Feb. 8, 1955 W. E. NORDMARK ET AL 2,701,693

SAFETY REEL

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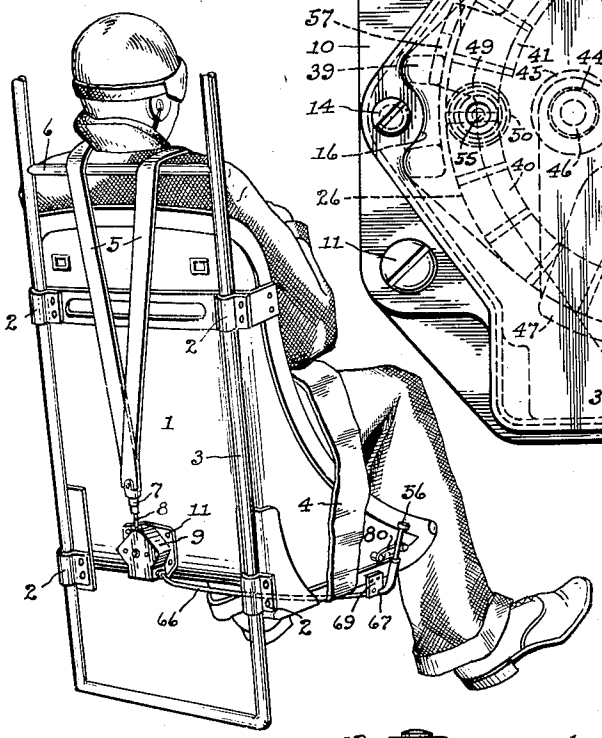
Fig. 1



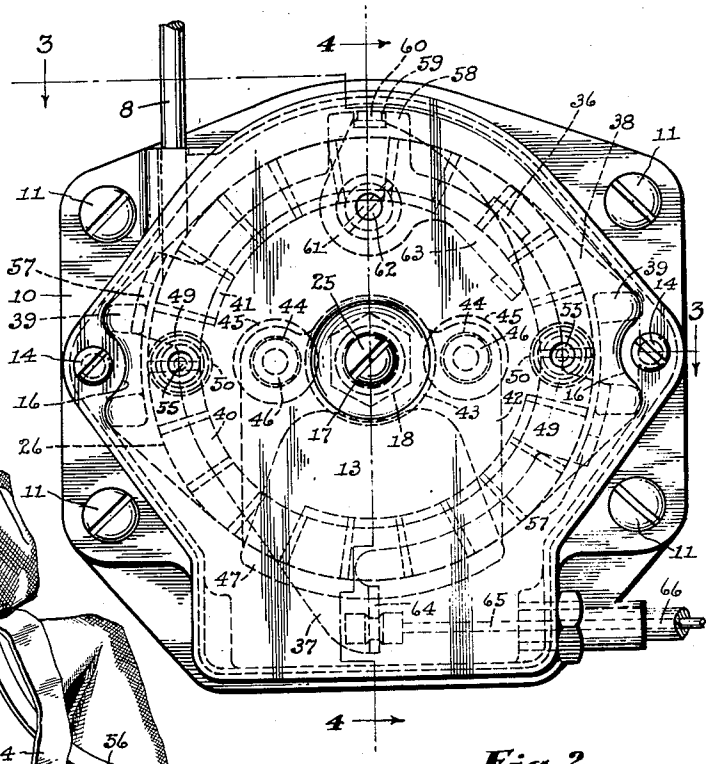


Fig. 2

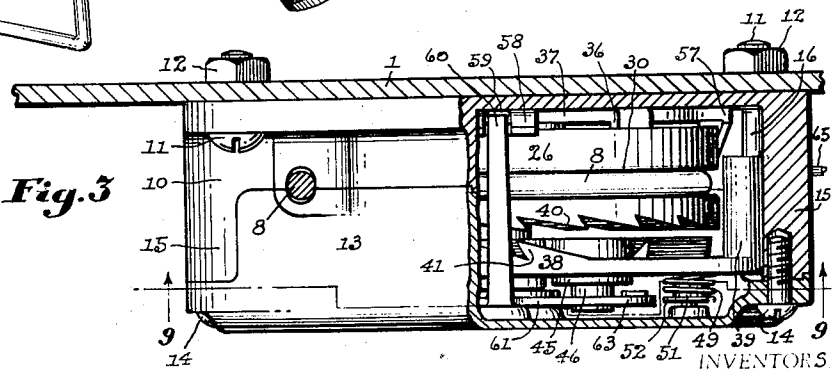


Fig. 3

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SAFETY REEL

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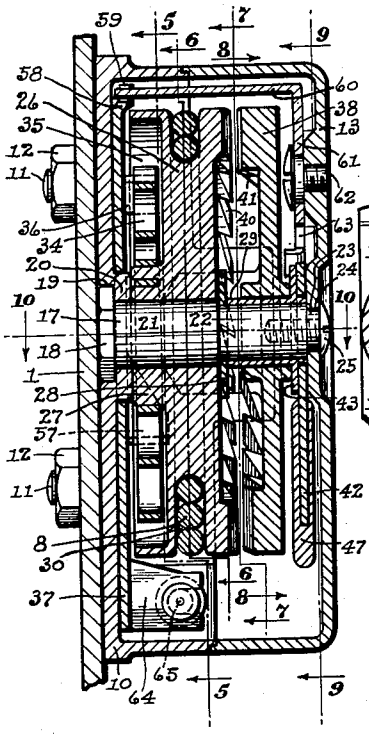

