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BY A. P. C.

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LOCKING MECHANISM FOR TOOTHED RACKS, PARTICULARLY FOR ADJUSTABLE STRUTS ADAPTED FOR USE ON AIRPLANES

Filed May 16, 1940

Serial No.
335,638

3 Sheets-Sheet 1

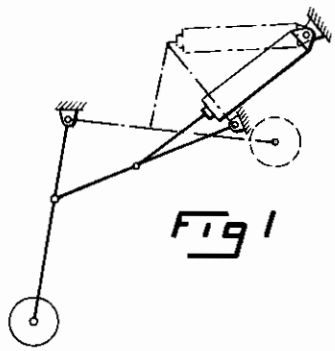

Fig 1

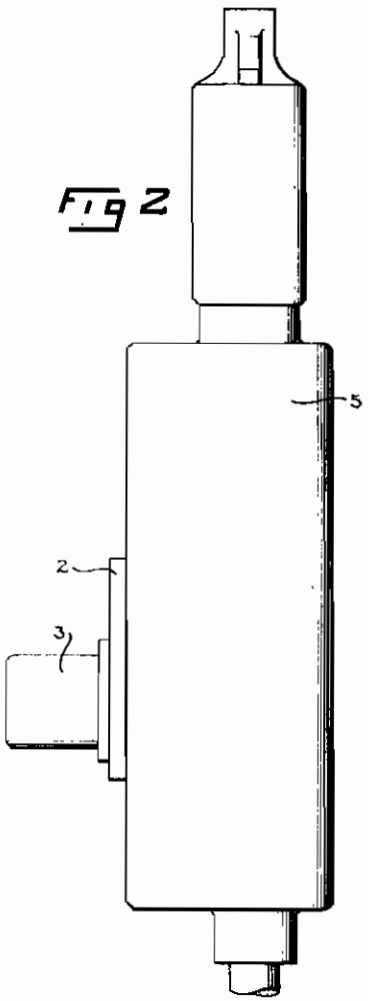

Fig 2

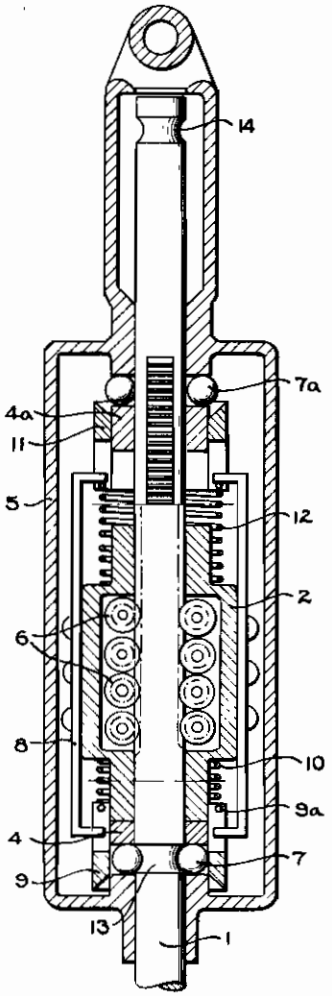

Fig 3

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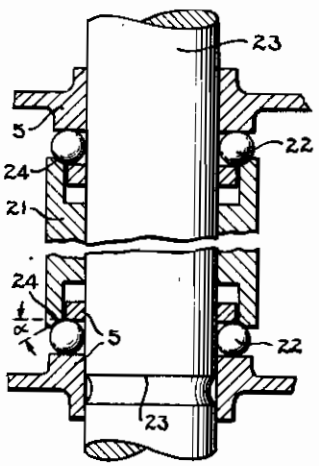

