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Gyuricsko et al.

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(54) **ACTUATION SYSTEM FOR A LIFT ASSISTING DEVICE AND LINED TRACK ROLLERS USED THEREIN**

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(51) **Int. Cl.**
B64C 13/28 (2006.01)
B64C 9/22 (2006.01)
(Continued)

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CPC ***B64C 13/28*** (2013.01); ***B64C 9/02*** (2013.01); ***B64C 9/22*** (2013.01); ***F16C 11/02*** (2013.01);
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(58) **Field of Classification Search**
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See application file for complete search history.

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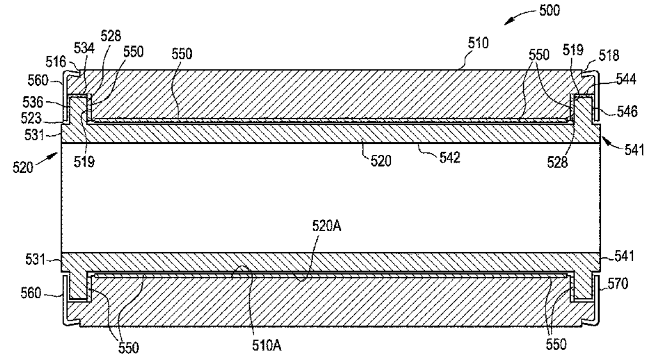
(57) **ABSTRACT**

An actuation system for deploying and retracting a lift assisting device of a leading edge of a wing of an aircraft including a track pivotally coupled to the lift assisting device. The track has first and second outer surfaces and side surfaces. The actuation system includes a shaft rotationally coupled within the wing of the aircraft and operable, in response to flight control signals, to deploy or retract the lift assisting device. The actuation system includes an actuator for actuating the lift assisting device, coupled to the shaft, between a retracted position to a deployed position along an arcuate path. The actuation system includes a plurality of track roller bearings rotatably contacting the first and second outer surfaces of the track to guide the track along the arcuate path. The plurality of track roller bearings includes one or more lined track roller assembly.

11 Claims, 9 Drawing Sheets



Related U.S. Application Data

which is a division of application No. 12/201,062, filed on Aug. 29, 2008, now Pat. No. 8,025,257.

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F16C 29/04	(2006.01)
B64C 9/02	(2006.01)

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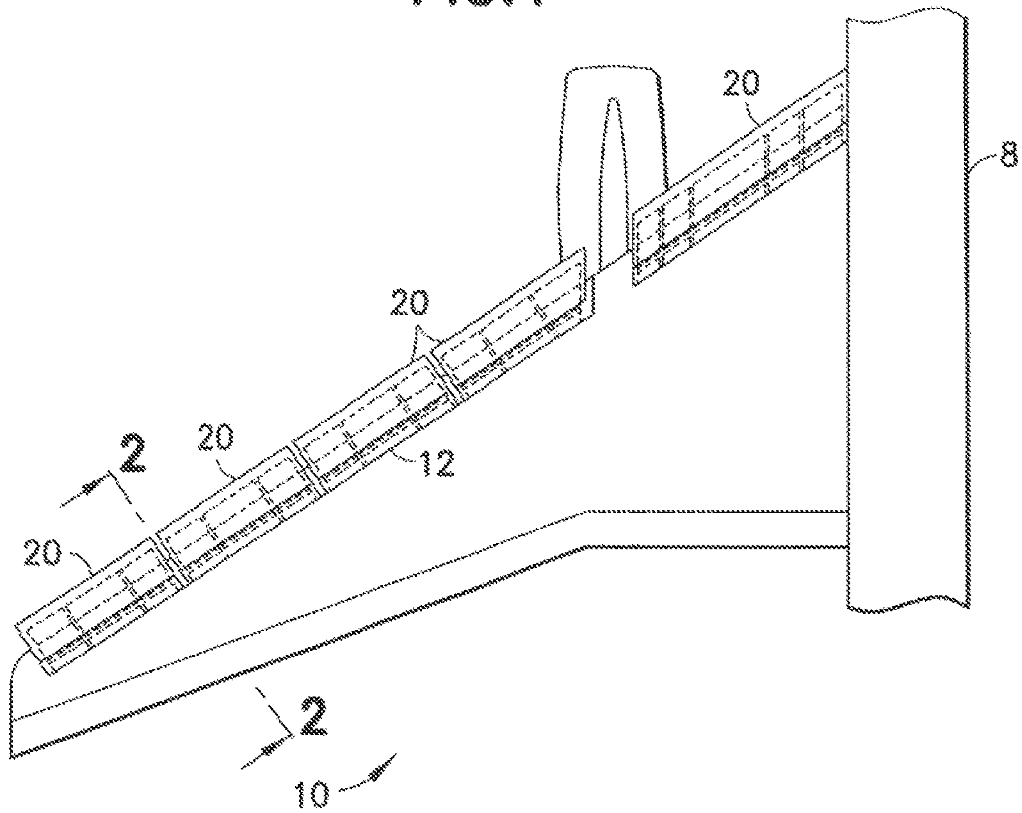
FIG. 1



