June 30, 1964 O. N. PETERSON 3,139,232

REFRIGERATION PUMP

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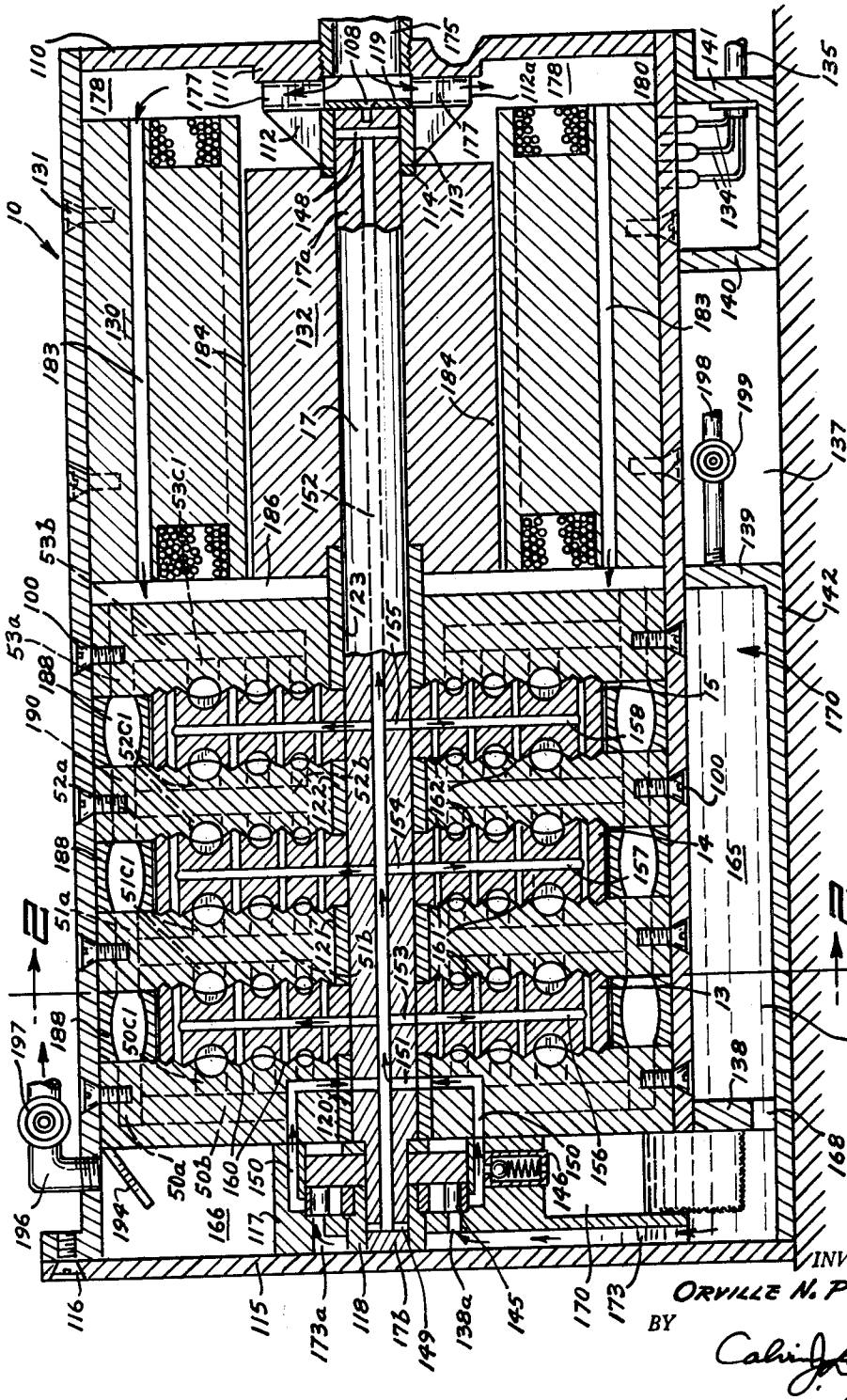


