Feb. 4, 1964 R. S. WEIL 3,120,109

COMPRESSED AIR SYSTEM OF AIR CONDITIONING

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FIG. 1.

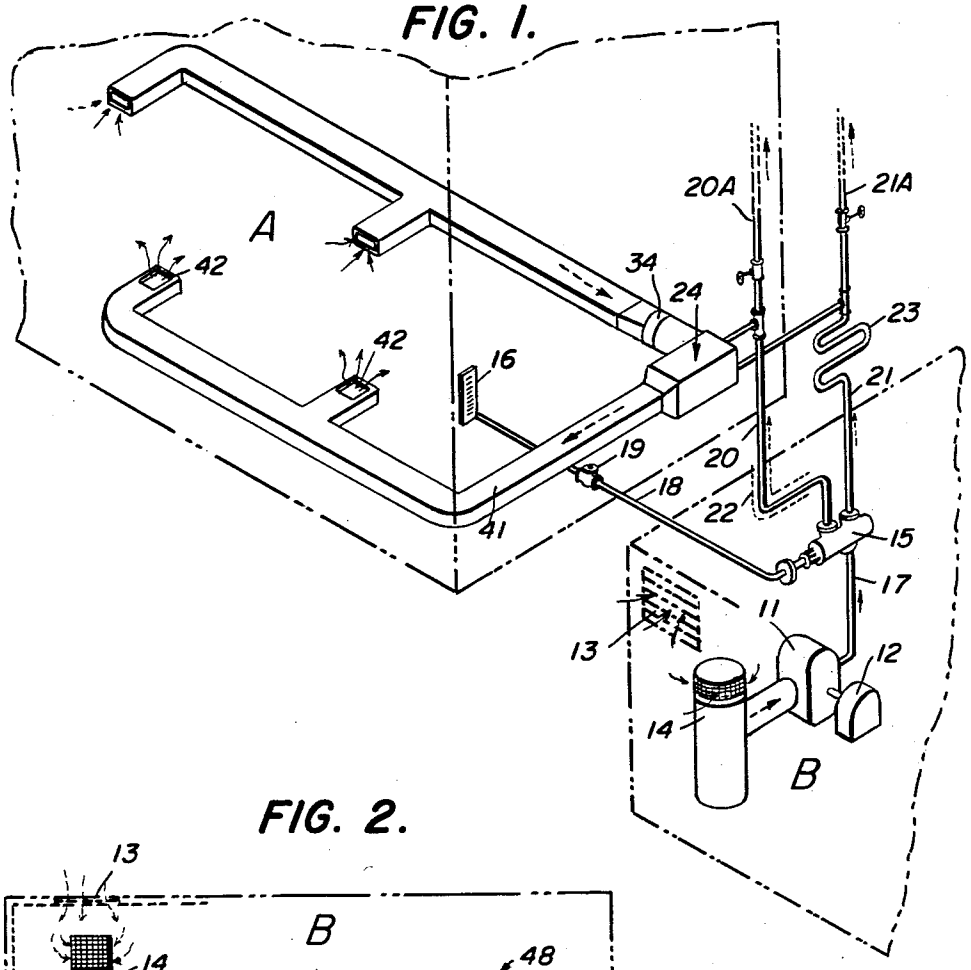
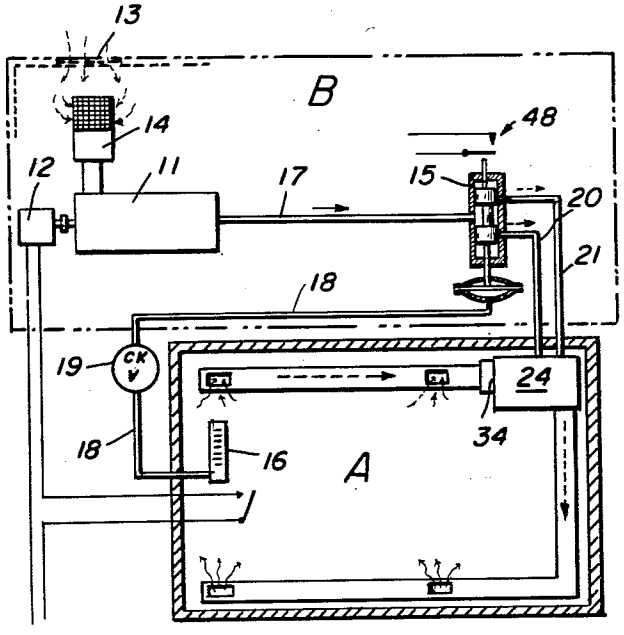


FIG. 2.



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FIG. 3.

