatures, such as 140°F., when heating in the building is required. There are normally four preheat coils **78,** each one being actuated by its own outside thermostat **80.**

Air handler **70** includes a blower **81** which delivers the tempered air through separate ducts **82,** one of which is shown for each heating coil. The air handler forces the tempered air through ducts **82** to separate factory prefabricated vertical ducts and pipe columns **83** on each side of the building. Each vertical duct column is adapted to deliver the air, by a damper **83a,** to a series of tempered air plenums of induced air units in a series of rooms on each floor of the building. The tempered air supplies all the ventilation and heating air required for each room in the building, and also supplies up to one-third of the cooling air required.

Pumps (not shown), and appropriate water piping (shown schematically at **84**) circulate chilled water continuously in a closed system from the chiller, through built-in vertical water supply riser pipes **85** at the prefabricated vertical duct and pipe columns on each side of the building, through the tubing in the heat transfer units in a set of rooms, through vertical return riser pipes **86,** and back to the chiller. (Central plant water piping **84** is shown only for one set of supply and return risers for clarity.)

The arrangement of the chilled water supply tubing for each heat transfer unit can be varied to provide temperature control for each individual room, or uniform temperature control, i.e., zone control, for a series of rooms. FIG. **3** shows separate heat transfer units mounted in a pair of adjoining rooms and having piping arrangements providing individual room control. A separate main supply conduit **20** extends through the heat transfer fins of each unit, and the supply conduits for adjacent rooms are connected by separate flexible pipe connections **88.** Similarly, main return conduits **21** extend through each heat transfer unit and are coupled room-to-room by separate flexible pipe connections **90.** Preferably, chilled water is circulated from each supply riser **85** (FIG. **2**) to a series of four adjoining rooms on each side of it, i.e., eight rooms in all, and the supply and return conduits at each end of the eight rooms are connected by separate U-shaped pipe couplings **91** represented in phantom line in FIG. **3.** Thus, chilled water continuously circulates in the supply conduits in each set of rooms, back through the return conduits, through the vertical riser, through the chiller, and is again pumped to the rooms.

The unit in each room has a separate one of the branched supply tubes **22** which circulates water through the unit, and then opens into a pair of branched return tubes **92** which circulate the water back through the unit to water return tube **24** which opens into return main **21.** The tubes **22** and **92** thus form a cooling coil in which chilled water is continuously circulated for each individual room. The supply of water for each room's cooling coil is controlled by a separate one of the valves **26** which is connected to supply tube **22** and controlled by a thermostat **93** (shown in FIGS. **2, 7,** and **8**) in the room. The valve opens on an increase in temperature and circulates the chilled water until the thermostat is satisfied.

FIG. **4** shows an alternate piping arrangement suitable for zone control. In this arrangement, main supply conduit **20** opens into a pair of branched supply mains **94** which then pass through the entire series of heat transfer fins. The branched supply mains then open into a single main which is connected, by a flexible pipe connection **96,** with an identical branched supply main in the next room. The supply main in the next room, i.e., at the end of a series of rooms, circulates water back through branched return tubes **97** disposed above it and extending through the entire series of fins. The return tubes are connected, by a flexible pipe connection **98,** to an identical set of branched return tubes in the first room, which then supplies water to the adjoining room or rooms on the opposite side. The chilled water circulates through the cooling coils in the entire set of rooms, and through the chiller, and so forth. In the zOne control arrangement of FIG. **4,** the water circulating through all supply mains **20** is controlled by valve **26** which, in turn, is controlled by a single thermostat (not shown) in one of the rooms. The cooling in the adjacent set of rooms thus is controlled uniformly.

The installation of the induced air system for a typical building will be understood best by referring to FIGS. **2, 5,** and **6.** After the outside walls and floors of the building are completed, horizontal ducts **82** and factory prefabricated vertical duct and pipe columns **83** are installed. The opposed side walls of duct **82** encase the air inlet section of the vertical duct and pipe columns. The chilled water piping **84** is directly coupled to supply and return piping **85** and **86,** respectively, at the vertical pipe column. One end of duct **83** has a pair of flanges **100** which enclose the two riser pipes **85, 86.** The flanges are connected to the outside wall, preferably by screws **102** shown in FIG. **6.** The factory prefabricated vertical duct and pipe columns are then stacked and connected one upon another depending upon the number of floors in the building. As described above, each vertical duct and pipe column combination is arranged so it feeds at least four rooms on each side of it. In a typical two-story building containing 24 rooms on each floor, there will be three vertical duct and pipe column combinations, per floor, each feeding eight rooms. The second floor will have three vertical duct and pipe columns stacked and connected to the vertical duct and pipe columns on the first floor. The tempered air delivery and chilled water delivery is connected to the duct and riser columns from the central plant as described above.

