April 2, 1968 J. RAUFEISEN 3,375,972

PUMP FOR A GASEOUS MEDIUM

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FIG. 1

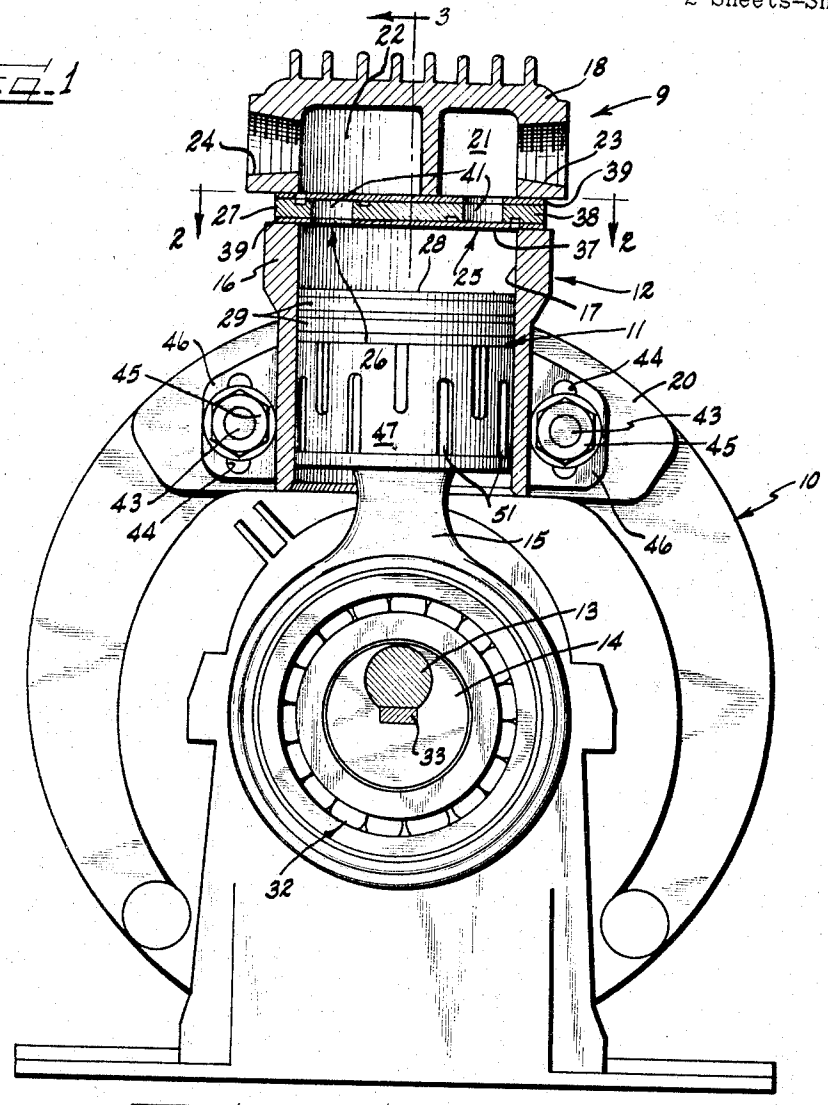
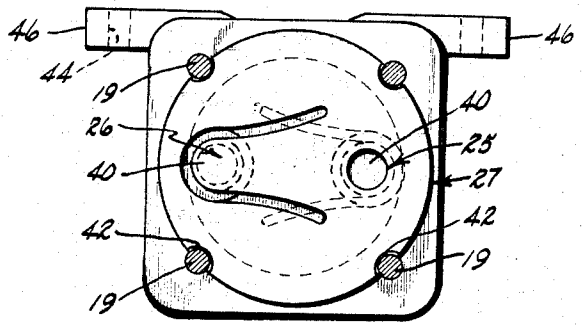