Fig. 4

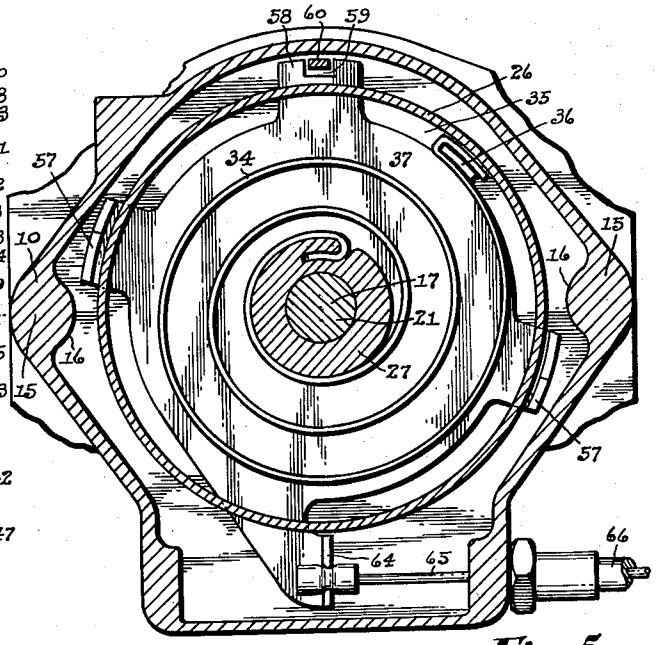

Fig. 5

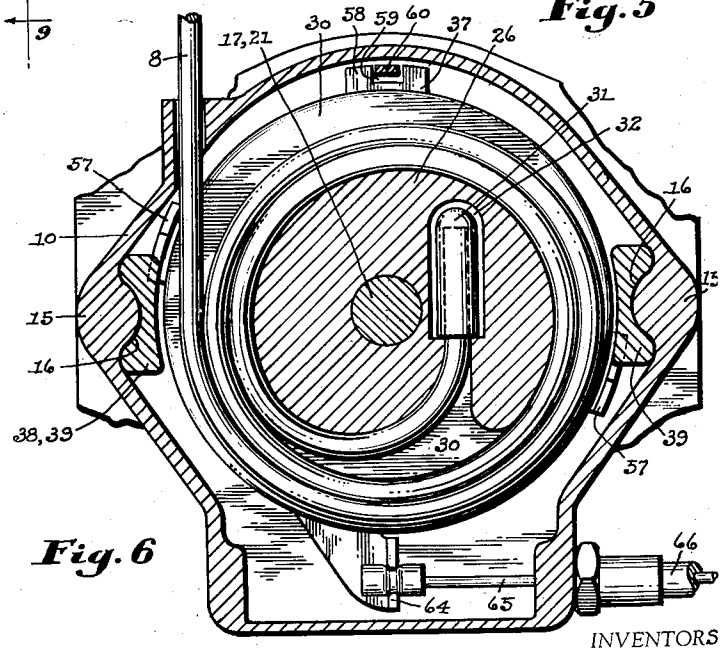

Fig. 6

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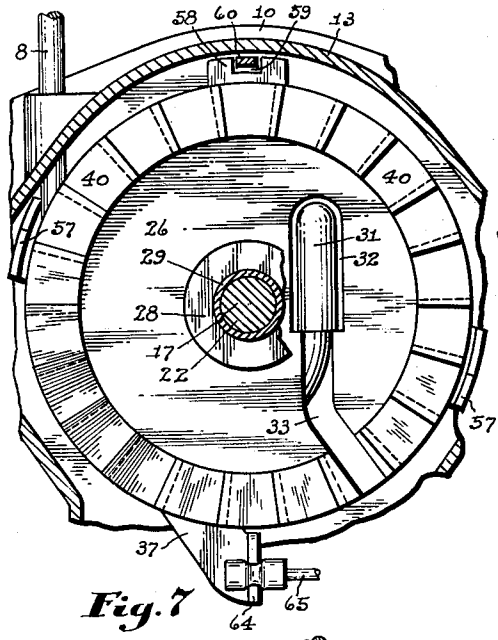

