MECHANICAL SEAT RECLINE LOCK MECHANISM WITH INTEGRATED DAMPING

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ABSTRACT

A mechanical seat recline lock mechanism that employs a lead screw device to backdrive a nut and disk. The disk is held in place by a spring-loaded friction pin when motion needs to be constrained. The rotating disk can be oiled or greased to provide damping action.
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CROSS-REFERENCE TO RELATED APPLICATIONS

0001 Not applicable.

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0002 Not applicable.

BACKGROUND OF THE INVENTION

0003 1. Field of the Invention

0004 The present invention relates to a lock mechanism for controlling seat recline function for passenger comfort. More specifically, the invention relates to a lock mechanism for controlling seat recline function that provides nearly infinite position options and incorporates integrated damping.

0005 2. Related Art

0006 The recline function for seat backs in the aircraft and automotive industry has been a standard for many years. The two industries have approached the solution from different perspectives. The automotive industry traditionally used a mechanical locking device that positively locks the seat back into a position by means of a spring and gear type engagement. This arrangement is adequate for the normal automotive application where the seat back is not adjusted very many times over the life of the product. However, it does not allow for possible engagement until the teeth are properly aligned, and therefore, results in substantial wear due to the high forces encountered when the teeth are forced to engage.

0007 The aircraft industry has a different need due to a different use profile. An aircraft seat recline function is activated at least twice per flight (take-off and landing) and potentially several times in flight with meals, reading, sleeping, etc. The solution implemented approximately 40 years ago was a hydraulic cylinder with a bypass port controlled by a lever. The cylinder piston separates two oil-filled chambers connected by a valve that allows oil to pass when activated, thereby allowing motion of the piston. This arrangement has many attractive features, including nearly infinite hold power, motion damping, and a small package. However, it also has disadvantages such as a propensity for leaks (internal and external), relatively heavy weight, and high cost. Aircraft-type hydraulic systems tend to leak because they are based on pressurized hydraulic fluid with tight tolerances (typical of hydraulic systems) on the internal dimensions to operate properly. Once these tolerances begin to wear, the performance of the device deteriorates rapidly.

0008 It is to the solution of these and other problems that the present invention is directed.

SUMMARY OF THE INVENTION

0009 It is accordingly a primary object of the present invention to provide a seat recline lock mechanism that is mechanical and has infinite adjustability.

0010 It is another object of the present invention to provide a seat recline lock mechanism that is mechanical and has integral damping.

0011 It is another object of the present invention to provide a seat recline lock mechanism that is mechanical and has a long life.

0012 It is another object of the present invention to provide a seat recline lock mechanism that is mechanical and that does not leak.

0013 It is another object of the present invention to provide a seat recline lock mechanism that is mechanical and light in weight.

0014 These and other objects are achieved by a mechanical seat recline lock mechanism that employs a lead screw device to backdrive a nut and disk. The disk is held in place by a spring-loaded friction pin when motion needs to be constrained. The rotating disk can be oiled or greased to provide damping action.

0015 Unlike prior art mechanical devices, the mechanical seat recline lock mechanism in accordance with the present invention is its infinite adjustability, integral damping, and longer life. In contrast to prior art hydraulic systems, the mechanical seat recline lock mechanism in accordance with the present invention does not leak and has a lighter weight.

0016 Other objects, features, and advantages of the present invention will be apparent to those skilled in the art upon a reading of this specification including the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

0017 The invention is better understood by reading the following Detailed Description of the Preferred Embodiments with reference to the accompanying drawing figures, in which like reference numerals refer to like elements throughout, and in which:

0018 FIG. 1 is a perspective view of a seat recline lock mechanism in accordance with the present invention.

0019 FIG. 2 is a side elevational view of the seat recline lock mechanism of FIG. 1.

0020 FIG. 2A is a partial side elevational view of an alternative head configuration of the lead screw as shown in FIG. 2.

0021 FIG. 3 is a cross-sectional view of the seat recline lock mechanism as shown in FIG. 2.

0022 FIG. 4 is an exploded perspective view of the seat recline lock mechanism of FIG. 1.

0023 FIG. 5 is a front view of the seat recline lock mechanism of FIG. 1.

0024 FIG. 6 is a back view of the seat recline lock mechanism of FIG. 1.

0025 FIG. 7 is a perspective view of a first type of seat in which the mechanical seat recline lock mechanism of the present invention is mounted, with the seat back in the upright position.

