Oct. 15, 1968 J. KAPLAN 3,405,929

SPRING SLIP ELEMENT FOR BI-DIRECTIONAL SLIP

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FIG. 3

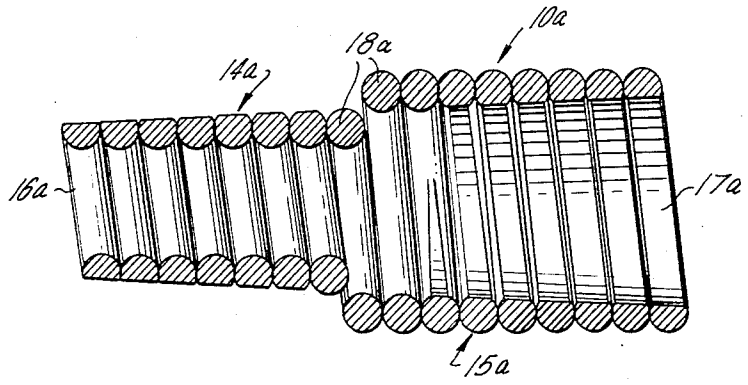


FIG. 1

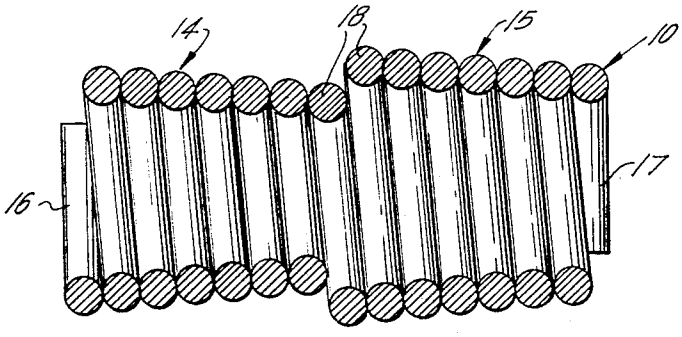
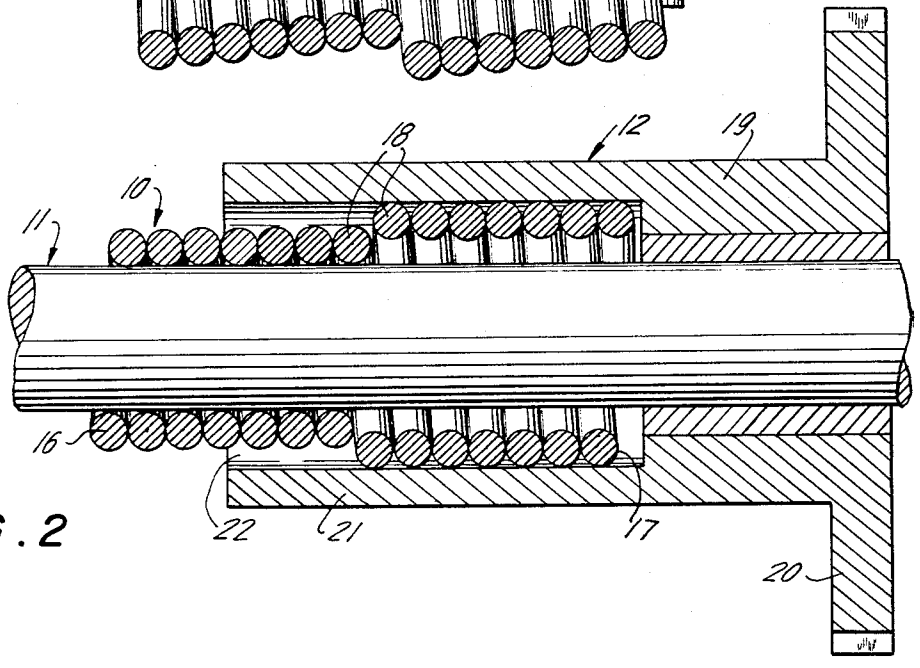


