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Curtis et al.
[11] 3,815,887
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[54] PLASTIC SPRING

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[52] **U.S. Cl.** **267/91**, 267/131, 5/351
[51] **Int. Cl.** **F16g 3/08**
[58] **Field of Search** 267/153, 181, 182, 91; 5/351, 353

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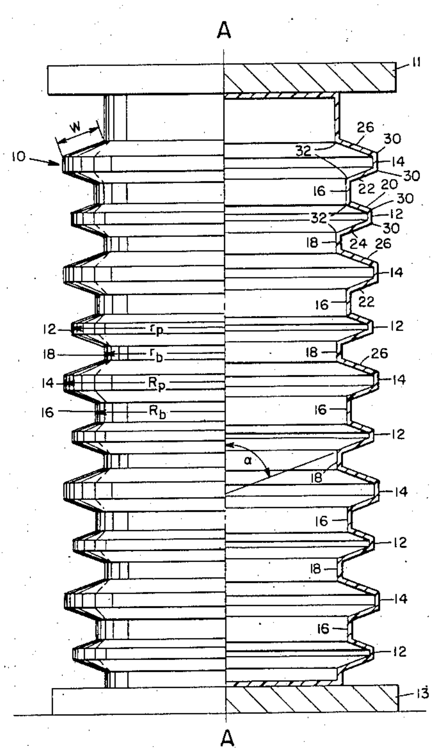
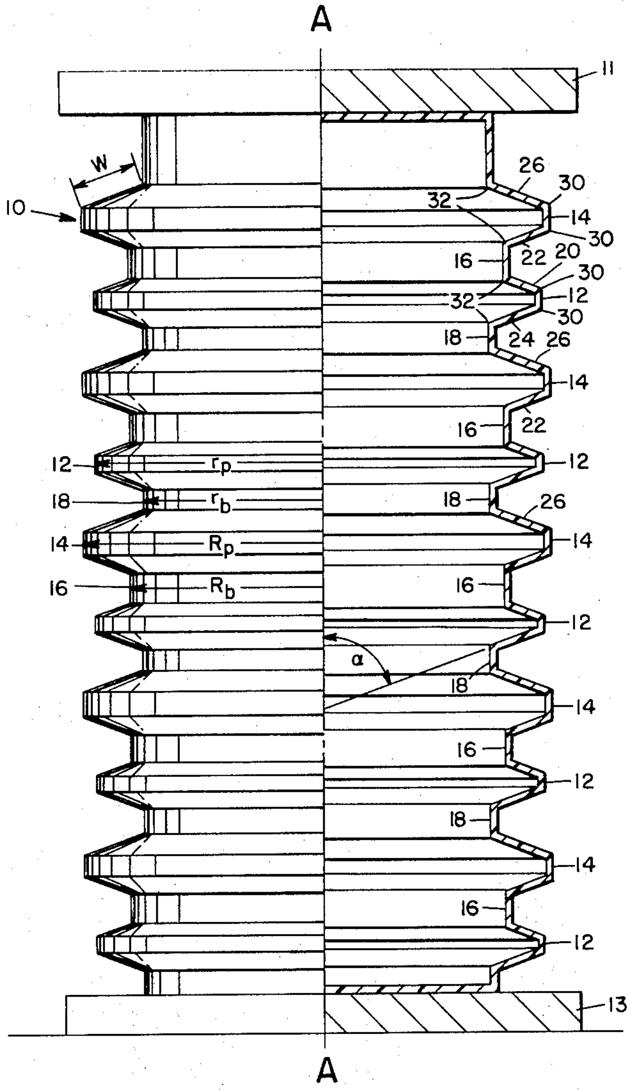
Attorney, Agent, or Firm—James W. Peterson

[57] **ABSTRACT**

A thin wall hollow, corrugated plastic spring is provided which has a plurality of annular peaks, each separated by a respective one of a plurality of annular valleys. A first group of bottoms of respective valleys are spaced a first distance from the longitudinal axis of the spring and a second group of valley bottoms, each of which alternate with a bottom of the first group, are spaced a second distance from the longitudinal axis of the spring. The peaks are arranged in the manner as the valley bottoms thereby providing a telescopic effect of the valley bottoms and a telescopic effect of the peaks when the spring is fully compressed. As modifications, all of the peaks may be at the same distance from the longitudinal axis while the distances of the valley bottoms vary as above described or vice versa. This provides for a telescoping effect of either the peaks or the valley bottoms. The spring rate is non-linear. The spring is preferably made of polypropylene and has primary utility in seating and reclining applications such as chairs, sofas, and bedding.

