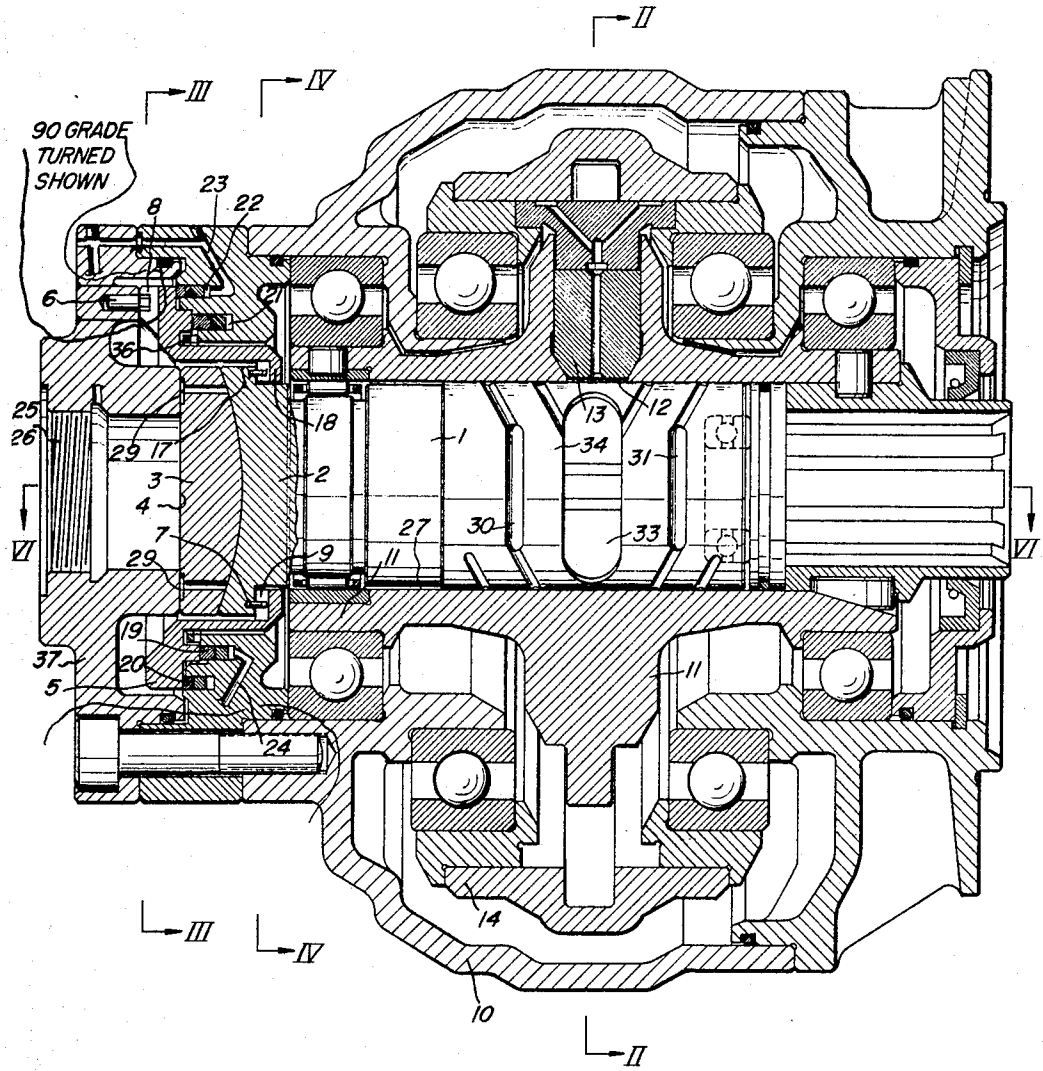
Oct. 25, 1966 K. EICKMANN 3,280,757

ROTARY MACHINE

Filed June 3, 1964 7 Sheets-Sheet 1

Fig. 1



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Oct. 25, 1966 K. EICKMANN 3,280,757

ROTARY MACHINE

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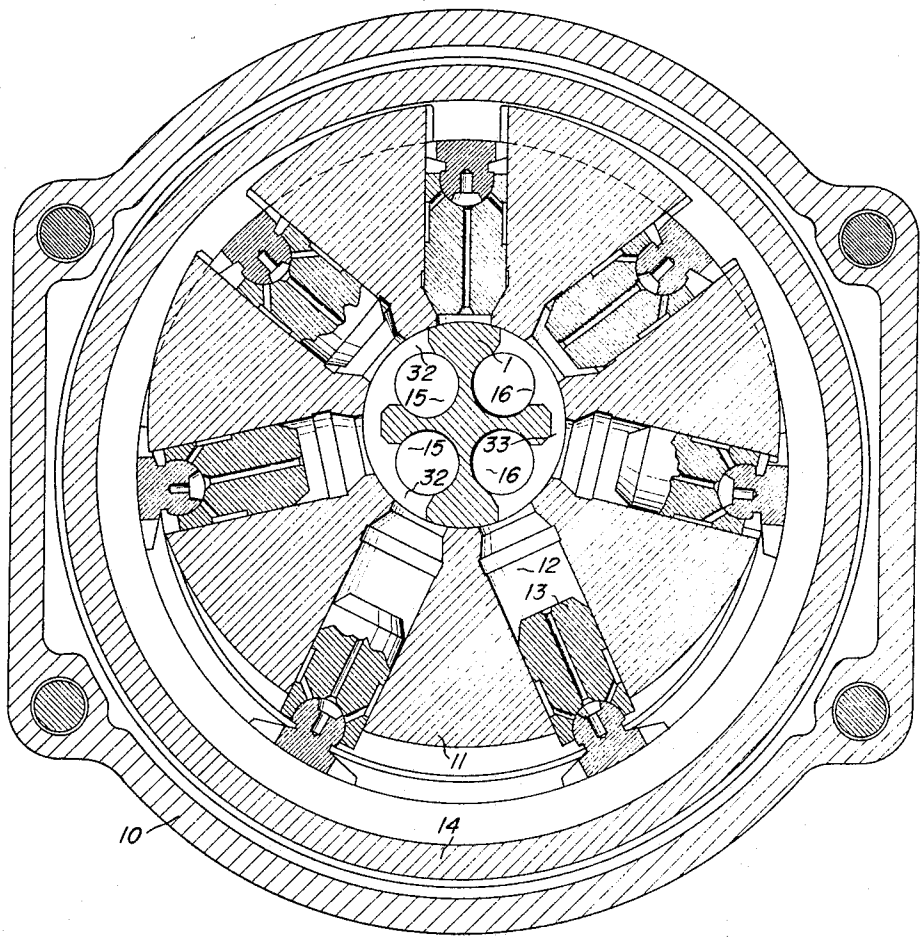
Fig. 2



