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MOUNTING ARRANGEMENT FOR THE DRIVE SYSTEM OF AN AIR-BEARING SPINDLE ON A MACHINE TOOL
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DISCLAIMER

MOUNTING ARRANGEMENT FOR THE DRIVE SYSTEM OF AN AIR-BEARING SPINDLE ON A MACHINE TOOL

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MOUNTING ARRANGEMENT FOR THE DRIVE SYSTEM OF AN AIR-BEARING SPINDLE ON A MACHINE TOOL

Background of the Invention

The present invention relates generally to machine tools employing air-bearing spindles and more particularly to a mounting arrangement for the drive assembly utilized for rotating the air-bearing spindle for maintaining the spindle and drive system in alignment with a rotational center line of the air bearing spindle. This invention was made as the result of a contract between Martin Marietta Energy Systems, Inc. and the U.S. Department of Energy.

In the art of machining metal with machine tools such as lathes increased emphasis is being placed on the capability of machining work pieces to within very narrow and precise tolerances. One of the more recent advances in machine tool technology which has had a significant impact on precision machining capabilities is the use of air-bearing spindles which provide for the rotation of the work piece on a precise rotational axis with minimal vibrations.

In using air-bearing spindles on machine tools the air-bearing spindle contained in a suitable casing is secured to a machine table or the ways of the machine with the air-bearing in the spindle so aligned that the rotational centerline or axis of the air bearing is parallel with the centerline of the machine tool ways. In conventional practice the air-bearing spindle is mounted in place upon the

machine and properly aligned. The spindle drive system is then installed on the machine and aligned so that the drive shaft of the drive system and the air-bearing in the spindle have a common rotational axis. Accurate alignment between the drive shaft and the air bearing is continuously required in order to assure proper operation of the air bearing.

The drive systems presently used for most air-bearing spindles include a belt-driven shaft of a jackshaft type arrangement which is connected to the air bearing by a flexible coupling so as to facilitate alignment. Many power transmission problems associated with driving air bearing spindles are substantially solved by using the jackshaft drive arrangement. However, it has been found that all of the current drive systems suffer extensive problems with respect to maintaining proper alignment between the air bearing and the jackshaft drive. Alignment between the air bearing and the jackshaft drive is maintainable during normal machining operations. However, in some instances when the spindle is inadvertently jarred by contact with a work piece or moveable machine tool components, the force of the contact may be sufficient to move the air bearing mounting on the machine tool so as to disrupt the alignment the air bearing with the drive system. Once this misalignment occurs between the spindle and the drive system, realignment is necessary so as to fully realize the advantages of the air bearing spindle. Further, in some instances where extensive misalignment occurs, the air bearing spindle can be sufficiently damaged by the continued operation so as to necessitate

replacement of the air bearing spindle. The realignment of a spindle with the drive system is normally achieved by employing specialized craftsmen or machine tool vendor representatives. The realignment procedures requires extensive periods of downtime for the machine and result in significant maintenance costs which detract from the desirability of the air-bearing spindle in many machining operations where alignment problems may occur.

Summary of the Invention

Accordingly, it is a primary aim or objective of the present invention to provide a mounting for the drive system wherein the alignment between the mechanical drive system and the air bearing spindle remains in a permanent correct alignment during all phases of the machining operation including being subjected to conditions which heretofore disrupted the alignment of the air bearing with the drive system which necessitated realignment. The present invention provides for such permanent alignment by employing a mounting arrangement on a machine tool which enables the drive system to be mounted directly on the air bearing spindle so that any movement of the air bearing spindle or the spindle mount will not disrupt the alignment between the drive system and the air bearing.

In general the present invention is in a machine tool which comprises an air-bearing spindle having a casing, an elongated machine way, and a bolting means for attaching the casing of the air bearing spindle to the machine way. Drive means are coupled to the air bearing spindle for rotating the air bearing spindle about a rotational

axis parallel to a centerline along the length of the elongated machine tool way. Drive support means comprising a housing are utilized for supporting the drive means. Coupling means are in turn utilized for attaching the housing of the drive support means to the casing of the air-bearing spindle for support thereby to maintain alignment of the drive means with the air-bearing spindle when the casing of the air-bearing spindle is displaced sufficiently to move the axis of rotation of the air-bearing spindle in a direction away from parallel with the centerline of the machine way.

