Nov. 17, 1959 J. D. BOTTORF ET AL 2,913,227

AIR CONDITIONING UNIT

Filed Feb. 6, 1956 2 Sheets-Sheet 1

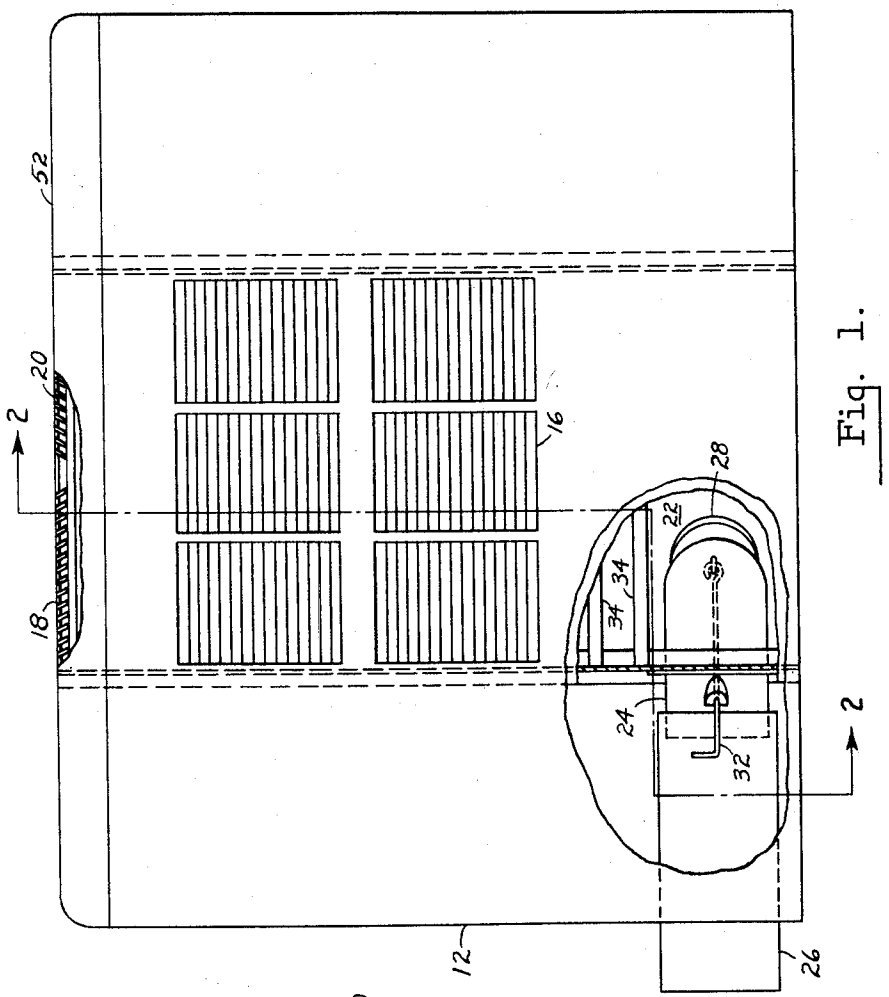

Fig. 1.

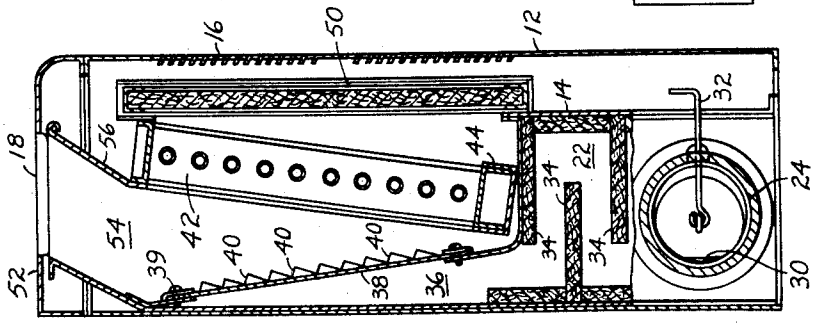

Fig. 2.

INVENTOR.
JAMES D. BOTTORF
OTTO A. LABUS

BY Holmes & Anderson

ATTORNEYS.