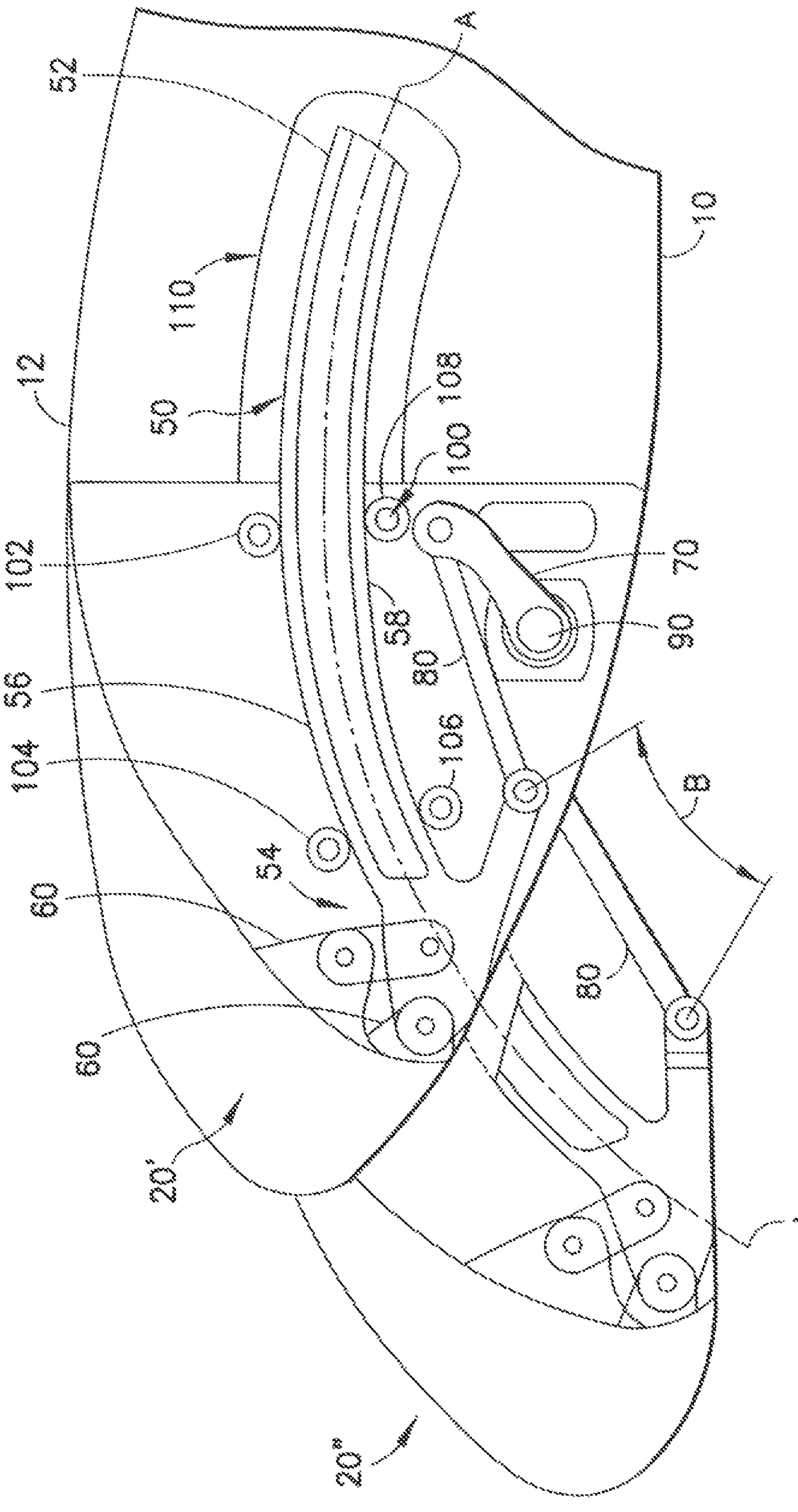


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FIG. 2

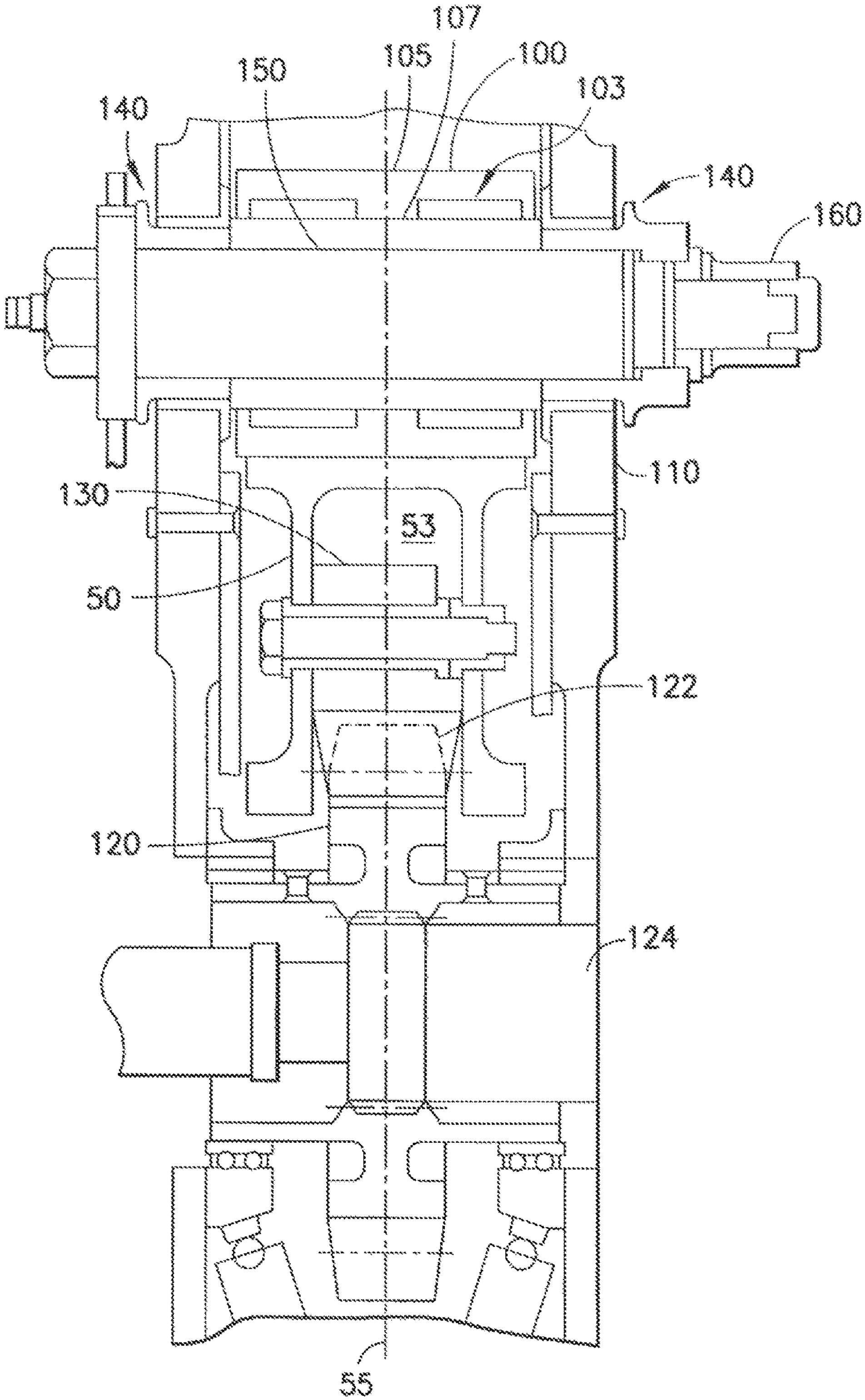

FIG.3

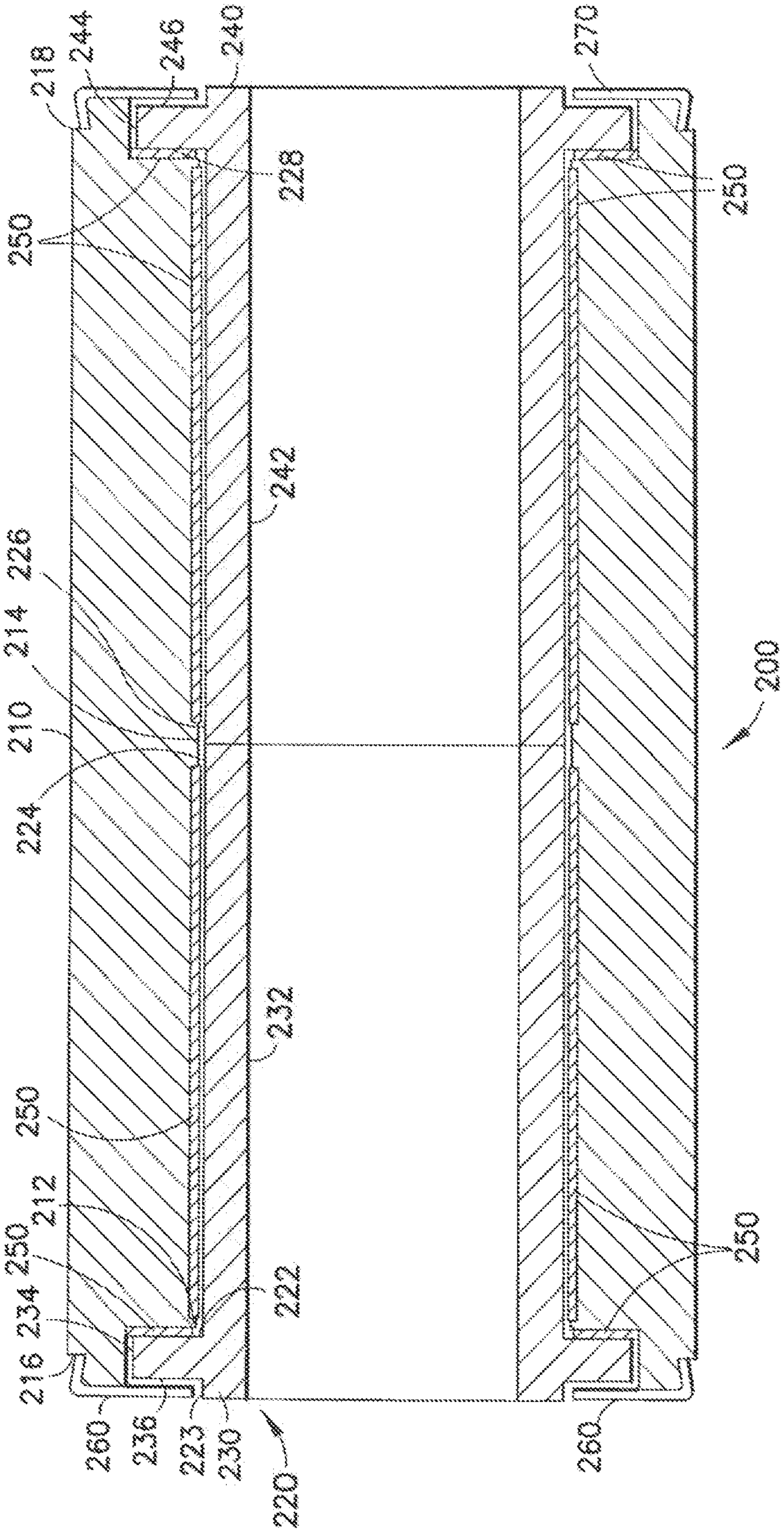
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FIG. 4