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Oct. 25, 1966 K. EICKMANN 3,280,757

ROTARY MACHINE

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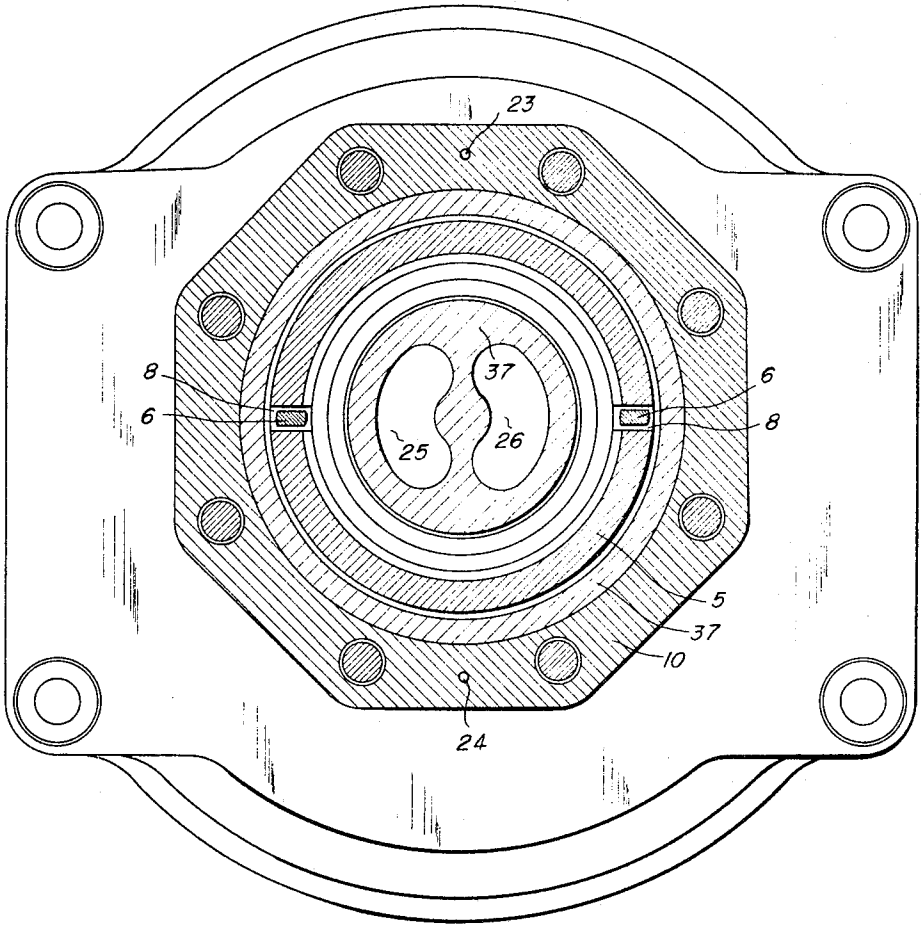
Fig. 3



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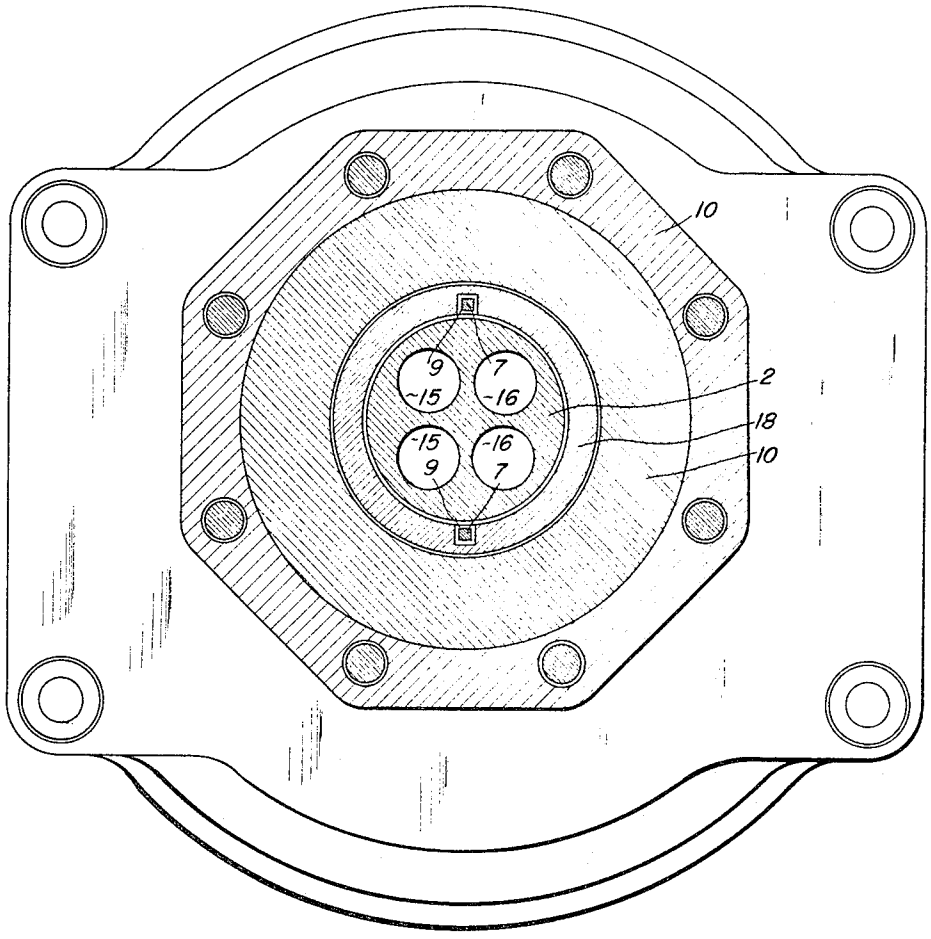
Oct. 25, 1966 K. EICKMANN 3,280,757

