(12) UK Patent Application (19) GB (11) 2 172 065 A

(43) Application published 10 Sep 1986

(21) Application No 8524362

(22) Date of filing 2 Oct 1985

(30) Priority data
(31) 60/042254 (32) 4 Mar 1985 (33) JP

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(51) INT CL⁴
F16D 43/20

(52) Domestic classification (Edition H):
F2C 1A11A2 1A1A3 1A4 1B2A 1B3B 1B3D2 1B5A 1B6B2

(56) Documents cited
GB A 2073336 GB 0849516 GB 0213328
GB 0945296

(58) Field of search
F2C
Selected US specifications from IPC sub-class F16D

(54) Coupling torque limiter

(57) A torque limiter for preventing an excessive load applied to an output element (15) from being transferred back to an input element (12) comprises a plurality of pairs of balls (19), which form a rotation-transmitting means, located in holes in a ring plate (16) fastened to the input element (12). The pairs of balls are positioned between a flange (13) and an axially movable slider (21) which are fastened to the input element. One ball of each pair is urged into a recess (30) in the flange (13) and the other ball is urged into a recess in the slider by springs (29). Provided in a space formed by the slider (21) and the input element (12) are a pair of parallel, trapezoidal cross-sectioned bars (24, 25) between which is located an intervener (26) formed by a multi-section ring of wedge-shaped cross-section. With the intervener (26) pushed partly out of the pair of bars by the springs, the slider is spring-urged to engage the balls in the recesses (30), whereby the rotation transmission is maintained. When an excessive load is applied to the output element (15), the balls ride out of the recesses in the flange and the bottom of the slider cams and rides over the intervener, depressing it between the pair of bars (24,25). Thus, the spring force applied to the balls is reduced, the balls will not drivingly re-engage the recesses (30), and the torque limiter remains released.