Fig. 7

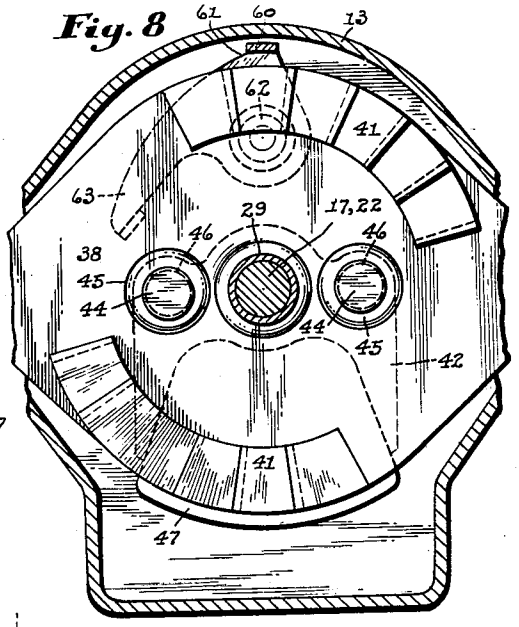

Fig. 8

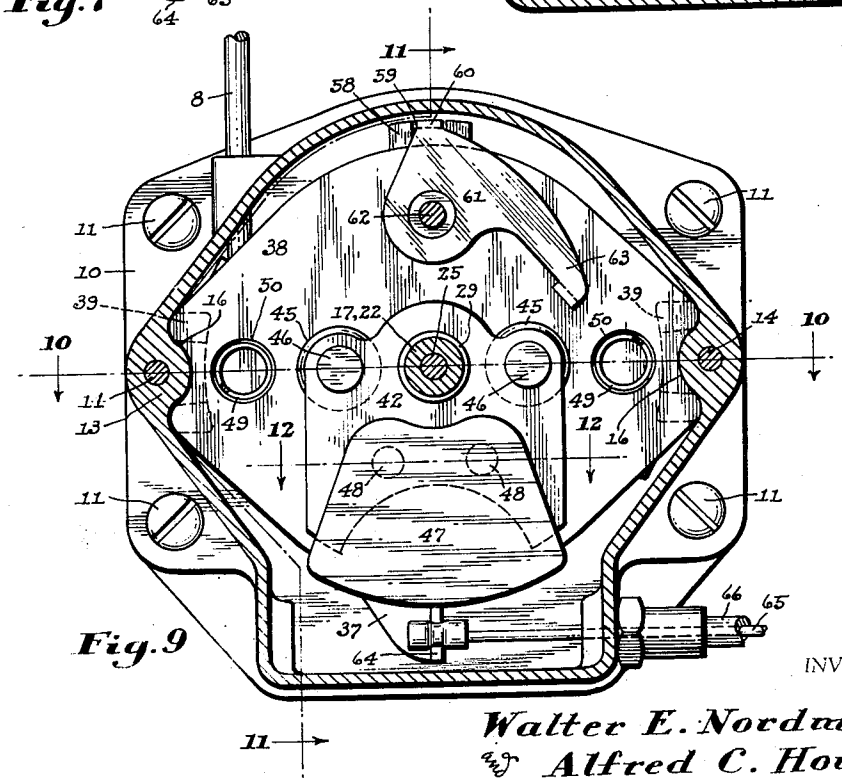

Fig. 9

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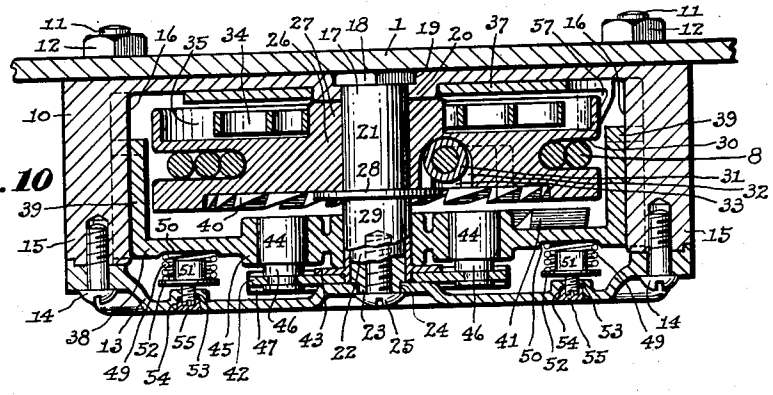


Fig. 10

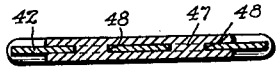
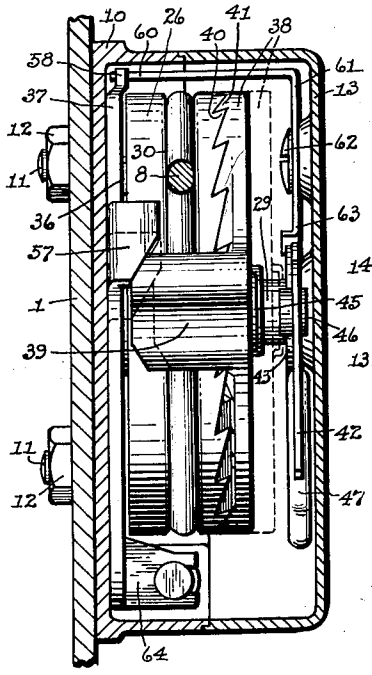


