

Oct. 9, 1945.

C. G. PUCHY

2,386,505

REFRIGERATION

Filed July 9, 1942

2 Sheets-Sheet 1

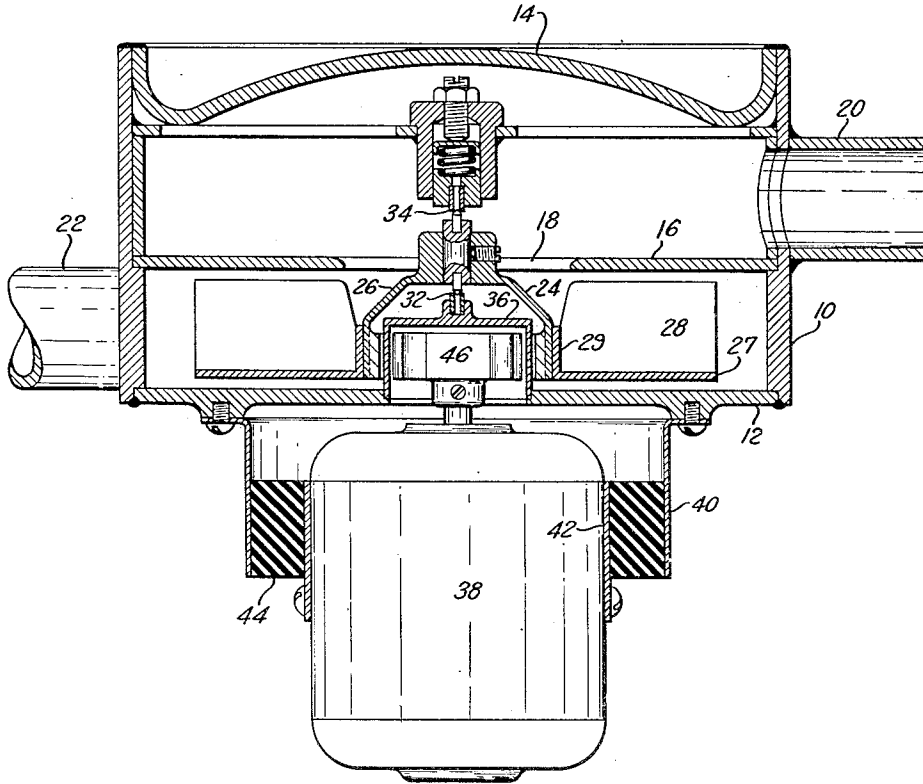


Fig. 1

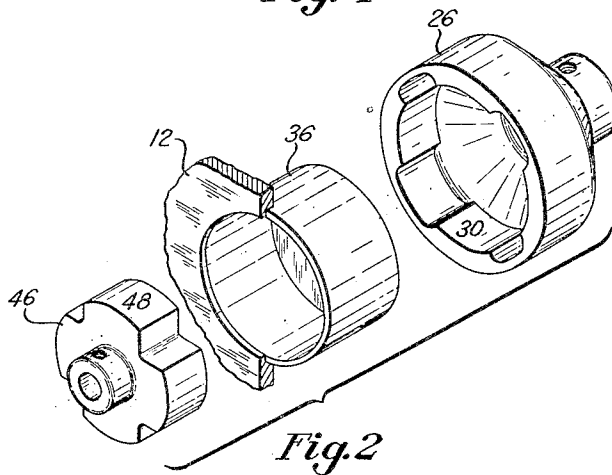


Fig. 2

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2 Sheets-Sheet 2

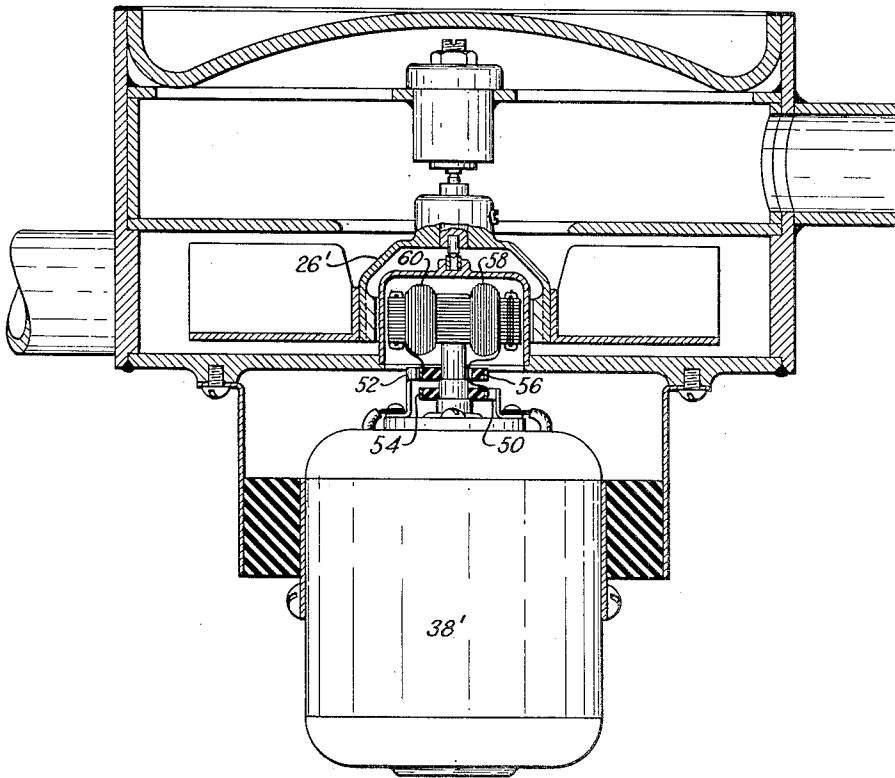


Fig. 3

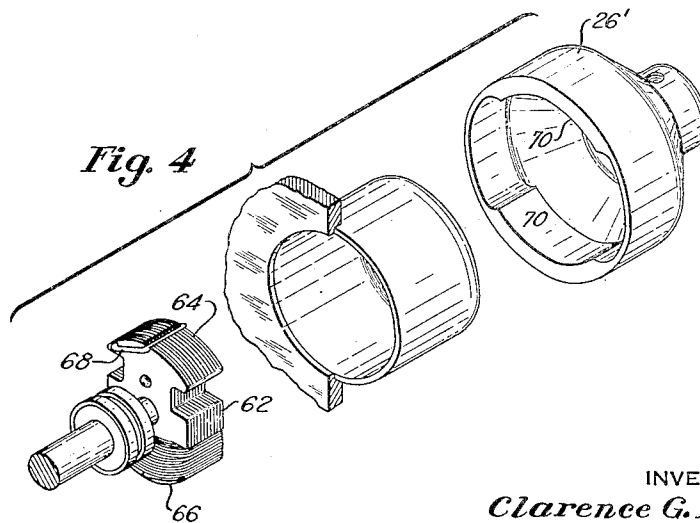


Fig. 4

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REFRIGERATION

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This invention relates to refrigeration and more particularly to a circulator unit for circulating the mediums in a three-fluid absorption refrigerating machine utilizing ammonia as the refrigerant, water as the absorbent and an inert pressure equalizing medium such as nitrogen or hydrogen.

Such machines are well known in the art and have a closed circuit between the evaporator and the absorber for the circulation of an inert gas therebetween.

The inert gas is for the purpose of equalizing the pressures throughout the entire machine, all of the parts of which are in open communication, and for carrying refrigerant vapor from the evaporator to the absorber. In the evaporator the refrigerant liquid is vaporized by diffusion into the inert gas and in the absorber the refrigerant vapor is absorbed out of the inert gas. A closed circuit is also provided between the generator and absorber for the circulation of the absorption solution usually consisting of a water solution of ammonia. In the generator, refrigerant vapor is driven from the solution by the application of heat and in the absorber the weak solution takes up refrigerant vapor from the inert gas. Some means must therefore be provided for circulating the inert gas between the evaporator and the absorber and the solution between the generator and the absorber.