FIG.1

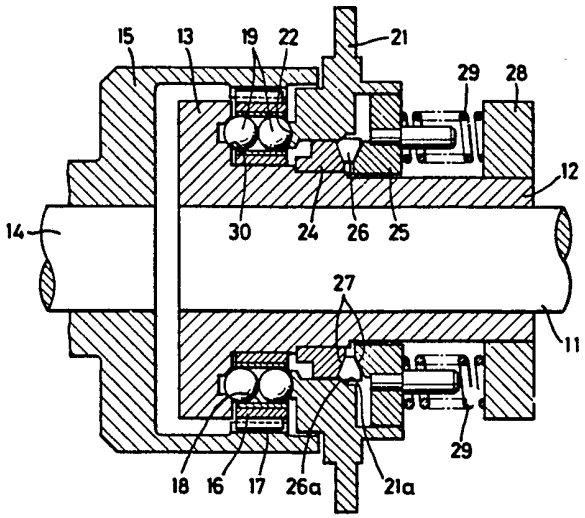

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FIG.1

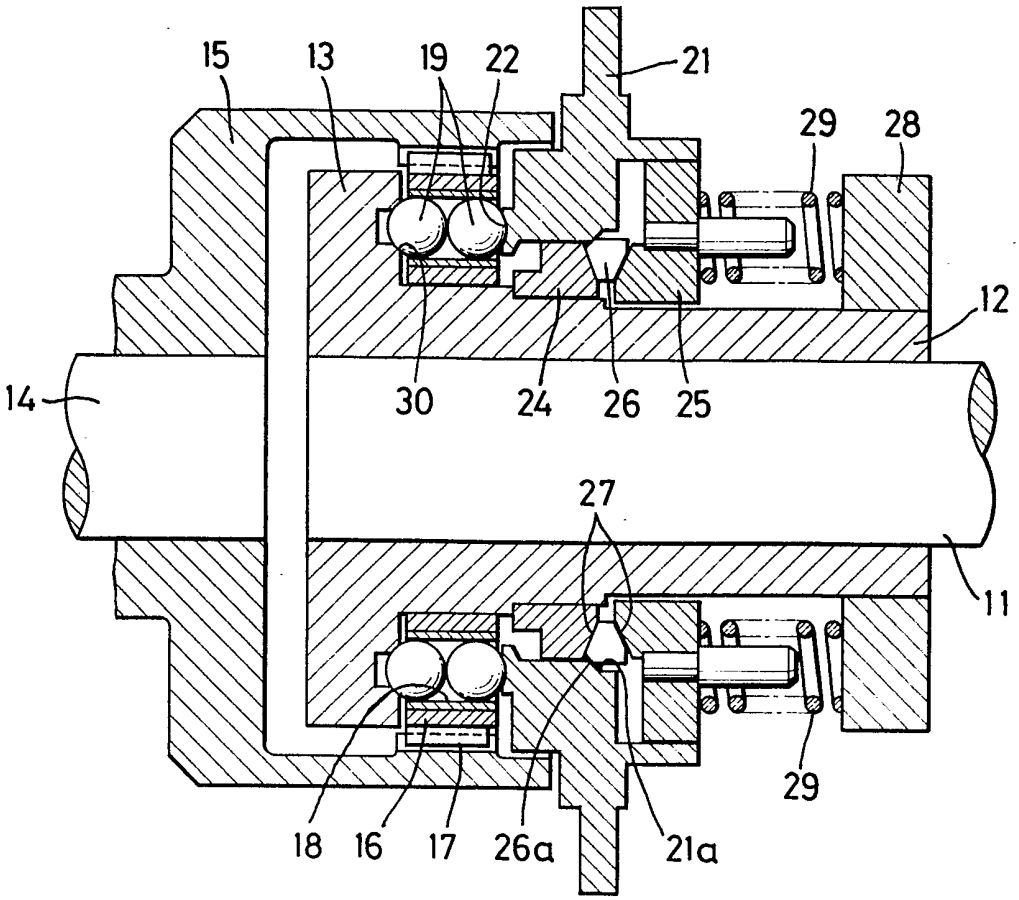

FIG.2

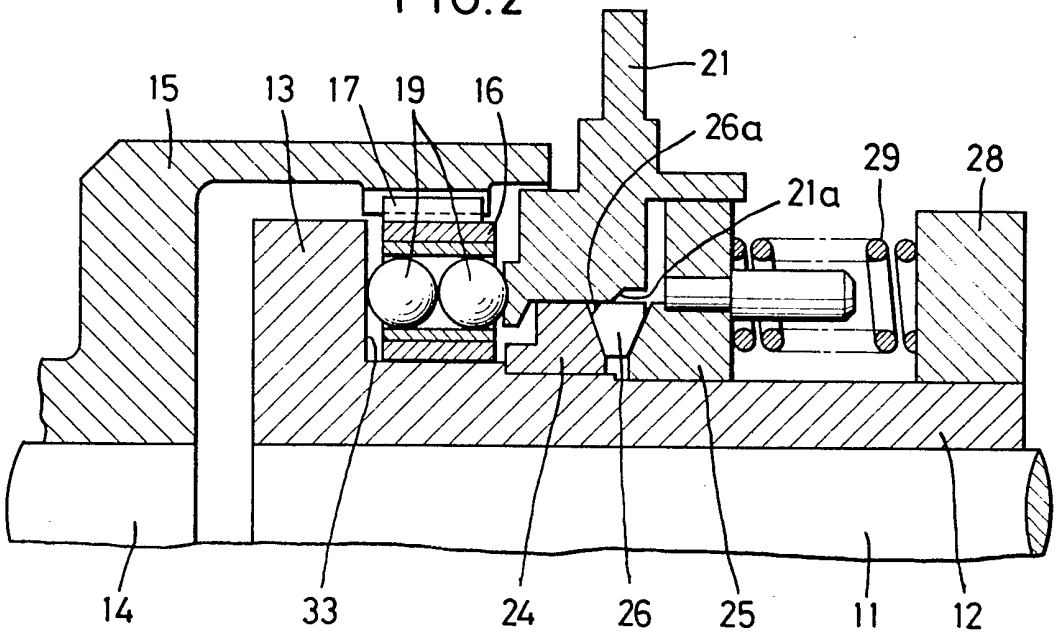

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FIG.3

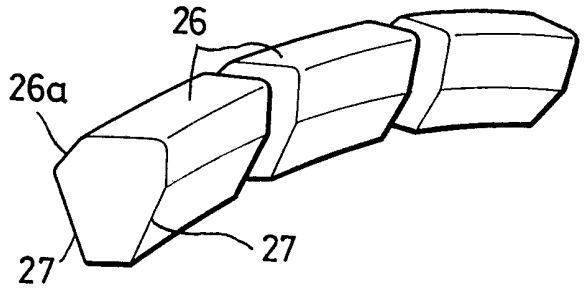


FIG.4

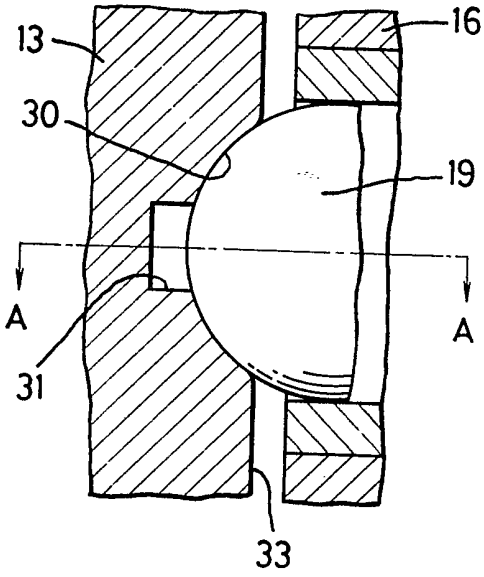


FIG.5

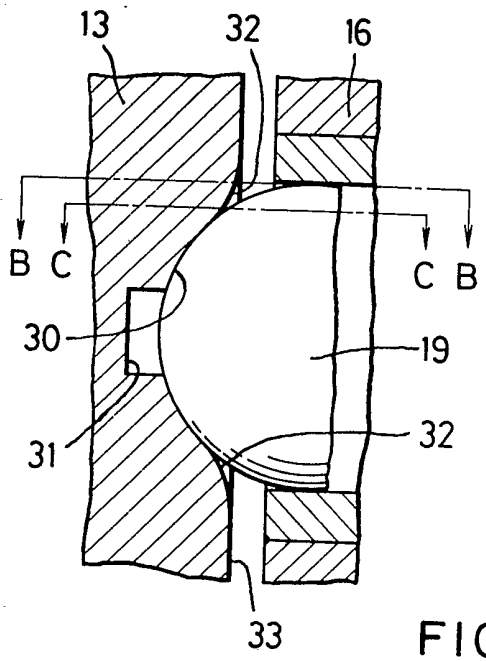


FIG.7

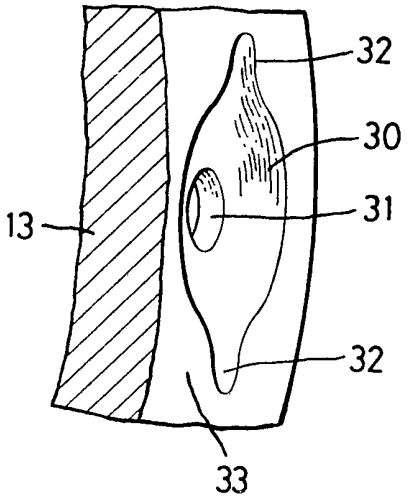
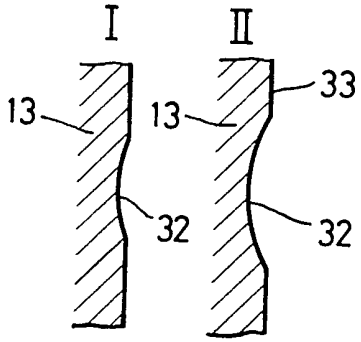


FIG.6



SPECIFICATION

Torque limiter

This invention relates to a torque limiter which can be built up into a rotation-transmitting coupling, and is used to protect an input element against excessive loads by breaking the transmission of rotational drive to an output element. More particularly, this invention relates to a torque limiter which is able to break or resume the transmission of rotation from an input element to an output element by the control of balls.

So far, many types of torque limiters of differing structures have been used in order to transmit rotation, and protect an input element against an excessive load applied to an output element. Therefore, it is well known to use balls to control the breaking and resumption of the transmission.