ROTARY MACHINE

Filed June 3, 1964 7 Sheets-Sheet 4

Fig. 4



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Oct. 25, 1966 K. EICKMANN 3,280,757

ROTARY MACHINE

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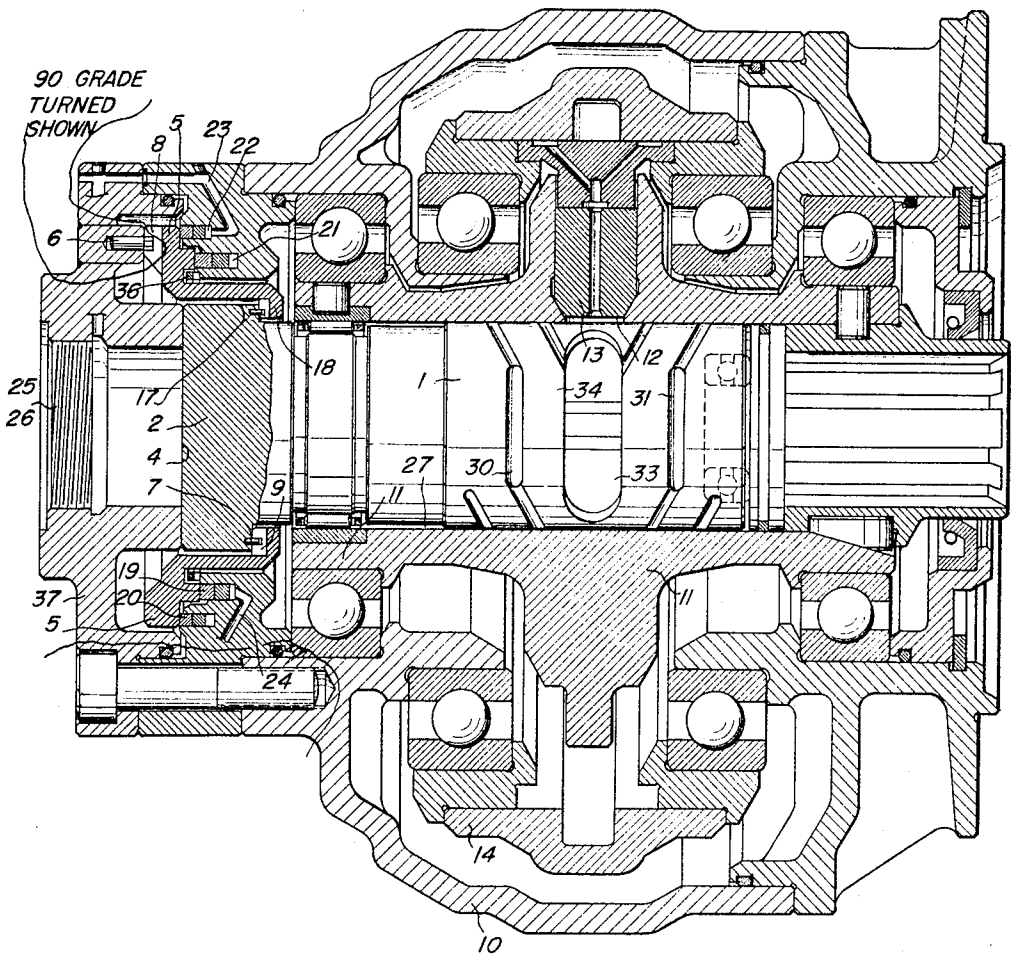
Fig. 5



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Oct. 25, 1966 K. EICKMANN 3,280,757

ROTARY MACHINE

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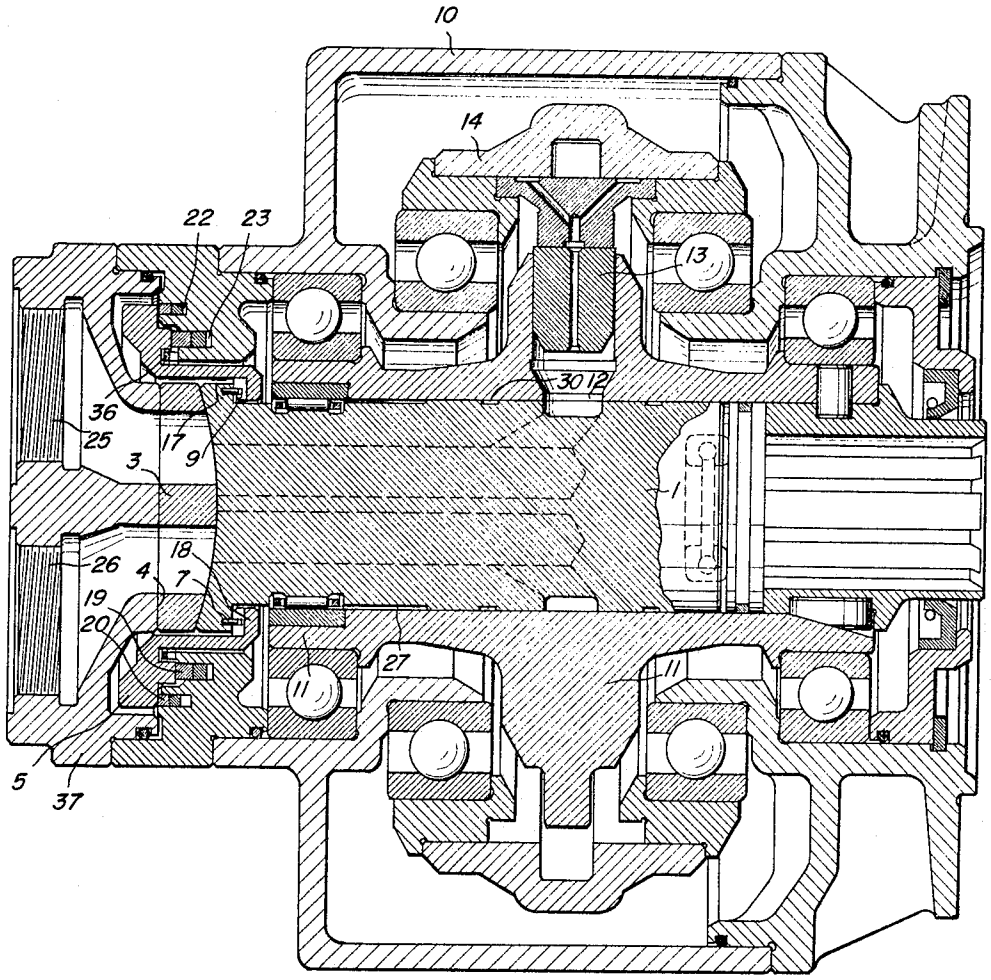
Fig. 6