After the vertical duct and pipe columns are installed, and when framing is finished, two of the wall brackets **48** are installed in the side walls of each room by nailing the brackets through narrow slots **104** to the wood framing. Dry-wall is applied over a portion of the brackets, leaving an opening for U-shaped lip **47** of the bracket. Each bracket also includes a flanged opening **106,** a light bulb **107,** and an electrical outlet **108** all of which are left exposed by the dry-wall. The light bulb provides indirect lighting for the room. The electrical outlet provides power for ultra-violet light **62.** An access panel **109** extends through both sides of the vertical pipe and duct column **83** to provide a workable service area for risers **85** and **86** and copper branch piping **110.** The dry-wall also leaves panel **109** exposed.

Each heat transfer unit is then installed by mounting the cooling coil support channels on lips **47** of brackets **48,** as described above. Flexible pipe connectors, described above for FIGS. **3** and **4,** are then coupled to the ends of certain water supply conduits and tubing, depending upon whether individual room control or zone control is desired. These flexible connections are fed through openings **111** provided in the wall brackets above lips **47,** through the interior wall, and are connected to the heat transfer unit piping in the adjoining room. The flanged openings **30** of adjacent tempered air plenums **28** are then attached, by appropriate flexible tubular ducts **112** (see FIG. **2**) through flanged openings **106** of the wall brackets. (Flexible water pipe connections **88, 90,** etc, are not shown in FIG. **2** for clarity). Diverter plates **58** are then installed, along with ultra-violet lights **62,** if required. A thermostat, as required, is then wired to each motorized control valve **26,** and the induced air unit is ready for operation.

Operation of the induced air unit during cooling and heating cycles is understood best by referring to FIGS. **7** and **8,** respectively. When the outside thermostat **80** puts the induced air unit on the cooling cycle, cool tempered air is blown through the slotted tempered air openings **36** of the plenum. As the room thermostat **93** calls for more cooling, motorized valve **26** opens to allow chilled water to circulate through the cooling coil of the heat transfer unit. The induced flow of tempered air through the openings of the plenum creates a motivating force for the natural convective flow of room air through the heat transfer fins, and thereby draws the warm ceiling air through the heat transfer fins, thus

cooling the air as sensible heat with no dehumidification within the unit. Since the tempered air has been dehumidified in the central plant, and is above condensation temperature, condensation does not occur in the heat transfer unit. Thus, there is no need for condensate collection trays and drain plumbing ordinarily used on valance air conditioning units.

As illustrated in FIG. **7**, cool air enters at the top of the unit, is cooled by the heat transfer fins, and gently flows down the outside wall at a very low velocity, and is drawn to the floor and the warm opposite wall. When the air reaches the opposite wall, the natural low velocity air patterns draw it back to the unit as return air, and the air once again flows through the induced air unit. This flow pattern becomes a continuous cycle, with the air being returned to the unit between about 6 to 8 times per hour. The velocity of the cool air is so low that drafts and air noise are eliminated. Moreover, the flow of induced air from the plenum stimulates the natural convective flow of room air such that faster cooling is provided than is ordinarily obtained by valance air conditioning units. When thermostat **93** is satisfied at the present temperature, it shuts off valve **26**, natural cooling by induction and convection stops, and the continuous supply of tempered air maintains the predetermined cooling temperature.

When the outside thermostat **80** calls for heating, the room is heated completely by warm tempered air distributed through the tempered air openings in the plenum. As illustrated in FIG. **8**, this causes a warm blanket of air at the ceiling to be drawn through the non-operating heat transfer element, and be forced to leave the unit under pressure and seek its own warm air level near the ceiling. This warm air travels across the ceiling to the opposite wall, turns back on itself, and returns to the unit with the cooler layer of air entering the air inlet of the unit. The air again is drawn through the non-operating heat transfer element, and is heated by the tempered air and forced away from the unit under pressure. The cycle of warm air leaving the unit is about 140°F., and radiates heat down into the room. This same warm air layer also warms the ceiling of the room and causes the ceiling to radiate heat to the room floor. When the desired room heating temperature is exceeded, thermostat **93** energizes the control valve **26** and allows chilled water to flow through the heat transfer element to cool the excessive warm air, once again, to the desired room temperature. With the thermostat now satisfied, it de-energizes valve **26**, and heating again will be supplied by the tempered air plenum.