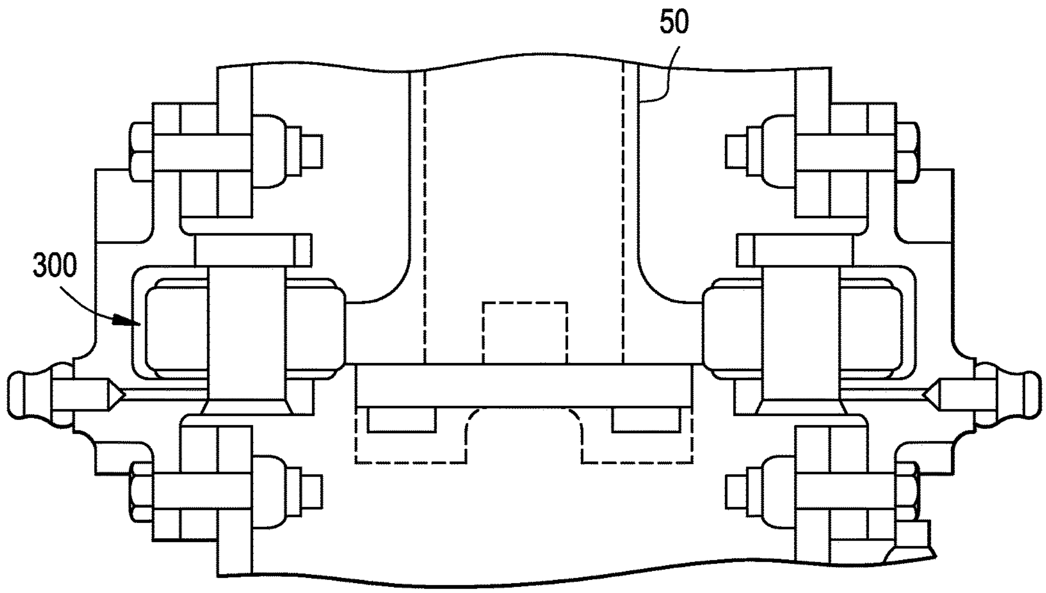

FIG. 5

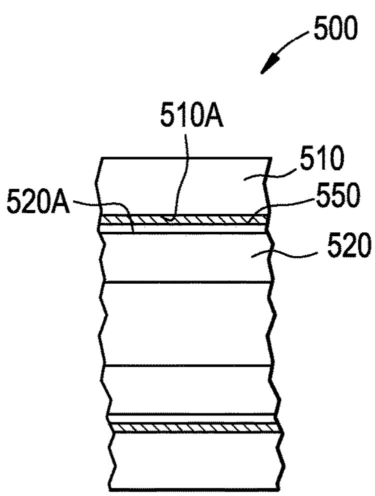

FIG. 6B

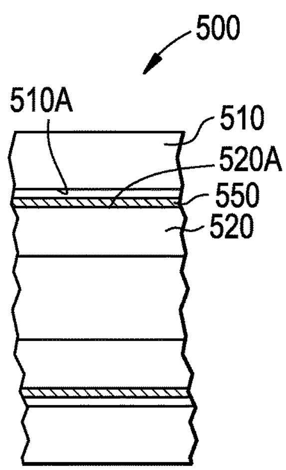

FIG. 6C

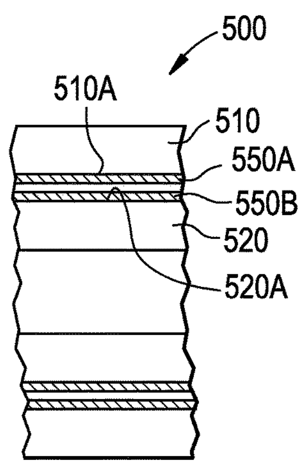

FIG. 6D

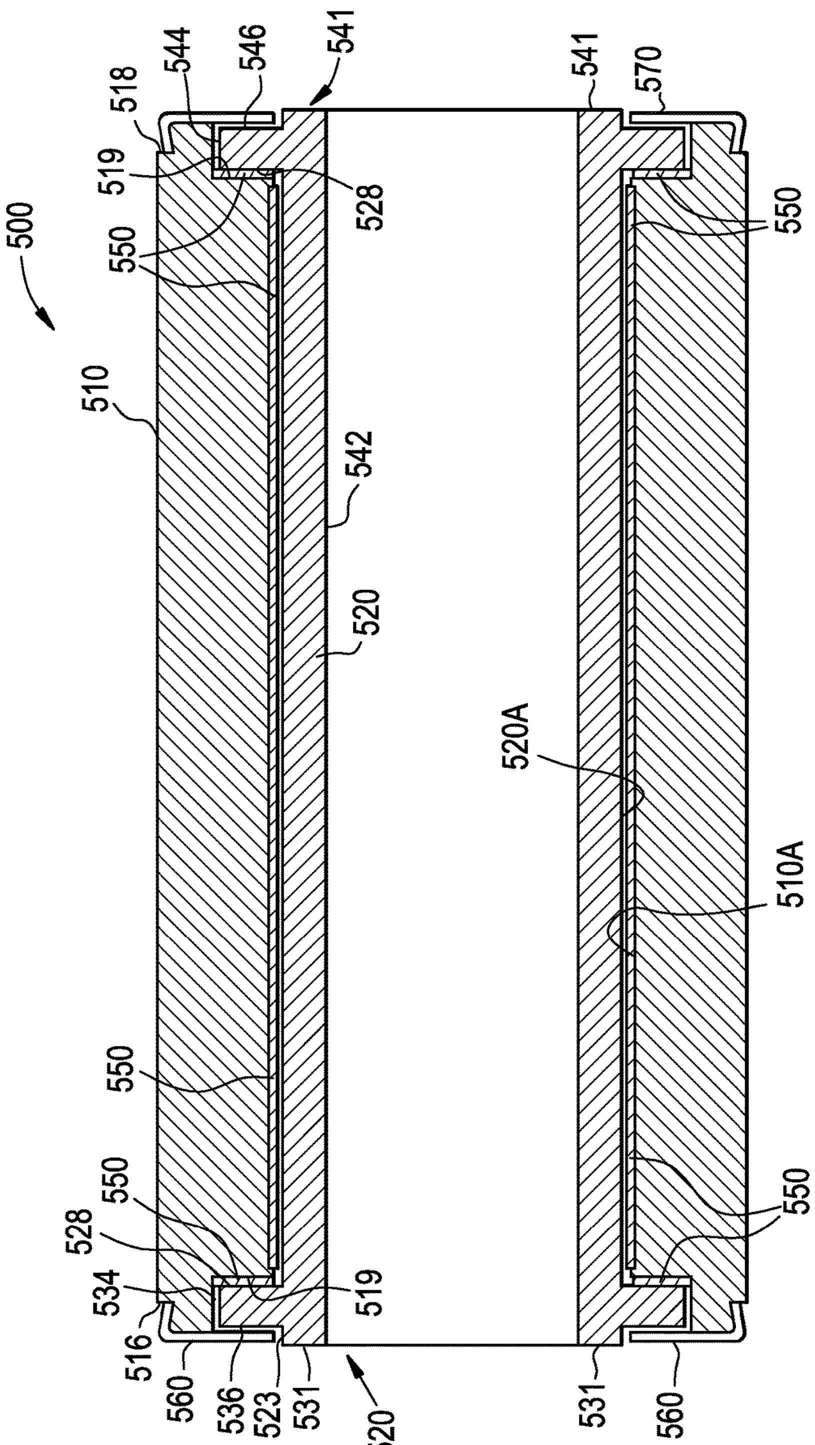
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FIG. 6A

