

**May 16, 1939.**

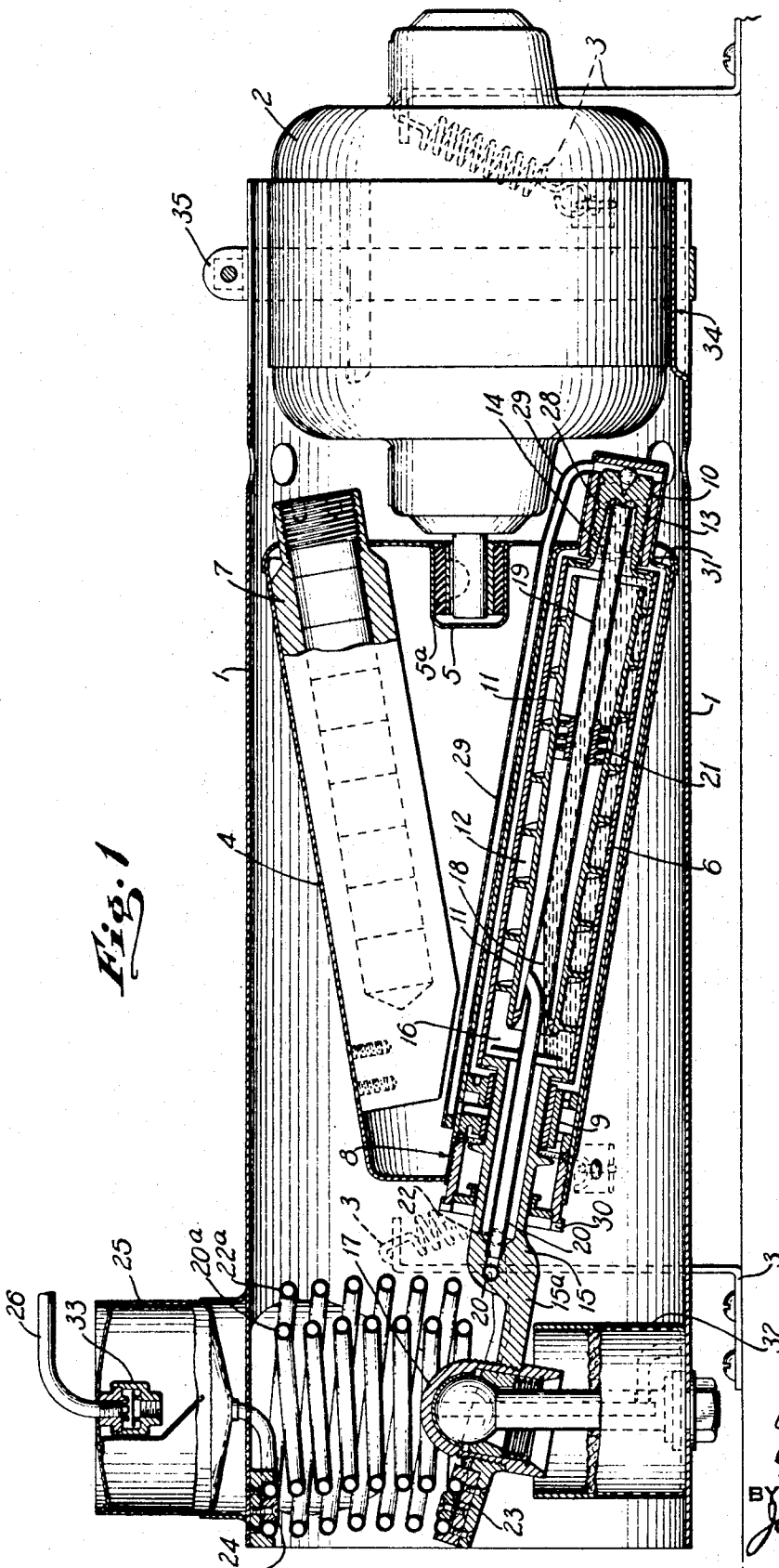
J. G. DE REMER ET AL

**2,158,109**

GYRATORY COMPRESSOR

Filed Nov. 23, 1935

2 Sheets-Sheet 1



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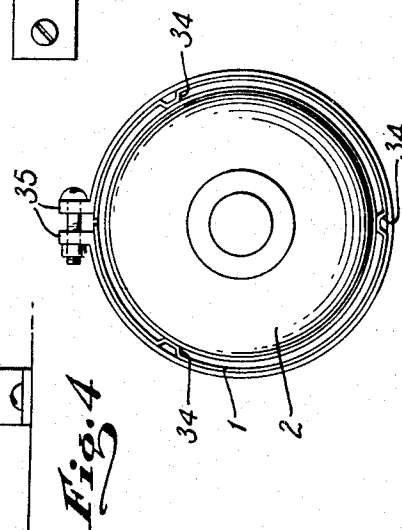