Nov. 17, 1959 J. D. BOTTORF ET AL 2,913,227

AIR CONDITIONING UNIT

Filed Feb. 6, 1956 2 Sheets-Sheet 2

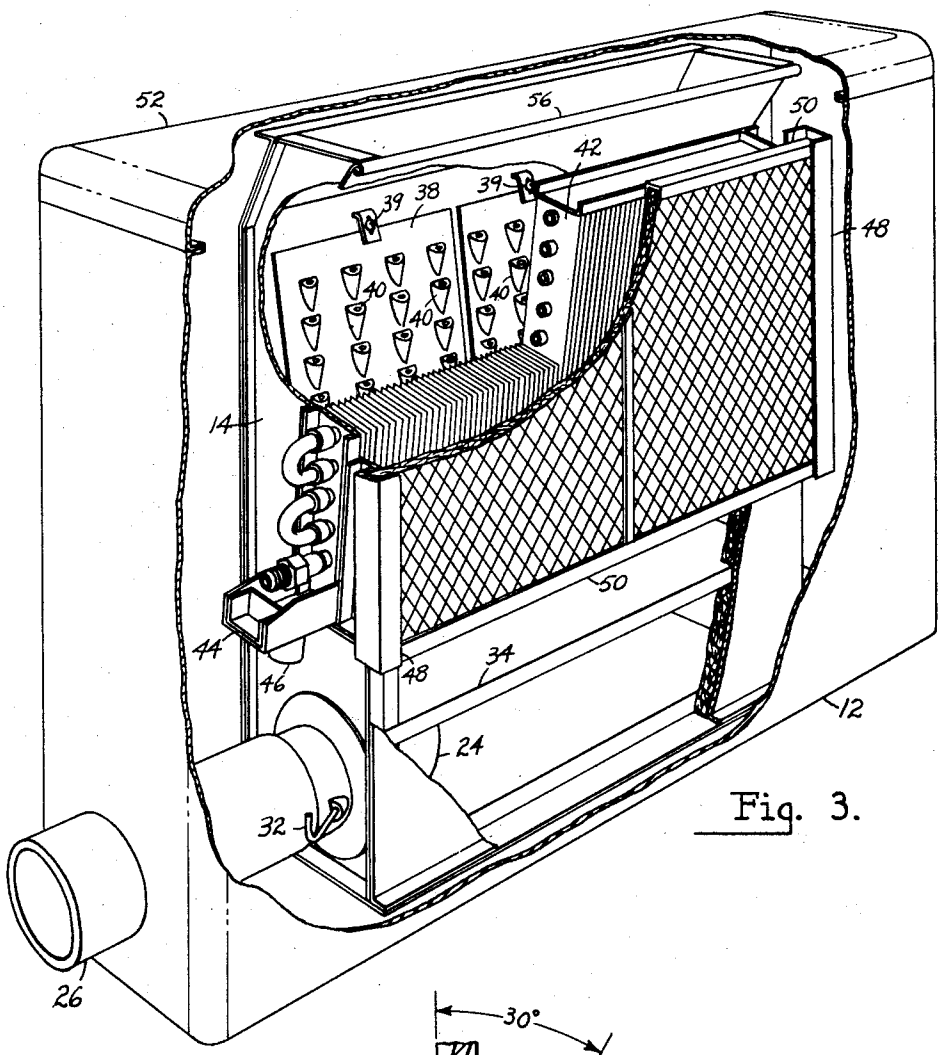

Fig. 3.

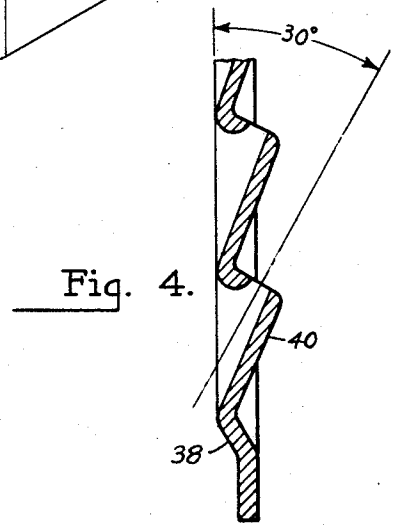

Fig. 4.

INVENTOR.
JAMES D. BOTTORF
OTTO A. LABUS
BY
Holmes & Anderson
ATTORNEYS.

United States Patent Office 2,913,227
Patented Nov. 17, 1959

2,913,227

AIR CONDITIONING UNIT

James D. Bottorf and Otto A. Labus, La Crosse, Wis., assignors to The Trane Company, La Crosse, Wis., a corporation of Wisconsin

Application February 6, 1956, Serial No. 563,517

5 Claims. (Cl. 257—137)

This invention relates to air conditioning units and more particularly to units adapted to be connected to a source of air under pressure.

