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Boyce

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[54] BEARING SERVICING TOOL

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[51] **Int. Cl.**[5] **B23P 19/00**

[52] **U.S. Cl.** **29/898.08**; 29/898.01; 29/898.07; 29/426.5; 29/263

[58] **Field of Search** 29/244, 245, 256, 258, 29/259, 263, 264, 426.5, 525, 724, 898.01, 898.07, 898.08, 402.03, 402.08

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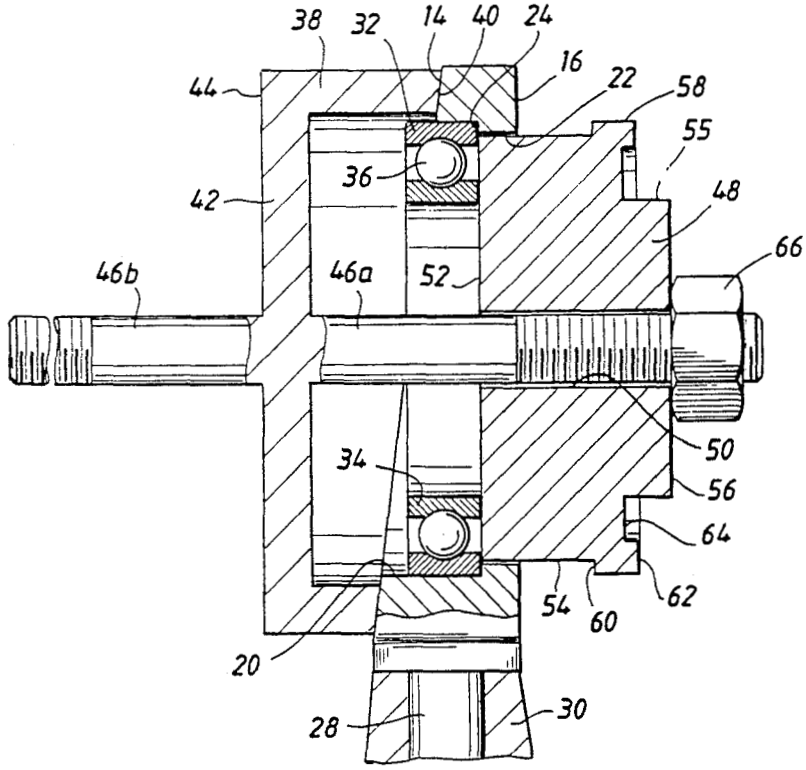
[57] **ABSTRACT**

A tool for removing and/or replacing bearings in situ comprises a brace having a first end adapted to engage a first end of the bearing housing, and a second end adapted to engage a second end of the bearing housing. If the two ends of the bearing housing are different in configuration, the respective ends of the brace are correspondingly configured. An elongate guide member integral with the brace has two parts, each projecting endwise from a respective end of the brace. A pressure plate is alternatively removable mountable on either part of the guide member for longitudinal movement therealong, and has first and second ends of different configurations adapted to engage first and second ends respectively of the bearing. A threaded-type drive is cooperative between the guide and the pressure plate to move the pressure plate longitudinally along the guide and apply a force to the bearing, either to remove the bearing from its housing, or to emplace a new bearing in the housing.

