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## (54) REELER DEVICE WITH DIRECT DRIVE


(71) We, SOCIETE NATIONALE DES POUDRES ET EXPLOSIFS, a French Corporate Body of 12, quai Henri IV—75181 Paris, Cedex 04, France, 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:—


This invention relates to a device for reeling up a flexible web, especially vehicle safety-belts.

Tensioning devices for the safety-belts employed for the protection of persons in vehicles have been known for several years. The tensioning devices enable the safety-belt to be put into contact with the person to be protected, only when a collision occurs, which leaves to the driver or passengers total freedom of movement as long as the vehicle is under normal conditions.

A first kind of known tensioning device consists of pyrotechnical jacks giving linear pull. As the length of pull must in practice be at least 16 cm the jacks must have a total length of close to 40 cm which hampers location of such devices in vehicles. Moreover accidents can occur through negligence when the belt is fully unwound, which is the normal condition.

A second kind of tensioning devices are arranged to reel in the belt, but known devices of this kind include a piston connected to control members which actuate a transmission system, such as a rack-and-pinion unit or a spiral-cam unit, and as a result exhibit a large bulk.

In French specification No. 74.14504 there is described a reeling device having an annular piston located within the reel and a spiral cam transmission, but the reel can only rotate through a limited number of revolutions. Moreover the device has a limited energy yield due to the small pitch of the spiral cam.

French patent specification 2136755 describes a tension device having a turbine driven reel. However the device has only a very limited performance due to the use of a simple compressed-gas cartridge as the source of driving fluid. In addition a paddle wheel is employed which has an efficiency in the neighbourhood of 0.6 even when specially profiled paddles are used, compared with an efficiency of about 0.95 which can be achieved with a direct drive. The paddle wheel does not allow continuous driving because the zone of impact of the gas-jet on each paddle changes as the wheel turns, resulting in a varying driving torque. Another disadvantage is that the device employs a motive system which is not symmetrical with respect to the reel axis.

In accordance with the present invention there is provided a reeling device for reeling up a length of flexible material, comprising support means, a drum supported by the support means for rotation relative thereto, and drive means for rotating the drum to reel the flexible material onto the drum, the drive means comprising a pyrotechnic charge for generating gas located within the drum, means for igniting the charge, and gas ejection means connected to the drum for discharging gas from the interior thereof whereby to rotate the drum.

A device according to the invention can generate a large driving torque while retaining a small bulk; enable an improved energy yield to be obtained whilst not limiting the rotation of the reel; can operate with a constant driving torque; and enable rotational balance of the rotor.

Where necessary means for readjustment of

reeling or locking of the drum can be provided.

The gas-ejection means preferably comprises at least two gas-ejection orifices connected to the interior of the drum at an axial end thereof, and each orifice preferably has a restricted section at or near an ejection outlet opening thereof to form a discharge nozzle.

The reeler device is intended especially for retracting vehicle safety-belts for which reason it is preferred that the reeling-up characteristics be reproducible with a low dispersal of the results, and it is therefore advantageous that the pyrotechnical charge include an electrical igniter, firing of which can be controlled by an electrical pulse generated by a collision detector which may especially be an establishing detector with an inertia mass or a Doppler-effect anticipatory detector.

To improve the energy yield of the reeler device, the gases are preferably ejected substantially in one or more planes perpendicular to the axis of rotation of the drum in order to minimize the axial component of the reaction force which is exerted on the drum, and the energy yield is the higher, the greater the tangential component of the force of reaction is with respect to the radial component.

The ejection orifices can be rectilinear ducts, preferably substantially tangential to the inner surface of the drum. Alternatively each of the ejectionorifices can be formed by a pipe member extending outwardly from the drum so as to increase the driving torque by increasing the effective distance between the axis of rotation of the drum and the point of application of the reaction force caused by the expulsion of the gas. The pipe member is preferably arranged to provide tangential ejection of gases.

To stabilize the flow of gas the ejection orifices preferably have a length greater than one third of the inner diameter of the drum, and preferably a length approximately equal to half the inner diameter of the drum.

As the gases are expelled at very high pressure which may reach some hundreds of bars, and at high temperature, the gas ejection means is preferably located within a deflector casing in order to avoid any dangerous spatter. The ejection orifices can be normally closed by a rupturable diaphragm for facilitating the initial rise in pressure at the time of firing of the pyrotechnical charge.

In a particular embodiment the drum is equipped with at least two ejection orifices at each end, and advantageously at least one grid is interposed between the pyrotechnical charge and the ejection orifices so as to contain and wedge this pyrotechnical charge in the zone of the bore which is deprived of ejection orifices.