Fig 4

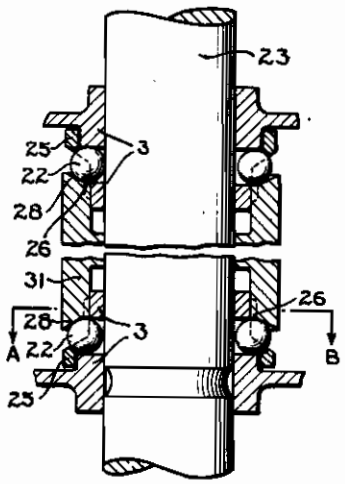

Fig 5

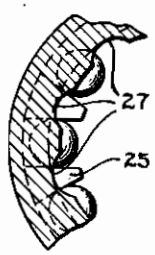

Fig 6

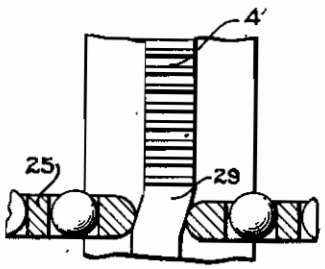

Fig 7

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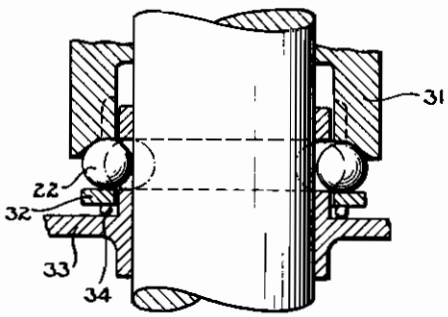

Fig 8

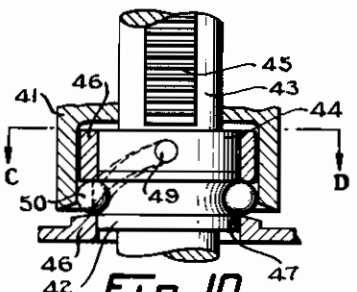

Fig 10

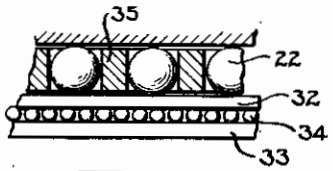

Fig 9

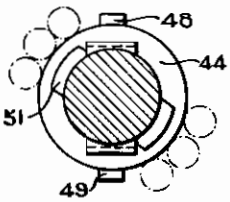

Fig 11

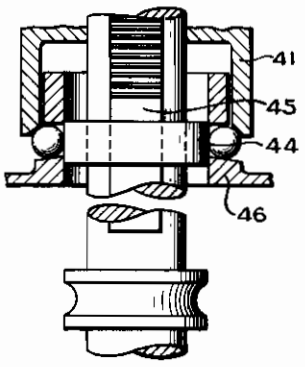

Fig 12

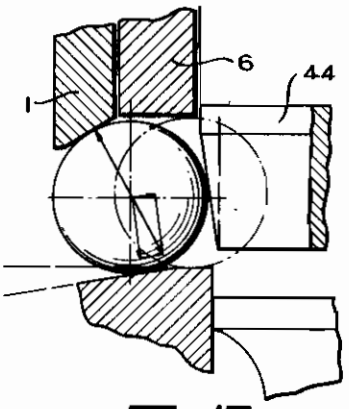

Fig 13.

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ALIEN PROPERTY CUSTODIAN

LOCKING MECHANISM FOR TOOTHED RACKS, PARTICULARLY FOR ADJUSTABLE STRUTS ADAPTED FOR USE ON AIRPLANES

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Application filed May 16, 1940

This invention relates to a locking mechanism for toothed racks, particularly for adjustable struts adapted for use on airplanes, in which the strut is provided at its periphery with ball notches cooperating with ring-shaped members for locking the balls.

Mechanisms of the above-indicated character have already been proposed for hydraulically operated retracting struts.

The invention relates to a particularly suitable construction of such locking mechanisms for electrically operated adjustable members. It consists in the use of an electric motor drive for said members to release and lock the same.

The essential features of the novel locking mechanism consist in the fact that a motor-driven transmission gear acting upon the balls through the ring-shaped locking members and in engagement with the rack toothed preferably at both sides thereof is provided and that the locking may be released and established upon the relative displacement of the transmitting gear with respect to the toothed rack.

