

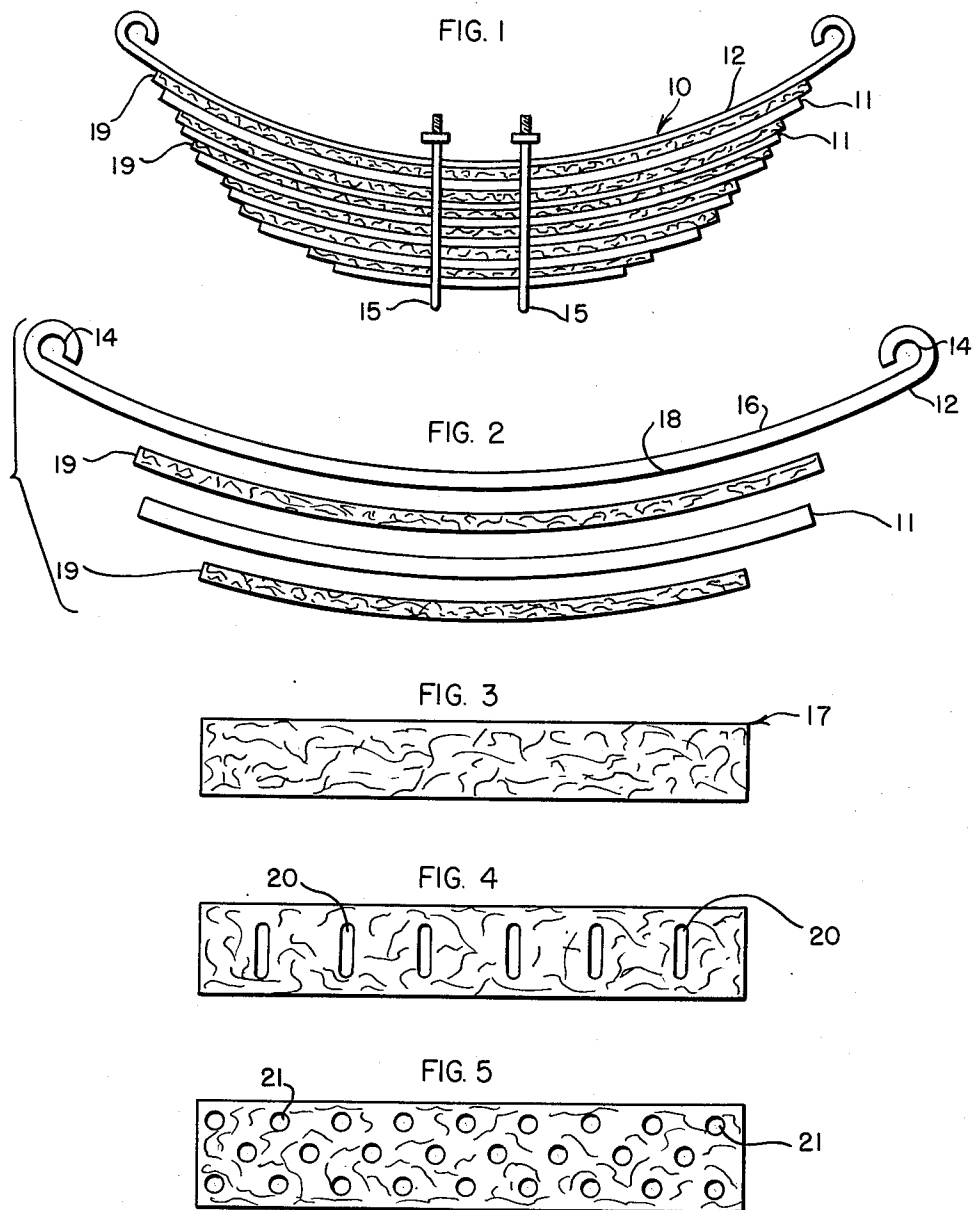
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SPRING STRUCTURE

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SPRING STRUCTURE

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1

2

This invention relates to spring structures and particularly to spring structures comprising in combination peened spring leaves and interleaf spacers.

It has long been the object of improvements in the spring manufacturing art to obtain springs having greater life. Early in the twentieth century, interleaf spacers became the subject of considerable investigation and a number of patents were filed thereon. While these interleaf spacers contribute materially to quieting the action of the springs, they are without effect in prolonging the life of the spring. Peened spring leaves have somewhat greater life than the unpeened leaves when tested singly, but the increase in life is not particularly significant in the normal spring assembly in which the leaves are allowed to rub on each other.

It is an object of this invention to provide spring structures having unexpectedly greatly increased life as compared with known spring structures having either peened leaves or interleaf spacers taken singly.

