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ATTACHMENT OF VANES TO HYDRAULIC ROTARY ACTUATOR WINGSHAFTS

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Fig. 1

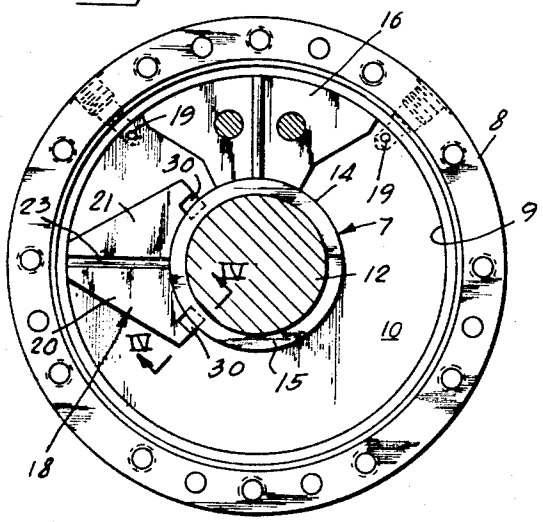


Fig. 3

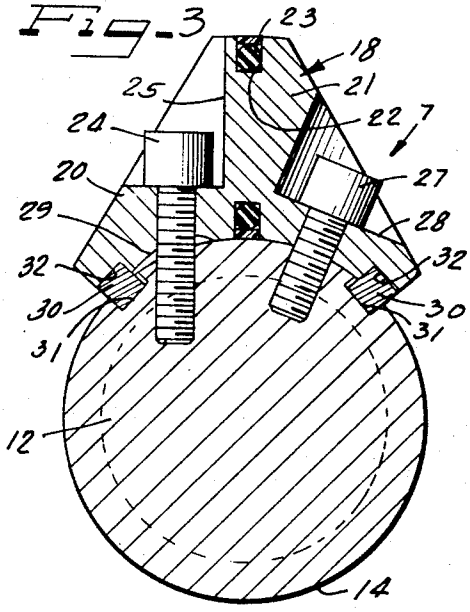


Fig. 2

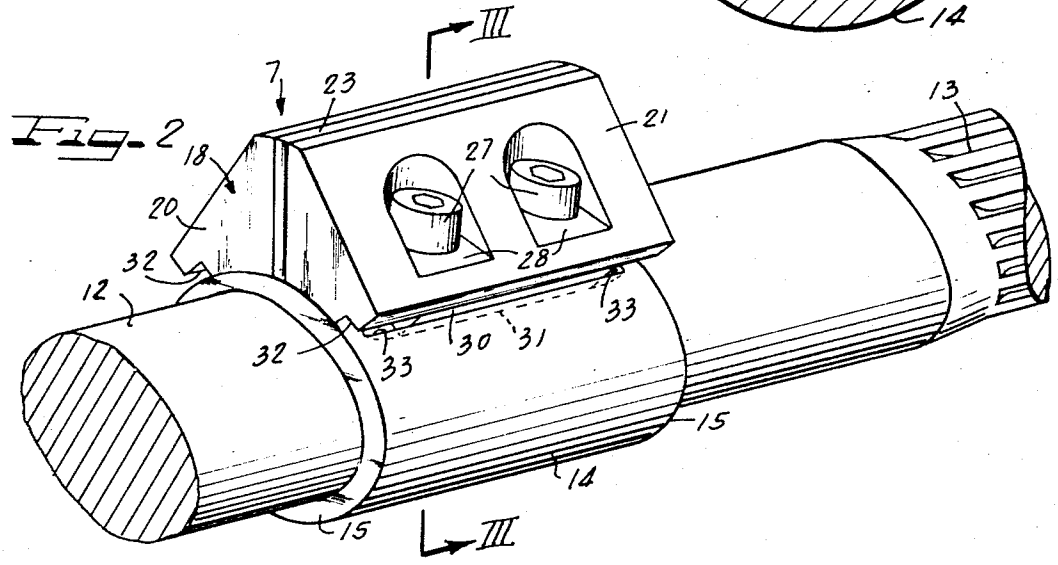


Fig. 5

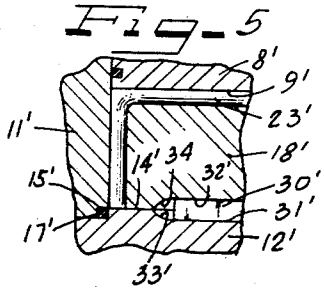
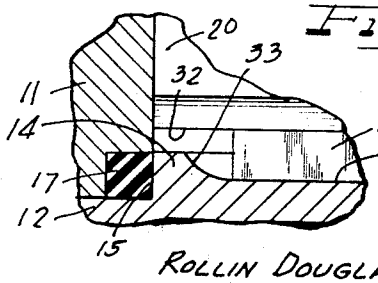


Fig. 4



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ATTACHMENT OF VANES TO HYDRAULIC ROTARY ACTUATOR WINGSHAFTS

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ABSTRACT OF THE DISCLOSURE

Separately formed vanes are bolted to the wingshafts, and keys between the vanes and the shafts assume torque loads on the assembly.

In the past it has been the practice to utilize principally one-piece shaft forgings in which the vanes are forged integrally with the shaft and the vanes are then slotted for accommodation of sealing means. In one commercially desirable form, the seal slot is cut to the hub diameter of the shaft. In larger sizes this technique becomes fairly expensive because of the depth of the slot that must be machined, and, also, because of the necessity for grinding the hub between the sides of a single vane or between the sides of a plurality of vanes.

Heretofore, various means have been utilized, especially in the larger sizes of wingshafts, to attach the vanes to the shafts, including dowels, bolts, ground and fitted stripper bolts, hollow dowels, and the like. All of these expedients have resulted in a non-interchangeable assembly. In addition, welded vanes have been tried with fair success. However, it is necessary that the weld penetrate from the outside surface of the vane all the way to the edge of the seal groove or slot, in a fully slotted vane, or at least to the center of the joint in a solid base vane. Since the maximum stress occurs at the juncture of the slot and the shaft, unless the weld is nearly perfect early fatigue failures propogate from this point. Resort has been to tie bolts between the vane halves which has been fairly successful in overcoming this fatigue failure. However, on larger shafts, and particularly longer ones, excessive warpage results from the welding, which requires hub grinding.

An important object of the present invention is to provide a novel means for attaching separately formed vanes to wingshafts, utilizing bolts and keys.