FIG. 1

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REFRIGERATION PUMP

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FIG. 2

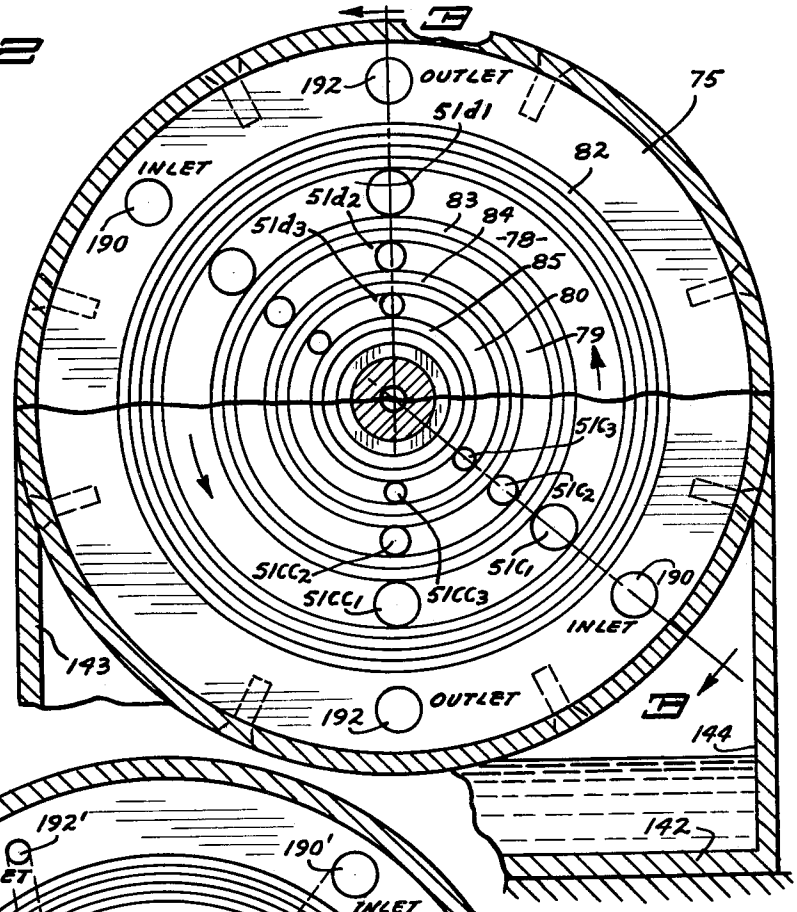
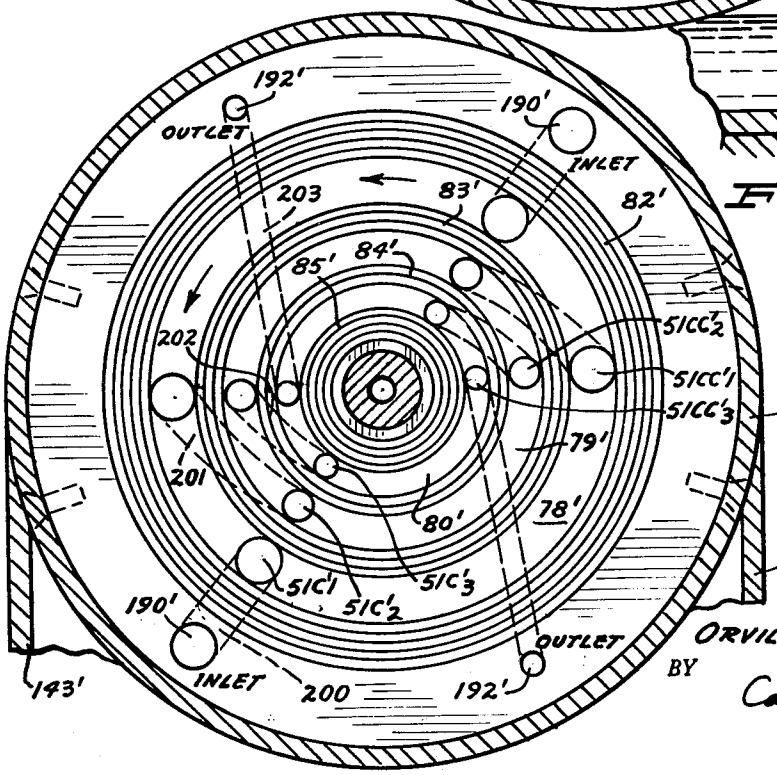