18 Claims, 8 Drawing Figures




A
11
W
10
26
30
32
14
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16
22
20
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24
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r_p
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FIG. 1

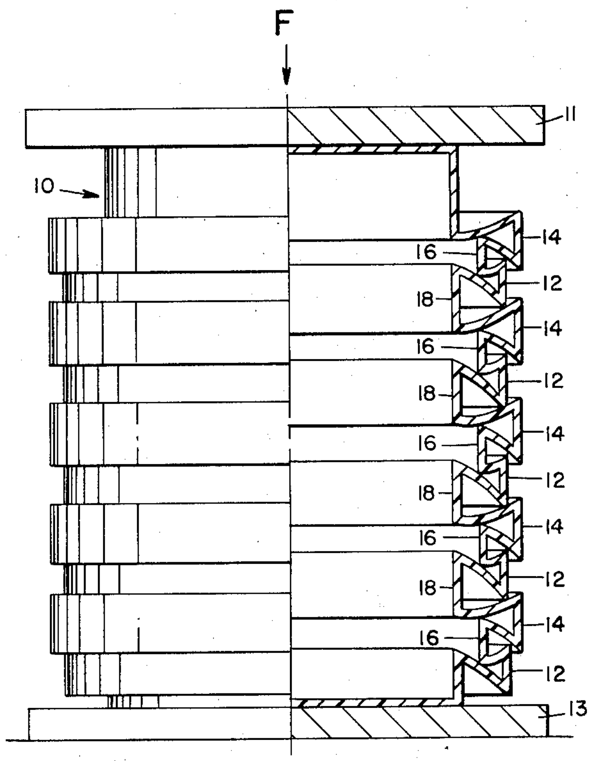

FIG. 2

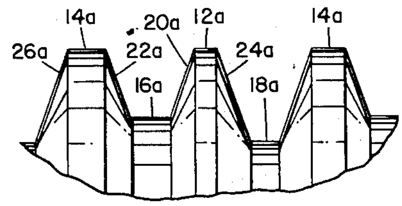

FIG. 3

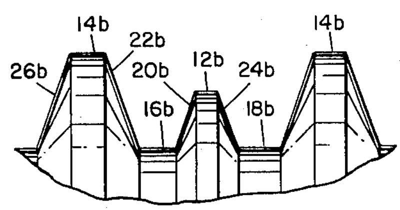

FIG. 4

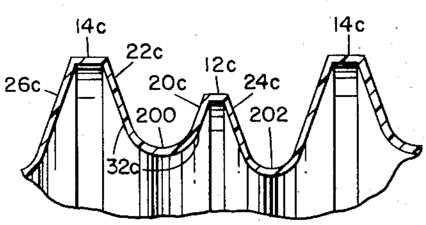

FIG. 5

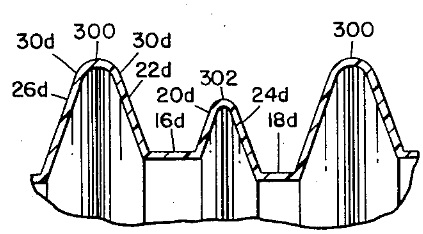

FIG. 6

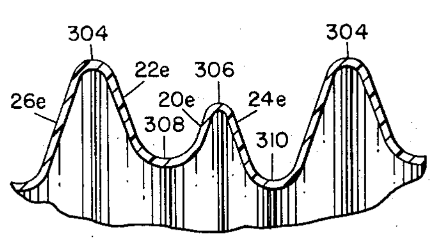

FIG. 7

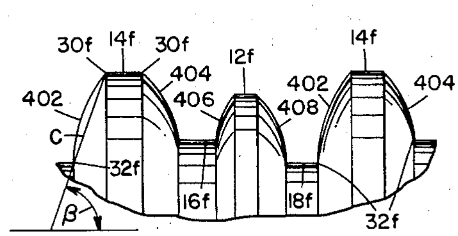

FIG. 8

PLASTIC SPRING

In the construction of many chairs and sofas it has been customary to employ wire coil springs. The use of such coil springs and the connection thereof to a chair or sofa frame is rather expensive.