Another object of the invention is to provide a novel means for securing separately formed vane members in assembly with a wingshaft in a manner which not only effects improved attachment, but also thoroughly keys the vane members and shaft together against torque load displacement of the members and shaft.

A further object of the invention is to provide a novel vane and wingshaft assembly in which the parts are readily interchangeable.

Yet another object of the invention is to provide a bolted on vane and wingshaft assembly in which the bolts need carry only tension loads, and torque loads are absorbed by novel key means.

Yet another object of the invention is to provide a keyed vane and wingshaft assembly in which the ends of the wingshaft hubs are free from keyway openings or the like which would interfere with proper sealing of the hub and end closures of the rotary actuator assembly against leakage.

Other objects, features and advantages of the present invention will be readily apparent from the following detailed description of certain preferred embodiments

thereof, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a fragmentary end elevational view of a hydraulic rotary actuator with an end closure removed;

FIGURE 2 is an enlarged fragmentary isometric view of the wingshaft of the actuator embodying features of the invention;

FIGURE 3 is a transverse sectional detail view taken substantially along the line III—III of FIGURE 2;

FIGURE 4 is an enlarged fragmentary sectional detail view taken substantially along the line IV—IV of FIGURE 1; and

FIGURE 5 is a fragmentary longitudinal sectional view showing a modification.

To exemplify the use of a wingshaft assembly **7** embodying features of the invention, a representative rotary hydraulic actuator is shown in FIGURE 1, including a body ring **8** defining a cylinderical working chamber **9** within which the wingshaft assembly is concentrically mounted. At its opposite ends, the chamber **9** is closed by closures **10** (FIG. 1) and **11** (FIG. 4), one of which may be integral with the body **8** while the other of which may be suitably secured in place on the end of the body, or both may be separately formed and secured to the respective opposite ends of the body, as preferred, to provide the actuator housing.

