

April 13, 1954

R. D. TUTT

2,674,934

AIR CONDITIONING AND DISTRIBUTING SYSTEM

Filed Dec. 15, 1949

3 Sheets-Sheet 1

Fig. 1

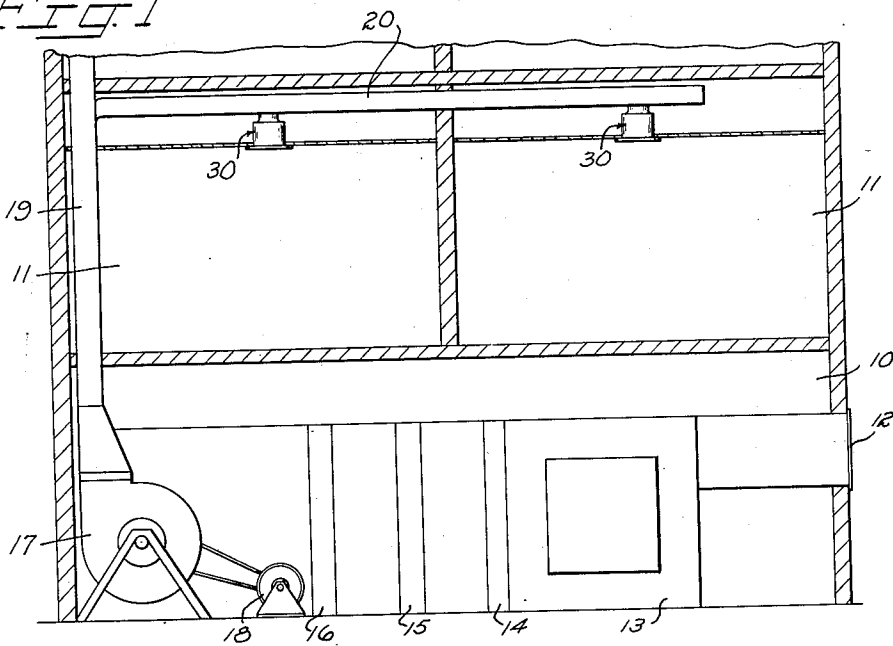
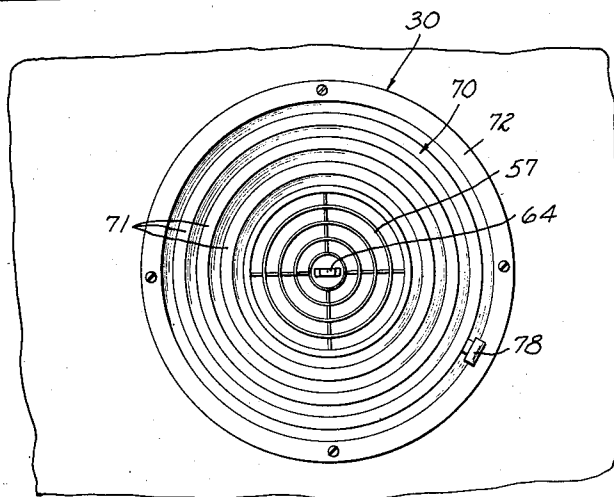