It is an object of this invention to provide a less expensive spring assembly by utilizing a specially designed plastic spring instead of a wire coil spring.

It is a further object of this invention to provide a plastic corrugated spring which possesses a non-linear spring rate.

Yet another object of the invention is to provide a plastic corrugated spring which has a short compressed height.

Other objects of this invention will become apparent from the following description with reference to the drawings wherein:

FIG. 1 is a view in section of a corrugated plastic spring;

FIG. 2 is a view in section of the corrugated plastic spring of FIG. 1 fully compressed;

FIG. 3 is a partial view in section of a modification of the spring of FIG. 1;

FIG. 4 is a partial view in section of another modification of FIG. 1;

FIG. 5 is a partial view in section of a further modification of the embodiment of FIG. 1;

FIG. 6 is a partial view in section of still another modification of FIG. 1;

FIG. 7 is a partial view in section of yet another modification of FIG. 1; and

FIG. 8 is a partial view in section of a further modification of FIG. 1.

Referring to FIG. 1, a spring is generally referred to by reference numeral **10**, and is supported between a force transmitting member **11** and a support **13**. The spring may either loosely rest on the support **13** or be secured thereto by an adhesive or other known means and the force transmitting member **11** may either loosely rest on the spring or be secured thereto by an adhesive or other known means. The force transmitting member **11** could represent a sofa cushion and the support **13** could represent a sofa frame. As can be seen by reference to the drawing, the spring comprises a tubular corrugated, thin-walled plastic member which has a plurality of peaks and valleys circumscribed about the longitudinal axis A—A of the spring at varying distances therefrom. Each peak **12** and **14** and each valley **16, 18** comprises a tubular wall, which is planar in cross-section and is generally parallel to the axis A—A. The side walls **20** and **22** of one valley and **24** and **26** of an adjacent valley are generally frusto-conical in shape and are at an angle α with the axis of the spring which can vary between 85° and 60°. The larger diameter edges **30** of the side walls are integral with one edge of a respective peak wall and the smaller diameter edges **32** of the side walls are integral with one edge of a respective one of the bottom walls of a respective valley. As can be noted from FIG. **1**, all of the bottoms **16** of the valleys are of the same radius R_b of circumscription about the longitudinal axis A—A and all of the bottoms **18** are of the same radius r_b of circumscription about the longitudinal axis and which radius is smaller than the radius R_b. All of the peaks **14** are of the same radius R_p of circumscription about the longitudinal axis A—A and all of the peaks **12** are of

the same radius r_p of circumscription about the longitudinal axis, which radius is less than the radius R_p.

The slant width "W" of wall **26** is the largest followed by the slant width of walls **24, 22** and **20** in order of magnitude. Obviously, depending upon the characteristics desired, the radii of circumscription of the walls can be varied whereby the slant width "W" of walls **22** and **24** are equal or the slant width of wall **22** may be greater than or less than the slant width of wall **24.**

When the spring is under a load "F" which has been applied to the force transmitting member **11,** the side walls are strained as shown in FIG. **2.** Upon release of the load, the stresses of the frusto-conical side walls are released and they return to their original unloaded position thereby expanding the spring back to its unloaded position. Air passages (not shown) may be provided in the spring to allow the spring to compress and expand.

The spring is made by extruding a tubular parison and placing the same in a mold and then blow-molding to expand the parison into the contour of the mold. The parison is the same length as the mold. In one particular spring design, the outer diameter of the parison is about 38 percent of the largest peak outer diameter, about 40 percent of the smallest peak outer diameter, about 52 percent of the smallest valley bottom outer diameter, and about 50 percent of the largest valley bottom outer diameter. The thickness of the parison is about 7½ times the average thickness of the spring after it is molded. Since the spring is corrugated, the longitudinal periphery is 180 percent of the original length of the parison. Thus, the spring comprises a polymer which is biaxially stretched. Due to the biaxially stretching, the wall thickness of the spring decreases as the diameter of the spring increases. Thus, in this particular spring design, the parison was 184 mils thick and the thickness of the valley bottom wall **18** was 43 mils, the thickness of the valley bottom wall **16** was 40 mils, the thickness of the peak wall **12** was 20 mils and the thickness of the peak wall **14** was 9 mils. This biaxial stretching effects a stronger spring and increases the fatigue life thereof.

