Sept. 8, 1936. R. J. S. PIGOTT 2,053,919

ROTARY PUMP

Filed July 30, 1932 5 Sheets-Sheet 1

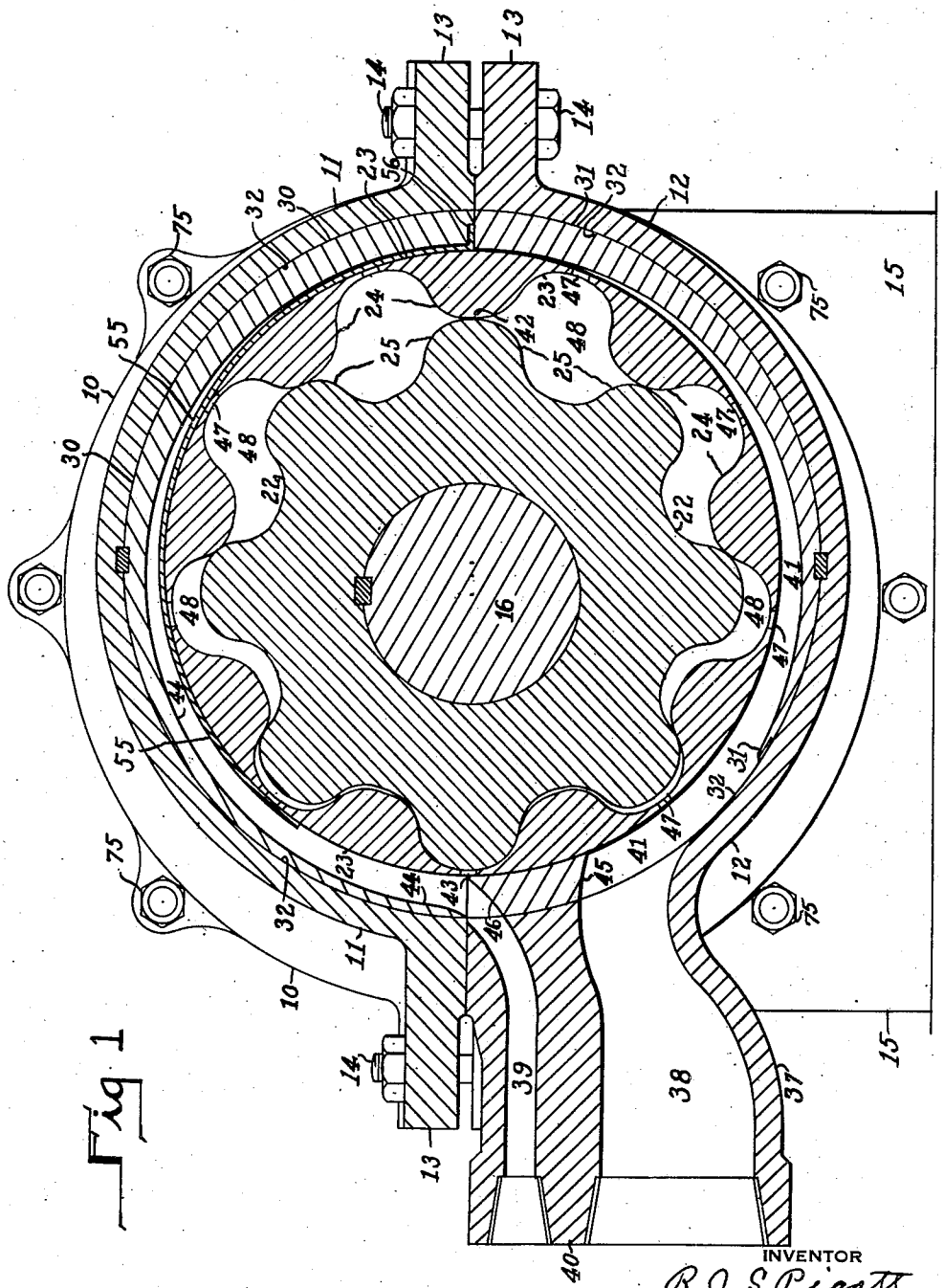

Fig. 1

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ROTARY PUMP

