Aug. 9, 1927.

F. I. L. BYLGER

1,638,183

GYRATORY PUMP OR COMPRESSOR

Filed Oct. 26, 1926

3 Sheets-Sheet 1

Fig. 1.

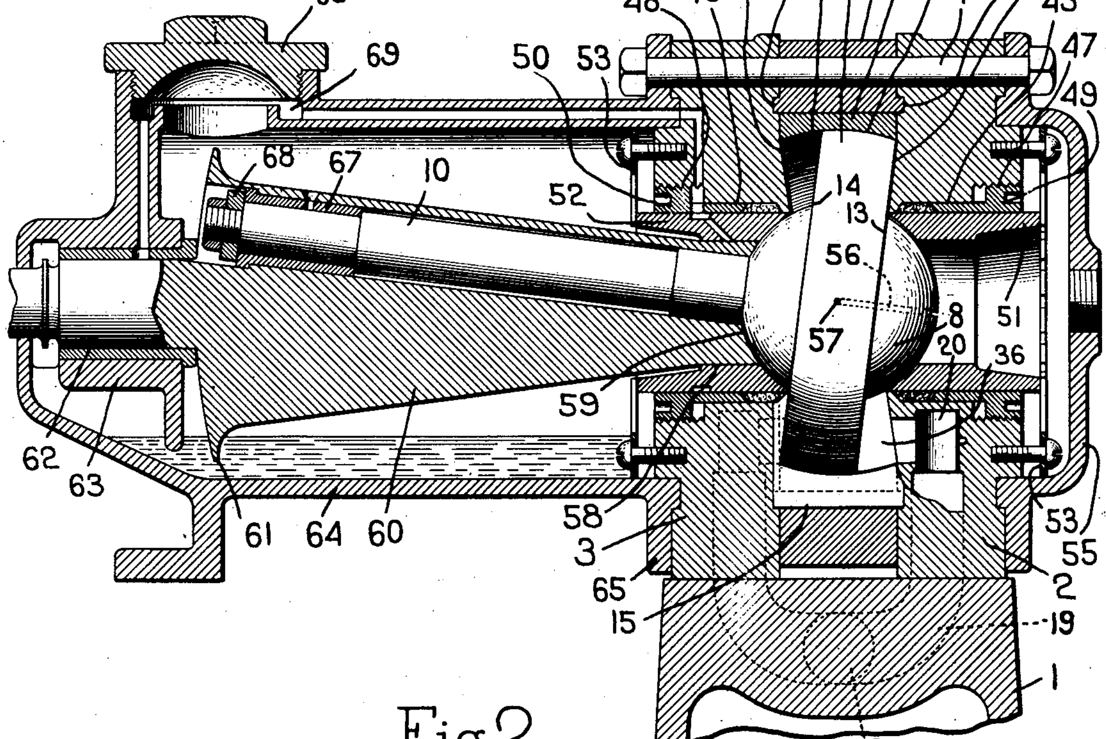
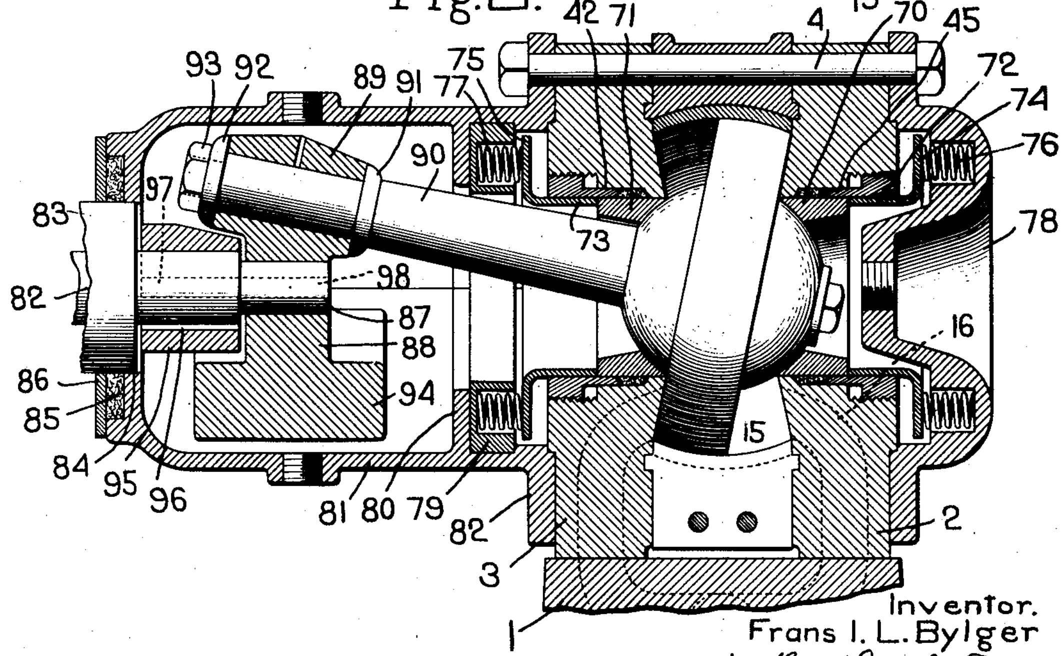


Fig. 2.



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3 Sheets-Sheet 2

Fig. 3.