In prior art machines it has been usual practice to circulate the inert gas thermosiphonically or by differences in specific weights of different columns of the inert gas and to circulate the solution by heat operated vapor liquid lift pumps. Such machines operate satisfactorily under ordinary circumstances but in hot climates and at high room temperatures they are unsatisfactory because they operate inefficiently and have very low capacity. The problem can be solved if some means is provided for circulating the mediums which is not affected by changes in temperature. This is especially true in air-cooled machines to which this invention relates.

It has been proposed to use mechanical pumps for the purpose of circulating the mediums in such refrigerating systems but the application of mechanical pumps to those systems is not a simple matter. The internal pressures of air-cooled machines of this type vary from 250 to 400 pounds per square inch under normal operating conditions and under certain abnormal conditions they go to a much higher value. Before being put into use, the systems are hydraulically tested up to 800 pounds per square inch.

Thus it is practically impossible to use me-

chanical pumps having moving parts extending through the walls of said system.

In order to solve this problem a way has to be found of hermetically sealing the moving parts of the mechanical circulator unit on the interior of the apparatus and the present invention has to do with the solution of that problem.

Since all of the parts of three-fluid absorption refrigerating machines are in open communication with each other, the internal pressure is substantially the same through all parts except for liquid columns and the resistances of the circuits. As a result of this, a circulator unit which will develop a pressure difference of approximately four inches of water is sufficient for circulating all of the mediums in their circuits. Thus the power unit should be made very small and the problem of sealing the moving parts on the interior of the apparatus is not simple. Where a motor is used, the field coils and rotor should not be placed on the interior of the apparatus because they would be attacked by the corrosive atmosphere in the interior of the apparatus.

According to this invention, the entire motor unit is positioned exteriorly of the walls of the refrigerating apparatus. The fan for circulating the mediums is hermetically sealed within the walls of the inert gas circuit and motion is transmitted through the walls of the apparatus by a magnetic transmission.

The magnetic transmission, according to this invention, comprises a combined magnetic follower and fan in which the fan hub is made of magnetic stainless steel with the fan blades secured thereto. The follower may have one or two poles. If desired, the follower may be a permanent magnet. The combined fan and magnetic follower is mounted for rotation on the interior of the inert gas circuit on dry type bearings having slight frictional losses. A driver magnet is positioned on the exterior of the walls of the inert gas circuit and is driven by an electric motor. The driver magnet and the magnetic follower are separated by a thin annulus of non-magnetic material, such as stainless steel, so as to reduce the air gap between the follower and driver.

The motor is so mounted that the gap between the driver magnet and the non-magnetic annulus may be made very small. The motor is mounted in a vertical position on an annular ring of rubber bonded to two metal rings so that the weight of the motor and driver places the rubber under a direct shear stress, while any forces tending to misalign the driver with the non-magnetic annu-

lus will subject the rubber to a direct compression stress. It is well known that rubber stressed in shear is about six times as soft as the same rubber subjected to a compression stress. Thus the mounting provides a very soft and resilient mounting for the motor and driver while providing a comparatively rigid support laterally for holding the motor and driver against misalignment with the non-magnetic annulus.

The driver magnet according to this invention may be a permanent magnet having two or four poles purchasable on the open market under the trade-name of "Alnico" (an alloy of aluminum, nickel, iron and cobalt), or any other type of permanent magnet or it may be an electro-magnet energized by current delivered to the field of the motor. Closed circuit bars or shading coils of heavy copper may be used on the poles of the driver so that when the driver and follower tend to get out of step, a current is induced in the bars which produces a force opposing relative movement between the driver and follower.