A further object of the invention is to provide a locking mechanism in which the transmission gear is arranged between the locking members and is in engagement through gears with the rack and through catches with the locking members.

A further object of the invention is to provide a locking mechanism in which by the displacement of the rack by means of the transmission gear, the locking member surrounding the balls completely in contact with the restricted portion of the strut is displaced by the catches of the transmission gear, thereby releasing the locking.

A further object of the invention is to provide a locking mechanism in which after releasing the locking by displacing the transmission gear with respect to the rack in the direction towards the locking member the latter is displaced by the catches of the transmission gear with respect to the balls and in which by further displacing the rack with respect to the transmission gear in a direction opposite to the above-said direction the locking may be reestablished.

A further object of the invention is to provide a locking mechanism in which the transmission gear is provided at its both ends with flanges having inwardly slant surfaces which form during the adjustment of the rack the contact surfaces of the transmission gear for the balls which are in engagement with the housing of the locking device, whereas the flanges serve when displaced as locking members surrounding the balls.

A further object of the invention is to provide a locking mechanism in which the toothed rack is provided with cylindrical recesses for the reception of the balls and extending in parallel relation to the axis of the rack, the rack being provided at its both ends with a bent portion and in which the balls are positively guided by the rack in a cage or on a thrust ring, so that when being displaced they are guided in the cylindrical recesses and rest on the straight surface portions of the transmission gear, whereas in the position of rest they are pressed against the slant surfaces of the driving gear.

A further object of the invention is to provide a locking mechanism in which on the rack between the ends thereof and the two circular locking bodies firmly secured to the rack is loosely arranged a pressure ring provided with recesses for the rack and which is guided by means of pins in spiral-shaped slots provided in the casing of the locking mechanism, the recesses and the pins being displaced with respect to each other to such an extent that upon the release of the locking the toothed rack passes through the recesses.

A further object of the invention is to provide a locking mechanism in which the surfaces of the pressure ring and of the casing are inclined with which the balls contact when bringing the balls in and out of engagement with their cooperating surfaces.

In the accompanying drawings are shown some embodiments of the invention in diagrammatic form.

Fig. 1 is a schematical representation of a wheel retracting gear for airplanes.

Fig. 2 is a lateral view of a retracting strut provided with a driving motor.

Fig. 3 is a sectional view of the strut shown in Fig. 2.

Fig. 4 is a fragmentary sectional view of a similar retracting strut with a modified locking device.

Fig. 5 shows another embodiment of the locking device.

Fig. 6 is a fragmentary sectional view taken along the line A—B of Fig. 5.

Fig. 7 shows a detail of the embodiment shown in Figs. 5 and 6 with the ball cage shown developed.

Fig. 8 shows another modified form of the locking device with a ball notch.

Fig. 9 shows a development of the bearing for the balls.

Fig. 10 shows a lateral view partly in section

of a modified form of the ball holding device in the locked position.

Fig. 11 is a sectional view taken along the line C—D of Fig. 10.

Fig. 12 shows a view corresponding to Fig. 10 in the released position.

Fig. 13 shows a modification of the ball holding device of Figs. 10 to 12.

To retract and lower the landing gear *a* (Fig. 1) with the aid of the retracting strut *b*, the motor-driven toothed rack cooperating with reduction gears is, for instance, employed instead of the known hydraulic drive without it being necessary to employ a substantially larger space than that required for the hydraulic drive. To relieve the gear it is preferable in such cases to lock both end positions. In this case the locking mechanism must be able to take up when retracting and lowering the landing gear a load which is a multiple of the maximum load of the strut *b*. If it were desirable to effect the mechanical displacement of the retracting strut, for instance, with the aid of a spindle drive, a particular locking mechanism might be under circumstances dispensed with; however, in this case the mechanism would have to be rather amply dimensioned in view of the great load. Furthermore, the efficiency would be small and a deflection of the strut might easily cause a jamming in the spindle nut.