Fig. 12

Fig. 11



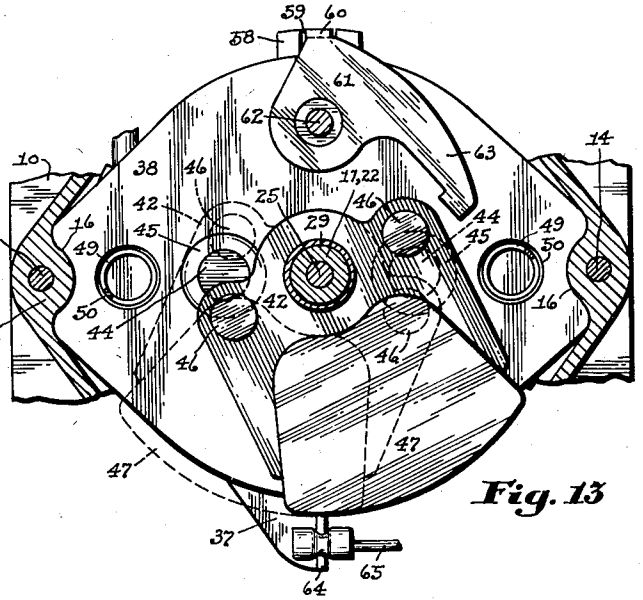


Fig. 13

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SAFETY REEL

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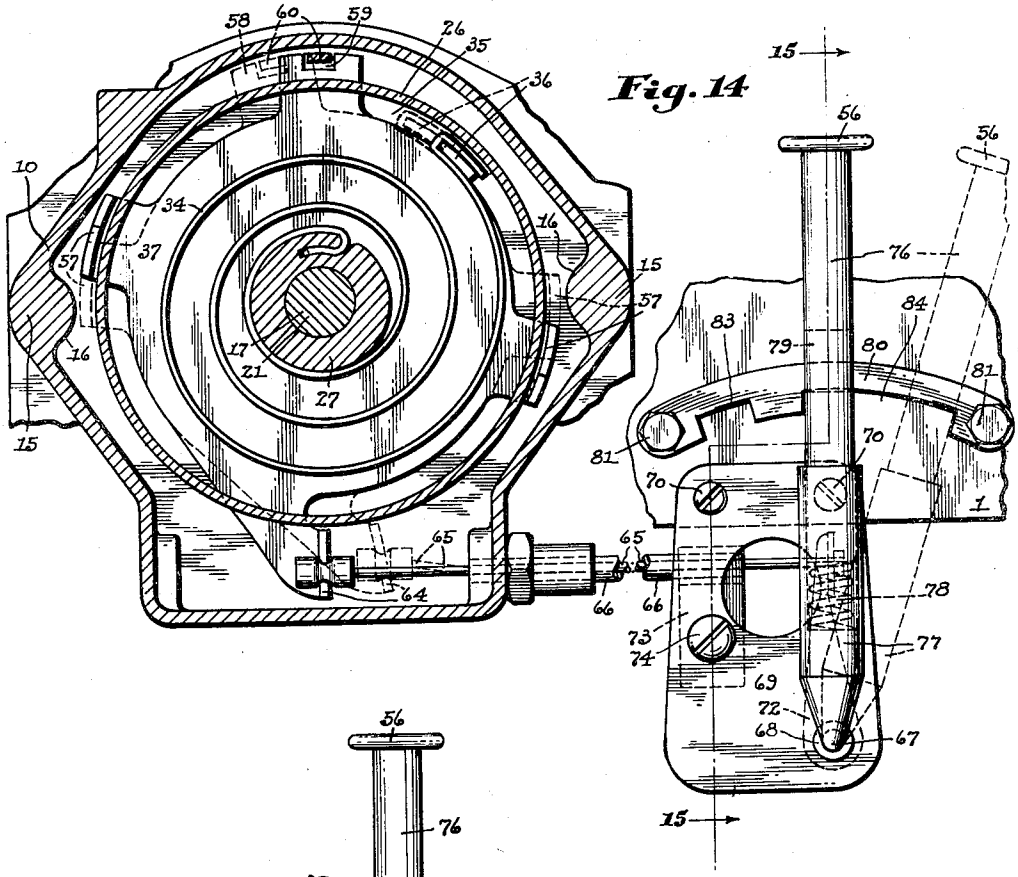

Fig. 14

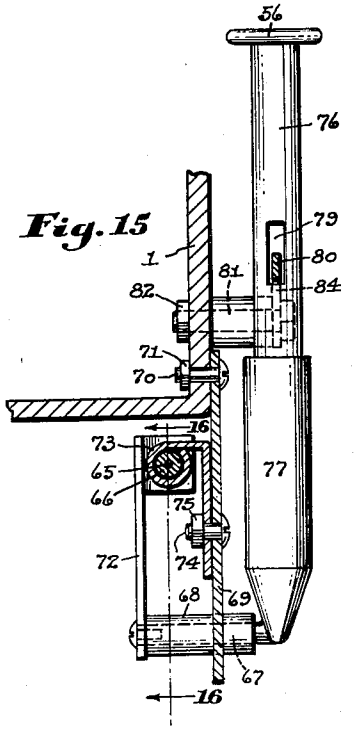

Fig. 15

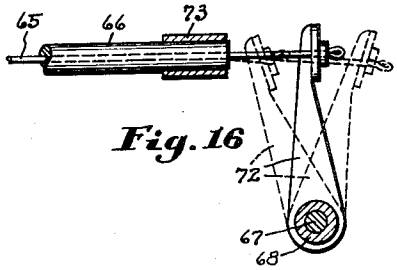

Fig. 16

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SAFETY REEL

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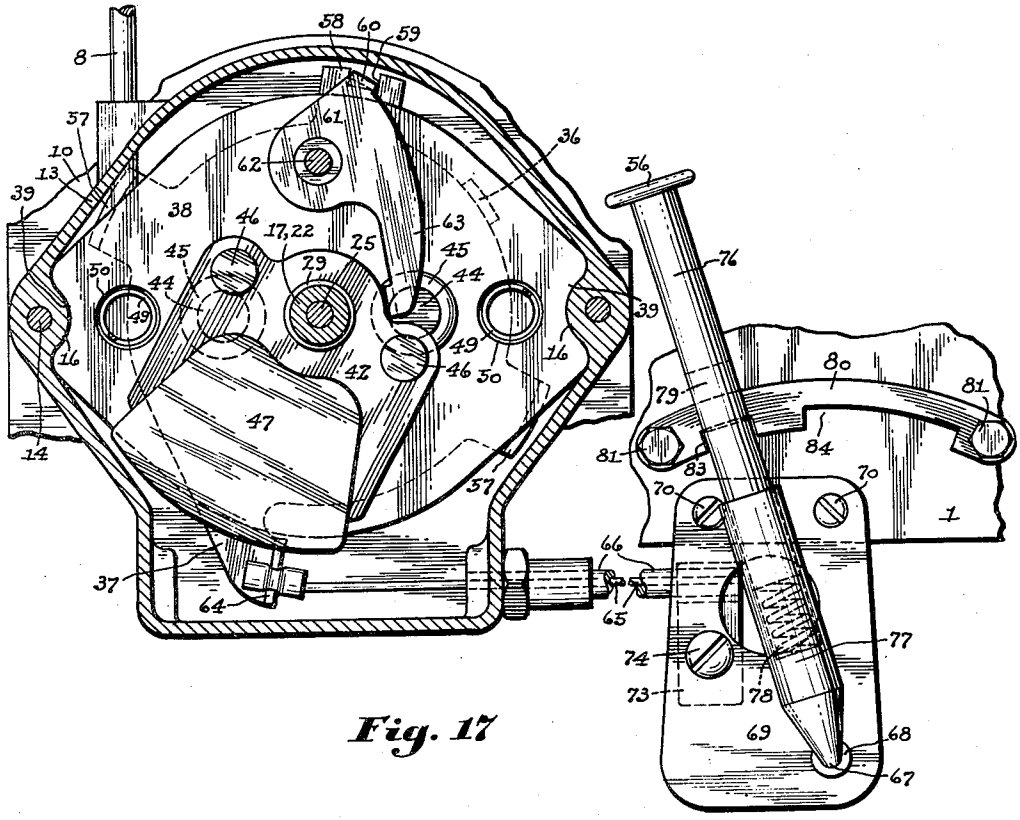

Fig. 17

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United States Patent Office 2,701,693 Patented Feb. 8, 1955

2,701,693

SAFETY REEL

Walter E. Nordmark and Alfred C. Hoven, Grand Rapids, Mich., assignors to American Seating Company, Grand Rapids, Mich., a corporation of New Jersey

Application February 15, 1951, Serial No. 211,076

6 Claims. (Cl. 242—107)

The present invention relates to safety reels and more particularly to an automatic inertia-operated reel for taking up the cable on a shoulder harness by means of which an occupant of an airplane or other vehicle is secured in his chair in the event of a crash.