Another object of this invention is to provide spring structures which have improved spring life and which may be constructed with but little variation from present day manufacturing procedures.

Still another object of this invention is to provide a spring structure characterized by quiet action in combination with increased spring life.

A further object of this invention is to provide an improved leaf spring structure capable of wide variation so as to be adaptable for many different applications.

Other objects and advantages of the present invention will become apparent from the following detailed description thereof when read in conjunction with the accompanying drawings in which

Figure 1 is a side elevation of a typical automobile spring,

Figure 2 is a side elevation of a spring similar to that shown in Figure 1 which is so drawn as to illustrate the manner of assembling the spring, and

Figures 3, 4, and 5 are plan views of several interleaf spacers suitable for use in the present invention.

In general, the present invention comprises spring structures in which peened spring leaves are separated by spacers.

As above pointed out, interleaf spacers, by themselves, do not in any manner add to the life of the spring, and only a moderate increase in

life is obtained by peening the leaves. An altogether new and unexpected result is obtained, however, by peening the spring leaves and spacing them from one another by means of suitable spacers. This is illustrated in the following Table 1 which sets forth data obtained by testing four parabolic nonblockfit springs having a drawfire finish:

Table 1

Sample No.	Surface Treatment	Interleaf Spacers	Cycles Run on Testing Machine ¹
O-62.....	Grease and graphite.....	None.....	137,300, Failed.
O-63.....	do.....	Pressedboard.	135,300, Failed.
O-76.....	Grease and graphite; all leaves completely peened.	None.....	233,500, Failed.
O-75.....	do.....	Pressedboard.	2,500,000, No failure.

¹ Testing machine is standard flexing machine having 4-inch stroke with movement originating at the center of the spring with the eyes of the main leaf held relatively stationary.

Sample No. O-63 shows failure at slightly fewer cycles than Sample No. O-62. This discrepancy is within the range of experimental error, however, and does not mean that the spacers actually decrease spring life. By peening the spring leaves, some increase in spring life may be obtained in certain instances, as shown by a comparison of Sample Nos. O-62 and O-76, although frequently no change at all in spring life is effected. This increase of about 100,000 cycles before failure resulting from shot peening the individual spring leaves is insignificant in comparison with the more than 2,000,000 cycles increase effected by combining shot peened leaves with interleaf spacers. Actually, the increase effected by this combination was much more than 2,000,000 cycles, since there was no failure at the 2,500,000-cycle mark. Such an increase in spring life cannot in any manner be attributed merely to the additive effect of shot peening and spacers, but is the result of a new combination of elements.

In order to illustrate the present invention more clearly, reference is now made to the accompanying drawings in which the particular embodiment disclosed in Figure 1 represents a typical automobile spring. Such a spring 10 is composed of a plurality of leaves 11-11, which may vary in number from 6 to 10 generally. The longest leaf 12 is termed the main leaf and is subjected to the greatest amount of flexing and movement as respects the adjacent leaf. It is customary in the art to identify the spring leaves

with number, beginning with the main leaf as No. 1 and continuing downwardly therefrom. The main leaf 12 is bent back on itself at both ends to form eyes 14—14 by means of which the springs are attached to the chassis of the automobile. The center of the spring is attached to the axle of the car by U-bolts 15—15, so that in operation the center of the spring moves up and down while the ends remain relatively stationary. This causes the upper side 16 of the leaf 12 to be put in tension and the under side 18 to be put in compression. The amount of camber in each leaf will determine the location and magnitude of the initial bending stresses in the assembled spring unit. Spacers 19—19, as shown particularly in Figure 2, are usually composed of such materials as wood, pressboard, canvas, etc., impregnated with, or covered by, graphite and a suitable grease or similar lubricant. Spacers may also be made of soft bearing metals, and, in some cases, certain plastics may be adequate. These spacers may take a variety of forms as is shown in Figures 3, 4, and 5. Figure 3 represents a conventional single-piece pressboard spacer 17, whereas the spacer in Figure 4 contains slots 20—20 in which lubricants such as graphite may be placed. The spacer shown in Figure 5 contains a plurality of holes 21—21 which may be filled with lubricant and, when held tightly between two spring leaves, will retain the lubricant therein so as to form self-lubricating springs. These and a large variety of other forms of interleaf spacers may be satisfactorily employed. Instead of a strip spacer running the length of the spring leaf, the tip of the leaf and the center under the U-bolts may be supported by interleaf spacers with nothing but air space existing between the U-bolt and the tips.

