

April 12, 1966

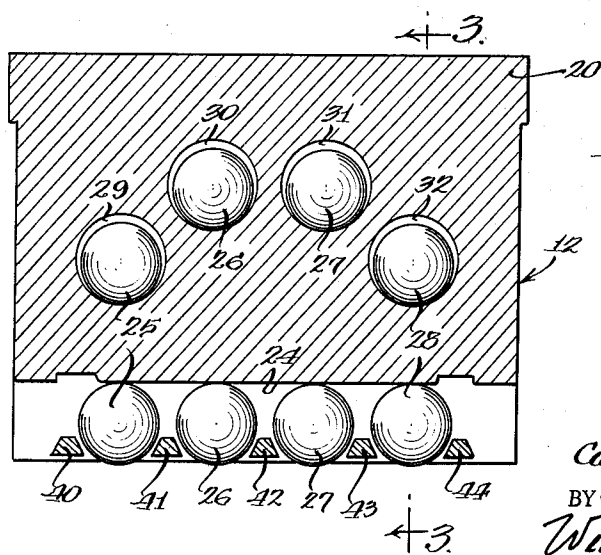
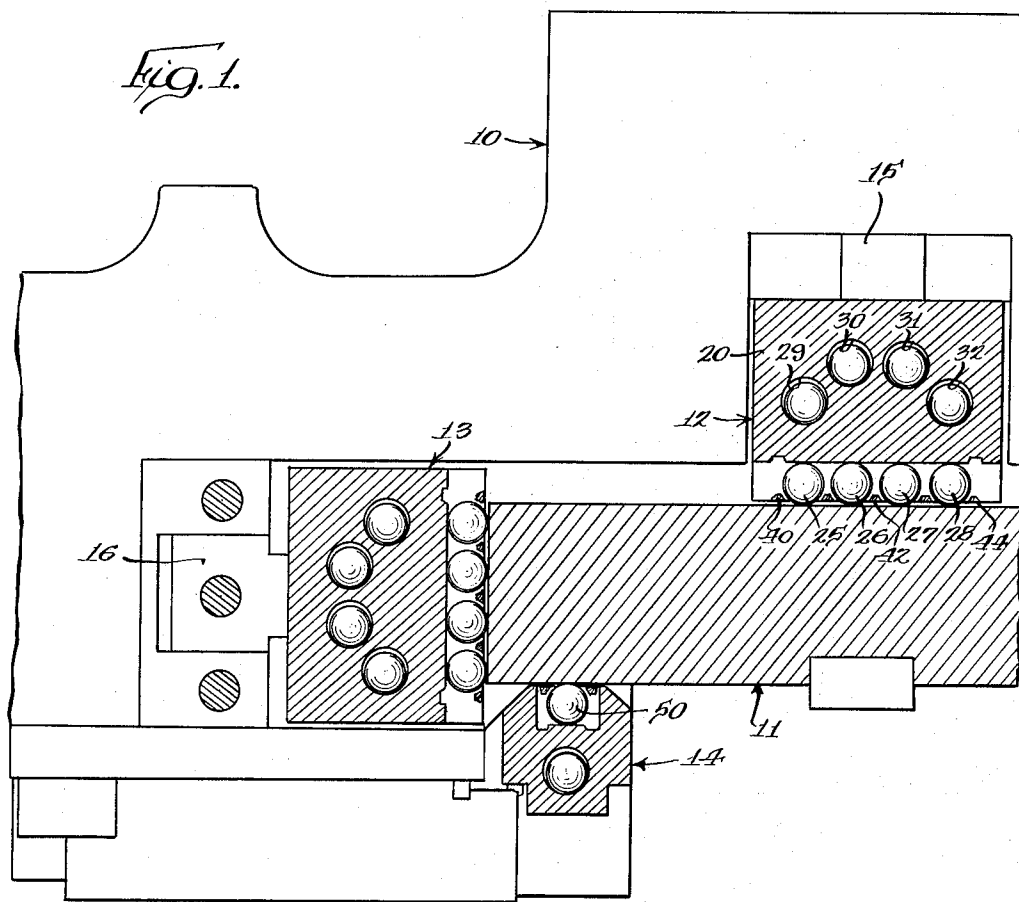
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3,245,731