The primary objects of the invention are to provide an improved inertia-actuated safety reel of the same general type as those disclosed in Nordmark Patents No. 2,434,119 issued January 6, 1948 and No. 2,480,335 issued August 30, 1949; to provide such a reel which is inertia-operable to automatically lock the occupant in his chair in event of collision, crash-landing or other emergency, regardless of the direction of impact of the vehicle against any external object including the earth.

Prior safety reels of the inertia-actuated type have operated to lock an airplane pilot, or other vehicle occupant, in his chair only in the event of a head-on collision of the vehicle. However, it sometimes happens, and more frequently with airplanes than with other vehicles, that an initial crash takes place otherwise than head-on. In such instances the chair occupant is not so likely to be thrown forward by inertia against the instrument panel of the vehicle as in the case of a head-on crash, but it is nevertheless desirable that he be immediately locked in his seat so that he will not be thrown sidewise or forward in the vehicle in the event of asubsequent crash, as when an airplane rebounds and crashes a second and perhaps a third and a fourth time, all in different directions.

The present reel is therefore constructed so as to lock by inertia under varidirectional impact of the vehicle with some external object.

An illustrative embodiment of the invention is shown in the accompanying drawings, wherein:

Figure 1 is a rear and side perspective view of an airplane pilot's chair showing a pilot seated therein and a safety shoulder harness passing over the pilot's shoulders and downwardly in the rear of the chair to operative connection with the new automatic reel mounted at the lower rear of the chair back.

Figure 2 is a rear elevational view of the new reel per se, certain internal parts thereof being indicated by dotted lines in this view;

Figure 3 is a view of the same partly in top plan and partly in horizontal section taken on line 3—3 of Figure 2;

Figure 4 is a central vertical sectional view of the same taken on line 4—4 of Figure 2, certain parts thereof being shown in their "unlocked" positions;

Figure 5 is a fragmentary, vertical sectional view of parts thereof, taken on line 5—5 of Figure 4;

Figure 6 is a fragmentary, vertical sectional view of parts thereof, taken on line 6—6 of Figure 4;

Figure 7 is a fragmentary, vertical sectional view of parts thereof taken on line 7—7 of Figure 4;

Figure 8 is a fragmentary, vertical sectional view of parts thereof, taken on line 8—8 of Figure 4;

Figure 9 is a vertical sectional view of the reel taken on line 9—9 of Figure 4;

Figure 10 is a horizontal sectional view of the same taken on lines 10—10 of Figures 4 and 9;

Figure 11 is a vertical sectional view taken on line 11—11 of Figure 9, certain internal parts of the reel being shown in side elevation, and some parts being shown in their "locked" positions;

Figure 12 is a horizontal sectional view of a "pendulum" element of the reel, taken on line 12—12 of Figure 9;

Figure 13 is a fragmentary vertical sectional view of parts of the reel, similar to Figure 9 but showing certain parts of the reel in other positions;

Figure 14 is a fragmentary composite view showing the reel in vertical section similar to Figure 5, and also showing in side elevation the manual control switch seen at the right of Figure 1, certain parts of the reel and the switch being shown in corresponding positions in full lines and in other corresponding positions in dotted lines;

Figure 15 is a fragmentary view showing the manual control switch partly in rear elevation and partly in section taken on line 15—15 of Figure 14;

Figure 16 is a fragmentary sectional view of parts of the same taken on line 16—16 of Figure 15 and showing certain parts in different positions in dotted lines; and

Figure 17 is a fragmentary composite view similar to Figure 14, certain parts being shown in still other positions in this view.

Referring now in detail to these drawings wherein like parts are designated by the same numerals in the several views, and referring first particularly to Figure 1, the pilot chair 1 there shown is provided with fittings 2 by means of which the chair is mounted upon a tubular supporting frame structure 3 adapted to be secured by any suitable means (not shown) in an upright position at the pilot's station in an airplane. The chair is equipped with a conventional lap belt 4 and with a shoulder harness for the pilot, the harness being provided with straps 5 which pass over a cross-tube 6 on the chair frame 3 and thence downwardly, the lower ends of the straps being connected to each other and to a clevis fitting 7, and the clevis fitting being in turn secured to one end of a harness-cable 8 which is taken up by the new reel when relaxed.

The reel, generally designated 9 in Figure 1, is mounted in a housing made in two parts—a base 10 adapted to be secured to the back of the chair 1 in the position indicated, by means of bolts 11 having nuts 12 thereon, and a cover 13 secured to the base 10 by means of screws 14 passing through apertures in the cover and threaded in the base 10.

The housing being mounted in upright position as shown for which position the reel is primarily designed, the base 10 has its opposite side portions 15 rearwardly extended, and the interior opposite sides of the base 10 are provided with rearwardly extending guides 16 of generally semicylindrical form, the purpose of which will hereinafter be fully described. A spindle 17 extends rearwardly from the center of the base 10 intermediate the guides 16, said spindle 17 having a hexagonal head 18 seated within a complementary recess 19 formed in the base 10 by an embossing 20 (see Figures 4 and 10), and the spindle is securely attached to the base as by welding. The forward shank portion 21 of the spindle 17 is of one diameter whereas the rearward shank portion 22 is of a slightly smaller diameter, and the rearwardmost end 23 of the spindle is further reduced and extended through an aperture 24 in the cover 13. A machine screw 25 is threaded into the rearward end of the spindle 17 to securely connect the spindle to the center of the cover.