FIG. 2



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FIG. 4

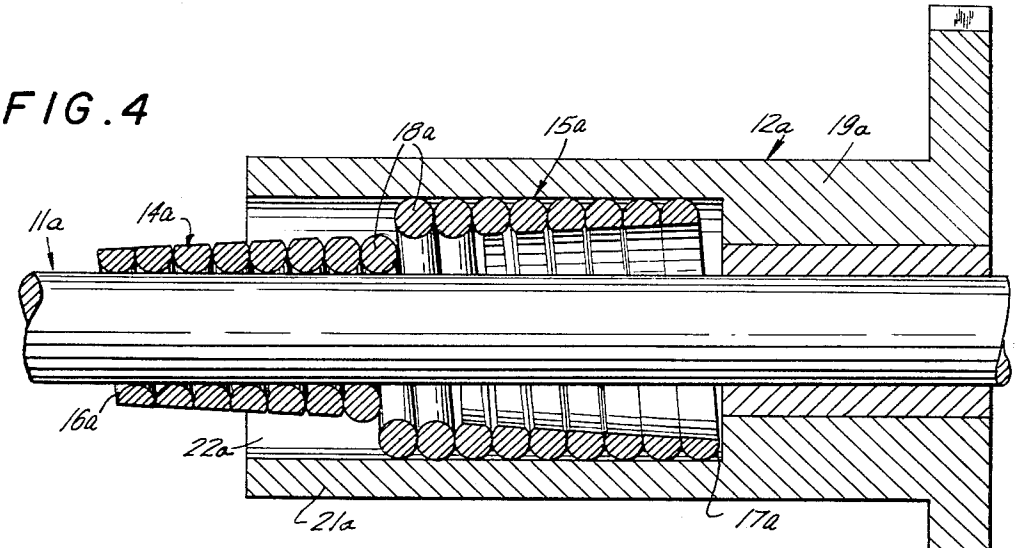


FIG. 5

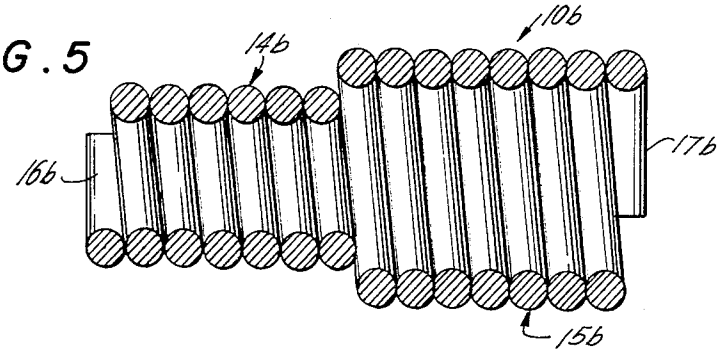
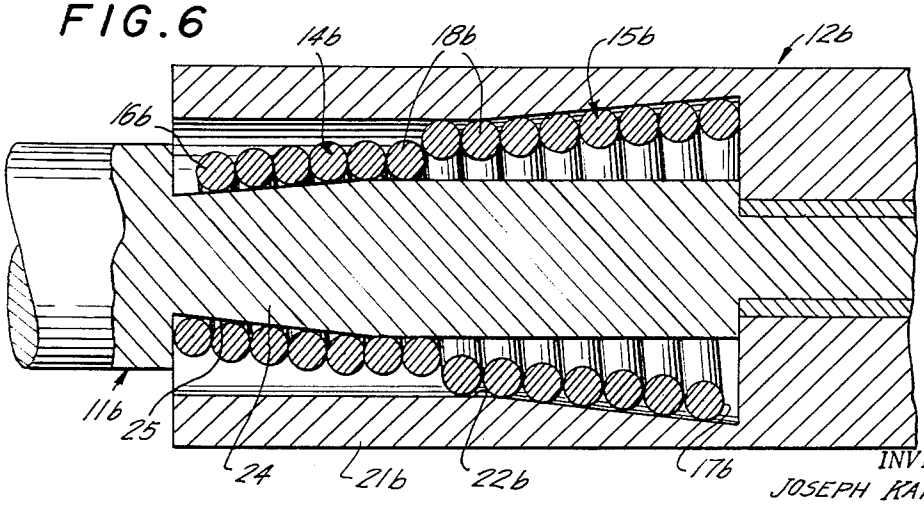