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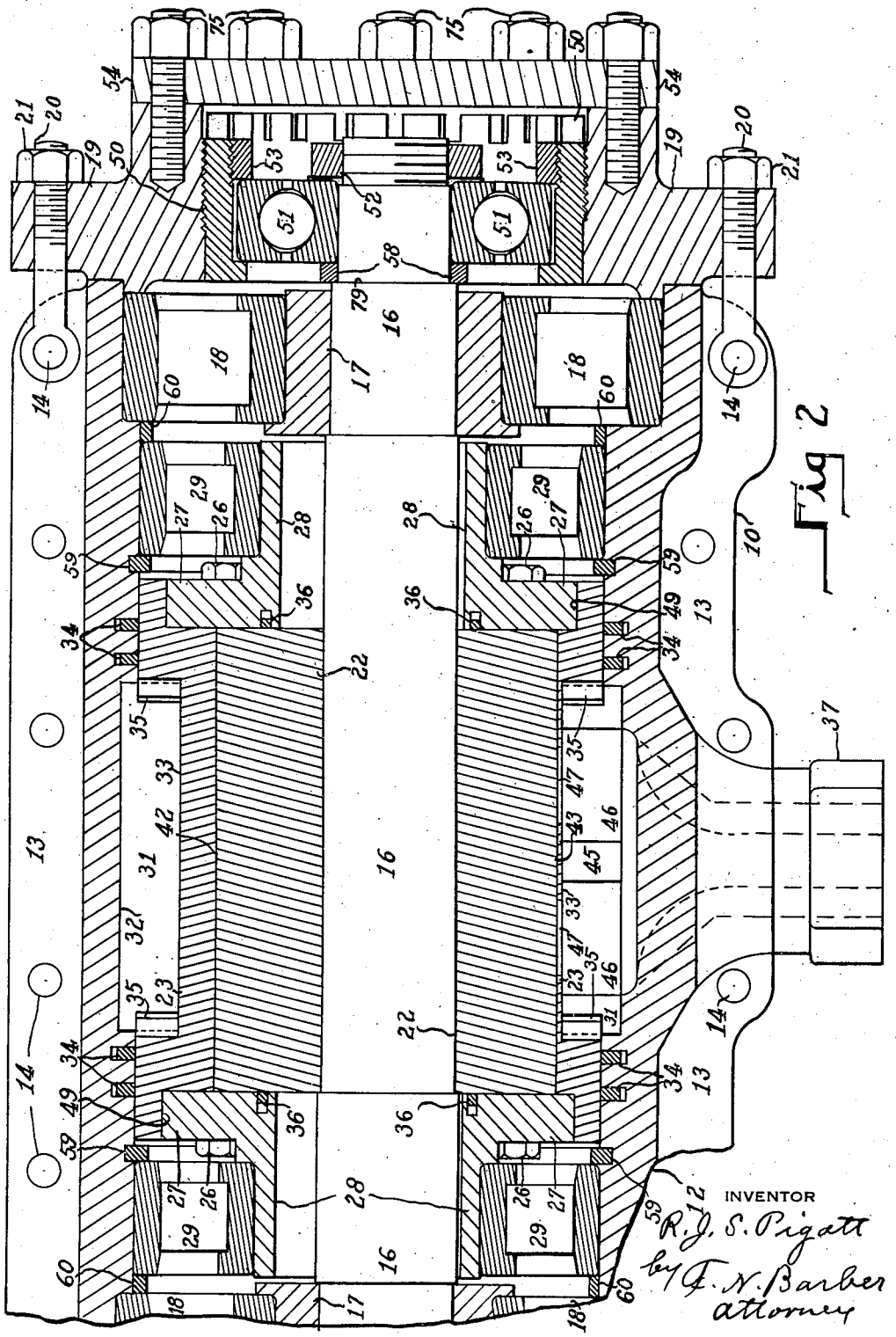

Fig 2

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Fig 4

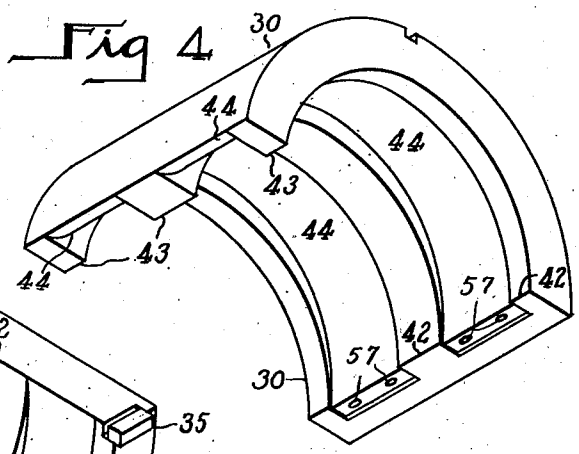
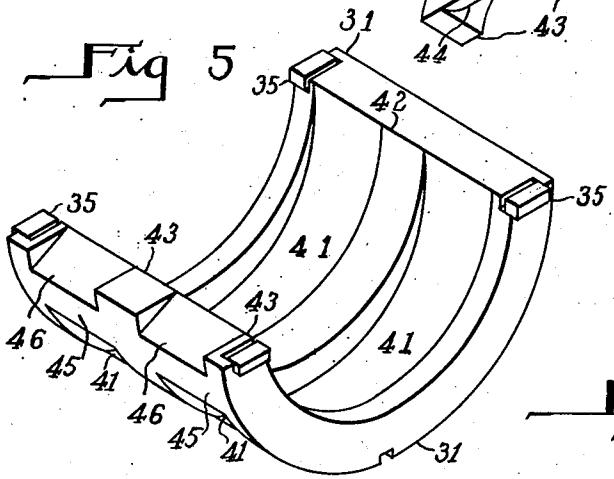