FIG. 4



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REFRIGERATION PUMP

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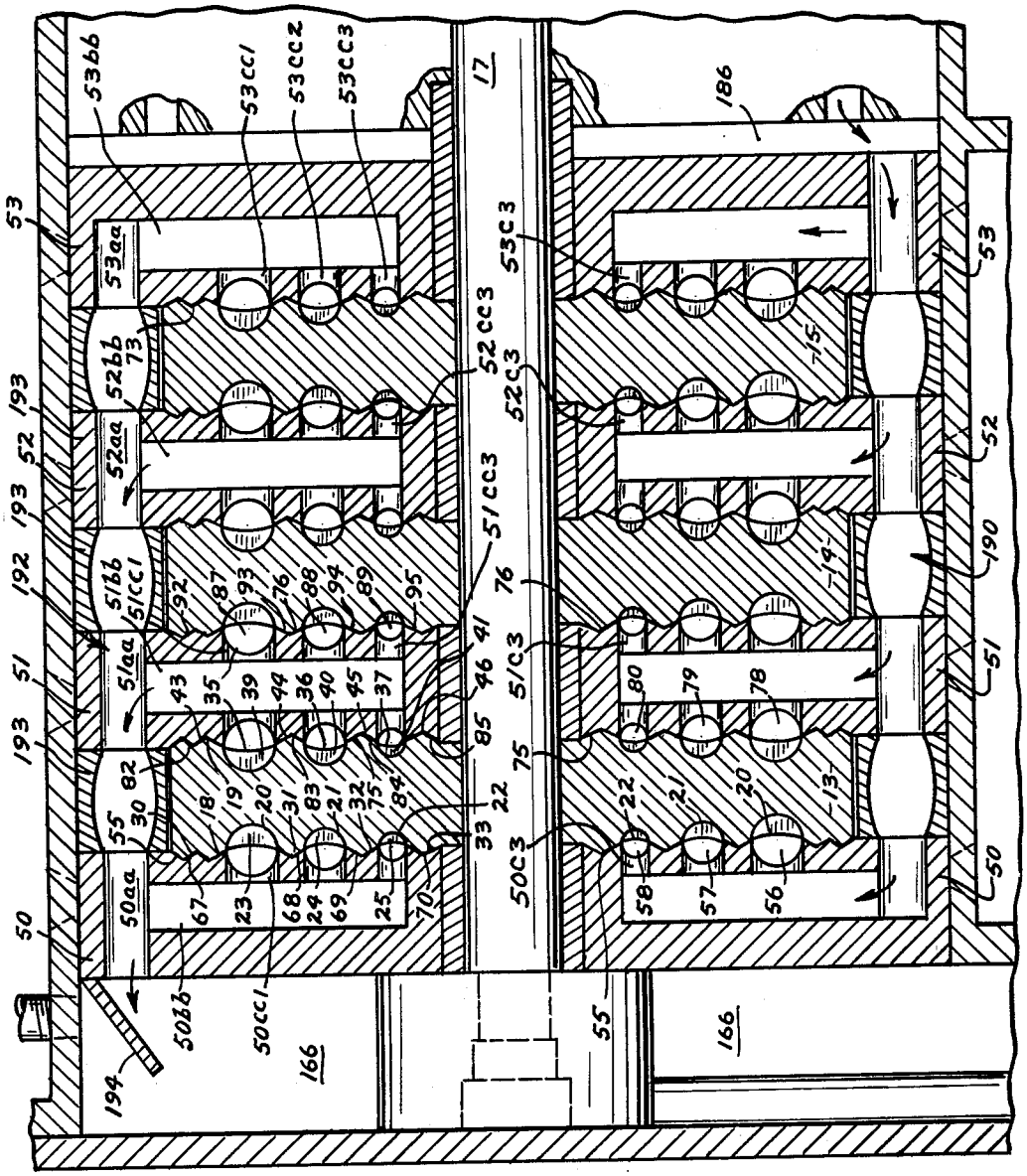


