Nov. 1, 1949 J. E. WHITFIELD 2,486,770

ARC GENERATED THREAD FORM FOR HELICAL ROTARY MEMBERS

Filed Aug. 21, 1946 6 Sheets-Sheet 1

Fig. 1

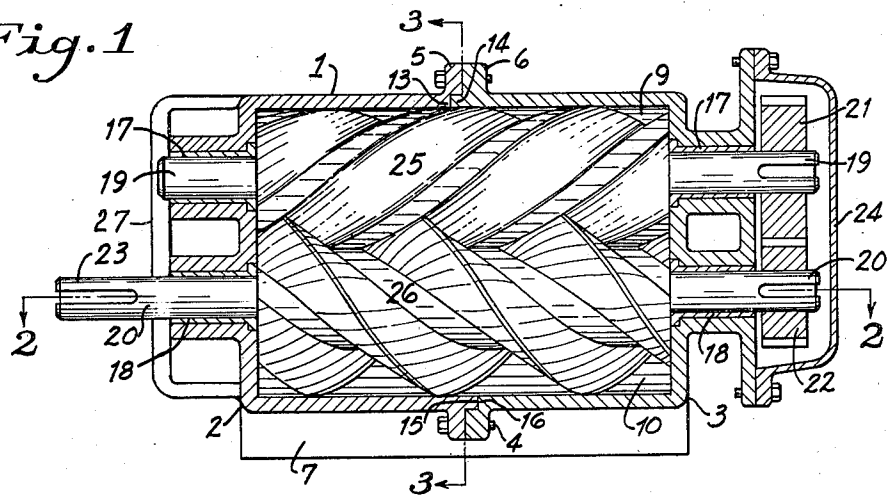


Fig. 2

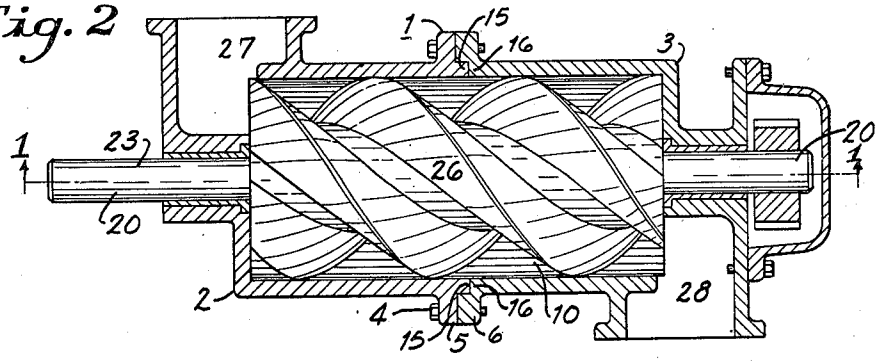
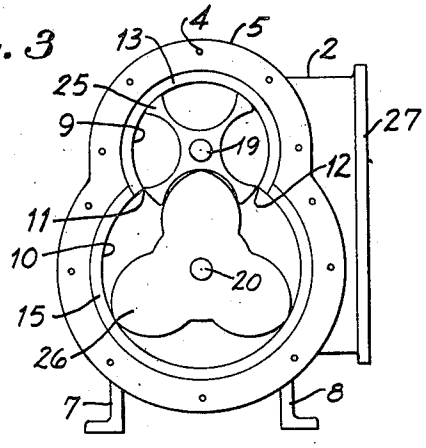


Fig. 3



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Filed Aug. 21, 1946 6 Sheets-Sheet 2

Fig. 4

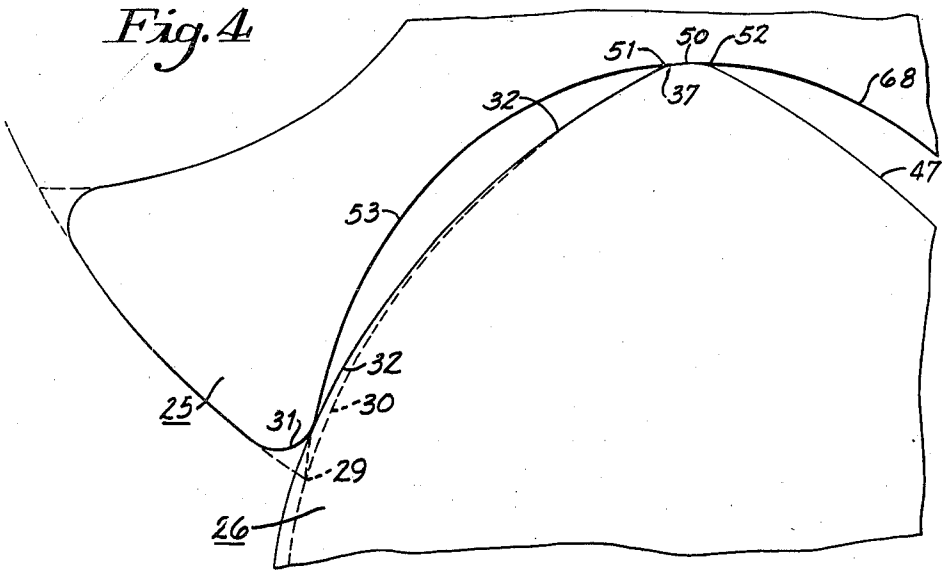
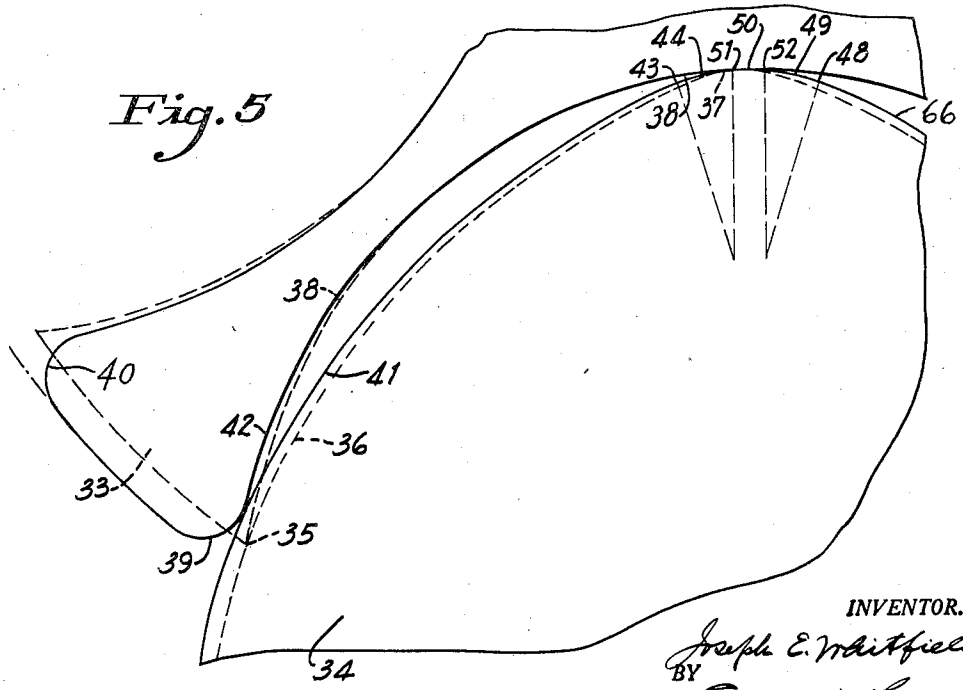