The general object of the invention is to provide a unit which produces a circulation of the air in a conditioned space by the discharge in the unit of a relatively small quantity of conditioned air.

It is another object of the invention to provide a unit having a heat exchanger for heating or cooling the air from the conditioned space and means for discharging conditioned primary air in the unit to induce a flow of air from the conditioned space through the heat exchanger in such a manner that the conditioned air and the air from the conditioned space are intimately mixed and discharged from the unit into the conditioned space.

Another object of the invention is to provide an arrangement of nozzles for the discharge of conditioned primary air by which the induction of secondary air occurs in a plurality of stages.

It is a further object of the invention to arrange the heating coil and the primary air nozzles in the cabinet in such a manner that the induction chamber has a cross-sectional area which increases in proportion to the amount of air flowing therethrough.

It is another object of the invention to provide means for controlling the rate of flow of primary air to the nozzles.

It is a further object of the invention to provide means for conducting the primary air from the supply duct to the discharge nozzles with a minimum of noise and a minimum loss of energy.

These and other objects and advantages of the invention will more fully appear from the following description to be read in connection with the accompanying drawings, in which:

Fig. 1 is a front elevational view of the unit of this invention with portions of the cabinet broken away to disclose the interior construction;

Fig. 2 is a sectional view of the unit taken on the line 2—2 of Fig. 1;

Fig. 3 is a perspective view of the unit with the casing broken away in part to disclose the interior construction; and

Fig. 4 is a sectional view taken on a vertical plane through the axes of a vertical row of nozzles.

Referring now to the drawings, similar numerals referring to the same or similar parts, the unit has a cabinet 12 of metal or other suitable material. The cabinet 12 may be of desired width, usually three to five feet, and of a height suitable to the area to be served. The cabinet 12 may be made in various depths, and it may be partly or wholly recessed in the wall of the space to be conditioned.

In the cabinet 12 an inner casing 14 is mounted centrally of the width of the cabinet. The cabinet 12 has an air inlet grille 16 formed in the front upper portion thereof. Vanes 18 and 20 are mounted in the top 52 of the cabinet 12 to direct the air flowing from the cabinet.

Vanes 18 and 20 are inclined outwardly with respect to the vertical center line of the unit in order to direct the air in a diverging stream from the unit.

The inner casing 14 has a plenum 22 to which air is delivered through conduit 24. Conduit 24 extends into the inner casing 14 and has a portion extending outside of the inner casing. The portion extending from the inner casing 14 is adapted to be connected to a source of conditioned air 26 having a total pressure on the order of ½" to 5" water gauge. The inner end of the conduit 24 terminates in a plane making a 45° angle with the vertical axial plane of the conduit. The air from source 26 is air which has been conditioned to a desired humidity and dry bulb temperature. A damper 28 is pivotally mounted at 30 on the inner end of duct 24. A rod 32 is pivotally secured to damper 28 and extends through conduit 20. Rod 32 may be held in adjusted position by friction or other suitable means whereby the damper 28 is held in adjusted position to control the volume rate of flow of air into plenum 22 and to effect the desired degree of pressure reduction. In operation, once the damper 28 has been adjusted to provide the desired static pressure within the plenum 22, it remains fixed in position. If it is desired for any reason to cut the unit out of service, the damper 28 is closed so that no air is discharged through such unit, while air continues to flow from the conditioned air source to other units continuing in active service.

The interior of plenum 22 is provided with a plurality of sound absorbing baffles 34 constructed of any suitable sound absorbing material, which cause the air delivered to the plenum 22 to flow in a circuitous path to the top of the plenum. The top of the plenum 22 is provided with an extension chamber 36 extending substantially the length of the inner casing 14. A plurality of nozzle plates 38 are secured by screws 39 to the front face of the extension chamber 36. The nozzle plates 38 make an angle of 8° with respect to a vertical plane. It should be understood that angles other than 8° might be used. However, we prefer that this angle be in the range of 5° to 30°.

The nozzle plates 38 may be constructed on any suitable material such as metal or plastic; however we prefer to make them of plastic. The nozzle plates 38 have a plurality of nozzles 40 arranged in rows in vertical planes. The longitudinal axes of the nozzles make an angle of 30° with respect to the nozzle plate 38. This angle may be as small as 20° but it should not be considerably greater than 35°, because the air discharged therefrom would then tend to oppose the air flowing into the cabinet through inlet grille 16. The cross sectional area of each nozzle 40 decreases continually from the entrance of the nozzle to the throat or discharge face. The entrances to the nozzles have smoothly rounded surfaces. For primary air pressures of about 1.5 inches water gauge we prefer to use nozzles having throat diameters in the range of .09 to .2 inch.

