US 20050249628A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0249628 A1**

Hsu et al. (43) **Pub. Date: Nov. 10, 2005**

(54) **METHOD FOR MAKING SLIDER OF LINEAR BEARING**

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(21) Appl. No.: **10/841,312**

(22) Filed: **May 7, 2004**

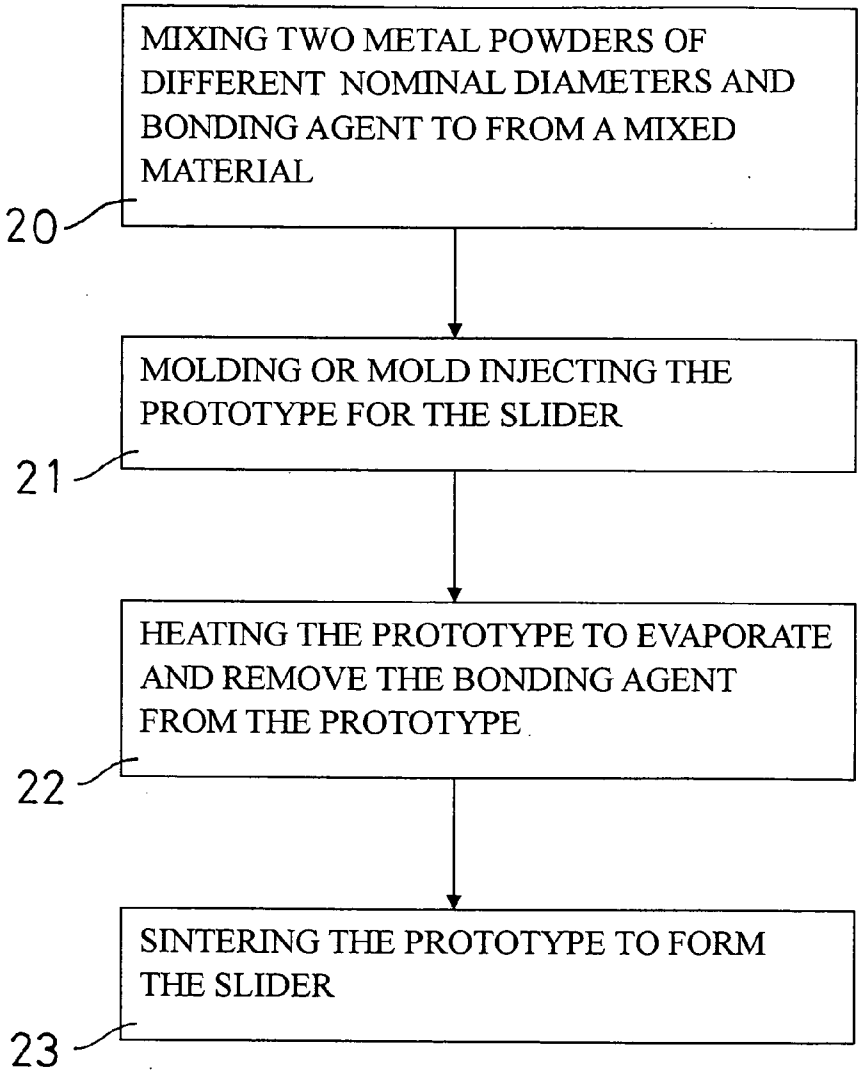
Publication Classification

(51) **Int. Cl.**[7] **B22F 3/12**

(52) **U.S. Cl.** **419/37**

(57) **ABSTRACT**

A method for manufacturing a slider for a linear bearing device includes mixing metal powders and bonding agent together, molding the metal powders and the bonding agent to form a prototype having one or more ball return passages formed in the prototype, heating the prototype to remove the bonding agent from the prototype, and sintering the prototype to form the slider. The metal powders include a number of greater and a number of smaller metal powders having different nominal diameters. The smaller metal powders include a spherical shape. The greater metal powders include an irregular shape.