FIG. 3

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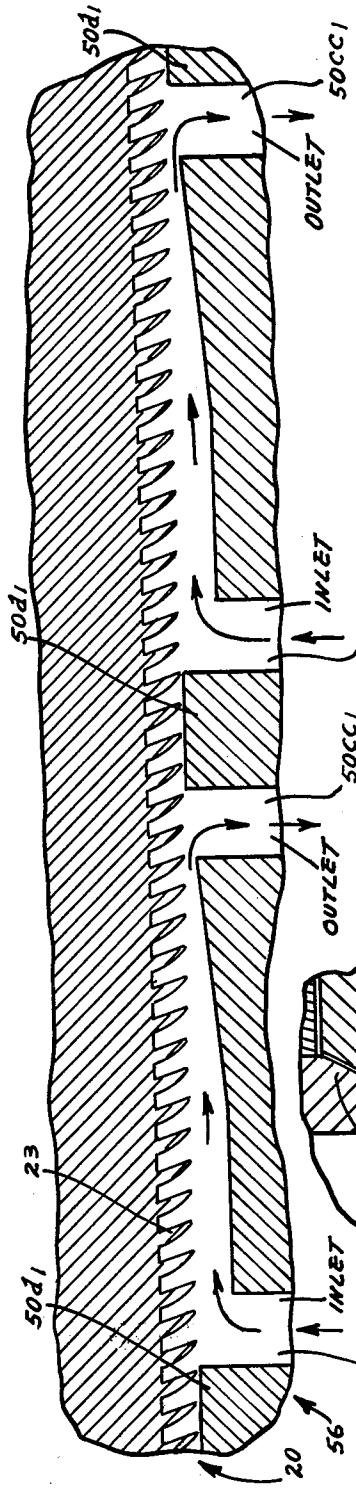
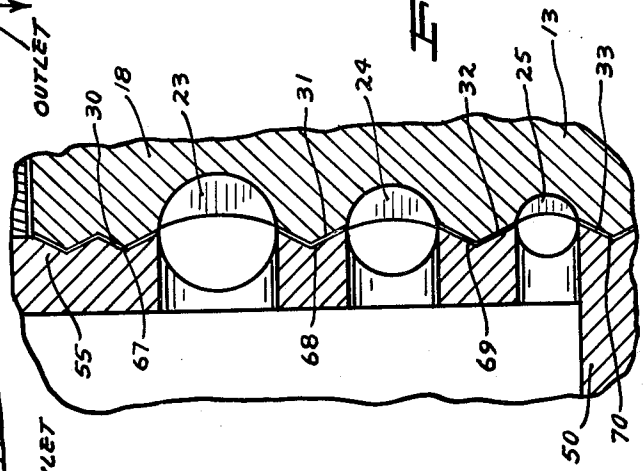


FIG. 6

FIG. 5



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REFRIGERATION PUMP

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Filed Aug. 24, 1959, Ser. No. 835,700
2 Claims. (Cl. 230—118)

This invention relates to an improvement in a refrigeration pump and more particularly to a regenerative turbine pump and is adapted for pumping a refrigerant to a much higher pressure than is possible with other commonly known like pumps such as centrifugal or radial flow types of pumps. This invention also relates to the use of oil under pressure as a lubricant and sealant in connection with said type of pump.

It is desirable to have a regenerative type of pump embodying the use of a plurality of concentric channels for greatly increasing the pressure of the refrigerant at the outlet point.

It is also desirable to have a regenerative type of pump embodying the use of a plurality of concentric channels arranged in series with the inlet in the outermost channel and the outlet in the innermost channel for a higher degree of pressure at the outlet point than could otherwise be produced.

It is further desirable in connection with a regenerative type of pump embodying the use of mating rotors and stators to have a fluid under pressure used as a lubricant and a sealant for the same.

It is therefore an object of this invention to provide a regenerative type of refrigeration pump comprising the use of a pluraltiy of concentric channels in parallel arrangement for producing a greater degree of pressure than would otherwise be possible.

It is a further object of this invention to provide a regenerative type of pump comprising a rotor in connection with a stator having a plurality of concentric channels therebetween respectively having inlets and outlets spaced about said channels, and said channels decreasing in dimension in a direction from the inlets toward the outlets thereof.

It is also an object of this invention in connection with the structure set forth in the previous object to provide oil under pressure to be used both as a sealant and as a lubricant between the rotor and mating stator and to provide a sump for the separation of the refrigerant from said oil.

It is another object of this invention to provide a regenerative type of pump comprising a rotor in connection with a mating stator having a plurality of concentric channels therebetween, said channels having a series arrangement having an inlet at the outermost channel and an outlet at the innermost channel for the production of a relatively high degree of pressure at the outlet.

It is a further object of this invention in connection with the structure set forth in the previous object to provide for a decrease in size of said channels respectively from the outermost to the innermost of said channels.

It is also an object of this invention to provide a regenerative type of pump comprising a plurality of rotors in connection with mating stators respectively having a plurality of concentric channels therebetween.

It is a further object of this invention in connection with the structure set forth in the previous object to provide for a self-contained hermetic unit comprising a source of oil and an oil pump to supply said oil under pressure as a sealant and lubricant.