FIG. 6



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United States Patent Office 3,405,929
Patented Oct. 15, 1968

3,405,929

SPRING SLIP ELEMENT FOR BI-DIRECTIONAL SLIP

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Filed Mar. 23, 1967, Ser. No. 625,531
7 Claims. (Cl. 267—1)

ABSTRACT OF THE DISCLOSURE

The instant invention, in essence, is concerned with a spring-type element wherein end portions of a spring engage with surfaces of element members, and the spring convolutions engage the element member surfaces with decreasing contact pressure in the direction toward the free ends of the convolutions.

Background of the Invention

This invention relates generally to spring-type slip elements such as drag brakes, slip clutches, slip couplings, and the like.

As is well known, spring-type slip elements are advantageous in many respects in particular where it is desirable to obtain a constant limit torque. However, heretofore wear of spring-type slip elements, due to uneven contact pressure of the spring convolutions with the frictional surface of an element member, shortened their operating life. This can be readily understood by appreciation of the contact pressure of a convolution under slip conditions being a function of the angle of wrap or location of the particular convolution from the free end of the spring. Where a helical spring of constant diameter or cylindrical configuration is forced to slip over or in companion members of constant diameter the contact pressure is maximum at the free spring end an decreases inward, so that wear occurs unevenly in relation to the contact pressure.

Summary

Accordingly, it is an important object of the present invention to provide a unique construction of slip element of the coil-spring type wherein contact pressure of the convolutions is more evenly distributed, so that wear of the free and convolution is minimized for increased durability and reliability over a greater useful life.

It is a further object of the present invention to provide a bi-directional torque-limiting spring slip element having the advantageous characteristics mentioned in the preceding paragraph, including means for decreasing the contact pressure between spring convolutions and the contacted element member in the directions toward the free spring ends, to more evenly distribute contact pressures over the several spring convolutions and minimize wear.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings, which form a material part of this disclosure.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, which will be exemplified in the construction hereinafter described, and of which the scope will be indicated by the appended claims.

In the accompanying drawings, the same reference numerals indicate the same parts throughout the various figures; and exponents of the reference numerals in alternate embodiments refer likewise to the same or related parts.

Brief description of the drawings

FIGURE 1 is a longitudinal sectional view showing a spring in undistended condition for use in a slip element of the present invention;

FIGURE 2 is a longitudinal sectional view showing the spring of FIGURE 1 in association with additional members of a slip element;

FIGURE 3 is a longitudinal sectional view showing a slightly modified form of spring of the present invention;

FIGURE 4 is a longitudinal sectional view illustrating the spring of FIGURE 3 in association with additional members of the slip element;

FIGURE 5 is a longitudinal sectional elevational view showing still another form of spring, in undistended condition, for a slip element of the present invention; and

FIGURE 6 is a longitudinal sectional view showing the spring of FIGURE 5 in operative association with additional members of a slip element.