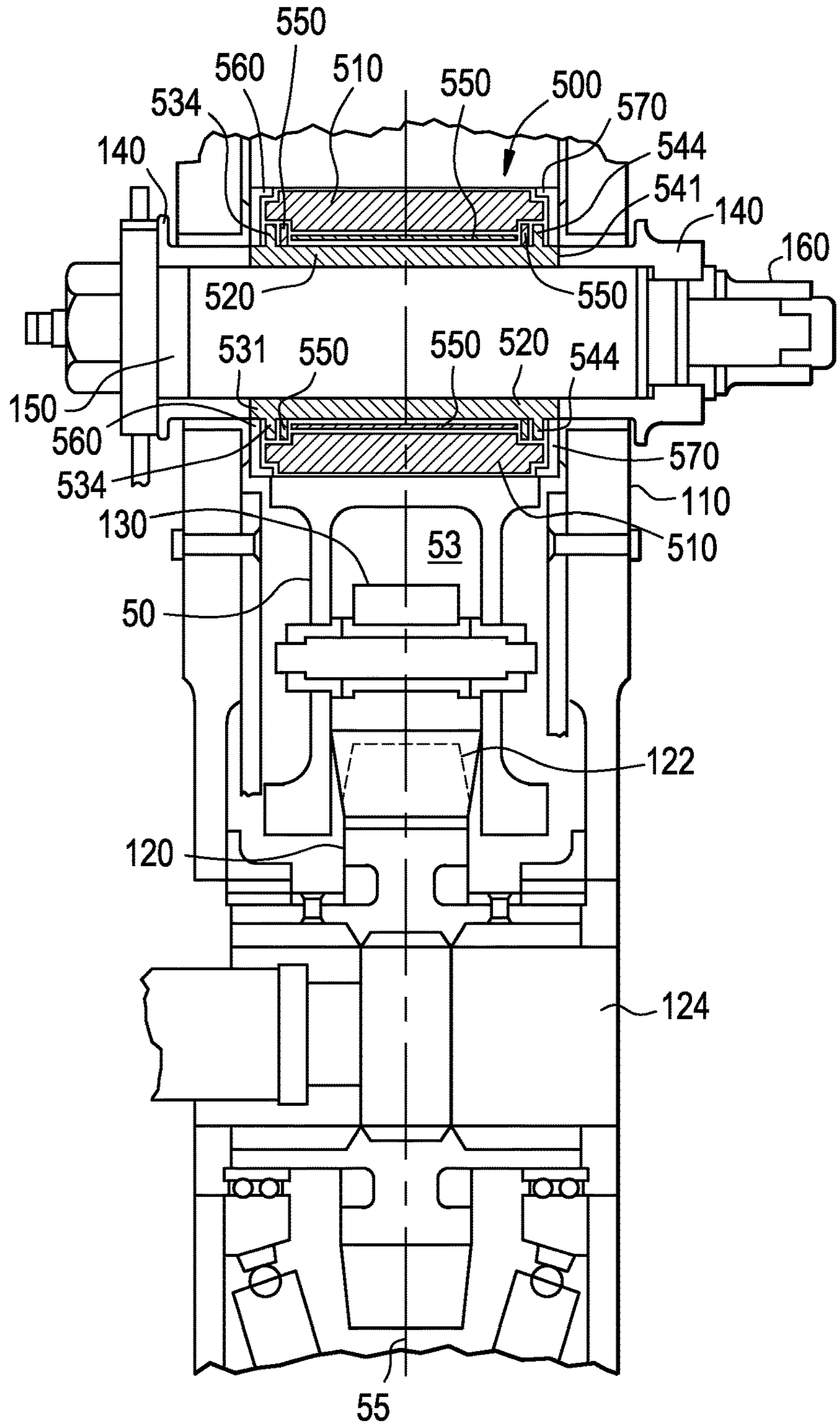
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FIG. 7

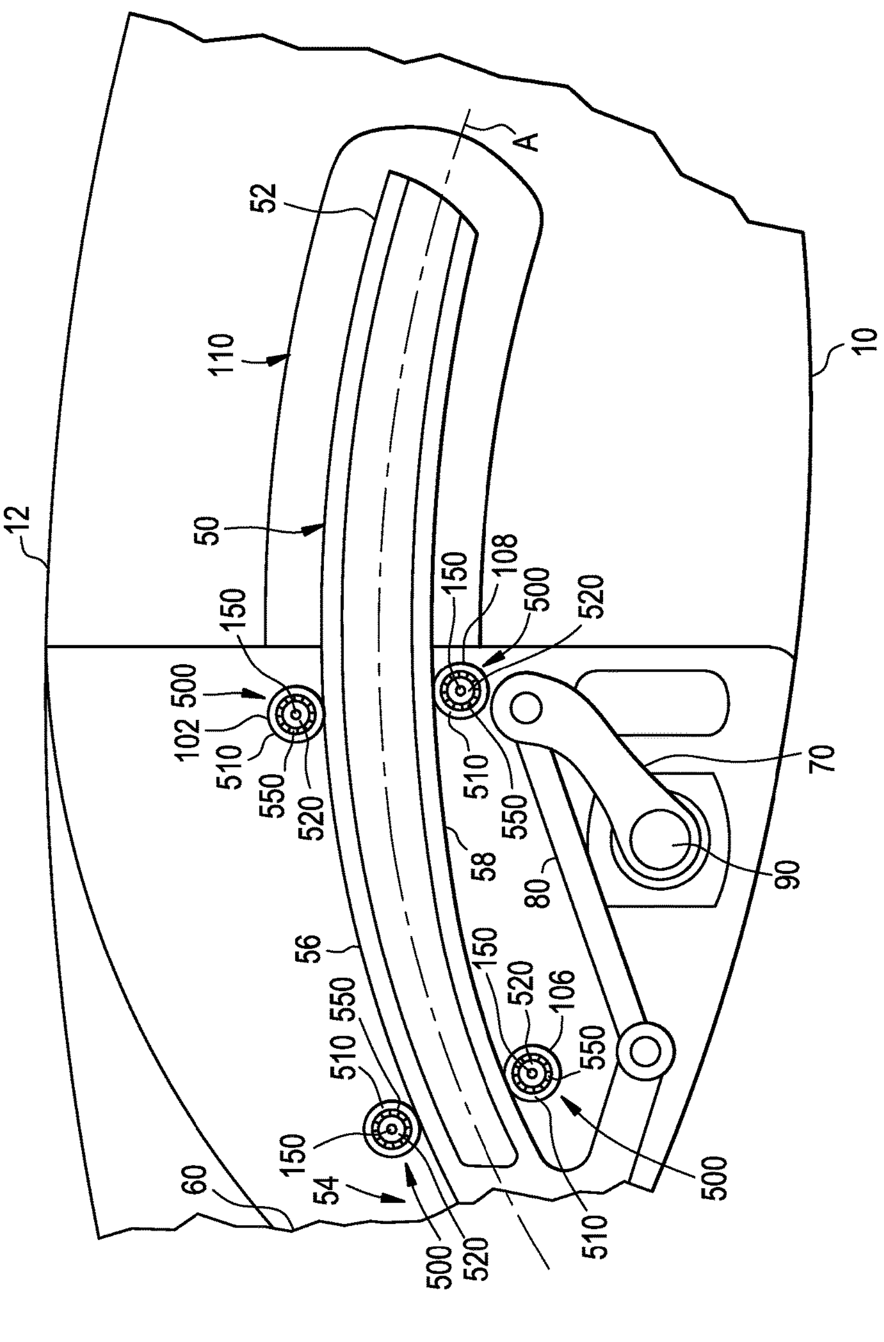
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FIG. 8