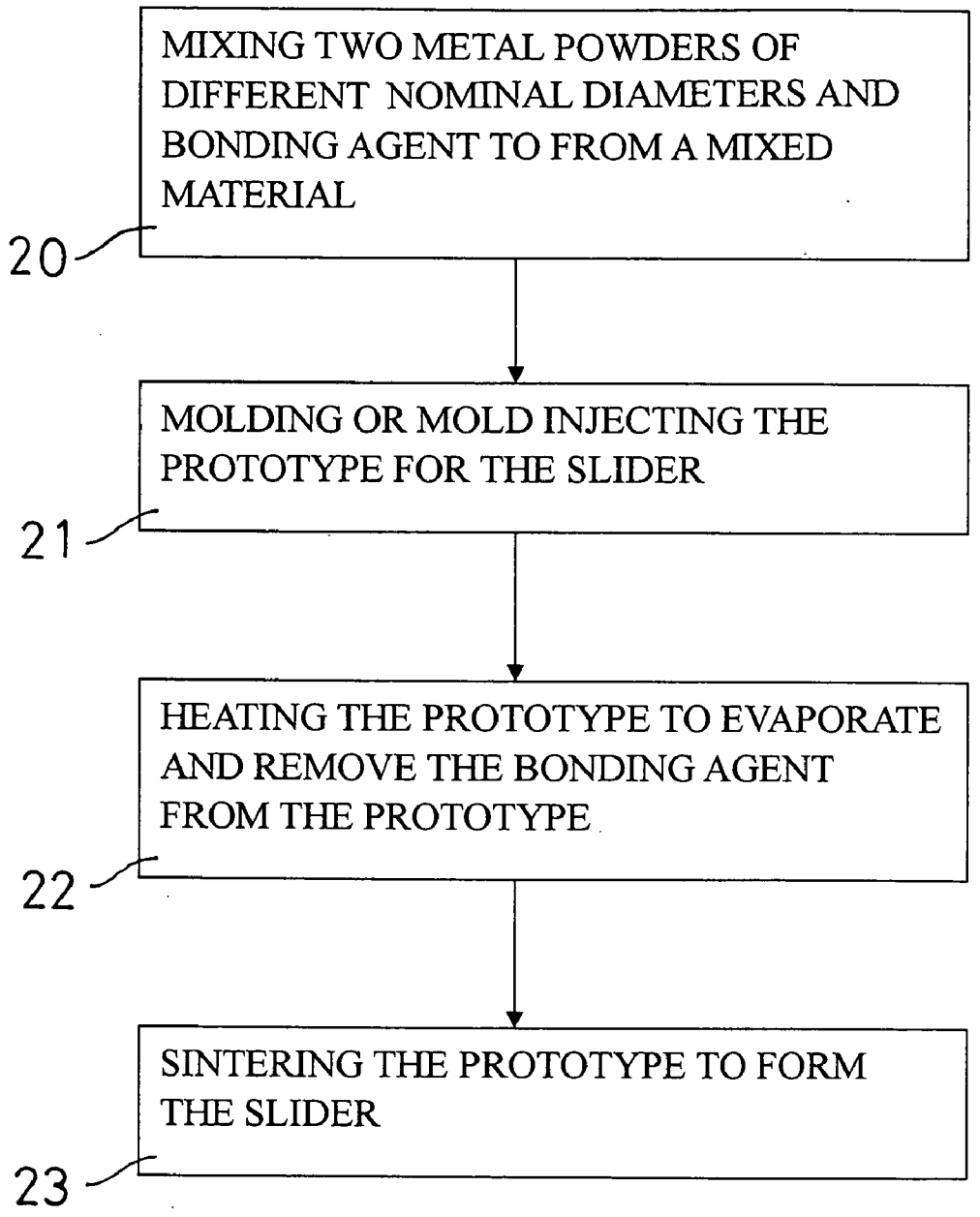

MIXING TWO METAL POWDERS OF DIFFERENT NOMINAL DIAMETERS AND BONDING AGENT TO FROM A MIXED MATERIAL
20
MOLDING OR MOLD INJECTING THE PROTOTYPE FOR THE SLIDER
21
HEATING THE PROTOTYPE TO EVAPORATE AND REMOVE THE BONDING AGENT FROM THE PROTOTYPE
22
SINTERING THE PROTOTYPE TO FORM THE SLIDER
23