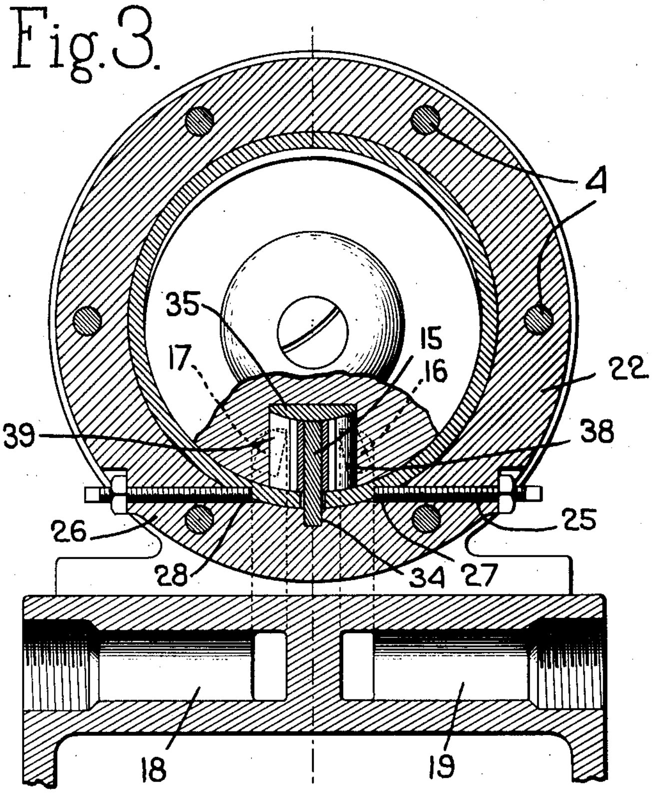


Fig. 4.

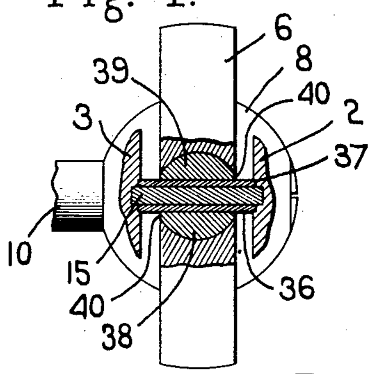


Fig. 5.

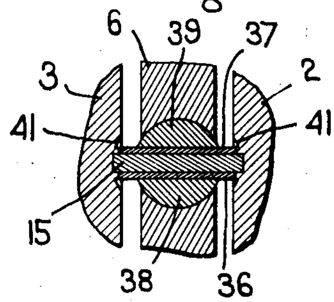


Fig. 6.

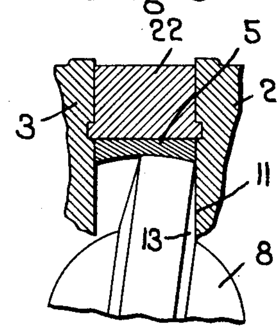


Fig. 7.

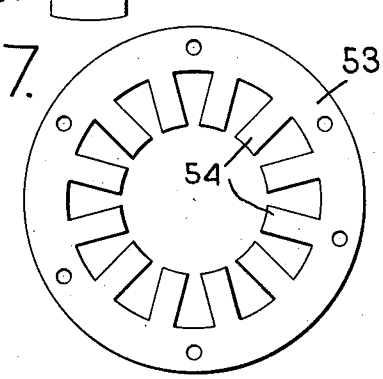


Fig. 8.

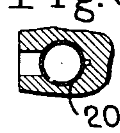
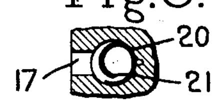


Fig. 9.



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GYRATORY PUMP OR COMPRESSOR

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Fig. 10.

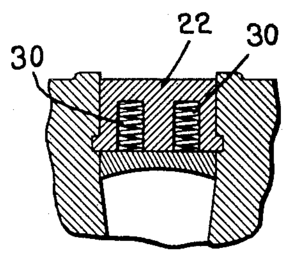


Fig. 11.

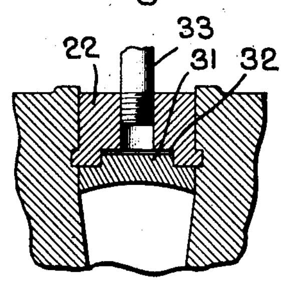


Fig. 12.

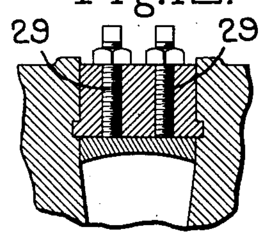


Fig. 13.

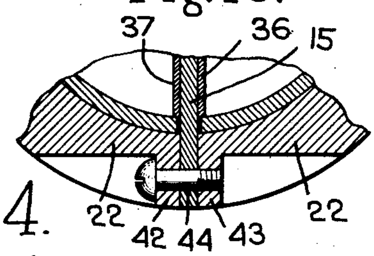


Fig. 14.

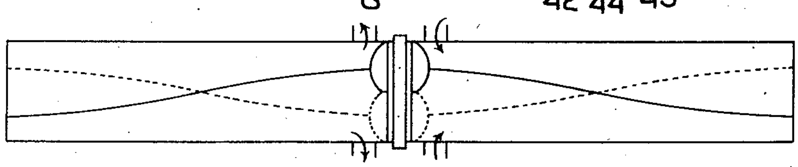


Fig. 15.

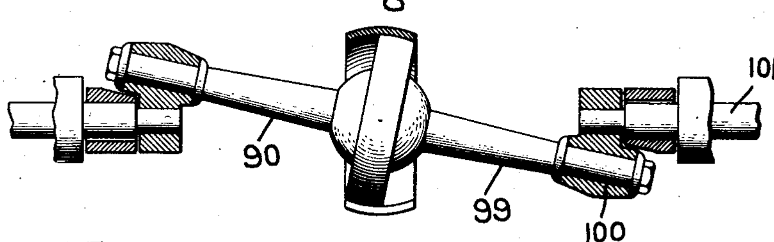
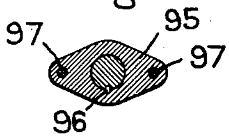


Fig. 16.



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Patented Aug. 9, 1927. 1,638,183

UNITED STATES PATENT OFFICE.