0026 FIG. 8 is an enlarged, partial perspective view of the mounting of the mechanical seat recline lock mechanism as shown in FIG. 7.
FIG. 9 is a side elevational view of a second type of seat in which the mechanical seat recline lock mechanism of the present invention is mounted, with the seat back in the upright position.

FIG. 10 is a side elevational view of the seat and mechanical seat recline lock mechanism of FIG. 9, with the seat back in a reclining position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In describing preferred embodiments of the present invention illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the invention is not intended to be limited to the specific terminology so selected, and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner to accomplish a similar purpose.

Referring now to FIGS. 1-6, the mechanical seat recline lock mechanism 100 in accordance with the present invention comprises an externally-threaded lead screw 10 having a shaft 10a and a head 10b, an externally-threaded lead screw nut 20 threadably engaging the lead screw 10, and an annular brake disk 30 concentric with and matingly engaging the perimeter of the lead screw nut 20. The head 10b provides an interface to the seat. The specific configuration of the head 10b depends upon the specifics of the interface, and is not considered to be a novel feature of the present invention. An alternative configuration of the head 10b is shown in FIG. 2A.

An annular bearing 40 comprising an annular race 40a with a plurality of ball bearings 40b is positioned on either side of the brake disk 30. A housing 50 is configured with a housing inner cavity that encases the lead screw nut 20, the brake disk 30, and the bearings 40, the housing inner cavity being sized to provide a small clearance between the brake disk 30 and the housing 50, into which oil is introduced during the assembly process, for a purpose to be described hereinafter. In order to prevent leakage of the oil from between the two parts 50a and 50b, a gasket or O-ring 60 can be provided between the two parts 50a and 50b.

The bearings 40 perform two functions, (1) constraining the lead screw nut 20 to the housing 50 against axial forces applied to the lead screw 10, and (2) providing low friction radial support of the lead screw nut 20 to the housing 50.

The housing 50 can be formed in two parts, a first part 50a and a second part 50b, for ease in manufacture and assembly. The first and second parts 50a and 50b define the housing inner cavity that receives the lead screw nut 20, the brake disk 30, and the bearing races. In order to reduce the weight of the housing 50, grooves 52 can be formed in the outer face of the first part 50a. Strengthening ribs 54 are formed on the outer face of the second part 50b. Because the housing 50 is formed of a lightweight material (examples of which include, but are not limited to, aluminum, titanium, magnesium, and plastic), the ribs 54 strengthen the housing 50 when the mechanism 100 is locked and restraining linear forces. As will be appreciated by those of skill in the art, other means besides the ribs 54 can be used to address mechanical loads.

An actuation lever 70 is pivotally mounted to the outer face of the first part 50a of the housing 50 (via, for example, a pin 72) so as to define a fulcrum 70a (which is coincident with the longitudinal axis of the pin 72), an effort arm 70b, and a resistance arm 70c. A spring 80 is connected at one of its ends to the effort arm 70b of the actuation lever 70 and at the other of its ends is seated in an aperture 56 in the outer face of the first part 50a of the housing 50 to bias the effort arm 70b away from the housing 50, and thus to bias the resistance arm 70c towards the housing 50 and the brake disk 30. A resistance pin 90 is inserted into and extends through an aperture in the housing 50 between the resistance arm 70c of the actuation lever 70 and the brake disk 30, so as to contact the brake disk 30 at its outer circumference.

The primary mechanical support is contained in the shaft 10b and highly concentrated in the housing 50. The load screw 10 is used to back drive the nut 20, which in turn rotates the disk 30. The disk 30 is captured between the two halves of the housing 50 with a small clearance. The oil in the clearance between the housing 50 and the disk 30 acts on the disk 30 in shear to provide a damping action. The pin 90, which has force from the spring 80 applied through the actuation lever 70, contacts the brake disk 30 so as to prevent its rotation, providing the locking action. When the effort arm 70b of the actuation lever 70 is moved towards the housing 50, either directly or through a cable, the force is removed from the pin 90, which allows the disk 30 to rotate, and therefore, allows the shaft 10b of the load screw 10 to move linearly through the seat recline lock mechanism 100, and more particularly, through the lead screw nut 20.