BALL WAY PACKAGE

Filed April 23, 1963

4 Sheets-Sheet 1



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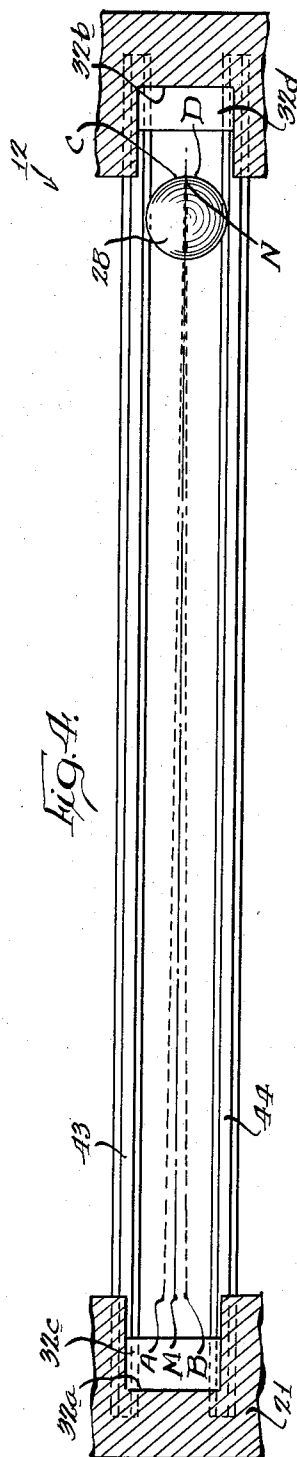