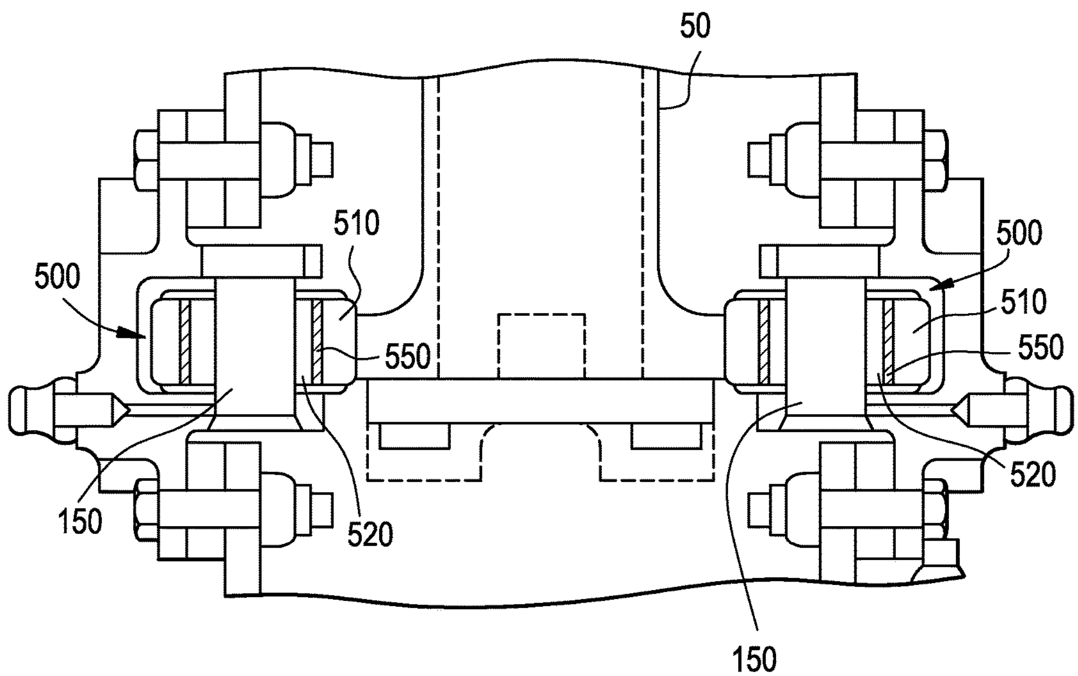

FIG. 9

ACTUATION SYSTEM FOR A LIFT ASSISTING DEVICE AND LINED TRACK ROLLERS USED THEREIN

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application is a continuation in part of and claims priority benefit under 35 U.S.C. § 120 to U.S. patent application Ser. No. 13/144,099, filed May 24, 2011, which is a divisional application of and claims priority benefit under 35 U.S.C. § 120 to U.S. patent application Ser. No. 12/201,062, filed Aug. 29, 2008, which is a U.S. Utility Application of U.S. Provisional Application Ser. No. 60/992,746, filed Dec. 6, 2007 and to which priority benefit under 35 U.S.C. § 119(e) is claimed, and all of which are hereby incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to roller bearing assemblies for use in critical applications and, more particularly, to lined track roller bearing assemblies used within an actuation system of a leading edge of a wing of an aircraft assembly.

Description of the Related Art

It is well known to use bearings to reduce friction between moving parts of a mechanical assembly. Similarly, it is well known to use bearings that roll on a fixed track to extend a first component from a second component. One implementation of such a track style bearing is within a wing of an aircraft. For example, fixed wing aircraft typically include slats movably arranged along a leading edge of each wing and flaps movably arranged along a trailing edge of each wing. By selectively extending, retracting, and deflecting the slats and flaps aerodynamic flow conditions on a wing are influenced so as to increase lift generated by the wing during takeoff or decrease lift during landing. For example, during take-off the leading edge slats are moved forward to extend an effective chord length of the wing and improve lift. During flight, the leading edge slats and trailing edge flaps are placed in a retracted position to optimize aerodynamic conditions.

Generally speaking, leading edge slat designs employ a series of roller style bearings that guide fixed tracks to extend the leading edge slats in order to increase lift at slow speed for landing and takeoff. The tracks may have multiple configurations such as, for example, general I-beam and PI-beam shapes. Since the tracks themselves are typically not overly robust in their construction, multiple load conditions may be realized by the track roller bearings. Similarly, side load rollers or pins typically slide against the track to assist in centering the main rollers on the track. The wing also includes actuation systems for positioning the slats and flaps. Actuation systems include, for example, drive motors (e.g., hydraulic or electric drive motors), drive shafts and other bearings such as spherical bearings, bushings and linkage bearings that assist in deployment and retraction of the slats and flaps. As can be appreciated, aircraft wing designs are being continually developed as engineers seek to improve aircraft performance while increasing system capabilities. Newer designs are tending to increase the number of systems employed within a wing cross section. Accordingly, space within the wing cross section is at a premium. Therefore, it is desirable to improve performance characteristics of components (e.g., to reduce maintenance) within the wing while also minimizing space needed for such components.

Based on the foregoing, it is the general object of this invention to provide an improved bearing for use in crucial applications.

SUMMARY OF THE INVENTION

The present invention resides in one aspect in an actuation system for deploying and retracting a lift assisting device of a wing of an aircraft. The actuation system includes a track pivotally coupled to the lift assisting device, a shaft rotating in response to flight control signals to deploy or retract the lift assisting device, means for actuating the lift assisting device between a retracted position and a deployed position along an arcuate path, a plurality of track roller bearings and a plurality of side roller bearings. The roller bearings rotatably contact the track to guide the track along the arcuate path. In one embodiment, the track roller bearings are comprised of an outer ring, a split inner ring and split liners disposed between bearing surfaces of the outer and the inner rings. The split inner ring is configured for accommodating deflection and bending of a mounting pin coupling the track roller bearing in proximity to the track. In another embodiment, the track roller bearings are comprised of an outer race, an inner race and needle roller elements.