The spring **10** comprises two spring rates with the walls **20** and **24** being of greater spring rate than the walls **22** and **26.** This characteristic, in addition to the fact that the spring is blow molded, results in a non-linear force displacement curve generally similar to a conical wire coil spring.

The primary purpose of alternating the radii of the valley bottoms **16** and **18** and of the peaks **12** and **14** is to provide a short, fully compressed height for the spring since the valley bottoms and peaks can telescope within one another as shown in FIG. **2.** Obviously, if all of the valley bottoms and peaks were of the same radius, the fully compressed height would be much greater since the valley bottoms would abut each other. A short, fully compressed spring is a necessity in furniture and therefore the design is very advantageous.

The difference in radii of the bottom walls **16** and **18** should be at least equal to the thickness of the bottom wall and the difference in radii of the peaks **12** and **14** should be at least equal to the thickness of the peak wall. The ratio of the two different radii of the valley bottoms should not exceed 1½:1 and the ratio of the two different radii of the peaks should not exceed 1½:1. The maximum peak radius should not be more than three times the minimum valley bottom radius.

The wall thickness at the valley bottom should not be greater than 18 times the thickness of the wall thickness at the peak.

The wall thickness of the spring may be within the range of from 5 mils to 90 mils. If the wall thickness is less than 5 mils, the spring rate is too low for an effective spring for most applications and buckling of the spring walls can occur. If the wall thickness is above 90 mils, the spring rate is too high for an effective spring for most applications.

The preferred plastic is polypropylene due to its crystallinity, high modulus, low cost, processibility, and excellent flexural life characteristics. Other plastic materials may also be used but are not considered as advantageous as polypropylene.

In certain designs the combined axial lengths of the walls of the valley bottoms **16** and **18** may be larger than the combined axial lengths of the walls of the peaks **12** and **14** whereby if the radii of the peaks were equal and the radii of the valley bottoms were equal, the valley bottom walls will abut each other while there will be space between some or all of the peaks. In this instance, the principle of this invention may be followed by varying only the radii of the valley bottoms as disclosed in FIG. **3** to permit telescoping of the valley bottoms to thereby shorten the compressed length of the spring. In other designs the combined axial lengths of the walls of the peaks **12** and **14** may be larger than the combined axial lengths of the walls of valley bottoms **16** and **18** whereby if the radii of the peaks were equal and the radii of the valley bottoms were equal, the peak walls will abut each other while there will be space between some or all of the valley bottoms. In this instance, the principle of this invention may be followed by varying only the radii of the peak walls as disclosed in FIG. **4** to permit telescoping of the peak walls to thereby shorten the compressed length of the spring. The same elements as in FIG. **1** are designated with the same reference numerals only with an "a" and "b" affixed thereto for FIGS. **3** and **4**, respectively.

The spring of any of the previous embodiment can be further modified by changing either the valley bottom wall or the peak wall, or both, to a curved or generally U-shaped wall without appreciably affecting the functional characteristics of the spring. The open ends of the curved peak or valley bottom merge with a respective side wall of the valley. These modifications are shown in FIGS. **5**, **6** and **7**, respectively, wherein the same elements as in FIG. **1** are designated with the same reference numerals only with a "c" affixed thereto for the modification of FIG. **5**, with a "d" affixed thereto for the modification of FIG. **6**, and with an "e" affixed thereto for the modification of FIG. **7**. The curved valley bottom walls are designated by reference numerals **200** and **202** in FIG. **5**, the curved peaks are designated by reference numerals **300** and **302** in FIG. **6**, the curved peaks are designated by reference numerals **304** and **306** and the curved valleys are designated by reference numerals **308** and **310** in FIG. **7**.

While the side walls **20**, **22**, **24** and **26** have been described as being generally planar in cross section, they may be bowed or concavo-convex as shown in FIG. **8** wherein the same elements as shown in FIG. **1** are designated with the same reference numerals only with an "f" affixed thereto. Each pair of side walls **402** and **404** and **406** and **408** which are connected to a common peak have their concave surfaces facing each other. The walls are slanted in such a manner that a chord line "c" connecting the larger diametered edge of each wall with its respective inner diametered edge will be at an angle β with the axis of the spring which can vary between 85° and 60°.