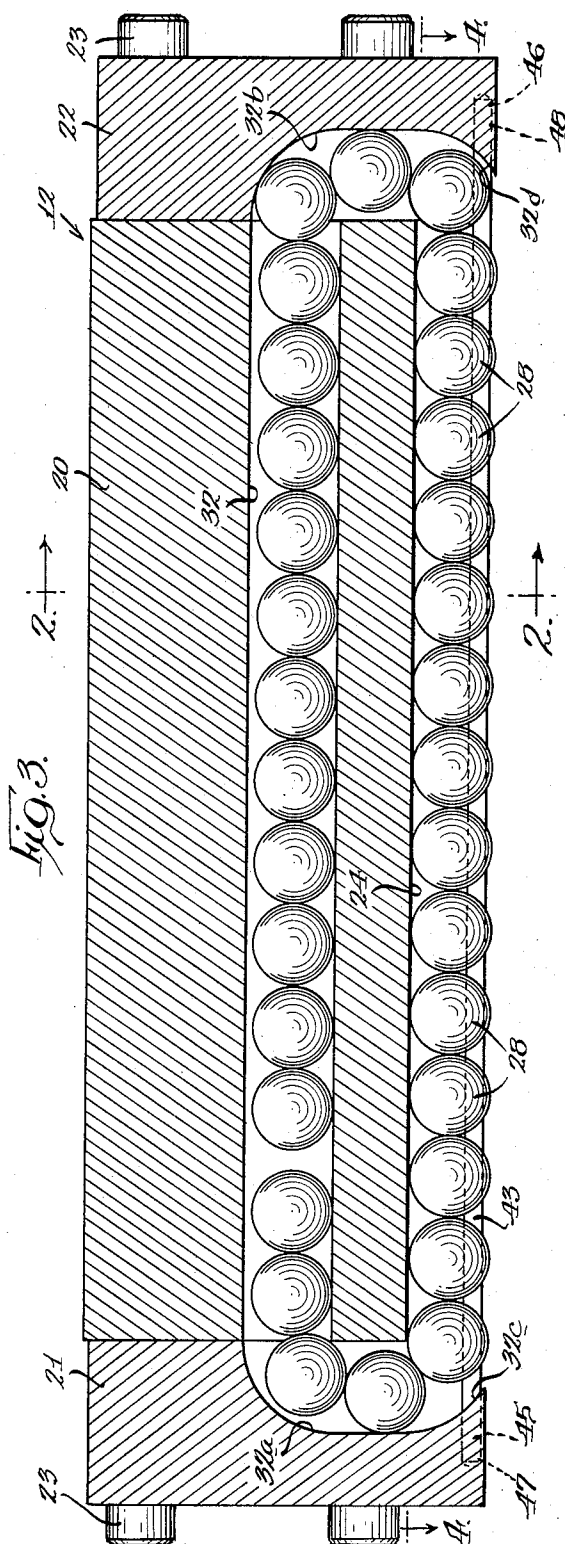
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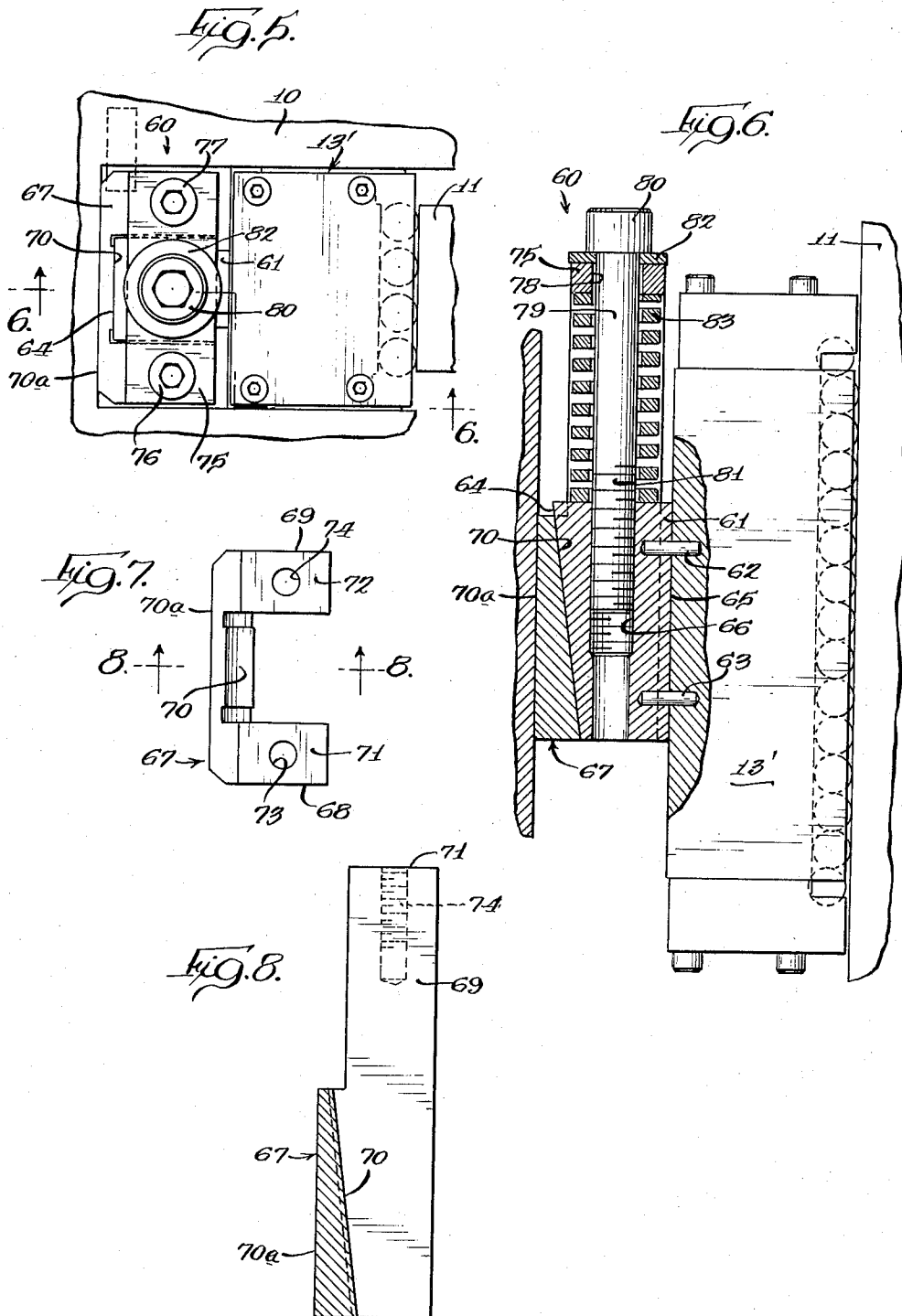


Fig. 10.