In one embodiment, the means for actuating includes a gear track coupled to the track and a pinion gear coupled to the shaft. The pinion gear has gear teeth that engage the gear track. When the shaft rotates in a first direction the pinion gear engages the gear track to move the lift assisting device from the retracted to the deployed position along the arcuate path. When the shaft rotates in a second direction the pinion gear engages the gear track to move the lift assisting device from the deployed position to the retracted position along the arcuate path. In another embodiment, the means for actuating includes an actuator arm coupled to the track and an actuator lever coupled to the shaft and to the actuator arm. When the shaft rotates in the first direction the actuator lever drives the actuator arm to move the track and the lift assisting device from the retracted to the deployed position along the arcuate path. When the shaft rotates in the second direction the actuator lever drives the actuator arm to move the track and the lift assisting device from the deployed position to the retracted position along the arcuate path.

In still another embodiment, each of the plurality of track roller bearings are comprised of an outer ring having inner bearing surfaces, an inner split ring having a first portion and a second portion, each of the first and second portions having outer bearing surfaces, and a plurality of liners disposed between the inner bearing surfaces of the outer ring and the outer bearing surfaces of the inner ring. Each of the inner rings is comprised of 17-4PH steel and each of the outer rings is comprised of AISI Type 422 stainless steel. In one embodiment, each of the outer rings is comprised of AISI Type 422 stainless steel with a special nitriding hardening process.

In one embodiment, there is provided an actuation system for deploying and retracting a lift assisting device of a leading edge of a wing of an aircraft including a track pivotally coupled to the lift assisting device. The track has first and second outer surfaces and side surfaces. The actuation system includes a shaft rotationally coupled within the wing of the aircraft and operable, in response to flight control signals, to deploy or retract the lift assisting device. The actuation system includes an actuator for actuating the lift assisting device, coupled to the shaft, between a retracted position to a deployed position along an arcuate path. The actuation system includes a plurality of track roller bearings rotatably contacting the first and second outer surfaces of the track to guide the track along the arcuate path. The plurality of track roller bearings includes one or more lined track roller assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of a wing of an aircraft illustrating a plurality of slat panels located at a leading edge of the wing;

FIG. **2** is a side cross-sectional view of the wing of FIG. **1** taken along line **2-2** illustrating one of the slat panels in a deployed and a retracted position;

FIG. **3** is a front, partial cross-sectional view of a portion of the wing illustrating an actuation system for a slat panel, in accordance with one embodiment of the present invention;

FIG. **4** is a cross-sectional view of a split type track roller bearing in accordance with one embodiment of the present invention;

FIG. **5** is a front, partial cross-sectional view of a portion of the wing illustrating side guide roller bearings in accordance with one embodiment of the present invention;

FIG. **6**A is a front, partial cross-sectional view of a portion of the wing illustrating an actuation system for a slat panel, having lined track roller assemblies;

FIG. **6**B is an enlarged view of one embodiment of the lined track roller of the present invention;

FIG. **6**C is an enlarged view of another embodiment of the lined track roller of the present invention;

FIG. **6**D is an enlarged view of another embodiment of the lined track roller of the present invention;

FIG. **7** is a cross-sectional view of a track roller bearing in accordance with one embodiment of the present invention;

FIG. **8** is a plan view of a wing of an aircraft illustrating a plurality of slat panels located at a leading edge of the wing and having lined track roller bearings assemblies; and

FIG. **9** is a front, partial cross-sectional view of a portion of the wing illustrating lined side guide roller bearings in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

FIG. **1** provides a plan view of a leading edge section **12** of a wing **10** of an aircraft **8**. The wing **10** includes a plurality of slat panels **20** deployed along the leading edge **12** of the wing **10**. As described herein, an actuation system selectively extends and retracts the slat panels **20** relative to the leading edge **12** in response to flight control signals, as is generally known in the art. FIG. **2** is a partial cross-sectional view of the wing **10** taken along line **2-2** of FIG. **1** and illustrates one of the leading edge slats **20** in a retracted position **20'** and in an extended position **20"**. As shown in FIG. **2**, in the retracted position (e.g., flight position) the slat **20'** is located against the leading edge **12** of the wing **10** and in the deployed position (e.g., take-off and landing position) the slat **20"** is deployed downwardly and forwardly away from the leading edge portion **12** of the wing **10** thus increasing a surface area of the wing **10** to vary the wing's lift-enhancing characteristics.

An actuation system **40** of each slat **20** includes a track **50** extending along an arcuate axis A from a rear portion **52** to a forward portion **54**. It should be appreciated that the track **50** may have multiple configurations such as, for example, an I-beam shape and a PI-beam shape. Generally speaking, webbing that constitutes support elements of the track is not overly robust. As such, multiple load conditions are experienced at the track during operation that may be carried and distributed by roller style bearings, as are described herein, to, for example, the wing structure of the aircraft.

As shown in FIG. **2**, the forward portion **54** of the track **50** is pivotally coupled to an interior surface of the slat **20**. In one embodiment, the track **50** is coupled to the slat **20** by means of, for example, linkage bearings **60**. The actuation system **40** also includes an actuator lever **70**. The actuator lever **70** is coupled to the track **50** via an actuator arm **80**. The actuator lever **70** is also coupled to a shaft **90**. As is generally known in the art, the shaft **90** extends along the leading edge section **12** of the wing **10** and operates a plurality of actuator levers (similar to lever **70**) coupled to respective ones of the plurality of slat panels **20** in response to flight control commands to extend the slats when rotating in a first direction and to retract the slats **20** when rotating in a second direction.

A plurality of track roller bearings **100** are disposed about a first outer surface **56** and a second outer surface **58** of the track **50**. The track roller bearings **100** are in rotational contact with the outer surfaces **56** and **58** of the track **50** to guide the track **50** in its arcuate path along axis A during deployment and retraction. The path of travel of the slat **20** is illustrated in FIG. **2** by arrow B. As shown in FIG. **2**, the plurality of track roller bearings **100** includes a first pair of track roller bearings **102** and **104** and a second pair of track roller bearings **106** and **108**. It should be appreciated that it is within the scope of the present invention to include more or less than the illustrated two pairs of roller bearings. For example, three roller bearings may be disposed about one or both of the first outer surface **56** and/or second outer surface **58** of the track **50**. As described in detail below, it is also within the scope of the present invention for the plurality of track roller bearings **100** to include rolling element needle style track rollers or self lubricating style track rollers. In one embodiment, a mounting web **110** encloses at least a portion of the track **50**. In one embodiment, the mounting web **110** extends into a fuel tank disposed within the wing of the aircraft.

In one embodiment illustrated in FIG. **3**, the actuation system **40** includes a pinion gear **120** having teeth **122** that drive a gear track **130** disposed within an interior portion **53** of the track **50**. Preferably, the gear track **130** is positioned on a vertical centerline **55** of the track **50**. The pinion gear **120** is coupled to a shaft **124** (such as the shaft **90**) that rotates in response to flight control commands. As the shaft **124** and the pinion gear **120** rotate, a drive force is provided to the gear track **130** for driving the track **50** along axis A between one of the retracted position **20'** and the extended position **20"** (FIG. **2**). As shown in FIG. **3**, the track roller bearing **100** is coupled to the mounting web **110** about the track **50**. For example, as shown in FIG. **3**, the track roller bearing **100** is coupled to the mounting web **110** above the track **50**.

