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Aldous

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[54] **SPIRAL SPRINGS AND METHODS OF MAKING THEM**

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[52] **U.S. Cl.** **267/156,** 29/173

[51] **Int. Cl.** **F16f 1/10**

[58] **Field of Search** .. 267/156, 157; 29/173; 72/146

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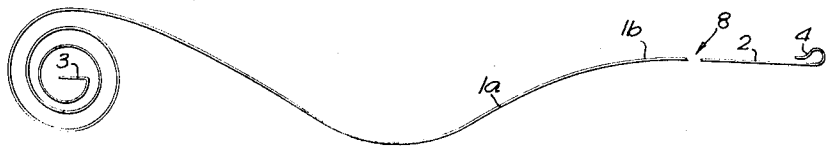
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Attorney, Agent, or Firm—Bacon & Thomas

[57] **ABSTRACT**

A method of making a spiral spring from a strip of spring material comprises the steps of forming an end portion of the strip of spring material so that the end portion is set to form a spiral coil and the remainder of the strip is substantially straight or is set to coil spirally around the said coiled end portion with a radius of curvature substantially greater than that of the coiled end portion, and then backwinding at least the said coiled end portion.

9 Claims, 5 Drawing Figures



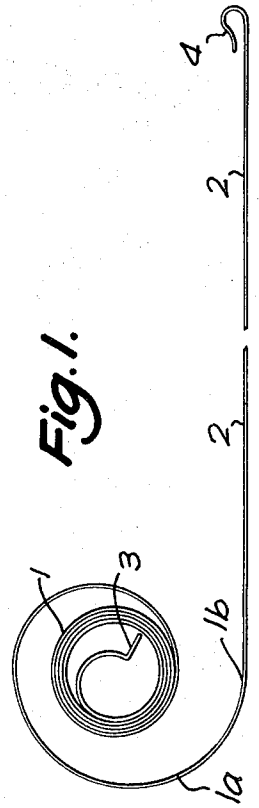


Fig. 1.

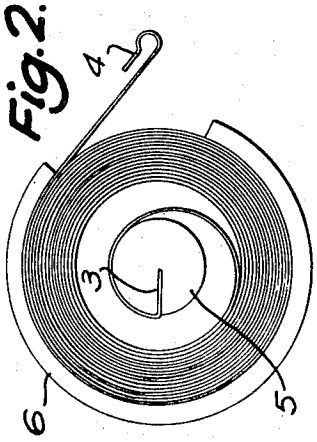


Fig. 2.

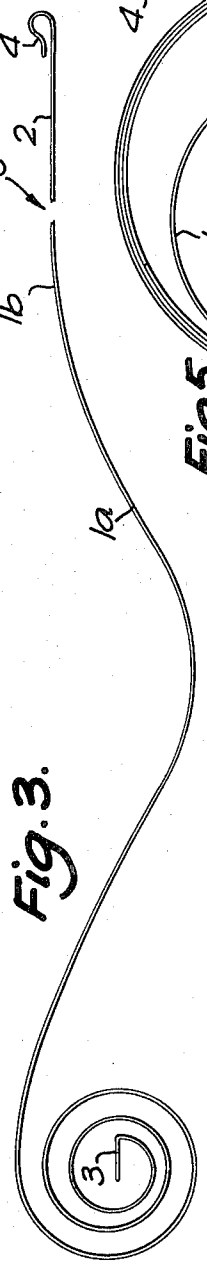


Fig. 3.

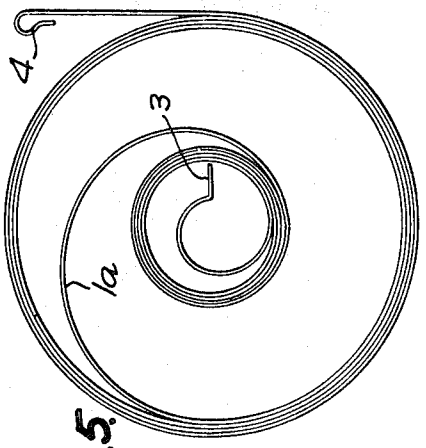


Fig. 5.

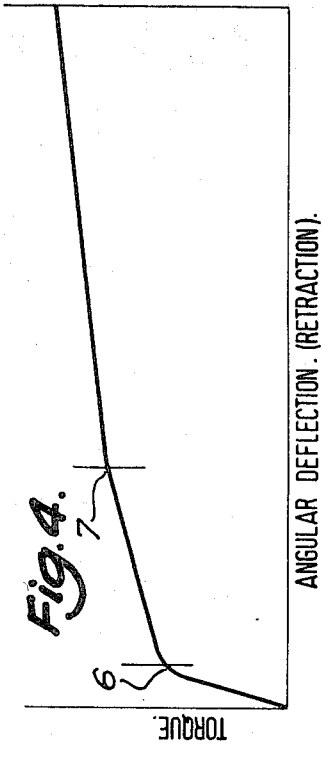


Fig. 4.

