United States Patent

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[72] Inventor Joseph D. Loveley
Grosse Pointe Woods, Mich.
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[73] Assignee American Standard Inc.
New York, N.Y.

[54] **CLOSET DOOR HAVING HIGH-LOW RETURN AIR SUPPLY FOR AIR CONDITIONER**
4 Claims, 6 Drawing Figs.

[52] U.S. Cl. .... **165/48,** 98/33 A
[51] Int. Cl. **F25b 29/00**
[50] Field of Search .... 165/48, 57; 98/33 R, 33 A

[56] **References Cited**
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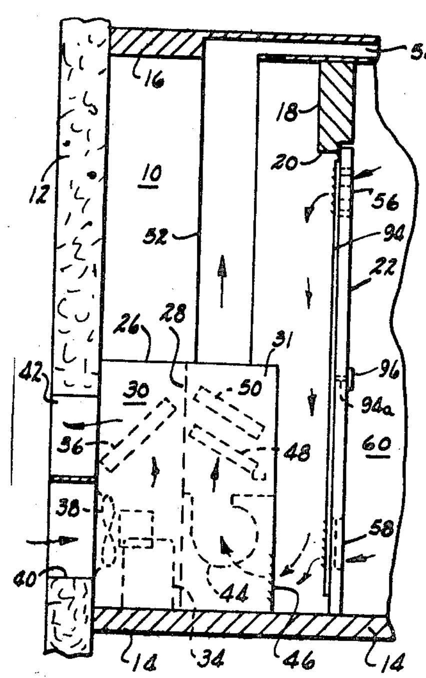
Primary Examiner—Carroll B. Dority, Jr.
Attorneys—John E. McRae, Tennes I. Erstad and Robert G. Crooks

ABSTRACT: An air conditioner housed within the closet of a living space, particularly an apartment, said closet having a special door construction equipped with dampered openings adjacent its top and bottom edges. During the cooling season the air conditioner draws its supply air from the upper door openings and during the heating season the air conditioner draws its supply air through the lower door openings. The invention improves the air conditioner efficiency and minimizes stratification and temperature differentials between the floor and ceiling.