As shown in FIG. **2**, the plurality of track roller bearings **100** are coupled to the mounting web **110** about the first and second outer surfaces **56** and **58** of the track **50** to support and guide the track **50** during deployment and retraction. In one embodiment, illustrated in FIG. **3**, the track roller **100** is coupled to the mounting web **110** using opposing bushings **140**, a mounting pin **150** and a nut **160**. In one embodiment, the opposing bushings **140** are comprised of eccentric bushings and the nut **160** is comprised of a castellated nut to allow adjustment to the track **50** at fit-up. As shown in FIG. **3**, the track roller bearing **100** includes a plurality of needle roller elements **103** (e.g., two rows of needle rollers in a double channel design). The needle roller elements **103** are lubricated with grease such as, for example, Aeroshell 33, Mobil 28, Aerospec 200 or Aeroplex 444 as is required by predetermined maintenance procedures. In one embodiment, an outer ring **105**, an inner ring and **107** and needle rollers **103** of the track roller bearings **100** are comprised of hardened stainless steel such as, for example, 440C, 52100, 422 stainless with a special nitriding process (AeroCres®) (AEROCRES is registered trademark of RBC Aircraft Products, Inc., Oxford, Conn. USA), XD-15NW, and Cronidur 30.

In another embodiment, illustrated in FIG. **4**, the track roller bearing **100** is comprised of a lined track roller assembly **200** including an outer ring **210** and an inner ring **220**. The inner ring **220** is a split ring including a first portion **230** and a second portion **240**. In one embodiment, the first portion **230** and the second portion **240** include respective body portions **232** and **242** as well as head portions **234** and **244**. The head portions **234** and **244** include flanges **236** and **246**, respectively. In accordance with the present invention, the split ring configuration of the first portion **230** and the second portion **240** due to their ability to deflect relative to one another, accommodate potential deflection and/or bending of the mounting pin **150** from stresses that may be encountered during, for example, aircraft takeoff and landing. As can be appreciated, unless accounted for a bending of the mounting pin **150** may result in high friction or binding of the track roller **100** or **200** and a failure to deploy or retract slats in response to flight control commands. The flanges **236** and **246** control axial motion of the outer ring **210** to substantially eliminate contact of the outer ring **210** and the opposing bushings **140** utilized to mount the track roller **100** and **200** within the mounting web **110**.

As shown in FIG. **4**, the lined track roller assembly **200** may also include liners **250** disposed between bearing surfaces **212**, **214** of the outer ring **210** and bearing surfaces **222**, **224**, **226** and **228** of the inner ring **220**. In one embodiment, the liners **250** are constructed of polytetrafluoroethylene (commercially available under the designation TEFLON®)(TEFLON is a registered trademark of E.I. DuPont De Nemours and Company, Wilmington, Del. USA), polyester, graphite, fabric impregnated with a polymer, urethane, polyimide, epoxy, phenolic or other type of resin. In one embodiment, the liners **250** are molded and are comprised of polytetrafluoroethylene (TEFLON®), polyester, graphite, fibers in a thermosetting composite resin made from polyester, urethane, polyimide, epoxy, phenolic or other type of resin. In one embodiment, the outer ring **210** and the inner ring **220** is comprised of hardened stainless steel such as, for example, 440C, 52100, Custom 455®, Custom 465® (CUSTOM 455 and CUSTOM 465 are registered trademarks of CRS Holdings, Inc., Wilmington, Del., USA), and corrosion resistance steel such as 17-4PH, 15-5PH and PH13-8Mo.

In one embodiment, the lined track roller assembly **200** also includes shields **260** and **270** disposed about shoulder portions **216** and **218** of an outer diameter of the outer ring **210** and extending to an outer diameter **223** of the inner ring **220**. The inventors have discovered that the shields **260** and **270** reduce friction and discourage dust and other contaminates from entering and compromising contact between the bearing surfaces **212**, **214** of the outer ring **210** and bearing surfaces **222**, **224**, **226** and **228** of the inner ring **220**.

In one embodiment, illustrated in FIG. **5**, a plurality of side guide roller bearings **300** are disposed about opposing sides of the track **50**. The side guide roller bearings **300** are in rotational contact with the opposing side surfaces of the track **50** to guide the track **50**, along with track roller bearings **100** and **200**, in its arcuate path along axis A during deployment and retraction. In one embodiment, the plurality of side guide roller bearings **300** are in rotational contact with wear pads affixed to the track **50**. In one embodiment, the plurality of side guide roller bearings **300** include needle roller bearings having outer races, inner races and needle rollers constructed of hardened stainless steel such as, for example, 440C, 52100, 422 stainless with a special nitriding process (e.g., the aforementioned AeroCres® process), XD-15NW, and Cronidur 30. In yet another embodiment, the side guide roller bearings **300** include end washers and seals. The end washers are constructed of, for example, 52100 steel with cadmium plate or 420 stainless steel. The seals are made from a thermoplastic such as, for example, an acetal copolymer with lubricant fillers or Delrin®/Celcon® (DELRIN is a registered trademark of E.I. DuPont De Nemours and Company, Wilmington, Del. USA, and CELRON is a registered trademark of CNA Holdings, Inc., Summit, N.J. USA). The seals retain grease and prevent of ingress dirt, dust and other contaminates into the bearings **300**. In one embodiment, needle roller elements of the bearings **300** are lubricated with grease such as, for example, Aeroshell 33, Mobil 28, Aerospec 200 or Aeroplex 444 as is required by predetermined maintenance procedures.

As described above, both the rolling element track bearings **100** and self lubricating track roller bearings **200** include a hard outer ring or race to work in harmony with the mating track **50** that the bearings roll against. In one embodiment, the track **50** is comprised of titanium or steel. In one embodiment, the track **50** may be coated with a material such as, for example, tungsten carbide, although a coating is not a requirement of the present invention.

In addition to a unique bearing mounting configuration, another aspect of the present invention is related to the materials from which the bearings are manufactured. Historically, lined track bearings are manufactured from relatively soft materials. For example, inner rings are typically comprised of precipitation-hardening martensitic stainless steel such as, for example, 17-4PH steel, having a Rockwell hardness in a range of about HRc 30 s to about HRc 40 s, while outer rings are typically comprised of precipitation-hardening stainless steel such as, for example, custom 455 steel, having a Rockwell hardness in the range of about HRc 40 s. Outer rings may also be manufactured as through hardened high strength steel having a Rockwell hardness of in the range of about HRc 50 s to avoid flats that can occur. 440C steel has also been used for outer rings. The inventors have discovered that, in certain applications, it is beneficial to maintain inner rings manufactured from 17-4PH steel, and that it is desirable to manufacture outer rings of AISI Type 422 stainless steel. In one embodiment, each of the outer rings is comprised of AISI Type 422 stainless steel with a special nitriding hardening process (e.g., the aforementioned AeroCres® process). Outer rings comprised of AISI Type 422 stainless steel with AeroCres® hardening are preferred for superior corrosion resistance and performance as compared to conventional outer rings manufactured of 440C steel.