These and other objects and advantages of the invention will be fully set forth in the following description made in connection with the accompanying drawings in which:

FIG. 1 is a view in central, longitudinal, vertical section through applicant's device;

FIG. 2 is a view on a somewhat enlarged scale in vertical cross section taken on line 2—2 of FIG. 1 as indicated by the arrows;

FIG. 3 is a view on an enlarged scale in longitudinal section taken on line 3—3 of FIG. 2 as indicated by the arrows with a portion thereof broken away;

FIG. 4 is a view in vertical cross section of a modification of applicant's device similar to the view in FIG. 2;

FIG. 5 is a fragmentary view of a portion of FIG. 3 on an enlarged scale showing a detail of applicant's sealing ring construction; and

FIG. 6 is a sectional view on an enlarged scale showing a linear extension of a channel and mating raceway construction.

Referring specifically to the drawings, like reference characters are used to indicate identical parts throughout the several views. Referring to FIGS. 1–3 a housing **10** is indicated. Said housing may be variously formed. In the embodiment of the invention as here disclosed it is indicated as being substantially cylindrical in form.

Said housing **10** is supported on an auxiliary housing or base portion **137** indicated as being substantially rectangular in plan having longitudinally spaced transversely extending wall portions **138**, **139**, **140**, and **141**. Said wall portions have their upper edge portions formed to receive and support the lower portion of said housing **10**. Said wall **141** forms an end wall for said base portion **137** and said end plate **115** removably secured to said housing **10** by screws **116** forms a closure for the other end of said base portion **137**. Said base portion has a bottom plate **142** and side walls **143** and **144**.

Disposed in said housing is a plurality of rotors or impellers **13**, **14** and **15**. Said rotors may be variously formed and are here shown to be dual-faced and cylindrical in form and are secured to a shaft **177**. Said rotor **13** comprises faces **18** and **19**. Said face **18** has disposed therein a plurality of concentric channels **20**, **21**, and **22** indicated as being substantially semi-circular in cross section, and respectively radially spaced therein are vanes **23**, **24**, **25** of a commonly used construction.

Formed in said face **18**, respectively, at each side of said channels **20**, **21**, and **22** is a plurality of sealing rings formed as annular grooved areas **30**, **31**, **32**, and **33**. Said channels **20**, **21**, and **22**, respectively, diminish in circumference and in cross-sectional dimension. Said annular grooved areas correspondingly diminish in circumference.

Formed in said face **19**, identical with the construction of said face **18**, are channels **35**, **36**, and **37** having spaced therein vanes **39**, **40**, and **41**.

Formed in said face **19** at either side of said channels **35**, **36**, and **37**, identical with the construction indicated in face **18**, are annular grooved areas **43**, **44**, **45**, and **46**.

Said rotors **14** and **15** are identical in construction in all details with said rotor **13**. It is believed that further description of these rotors is not necessary.

Said rotors **13**, **14**, and **15** are in operative relation with mating stators **50**, **51**, **52**, and **53**. Said stators are substantially cylindrical in form and of somewhat greater diameter than said rotors. Said stators **50** and **53** at the outersides of said rotors **13** and **15** are single-faced. Said stators **51** and **52**, respectively disposed between said rotors **13–14** and **14–15**, are dual-faced. Said stator **50** comprises face **55** having formed therein a plurality of concentric raceways **56**, **57**, and **58**, in opposed relation respectively with said channels **20**, **21**, and **22** in operative association to form an enclosed passage and having respectively spaced thereabout inlets in alternate relationship with outlets hereinafter to be described.

Said face **55** has thereon annular grooved areas **67**, **68**, **69**, and **70** adapted for mating engagement or meshing with grooves **30**, **31**, **32**, and **33** in said face **18**.

Said stator 53 has face 73 which is a mirror image in all details of said face 55.

Said stator 51 comprises faces 75 and 76 respectively identical in construction with said faces 73 and 55 with said face 75 having concentric raceways 78, 79, and 80 mating respectively with the channels in said face 19 in operative association to form an enclosed passage. Formed in said face 75 for respective mating engagement or meshing with said grooves 43, 44, 45, and 46 in said face 19 are grooves 82, 83, 84, and 85.

Said face 76 comprises a plurality of concentric raceways 87, 88, and 89 and has formed therein grooves 92, 93, 94, and 95.

Said stator 52 is identical in all details of construction with stator 51.

Said stators 50–53 are respectively secured in position by a plurality of circumferentially spaced screws 100 threaded thereinto through adjacent portions of said housing 10.

Extending inwardly centrally of any one end 110 of housing 10 is a hub portion 111 having mounted thereon a bearing support 112 here shown to be somewhat frustoconical in form and having a cylindrical base portion 112*a* having mounted therein bearing 113 in which the adjacent end 17*a* of said shaft 17 is journalled. Secured about said shaft 17 adjacent the inner end of bearing 113 is a collar 114 and secured to said shaft by screws 108 at the outer end of said bearing 113 is a retaining plate 119. Said collar and said plate limit the end play in said shaft 17.