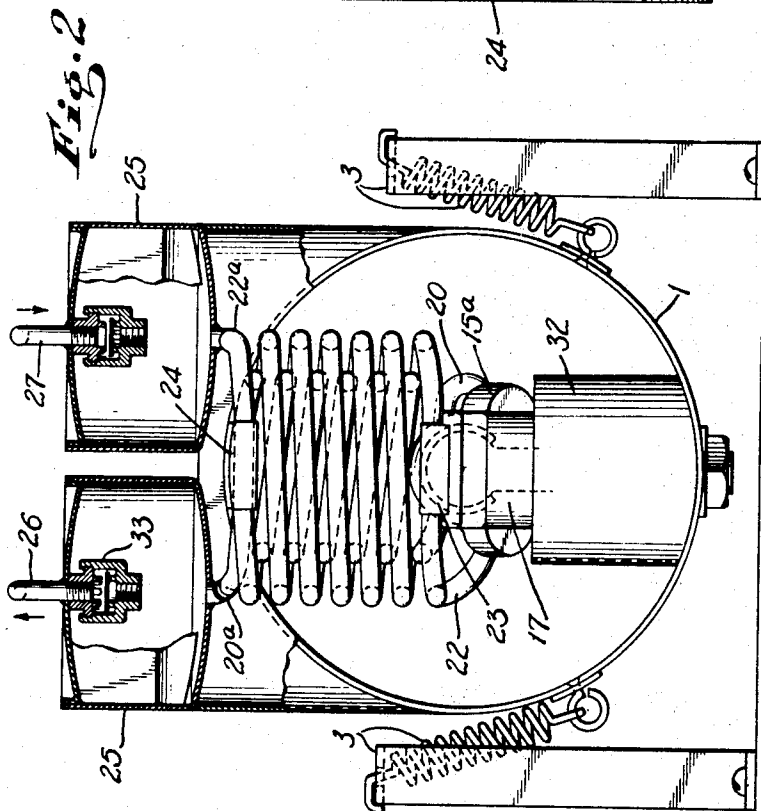
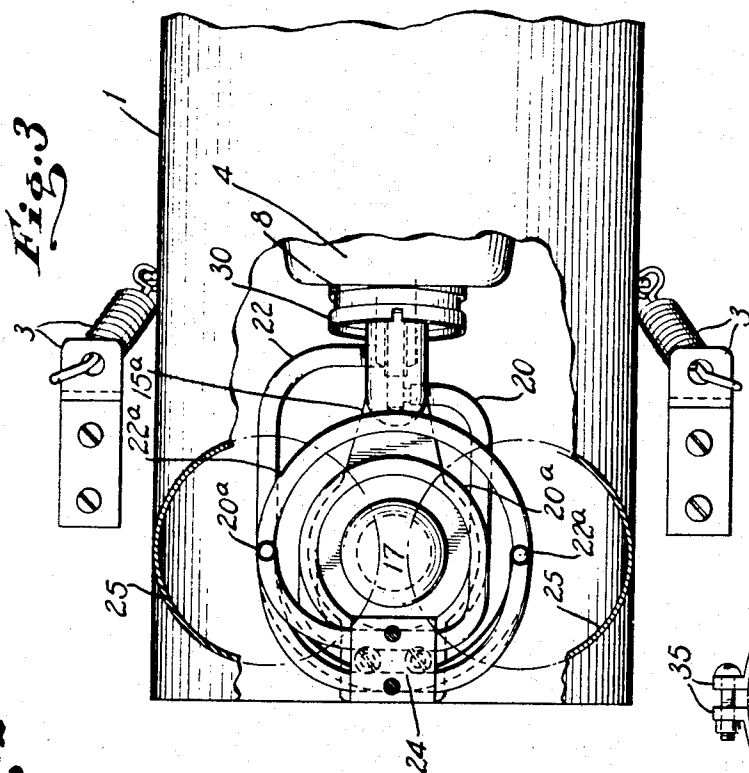
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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