The wingshaft assembly **7** comprises a shaft **12** which is suitably journalled through the end closures **10** and **11** and may have on one or both of its end portions means such as splines **13** for attachment to part of relatively rotary apparatus while the housing of the actuator is suitably attached to another part of the relatively rotary apparatus with which the actuator is employed, as is known practice. Within the working chamber **9** of the actuator housing, the shaft **12** has a hub **14** of larger diameter and provided at its opposite ends with axially facing end faces **15** which are adapted to oppose dynamic shaft seal means **17** (FIG. 4) mounted in the inner margin of the respective associated end closure member.

Within the working chamber **9**, at least one abutment **16** is suitably mounted fixedly and slidably engages the hub **14**, and cooperates with a vane **18** carried by the hub **14** to subdivide the working chamber into respective subchambers. Suitable means such as respective ports **19** opening through the end closure **10** adjacent to the opposite sides of the abutment **16** provide for introduction of hydraulic operating fluid into and displacement of such fluid from the respective working subchambers for driving the wingshaft operatively relatively rotatably in the actuator housing.

According to the present invention, the vane **18** is formed separately from the wingshaft **12** and is bolted to the perimeter of the hub **14**. In one desirable construction, the vane **18** comprises a monolithic member having complementary opposite side portions **20** and **21** having therebetween a seal groove **22** within which is mounted a ring type vane seal assembly **23** dimensioned to engage sealingly with the perimeter of the hub **14** between the wingshaft members and projecting edgewise from the groove **22** to engage sealingly with the walls defining the working chamber **9**.

Each of the vane portions **20** and **21** is bolted in place to the wingshaft on the perimeter of the hub **14**. Both of the vane portions **20** and **21** may be identical, for ready interchangeability. However, they are, for illustrative purposes, shown as each having a slightly different bolting arrangement. Thus, the vane portion **20** is shown as secured onto the shaft by means of one or more bolts **24**, the head of each of which is received in a suitable clearance recess **25** and with the bolts extending into the shaft on an axis which is in a plane parallel to the axis

of the shaft. On the other hand, the vane portion **21** is shown as having a pair of securing bolts **27**, the heads of which are received in respective clearance recesses **28** and the shanks of which are extended into the shaft in a plane which is radial to the shaft axis. In order to reduce machining effort, and more particularly grinding-in of the seating surface of the vane member to the cylindrical perimeter of the hub **14**, and to compensate for surface variables in seating of the vane member, the seating surface thereof may be provided with a longitudinal relief groove **29** through which the securing bolt shank extends. Such relief groove is shown only in the seating surface of the vane portion **20**, but it will be apparent that it may also be provided in the seating surface of the vane portion **21**, if desired. For standardization, of course, the wingshaft will generally be provided with only one style of vane member, that is either a vane member with both side portions **20** or a vane member with both side portions **21**. By having the vane member **18** generally symmetrical, of course, it will be readily interchangeable with other like vane members and may be mounted with either of its ends at either end of the hub **14**.

Substantial relief of shear stresses on the vane-securing bolts, and minimizing of the bolt load is attained by keying the vane **18** to the hub **14**. For this purpose, an elongated key **30** of preferably square cross section is mounted in a respective longitudinally extending complementary keyway groove **31** in the hub **14** and engaged within a two-sided rabbet keyway groove **32** in each respective heel of the vane member and more particularly in the outer margin of the seating face of each of the portions **20** and **21**. At least one of the keys **30** is desirably ground at assembly into substantially accurate fit in the keyway and receptive vane groove so as to eliminate backlash. To facilitate this the key in question may be narrower than its keyway groove **31**, bearing on its outer face against the groove wall and on its inner face against the opposing wall defining the vane groove **32**. If preferred, the relief groove **29** may run into its adjacent key groove **32** so that the bolts **24** will deflect the vane portion **20** slightly to insure a tight fit on top of the associated key **30**. The vane bolts are required only to carry tension loads. Furthermore, the distance between the bolts at either side and the opposite heel of the vane member provides a relatively large base for load-carrying moments, thereby minimizing the bolt load under the extremes of torque to which the wingshaft assembly may be subjected in use.