A heat exchanger 42 is mounted in the inner casing so that it is inclined upwardly toward the front of the cabinet. The heat exchanger 42 is preferably of the fin and tube type in which a heat transfer fluid such as water is circulated through the tubing. The tubing of the heat exchanger 42 is connected to a source of supply of heat transfer fluid and the supply fluid may be varied in temperature to heat or cool the air flowing through the heat exchange 42 from the grilles 16 in the front of the cabinet. A drain pan 44 is provided under the heat exchanger 42 to receive condensate flowing by gravity from the heat exchanger 42. The drain pan 44 has an outlet 46 which is adapted to be connected to a sewer pipe not shown. The heat exchanger 42 is inclined with respect to the vertical at an angle of 8°;

however this angle may be somewhat less or greater than 8°. By mounting the heat exchanger at 8° we have obtained a unit which has the desired depth, and yet the heat exchanger 42 is inclined at a suitable angle with respect to the direction of air flow from the nozzles 38. The inner casing 14 has on its front face two channels 48 which slidably receive the usual filter 50 for removing dirt from the air on its way from the inlet grilles 16 to the heat exchanger 42. The top 52 of cabinet 12 is mounted for removal for the purpose of removing the filter to inspect it, replace it, or clean it.

An inducing chamber 54 in the inner casing 14 between the nozzle plates 38 and the heat exchanger 42 provides a space in which secondary air is induced and mixed with the primary air from the nozzles 40. In this chamber 54 the flow of primary air from the nozzles 40 induces a flow of secondary air from the conditioned space through the grilles 16 thence through the filter 50 and thence through the heat exchanger. The shape of the chamber 54 is such that its cross-section in the direction of air flow increases in proportion to the increase in volume of air flowing therethrough. The nozzles arrangement is such that the nozzles 40 act in succession upon the air flowing from the heat exchanger in a staged manner.

The inner casing 14 has a duct 56 for conducting the air from the chamber 54 to the discharge vanes 18 and 20. The axis of the duct 56 in the direction of air flow is substantially parallel to the direction of flow of air from the nozzles 40. The cross-sectional area of the duct 56 increases slightly from inlet to outlet to convert some velocity air pressure to static air pressure in the passage of the air from the chamber 54 to the discharge vanes 18 and 20.

The conditions of temperature, humidity and pressure of the primary air and the conditions of temperature and rate of flow of the heat transfer fluid through the heat exchanger 42 may be controlled in a manner well known in induced air systems. For instance these conditions may be controlled as shown and described in U.S. patent to W. H. Carrier No. 2,363,294 issued November 21, 1944.

Although we have described specifically the preferred embodiments of our invention, we contemplate that changes may be made without departing from the scope or spirit of our invention and we desire to be limited only by the claims.

We claim:

1. An air conditioning unit adapted to be mounted in a conditioned space, comprising a substantially rectangular cabinet, a recirculated air inlet opening in the front side of said cabinet, a nozzle plate having a plurality of vertically spaced nozzles arranged substantially in a plane inclined upwardly toward and extending along the back of said cabinet, means for supplying air under pressure to said nozzles, a heat exchanger having a plurality of passageways for the flow of air, said bent exchanger being mounted in said cabinet opposite said recirculated air inlet opening, said heat exchanger being spaced from said nozzle plate to provide an inverted substantially triangular shaped chamber between said nozzles and said heat exchanger for the induction of recirculated air through said recirculated air inlet opening and thence through the passageways of said heat exchanger, a discharge opening in the top of said cabinet for discharging air from said cabinet, and means for conducting air from said inverted triangular shaped chamber to said discharge opening.

2. An air conditioning unit adapted to be mounted in a conditioned space comprising a relatively tall and relatively narrow upright rectangular cabinet, a plenum extending upwardly along the back of said cabinet, said plenum being adapted to be connected to a source of conditioned primary air under pressure, said plenum having a substantially planar front face inclined upwardly toward the back of said cabinet at an angle of greater than 45° with respect to the horizontal, a plurality of vertically spaced nozzles in the front face of said plenum, the longitudinal axes of said nozzles being inclined upwardly in the direction of air flow toward the front side of the unit at an angle of greater than 45° with respect to the horizontal, a recirculated air inlet opening in the front side of said cabinet for admitting air to said cabinet, a heat exchanger in said cabinet between the recirculated air inlet opening and said plenum and having a plurality of passageways for conducting air from said inlet opening to said plenum, said heat exchanger being arranged with respect to said plenum to provide therebetween an inducing and mixing chamber for inducing recirculated air through the passageways of said heat exchanger and for mixing it with the primary air flowing from said nozzles, and an outlet opening in said cabinet for discharging the mixed air.