By making the magnetic follower and fan as a single unit, the moving parts on the interior of the apparatus can be made very light and of a material which is not affected by the corrosive atmosphere on the interior of the system. This will decrease the bearing drag and it has been found that the fan load at its rated speed may be as low as $\frac{3}{4}$ to one watt.

The non-magnetic annulus between the driver and the follower may be made quite thin and still withstand the high pressures involved. It has been found that it can be made 0.020 inch in thickness, thus materially reducing the magnetic losses and increasing the efficiency of the entire unit.

Other objects and advantages of this invention will become apparent as the description proceeds when taken in connection with the accompanying drawings, in which:

Figure 1 is a vertical sectional view of the circulator unit according to this invention;

Figure 2 is an exploded view showing the details of the magnetic transmission of Figure 1;

Figure 3 is a vertical sectional view of a modified form of circulator unit according to this invention; and

Figure 4 is an exploded view of the magnetic transmission of Figure 3.

Referring to Figures 1 and 2, the circulator unit, according to this invention, comprises a cylindrical casing 10 having a bottom plate 12 and a top plate 14 welded thereto. Casing 10 is divided into a suction chamber and a pressure chamber by a division plate 16 having an opening 18 therein leading to the eye of the fan. The casing 10 is welded to the inert gas circuit of an absorption refrigerating apparatus by means of conduits 20 and 22. A mixture of inert gas and refrigerant vapor enters by conduit 20 and exits by conduit 22.

The combined fan and magnetic follower indicated generally by the reference numeral 24 comprises an inverted cup-shaped member 26 and a fan 28 secured thereto. The fan 28 comprises a shroud 27 and an annular ring 29 extending at right angles thereto and having an inner diameter so that it can be pressed tightly over the cup 26. The fan blades extend radially of the annulus 29 and are secured to the shroud 27. The inverted cup-shaped member 26 is made of magnetic material preferably stainless steel so as to resist the corrosive atmosphere within the system. It has a plurality of poles 30 and

constitutes a magnetic follower. The fan 28 may be made of any non-magnetic material which is resistant to the corrosive atmosphere within the casing 10, or it may be made of magnetic material. If it is made of non-magnetic material it will not collect magnetic scale which may be circulated in the inert gas circuit. If it is made of magnetic material, the magnetic circuit of the follower will be better.

The combined magnetic follower and fan is mounted on the interior of the casing 10 by bearing assemblies 32 and 34. The bearing surfaces of the bearing assemblies 32 and 34 are preferably made of a material which does not require lubrication such as tungsten carbide. The upper bearing assembly 34 is preferably spring pressed, as shown, to take up for any slight wear on the bearing surfaces.

The bottom plate 12 is provided with a central opening, and welded to the periphery of this opening is an inverted cup 36, the top of which supports the lower bearing assembly 32. The side walls of the cup 36 are positioned closely adjacent the poles 30 of the magnetic follower 26 so as to provide only a slight air gap therebetween. Cup 36 is made of non-magnetic material, preferably a non-magnetic stainless steel, so as to resist corrosion by the ammonia.

Supported from the bottom plate 12 of the casing 10 is an electric motor 38. Motor 38 is supported by means of an annular metal ring 40 secured to the plate 12 and an annular metal ring 42 secured to the motor 38 separated by an annular rubber ring 44 bonded to the rings 40 and 42.

The rotating shaft of the motor 38 carries a permanent magnet 46 having a plurality of poles 48 corresponding in number to the poles 30 on the magnetic follower 26 and constitutes a driver magnet. The motor 38 is mounted so that its shaft is in the exact center of the inverted cup 36 and the poles 48 of the magnetic driver 46 are of such size that only a small air gap is provided between the poles 48 and the interior of the cup 36. The magnetic driver 46 is preferably made of a nickel-aluminum-cobalt-iron alloy purchasable on the open market under the trade-name "Alnico."