In actual operation, the ends of the leaves 14—14 attached to the chassis are held in a relatively stationary position and the middle of the spring moves up and down as the shock is transmitted by the road to the wheel, through the axle, and to the spring. Pulling or tension stresses are exerted upon the inner or upper side of the spring leaf when its center is bent upwardly and, simultaneously, pushing-together or compression stresses are exerted upon the lower or outer side of the leaf. In fatigue failures of leaf springs, the compression stresses appear to play a very minor part, whereas the tension stresses are major factors in causing failures because they give rise to surface cracks or separations. The interleaf spacers 19—19 extend slightly over the end of the leaves 11—11 so as to prevent any rubbing of one leaf upon the other to produce fret marks or other surface defects. Thus, the interleaf spacers lubricate the movement of the spring leaves with respect to one another so as to reduce or eliminate squeaking, while at the same time preventing any interaction between the surfaces of the spring leaves so as to damage one another.

"Peening" may be technically defined as a process of striking the surface of a metal with a very large number of light blows. For purposes of this invention, shot peening and grit blasting are equivalent processes, so that the word "peening," as used throughout the present specification and the accompanying claims, includes the process of blasting a metal surface with grit or angular metal particles as well as shot or rounded metal particles. Grit blasting is preferred, however, where there is considerable scale on the spring leaf, because the grit removes more

metal than does the shot. The size of the shot or grit employed is apparently immaterial as long as a thorough and uniform cold working of the surface to be treated is effected. Furthermore, the hardness of the metal particles employed is not critical, as long as they are sufficiently hard to effectively cold work the metal surface to be peened.

The most critical feature of the peening operation in the present invention is that there be complete coverage, and coverage is a function of shot or grit size, velocity or impact force, and time of exposure. By "coverage" is meant the peening of the metal surface to such an extent that the compressive stresses raised by the peening operation penetrate below the decarburized layer on the surface of the metal. The usual spring leaf has this decarburized layer of amorphous metal crystals which comprises a weak area in which cracks may originate and ultimately penetrate the entire leaf unless this layer is removed or altered by cold working such as peening. The peening factors will vary from one type of spring leaf to another, but the accompanying examples indicate certain optimum conditions for given springs. The entire spring leaf should be peened whenever the leaf will be subject to reverse stresses, as in the first three leaves of the normal nine-leaf automobile spring, but experience has shown that only the edges and the tension side of the leaves which are not subjected to tension stresses on their compression sides need to be peened to obtain the optimum results. More particularly stated, only those surfaces 2 need be peened that are subjected to tension stresses beyond their endurance limit, be they drawfire finished or otherwise. Peening of the edges of the spring leaf counteracts the tension stresses extending from the tension side in the direction of the under side or compression side. The number of leaves of each spring that are preferably completely peened depends upon the number and length of the spring leaves, as well as the type of spring involved. In automotive springs containing eight or nine leaves, complete peening of the first three leaves, Nos. 1, 2, and 3, has been shown to be adequate. A general rule to use as a guide in applying the present invention is to peen all surfaces which are put into tension during the use of the spring.

The particular material, size, shape, or location of the spacers, or the particular lubricant employed therein is immaterial as long as the spring leaves are prevented from rubbing on one another. It is obvious, of course, that these spacers cannot be made of a hard metal, since they would damage the spring leaves; however, a variety of metals which are sufficiently soft or bearing-like so they would not damage the spring leaves and which have no other detrimental effect upon the spring can be used.

In order to better enable those skilled in the art to practice the present invention, the following detailed examples thereof are given. It is to be understood, however, that the following examples are merely illustrative of the invention and that the present invention is applicable to widely different spring structures, including variations in type of spring, size of leaves, spacers, and peening treatment of the leaves.

Example 1

A standard automotive vehicle spring of the semi-elliptical type, having nine leaves with rectangular sections and composed of SAE No. 9260

5

steel, was blockfitted and then each leaf completely grit blasted manually in an aspirating air lift type sandblast machine. Grade 60 grit was projected at 90 pounds per sq. in. air pressure onto the individual leaves by means of a rubber hose. Approximately 15 seconds of continuous blasting was required to completely cover a given spot. The spring was assembled using vulcanized fiber center spacers with steel tips attached to the outer ends of the leaves, the center spacers and steel tips being lubricated with a mixture of flake graphite and heavy grease, such as Marfax No. 3. The spring thus constructed passed 1,000,000 cycles on the testing machine heretofore described in connection with Table 1.

Example 2

A spring otherwise identical to that described in Example 1 was assembled using pressboard spacers lubricated with a mixture of flake graphite and heavy grease, such as Marfax No. 3, in place of the center spacer-steel tip arrangement of Example 1. Leaves Nos. 1, 2, and 3 were completely peened as in Example 1, but the remaining six leaves were peened only on their tension side and edges. This spring also passed 1,000,000 cycles on the testing machine without failure.