10 Claims, 2 Drawing Sheets



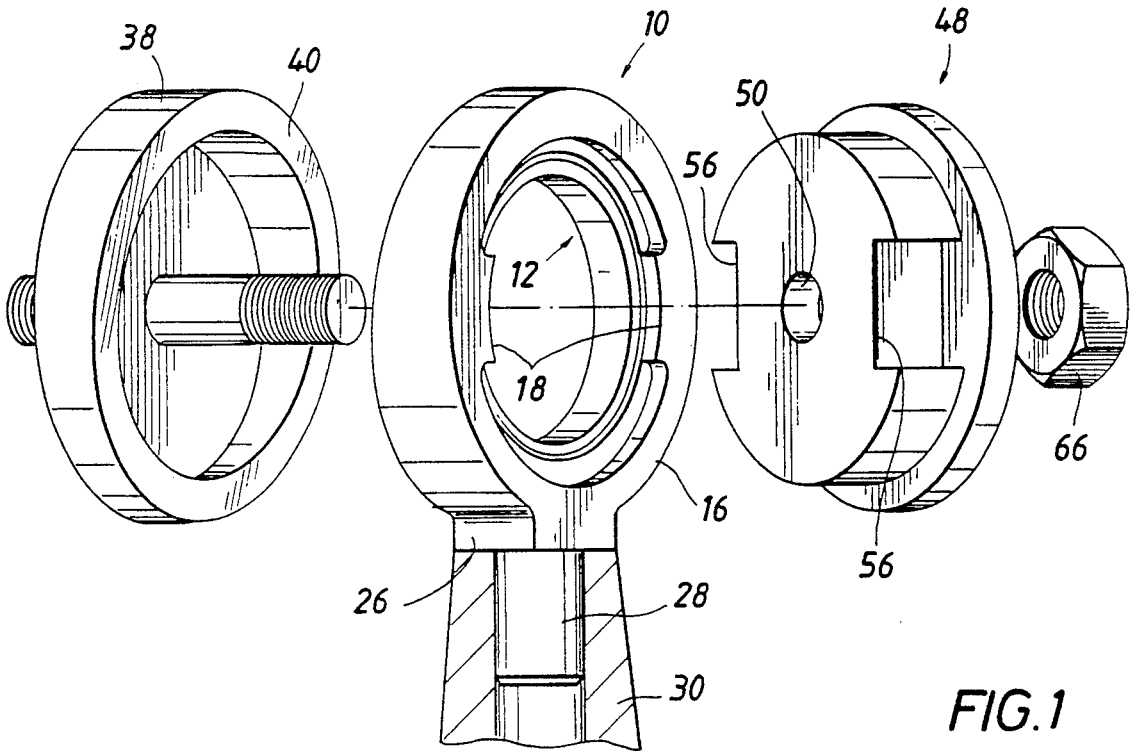

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FIG. 1

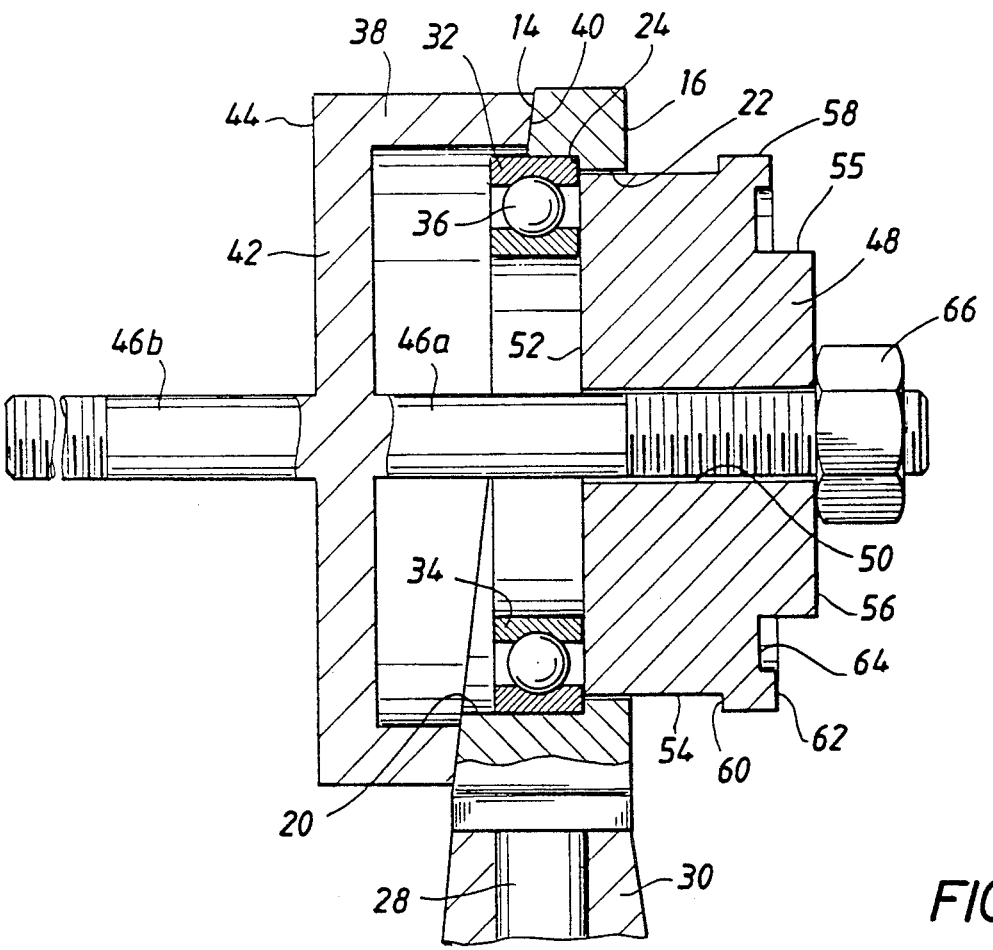
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FIG. 2