When designing the strut drive and the strut locking device as shown in Figs. 2 and 3 the retracting strut 1 is designed in the form of a rack toothed at both sides thereof. The movable transmission gear 2 with the flange electric motor 3 is movably mounted on the retracting strut. Only in the axial direction the movement of the transmission gear 2 with respect to the casing 5 is limited by the ring-shaped stops 4 and 4*a* of the casing 5. In the embodiment shown the power is transmitted to the toothed rack through eight gears 6. The locking is effected by the balls 7 and 7*a* respectively which at the end positions are in engagement with the restricted portions 13 and 14 of the strut 1. The retracting strut is locked as shown in Fig. 3 in the retracted position. If the strut is to be lowered the motor 3 is rotated in such a direction as to cause the transmission gear 2 to move in the upward direction with respect to the strut 1. In this case the locking device is moved in the upward direction by the catches 8 which comes into engagement with the pins 9*a* secured to the locking ring 9. At the same time by the interposition of the spring 12 the upper locking ring 11 is pressed against the upper balls 7*a*. As soon as the lower edge of the slant surface of the ring 9 has passed when moving in the upward direction beyond the center of the balls 7, the latter are pressed in the downward direction by the force of the strut 1 stressed by the weight of the landing gear and come into engagement with the slant surface of the ring 9. After the balls 7 have released the strut 1 the latter moves together with the transmission gear 2 in the downward direction still the latter comes into engagement with the stop 4 of the casing 5, thus compressing the spring 10, whereas the ring 9 comes to rest on the balls 7. Consequently, the strut permits the landing gear to be gradually lowered until the counterpressure has become so great that an additional compressive force must be brought about by the strut. As soon as this condition has been fulfilled, the transmission gear 2 moves in the upward direction till it contacts with the ring 11, thus causing the ring 11 to be pressed against the upper balls 7*a*, and the springs 12 are compressed, whereas the springs 10 are relieved of the compressive force. The landing gear may now be lowered to the end position. As soon as the end position is reached, the ring 11 presses the balls 7*a* into the upper restricted portion 14 of the strut 1 and moves in the upward direction to press the balls 7*a* against the restricted portion 14, thereby locking the strut 1. The landing gear is retracted in the reverse manner.

To prevent under all circumstances when unlocking the ball holding device the strut and the transmission gear from being suddenly released and the transmission gear from striking the stop 4, the locking mechanism may be designed in the manner as shown in Fig. 4. In this case the slant surfaces 24 of the transmission gear 21 are in engagement with the balls 22 when the landing gear is being retracted or lowered. If the edge 51 of the restricted portion of the strut 23 passes beyond the center of the balls when the strut is being retracted, the balls are caused by the transmission gear 21 which moves slowly in a direction opposite to the direction of the strut to glide into the restricted portion of the strut. If the balls 22 fit snugly the restricted portion of the strut 23 so as to lock the latter, the extensions 52 of the transmission gear 21 are moved over the balls 22, thus locking the strut in the end position. When the landing gear is being lowered the transmission gear 21 moves in the upward direction to such an extent as to release the balls which upon the further displaeement of the transmission gear 21 are continuously pressed against the slant surfaces thereof, thereby preventing the balls from falling out. In order that the pressure of the balls against the strut does not become too great during the retraction and lowering of the landing gear, the angle α at which the surface 24 is inclined must be relatively small.