Fig. 2



Inventor
RICHARD D. TUTT

By
Lindsey Prutzman & Just
Attorneys

April 13, 1954

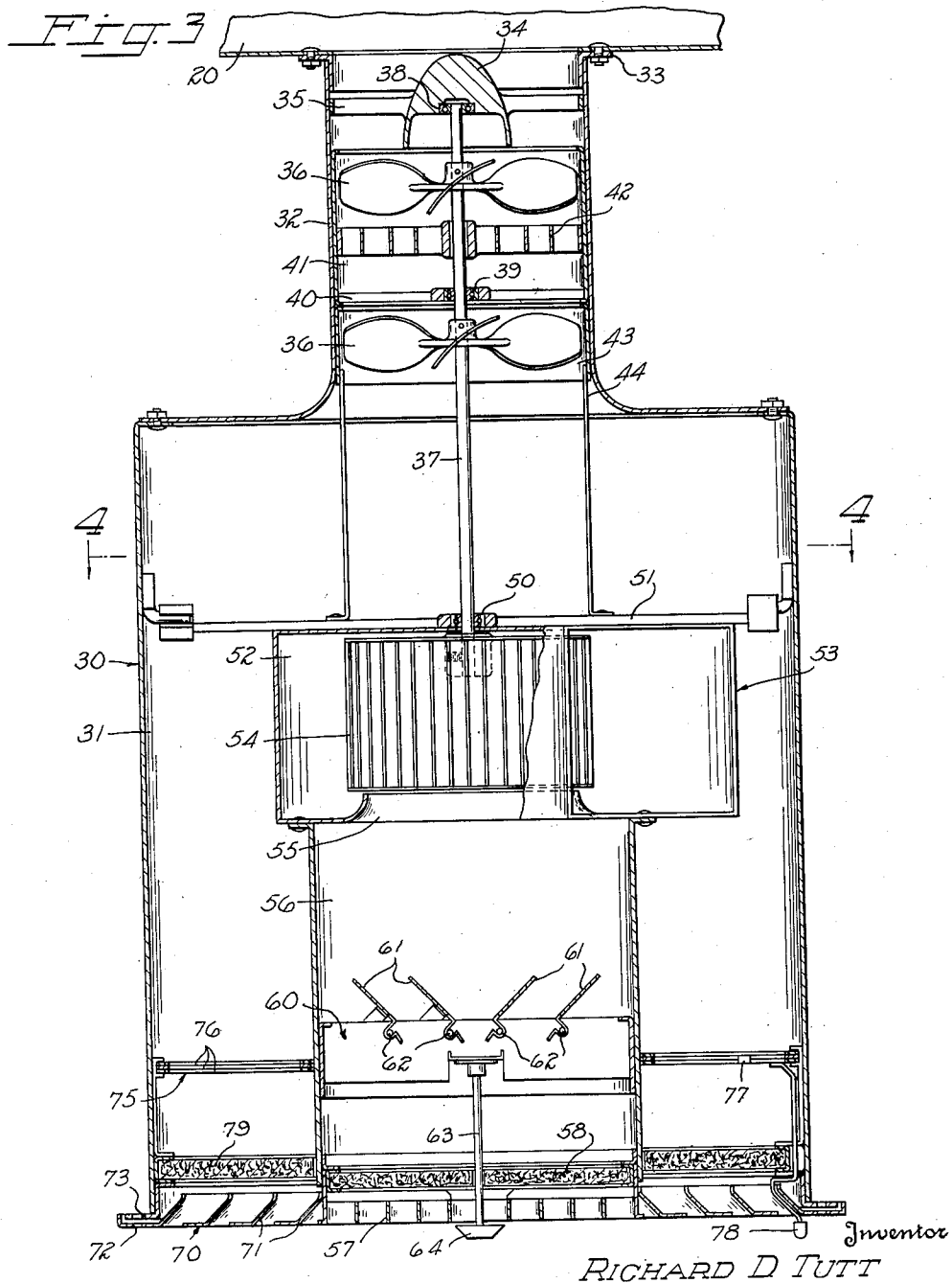
R. D. TUTT

2,674,934

AIR CONDITIONING AND DISTRIBUTING SYSTEM

Filed Dec. 15, 1949

3 Sheets-Sheet 2



334
Lindsey, Prutzman & Just
Attorneys

April 13, 1954

R. D. TUTT

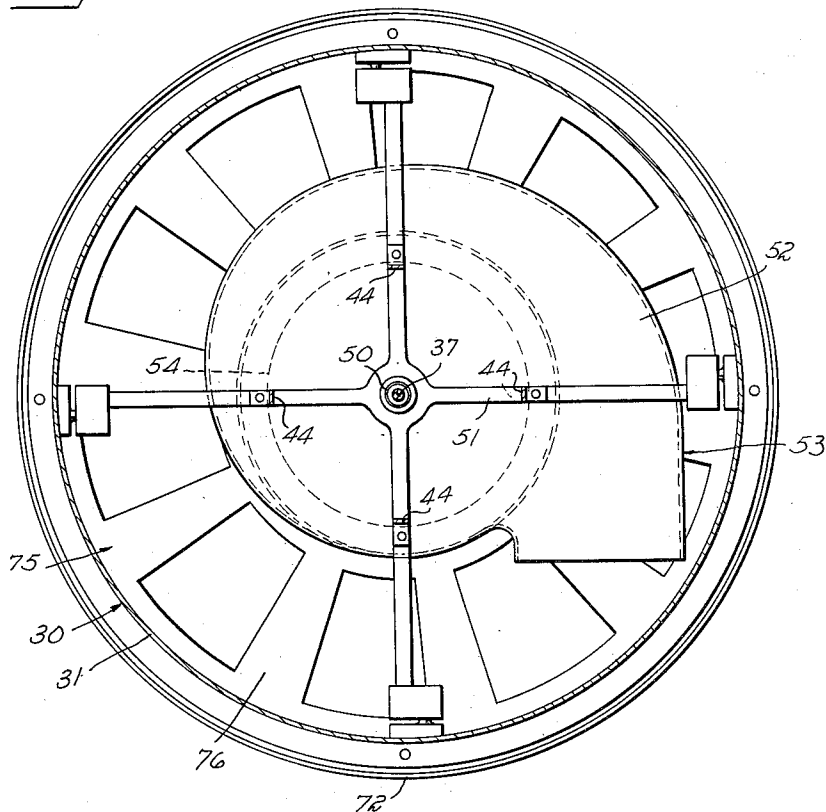
2,674,934

AIR CONDITIONING AND DISTRIBUTING SYSTEM

Filed Dec. 15, 1949

3 Sheets-Sheet 3

Fig. 4



Inventor
RICHARD D. TUTT

By
Lindsey, Prutzman + just
Attorneys

UNITED STATES PATENT OFFICE

2,674,934

AIR CONDITIONING AND DISTRIBUTING
SYSTEMRichard D. Tutt, New Britain, Conn., assignor to
Tuttle & Bailey, Incorporated, New Britain,
Conn., a corporation of Connecticut

Application December 15, 1949, Serial No. 133,128

10 Claims. (Cl. 98—38)

1

The present invention relates generally to the distribution of conditioned air and, more particularly, to an improved and novel system of supplying conditioned air to an enclosure the use of which results in the obtaining of good performance characteristics and efficient operation accompanied by a great economy of size and cost of installation.

The present invention is related generally to a type of air distribution or air conditioning system wherein air being supplied to a room or other enclosure includes a proportion of outside or "fresh" air which has been conditioned at least to afford a desired temperature and moisture control and usually also to remove dust, etc. As compared therewith, however, the system of the present invention is particularly advantageous because it avoids the necessity for return ducts and large size transmission ducts customarily employed in systems of this type while at the same time retaining all of the advantages of such systems including efficiency of operation, low noise level, good air distribution and freedom from drafts, and flexible control among others.

It is a principal aim of the present invention to provide a system of air distribution or conditioning which employs a type or principle of operation which is different from that of the usual commercial installations which employ large duct work to convey air at moderate temperature and pressure differentials to the point of distribution and for withdrawing and recirculating air from the room. The aim is to provide with the novel system of the present invention at least comparable distribution results without the use of such large and extensive duct work, and without at the same time causing a material loss of efficiency or introducing any types of equipment which of itself would require large installation spaces or which would be difficult and expensive to assemble and install.

Other objects will be in part obvious, and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application of which will be indicated in the appended claims.