Fig 5



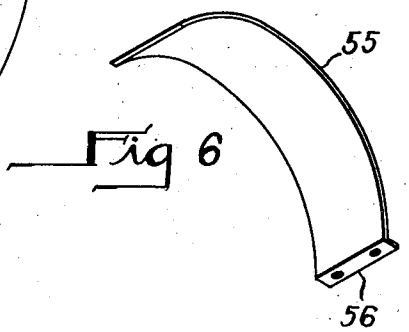


Fig 6

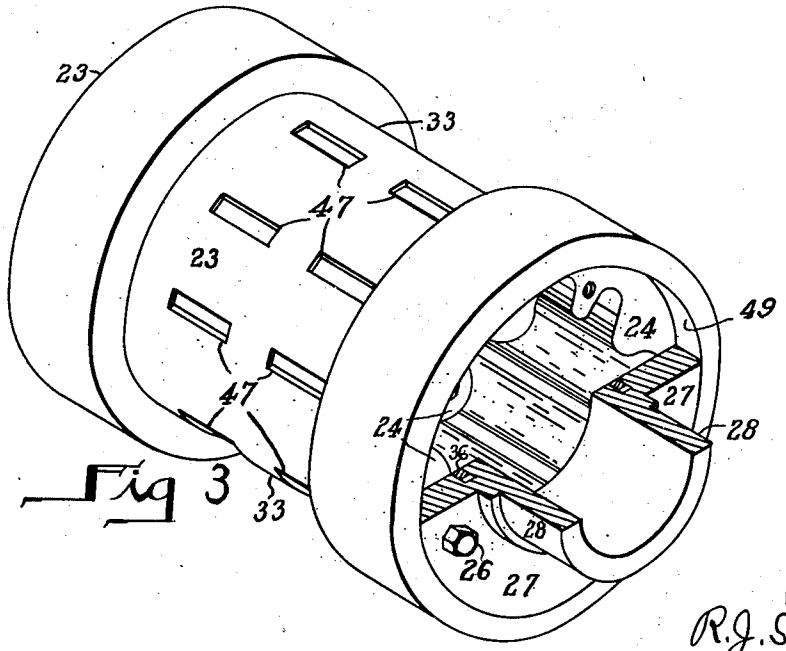


Fig 3

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ROTARY PUMP

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Fig 8

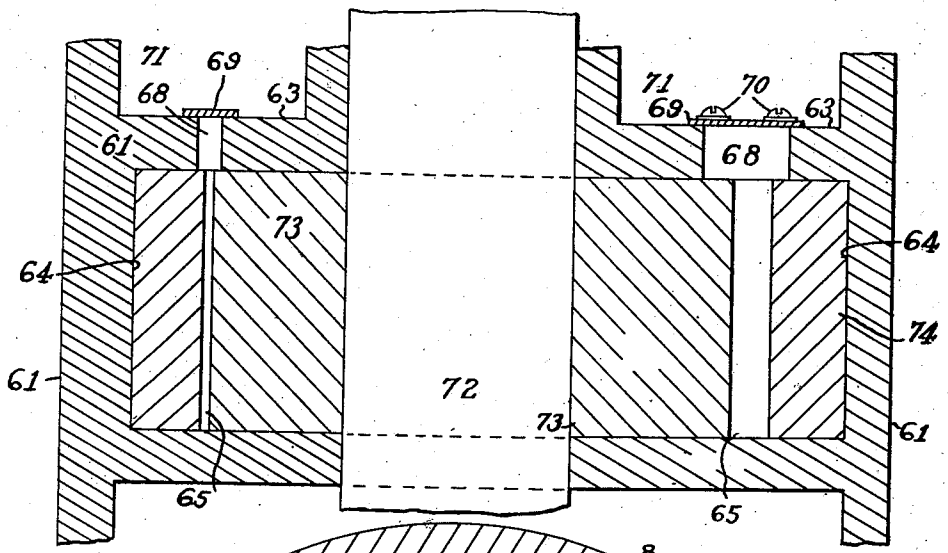
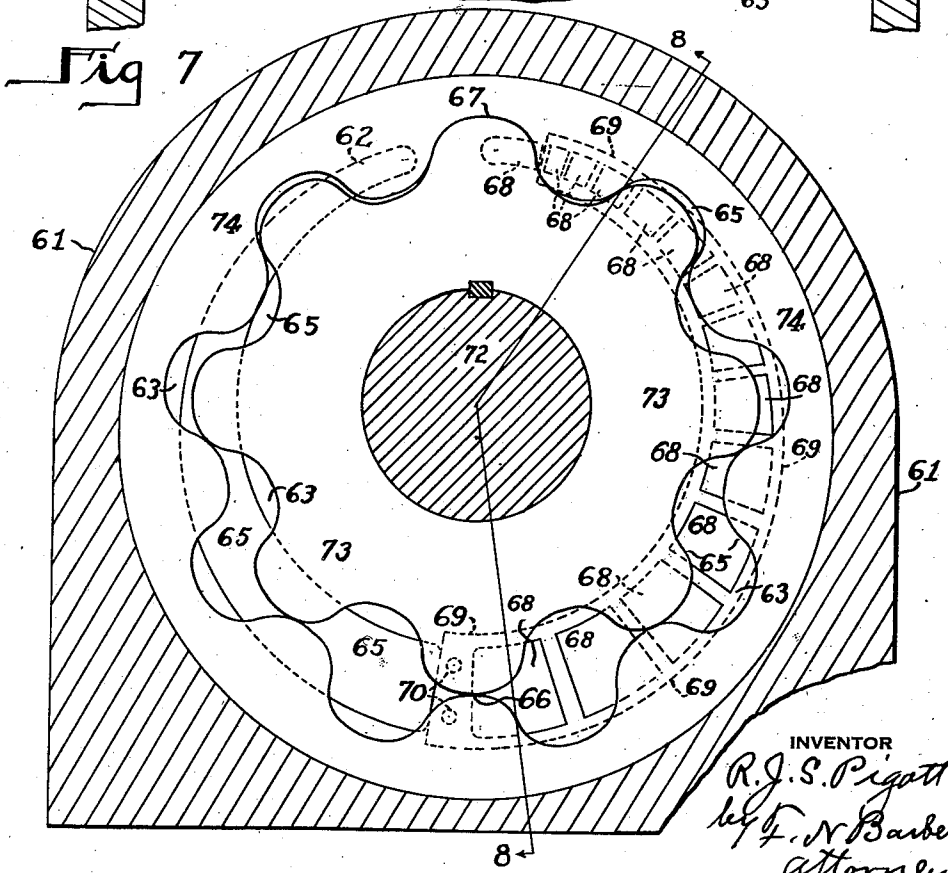