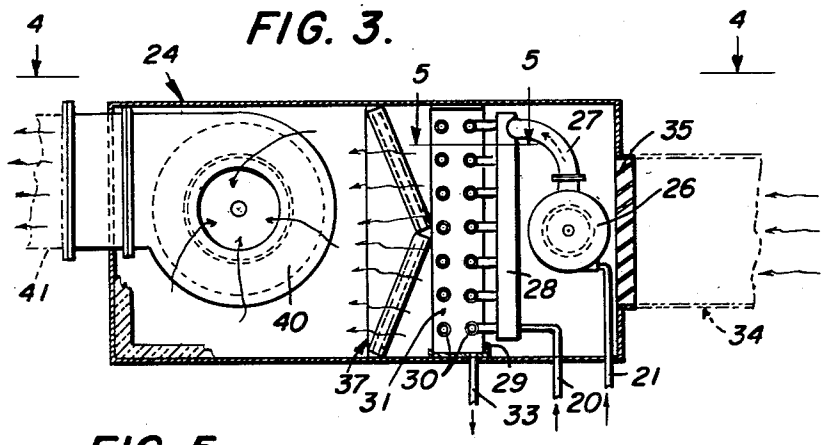


FIG. 5.

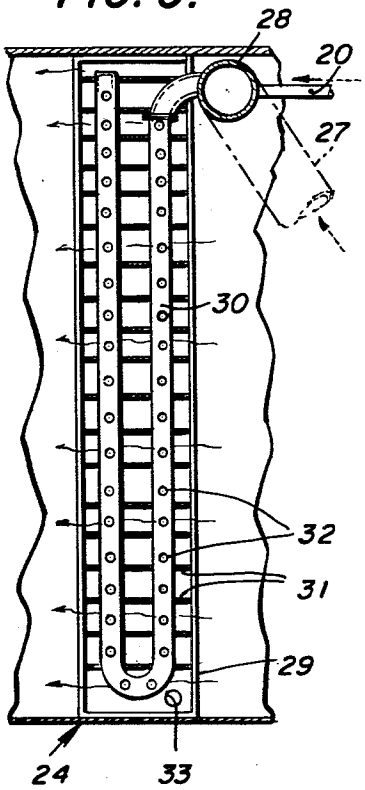
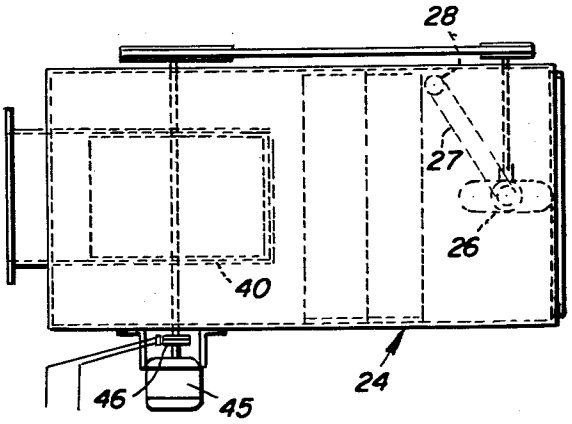


FIG. 4.



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COMPRESSED AIR SYSTEM OF AIR CONDITIONING

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8 Claims. (Cl. 62—172)

This invention relates to an air conditioning system applicable to office buildings and the like.

One object of the invention is to provide an air conditioning system for single or multiple room buildings in which the space required for air ducts is minimal. Another object is to provide means for heating or cooling the air in a room by means of compressed fresh air as the heat transfer medium. Another object is to provide in an air conditioning system means for dehumidifying both the compressed air heating and cooling medium, and the recirculated air. A further object is to provide a combined dehumidifier, heat exchanger and mixer for an air conditioning system. Still another object is to provide in an air conditioning system means for thoroughly mixing the heated or cooled fresh air with the recirculated air so that there is no sharp change in temperature at the outlets in the room.

These and other objects are attained by my invention which will be understood from the following description, reference being made to the accompanying drawings in which

FIG. 1 is a perspective schematic view of one room which is to be air conditioned, together with an isolated room for housing the air compressor machinery;

FIG. 2 is a diagrammatic view of the same;

FIG. 3 is a side elevational view partly in section showing details of the air mixing chamber and dehumidifier;

FIG. 4 is a plan view taken from the position 4—4 of FIG. 3; and

FIG. 5 is a fragmentary cross-sectional view taken on the line 5—5 of FIG. 3.

In the drawings, the room or space marked A represents a room which is to be air conditioned, and that marked B represents an isolated space (usually in a basement) where the compressor and certain auxiliary equipment are located.

In general my system operates by compressing fresh outside air, pre-cooling it to a desired temperature, dehumidifying it (when necessary) and then further cooling the compressed air at the room which is to be conditioned, by expansion to atmospheric pressure, and mixing the fresh air with room recirculated air, the recirculated air also being dehumidified as required.

