United States Patent

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[54] **OSCILLATORY COMPRESSOR**
11 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **417/417**
[51] **Int. Cl.** **F04b 35/05**
[50] **Field of Search** 417/363, 416, 417

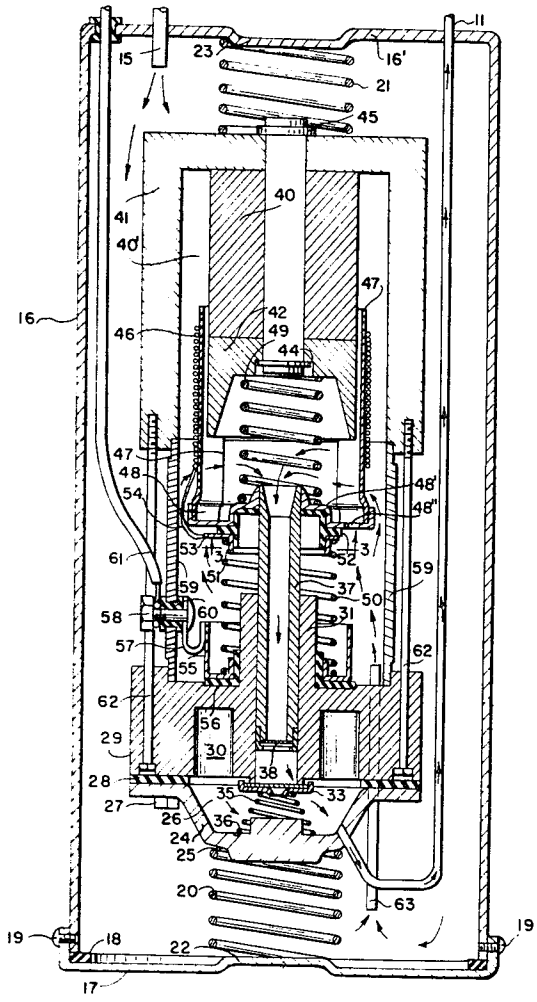
[56] **References Cited**

UNITED STATES PATENTS

2,853,229	9/1958	Dolz	417/417 X
2,894,678	7/1959	Hintz	417/363
3,171,585	3/1965	Gauss	417/417

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ABSTRACT: An oscillatory compressor having a high pressure chamber with a cylinder thereon and an open-ended tubular piston slidably mounted therein with a pressure responsive valve between the cylinder and the high-pressure chamber providing for passage of compressed fluid from said cylinder to said chamber when the fluid pressure in the cylinder exceeds a predetermined value, and closing the communication therebetween below the predetermined pressure. A pulsating drive for reciprocating the piston including a permanent magnet with poles spaced by an annular airgap and having a movable coil extending into the airgap and drivingly secured to the piston by a free-flow perforated mounting plate providing for unrestricted passage of fluid therethrough from space exterior to the coil and piston into space interiorly thereof. Energization of the coil is provided through one of a pair of opposed springs supporting the piston and coil in a centered position and comprising a contact brush mounted to engage a conductive spring seat mounted on and insulated from the high pressure chamber. The entire assembly is encased in a sealed container with opposed springs resiliently supporting the compressor assembly therein, with a fluid supply inlet into the container from the fluid system, such as a cooling system and a compressed fluid exhaust or withdrawal outlet from the container extending to the high-pressure chamber of the compressor.



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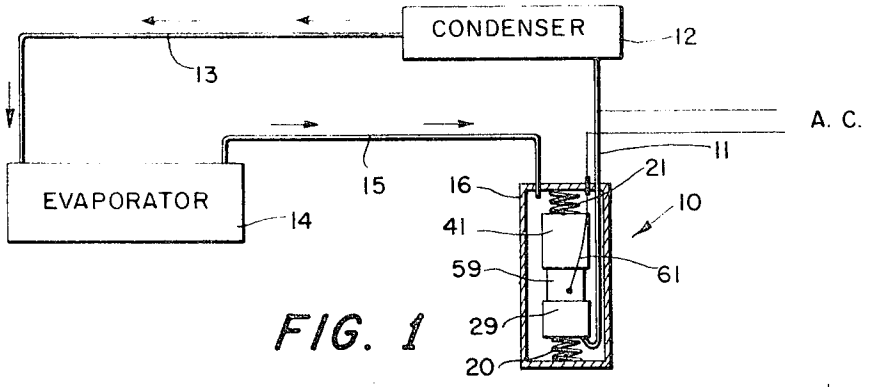