Two embodiments of the invention will now be described in more detail, by way of example with reference to the accompanying drawings, in which:

Figure 1 is an axial section through a reeling device in accordance with the present invention;

Figure 2 is a cross section taken along the line II–II of Figure 1;

Figure 3 is a cross-section taken along the line III–III of Figure 1;

Figure 4 is an axial section through a second device in accordance with the invention; and

Figure 5 is a half-section taken along the line V–V of Figure 4.

The two reeling devices illustrated in the Figures are intended for the retraction of the safety-belts installed in motor vehicles, where particularly short reeling times, of the order of 10 milliseconds, are required.

The reeling device of Figures 1, 2 and 3 includes a reel drum which is axially fixed in a channel-shaped support. The drum 1 is free to rotate with respect to this support in a reeling up direction, rotation in the reverse direction being blocked by a system of balls 10 known per se and contained in the cheek disc. The drum extends beyond flange 2*a* of the support 2 and is provided with two gas ejectors arranged symmetrically with respect to the drum axis and each consisting of a cranked external pipe 3*a*, 3*b* and tangential nozzle 11*a*, 11*b*. The drum is hollow and contains the pyrotechnic charge 4 with its ignition system 12 which is connected to a collision detector (not shown) by means of electrical conductors 5 passing through a gastight passage in the end of the drum opposite the gas ejectors. The other end of the drum is closed by a gastight stopper 13. The pyrotechnic charge generates gas when ignited and consists of two grammes of propergol with a nitrocellulose base. The ignition system includes an electrical igniter and two grammes of ignition powder with a base of zirconium and barium chromate. The interior of the drum, and hence charge 4, is isolated from the pipes 3*a*, 3*b* by a cylindrical diaphragm 6 which ruptures when the internal pressure within the drum reaches 60 bars. The ejectors are housed within a deflector housing 7 having an opening 8 to allow the gases to escape. The drum includes a slot opening 14 (Figure 3) in its wall and the webbing of the safety-belt 15 is passed through the slot 14 to secure it to the drum.

In normal use the safety-belt extends from the drum and over the guide rod 16 and the parts of the reeling device remain stationary. In the event of a violent deceleration the collision detector generates an electrical pulse which is transmitted through the conductors 5 to the igniters of the ignition system 12. The combustion of the pyrotechnic charge is progressive and occurs over a duration of the order of 10 milliseconds. As long as the pressure in the bore of the drum remains below 60 bars the cyclindrical diaphragm 6 prevents the gas entering the ejection pipes 3*a* and 3*b*. As soon as the critical pressure is reached the diaphragm ruptures and the combustion gases are ejected through the nozzles 11*a* and 11*b*

and the drum is driven in rotation by the reaction and winds up the safety-belt 15. The number of revolutions carried out by this drum is not limited by the device and is determined by the opposing torque exerted on the drum by the tension in the safety-belt. A force limiting arrangement is unnecessary because the propellant system is open. After the belt has been reeled onto the drum to tighten the belt against the person to be protected, rotation of the drum in a belt unwinding direction is opposed by the system of balls 10 which jam against the drum. The balls do not completely prevent such reverse rotation, but permit limited unreeling by less than one complete turn, the limited reverse rotation being frictionally opposed to break the force on the person to be protected by absorbing a large amount of energy.

The reeling device shown in Figures 4 and 5 has a drum 20 which is held against axial movement by the two supporting angle brackets 21*a* and 21*b*. The drum is free to rotate with respect to these brackets in one direction, rotation in the reverse direction being substantially opposed by two energy adsorbing systems 22*a*, 22*b* which include balls located in grooves in the brackets 21*a*, 21*b* the depth of the grooves decreasing in the circumferential direction so that when the drum rotates in the reverse direction the balls 22*a*, 22*b* are pressed into guide collars 23*a*, 23*b* on the drum. The drum has a bind bore the open end of which is closed by a threaded plug 24 equipped with a gastight passage for electrical conductors connected to the ignition system 25 of a pyrotechnic charge 26 held between two grids 27*a*, 27*b* in the drum. The grids form free spaces at each end of the drum bore which communicate with rectilinear ducts formed in the drum. A group of four ducts 28 is provided at each end of the drum axially beyond a seat-belt receiving portion of the drum. The rectilinear ducts are tangential to the drum bore and have their outer ends closed by heat-retracted plastics sheaths 29*a*, 29*b*. The safety-belt (not shown) is engaged in the linear slot formed by a reeler bar 30 and the bottom of a recess in the drum for seating the belt.

WHAT WE CLAIM IS:—

1. A reeling device for reeling up a length of flexible material, comprising support means, a drum supported by the support means for rotation relative thereto, and drive means for rotating the drum to reel the flexible material onto the drum, the drive means comprising a pyrotechnic charge for generating gas located within the drum, means for igniting the charge, and gas ejection means connected to the drum for discharging gas from the interior thereof whereby to rotate the drum.