The induced air system eliminates the need for a separate fresh air duct for each room. Moreover, each heat transfer unit carries its own supply and return mains, and flexible connections for the adjoining rooms. Therefore, installation time for the unit is reduced substantially, and the overall building contracting is simplified when compared with valance air conditioning systems.

I claim:

**1.** An induced air system for conditioning air in an enclosure having a ceiling and a pair of spaced apart walls, the system comprising a heat transfer unit including a plurality of spaced apart, elongated heat transfer tubes for circulating a cooling fluid, and a series of longitudinally spaced apart, flat heat transfer fins mounted on the heat transfer tubes; a supporting framework for holding the heat transfer unit in a fixed position between the walls and adjacent the ceiling, the heat transfer tubes being comprised of an elongated supply conduit extending through the series of heat transfer fins and having couplings at both ends for connection to identical supply conduits in adjacent enclosures, and elongated return conduit extending through the series of heat transfer fins, the return conduit having couplings on both ends for connection to identical return conduits in adjacent enclosures, and a tubular coil having one end coupled to the supply conduit, another end coupled to the return conduit, and an intermediate portion extending through the series of heat transfer fins for circulating a cooling fluid supplied from the supply conduit; and an elongated, tubular tempered air plenum mounted to the supporting framework and held closely spaced from the heat transfer tubes so the plenum extends in the same general direction as the heat transfer tubes, the tempered air plenum having at least one opening extending along its length adjacent the heat transfer tubes so that tempered air forced through the plenum can be induced to flow out through the opening to stimulate the natural convective flow of room air passing through the heat transfer tubes.

**2.** An induced air system for conditioning air in an enclosure having a ceiling and a pair of spaced apart walls, the system comprising a heat transfer unit including a plurality of spaced apart, elongated heat transfer tubes for circulating a cooling fluid, and a series of longitudinally spaced apart, flat heat transfer fins mounted on the heat transfer tubes; a supporting framework for holding the heat transfer unit in a fixed position between the walls and adjacent the ceiling; the heat transfer tubes being comprised of one or more elongated supply conduits extending through the series of heat transfer fins, at least one of the supply conduits having a separate coupling at each end for connection to identical supply conduits in adjacent enclosures, and one or more return conduits extending through the fins above the supply conduits, one or more of the return conduits providing separate couplings at opposite ends of the heat transfer fins for connection with identical return conduits in adjacent enclosures; and an elongated, tubular tempered air plenum mounted to the supporting framework and held closely spaced from the heat transfer tubes so the plenum extends in the same general direction as the heat transfer tubes, the tempered air plenum having at least one opening extending along its length adjacent the heat transfer tubes so that tempered air forced through the plenum can be induced to flow out through the opening to stimulate the natural convective flow of room air passing through the heat transfer tubes.

**3.** An induced air system for conditioning air through several enclosures in series in which each enclosure has a ceiling and a pair of spaced apart walls, the system comprising a separate heat transfer unit in each enclosure, each unit including a plurality of spaced apart, elongated heat transfer tubes for circulating a cooling fluid, and a series of longitudinally spaced apart, flat heat transfer fins mounted on the heat transfer tubes; a separate supporting framework in each enclosure for holding the heat transfer unit in a fixed position between the walls and adjacent the ceiling; a separate elongated tubular tempered air plenum mounted to the supporting framework in each enclosure and held closely spaced from the heat transfer tubes so the plenum extends in the same general direction as the

heat transfer tubes; duct means coupling at least some of the heat transfer tubes in one enclosure with at least some of the heat transfer tubes in an adjoining enclosure; and duct means interconnecting the tempered air plenums of said adjacent enclosures; the heat transfer tubes in a pair of adjacent enclosures being comprised of a separate elongated main fluid supply conduit extending through a series of heat transfer fins in each enclosure, a separate main fluid return conduit extending through the series of heat transfer fins in each enclosure, means joining the supply conduit in one enclosure with a corresponding supply conduit in an adjacent enclosure, means joining the return conduit in one enclosure with a corresponding return conduit in the adjacent enclosure, and a separate tubular coil for each enclosure, each coil having one end coupled to its corresponding supply conduit, another end coupled to its corresponding return conduit, and an intermediate portion extending through the series of heat transfer fins for circulating a cooling fluid forced through the supply conduit; the tempered air plenum in each enclosure having at least one opening extending along its length adjacent the heat transfer tubes so that tempered air flowing through the plenum can be induced to flow out through the opening to stimulate the natural convective flow of room air passing through the heat transfer tubes.