SPIRAL SPRINGS AND METHODS OF MAKING THEM

BACKGROUND OF THE INVENTION

The invention relates to spiral springs (more particularly to backwound spiral springs) and methods of making them.

DESCRIPTION OF PRIOR ART

Backwound spiral springs are known which are constructed by setting the entire length of a strip of spring material to form a spiral coil, and then backwinding the entire coil. They are sometimes referred to as "S" springs inasmuch as when the spiral coil is backwound the major length of the strip is stressed beyond its elastic limit and is permanently deformed to take a shape which when released resembles the letter S.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a backwound spiral spring, for example for a spring motor, characterised by a high starting torque.

It is a further object to provide a backwound spiral spring which combines a high starting torque with a low torque gradient over a long deflection.

Accordingly the invention provides a method of making a spiral spring from a strip of spring material comprising the steps of forming an end portion of the strip of spring material so that the end portion is set to form a spiral coil and the remainder of the strip is substantially straight or is set to coil spirally around the said coiled end portion with a radius of curvature substantially greater than that of the coiled end portion, and then backwinding at least the said coiled end portion.

In use the spring may be arranged in a spiral coil about an arbor, with the said one end attached to the arbor, and may be used, for example, as the return spring for a car seat belt of the kind arranged to wind onto a reel after release. When used in this way, initial withdrawal of the seat belt from the reel causes rotation of the arbor, and the spring begins to wind up. The backwound coiled end portion winds up first, providing a significant starting torque but as the remainder of the seat belt is withdrawn and the remaining portion of the spring winds up the torque exerted by the arbor does not increase significantly.

The backwinding of said coiled end portion may be carried out so that the spring material is stressed beyond its elastic limit so as to be permanently deformed whereby at least some of the coils take up a curvature in the reverse direction to that in which the coils were initially set.

Preferably the said coiled end portion before backwinding is set to a uniform radius of curvature so that adjacent coils are in close contact but it is within the scope of the invention for the coiled end portion to be set before backwinding so that adjacent coils are not in contact.

The said end portion of the strip preferably comprises less than half the total length of the strip. It may for example comprise one quarter of the total length.

Preferably the said end portion before backwinding is set to coil by the known method of prestressing whereby beneficial residual stresses of a tensile and compressive nature are imparted to the strip.

The invention includes a spiral spring when made by the method described above.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a first stage in the manufacture of a spring according to the invention;

FIG. 2 shows a second stage in the manufacture of a spring according to the invention;

FIG. 3 shows a spring according to the invention;

FIG. 4 shows a graph of torque against deflection for the spring shown in FIG. 3; and

FIG. 5 shows an alternative stage of manufacture to that shown in FIG. 1.

DESCRIPTION OF ONE EXAMPLE OF THE INVENTION

FIG. 1 shows a strip 2 of spring material an end portion 1*a* of which has been set to form a spiral coil 1. The extreme ends 3, and 4 of the strip have been formed for attachment purposes.

To complete the manufacture, the entire length of strip shown in FIG. 1 is wound tightly onto an arbor 5 so that the spiral coil 1 is tightly backwound about the arbor and the remainder of the strip is wound on top of the backwound coil. The strip is then allowed to expand radially outwardly into a temporary retaining ring 6. On removal from the ring 6 the finished spring has the shape shown in FIG. 3. As may be seen from a comparison of FIGS. 1 and 3, the uncoiled portion of the strip shown in FIG. 1 (i.e. the portion extending to the right from point 8 in FIG. 3) may suffer only slight deformation as a result of the winding, while the coiled portion 1*a* is permanently deformed to a curvature the reverse of the original set. The configuration shown in FIG. 3 is variable to a large extent, and is dependent upon the original radius of set of the coil 1, the diameter of the arbor 5, and the overall length of the original strip.

In use, the spring is inserted into the casing in which it is to be housed while still in the form shown in FIG. 2. The ring 6 is then removed, the spring expands to fill its casing, and the arbor 5 and free end 4 are connected up as desired. For example end 4 may be secured to the casing, and arbor 5 arranged to drive a shaft. The arbor may, for example, be arranged to drive a reel carrying a retractable seat belt.