Extending inwardly centrally of the other end 115 of said housing 10 is a hub portion 117 having disposed therein bearing 118 in which is journalled the adjacent end portion 17*b* of said shaft 17 with said portion 17*b* being somewhat reduced in diameter. Said end 115 is formed as a removable plate being secured to said housing by screws 116.

Disposed centrally in said stators 50–53 respectively are bearings 120, 121, 122, and 123 through which said shaft 17 extends and is journalled into.

Said shaft 17 may be variously driven by means within or outside of said housing 10. In the embodiment here disclosed there is provided mounted in said housing 10 adjacent to said end 110, a motor 130 having its casing secured to said housing 10 by a plurality of screws 131 and having its rotor 132 secured to said shaft 17 whereby said shaft will be driven by said motor. Said motor is here indicated as being electrical, having conductors 134 running to a source of power through conduit 135.

Mounted in said hub portion 117 and secured to end portion 17*b* of said shaft 17 and driven thereby is an oil pump 145. No particular novelty is claimed in the specific construction of said pump. It is here indicated as being a common impeller type of pump provided with a relief valve 146.

Said oil pump 145 has extending therefrom oil passages 150 for communication with radial oil passage 151 disposed in said shaft 17 and in turn connected to the axially extending oil passage 152 in said shaft 17. Said passage 152 extends substantially the full length of said shaft. At either end of said passage 152 are radially extending passages 148 and 149 which respectively provide lubrication for said motor 130 and said oil pump 145. Said passage 152 communicates with radial oil passages 153, 154, and 155 of said shaft 17 which are respectively aligned with radial passages 156, 157, and 158, of rotors 13, 14, and 15.

Said passages 156, 157, and 158 are respectively intersected by transversely extending passages 160, 161, and 162 which respectively communicate with the grooved areas in rotors 13, 14, and 15 as previously described, there being respectively a plurality of passages 160, 161, and 162.

A sump is provided in connection with said oil pump for containing the oil used. Said sump may be variously formed and may comprise a various number of chambers but is here shown comprising a pair of associated chambers as hereinafter described.

Said base portion 137 has formed therein between walls 138 and 139 a chamber 165. Formed between the outer side of said stator 50 and the end plate 115 is a chamber 166. Providing communication between chambers 165 and 166 is a plurality of passages 168 extending through the wall 138. Said chambers 165 and 166 form a common sump 170. Disposed in said sump 170 and suitable for lubrication and sealing purposes is an oil 172. Adapted for said oil 172 to be fed into said oil pump 145 is an oil intake tube 173 having inlets 173*a* leading directly into said oil pump 145.

Extending centrally through hub 111 is a main inlet 175 for a suitable gas refrigerant 180, said inlet 175 communicating with transverse inlets 177 extending through the base portion 112*a* of said bracket 112 into chambers 178 formed at either side of said hub 111 between said end 110 of said housing 10 and the adjacent portion of said motor 130.

Leading from said chamber 178 is a plurality of principal passages 183 and additional passages 184 for passage of said refrigerant 180 into a chamber 186 formed between adjacent ends of said motor 130 and said stator 53.

Extending transversely through said stators 53, 52, and 51 and partially through stator 50 in diametrically opposed positions are inlet passages 53*a*, 52*a*, 51*a*, and 50*a*, and connecting the same are connecting members 188 indicated here as being in the form of nipples to form continuous inlet passages 190 having communication with chamber 186. Extending centrally radially for a substantial distance through said stators 53–50 in communication with said passages 53*a*–50*a* respectively are passages 53*b*, 52*b*, 51*b*, and 50*b*. Connecting said passages 53*b*–50*b* with the several raceways above described in said stators 53–50 are transversely etxending inlets 53*c*1–3, 52*c*1–3, 51*c*1–3 and 50*c*1–3 representatively indicated in FIG. 3. Said inlets 53*c*1–3 through 50*c*1–3 respectively are of the same transverse dimensions as the respective raceways with which they are connected whereby communication is provided between said raceways and said chamber 186 for the passage thereto of said refrigerant 180.