**4.** The system according to claim **3** including a separate thermostatically controlled valve in each enclosure coupled with one of the heat transfer tubes.

**5.** An induced air system for conditioning air through several enclosures in series, each enclosure having a ceiling and a pair of spaced apart walls, the system comprising a separate heat transfer unit in each enclosure, each unit including a plurality of spaced apart, elongated heat transfer tubes for circulating a cooling fluid, and a series of longitudinally spaced apart, flat heat transfer fins mounted on the heat transfer tubes; a separate supporting framework in each enclosure for holding the heat transfer tubes in a fixed position between the walls and adjacent the ceiling, a separate elongated, tubular tempered air plenum in each enclosure mounted to the supporting framework therein and held closely spaced from the heat transfer tubes so the plenum extends in the same general direction as the heat transfer tubes; pipe means coupling at least some of the heat transfer tubes in one enclosure with at least some of the heat transfer tubes in an adjoining enclosure; and duct means interconnecting the tempered air plenums of said adjoining enclosures; the heat transfer tubes in adjoining enclosures comprising a separate elongated supply conduit extending through the series of heat transfer fins in each enclosure, a separate fluid return conduit extending through the series of heat transfer fins in each enclosure, means joining the supply conduit in one enclosure with a corresponding supply conduit in an adjacent enclosure, means joining the return conduit in one enclosure with the corresponding return conduit in the adjacent enclosure, and means joining the supply conduit in one enclosure with the return conduit in the same enclosure; the tempered air plenum having at least one opening extending along its length adjacent the heat transfer tubes so that tempered air forced through the plenum can be induced to flow out through the opening to stimulate the natural convective flow of room air passing through the heat transfer tubes.

**6.** The system according to claim **5** including one thermostatically controlled valve coupled to only one of said supply conduits.

**7.** An induced air system for conditioning air in an enclosure having a ceiling and a pair of spaced apart walls, the system comprising a heat transfer unit including a plurality of spaced apart, elongated heat transfer tubes for circulating a cooling fluid, and a series of longitudinally spaced apart, flat heat transfer fins mounted on the heat transfer tubes; a supporting framework for holding the heat transfer unit in a fixed position between the walls and adjacent the ceiling; and an elongated, tubular tempered air plenum mounted to the supporting framework and held closely spaced from the heat transfer tubes so it extends in the same general direction as the heat transfer tubes; the supporting framework including an upwardly opening, U-shaped structure including a bottom wall and a pair of laterally spaced apart front and rear walls extending in the same general direction as the heat transfer tubes, the fins extending between the front and rear walls of the framework and being held in place by the heat transfer tubes on which they are mounted; the tempered air plenum including a top wall spaced above the bottom wall of the framework structure and disposed below the series of heat transfer fins so as to extend in the same general direction as the fins, the plenum top wall being attached at its ends to the front and rear walls of the framework structure to provide an elongated, tubular conduit, the plenum having one or more slotted openings formed in its top wall along one edge thereof so that air passing through the plenum is induced to flow out through the openings and through the space between the heat transfer fins and the top wall of the plenum so as to stimulate the natural convective flow of room air passing through the transfer tubes.

**8.** The system according to claim **7** in which the heat transfer tubes comprise an elongated supply conduit extending through the series of heat transfer fins, and having couplings at both ends for connection to identical supply conduits in adjacent enclosures, an elongated return conduit extending through the series of heat transfer fins, the return conduit having couplings on both ends for connection to identical return conduits in adjacent enclosures, and a tubular coil having one end coupled to the supply conduit, another end coupled to the return conduit, and an intermediate portion extending through the series of heat transfer fins for circulation of cooling fluid supplied from the supply conduit.

**9.** The system according to claim **7** including one or more elongated supply conduits extending through the series of heat transfer fins, at least one of the supply conduits having a separate coupling at each end for connection to identical supply conduits in adjacent enclosures, and one or more return conduits extending through the fins above the supply conduits, one or more of the return conduits providing separate couplings at opposite ends of the heat transfer fins for connection with identical return conduits in adjacent enclosures.