To prevent the balls from being pressed against the strut during the retraction and lowering of the landing gear, the locking device may be modified in a manner as shown in Figs. 5 to 7. The locking device is designed in the same manner as shown in the embodiment in Fig. 4 except that the balls 22 are arranged in a particular ball cage 25 which with respect to the transmission gear 31 is rotatably mounted on the toothed rack 29. In this case the toothed rack is bent at the ends as shown in Fig. 7. At the same time the transmission gear 31 is designed at the point at which it is in engagement with the balls 22 in the manner as shown in Figs. 5 and 6, i. e., the straight contact surface portion 26 of the transmission gear 31 perpendicular to the axis of the strut is in engagement with the balls during the retraction and lowering of the strut. Only in the neighborhood of the end position of the adjustable strut, the bent end 29 of the toothed rack 4 rotates the ball cage 25 to such an extent that the balls come into engagement with the cylindric grooves 27 of the transmission gear 31. As long as the upper edge of the restricted portion of the strut has not yet passed beyond the center of the ball, the slant surface 28 of the transmission gear rests on the balls and presses the same against the strut. However, if the upper edge of the restricted portion of the strut passes beyond the center of the ball, the balls move radially into the restricted portion. The transmission gear is then slowly lowered, for instance, during the retraction of

the strut. In the end position of the strut the balls fit snugly the restricted portion of the strut and prevent a further movement of the same. The transmission gear with its cylindric notches **27** is now allowed to move in the downward direction beyond the center of the ball, thus locking the strut in the end position. When the strut is to be lowered, the transmission gear moves in the upward direction, releases the balls which are pressed outwardly and come into engagement with the slant surfaee **28** of the transmission gear **31**. As soon as the strut is released the ball cage is again rotated in such a manner as to cause the balls to come into engagement with the straight surface **26** of the transmission gear **31** so that when the strut is lowered to a further extent they no longer exert a radial pressure on the strut. In this manner any sudden change of the position of the strut and the transmission gear is prevented in the embodiment just described.

To disconnect the driving motor, end switches are employed, which are actuated when the transmission gear **31** reaches the lower and upper end position.

Figs. 8 and 9 show an improved ball holding arrangement according to Figs. 5 to 7 in which the gliding of the balls is prevented during the rotation of the ball cage by means of a thrust bearing for the balls. The latter contact the ring **32** in the position shown which permits the balls to roll when the ball cage **25** is being rotated. The ring in turn is rotatably mounted with respect to the casing **33**, since it is supported on balls **34**. To displace the balls **22** with respect to the casing **31**, the ring **32** is preferably only rotated. In this case only half the power is necessary as compared to that necessary for rotating the ball cage **25** according to the previous embodiment, the angle of displacement must, however, be twice as great as that of the preceding embodiment (see Fig. 9).

A further embodiment is shown in Figs. 10 to 12. The transmission gear **41** is substantially designed in the same manner as that shown in Fig. 4. A locking ring **42** provided with the restricted portion **47** is firmly secured to the strut **43**. The pressure ring **44** which loosely surrounds the strut **43** between the end of the toothed rack **45** and the locking ring **42** is guided in two spiral-shaped slots **53** of the casing **46** with the aid of pins **48** and **49**. The balls **50** no longer surround the entire periphery of the strut **43**. They are symmetrically arranged with respect to the diameter of the strut as will be seen from Fig. 11.

In this embodiment the strut is lowered in the following manner: The transmission gear **41** moves at first in the upward direction and releases the balls **50** so that the latter are allowed to leave the restricted portion **47**, whereupon the strut **43** moves in the downward direction. The toothed rack **45** is thus stressed against the pressure ring **44** which is forced in the downward direction and carries out a rotation owing to the spiral-shaped slots in the casing **46**, so as to position the ring **44** in front of the balls **50** in the manner as shown in Fig. 12. The recess of the ring **44** is at the same time so positioned that the rack **45** toothed at both sides thereof may pass through the recess upon the further rotation of the pressure ring **44**.

To lock the strut in the lowered position the same locking arrangement is employed in the upper end of the transmission gear.

When the strut is in the retracted position the ring **42** entrains the pressure ring **44** in the upward direction which is rotated again to the initial position and the balls **50** glide again into the restricted portion **47** of the ring **42**.

To improve the conditions of friction when locking and unlocking the strut, the contact surfaces of the pressure ring **44** and of the casing **46** for the balls **50** may be slanted off as shown in Fig. 13.

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