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(54) AUTOMATIC LOCKING ACCELERATION ACTUATED VEHICLE SAFETY BELT RETRACTOR

(71) We, TAKATA KOJYO CO. LTD., 10 Mori Building, 28 Sakuragawa-cho, Nishikubo, Shiba, Minato-ku, Tokyo, Japan, a body corporate organised under the laws of Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to automatic locking safety belt retractors.

In order to restrain a vehicle seat occupant against forward motion in the event of a sharp or rapid slowing of the vehicle's forward motion, such as that accompanying a collision or similar occurrence while affording free and unhampered movement to the seat occupant under normal vehicle conditions, it is a common practice to take up the safety belt by a spring biased retractor reel which permits free withdrawal of the safety belt except under rapid vehicle deceleration conditions, under which conditions the reel is automatically locked against belt withdrawal. One type of such reel responds to the belt withdrawal speed exceeding a predetermined rate to lock the reel against further withdrawal. While the reel may respond to any desired belt pull, it should advantageously respond to a pull exceeding 0.3 G. This type of reel which has been heretofore available possesses numerous drawbacks and disadvantages. They are complicated, bulky, expensive devices of limited application, difficult and inconvenient to install, and of little versatility and adaptability.

It is a principal object of the present invention to provide an improved vehicle safety belt retractor.

Another object of the present invention is to provide an improved automatic locking vehicle safety belt retractor reel.

Still another object of the present invention is to provide a safety belt retraction reel which automatically locks against belt withdrawal when the belt is withdrawn under a pull exceeding a predetermined value.

A further object of the present invention is to provide a device of the above nature, characterised by its high reliability, great compactness, low cost, ease and convenience of installation, and great versatility and adaptability.

According to the invention, there is provided an automatic locking safety belt retractor comprising a shaft, a take-up reel mounted fast on and rotatable with the shaft and spring-biased in a belt rewinding direction, a safety belt connected to and retractable by and withdrawable from the reel, a first ratchet wheel rotatable with the reel, a first pawl mounted for movement between positions engaging and disengaged from the first ratchet wheel, a second ratchet wheel mounted on and rotatable relative to the shaft, a fly wheel rotatably mounted on the shaft, a second pawl mounted on the fly wheel and movable therewith and movable relative to the fly wheel between positions engaging and disengaged from the second ratchet wheel, a cam member mounted on and rotatable with the shaft and engageable with the second pawl whereby rotation of the cam member a predetermined angle in advance of the fly wheel by the rotation of the shaft in response to a predetermined pull on the belt effects the actuation of the second pawl by the cam member into engagement with the second ratchet wheel to forwardly rotate the second ratchet wheel, and actuating means coupling the secand ratchet wheel and the first pawl whereby forward rotation of the second ratchet wheel advances the first pawl into engagement with the first ratchet wheel to lock the reel against belt withdrawal rotation, the first and second ratchet wheels having equal numbers of ratchet teeth.

Preferably the cam member and the first and second ratchet wheels are so angularly related about the shaft, that the first and second pawls, when actuated to their engaged positions, engage the base portions of corresponding ratchet teeth of the respective first and second ratchet wheels.

In a preferred form of the retractor, the

shaft is journalled between the side walls of a U-shaped bracket which rockably supports a cross bar having a pair of first pawls which are in the proximity of a pair of first ratchet wheels at opposite ends of the reel. The second ratchet wheel is internally toothed and surrounds the fly wheel and the second pawl which is pivotally mounted on the fly wheel. The means coupling the first pawl carrying cross bar and the second ratchet wheel, includes a transverse leg extending from the bar and engaged by an arm which includes a pin slidably engaging a radial slot in an end wall of the second ratchet wheel.