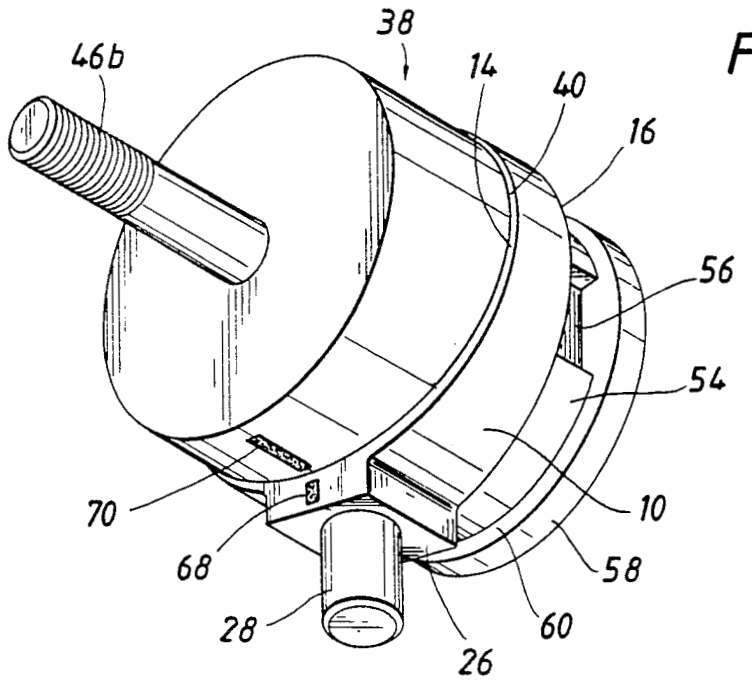
38
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FIG. 3

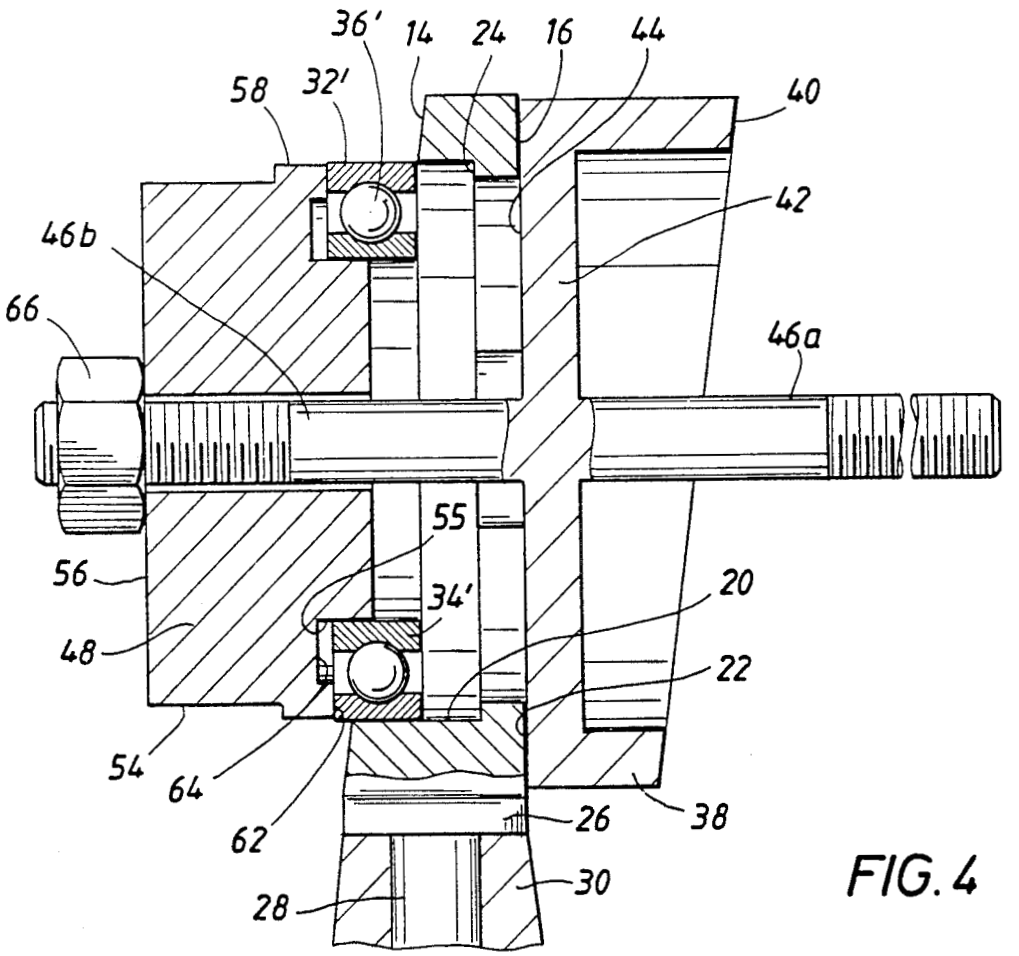
36'
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FIG. 4

