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FREEZER AND COOLED CHAMBER CONSTRUCTION OF A COLD-GAS REFRIGERATOR

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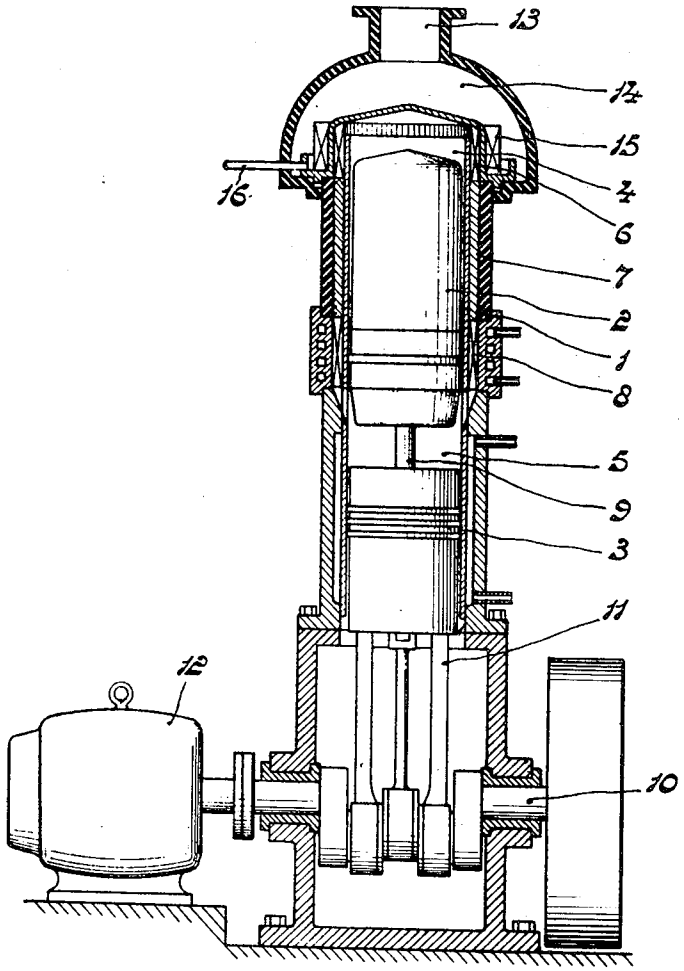

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FREEZER AND COOLED CHAMBER CONSTRUCTION OF A COLD-GAS REFRIGERATOR

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3 Claims. (Cl. 62—136)

The invention relates to a cold-gas refrigerator comprising a space of lower temperature and a space of higher temperature, these spaces being in open communication with one another through a freezer, which has a temperature of —40° C. or less during normal operation of the refrigerator, through a regenerator and through a cooler. The volume of each of these spaces may be varied by one or more piston-shaped bodies; in the machine a gas being invariably in the same state of aggregation performs a closed, thermodynamic cycle. A cold-gas refrigerator is often termed a cooling machine operating on the reversed hot-gas reciprocating engine principle.

These machines may be constructed in various ways, for example as a displacer-piston machine, as a double acting machine, as a machine, the cylinders of which are at an angle to one another or as a machine, the working space of which is combined with that of a hot-gas reciprocating engine. By means of this type of refrigerator it is possible to bridge in one step a large temperature difference, for example of 100° C. It is even possible, in certain cases, to bridge a still larger temperature difference, for example of 230° C.

According to the invention it has been found that the cooling power of the machine varies to a great extent with the relationship between the magnitude designating the ratio between the stroke volume of the space of higher temperature and that of the space of lower temperature and a magnitude denoting the ratio between the absolute temperatures of the cooler and of the freezer. If the limits referred to below for the relationship between these two magnitudes are exceeded the cooling power of the refrigerator will decrease materially as has been found from experiments, the conditions being otherwise the same.

Further, according to the invention, the refrigerator is proportioned in a manner such that to the quotient v of the stroke volume of the space of higher temperature and that of the space of lower temperature applies that v is at least $1+0.025\ \tau$ and at the most most τ, preferably at least $1+0.10\ \tau$ and at the most $0.8\ \tau$, wherein τ designates the quotient of the absolute temperature of the cooler and that of the freezer.

The aforesaid values apply to the normal operation of the refrigerator concerned. In one embodiment of the invention the refrigerator is constructed as a displacer-piston machine. The construction of this type of refrigerator is particularly suitable to choose the desired stroke volume of the various spaces. With this kind of machine it is, for example, not necessary for the two piston-shaped bodies moving up and down in the machine to have the same stroke.

The invention will be described more fully with reference to one embodiment.