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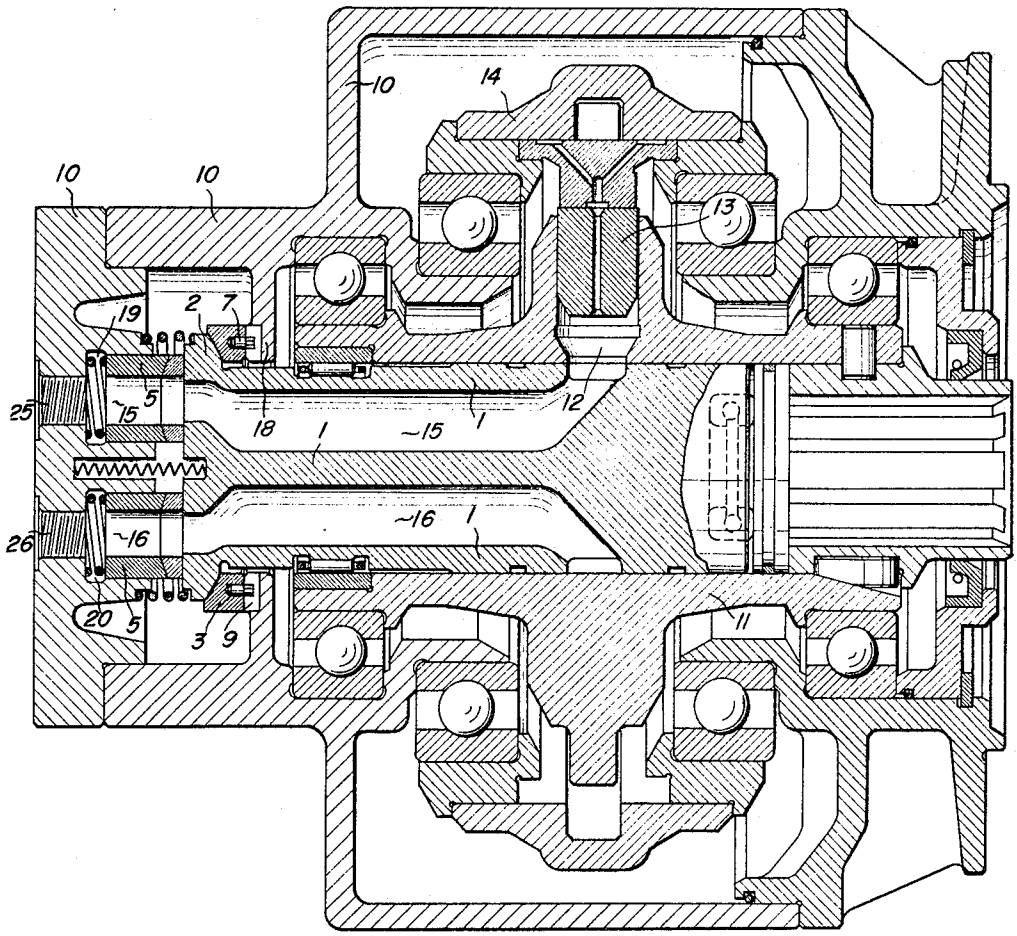
Oct. 25, 1966 K. EICKMANN 3,280,757

ROTARY MACHINE

Filed June 3, 1964 7 Sheets-Sheet 7

Fig. 7



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United States Patent Office

3,280,757
Patented Oct. 25, 1966

3,280,757

ROTARY MACHINE

Karl Eickmann, 2420 Isshiki, Hayama-machi, Kanagawa-ken, Japan

Filed June 3, 1964, Ser. No. 373,605
Claims priority, application Germany, Mar. 7, 1960, E 19,002
20 Claims. (Cl. 103—162)

This invention relates to rotary apparatus using fluid as a driving or displaced medium and of the type in which the fluid is circulated to and from a rotor substantially axially thereof through a relatively stationary control shaft substantially coaxial with the rotor. More particularly the invention is directed to a novel and improved control shaft and mounting thereof by means of which the overall efficiency of such apparatus is greatly increased. This is a continuation in part of my copending United States patent application Serial No. 96,342, now U.S. Pat. No. 3,136,260, issued June 9, 1964.