FIG. 1

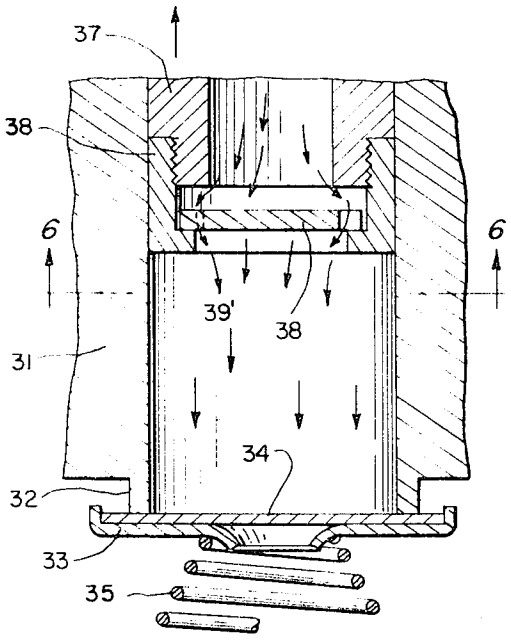


FIG. 4

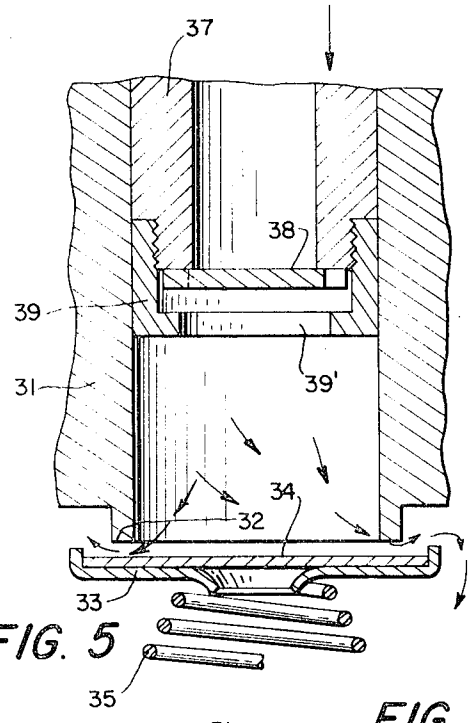


FIG. 5

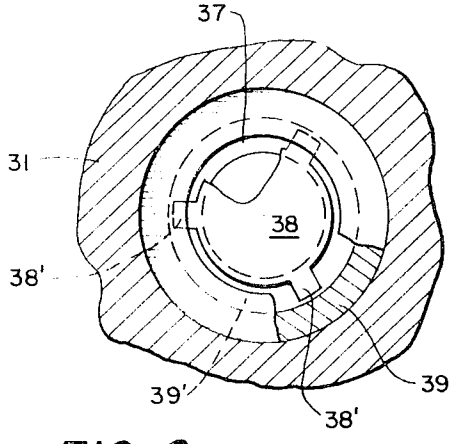


FIG. 6

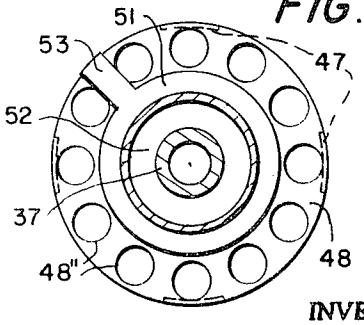


FIG. 3

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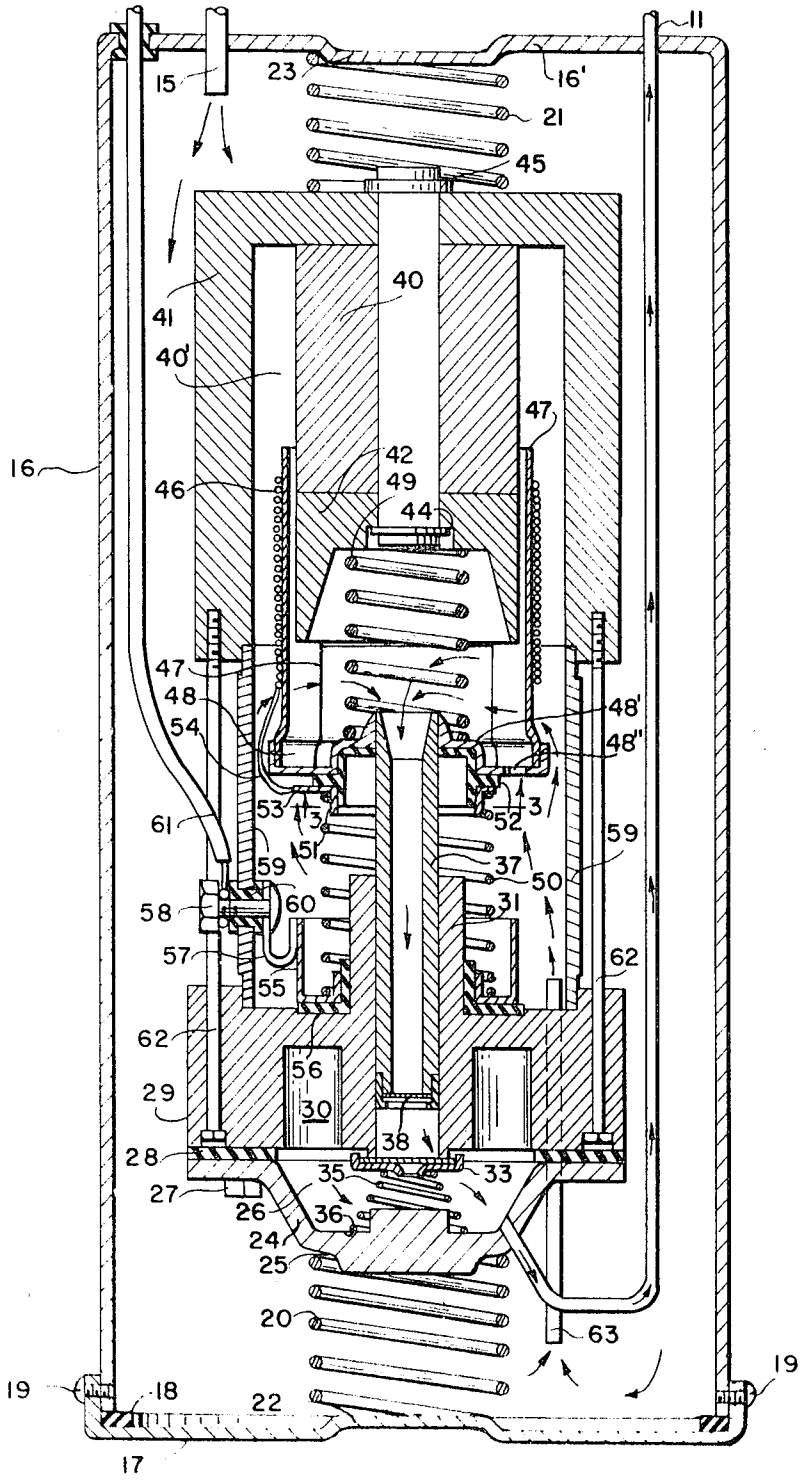


FIG. 2

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OSCILLATORY COMPRESSOR

BACKGROUND OF THE INVENTION

1. Field of the Invention.

This invention relates to fluid compressors or pumps and more particularly to oscillatory compressors of the type driven by a pulsating or reciprocating electromagnetic drive.

2. Description of the Prior Art.

Oscillatory plunger piston type compressors have been used in the past in cooling systems of household refrigerators. In such systems, the oscillatory drive has generally been by an electromagnetic source in which the driving member comprises a coil which reciprocates in an annular airgap between the poles of a permanent magnet and oscillates at the frequency of the exciting current. Opposed compression springs have supported the coil and plunger piston in a central operative position.