2. A reeling device according to claim 1, wherein the gas ejection means comprises at least two gas-ejection orifices connected to the drum interior at an axial end thereof.

3. A reeling device according to claim 2, wherein each orifice has a restricted section located in the vicinity of an ejection outlet opening thereof.

4. A reeling device according to claim 2 or 3, wherein the ejection orifices are rectilinear ducts.

5. A reeling device according to claim 4, wherein the ducts are substantially tangential to the inner peripheral surface of the drum.

6. A reeling device according to claim 1, 2 or 3, wherein each ejection origice comprises a pipe member extending outwardly from the drum.

7. A reeling device according to claim 6, wherein the pipe member has a free end portion defining an outlet opening substantially tangential to a circle centred at the drum axis and passing through the opening.

8. A reeling device according to any one of the claims 2 or 7, wherein the ejection orifices have a length greater than one third of the inner diameter of the drum.

9. A reeling device according to any one of claims 1 to 8, wherein the ejection orifices are normally closed by a rupturable diaphragm.

10. A reeling device according to any one of claims 1 to 9, wherein at least two ejection orifices are connected to each axial end of the drum interior.

11. A reeling device according to any one of the preceding claims, wherein at least one grid is located within the drum to define a space between the pyrotechnic charge and the ejection orifices.

12. A reeling device for reeling up an elongate flexible web, substantially as herein described with reference to the accompanying drawings.

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FIG_1

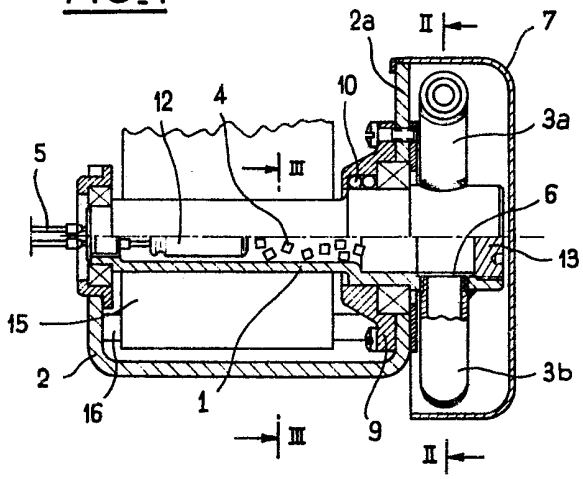


FIG_2

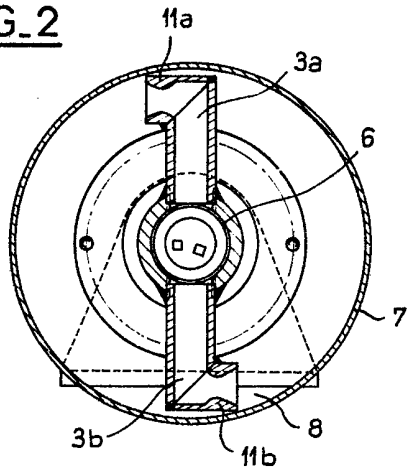

FIG.3

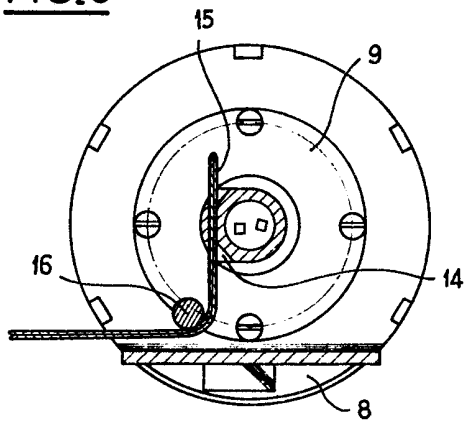


FIG.4

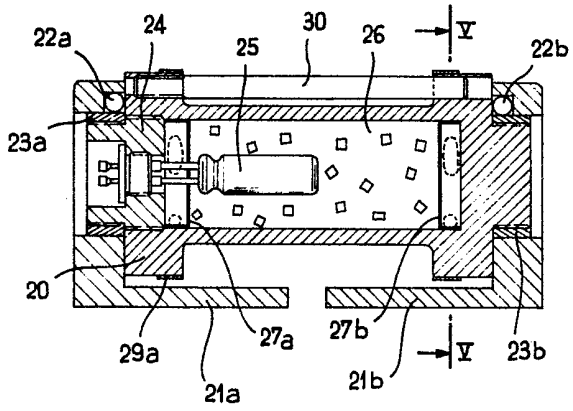


FIG.5