In another embodiment, illustrated in FIG. **6A**, the lined track roller bearing **500** is similar to the track roller bearing of FIG. **4**, thus like elements have been assigned similar element numbers with the first numeral 2 being replaced with the numeral 5. The lined track roller bearing **500** is a lined track roller assembly **500** including an outer ring **510** and an inner ring **520**. The inner ring **520** is disposed at least partially in the outer ring **510**. The outer ring **510** defines an inner bearing surface **510**A and the inner ring **520** defines an outer bearing surface **520**A. The inner ring **520** extends continuously from a first end **531** to a second end **541**. Thus the lined track roller bearing **500** has no split and no separate first portion **230** and second portion **240**, as shown in FIG. **4**. The inner ring **520** defines a continuous body portion **542** as well as head portions **534** and **544** proximate the first end **531** and the second end **541**, respectively. The head portions **534** and **544** include flanges **536** and **546**, respectively. The flanges **536** and **546** control axial motion of the outer ring **510** to substantially eliminate contact of the outer ring **510** with the opposing bushings **540** utilized to mount the track roller **500** within the mounting web **310**, illustrated in FIG. **7**. While the lined track rollers **500** are shown and described as having no split and no separate first portion **230** and second portion **240**, the present invention is not limited in this regard, as the lined track rollers **500** having a split configuration as shown in FIG. **4** may also be employed without departing from the broader aspects defined herein.

As shown in FIGS. **6**A and **6**B, the lined track roller assembly **500** includes liners **550** disposed between the outer ring **510** the inner ring **520**. As shown in FIGS. **6**A and **6**B, the liner **550** is disposed on, for example, secured to (e.g., by an adhesive or by bonding) the inner bearing surface **510**A of the outer ring **510** and the liner **550** slidingly engages the outer bearing surface **520** of the inner ring **520**. A liner **550** is also disposed between an inside facing lateral surface **528** of the each of the head portions **534** and **544** and an outwardly facing lateral surface **519** of the outer ring **510**. The lined track roller assembly **500** also includes shields **560** and **570** disposed about shoulder portions **516** and **518** of an outer diameter of the outer ring **510** and extending to an outer diameter **523** of the inner ring **520**. The liners **550** are manufactured from materials similar or identical to those described above for the liners **250**. While the liner **550** is shown in FIGS. **6**A and **6**B and described as being disposed on the inner bearing surface **510**A, the present invention is not limited in this regard as the liner **550** may be disposed on the outer bearing surface **520**A of the inner ring **520** and the liner **550** slidingly engages the inner bearing surface **510**A of the outer ring **510**, as shown in FIG. **6**C. In another embodiment, as shown in FIG. **6**D, a liner **550**A, similar to the liner **550**, is disposed the inner bearing surface **510**A of the outer ring **510** and a liner **550**B, similar to the liner **550**, is disposed in the outer bearing surface **520**A of the inner ring **520**, as shown in FIG. **6**D, wherein the liners **550**A and **550**B slidingly engage one another.

The mounting web **510** of FIG. **7** is similar to the mounting web of FIG. **3**; therefore like elements for the track roller bearing **500** have been assigned similar element numbers with the first numeral 2 being replaced with the numeral 5. As shown in FIG. **7**, the track roller bearing **500** is coupled to the mounting web **110** above the track **50**. With reference to FIG. **1**, one or more of the track roller bearings **102**, **104**, **106** and **106** are lined track rollers **500** as illustrated in FIG. **5**. The lined track roller **500** is coupled to the mounting web **110** using opposing bushings **140**, a mounting pin **150** and a nut **160**.

Referring to FIG. **8**, in one embodiment, all of the track roller bearings **102**, **104**, **106** and **108** are lined track rollers **500** similar to those as illustrated in detail in FIGS. **6**A, **6**B, **6***c* and/or **6**D.

Referring to FIG. **9**, the plurality of side guide roller bearings **500** are disposed about opposing sides of the track **50** in a manner similar to that described above with reference to the side guide track roller **300** of FIG. **5**. However, one or more of the side guide roller bearings **500** are lined roller bearings similar to the lined track roller bearings **500** shown in FIGS. **6**A, **6**B, **6**C, and/or **6**D. In one embodiment, all of the side guide roller bearings **500** are lined roller bearings similar to the lined track roller bearings **500**.

Surprisingly, use of the lined track rollers **500** in the actuation system of leading edge flaps on an aircraft has benefit over bearings having needle rollers. Actuation systems are limited as to how much force they can apply. Since lined track rollers have a higher friction coefficient than needle roller track rollers, one skilled in the art of bearing design for aircraft applications would be discouraged from using a system that includes lined track rollers as it will take more force to actuate the system. However, one surprising benefit of lined track rollers is to move away from track rollers that require grease. By moving away from rollers that require grease, heavy hydraulic greasing systems do not have to be included on the aircraft and this benefit of reduced weight and complexity has been discovered overcome the determinant of higher friction compared to the lower friction needle rollers.

Although the invention has been described with reference to particular embodiments thereof, it will be understood by one of ordinary skill in the art, upon a reading and understanding of the foregoing disclosure that numerous variations and alterations to the disclosed embodiments will fall within the spirit and scope of this invention and of the appended claims.

What is claimed is:

1. An actuation system for deploying and retracting a lift assisting device of a leading edge of a wing of an aircraft, the actuation system comprising:

a track pivotally coupled to the lift assisting device, the track having first and second outer surfaces and side surfaces;

a shaft rotationally coupled within the wing of the aircraft and operable, in response to flight control signals, to deploy or retract the lift assisting device;

means for actuating the lift assisting device, coupled to the shaft, between a retracted position to a deployed position along an arcuate path; and

a plurality of track roller bearings rotatably contacting the first and second outer surfaces of the track to guide the track along the arcuate path,

wherein each of the track roller bearings comprises an inner ring having an outer bearing surface and an outer ring having an inner bearing surface, the inner ring being disposed at least partially in the outer ring and at least one of the track roller bearings has a self lubricating liner secured to at least one of the outer bearing surface and the inner bearing surface, to carry loads transmitted to the track roller bearing from the track.

2. The actuation system of claim **1**, wherein at least one of the plurality of track roller bearings is in rotational contact with an upper surface of the track and at least one of the track roller bearings is in rotational contact with a lower surface of the track.

3. The actuation system of claim **1**, wherein the all of the plurality of track roller bearings have one of the self lubricating liners secured to at least one of the outer bearing surface and the inner bearing surface.

4. The actuation system of claim **1**, wherein the means for actuating is comprised of:

an actuator arm coupled to the track; and

an actuator lever coupled to the shaft and to the actuator arm;

wherein when the shaft rotates in a first direction the actuator lever drives the actuator arm to move the track and the lift assisting device from the retracted to the deployed position along the arcuate path, and when the shaft rotates in a second direction the actuator lever drives the actuator arm to move the track and the lift assisting device from the deployed position to the retracted position along the arcuate path.

5. The actuation system of claim **1**, wherein the actuation system further includes a mounting web enclosing at least a portion of the track and wherein the plurality of track roller bearings are coupled to the mounting web.

6. The actuation system of claim **5**, wherein the track roller bearings are coupled to the mounting web with opposing bushings, a mounting pin and a nut.

7. The actuation system of claim **6**, wherein the opposing bushings are comprised of eccentric bushings and the nut is comprised of a castellated nut to allow adjustment to the track at fit-up.

8. The actuation system of claim **1** further comprising a plurality of side roller bearings rotatably contacting at least one side of the track to guide the track along the arcuate path.

9. The actuation system of claim **8** wherein each of the plurality of the side roller bearings comprise an inner ring having an outer bearing surface and an outer ring having an inner bearing surface, the inner ring being disposed at least partially in the outer ring at least one of the side roller bearings has one of the self lubricating liners secured to at least one of the outer bearing surface and the inner bearing surface.

10. The actuation system of claim **1**, wherein the at least one track roller bearing having the self lubricating liner has no balls, no needles and no cage.

11. The actuation system of claim **1**, wherein the securing of the liner comprises at least one of by bonding and by an adhesive.

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