FIG. 2



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Fig. 3

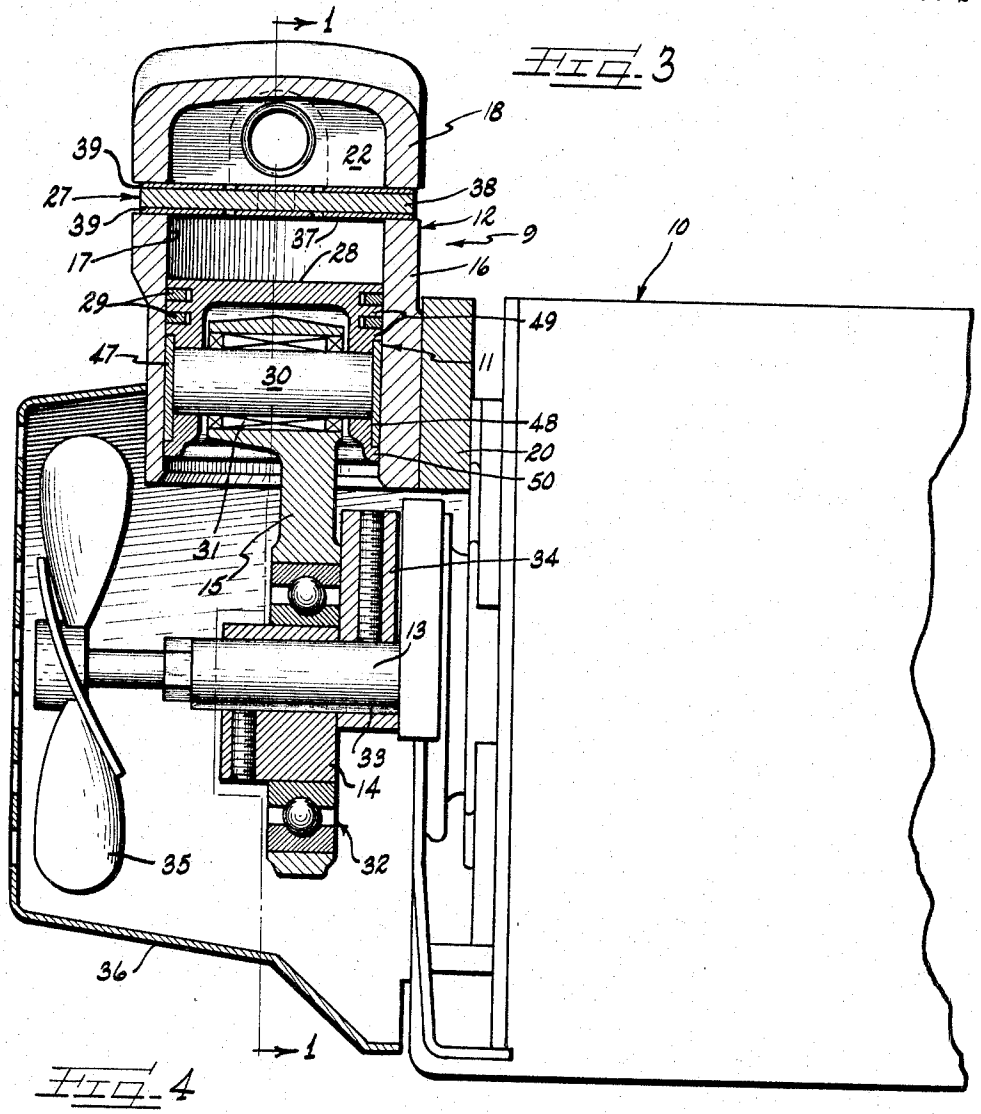
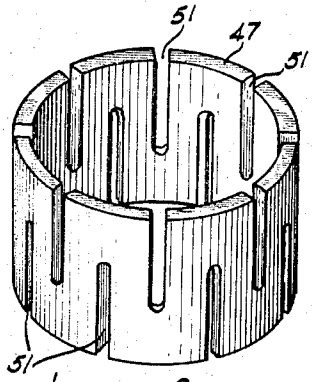