BEARING SERVICING TOOL

ORIGIN OF THE INVENTION

The invention described herein was made by an employee of the United States government and may be manufactured and used by and for the government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

The present invention pertains to the servicing of rotary bearings, and more particularly to the removal of rotary bearings in which the outer race is press fit into a generally annular housing and/or to re-emplacement of a new bearing into such housing. Such servicing may be particularly difficult and time consuming if it is necessary, and also difficult, to remove the bearing housing from the apparatus in which it is normally employed and send that housing to a shop or the like. An example of a particularly difficult environment is in the horizontal tail control system of certain aircraft. An exemplary set of instructions for removing the bearing housing from such an aircraft portion comprises some nine pages of instructions and illustrations, and in practice, takes several hours to perform; this is before the actual process of removing the old bearing from the housing can even begin.

Furthermore, apparatus typically used for the actual bearing removal process is often expensive, bulky and/or dangerous, e.g. hydraulic or pneumatic equipment.

A number of prior art devices have been developed for attempting to provide smaller, simpler tools for removing bearings from their housing, and at least some of which might be used with the housing in situ in the apparatus, typically an automotive vehicle. These typically utilize a stationary member for taking purchase against the bearing housing and a movable member for pushing against the bearing proper, the members being interconnected by some type of screw thread drive. However, these have suffered from a variety of disadvantages.

U.S. Pat. No. 3,393,441 to Gebhart discloses a device which is only usable for forming or breaking a press fit of an inner bearing race with respect to a shaft. Furthermore, it utilizes a number of different separable parts, and different combinations of these parts must be used depending upon whether the apparatus is being used to emplace a new bearing or remove an old bearing. These parts can be lost or mislaid, and the manner of assembly for the different functions of the tools is relatively complicated.

U.S. Pat. No. 2,287,767 discloses a device which is only for emplacing a pair of axially spaced bearings, and which is designed to apply pressure only to the inner races of those bearings. The device cannot be used to remove bearings.

U.S. Pat. No. 4,437,220 to Gregory is specialized for use in a particular type of universal joint, and while fairly simple in and of itself, actually makes use of certain parts of the universal joint, so that it is not applicable to rotary bearings in general.

U.S. Pat. No. 4,624,040 to Sabo is even more complicated, in terms of the number of different parts, than the aforementioned patent to Gebhart, not only requiring different parts for removing and emplacing bearings, but also having further parts for removing and emplacing wheel hubs. The chance of dissemination of the parts and/or confusion by the operator is therefore increased.

U.S. Pat. No. 4,542,571 to Sullivan discloses a fairly simple device wherein the same parts, if rearranged, can be used for either emplacing or removing bearings. However, this device is not readily applicable to the types of bearings described above in connection with aircraft, wherein the opposite ends of the bearing housing are different in configuration, and wherein it is undesirable to apply pressure to both the inner and outer bearing races when pressing a new bearing into its housing.

SUMMARY OF THE INVENTION

The present invention addresses the above problems by providing a tool which can be used in situ either for removing or emplacing bearings, even bearings such as those of aircraft, which may have asymmetrical housings. Nevertheless, the tool is fairly simple, both in construction and operation, and includes relatively few separate parts. Furthermore, those few parts, when not in use, can be connected together in a simple manner which will prevent their dissemination or loss.

More specifically, apparatus in accord with one preferred embodiment of the invention comprises a bracing body having first and second ends adapted to engage first and second ends, respectively, of a bearing housing, in the alternative; that is to say, the first end of the bracing body may engage a first end of the bearing housing for bearing removal operation, and the bracing body can be repositioned so that its second end engages the second end of the bearing housing for use in installing a new bearing in the housing. An elongate guide member has first and second parts projecting endwise from the first and second ends, respectively, of the bracing body. A motive body is removably mountable on either of the two parts of the guide member, in the alternative, for longitudinal movement therealong. The motive body has first and second ends of different configurations adapted to engage first and second ends, respectively, of a bearing in, or to be emplaced within, the bearing housing. A force transmission means is cooperative between the guide member and the motive body to move the motive body longitudinally along the guide member and apply a force to the bearing.