Example 3

This spring was constructed in a manner identical to that of the spring described in Example 2, with the exceptions that the leaves were of parabolic section and that the peening operation was carried out in a commercial, automatic apparatus. A mixture of No. 25 shot and No. 45 grit was thrown against the spring leaves at an air stream pressure of approximately 125 p. s. i., and the leaves moved past this stream at the rate of about 25 feet per minute. As in Example 2, this spring passed 1,000,000 cycles on the spring assembly testing machine without failure.

Example 4

A nonblockfit spring having leaves of parabolic section was constructed in a manner otherwise identical to, and with materials similar to, the spring set forth in Example 2. Upon testing, this spring passed 1,000,000 cycles without failure.

Example 5

A spring was constructed similar to the one described in Example 3, except that the leaves were manually grit blasted only on the tension side instead of being peened all over in a commercial peening machine with a mixture of grit and shot. This spring ran 867,000 cycles on the testing machine before failing. Failure occurred on the compression side of No. 1 leaf.

A comparison of Example 1 with Examples 2, 3, and 4 shows that complete peening of all of the spring leaves is no improvement over peening completely just the first three leaves and only the tension side and edges of the remaining leaves. Test measurements had shown that only in the first three leaves of the eight- and nine-leaf springs tested were there tension stresses on the compression sides, so that there was no need to peen the compression sides of the remaining leaves.

The present invention applies equally to rectangular and parabolic section springs, as shown by a comparison of Examples 2 and 3, which examples also disclose that the employment of widely different peening operations does not affect the life of the resultant spring. The pressboard spacers used in the springs shown in all

6

of the examples other than 1 appeared to be equivalent to the greatly different steel tip-center spacer arrangement used on the Example 1 spring.

Blockfit and nonblockfit springs proved to be equally good after being constructed in accordance with the present invention, as seen by a comparison of Examples 2 and 4. A very important difference was apparent, however, when all of the spring leaves were merely peened on their tension side, as in Example 5. It is significant that the failure of the spring in Example 5 occurred on the unpeened compression side of the main leaf, undoubtedly due to tension stresses caused by reversals of the main leaf.

In summarizing the above comments on the examples set forth, it appears that the peening operation may be varied widely without detrimentally affecting the life of the spring. Nor does it appear that there is anything critical in the particular shape of the leaf or particular spacing means.

It is apparent that the present invention comprises spring structures which include the combination of peened spring leaves and interleaved spacers. By practicing the present invention, the life of the spring structure is greatly improved whether it be a blockfit or nonblockfit type spring.

A number of variations from the above-detailed description of this invention may be made without departing from the scope of the following claims. For example, a variety of spacers of different sizes, shapes, and materials may be employed as long as they perform the essential function of preventing the rubbing of one leaf upon another. Several different methods of throwing shot and grit are now in commercial use and any of them may be employed in the present invention as long as adequate coverage is obtained. Flat springs, such as heavy tractor springs, and other types of leaf springs may be constructed in accordance with the present invention.

What is claimed is:

1. A leaf spring structure comprising in combination spring leaves having all surfaces subject to tension stresses completely peened, said peened surfaces being such that the compression stresses resulting from the peening operation penetrate below the decarburized layer, and means, spacing said leaves from each other, interposed between at least those leaves having peened surfaces, and adjacent said peened surfaces.

2. A leaf spring structure comprising a plurality of leaves, each leaf having essentially its entire surface peened, and spacers interposed between adjacent spring leaves to prevent frictional action of any leaf upon another.

3. A multiple leaf spring structure comprising at least one leaf having all of its surfaces completely peened and the remaining leaves having their tension side and edges peened, and spacing means interposed between adjacent leaves.

4. A leaf spring structure comprising a plurality of leaves, each of which has the tension side and edges thereof peened, and means interposed between adjacent leaves for spacing one from the other.

5. A leaf spring structure comprising a plurality of leaves, each of which has the tension side thereof peened and lubricating spacers interposed between adjacent spring leaves to prevent frictional action of any leaf upon another.

6. A semi-elliptical leaf spring structure for automotive vehicles comprising approximately eight to ten leaves, the three longest leaves being

7

completely peened on all surfaces and the other leaves being peened on the tension side and edges thereof, and lubricating spacers interposed between adjacent spring leaves.

7. A leaf spring structure comprising a plurality of leaves, each of which has all of the surfaces peened which will be subjected to tension strains beyond their endurance limits, and means, for preventing damaging frictional action of one leaf upon another, interposed between at least those leaves having peened surfaces, and adjacent such peened surfaces.

8. An automotive vehicle spring of the multiple leaf type, which comprises a completely peened main leaf, additional leaves peened on their tension side and edges, and lubricated pressedboard spacers, for preventing damaging frictional engagement of the leaves, interposed between at

8

least those leaves having peened surfaces, and adjacent such peened surfaces.

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