

Oct. 3, 1939.

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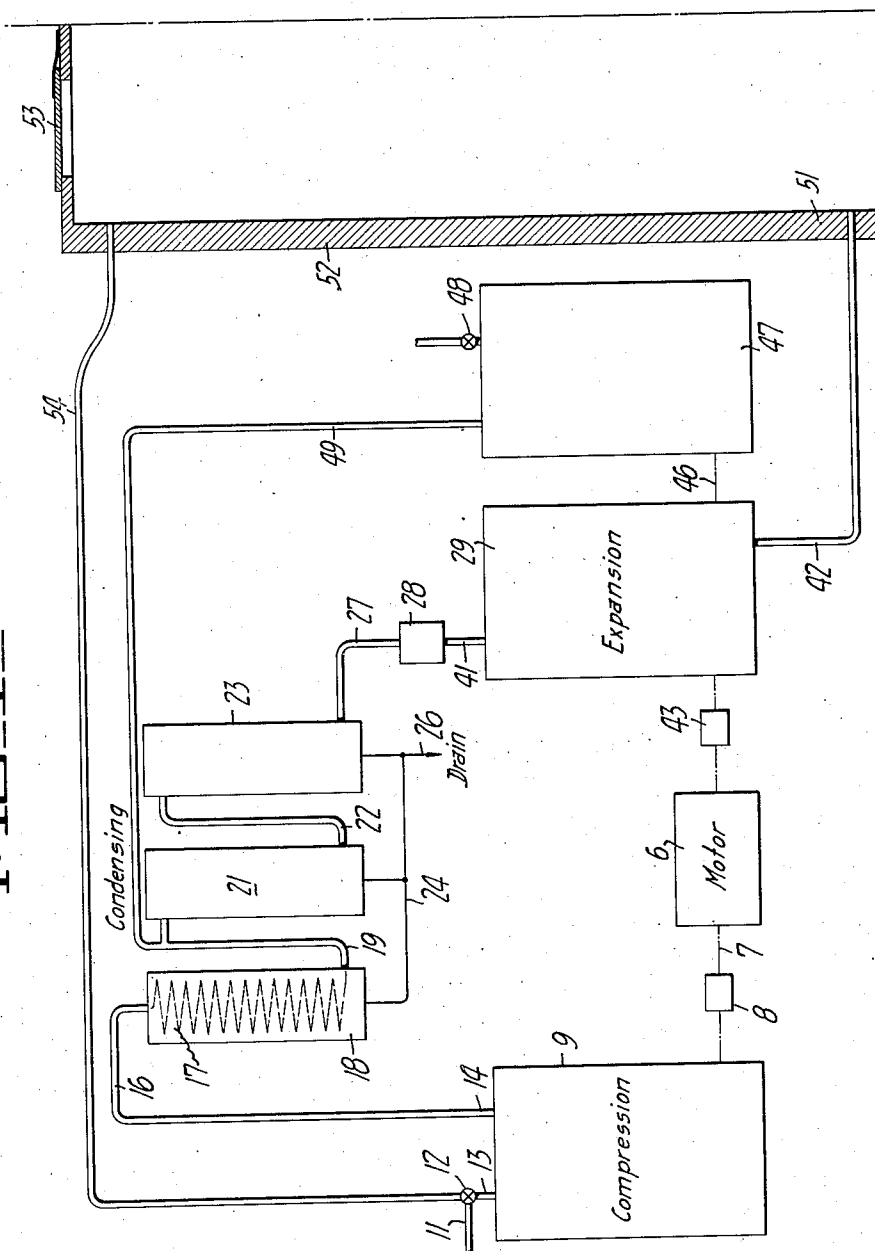
2,174,584