Fig. 5



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ARC GENERATED THREAD FORM FOR HELICAL ROTARY MEMBERS

Filed Aug. 21, 1946 6 Sheets-Sheet 3

Fig. 6

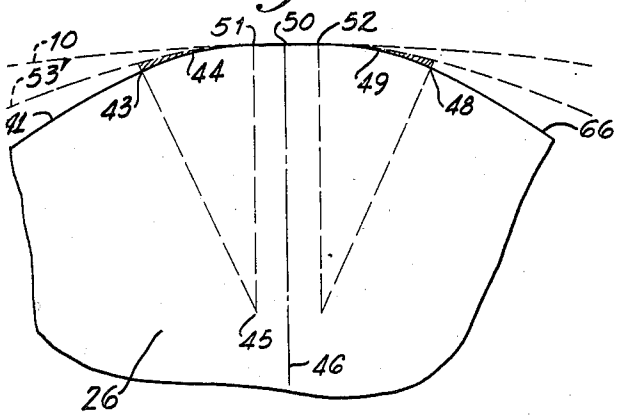


Fig. 7

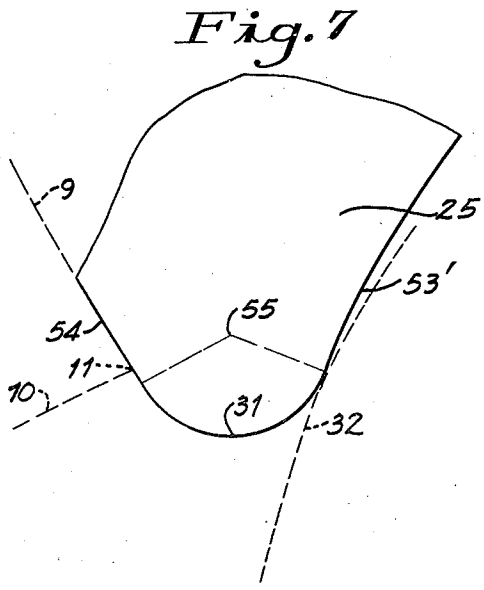
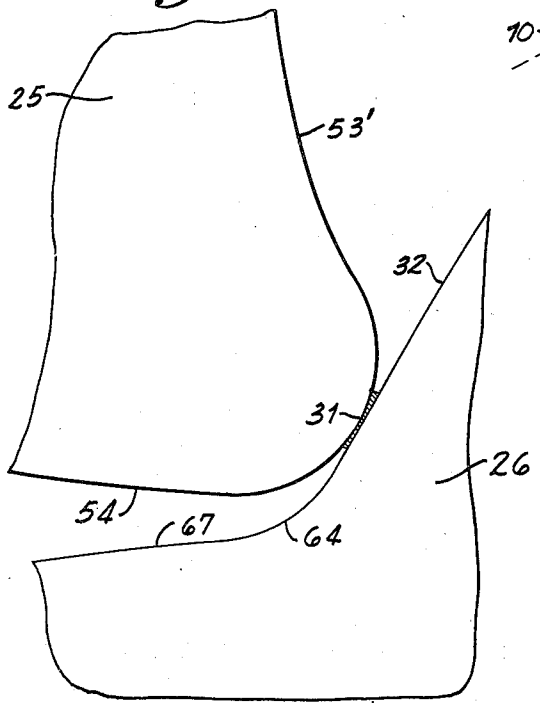


Fig. 8



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Nov. 1, 1949 J. E. WHITFIELD 2,486,770

ARC GENERATED THREAD FORM FOR HELICAL ROTARY MEMBERS

Filed Aug. 21, 1946 6 Sheets-Sheet 4

Fig. 9

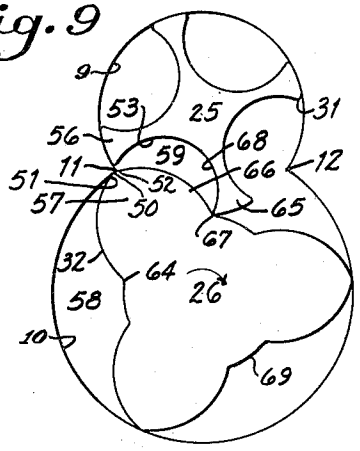


Fig. 10

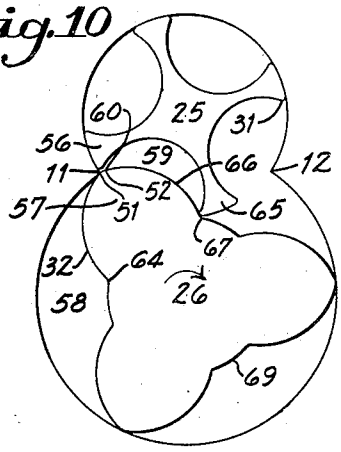


Fig. 11

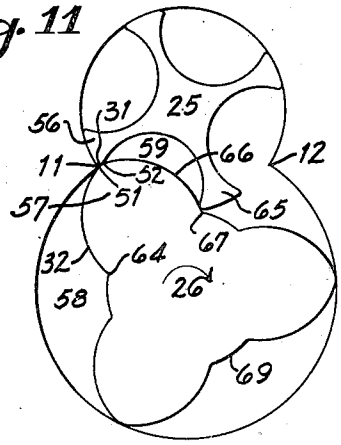


Fig. 12

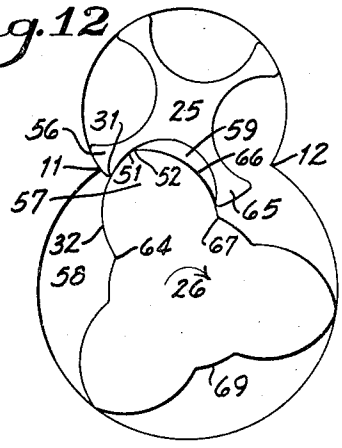
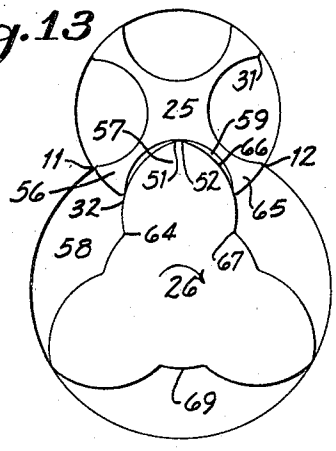