In my said copending patent application there is disclosed a rotary machine using fluid as a working medium and including a stator casing, a rotor rotatably mounted in the casing and a relatively non-rotatable control body substantially coaxial with the rotor and having one end formed as a control shaft, extending coaxially into the hub of the rotor; the control shaft being formed with passages for admitting fluid to the rotor and returning fluid from the rotor, wherein the improvement comprises means mounting the control shaft in the casing for limited universal angular movement and limited axial sliding movement; a bearing flange on the other end of the control shaft having a spherical outer surface; a thrust bearing having a spherical inner surface substantially mating with said spherical outer surface; and a plane diametric outer surface; and an end wall for said casing, having a plane diametric inner surface engaging said plane diametric outer surface for sliding of the latter thereover; said end wall and thrust bearing being cooperatively ported for flow of fluid therethrough to and from the control shaft passages.

My copending patent application, also discloses means for introducing pressure fluid between the mating surfaces of the flange and of the bearing and end wall.

This invention described in my copending application increases substantially the efficiency of fluid operated or fluid operating rotary machines such as hydraulic pumps, hydraulic motors, compressors, combustion engines or rotary combustion engines and the like. However, it is found, in accordance with this present invention, that the control shaft and its mounting device which was disclosed in my parental patent application can still be more simplified and several parts can be eliminated.

One of the essential parts in my copending patent application is the universal joint type ring, wherein the flange of the control shaft was fastened, prevented from rotation and limited to universal movement in a limited extent.

The said mounting of the control shaft or control shaft flange in the universal joint type ring, mechanism, or cardan ring, can be limited in accordance with this invention.

Accordingly, the principal object of the present invention is to provide a universal mounting of the control body, through a flange thereon, directly on the casing, on a casing port, or on a bearing body without the necessity of providing an intermediate cardan or universal joint ring connection between the parts.

Another object of the invention is to provide a guiding or bearing body for the purpose of guiding the control body for engagement on cooperating respective seats on the casing or on the thrust bearing.

It is another object of this invention to provide a control body flange with plane faces for the purpose of simplifying the configuration and manufacturing of the control body.

Another object of the invention is to divide the control body proper into the control body with only a small radially extending control body flange and a separate bearing body for engagement on the control body flange for guiding the control body into its position.

And it is another object of this invention to adapt the control body flange to engage directly against a respective end wall face of a casing, or of a casing member or insertion, without the provision of a thrust bearing between the control body and the casing or the end wall face of the casing or casing member.

By the objects, means and features of this invention, the manufacturing of the control body can be simplified and thereby become more inexpensive. By the division of the control body and its flange into several parts, it is possible to manufacture the control body from a material differing from that of the bearing body.

This reduces the manufacturing costs of the control body substantially.

Furthermore, the heretofore used cardan ring is eliminated and is replaced by a direct universal mounting of the control body, its flange, or its guiding or bearing body within the casing of the machine.

Despite the simplifying of the manufacturing of the control body and its mounting means, the control body itself can also be shortened and thereby losses by friction in fluid can be reduced. The fluid passages in the control pintle can extend directly to the fluid ports in the casing, or casing member, or thrust bearing in the rotary fluid operated or fluid operating machine.

Due to the universal joint type mounting of the control body flange, or of the guiding body of the control body, the control body is able to execute a limited radial- and inclination-movement during operation of the machine, so that the control body shaft at all times floats in the rotor hub of the machine without mechanical wear, friction, or pressing or tilting against the inner surface of the rotor hub.

More objects and features will become apparent from the study of the figures and the description thereof.

FIG. 1 is a longitudinal sectional view through a rotary fluid machine containing the control body and fastening means of this invention.

FIG. 2 is a cross sectional view through FIG. 1 taken along the line II—II.

FIG. 3 is a cross sectional view through FIG. 1 taken along the line III—III.

FIG. 4 is a cross sectional view through FIG. 1 taken along the line IV—IV.

FIG. 5 is a longitudinal sectional view through a rotary fluid machine wherein another embodiment of a control flange mounting of this invention is demonstrated.

FIG. 6 is a longitudinal sectional view through FIG. 1 taken along the line VI—VI.

FIG. 7 is a longitudinal sectional view through another embodiment of the invention.

Referring to the drawing, the illustrated fluid operated or fluid operating rotary machine, which may use gas or liquid as a working medium, includes the housing **10** rotatably mounting the rotor means **11**. Working chambers **12** are provided in the rotor means **11** to receive the displacement means **13** guided by the guide means **14** in such a way that the displacement means **13** substantially increase and decrease the volumes of the working chambers **12** when the machine is operated under power. The working chambers **12** may be cylinders, intervane spaces, or otherwise configured, periodically increasing and decreasing chambers.

A rotor hub **27** is provided coaxially in the rotor means and extends thereinto or therethrough.

The control body **1** has a substantially cylindrical part hereinafter referred to as the control shaft **34**. The control shaft **34** extends into the rotor hub and has a fit therein such that only a small amount of leakage can pass through the clearance between the outer surface of tht control shaft and the inner surface of the rotor means **11** or rotor hub **27**, while at the same time the rotor means **11** can revolve around the substantially stationary control body **1**, respectively its control shaft **34**.

The control body **1** is provided with fluid passages **15** and **16** which extend through the control body **1** from one end thereof into the control ports **32** or **33** respectively. During the operation of the machine, fluid, like liquid or gas, flows through the fluid passages **15** or **16** of control body **1** into the control port **32** or **33** of control shaft **34** and from one of the control ports into those working chambers **12** whose volume is, at that time, increasing. Fluid from those working chambers **12** whose volume is, at that time, decreasing, returns through the other control port and its associated passage and exits from control body **1**.

The control body **1** may be provided with balancing recesses **30** or **31** providing a floating support of the control shaft **34** of control body **1** inside of rotor hub **27** of the rotor means **11**. The bearing **35** also assists the coaxial floating of the control body **1** with its control shaft **34** in the rotor hub **27** of rotor means **11**.

One axial end of the control body **1** is provided with the control body bearing flange **2**. The end surface of the bearing flange **2** engages with a mating surface of the thrust bearing **3**, while the rotor face of the thrust bearing engages on the end wall surface **4** of the housing **10** of the fluid machine. Fluid passages extend through the thrust bearing flange into the respective ports **25** or **26** in the casing **10** or a part or insertion thereof.