2,158,109

## GYRATORY COMPRESSOR

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Application November 23, 1935, Serial No. 51,264

22 Claims. (Cl. 230—75)

The invention relates to compressors of the gyratory type suitable for refrigerating and like purposes, and consists in part of a new disposition of the gyratory compressor unit and its drive and fluid connections, whereby a higher general efficiency and a greater degree of compactness and convenience are secured, and in part, of the individual features hereinafter pointed out, which contribute separately and in combination to the same general ends.

The principle of operation of compressors of the type to which this invention relates is well known to the art and involves the rotation of a helical passage about an axis inclined to its own axis so that slugs of mercury or other dense liquid admitted to the passage are screwed through it, acting as pistons for compressing gas or a lighter fluid ahead of them. De Remer Reissue Patent 15,590 may be referred to for example.

In the accompanying drawings,

Figure 1 is a vertical elevation partly in section of the form of the invention at present preferred;

Figure 2 is an end view thereof;

Figure 3 a partial plan with parts broken away, and Figure 4 an end elevation.

The apparatus illustrated comprises a main frame or support which can be variously constructed, but which according to the preferred form of this invention is a substantially cylindrical or a tubular casing 1, perforated or fenestrated for ventilation purposes and having the driving motor 2 removably fitted into or applied to one end, the gyratory compressor unit occupying its interior, and the fluid pipe connections of the latter mounted in or on the other end. It is provided with spring hangers 3 to support it in horizontal position. However, it is a feature and an advantage of this invention that the machine may also be easily arranged for vertical installation, if desired, inasmuch as at the high operating speeds permitted by the invention the gravitational pull on the contained mercury is without appreciable effect, but in any position of mounting the tandem arrangement of the motor, unit and pipe connections provides a desirable compactness adapting the machine to ready accommodation in household refrigerators and other units.

The compressor mechanism includes a rotary carrier or frame 4 in the form of a casing of generally frusto-conical shape or circular section, made preferably of welded sheet metal and fitted with an axial socket 5 at its wide end by which

it can be coupled to and supported on the armature shaft of the electric motor 2. A yielding bushing 5<sup>a</sup> of rubber is included in the coupling to compensate for possible inaccuracies of alignment or balance.

The compressor unit 6, in which is contained the helical piston passage above referred to, is carried within and on one side of the carrier casing 4 and a counter-balancing weight 7 is mounted therein on the other side, the compressor unit being held in a deep socket 8 built into the carrier to support the unit bearings 9 and 10 therein. These hold the unit at an angle of about 8° or 10° to the rotary axis of the carrier or main axis of the machine. The bearing 10 includes a ball step constituting it also as a thrust bearing.

The unit comprises a hollow steel core 11 formed with an external screw-thread rib of at least six and preferably about eight or nine turns over which the cylindrical shell 6 is accurately fitted and shrunk, thus forming the helical piston passage marked 12. At the outer end of this helical passage the shell 6 is welded or otherwise attached to a base fitting 13 which constitutes the journal member of the bearing 10 and also serves as the high pressure chamber 14 of the compressor. The other end of the shell 6 is closed by a neck-fitting 15 constituting the journal member for the bearing 9 and also serving as the low pressure chamber of the compressor, which chamber is marked 16. An arm 15<sup>a</sup> extended from this neck-fitting is shaped as one member of a ball and socket mounting 17, the pivotal center of which coincides with the main or rotary axis of the carrier. The latter is thus supported at one end on the motor armature shaft and at the other on the bearing 9, which in turn is supported by the ball and socket mounting.