In accordance with the invention, the outside or "fresh" air which it is desired to mix with "room" air and to distribute into the various rooms or other enclosures being supplied is conditioned before it is mixed with the "room" air

2

and at that time is brought to a condition of relatively high pressure and at a considerable temperature differential such that it normally could not be released directly into a room by ordinary methods of air distribution without causing so much noise, disturbance, etc., as to make the system entirely unsatisfactory. The air so conditioned is conducted at a high rate of flow through conventional transmission ductwork which, however, may be considerably reduced in size compared with that which would be normally employed in conventional air distributing installations of the same capacity due to the greater rate of flow and because no "room" air is being recirculated. Adjacent or at the rooms where the air is to be distributed, this air at relatively high pressure and temperature differentials is introduced to a novel distributing unit which is devised in accordance with the present invention to employ the energy of the supplied air to drive a prime mover, which in turn operates a fan of a mechanism for withdrawing air from the room or enclosure and admixing it in suitable proportion with the conditioned air being supplied, which mixture is then released into the room through a diffuser which may be comparable in construction to standard diffusers presently in use with conventional low pressure systems and with the mixed air delivered at a pressure and temperature which is now sufficiently close to that of the room air that it may be handled satisfactorily according to accepted practice.

In order to afford a better understanding of the invention, a specific embodiment of the invention is shown in the accompanying drawings in which:

Fig. 1 is a fragmentary diagrammatic view of a complete installation of the system of the present invention in a multi-room structure;

Fig. 2 is a view of the outlet end of the novel mixing and diffusing unit of the present invention which is employed in the system;

Fig. 3 is an enlarged view partially in cross section of the air mixing and diffusing unit; and

Fig. 4 is a cross sectional view taken along lines 4—4 of Fig. 3.

Referring to the drawings, and particularly to Fig. 1 thereof, there is shown in diagrammatic form an equipment room 10 containing a central air conditioning station and a plurality of rooms 11 to which conditioned air is to be supplied. As mentioned above, the showing in Fig. 1 is diagrammatic and is intended merely for illustrative purposes to show one possible general

arrangement of the various system compartments without, however, intending to limit the invention to that particular arrangement or to a use in a particular kind of structure. For brevity of disclosure, details of construction, particularly of standard equipment, which do not of themselves form a part of the present invention and which are well known to those skilled in the art will receive no detailed explanation here.

At one end of the equipment room 10 there is illustrated a conventional type fresh air inlet 12 which provides an opening for the entrance of fresh air from outside the building to a compartment 13. The air in passing from the compartment 13 is permitted to flow through a filter 14, cooling coils 15 and heating coils 16. These instrumentalities are merely shown diagrammatically, inasmuch as they are well known in the art and may be of any conventional type such as is employed in conventional air conditioning systems. In the illustrative installation shown in the drawings, cooling coils 15 and heating coils 16 are intended to be utilized in the alternative, depending upon whether the rooms 11 are to be supplied with heated or cooled air.

The flow of air may be induced by a centrifugal type fan 17 which is arranged for operation by any suitable prime mover such as the motor 18. The fan 17 and motor 18 are of usual construction but rated to deliver air at a much greater pressure and velocity than that normally employed in conventional air distributing and conditioning systems. The delivery end of the fan 17 is connected to a main riser duct 19 which also is of conventional construction except, as explained above it may be smaller in section than that of a riser duct which would normally be employed in comparable installations of conventional air conditioning and distributing systems. The riser 19 is connected in turn to lateral branch ducts 20 (one shown) for supplying the air to the various rooms of the various floors of the structure supplied by the main riser 19. It will be understood that, if desired, the ducts 19 and 20 may be built into the walls of the structure or may be exposed, or both. Branch ducts 20 may extend along the wall or along the ceiling as illustrated.

As mentioned above, the air supplied by the fan 17 is at a relatively high pressure compared with the pressures normally used in air conditioning and distributing systems and greatly in excess of that which could be released directly into a room under present day practices. This pressure is preferably of the order of 4 to 6 inches of water and the air may be permitted to flow through the riser conduit 19 and branch ducts 20 at rates as high as 3,000 to 10,000 feet per minute.

The cooling coils 15 or heating coils 16, whichever is used, are preferably so regulated that the temperature of the air being supplied through the ducts is at a temperature differential of the order of 20° to 45° below room temperature when the cooling coils are used, and of the order of 75° to 150° above room temperature when the heating coils are utilized. As will be explained hereinafter, the relatively highly heated or cooled air is not released directly into the rooms 11 but is first mixed with room air in sufficient amount to reduce the temperature differential of the mixture to a range which is acceptable for diffusion of the mixture into the rooms. In general, a much greater temperature differential

is permitted when the air being supplied is heated air, and it is the common practice to permit the air to be released into a room at a greater temperature differential when heated air is being diffused.

