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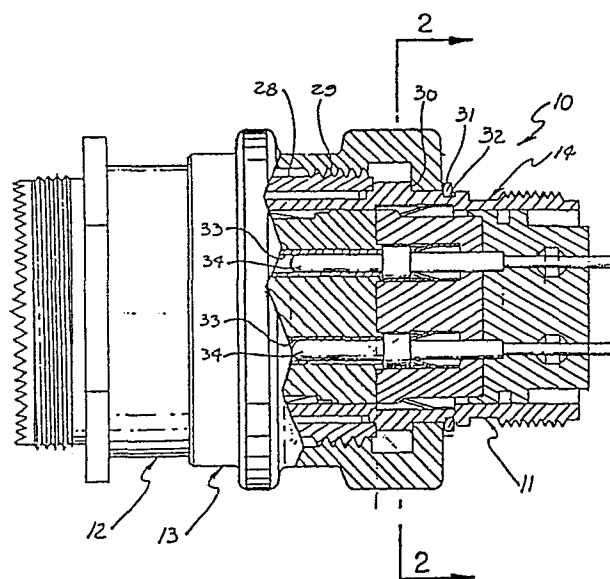
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⑤④ **Radial force anti-decoupling connector.**

⑤⑦ An electrical connector (10) for use between a plug barrel (14) and coupling nut (13) to resist yielding to rotation of the coupling nut in either a coupling or decoupling direction by means of drag means (15, 16-19, 23).



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This invention relates to electrical connectors, and more particularly to spring means for applying a radial force to resist coupling and decoupling.

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Electrical connectors are often used in conditions where extreme decoupling forces act. For example, some are used under conditions of vibration. Under conditions of this type, some are designed to resist unmating forces. This application deals with apparatus for preventing accidental decoupling of electrical connectors under extreme conditions, while still allowing for ease of mating, ease of manufacture and ease of inspection. Superior reliability is also sought.

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Most prior art connector products designed for environments where accidental decoupling is possible use a spring and ratchet type mechanism. Several prior art designs have been used in this area. One such design uses a spring element which engages one of three recesses to hinder decoupling. A second prior art design uses a number of leaf spring type members with small projections which contact a series of miniature gear-like teeth. A third example of prior art is a design which is very similar to the second case with the exception that the leaf spring elements are of plastic-metal laminate. The plastic layer is used to reduce wear incurred by the mechanism during service.

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These prior art designs present a number of disadvantages including low reliability and difficulty of manufacture. In the second and third prior art examples, it is possible to buckle the leaf spring member. This is true because the high load produced during unmating acts compressively on the spring. These two designs operate with rather substantial preloads causing high longitudinal stress during spring flexure. This can result in premature fatigue or spring set.

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In the second prior art design, repeated coupling and decoupling causes a degradation of the contacting surfaces. This reduces torque values and introduces abrasive metal particles into the mechanism interface and threads. The method of lubrication used to minimize wear presents a continuing maintenance requirement which is not desirable.

The third design may have been developed to reduce wear on the mechanism. This design can be susceptible to any significant temperature range. The laminate nature of the plastic/metal bond can also induce additional operating stresses from differential thermal expansion. These stresses can promote bond separation or material fatigue during service.

Prior art is disclosed in some U.S. patents as follows:

Waldron et al	4,109,990
Schildkraut et al	4,268,103
Frazier et al	4,457,572
Werth et al	4,462,652

Waldron et al. discloses a coupling nut 300 having a leaf spring 321 pivoted thereon. The leaf spring 321 has a detent-like body 323 thereon. The leaf spring 321 extends from its pivot point in a direction opposite coupling. The body 323 rides over a ratchet-like surface carried by a shell 100.

The disclosure of Waldron et al. as described herein is duplicated in Schildkraut et al except that the leaf spring in the latter is made of a plastic material.

Frazier et al. discloses a radially directed detent 318 spring loaded by a coil spring 322 against a ratchet-like member 130.

Werth et al. discloses a pivoted pawl-like member 60 which carries a detent 68 that is spring biased at 66 into contact with a ratchet-like member 16.

In accordance with the connector of the present invention, the above-described and other disadvantages of the prior art are overcome by providing a radial force anti-decoupling mechanism. The mechanism comprises a central barrel from which project a plurality of radially acting teeth. These teeth interact with a number of beam like leaf springs through a shaped dimple formed medially on each spring. As the connector is mated or unmated the springs, which are mounted upon the coupling nut, move relative to the barrel teeth. The spring dimples are forced out of their paths by the barrel teeth. This causes the beam like springs to deflect in a radial direction. The leaf springs are attached to the coupling nut by retaining pins. The pins are pressed into the coupling nut so that a forward smaller diameter section on each pin enters an interference fit with a formed circular end of each respective leaf spring.