The compressor unit has no rotation on its own axis, being held against rotation by its intake and delivery connections presently referred to, but it turns, relatively speaking, in its bearings in the carrier frame as the latter rotates on the main axis. The unit is filled with mercury or like heavy liquid to establish a normal level, during rotation, such as indicated by the line 18, and under the centrifugal effect, this level is maintained while the machine is in action regardless of the attitude in which the machine is mounted. The gyratory motion of the unit has the effect of bringing the entrance of the helical passage 12 alternately above and below the mercury level so that it alternately takes in bodies

of gas and bodies of mercury, which bodies are then screwed along through the passage toward and into the high pressure chamber 14 compressing the gas in the meantime. The mercury passes back to the low pressure chamber 16, through the axial tube 19 within the core 11, and the compressed gas, separating from the mercury, fills the annular space around the tube 19 and within the core, passing thence through the gas tube 20, which extends through the side wall of the low pressure chamber 16.

A baffle 21 is interposed in the gas path from the high pressure chamber for the purpose of intercepting any mercury that might be entrained with it. This baffle, as indicated, is a screw properly directed to push back such mercury as encounters it.

The compressor pipe connections, that is to say, the intake tube 22 which is connected through the side of the neck-fitting with the low pressure chamber 16 and the delivery tube 20 from the high pressure chamber are both fastened to the pivot arm 15<sup>a</sup> of the unit by means of a twin clamp 23 and are thence coiled into concentric spring helices of five or six turns each, one helix (20<sup>a</sup>) having all its turns of smaller diameter than those of the other and being within the other (22<sup>a</sup>) which helices are clamped at their upper ends in another twin clamp 24 fixed to the main support 1 whence they lead respectively into two mercury traps 25. The function of the spring helices, as will be understood, is to accommodate the gyratory motion of the unit as well as to hold it against rotation on its own axis. From the traps the pressure or delivery line 26 leads to the condenser of a refrigerating system, or to some other place of delivery, not shown, while the suction or low pressure line 27 runs to the vaporizer of the refrigerating system or to some other source of fluid or gas to be compressed or pumped. The concentric disposition of the spring tube helices permits them to be easily accommodated in the space within and protected by the end of the tubular main frame 1, either in the position shown when the base 1 is horizontally mounted or turned 90° when it is vertical.

The annular space between the unit 6 and the wall of the socket 8 in which it is housed receives lubricating oil from a reservoir supply contained within the carrier casing 4. Under the centrifugal effect the oil is not likely to reach the neck bearing 9, and on this account a forced feed is supplied to that bearing represented by a helical groove 28 of proper pitch cut in the journal member 13 of the bearing 10. This groove forces or screws the oil which floods that bearing into the end of the step bearing with a force sufficient to counteract centrifugal action and press the oil into and through the oil pipe 29. The latter debouches on the inner side of the neck bearing 9, thus keeping the latter at all times flooded in an oil circulation. A screw collar 30 applied to the projecting end of the unit socket 8 prevents escape of oil at that point and an oil hole 31 in the base of the socket provides a pressure balance to its exterior. The ball and socket mounting at the pivotal end of the unit is oiled by a reservoir and wick indicated at 32, the three bearings just referred to being the only points requiring lubrication outside of the motor.

Light disc check valves 33 are desirably located inside of the mercury traps 25, the function of which is to prevent an unpleasant lurch in the machine when it is being shut down, due

to blow-back from the high pressure to the low pressure side. Such valves do not require to be tight as they have no other function.

For facilitating ventilation of the interior of the tubular base the motor is set on three spacers 34 in the end of the tube which provide an annular air flow crevice around the motor and the latter is clamped in place by the clamp strap marked 35.

It is pointed out that the organization above described is adapted for operation at higher speeds than heretofore practical for this type of compressor and with correspondingly increased capacity and delivery pressures. We found that by the use of a helical piston passage of decidedly narrow diameter in proportion to its axial length, that is to say, of a helix having a length at least more than three times its average diameter, higher gyratory speeds are possible and practical without creating such turbulence in the slugs themselves as to impair their piston function or reducing the delivery pressures. For best practical results the diameter should not exceed two inches, that of the machine shown in the drawing being somewhat under one and a half inches and for refrigerator units the number of turns should preferably be at least six. With such relative dimensions and by setting the helical axis at an angle of 12° or less to the main axis of rotation, say eight or ten degrees (as compared to the fifteen to twenty degrees of prior forms) higher speeds are possible with good dynamic balance, giving substantial increase of capacity in relation to power consumption and the amount of mercury required, and permitting the direct drive of the unit from the armatures of ordinary alternating current motors, which operate at speeds of 1750 upwards, thereby doing away with the heavy and costly drive-gear heretofore considered indispensable to this gyratory type. The lower inclination at the same time affords the advantages that the diameter of the carrier frame can be within that of the motor suited for driving it which is a convenience of compactness and also of appearance, and that it requires a less flexure for the spring tube helices, forestalling all possibility of their failure from fatigue.

Disassembly of the machine is particularly simple, as will now be evident. By releasing the motor from the main frame it can be drawn out of it and of the socket 5 in the carrier 4, for inspection, repair or replacement as the case may be. Then by releasing the oil guard collar 30, the carrier itself can be drawn off of the compressor unit 6, thus rendering the bearings 9 and 10 accessible, all of this being possible, as will be apparent, without opening or disturbing the refrigerant circuit or disking the spillage of the mercury which remains at all times sealed in the system.

While the particular detail of the compressor unit and its mounting above described constitutes part of the invention and is preferred, it will be understood that in its broader aspect the invention is not limited thereto so long as the unit and its piston passage are adapted for operation at the high speed and low angle and with the advantages incident thereto which have been above pointed out.

We claim:

1. Gyratory compressor apparatus comprising a liquid-piston compressor unit including a helical piston passage operating by virtue of its rotation about an axis inclined to the axis of the helix,

a rotary carrier for said unit, a supporting base, a motor mounted on one end of the base directly coupled to said carrier, and flexing supply and delivery pipe connections for said unit fixed to the other end of said base.

2. Apparatus as in the preceding claim wherein said supporting base is tubular and encloses said carrier, the compressor unit and said pipe connections.

3. Apparatus as in claim 1 wherein said pipe connections include two spring tube helices one within the other, one end of each helix being connected to the compressor unit and the other fixed to said supporting base.

4. Apparatus as in claim 1 wherein said base is tubular and said motor, carrier, unit and pipe connections are all enclosed therein, the motor being removably held in one end and said pipe connections being mounted on the opposite end.

5. Gyratory compressor apparatus comprising an electric motor, a carrier directly coupled to the armature shaft thereof, and a compressor unit journaled in said carrier at an acute angle to the armature axis and comprising a helical piston passage of small helical diameter.

6. Apparatus as in the preceding claim in which the axial dimension of the helical piston passage in the unit is at least greater than three times its helical diameter.

7. Apparatus as in claim 5 in which the helical piston passage has a diameter of not over two inches and an inclination to the main axis of less than twelve degrees.

8. In gyratory compressor apparatus, a liquid piston compressor unit having a helical piston passage revolving about an axis eccentric to its helical axis and a rotary carrier therefor composed of a casing of circular section, said unit being journaled within said casing at one side and a counterbalancing mass secured within said casing at the other side.

9. In gyratory compressor apparatus, a liquid-piston compressor unit operating by virtue of its rotation about a main axis inclined to its own axis, a rotary carrier in which said unit is journaled, said unit having a terminal fixture extended to an intersection with the main axis and forming a support for said carrier.

10. In gyratory compressor apparatus, the combination of a motor, a gyratory compressor unit revolving about an eccentric axis and a rotary carrier in which said unit is journaled, supported at one end by said motor and at the other by said unit.