Fig. 13



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Nov. 1, 1949 J. E. WHITFIELD 2,486,770

ARC GENERATED THREAD FORM FOR HELICAL ROTARY MEMBERS

Filed Aug. 21, 1946 6 Sheets-Sheet 5

Fig. 14

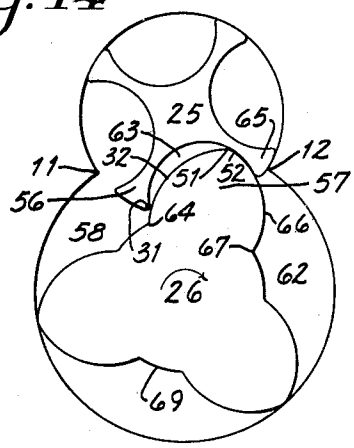


Fig. 15

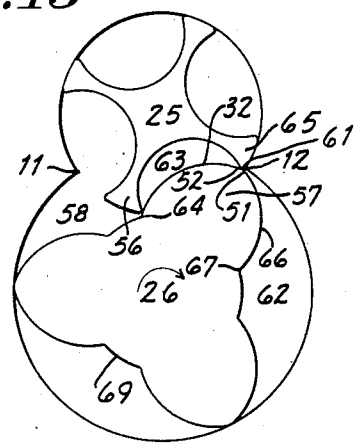


Fig. 16

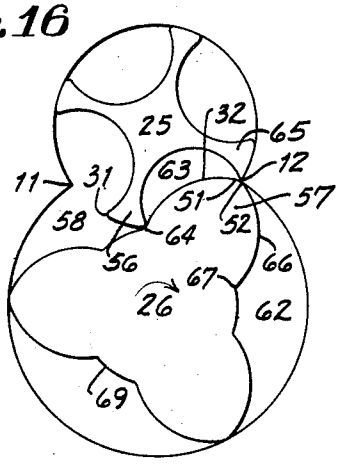
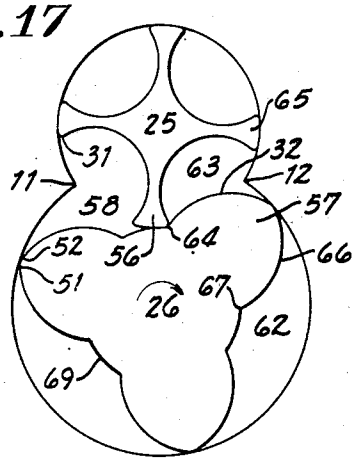


Fig. 17



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Nov. 1, 1949 J. E. WHITFIELD 2,486,770

ARC GENERATED THREAD FORM FOR HELICAL ROTARY MEMBERS

Filed Aug. 21, 1946 6 Sheets-Sheet 6

Fig. 18

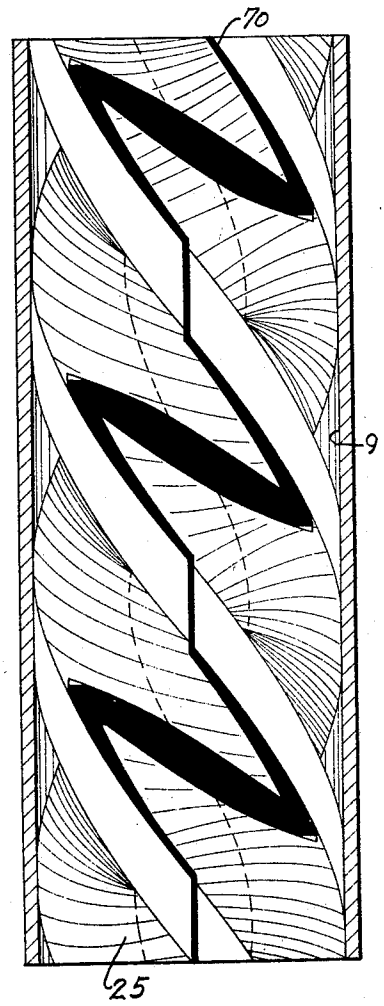
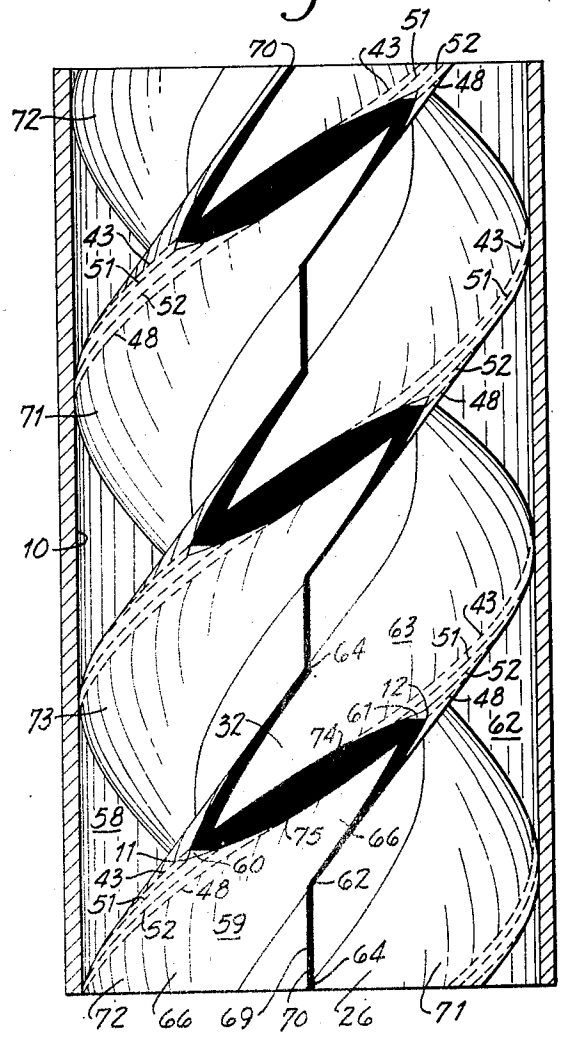


Fig. 19



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UNITED STATES PATENT OFFICE

2,486,770

ARC GENERATED THREAD FORM FOR HELICAL ROTARY MEMBERS

Joseph E. Whitfield, Hamilton, Ohio

Application August 21, 1946, Serial No. 692,061

19 Claims. (Cl. 103—128)

1

This invention relates generally to fluid devices such as axial flow intermeshed rotary screw members for compressors, blowers, pumps, motors and the like, and more particularly to the thread form of the rotary screw members for fluid devices of this character.