Conventional torque limiters which employ balls for this purpose are constructed of a ring plate pierced with holes in which the balls are held, the ring plate being fixed to and rotating in association with an output element, a flange provided with tapered holes that allow the balls to ride in and out, which is united with an input element, and a slider to press the balls against the flange across the ring plate, which is fitted on the input element so as to be freely movable thereon. A pair of tapered bars are located between the slider and the input element; a plurality of balls are placed between the two opposing tapered bars; and a compressed spring is provided for one of the bars. By this construction, the balls are pressed between the bars and urged outwardly from between the bars. The balls fix the slider in an advanced position when they are out of the bars, in order to transmit rotation from the input element to the output element; they fix the slider in a retracted position when they are let in between the bars to spread of the bars, in order to break the transmission of rotation.

In a conventional torque limiter like this, the balls are kept in point contact with the tapered bars. Thus, an acting load is concentrated at the point of contact; hence there has been a problem in that the balls and the tapered bars are liable to wear down by repeatedly applied loads.

Under the circumstances, it is an object of this invention to provide a torque limiter in which the concentration of acting loads due to the point contact is avoided, so as to greatly lessen the wear of the balls and the tapered bars. It is another object of the invention to provide a torque limiter whose life and durability are significantly improved by this considerably lessened wear.

From one aspect, the invention provides a torque limiter which is operable to prevent an excessive load from being transferred back from an output element to an input element, wherein an intervener is provided between a pair of generally parallel and trapezoidal cross-section bars located between a slider and an input element, the intervener being compressed by spring means or other resilient means, the intervener further having the form of a ring divided into many sections and having a tapering wedge-like cross-section in order that both sides thereof may have surface contact with the pair of bars.

From another aspect, the invention provides a torque limiter comprising: first and second rotatable members, one of which is an input member and the other of which is an output member; releasably interlocking first and second coupling means, rotatable with the first and second rotatable members respectively, and capable of riding out of a mutually interlocked condition; spring means operable, via the intermediary of pressure transfer means, normally to apply a spring pressure to the coupling means sufficient to retain the latter in said interlocked condition and transmit rotational torque from the input member to the output member; the pressure transfer means being axially slidably mounted on one of the rotatable members, and including an annular slider, and an annular thrust assembly comprising a pair of thrust members urged towards each other by the spring pressure, and spaced apart by an intervener, the slider being telescopically axially slidable over the thrust assembly; the intervener comprising a segmental ring of generally conical cross-section with the apex of the cone directed generally radially inwardly and the sides of the cone engaging between the thrust members, the intervener being normally urged generally radially outwardly of the thrust members, due to compression of the intervener between the thrust members, to engage the slider and block the telescopic sliding movement of the latter, whereby the spring pressure is transferred to the coupling means via the intervener and slider blocked thereby, the intervener being displaceable by the slider, inwardly relative to the thrust members, when the slider is subjected to an axial force resulting from the tendency of the coupling means to ride out of their mutually interlocked condition which occurs when the output member is subjected to an excessive torque, to unblock and release the slider for telescopic sliding movement and thereby reduce the spring pressure applied to the coupling means.

In order that the invention may be more readily understood, one embodiment thereof will now be described with reference to the accompanying drawing, wherein:

Fig. 1 is a longitudinal cross-sectional view of a torque limiter embodying this invention;

Fig. 2 is a partially cut away longitudinal cross sectional view of the torque limiter of Figure 1, shown in a condition in which an

excessive load is applied thereto;

Fig. 3 is an enlarged perspective view of the intervener incorporated in the torque limiter of Figures 1 and 2;

Fig. 4 is an enlarged sectional view of one of the power transmission balls and associated depressions or holes taken in the radial direction;

Fig. 5 is a cross-sectional view on the line A-A in Fig. 4;

Figs. 6 I and II are cross-sectional views on the lines B-B and C-C respectively in Fig. 5;

Fig. 7 is a partially cutaway enlarged perspective view of the flange provided with the holes in one of its surfaces, incorporated in the torque limiter of Figures 1 and 2.