In the room B there is located an axial compressor 11 driven by a motor 12 and receiving ambient air through the wall louvres 13. A noise muffler 14 may precede or follow the compressor. The outside air is compressed to a pressure of 1½ to 3½ atmospheres, preferably to about 1½ atmospheres. A positive-displacement helical type axial flow rotary compressor, such as for example an "Axi-Compressor" made by Ingersoll-Rand, is preferred, this type compressor being essential from a practical point of view because of the complete freedom from lubricating oil in the compressed air. The compressed air passes by pipe 17 from the compressor to an air switch valve 15 which is controlled by the thermostat 16, located in the room A, there being an air pressure pipe 18 from the thermostat to the switching valve 15, including a back pressure check valve 19. The compressed air from the compressor 11 is delivered to the room A, from the switching valve 15, alternatively, by relatively small pipe line 20 or 21, the pipe line 20 being provided with heat insulation 22 and designated as a hot line, and the

pipe line 21 being provided with air cooling means, indicated by pipe loops 23, and being designated as a cold line. When ambient temperatures are not too far removed from desired room temperatures, sufficient cooling may be attained simply by the long pipe runs in ventilated pipe ways.

When the thermostat 16 calls for more cooling in the air conditioned room A, the air switching valve 15 will direct the compressed air through the cold line 21 to a heat insulated mixing chamber 24 which is disposed in an out of the way space in or near the room A. Within the mixing chamber 24, the compressed air expands in and operates an air turbine or turbo-expander 26 at speeds in the range from 4000 to 8000 r.p.m., this speed being governed by the load on the recirculating fan 40. The outlet 27 of the air turbine 26 delivers decompressed fresh air to the header 28 of the dehumidifier, the header distributing the air to a plurality of heat exchange coils 30. The dehumidifier coils 30 are interconnected by metal fins 31 which present large surface areas for the transfer of heat or cooling to the stream of recirculated room air which enters through the control louvres 35 of the return duct 34 adjacent the mixing chamber 24, flowing around the air turbine 26 and over the coils 30 and fins 31. The dehumidifier coils 30 are provided with a plurality of small holes 32 through which the decompressed fresh air in the coils enters the air stream and thoroughly mixes with the recirculated air. The mixture of decompressed fresh air and return air is then preferably passed through carbon and dust filters 37 which remove odors and solid particles from the air stream after which it enters the blower 40. The blower moves the purified and dehumidified air to the supply ducts 41 which distribute the air through outlets 42 in the room A which is to be air conditioned.

When the thermostat 16 calls for more heat in the air conditioned room, the air switching valve 15 is actuated so that the hot compressed air will enter the insulated line 20, by-passing the air turbine, and be carried directly to the header 28 of the dehumidifier coils 30 where it is decompressed through the multiplicity of holes 32 in the coils 30 to atmospheric pressure. The room recirculated air passes as before over the fins 31 and mixes with the air escaping from the holes 32 and is heated. The combined air stream is then passed through the carbon and dust filters 37, and into the intake of the blower 40, which is now actuated by the auxiliary motor 45. A magnetic clutch 46 is provided, and this is automatically actuated to operative position relative to the blower 40 when the air turbine 26 is bypassed, this actuation of the magnetic clutch being controlled by the thermostat 16, through an electrical switch 48 actuated by the air switching valve as indicated in FIG. 2.

The general operation of my air conditioning system has been indicated in the above description, but further details are as follows:

When the room thermostat 16 calls for cooling, the air from the compressor which is cooled by passing either through a long uninsulated pipe line 21 or by means of the pipe coils 23 passes through the air turbine 26 and into and out of the dehumidifier coils 30 where it is mixed with the recirculated air, and is passed through the filters and into the supply ducts 41 to the room A by the blower 40. The temperature is reduced in the air turbine due to the expansion from a pressure in the range of 1½ to 3½ atmospheres to approximately 1 atmosphere. The air turbine is performing work by driving the blower which forces the mixed air into the supply ducts. Under these conditions the air leaving the holes 32 in the dehumidifier coils 30 will be at temperatures in the range from about 5 to 25° F. during the cooling cycle, and when mixed with the return air in the proportion of about 80–85 percent return air and 15 to 20 per-

cent fresh air by volume, a temperature in the conditioned room, as selected, for example, about 72° F., is attained.

When the thermostat **16** calls for more heat in the room, the compressed air from the compressor **11** bypasses the air turbine **26**, being delivered by insulated pipe line **20** to the header of the dehumidifier coils **30**, being then at a temperature of about 74° F. When expanded and mixed by release from the holes **32** with the return air, this gives an elevation in temperature to the supply air going into the room A, until the selected room temperature is attained, at which time the thermostat again reverses the cycle.