There is also provided an automatic locking safety belt retractor comprising a rotatable take-up reel spring-biased in a belt rewinding direction, a safety belt connected to and retractable by and withdrawable from the reel, a first ratchet wheel rotatable with the reel, a first pawl mounted for movement between positions engaging and disengaged from the first ratchet, a second ratchet wheel coaxial with and rotatable relative to the first ratchet wheel, a second pawl rotatable with the first ratchet wheel and movable between positions engaging and disengaging the second ratchet wheel and normally urged to the ratchet wheel disengage position, actuating means for urging the second pwal into engagement with the second ratchet wheel, and means coupling the second ratchet wheel and the first pawl whereby rotation of the second ratchet wheel advances the first pawl into engagement with the first ratchet wheel to lock the reel against belt withdrawal rotation, the first and second ratchet wheels having equal numbers of ratchet teeth.

The control components which require close tolerances may be injection moulded from a polymeric resin.

In the accompanying drawings:

Figure 1 is an exploded perspective view of an automatic locking belt retractor according to the present invention;

Figure 2 is a fragmentary front elevational view thereof;

Figure 3 is a side elevational view of the retractor shown in Figure 1;

Figure 4 is a sectional view taken along line X—X in Figure 2, showing the retractor in its normal operating condition;

Figure 5 is a view similar to Figure 4, showing the retractor in its locked condition;

Figure 6 is a side elevational view of another embodiment of the present invention;

Figure 6^1 is a perspective view of a component thereof; and

Figure 7 is a side elevational view of a further embodiment.

Referring now to the drawings particularly Figures 1 to 5 thereof, which illustrate a preferred embodiment of the present invention, the reference numeral 1 generally designates a U-shaped bracket or frame which constitutes the main support body of the retractor by which it may be securely mounted to the floor, seat, or other suitable portion of an automotive vehicle. A shaft 3 having secured thereto a reel 4 is rotatably mounted between the upright side walls of the frame 1, the reel 4 being attached, in turn, to one end of a safety belt 2. A cap-shaped return spring cover 5 and a helical return spring 6 are located on the outside face of a side wall of the U-shaped frame 1, the ends of the return spring 6 being fastened to the cover 5 and the shaft 3 respectively and operative to keep the safety belt 2 wound up on the reel 4 by its resilient recoiling force. Ratchet wheels 7, 7^1 are fitted or otherwise secured to both ends of the reel 4 adjacent to the frame side walls.

A pawl member 8 is mounted in the proximity of the ratchets 7, 7^1 and includes a cross bar rockably engaging opposing segment shaped openings 9, 9^1 formed in the side walls of the frame 1, and pawl teeth 10, 10^1 projecting from the cross bar of the pawl member 8 and engageable with ratchet teeth 7, 7^1. A return spring 11 engages one end of the cross bar of the pawl member 8 and resiliently biases the pawl member 8 out of meshing engagement with the ratchet teeth 7, 7^1 by the pawl teth 10, 10^1. A cap-shaped ratchet latch wheel 12 made of a polymeric resin material and having the same number of internal ratchet teeth as each of the ratchet wheels 7, 7^1 is mounted on the portion of shaft 3 projecting beyond one side wall of the frame 1 and is rockable and restricted against axial movement by C-shaped ring 13. The outer surface of the end wall of the latch wheel 12 has several bosses 14, by means of which the latch wheel 12 is rotatbale with reduced friction on the confronting face of the side wall of the frame 1.

An elongated opening or slot 15 is formed in the end wall of the ratchet wheel 12 for coupling to a bent portion or transverse tongue 17 on the pawl member 8 by engagement with an end pin 18 located on a pawl member actuating arm 16, to which the bent part 17 of the pawl member 8 is secured, for example by spot welding. Thus, the pawl member 8 is actuated by the rotation of the latch wheel 12. An inertia or fly wheel 20 made of metal is freely rotatably carried by shaft 3 inside the latch wheel 12 and held by a C-shaped ring 13^1 against axial displacement on the shaft. The inertia wheel 20 has small holes 21, 21^1, and a stepped pin 22^1 is suitably anchored in the hole 21^1 while another

stepped pin 22 registers with an opening 24 in a pawl 23 and is suitably anchored in the hole 21, the pawl 23 thus being lightly slideable on the surface of the inertia wheel 20. The free end portion of the pawl 23 has a spring engaging aperture 25, by which a tension spring 26 connected to the stepped pin 22 is retained. The pawl 23 is normally resiliently urged or biased by spring 26 towards a cam wheel 27, later to be described, and out of meshing engagement with the latch wheel 12. The cam wheel 27, an undulate ring spring 28 and a stopper plate 29 are fitted to the shaft 3 and retained thereon by a C-shaped ring 13^{11}. The cam wheel 27 is made of a polymeric resin material and press fitted on the shaft 3. Segment shaped peripherally extending camming recesses 30 are formed in the surface of the cam wheel 27 facing to the inertia wheel 20.