Fig. 4



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PUMP FOR A GASEOUS MEDIUM

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9 Claims. (Cl. 230—172)

This invention relates generally to pumps for gaseous media and, more particularly, to compressors and vacuum pumps of the oilless type having a cylinder mounted on a support structure such as the housing of a motor or engine and a piston reciprocable in the cylinder and connected to the rotary output shaft of the motor through an eccentric and connecting rod. When used as compressors, such pumps are usually rated to provide a predetermined output of compressed air or other gas which depends on various factors including the cylinder diameter, the throw of the eccentric which determines the piston stroke, and the speed of the motor shaft. The efficiency of the compressor varies directly with the amount of gas evacuated with each stroke of the piston and therefore indirectly with the volume of clearance between the piston and the cylinder parts when the piston is at the outer limit of the stroke. To avoid the use of oil, a sleeve of an oilless, self-lubricating bearing material is interposed between the piston and the cylinder.

The primary object of the present invention is to provide a novel pump of the above character which is of simple and inexpensive construction, which compensates for deviations in manufacturing tolerances, and in which it is possible to achieve the same minimum clearance volume between the piston and the cylinder parts for a uniformly high efficiency when using eccentrics having different throws to compensate for different output speeds of the driving shaft.

A more detailed object is to mount the cylinder on the support structure in a novel manner for varying the position of the cylinder with respect to the driving shaft to obtain the same clearance volume with eccentrics having different throws.

The invention also resides in a novel construction of the piston bearing sleeve which is simple and inexpensive to manufacture and install, which is easy to retain in place between the piston and cylinder, and which facilitates the dissipation of heat from the piston.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings in which:

FIGURE 1 is a vertical sectional view of a motor with a compressor embodying the novel features of the present invention, the view being taken along the line 1—1 of FIGURE 3 and omitting a housing for some of the compressor parts;

FIGURE 2 is a sectional view taken along the line 2—2 of FIGURE 1;

FIGURE 3 is a side elevational view of the motor and compressor combination with the compressor shown in section along the line 3—3 of FIGURE 1;

FIGURE 4 is an isometric view of a bearing sleeve for the piston of the compressor.

The invention is shown in the drawings, for purposes of illustration, embodied in a pump 9 used as a compressor and mounted on the housing of an electrical motor 10. The compressor comprises generally a piston 11 reciprocable in a cylinder 12 and connected to the rotary output shaft 13 of the motor through an eccentric 14 and connecting rod 15. The cylinder comprises a body 16 with a bore 17 open at opposite ends and a head 18 at one end of the body secured thereto by suitable mounting bolts 19. The body is secured to a mounting

plate 20 rigid with one end of the motor housing with the axis of the bore lying along a radius of the motor shaft. The head is divided into inlet and outlet chambers 21 and 22 having corresponding ports 23 and 24 and respectively communicating with the cylinder bore through inlet and outlet valves 25 and 26 of a valve assembly 27 interposed in this instance between the head and the cylinder body.

The piston 11 is of cylindrical shape closed at one end by a flat head 28 and open at its other end to receive the connecting rod 15. Axially spaced, outwardly opening peripheral grooves adjacent the head end of the piston receive seal rings 29 which are formed of a suitable self-lubricating material, for example, a copolymer, tetrafluoroethylene which is sold under the trade name "Teflon" or a compound of such material. The rings are flexible and, in this instance, are backed by leaf springs (not shown) which act between the rings and the bottoms of the grooves to urge the rings outwardly against the wall of the bore 17.