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GYRATORY PUMP OR COMPRESSOR.

Application filed October 26, 1926. Serial No. 144,227.

This invention relates to improvements in machines comprising gyratory pumps, compressors, blowers, engines, and the like, in which an impeller having a gyratory motion in a suitable chamber operates to admit a fluid and expel it under pressure, or if the fluid is introduced under pressure acts to impart rotation to a suitable shaft and thereby transmit power.

The invention more particularly relates to a gyratory pump for admitting and delivering a gaseous or liquid fluid under pressure. The invention, therefore, will be described as a pump, although it will be obvious to those skilled in the art that by the introduction of fluid under pressure into the chamber of the machine the impeller will be caused to gyrate and thereby to act as a motor.

One of the objects of the invention is to increase the efficiency of this type of machine by improvements in simplicity and compactness of construction and in vital details so that such advantages as direct connection to high speed motors with low surface speeds of wearing parts will be attained.

A further object of the invention is to provide a mechanism which requires no priming and which will be capable of acting upon, or being acted upon, by liquids, steam or gas efficiently and in a practical way.

The important object of the invention is to provide an adjustable spherical shell complementary to the spheroidal periphery of the impeller which may be either automatically or manually adjusted to maintain a close running fit upon the impeller and also to permit the impeller to grind its own perfectly fitting surface in the shell.

A further object of the invention consists in providing an improved partition crossing the chamber and intersecting the impeller with a sliding swivel joint of such a character as to prevent the escape of liquid from the compression side of the chamber to the opposite side thereof.

A further feature of the invention consists in providing an improved check valve for the ports leading to or from the chamber of the machine.

A further object of the invention is to provide automatically adjustable glands to co-operate with the spherical hub of the impeller and also to provide means adapted to form an oil seal for such glands.

A further object of the invention is to provide a novel form of counterbalanced driving mechanism for the impeller shaft.

A further feature of the invention consists in providing a construction in which the shaft of the impeller may be constructed in two sections adapted to be driven by a separate motor.

Various other objects and features of the invention will more fully appear from the following description and the accompanying drawings and will be particularly pointed out in the claims.

Preferred embodiments of the invention are illustrated herein as applied to pumps operable to pump a liquid or a gas or to act as a compressor. It will be readily understood that machines embodying the invention may be made of any desired size, but that the primary object thereof is to provide a relatively small machine which may be actuated at a high speed and which may be used not only as a pump, but which may be readily installed as a compressor in small refrigerating systems as those employed in domestic refrigerators.

In the drawings:

Fig. 1 is a vertical longitudinal section of a pump or compressor embodying the invention, the impeller and its shaft being shown in elevation;

Fig. 2 is a similar view of a slightly modified embodiment of the invention;

Fig. 3 is mainly a vertical transverse section, a portion of the impeller disk and its hub being shown in elevation;

Fig. 4 is a detail view, partially in horizontal section, showing the relative positions of the construction of the partition for the working chamber of the machine and the sliding swivel joint between the same and the impeller disk;

Fig. 5 is a sectional view showing a slightly modified form of the swivel and sliding joint between the partition and the impeller;

Fig. 6 is a detail view illustrating a modified form of impeller disk and showing a portion of the co-operating heads and shell in operative relation thereto;

Fig. 7 is a detail view showing a preferred form of spring plate for automatically maintaining a gland in fluid-tight relation to the spherical hub of the impeller;

Fig. 8 is a detail sectional vew illustrating one of the conduits leading to or from the chamber of the machine, with a split cylindrical spring check valve therein, the valve being shown in closed position;

Fig. 9 is a similar view illustrating the valve in open position to permit passage of fluid from the chamber;

Fig. 10 is a detail sectional view of a portion of the casing and the annular shell therein which surrounds and co-operates with the impeller, illustrating the springs for automatically and concentrically adjusting the shell upon the impeller;

Fig. 11 is a similar view illustrating means for automatically adjusting the shell by the fluid under pressure;

Fig. 12 is a similar view illustrating screws for adjusting the shell;

Fig. 13 is a detail view illustrating the modified form of casing in which the shell supporting portion of the casing is made in sections and the partition for the working chamber clamped between adjacent end portions of the section;

Fig. 14 is a view showing the sliding swivel connection between the partition of the chamber and the impeller and illustrating diagrammatically the motion of the impeller which acts upon the sliding joint;

Fig. 15 is a detail view illustrating the impeller disk as being provided with a shaft having oppositely disposed sections extending perpendicularly to the median plane of the impeller and acted upon at their ends by independent driving motors, whereby the power applied to the impeller may be practically doubled; and,

Fig. 16 is a detail sectional view showing the connection of the driving shaft to an arm in which the actuating shaft of the impeller, illustrated in Fig. 2, is journalled.

The machines illustrated in the drawings comprise a base 1 having suitable legs upon which is mounted a pair of ends or heads 2 and 3 which are connected by suitable bolts 4 and clamp between them an annular member, such as a shell 5, to form a chambered casing for the impeller. The impeller is in the form of a disk 6 having a spheroidal periphery 7 and provided with a spherical hub 8. The shell 5 is provided with a spherical surface 9 which is complementary to the spheroidal surface of the impeller disk and engages the same with a close running fit. An actuating shaft 10 extends from the hub 8 of the impeller perpendicular to the median plane of the impeller disk and is actuated by suitable means which will hereinafter be more fully described.

The ends or heads 2 and 3 are provided respectively with faces 11 and 12 which are complementary to the respective faces 13 and 14 of the impeller disk to provide a progressively moving line of contact therewith during the gyratory movement of the impeller. The faces 13 and 14 of the disk are illustrated herein as flat while the complementary faces 11 and 12 of the heads are shown as slightly conical, but it will be understood that the disk may be provided with conical faces and the heads with flat faces, as illustrated in Fig. 6, or that any other complementary arrangement of the faces may be employed within the scope of the invention.