What we claim and desire to protect by Letters Patent is:

1. A biaxially stretched spring comprising a hollow, corrugated shell having a plurality of annular peaks and annular valleys separating each of said peaks, a first group of valley bottoms being arranged to be a first distance from the longitudinal axis of the spring and a second group of valley bottoms being arranged to be a second distance from the longitudinal axis of the spring, said groups of valley bottoms being arranged so that a bottom of one group alternates with a bottom of the other group, said first distance being greater than said second distance by at least the wall thickness of the spring at the valley bottoms, said first valley bottoms being dimensionally greater than said second valley bottoms, a plurality of side walls for each valley, each said side wall being generally frusto-conical in shape with the smaller diametered edge thereof being integral with one edge of a respective valley bottom and the larger diametered edge thereof being integral with one edge of a respective peak, the side walls integral with a common peak diverging from each other, the thickness of any portion of said spring shell not exceeding about 90 mils.

2. A spring as recited in claim **1** wherein a first group of peaks are arranged to be a third distance from the longitudinal axis of said spring, a second group of peaks are arranged to be at a fourth distance from the longitudinal axis of said spring, said first and second groups of said peaks being arranged that one peak of one group alternates with a peak of the other group, said third distance being greater than said fourth distance.

3. A spring as recited in claim **1** wherein all of the peaks are arranged to be equal distance from the longitudinal axis of the spring.

4. A spring as recited in claim **1** wherein said side walls are slanted between 60° and 85° with the longitudinal axis of the spring.

5. A spring as recited in claim **4** wherein the radius of circumscription of the peak farthest from the spring axis is no more than 3 times the radius of circumscription of the valley bottom closest to said axis, the thickness of the valley bottom wall closest to said axis is no greater than 18 times the thickness of the peak farthest from said axis.

6. A spring as recited in claim **2** wherein said side walls are slanted between 60° and 85° with the longitudinal axis of the spring.

7. A spring as recited in claim **6** wherein the radius of circumscription of the peak farthest from the spring axis is no more than 3 times the radius of circumscription of the valley bottom closest to said axis, the thickness of the valley bottom wall closest to said axis is no greater than 18 times the thickness of the peak farthest from said axis.

8. A spring as recited in claim **7** wherein the ratio of the different radii of circumscription of the valley bottoms is no greater than 1½:1 and the ratio of the different radii of circumscription of the peaks is no greater than 1½:1.

9. A spring as recited in claim **8** wherein the side walls are generally planar in cross section.

10. A spring as recited in claim 8 wherein the side walls are generally concavo-convex in cross section, the pair of side walls connected to a common peak having the concave surfaces thereof facing each other.

11. A spring as recited in claim 8 wherein the valley bottoms and the peaks are planar in cross section and generally parallel to the longitudinal axis of the spring.

12. A spring as recited in claim 8 wherein the valley bottoms and the peaks are U-shaped in cross section with the open ends thereof merging into a respective one of said side walls.

13. A spring as recited in claim 8 wherein the spring is made of polypropylene.

14. A biaxially stretched spring comprising a hollow, corrugated shell having a plurality of annular peaks and annular valleys separating each of said peaks, a first group of peaks being arranged to be a first distance from the longitudinal axis of the spring and a second group of peaks being arranged to be a second distance from the longitudinal axis of the spring, said groups of peaks being arranged so that a peak of one group alternates with a peak of the other group, said first distance being greater than said second distance by at least the wall thickness of the spring at the peaks, said first peaks being dimensionally greater than said second peaks, a plurality of side walls for each valley, each said side wall being generally frusto-conical in shape with the smaller diametered edge thereof being integral with one edge of a respective valley bottom and the larger diametered edge thereof being integral with one edge of a respective peak, the side walls integral with a common peak diverging from each other, the thickness of any portion of said spring shell not exceeding about 90 mils.

15. A spring as recited in claim 14 wherein all of the bottoms of the valleys are arranged to be equal distance from the longitudinal axis of the spring.

16. A spring as recited in claim 14 wherein said side walls are slanted between 60° and 85° with the longitudinal axis of the spring.

17. A spring as recited in claim 16 wherein the radius of circumscription of the peak farthest from the spring axis is no more than three times the radius of circumscription of the valley bottom closest to said axis, the thickness of the valley bottom wall closest to said axis is no greater than 18 times the thickness of the peak farthest from said axis.

18. A spring as recited in claim 14 wherein the annular peaks and the annular valleys are u-shaped in cross-section with the open ends thereof merging into a respective one of said side walls.

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