In Figs. 1 and 2, the numeral 11 designates an input shaft; the numeral 12 designates an input element fitted on the input shaft; and the numeral 13 designates a flange provided at the front end of the input element. The numeral 14 designates an output shaft; a cylindrical output element 15 fastened to an end of the output shaft 14 covers the flange 13, leaving a little space therebetween. A ring plate 16 for holding the balls within its holes is fitted on the input element 12 behind the flange 13, with sufficient play to enable it to be rotatable on the input element. An axially extending coupling means 17, composed of a groove and a screw, or axially slidable interengaging splines, couples the outside of the ring plate 16 and the inside of the output element 15 in order for the ring plate and the output element to rotate in association.

Near the outer circumference of the ring plate 16 is a plurality of circumferentially distributed, axially extending or pierced, passages or holes 18. A pair of balls 19 for transmitting rotational power is located in each hole. The same number of holes or recesses 30 are formed in the rear side of the flange 13 so as each to receive part of one of an associated pair of balls.

The numeral 21 designates a slider in the form of a ring. Part of the other ball of each pair of balls 19 is engaged loosely in a shallow groove having an arcuate cross-section which is formed in the front side of the slider.

A tapered groove is formed between the inside of the slider 21 and the outside of the input element 12, the groove being defined by a pair of parallel, trapezoidal cross-section bars 24, 25 in the form of rings which are disposed at right angles to the axial direction. One of the pairs of bars 25 is slidable, and a intervener 26 is located between the bars. The intervener 26 is in the form of a ring divided into many sections, and its cross-section tapers off toward the input shaft like a wedge. The opposed faces of the bars closely fit both tapering sides of the intervener 26. One side of the intervener, which contacts the bar 24, is truncated so as to form a face or plane 26*a* at its corner. Another face or plane 21*a*, which is capable of facing or opposing the face or plane 26*a*, is formed at the bottom of the slider 21. Therefore, when the intervener is pushed out by the pair of bars 24, 25, the face 26*a* is brought into close contact with the face 21*a*, with the result that the slider 21 is advanced and pressed against the balls 19 so as to transmit the rotational drive from the input shaft to the output shaft, as shown in Fig. 1.

Conversely, when the intervener is pushed in between the pair of bars 24, 25, the faces 21*a*, 26*a* move out of contact and the slider 21 is retracted so as to break the rotational transmission, as shown in Fig. 2.

A ring 28, which receives compressed springs 29, is fastened to the rear end of the input element 12; that is, a plurality of springs 29 are located between the bar 25 and the ring 28 in a compressed condition. The inside of each of the holes or recesses 30 in the flange 13 is made spherical in order that part of one of the associated pair of balls may fit it, as shown in Figs. 4 and 5. The bottom of each recess or seat 30 is undercut to form a straight hole 31. Also, in order to reduce the contact pressure of the balls when they ride out of the recesses 30, a circular ball-guide groove 32, whose curvature is nearly the same as the outside curvature of the balls 19, is provided inside each recess 30 in such a way that it gradually becomes shallow and disappears where it blends with the surface 33 of the flange 13, describing a curve in the direction in which the balls rotate.

In this respect, in the illustrated embodiment, the recesses 30 each have a spherical interior, and the ball guide groove 32, to ease the ride-out of the balls from the holes, is provided on opposite sides of the recesses. However, alternatively, the rims of the recesses may be wholly chamfered there around and the groove may be removed.

In the illustrated embodiment, when the input shaft is driven, the flange 13 rotates, and the ring plate 16 coupled to the flange also rotates, because the balls 19 in the ring plate are engaged in the recesses 30 in the flange, as shown in Fig. 1. As a result, the output element 15, coupled with the ring plate 16, rotates so as to transmit the rotational power to the output shaft 14. During transmission, if an excessive load is applied to the output element for some reason and makes its rotation difficult, the input element 12 is caused to rotate relative to the output element 15. At this moment, the balls 19 engaged in the recesses 30 of the flange 13 are forced to ride out therefrom with the help of the ball guide grooves 32, onto zones of the ring plate which are devoid of recesses. This moves the slider axially into a retracted or withdrawn position, as shown in Fig. 2. Furthermore, at this moment, the intervener 26 is pushed radially inwardly between the pair of bars 24, 25 so

as to increase their axial separation, because the face 21*a* inside the slider 21 presses and cams the face 26*a* of the intervener inwardly. One of the bars, i.e. the bar 24, cannot move forward since there is a step in the input element before and stopping it, so that only the other bar 25 moves, in a backward direction, and compresses the springs 29.