Description of the preferred embodiments

Referring now more particularly to FIGURES 1 and 2, a coil spring is there generally designated **10**, and shown in FIGURE 2 in operative association with male and female slip element members **11** and **12**. In the undistended spring condition of FIGURE 1, the spring **10** includes a pair of steps or end portions **14** and **15**, the former being of smaller diameter for external engagement with a male element member or shaft, and the latter being of larger diameter for internal engagement with the female element member **12**. It will appear that the coils or convolutions of spring **10** are all of substantially identical thickness, the wire of the spring being of constant cross section throughout its length, although the terminal regions **16** and **17** of respective end portions **14** and **15** may be tapered in the conventional manner, if desired. While the spring **10** may include one or more intermediate convolutions **18**, the end portions **14** and **15** extend generally outwardly in opposite directions from the intermediate coil or coils **18**. Further, the end portion **14** extends longitudinally outward from the intermediate coil or coils **18**, and the coils or convolutions of end portion **14** are of progressively increasing diameter in the direction away from the intermediate coil. Further, the spring end portion **15** extends away from the intermediate coil or coils **18** in the opposite direction from the spring end portion **14**, and the coils or convolutions of spring end portion **15** are of progressively decreasing diameter in the direction toward the terminal region **17**. Also, advantageously the spring end portion or step **15** may have its coils or convolutions of an average diameter greater than that of the spring end portion **14**.

It may therefore be stated that the spring end portions **14** and **15** are of tapering configuration, the former tapering inwardly away from its remote end region **16**, and the latter tapering inwardly toward its remote end region **17**.

The male element member **11** may be a shaft having a generally cylindrical outer surface, while the female element member **12** may include a bearing portion **19** rotatably receiving the shaft **11**. Extending from the bearing or journal part **19**, radially outward with respect thereto may be a toothed flange or gear **20**, as for power transmission; and, a sleeve **21** extends from the journal part **19** in spaced relation about the shaft **11**. The sleeve **21** includes a generally cylindrical internal surface **22** spaced coaxially about the external surface of shaft **11**.

In the assembly of FIGURE 2, the spring 10 has been interposed in operative engagement between the element members 11 and 12. In particular, the larger step or end portion 15 of spring 10 has been engaged in the sleeve 21 of the female element member 11, the spring end portion 15 being resiliently distorted to assume a generally cylindrical configuration with its convolutions having their outer surfaces in conforming engagement with the generally cylindrical internal surface 22. The small step or spring end portion 14 is resiliently distended to a generally cylindrical configuration in conforming bearing engagement about the external surface of cylindrical shaft 11. Thus, the spring end portions 14 and 15, in their undistended or rest conditions are of tapered configuration relative to the engaged surfaces of shaft 11 and sleeve 21, the surfaces both being cylindrical. Viewed otherwise, successive inward convolutions of the spring portions 14 and 15 are increasingly more distended in the assembled condition of FIGURE 2, so as to apply increasingly greater contact pressure against their respective engaged surfaces. If desired, the average convolution diameter of each of the end portions 14 and 15 may be selectively determined to thereby calibrate the strength or condition of slip, as desired for the particular direction of power transmission.

In FIGURES 3 and 4 are shown a slightly modified spring slip member 10*a* for use in association with a shaft 11*a* and female element member 12*a*, as in the first-described embodiment. The spring 10*a* may include a pair of steps or end portions 14*a* and 15*a*, each of helical configuration and connected together by one or more medial convolutions 18*a*. The spring 10*a* may be initially wound of wire material having constant cross section throughout its length, with the end portion or step 14*a* of a cylindrical configuration of one size or diameter, and the end portion or step 15*a* of a cylindrical or constant diameter configuration of another size.

However, by the teachings of the instant invention, distention of the spring end portions 14*a* and 15*a* is to decrease in force toward the distal or remote convolutions 16*a* and 17*a* when the spring 10*a* is assembled with the element members 11*a* and 12*a*.

To effect this end, the spring end portions or steps 14*a* and 15*a* are afforded a tapered configuration, respectively externally and internally, leaving their respective internal and external surfaces of generally cylindrical configuration. That is, the convolutions of spring end portion 14*a* may be externally ground or otherwise machined to define an external taper extending in the direction toward the remote convolution 16*a*. The spring end portion or step 15*a* is internally ground or otherwise machined to form an inwardly extending internal taper. Hence, the smaller spring end portion 14*a* remains cylindrical internally while being of decreasing cross section, and consequently of decreasing strength, toward its distal end; and, the spring end portion 15*a* remains externally cylindrical while being of decreasing cross section and strength toward its distal end.