FIG. 1

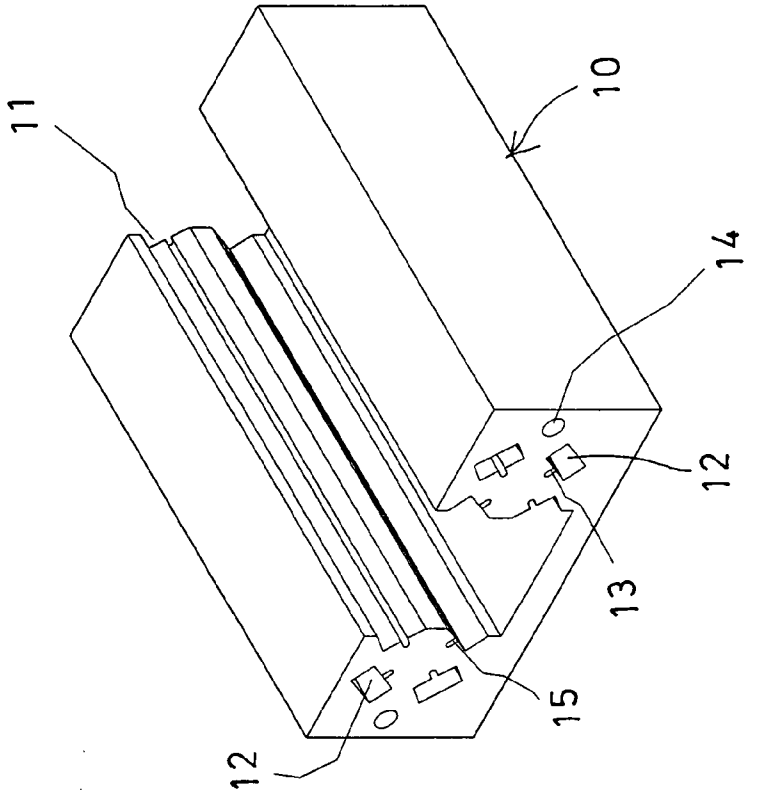


FIG. 2

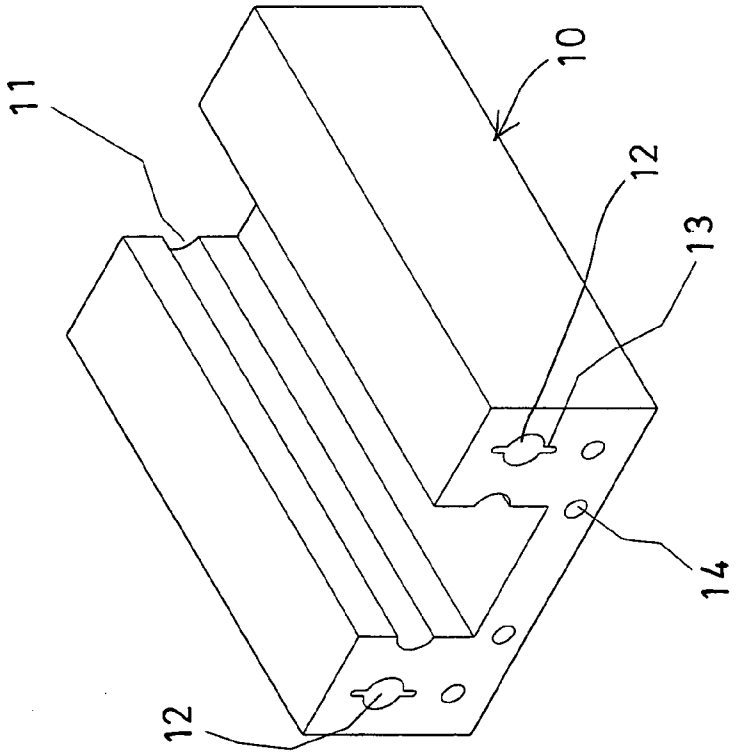


FIG. 3

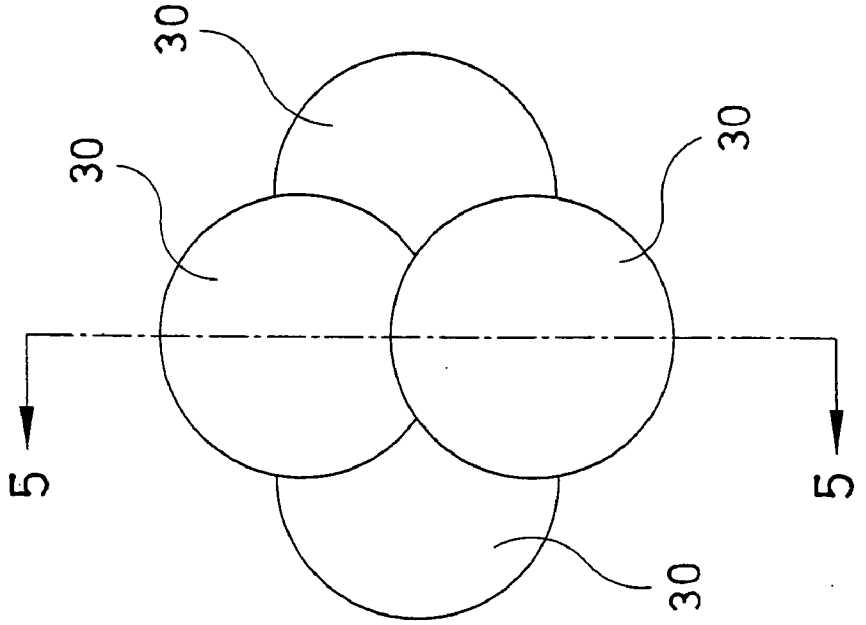


FIG. 4

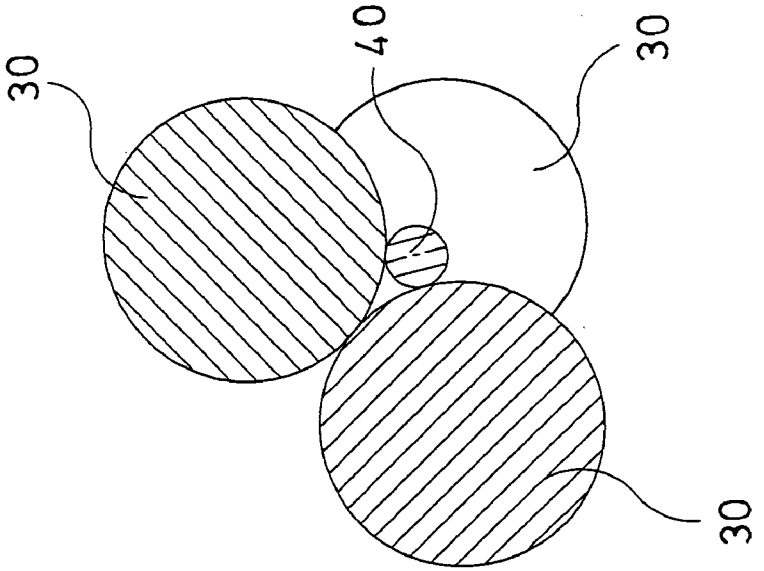


FIG. 5

METHOD FOR MAKING SLIDER OF LINEAR BEARING

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a slider of a linear guide or bearing device, and more particularly to a method for making slider of a linear guide or bearing device.

