July 7, 1936. G. N. BENKLY 2,046,314

ROOM COOLING UNIT

Filed Oct. 26, 1932 2 Sheets-Sheet 1

Fig. 1.

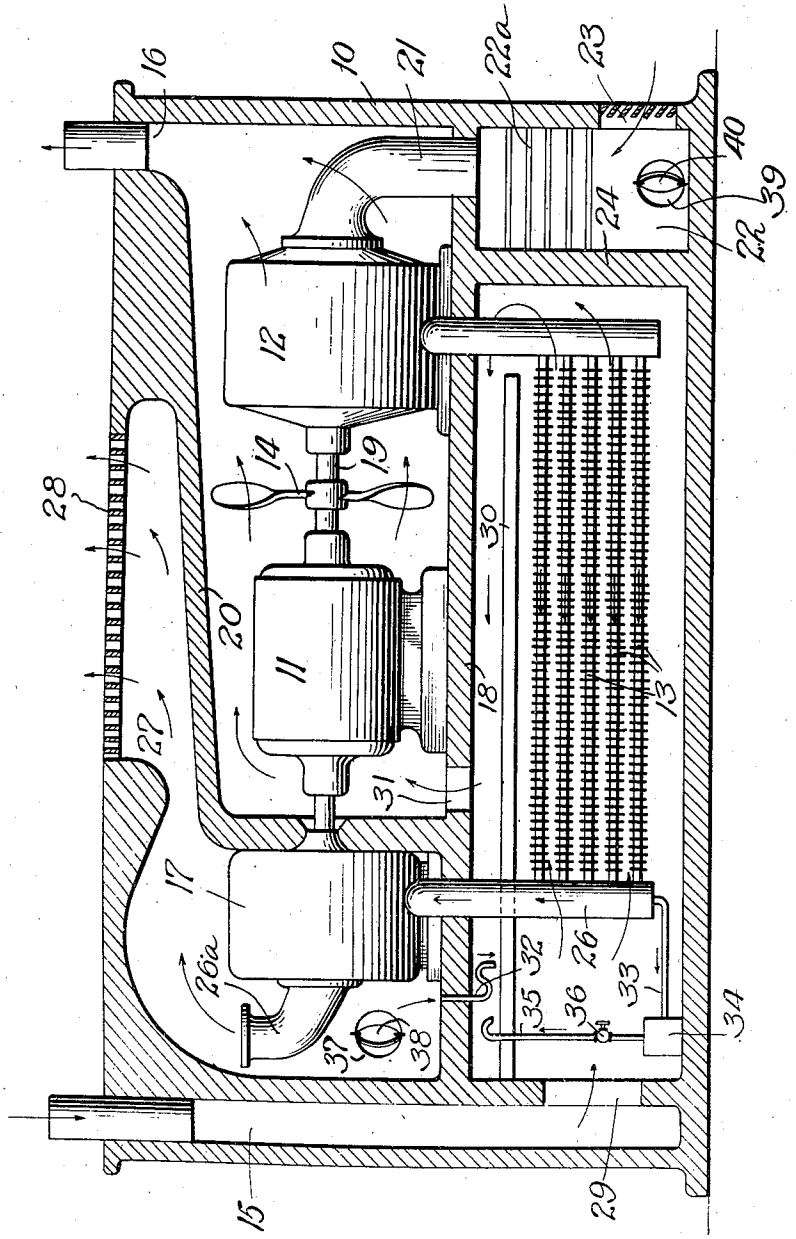

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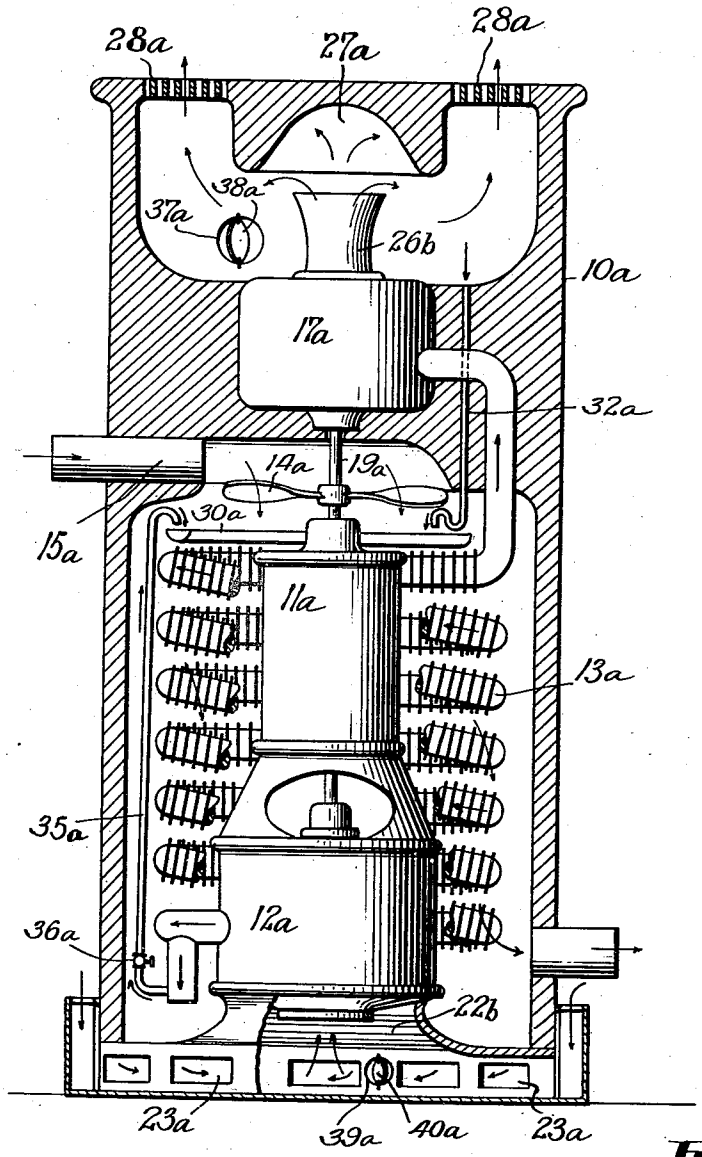
Fig. 2.



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2,046,314

ROOM COOLING UNIT

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Application October 26, 1932, Serial No. 639,653

6 Claims. (Cl. 62—136)

This invention relates to air coolers and more particularly to the cooling and ventilating of enclosed spaces occupied by human beings, for example, living rooms, offices, cars, and the like.

The invention is particularly adapted for application to a unit type of apparatus for cooling and dehumidifying enclosed spaces of the general type referred to. To insure maximum comfort in such places, particularly during the summer months, it is desirable to maintain room temperatures and humidity as near as practicable to certain predetermined values and to keep the air in circulation in order to absorb the heat and moisture including that given off by the occupants. In this connection it should be kept in mind that such predetermined values of temperature and humidity may to advantage be varied to correspond to some extent with changes in conditions.

An important object of this invention is to provide novel and advantageous air-cooling means of the general character specified. Another object of the invention is to provide a novel and advantageous as well as simple and efficient unit of the general character described. It is also an object of the invention to provide a simple and efficient cooling and dehumidifying unit of portable character and including all elements necessary to its operation to enable it to be readily installed in any place in which it is to be used. It is a further object of the invention to provide a cooling and dehumidifying unit adapted to use as a refrigerating medium only the air from the enclosure in which it is installed. Another object of the invention is to provide a cooling and dehumidifying unit in which the heat of compression and the heat generated by the prime mover are removed or counteracted by the introduction and removal of air exterior to the enclosure in which the unit is located.

