Oct. 17, 1967 R. T. BECKER 3,346,938

METHOD OF MAKING A COIL SPRING

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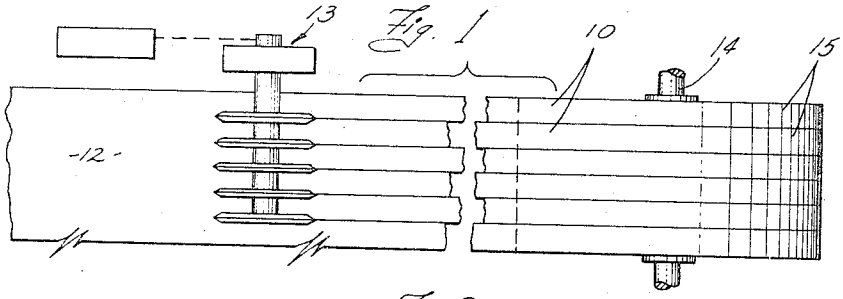


Fig. 1

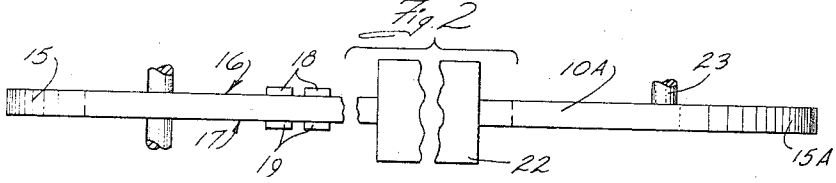


Fig. 2

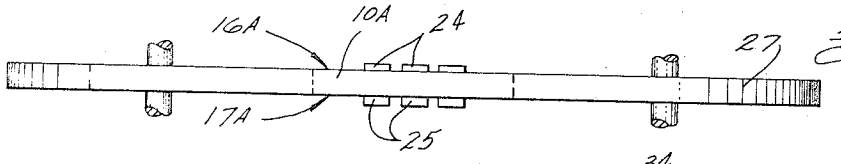


Fig. 3

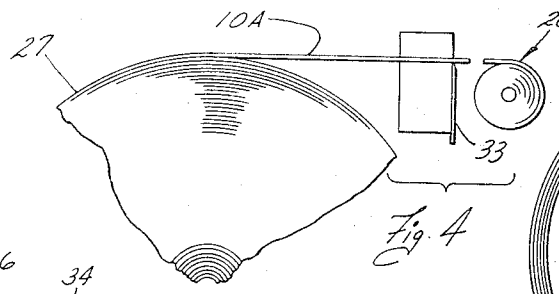


Fig. 4

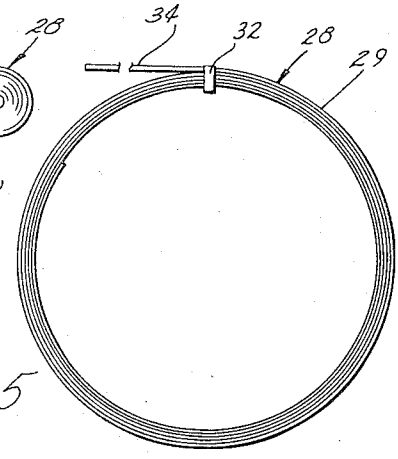


Fig. 5

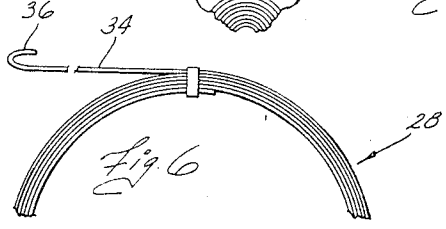


Fig. 6

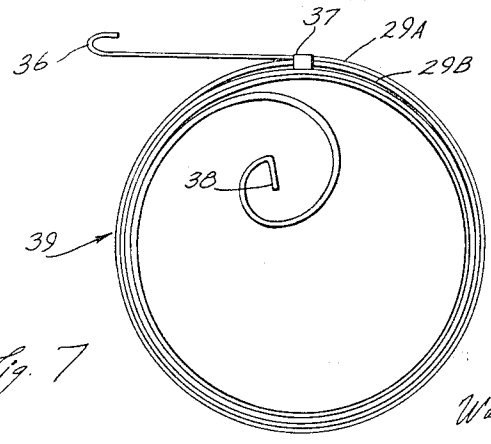


Fig. 7

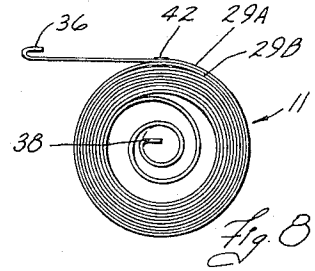


Fig. 8

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METHOD OF MAKING A COIL SPRING

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This invention relates in general to the manufacture of coil springs and, more particularly, to a method whereby the useful life of a spring, which is initially cut from a sheet of steel, is substantially increased.