The working chamber in which the impeller gyrates is divided transversely by a partition 15 which preferably is located in the lower portion of the chamber and intersects the impeller disk, and inlet and outlet ports 16 and 17 are located adjacent to and upon opposite sides of the partition 15. The inlet and outlet ports are respectively connected by manifolds 18 and 19 so that the fluid may be introduced through the inlet manifold to the inlet ports on both sides of the impeller and the outlet ports from each side of the impeller may likewise communicate with a common outlet conduit. Desirably these ports are of cylindrical form—a form most easily constructed—and are provided with check valves, a preferred form comprising a split spring cylinder 20 which is expanded into the cylindrical portion of the conduit to present a free edge 21 to the outlet port 17. The spring cylinder may be provided with a lug or projection entering a recess in the wall of the port to hold it in place. Pressure of the fluid will force the free end portion of the spring valve inwardly, as illustrated in Fig. 9, permitting the fluid to flow from the chamber so long as the fluid is under compression. As soon, however, as the compression is relieved the spring valve will expand and close the port, as illustrated in Fig. 8.

By reason of this construction a two-way pump is provided in which the fluid is taken into the working chamber upon each side of the impeller and is expelled from the portions of the chamber upon each side of the impeller as the latter gyrates, thus producing a double-acting pump. It will, however, be understood that by providing separate ports leading to and from the chamber upon separate sides of the piston, the pump may be made single-acting where the fluid is supplied to the chamber upon one side of the impeller only, or the pump may be employed to pump simultaneously different flunds from the chambers upon opposite sides of the impeller.

One of the principal features of the present invention is to provide means for preventing leakage between the spheroidal peripheral surfaces of the impeller and the wall of the chamber which surrounds it. In the preferred embodiment of the invention illustrated herein an annular shell 5 is provided which has a spherical surface 9 complementary to the surface of the periphery of the impeller disk. This shell desirably is split and the adjacent ends thereof preferably located at the bottom of the chamber and upon opposite sides of the vertical partition 15. Desirably the shell is surrounded by a re-enforcing ring 22 which is provided with laterally extending flanges 23 and 24 which enter complementary grooves in the heads 2 and 3, the ring being clamped between the heads by the bolts 4. The shell 5 may be, and preferably is, slightly narrower in width than the space between the heads to permit it to be concentrically adjusted, as the prevention of leakage between the spheroidal surface of the impeller and the complementary surface of the shell is most important in producing a construction having a maximum efficiency. The usual method of employing packing rings as parts of the impeller offers serious objection as the fluid under pressure must not only be prevented from leaking across the face of the impeller, but along the peripheral edges of the impeller formed by the junction of the respective faces with the spheroidal surface thereof.

Leakage across the face of the impeller and along its peripheral edges is prevented by the employment of a split shell as aforesaid, preferably with such initial spring as to cause it to contract around the impeller after having been expanded sufficiently to slip over the impeller during the assembling of the machine. This resilience of the shell may be employed to cause the impeller to grind itself and seat in the shell so that a close running fit throughout the entire circumference of the impeller will be obtained.

In order to maintain such a close running fit means desirably are provided for concentrically adjusting the shell. Various means may be used to accomplish this purpose. A preferred means illustrated in Fig. 3 comprises a pair of adjusting screws 25 and 26 which pass through the lower portion of the ring 22 and abut at their inner ends against shoulders 27 and 28 formed in the shell in proximity to the ends thereof. By setting up these screws the lower ends of the ring may be drawn together and the resilience of the shell will cause the shell to contract concentrically. This adjustment of the ring is usually sufficient, but may, if desired, be supplemented by radially disposed re-enforcing adjusting screws 29, as illustrated in Fig. 12, or such radially arranged adjusting screws located at suitable intervals along the periphery of the ring may be employed in themselves to provide such adjustment.

The adjustment of the shell may also be accomplished automatically by providing a series of preferably pairs of helical springs 30 seated in suitable recesses extending into the ring 22 from the inner wall thereof, the springs 30 engaging the outer face of the shell 5, as illustrated in Fig. 10.

Another means for automatically adjusting the shell is illustrated in Fig. 11 in which the outer surface of the shell is provided with a thickened portion 31 which fits in a complementary annular recess 32 extending outwardly from the inner face of the ring 22, the space between the thickened portion 31 and the bottom of the recess 32 providing a chamber into which fluid under pressure may be introduced from a suitable source through a pipe 33. Where means are provided for automatically adjusting the shell the heads will not be clamped upon the edges of the shell sufficiently to prevent the shell from contracting, or at necessary intervals the nuts upon the bolts 4 may be slackened sufficiently to permit the automatic adjustment of the shell and thereafter tightened up. Where manual adjustment is provided the heads will be clamped tightly upon the shell and the nuts on the bolts 4 loosened at such times as adjustment is effected. Other means for manually or automatically adjusting the shell concentrically to maintain a close running fit upon the periphery of the impeller may be made within the scope of the following claims.

One of the prominent features of the invention consists in providing a construction which will prevent the passage of the fluid from the compression portions of the chamber past the partition which separates the compression side of the chamber from the inlet side thereof. In the construction illustrated in Figs. 1 and 3 the re-enforcing ring 22 is illustrated as being an integral ring. In this construction the partition 15 is seated in a recess 34 in the ring and its vertical edges are seated in corresponding recesses in the respective heads 2 and 3. The upper edge of the partition is spheroidally concave to fit upon the spherical surface of the hub. The hub 8 is provided with a separately formed segment 35 which forms a continuation of the spherical surface of the hub of the impeller disk as will be hereinafter more particularly described. This segment is also engaged by the upper edge of the partition 15.