Axial flow fluid devices are provided with complementary intermeshing rotary screw members commonly referred to as the rotor and the gate, the former generally having a fully addendum thread and the latter a fully dedendum thread. The rotor may have two or three lobes and the gate for either of these rotors generally has four thread forming troughs or grooves. Other combinations of lobes and troughs may be employed although two or three lobe rotors are considered to be the best types for production and performance.

There are two general types of thread forms known in the art for rotary screw members of this character, namely, a symmetrical form wherein both sides of the threads are similar and are usually of generated thread form, and an asymmetrical form wherein one side of the thread is dissimilar to the other, one side usually being generated and the other side having some other form which does not match the first side.

In a fully generated symmetrical thread form the pointed tips or continuous edges of the rotor lobes generate the adjacent sides of the gate troughs and the pointed tips or continuous edges of the gate threads generate the adjacent sides of the rotor lobes.

The most efficient asymmetrical thread form is made by one edge of the rotor lobe generating the adjacent side of the gate trough and the corresponding edge on the gate thread generating the adjacent side of the rotor lobe. This is merely one-half of the symmetrical or generated thread form. The other half of the asymmetrical thread form is made up of matched radii or matched arcs while the lobe is in its full meshed position and the balance of the lobe surface is a generated section to the root of the lobes. Even though a portion of said other half of the asymmetrical thread form has a generated section none of the points along the surface of the lobe or trough are symmetrical with respect to corresponding points on the other or generated flank of the rotor lobe or gate trough. Thus the two thread forms are well named symmetrical and asymmetrical.

The present invention is adaptable for use with any thread form including either of these thread forms and any feasible combination of rotor lobes and gate troughs. However this invention is directed specifically to arc generation as distinguished from point generation.

2

From general practice it has been found that the symmetrical thread form is the superior form of the two owing to the more generous limitations and arrangements of the inlet and outlet ports permitted in the fluid devices and the higher efficiency attainable for given rotor diameters.

The problem presented in this disclosure is based principally upon the practical production of fluid devices of this character. In machining and handling the rotor and gate members the sharp edges forming the tips of the rotor lobes and gate threads are broken off due to the pointed forming tools pulling the metal off the member when being machined or they may be otherwise damaged by handling and assembling the rotary members. Obviously the rotary screw members must have a shop tolerance and the seal provided between the intermeshed rotary screw members depends on the sharp generating edges. Thus theoretically a very good seal is provided by the edges of the threads of one member extending along the sides of the other member but in reality the seal is poor as these sharp edges are not practical to make or they break off and a relatively large leak occurs for the full length of the members.

Again the theoretically sharp generating edges of the rotary members accurately seal with each other at the intersection between the parallel chambers housing the rotor and gate but in practice when these sharp edges are broken off a small leakage hole occurs between the rotor and gate at the intersection between their chambers and travels from one end of the housing to the other as the members rotate. This leakage path at the chamber intersection may be considered a part of the leakage path along the edges of the gate and rotor threads and is in fact materially less when comparing them as separate leakage paths.

Thus a leakage produced by the broken crest edges of point generated rotary members represents a loss. It has been found impractical to produce the rotary members with truly sharp crest edges. When they are not sharp leakage exists between the rotary members all along the crest edges of these members. In this invention it is therefore intended to produce crest edges on the rotary members with a curve of definite size and shape so that the size and shape of the mating member can be changed accordingly to prevent the formation of the extra clearance due to broken or misshaped crest

edges of the gate member which produces leakage between the rotary members.

The principal object of this invention is the provision of complementary intermeshed rotary screw members for a fluid device, the sides of the threads of each member being generated by a continuously changing point on the rounded crest edges of the threads of the other member. The sides of the threads of the main rotor are generated by a constantly changing point on the rounded crest edges of the gate, and the troughs of the gate are generated by a constantly changing point on the rounded crest edges on the tip of the main rotor.

Another object of this invention is the method and apparatus that provides arcuately generated rotor lobe flanks and gate troughs which improves the sealing conditions between intermeshed rotory screw members of a fluid device and simplifies the manufacture thereof.

Another object is the provision of the generation of the rotor flanks and gate troughs by an arc to produce zone sealing between the intermeshed screw members forming a fluid device.

Another object is the provision of a method and apparatus for generating the thread flanks of rotary screw members by an arcuately shaped tool which simplifies and facilitates the cutting, increases the life of the tool by progressing the center of the cutting load, improves the finish of the member, expands or enlarges the gate trough, and improves the sealing relation between the members to provide a more efficient fluid device.

Other objects and advantages appear in the following description and claims.

Practical embodiments illustrating the principles of this invention are shown in the accompanying drawings wherein:

Fig. 1 is a vertical section taken along the line 1—1 of Fig. 2 of a fluid device showing the intermeshed rotary members comprising this invention rotatably supported in a housing.

Fig. 2 is a view in horizontal section taken on the line 2—2 of Fig. 1.

Fig. 3 is a view in transverse section taken on the line 3—3 of Fig. 1 showing the gate to have four threads and the rotor to have three threads.

Fig. 4 is an enlarged fragmentary view of superimposed rotors having three threads, and superimposed gates having four threads to illustrate the difference in the profiles of arc generated and point generated threads.

Fig. 5 is a view similar to Fig. 4 illustrating the comparative profile structures of a rotor having two threads and a gate having four threads.

Fig. 6 is an enlarged view of the arc generated surface of the rotor lobe crest edge.

Fig. 7 is an enlarged view of the arcuate generating surface of the gate thread.

Fig. 8 is an enlarged view of the rotor and gate showing the seal created by the arc generated rotary members.

Fig. 9 is an end view of arc generated rotary members in a casing wherein the rotor lobe is approaching a gate trough.

Fig. 10 is a view similar to Fig. 9 showing the rotor lobe about to leave its chamber and enter the gate trough.

Fig. 11 is a view similar to Fig. 9 showing the rotor lobe sealing with the gate trough.

Fig. 12 is a view similar to Fig. 9 showing the gate thread progressed sufficiently to seal with the housing.

Fig. 13 is a view similar to Fig. 9 showing the rotor lobe at full mesh position.

Fig. 14 is a view similar to Fig. 9 showing the rotor lobe progressed beyond the full mesh position.

Fig. 15 is a view similar to Fig. 9 showing the rotor lobe about to leave the gate thread.

Fig. 16 is a view similar to Fig. 9 showing the rotor lobe about to enter its chamber.

Fig. 17 is a view similar to Fig. 9 showing the gate thread about to leave the surface of the rotor lobe.

Fig. 18 is a view of an elongated gate member illustrating the band seal produced by arc generation between the rotory members.

Fig. 19 is a view on an elongated rotor member illustrating the band seal produced by arc generation between the rotory members.