The housing utilized for the drive support means of the present invention is an open framework having a horizontally extending upper plate, a vertically extending end plate with an opening therethrough with the end plate being connected at the uppermost end thereof to the end of the upper plate. A base support plate underlies the upper plate and is disposed intermediate opposite horizontally spaced apart ends of the upper plate and is connected to the upper plate and the end plate for providing a single structure. The upper plate has an end portion thereon which longitudinally extends over a portion of the casing for the air-bearing spindle and the base support plate is disposed in an abutting relationship with an end surface of the casing of the air-bearing spindle. The coupling means for attaching the housing to the casing comprises a bolting arrangement which connects the end portion of the upper plate and the base support plate to the casing of the air-bearing spindle. The alignment of the drive system with the air bearing spindle is provided by placing spacers between the end

surface of the casing and the base support plate and the extended portion of the upper plate and the casing for the air-bearing spindle. These spacer plates are precisely machined to desired thicknesses so that when positioned between the housing and the casing they provide for proper alignment of the drive system with the air bearing. The spacer plates once in position are secured in place by bolting arrangement utilized to join the housing to the casing of the air bearing spindle.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described or will be indicated in the appended claims and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

Description of the Drawings

Fig. 1 is a plan view showing schematically a machine tool in which an air-bearing spindle is disposed in an operable relationship with a tool holder on the ways of the machine tool with the air-bearing spindle aligned so its rotational axis is parallel with the longitudinal centerline of the machine ways;

Fig. 2 is an elevational view partly broken away showing details of the drive system mounting arrangement of the present invention which is utilized for providing a permanent alignment between the drive means and the air-bearing spindle during all phases of operation; and

Fig. 3 is an end view of the Fig. 2 embodiment showing details of the belt drive for the air-bearing spindle and details of the housing supporting the drive system on the air-bearing spindle.

A preferred embodiment of the invention has been chosen for the purpose of illustration and description. The embodiment illustrated is not intended to be exhaustive or to limit the invention to the precise form disclosed. It is chosen and described in order to best explain the principles of the invention and their application and practical use to thereby enable others skilled in the art to best utilize the invention and various modifications and embodiments thereof as are best adapted to particular use contemplated.

Detailed Description of the Invention

With reference primary to Figs. 1 - 3 the present invention is utilized on a machine tool such as the lathe shown generally at 10 which employs an air bearing spindle 12 for precise machining of various work pieces. The air bearing spindle 12 may be of a conventional configuration and structure as is well known in the art and is mounted in a conventional manner on a plate on the machine or on elongated ways 14 of the lathe 10. These ways 14 are of conventional design such as a dovetail arrangement commonly used on lathes. The lathe 10 is also of the type which may be provided with a tail stock (not shown) and/or a tool holder 16 which is shown mounted on a carriage 18 for displacement along the ways 14 by a drive arrangement 20 which is utilized to move the cutting tool into a working relationship with a work piece (not shown) supported in any suitable manner on the

air-bearing spindle 12 and rotated about an axis of rotation 21 that is parallel with the centerline 22 of the ways 14. The air bearing spindle 12 is provided with a casing 24 which houses the air bearing and includes a base plate 26. This base plate 26 is utilized to fixedly mount the air bearing spindle on a suitable table or directly to the ways 14 of the lathe. This mounting is achieved by using bolts 28 which secure the air bearing spindle to the ways and also provide for sufficient movement of the casing to permit the parallel alignment of the axis of rotation 21 of the spindle with the centerline of the machine ways 14 prior to tighting the bolt 28.

In order to rotate the air-bearing spindle 12 about its rotational axis, a suitable drive means is utilized and is carried by the drive support or mounting arrangement of the present invention as generally shown at 30. This support arrangement comprises a housing 32 of a generally C-shaped boxed frame construction which has an open front and solid top and rear panels or plates. The housing 32 is formed of steel of a sufficient thickness to support the motor and the drive system utilized for the particular lathe on which the housing is installed. This housing 32 may be cast in the desired configuration with selected surface portions being machined to specific dimensions in the usual manner. The housing 32 is shown comprising a solid upper plate 34 which is horizontally disposed on the housing and is joined at an end thereto to a vertically oriented end plate which is rear most on the housing 32 away from the air-bearing spindle 12. The vertical end plate 36 is provided with an opening 38 therethrough for the

passage of the drive shaft for the air-bearing spindle as well as a base for supporting a bearing arrangement utilized for the support and rotation of the air-bearing drive shaft.

The upper plate 34 is provided with a longitudinally extending section or portion 40 which overlaps or projects over an end section of the spindle casing 24. This portion 40 of the housing is utilized for attaching the housing 32 to the casing 24 by a suitable bolting arrangement such as generally shown at 42. Two bolts 42 are generally shown in Fig. 1 for effecting the attachment of the housing 32 to the upper part of the air-bearing casing 24but a greater number of bolts 42 may be utilized if desired.