To connect the piston 11 to the connecting rod 15, a piston pin 30 is pressed into diametrically alined holes in the cylindrical wall of the piston and is journaled in bearings 31 on one end of the rod. At its other end, the rod is journaled on the eccentric 14 through the medium of a ball bearing assembly 32. The eccentric is simply a cylindrical plug having a bore and a keyway off-set from its axis and receiving the motor output shaft 13 and a key 33 thereon, the eccentric and the key being secured to the shaft as by a set screw. Where, as in this instance, there is only one cylinder, it is preferred to balance the offset weight of the eccentric with a suitable counterweight 34 secured to the shaft. A fan blade 35 is secured to the motor shaft outwardly beyond the eccentric and forces cooling air inwardly through openings in a housing 36 around the eccentric and the inner end of the piston and into the motor housing which it is exhausted through suitable openings (not shown).

With the compressor 9 as described thus far, air is drawn into the cylinder bore 17 through the inlet valve 25 and the inlet port 23 on the intake stroke of the piston away from the cylinder head 18 and is forced out through the outlet valve 26 and port 24 on the compression stroke in the opposite direction. Because the efficiency of the compressor varies directly with the amount of air evacuated during each compression stroke, it is desirable that the clearance volume defined by the piston head, cylinder bore wall, and valve assembly 27 be as small as possible when the piston 11 is at the end of its stroke. The valve assembly thus presents a flat surface 37 in a plane parallel to the head and normal to the cylinder axis, such surface extending over substantially the entire area of the inner side of the assembly at the end of the bore.

The valve assembly 27, in the present instance, is of the so-called wafer type having a center plate 38 sandwiched between two thin sheets 39 of metal which are cut away to form cantilevered reeds 40. At their free ends, the reeds lie against and cover the peripheries of holes 41 in the plate to form the valves, the reed of the input valve being located on the inner side of the plate and the output valve reed being located on the opposite side. The assembly is clamped between the head and the cylinder body and peripheral cut-outs 42 are provided in the plate and sheets to receive the mounting bolts 19 loosely. The inner side of the input valve sheet constitutes the inner surface 37 parallel to the valve head and within the area of the cylindrical bore and is flat except for the hole for the output valve and except for the cut out portion around the input valve reed 40.

A compressor of the above character normally is used with a synchronous motor and is rated in cubic feet per minute in accordance with the power rating of the motor,

the speed of the motor shaft and the displacement of the piston which depends on the length of its stroke and the diameter of the cylinder bore. Thus, where a compressor and motor are designed for use at a speed depending on one frequency of electrical current such as the 60 cycles per second current available in this country, its use with another frequency such as the 50 cycles available in some European countries results in the loss of output unless an eccentric with a different throw and a correspondingly different cylinder are substituted for those designed for the other speed.

In accordance with the present invention, the cylinder **12** is mounted in a novel manner in relation to the shaft **13** so that the same cylinder may be used and only the eccentric **14** need be changed to compensate for a different speed and still obtain the same output and efficiency. The improved mounting also makes it possible to compensate for deviations in manufacturing tolerances and to match the clearance volume with the motor for operation at the maximum motor efficiency. To these ends, novel mounting means is provided for changing the position of the cylinder longitudinally of its axis and radially with respect to the shaft and for securing the cylinder in different positions to achieve desired clearance volumes for different eccentrics and motors. The mounting means thus includes guide elements **43** and **44** on the mounting plate **20** on the motor and on opposite sides of the cylinder and securing members **45** are provided to hold the cylinder rigidly in place.

Although they may take other forms, for simplicity and economy of construction, the guide elements **43** and **44** preferably take the form of pin and slot connections between the mounting plate **20** on the motor and flanges **46** projecting from opposite sides of the cylinder body **16**. In the present instance, there are two such connections each with one guide **43** in the form of a threaded stud projecting rigidly from the mounting plate on the motor and the other guide element **44** in the form of a slot. The two slots are formed in the flanges on the cylinder body and parallel the cylinder axis. The securing members **45** are nuts threaded on the studs and clamping the flanges against the mounting plate to retain the cylinder securely in the desired position.