Referring to Figs. 1 to 3 of the drawings the housing 1 of the fluid device is constructed in two sections 2 and 3, joined together at the center by the bolts 4 extending through the mating radial flanges 5 and 6. Each section has a pair of legs 7 and 8 for supporting the housing. As shown in Fig. 3 the housing contains a pair of parallel cylindrical chambers 9 and 10 which intersect at 11 and 12 to form a common chamber. In order to properly interlock and seal the housing sections 2 and 3 the former is provided with a groove 13 encircling the chamber 9 and the latter is provided with an axially extending flange 14 complementary to this groove and section 2 is provided with an axial flange 15 encircling the chamber 10 and a complementary groove 16 is provided in section 3 to receive the flange 15. With this housing joint construction the sections may be accurately machined to properly aline the housing bores.

Extensions are provided on the ends of each housing section for receiving the sleeve bearing 17 and 18 in which the shafts 19 and 20 are journaled. The shaft 19 extends beyond the end of the housing section 3 and has the timing gear 21 keyed thereto. The shaft 20 extends beyond both ends of the housing, at one end the timing gear 22 is keyed to the shaft 20 and is arranged to mesh with and drive the timing gear 21 on the shaft 19. The other end 23 of the shaft 20 is arranged to be connected to any suitable source of power for driving the fluid device or to supply rotary power if the fluid device is used as a prime mover. The timing gears are enclosed by the cover 24.

The rotary members making up this fluid device are the gate member 25 and the rotor member 26 which occupy the cylindrical chambers 9 and 10 respectively having only a running clearance therein which allows for expansion due to heat if the fluid device is designed to function under elevated temperature conditions.

The rotor and the gate are provided with complementary threads and grooves, the threads of the rotor are substantially fully addendum and those of the gate are substantially fully dedendum and the perimetral surface of the gate need not be commensurate with its pitch circle which coincides with the corresponding pitch circle of the timing gear 21. However when the sides of the threads are generated by a continuously changing point on the rounded crest edges of the threads of the opposite member, it is possible to make the gate larger in diameter than its pitch circle without getting a leakage path at the root of the rotor threads. Thus the gate member may be either larger or smaller than its pitch circle

and still provide a continuous sealing line between the rotary members. On the other hand it is impossible to make the gate rotor larger in diameter than its pitch circle, when the crest edges of the gate are sharp without producing a leakage path between the rotors.

In Figs. 1 to 4 and 6 to 19 the gate is provided with four threads and the rotor with three threads. In Fig. 5 the gate has four threads and the rotor two. The helical threads of the rotary members cooperate with one another and with the walls of the housing to produce pockets that are created at one end of the housing and travel to the other end where they run out. Thus the housing is provided with diagonally disposed ports **27** and **28** at opposite ends of the housing which function as inlet or outlet ports depending upon the direction of rotation of the rotary members. As shown in Figs. 1 to 3 the rotor member is provided with right hand threads and the gate with left hand threads, thus if the rotor was turned clockwise in Fig. 3 port **27** would become the inlet and port **28** the outlet if rotated counterclockwise the port functions would reverse.

Fluid devices of this character are disclosed in United States Letters Patent No. 2,287,716 which provides similar rotary members but their complementary surfaces are point generated, that is, the continuous crest edges of the gate threads generate the adjacent flanks of the rotor threads and the continuous crest edges of the rotor threads generate the adjacent sides of the gate trough. Since the crest edges of the point generated rotary members are defined lines they represent points in any transverse plane which points are simulated in their corresponding position by pointed tools to cut their respective thread portions of the other rotary member, hence the definition of point generation. The seal line between the gate and rotor produced by point generation would also be a line seal with the exception of where the perimetral cylindrical surface of the gate travels across the cylindrical surface of the rotor trough where a small band seal may be produced but this band has a relatively narrow zone owing to the curvature of the adjacent cylindrical surfaces.

Point generation of some of the rotary members is illustrated in dotted lines, in Figs. 4 and 5. These two views illustrate the relative difference between point generation and arc generation of a rotor member having three and two threads respectively.

Where the continuous crest edges of the gate are arcuate and are employed to generate the adjacent flanks of the complementary rotor member the whole of the arcuate surface of the gate crest edge is employed in cutting its complementary rotor flank thus providing arc generation. Arc generated threads are shown in full lines in these views on the drawings. The best comparison is shown in Fig. 4 where the gate **25** has four threads and the rotor **26** has three threads. Here the perimetral surface of the gate lies in its pitch circle and there is no difference between the flanks of the gate thread as it is point generated. However, the crest edge **29** of the gate provided the point that was used to generate the rotor flank **30**. Since the point **29** had to be cut back to form the arcuate crest edge **31** of the rotor **25**, this arcuate crest edge will generate the flank **32** of the rotor **26** which results in a rotor lobe that increases in thickness toward its base.

The difference between the dotted lines representing a point generated surface and the solid lines representing an arc generated surface of the rotor flanks, as shown in Figs. 4 and 5, indicate where the leakage occurs between the rotary members if these members are point generated and the crest edges of the gate member are broken away. This leakage path continues along the crest edge of the gate which extends up across the lobe surface of the rotor. This leakage path has considerable length, and therefore is many more times larger than the area of a small leakage path formed by the crest edges of a gate member that provides an arcuate generated flank of a rotor member. Thus the increased thickness of the arc generated rotor over that of a point generated rotor represents the amount of the leakage clearance of point generated rotary members when the crest edges of the gate member are broken off when machined or when handled.

In Fig. 5 where the gate **33** has four threads and the rotor **34** has two threads point generation by the crest edge **35** of the gate produces the flank surface **36** of the rotor lobe and the crest edge **37** of the rotor produces the flank **38** of the gate as shown in dotted lines. When the crest edges are made arcuate as shown at **39** and **44** on the gate and rotor respectively they produce the flanks **41** and **42** respectively of the rotor and gate. The threads of the arc generated gate are thinner than those of the point generated gate. This would be true even if the gate **33** was larger or smaller than its pitch circle. The gate having the crest edge **35** is the same diameter as its pitch circle, which is also the pitch circle for the gate **33**.

The enlarged view Fig. 6 illustrates the arcuate crest edges of the rotor thread **26** of Fig. 4 if it had an arcuate crest edge similar to the rotor thread **34** of Fig. 5. The flank **41** is generated from the root of the thread to the point **43** and is extended by the arc **44** struck from the center **45** on one side of the line **46** that bisects the rotor lobe. The other flank **66** is also generated from the base or root of the thread to the point **48** from which the arc **49** is struck. The arc **50** between the points **51** and **52** is cylindrical and is struck from the center of the rotor axis and represents the perimetral surface of the rotor threads. The smaller arcs **44** and **49** are selected to blend into their respective generated surfaces **41** and **66** and with the perimetral surface **50**.