[0003] 2. Description of the Prior Art

[0004] Various kinds of typical linear guide or bearing devices have been developed and provided for guiding a movable body, such as a work table or an industrial robot of a machine tool under load which moves along a track rail arranged at a fixed portion such as a bed, a column or the like.

[0005] For example, U.S. Pat. No. 4,417,771 to Teramachi discloses one of the typical linear ball bearing devices and comprises a number of members or elements required to be manufactured and then assembled together, and a number of screw or threaded holes are required to be formed in the members or elements to engage with fasteners, such that the manufacturing processes are complicated and time consuming.

[0006] U.S. Pat. No. 5,947,605 to Shirai discloses another typical linear ball bearing device and comprises a slider having a number of loaded ball rolling grooves, inner and outer peripheral guide portions, non-loaded ball return passages formed therein. For allowing the loaded ball rolling grooves, the inner and outer peripheral guide portions, and the non-loaded ball return passages to be formed within the slider, the slider may not be made with a great strength. However, the slider may not have a strength good enough to support the balls or rollers of the bearing devices.

[0007] U.S. Pat. No. 6,042,269 to Konomoto and U.S. Pat. No. 6,085,420 to Konomoto disclose two other typical linear ball bearing devices and comprise a slider to be made by inserting a block main body into a mold and injection molding of a synthetic resin, to build ball retaining portions on both sides of the load rolling faces of the block main body. However, the manufacturing processes are complicated and time consuming.

[0008] U.S. Pat. No. 6,109,789 to Chen discloses a further typical linear ball bearing device and comprises a slider having a number of loaded ball rolling grooves, inner and outer peripheral guide portions, non-loaded ball return passages formed therein. Similarly, a number of complicated manufacturing processes are required to manufacture the loaded ball rolling grooves, the inner and outer peripheral guide portions, and the non-loaded ball return passages within the slider.

[0009] U.S. Pat. No. 6,390,678 to Shirai and U.S. Pat. No. 6,652,146 to Lee disclose two still further typical linear ball bearing devices, and each also comprises a slider having a number of loaded ball rolling grooves, inner and outer peripheral guide portions, non-loaded ball return passages, or the like that are required to be manufactured and formed within the slider with a number of complicated manufacturing processes, such as machining, grinding, drilling processes or the like.

[0010] The present invention has arisen to mitigate and/or obviate the afore-described disadvantages of the conventional methods for making the sliders of the linear guide or bearing devices.

SUMMARY OF THE INVENTION

[0011] The primary objective of the present invention is to provide a method for making a slider of a linear guide or bearing device having one or more loaded ball rolling grooves, inner and outer peripheral guide portions, non-loaded ball return passages, or the like formed therein, with decreased manufacturing costs.

[0012] The other objective of the present invention is to provide a method for making a slider of a linear guide or bearing device having a good working strength.

[0013] In accordance with one aspect of the invention, there is provided a method for manufacturing a slider for a linear bearing device, the method comprising mixing metal powders and bonding agent together, molding the metal powders and the bonding agent to form a prototype having at least one ball return passage formed therein, heating the prototype to remove the bonding agent from the prototype, and sintering the prototype to form the slider.

[0014] The metal powders include a plurality of greater and a plurality of smaller metal powders having different diameters. The greater metal powders preferably include a nominal diameter three (3) to six (6) times greater than that of the smaller metal powders. The smaller metal powders preferably occupy a weight of no more than 3% of the metal powders for forming the slider.

[0015] The smaller metal powders preferably include a spherical shape. The greater metal powders preferably include an irregular shape.

[0016] In accordance with another aspect of the invention, there is provided a slider for a linear bearing device comprising at least one loaded ball rolling face and at least one ball return passage formed therein, and the slider is manufactured with mold injecting processes.

[0017] The ball return passage of the slider includes a square cross section. The slider includes at least one groove formed therein and communicating with and parallel to the ball return passage. The slider includes at least one peripheral slot formed therein.