To avoid the use of oil or other liquid lubricant, a bearing cylinder **47** of self-lubricating material encircles the inner portion of the piston **11** between the piston rings **29** and the inner open end of the piston. In accordance with another aspect of the invention, this bearing and the related parts of the piston are constructed in a novel manner simplifying the construction and assembly of the parts and also insuring proper operation as the parts become heated during service use. The bearing thus is formed as an endless sleeve which fits about an intermediate portion **48** of the piston and the latter is formed as a spool with flanges **49** and **50** projecting radially and outwardly from opposite ends of the intermediate portion to retain the sleeve on such portion. To permit the use of an endless sleeve and obtain a tight fit of the same on the piston, slits **51** extend inwardly from each end of the sleeve and short of the other end at angularly spaced points around the sleeve. The slits extending inwardly from each end of the sleeve alternate circumferentially with the other slits from the other end and overlap axially with such other slits at their adjacent inner ends.

The slits **51** are utilized to dissipate heat from the piston during operation of the compressor by spacing opposed side walls of each slit apart circumferentially of the sleeve **47**. In the present instance, the slits have spaced parallel side walls which are parallel to the axis of the sleeve. The outer diameter of the flanges **49** and **50** is slightly less than the diameter of the cylinder bore **17** and is less than the outer diameter but greater than the inner diameter of the sleeve when the sleeve is assembled on the piston.

To insure a tight fit of the sleeve **47** on the piston **11**, the relaxed inner diameter of the sleeve preferably is slightly less than the outer diameter of the intermediate portion **48** of the piston between the flanges **49** and **50**. The outer flange is of a greater axial extent than the inner flange to provide space for formation of the grooves for the piston rings **29**.

A suitable material for the sleeve **47** is the same copolymer as that used for the piston rings **29**, this material having a high heat co-efficient of expansion. The cylinder head **18**, cylinder body **16**, and piston **11** are die cast aluminum parts.

In the assembly of the parts, the bearing sleeve **47** is placed on the piston **11** after the piston pin **30** has been inserted in the alined holes and in the bearing **31** on the connecting rod **15**. By virtue of the slits **51** in the sleeve and their axially overlapping relation, the sleeve may be telescoped axially over one of the piston flanges **49** even though the relaxed inner diameter of the sleeve is less than the outer diameter of the intermediate portion **48** of the piston. Once in place between the flanges **49** and **50**, the sleeve contracts tightly around the intermediate portion and is retained in place by the flanges during axial movement of the piston within the cylinder bore **17**. Due to its extension radially beyond the flanges, the sleeve contacts the bore wall to provide an anti-friction, self-lubricating bearing for the piston.

After the eccentric **14** and connecting rod **15** have been assembled on the shaft **13** and the piston **11** has been assembled in the cylinder body **16**, the body is located in the desired position with its axis alined with a radius of the shaft. To locate the cylinder in this position and provide the desired minimum volume clearance between the piston head **28** and the inner flat side **37** of the valve assembly, the shaft and eccentric are turned until the piston is in its top dead center position. Then, a few thousandths of an inch then is placed on the piston head and, using a straight edge across the top of the cylinder body, the body is shifted radially as permitted by the slots **44** until the outer surface of the cylinder body and the piston head lie in the same plane. With the parts in this position, the nuts **45** are tightened on the studs **43** to secure the cylinder in place. Finally, thin gaskets a few thousandths of an inch thick are placed between the cylinder body and the valve assembly and between the latter and the cylinder head and the valve assembly **27** and cylinder head are bolted in place, the gasket between the body and the valve assembly determining the minimum clearance between the piston head and the valve assembly.

In the event the improved compressor is to be used with a motor having a different speed and requiring an eccentric with a different throw to compensate for the different speed, the same cylinder may be used with the different eccentric and still obtain the same output of the compressor. It is only necessary, after the eccentric has been changed, to repeat the assembly process of the cylinder but shifting the cylinder body radially of the shaft to a different position of minimum volume clearance as permitted by the pin and slot connections **43, 44** between the cylinder body flanges **46** and the motor mounting plate **20**.