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3,245,731

BALL WAY PACKAGE

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15 Claims. (Cl. 308-6)

This application is a continuation-in-part of application Serial No. 240,065, filed November 26, 1962, now abandoned.

This invention relates to mechanism providing an improved mounting for movable parts and, more particularly to a ball way package.

An object of this invention is to provide a bearing unit avoiding side forces which result in deflections resulting in improper positioning of moving parts or which necessitates more massive constructions to minimize such deflections.

Another object of this invention is to provide a ball way package in which the ball bearings are free to move along any desired path within limits to avoid substantial side forces.

Still another object of the invention is to provide a ball way package in which ball bearings travel about a circuit including a load zone in which they contact a bearing surface of the package body and pass through a channel having opposite ends adjacent the ends of the bearing surface with means for holding the ball bearings in association with the body and causing a ball bearing to leave a channel end in centered relation to the channel, the channel being of a size greater than the ball bearings, while permitting movement of the bearing along said bearing surface at an angle to a line between the centers of said channel ends.

A further object of the invention is to provide a ball way package as defined in the preceding paragraph in which there are a series of rows or circuits of ball bearings, each with a channel through which the ball bearings pass and with the means for guiding a ball bearing comprising a plurality of wires, there being a wire at each side of a row of ball bearings, with the wires being spaced apart a distance less than the diameter of a ball bearing and spaced from the bearing surface less than the diameter of the ball bearing with the ends of the wires being mounted to the package body to permit lengthwise movement of the wires as they flex, said wires being positioned to receive a ball bearing in centered relation to the channel end as a bearing exits said channel.

A still further object of the invention is to provide a ball way package as defined in the previous paragraph with means for taking up clearance as the movably supported member moves relative to the way.

And another object of the invention is to provide a ball way package with means for preloading the package a given predetermined amount.

Further objects and advantages will become apparent from the following detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a fragmentary elevational view with parts in section showing the mounting of a machine tool component onto a guide way;

FIG. 2 is a vertical section through a ball way package taken generally along the line 2-2 in FIG. 3 and showing a package similar to that shown in FIG. 1;

FIG. 3 is a vertical section taken generally along the line 3-3 in FIG. 2;

FIG. 4 is a fragmentary section taken generally along the line 4-4 in FIG. 3;

FIG. 5 is a fragmentary elevational view showing a ball way package having taken up means;

FIG. 6 is a sectional view taken substantially as shown along line 6-6 of FIG. 5;

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FIG. 7 is an end view of a wedge member of the present invention;

FIG. 8 is a sectional view taken along line 8-8 of FIG. 7.

FIG. 9 is a central sectional view of a modified ball way package similar to that shown in FIG. 5; and

FIG. 10 is a plan view of the structure shown in FIG. 9.

While this invention is susceptible of embodiment in many different forms, there is shown in the drawings and will herein be described in detail a preferred embodiment of the invention together with a modification thereof with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiments illustrated. The scope of the invention will be pointed out in the appended claims.

The ball way package disclosed herein is provided for supporting one part for substantially free motion relative to another part without imposing side forces. At the present time, machine tools are built and furnished with controls to obtain extremely accurate positions. These positions can only be obtained in a machine tool if the relatively movable parts do not have uncontrollable forces applied thereto.

As shown in FIG. 1, a table or slide indicated generally at 10 is movable relative to a pair of ways, with one of the ways being indicated generally at 11. The association between these parts is only shown in connection with one way 11; however, a similar mounting would be provided in conjunction with a second way.