The barrel teeth are shaped so that they possess a non-symmetrical profile. This tooth profile consists of two inclined sides. The coupling side slopes very gradually and the decoupling side slopes steeply. The exact angles are selected in order to provide a mating to unmating torque ratio of less than, for example, 60%.

The leaf springs extend from pinned ends in a direction which is the same as the direction in which the coupling nut is rotated to achieve coupling.

The leaf springs are made of metal stampings with the dimples formed integrally therein.

In the drawings which are to be regarded as merely illustrative:

Fig. 1 is a longitudinal sectional view, partly in elevation, of an electrical connector constructed in

accordance with the present invention; and,

Fig. 2 is a transverse sectional view of the connector taken on the line 2-2 shown in Fig. 1.

5 Fig. 3 is a partial enlarged sectional view similar to Fig. 2.

10 In the drawing, in Fig. 1, an electrical connector 10 is shown including a plug 11, a receptacle 12 and a coupling nut 13. The plug 11 comprises a central barrel 14 on which are fixed radially projecting radially acting teeth 15 (Fig. 2). The teeth 15 interact with four leaf springs 16-19 through shaped dimples 20-23 formed medially on the springs 16-19, respectively. As the connector 10 is mated or unmated, the springs 16-19 which are fixed to the coupling nut 13, move relative to the barrel teeth 15. Each of the spring dimples 20-23 are forced out of their paths by the barrel teeth 15 causing the beam like springs 16-19 to deflect in a radial direction. Each of the leaf springs 16-19 is attached to the coupling nut 13 by a retaining pin. See pin 24, for example, for leaf spring 16. The pin 24 may be pressed into a hole (not shown) in the coupling nut 13 so that a forward smaller diameter section on the pin enters an interference fit with a formed circular end 25 of the leaf spring 16.

25 The barrel teeth 15 are shaped to possess a non-symmetrical profile. This tooth profile consists of two inclined sides. Coupling sides 26 slope very gradually and decoupling sides 27 slope steeply. The exact angles are selected in order to provide particular mating and unmating torques, as well as a mating to unmating torque ratio of less than 60%.

30 The barrel teeth 15 are covered with a conventional permanent wear resistant lubricant coating. This coating eliminates the need for any in service maintenance as well as the need for a bimaterial spring.

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Each of the anti-decoupling leaf springs 16-19 is a single beam structure, and is formed from one material, i.e., it is isotropic, rather than a laminate. The springs 16-19 may be metal stampings if desired, with dimples 20-23 formed integrally therewith. Stresses developed during flexure are predominantly of an axial nature, and therefore, the grain structure of the spring material is specified with an axial orientation. The leaf springs 16-19, due to their shape and simplicity, are relatively free from major geometric discontinuities. In addition, the spring material must also be free from cracks or major material discontinuities in order to maximize the fatigue life of the spring members 16-19.

The mechanism components have been oriented so that coupling and decoupling stresses on the leaf spring act in the direction most favorable to the spring's function. The leaf spring's position within the mechanism was chosen to ensure that the forces due to a higher unmating torque act as a tensile stress on the spring. The lower mating torque would, therefore, act in compression on the spring greatly in reducing the possibility of compressive buckling. The springs within the mechanism do not require any pre-stressing, since the operating stress of the springs is comparatively low. This lower stress level is achieved through the elimination of the large preload, which is used on the second and third prior art designs. In the disclosed design a preload is not required to satisfy torque and space constraints, which might be placed on the mechanism.

The mechanism is located near the rear of the connector. This fact allows easy access for inspection during service. All other aforementioned attributes of this mechanism provide it with a greater coupling durability and component reliability than the existing art.

In Fig. 1, note will be taken that receptacle 12 has a shell 28 threaded to coupling nut 13 at 29.

Axial movement of coupling nut 13 is limited by a shoulder 30 on plug barrel 14, and a snap ring 31 (C-ring) in a plug barrel groove 32.

5 Receptacle 12 has socket contacts 33 adapted to receive plug barrel pin connectors 34.

Engagement of the coupling nut and receptacle shell threads at 29 mate or unmate the connector 10 depending upon which direction the coupling nut 13 is turned.

10 A pin 24' similar to pin 24 is shown in Fig. 3 in an enlarged view with an end 25' of leaf spring 19 similar to end 25 of leaf spring 16.