Thus, in a bearing removal mode, after the central shaft which is normally supported by the bearing has been removed, but with the bearing housing still in situ, the first end of the bracing body can be placed in engagement with the first end of the bearing housing, with the first part of the guide member extending centrally through the bearing along its axis. The motive body is then installed on the first part of the guide member, with its first end facing the bearing, that first end being sized to fit within the adjacent (second) end of the bearing housing and to abut the bearing, preferably including abutment of the outer race of the bearing. The force transmission means, which may include threads on the guide member and on a drive nut emplaced on the drive member outwardly of the motive body, may then be used to move the motive body inwardly on the guide member, thereby forcing the bearing out of its housing.

In a bearing installation mode, the second end of the bracing body is placed in engagement with the second end of the bearing housing, with the second part of the guide member extending centrally through the bearing.

A new bearing is placed on the second end of the motive body, which is preferably adapted, by the provision of portions of different outer diameter, to carry the bearing. This subassembly is then placed on the guide member with the bearing and the second end of the motive body facing toward the bearing housing. The drive nut is once again emplaced on the guide member outwardly of the motive body and used to move that body inwardly on the guide member, thereby forcing the bearing carried thereby into its housing. Preferably, the second end of the motive body has an axial recess which clears the inner race of the bearing, so that the pressing force is applied only to the outer race of the bearing during the installation process.

The invention contemplates a number of other salient features which, in various embodiments of the invention, can be combined with the above features or used independently.

More particularly, the two ends of the bracing body may be of differing configurations so as to accommodate an asymmetrical bearing housing such as is often found in aircraft. Even more specifically, the first end of the bearing housing may have an annular axially outer surface which is inclined with respect to the bearing axis. The first end of the bracing body may be correspondingly inclined, and indicia marks may be provided on the bearing housing and the bracing body to aid in properly "mating" those inclined surfaces, i.e. abutting them in complementary relationship. The second ends of the bearing housing and bracing body may be of different configuration or orientation, e.g. perpendicular to the axis of the bearing and the tool (which are collinear in use).

Another such salient feature is that the guide member may be integrated with the bracing body, so as to reduce the number of separable parts, and thus the chances for dissemination and/or loss of parts of the apparatus.

Still other salient features of the invention, as well as various objects and advantages thereof, will be made apparent by the following detailed description, claims, and the drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view of the apparatus addressing a bearing housing from which a bearing is to removed.

FIG. **2** is a longitudinal cross-sectional view, with some parts in elevation, of the apparatus in bearing removal mode, and also showing the bearing to which the apparatus is applied.

FIG. **3** is a perspective view of the assemblage of FIG. **2**.

FIG. **4** is a view similar to that of FIG. **2**, but showing the apparatus in bearing installation mode.

DETAILED DESCRIPTION OF THE INVENTION

An exemplary embodiment of the invention is illustrated in conjunction with a bearing of a type used in the horizontal tail control system of an aircraft, and the illustrated embodiment is particularly adapted for use with this type of bearing. It will be appreciated that the configuration of certain parts of the tool apparatus could be modified for use with bearings having different configurations, within the spirit of the present invention.

The bearing assembly includes an annular bearing housing **10** having the annular bearing proper **12** concentrically mounted therein. The bearing housing **10** has a first end with an annular axially outwardly facing surface **14** which is inclined with respect to the central axis of the bearing, as best seen in FIGS. **2** and **4**. The other or second end of the bearing housing has an annular axially outer surface **16** which lies perpendicular to the bearing axis. Adjacent surface **16**, the housing **10** includes a pair of diametrically opposed ears **18** which project radially into the interior of the bearing housing at its second end; ears **18** do not extend the full length of the bearing housing **10**. The housing **10** has a relatively large inner diameter, as indicated at **20**, at its first end, and a smaller inner diameter **22** at its second end, a shoulder **24** facing axially toward the first end thus being formed at the juncture between the large and small inner diameter parts **20** and **22**. A base portion **26** is integrally formed on the housing **10** and extends radially outwardly therefrom, more specifically downwardly in use, as shown. A trunion-like pin **28** integral with and extending further outwardly from base **26** is adapted for disposition in a bore of a bearing support member **30** in the aircraft.

The bearing proper includes an outer race **32** press fitted into the large diameter part **20** of the housing **10** and in abutment with the shoulder **24**, an inner race **34**, which, in use, engages and rotates with a shaft (not shown) supported by the bearing **12**. The races **32** and **34** are spaced apart, and have opposed surfaces configured to capture a set of anti-friction elements, in this case balls **36**, which complete the bearing subassembly **12**.