The control body **1** has its bearing flange **2** firmly pressed against the thrust bearing **3**, while the thrust bearing **3** is pressed against the end wall surface **4** of the respective member of casing **10**.

The pressing of the control body **1** against the thrust bearing and of the thrust bearing against the end wall surface **4** is provided by respective thrust bodies **19** or **20** which are located in pressure chambers **21** or **22**. Fluid under pressure in the pressure chambers **21** or **22** exerts an outward force against the respective thrust bodies **19** or **20** which directly or indirectly transfer the forces due to fluid pressure against the bearing flange **2**, together with thrust bearing **3**, into engagement with the end wall surface **4** of casing **11** or one of its parts. Since the bearing flange means is pressed against the thrust bearing **3** and the thrust bearing **3** is pressed against the end wall surface **4**, leakage through the clearance or through the faces of the said parts is prevented or limited to negligible small amounts.

Nevertheless, control body **1** with its bearing flange **2** is still able to execute a limited radial and/or spherical movement along the respective surface or surfaces of the thrust bearing **3**, or of the end wall surface **4** of the casing **10**. The thrust bearing **3** can also move substantially radially in a limited extent along the end wall surface **4** of the casing **10**.

Fluid under pressure from the respective ports **25** or **26** flows through respective passages **23** and **24** into the associated pressure chambers **22** and **21**.

Therefore, the fluid pressure which is acting in one of the machine ports **25** or **26** is also at the same time acting in one of the pressure chambers **21** or **22**, while the fluid pressure in the other of the machine ports **25** or **26** is always acting in the other of the pressure chambers **21** or **22**. Thereby it is assured that fluid pressure always acts against at least one of the thrust bodies **19** or **20**.

The above described construction is in principle already described in my copending parental patent application

No. 96,342. However, in my copending patent application, a universal joint type ring is provided, which floats between the control body flange **2** and the casing **10**.

Additionally, in the prior construction, bolts project in diametrically opposite directions from the control flange into the cardan ring, while other bolts project in diametrically opposed directions, and along a diameter perpendicular to the common diameter of the first mentioned bolts, from the cardan ring into the casing. Slide shoes are provided on a pair of these bolts for enabling a limited axial movement of the control body relative to the casing.

These cardanic rings or universal joint type ring means and the flexible fastening of the control body therein needed investment and manufacturing expenses.

In accordance with the present invention, the first improvement thereof resides in the elimination of the cardan ring.

In order to achieve this goal, two pins **7** are provided in the control shaft **2**. The retaining means or pins **7** are located in diametrically opposite relation and extend from the control shaft **2** either axially or radially. The pins **7** enter into respective slots or recesses **9**. Slots or recesses **99** are located diammetrically opposite each other and the pins **7** are able to slide in the slots or recesses **9** to a limited extent radially. The retaining means or pins **7** also have a limited axial movement within the respective slots or recesses **9**. The slots or recesses **9** are preferably provided in the bearing or locating body **5**.

Instead of providing the recesses or slots **9** in the bearing body **5**, it is also possible to provide the slots or recesses **9** in the bearing flange **2** of the control body **1** and the pins **7** in the bearing body **5** or in the casing member.

Another pair of retaining means or pins **6** are provided in the casing or casing member **10**. Pins **7** are located in diametrically opposed relation to each other and engage in respective slots or recesses **8**. The slots or recesses **8** are preferably provided in the body **5**.

However, instead of providing the slots or recesses **8** in the body **5** and the pins **6** in the casing **10**, it is also possible to provide the pins **6** in the body **5** and the slots or recesses **8** in the casing **10** or a member thereof. Pins **6** are able to slide to a limited extent radially and/or axially within the slots or recesses **8**.

Relative to the axis of the control body **1**, the pins **6** and slots or recesses **8** are not only located, but they are also located in diametric opposition on a diameter normal to that of the other pair of pins **7** and slots or recesses **9**.

In the embodiment of FIG. 1, it is therefore possible for the body **5** to move normal to the axis of the control body **1** in one respective direction while the control body **1** is able to move in another direction normal to the direction of movement of body **5**. The control body **1** is therefore able to move to a limited extent in all radial directions.

According to the above described improvement of the invention, the body **5** performs the function of the heretofore used universal joint type ring, or cardan ring; and the universal joint type ring or cardanic ring is therefore eliminated in accordance with this invention. At the same time, movement in any radial direction of control body **1**, is assured to a limited extent.

If the control body **1**, the thrust bearing **3**, or the casing member **10** are provided with spherical faces, and if the thrust bearing **3** is provided between the control body flange **2** and the casing **10**, then the control body **1** is also able to incline its axis to a limited extent while at the same time the sealing between the control flange **2**, the thrust bearing **3** and the end wall surface **4** is maintained. In such case, the control body **1** is not only able to have limited radial movements but is also able to execute limited spherical movements, in order to follow all inaccurate movements of the rotor means **11**.

One difficulty of the control bodies according to my copending patent application, exists in that the control body flange **2** has a relatively large diameter, compared to that of the control body shaft part **34** of the present control body **1**.

This larger dimension was necessary therefore, that the control body flange **2** could contain respective pressure chambers or that the control body flange **2** could receive the pressure and force acting in an axial direction out of the respective chambers.

The large diameter of the control shaft flange **2** made a large investment of material necessary, because, in the case of hardened steel used in the manufacturing of the control body **1**, a large quanity of steel or other material had to be removed during the manufacturing of the control body.

It is therefore the other object of this invention to divide the control body proper **1** into a control body **1** and a guiding or locating body **5**. The bearing flange **2** of control body **1** of this invention thus has a greatly reduced diameter, so that flange **2** extends only a limited amount in a radial direction beyond the diameter of control body **1**. Flange **2** thus forms a control body flange seat **17**. The control body flange seat **17** is preferably a radial plane face, a spherical face, or a conical face. The body **5** is provided with a seat **18**.