Referring now to FIGS. 7 and 8, there is shown a first type of seat 200 in which the mechanical seat recline lock mechanism 100 of the present invention is mounted. The seat 200 comprises a seat pan 210, a seat pan frame 212 extending from the back of the seat pan 210, a seat back 220, and a seat back frame 222 extending from the bottom of the seat back 220, the seat back frame 222 being pivotably mounted to the seat pan frame 212 to permit the seat back 220 to recline relative to the seat pan 210. The housing 50 of the mechanical seat recline lock mechanism 100 is fixedly mounted to a bracket 214 extending downwardly from the bottom of the seat pan 210, while the head 10b of the lead screw 10 threadably engages a bracket 224 fixedly mounted to the seat back frame 222. The brackets 214 and 224 are positioned along one side of the seat 200 so that the mechanical seat recline lock mechanism 100 is easily accessible to the person sitting in the seat 200. Operation of the mechanical seat recline lock mechanism 100 results in reclining motion of the seat back 220 as indicated by the arrow A1.

Referring now to FIGS. 9 and 10, there is shown a second type of seat 200’ in which the mechanical seat recline lock mechanism 100 of the present invention is mounted. The seat 200’ comprises a seat pan 210, a seat pan frame 212 extending from the back of the seat pan 210, a seat back 220, and a seat back frame 222 extending from the bottom of the seat back 220. The seat pan 210 is slidably mounted in fixed left and right tracks 230 via front and back rollers 240a and 240b, and the seat back frame 222 is pivotably mounted to the seat pan frame 212 in alignment with the back rollers 240b. A pair of struts 250 on either side of the seat 200’ are pivotally connected at one end to the seat back 220 and at the other end to the back ends of the tracks 230. The left and right tracks 230 are themselves mounted to a fixed base 250.
The housing 50 of the mechanical seat recline lock mechanism 100 is fixedly mounted to a bracket 214 extending downwardly from the bottom of the seat pan 210, while the head 106 of the lead screw 10 threaded engages a bracket 264 fixedly mounted to the base 260. As with the first type of seat 200, the brackets 214 and 264 are positioned along one side of the seat 200 so that the mechanical seat recline lock mechanism 100 is easily accessible to the person sitting in the seat 200. Operation of the mechanical seat recline lock mechanism 100 results both in reclining motion of the seat back 220 as indicated by the arrow A1 and forward and backward motion of the seat pan 210 as indicated by the arrow A2.

[0038] The basic principles upon which the seat recline lock mechanism 100 is constructed allow it to be designed and built with: (1) any variation of gear reduction between the lead screw 10 and the lead screw nut 20, as long as it can be back driven; (2) any multiple of brake disks 30 and spring 80/lever 70 combinations to provide normal forces and friction adequate to hold the brake disk 30, and thereby hold the nut 20 to which it is matingly engaged, from rotating; (3) any viscosity of oil to vary damping characteristics; (4) a barrel type configurations for the housing 50 for lower profile construction; and (5) any means that can replace the lead screw 10/lead screw nut 20 combination to transform motion from linear to rotational, including, but not limited to spur gears, rack and pinion gears, planetary gear set, and chain and sprockets, all of which are also capable of being back driven.

[0039] Because the seat recline lock mechanism 100 is a friction-based device, there are no gear teeth to wear away, and there is no harsh “locking” action. The seat recline lock mechanism 100 also provides infinite adjustability, as well as integrated damping due to shear of the oil in the lock mechanism acting on the disk 30.

[0040] Further, the seat recline lock mechanism 100 is not under pressure or required to constrain oil under pressure, thereby preventing the occurrence of leaks. The internal tolerances are much less critical than in a hydraulic system. It weighs less than a conventional hydraulic lock system because it only requires a few drops of oil compared to approximately 100 mL in the conventional hydraulic lock system.

[0041] Modifications and variations of the above-described embodiments of the present invention are possible, as appreciated by those skilled in the art in light of the above teachings. It is therefore to be understood that, within the scope of the appended claims and their equivalents, the invention may be practiced otherwise than as specifically described.