The dotted line **10** represents the inner surface of the cylindrical chamber **10** and the dotted line **53'** represents an arc generated trough of the gate member **25**. Even though there is running clearance between either of these surfaces and the rotor crest a sealing zone extends between the points **43** and **48** of the rotor crest and the surfaces with which there is relative movement. Since the wall of the chamber **10** is of greater radius than the generated arc **53'** of the gate trough the latter provides a wider zone sealing than the former. That is, the same capillary space created by the running clearance between these members extends further on the gate trough surface than it does on the chamber wall **10** due to the differences in their radius. But in each instance a zone and not a line seal is provided.

The crest edge of the gate is rounded in the form of the arc **31** shown in Fig. 7. So long as this arc blends in at one end with the perimetral surface **54** of the gate and with the generated trough **53'** at its other end the arc **31** may be of any desired shape or combinations of a series of blending arcs. As shown in Fig. 7 the arc **31**

is a portion of a circle struck from the point 55. The perimetral surface 54 of the gate crests is shorter than that of a point generated thread but this surface is ordinarily much wider than any other sealing surface in the device and materially more than that required to properly seal gases under pressure. Fig. 7 also illustrates the zone sealing produced by the arcuate crest edge 31 of the gate with the rotor lobe flank 32.

In Fig. 8 the arcuate crest edge generating surface 31 of the gate is shown adjacent the root of the rotor flank 32. In this position only the arcuate surface 31 provides the whole of the sealing zone with the rotor lobe flank which results in a narrower sealing zone as indicated. Thus the sealing zone produced between the rotary members varies in width owing to the curvature of the surfaces in close proximity that produce this sealing zone.

The point of least clearance between the rotary members provides the most effective seal in the sealing zone. As the surfaces diverge from this point in either direction the degree of seal becomes less effective until the remote edges of the sealing zone is reached. However, the remote edges or width of the sealing zone is determined by the nature of the fluid passing through the device. A dense gas or a liquid will obviously provide a wider sealing zone than a light gas as the molecular structure of the dense gas or liquid provide a higher resistance to movement through a greater clearance. Thus the ultimate width of the continuous sealing zone between the arcuate generated rotary members depends upon the nature of the fluid employed.

Since the crest edges of the gate and rotor threads are arcuate the tool employed to cut these thread forms would likewise be arcuate and positioned in the same relative position as the crest edge of the member that generates the surface being cut. In practice these rotary members are made up or cast oversize and a tool having the full shape of the crest edge is employed to finish the complementary member. In Figs. 9 to 17 the members are shown at different relative positions in the housing 1, but these illustrations also simulate the different relative positions of the crest edge tool of one member in cutting the generated surface of the other member both being produced by arc generations.

In Fig. 9 the thread 56 of the gate 25 and the thread 57 of the rotor 26 are approaching the chamber intersection 11 and the latter is about to move into the gate trough. Since the cylindrical perimetral surface 50 of the rotor thread is adjacent the wall of the chamber 10 the areas 58 and 59 on each side of the rotor thread are sealed from one another between the crest of the rotor lobe and the wall 10 when the structure is considered in a single transverse plane.

In Fig. 10 the perimetral surface 50 of the rotor thread 57 has just passed the chamber intersection 11 and if the gate thread was point generated it would engage the flank 32 of the rotor thread 57 and maintain the seal between the areas 58 and 59 across the crest of the rotor but here the crest edge of the gate thread 56 is rounded by the arc 31 which permits leakage between areas 58 and 59 over the crest edge of the rotor. This leakage path is designated as 60 and its dimension is regulated by the amount of material removed from between the arcuate edge 31 and the line of the flank 32 as shown in Figs. 10 and 19. In comparison with the leakage that exists along the full length of a crest

edge of a point generated gate and the flank of a rotor thread of an actual structure the leakage path 60 is extremely small. The sharp crest edge 29 cannot be accurately formed, particularly in the soft metals, as the tool drags the metal off the point when the sides are being shaped or they are bumped off when handling. However, the extent of the leakage path 60 may be measured from the time that the point 51 of arc 50 on the rotor thread leaves the intersection 11 until this same point 51 engages the juncture of the arc 31 and the generated trough surface 53' of the gate. This leakage path is between consecutive areas such as 58 and 59, or transversely over the crest of the rotor thread. As the rotary members rotate this small leakage path 60 traverses the length of the housing along the chamber intersection 11. A similar leakage path occurs over the crest of the rotor thread as it leaves the arc 31 of the gate thread until the point 52 engages the cylindrical wall 10 at the intersection 12 on the opposite sides of the housing as illustrated in Fig. 19. If the rotor moves clockwise as shown in Figs. 9 to 17 and its threads are right hand as disclosed, the leakage path 61 will lag the leakage path 60 in traversing the housing from left to right in Figs. 1 and 2. If the threads of the rotary members were of opposite hand the leakage path 60 would lag. If the rotation of the rotor was counterclockwise the leakage paths would move from right to left in Figs. 1 and 2.

Thus the leakage path 60 exists in point of time from the slight rotary movement between the showings of Figs. 10 and 11 where 51 is leaving 11 and 52 engages 53'. On the other hand the leakage path 61 exists between the areas 62 and 63 and is indicated by the relative positions of the rotary members shown in Figs. 15 and 16.

In observing the progressive movement of the rotary members in Figs. 9 to 17 and 19 it will be seen that the area 59 is running out and is substantially all gone in Fig. 14. Thus port 28 is the outlet end when the right hand rotor thread is rotated clockwise. This leakage hole amounts to a very small loss in efficiency because the volume delivered to the outlet is practically incomparable to that capable of being discharged through the leakage path. Particularly if the arcuate crest edge 41 is not a circle but a curve that becomes progressively greater in curvature between the trough surface 53' and the perimetral surface of the gate thread.

In Figs. 5, 6 and 11 to 17 it will be noted that the whole of the arcuate surface 31 of the gate thread 56 is employed to generate the flank 32 of the rotor thread from the crest to the base of the thread flank. Each increment degree of rotation of the members provides an increment change in engagement along the arcuate crest surface 31 of the gate thread. If this arcuate crest surface is cutting or generating the lobe flank 32 the cutting point changes in the same manner. A changing cutting point of this character is far more economical and accurate than that of a point generating tool. This is a particular and important object and advantage of this invention.

At the same time the arcuate surface 31 of the gate thread 56 is generating the flank 32 the arcuate surface 31 of the gate thread 65 is generating the lobe flank 66 from the base 67 to the point 48 as shown in Figs. 5, 6 and 9 to 15.

In like manner the arcs 44 and 49 representing the crest edges of the rotor lobe as shown in Figs. 5 and 6 generate the respective sides of the

gate trough. The cutting point thus shifts along these arcuate surfaces 44 and 49. The normal point generated crest edge of the rotor is a point but when formed by arcs 44 and 49 an improved surface results. Thus arc generation of the surfaces of the rotary members provides an improved structure that can be made within closer shop tolerances and provides a superior sealing between the members.