In the assembly of FIGURE 4, the spring end portion or step 14*a* is circumposed about the shaft 11*a*, in frictional engagement therewith, while the spring end portion or step 15*a* is inserted in the sleeve 21*a* in frictional engagement with the internal cylindrical sleeve surface 22*a*. Thus, the spring 10*a* remains in a configuration having its spring end portions 14*a* and 15*a* relatively tapered with respect to their engaged element member surfaces. By the progressively decreasing strength of the convolutions of spring portions 14*a* and 15*a* in the outward directions thereof, the bearing engagement between spring convolutions and the surfaces of shaft 11*a* and sleeve 21*a* is more evenly distributed or equalized to minimize wear.

Regarding the embodiment of FIGURES 5 and 6, a spring slip member is there generally designated 10*b*, and includes a pair of spring end portions or steps 14*b* and 15*b* which, in their undistended condition are each of generally cylindrical configuration, both internally and externally.

A male element member 11*b* includes a tapered shaft portion 24, having an external surface 25 of tapered configuration. A female element member, generally designated 12*b*, includes a sleeve 21*b* having an internal surface portion 22*b* also of tapered configuration. The male member 11*b* enters in spaced relation within the sleeve 21*b* of the female member 12*b*, with the spring 10*b* interposed between the male member and sleeve.

More specifically, the spring 10*b* has its smaller step or spring end portion 14*b* circumposed about the tapered shaft portion 24 in conforming engagement with the tapered surface 25 so that the spring end portion 14*b* tapers or increases in size toward the intermediate convolution 18*b*. The larger spring step or portion 15*b* is engaged in the sleeve 21*b* in conforming engagement with the internal tapered surface 22*b*, so that the step 15*b* decreases in diameter toward the intermediate convolution 18*b*. Thus, distention of the spring 10*b* for assembly with the element members 11*b* and 12*b* is such as to distort the convolutions of the steps 14*b* and 15*b* progressively less in the directions toward their outer or remote convolutions. The convolutions of the spring end portions 14*b* and 15*b* are thereby stressed increasingly less toward their remote convolutions for progressively increased reduction in the application of pressure against the engaged surfaces 25 and 22*b*.

Here again, the relatively tapered configurations between spring end portions in their undistended condition and the respective engaged surfaces effects a progressively decreasing resilient force of distention of the convolutions toward the distal ends. This counteracts the increasing force of contact pressure between spring convolutions and engaged surfaces in the conventional cylindrical relation, to effectively distribute or equalize contact pressures for greatly decreased wear and increased reliability.

Although the present invention has been dscribed in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be made within the spirit of the invention and scope of the appended claims.

What is claimed is:

1. A torque-limiting slip element comprising a first rotary member having an outer surface, a second rotary member having an inner surface, and a coil spring having first and second end portions respectively engaging externally about said outer surface and internally within said inner surface for transmitting torque between said members, and means for decreasing contact pressure between said spring end portions and surfaces in the directions toward the free end convolutions of said spring end portions when the latter are inactive, to more evenly distribute said contact pressure among the convolutions when active.

2. A torque-limiting slip element according to claim 1, said means comprising relatively tapered configurations of said member surfaces and respective engaging spring portions.

3. A torque-limiting slip element according to claim 1, said tapered configurations comprising generally cylindrical member surfaces, and spring portions of progressively varying convolution diameters in undistended condition.

4. A torque-limiting slip element according to claim 3, said first spring end portion being of progressively varying external convolution diameter, and said second spring end portion being of progressively varying internal convolution diameter.

5. A torque-limiting slip element according to claim 2, said relatively tapering configuration comprising generally cylindrical spring end portions, in undistended con-

dition, and member surfaces of progressively varying diameters.

6. A torque-limiting slip element according to claim 1, said means comprising spring end portions of progressively varying convolution strength.

7. A torque-limiting slip element according to claim 6, said spring end portions each being of independently calibrated strength, for selective slip control in opposite directions.

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