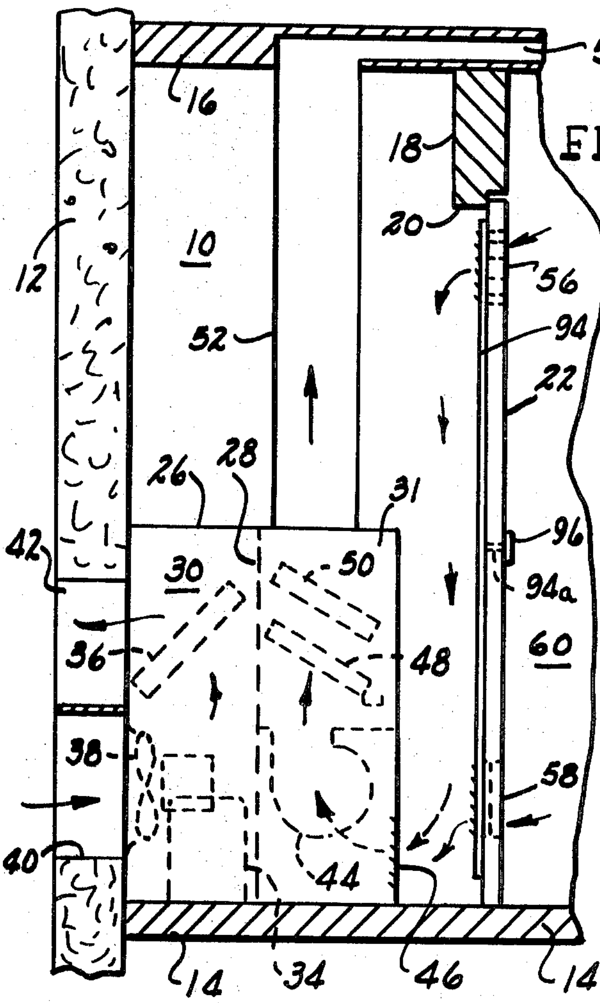


FIG_1

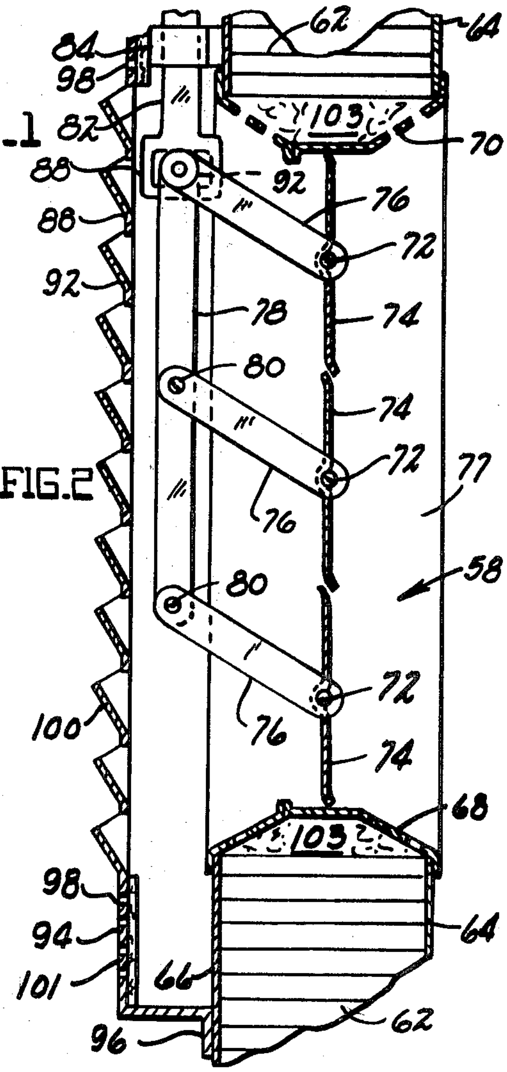


FIG.2

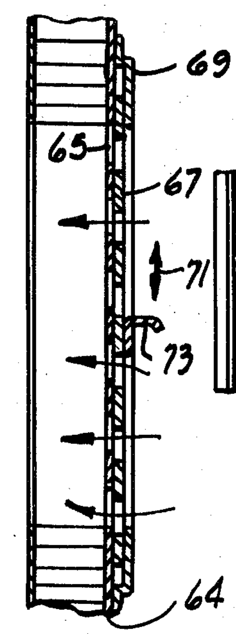
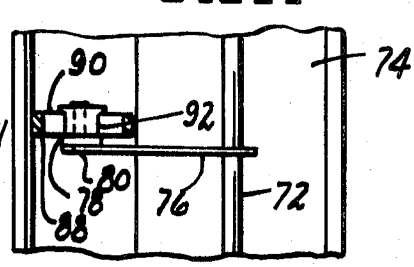


FIG_6

FIG_4



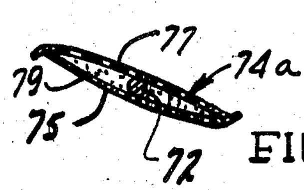


FIG_5

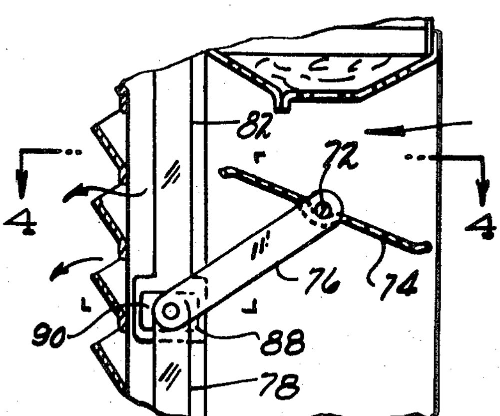


FIG.3

INVENTOR.
JOSEPH D. LOVELEY

CLOSET DOOR HAVING HIGH-LOW RETURN AIR SUPPLY FOR AIR CONDITIONER

THE DRAWINGS

FIG. 1 schematically illustrates a closet-air-conditioner arrangement incorporating the invention.

FIG. 2 is an enlarged sectional view through a portion of the closet door in FIG. 1.

FIG. 3 is a fragmentary view similar to FIG. 2, but showing certain dampers in adjusted positions.

FIG. 4 is a fragmentary sectional view on line 4—4 in FIG. 3.

FIG. 5 is a view through a louver that may be used in practice of the invention.

FIG. 6 is a fragmentary sectional view through another door construction utilizing the invention.

FIG. 1 IN GREATER DETAIL

FIG. 1 shows a closet **10** defined by an outside building wall **12**, a floor **14** and a ceiling **16**. The front wall **18** of the closet is provided with a door opening **20** arranged to be closed by a swinging or sliding door **22** of sufficient adult height to permit walk in. Normally the closet would be located in one of the rooms or at the end of a hallway. Arranged within the closet is an air conditioner **26** of rectangular shape. As shown, the conditioner housing is subdivided by a vertical partition **28** into an outer compartment **30** and an inner compartment **31**. Arranged within the outer compartment is a refrigerant compressor **34**, refrigerant condenser coil **36**, and motor-driven fan **38**. As shown in FIG. 1, the fan draws outside air into compartment **38** through an intake opening **40**; the air is forced upwardly through condenser coil **36** and out through an opening **42**, thereby causing the refrigerant flowing through the condenser coil to be condensed in the usual manner.