Fig 7



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ROTARY PUMP

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Fig 10

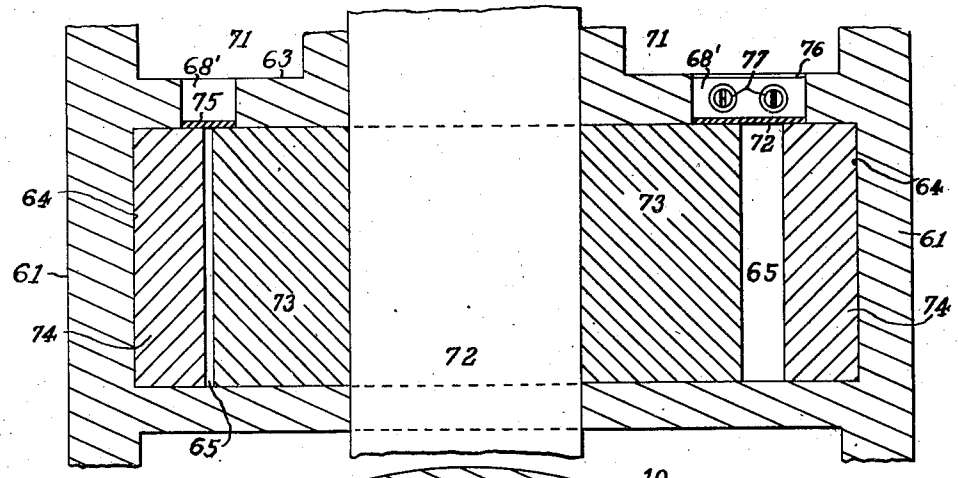
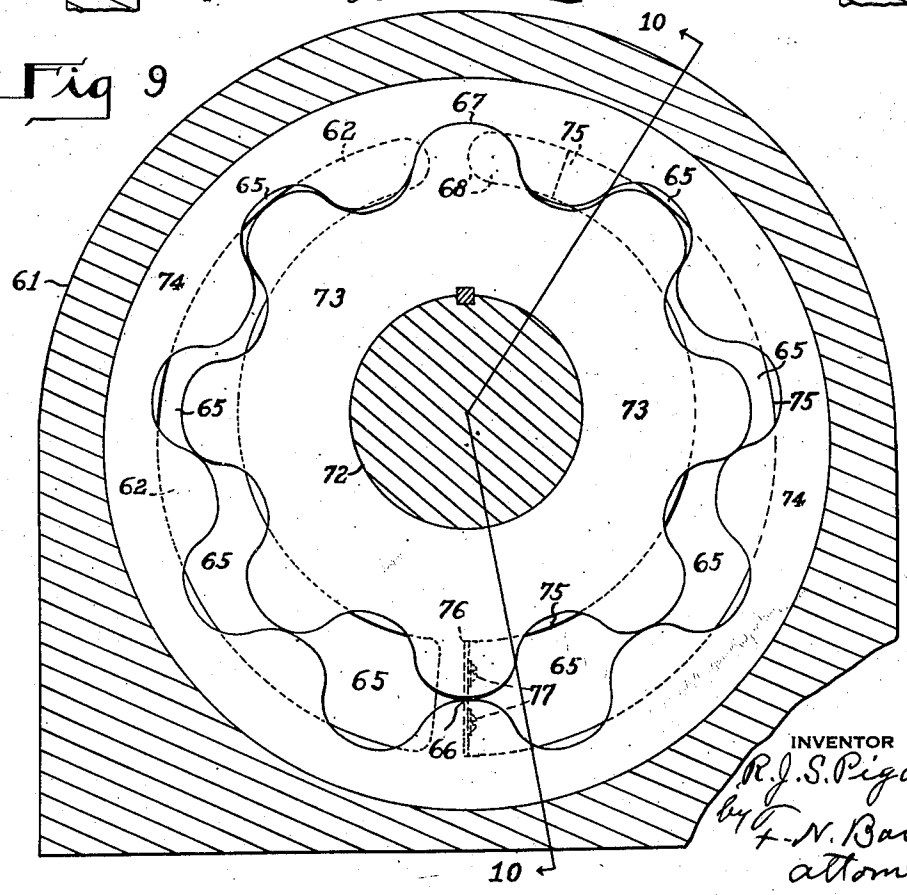


Fig 9



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Patented Sept. 8, 1936 2,053,919

UNITED STATES PATENT OFFICE

2,053,919

ROTARY PUMP

Reginald J. S. Pigott, Pittsburgh, Pa., assignor, by mesne assignments, to Gulf Research & Development Company, Pittsburgh, Pa., a corporation of Delaware

Application July 30, 1932, Serial No. 626,420

15 Claims. (Cl. 103—126)

This invention relates to gear pumps or compressors for gaseous matter, but may be used for pumping liquids. The description will, however, be directed to the invention as a compressor unless attention is otherwise directed.