REFRIGERATION APPARATUS

Filed March 10, 1937

2 Sheets-Sheet 1

FIG. 1



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2 Sheets-Sheet 2

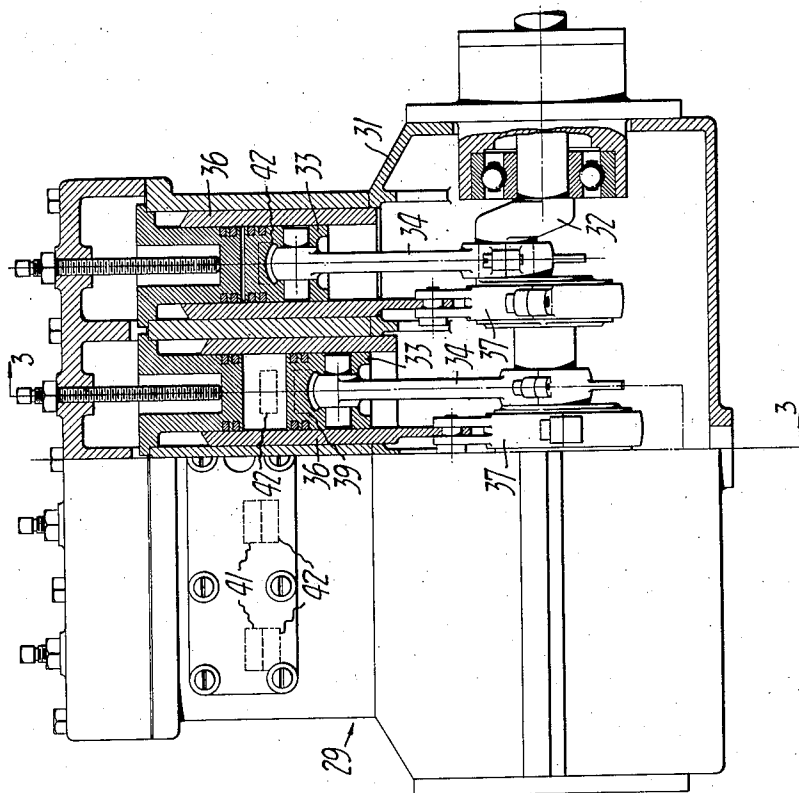


FIG. 2—

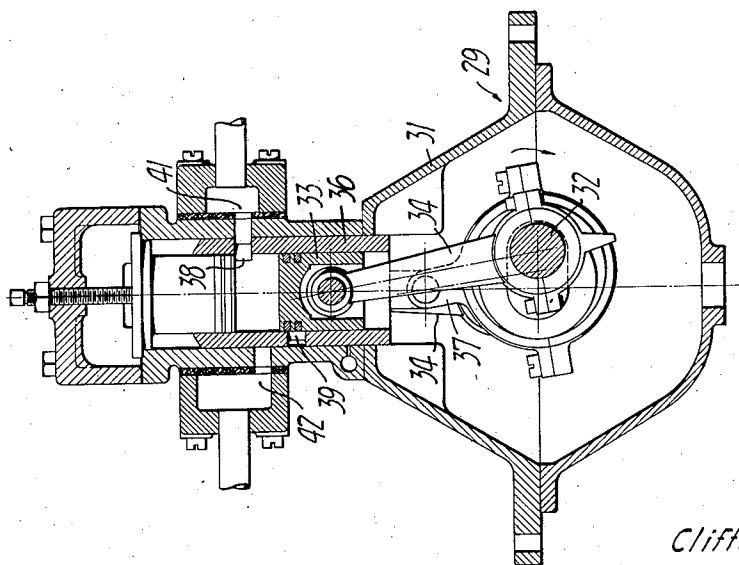


FIG. 3—

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REFRIGERATION APPARATUS

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Application March 10, 1937, Serial No. 129,975

5 Claims. (Cl. 62—136)

My invention relates to a means for space cooling, and is concerned particularly with a means for reducing the temperature of enclosures of various types by reducing the temperature of the air therein.

An object of my invention is to provide means for reducing the temperature of air.

A further object of my invention is to provide mechanism which is composed of generally standard units, for efficiently extracting heat from a body of fluid such as air.

An additional object of my invention is to provide means for controlling the reduction of heat content of air.

The foregoing and other objects are attained in the embodiment of the invention disclosed in the drawings, in which—

Fig. 1 is a schematic diagram of a refrigeration means which is utilized to carry out my invention;

Fig. 2 is on the left half a side elevation of the expansion unit included in the assembly of Fig. 1, and on the right half a cross-section on a median plane of the expansion unit; and

Fig. 3 is a cross-section the plane of which is indicated by the lines 3—3 of Fig. 2.

In its preferred form, the refrigeration apparatus of my invention incorporates the compression of air to a superatmospheric pressure and cooling the air, while compressed, to substantially the temperature of the atmosphere, and then expanding the compressed and cooled air substantially to atmospheric pressure while it does external work in order that further heat may be extracted from the expanding air and the temperature thereof will be reduced considerably below that of the general atmosphere.

Although the apparatus of my invention is adaptable to numerous different environments and can be varied within wide limits to obtain the results desired, I preferably include the apparatus in an assembly such as shown in Fig. 1, which is effective to carry out my invention.

In this arrangement, a motor 6, which is any suitable source of power, such as an electric motor or an internal or external combustion engine, through a suitable shaft 7 and a coupling 8 rotates an air compressor 9 preferably of the displacement or piston type, although a centrifugal or rotary blower can alternatively be used. I prefer the displacement type, however, since the pressure gain is higher. The compressor 9 preferably derives its working fluid from the atmosphere through an intake 11 controlled by a three-way cock 12 leading to the inlet 13 of the

compressor. The compressed fluid is discharged through the outlet 14 of the compressor, having had its pressure increased considerably and, correspondingly, having a temperature considerably higher than that of the atmosphere.

From the outlet 14 the compressed and heated fluid travels through a conduit 16 to cooling coils 17 of any customary character, preferably arranged so that the fluid flows therethrough in series from the bottom of the first unit 18 through a duct 19 to the top of the second unit 21, and from the bottom of the second unit 21 through a duct 22 to the top of the third unit 23, and so on. The air which is passed through the compressor and is travelling in the duct 16 has a temperature elevated sufficiently so that there is a certain sterilizing action upon the air, and hence the condensers 18, 21 and 23 are preferably maintained air-tight or closed so that the fluid therein does not come into contact with any contamination. In the condenser 18 the contained air is reduced materially in temperature, although the pressure drop is inconsequential; but, due to the reduction in temperature in passing through the condensers, the air is separated from a large part of its contained water vapor, which is discharged through a manifold 24 leading to a suitable drain 26, the run-off from which is sufficient to maintain the condenser 18 substantially free from released water.