Extending through said stators 53–50 in diametrically opposed positions and respectively spaced from said inlets 190 are outlet passages 192. In the embodiment of the invention here disclosed said outlet passages 192 are indicated as being spaced from said inlet passages 190 respectively approximately 135°. Said outlet passages 192 are identical in construction with said inlet passages 190 and comprise transversely extending passages 50*aa*, 51*aa*, and 52*aa* extending through said stators 50–52 and 53*aa* extending partially through said stator 53 and connecting members 193 indicated here as being in the form of nipples. Extending radially substantially through stators 50–53 in communication with said passages 50*aa*–53*aa* respectively are passages 50*bb*, 51*bb*, 52*bb* and 53*bb*. Connecting said passages 50*bb*–53*bb* with the several raceways above described in said stators 50–53 are the transversely extending outlets 50*cc*1–3, 51*cc*1–3, 52*cc*1–3, and 53*cc*1–3 representatively indicated in FIG. 3. Said outlets 50*cc*1–3 through 53*cc*1–3 respectively are of the same transverse dimensions as the respective raceways with which they are connected whereby communication is provided between said raceways and said chamber 166 for the passage therefrom of said refrigerant 180.

Said inlets and outlets above described may vary in number as to each raceway as may be desired. In the present embodiment of the applicant's invention said raceways as indicated by raceways 56–58 are respectively indicated as having pairs of alternating inlets and outlets. Also as indicated in FIG. 6 there is shown a linear extension of raceway 56 of said face 55 and related chan-

nel **20** of said face **18** in which said raceway is indicated as diminishing in depth or, in other words in volume from said inlets **50***c***1** in the direction of said outlets **50***cc***1**. At the sides of all outlets remote from their respective inlets are formed shoulders as indicated in FIG. 6 by shoulders **50***d***1** and in FIG. 2 by shoulders **51***d***1–51***d***3**.

Overhanging said outlet passages **192** at an angle and secured to the inner side of said housing **10** in a suitable manner are baffle plates **194**.

Extending outwardly of said chamber **166** is a conduit **196** here provided with a shut off valve **197**. Said conduit **196** will extend to a condenser not here shown and not forming a part of applicant's invention. Extending outwardly of said chamber **165** is a conduit **198** forming a gas outlet having a shut off valve **199** and which will extend to said condenser.

With reference to FIG. 6 the linear extension of a channel construction is shown indicating details thereof typical of all of the channel construction in the applicant's device. For this purpose raceway **56** and channel **20** of the mating faces **55** and **18** of stator **50** and rotor **13** respectively are shown comprising vanes **23**, inlets **50***c***1**, outlets **50***cc***1**, and shoulders **50***d***1** between adjacent of said outlets and inlets. Said raceway **56** is shown diminishing in depth respectively in the direction from the inlets to the outlets and is here shown diminishing in depth from a point substantially centrally between said inlets and their respective outlets. Said shoulders **50***d***1** are of a height providing just sufficient clearance for said vanes **23** to pass thereby. As here indicated shoulders **50***d***1** respectively form the back walls for said outlets **50***cc***1**.

Operation

Commencing with applicant's device in the position shown in FIG. 1 an adequate supply of oil **172** will be present in chamber **165** and will pass through inlet **173** into oil pump **145**. Motor **130** will be activated to drive shaft **17** which operates said oil pump **145** supplying oil under pressure through passages **150** into passage **152** and through said passage **152** and the related radial passages in said shaft respectively through said passages **156, 157,** and **158** and through their intersecting passages as indicated into the grooved areas respectively connected therewith. More particularly with respect to rotor **13** driven by said shaft **17** and stator **50**, said oil **172** will be fed under pressure of said pump **145** into the grooved areas **30, 31, 32,** and **33**. Said oil will act as a lubricant between adjacent faces **55** and **18** respectively of said stator and said rotor and will also act as a cushion to absorb any oscillatory vibration which may develop in said rotor **13**. Said oil under constant pressure provides a highly effective sealing means to prevent loss of refrigerant from adjacent channels and raceways as will be hereinafter described.

From a suitable source not here shown a gas refrigerant **180** is provided entering into applicant's device through inlet **175** and passages **177, 183,** and **184** respectively into chamber **186** under low pressure for passage through the main inlets **190** into the respective raceways. Reference is made to FIGS. 1–3 for a detail of the passage of said refrigerant as to a portion of applicant's device indicative of the operation of applicant's entire device. Said refrigerant **180** will enter through inlets **51***c***1–51***c***3** of stator **51** through connecting passages as previously indicated to be impelled through raceways **78, 79** and **80** by vanes **39, 40** and **41** carried by said rotor **13** to impel said refrigerant in the direction of said outlets **51***cc***1–51***cc***3** with said raceways diminishing in depth in the direction of said outlets whereby said refrigerant is caused to attain an unusually high degree of pressure within a relatively short distance. Reference is made to FIG. 6 for a showing of the detail of a channel construction.