It is one object of this invention to employ a flexible abutment or valve to cover the ring-gear ports or some of them at the discharge side of the compressor. Another object is to shorten the radial ports in the ring gear and reduce the clearance volume which is very important in compressors. Another object is to provide the ring gear with spuds which are carried in antifriction bearings, that is, to support the ring gear on bearings independent of the periphery of the same.

Another object is to provide a casing which permits the mounting of the several required sets of bearings as if in a single piece without joints to alter their accuracy. The invention also limits the setting for eccentric cuts to one operation instead of requiring four operations.

Other objects appear hereinafter.

Referring to the accompanying drawings, Fig. 1 is a transverse central section of the preferred form of my rotary pump; Fig. 2, a longitudinal section, parts at the left being broken away; Fig. 3, a perspective view of the ring gear; Fig. 4, a perspective view of the lower rigid abutment or liner member; Fig. 5, a perspective view of the upper rigid abutment or liner member; Fig. 6, a perspective view of the flexible abutment or valve; Fig. 7, a transverse section of a compressor or pump of the type described, but having end suction and discharge ports; Fig. 8, a section on the line 8—8 on Fig. 7. Figs. 9 and 10 are views like Figs. 7 and 8, but showing a modification thereof, Fig. 10 being a section on the line 10—10 on Fig. 9.

Referring first to Figs. 1 to 6, 10 designates a hollow substantially cylindrical casing divided longitudinally and centrally into the upper and lower halves, sections or members 11 and 12 provided at their opposite sides with the overlapping or mutually registering longitudinal flanges 13 which receive the bolts 14 for clamping the sections together into a rigid unit. The lower section is supported in any suitable manner.

16 is a power shaft lying axially in the casing centrally between the casing sections 11 and 12, and having secured thereto the sleeves or bushings 17 between each of which and the inner wall of the casing 10 is a set of antifriction bearings 18 whereby the shaft is supported. The right hand set of bearings is held from longitudinal movement toward the right by the ring 19 which is connected to the adjacent end of the casing by the bolts 20 anchored in the casing and provided with the nuts 21 screwed against the outer face of the ring. The manner of retaining the left set of bearings 18 is not illustrated, but they may be held in place in any suitable manner.

22 is the inner rotor or pinion of my internal-external gear pump or compressor and arranged concentric with the shaft and keyed thereto and positioned centrally between the bearings 18 and spaced therefrom. 23 is the annular rotor or the ring gear which encloses the pinion 22 and is eccentric therewith. The ring gear has internal teeth 24 cooperating with the external teeth 25 of the pinion, the number of teeth on the latter being one less than that on the former. The ends of the ring gear are connected by bolts 26 to the side plates or flanges 27 which have the spuds 28 encircling the shaft 16 between the collars 17 and the pinion, but eccentric therewith. Antifriction bearings 29 are between each spud and the adjacent inner wall of the casing to support the ring gear independently of the usual sole support thereof by its periphery.

I prefer for convenience of construction, inspection and repair, to make the casing in halves and to provide a separate detachable ring or lining insertable into the casing when disassembled and embracing the central reduced portion of the periphery of the ring gear. Accordingly, I have provided such a ring or lining comprising two semi-annular members 30 and 31, seated in the internal groove 32 in the casing sections 11 and 12, the member 30 being in the casing section 11 and the member 31 in the casing section 12. The inner face or wall of the ring or annular lining is seated in the peripheral groove 33 in the ring gear while the unreduced parts of the latter beyond each end of the groove 33 are in contact with the inner wall of the casing, as shown in Fig. 2, where annular packings 34 are provided in the casing bearing against the periphery of the ends of the ring gear. Packing blocks 35 are also provided between the ring gear and the ends of the lining members 30 and 31. Packing rings 36 are interposed between the contiguous ends of the pinion and the flanges or plates 27.

The casing section 12 has the substantially radial projection 37, whose upper face is flush with the upper face of the section 12 and contacts with the lower face of the adjacent flange 13 on the section 11. This projection has therein the inlet or suction passage 38 and the outlet or pressure passage 39 separated by the partition 40. The inner end of the passage 38 opens into two grooves 41 in the lining member 31, these grooves being wide at their receiving ends and gradually tapering until they disappear at 42, which is the point or line where the teeth of the rotors are in complete open mesh, the point or line 43 where the teeth are in full mesh being diametrically opposite the point or line 42. The points 42 and 43 are between the meeting faces of the casing members 11 and 12.

The passage 38 communicates with the outlet ends of the two passages 44 which are open on the side thereof nearest the ring gear and gradually taper to the point or line 42. The lining member 31 has the partition or abutment 45 to separate the suction and pressure passages 38 and 39. The upper face of the member 31 is slightly grooved at 46 to form a continuation of the passage 39.

The spaces between the teeth of the ring gear have radial ports 47 connecting the grooves 41 and 44 with the tooth spaces 48 enclosed by the teeth of the rotors.