SUMMARY OF THE INVENTION

The present invention is an improved oscillatory piston-type compressor wherein the compression of fluid is achieved by an electromagnetically driven open-ended piston axially reciprocated in a cylinder mounted on a high-pressure chamber and having a pressure responsive valve which closes an end of the cylinder open to the high-pressure chamber for pressures in the cylinder below a predetermined value and opens when this pressure exceeds this value. A one-way valve in the end of the tubular piston permits passage of fluid through the piston into space in the cylinder between the end of the piston and the pressure responsive valve during the part of the operating stroke while the piston is being withdrawn from the cylinder and is closed to prevent reverse fluid flow for the opposite stroke while the piston is being moved into the cylinder. Opposed compression springs bias the piston to a predetermined centered position partly out of the cylinder.

The pulsating reciprocating drive of the piston is provided by a coil mounted axially freely oscillatable in an annular airgap between the poles of a permanent magnet and drivingly secured to the piston by an improved mounting plate structure. It has been found that the efficiency and life of this type of pump are both greatly improved by facilitating the free flow of fluid into the piston during the intake or suction stroke. Also, the forces on the mechanism improve its operative life and efficiency if they be substantially balanced in directions transverse to the axial movement of the coil and piston. An important feature of the present improvement is the provision of a fluid free-flow coil mounting plate wherein the plate is perforated by a plurality of openings circumferentially spaced substantially equally around its surface. This eliminates unequal forces transversely of the operating mechanism and minimizes resistance of fluid to the free movement of the coil and piston, and provides for the maximum utilization of the driving force for the compression of the fluid in the cylinder.

Further, the efficiency has been increased by an improved electrical connection of the coil to its source of energization; and the entire mechanism has been greatly silenced in operation by an improved cushioned mounting by resilient compression springs in an outer sealed container into which the fluid is returned before passing into the compressor space around the operating coil and piston.

It is an object of the present invention to provide an improved oscillatory compressor.

Another object of the present invention is to provide an improved and more efficient fluid flow structure in an oscillatory compressor.

A further object of the present invention is to minimize the noise and vibration produced by an oscillatory compressor.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic representation of a refrigerating system provided with an embodiment of the present invention;

FIG. 2, a longitudinal sectional view through the compressor shown in the FIG. 1 system including embodiments of the improvements of the present invention;

FIG. 3, a sectional view taken along line 3–3 of FIG. 2 illustrating the improved mounting plate;

FIG. 4, an enlarged sectional view of the compression section of the cylinder and adjacent end of the piston with the cooperating one-way valve and pressure responsive valve during an intake or suction stroke;

FIG. 5, a sectional view of the FIG. 4 structure illustrating the parts during a compression stroke; and

FIG. 6, an enlarged sectional view, partly broken away, taken along line 6—6 of FIG. 4, showing details of the one-way valve.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings, an embodiment of an improved oscillatory compressor **10** according to this invention is shown in FIG. **1**, connected by a high-pressure fluid pipe or tube **11** to a suitable refrigerating system condenser **12**. The condenser **12** is connected by a suitable tube or pipe **13** to an evaporator **14** where the fluid expands and is vaporized, producing its ambient cooling effects. The vaporized gaseous fluid then passes through a tube or pipe **15** back into a sealed container **16** of the compressor **10**, where the fluid is recompressed and recycled through the pipe **11** and the rest of the system.

Details of the compressor are more clearly shown in FIGS. **2—6**. In the illustrated embodiment, the sealed container **16** and the compressor therein are adapted to operate with the longitudinal axis thereof vertical. This is important as the oscillation of the mechanism is along this longitudinal axis and special resilient cushioning of the compressor in the casing along this axis provides an exceptionally quiet, vibrationless device. The casing **16** may be made of any suitable material, such as pressed steel, and includes a main body portion with an open end and a closed end **16'**. The open end is adapted to be sealed and closed after the compressor is assembled therein and the closure may comprise any suitable member, such as a cover **17** fitted over a gasket **18** and secured in position in any suitable manner, as by screws **19**. The compressor is cushioned and resiliently mounted in the container **16** by a pair of opposed compression springs **20** and **21**, respectively seated on spring seats **22** and **23** pressed in the ends **16'** and **17** of the container and engaging opposite ends of the compressor. This provides a very efficient cushioned support for the compressor and permits it to operate as a fully self-contained unit without affecting or being affected by other parts of the system or nearby units.