To prepare the bearing assembly **10**, **12** for servicing, the shaft has been removed leaving the interior of the bearing free and open, but the bearing housing **10** has been left in situ on its support **30** in the aircraft. FIGS. **1-3** show how a tool in accord with the present invention is then applied to the bearing assembly for removal of the bearing proper **12**.

The tool includes a bracing body **38** which is generally cylindrical, having a first, open end terminating in the annular axially outer surface **40** which is inclined at a corresponding angle to surface **14** of bearing housing **10**. The second end of the bracing body **38** is closed by an end wall **42** whose axially outer face **44** lies perpendicular to the axis of the cylindrical bracing body **38**. Surfaces **40** and **44** could be configured in any suitable manner so as to properly engage surfaces such as **14** and **16**, but of bearing housings of different configurations. It is noted that, when it is said that the surfaces **40** and **44** engage respective surfaces **14** and **16**, it is meant that such engagement occurs in the alternative, depending upon whether the tool is assembled for bearing removal (FIG. **2**) or bearing emplacement (FIG. **4**).

The tool of the invention further includes an elongate guide member in the form of a large threaded pin having first and second parts **46***a* and **46***b*, respectively. Pin **46***a*, **46***b*, in the embodiment shown, is formed monolithically with end-wall **42** of bracing body **38**. However, in other embodiments, it is possible to form the pin **46***a*, **46***b* separately, and place it in a suitable hole in end wall **42**, and then integrate it with wall **42** by welding, or removably secure it to wall **42**, as by suitable grooves and snap rings or the like. In any event, it is preferred that the pin **46***a*, **46***b* either be integral with body **38** or connected thereto by secure means which minimize the

chance of separation of the pin from the bracing body and dissemination of these parts of the apparatus.

In any case, first part **46***a* of the pin extends through the interior of body **38** toward and beyond its first end surface **40**, whereas the second part **46***b* extends from and beyond the second end surface **44**, both coaxially with the cylindrical bracing body **38**. Each of the pin parts **46***a* and **46***b* has its outermost portion externally threaded.

The tool further includes a motive body **48** having generally circular exterior surfaces and a central aperture **50** sized for sliding receipt of either first part **46***a* or second part **46***b* of the guide member. The motive body **50** has a first end including a continuous annular face **52** lying perpendicular to its axis and a peripheral surface **54** which, but for the interruption provided by slots **56**, which are sized to receive and bypass housing ears **18**, is cylindrical and sized for a sliding fit in relatively small inner diameter part **22** of the bearing housing **10**.

The second end of the motive body **48** has a different configuration from that of its first end, for reasons to be developed below. The second end includes an axially outermost, relatively small outer diameter part **55** sized for sliding receipt in inner race **34** of the bearing **12** and having a continuous, annular, axially outer face **56**. Axially set back from face **56**, the second end of the motive body **48** also includes a relatively large outer diameter part **58** sized for a sliding fit in the relatively large inner diameter part **20** of the bearing housing **10**. An external axially facing shoulder **60** is formed at the juncture of large diameter part **58** of the second end and intermediate diameter part **54** of the first end of the motive body. Another shoulder, **62**, facing in the opposite axial direction, is formed at the juncture of the two parts **55** and **58** of the second end of the motive body. This shoulder **62** has an annular axial recess **64** adjacent small diameter part **54**.

The third and final part of the tool illustrated is a drive nut **66** adapted to be threaded onto either of the pin parts **46***a* or **46***b*, in the alternative.

To remove the bearing **12** from its housing **10**, the respective first ends of the bracing body **38** and bearing housing **10** are engaged by abutting their surfaces **40** and **14**, as shown in FIGS. **2** and **3**. To be sure that the inclined surfaces **40** and **14** "mate," i.e. that they are arranged in complementary manner so that pin **46***a*, **46***b* lies along the axis of the bearing, indicia marks **68** and **70** are provided on the outside of the housing **10** and body **38**, as shown in FIG. **3**, and are visually aligned. It will be seen that, with surfaces **14** and **40** properly abutting, first part **46***a* of the guide pin extends through the bearing housing **10** and projects out the other side.

Motive body **48** is emplaced on first part **46***a* of the guide pin with its first end **54** innermost. For convenience, it is noted that the term "first" has been used for those ends of the various parts of the apparatus which are engaged or operative during a bearing removal operation, as shown in FIGS. **1-3**. Motive body **48** is advanced inwardly along first part **46***a* of the guide pin until it slides into the smaller diameter part **22** of the bearing housing **10**, and then nut **66** is threaded onto pin part **46***a* outwardly of and abutting motive body **48**, so that the entire assemblage is retained on the bearing housing **10**.