As the inertia wheel 20 is rotated with rotation of cam wheel 27 but with a lag, the camming recesses 30 act on the inwardly directed cam follower part 31 of the pawl 23, thereby rotating the pawl 23 outwardly and urging the pawl 23 into engagement with a ratchet tooth of the latch wheel 12. The cam wheel 27 is urged towards the inertia wheel 20 by the ring spring 28 backed by the stopper plate 29 and constrained by the C-shaped ring 13^1. In order to synchronize the operation of the ratchet wheels 7, 7^1 with that of the latch wheel 12 under conditions of locking operation, the latch wheel 12 is turned partially counterclockwise as shown in Figure 3 during assembly until the pawl teeth 10, 10^1 of the pawl member 8 are in full meshing engagement with corresponding teeth of the ratchet wheels 7, 7^1, that is, with the bases of the teeth, and the cam wheel 27 is then turned partially counter-clockwise until the pawl 23 is in complete engagement with the bottom or base of a tooth of the latch wheel 12. The cam wheel 27 is then mounted fast on the shaft 3 in this position.

In operation, when the safety belt 2 is withdrawn at an ordinary normal speed, the reel 4, shaft 3, C-shaped ring 13^{11}, ring spring 28, stop plate 29, cam wheel 27, C-shaped ring 13^1 and inertia wheel 20 are simultaneously turned with the rotation of the shaft 3. The pawl 23 is pulled by the tension spring 26 so as not to engage the teeth of the latch wheel 12 and rotated in unison with the interia wheel 20, received in the camming recess 30 of the cam wheel 27. Thus, the latch wheel 12 remains stationary and the pawl member 8 is held disengaged from the ratchets 7, 7^1 under the influence of the spring 11. The safety belt 2 can then be withdrawn or retracted as desired with the body movement of the vehicle seat occupant. When a load higher than 0.3 G is suddenly applied to the safety belt 2 by the seat occupant's forward movement, in the case of some abnormal situation encountered by the automotive vehicle such as sharp deceleration, and the safety belt 2 is suddenly withdrawn, the cam wheel 27 starts to rapidly rotate with the shaft 3. The inertia wheel 20 starts to rotate with the cam wheel 27, but with a certain lag, because the inertia wheel 20 is fitted loosely on the shaft 3 and is made of a metallic material and thus has considerable weight. Thus, the cam follower portion 31, i.e. the end face, of the pawl 23 is pushed upwards by the end face of the camming recess 30 of the cam wheel 27, as shown in Figure 5. The pawl 23 is swung outwardly about the pin 22 as a fulcrum and against the force of the spring 26, the free end part of the pawl 23 thus engaging the ratchet teeth of the latch wheel 12. The pawl 23 is rotated by the rotation of the cam wheel 27 thereby causing the turning of the latch wheel 12 to thereby swing the pawl teeth 10, 10^1 of the pawl member 8 into engagement with the ratchet wheels 7, 7^1 and thus bring the rotation of the reel 4 to a stop. In this locking process, when the pawl 23 is completely engaged with the ratchet teeth of the latch wheel 12 and the wheel 12 starts its rotation, the latch wheel 12 is synchronized with the ratchet wheels 7, 7^1, so that the end parts of the pawl teeth 10, 10^1 are kept in the position of the tooth tips is thus rotated until the pawl teeth 10, 10^1 are engaged completely with the tooth bottom regions of the ratchet wheels 7, 7^1. At this time, the ratchet wheels 7, 7^1 are rotated simultaneously into complete meshing with the pawl teeth of the pawl member 8. With the ratchet wheels 7, 7^1 thus engaged with the pawl teeth 10, 10^1 the reel 4 is locked against belt withdrawal rotation to keep the safety belt 2 from further extraction, thereby restraining the occupant in his seat and promoting his safety.