The compressor includes an end plate **24** formed with a spring seat **25** on one side against which the compression cushioning spring **20** is seated. This end plate is formed with a cavity **26** on the side opposite the spring seat **25** and is sealingly secured by a plurality of bolts **27**, in engagement with a gasket **28**, to a headplate **29**. The head plate **29** preferably is formed with a cavity **30** facing and communicating with the end plate cavity **26** and forming therewith a high-pressure chamber for receiving fluid compressed by the compressing mechanism.

This compressing mechanism includes a cylinder **31**, shown formed integral with the headplate **29**, with the lower end thereof formed with a valve seat **32** and open into the high-pressure chamber. A pressure-responsive valve, comprising a retained and spring seat member **33** with a valve **34** thereon, is resiliently biased by a predetermined spring pressure against the cylinder valve seat **32** by a compression spring **35** seated on the valve spring seat **33** and a spring seat **36** formed in the cavity **26** on the end plate **24**. In this manner, the cylinder **31** is closed to the high pressure chamber for all pressures below a predetermined valve and is opened to the high-pressure chamber by the valve **34** when the compressed fluid in the cylinder is above this predetermined valve. FIGS. **4** and **5** respectively show the closed and open valve conditions.

Compression of fluid in the cylinder **31** is done by a plunger-type open-ended tubular piston **37** which is axially slidably fitted in the cylinder **31** through the end thereof opposite the pressure chamber end. The lower end of the piston **37** is provided with a one-way valve mechanism comprising an axially displaceable valve **38** loosely movably mounted in a valve housing **39** secured to the end of the piston **37** by threaded engagement therewith. The valve housing is formed with a valve retaining ring **39'**, FIGS. **4**, **5** and **6**, which has a central opening diameter greater than the diameter of the main central body of the valve **38**, FIG. **6**. The valve is formed with a plurality of outwardly extending fingers **38'** which project over the retaining ring **39'** and allow free passage of fluid from the piston **37** into the cylinder **31** between the fingers **38'** through the space between the outer periphery of the body of the valve **38** and the inner periphery of the retaining ring **39'** when the valve is in its lower position as shown in FIG. **4**. The diameter of the main body of valve **38** is greater than the diameter of the bore of tubular piston **37** so that when the valve is moved to its upper position, as shown in FIG. **5**, when the fluid pressure in the cylinder **31** between the valves **34** and **38** is higher than the fluid pressure in the bore of the piston **37**, the valve **38** effectively closes the end of the piston bore and prevents reverse flow of fluid from the cylinder **31** into the piston **37**. These two positions of valve **38** result as the piston is moved respectively away from and toward the high pressure chamber end of the cylinder **31**.

This reciprocating movement of the piston is provided by an oscillatory or pulsating drive comprising a suitable permanent magnet having a pair of pole face pieces **41** and **42** concentrically secured together, as by a pin **43** fastened by any suitable means, such as retainer rings **44** and **45** in engagement with grooves in the pin **43**. The pole pieces form concentric poles spaced by an annular airgap **40'**, the uppermost pole piece **41** being in the form of a depending sleeve which surrounds and extends slightly beneath the lower pole piece **42**, and a coil is placed axially movable in this airgap. This coil is preferably wound on a plurality of axially extending fingers **47** secured to a mounting plate **48** which is rigidly secured to the end of the piston **37** opposite the one-way valve **38**, thus providing a driving connection between the coil **46** and the piston **37**.