In order to avoid any interference with the shaft seal or seals **17** at the end faces **15** of the hub **14**, the keyways **31** have their runouts **33** spaced inwardly from the end faces **15**. This leaves the end faces uninterrupted and in continuous engagement with the shaft seals **17**. Further, this avoids bypass leakage areas as would be encountered if the keyways ran out through the end faces **15**.

If preferred, a vane member **18'** (FIG. 5) may, especially for low torque uses, have a single longitudinal centrally disposed key **30'** engaged in opposed matching keyways **31'** and **32'**. with respective runouts **33'** and **34** spaced from the hub end face **15'** in the end of the vane, as shown. In such instance a generally U-shaped vane seal **23'** is employed in engagement with the wall surfaces defining the working chamber **9'** within the housing comprising the body **8'** in the end members of which the member **11'** is shown and with the shaft seal **17'** in position about the shaft **12'** at the hub end face **15'**.

It will be apparent that the use of bolted on vane structure affords substantial advantages, especially in larger sizes of wingshafts since it substantially simplifies grinding of the shafts, enabling finishing of the shafts and more particularly the hub portions thereof by centerless grinding. Further, the bolted and keyed attachment of the vane to the wingshaft affords a rugged, high performance assembly. Avoidance of runout of the keyways through the seal seating end faces of the wingshaft hub affords substantial advantages as already pointed out.

It will be understood that variations and modifications may be effected without departing from the spirit and scope of the novel concepts of this invention.

I claim as my invention:

1. A hydraulic auctuator wingshaft assembly comprising:
- a shaft body including a hub having a perimeter;
- a vane having a face confronting said hub perimeter;
- bolt means securing said vane to the hub;
- said hub perimeter and said vane face having longitudinal matching confronting keyways therein; and
- a key engaging in said keyways and assuming torque loads to which the assembly may be subjected in use;
- said vane having a longitudinal relief groove in said face and confronting said hub perimeter.

2. An assembly according to claim **1**, in which said bolt means extend through said relief groove.

3. An assembly according to claim **2**, in which said keyway in said vane face is along one side of the vane and said relief groove runs into said keyway in said face to enable slight deflectional tightening of the vane against the key by action of said bolt means.

4. A hydraulic actuator wingshaft assembly comprising:
- a shaft body including a hub having a cylindrical perimeter;
- a vane having a face generally complementary to said cylindrical perimeter and confronting said perimeter;
- said vane being of monolithic structure having side portions each of which has a heel along its outer side;
- bolt means in each of said portions of the vane inwardly from said heels securing the vane to the hub;
- said vane having an outwardly opening groove extending therealong between said side portions and sealing means therein for engagement sealingly with a chamber wall of a rotary actuator housing;
- said hub perimeter and said vane surface having longitudinal matching confronting keyways therein having respective oppositely circumferentially facing surfaces; and
- a key in said keyways and engaging said surfaces to assume torque loads to which the assembly may be subjected in use, said bolt means and said key being spaced from one another.

5. An assembly according to claim **4**, in which each of said heels has a keyway outwardly from the adjacent bolt means, said hub has a respective keyway matching each of the vane keyways, and a respective key in each of said vane keyways and the matching hub keyway.

6. An assembly according to claim **5**, in which said keyways in said heels are rabbet grooves.

7. An assembly according to claim **5**, in which said seal groove extends entirely around said vane between said bolt means and said seal is a ring seal in said groove and effecting a sealed engagement with said perimeter.

8. An assembly according to claim **4**, in which said seal groove extends along said vane between said bolt means and along ends of the vane, and said keyways extend along a central plane between said bolt means.

9. An assembly according to claim **4**, in which said keyways and said key extend longitudinally between said bolt means.

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