3. An air conditioning unit adapted to be mounted in a conditioned space comprising a relatively tall and relatively narrow upright cabinet, a plenum in the lower portion of said cabinet, a conduit extending into a lower portion of said plenum, said conduit being adapted to be connected to a source of conditioned air under pressure, said plenum having an extension chamber extending upwardly along the back of the cabinet, a baffle mounted in said plenum above said conduit and extending toward but terminating short of the back of the cabinet to provide a passageway for the flow of air from said conduit to said extension chamber, said conduit terminating on a bias such that the longer side is toward the front of the unit, a damper member pivoted to said conduit at the shorter side to direct the air toward the front of the cabinet when the damper is in open position, a plurality of nozzles in the extension chamber of said plenum, said nozzles being arranged to discharge a plurality of jets of air upwardly in said cabinet, a recirculated air inlet in the front of said cabinet, a heat exchanger mounted in said cabinet between said air inlet and said nozzles whereby the jets of air from said nozzles induces and mixes with a flow of recirculated air through said recirculated air inlet and through said heat exchanger, and an opening in said cabinet for discharging air from the cabinet.

4. An air conditioning unit adapted to be mounted in a conditioned space, comprising a substantially rectangular cabinet, a recirculated air inlet opening in the front side of said cabinet, a nozzle plate arranged substantially in a plane inclined upwardly toward and extending along the back of said cabinet, a plurality of nozzles spaced along the height of the nozzle plate, means for supplying air under pressure to said nozzles, a heat exchanger having air passageways and being mounted in said cabinet opposite said recirculated air inlet opening, said heat exchanger being spaced from said nozzle plate to provide a chamber between said nozzle plate and said heat exchanger, said chamber having a cross-sectional shape substantially that of an inverted acute isosceles triangle said chamber serving for the induction of recirculated air through said recirculated air inlet opening and thence through the air passageways of said heat exchanger, a discharge opening in the top of the cabinet for discharging air from said cabinet and means for conducting air from said chamber to said discharge opening.

5. An air conditioning unit adapted to be mounted in a conditioned space comprising a relatively tall and relatively narrow upright rectangular cabinet, a plenum extending upwardly along the back of said cabinet, said plenum being adapted to be connected to a source of conditioned primary air under pressure, said plenum having a substantially planar front face inclined upwardly toward the back of said cabinet at an angle of greater than 45° with respect to the horizontal, a plurality of nozzles in the front face of said plenum, the longitudinal axes of said nozzles being inclined upwardly in the direc-

tion of air flow toward the front of the unit at an angle of greater than 45° with respect to the horizontal, a recirculated air inlet opening in the front of said cabinet for admitting air to said cabinet, a substantially rectangular heat exchanger in said cabinet between the recirculated air inlet opening and said front face of said plenum, said heat exchanger having air passageways and being arranged with respect to said plenum to provide therebetween an inducing and mixing chamber for inducing recirculated air through the air passageways of said heat exchanger and mixing it with the primary air flowing from said nozzles, said nozzles being arranged in the front face of said plenum in a substantially rectangular pattern having a height greater than one-half the height of said heat exchanger and having a length not substantially less than the length of said heat exchanger,

an outlet opening in said cabinet for discharging air from said cabinet and means for conducting air from said inducing and mixing chamber to said discharge opening.

References Cited in the file of this patent

UNITED STATES PATENTS

2,140,305	Ashley et al.	Dec. 13, 1938
2,251,907	Hoesel	Aug. 12, 1941
2,283,928	Huggins	May 26, 1942
2,348,127	Grimes	May 2, 1944
2,363,294	Carrier	Nov. 21, 1944
2,363,945	Carrier	Nov. 28, 1944
2,442,963	Sewell et al.	June 8, 1948
2,492,757	Meek	Dec. 27, 1949
2,567,758	Ashley	Sept. 11, 1951

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,913,227 November 17, 1959

James D. Bottorf et al.

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

Column 3, line 57, for "bent exchanger" read -- heat exchanger --.

Signed and sealed this 10th day of May 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,913,227 November 17, 1959

James D. Bottorf et al.

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

Column 3, line 57, for "bent exchanger" read -- heat exchanger --.

Signed and sealed this 10th day of May 1960.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents