June 18, 1935. E. H. BELDEN 2,004,920

ROTARY COMPRESSOR

Filed July 18, 1932

Fig. 1.

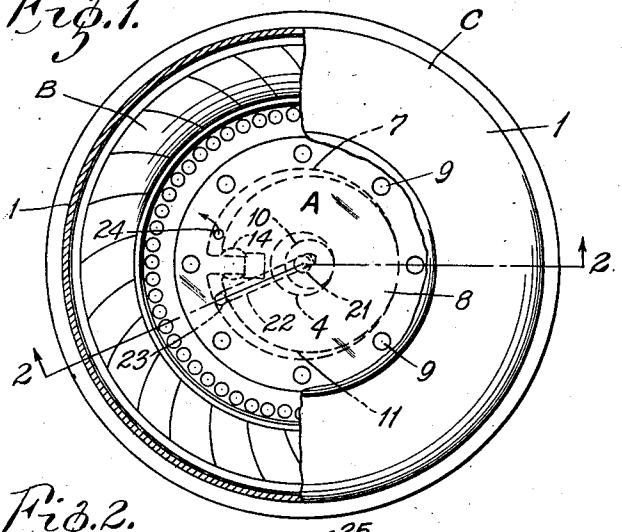


Fig. 8.

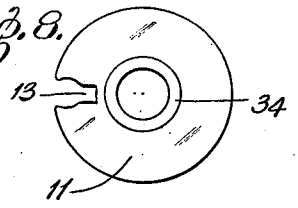


Fig. 9.

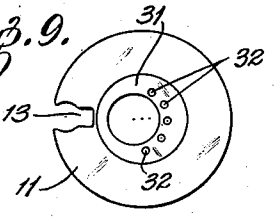


Fig. 2.

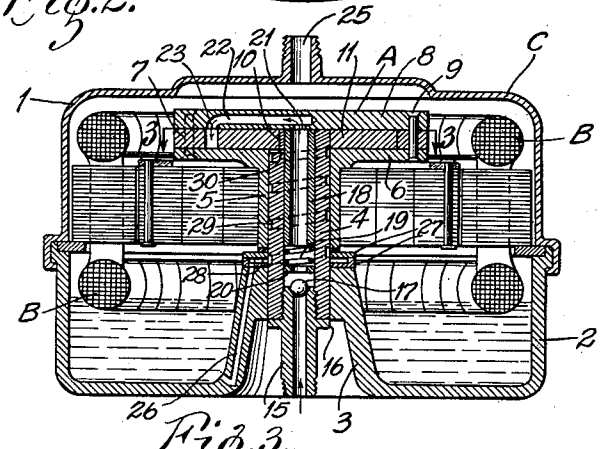


Fig. 6.

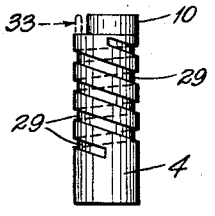


Fig. 3.

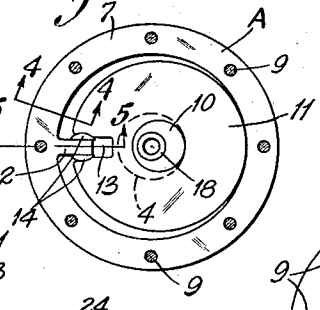


Fig. 10.

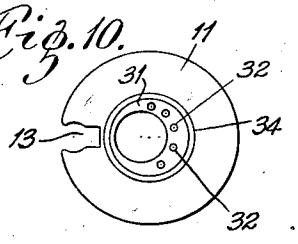


Fig. 5.

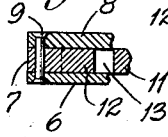


Fig. 7.

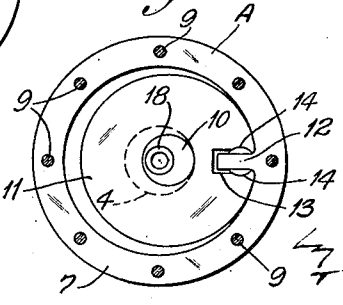
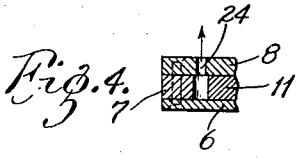


Fig. 4.



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UNITED STATES PATENT OFFICE

2,004,920

ROTARY COMPRESSOR

Edward H. Belden, Detroit, Mich.

Application July 18, 1932, Serial No. 623,174

3 Claims. (Cl. 230—140)

My invention relates to rotary compressors, particularly such as are adapted for use in air-cooling and conditioning units, domestic refrigerating systems and the like. The principal objects of the invention are to provide a mechanism that can be operated at high speeds in order to reduce the over all dimensions to a size that will be satisfactory to meet present day demands for portable air cooling units and refrigerators, to dispense with wiping vanes and otherwise to minimize friction and wear, avoid reciprocation of parts, prevent vibration and noise, provide for adequate lubrication, prevent leakage, provide for mounting of the compressor casing on the motor armature to be directly driven thereby, to provide for the driving of the impeller directly by said casing, to provide for the adjustment of the impeller relative to the casing, for housing the motor and all moving parts entirely inside a pressure chamber, to simplify and reduce the number, weight and cost of parts, to facilitate their assembly, and to obtain other advantages hereinafter appearing.

The invention consists in rotatably mounting the armature of the motor on an upright spindle and using said armature for supporting and driving the compressor casing. It also consists in arranging the compressor casing to rotate with the armature while a cylindrical impeller eccentrically mounted inside thereof but on a stationary spindle is driven by said casing through a slidable connection. It also consists in flanging the upper end of the armature sleeve to constitute the bottom of a cylindrical compressor casing and securing thereto the cover member of said casing which is continuous and imperforate over the end of the spindle. It also consists in encasing the motor and compressor in an air-tight compression chamber. It also consists in an improved oil lubricating system hereinafter described. It also consists in a floating ring interposed between the impeller and the spindle on which is mounted to permit slight radial movement of the impeller relative to the peripheral wall of the compressor casing so as to improve lubrication and prevent slippage. It also consists in the parts and combinations of parts hereinafter described and claimed. It also consists in mounting on the spindle of the impeller a rotatably adjustable ring with its outer cylindrical surface eccentric with relation to its inner surface and of proper size for the bore of the impeller to fit together with means for locking said ring in adjusted position.

In the accompanying drawing, wherein like numerals refer to like parts wherever they occur,

Fig. 1 is a plan view of the apparatus embodying my invention, a portion of the top of the housing being shown broken away to disclose the parts inside thereof;

Fig. 2 is a vertical sectional view of the apparatus on the line 2—2 in Fig. 1;

Fig. 3 is a horizontal section through the pump casing on the line 3—3 in Fig. 2;

Fig. 4 is a vertical section on the line 4—4 in Fig. 1;

Fig. 5 is a vertical section on the line 5—5 in Fig. 3;

Fig. 6 is a detailed side view of the spindle on the body of which are rotatably mounted the motor armature and shaft and on the end of which the pump impeller is mounted eccentrically with relation to the armature;

Fig. 7 is a view similar to Fig. 3, showing the parts in moved position;

Fig. 8 is a plan view, showing an impeller equipped with a floating ring;

Fig. 9 is a plan view, showing an impeller equipped with an adjusting ring; and

Fig. 10 is a plan view of an impeller equipped with a floating ring and an adjusting ring.

In the construction illustrated in the accompanying drawing, a compressor A and a motor B are encased in an air-tight housing C composed of separable members 1 and 2. The middle portion of the lower member 2 of the housing C extends inwardly and upwardly in the form of a hub 3 and is adapted to constitute a seat for a vertically disposed stationary tubular spindle 4 whose lower end is preferably press-fitted into said seat. Said spindle is a stub spindle, that is, its upper end has no direct support of its own, and it terminates below the top of the housing. Rotatably mounted on said stationary spindle 4 is a tubular hub or sleeve 5 which is fixed concentrically to the armature of the electric motor B suitably mounted inside of said housing with the lower end of said sleeve bearing on a seat provided therefor on said hub. The upper end of this armature sleeve 5 has a wide disk-like flange 6 at its upper end, which constitutes the bottom of the compressor casing. A thick circular ring 7 is mounted on the peripheral portion of said disk-like flange and constitutes the outer wall of the compressor casing. A disk-like plate 8 is mounted on top of said ring and constitutes the top of the compressor casing, said disk extending above the end of said stub spindle. Preferably, said top member and peripheral member are secured to the bottom member by rivets 9 extending

through them all.

The portion of the spindle above the bottom member of the compressor casing is of reduced diameter and offset to constitute a journal 10 that is eccentric with relation to the main axis of said spindle, which main axis is the axis of rotation of the armature and of the compressor casing. On this eccentric journal is rotatably mounted a circular impeller 11 of such thickness that it will have a slidable fit between the top and bottom of the compressor casing. The diameter of this eccentric impeller is such that, at their nearest point of approach, the periphery of the impeller just barely falls short of contact with the circular wall of the compressor casing.

The impeller 11 is operatively connected to the compressor casing so as to be moved thereby. For this purpose, the circular wall of the compressor casing has a radially disposed parallel-sided lug 12 extending inwardly therefrom into a radially disposed notch 13 in the periphery of said impeller 11. As the impeller is eccentrically mounted with respect to the compressor casing and its axis is stationary, the point of nearest approach between the impeller and the wall of the compressor casing rotates along the circular wall of said casing, causing the lug on the compressor casing to have a relative movement towards and away from the center of the impeller.

In connection with this in-and-out movement, said lug 12 also has a relative oscillating movement across the rotating radial line which extends from the center of the impeller 11 through the middle of the notch 13 therein. In order to provide for such oscillating or rocking movement, as well as the in-and-out movement without permitting slippage of the fluid past the lug 12 on the compressor casing, the side walls of the notch in the impeller 11 are formed with cylindrical seats, and in said seats are rotatably mounted segmental guide members 14 whose flat sides are spaced apart about the thickness of said lug. By this arrangement, said segmental members 14 constitute guides which permit radial sliding movement of the lug 12 and at the same time said segmental members are free to rock in their cylindrical seats to permit the oscillation of the lug above mentioned.

As stated above, the stationary spindle 4 is tubular. Preferably the bore of the spindle at the lower end thereof is screw-threaded to receive a hollow stem 15 which communicates through a suitable tube or pipe line with the expansion chamber of the system (not shown). The tubular stem 15 has an annular rib 16 which engages the bottom of said stationary spindle; and the upper end of said tubular stem is formed into a seat for a ball 17 which constitutes a check valve.

In the upper portion of the bore of said spindle is a sleeve 18 which has a sliding fit therein, with its lower end resting on a helical spring 19 whose lower end bears against an abutment 20 provided therefor in said bore. The upper end of said sleeve bears against the underside of the top 8 of the compressor casing. The top 8 of the compressor casing has a port 21 at the center thereof registering with the bore of the sleeve 18, and said central part communicates with a passageway 22 that extends radially outwardly to a port 23 in the underside of said top close to the peripheral wall of said casing and fairly close to the radial lug 12 on the cylindrical wall thereof. Also fairly close to said lug but on the opposite side thereof is a passageway 24 extending from the interior of said casing to the exterior thereof. This passageway may be conveniently located in the top member 8 of said casing. The upper part of the housing C, preferably the middle of the top thereof, is provided with a discharge opening 25 which communicates by means of suitable tubing or piping with the expansion chamber (not shown).

The bottom portion 1 of the housing C constitutes an oil receptacle. A passageway 26 is provided in the hub portion 3 of the housing and extends from the lower portion of said oil receptacle to the upper end of said hub member. Resting on said hub member are thrust bearing rings 27 that support the armature sleeve 5. These rings are provided with radial grooves 28 in position to communicate with helical grooves 29 in the outer surface of the spindle. As the oil is under considerable pressure, and a lower pressure is maintained at the clearance space between the sleeve 18 and the spindle 4, it will pass upwardly the full length of the spindle 4 and thus furnish lubricant for the thrust bearing at the foot of the armature sleeve 5, and also for the bore of the armature sleeve and for all rotating parts. It is noted that on account of the pressure of the spring 19 against the slidable sleeve 18 in the bore of the spindle 4, an airtight-fit is made between the upper end of said sleeve and the top 8 of the expansion chamber. The sleeve itself is lubricated through a radially disposed passageway 30 through the wall of the spindle.

It is desirable to provide for an adjustment of the impeller with relation to the compressor casing so as to insure proper positioning of these parts at their point of nearest approach. As shown in Fig. 9, a suitable means of adjustment comprises a ring 31 adapted to be mounted on the impeller spindle 4 with its outer surface eccentric thereto. The lower face of said ring is provided with a series of holes or notches 32 adapted to receive a dowel pin 33 (see Fig. 6 mounted in the top of said spindle. The adjustment is made by turning said ring to proper angular position and then pressing it down so that said dowel pin will enter the hole thereof that is in position to receive it. In this case the eccentric ring 31 functions as the journal on which the bore of the impeller turns.

In the construction illustrated in Fig. 2, the bore of the impeller 11 is directly journaled on its spindle 4. In some cases, however, it is desirable to make the bore of the impeller 11 (see Fig. 8) larger than the spindle so as to accommodate a floating ring 34 between them, said floating ring being journaled on the spindle and the impeller being journaled on said floating ring. By this arrangement, there are two films of oil between the impeller and its spindle instead of one, whereby the impeller is enabled to have a very slight movement relative to its spindle if and when occasion requires. As shown in Fig. 10, this floating ring may be used conjointly with the eccentric adjusting ring described above.

The operation of the construction illustrated is as follows: Assuming that there is a complete circulatory system comprising an expansion chamber connected by suitable piping to the delivery opening 25 of the housing C and also connected to the inlet port in the stem 15, the course of the fluid is through the bore of the spindle 4 into and through the cover or top 8 of the compressor casing into the crescent-shaped expansible chamber between the impeller 6 and the

circular wall of the compressor casing, and thence through the exhaust port 24 of said chamber into the pressure chamber formed by the housing C and thence through the delivery line to the expansion chamber and thence back through the inlet line. The check valve 17 in the bore of the stem 15 protects the inlet line against the pressure of the compressor.

As the compressor casing is secured directly to the sleeve 5 of the armature and the impeller is operatively connected to said casing, the entire compressor including the impeller 11 thereof rotates with said armature, said impeller being driven by the compressor casing by reason of the lug and notch engagement 12 and 13 thereof. As the impeller is of smaller diameter than the diameter of the compressor casing and has its axis so located that its periphery almost touches the circular wall of the compressor casing at one point, there is a crescent-shaped space between the periphery of the impeller and said circular wall of the compressor casing. When the lug 12 on the casing and the center of the impeller 11 are in radial alinement with the center of said compressor casing, said crescent-shaped space is clear and unobstructed throughout almost an entire circle. When, however, the lug is shifted from this position, it divides said space into two chambers, one of which increases in volume progressively as the other decreases in volume. This is due to the fact that the straight line through the two centers remains fixed and the point of closest approach of the impeller to the circular wall of the casing is always in this line, although the lug 12 which separates the crescent-shaped space into two chambers is revolving. As the inlet port 23 opens into the chamber on one side of the lug 12 and the discharge port 24 opens into the chamber on the other side of said lug, and as the point of closest approach between the impeller 11 and circular casing wall is continuously revolving, the fluid enters through the inlet port and fills the crescent-shaped chamber which gradually decreases in volume so as to compress said fluid and force it out through the discharge port into the housing. Thus the pressure in said housing is gradually built up and maintained and the compressed fluid is delivered therefrom to the expansion chamber of the system as required.

All parts of the compressor together with the driving motor are inside the air-tight housing C, in which considerable pressure is maintained (say sixty to one hundred pounds per square inch for ordinary domestic use); and the lower portion of said housing serves as a receptacle for the lubricating. Thus the lubricant finds its way to the bearings of all moving parts including not only the journal of the armature and of the impeller but also the thrust bearing on which the armature sleeve is supported and also the flat bearing between the underface of the cover of the compressor casing and the top end of the spring-pressed sleeve 18 in the bore of the spindle and the cylindrical surface of said sleeve, the principal duty of said sleeve being to seal the compressor casing at this point. Sufficient oil for lubricating the surfaces of the impeller enters the compressor casing through the space between spindle 4 and sleeve 18, and the oil in the compressor casing forms a film that not only functions as a lubricant between the impeller and the casing but for the prevention of slippage of fluid between them at their nearest point of approach.

Among the advantages of the construction hereinbefore described are the following: The compressor is composed of a very small number of parts, all of which are of very simple forms that may be easily and inexpensively made with precision. The compressor is very light, its cylindrical surfaces are free from wear and the other parts are well lubricated; and it is practically noiseless and free from vibration. The compressor is mounted to rotate directly with the armature without the intervention of gearing or other transmission devices. As the casing of the compression chamber is directly connected to the motor armature, and directly drives the impeller, the transmission is very simple and effective and as all rotating parts turn on their own centers in one direction without vibration or friction, it is especially well adapted for high speed.

While I have described one form of construction embodying my invention, it is obvious that modifications may be made without departing from the invention and I do not wish to be restricted to the particular construction described.

What I claim is:

1. The combination with a tight housing having an oil receptacle in its lower portion of an electric motor and a compressor in said housing, said housing having the middle of its bottom portion arranged to receive a vertically disposed stub spindle and a horizontal annular shoulder, a vertically disposed stub spindle fixed in said bottom portion with a helical groove on its outer surface and having its topmost portion arranged to form an eccentric spindle, said motor having an armature sleeve journaled on said spindle with its lower end supported by said shoulder, said compressor comprising a casing concentric with said armature and with its bottom directly connected with said armature sleeve, a circular impeller in said casing mounted on said eccentric spindle, and a vertically slidable spring-pressed sleeve mounted in the main spindle and bearing against the top of said casing, said housing having a passageway extending from the lower portion of the oil receptacle and communicating with the outer surface of said spindle.

2. The combination with a tight housing having an oil receptacle in its lower portion of an electric motor and a compressor in said housing, said housing having the middle of its bottom portion arranged to receive a vertically disposed stub spindle and a horizontal annular shoulder, a thrust bearing on said shoulder, a vertically disposed stub spindle fixed in said bottom portion with a helical groove on its outer surface and having its topmost portion arranged to form an eccentric spindle, said motor having an armature sleeve journaled on said spindle with its lower end supported by said bearing, said compressor comprising a casing concentric with said armature and with its bottom directly connected with said armature sleeve, a circular impeller in said casing mounted on said eccentric spindle, and a vertically slidable spring-pressed sleeve mounted in the main spindle and bearing against the top of said casing.

3. The combination with a tight housing having an oil receptacle in its lower portion of an electric motor and a compressor in said housing, said housing having the middle of its bottom portion arranged to receive a vertically disposed stub spindle and a horizontal annular shoulder, a vertically disposed stub spindle fixed in said bottom portion with a helical groove on its outer surface, said motor having an armature sleeve journaled

on said spindle with its lower end supported by said shoulder, said compressor comprising a casing concentric with said armature and with its bottom directly connected with said armature sleeve, and a circular impeller in said casing, and a vertically slidable spring-pressed sleeve mounted in the main spindle and bearing against the top of said casing, said housing having a passageway extending from the lower portion of the oil receptacle and communicating with the outer surface of said spindle and said shoulder.

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