The accompanying figure shows a cold-gas refrigerator constructed as a displacer-piston machine. This machine comprises a cylinder **1** in which a displacer piston **2** and a piston **3** move up and down with substantially

constant phase difference. Thus the volume of the space **4** of lower temperature, also termed the freezing space, is varied. Also the volume of the space **5** between the displacer piston **2** and the piston **2** and the piston **3**, this space having the higher temperature and being also referred to as the cooled space, is varied.

The two spaces are in open communication with one another through a freezer **6**, a regenerator **7** and a cooler **8**. In the machine a gas, for example hydrogen, is mainly expanded in the space **4** and mainly compressed in the space **5**.

The displacer piston 2 is coupled through a connecting-rod system **9** with a crank of a crank shaft **10**, whereas the piston **3** is connected through a connecting-rod system **11** with cranks of the same crank shaft. The refrigerator is driven by an electric motor **12**.

Owing to the thermodynamic cycle performed in the machine the freezer assumes a low temperature, so that by means of this freezer a medium located outside the machine may be cooled. This medium, for example air, may be supplied through an opening **13** to a condenser space **14**, in which it condenses at vanes **15** of the freezer **6**, the condensate being conducted away through a duct **16**.

The temperature of the cooler **8** may for example be 300° K. and the temperature of the freezer **6** may be for example 75° K. The quotient of the temperature of the cooler and of the temperature of the freezer is therefore

$$\tau=\frac{300}{75}=4$$

In this case the magnitude v is at least $1+0.025\times4$ is 1.1 and at the most, is 4. Preferably the magnitude v is at least $1+0.1\times4$ is 1.4 and at the most 0.8×4 is 3.2.

If the volume of the space of lower temperature is 100 ccms., it may be calculated within which limits the stroke volume of the space of higher temperature must lie.

The magnitude v is the stroke volume of the space of higher temperature divided by the stroke volume of the space of lower temperature. In this case the volume of the space of higher temperature is at least 1.1×100 is 110 ccms. and at the most 4×100 is 400 ccms., preferably, however, at least 1.4×100 is 140 ccms. and at the most 3.2×100 is 320 ccms.

By proportioning the machine in a manner such that the volume of the space of higher temperature lies within the said limits, it may be assured that the cooling power of the machine is not affected to an undesirable extent due to improper proportioning.

While I have shown and described the preferred embodiment of my invention, it will be understood that the latter may be embodied otherwise than as herein specifically illustrated or described and that in the illustrated embodiment certain changes in the details of construction and in the arrangement of parts may be made without departing from the underlying idea or principle of the invention within the scope of the appended claims.

What is claimed is:

1. A refrigerator of the type described provided with a first space having a temperature lower than —40° C. and a second space having a higher temperature than said first space, further comprising a cooler, a regenerator, a freezer, said first and second spaces being in open communication with each other through said cooler, regenerator and freezer, a cylinder means enclosing said first and second spaces, a gas of invariable chemical composition performing a closed thermodynamic cycle in said refrigerator, two pistons for reciprocation in said cylinder means to thereby vary the volume of said gas in said spaces, said refrigerator being proportioned in such a manner that the quotient v of the stroke volume of the space of higher temperature and that of the space of

lower temperature is equal to at least $1+0.025\ \tau$ and at most τ, wherein τ denotes the quotient of the absolute temperatures of the cooler and the freezer.

2. A refrigerator of the type described provided with a first space having a temperature lower than −40° C. and a second space having a higher temperature than said first space, further comprising a cooler, a regenerator, a freezer, said first and second spaces being in open communication with each other through at least said cooler, regenerator and freezer, a cylinder means enclosing said first and second spaces, a gas of invariable chemical composition performing a closed thermodynamic cycle in said refrigerator, at least one piston for reciprocation in said cylinder, means to thereby vary the volume of said gas in said spaces, said refrigerator being proportioned in such a manner that the quotient ν of the stroke volume of the space of higher temperature and that of the space of lower temperature is equal to at least $1+0.025\ \tau$ and at most τ, wherein τ denotes the quotient of the absolute temperatures of the cooler and the freezer.

3. A refrigerator of the type described comprising

cylinder means, piston means adapted to reciprocate in said cylinder means and forming therewith a first space and a second space, said spaces being adapted to receive a gas of invariable chemical composition, a cooler, a generator, and a freezer connecting said first space to said second space, said gas having during operation a temperature below −40° C. when in said first space and a higher temperature when in said second space, the quotient ν of the stroke volume of said first space and the stroke volume of said second space being above $1+0.025\ \tau$ and below τ, wherein τ indicates the quotient of the absolute temperature of the cooler and the absolute temperature of the freezer.

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