The slide or table 10 is associated with the way 11 by means of a plurality of ball way packages, three being shown in FIG. 1 indicated generally at 12, 13 and 14, with the package 12 supporting the weight of the movable part 10, the package 13 performing the side guiding of the movable part 10 and the ball way package 14 being of the gib type. The ball way packages are mounted with side clearance and each of the packages 12 and 13 are engaged centrally along their length by blocks 15 and 16, respectively, to take up the forces exerted through the ball way package, with the contact area being purposely small with respect to a load zone of the ball way package subsequently to be described and centered on this zone so that the loads will be evenly distributed over all the ball bearings. The ball way packages are mounted against the blocks 15 and 16 in a manner to permit slight tilting of the ball way packages either transversely or longitudinally to allow for inaccuracies in parallelism between the surfaces of part 10 where contacted by blocks 15 and 16 and the way surfaces.

Each of the ball way packages 12 and 13 are of basically the same construction and the package 12 will be described in detail and is shown in FIGS. 2, 3 and 4 as typical of both the packages 12 and 13.

The ball way package 12 comprises an elongate body 20 with a pair of end caps 21 and 22 which are secured to opposite ends of the body by suitable means such as a flange screw 23. Each package body is provided with an enlarged portion, such as shown at 20a in package 12, which is positioned next to the adjacent slide or table surfaces to provide means for guiding the package when it tilts longitudinally about its center support. One side 24 of the body 20 constitutes a bearing surface for ball bearings. There are four rows or circuits of ball bearings 25, 26, 27 and 28, which pass along the bearing surface 24 and complete the circuit through a series of channels formed within the body 20. These channels are indicated at 29, 30, 31 and 32. The channels each have curved sections, such as sections 32a and 32b for the channel 32 which terminate in ends 32c and 32d adjacent opposite ends of the bearing surface 24. Each row or

circuit of ball bearings includes a sufficient number to completely fill the associated channel and to form a row of bearings engageable with the bearing surface 24.

A primary feature of the invention is the control of the ball bearings to permit relatively free travel of the bearings from one channel opening to the other. It will be apparent that the ball way package must operate in either direction of travel of the machine slide 10, so that balls can travel either into or from the channel opening 32c. Referring to FIG. 4, a center line running between the centers of channel openings 32c and 32d is shown in broken line extending between points M and N. The channels 29-32 are of a size greater than the ball bearings as is apparent in FIGS. 2, 3, and 4 and, thus, the channels cannot, of themselves, assure that a ball will be at either points M or N on either exiting or entering a channel opening.

Means are provided for assuring this central location of a ball bearing. This means also permits travel of the bearing along an angled path relative to the line M-N, so the bearing travels through the load zone defined by the length of the bearing surface 24. Assuming a ball bearing 28 exits the channel through the opening 32d, as shown in FIG. 4, the means to be described will have the center of the ball along the line M-N. As the ball progresses to the channel opening 32c, the ball can follow the center line or can follow diverging lines with the extremes of divergence being shown by broken lines extending between the point N and the points A and B. Conversely, a ball travelling in the opposite direction and diverge from point M to either point C or D.

This means comprises flexible members which function to retain the ball bearings as part of the package and also to obtain the central positioning of a ball bearing as it exits the channel while permitting subsequent travel along an angled path. As shown in the drawings, the members are a series of wires 40, 41, 42, 43 and 44 of a generally triangular cross section. The members may be formed differently; however, triangular wires provide greater width for holding ball bearings and provide a greater cross sectional area resisting deflection for opposing drop out of ball bearings.

There are a pair of wires associated with each row or circuit of ball bearings and the relationship is such to permit use of a single wire between adjacent rows of bearings. In every instance, the wires define a pair for each row or circuit of ball bearings. Each pair of wires are spaced apart a distance less than the diameter of a ball and spaced from the bearing surface 24 less than the diameter of the ball to hold the bearings in association with the package and, as the wires flex, they may move away from the bearing surface 24 since they are spaced from the surface of the way 11. The wires are each mounted for lengthwise movement as they are flexed by having the ends of each wires, such as ends 45 and 46 of the wire 43, loosely fitted in recesses 47 and 48, respectively, of the end caps 21 and 22. Thus, the wires may flex as permitted by the loose mounting of the wire ends with a sufficient length of the wires being disposed within the recesses so that the wire ends cannot move entirely out of the recesses.