Then, the nut **66** is simply threaded inwardly along pin part **46***a*, forcing motive body **48** ahead of it. It is noted that the shoulder **24** in the bearing housing **10** is sized so that outer race **32** projects radially inwardly from the shoulder, and that diameter **54** of the motive body **48** is sized so that its end face **52** will overlap and abut the outer bearing race **32**. Thus, face **52** abuts both the inner and outer bearing races **32** and **34**, and as the drive nut **66** is moved inwardly, the entire bearing **12** will be forced out of housing **10** and into the cavity formed by the interior of cylindrical body **38**. During bearing removal, shoulder **60** serves as a stop against surface **16** of the bearing housing. Thereafter, the parts are simply disassembled by removing nut **66**, removing motive body **48**, and withdrawing body **38**, with the removed bearing therein, from the housing **10**.

To install a new bearing **32'**, **34'**, **36'**, the bracing body is placed on the second side of housing **10** so that the perpendicular end face **44** of its second end abuts the perpendicular end face **16** of the bearing housing. Thus, second pin part **46***b* will extend through the bearing housing **10** and beyond its first end surface **14**. The new bearing **32'**, **34'**, **36'** is emplaced on the second end of the motive body **48** so as to be carried thereby, and more specifically inner race **34'** is slipped over small diameter part **54** until the outer race **32'** abuts the shoulder **62**. It is noted that the recess **64** is sized so that shoulder **62** will clear inner race **34'**, as it is undesirable to apply pressure to the inner race while press fitting the outer race into the housing. Rather, the inner race **34'** should be non-forcibly carried along by means of balls **36'** interengaging the opposed grooves in the two bearing races.

Motive body **48** is now emplaced on second pin part **46***b* with its second end **55**, **58** facing the housing **10**, and the bearing carried by the second end of the motive body. The nut **66** is next threaded onto pin part **46***b* outwardly of but abutting motive body **48**.

The larger inner diameter **20** of the housing **10** typically has a slight outward taper which allows outer bearing race **32'** to be started into the end of the housing without the application of substantial force, so as to temporarily coaxially align the tool with the bearing housing. Thereafter, nut **66** is threaded inwardly along pin part **46***b*, forcing motive body **48** and the bearing carried thereby ahead of it, and thus pressing race **32'** into the large diameter **20** of the bearing housing **10** until the bearing abuts the internal shoulder **24**. The tool is then simply removed by removing nut **66**, then motive body **48**, then bracing body **48**.

When the tool is not is use, the motive body **48** can be placed on either of the pin parts **46***a* or **46***b*, and retained there by threading nut **66** onto that pin part outwardly of the motive body **48**. Thus, all three parts of the tool are held together so as to minimize the possibility of their dissemination and/or loss.

Certain modifications of the present invention have been suggested above, and still others will suggest themselves to those of skill in the art. By way of example only, motive body **48** has been shown as having a free sliding fit on the pin parts **46***a* and **46***b*, and a separate threaded drive nut **66** is provided. However, in other embodiments, the motive body **48** could be directly threadedly engageable with pin parts **46***a* and **46***b*. This would further reduce the number of separable parts of the apparatus. However, in some instances, the addition of a third part, i.e. nut **66**, may be considered to be balanced by the relative ease with which such a nut can be engaged and rotated by a wrench, possible undesirability of relative movement between the motive body **48** and the bearing **48** in use, and the relative ease

of replacing nut **66**, which can be an inexpensive, even standardized part.

The use of a single reversible motive body **48**, having the configurations of its two ends differing as needed to properly engage a bearing for respective removal and reinsertion procedures, is one salient feature of the invention which minimizes the necessary number of separable parts. However, in other embodiments, other salient features of the invention, e.g. the end surface of the bracing body inclined to match the inclination of the end of a special housing, or the integration of the guide pin with the bracing body, might be used with motive body means comprising two different motive bodies, one for bearing removal, and the other for bearing insertion. In such an embodiment, it is still possible to retain the motive bodies on the guide pin by one or two nuts, so as to minimize the chance of dissemination and loss thereof when the tool is not in use.

It is intended that the scope of the invention be limited only by the claims which follow.