11. In gyratory compressor apparatus, a liquid piston compressor unit having a helical piston passage rotating about an axis inclined to its own axis and a rotary carrier therefor, said carrier having a deep socket adapted to receive and support both ends of said unit to hold it at said inclination and being withdrawable endwise from said unit without disturbing the pipe connections of the latter.

12. Gyratory compressor apparatus comprising a base, a rotary carrier, a liquid-piston compressor unit including a helical piston passage revolving about an axis inclined to its own axis, two bearings for said unit supported on said carrier and a third bearing for the unit fixed on said base in alignment with the other two and with the carrier axis.

13. Gyratory compressor apparatus comprising a liquid-piston type compressor unit having a helical piston passage and operating by virtue of the rotation of said passage about an axis in-

clined to its helical axis, the axial length of said helical passage being at least several times the maximum diameter of the helix and the angle of the inclination being substantially less than twelve degrees.

14. In gyratory compressor mechanism of the kind described, a rotary carrier frame having two aligned journal bearings, a compressor unit having a helical piston passage carried on said bearings, an oil feed screw associated with one of said bearings, and a passage leading oil from said screw to the other bearing.

15. In gyratory compressor apparatus, a rotary carrier, a compressor unit containing a helical piston passage journaled in said carrier and revolved therein about an axis inclined to its own helical axis, said carrier being organized for holding lubricating oil and containing an oil feed screw, and means for conducting oil from said screw to one of the journals of said unit.

16. In gyratory compressor apparatus, a combination with a motor, a rotary carrier aligned with and directly coupled to the armature thereof, a liquid piston compressor unit eccentrically journaled in said carrier and containing a helical piston passage having an axial length several times greater than its helical diameter and pipe connections to said unit holding it from rotation about its own axis.

17. In gyratory compressor apparatus, a liquid piston compressor unit containing a helical piston passage and adapted to be rotated about an axis eccentric to its own helical axis, means at one end of said unit adapted to hold it against rotation on its helical axis, a rotary carrier in which such unit is eccentrically journaled and from which said carrier is separable by withdrawal in the direction of its own axis, a drive motor for said carrier separably engaged therewith and withdrawable therefrom in the direction of the axis of said carrier, and means for normally holding the aforesaid parts in their engaged relation.

18. In gyratory compressor apparatus, a liquid piston compressor unit containing a helical piston passage adapted to be rotated about an axis eccentric to its own helical axis, two spring tube helices, one being of smaller diameter than and located within the other, both connected at their lower ends to one end of said unit and adapted to hold said unit against rotation on its helical axis, mercury traps connected to said tubular helices at their upper ends, a rotary carrier in which said unit is eccentrically journaled and a drive motor coupled to said carrier.

19. In compressor apparatus, the combination of a compressor unit having a helical mercury piston passage and operating by virtue of the rotation of said passage about an axis inclined to its own axis, a conduit system including a return conduit and in or through which such unit establishes a pressure condition when in action and check-valve means organized between the unit and said system to restrain reverse flow between said unit and system when said unit becomes inactive.

20. Compressor apparatus as in the preceding claim including a mercury trap between said unit and system and a check valve incorporated in said trap adapted to restrain reverse flow on shut down.

21. Gyratory compressor apparatus comprising a rotary carrier, a liquid-piston-compressor unit journaled therein on an axis inclined to the carrier axis, a tubular supporting base containing

the carrier and unit and a motor mounted in the base directly coupled to the carrier, said motor being of less diameter than the tubular base and providing a cooling air flow passage therebetween.

- 5 22. In gyratory compressor appartus, a base, a liquid piston compressor unit containing a helical piston passage adapted to be rotated about an axis eccentric to its own helical axis, two  
10 spring tube helices, one having all its turns of

smaller diameter than the turns of the other helix and located within the other, each connected at one end to one end of said unit, means securing their other ends to said base adapted to hold said unit against rotation on its helical axis, 5  
a rotary carrier in which said unit is eccentrically journaled and a drive motor for rotating said carrier.

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