From the condensing unit 23, the air, which still is at superatmospheric pressure, is substantially at atmospheric temperature and is discharged through an outlet pipe 27 and a suitable regulator 28, into an expansion unit 29. This expansion unit is preferably of the type illustrated in Figs. 2 and 3 and contains a general casing and framework 31 within which a crank shaft 32 is suitably journaled. Pistons 33 are connected to the crank shaft by connecting rods 34 and operate in cylinders formed by sleeve valves 36 suitably operated in synchronism with the operation of the engine by eccentric rods 37 attached thereto. An inlet port 38 and an outlet port 39 in each sleeve register with suitable inlet conduits 41 and exhaust ducts 42, to afford a suitable control of pressure fluid.

In the operation of the expansion unit, the incoming fluid from the duct 41 is admitted to exert its pressure upon the piston 33, and drives the piston downwardly to rotate the crank shaft 32, thereby doing useful work and reducing the temperature of the fluid passing through the expansion unit in accompaniment to the reduction in pressure thereof. Preferably, the cut-off and

expansion characteristics of the unit 29 are such that the fluid from the inlet pipe 41 is reduced to substantially atmospheric pressure when it passes into the exhaust duct 42, but its temperature, due to the fact that it gives up a great deal of heat in doing useful work in rotating the crank shaft 32, is considerably below that of the atmosphere. In actual operation, the temperature usually extends down to 15 to 20 degrees below zero Fahrenheit at the exhaust duct 42.

The work done by the rotating crank shaft 32 can be usefully utilized, for example, through an overrunning clutch connection 43 to the motor 6 so that the compressor 9 is partially driven by the work of the expanding air going through the expansion mechanism 29. Alternatively, the expansion unit 29 by a shaft 46 may drive a secondary compressor 47 deriving atmospheric air through an inlet 48 and delivering the compressed and heated atmospheric air through an outlet 49 into an intermediate one of the condenser units, for example the condenser unit 21.

The fluid, which is substantially at atmospheric pressure and is considerably below atmospheric temperature, discharged through the duct 42, is preferably introduced into the lower portion 51 of a compartment 52 within which refrigeration is to be effected. The relatively cold air being pumped in through the inlet 42 gradually displaces the warmer air above it which finally is released to the atmosphere through a spring-loaded trap 53 in accordance with the adjustment thereof, or is discharged for closed-cycle operation through a return duct 54 leading from the top of the compartment 52 to the three-way valve 12 adjacent the inlet 13 of the compressor, so that the same body of air can be recycled substantially continuously, or there can be a mixture of fresh atmospheric air and recycled air going into the compressor 9.

It will be appreciated that the atmospheric air is heated and sterilized in the compressor 9, and is cooled without great pressure loss within the condensers wherein the liquid content is discharged through the drain 26 so that the air is substantially entirely dehumidified; that the high pressure but low temperature air from the condenser is expanded in the expansion unit 29 so that its pressure is reduced to substantially that of the atmosphere and its temperature is further reduced since heat is extracted to do useful work in assisting in driving the motor 6 or in driving a comparable compressor 47; and that, finally, the refrigerated air positively displaces air within a compartment to be cooled and is then

either released to the atmosphere or wholly or partly recycled in the system.

I claim:

1. A refrigeration apparatus comprising means for compressing atmospheric air, means for cooling said compressed air, an expansion device driven by said cooled compressed air, and an overrunning clutch driving connection between said expansion device and said compressing means.

2. A refrigeration apparatus comprising means for compressing atmospheric air, means for cooling said compressed air, means for expanding said cooled compressed air substantially to atmospheric pressure and extracting work therefrom, and means including a clutch effective only when said expanding means tends to run faster than said compressing means for coupling said expanding means and said compressing means.

3. A refrigeration apparatus comprising means for compressing atmospheric air, means for cooling said compressed air, controllable means for expanding said cooled compressed air substantially to atmospheric pressure and extracting work therefrom, means including a clutch effective only when said expanding means tends to run faster than said compressing means for coupling said expanding means and said compressing means, and means for recycling said expanded air.

4. A refrigeration apparatus comprising means for compressing air, means for driving said compressing means, means for cooling said compressed air, an expansion device driven by said cooled compressed air, and means including a clutch effective only when said expansion device tends to run faster than said compressing means for coupling said expansion device to said compressing means to assist in driving said compressing means.

5. A refrigeration apparatus comprising a compartment, means for compressing air, means for cooling said compressed air, an expansion device driven by said cooled compressed air, means for regulating the flow of said air to said expansion device, means including a clutch effective only when said expansion device tends to run faster than said compressing means for coupling said expansion device to said compressing means, means for conducting air discharged by said expansion device to said compartment, and means for conducting air from said compartment to said compressing means.

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