Compartment **31** contains a centrifugal blower **44** which receives its air supply from a louvered inlet opening **46**, and which discharges its air upwardly through a refrigerant evaporator coil **48** heating unit **50** (electrical resistance heater, gas-fired heat exchange unit, etc.

During the heating season the compressor **34** is inactive so that coil **48** does not cool the air flowing upwardly from blower **44**; at this time the heating unit **50** may be periodically energized by a room thermostat, (not shown), so that the upflowing air is heated and delivered to a vertical riser duct **52**. The heated air is distributed to the rooms via one or more horizontal branch ducts **54**.

During the cooling season the heating unit **50** is deenergized, and the refrigerant compressor **34** is energized so that upflowing air from blower **44** is cooled as it passes through coil **48**; the cooled air is distributed to the rooms through ducts **52** and **54**.

SUPPLY AIR FOR THE CONDITIONER

In multifloor home air-conditioning systems it is common to provide return air registers in each room. Such return registers connect with a common return duct which returns the air to the central air conditioner for heating during winter and cooling during summer. In single floor residences, particularly apartments, the return air may be supplied merely through open doorways.

In the present invention, (designed particularly for single floor residences) the return air for the conditioner is taken from space **60** in front of the closet door **22**; this may be either a hallway or a room. As shown by the flow arrows in FIG. 1, the air can move through an upper passage **56** in the door (cooling season) or through a lower passage **58** (heating season). As will be apparent hereinafter, dampers in the two passages preclude simultaneous air flow through both passages; when one is closed the other is open, and vice versa.

AIR STRATIFICATION

During the heating season it is desirable that return air be taken from points in room **60** near the floor because the floor air is cooler and has an uncomfortable feeling. During the cooling season it is desirable that the return air be taken from points in room **60** near the ceiling because the ceiling air will be hotter and the least comfortable. In conventional arrangements the return air is usually taken from the same point during both seasons, either near the ceiling or near the floor, depending on the particular compromise chosen. With conventional arrangements the occupants are not completely comfortable on a year round basis, since as much as a 10° temperature differential often exists between floor level and areas about 6 feet above the floor (in moderate weather 55° F. there is little differential). It is an object of the present invention to provide an arrangement that eliminates or minimizes this air stratification or temperature differential feature.

HEATING COOLING PERFORMANCE

In general the performance of the air conditioner is improved by increasing the temperature differential between the entering air stream (through louver **46**) and the discharge stream (through duct **52**). Thus, during the cooling season the refrigerant evaporator will produce more air cooling when the entering temperature at louvers **46** is relatively high; during the heating season the air conditioner will provide more heating when the entering air temperature through louvers **46** is relatively low.

In the air cooling mode a high entering air temperature means a greater temperature differential between the air and refrigerant, thus tending to increase the average mass flow of refrigerant to satisfy the demand. The cooling unit therefore tends to operate nearer its rated capacity. A cooling unit fully rated at 80° F. entering air temperature might have only about 82 percent of rated capacity with entering temperatures of about 70° F.

In the air-heating mode a low entering air temperature means a greater temperature differential between the air and heater surface (electric or flame-heated). The larger temperature differential means greater heat transfer and operation closer to rated heater capacity.

The illustrated arrangement of dampered passages **56** and **58** provides the desired entering air temperatures, and thus improves the capacity of the air conditioner to heat in the winter and cool in the summer. It may thus be possible by using the described dampered passages to reduce the size of air conditioner needed for a given room area and geographical location.

LOCATION OF AIR RETURNS

As shown in FIG. 1 the closet door **22** is provided with an air passage **56** adjacent its upper edge i.e. about 7 feet from the floor, and a second air passage **58** adjacent its lower edge, i.e. about one -half foot off the floor. Each air passage **56** or **58** is provided with an individual damper so that the upper passage can be closed while the lower passage is open, and vice versa. During the cooling season it is contemplated that passage **58** will be closed and passage **56** opened. Blower **44** will draw air from room **60** through the upper passage **56**, thereby tending to minimize the aforementioned stratification problem. During the heating season it is contemplated that passage **56** will be closed and passage **58** opened so that blower **44** will draw air from the room **60** at points adjacent floor **14**, thus tending to minimize the stratification problem during the heating season.