It is to be noted that the diameter of the ring gear has been very much reduced as compared with those now in use, so that the ports 47 are very short. The ring gear is not weakened thereby as its ends beyond the ports 47 are very thick. The pinion works not only on the portion where the ports 47 are, but also on the thickened ends which are bored out at 49 to receive the side plates or flanges 27 which carry the spuds 28.

A large collar 50 is screwed into the ring 19. Between the ring and the shaft 16 is the anti-friction bearing 51. A thrust ring 58 is on the shaft 16 between the shoulders 79 thereon and the inner race of the bearings 51. 52 is a nut on the end of the shaft for holding the inner race of the bearings tightly in place against the thrust ring 58, the outer race being held in place by the ring 53 screwed inside the collar 50. The ends of the collar 50 and the ring 53 are castellated to facilitate the use of a spanner or bar for turning them. By turning the collar 50 one way or the other the shaft 16 may be adjusted longitudinally as may be required to set clearances. The outer end of the ring 19 is covered beyond the collar 50 by the cap plate 54 held in place by the bolts 75 screwed into the ring 19.

Spacing rings 59 are set in the casing to retain the outer races of the bearings 29 in place. Also spacing rings 60 are set between the outer races of the bearings 18 and 29. Flexible abutments or valves 55 made preferably of spring steel have one end countersunk in the inner faces of the upper liner member 30, the secured ends being at the point or line 42, while the free remainder thereof lies on the periphery of the ring gear 23 so as to cover a selected number of the ports 47 as shown in Fig. 1. The valves may be secured in place by the flanges 56 clamped between the ends of the members 30 and 31, or they may be secured by screws or pins in the holes 57 in the member 30, or both.

The operation of my compressor is as follows: As the shaft 16 and the rotors rotate anticlockwise, the suction or lower side operates as in the usual gear pump of the type shown, namely, a full volume of gas is drawn through the passages 38 and 41 and the lower radial ports 47 while the latter are passing along the liner member 31. Volumes are generated in the increasing tooth spaces 48 as in the liquid pump, the tooth spaces being at maximum volumes when they arrive at the line 42, from which the radial ports travel along the concave face of the flexible abutment or valve 55. As the ports move beyond the line 42, the tooth spaces 48 become gradually reduced in volume until at the line 43 they are completely emptied, though a small volume is carried in the ports 47 along the fixed abutment or partition 45 to the suction passage 38.

To compress gas, in which I include all gaseous or vaporous material, the abutment 55 must be carried up around the ring gear on the outlet or pressure side to a point where the volumes of gas in the spaces 48 between the teeth have been reduced sufficiently to generate therein pressures equaling or exceeding the discharge pressure. If the discharge pressure is constant, the abutment may be rigid, but it is desirable that it be flexible, since many compressors are required to discharge at varying pressures, depending on external conditions. The discharge pressure from a refrigerating fluid compressor will vary with changes in temperature of the cooler. When using SO_2 with cooling air at 60° the discharge pressure will be about 60 lbs. gage, while with cooling air at 110° the pressure will rise to about 140 lbs. Under the first example the abutment would end at about 70% reduction of the total volume, while under the second at about 81% which in the latter example, if the abutments are rigid, would require the lengthening of the abutment. By using my flexible abutment, the adjustment to the different pressures above given or to other pressures will be automatically attained. Full discharge pressure in the passage 39 applied to the exterior or convex surface of the abutment 55 tends to press it against the ring gear at all places where the pressure in the tooth spaces 48 is less than the discharge pressure. As the spaces move toward the fixed abutment 45 the pressure in them continually increases, finally equaling the discharge pressure plus the pressure required to overcome the stiffness of the spring abutment 55. When the pressure in any space 48 reaches this condition it lifts the abutment off the ring gear at the port 47 where the said pressure exists and the compressed gas therein flows out into the pressure passages. The abutment 55 is made long enough to compress the gas to the highest discharge pressure required, but it will be lifted from the ring gear to correspond to any lower discharge pressure.

A flexible abutment or valve prevents trapping. Most rotary compressors are sealed against leakage by admitting oil in small quantity which fills the capillary spaces. If too much oil is admitted, it is possible that the tooth spaces would be sufficiently filled with oil to cause much higher pressures to obtain, resulting in damage to the compressor if rigid abutments are used. As my spring abutment will lift at any point whenever the pressure in a tooth space exceeds the discharge pressure slightly, it will relieve the excess pressure whatever the cause.

The rigid section abutment 45 is made sufficiently long to expand any gas carried along in ports 47 to substantially suction pressure by the time it reaches the suction passage 38. This saves a small amount of energy which would otherwise be lost.

As the abutment 55 is free to relieve trapping, the entering edge thereof can safely be put on the center line 42 of eccentricity. In liquid pumps the corresponding but rigid abutment is disposed about equally on either side of this line to avoid trapping, which arrangement slightly cuts down the volume of discharge per revolution.

The flexible abutment is useful in liquid pumps for the purpose of reducing noise and vibration when air or gas is present in the liquid. Tests show that small bubbles of gas in liquid are at low pressure before passing the open mesh position at the line 42 and are at high pressure immediately on passing that position. This sudden compression practically collapses the bubbles and gives rise to a pronounced crackle or rattle

and to some vibration. When the flexible abutment is used, the bubbles are slowly compressed and later released without noise, thereby eliminating vibration and saving a small amount of energy.