It is still another object of the invention to increase the efficiency of the compressed air intercooling surface by utilizing on this surface moisture which is being continuously removed from the air in the room. In this connection it should be understood that the greater part of the moisture condensed from the room air is condensed in the intercooling part of the apparatus and that the amount of moisture condensed from the room at the expansion end of the unit is comparatively small. According to a further feature, by using this moisture in the manner described, said moisture is disposed of by evaporation and the necessity for providing drain lines is eliminated.

With the above and other objects in view, the nature of which will more fully appear as the description proceeds the invention consists in the novel features including those of construction, combination and arrangement of parts as herein more fully described and illustrated.

In the accompanying drawings,

Fig. 1 is a vertical sectional view of a horizontal type of apparatus embodying the invention; and

Fig. 2 is a vertical section taken through the axis of a vertical embodiment of the invention.

Referring to Fig. 1 there is disclosed a horizontal form of the apparatus which preferably includes a heat-insulated cabinet 10 divided into two main compartments insulated from each other and, as shown, somewhat irregular in shape. One of these compartments contains the compression side of the refrigerating system which may include an actuating device such as an electric motor 11, a compressor 12 preferably of the rotary type, a cooler 13 for the compressed air, and a fan 14 whereby air from space exterior to the room is caused to enter the compartment through an inlet 15 and, after cooling or taking heat from the compressed air cooler or intercooler 13, the compressor 12, and the electric motor 11, to pass through an outlet 16 to a point exterior to the room. The other compartment contains a rotary air motor 17, preferably a turbine, which acts as an air cooler in that the air in expanding and doing work tends to take up heat and is itself cooled.