In order to insure tight joints around the partition, and particularly between the partition and the spherical hub of the impeller disk, and further to provide a guide for the reciprocatory movement of the impeller along the partition, hardened guiding and packing plates 36 and 37, which may be of any desired thickness, are placed along the opposite sides of the partition and at their edges set in suitable recesses in the heads 2 and 3. The lower edges of these guiding and packing pieces are made of spherical form and rest upon and fit the inner periphery of the ring 5, while the upper edges are spherically concave to fit upon the periphery of the spherical hub 8 of the impeller and of the segment 35 thereof as illustrated in Fig. 3. By reason of the fact that the lower edges of these plates are engaged by the shell, adjustment of the shell will automatically force the upper edges thereof more tightly into contact with the segment 35 and hub, thus making them in effect self-adjusting.

In order to permit the necessary relative movement between the impeller disk 6 and the partition 15, a swivel and sliding joint with the partition is provided. This is formed by boring a radial aperture in the edge of the impeller, the diameter of the aperture being somewhat greater than the thickness of the impeller disk. The segment 35 is located at the bottom of this bore and, as heretofore stated, comprises a continuation of the spherical surface of the hub. Cylindrical segments 38 and 39 are inserted in this bore upon opposite sides of the partition and slidably engage respectively the guiding and packing members 36 and 37.

In order to permit full vibration of the impeller disk transversely of the working chamber so as to preserve the continuous lines of contact between the disk and the respective heads, the edges of the cylindrical segments 38 and 39 may be slabbed off to present flat faces 40 which are flush with the walls of the impeller disk as illustrated in Fig. 4, or as an alternative construction the walls 2 and 3 of the head may be bored to provide countersinks 41 into which the projecting edges of the segments 38 and 39 may enter when the impeller disk reaches the limit of its sliding movement along the partition 15 and its guiding and packing members 36 and 37. By reason of these constructions the impeller disk is enabled to oscillate sufficiently to maintain the continuity of the movement of its lines of contact with the respective heads of the working chamber and thereby reduces the clearance practically to zero—the term "clearance" being used in the sense employed in defining the space between the cylinder head and piston in a reciprocating piston engine. The travelling movement of the sliding and swivel joint is graphically illustrated in the development shown in Fig. 14.

This construction provides a tight swivel and sliding joint which will prevent the passage of fluid from one side of the impeller to the other so that the two sections into which the working chamber is divided by the gyratory impeller disk may be used independently and different fluids pumped or compressed in the respective sections of the chamber by merely modifying the form of inlet and outlet to receive and discharge separate fluids instead of having the inlets and outlets connected by respective manifolds.

In Figs. 2 and 13 a slightly modified construction is shown in which the re-enforcing ring 22 is made in two parts which are connected together at the top and also at the bottom. The connection at the top is not shown, but the connection at the bottom is illustrated in detail in Fig. 13. In this construction the ends of the split re-enforcing ring 22 are countersunk to present flanges 42 and 43 which are clamped together by suitable screws or bolts 44. The partition 15 in this construction is clamped between the lower edges of the sections of the re-enforcing ring 22. In this construction the same form of guiding and wear plates 36 and 37 and swivel and sliding joint connection to the impeller are provided.

Another object of the invention is to provide a fluid-tight seal between the spherical hub of the impeller and the heads 2 and 3, the inner faces of which form the walls of the working chamber and thus prevent leakage of fluid from the working chamber. This is particularly important where machines of this type are employed in household refrigerators in which it is undesirable that the fumes shall escape from the working chamber.

In the preferred construction illustrated in Fig. 1 the heads are provided with annular recesses 45 and 46 having enlarged countersunk portions provided with screw threaded walls 47 and 48 which receive sleeves 49 and 50, the inner cylindrical surfaces of which are accurately turned or ground. The recesses 45 and 46 are of sufficient depth to receive a suitable soft packing which is engaged by the sleeves 49 and 50 thereby forming an adjustable stuffing box. Glands 51 and 52 are slidably mounted in these sleeves with a very close fit and are provided with spherical inner edges which engage the spherical surface of the hub 8 of the impeller. Suitable springs are provided to bear against the outer ends of these glands. As illustrated in Figs. 1 and 7 the springs are in the form of plates 53 of spring steel slotted to provide inwardly extending tongues 54 which bear against the ends of the glands 51 and 52. These annular spring plates are secured to the respective hubs by suitable machine screws. A suitable cap 55, which may be secured to the outer head 2 by the bolts 4, encloses the end of the gland 51 and with it forms a chamber to receive a lubricant which will maintain proper lubrication between the spherical hub of the impeller and the gland. In order to provide for the lubrication of the spheroidal periphery of the impeller disk a duct 56 may be provided in the spherical hub communicating with this oil chamber and suitable branches 57 may be provided to lead from the duct 56 to the periphery of the impeller.

The glands 51 and 52 desirably are made of identical form and are provided with cylindrical bearing surfaces 58 to receive the end of a driving shaft. The end of the driving shaft is of concavedly spherical form 59 to fit the spherical surface of the hub of the impeller disk. A conical section 60 tapers toward and merges into the cylindrical section 58. The larger end of the conical portion 60 desirably is provided with a peripherally extending flange or fin 61 which dips into a lubricant as will hereinafter more fully appear. The base of the conical portion is reduced in diameter to provide a cylindrical section 62 adapted to be journalled in a suitable bearing 63 in a casing 64 having at its opposite end an annular flange 65 which is secured to the head 3 by the bolts 4. The conical section of the driving shaft is bored lengthwise at an angle to its axis corresponding to the working angle of the impeller to receive the actuating shaft 10 of the impeller. A suitable bushing or bushings 67 may be provided for the impeller shaft within this bore. The impeller shaft has a screw threaded end of reduced diameter which is engaged by suitable nuts 68 which abut against the base of a countersink, or against the bushing 67 and when adjusted hold the impeller and driving shaft in fixed angular and longitudinal relation. Such positive relation of the impeller and driving shafts may also be maintained by the engagement of the shoulder of the driving shaft at the base of the conical portion with the flanged end of the bearing 63.