The air supplied to the rooms 11 by the branch ducts 20 is released into the room or rooms through the units 30 which are an important feature of the present invention and which will be described in full detail later in connection with the enlarged showing of the unit 30 in Figs. 2, 3 and 4 of the drawings.

It will be noted that, in general, the air conditioning or distributing system illustrated in Fig. 1 of the drawings is similar to that of conventional installations in many respects but, specifically differs therefrom, notably, in the case of the units 30, in size, and in the absence of any return ducts. As is well known, most air conditioning systems supply return ducts which, despite the fact that they take up a considerable amount of valuable space, are normally deemed essential from the standpoint of efficiency in air distributing and conditioning systems for otherwise it would be necessary to supply and condition large quantities of 100% fresh air for distribution into the rooms 11.

Referring now more particularly to Figs. 2, 3 and 4 of the drawings, there is shown, in detail, a specific embodiment of a unit 30 which in accordance with the invention permits the use of high pressure air at an excess temperature differential in an efficient and satisfactory manner. The unit 30 comprises a connecting housing 32 arranged for connection to an outlet flange 33 of one of the ducts 20 and to which is secured a larger cylindrical housing 31.

Within the housing 32 adjacent the flange 33, there is provided a rounded member 34 supported centrally thereof by the spider 35 which is utilized primarily to cause the entering stream of air to be concentrated adjacent the periphery of the housing 32. A stream of air entering around the member 34 first encounters the upper of two turbine impellers 36 of the axial flow type which are fixed to a rotatable shaft 37 journaled at one end in an anti-friction bearing 38 mounted in the member 34, and intermediate its ends in a second anti-friction bearing 39 carried by the spider 40 fixed to the impeller sleeve 41. The flow of air then passes through a plurality of guide vanes 42 also carried by the impeller sleeve 41 which are provided primarily to overcome turbulence in the air flow. The flow of air then encounters the second impeller 36 and from thence is released into the upper end of the enlarged housing 31. The impeller sleeve 41 is carried by a second impeller sleeve 43 supported on brackets 44.

The lower end of the shaft 37 is mounted in an anti-friction bearing 50 which is supported by the spider 51 which also supports the brackets 44, previously mentioned, for holding the impeller sleeve 43. The spider 51 also supports the scroll or housing 52 of the fan assembly 53. The fan 53 is of the centrifugal type and contains an impeller 54 which is fixed to the lower end of the shaft 37. Accordingly, when the incoming air drives the impeller blades 36, the resulting rotation is transmitted through the shaft 37 to the impeller 54. The fan housing 52 has a downwardly facing centrally located inlet opening 55 which communicates with an inner duct 56 extending to the bottom of the housing 31 and thereby opening into the room, the opening be-

ing provided with a suitable grill 51. Accordingly, the action of the fan 53 is to draw air upwardly through the inner duct 55 from the room into the housing 52 and to discharge it in a swirling stream around the outside thereof. A suitable filter 58 may be provided above the grill 57 to filter the incoming room air.

The inward flow of room air may be regulated in part by means of a damper assembly 60 which comprises a plurality of parallel blades 61 mounted for pivoting movement adjacent one edge on pins 62 to vary the effective opening. Any convenient means for regulating the pivoted position of the damper blades 61 may be provided such as the shaft 63 which is suitably connected to the blades 61 and is provided with a manually turnable knob 64. It will be appreciated that any other suitable damping mechanism could be utilized in place of that specifically shown in the drawing. The damper mechanism shown in the drawing of itself does not form a part of the present invention, and is described and claimed in a copending application of Ernest H. Person and Richard D. Tutt, Serial No. 112,198, filed August 25, 1949, now Patent No. 2,621,579.