This operation takes place simultaneously throughout all the channels and raceways indicated for a discharge of said refrigerant through both or either of the outlets **196** and **198** as may be desired. The diminution in the depth of raceways adds an unusual degree of efficiency in developing a very high degree of pressure in the refrigerant at the point of discharge at the outlet. The use of oil under pressure as a sealant at either side of each of the channels and raceways of applicant's device in effectively preventing crossleakage of the refrigerant adds materially to the attaining of said high degree of pressure.

It is obvious from the above description of the applicant's device and the operation thereof that the respective raceways and their respective separate inlets and outlets are in a parallel arrangment.

As has been indicated applicant's device is an improvement over similar devices in providing under constant pressure a sealant and lubricant between the adjacent faces of rotors and stators to prevent leakage of the refrigerant, to provide lubrication for the opposing faces, and to provide a cushion to absorb any vibratory action which may develop. The applicant has made a marked advance in this art in providing an oil pump to be used in connection with his apparatus for the purposes stated. The positive lubrication provided permits a higher speed of operation than would otherwise be practical and also permits the use of less exacting tolerances between mating faces respectively of adjacent rotors and stators in the operation with a resulting higher degree of efficiency with a less expensive cost of construction and operation than would otherwise be possible. The lubricant under pressure forms an effective sealant and prevents leakage of the refrigerant from its channels and provides a positive separation between the high and low pressure stages of said refrigerant.

The use of applicant's oil pump makes possible the efficient operation of a multi-stage turbine type of refrigeration compressor wherein a plurality of concentric channels and raceways is provided. But for the use of applicant's lubricant under pressure to act as a sealant as indicated the loss of refrigerant between the adjacent of said channels would be such that the operation of the device would be inefficient to the point of being an undesirable one.

The lubricant as an efficient sealant permits the refrigerant to be placed under an unusually high degree of pressure and permits an unusually high degree of acceleration of the pressure of said refrigerant from an inlet to an outlet and particularly in connection with a raceway construction diminishing in depth from the inlet in the direction of the outlet thereof.

Referring to FIG. 4 wherein is indicated a modification of applicant's device, all parts identical in construction with those indicated in FIGS. 1–3 and 5 are indicated by the same characters with primes added.

The difference in construction of this modification is that the several concentric raceways of each stator face are connected in series instead of being in a parallel arrangement as above described.

The structure in FIG. 4 is indicated as showing stator face **75′** having the inlets **190′** communicating with the inlets **51***c***′1** of raceway **78′** by means of passage **200**. A passage **201** connects the outlet **51***cc***′1** of said raceway **78′** with inlet **51***c***′2** of raceway **79′**. Outlet **51***cc***′2** of said raceway **79′** is connected to inlet **51***c***′3** of raceway **80′** by passage **202**. Outlet **51***cc***′3** of said raceway **80′** discharges by means of passage **203** through the common outlet **192′**.

The operation of this modified construction results in a refrigerant under low pressure entering the common inlet **190′** and passing into said outermost raceway **78′** in which raceway the pressure is quickly raised and it is discharged into said intermediate raceway **79′** where the pressure is further raised and from here the refrigerant is discharged into said innermost raceway **80′** where the pressure is raised to a maximum degree and the refrig-

erant is discharged through the outlet 192' to do its work.

It will of course be understood that various changes may be made in the form, details, arrangement and proportions of the parts, without departing from the scope of applicant's invention which, generally stated, consists in a device capable of carrying out the objects above set forth, in the parts and combinations of parts disclosed and defined in the appended claims.

What is claimed is:

1. A refrigeration pump having in combination,
an impeller comprising a plurality of concentric channels respectively having a plurality of spaced vanes thereabout,
a plurality of concentric raceways in operative association with said channels respectively forming enclosed passages therewith,
an inlet and an outlet spaced about each of said raceways and being unobstructed therebetween, and
each of said raceways diminishing in volume from a point inwardly of its inlet in the direction towards its outlet.

2. A refrigeration pump havinng in combination,
a housing, an impeller in said housing comprising a plurality of concentric channels respectively having a plurality of spaced vanes thereabout,
a plurality of concentric raceways in operative association with said channels forming enclosed passages therewith,

said raceways each having a plurality of alternating inlets and outlets spaced thereabout and being unobstructed therebetween, and
each of said raceways diminishing in volume from a point intermediate each inlet and its respective outlet in the direction towards said respective outlets.

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