The embodiments of the present invention illustrated in Figures 6 to 7 of the drawings differ from that described above only in the manner of the drive coupling the latch wheel 12 to the pawl member 8. Thus, in the embodiment shown in Figures 6 and 6^1, an actuating lever 16^1 is enlarged between its ends and provided with an opening rotatably engaging the shaft 3 adjacent to the end wall of latch wheel 12. One end of the lever 16^1 terminates in a thickened yoke portion 19^1 which engages the tongue 17 projecting from the end of the cross bar of pawl member 8 and a pin 18^1 projects from the other end of lever 16^1 into sliding engagement with the slot 15 in the latch wheel end wall. In the embodiment illustrated in Figure 7, a radial projection is integrally formed on the outside peripheral

face of latch wheel 12 and has an enlarged radial recess 12¹ formed therein which slideably engages the tongue 17 on pawl member 8, so that rocking of the latch wheel 12 swings the pawl member 8. In operation, and in all other constructional details and relationships, the embodiments described with reference to Figures 6 and 7 are similar to that described with reference to the remaining Figures.

Conventional emergency locking and winding mechanisms are usually provided with a complicated clutch mechanism to protect the sensor unit from excessive load application and prevent incomplete locking at the time of operation. This results in the deficiencies and errors in sensitivity and in increased difficulty in producing a compact device. With the mechanism of the present invention, the device may be made highly compact due to omission of the complicated clutch mechanism used in the conventional device. Moreover, the various defects encountered in the conventional apparatus at a time of emergency may be obviated without any reduction in the reliability of operation.

WHAT WE CLAIM IS:—

1. An automatic locking safety belt retractor comprising a shaft, a take-up reel mounted fast on and rotatable with the shaft and spring-biased in a belt rewinding direction, a safety belt connected to and retractable by and withdrawable from the reel, a first ratchet wheel rotatable with the reel, a first pawl mounted for movement between positions engaging and disengaged from the first ratchet wheel, a second ratchet wheel mounted on and rotatable relative to the shaft, a fly wheel rotatably mounted on the shaft, a second pawl mounted on the fly wheel and movable therewith and movable relative to the fly wheel between positions engaging and disengaged from the second ratchet wheel, a cam member mounted on and rotatable with the shaft and engageable with the second pawl whereby rotation of the cam member a predetermined angle in advance of the fly wheel by the rotation of the shaft in response to a predetermined pull on the belt effects the actuation of the second pawl by the cam member into engagement with the second ratchet wheel to forwardly rotate the second ratchet wheel, and actuating means coupling the second ratchet wheel and the first pawl whereby forward rotation of the second ratchet wheel advances the first pawl into engagement with the first ratchet wheel to lock the reel against belt withdrawal rotation, the first and second ratchet wheels having equal numbers of ratchet teeth.

2. A retractor as claimed in Claim 1 wherein the first and second ratchet wheels and the cam member are so angularly related that the first and second pawls, when actuated to their engaged positions, engage the base portions of corresponding ratchet teeth of the respective first and second ratchet wheels.

3. A retractor as claimed in Claim 1, including a first spring resiliently biasing the first pawl toward its disengaged position and a second spring resiliently biasing the second pawl toward it disengaged position.

4. A retractor as claimed in Claim 3, comprising a mounting bracket including a pair of transversely spaced side walls, the shaft extending between and projecting beyond and journalled to the side walls, a pair of the first ratchet wheels disposed at opposite ends of the reel adjacent to the confronting faces of the bracket side walls, a transverse cross bar extending between and rockably supported by the bracket side walls adjacent to the first ratchet wheels, and a pair of the first pawls located on the cross bar and rockable between positions engaging and disengaged from respective first ratchet wheels.

5. A retractor as claimed in Claim 4, wherein the fly wheel, the second ratchet wheel and the cam member are located on the shaft alongside the outside face of one of the bracket side walls.