The conditioned air which has been reduced in energy by passage through the impellers 36 then enters the housing 31 and becomes mixed in the swirling stream of room air discharged at the periphery of the fan housing 52. This mixing action accomplishes the necessary reduction in temperature differential of the supplied air. The resulting mixture is permitted to flow downwardly in the space between the inner duct 55 and the housing 31, and is released into the room through a diffuser assembly 70 which is annular in shape and comprises a plurality of flanged concentric ring members 71 supported in a circular frame 72, the latter of which is placed into engagement with the lower extremity of the housing 31, for example, by use of flanged member 73.

For the purpose of regulating the flow of air outwardly into the room and the back pressure on the fan 53, there is provided a damper 75 which comprises a plurality of apertured sliding members 76 (three shown). The alignment of the apertures of the sliding member 76 may be varied by manually moving the handle 78, which is connected to the lower of the sliding members 76 which in turn carries a stop 77 for engaging the middle sliding member. An annular filter 79 may be provided in the space above the diffuser 70 to filter the air mixture before it is released into the room.

As explained heretofore, the conditioned air supplied through ducts 20 is at a relatively high pressure and at a relatively great temperature differential. The energy possessed by the flow of air is therefore adequate to drive the impellers 36 at a relatively high velocity even under load and the resultant use of this energy to withdraw air from the room for admixture with the supplied air provides a useful employment of this energy. The effect of driving the impellers 36 is to cause the conditioned air to lose much of its energy and to permit it to expand so that when this conditioned air is released into the larger portion of the housing 31 and mixed with room air, it is no longer under temperature and pressure conditions so that it cannot be released into the room. I have found that with a relatively small unit of the order of 3 feet in length and 21 inches in maximum diameter, it is possible to obtain a

resulting pressure such that the velocity of the air when released into the room will not exceed 2500 feet per minute and a desired temperature differential such as 10 to 15° below room temperature in the case of cooled air and 30 to 40° above room temperature in the case of heated air, this being well within the ranges generally acceptable in commercial practice.

The fan 53 is designed to withdraw an adequate proportion of room air through the grill 57 so as to effect the desired temperature change of the incoming conditioned air when admixed therewith. The action of the inlet grill 57 and the outlet diffuser 70 is complementary since there is set up in the room a desired air flow pattern which consists in a flow of conditioned air mixed with room air radially outwardly from the periphery of the unit and a return flow axially of the unit.

Also, by reason of the damper units 60 and 75, very close control is provided of the operation of the unit. By regulating the damper 60, the amount of air withdrawn by the fan 53 can be controlled while the damper 75 on the other hand will vary the back pressure on the fan 53 which will affect the rate of speed at which the fan 53 is driven. Thus, two means are provided which can be varied independently for obtaining the desired flow of air into the room, both in respect to the total amount delivered and the proportion of conditioned air to room air.

Other forms or types of impellers may be employed in place of the impellers 36 and various other types of fans and fan housings may be substituted for that of fan assembly 53 depending upon the desired performance characteristics, space available, and similar considerations, with comparable results.

No provision is made in the installation shown in the drawing for release of air from the rooms 11. In general, it will be sufficient to rely on exfiltration or vents in toilet areas, etc. A slightly pressurized building is, of course, advantageous, since it tends to prevent the entering of outside air and dust.

Although in the illustration, the units 30 are shown mounted vertically and in the ceiling, they will function satisfactorily if mounted in a wall and in other than a vertical position.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. An air mixing and distributing apparatus comprising an elongated housing adapted to be connected at one end to a supply of primary air under relatively high pressure and having an opening at the other end, a concentrically arranged inner housing of smaller section having an open end adjacent the open end of the first housing, a centrifugal fan having an inlet connected to the inner housing and an outlet discharging into the outer housing, a conduit forming the sole supply of primary air to the outer housing, and impeller means extending across said conduit and driven by the flow of primary air into the outer housing for operating the fan, said housing providing a chamber for admixing primary air after discharge through the impeller with air supplied by the fan.