Again referring to FIG. 4, it will be seen that the wires 43 and 44 function to have the ball bearing 28 centrally located of the channel opening 32d as the ball bearing exits the channel. The wires 43 and 44 may then flex as a bearing tends to follow an angled path to permit the bearing to follow such path. If a ball bearing has done so, it can still freely move into the channel 32c because of the over-sizing thereof. The same action can occur if the ball way package is travelling in the opposite direction.

As will be seen in FIG. 2, the channels 29-32 are grouped and staggered in elevation to provide proper wall thickness between channels.

The ball way package 14, of the gib type, is of the same construction as described in connection with packages 12 and 13; however, as seen in FIG. 1, only a single row of ball bearings 50 is utilized. However, the construction for the single row is the same as for any specific row of bearings shown for package 12.

With the foregoing construction, angular misalignment does not result in deflection forces which are of a value to be troublesome as compared to roller-type way packages in which rollers are restrained to move along a straight line and which require an accuracy of mounting which is substantially impossible to obtain.

Referring now to FIGS. 5 and 6, means are shown in association with guide way package 13' for providing zero clearance between the package and way 11. This means is indicated generally by reference numeral 60, and is in the form of a spring loaded wedge which functions to take up any clearance which may result as slide or table 10 moves relative to the ways. Take up means 60 includes a first wedge member 61 abutting package 13' and mounted thereon by suitable means, such as by pins 62 and 63. Wedge 61 includes a surface 64 which is inclined with respect to the surface 65 that engages package 13'. A threaded bore 66 is provided in wedge 61, and is positioned in parallelism with surface 65.

Take up means 60 further includes a second wedge member 67 having a pair of spaced apart arms 68 and 69, a central portion with an inclined surface 70 corresponding to the inclination of surface 64 and a surface 70a parallel to surface 65. The ends 71 and 72 of arms 68 and 69 are substantially parallel, and are provided with threaded holes 73 and 74. An end plate 75 abuts against ends 71 and 72, and is provided with a pair of clearance holes which are aligned with holes 73 and 74, and which receive therethrough bolts 76 and 77 which are threaded into holes 73 and 74 to secure end plate 75 to wedge 67.

End plate 75 is also provided with a central hole 78 that is aligned with bore 66 in wedge 61. A bolt 79 passes through hole 78, and includes an enlarged head 80 and a threaded end portion 81 threadably received in bore 66. A washer 82 is disposed under head 80 and abuts against end plate 75. A spring 83 surrounds bolt 79 and abuts against end plate 75 and wedge 61.

It will be readily understood that by threading bolt 79 into bore 66, wedge surface 70a will be forced inwardly with respect to package 13'. This reduces the thickness of the assembly and enables it to be slipped into position against the ball package. Bolt 79 is then loosened until washer 82 is free and wedge surface 70a engages the adjacent surface of slide or table 10. Slide or table 10 is then moved back and forth and spring 83 will move wedge 67 outwardly with respect to package 13' to take up any clearance between package 13' and way 11, and apply a predetermined amount of compressive preload to package 13'. Bolt 79 is then tightened until washer 82 is tight, and then the bolt is loosened a predetermined amount to provide take up means for a desired maximum clearance between the ball package and the way which occurs during normal machine operation.

Referring now to FIG. 9 and FIG. 10, a modified form of the ball way package is indicated in its entirety by reference numeral 90. Package 90 includes an elongated body 91 having apertured projections 92 and 93 at each end thereof. One side 94 of the body 91 constitutes a bearing surface for the ball bearings, one now being shown at 95. Suitable channels, such as that shown at 96, are provided for each row of balls which may be positioned at different elevations, as is shown in FIG. 1 and FIG. 2. Projections 92 and 93 are provided with corresponding grooves 97a and 97b which are adapted to receive balls 95, it being understood that a pair of grooves are provided for each row of balls. Apertured end caps 98-101 are positioned against the body projections, with a set of opposed arcuate grooves 102a and 102b provided

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in caps 98 and 100, respectively, and a set of opposed arcuate grooves 103a and 103b provided in caps 99 and 101, respectively. It will be readily apparent that channel 96, grooves 97a and 97b, grooves 102a and 102b and 103a and 103b, and bearing surface 94 form a continuous path through which balls 95 travel. Flexible members, not shown, identical to those shown at 40-44 in FIG. 1-FIG. 4, are provided to retain a set of balls in its proper path, and to guide the balls into the arcuate openings, such as those shown at 103a and 103b.