Referring now to Figs. 7 and 8, I show the shaft 72 to which the pinion 73 is keyed. 74 is the ring gear having its periphery turning on the inner wall of the casing 61. The suction port 62 is in the end wall 63 of the pump chamber 64. This suction port is open opposite the ends of the tooth spaces 65 so that as the pinion and ring gear rotate anticlockwise, liquid will be drawn into these spaces situated on the left hand side of Fig. 7 as is readily understood. After the completely filled spaces 65 pass the open mesh point 66, the spaces on the right hand side of Fig. 7 become gradually smaller as they move toward the full mesh position at 67, thereby forcing the fluid in them out through the inlet ports 68 in the wall 63.

My flexible abutment or valve 69 when applied to Figs. 7 and 8 comprises a strip of spring metal having one end secured to the outer face of the wall 63 by screws 70 or their equivalent. The abutment is arcuate in shape to cover the outlet ports 68. The operation is substantially as in Figs. 1 and 2. When the rising pressure in any right hand tooth space 65 exceeds the discharge pressure in the discharge passage 71, it moves the abutment away from the wall 63 and the fluid therein flows out into the pressure passage 71.

Figs. 9 and 10 are similar to Figs. 7 and 8. Identical parts in these four views bear the same reference characters. The main difference between Figs. 7 and 8 and Figs. 9 and 10 lies in the location of the flexible abutment or valve which is marked 69 in Figs. 7 and 8 and 75 in Figs. 9 and 10. In Figs. 7 and 8 the flexible abutment 69 is located on the wall 63 and at the outlet end of the discharge ports 68 and in the discharge passage 71, while in Figs. 9 and 10 the analogous flexible abutment 75 is positioned at the inlet end of the long continuous arcuate tapering discharge port 68' and bears directly on the ends of the pinion 73 and the ring gear 74 and directly over some at least of the tooth spaces 65 at the discharge side of the pump. The ends of these tooth spaces are in effect "rotary outlet ports" and are to be construed as satisfying this limitation in the claims. The abutment 75 is shown having a flange 76 through which screws 77 pass into the wall 63 at the end of the discharge port 68' nearest the open mesh point 66. The ports 62 and 68' are widest near the point 66 and taper toward the point 67 to correspond to the decreasing volumes of the tooth spaces 65 from the point 66 to the point 67.

I claim:—

1. In a rotary compressor of the internal-external type, a casing having suction and discharge passages, a chamber containing cooperating eccentrically-arranged internal and external rotors rotatable therein, inlet and rotating outlet means for conducting fluid from the suction passage into the tooth spaces between the teeth of the rotors and from the said spaces into the discharge passage, and a flexible abutment supported by, seated directly upon and covering the rotating outlet means at the discharge end, the fluid under compression being confined in the toothed spaces until its pressure equals or slightly exceeds that in the discharge passage.

2. In a rotary compressor of the internal-external type, a casing having suction and discharge passages, a chamber containing cooperating eccentrically-arranged internal and external rotors rotatable therein, ports in the periphery of the external rotor connecting the said passages with the spaces between the teeth of the rotors, and a flexible abutment supported by, seated directly upon and covering the rotating outlet ports at the discharge end, the fluid under compression being confined in the toothed spaces until its pressure equals or slightly exceeds that in the discharge passage.

3. In a rotary compressor, provided with suction and discharge passages, rotary compressor mechanism having a series of rotating outlet ports leading directly into the discharge passage and a flexible abutment supported by, seated directly upon and covering the rotating outlet ports at the discharge end, the fluid under compression being confined in the toothed spaces until its pressure equals or slightly exceeds that in the discharge passage.

4. In a rotary compressor, provided with suction and discharge passages, rotary compressor mechanism having a series of rotating outlet ports leading directly into the discharge passage and non-rotatable means supported by, seated directly upon and covering said ports at the discharge end, the fluid under compression being confined in the toothed spaces until its pressure equals or slightly exceeds that in the discharge passage.

5. In a rotary compressor in combination: a casing having suction and discharge passages, rotary compressor mechanism provided with ports rotatable therewith and communicating with said passages, and an abutment comprising a flexible strip supported by, seated directly upon and covering a plurality of ports in the discharge passage, said strip being rigidly fastened to the casing and in sealing contact with said rotary mechanism at the point where compression is initiated.

6. In a rotary compressor in combination: a casing having suction and discharge passages, rotary compressor mechanism provided with ports rotatable therewith and communicating with said passages, and an abutment comprising flexible means supported by, seated directly upon and covering a plurality of ports in the discharge passage, said means starting at the point where compression is initiated and being non-rotatable.

7. In a rotary compressor of the internal-external type, a casing having suction and discharge passages, a chamber containing cooperating eccentrically arranged internal and external rotors rotatable therein and provided with cooperating external and internal teeth respectively, the spaces between said internal teeth approaching closely to the outer periphery of said external rotor and adapted to be substantially filled by said external teeth in the position of maximum compression of said rotors, said external rotor being provided with radial ports through its thinnest portions and said ports connecting said passages with said spaces, and a flexible non-rotatable abutment supported by, seated directly upon and covering a plurality of said ports.

8. In a rotary compressor of the internal-external type, a casing having suction and discharge passages, a chamber containing cooperating eccentrically arranged internal and external rotors rotatable therein and provided with cooperating external and internal teeth respectively, the spaces between said external and internal

teeth being open at one end, and pressure-releasable, non-rotatable means supported by and seated directly upon said open ends of said external and internal teeth and completely covering a plurality of the spaces therebetween, the fluid under compression being confined in the tooth spaces until its pressure equals or slightly exceeds that of the discharge passage.