Coil springs have been used for a variety of purposes, such as in spring motors, and for many years. However, the use of such springs in general, and in spring motors specifically, has often been limited by the fact that the springs sometimes break after strenuous and/or continuous use, and there is no completely reliable method of predicting the failure of the spring. Thus, important associated equipment may be immobilized by such a spring failure.

While springs for these purposes have been steadily improved over the years, the problem of breakage still exists, and many efforts and much time have been devoted to the solution of this problem.

While seeking ways of overcoming, or at least further reducing the problem of spring breakage, as applied to spring motors, it came to my attention that certain batches of strip steel obtained for the purpose of making coil springs seem to produce springs having useful lives somewhat longer than springs produced from other batches of strip steel. In pursuing this finding, it was discovered that some of the strip material received for springs had a greater number of fine hairline cracks along the lateral edges thereof than did other strips of the sheet steel. It is thought that the cracks are produced by the shearing mechanism used to cut sheets of the steel into strips thereof, and the duller shears probably produce the most cracks. Accordingly, when such a strip of sheet metal is continuously or frequently flexed in the region of the hairline cracks, the flexing apparently tends to increase the length and size of the hairline cracks until a fracture, hence failure, of the spring occurs.

While experimenting with these strips of material, it was found that most, if not all, of the hairline cracks along the edge of the strip could be removed by grinding or otherwise abrading the lateral edges of the strip.

Hairline cracks, or any other crack, represent, at least in effect, a breakdown in the adhesion between adjacent molecules along a given line of cleavage. Thus, it occurred to me that any means of strengthening such molecular adhesion would also tend to increase the spring's ability to resist fracture or breakage during operations requiring continuous flexing. In pursuing this viewpoint, it was found that shot peening of the spring, after it was hardened and ready for the final assembly, apparently tended to increase this molecular adhesion and, accordingly, the useful life of the spring. Moreover, this result appeared to be independent of the problem of crack propagation.

Accordingly, the primary object of the invention was to provide a method of treating the strip material so that the hairline cracks would be removed or substantially removed and the molecular adhesion within the resulting strip would be further increased to produce a coil spring having a longer useful life than coil springs made by previous methods.

Other objects of the invention may become apparent to persons familiar with coil springs upon reading the following specification and examining the accompanying drawings, in which:

FIGURE 1 is a somewhat schematic and broken top plan view of a sheet of steel passing through a device for shearing the steel into strips thereof which are collected in rolls.

FIGURE 2 is a broken, top plan view of a strip of sheet metal being removed from one roll thereof, passed through abrading elements and a heat treating device and then rerolled.

FIGURE 3 is a top plan view of a roll of said strip material being further abraded along its lateral edges.

FIGURE 4 is a fragmentary, side elevational view of a roll of fully abraded strip material being cut into predetermined lengths for temporary storage.

FIGURE 5 shows a length of coiled strip steel in a loosely looped arrangement for treatment of the ends thereof.

FIGURE 6 is a fragment of FIGURE 5 after the outer ends of the length have been altered.

FIGURE 7 is a side elevational view of the loop in FIGURE 5 after the inner and outer ends have been altered.

FIGURE 8 is a side elevational view of reduced scale showing the spring of FIGURE 7 ready for use in a spring motor.

For convenience in description, the terms "inner," "outer" and derivatives thereof will have reference to the geometric center of the coil spring.

General discussion

The objects and purposes of the invention, including those set forth above, have been met by providing a method, and an apparatus for carrying out said method, whereby a strip of steel is abraded, heat treated, further abraded and then cut to predetermined lengths. Thereafter, the strip is coiled and the end portions of the coil are properly formed for use in connecting the coil to the housing and shaft of a spring motor. The spring is then shot peened and tightly coiled in its final form for assembly within the housing.

Detailed description

It is believed that the method of the invention can best be described in terms of the apparatus and tools by which it is carried out. Thus, while specific apparatus and tools will be mentioned hereinafter, it will be recognized that the practice of the method is not necessarily limited thereto.

The strips or ribbons **10** (FIGURE 1), from which the spring **11** (FIGURE 8) is fabricated, are usually formed by simultaneously cutting a plurality of the strips from a sheet **12** of steel which is in a relatively soft condition. This is accomplished by a slitting or shearing machine **13** of any conventional type after which the strips **10** are wound in roll **15** upon a mandrel **14**.