A drum 26 is rotatably mounted on the forward shank portion 21 of the spindle 17. The front center or hub portion 27 of the drum bears against the embossing 20 on the base 10 while the rear center portion of the drum 26 bears against a washer 28 held in position against the middle shoulder of the spindle 17 by means of a sleeve 29 which circumscribes the spindle's reduced shank portion 22 and which has its forward end bearing against the washer 28 and its rearward end bearing against the cover 13 of the housing. The drum 26 is thus prevented from sliding longitudinally on the spindle 17, and although nonslidable is freely rotatable on the spindle.

The drum 26 has a peripheral groove 30 therein for the accommodation of several turns of the harness-cable 8, the drum end of the cable being secured to the drum by means of a cable-pin 31 seated in a well 32 in the drum (see Figures 6, 7 and 10) and communicating with the groove 30. As seen in Figures 7 and 10 the well 32 opens through the rear wall of the drum, and rear wall also has a slot 33 therein which extends through the wall to the cable groove 30 and from the well 32 to the outer

periphery of the drum. This slot 33 is provided for entry of the cable 8 when the cable is initially assembled to the drum.

Means are provided for normally urging the drum 26 in a direction for winding the cable thereon, so that slack in the cable is taken up at all times. These means comprise a spiral spring 34 disposed in an annular cavity 35 in the rear of the drum, the inner end of the spiral spring being secured to the hub 27 of the drum (see Figure 5) and the outer end of the spring being secured to a lug 36 on a control lever 37 turnably mounted on the boss formed by the embossing 20 on the base 10 of the housing. (The construction and operation of the control lever 37 are described in detail hereinafter.)

A locking member 38 is longitudinally slidably mounted on the sleeve 29 which circumscribes the reduced shank portion 22 of spindle 17, said locking member 38 being disposed rearwardly of the drum and having key means 39 at opposite sides thereof which are forwardly-rearwardly movable on the housing's guides 16. The locking member is thus keyed to the housing and is non-rotatable on the spindle 17. Cooperative locking means here shown in the form of ratchets 40 and 41 are provided on the rearward part of the drum 26 and on the forward part of the locking member 38, respectively. It will be seen that when the locking member is slid forwardly into engagement with the drum, these ratchet teeth 40 and 41 interlock to prevent rotation of the drum in a direction for unwinding the cable while permitting rotation of the drum in the opposite direction for winding the cable thereon. Thus when these parts are in engagement the cable cannot pay out to permit farther forward movement of the chair occupant, but should the occupant move farther rearwardly the cable will be taken up.

A pendlum 42 is laterally swingably mounted on the sleeve 29 which circumscribes the reduced portion 22 of spindle 17, the pendulum being located rearwardly of the locking member 38 and being confined on the sleeve between a collar 43 on the sleeve and the inner wall of the housing's cover 13, so that the pendulum is swingably but non-slidably mounted on the spindle. Severable, magnetic connecting means are provided on the locking member 38 and the pendulum 42 whereby the locking member may be releasably maintained in contact with the pendulum, in a rearward position of disengagement from the drum 26. These means comprise a pair of magnetic inserts 44 mounted in bosses 45 on opposite sides of the locking member's center, and a pair of cooperating magnetic inserts 46 secured as by riveting to the upper end of the pendulum 42 on opposite sides of the pendulum s center. The lower end of the pendulum is weighted as by means of a lead mass 47 which extends through apertures 48 (see Figures 9 and 12) in the pendulum's flat sheet metal body thus to secure the lead mass in position on the pendulum. The pendulum thus normally depends perpendicularly from the spindle 17 as illustrated in Figure 9, in which position the magnetic inserts 46 on the pendulum are in forward-rearward alignment with the magnetic inserts 44 on the locking member. Although the inserts 44 and 46 are all herein referred to as "magnetic," it will be understood that either pair of inserts may be magnetized while the other pair is of unmagnetized but magnetically responsive metal.

With the locking member 38 in its rearward position of magnetic contact with the pendulum 42, and thus disengaged from the drum 26, lateral swinging movement of the pendulum in either direction as illustrated in Figure 13 severs the magnetic connections between the inserts 44 and the inserts 46, and the locking member 38 is thus free to move forwardly into engagement with the drum 26. In order to insure such forward movement of the locking member upon severance of the magnetic connections, coiled compression springs 49 are interposed between the locking member and the housing's cover 13 at opposite sides thereof. The forward ends of these springs are seated in recesses 50 (see Figures 9 and 10) in the rear surface of the locking member, and the rearward ends of these springs 49 circumscribe the forward ends of studs 51 and abut against collars 52 on said studs. The studs have threaded rearward ends 53 by means of which they are mounted in the cover 13, and the rearwardmost ends of the studs extend into wells 54 formed in the cover's exterior. When the reel is first assembled and tested, these studs are turned to adjust the springs 49 to the desired degree of compression, after which the studs may be sealed in adjusted position by filling the wells 54 with a fusible metal 55, as best seen in Figure 10. The adjustment of the springs 49 cannot thereafter be inadvertantly disturbed, but can only be changed by first removing the fusible metal slugs 55.

The control lever 37 turnably mounted on the base 10 of the housing, together with the manual control switch 56 shown in Figures 14 through 17, provide means whereby the locking member 38 may be manually moved either to a forward position of engagement with the drum 26 or to a rearward position of disengagement from the drum. The control lever 37 is provided with rearwardly extending camming lugs 57 at opposite sides thereof (see Figure 11), which lugs engage the forward ends of the locking member's key means 39, so that when the control lever 37 is turned counter-clockwise as indicated by the dotted lines of Figure 14, the locking member 38 is moved rearwardly from its forward position shown in full lines in Figure 11 to its rearward position indicated by dotted lines in the same view. At its upper end the control lever 37 is provided with an upper extension 58 having a kerf 59 in which is engaged the forward end of a finger 60 which extends forwardly from a crank 61 pivotally mounted on a stud 62 threaded in the cover 13 of the housing. The crank's rearward arm 63 is adapted to contact the upper right corner surface of the pendulum 42 (see Figure 17) when the control lever 37 is moved in a clockwise direction thus laterally swinging the pendulum 42 to the left so as to sever the magnetic connections between the pendulum and the locking member 38 thus permitting the locking member to move forwardly into engagement with the drum 26 by the force of springs 49.