2. An air mixing and distributing apparatus for a room comprising a housing having a discharge opening at one end communicating with the room, a conduit for introducing primary air under pressure to the other end of the housing, a bladed impeller mounted crosswise of the conduit for rotation by the flow of primary air therethrough, a concentrically arranged duct of smaller section than the housing having an inlet adjacent the discharge opening of the housing, and a coaxially arranged centrifugal fan operatively connected to the impeller for rotation therewith and disposed on the duct with its inlet connected thereto and its outlet discharging into the housing, the space within the housing between the fan and the primary air being substantially unobstructed, said fan being effective for drawing room air into the housing in proportion to primary air and said impeller being effective for reducing the energy of the primary air such that the resulting mixture of primary and room air for release into the room is at a desired temperature and pressure differential.

3. An air mixing and distributing apparatus comprising a housing adapted to be connected at one end to a supply of primary air under relatively high pressure and having an outlet at the other end, a concentrically arranged duct of smaller section than the housing having an inlet adjacent the outlet of the housing, a centrifugal fan having an inlet connected to the duct and an outlet discharging into the housing, means forming the sole entranceway for primary air to the housing, impeller means located in said passageway driven by the flow of primary air into the housing for operating the fan and for releasing the primary air discharged therethrough adjacent the outlet of the fan, variable damper means between the inlet of the duct and the inlet of the fan, and variable damper means between the outlet of the fan and the outlet of the housing.

4. An air mixing and distributing apparatus comprising a housing having an inlet opening at one end adapted to be connected to an air supply duct and having an outlet opening at the other end, means forming the sole passageway for introducing primary air into said housing, a shaft rotatably mounted axially of the housing, a pair of turbine impellers fixed to the shaft and disposed in said passageway adjacent said inlet opening of the housing for operation by the air supply and arranged to release the air discharged therethrough into the housing, a concentrically arranged inner housing having an open end adjacent the outlet opening of the first housing, a centrifugal fan driven by said shaft having an inlet connected to the inner housing and an outlet communicating with the outer housing, damper means in the first housing intermediate the open end of said first housing and the fan outlet, and damper means in the inner housing between the open end of said inner housing and the fan inlet.

5. An air mixing and distributing apparatus comprising an elongated housing adapted to be connected at one end to a primary air supply duct and having an opening at the other end, means forming the sole passageway for admitting primary air into the housing, a concentrically arranged inner housing of smaller section having an open end adjacent the open end of the first housing, a centrifugal fan having an inlet connected to the inner housing and discharging into the outer housing, an impeller disposed in said

passageway and driven by the flow of primary air and arranged to release air discharged therethrough into the first housing, means forming a driving connection between the impeller and the fan, and means at the outlet of the first housing for directing air from the housing radially outwardly therefrom.

6. An air mixing and distributing apparatus comprising an elongated cylindrical housing adapted to be connected at one end to an air supply duct and having an opening at the other end, a concentrically arranged cylindrical duct within the housing having an open end substantially coterminous with the open end of the housing, a centrifugal fan for discharging air from the last named duct to the housing, means forming the sole passageway for admitting primary air into the housing, impeller means located in said passageway and driven by the flow of air from the supply duct to the housing for operating the fan, said impeller means being arranged to release the primary air discharged therethrough into the housing for admixture with air discharged by the fan and air deflecting means at the open end of the housing between the peripheries of the housing and the concentric duct comprising a plurality of spaced concentric rings having radially extending flanges.

7. An air conditioning and distributing system for a room comprising, in combination, an outlet unit including a housing having a discharge opening communicating with the room and an inlet spaced from the discharge opening, means for supplying primary air at a pressure and temperature differential in excess of that desired for air to be released into the room, a conduit extending between the last-named means and the inlet of the housing capable of carrying the primary air under said velocity at a pressure of the order of 4-6 inches of water, a bladed impeller mounted in the conduit adjacent said inlet for actuation by the flow of primary air released into the housing, said housing defining a passageway for the primary air discharged through the impeller, conduit means forming an enclosed air inlet passageway between the room and the interior of the housing of smaller cross section than said discharge opening and mounted coaxially in the discharge opening, and a centrifugal fan operatively connected for operation by the impeller having an inlet connected to the conduit means and an outlet discharging into the housing whereby room air is admixed with the primary air discharged through the impeller in advance of the discharge opening of the housing.