The strip **10** on each roll **15** then has its lateral edges **16** and **17** abraded by abrading tools **18** and **19**, respectively, which may be files, stones or the like. The strip **10** is thereafter moved through a heat treating oven **22** to produce a hardened strip **10A** having the necessary characteristics of spring steel. The first abrading operation and the heat treating operation may, under some circumstances, be integrated with and directly following the slitting operation so that the hardened and abraded strip **10A** will be received upon the mandrel **14**. However, in this particular showing, the abraded and hardened strip **10A** (FIGURE 2) is received in a roll **15A** upon another mandrel **23**.

The strip **10A** (FIGURE 3) is now removed from the roll **15A** and passed between a further set of abrading tools **24** and **25**, which engage the opposite lateral edges **16A** and **17A** of said strip **10A**. The tools **24** and **25** provide the final abrading operation which removes sub-

stantially all of the remaining hairline cracks along the edges of the strip and, at the same time, reduces the width of the strip **10A** to its final dimension. The abrading tools **24** and **25** mays be files, stones or the like.

The roll **27** of completely abraded and hardened strip material **10A** (FIGURE 4) can now be cut into predetermined lengths **28** which may be tightly coiled for storage. Alternatively, as shown in FIGURE 5, each predetermined length **28** may be loosely coiled and the loops **29** thereof held together near the outer end of the coil by a band or clamping device **32**.

It will become apparent that the steps of effecting the final abrading on the strip **10A** (FIGURE 3) and of cutting the strip **10A**, by means of the shear **33** (FIGURE 4), into predetermined lengths, as shown in either FIGURE 4 or FIGURE 5, can be accomplished sequentially in a continuous operation.

In the disclosed form of the invention, the outer end **34** (FIGURE 5) of the loosely coiled length **28** is annealed so that the hook **36** can be formed therein. Thereafter, the outer end portion **34** is hardened again. The two outer convolutions or loops **29A** and **29B** (FIGURE 7) of the hardened steel strip **10A** are now clamped together by the band or clamping device **37** and the inner end portion **38** of the length **28** is tightly curled. It may or may not be necessary to anneal and then reharden the inner end portion **38** during the tight curling operation thereof because this end portion experiences relatively little flexing during the normal operation of the spring for its intended purposes within a spring motor (not shown). That is, and as a general rule, the inner end portion **38** of the spring performs primarily as a pivoted connection between a shaft (not shown and the remainder of the spring.

At this point, the nearly complete spring structure **39** (FIGURE 7) is shot peened according to known procedures whereby the potential strength and life of the spring are greatly increased. Then, the band **37** is removed, the spring structure **39** is tightly coiled, as appearing in FIGURE 8, after which the two outer loops **29A** and **29B** are firmly connected together by means, such as the rivet **42**. The spring **11** is shown with its inner end portion **38** centered, about as it would be when attached to a shaft in a spring motor.

Although a particular preferred embodiment of the invention has been disclosed above for illustrative purposes, it will be recognized that variations or modifications thereof, which come within the scope of the appended claims, are fully contemplated.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a method for making a coil spring from a strip of steel cut from a relatively soft sheet thereof, the steps comprising:

engaging the opposite lateral edges of said strip with abrading instruments for removing a portion of the edge material;

heat treating and thereby hardening the strip material after said abrading;

engaging the opposite lateral edges of said strip material with abrading instruments and thereby removing additional material therefrom so that said strip is substantially at its finished width;

cutting said strip into predetermined lengths and loosely coiling each length into substantially concentric loops and fastening said loops together;

forming attachment means on the outer end portion of each loose coil;

forming a relatively tight radius of curvature in the inner end portion of each loose coil;

shot peening at least said inner and outer end portions of each loose coil;

substantially reducing the diameter of the outside loop in each loose coil and the majority of the loops therewithin; and

rigidly connecting the two outermost loops near said outer end portion of each loose coil.

2. The method of claim **1**, wherein the outer end of said coiled length is annealed, bent into the form of a hook and then hardened.

3. In a method for making a coil spring from a strip of steel cut from a relatively soft sheet thereof, the steps comprising:

engaging the opposite lateral edges of said strip with abrading instruments for removing a portion of the edge material;

heat treating and thereby hardening the strip material after said abrading;

engaging the opposite lateral edges of said strip material with abrading instruments and thereby removing additional material therefrom so that said strip is substantially at its finished width;

shot peening the strip material;

cutting said strip material into predetermined lengths and loosely coiling each length into substantially concentric loops and fastening said loops together;

forming attachment means on the outer end portion of each loose coil;

forming a relatively tight radius of curvature in the inner end portion of each loose coil;

substantially reducing the diameter of the outside loop in each loose coil and the majority of the loops therewithin; and

rigidly connecting the two outermost loops near said outer end portion of each loose coil.

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