[0018] The slider is made of a plurality of greater and a plurality of smaller metal powders having different diameters. The greater metal powders include a nominal diameter three (3) to six (6) times greater than that of the smaller metal powders. The smaller metal powders occupy a weight of no more than 3% of the metal powders for forming the slider.

[0019] One or more threaded holes may further be provided and formed in the slider. The slider preferably includes a density greater than 98% of density of raw material.

[0020] Further objectives and advantages of the present invention will become apparent from a careful reading of the detailed description provided hereinbelow, with appropriate reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] **FIG. 1** is a block diagram illustrating processes of a method in accordance with the present invention;

[0022] **FIG. 2** is a perspective view of a slider of a linear guide or bearing device to be made with the method in accordance with the present invention;

[0023] **FIG. 3** is a perspective view illustrating another slider of the linear guide or bearing device to be made with the method in accordance with the present invention;

[0024] **FIG. 4** is an enlarged perspective view showing the crystallization of the material for forming the slider of the linear guide or bearing device to be made with the method in accordance with the present invention; and

[0025] **FIG. 5** is a cross sectional view taken along lines **5-5** of **FIG. 4**, illustrating the crystallization of the material for forming the slider of the linear guide or bearing device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0026] Referring to the drawings, and initially to **FIGS. 2 and 3**, illustrated are two examples of sliders **10** for linear guide or bearing devices to be made with a method in accordance with the present invention, the configurations or the structures of the sliders **10** and/or of the linear guide or bearing devices have been disclosed in the cited arts which may be taken as references for the present invention.

[0027] Each of the sliders **10** for the linear guide or bearing devices comprises one or more loaded ball rolling faces **11**, one or more non-loaded ball return passages **12** of square or circular cross section, one or more grooves **13** formed therein and communicating with and/or parallel to the non-loaded ball return passages **12**, one or more threaded holes **14**, and/or one or more inner and outer peripheral slots **15** formed therein, depending on the locations and the purposes of the sliders to be attached or installed.

[0028] Referring next to **FIG. 1**, illustrated are the processes of the method in accordance with the present invention. Firstly, a mixing process **20** is provided to mix two metal powders **30** and **40** (FIGS. **4**, **5**) of different nominal diameters together with bonding agent introduced and mixed therein to form a mixed material.

[0029] It is to be noted that the diameters of metal powders may be different from each other in one bag, and will have some tolerances in the same bag, such that the main diameter of the metal powders will be defined as the "nominal diameter" hereinafter.

[0030] As best shown in **FIGS. 4 and 5**, it is preferable that the metal powders **30** includes a width, length, or outer or nominal diameter three (3) to six (6) times greater than that of the other or smaller metal powders **40**, to have a nominal diameter ratio of about 1:0.225 between the greater and smaller metal powders **30**, **40**. In addition, it is preferable that the smaller metal powders **40** occupy a weight of about 1% of the mixed material; i.e., $0.225^3=0.011$. However, it is preferable that the smaller metal powders **40** occupy a weight of no more than 3% of the mixed material.

[0031] The smaller metal powders **40** may be manufactured or formed by the conventional gas atomization processes, and preferably include, but not necessarily, a spherical outer appearance. The greater metal powders **30** may be manufactured or formed by the conventional water atomization processes, and may include various or different or irregular outer appearances.

[0032] The mixed material is then molded or mold injected with mold devices (not shown), to form the prototype for the sliders **10** having the loaded ball rolling faces **11**, the non-loaded ball return passages **12**, the grooves **13**, the non-loaded ball return passages **12**, the threaded holes **14**, and/or the inner and outer peripheral slots **15** formed therein simultaneously in the molding or mold injecting process **21**, in which the loaded ball rolling faces **11**, the non-loaded ball return passages **12**, the grooves **13**, the non-loaded ball return passages **12**, the threaded holes **14**, and/or the inner and outer peripheral slots **15** may be formed into various or different shapes or appearances or contours.