Bolts 104-107 impale the apertures in end caps 98-101 and projections 92 and 93 to retain the package as a unitary assembly. It will be appreciated that the package embodiment just described, obviates the necessity of providing lengthy tie rods, such as those shown at 23 in FIG. 1-FIG. 4.

Take up means, similar to that shown in FIG. 5-FIG. 8, are also associated with package 90. Body 91 includes a pair of spaced sides 108 and 109 on opposite sides of an inclined central surface 110 which defines a first wedge. A second wedge 111 is slidably mounted on surface 110 and includes an inclined face 112 corresponding in inclination to surface 110, and a surface 113 parallel to bearing surface 94. Wedge 111 includes a threaded hole 114 that is parallel with surface 112, and which threadably receives the threaded end 115 of a bolt 116 that passes through a suitable inclined aperture in end cap 100. The enlarged head 117 of bolt 116 is seated in a recess 118 provided in the face of end cap 100. A spring 119 surrounds bolt 116 and engages an undercut inclined surface 120 on end cap 110 and wedge 111 to urge surface 113 away from bearing surface 94.

I claim:

1. A ball way package comprising, a body, a bearing surface at one side of the body, said body having a channel with ends adjacent the ends of said surface, a plurality of ball bearings with some positioned in said channel and some against said surface, said channel ends being of a size greater than the ball bearings, and yieldable means for causing a ball bearing to be in generally centered relation to the channel as the ball bearing leaves the channel while permitting movement of the bearing along said surface in a straight line which is at an angle to a line between the centers of said channel ends because of said yieldability.

2. A ball way package as defined in claim 1 in which said means comprises a pair of flexible wires extending between the channel ends with their ends loosely mounted in said body, said wires being spaced apart a distance less than the diameter of a ball and located at a distance from said surface less than the diameter of a ball whereby one of the wires may flex in a direction away from said surface as a ball moves at said angle.

3. A ball way package comprising, an elongate body, a bearing surface at one side of said body encompassing a load zone, a plurality of generally side-by-side channels in said body each having curved sections terminating in ends located adjacent opposite ends of and beyond said bearing surface, a row of ball bearings associated with each of said channels and including a sufficient number to substantially fill each channel and extend along said bearing surface, each of said channels being of a size greater than a ball bearing, and means for retaining the rows of ball bearings in association with said bearing surface comprising, a plurality of generally parallel flexible members with there being a member between rows of ball bearings and one outside of each of the outermost rows, said members being spaced apart a distance less than the diameter of a ball bearing and spaced from the bearing surface less than the diameter of a ball bearing, and recesses in said body at a distance beyond said bearing surface said recesses being located to position the members to engage a ball bearing leaving a channel end and guide the bearing for exit centrally of the channel width and into the load zone while permitting movement

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of a ball bearing along said bearing surface at an angle to a line between the centers of opposite channel ends by flexing of a member with the members receiving a ball bearing after the bearing has left the load zone.

4. A bearing for use between a fixed member and a movable member comprising, a body adapted to be secured to one of said members and having a bearing surface adapted to be disposed adjacent the other member, said body having a channel with opposite ends adjacent opposite ends of said surface, a plurality of bearing elements positioned in said channel and some engaging said surface, a first wedge secured to the body, said wedge having a surface inclined with respect to said bearing surface and a threaded bore, a second wedge movable along said inclined surface and having a face substantially parallel to said bearing surface, and yieldable means for moving said second wedge along said inclined surface including a bolt threadably received in said bore and a spring surrounding said bolt and biased against said second wedge.

5. A bearing as defined in claim 4 wherein said second wedge includes a pair of spaced apart arms, and an end plate spanning the ends of said arms and secured thereto, said spring acting between said first wedge and said end plate to create said bias.

6. A ball package between a movable member and a fixed way member comprising, a body carried by one member and having a bearing surface disposed adjacent the other member, said body having a channel with opposite ends adjacent opposite ends of said surface, a plurality of ball bearings positioned in said channel and some engaging said surface, means for guiding the entry of said ball bearings onto said surface and retaining the balls associated with the surface, and means mounting said body for lateral and longitudinal tilting movement relative to said member about two mutually perpendicular axes which are parallel to said bearing surface.