At the lower end of the control lever 37 is a rearwardly extending lug 64 in which is engaged the reel end of a flexible control cable 65 which extends from the reel through a flexible control tube 66 to the manual control switch 56 which has a shaft 67 pivotally mounted in a bearing 68 on a bracket 69 secured to the side of the pilot's chair 1 as by means of bolts 70 and nuts 71. The switch end of the control cable 65 is connected to the upper end of an arm 72 on the inner end of the switch's shaft 67, while the switch end of the flexible control tube 66 is fastened to a bracket 73 secured to bracket 69 by means of a bolt 74 and nut 75. The manual control switch lever is in the form of a plunger 76 slidably mounted in a barrel 77 extending upwardly from the shaft 67, the plunger 76 being normally urged upwardly by a spring 78 disposed within the barrel. Upward movement of the plunger 76 is limited by contact of the bottom of a slot 79 in the plunger with an arcuate guide 80 secured to the pilot seat 1 by means of bolts 81 and nuts 82. The guide 80 has a rearward notch 83 and an elongated forward notch 84 for engagement of the plunger 76 in the latter's several positions hereinafter described.

Operation

The reel herein disclosed may be either manually set to lock an airplane pilot in position at all times, which is desirable during take-off or landings, or manually set for automatic inertia-locking to lock the pilot in his seat in case of a crash during flight. In the latter case, the inertia-locking takes place under multidirectional conditions of impact, that is to say the airplane may crash in a forwardly direction, or sidewise, or at an angle, and the reel will be locked by inertia to secure the pilot in a rearwardly position in his seat. To set the reel for automatic inertia-locking, the manual control switch 56 is first moved to its extreme forward position, indicated by dotted lines at the extreme right in Figure 14. This moves the flexible cable 65 so that the control lever 37 is turned counter-clockwise to its dotted line position shown in Figure 14, which movement causes the camming lugs 57 on the control lever 37 to move the locking member 38 rearwardly from its position shown in full lines in Figure 11 to its position indicated in dotted lines in that view. The latter or rearward position of the locking member is also shown in full lines in Figures 3, 4 and 10. The locking member 38 is thus disengaged from ratchet interlock with the drum 26, and the locking member 38 is releasably maintained in this rearward position of disengagement by the magnetic contact of the magnetic inserts 44 on locking member 38 with the magnetic inserts 46 on the pedulum 42. With the parts so positioned,

the drum 26 is free to rotate thus permitting complete freedom of movement of the pilot, and the drum 26 pays out or takes up the harness cable 8 as necessary. The spiral spring 34 urges the drum 26 in a direction for taking up the cable, and the drum 26 and spring 34 thus constitute resilient means operatively connecting the harness to the supporting structure for the reel—i. e., the pilot's chair 1 as shown. The spring 34 serves a further purpose by returning the control lever 37, the flexible control cable 65 and the manual control switch 56 from their dotted line positions shown in Figure 14 to their solid line positions shown in the same view, and the reel is now "cocked" for inertia-operation.

The coil springs 49 are so adjusted that, upon forward impact of the vehicle with an external object, e. g. the earth, at a specified number of "g's," the magnetic connections between the locking member 38 and the pendulum 42 will be severed by the inertia of the locking member, whereupon such inertia and the force of the coil springs 49 will move the locking member forwardly into ratchet-engagement with the cable-drum 26.

Sidewise or angular impact of the vehicle with an external object will cause the pedulum 42 to laterally swing to one side or the other by its inertia, as indicated in Figure 13, thus throwing the magnetic inserts 46 on the pendulum out of alignment with the magnetic inserts 44 on the locking member. These magnetic conneotions between the locking member and the pendulum are thus severed and the locking member is moved forwardly by the coil springs 49 into ratchet engagement with the cable drum 26.

The reel may be manually locked, from its "cocked" position for inertia-locking, by moving the manual control switch 56 to its full line position shown in Figure 17, in which position the control switch is maintained until manually released by engagement of the slot 79 on the plunger 76 with the notch 83 on the arcuate guide 80. This movement of the manual control switch 56 turns the control lever 37 in a clockwise direction as shown in solid lines in Figure 17, thus manually severing the magnetic connections between the pendulum 42 and the locking member 38 and permitting the locking member to be moved forwardly by the force of coil springs 49 into ratchet engagement with the cable-drum 26.

When the locking member 38 is in its forward position of ratchet engagement with the cable-drum 26, whether moved there by inertia or manually, the harness-cable 8 is always taken up if the chair occupant moves rearwardly because the ratchet form of interlock permits movement of the drum 26 in that direction. However, the harness cable is positively locked against any further paying-out, and the occupant is thus prevented from being thrown forward against the instrument panel or other appurtenance of the vehicle. The reel remains in this locked condition until manually unlocked as hereinbefore described.

It will thus be seen that the invention provides a novel, automatic, multidirectional inertia-operable safety-harness take-up reel for providing safety to the occupants of chairs in any type of moving vehicle, and while but one specific embodiment of the invention has been herein shown and described, it will be understood that numerous details may be altered or omitted, without departing from the spirit of the invention as defined by the following claims.

We claim:

1. A safety device for use on a vehicle having therein a chair and a harness for the chair occupant associated with the chair, said safety device comprising: a housing mounted in the vehicle; a drum mounted in the housing for rotation about an axis extending forwardly-rearwardly of the vehicle; a cable connected to the harness and to the drum whereby rotation of the drum in one direction winds the cable thereon and opposite rotation of the drum unwinds the cable; spring means normally yieldingly urging said drum in a direction for winding the cable thereon; a locking member keyed at opposite sides to the housing for forward-rearward sliding movement therein rearwardly of the drum; cooperative ratchet means on the rearward part of the drum and on the forward part of the locking member adapted to engage and prevent rotation of the drum in a direction for unwinding the cable while permitting rotation of the drum in the opposite direction; and inertia-responsive means mounted in the vehicle and operatively connected to said locking member whereby sudden deceleration of the vehicle moves said locking member forwardly into engagement with the drum.