Another attachment of the housing 32 to the casing 24 of air bearing spindle 12 is provided at the base support plate 44 which is connected to the vertically extended end plate 36 and the upper plate 34 by sidewall beams or ribs 46 and 48. The base support plate 44 is provided with spaced apart raised shoulders or surface portions 50 and 52 which abutt against the rear surface of the casing 24 at spaced apart locations. Bolts 54 and 56 are then passed through suitable holes in the raised surface portions 50 for attaching the base plate 44 to the casing 24 and for aligning the drive shaft with the air bearing in horizontal directions as will be discussed below.

The drive system for the air bearing spindle comprises an electric motor 58 mounted on top of the upper plate 34 of the housing by a suitable bolting arrangement 60. Rotational power is transmitted from the motor to the air bearing spindle 12 by a belt drive generally

shown at 62 and elongated jackshaft drive arrangement generally shown at 64. A pulley 66 on motor 58 and a pulley 68 on a drive shaft 70 of the jackshaft drive together with an idler pulley 72 carried by the vertical end plate of the housing are driven by belt 74 for effecting rotation of the shaft 70. The idler pulley is selectively adjustable to provide the proper tension on the belt system. A bearing 76 is placed in the opening 38 in the vertical end 36 plate for supporting the shaft 70 which passes therethrough. Preloaded duplex bearings are preferably used to minimize slippage or looseness during operation of the drive system. The jackshaft drive includes a a flexible coupling arrangement generally shown at 78 for facilitating alignment of the drive 64 with the air bearing. The shaft 70 of the jackshaft drive extends from beyond the rear of the housing 32 through the bearing 76 into the air bearing through the flexible coupling 18. Further, an encoder generally shown at 80 is coupled to the drive shaft 70 by a belt 82 for rotation thereby for controlling the rotational position of the air bearing spindle 12 through a computer control arrangement (not shown) in a conventional fashion.

In order to provide for alignment of the air bearing 12 with the drive shaft 64 so as to inhibit the damage of the air bearing as described above, the housing 32 is aligned with and attached to the air bearing spindle 12 prior to placement of the air-bearing spindle 12 on the machine tool. This alignment of the drive shaft with the air bearing is readily achieved by utilizing a precisely machined plate 84 between the upper surface of the casing 24 and the upper plate 34 of

the housing. This plate 84 provides for the vertical alignment of the shaft with the air bearing to assure that the rotational axis of the drive shaft and the air bearing are on a common vertical plane. In addition to this plate 84, plates 86 and 88 (one plate 86 is shown) are provided for the base support 44 so as to be positioned between the end of the casing 24 and each of the raised surface portions 50 on a base support plate 44. These plates 86 and 88 like plate 84 are precisely machined to selective thicknesses so that the horizontal movement and alignment of the shaft may be achieved to horizontally align the axis of the shaft 64 with the axis of the air bearing. The proper alignment of the drive system 64 with the air bearing may necessitate the removal and replacememt of plates 84 and 86 with similar plates of different thicknesses several times during a single operation procedure. When the alignment is completed, the air bearing spindle is mounted on the machine tool and placed in alignment with the centerline 22 of the machine tool. Once this alignment with the machine tool is achieved and the air bearing spindle casing 24 secured to the machine tool by the bolts 28, the drive system remains permanently in alignment with the air bearing spindle so as to obviate the problems heretofore encountered with respect to misalignment problems associated with the movement of the air bearing spindle with respect to the drive system.

It will be seen that the present invention overcomes a significant problem in the operation of air bearing spindles on machine tools. The present invention also obviates any misalignment and

damage to the air bearing spindle resulting from the use of drive systems mounted independently of the air bearing spindle as heretofore employed. Further the initial alignment of the drive system with the machine tool is more readily achieved in the present invention than with the independently mounted drive system previously utilized.

Abstract of the Disclosure

The present invention is directed to a mounting arrangement for the drive system of an air-bearing spindle utilized on a machine tool such as a lathe. The mounting arrangement of the present invention comprises a housing which is secured to the casing of the air bearing in such a manner that the housing position can be selectively adjusted to provide alignment of the air-bearing drive shaft supported by the housing and the air-bearing spindle. Once this alignment is achieved the air bearing spindle and the drive arrangement is maintained in permanent alignment so as to overcome misalignment problems encountered in the operation of the machine tool between the air-bearing spindle and the shaft utilized for driving the air-bearing spindle.