The seat **18** engages flange seat **17**. A clearance space remains between the outer diameter of the control shaft **34** and the inner diameter of the seat **18**. The seat **18** preferably is pressed against the flange seat **17** by a spring means **36**.

The casing **10**, or a member or insertion thereof, is provided with the pressure chambers **21** or **22** and the pressure chambers **21** and **22** contain thrust bodies **19** or **20**. Fluid pressure in the respective pressure chambers **21** or **22** act in an axial direction against the respective thrust body **19** or **20** and presses the respective thrust body **19** or **20** against the body **5**. Thereby, and preferably augmented by the spring means **36**, the body **5** is pressed in an axial direction away from the center part of the housing **10** and engages with its seat **18** on the seat **17** so that the flange **2**, as a part of the control body **1**, is pressed in an axial direction away from the central interior of casing **10**, so that the control body **1**, with its flange **2**, rests on the respective thrust, bearing **3** or on the end wall surface **4** of the casing **10**.

According to the above described provision of the body **5**, it is possible to manufacture the body **5** and the control body **1** as separate elements. Thereby control body **1** has a very much smaller overall diameter than the flange of the control body in my copending patent application. The body **1** and the body **5** can also be made of different materials according to this embodiment of the invention. For instance, the control body may be of hardened steel or bronze, while the body **5** may either be forged or cast of soft steel, inexpensive steel, bronzes, or the like.

The division of the control body of my copending patent application into the control body proper **1** and the guiding body **5** also has the advantage, that flexibility between the body **1** and the body **5** can be realized and that both can move radially relative to each other or, in certain embodiments, also spherically relative to each other.

In the embodiment of the invention illustrated in FIG. 5, the control body flange **2** is directly engaged with the end wall surface **4** of the casing **10**, or the member, insertion or a respective end member thereof. The thrust bearing **3**, between the control body flange **2** and the end cover of casing **10**, is thereby eliminated.

Flange **2** of body **1** is then pressed directly against the end wall surface **4** of a casing **10** or of a respective end member, insertion or cover member of casing **10** by means of the body **5**.

The control body flange seat **17** and the pressing body seat **18** may be formed substantially as in FIG. 1, and

the respective pressure chambers, fluid passages, pins and slots or recesses may also be provided substantially in FIG. 5 as they are in FIGS. 1, 3 and 4.

The embodiment of FIG. 5 eliminates the thrust bearing **3** but still enables a radial movement of control body **1** to a limited extent. A feature of this design is that the machine can be built shorter in axial direction, whereby the fluid passages become shorter and friction during the flow of fluid through the control body passages is thereby reduced.

Since certain inclinations, to a limited extent, may be imparted to control body **1**, it is preferable to provide suitable flexible or plastic deformable packings or seals between the bearing of control body **1** and the end wall surface **4** of the casing **10** or of an end cover or insertion of the casing **10**.

In those embodiments of the invention wherein a thrust bearing **3** is provided, it is convenient to provide balancing recesses **28** and **29** between or in the thrust bearing **3**, the control body bearing flange **2**, or the end wall surface **4** of the casing or insertion **10**. Such balancing recesses could also be provided between the control body flange **2** and the end wall surface **4** of the casing **10** or of an end cover member thereof.

In the embodiments of the invention described heretofore, the control body **1** is pressed in an axial direction away from the interior of the casing **10**.

It is also possible to press the control body **1** in an axial direction toward the interior of the casing **10**, by providing the respective thrusting or bearing body **5** and the thrust bodies and pressure chambers **19**, **20**, **21** and **22** to act in the opposite direction.

In such case, a casing member must extend from the casing **10** a radial direction inwardly so that the control body **1**, control body bearing flange **2**, or a respective thrust bearing or thrust bearing ring **3** can engage therewith in such opposite axial direction.

In such cases, it is suitable to provide respective thrust bearings **5** aligned with the respective machine port **25** and **26**, with the thrust bearings having a limited axial movement in the associated ports, and pressing them, by the fluid pressure inside the respective ports **25** or **26**, directly against the control body bearing flange **2** or against the control body **1**.

An example of this embodiment of the invention is shown in a longitudinal sectional view in FIG. 7.

FIG. 1 illustrates how the sections of the respective figures are taken through a respective rotary fluid machine.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

It is therefore desired that the patent shall not be limited to the illustrated embodiments, but shall be fully covered by suitable expression in the appended claims.

I claim:

1. In a rotary machine using fluid as working medium, and including a stator casing; a rotor including a hub, rotatably mounted in the casing and having working chambers periodically increasing and decreasing in volume during operation of the machine under power; a relatively non-rotatable control body substantially coaxial with the rotor and having one end, formed as a control shaft, extending coaxially into the hub of the rotor, the control body being formed with passages for admitting fluid to the rotor and returning fluid from the rotor; means mounting said control body in the casing for limited universal angular movement and limited axial sliding movement; a bearing flange on the other end of the control body having a bearing surface; a thrust bearing, between an end wall part of the stator casing and the bearing flange of the control body, having a cooperating bearing surface means biasing; the bearing

flange of the control body into sealing engagament with the thrust bearing surface so that the two bearing surfaces form a substantially fluid-tight seal; the end wall part of the housing and the thrust bearing being cooperatively ported for flow of fluid therethrough to and from the control body passages; said bearing flange, thrust bearing and end wall part constituting components of a bearing means for said control body; the improvement comprising a first pair of diametrically opposed radially extending slots; a second pair of diametrically opposed radially extending slots aligned along a common diameter normal to the common diameter of the first pair of slots; all of said slots being formed in a component of said bearing means; retaining means extending into each of the slots and arranged in two pairs, each including two diametrically aligned retaining means; one pair of the retaining means extending into the stator casing while the other pair of retaining means extends into the control body.

2. The improvement defined in claim 1 wherein one pair of the slots is provided in the end wall of the stator casing while the other pair of slots is provided in the bearing flange of the control body.

3. The improvement defined in claim 1 wherein both pairs of slots are provided in a floating body located adjacent the bearing flange of the control body and adjacent the end wall of the stator housing.