The weight of the motor 38 and the driver 46 is carried by the rubber ring 44 by a shear stress on the rubber while any force tending to move them laterally is taken by a compression stress on the rubber. Since rubber is approximately six times as soft when subjected to a shear stress than when subjected to a compression stress, the mounting provides a very soft resilient mounting for the motor 38 and driver 46 while the support is comparatively rigid in lateral direction so as to prevent misalignment of the driver 46 with the interior of the cup 36.

In operation, the motor 38 is energized and rotates the driver magnet 46. The driver magnet 46 will form magnetic circuits in the magnetic follower 26 with the north poles of the driver 46 opposite south poles in the follower 26 and with its south poles opposite north poles in the magnetic follower 26. When the driver magnet 46 begins rotation, the poles formed in the magnetic follower 26 will tend to follow the poles of the driver 46 due to the resistance to change in magnetism in the follower 26. The slip between the driver 46 and the follower 26 will be greatest at starting; however, this is reduced as the fan comes up to speed and eventually the driver 46 and follower

26 will fall into step. The slippage will allow the motor to come up to speed quickly.

The making of the follower 26 and the fan 28 as a single unit renders it possible to materially reduce the weight of the moving parts within the interior of the system so that the total power required is reduced and the load on the bearings is not nearly so great as would otherwise be the case.

Figures 3 and 4 disclose a circulator unit similar to that disclosed in Figures 1 and 2. Where the parts are the same they will be given the same reference characters primed. Leading from the field winding of the motor 38' are a pair of electrical contacts 50 and 52 which contact a pair of slip rings 54 and 56, rotatable with the motor shaft. The slip rings 54 and 56 are electrically connected to a pair of windings 58 and 60 which constitute the energizing winding of an electro-magnet formed of a laminated core 62 having two poles 64 and 66. A short circuit or shading coil 68 is provided for each of the poles 64 and 66.

The core 62, windings 58 and 60 and shading coil 68 constitute the driver magnet corresponding to the driver magnet 46 of Figures 1 and 2. The magnetic follower 26' has two poles 70 corresponding to the number of poles on the core 62 instead of four as in Figures 1 and 2.

In operation when the motor 38' is energized with an alternating current the coils 58 and 60 are also energized forming north and south poles in the driver. The driver magnet rotates and its poles form opposite poles in the follower 26' as in the modification of Figures 1 and 2. The follower 26' thus tends to follow the driver magnet as in Figures 1 and 2. The slip between the driver and follower will be greatest at the start but eventually they will fall into step. When the follower and driver tend to get out of step a current is set up in the shading coil 68 which creates a force opposing this relative movement. The shading coil 68 also prevents vibration and chattering of the magnet.

The advantages of the electro-magnet driver over the permanent magnet driver of Figures 1 and 2 is that it cannot become demagnetized and its strength can be regulated by regulating the power supply.

From the foregoing it will be evident that this invention provides a circulator unit for the mediums in an absorption refrigerating apparatus which is compact, quiet in operation, requires only a small power input and in which the moving parts on the interior of the system are light in weight by reason of the fan and magnetic follower being combined into a single unit. The motive power unit is located entirely exteriorly of the walls of the apparatus so that none of its parts can be affected by the corrosive atmosphere on the interior of the system. The moving parts on the interior of the system can be made of material not affected by the corrosive atmosphere and no lubrication is required.

While I have shown but a number of modifications of my invention it is to be understood that these modifications are to be taken as illustrative only and not in a limiting sense. I do not wish to be limited to the specific structure shown and described but to include all equivalent variations thereof except as limited by the scope of the claims.

I claim:

1. A hermetically sealed circulator unit comprising, a casing, a magnetic follower mounted for rotation in said casing and including an an-

nulus of magnetic material, a fan secured to the outer periphery of said annulus, an inverted cup-shaped member of non-magnetic material hermetically sealed to said casing and extending upwardly therein into the interior of and closely adjacent said magnetic annulus and a magnetic driver mounted exteriorly of said casing and extending into and closely adjacent the interior of said inverted cup-shaped member.