Opposed spring means, comprising a pair of electrically conductive compression springs **49** and **50**, support the coil **46** and piston **37** centered respectively partially axially out of the airgap and cylinder. The upper spring **49** is seated on a spring seat formed on the lower side of the magnet pole face piece **42** and on a spring seat formed on a shoulder **48'** on the mounting plate **48**. The lower spring **50** forms part of the electrical circuit for energizing the coil **46**. This circuit includes a connecting ring **51** mounted on an insulating bushing **52** on the mounting plate **48** which forms the upper spring seat for the spring **50**. This ring **51** is provided with an outwardly projecting tab **53** to which the coil is electrically connected through lead **54**. The bottom of spring **50** is seated on a spring seat formed by a connecting ring **55** mounted on an insulating bushing **56** on the headplate **29**, thereby forming an electrical circuit between the two rings **53** and **55**. Electrical energization is provided to the coil **46** through the rings and spring by a sliding brush-type contactor **57** connected to a terminal **58** mounted on an enclosing casing **59** by an insulating bushing **60** to which a supply lead **61** is connected. This supply lead extends out through the container **16** and is adapted to be connected to a suitable alternating current supply. The casing **59** is fitted into grooves in the inner ends of pole facepiece **41** headplate **29** and the entire assembly is rigidly secured together by a plurality of through bolts **62** which extend through the headplate **29** and threadedly engage the end of the pole facepiece **41** with the bolt heads in sockets in the headplate.

As previously explained, the gaseous fluid is returned to the container **16** through the tube **15**. It then passes from the container **16** through a tube **63** into the space within the casing **59**. Energization of the coil **41** by alternating current alternately biases the coil into and out of the airgap **40'** against the centering action of the opposed springs **49** and **50** at the frequency of the alternating current, whereby the piston **37** is respectively reciprocated away from and toward the end of the cylinder open to the high-pressure chamber **30**. As the piston moves outwardly from the cylinder, a suction is created in the bore of the piston and the one-way valve **38** moves to its lower position, FIG. **4**, so that fluid in the piston bore flows into the cylinder through the opening between the valve fingers **38'**. This fluid must be drawn into the interior of the piston from fluid within the space inside the coil **46**. A small amount of fluid can pass from the exterior of the coil to its interior over the upper edge of the coil in the airgap **40**, but this is a rather restricted passage. An important feature of this invention is the improved inlet structure provided by a plurality of perforation **48''** formed around the mounting plate **48**. These provide for an even free flow of fluid into the coil interior and from thence into the piston bore with substantially no resistance to the operation. Alternate movement of the piston into the cylinder **31** causes the valve **38** to move to its upper position and prevents reverse flow of fluid out of the piston. This movement compresses fluid in the cylinder **31** to a pressure above the predetermined pressure and causes the pressure responsive valve **34** to open, FIG. **5**, so that the compressed fluid passes out of the cylinder into the high pressure chamber **30**. The exhaust tube **11** extends into the container **16** and passes through the end plate **24** into the high-pressure chamber cavity **26** so that the compressed fluid can pass out through the tube **11** as it is needed in the system.

I claim:

1. A compressor comprising:

a headplate;

a high-pressure chamber means mounted beneath said headplate;

a cylinder on said high-pressure chamber means with an end open thereto;

pressure-responsive valve means for closing said end of said cylinder open to said high-pressure chamber for pressures in said cylinder below a predetermined value and for opening said cylinder end to said pressure chamber over said predetermined pressure;

an open-ended tubular piston means axially slidably fitted in said cylinder through the end thereof opposite said pressure chamber end and having a one-way valve means for alternatively providing communication and closing passage between the interior of said tubular piston means and said cylinder respectively allowing passage of fluid through said piston means into space in said cylinder between said piston and said pressure-responsive valve means and for preventing reverse flow of fluid respectively as said piston means moves away and toward said pressure-responsive valve means;

pulsating drive means for reciprocating said piston means comprising a permanent magnet with a pair of concentric poles spaced by an annular airgap and having a movable coil extending into said airgap; the uppermost of said concentric poles being in the form of a depending sleeve surrounding the other of said concentric poles and depending therebeneath, the lower extremity of said depending sleeve forming a seat for an enclosing casing extending therefrom to said headplate;

means comprising a mounting plate for supporting said coil and drivingly securing it to said piston means; said mounting plate including a plurality of axially extending fingers about which said coil is wound;

opposed spring means for supporting said coil and piston means centered respectively partially axially out of said airgap and said cylinder;

means for electrically energizing said coil with an alternating current for alternately biasing said coil out of and into said airgap against the centering action of said opposed spring means whereby said piston means is reciprocated toward and away from the end of said cylinder open to said high-pressure chamber respectively compressing

fluid in said cylinder to a pressure above said predetermined pressure and alternatively drawing fluid into said cylinder through said piston means;

said electrical coil-energizing means comprising a conductive top spring seat on said mounting plate insulated therefrom, a conductive annular bottom spring seat on said high-pressure chamber means insulated therefrom, said spring means including a spring of conductive material compressed between said spring seats and providing a good electrical conductor therebetween, means electrically connecting said coil to said top spring seat, and means including a sliding contactor engaging said bottom spring seat for connecting a source of AC electrical energization thereto.