7. A ball package as defined in claim 6 in which there are a plurality of ball bearing circuits positioned to carry substantially parallel loads each including a channel with one of said axes being parallel to said circuits to distribute the load among the circuits.

8. A ball way package for use with a machine tool to have a machine tool element movable relative to a way with minimum friction and side loading said package comprising, a body, a bearing surface at one side of the body, said body having a channel with ends adjacent the ends of said surface, a plurality of ball bearings with some positioned in said channel and some against said surface, said channel ends being of a size greater than the ball bearings, and yieldable means for causing a ball bearing to be in generally centered relation to the channel as the ball bearing leaves the channel while permitting movement of the bearing along said surface in a straight line which is at an angle to a line between the centers of said channel ends because of said yieldability.

9. A package as defined in claim 8 in which said body constitutes a beam having a neutral axis and there are a plurality of rows of ball bearings with each row having an individual one of said channels, said channels being positioned adjacent said neutral axis.

10. A ball way package comprising, a body, an exposed bearing surface at one side of the body, said body having a channel with opposite ends thereof adjacent opposite ends of said surface, a plurality of ball bearings positioned one after the other to form a row extending along said surface and through said channel, and flexible members extending along both sides of the bearings which engage the bearing surface, said flexible members being mounted on said body at a distance beyond the ends of said bearing surface to provide a length thereof beyond the ends of the bearing surface which is flexible, said members retaining the ball bearings in the package and being yieldable along a length thereof greater than the length of the bearing surface to permit movement of the

bearings along a straight path which may be at an angle between ends of the channel while recentering a bearing beyond an end of said bearing surface.

11. A package as defined in claim 10 in which said members are wires of triangular cross section.

12. A ball way package comprising, a body having a bearing surface, said body having a channel with opposite ends thereof adjacent opposite ends of said surface with said ends defining a ball exit zone and a ball entry zone relative to the bearing surface functionally interchangeable dependent upon the direction of ball travel, a plurality of ball bearings positioned some in said channel and some engaging said surface, with the balls traveling between end entry and exit zones being substantially free of constraint against lateral movement, laterally spaced-part guide means at the zones effective alternatively dependent on the direction of ball bearing travel to deliver the ball bearings from the entry zone at an intermediate position between the guide means intermediate the extreme lateral positions of ball travel, and means mounting said guide means at a distance beyond the ends of said bearing surface to have said guide means engage a ball herebetween in said exit zone beyond the bearing surface for centering of the ball without side loading on the package.

13. A package as defined in claim 12 in which said mounting means is provided by a member separate from said body, and means for holding said member assembled to said body.

14. A ball way package as defined in claim 12 in which said body is composed of a central section and apertured members at opposite ends thereof, said channel having non-linear parts thereof formed in said members, and means passing through the apertures of said members and adjacent parts of said central section for fastening said members and central section.

15. A ball way package comprising, an elongate body having opposed ends with apertured projections, bearing surface at one side of said body, a plurality of channels

in said body, apertured end caps secured to the opposed ends of said body and abutted against said projections with the end cap apertures aligned with the projection apertures, connective members extending through said aligned apertures to secure said end caps to said body, channels in said end caps communicating with said body channels and having curved sections terminating in ends located adjacent opposite ends of said bearing surface, a row of ball bearings including a sufficient number to fill the channels and extend along said bearing surface, said channels being of a size greater than a ball bearing, and means for retaining the row of ball bearings associated with said bearing surface and for guiding thereof comprising, a pair of generally parallel guide members, said guide members being spaced apart a distance less than the diameter of a ball and spaced from the bearing surface less than the diameter of a ball and being mounted beyond the ends of said bearing surface, said guide members being positioned to engage a ball bearing leaving an end cap channel end and guide the bearing for exit centrally of the end cap channel width while permitting movement of a ball bearing along said surface at an angle to a line between the centers of opposite end cap channel ends and receipt of an off-center ball bearing entering a channel.

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