8. An air conditioning and distributing system for a room comprising, in combination, an outlet unit including a housing having a discharge opening communicating with the room and an inlet spaced from the discharge opening, means for supplying primary air at a velocity of at least 3000 feet per minute and cooled to a temperature of at least 20° below room temperature, a conduit extending between the last-named means and the inlet of the housing capable of carrying the primary air under said velocity at a pressure of the order of 4-6 inches of water, a bladed impeller mounted in the conduit adjacent said inlet for actuation by the flow of primary air released into the housing, said housing defining a passageway for the primary air discharged through the impeller, conduit means forming an enclosed air inlet passageway between the room and the interior of the housing of smaller cross section than said discharge opening and mounted

coaxially in the discharge opening, and a centrifugal fan operatively connected for operation by the impeller having an inlet connected to the conduit means and an outlet discharging into the housing whereby room air is admixed with the primary air discharged through the impeller in advance of the discharge opening of the housing, said impeller being effective to reduce the energy of the primary air and said fan being effective to introduce a proportion of room air such that the mixture of primary air and room air is discharged at a rate not exceeding 2500 feet per minute and at a temperature not more than 15° below room temperature.

9. An air conditioning and distributing system for a room comprising, in combination, an outlet unit including a housing having a discharge opening communicating with the room and an inlet spaced from the discharge opening, means for supplying primary air at a velocity of at least 3000 feet per minute and heated to a temperature of at least 75° above room temperature, a conduit extending between the last-named means and the inlet of the housing capable of carrying the primary air under said velocity at a pressure of the order of 4-6 inches of water, a bladed impeller mounted adjacent said inlet for actuation by the flow of primary air released into the housing, said housing defining a passageway for the primary air discharged through the impeller, conduit means forming an enclosed air inlet passageway between the room and the interior of the housing of smaller cross section than said discharge opening and mounted coaxially in the discharge opening, and a centrifugal fan operatively connected for operation by the impeller having an inlet connected to the conduit means and an outlet discharging into the housing whereby room air is admixed with the primary air discharged through the impeller in advance of the discharge opening of the housing, said impeller being effective to reduce the energy of the primary air and said fan being effective to introduce a quantity of room air such that the mixture of room air and primary air is discharged at a rate not

exceeding 2500 feet per minute and at a temperature not exceeding 40° above room temperature.

10. An air conditioning and distributing system for a room comprising, in combination, an outlet unit including a tubular housing having an air inlet at one end and a discharge opening at the other end communicating with the room, duct means for supplying primary air to said housing inlet at a pressure and temperature differential in excess of that desired for air to be released into the room, a tubular conduit of smaller cross section than the housing discharge opening and mounted coaxially in the opening to provide a room air inlet passageway, a centrifugal fan mounted on the top of the conduit for discharging room air from the conduit into the housing, said housing being of substantially greater length than the conduit to form a substantially unobstructed chamber about the fan, and a bladed impeller mounted coaxially with the centrifugal fan and connected thereto, said impeller being disposed in the duct means adjacent the housing inlet for actuation by the supply of primary air and for releasing the primary air therethrough to the housing for admixture with room air in advance of the discharge opening.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,576,485	Surls et al.	Mar. 9, 1926
1,673,149	Kohn et al.	June 12, 1928
2,038,347	Cornell, Jr.	Apr. 21, 1936
2,093,936	Spielmann	Sept. 21, 1937
2,126,230	Troxell, Jr.	Aug. 9, 1938
2,140,787	Cornell, Jr.	Dec. 20, 1938
2,148,254	Bergstrom	Feb. 21, 1939
2,188,176	Cornell, Jr.	June 23, 1940
2,217,944	Collicutt	Oct. 15, 1940
2,244,319	Thatcher	June 3, 1941
2,267,425	Rowe et al.	Dec. 23, 1941
2,314,696	Funk	Mar. 23, 1943
2,403,291	Kurth	July 2, 1946
2,407,284	Kennedy	Sept. 10, 1946