DOOR-PASSAGE CONSTRUCTION

As shown in FIG. 2, a typical closet door **22** is formed by a honeycomb core **62** and facing panels **64** and **66**. The honeycomb may be formed for example of resin-impregnated Kraft paper arranged with the honeycomb passages horizontal and normal to the door plane. The front and rear edges of the honeycomb may be adhered to the metal or plywood panels 64 and 66. The invention is not dependent on the use of panel-surfaced honeycomb construction; however this structure does have some sound absorption characteristics, and is thus well adapted for the purpose. Conventional panel wooden door construction is believed also suitable.

FIG. 2 illustrates a section of the door having an opening therethrough which defines the aforementioned passageway 58. As shown, the passageway comprises a metal frame 77 having a lower frame wall 68 and an upper frame wall 70. Additional unnumbered sidewalls complete the frame. Extending horizontally between the frame sidewalls are three pivot shafts 72, each shaft being secured to and supporting a butterfly damper vane element 74. FIG. 2 illustrates the damper vanes in the closed position while FIG. 3 illustrates one of the dampers in an opened position.

Each shaft 72 has a platelike arm or link 76 welded thereto at or near the shaft midpoint. The various arms 76 are linked together by means of a vertical tiebar 78. As best shown in FIG. 4, a suitable pin 80 goes through each arm 76 and the tiebar to form a pivotal connection, whereby vertical movement of the tiebar is effective to rotate the individual dampers 74 between their FIG. 2 and FIG. 3 positions.

To effect vertical movement of tiebar 78 there is provided a vertical rod 82 suitably mounted in a slideway 84 affixed to the rear panel 66 of the door; a similar slideway (not shown) shown) would guide the upper portion of rod 82. Rod 82 includes a block element 88 which has a slot 90 extending laterally therethrough for accommodating a roller 92 carried on one of the pins 80. It will be seen that downward movement of rod 82 will cause block 88 to force the tiebar 78 downwardly with a rolling engagement between roller 92 and the upper surface of slot 90; this action causes the three damper vanes 74 to move from their FIG. 2 closed positions to their FIG. 3 opened positions. In the opened position the dampers permit room air to flow through the door passage into the closet 10 for eventual flow through the air conditioner, as previously explained.

DAMPER OPERATION

It is contemplated that passage 56 in the upper portion of the closet door would have damper vanes similar to the three vanes 74 shown in passage 58. These upper vanes would be operated by the same rod 82 that is used to operate the passage 58 damper vanes. However since it is desired that passage 56 be closed when passage 58 is open, and vice versa, the upper damper vanes must have a different relation to the upper block 88. This may be accomplished by disposing the upper damper assembly in an upside down relation; i.e. frame wall 68 would be the top wall of the frame, and frame wall 70 would be the bottom wall of the frame. The upper block element 88 would be located at the correct point on rod 82, as by a set screw adjustment.

Rod 82 could be actuated from either side of the door, i.e. front or rear. As shown in FIG. 1, the actuating connection is located front-side, in the form of a handle 96 on the door front face. A suitable bar 94*a* may extend from rod 82 forwardly through a slot in the door to connection with the actuating knob 96 on the front face of the door. Movement of the knob upwardly would close the lower set of dampers in passage 58 For thereby adapting the mechanism to cooling operation. Movement of Knob 96 downward wound close the dampers in passage 56 thus adapting the mechanism to heating operation. Suitable indicia on the front face of the door would indicate to the user the correct knob position for each season. Preferably a latch would be built into knob 96 to hold the dampers in their adjusted positions in spite of gravity and air pressure forces on the damper vanes.

PASSAGE DIMENSION

A typical apartment size air conditioner might require an air flow of about 1,200 cubic feet per minute through blower 44 and the air-conditioning components. Passages 56 and 58 must be of sufficient size to handle this air flow without introducing appreciable pressure drop or excessive sound pulsation Generally the linear air flow rate through each passage (56 or 58) should be no higher than about 800 feet per minute. With a door width of about 26 inches each rectangular frame 77 could be sized to define an air opening on the order of 20 inches wide by 9 inches high. Assuming each vane 74 to be about 2 inches wide (about the depth of the door), four or five vanes would be required in each passage. Merely for illustration purposes FIG. 2 shows three vanes; in practice a greater number of dampers might be necessary. Different size air conditioners require different passage dimensions so that linear flow in all cases is kept below about 800 feet per minute.

SOUND ABSORPTION

During operation of the air conditioner air flow through blower 44 and through fan 38 may produce some objectionable noise; compressor 34 and duct 52 may also produce some noise. It is desirable that such noises be minimized as much as possible because the air conditioner would usually be located closely adjacent the living areas, and not in the basement. Much of the noise can be dampened by lining chambers 30 and 31 with sound-absorbent material, and by encasing duct 52 in a sound-absorbent sleeve. However inevitably some blower 44 noise propagates back through louvers 46 toward room 60. To minimize such noise propagation into the room the door 22 preferably has secured to its rear face a sound-absorbent panel 94; the panel may be peripherally flanged, as at 96, and secured to door panel 66 by screws, welding, etc. Panel 94 is perforated as at 98, and lined with suitable sound insulation 101, such as urethane foam, felt, may-type fiberglass, celotex, mineral fiber, etc. Also, the areas of plate 94 in direct registry with passage 58 may be louvered, as at 100, so that passage 58 has no direct line of sight with the louvers 46 on the air conditioner. The louvers 100 thus prevent sound waves eminating through louvers 46 from blasting through passage 58 when the dampers 74 are in the open position. Additional sound insulation may be provided around the periphery of the passage 58, as at 103. Various other sound-absorbing techniques can be used. For example, dampers 74 can be constructed to include sound-absorbent material as shown in FIG. 5. As there shown, each damper 74*a* is formed by two spaced sheets 75 and 77, and the interior space filled with sound-absorbent material 79.

WHY PLACE THE AIR RETURNS IN THE DOOR?

As shown in FIG. 1, the air conditioner is disposed in a closet having a fixed front wall 18. Although not shown, the closet preferably has a width that is only slightly greater than the width of the air conditioner, the aim being to reduce the closet dimension and thereby increase the useful living area. When the air conditioner is employed in a closet of very small width the door 22 occupies substantially the entire width of the closet; the door itself is therefore the only structure available for reception of the return air inlets 56 and 58.

It should also be noted that doors are commonly manufactured in factories, and that the louvered damper construction as shown in FIGS. 2 and 3 is most conventionally manufactured and installed by factory methods. Therefore manufacturing economies tend to dictate that the high-low returns be incorporated in the door rather than in fixed wall structures. Preferably however the air passages are incorporated with the least possible modification of the conventional door structure. As shown in FIG. 2, the door is conventional except that a rectangular hole has been cut to accommodate frame 77. Rod 82 is installed on the door after the frame 77 has been mounted in the door opening. Preferably the actuating device **82** is located outside the door (i.e. outside the space between panels **64** and **66**) to avoid special door-manufacturing techniques or skills.

FIG. 6

FIG. **6** shown in horizontal section a door similar to the door of FIG. **2**, except that front door panel **64** is perforated to provide vertical shotlike passageways **65**. A perforated damper plate **67** is slidably positioned on the front face of panel **64** for lateral slidable movement within frame **69** in the arrow **71** directions; frame **69** is held on panel **64** by screws, welding, etc. It will be seen that manual adjustment of damper **67** via knob **73** can be employed to open and close the air passages **65**.

In practice the FIG. **6** damper assembly would be duplicated near the top and bottom edges of the door to provide the high-low air return feature of FIG **1**.

I claim:

1. Building construction comprising a closet communicating with a room through a door opening of adult height; an air conditioner located within the closet; said conditioner comprising (1) a casing having a return air inlet for receiving air from the closet space, (2) an air-heating unit within the casing, (3) an air-cooling unit within the casing, and (4) an air blower for flowing air from the casing inlet through the heating and cooling units to the casing outlet: the improvement comprising a door for the closet opening; said door having a first air passage therethrough adjacent its upper edge and a second air passage therethrough adjacent its lower edge, an upper damper operable to close the upper air passage during the heating season, and a lower damper operable to close the lower air passage during the cooling season; whereby the air conditioner receives air solely from the lower spaces of the room during the heating season, and whereby the air conditioner receives air solely from the upper spaces of the room during the cooling season.

2. The construction of claim **1** and further including a mechanical connection between the dampers whereby movement of one damper to the closed position automatically moves the other damper to the open position, and vice versa.

3. The construction of claim **1** wherein each damper comprises a set of butterfly vanes, the arrangement further including manually movable rod means interconnecting the two sets of damper vanes so that (1) movement of the rod means in one direction causes the upper damper vanes to close and the lower damper vanes to open, and (2) movement of the rod means in the other direction causes the upper damper vanes to open and the lower damper vanes to close.

4. The construction of claim **3** wherein the damper vanes are arranged for parallel pivotal movements about horizontal axes.