4. In a rotary machine using fluid as working medium, and including a stator casing; a rotor, including a hub, rotatably mounted in the casing and having working chambers periodically increasing and decreasing in volume during operation of the machine under power; a relatively non-rotatable control body substantially coaxial with the rotor and having one end, formed as a control shaft, extending coaxially into the hub of the rotor, the control body being formed with passages for admitting fluid to the rotor and returning fluid from the rotor; means mounting said control body in the casing for limited universal angular movement and limited axial sliding movement; a bearing flange on the other end of the control body having a bearing surface; a thrust bearing, between an end wall part of the stator casing and the bearing flange of the control body, having a cooperating bearing surface; means biasing the bearing flange of the control body into sealing engagement with the thrust bearing surface so that the two bearing surfaces form a substantially fluid-tight seal; the end wall part of the housing and the thrust bearing being cooperatively ported for flow of fluid therethrough to and from the control body passages; the improvement comprising a bearing body having a bearing body seat; the bearing flange of the control body having a control body flange seat engaging the bearing body seat; and pressing means for biasing the bearing body in one axial direction to transfer the axially directed biasing force to the control body through said seats.

5. The improvement defined in claim 4 wherein a ring means is provided between the bearing body and the bearing flange of the control body.

6. The improvement defined in claim 5, wherein plane faces and spherical faces are formed on the bearing body seat and the bearing flange of the control body.

7. The improvement defined in claim 5 wherein the ring means is able to slide radially or spherically relative to the bearing body and the bearing flange of the control body.

8. The improvement defined in claim 4 wherein spring means are provided between the stator casing and the bearing body.

9. The improvement defined in claim 4 wherein thrust bodies are provided in pressure chambers formed in one of said casing and said bearing body, and by fluid passages connecting the chambers with the fluid passages in the control body, while the fluid pressure in at least one of the pressure chambers presses a respective thrust body axially against the adjacent part.

10. The improvement defined in claim 9 wherein the pressure chambers are provided in the stator casing while the respective thrust body presses axially against the bearing body.

11. The improvement defined in claim 9 wherein the pressure chambers are located in the bearing body while the respective thrust body presses axially against the stator casing.

12. The improvement defined in claim 4 wherein the control body is connected to the stator casing for universal movement by pins engaged in grooves, the pins and grooves constituting connecting components, interconnecting the control body, bearing body and stator casing constituting joint components of a universal joint assembly; two pairs of radially extending grooves being provided in said joint components; the grooves of each pair being located diametrically opposite each other, while the common diameter of one pair of grooves is normal to the common diameter of the other pair of grooves; at least one pair of connecting components being provided on the bearing body.

13. The improvement defined in claim 12 wherein the two pairs of grooves are provided in the bearing body.

14. The improvement defined in claim 12 wherein the two pairs of pins are provided on the bearing body.

15. The improvement defined in claim 4 wherein an end wall is provided on the stator casing, and the end surface of the control body flange directly abuts the end wall of the stator casing.

16. The improvement defined in claim 4 wherein radially extending plane faces and spherical faces are provided on the engaging surfaces of the thrust bearing, control body flange and the end wall of the stator casing.

17. The improvement defined in claim 4 or claim 15 wherein said control body, stator casing and thrust bearing constitute components of a joint assembly having interengaging surfaces, and sealing means are provided between at least one pair of interengaging surfaces.

18. In a rotary machine using fluid as working medium, and including a stator casing; a rotor, including a hub, rotatably mounted in the casing and having working chambers periodically increasing and decreasing in volume during operation of the machine under power; a relatively non-rotatable control body substantially coaxial with the rotor and having one end, formed as a control shaft, extending coaxially into the hub of the rotor, the control body being formed with passages for admitting fluid to the rotor and returning fluid from the rotor; means mounting said control body in the casing for limited universal angular movement and limited axial sliding movement; a bearing flange on the other end of the control body having a bearing surface; a thrust bearing, between an end wall part of the stator casing and the bearing flange of the control body, having a cooperating bearing surface; means biasing the bearing flange of the control body into sealing engagement with the thrust bearing so that the two bearing surfaces form a substantially fluid-tight seal; the end wall part of the housing and the thrust bearing being cooperatively ported for flow of fluid therethrough to and from the control body passages; the improvement comprising a radial bearing surrounding the control shaft adjacent the control body flange and mounted in said rotor; and balancing recess means formed in the periphery of the control shaft; means supplying fluid under pressure from the at least one control body passage to said recess means; the fluid in the balancing recess means exerting a force counter balancing lateral axial forces on the control body flange and effective to swing the control body around the center point of the radial bearing to a limited extent; whereby the control shaft mantains a substantially centered floating relation in the hub of the rotor means despite lateral forces on the control body flange.

19. In a rotary machine using fluid as working medium, and including a stator casing; a rotor, including a

hub rotatably mounted in the casing and having working chambers periodically increasing and decreasing in volume during operation of the machine under power; a relatively non-rotatable control body substantially coaxial with the rotor and having one end, formed as a control shaft, extending coaxially into the hub of the rotor, the control body being formed with passages for admitting fluid to the rotor and returning fluid from the rotor; means mounting said control body in the casing for limited universal angular movement; the improvement comprising an end wall on the stator casing having ports provided therethrough in communication with said passages; said control body having an end surface adjacent said end wall; and axially moveable passage forming bodies mounted in the ports; each passage formed body having an end face and being slideably and tightly sealingly engaged with the end face of the control body and with the inner peripheral surface of the respective

port; thereby providing a sealed flow of fluid in both axial directions between the respective port and a fluid passage in the control body through the associated passage forming body.

20. The improvement defined in claim **19**, including biasing means in each port biasing the respective passage forming body in an axial direction for engagement the end face of the control body.

References Cited by the Examiner

UNITED STATES PATENTS

2,620,736	12/1952	Overbeke	103—161
2,785,637	3/1957	Nubling	103—120

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