By reason of the mounting of the impeller shaft in a bore in the conical portion of the driving shaft the weight of the driving shaft is counterbalanced by the mass of material in the conical portion diametrically opposite to the bore for the impeller shaft.

In order to lubricate the bearings for the driving shaft and the impeller-actuating shaft the casing 64 is provided directly above the flange 61 of the driving shaft with a port the wall of which is surrounded by an annular recess 69 from which ducts lead to the respective bearings for the driving shaft. The cover 69$^{\times}$ for this port desirably presents a concave under face upon which the oil is projected from the flange 61 by centrifugal force and from which the oil flows into the annular recess 69 and thence through the ducts to the bearings of the driving shaft.

Any suitable means may be employed for driving the shaft. Preferably an electric motor is to be used as the machine is designed to be driven at a high speed.

A modified form of the invention is illustrated in Fig. 2 which differs mainly from that above described in that the re-enforcing ring is formed in sections which are clamped together with the partition between the adjacent lower ends of the re-enforcing ring and in that the glands for the hub of the impeller are somewhat differently formed and different means used to automatically hold them in place, and in that a different connection is provided between the driving shaft and the impeller shaft.

In the construction illustrated in Fig. 2 the glands 70 and 71 are duplicates and are slidably mounted in sleeves 45 like those shown in Fig. 1. These glands are provided with concave spherical surfaces which engage the spherical hub of the impeller and are held in such engagement by rings 72 and 73 having ends abutting against the respective glands and provided with outwardly extending flanges 74 and 75 which are engaged respectively by series 76 and 77 of spiral springs. The series of spiral springs 76 are seated in a suitable cap 78 which is secured to the head 2 by the bolts 4, while the springs 77 are seated in suitable recesses in a ring 79 which is engaged by a flange 80 which extends inwardly from a housing 81 having an outwardly extending flange 82 which is secured to the head 3 by the bolts 4.

The construction illustrated in Fig. 2 is so designed that it may be caused to abut against or fit upon the cylindrical end of the casing of a usual type of motor through which the driving shaft of the motor projects. In the construction illustrated in the accompanying drawings the motor shaft 82 is shown as projecting into the end of the housing 81 while the bearing 83 for the motor shaft—and which is a part of the motor casing—projects into a recess 84 in the end of the housing 81. A suitable packing 85 is clamped in a countersink in the end of the housing by a plate 86 which is secured to the end of the housing, thereby providing an oil-tight joint which will prevent the escape of lubricant from the chamber of the housing. The driving shaft is provided with an end portion 87 of reduced diameter whch extends into an aperture in a cross head 88 in one arm 89 of which the driving shaft 90 of the impeller is journalled. In this construction the driving shaft is provided with a flange 91 which abuts against one end of the arm 89 of the cross head and a washer 92 and nut 93, on the end of the driving shaft engaging the opposite end of the arm 89, serve to prevent longitudinal movement of the driving shaft in its bearing. The other arm of the cross head is provided with a counterweight 94 diametrically opposite to the bearing for the impeller shaft. This counterweight is of sufficient weight to balance the weight of the arm and the shaft of the impeller which is journalled therein.

The cross head 88 is connected to the driving shaft by a plate 95 which is shown in detail in Fig. 16 and which is secured to the driving shaft 82 by a key 96. Pins 97 extend from the plate 95 into suitable apertures 98 in the cross head thereby providing for relative longitudinal movement between the cross head and the driving shaft, but causing positive rotation of the cross head.

The operations of the device as shown in Figs. 1 and 2 are identical. The rotation of the driving shaft imparts through the actuating shaft of the impeller a gyratory motion to the impeller disk. Diametrically opposite faces of the impeller disk engage the walls 11 and 12 respectively of the heads 2 and 3. The gyratory motion of the disk causes lines of contact between the impeller and the heads of the disk progressively to rotate. The partition 15, which crosses the chamber between the heads of the machine and also intersects the impeller, divides the chamber into intake and compression portions upon each side of the impeller disk. When, during the gyration of the impeller, the line of contact between the impeller and the wall 11 of the casing, for example, passes the partition 15, its progressive movement forces the fluid, which is ahead of the line of contact, toward and through the outlet port, while the constantly increasing space behind the line of contact produces a partial vacuum in that portion of the chamber and permits the gradual introduction of fluid into the chamber behind the moving line of contact. When the line of contact of the impeller again passes the partition 15 compressive pressure is exerted upon the fluid as aforesaid so that the operation of the device is continuous. The opposite side of the impeller disk operates in the same manner, but independently, the line of contact between the impeller disk and the wall of the face 12 of the head being always at one hundred eighty degrees to the line of contact between the impeller disk and the face 12. By reason of this balanced construction a practically continuous delivery of fluid under pressure is maintained when the inlet ports are supplied from a common manifold and the fluid delivered through a common manifold.

In the operation of the machine leakage past the partition 15 is prevented by the mechanism above described and leakage from the chamber around the hub of the impeller is prevented by reason of the self-adjusting glands and the oil seal maintained thereby.

By reason of the adjustability of the shell which surrounds and fits upon the impeller leakage from one side of the impeller to the other is prevented. Thus a machine is produced of maximum efficiency.

The machines above described further present numerous advantages in economy of construction including the ability to manufacture the shell which co-operates with the gyratory impeller in a separate piece which can be readily machined; in that the heads, the glands, the sleeves, and other parts of the machine may be made of duplicate construction which greatly reduces the cost of manufacture.