6. A retractor as claimed in Claim 4 or 5, wherein the second ratchet wheel is internally toothed and is cap-shaped and provided with an end wall journalled on the shaft, the fly wheel and second pawl being disposed within the space delineated by the second ratchet wheel.

7. A retractor as claimed in any of Claims 4 to 6, wherein the second ratchet wheel end wall has a radially extending slot formed therein, and the actuating means comprises a lever engaging and rockable with the cross bar and provided with a follower element remote from the cross bar slideably engaged in the slot.

8. An automatic locking safety belt retractor comprising a rotatable take-up reel spring-biased in a belt rewinding direction, a safety belt connected to and retractable by and withdrawable from the reel, a first ratchet wheel rotatable with the reel, a first pawl mounted for movement between positions engaging and disengaged from the first ratchet, a second ratchet wheel coaxial with and rotatable relative to the first ratchet wheel, a second pawl rotatable with the first ratchet wheel and movable between positions engaging and disengaging the second ratchet wheel and normally urged to the ratchet wheel disengage position, actuating means for urging the second pawl into engagement with the second ratchet wheel, and means coupling the second ratchet wheel and the first pawl whereby rotation of the second

* C L M S *

face of latch wheel 12 and has an enlarged radial recess 12' formed therein which slideably engages the tongue 17 on pawl member 8, so that rocking of the latch wheel 12 swings the pawl member 8. In operation, and in all other constructional details and relationships, the embodiments described with reference to Figures 6 and 7 are similar to that described with reference to the remaining Figures.

Conventional emergency locking and winding mechanisms are usually provided with a complicated clutch mechanism to protect the sensor unit from excessive load application and prevent incomplete locking at the time of operation. This results in the deficiencies and errors in sensitivity and in increased difficulty in producing a compact device. With the mechanism of the present invention, the device may be made highly compact due to omission of the complicated clutch mechanism used in the conventional device. Moreover, the various defects encountered in the conventional apparatus at a time of emergency may be obviated without any reduction in the reliability of operation.

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2. A retractor as claimed in Claim 1 wherein the first and second ratchet wheels and the cam member are so angularly related that the first and second pawls, when actuated to their engaged positions, engage the base portions of corresponding ratchet teeth of the respective first and second ratchet wheels.

3. A retractor as claimed in Claim 1, including a first spring resiliently biasing the first pawl toward its disengaged position and a second spring resiliently biasing the second pawl toward it disengaged position.

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5. A retractor as claimed in Claim 4, wherein the fly wheel, the second ratchet wheel and the cam member are located on the shaft alongside the outside face of one of the bracket side walls.

6. A retractor as claimed in Claim 4 or 5, wherein the second ratchet wheel is internally toothed and is cap-shaped and provided with an end wall journalled on the shaft, the fly wheel and second pawl being disposed within the space delineated by the second ratchet wheel.

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8. An automatic locking safety belt retractor comprising a rotatable take-up reel spring-biased in a belt rewinding direction, a safety belt connected to and retractable by and withdrawable from the reel, a first ratchet wheel rotatable with the reel, a first pawl mounted for movement between positions engaging and disengaged from the first ratchet, a second ratchet wheel coaxial with and rotatable relative to the first ratchet wheel, a second pawl rotatable with the first ratchet wheel and movable between positions engaging and disengaging the second ratchet wheel and normally urged to the ratchet wheel disengage position, actuating means for urging the second pawl into engagement with the second ratchet wheel, and means coupling the second ratchet wheel and the first pawl whereby rotation of the second

ratchet wheel advances the first pawl into engagement with the first ratchet wheel to lock the reel against belt withdrawal rotation, the first and second ratchet wheels having equal numbers of ratchet teeth.

9. A retractor as claimed in Claim 8, wherein the actuating means is responsive to a predetermined angular acceleration of the reel.

10. A retractor as claimed in Claim 8 or 9, wherein the first and second ratchet wheels are so angularly related that the first and second pawls, when advanced to their ratchet wheel engaging positions, engage the base portions of corresponding ratchet teeth of the respective first and second ratchet wheels.

11. An automatic locking safety belt retractor, substantially as herein described, with reference to Figures 1 to 5 or Figures 6 and 7 of the accompanying drawings.

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