[0033] The prototype is then heated in a heating process **22** to a temperature greater than an evaporating temperature of the bonding agent, to have the bonding agent evaporated, and thus to have the bonding agent removed from the prototype; and is then heated or sintered in a sintering process **23** to a temperature to allow the greater and the smaller metal powders **30**, **40** to be sintered and solidly secured together with such as re-crystallization, for example, and to form the sliders **10**.

[0034] It is to be noted that, in the manufacturing processes of the method in accordance with the present invention, the greater and the smaller metal powders **30**, **40** have not been completely melted, such that the sizes or widths or lengths or heights or volumes of the sliders **10** may be precisely controlled or pre-determined.

[0035] Referring again to **FIGS. 4 and 5**, in the crystallization of the material for forming the sliders **10**, the greater metal powders **30** may be arranged in a compact pyramid or cone shape having a density of about 74% of the raw material for forming the sliders **10**. The smaller metal powders **40** may be engaged between the greater metal powders **30**, to form a density of more than 98% of the density of the raw material for forming the sliders **10**, such that the fatigue strength, the yielding strength or the other strengths of the sliders **10** may be good.

[0036] It is further to be noted that the loaded ball rolling faces **11**, the non-loaded ball return passages **12**, the grooves **13**, the non-loaded ball return passages **12**, the threaded holes **14**, and/or the inner and outer peripheral slots **15** may be simultaneously or directly formed in the sliders **10** without additional machining, grinding, or other processes.

[0037] Accordingly, the method in accordance with the present invention may be used for making the slider of the linear guide or bearing device having one or more loaded ball rolling grooves, inner and outer peripheral guide portions, non-loaded ball return passages, or the like formed therein, with decreased manufacturing costs, and having increased working strengths.

[0038] Although this invention has been described with a certain degree of particularity, it is to be understood that the present disclosure has been made by way of example only and that numerous changes in the detailed construction and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

I claim:

1. A method for manufacturing a slider for a linear bearing device, said method comprising:

mixing metal powders and bonding agent together,

molding said metal powders and said bonding agent to form a prototype having at least one ball return passage formed therein,

heating said prototype to remove said bonding agent from said prototype, and

sintering said prototype to form said slider.

2. The method as claimed in claim 1, wherein said metal powders include a plurality of greater and a plurality of smaller metal powders having different nominal diameters.

3. The method as claimed in claim 2, wherein said greater metal powders include a nominal diameter three (3) to six (6) times greater than that of said smaller metal powders.

4. The method as claimed in claim 2, wherein said smaller metal powders occupy a weight of no more than 3% of said metal powders for forming said slider.

5. The method as claimed in claim 2, wherein said smaller metal powders include a spherical shape.

6. The method as claimed in claim 2, wherein said greater metal powders include an irregular shape.

7. A slider for a linear bearing device comprising:

at least one loaded ball rolling face and at least one ball return passage formed therein, and

said slider being manufactured with mold injecting processes.

8. The slider as claimed in claim 7, wherein said at least one ball return passage of said slider includes a square cross section.

9. The slider as claimed in claim 7, wherein said slider includes at least one groove formed therein and communicating with and parallel to said at least one ball return passage.

10. The slider as claimed in claim 7, wherein said slider includes at least one peripheral slot formed therein.

11. The slider as claimed in claim 7, wherein said slider is made of a plurality of greater and a plurality of smaller metal powders having different nominal diameters.

12. The slider as claimed in claim 11, wherein said greater metal powders include a nominal diameter three (3) to six (6) times greater than that of said smaller metal powders.

13. The slider as claimed in claim 11, wherein said smaller metal powders occupy a weight of no more than 3% of said metal powders for forming said slider.

14. The slider as claimed in claim 11, wherein said smaller metal powders include a spherical shape.

15. The slider as claimed in claim 11, wherein said greater metal powders include an irregular shape.

16. The slider as claimed in claim 7 further comprising at least one threaded hole formed therein.

17. The slider as claimed in claim 7, wherein said slider includes a density greater than 98% of a density of raw material for forming said slider.

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