The construction is such that if desired the impeller may be driven by two motors instead of one by merely supplying the hub of the impeller with a second driving shaft in axial alinement with that shown, driving such shaft from duplicate mechanism to that illustrated, and enclosing the shaft in a suitable housing which may be a duplicate of the housing illustrated. Such a construction may be employed in respect to either of the devices shown in Figs. 1 and 2. An illustrative example as applied to that shown in Fig. 2 is illustrated in Fig. 15 in which an additional driving shaft 99 is mounted in axial alinement with the shaft 90 and is connected to a cross head 100 which is rotated by the driving shaft 101 in the manner heretofore described. By reason of such construction any desired amount of power may be imposed upon the impeller. It also provides a further advantage of permitting the use of two relatively small motors in place of a single large one of a capacity equal to the two.

It will be understood that the embodiment of the invention disclosed herein is of an illustrative character and is not restrictive and that various changes in form, construction and arrangement of parts may be made within the spirit and scope of the following claims.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is:

1. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, means for actuating the same, a chambered casing having a partition radial to and intersecting said impeller and having a head complementary to one of the faces of said impeller to provide a progressively moving line of contact therewith during the gyratory movement thereof and provided with inlet and outlet ports in close proximity to and upon opposite sides of said partition; a peripheral annular shell within said casing presenting a spherically concave surface complementary to the spheroidal surface of said impeller and engaging the same with a close running fit, where-

by leakage of the compressed fluid around the periphery of the impeller will be prevented.

2. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, means for actuating the same, a chambered casing having a partition radial to and intersecting said impeller and having a head complementary to one of the faces of said impeller to provide a progressively moving line of contact therewith during the gyratory movement thereof and provided with inlet and outlet ports in close proximity to and upon opposite sides of said partition; a peripheral annular shell within said casing, split to receive said partition, presenting a spherically concave surface complementary to the spheroidal surface of said impeller and engaging the same with a close running fit, whereby leakage of the compressed fluid around the periphery of the impeller will be prevented and means for concentrically adjusting said annular shell to maintain said close running fit.

3. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, means for actuating the same, a chambered casing having a partition radial to and intersecting said impeller and having a head complementary to one of the faces of said impeller to provide a progressively moving line of contact therewith during the gyratory movement thereof and provided with inlet and outlet ports in close proximity to and upon opposite sides of said partition; a peripheral annular shell within said casing, split to receive said partition, presenting a spherically concave surface complementary to the spheroidal surface of said impeller and engaging the same with a close running fit, whereby leakage of the compressed fluid around the periphery of the impeller will be prevented, means for concentrically adjusting said shell including adjusting screws seated in said casing engaging respectively the end portions of said ring in proximity to said partition operable to force the ends of said ring toward each other.

4. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, means for actuating the same, a chambered casing having a partition radial to and intersecting said impeller and having a head complementary to one of the faces of said impeller to provide a progressively moving line of contact therewith during the gyratory movement thereof and provided with inlet and outlet ports in close proximity to and upon opposite sides of said partition; a peripheral annular shell within said casing, split to receive said partition, presenting a spherically concave surface complementary to the spheroidal surface of said impeller and engaging the same with a close running fit, whereby leakage of the compressed fluid around the periphery of the impeller will be prevented, means for concentrically adjusting said shell including adjusting screws seated in said casing engaging respectively the end portions of said ring in proximity to said partition operable to force the ends of said ring toward each other and other radially disposed adjusting screws seated in said casing engaging said shell at suitable intervals along its periphery.

5. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, means for actuating the same, a chamber casing having a partition radial to and intersecting said impeller and having a head complementary to one of the faces of said impeller to provide a progressively moving line of contact therewith during the gyratory movement thereof and provided with inlet and outlet ports in close proximity to and upon opposite sides of said partition; and a check valve in the outlet port automatically operable to prevent the fluid expelled from said chamber from returning thereto.

6. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, means for actuating the same, a chambered casing having a partition radial to and intersecting said impeller and having a head complementary to one of the faces of said impeller to provide a progressively moving line of contact therewith during the gyratory movement thereof and provided with cylindrical inlet and outlet ports in close proximity to and upon opposite sides of said partition; a check valve in said outlet port comprising a longitudinally split spring cylinder located in said cylindrical port presenting a free edge to the chamber and yieldable to the fluid pressure produced in said chamber.

7. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, means for actuating the same, a chambered casing having heads complementary respectively to the opposite faces of said impeller disk to provide diametrically opposite, progressively movable, lines of contact therewith during the gyratory movement thereof, each of said heads being provided with an inlet and an outlet port located in close proximity to and upon opposite sides of said partition; a peripheral concentrically adjustable annular shell within said casing presenting a spherically concave surface complementary to the spheroidal surface of said impeller and engaging the same with a running fit, thereby dividing the chamber of the casing into two compartments into which and from which fluid will be alternately admitted and expelled.

8. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, means for actuating the same, a chambered casing having heads complementary respectively to the opposite faces of said impeller disk to provide diametrically opposite, progressively movable, lines of contact therewith during the gyratory movement thereof, each of said heads being provided with an inlet and an outlet port located in close proximity to and upon opposite sides of said partition, an outlet conduit communicating with the outlet ports, an inlet conduit communicating with the inlet ports, an annular shell within said casing presenting a spherically concave surface complementary to the spheroidal surface of said impeller and engaging the same with a running fit, thereby dividing the chamber of the casing into two compartments into which and from which fluid will be alternately admitted and expelled and a substantially continuous flow of fluid from said chamber maintained.

9. In a machine of the class described comprising a gyratory impeller disk having a spherical hub, means for actuating the same, a chambered casing having a head complementary to one of the faces of said impeller to provide a progressively moving line of contact therewith during the gyratory movement thereof, a partition seated in slots in the casing crossing said chamber, radial to and intersecting said disk and having its end fitting said hub, and a cylindrical swivel and sliding joint between said partition and impeller operable to permit free movement of the impeller without leakage therethrough.

10. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery and a spherical hub, means for actuating the same, a chambered casing having a head complementary to one of the faces of said impeller to provide a progressively moving line of contact therewith during the gyratory movement thereof, an annular shell, a partition seated in slots in the casing crossing said chamber, radial to and intersecting said disk and having its end fitting said hub, packing members on opposite sides of said partition seated upon the inner wall of said shell and engaging said spherical hub, a swivel and sliding joint between said partition and impeller comprising cylindrical segments seated in a radial bore in said impeller and having their flat faces engaging and slidably fitting said packing members, the wall of said bore permitting sufficient clearance from engagement with said packing members to permit maximum angular movement of the impeller.

11. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery and a spherical hub, a casing having a head complementary to one of the faces of said impeller and cooperating therewith to provide a progressively movable line of contact therewith during the gyratory movement thereof and having an annular spherical surface complementary to the spheroidal periphery of said impeller, adjustable packing glands engaging said spheroidal hub, a driving shaft having its axis in line with the center of said spherical hub, an actuating shaft extending from said hub at an angle to the axis of said driving shaft, a bearing connecting said driving shaft and actuating shaft and means for counterbalancing the weight produced by the offset connection of said driving shaft to said actuating shaft.

12. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, a spherical hub and an actuating shaft extending from said hub perpendicular to the median plane of said impeller, a casing having heads complementary respectively to the opposite faces of said impeller to provide diametrically opposite, progressively movable, lines of contact therewith during the gyratory movement thereof and an annular spherical surface complementary to the spheroidal periphery of the impeller; a partition crossing said chamber radial to and intersecting said disk and fitting said hub, automatically adjustable packing glands engaging said spheroidal hub and oil chambers communicating with said glands thereby providing oil seals therefor.

13. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, a spherical hub and an actuating shaft extending from said hub perpendicular to the median plane of said impeller, a casing having heads complementary respectively to the opposite faces of said impeller to provide diametrically opposite, progressively movable, lines of contact therewith during the gyratory movement thereof and an annular spherical surface complementary to the spheroidal periphery of the impeller; a partition crossing said chamber radial to and intersecting said disk and fitting said hub, automatically adjustable packing glands engaging said spheroidal hub, comprising bushings slidably mounted in said casing heads and having spherically concave ends engaging said spherical hub and springs under tension abutting upon the opposite ends of said bushings and oil chambers communicating with said glands to provide oil seals therefor.

14. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, a spherical hub and an actuating shaft extending from said hub perpendicular to the median plane of said impeller, a casing having heads comple-

mentary respectively to the opposite faces of said impeller to provide diametrically opposite, progressively movable, lines of contact therewith during the gyratory movement thereof and an annular spherical surface complementary to the spheroidal periphery of the impeller; a partition crossing said chamber radial to and intersecting said disk and fitting said hub, automatically adjustable packing glands engaging said spheroidal hub, comprising bushings slidably mounted in said casing heads and having spherically concave ends engaging said spherical hub and springs under tension abutting upon the opposite ends of said bushings and oil chambers communicating with said glands to provide oil seals therefor and means for transmitting oil from one of said oil chambers through said hub and impeller to the spheroidal periphery of said impeller.

15. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery, a spherical hub and an actuating shaft extending from said hub perpendicular to the median plane of said impeller, a casing having heads complementary respectively to the opposite faces of said impeller to provide diametrically opposite, progressively movable, lines of contact therewith during the gyratory movement thereof and an annular spherical surface complementary to the spheroidal periphery of the impeller; a partition crossing said chamber radial to and intersecting said disk and fitting said hub, automatically adjustable packing glands engaging said spherical hub, comprising bushings slidably mounted in said casing heads and having spherically concave ends engaging said spherical hub and springs under tension abutting upon the opposite ends of said bushings, a driving shaft having its end journalled in one of said bushings and provided with a conical portion tapered toward said bushing having a bore therethrough in an axial plane of, and in angular relation to, its axis to provide a bearing for the shaft of the impeller in its normal conical path of rotation, a casing enclosing said driving shaft to contain sufficient lubricant to engage said shafts, whereby lubrication of the bearings of said shafts and the oil seal of said bushings will be maintained.

16. In a machine of the class described comprising a gyratory impeller disk having a spheroidal periphery and a spherical hub, a shaft having sections extending in opposite directions from said hub perpendicular to the median plane of said impeller, a chambered casing having heads complementary to the respective faces of said impeller to provide diametrically opposite, progressively movable, lines of contact therewith during the gyratory movement thereof, automatically adjustable packing glands engaging said spherical hub, a partition crossing said chamber radial to and intersecting said disk and fitting said hub, the heads of said casing being provided respectively with inlet and outlet ports located upon opposite sides of said partition and driving means for actuating both sections of said shaft.

17. In a machine of the class described comprising a gyratory impeller disk having an actuating shaft, a driving shaft therefor having a conical portion provided with a bore extending longitudinally thereof in angular relation to the axis of the driving shaft and substantially fitting the actuating shaft, whereby the weight of the metal of the driving shaft is counterbalanced by the mass of metal of the conical portion located diametrically opposite thereto.

18. In a machine of the class described comprising a chambered casing, a gyratory impeller disk therein having an actuating shaft, a driving shaft journalled in said casing having a conical portion, provided with a bore extending longitudinally thereof in angular relation to the axis of the driving shaft and substantially fitting the actuating shaft and having at its base a peripheral flange, a housing for said driving shaft secured to said casing providing an oil chamber of sufficient depth to permit said flange to enter the oil therein and having a port located above said flange, an annular recess surrounding said port, a cover for said port and annular recess provided with a concave under surface adapted to receive oil projected from said flange by centrifugal force and direct the same toward said annular recess, and ducts leading from said annular recess to a bearing for said driving shaft.

In testimony whereof, I have signed my name to this specification.

FRANS IVAR L. BYLGER.