**10.** The system according to claim **7** including an elongated diverter plate secured to the framework and adapted to extend between the heat transfer tubes and the ceiling to direct the flow of room air down over the heat transfer tubes so the air can pass through the space between the tubes and the tempered air plenum.

11. The system according to claim 7 in which the heat transfer tubes include a supply conduit extending through the heat transfer fins, and a separate return conduit extending through the fins, the supply and return conduits each having opposed ends adapted for connection to identical supply and return conduits in adjacent enclosures.

12. The system according to claim 11 including a plurality of spaced apart heat transfer fluid circulation tubes extending through the heat transfer fins adjacent the supply and return conduits.

13. The system according to claim 12 including means connecting one end of the heat transfer fluid circulation tubes with one end of the supply conduit.

14. The system according to claim 12 including means connecting one end of the heat transfer fluid circulation tubes with one end of the return conduit.

15. The system according to claim 7 in which the framework structure has an open top to be spaced below the ceiling, the front wall of the framework structure providing a continuous barrier against air flow for facing a major portion of the room so that room air flowing adjacent the ceiling and toward the front wall will flow through the open top of the framework structure; and in which the rear wall of the framework structure is to be located remote from a major portion of the room, the heat transfer tubes being disposed behind the front wall of the framework structure so that the room air flowing through the open top of the framework will flow downwardly past the tubes; the slotted openings extending through the top wall of the plenum along the length thereof behind the air barrier provided by the front wall of the framework structure; the rear wall of the supporting framework having an opening in it below the heat transfer unit and above the plenum top wall so that air flowing through the plenum will pass through the slotted openings under a major portion of the heat transfer unit and toward the opening in the rear wall of the framework structure.

16. The system according to claim 15 in which the openings in the top wall of the plenum face the rear wall of the framework structure and are provided with air flow deflecting means positioned above the openings for directing air passing through the openings to flow toward the opening in the rear wall of the framework so that the natural convective flow of room air passing through the open top of the supporting framework and down past the heat transfer tubes will be stimulated to flow toward the opening in the rear wall of the framework by the flow of air passing from the openings in the plenum.

17. The system according to claim 16 in which the slotted openings are located in a portion of the plenum top wall which is inclined so as to face toward the opening in the rear wall of the framework structure.

18. An induced air system for conditioning air in an enclosure having a ceiling and a pair of spaced apart walls, the system comprising a heat transfer unit including a plurality of spaced apart, elongated heat transfer tubes for circulating a cooling fluid, and a series of longitudinally spaced apart flat heat transfer fins mounted on the heat transfer tubes;

a supporting framework for holding the heat transfer unit in a fixed position between the walls of the enclosure and adjacent the ceiling thereof; and

an elongated, tubular tempered air plenum mounted to the supporting framework and held closely spaced below the heat transfer tubes so it extends in the same general direction as the heat transfer tubes;

the supporting framework comprising an upwardly opening, U-shaped structure which includes a bottom wall and a pair of laterally spaced apart front and rear walls extending in the same general direction as the series of heat transfer tubes, the fins extending between the front and rear walls of the framework and being held in place by the heat transfer tubes on which they are mounted;

the supporting framework having an open top spaced below the ceiling, the front wall of the supporting framework providing a continuous air barrier for facing a major portion of the room so that room air flowing adjacent the ceiling and toward the front wall of the framework will flow through the open top of the supporting framework;

the heat transfer unit being mounted below the open top of the supporting framework and behind the front wall thereof so that room air flowing through the open top of the supporting structure will flow downwardly past the heat transfer tubes;

the tempered air plenum including a top wall spaced above the bottom wall of the supporting framework and disposed below the series of heat transfer fins so as to extend in the same general direction as the fins, the plenum top wall being attached at its ends to the front and rear walls of the framework structure to provide an elongated, tubular conduit located behind the air barrier provided by the front wall of the framework structure;

the plenum having one or more slotted openings formed in its top wall along one edge thereof so that tempered air flowing through the plenum will pass through the openings, the openings being positioned to face toward the rear wall of the framework structure and being provided with air flow deflecting means positioned above the openings for directing air passing through the openings to flow under a major portion of the heat transfer unit and toward the rear wall of the support structure;

the rear wall of the support structure having an opening in it below the heat transfer unit and above the plenum and toward which the flow of air from the plenum openings is directed by the air flow deflecting means so that the natural convective flow of room air passing through the open top of the framework structure and down past the heat transfer tubes will be stimulated to flow toward the opening in the rear wall of the framework structure by the flow of tempered air passing from the openings in the plenum.

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