The perimetral surface of the crests of the gate threads may be employed in the shape of the cutting tool to form the bottom 69 of the rotor threads. If the gate threads are greater in diameter than the gate pitch circle this perimetral surface of the gate threads will slide as well as roll over the bottoms 69 of the rotor troughs.

The continuous sealing band between the rotary members is shown on these members in Figs. 18 and 19. These rotary members 25 and 26 are extended in length to provide a better understanding of this continuous sealing band 70. It will be noted that the dimensions of the sealing band 70 are the same on both the gate and the rotor. They are in fact the same band when the figure of the gate is raised and turned face down on the figure of the rotor. This band 70 thus represents the extent of the sealing zone for a given fluid in any transverse plane of the members along their length. The width of the band 70 changes along its length because the curvatures of the mating surfaces of the rotary members change, as previously described, but the pattern is repeated and is similar to the seal line of a point generated thread structure.

Starting from the bottom of Fig. 19 the seal line 70 commences at the base 64 of the rotor lobe 71 and travels across the bottom 69 of the rotor trough to the base 62 of the flank 66 of the rotor lobe 72 and then proceeds up the flank getting wider as it progresses to the crest end 48 of the flank 66. The far side of the seal band then follows a transverse plane toward the center of the rotor to the line 51 and deviates to the point 74 on the line 43. The near side of the band at this time traces back along the line 48 to the point 75. The line 74, 75 represents diagonal "contact" line of a point generated thread form when the rotor lobe is in full mesh position. The seal band proceeds from point 75 diagonally to line 52 and then follows a transverse plane to the line 43 where the gate thread leaves the crest of the rotor thread and passes down the flank 32 to the base thereof as indicated at 64, the sealing band becoming narrower toward the base 64. This completes one full cycle of the sealing band which is repeated over each of the rotor lobes 71, 72 and 73.

The leakage paths 60 and 61 are indicated respectively by the small triangular spaces at the remote ends of the seal band and the apex of these triangles represent the relative positions of the intersections 11 and 12. The depth of these leakage paths 60 and 61 is less than the extent of the breadth of the triangles shown and the crests of the rotor and gate threads seal with the walls of their respective cylindrical chambers 9 and 10 between the points 11 and 12 or around the back of the chambers as viewed in Figs. 18 and 19.

When the device is used as a compressor it is better that the crest edges of the rotary members wipe the discharge port edges, that is, the crest edges gradually open under the discharge port edges in place of suddenly opening the pocket for the full extent of the crest edges.

When a liquid is being employed whether the device is used as a pump or motor, the discharge port lines should open the pocket before the pocket reduces its volume on a solid liquid. However if the device is designed to carry an air space in each pocket with a given amount of liquid then the volume of the pocket can be reduced until the air or gas is compressed to within safe pressures before opening the pocket to discharge.

If the device is to be used as a reversible blower or pump then the outlet and the inlet ports should match one another to provide the same characteristics when operated in either direction and when pumping a liquid the pockets should be opened to discharge at the same instant that they are closed to the intake.

The term "arcuate" as employed in the specification and claims, defines the continuous crest edges of the rotary members that are formed by the line connecting the sides or flanks of the threads with the perimetral surface of the threads, the latter being a circular arc struck from the axis of the members. This "arcuate" line when traced in a plane transversely of the axis of the member may be a portion of any character of mathematical curve such as a circle, a parabola, a spiral and the like, or an arc that has a progressively changing curvature wherein the curvature increases as it approaches the perimetral surface of the thread and does not necessarily follow a mathematical formula. It is of course important that the ends of this arcuate crest edge smoothly meld into the surfaces that they join.

When the "arcuate" crest edge of the thread of one member is employed to generate the flank or side of the thread of the other member it machines or cuts over its full arcuate extent by constantly changing the cutting point progressively around the arcuate crest edge.

In generating the rotor flank from the crest to the root the final point of generation on the arcuate crest edge surface of the gate affecting the shape of the rotor thread thus may be within or on the pitch circle of the gate but never beyond it without undercutting the rotor at the root of the thread resulting in a leakage path through the seal line between the rotary members. However any portion of the arcuate crest edge of the gate thread beyond the final point of generation and outside diameter of the gate may be said to form the root and hub of the rotor but it is ineffectual in shaping the generated portion of the rotor thread flank and will produce a continuous seal line between the rotary members. Thus a portion of the arcuate crest edges of the gate may be beyond its pitch circle or wholly within its pitch circle.

Thus the sides of the threads of the rotor are generated by a constantly changing point on the arcuate crest edge of the gate. The connecting fillet between the flanks and the hub of the rotor are formed by the remaining portion of the arcuate crest edges of the gate beyond its pitch circle. Correspondingly, the sides of the gate trough are generated by a constantly changing point on the arcuate crest edges of the rotor and the arcuate crest edges of the gate may be formed by the connecting fillet between the generated sides of the rotor thread and the cylindrical hub portion.

I claim:

1. Rotary elements for use in a ported housing of an axial flow fluid device, comprising rotor

and gate members rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, the crest edges of the threads of the members being arcuate, and the sides of the threads of each member being generated or described by a constantly changing point progressing laterally around and advancing along the continuous arcuate crest edges of the threads of the member intermeshed therewith.

2. Rotary elements for use in a ported housing of an axial flow fluid device, comprising rotor and gate members rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, the thread crest edges of the gate member being arcuate, and the sides of the threads of the rotor member being generated or described by a constantly changing point progressing laterally around and advancing along the continuous arcuate crest edges of the threads of the gate member intermeshed therewith.

3. Rotary elements for use in a ported housing of an axial flow fluid device, comprising rotor and gate members rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, the crest edges of said members being curved, and the sides of the threads of each member being generated or described by a constantly changing point progressing laterally around and advancing along the continuous curved crest edges of the threads of the gate member intermeshed therewith.

4. Rotary elements for use in a ported housing of an axial flow fluid device, comprising rotor and gate members rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, the defined edges of the thread crests of the gate member being curved, and the sides of the threads of the rotor member being generated or described by a constantly changing point progressing laterally around and advancing along the continuous curved crest edges of the threads of the gate member intermeshed therewith.

5. A pair of rotary elements for use in a ported housing of an axial flow fluid device, comprising a rotor member and a gate member rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs with continuous crest edges, the helical threads of the gate lying wholly within its pitch circle, the helical thread crests of one member being bounded by continuous arcuate edges, the sides of the rotor threads being generated or described by the whole continuous crest edges of the gate threads, and the sides of the gate threads being generated or described by the whole continuous crest edges of the rotor threads.

6. A pair of rotary elements for use in a ported housing of an axial flow fluid device, comprising a rotor member and a gate member rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the crests of the threads of the members being arcuate and bounded by continuous curved edges, the sides of the rotor threads being generated or described by a constantly changing point progressing laterally around and advancing along the continuous curved edges of the helical threads of the gate, and the troughs of the gate being generated or described by a constantly changing point progressing laterally around and advancing along the continuous curved edges of the crest of the helical threads of the rotor.