I claim:

1. The combination of a support structure and a rotary output shaft mounted thereon, a cylinder having a cylindrical body, means mounting said cylinder on said structure with the axis of the body disposed radially of said shaft, a head having inlet and outlet ports and secured to one end of said body remote from the shaft, and a valve assembly mounted at said end of said body and having inlet and outlet valves communicating respectively with said inlet and outlet ports, a piston reciprocable in said cylinder, and an eccentric rotatable with said shaft and connected to said piston to reciprocate the piston through a stroke equal to the throw of the eccentric during rotation of the shaft, said mounting means including guide elements permitting shifting of said cylinder body relative to said support structure and into a different position radially

of said shaft to provide a minimum clearance volume defined by said piston, said cylinder body and said valve assembly when said piston is at the outer limit of its stroke and when said eccentric is replaced by an eccentric having a different throw.

2. The combination of claim 1 in which said guide elements are pin and slot connections between said cylinder body and said support structure.

3. The combination of claim 1 in which said guide elements are slots formed on flanges on said cylinder body in parallel with the cylinder axis and pins projecting rigidly from said support structure and into said slots.

4. The combination of a support structure and a rotary output shaft mounted thereon, a cylinder having a cylindrical body with open ends, means mounting said cylinder on said support structure with the axis of the body disposed radially of said shaft, a head having inlet and outlet ports and secured to one end of the body remote from the shaft, and a valve assembly mounted at said end of said body and having inlet and outlet valves communicating respectively with said inlet and outlet ports, said valve assembly having a flat surface lying in a plane normal to said cylinder axis on the inner side of the assembly adjacent the interior of said body and extending over substantially the entire area of such side, a piston reciprocable in said cylinder and having a flat inner face parallel to and opposing said flat valve assembly surface, and an eccentric rotatable with said shaft and connected to said piston to reciprocate the piston through a stroke equal to the throw of the eccentric during rotation of the shaft, said mounting means including guide elements permitting shifting of said cyilnder body relative to said housing and into different positions radially of said shaft to provide a minimum clearance between said face and said surface when said piston is at the outer limit of its stroke and when said eccentric is replaced by an eccentric having a different throw.

5. The combination of a cylinder having a bore, a piston of spool shape reciprocable in said bore and having flanges projecting radially and outwardly from opposite ends of a cylindrical intermediate portion, and an endless cylindrical sleeve of flexible bearing material interposed between and engaging the wall of said bore and said intermediate portion of said piston and extending around the intermediate portion and axially between said flanges, said sleeve having slits extending inwardly from each of its ends toward but short of the other end at angularly spaced points around its periphery to facilitate assembly

of the sleeve on said piston by telescoping the sleeve over one of said flanges and the outer diameter of said flanges being greater than the inner diameter and less than the outer diameter of said sleeve.

6. The combination of claim 5 in which first ones of said slits extending inwardly from one of said sleeve ends alternate circumferentially of the sleeve with second ones of the slits and extend inwardly from said one end of the sleeve to overlap axially of the sleeve with the second slits.

7. The combination of claim 5 in which opposed walls of each of said slits are spaced apart circumferentially of said sleeve to expose areas of said intermediate portion of the sleeve for dissipation of heat from the sleeve.

8. The combination of claim 5 in which the relaxed inner diameter of said sleeve is less than the outer diameter of said intermediate portion of said piston to obtain a tight fit of the sleeve on the intermediate portion.

9. For use with a cylinder having a bore and a piston of spool shape reciprocable in said bore and having flanges projecting radially and outwardly from opposite ends of a cylindrical intermediate portion of the piston, an endless cylindrical sleeve of flexible bearing material interposed between and engaging the wall of said bore and said intermediate portion of said piston and extending around the intermediate portion and axially between said flanges, said sleeve having slits extending inwardly from each of its ends toward but short of the other end at angularly spaced points around its periphery to facilitate assembly of the sleeve on said piston by telescoping the sleeve over one of said flanges, and the outer diameter of said flanges being greater than the inner diameter and less than the outer diameter of said sleeve.

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