2. A hermetically sealed circulator unit comprising, a casing, an inverted cup-shaped magnetic follower mounted for rotation in said casing, fan blades secured to the exterior of said magnetic follower and radiating therefrom, an inverted cup-shaped member hermetically sealed to said casing and extending upwardly therein into the interior of and closely adjacent to the interior walls of said magnetic follower and a magnetic driver mounted exteriorly of said casing and extending into and closely adjacent the interior walls of said inverted cup-shaped member.

3. A hermetically sealed circulator unit comprising, a casing, a combined magnetic follower and fan mounted for rotation in said casing and including an annulus of magnetic material, an inverted cup-shaped member of non-magnetic material hermetically sealed to said casing and extending upwardly therein into the interior of and closely adjacent said magnetic annulus, a magnetic driver on the exterior of said casing and extending into and closely adjacent the inner walls of said inverted cup-shaped member and means for mounting said magnetic driver on the exterior walls of said casing, said mounting means being comparatively resilient in a vertical direction and comparatively rigid in a lateral direction.

4. A hermetically sealed circulator unit comprising, a casing, an inverted cup-shaped magnetic follower mounted for rotation in said casing, fan blades secured to the exterior of said magnetic follower and radiating therefrom, an inverted cup-shaped member hermetically sealed to said casing and extending upwardly therein into the interior of and closely adjacent to the interior walls of said magnetic follower, a magnetic driver on the exterior of said casing and extending into and closely adjacent the inner walls of said inverted cup-shaped member and means for mounting said magnetic driver on the exterior walls of said casing, said mounting means being comparatively resilient in a vertical direction and comparatively rigid in a lateral direction.

5. In combination, a hermetically sealed casing, an inverted cup-shaped member hermetically sealed to said casing and extending upwardly therein, a rotatable driven element on the exterior of said casing and extending upwardly into and closely adjacent the inner walls of said inverted cup-shaped member, means directly connected to said rotatable element for driving the same and means for mounting said driving means on the exterior of said casing, said mounting means comprising a rubber element so arranged relative to said driving means that the weight of the rotatable element and driving means is carried by a shear stress on said rubber element and lateral forces subject said rubber element to a compression stress.

6. In combination, a horizontally positioned hermetically sealed casing having an annular recess extending upwardly into the bottom thereof, a rotatable element on the exterior of said casing and extending upwardly into and closely adjacent to the inner periphery of said annular recess, a vertically positioned motor for

driving said rotatable element having its rotor directly connected thereto and means for mounting said motor to the bottom of said casing, said mounting means comprising an annular metal ring secured to the bottom of said casing and extending downwardly therefrom, an annular metallic ring secured to the outer casing of said motor and spaced from the first annular metal ring so as to form an annular space therebetween and a rubber ring in said annular space bonded to the vertical surfaces of said annular metallic rings whereby the weight of said rotating element and motor is carried by said rubber ring in shear and lateral forces tending to misalign the rotatable element with the inner periphery of said recess will subject said rubber ring to a compression stress.

7. A combined fan and follower for a magnetic transmission comprising, a magnetic cup-shaped member having a bottom portion with an annular portion extending therefrom, fan blades secured to the outer periphery of said annular portion and bearing surfaces on the inner and outer sides of said bottom portion.

8. A combined fan and magnetic follower comprising, a magnetic cup-shaped member and a fan secured to the outer periphery of said cup-shaped member, said fan comprising a shroud having an opening in the center thereof, an annular ring extending at right angles to said shroud at said opening and fan blades secured to said shroud, said annular ring being secured to the outer periphery of said cup-shaped member.