2. A compressor as defined in claim 1 wherein said mounting plate is perforated to provide for free passage of fluid therethrough from space exterior to said coil and piston means into space interiorly thereof.

3. A compressor as defined in claim 1 having means for withdrawing compressed fluid from said high-pressure chamber means.

4. A compressor as defined in claim 1 having a sealed container around said compressor, means for supplying gaseous fluid into said container, and means for withdrawing compressed fluid from said high-pressure chamber and out of said container.

5. A compressor as defined in claim 4 having an opposed compressed spring means resiliently supporting said compressor in said container.

6. A compressor comprising:

an end plate;

means including a headplate secured to said end plate and forming a high-pressure chamber therewith;

a cylinder on said headplate with an end open into said high-pressure chamber and having a valve seat on said open end;

pressure-responsive valve means engaging said valve seat for closing said end of said cylinder open to said high-pressure chamber for pressures in said cylinder below a predetermined value and for opening said cylinder end to said high-pressure chamber above said predetermined pressure;

an open-ended tubular piston means axially slidably fitted in said cylinder through the end thereof opposite said pressure chamber end and having a one-way value means for alternatively providing communication and closing passage between the interior of said tubular piston means and said cylinder respectively allowing passage of fluid through said piston means into space in said cylinder between said piston and said pressure-responsive valve means and for preventing reverse flow of fluid respectively as said piston means moves away from and toward said pressure-responsive valve means;

pulsating drive means for reciprocating said piston means comprising a permanent magnet with a pair of concentric poles spaced by an annular airgap and having a movable coil extending into said airgap, the uppermost of said concentric poles being in the form of a depending sleeve surrounding the other of said concentric poles and depending therebeneath, the lower extremity of said depending sleeve forming a seat for an enclosing casing extending therefrom to said headplate;

means comprising a mounting plate for supporting said coil and drivingly securing it to said piston means, said mounting plate including a plurality of axially extending fingers about which said coil is wound;

said counting plate being perforated to provide for free flow of fluid therethrough from space exterior to said coil and piston means into space interiorly thereof;

opposed spring means for supporting said coil and piston means centered respectively partially axially out of said airgap and said cylinder;

means for electrically energizing said coil with an alternating current whereby said piston means is reciprocated toward and away from the end of said cylinder open to said high-pressure chamber respectively compressing fluid in said cylinder to a pressure above said predetermined pressure and causing said pressure-responsive valve to open and alternately drawing fluid into said cylinder through said piston means and one-way valve by way of said perforated mounting plate;

said electrical coil energizing means comprising an insulating bushing on said mounting plate and a conductive top spring seat thereon insulated thereby from said mounting plate, another insulating bushing on said headplate and a conductive annular bottom spring seat thereon insulated thereby from said headplate, said opposed spring means including a spring of conductive material compressed between said spring seats, means electrically connecting said coil to said top spring seat, and means including a sliding contactor engaging said bottom spring seat for connecting an AC source of electrical energization thereto.

7. A compressor as defined in claim 6 having means for withdrawing compressed fluid from said high-pressure chamber means.

8. A compressor as defined in claim 6 having a sealed container around said compressor, means for supplying gaseous fluid into said container, and means for withdrawing compressed fluid from said high-pressure chamber and out of said container.

9. A compressor as defined in claim 8 having an opposed compressed spring means resiliently supporting said compressor in said container.

10. A compressor as defined in claim 6 wherein said end plate has a cavity on one side and said headplate has a cavity facing said end plate cavity and forming therewith said high-pressure chamber means.

11. A compressor as defined in claim 10 wherein said end plate has a spring seat in said cavity and said pressure-responsive valve means includes a spring seated on said end plate spring seat and arranged in engagement with said valve means biasing it to closed position on said cylinder end valve seat.