7. A pair of rotary elements for use in a ported housing of an axial flow fluid device, comprising a rotor member and a gate member rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, a constantly changing point progressing laterally around and advancing along the defined crest edges of the threads of each member generating or describing the sides of the threads of the other member, and the crest edge surfaces of the threads of the members being curved to provide a band seal between the members.

8. A pair of rotary elements for use in a ported housing of an axial flow fluid device, comprising a rotor member and a gate member rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, a constantly changing point progressing laterally around and advancing along the defined crest edges of the threads of each member generating or describing the sides of the threads of the other member, the crest edge surfaces of one side of the gate member threads being curved to provide a band seal between said curved edge surfaces and the sides of the rotor thread surfaces that they describe.

9. A pair of rotary elements for use in a ported housing of an axial flow fluid device, comprising a rotor member and a gate member rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, a constantly changing point progressing laterally around and advancing along the defined crest edges of the threads of each member generating or describing the sides of the threads of the other member, the crest edge surfaces of both sides of the gate member threads being curved to provide a band seal between said curved edge surfaces and the sides of the rotor thread surfaces that they describe.

10. A pair of rotary elements for use in a ported housing of an axial flow fluid device, comprising a rotor member and a gate member rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, a constantly changing point progressing laterally around and advancing along the defined crest edges of the threads of each member generating or describing the sides of the threads of the other member, the crest edge surfaces of the threads of both members being curved to provide a continuous band seal between the adjacent surfaces of the intermeshed members.

11. In an axial flow fluid device, the combination of a housing having a plurality of closed parallel cylindrical chambers which intersect to form a common chamber, a rotary member operable in each cylindrical chamber and having running clearance with the walls of the chambers, the rotary members being provided with a plurality of complementary intermeshing helical threads with crests and troughs which cooperate with each other and with the walls of the housing to form fluid pockets that progress from one

end of the housing to the other during rotation of the members, port openings in the housing arranged to admit and discharge fluid from the moving pockets, the thread crests of one member having continuous curved edges, and the sides of the threads of said one member being generated or described by a constantly changing point progressing laterally around and advancing along the continuous crest edges of the other member and providing a running clearance therebetween.

12. In an axial flow fluid device, the combination of a housing having a plurality of closed parallel cylindrical chambers which intersect to form a common chamber, a rotary member operable in each cylindrical chamber and having running clearance with the walls of the chambers, the rotary members being provided with a plurality of complementary intermeshing helical threads with crests and troughs which cooperate with each other and with the walls of the housing to form fluid pockets that progress from one end of the housing to the other during rotation of the members, port openings in the housing arranged to admit and discharge fluid from the moving pockets, the thread crests of each member having continuous curved edges, and the sides of the threads of each member being generated or described by a constantly changing point progessing laterally around and advancing along the continuous crest edges of the other member and providing a running clearance therebetween.

13. In an axial flow fluid device, the combination of a housing having a plurality of closed parallel cylindrical chambers which intersect to form a common chamber and providing defined intersection ridges, a rotary member operable in each cylindrical chamber and having running clearance with the walls of the chambers, the rotary members being provided with a plurality of complementary intermeshing helical threads with crests and troughs which cooperate with each other and with the walls of the housing to form fluid pockets that progress from one end of the housing to the other during rotation of the members, port openings in the housing arranged to admit and discharge fluid from the moving pockets, the threads of the members having continuous crests with defined edges. a constantly changing point progressing laterally around and advancing along the defined crest edges of each member generating or describing the sides of threads of the other member, and the crest edge surfaces of the threads of one member being curved to have a progressively greater curvature from the side of the thread to the perimetral surface thereof.

14. In an axial flow fluid device, the combination of a housing having two closed parallel cylindrical chambers which intersect to form a common chamber and provide defined intersection ridges on opposite sides of the common chamber, a gate member rotatably mounted in one chamber and a rotor member rotatably mounted in the other chamber, said members having a running clearance with the chambers and being provided with a plurality of complementary intermeshing helical threads with crests and troughs which cooperate with each other and with the walls of the housing to form fluid pockets that progress from one end of the housing to the other during rotation of the members, port openings in the housing arranged to admit and discharge fluid from the moving pockets, the threads of the members having continuous crests with defined edges, a constantly changing point progressing laterally around and advancing along the defined crest edges of each member generating or describing the sides of the threads of the other member, and the crest edge surfaces of the gate threads being curved to have a progressively greater curvature from the trough of the thread to the perimetral surface thereof.

15. Rotary elements for use in a ported housing of an axial flow fluid device, comprising rotor and gate members rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, the crest edges of the threads of the members being arcuate, and the sides of the threads of each member being generated or described by a continuously changing point progressing laterally around the arcuate crest edges of the threads of the member intermeshed therewith.

16. Rotary elements for use in a ported housing of an axial flow fluid device, comprising rotor and gate members rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, the crest edges of the threads of the members being arcuate, and the sides of the threads of each member being generated or described by a continuously changing point progressing laterally around the arcuate crest edges of the threads of the member intermeshed therewith, no portion of the threaded surface of one member having a curve in a transverse plane that matches the threaded surface of the other member.

17. Rotary elements for use in a ported housing of an axial flow fluid device, comprising rotor and gate members rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, the thread crest edges of the gate member being arcuate, the sides of the threads of the rotor member being generated or described by a constantly changing point progressing laterally around and advancing along the continuous arcuate crest edges of the threads of the gate member intermeshed therewith, the thread crests of the rotor member having a cylindrical surface the radius of which extends to the center of the rotor and an arc on each side of the cylindrical surface, the radii of said arcs being less than the height of the rotor thread, the adjacent ends of the arcs being tangent to said cylindrical surface and the remote ends of the arcs being tangent to their respective generated sides of the rotor threads.

18. Rotary elements for use in a ported housing of an axial flow fluid device, comprising rotor and gate members rotatably disposed in parallelism and having complementary intermeshing helical threads and troughs, the threads of the members having continuous crests with defined edges, the thread crest edges of the gate member being arcuate and lying wholly within its pitch circle, and the sides of the threads of the rotor member being generated or described by a constantly changing point progressing laterally around and advancing along the continuous arcuate crest edges of the threads of the gate member intermeshed therewith.

19. Rotary elements for use in a ported housing of an axial flow fluid device, comprising rotor and gate members rotatably disposed in parallelism and having complementary intermeshing

helical threads and troughs, the threads of the members having continuous crests with defined edges, the thread crest edges of the gate member being arcuate and lying partially within its pitch circle, and the sides of the threads of the rotor member being generated or described by a constantly changing point progressing laterally around and advancing along the continuous arcuate crest edges of the threads of the gate member intermeshed therewith.

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