2. A safety device for use on a vehicle having therein a chair and a harness for the chair occupant associated with the chair, said safety device comprising: a housing mounted in the vehicle; a drum mounted in the housing for rotation about an axis extending forwardly-rearwardly of the vehicle; a cable connected to the harness and to the drum whereby rotation of the drum in one direction winds the cable thereon and opposite rotation of the drum unwinds the cable; a locking member keyed at opposite sides to the housing for forward-rearward sliding movement therein rearwardly of the drum; cooperative locking means on the rearward part of the drum and on the forward part of the locking member adapted to engage and prevent rotation of the drum when the locking member moves forwardly; a pendulum mounted in the vehicle for lateral swinging movement rearwardly of the locking member; and severable magnetic connecting means on the locking member and the pendulum for releasably maintaining the locking member in contact with the pendulum, said magnetic connecting means being severable by the forward inertia of the locking member upon forward impact of said vehicle with an external object and being severable by the lateral inertia of the pendulum upon sidewise impact of said vehicle with an external object; and means for urging said locking member forwardly upon severance of said magnetic connecting means.

3. In a reel device of the class described: a housing adapted for mounting in an upright position on a suitable supporting structure, said housing having rearwardly extending guides at the opposite interior sides thereof; a spindle mounted in the housing and projecting rearwardly therein between said guides; a drum rotatably and non-slidably mounted on the spindle and adapted to receive a cable wound thereon; a locking member slidably mounted on the spindle rearwardly of the drum and having key means at opposite sides thereof forwardly-rearwardly movable on the housing's guides whereby the locking member is keyed against rotation; cooperative locking means on the rearward part of the drum and on the forward part of the locking member adapted to engage when the locking member is slid forwardly into engagement with the drum thus to prevent rotation of the drum; a pendulum non-slidably mounted on the spindle for lateral swinging movement rearwardly of the locking member; severable connecting means on the locking member and the pendulum for releasably maintaining the locking member in a rearward position contacting the pendulum in which position the locking member is disengaged from the drum, said connecting means being severable by sidewise swinging movement of the pendulum; and means for urging said locking member forwardly upon severance of said connecting means.

4. In a reel device of the class described: a housing adapted for mounting in an upright position on a suitable supporting structure; said housing having rearwardly extending guides at the opposite interior sides thereof; a spindle mounted in the housing and projecting rearwardly therein between said guides; a drum rotatably and non-slidably mounted on the spindle and adapted to receive a cable wound thereon; a locking member slidably mounted on the spindle rearwardly of the drum and having key means at opposite sides thereof forwardly-rearwardly movable on the housing's guides whereby the locking member is keyed against rotation; cooperative locking means on the rearward part of the drum and on the forward part of the locking member adapted to engage when the locking member is slid forwardly into engagement with the drum thus to prevent rotation of the drum; a pendulum non-slidably mounted on the spindle for lateral swinging movement rearwardly of the locking member; severable magnetic connecting means on the locking member and the pendulum for releasably maintaining the locking member in a rearward position contacting the pendulum in which position the locking member is disengaged from the drum, said magnetic connecting means being severable by sidewise swinging movement of the pendulum; and means for urging said locking member forwardly upon severance of said magnetic connecting means.

5. In a reel device of the class described: a housing adapted for mounting in an upright position on a suitable supporting structure, said housing having rearwardly ex-

tending guides at the opposite interior sides thereof; a spindle mounted in the housing and projecting rearwardly therein between said guides; a drum rotatably and non-slidably mounted on the spindle and adapted to receive a cable wound thereon; spring means normally urging the drum in a direction for winding the cable thereon; a locking member slidably mounted on the spindle rearwardly of the drum and having key means at opposite sides thereof forwardly-rearwardly movable on the housing's guides whereby the locking member is keyed against rotation; cooperative ratchet means on the rearward part of the drum and on the forward part of the locking member adapted to engage when the locking member is slid forwardly into engagement with the drum thus to prevent rotation of the drum in a direction for unwinding the cable while permitting rotation of the drum in a direction for winding the cable thereon; a pendulum non-slidably mounted on the spindle for lateral swinging movement rearwardly of the locking member; severable connecting means on the locking member and the pendulum for releasably maintaining the locking member in a rearward position contacting the pendulum in which position the locking member is disengaged from the drum, said connecting means being severable by lateral swinging movement of the pendulum; and means for urging said locking member forwardly upon severance of said connecting means.

6. A safety device for use on a vehicle having therein a fixed support, a chair, and a harness for the chair occupant associated with the chair, said safety device comprising: a housing adapted for mounting on the fixed support, said housing having guides at the opposite interior sides thereof; a spindle mounted in the housing and projecting between the guides; a drum rotatably and non-slidably mounted on the spindle and adapted to receive a cable wound thereon; spring means normally urging the drum in a direction for winding the cable thereon; a locking member slidably mounted on the spindle and having key means at opposite sides thereof movable on the housing's guides whereby the locking member is keyed against rotation; cooperative ratchet means on the drum and the locking member adapted to engage when the locking member is slid into engagement with the drum thus to prevent rotation of the drum in a direction for unwinding the cable while permitting rotation of the drum in a direction for winding the cable thereon; severable magnetic connecting means in the housing and associated with the locking member for normally attracting the locking member into a slid position out of engagement with the drum; a pendulum mounted in the vehicle and operatively associated with the magnetic connecting means whereby movement of the pendulum in response to sudden deceleration of the vehicle severs said magnetic connecting means; and spring means for urging the locking member into engagement with the drum upon the serverance of said magnetic connecting means.

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