As illustrated in Fig. 1 the electric motor 11, compressor 12 and air cooler or motor 17 are mounted in alignment on a horizontal partition or floor 18 and preferably are connected by a shaft or line of shafting 19. The electric motor and compressor may be separated from the air motor 17 by a suitable insulated partition 20. Preferably the electric motor 11 is arranged near the air cooler 17 and the compressor 12 is located near the end wall of the cabinet where it is connected by means of a downwardly curved duct 21 with an inlet chamber 22 containing a filter 22a and communicating with the interior of the room through an inlet opening 23. The fan 14 is preferably located on shaft 19 between the electric motor and the compressor.

Beneath the floor 18 and separated from the chamber 22 by a partition 24 is a compartment containing the compressed air cooler or intercooler 13 which may include a plurality of lon-

gitudinal tubes provided with suitable heat transfer fins and connected at one end with a tubular member **25** receiving compressed air from the compressor **12** and at the other end with a hollow connector **26** communicating with the combined air motor and cooler **17**.

In operation the air is drawn in through the inlet **23** to the compressor **12** and forced therefrom into the compressed air cooler or intercooler **13** from which it passes to the air cooler or motor **17** where it expands and does work, at the same time cooling the air which passes from the air motor through an air diffusing funnel **26***a*, to a suitably shaped passage or chamber **27** over the top of the compartment containing the electric motor and out of the cabinet through a suitable grating or the like **28**. The fan **14** draws the air downwardly through the inlet duct **15** and through an opening **29** below the floor **18** to the intercooler, being compelled to pass the full length thereof by means of a suitable baffle member **30**, which may also serve as a drip pan. The air then passes over the top of the baffle and up through an opening **31** in the floor **18** and then over the electric motor **11** and compressor **12** to the outlet **16** from which it passes to a point outside of the room.

In the chamber containing the air cooler or motor **17** there will be considerable condensation. In order to remove the moisture, thus deposited, provision is made of condensation tubing **32** leading the moisture to the top of the baffle **30** and provided with a trap to prevent air leakage between the compartments. Provision is also made of condensation tubing **33** connecting the intercooler **13** with a condensation receiver **34** from which the moisture may be forced upwardly through a tube **35** to the baffle **30** under control of a valve **36** in said tube and automatic device such as float control valve.

The air from the air cooler and motor **17** may be so cold that it would be undesirable to discharge such a cold current directly into the room. This condition may be avoided by admitting air from the room to the air cooler compartment through an inlet **37** controlled by a damper **38**. The current of air from the air-diffusing funnel **26***a* would induce a current through the inlet **37**. In order to supply fresh outside air to the room, there is provided an inlet **39** connected to space exterior to the room and controlled by a damper **40**.

The complete operation would be substantially as follows: Air is withdrawn from the room to be cooled through inlet **23**, chamber **22** and filter **22***a* by the compressor **12** where the air is compressed to a suitable pressure, to intercooler **13** over which air from space exterior to the room is drawn through inlet **15** circulated by fan **14** and caused to pass over the electric motor **11** and compressor **12** and then to a space outside of the room through the outlet **16** and any suitable connection. The temperature of the air is reduced in the intercooler **13** without any substantial change in pressure.

From the intercooler **13**, the compressed air passes to turbine-air-cooler **17** where, as it expands and does useful work such as aiding the motor **11**, its temperature drops until, as it is discharged or exhausted through cold air diffusing funnel **26***a* and cold air diffusing chamber or passage **27**, its temperature is considerably below that of the room to be cooled. Moisture deposited in the chamber **27** passes downwardly through drip pipe **32**, provided with a suitable trap, to the drip or condensation pan **30**. Condensation from the intercooler **13** is supplied to the condensation pan through the pipe **33**, receiver **34** and pipe **35**. The condensed moisture from the interior of the intercooler **13** is very considerable in amount in comparison with that deposited in the chamber **27**.

The moisture from the condensation pan drips over the intercooler **13** and the heat from the latter evaporates the moisture which is carried to space exterior to the room. Thus wet bulb instead of dry bulb temperatures are obtained in the intercooling surface and the moisture of the room is dissipated without the necessity of resorting to drain lines.

It will be evident that the air motor and cooler **17** may be and is utilized to take from the electric motor **11** a large part of this load. In fact at least 60 to 85% of the power input into the air motor or cooler must be recuperated in practice, for otherwise the cost of running such a unit becomes prohibitive. If desired an overrunning clutch may be provided, preferably at the connection between the shaft **19** and the rotor of the air motor **17**, so that in starting the apparatus the electric motor **11** will be relieved of the load of turning said rotor and later the rotor may act on the shaft in the same direction as the electric motor and therefore assist the same.

In Fig. 2 there is illustrated a vertical form of the cooling unit. A motor **11***a* is located above a compressor **12***a* which draws in air through an exterior casing at the foot of a main cabinet **10***a*, inlets **23***a* in the base of the cabinet, and a filter **22***b*. From the compressor **12***a*, the heated as well as compressed air passes into a compressed air cooler or intercooler **13***a* here shown as a helically coiled tube surrounding the compressor and motor and finally passing through a portion of a partition **20***a* into an air cooler or motor **17***a* in which the cooled compressed air is expanded and does work.