9. In a rotary compressor provided with a casing having suction and discharge passages and rotary compressor mechanism, a cylindrical ring gear member of reduced diameter between its ends provided with means for separating said suction and discharge passages, said reduced portion being also provided with ports adapted to communicate with said passages, the ends of said cylindrical ring gear member being adapted to make sealing contact with said casing, and differential pressure-responsive closure means for said ports located in the space provided by said reduced portion.

10. In a rotary compressor of the internal-external type, a main casing body member, a drive shaft arranged longitudinally therein, a pinion member of the external-internal type of gear compressor on said shaft, a ring gear member of said compressor arranged eccentrically around said pinion member, bearings carrying said shaft, separate bearings carrying said ring gear member and eccentric seats for said bearings formed solely in said main casing body member, so that a single machine fit determines the eccentricity of the pinion and ring gear.

11. In a rotary compressor of the internal-external type, a casing having suction and discharge passages, a chamber containing cooperating eccentrically-arranged internal and external rotors rotatable therein, ports in the periphery of the external rotor connecting the said passages with the spaces between the teeth of the rotors, and a flexible abutment in direct contact with and covering a plurality of the ports at the discharge side thereof, the end of the abutment remote from the discharge outlet in the casing being fixed while the remainder thereof is free to be lifted whenever the pressure in any tooth space covered thereby exceeds the discharge pressure in the discharge passage.

12. In a rotary compressor of the internal-external type, a casing, a shaft arranged axially therein, a pinion member of an internal-external type of gear compressor secured to the shaft, a ring gear member of said compressor arranged eccentrically around the pinion member and having the periphery of its ends rotatable close to the inner wall of the casing and a portion between its ends reduced in diameter, radial ports in the wall of the reduced portion opening into the tooth spaces between the teeth of the rotors, an annular abutment seated in the reduced portion of the ring-gear member and having grooves in its inner face communicating with the outer ends of the said ports, suction and discharge passages in the casing in communication with the said grooves, and a flexible abutment covering the outer ends of at least some of the ports at the discharge side of the ring-gear member.

13. In a rotary compressor of the internal-external type, a casing, a shaft arranged axially therein, a pinion member of an internal-external type of gear compressor secured to the shaft, a ring gear member of said compressor arranged eccentrically around the pinion member and having the periphery of its ends rotatable close to the inner wall of the casing and a portion between its ends reduced in diameter, radial ports in the wall of the reduced portion opening into the tooth spaces between the teeth of the rotors, an annular abutment seated in the reduced portion of the ring-gear member and having grooves in its inner face communicating with the outer ends of the said ports, suction and discharge passages in the casing in communication with the said grooves, and a flexible abutment covering the outer ends of at least some of the ports at the discharge side of the ring-gear member, the annular abutment being separable from the casing, and the periphery thereof being countersunk in the inner wall of the casing.

14. In a rotary pump compressor of the internal-external type, a casing, a shaft arranged axially therein, a pinion member of an internal-external type of gear compressor secured to the shaft, a ring gear member of said compressor arranged eccentrically around the pinion member and having the periphery of its ends rotatable close to the inner wall of the casing and a portion between its ends reduced in diameter, radial ports in the wall of the reduced portion opening into the tooth spaces between the teeth of the rotors, an annular abutment seated in the reduced portion of the ring-gear member and having grooves in its inner face communicating with the outer ends of the said ports, suction and discharge passages in the casing in communication with the said grooves, and a flexible abutment covering the outer ends of at least some of the ports at the discharge side of the ring-gear member, the annular abutment being separable from the casing, and the periphery thereof being countersunk in the inner wall of the casing, in combination with a thrust bearing for the shaft and means for adjusting the thrust bearing whereby clearances between the annular abutment and the adjacent walls of the unreduced portions of the ring-gear member may be adjusted.

15. In a rotary compressor of the internal-external gear type, a ring gear member having radial ports and a reduced diameter between its ends, a casing having suction and discharge passages, and two abutments separating said passages, the inner faces of the abutments contacting on the periphery of the ported portion of the rotating ring gear, the abutment in the region of full mesh being rigid, beginning at the line of centers of the gears to avoid trapping, and continuing in the direction of rotation sufficiently to expand the clearance gas back to suction pressure by the time a port reaches the end of the abutment, the other abutment in the region of open mesh consisting of a flexible strip lying directly on said gear, beginning at the line of centers, and rigidly fastened at this point, and continuing in the direction of rotation to a point on the periphery of said gear, where the remaining reduced volume of the tooth space between the pinion and gear shall have produced a pressure equal to or greater than the discharge pressure, the radial depth of the ports being reduced to reduce the clearance volume for gas passing therewith from the discharge to the suction passage.

REGINALD J. S. PIGOTT.

CERTIFICATE OF CORRECTION.

Patent No. 2,053,919. September 8, 1936.

REGINALD J. S. PIGOTT.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 42, claim 11, before the word "covering" insert directly; and second column, line 19, claim 14, strike out "pump"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of December, A. D. 1936.

(Seal)

Henry Van Arsdale
Acting Commissioner of Patents.