What is claimed is:

1. Apparatus for servicing a bearing, comprising:

a bracing body having a first end adapted to engage a first end of a housing for the bearing and a second end adapted to engage a second end of the bearing housing;

an elongate guide member projecting endwise from the bracing body;

a motive body removably mounted on the guide member for longitudinal movement therealong and having first and second ends of different configurations adapted to alternatively engage first and second ends, respectively, of the bearing;

and force transmission means cooperative between the guide member and the motive body to move the motive body longitudinally along the guide member and apply a force to the bearing,

wherein, the guide member has first and second portions adapted to project from the respective ends of the motive body, each of the portions having threads fromed thereon and the force transmission means comprises threaded drive means including threads formed on the guide member, wherein the first end of the bearing housing has a relatively large inner diameter, the second end of the bearing housing has a relatively small inner diameter, and there is an axially directed stop shoulder at the juncture of the two inner diameters of the bearing housing;

wherein the first end of the motive body has an outer diameter small enough to fit within the second end of the bearing housing and large enough to abut an outer race of the bearing;

and wherein the second end of the motive body comprises a small-outer-diameter, axially-outermost part, sized to fit within an inner race of the bearing, and a large-outer-diameter, axially-set-back part, sized so that a shoulder formed between the large and small outer diameter parts of the motive body will axially abut the outer race of the bearing near its outer diameter, but the large outer diameter part of the second end of the motive body will fit within the first end of the bearing housing.

2. The apparatus of claim **1** wherein the second end of the motive body has an annular recess extending axially thereinto at an inner portion of the shoulder between the large and small outer diameter parts thereof, and sized to clear the inner race of the bearing.

3. The apparatus of claim **2** wherein the first end of the bearing housing has an annular axially outer surface inclined with respect to the bearing axis, and the first end of the bracing body has a correspondingly inclined, annular, axially outer surface;

the bearing housing and the bracing body having indicia marks to aid in mating the inclined surfaces.

4. The apparatus of claim **3** wherein the bracing body has a cavity opening axially through the inclined surface and sized to receive the bearing.

5. The apparatus of claim **3** wherein the second ends of the bearing housing and the bracing body have axially outer surfaces perpendicular to their axes.

6. The apparatus of claim **1** wherein the second end of the bearing housing has radially inwardly projecting ears;

and wherein the first end of the motive body has radial notches to allow the first end of the motive body to bypass the ears.

7. Apparatus for servicing a bearing, comprising:

a bracing body having a central axis for general alignment with the axis of the bearing in use, a first end having an annular, axially outer surface, inclined with respect to the axis and adapted to engage a correspondingly inclined, annular, axially outer surface of a housing for the bearing, and a second end having an axially outer surface perpendicular to the axis and adapted to engage a correspondingly perpendicular, annular, axially outer surface of the bearing housing, the bracing body and the bearing housing having indicia marks to aid in mating the inclined surfaces;

an elongate guide member having first and second parts adapted to project endwise from the first and second ends, respectively, of the bracing body;

motive body means alternately removably mountable on the first or second parts of the guide member for longitudinal movement therealong and engageable with the bearing;

and force transmission means cooperative between the guide member and the motive body to move the motive body along the guide member and apply a force to the bearing.

8. The apparatus of claim **7** wherein said motive body means comprises a single motive body having first and second ends adapted to alternatively engage first and second ends, respectively, of the bearing.

9. The apparatus of claim **8** wherein the first and second ends of the motive body have different configurations.

10. A method of servicing a bearing in situ, comprising the steps of:

removing a shaft rotatably mounted in the bearing;

abutting a first end of a bracing member against a first end of a housing for the bearing, with an elongate guide member rigidly projecting endwise from the bracing member through the center of the bearing;

emplacing an apertured motive body on the guide member generally on the opposite side of the bearing from the bracing member and centering a first end of the motive body within the bearing housing;

threading a nut onto an end of the guide member projecting outwardly beyond the motive body;

advancing the nut inwardly along the guide member, thereby urging the first end of the motive body against the bearing and pushing the bearing out of the bearing housing and into a cavity in the bracing member;

removing the nut and the motive body from the guide member;

removing the bracing body from the bearing housing;

removing the ejected bearing from the cavity in the bracing body;

placing the bracing body generally on the other side of the bearing housing, with a second end of the bracing body abutting a second end of the housing and a second part of the guide member rigidly projecting endwise from the bracing body through the center of the bearing;

placing a new bearing on a carrier portion of a second end of the motive body;

placing the motive body on the second part of the guide member with the second end thereof facing the bearing housing;

threading the nut onto the second part of the guide member axially outwardly of the motive body;

and advancing the nut inwardly along the guide member thereby urging the second end of the motive body toward the bearing housing and forcing the bearing carried thereby into the bearing housing.

* * * * *