What is claim is:

1. A mechanical seat recline lock mechanism for a reclining seat, comprising:
   - motion-transforming means for transforming linear motion to rotational motion, the motion-transforming means including an interface to the reclining seat;
   - at least one brake disk rotationally driven by the motion-transforming means;
   - damping means for providing a damping action to the at least one brake disk; and
   - holding means for selectively applying normal forces and friction adequate to hold the at least one brake disk and thereby preventing the motion-transforming means from rotating.

2. The mechanical seat recline lock mechanism of claim 1, wherein the motion-transforming means comprises a back-drivable, externally-threaded lead screw and an internally-threaded lead screw nut threadably engaging the lead screw.

3. The mechanical seat recline lock mechanism of claim 2, wherein the at least one brake disk is an annular brake disk concentric with and matingly engaging the perimeter of the lead screw.

4. The mechanical seat recline lock mechanism of claim 1, further comprising a housing configured with a housing inner cavity encasing the at least one brake disk, the housing inner cavity being sized to provide a clearance between the brake disk and the housing, and wherein the damping means comprises oil within the cavity.

5. The mechanical seat recline lock mechanism of claim 1, wherein the holding means comprises:
   - a pivotable actuation lever having an effort arm and a resistance arm;
   - a resistance pin positioned between the resistance arm and the at least one brake disk so as to contact the at least one brake disk at the outer circumference thereof; and
   - means for biasing the resistance arm towards the at least one brake disk.

6. The mechanical seat recline lock mechanism of claim 5, further comprising a housing configured with a housing inner cavity encasing the at least one brake disk and an aperture therein for receiving the resistance pin, and wherein the actuation lever is pivotally mounted on an outer face of the housing.

7. A mechanical seat recline lock mechanism for a reclining seat, comprising:
   - an externally-threaded lead screw and a back-drivable, internally-threaded lead screw nut threadably engaging the lead screw for transforming linear motion to rotational motion, the lead screw including an interface to the reclining seat;
   - at least one brake disk rotationally driven by the lead screw nut;
   - damping means for providing a damping action to the at least one brake disk; and
   - holding means for selectively applying normal forces and friction adequate to hold the at least one brake disk and thereby prevent rotation of the lead screw nut.

8. The mechanical seat recline lock mechanism of claim 7, wherein the at least one brake disk is an annular brake disk concentric with and matingly engaging the perimeter of the lead screw.

9. The mechanical seat recline lock mechanism of claim 7, further comprising a housing configured with a housing inner cavity encasing the at least one brake disk, the housing inner cavity being sized to provide a clearance between the brake disk and the housing, and wherein the damping means comprises oil within the cavity.

10. The mechanical seat recline lock mechanism of claim 7, wherein the holding means comprises:
a pivotable actuation lever having an effort arm and a resistance arm;

a resistance pin positioned between the resistance arm and the at least one brake disk so as to contact the at least one brake disk at the outer circumference thereof; and

means for biasing the resistance arm towards the at least one brake disk.

11. The mechanical seat recline lock mechanism of claim 10, further comprising a housing configured with a housing inner cavity encasing the at least one brake disk and an aperture therein for receiving the resistance pin, and wherein the actuation lever is pivotably mounted on an outer face of the housing.

12. A mechanical seat recline lock mechanism for a reclining seat, comprising:

an externally-threaded lead screw and a back-drivable, internally-threaded lead screw nut threadably engaging the lead screw for transforming linear motion to rotational motion, the lead screw including an interface to the reclining seat;

at least one brake disk rotationally driven by the lead screw nut;

a housing configured with a housing inner cavity encasing the at least one brake disk, the housing inner cavity being sized to provide a clearance between the brake disk and the housing;

oil within the cavity for providing a damping action to the at least one brake disk;

a pivotable actuation lever pivotably mounted on an outer face of the housing, the actuation lever having an effort arm and a resistance arm;

a resistance pin positioned between the resistance arm and the at least one brake disk so as to contact the at least one brake disk at the outer circumference thereof; and

means for biasing the resistance arm towards the at least one brake disk holding means for selectively applying normal forces and friction adequate to hold the at least one brake disk and thereby prevent rotation of the lead screw nut.

13. The mechanical seat recline lock mechanism of claim 12, wherein the at least one brake disk is an annular brake disk concentric with and matingly engaging the perimeter of the lead screw.

14. The mechanical seat recline lock mechanism of claim 12, wherein the housing includes an aperture therein and the resistance pin extends through the aperture.

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