15 The mechanism of the invention contains radially acting teeth 15 projecting directly from central barrel 14 independent of any shoulder so as to allow for use in very limited dimensional envelopes.

20 The mechanism of the invention incorporates teeth 15 with a profile which has been designed to provide less than a 60% ratio between the unmated coupling and decoupling torques. This feature surpasses the existing art, since the prior art designs provide torque ratios very close to or exceeding 100% with little control or consistency.

25 The mechanism of the present invention incorporates teeth 15 coated with a permanent wear resistant lubricant coating. This coating allows the mechanism to function with a minimum of contaminations, dirt, galling or adverse affect on operation through added stress or delamination.
30 The prior art requires either continued maintenance with the possibility of lubricant removal due to fluids or viscosity change at higher temperatures, or a possible delamination under adverse conditions. Other factors include the effects of grease lubricant or a plastic laminate on the control and
35 consistency of connector torques.

The mechanism of the invention allows a user to feel a definite physical torque difference between the mating and

unmating directions while blind mating. This is not possible with the prior art because little consistent difference between torque direction exists.

5 The mechanism of the invention is designed for low operating stress levels not requiring a heavy preload for proper function. The existing art operates with a relatively large preload in order to provide an adequate torque within the space requirements.

10 The mechanism of the invention is less susceptible to damage during assembly because it is not required to overcome a sizable spring preload upon insertion of the barrel 14.

15 The mechanism of the invention contains anti-vibration springs 16-19 with dimples 20-23, respectively, possessing sloped sides 26-27.

The mechanism of the invention has sloped sides 26-27 that are distinctly different..

20 The mechanism of the invention where the anti-vibration springs 16-19 are positioned within the mechanism so that no preloading is necessary. The closest prior art operates with a substantial preload.

25 The mechanism of the invention prevents excessively high stress levels within the anti-vibration springs 16-19. The existing art evidences high stress levels due to high preload. These levels can cause premature failure and reduced reliability.

30 The mechanism of the invention incorporates anti-vibration springs 16-19 positioned within the mechanism so as to incur a tensile stress during unmating. This produces a wiping action of the teeth on the springs reducing the amount of required flex on the pinned end.

35 The mechanism of the invention employs anti-vibration springs 16-19 positioned within the mechanism so as to incur a lower stress level from the mating torque in compression, reducing the possibility of compressive spring buckling failure.

The mechanism of the invention provides easy access

for inspection and servicing.

The mechanism of the invention, though used in widely varied environmental conditions or applications, may be manufactured from a variety of materials such as plastic or ceramic and is not limited to metallic components.

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CLAIMS

1. An electrical connector (10) comprising :
 - a plug (11) including a barrel (14) having a longitudinal axis;
 - a threaded coupling nut (13) axially fixed but
5 rotatable on said plug barrel about said barrel axis;
 - a receptacle (12) including a shell threadable with said coupling nut to mate and unmate the connector; and
 - drag means between said coupling nut and said
10 plug barrel to resist yieldingly rotation of said coupling nut in directions respectively to couple and to decouple the connector,
 - said drag means including a wheel member having ratchet-like teeth (15) fixed with said plug barrel and a
15 plurality of leaf springs (16-19) mounted on said coupling nut and spaced around said plug barrel in engagement with said teeth,
 - each of said leaf springs being rotatable on said coupling nut about a longitudinal axis (24') through one
20 end thereof,
 - each leaf spring having a detent-like body (23) to engage said member teeth to resist yieldingly coupling and decoupling rotation of said coupling nut relative to said plug barrel,
 - 25 each of said leaf springs extending in a generally arcuate direction from said axis thereof,
 - said generally arcuate direction being the same as that in which said coupling nut is rotated to achieve coupling.

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2. The invention as defined in claim 1, wherein:
said plug barrel is generally cylindrical
in shape.

5 3. The invention as defined in claim 1, wherein:
said leaf springs are made of a material which
is isotropic.

10 4. The invention as defined in claim 3, wherein:
said leaf springs include metal stampings.

15 5. The invention as defined in claim 4, wherein:
said detent-like bodies include upset integral
portions of said leaf springs.

20 6. The invention as defined in claim 1, wherein:
said coupling nut has a bore,
said leaf springs being substantially flat and
being positioned as respective chords of arcs of said
coupling nut bore.

25 7. The invention as defined in claim 1, wherein:
said coupling nut has pins axially extending
at the positions of respective corresponding leaf spring
axes,

said leaf springs being press fit over
respective corresponding ones of said pins.

FIG. 1