9. A hermetically sealed circulator unit comprising, a casing, a combined magnetic follower and fan mounted for rotation in said casing and including an annulus of magnetic material, an inverted cup-shaped member of non-magnetic material hermetically sealed to said casing and extending upwardly therein into the interior of and closely adjacent said magnetic annulus and a magnetic driver mounted exteriorly of said casing and extending into and closely adjacent the interior of said inverted cup-shaped member, said magnetic driver comprising a permanent magnet.

10. A hermetically sealed circulator unit comprising, a casing, a combined magnetic follower and fan including a magnetic annulus having a plurality of poles on its inner periphery and a plurality of fan blades on its outer periphery and being mounted for rotation within said casing, a cup-shaped member of non-magnetic material hermetically sealed to said casing and extending into the interior of and closely adjacent the poles of said magnetic annulus and a rotatable permanent magnet having the same number of poles as said magnetic annulus on the exterior of said casing and extending into said cup-shaped member with the poles thereof closely adjacent the inner periphery of said cup-shaped member.

11. A hermetically sealed circulator unit comprising, a casing, a combined magnetic follower and fan including a magnetic annulus having a plurality of poles on its inner periphery and a plurality of fan blades on its outer periphery and being mounted for rotation within said casing, a cup-shaped member of non-magnetic material hermetically sealed to said casing and extending into the interior of and closely adjacent to the poles of said magnetic annulus, a rotatable permanent magnet having the same number of poles as said magnetic annulus on the exterior of said

casing and extending into said cup-shaped member with the poles closely adjacent the inner periphery thereof, means directly connected to said permanent magnet for driving the same and means for supporting said driving means on the exterior of said casing.

12. A hermetically sealed circulator unit comprising, a casing, a combined magnetic follower and fan including a magnetic annulus having a plurality of poles on its inner periphery and a plurality of fan blades on its outer periphery and being mounted for rotation within said casing, a cup-shaped member of non-magnetic material hermetically sealed to said casing and extending into the interior and closely adjacent the poles of said magnetic annulus, a rotatable electro-magnet having the same number of poles as said magnetic annulus on the exterior of said casing and extending into said cup-shaped member with the poles closely adjacent the inner periphery thereof, and means for driving said electro-magnet including means for energizing the coils thereof.

13. A hermetically sealed circulator unit comprising, a casing, a combined magnetic follower and fan including a magnetic annulus having a plurality of poles on its inner periphery and a plurality of fan blades on its outer periphery and being mounted for rotation within said casing, a cup-shaped member of non-magnetic material hermetically sealed to said casing and extending into the interior of and closely adjacent the poles of said magnetic annulus, a rotatable electro-magnet having the same number of poles as said magnetic annulus on the exterior of said casing and extending into said cup-shaped member with the poles closely adjacent the inner periphery thereof, a motor for rotating said electro-magnet having its rotor directly connected thereto, a pair of slip rings carried by the rotor of said motor and being electrically connected to the coils of said electro-magnet and means for electrically connecting said slip ring to the field coils of said motor.

14. In combination, an electric motor, a rotatable member directly connected to the rotor of said motor for rotation therewith, said rotatable member being mounted to rotate with small clearance in an annular recess, means for mounting said motor and rotatable member in axial alignment with said recess, said mounting means including a rubber element so constructed and arranged that forces tending to move said motor and rotatable element axially of said recess subject said rubber element to a shear stress and forces tending to move said motor and rotatable element radially of said recess subject said rubber element to a compression stress.

15. In combination, an electric motor, a rotatable member directly connected to the rotor of said motor for rotation therewith, said rotatable member being mounted to rotate with small clearance in an annular recess, means for mounting said motor and rotatable member in axial alignment with said recess, said mounting means including an annulus of rubber so related to said motor and recess that forces tending to move said motor and rotatable member axially of said recess subject said rubber annulus to a shear stress and forces tending to move said motor and rotatable member radially of said recess subject said rubber annulus to a compression stress.

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