From the air motor **17***a*, the cooled air is discharged through a cold air diffusing funnel into a chamber or passage **27***a* provided in its upper wall with a concave recess above a funnel **26***b* so that the cooled air will be directed downwardly and outwardly before passing upwardly and out of the cabinet through one or more gratings **28***a* or the like. In this form, a fan **14***a* is mounted on the shaft **19***a* above the electric motor as well as the compressor and forces air introduced through a side inlet **15***a* downwardly through the cabinet to cool the electric motor, the compressor, and the compressed air cooler before discharge through an outlet **16***a*.

In this form also there is a condensation tube **32***a* to drain moisture to a drip pan **30***a* above the compressed air cooler, and a receiver **34***a* from which moisture collected from the compressed air cooler **13***a* is discharged through a pipe **35***a* with a valve **36***a* into the drip pan **30***a*. In this form also, it is desirable to have an inlet **37***a* to admit air from the room to the chamber **27***a*, and to provide a damper **38***a* to control the passage of air through the inlet.

If desired fresh air may be added to the room air through suitable connections including an inlet **39***a* at the base of the cabinet and a damper **40***a* for controlling the amount of air passing through this inlet.

It should be understood that various changes may be made in the construction and arrangement of parts and that certain features may be used without others without departing from the true spirit and scope of the invention.

Having thus described my invention, I claim:

1. A self contained room cooling unit for location directly within the space to be cooled, comprising a prime mover, air compressing and cooling means including a compressor driven by the prime mover and taking its supply of air from the room to be cooled, a compressed air motor driven by air from the air compressing and cooling means and exhausting into the room the air cooled by its expansion in driving the compressed air motor, and means for collecting moisture of condensation from the air passing through said compressed air motor and vaporizing it in connection with cooling the compressed air.

2. A self contained room cooling unit for location directly within the space to be cooled, comprising a prime mover, a compressor driven by the prime mover and taking its supply of air from the room to be cooled, a cooler for the compressed air, a compressed air motor driven by air from the compressor and the cooler and exhausting into the room the air cooled by its expansion in driving the compressed air motor, and means for collecting the moisture condensed at said compressed air motor and causing it to be vaporized in connection with the cooling of the compressed air.

3. A self contained room cooling unit for location directly within the space to be cooled, comprising a prime mover, a compressor driven by the prime mover and taking its supply of air from the room to be cooled, a compressed air cooler, a compressed air motor driven by air from the compressed air cooler and exhausting into the room the air cooled by its expansion in driving the compressed air motor, means for passing cooling air drawn from outside of the room over the compressed air cooler, the motor and compressor and discharged outside of the room, and means for vaporizing on the cooler moisture condensed from the air passed through the compressor.

4. In a self contained room cooling unit for location within a space to be cooled, means for compressing a refrigerant and then releasing it into a region of lower pressure to cool room air passed through the unit and to condense moisture therefrom before return to the room, means for removing the heat of compression by the use of cooling air drawn from the outside air and returned thereto, and means for utilizing moisture condensed from the room air to assist the cooling air in removing the heat of compression.

5. In a self contained room cooling unit for location in the space to be cooled, means for drawing room air through the cooling unit and restoring it to the room, means for compressing a refrigerant and then releasing it into a region of lower pressure to cool room air passing through the unit and to condense moisture therefrom, means for removing the heat of compression by the use of cooling air drawn from outside of the room and then returned, and means for dissipating moisture condensed from the room air by utilizing the heat of compression.

6. A self contained room cooling unit for location directly within the space to be cooled, including a prime mover; an air compressor driven by said prime mover and drawing air from the room to be cooled; a compressed air cooler receiving air from the compressor; a compressed air motor driven by the compressed air from the compressed air cooler and exhausting, into the room, air cooled by expansion in driving the compressed air motor and dehumidified in the compressed air cooler and by its expansion in the motor; a casing of insulating material divided by an insulating partition into two main compartments—one containing the prime mover, the compressor and the compressed air cooler and the other the compressed air motor—, said casing having a duct to supply air directly from the room to the compressor, a duct to deliver air from the compressed air motor to the room, a duct to deliver outside air for cooling to the first mentioned compartment near the compressed air cooler and a duct to discharge outside of the room air from this compartment after passing over the prime mover and compressor; means driven by said prime mover for causing a flow of cooling air through the first mentioned compartment; and means causing the moisture condensed in the conditioning action to drip on the compressed air cooler and be evaporated by the heat therefrom and then to be carried to the outside air by the flow of cooling air.

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