Where there is an excess of moisture in the expanded air, liquid water may be condensed out at the holes **32**, and is drained away along with the condensate collected on the fins and tubes of the dehumidifier from the recirculated air, from the collecting trough **29**, by the drain-off pipe **33**.

During seasonable weather, and during certain times of a day, the proportion of compressed air may be reduced from the 15 to 20 percent set forth in the above description, to about 5 to 10 percent, by admitting uncompressed outside fresh air into the return air system. For example, an air intake vent, preferably with a thermostat controlled damper, may be provided leading to the return air conduit **34**. This provides means for large operating economies in the system.

The advantages of my system will be clear from the above description. The little noise made by the operation of the axial flow compressor is confined to an isolated room. Only small round pipes instead of the usual large sheet metal ducts are used for conveying the make up or fresh air into the system. As shown, particularly in FIG. 1, compressed air, whether hot or cold, can be delivered to other isolated spaces (not shown) which are to be air conditioned, using only relatively small pipes **20A** and **21A** for this purpose. The supply ducts and the exhaust ducts which distribute and collect air in the space which is being air conditioned are of the usual sheet metal type, which may be concealed in the usual spaces provided in the building structure. In this way much space which would be otherwise taken up by large delivery ducts is saved. The system uses only compressed fresh air as the heat transfer medium, and except for the dehumidifier cooling coils employs conventional pieces of equipment for constituting the new combination. The system eliminates the use of burning fuel as a source of heat.

I claim:

1. An air conditioning system for a building having a plurality of room spaces to be individually air-conditioned comprising a central motor-actuated axial flow compressor for compressing fresh makeup air; delivery pipe means for conveying said compressed air to each of the room spaces to be conditioned; expanding means disposed in each selected room space for alternatively (I) expanding said compressed fresh air with extraction of heat as mechanical energy to produce a reduced temperature in said expanded fresh air and (II) expanding said compressed fresh air without extraction of heat as mechanical energy to produce an elevated temperature in said expanded fresh air; valve control means disposed in each room space operatively associated with each of said delivery pipe means and responsive to the temperature in the selected room space to be conditioned to selectively expand said compressed fresh air under conditions (I) and (II); mixing and dehumidifying means for blending said expanded air with air recirculated from said selected room space; and air circulating means including recirculating

fan means and inlet and outlet ducts for circulating air to and from said selected room space.

2. The air conditioning system defined in claim 1, in which the expanding means (I) for expanding said compressed fresh air with extraction of heat as mechanical energy to produce a reduced temperature in said expanded fresh air comprises an air turbine.

3. The air conditioning system defined in claim 1 in which the mixing and dehumidifying means consists essentially of a coil and fin heat exchanger disposed in a duct leading to the inlet to said circulating fan, the coils of said heat exchanger being provided with a plurality of small outlet holes to release said expanded air throughout the return air stream passing through said duct.

4. The air conditioning system defined in claim 2 in which the air circulating fan means is actuated by said air turbine.

5. The air conditioning system defined in claim 1 in which the axial flow compressor compresses the fresh makeup air to a range from about one and one-half atmospheres to three and one-half atmospheres..

6. The air conditioning system defined in claim 1 in which fresh air ducts within a selected room area connected to said outlet ducts for bringing in additional fresh air, are provided.

7. An air conditioning system for a room or building comprising an axial flow compressor for compressing fresh makeup air; motor means arranged for actuating said compressor; heat exchange means for ambient air-cooling of said compressed air disposed in the pipe-line from said compressor to an expanding means; air turbine means for expanding said cooled compressed air; an air circulating fan operatively connected to and actuated by said air turbine means for circulating air to and from said air conditioned room; a dehumidifier means having heat transfer coils and interconnected fins arranged to receive and distribute the expanded and cooled air received from the outlet of said air turbine means, said coils having a plurality of small openings for releasing decompressed cold air to the return air stream flowing over said coils; and air duct means for passing recirculated air from said room or building over said dehumidifier coil whereby to cool said recirculated air and mix it with said expanded cooled air escaping from said coils.

8. An air conditioning system for a room or building comprising an axial flow compressor for compressing fresh makeup air; motor means for actuating said compressor; a motor-actuated air circulating fan for circulating air to and from said air conditioned room; a dehumidifier means having heat transfer coils and interconnected fins arranged to receive and expand the hot compressed fresh air from said compressor, said coils having a plurality of small openings for releasing decompressed warm air to the return air stream flowing over said coils; and air duct means for passing recirculated air from said room or building over the coils of said dehumidifier means whereby to heat said recirculated air and mix it with said expanded warm air escaping from said coils.

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