In FIG. 4 the vertical axis represents torque produced by the spring, and the horizontal axis represents angular deflection of the arbor. The graph represents the path followed during retraction of the spring from the fully wound to the unwound condition. The path followed during winding up of the spring has higher torque figures owing to intercoil friction, but the shape of the curve would be substantially identical.

As the coil is wound up from the fully unwound position where the torque produced by the arbor is zero the first few turns of the arbor draw onto the arbor the innermost backwound coil which produces an almost immediate high starting torque culminating at point 6 on FIG. 4. Further turns of the arbor draw off the remaining portion of the backwound coiled end 1a, culminating at point 7. All the further turns of the arbor wind onto the arbor the substantially unstressed remainder of the strip which adds little to the torque but adds to the number of turns available for winding onto the arbor.

In the alternative method of manufacture illustrated in FIG. 5 the portion of the strip 2 which is not wound into the coil 1, instead of remaining straight as shown in FIG. 1, is coiled about the coil 1 with a substantially larger radius of curvature. The object of coiling the remainder as shown in FIG. 5 is to provide an article which is more conveniently handled than that shown in FIG. 1. It is desirable to impart as little stress as possible to this remainder in forming it into a larger coil, as any substantial stress would, after the spring has been backwound, cause an undesirable increase in the torque produced by the spring from the point 7 on FIG. 4 onwards.

It may be seen that the spring forming the subject of this example comprises an inner core of torsionally strong coils surrounded by a greater number of torsionally weak coils.

As already mentioned, when the spring is wound upon the arbor in use, the inner torsionally strong coil begin to move inwardly one by one to form an open spiral about the arbor. In the absence of any torque applied to the arbor these inner coils urge themselves outwardly tending to keep the torsionally weaker coils inoperative until such time as the torsionally strong coils have wound onto the arbor. When the last torsionally strong coil winds towards the arbor the torsionally weaker coils immediately collapse inwards onto the torsionally strong coils. As may be seen from FIG. 4 such collapse does not register on the torque output as the torque is maintained by the inner torsionally strong coils which do not move during the collapse.

Further winding draws the torsionally strong coils tightly about the arbor, and the torsionally strong coils in turn draw inwardly the torsionally weak coils. The high starting torque is maintained throughout the winding by the torsionally strong inner coils, and the outer torsionally weak coils merely add to the number of turns available to the arbor without adding greatly to the torque gradient.

With the spring forming the subject of this example there is no steady comparatively steep torque gradient upon final winding up of the spring as is observed in normal clock springs. The torque increases gradually as shown in FIG. 4 until there is a very sudden rise in torque due to intercoil friction before the coils bind solid. This sudden rise in torque takes place over about one quarter of a turn of the arbor.

The invention is not restricted to the features of the foregoing example.

I claim:

1. A method of making a spiral spring from a strip of spring material comprising the steps of forming an end portion only of the strip of spring material so that the end portion is set to form a close wound spiral coil, and then winding the whole length of the strip in a direction whereby the previously set end portion is backwound and the remainder of the strip is wound around the backwound end portion.

2. A method as claimed in claim 1 in which the backwinding of said coiled end portion is carried out so that the spring material is stressed beyond its elastic limit so as to be permanently deformed whereby at least some of the coils take up a curvature in the reverse direction to that in which the coils were initially set.

3. A method as claimed in claim 1 in which the said end portion of the strip comprises less than half the total length of the strip.

4. A method as claimed in claim 5 in which the said end portion of the strip comprises one quarter of the total length.

5. A spiral spring when made by the method claimed in claim 1.

6. A spiral spring as claimed in claim 5 arranged in a spiral coil about an arbor, with the said one end attached to the arbor.

7. A method of making a spiral spring from a strip of spring material comprising the steps of forming an end portion only of the strip of spring material so that the end portion is set to form a close wound spiral coil, the remainder of the strip being substantially straight, and then winding the whole length of the strip in a direction whereby the previously set end portion is backwound and the remainder of the strip is wound around the backwound end portion.

8. A method of making a spiral spring from a strip of spring material comprising the steps of forming an end portion only of the strip of spring material so that the end portion is set to form a close wound spiral coil, forming the remainder of the strip so that it is set to coil around said coiled end portion with a radius of curvature substantially greater than that of the coiled end portion, and then backwinding the whole length of the strip, said remainder of the strip still having a radius of curvature substantially greater than said coiled end portion.

9. A method as claimed in claim 1 in which the step of forming the said coiled end portion before it is backwound acts to impart beneficial residual stresses of a tensile and compressive nature to the said end portion.

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