When the slider 21 is moved further back, the intervener 26 is retained depressed between the bars 24, 25 because the slider 21 overlies the intervener 26 and presses it down with its flat bottom. In this condition, the spring pressure applied to the balls is reduced to an extent that they do not re-enter the recesses 30 of the flange, or at least do not drivingly cooperate therewith to any significant extent. Thus, the torque limiter is left in its released condition, and the rotation of the input element is not transmitted to the output element.

CLAIMS

1. A torque limiter which is operable to prevent an excessive load from being transferred back from an output element to an input element, wherein an intervener is provided between a pair of generally parallel and trapezoidal cross-section bars located between a slider and an input element, the intervener being compressed by spring means or other resilient means, the intervener further having the form of a ring divided into many sections and having a tapering wedge-like cross-section in order that both sides thereof may have surface contact with the pair of bars.

2. A torque limiter as claimed in claim 1, in which the outside edge of the intervener which projects from between the pair of bars when compressed, and the inside edge of the slider, are chamfered so as to form respective planes or faces which have the same inclination and are able to come into close contact with each other in order to enable the intervener to be pushed in between the pair of bars by relative sliding between the said planes or faces when the slider moves to a retracted position.

3. A torque limiter comprising: first and second rotatable members, one of which is an input member and the other of which is an output member,; releasably interlocking first and second coupling means, rotatable with the first and second rotatable members respectively, and capable of riding out of a mutually interlocked condition; spring means operable, via the intermediary of pressure transfer means, normally to apply a spring pressure to the coupling means sufficient to retain the latter in said interlocked condition and transmit rotational torque from the input member to the output member;, the pressure transfer means being axially slidably mounted on one of the rotatable members, and including an annular slider, and an annular thrust assembly comprising a pair of thrust members urged towards each other by the spring pressure, and spaced apart by an intervener, the slider being telescopically axially slidable over the thrust assembly; the intervener being normally urged generally radially outwardly of the thrust members, due to compression of the intervener between the thrust members, to engage the slider and block the telescopic sliding movement of the latter, whereby the spring pressure is transferred to the coupling means via the intervener and slider blocked thereby, the intervener being displaceable by the slider, inwardly relative to the thrust members, when the slider is subjected to an axial force resulting from the tendency of the coupling means to ride out of their mutually interlocked condition which occurs when the output member is subjected to an excessive torque, to unblock and release the slider for telescopic sliding movement and thereby reduce the spring pressure applied to the coupling means.

4. A torque limiter as claimed in claim 3, wherein the first rotatable member comprises the input member, and the first coupling means comprises an annular flange rotatable with the input member and having a radial face provided with a circumferentially distributed array of recesses, and wherein the second rotatable member comprises the output member, and the second coupling means comprises an annular plate rotatable with the output member and having a circumferentially distributed array of passages, corresponding to the recesses in the flange, each containing at least one ball, the balls being normally urged by the spring pressure, partly out of their respective passages and into associated recesses in the flange to lock the flange and plate against relative rotation.

5. A torque limiter as claimed in claim 3 or 4, wherein the base and/or one side of the conical-section intervener, and/or the internal surface of the slider, have camming surfaces which are cooperable, when the slider is urged axially by the application of an excessive torque to the output member, to cam the intervener inwardly from its extended slide-blocking position.

6. A torque limiter as claimed in claim 3, 4 or 5, wherein axial movement of the thrust member most adjacent the coupling means, in a direction towards the latter, is limited by stop means.

7. A torque limiter as claimed in claim 4, or claim 4 in combination with claim 5, 6 or 7, wherein the rims of the recesses in the flange are formed with curved grooves, or are chamfered, at least in the direction of rotation of the balls when they ride out of the recesses.

8. A torque limiter substantially as hereinbefore described with reference to the accompanying drawings.

Printed in the United Kingdom for
Her Majesty's Stationery Office, Dd 8818935, 1986, 4235.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.