Nov. 4, 1941. H. B. HATHAWAY 2,261,878

METHOD OF MANUFACTURING COIL SPRINGS

Filed Sept. 11, 1939

FIG. 1.

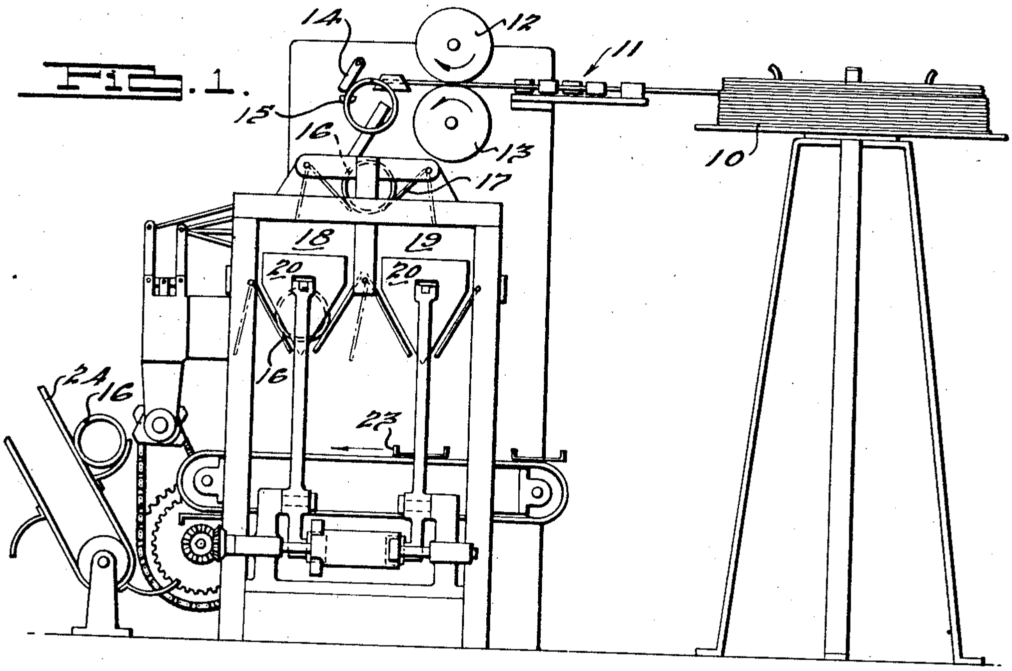
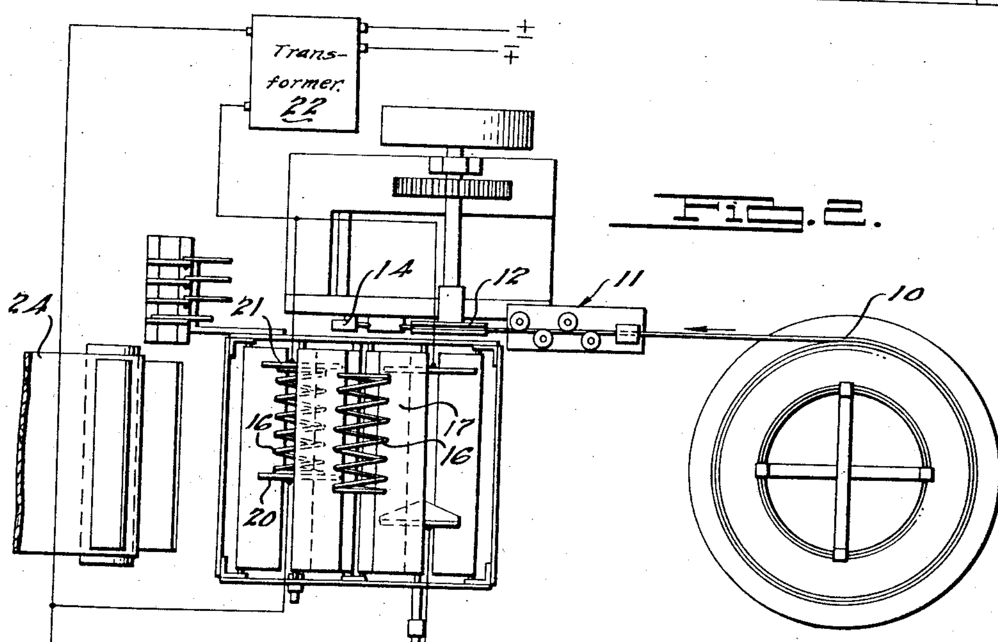


FIG. 2.



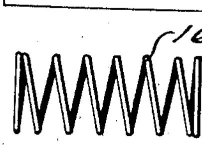


FIG. 3.

INVENTOR
Hubert B. Hathaway.
BY Dike, Calver & Gray
ATTORNEYS.

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METHOD OF MANUFACTURING COIL SPRINGS

Hubert B. Hathaway, Windsor, Ontario, Canada, assignor to L. A. Young Spring & Wire Corporation, Detroit, Mich., a corporation of Michigan

Application September 11, 1939, Serial No. 294,238

3 Claims. (Cl. 148—10)

The present invention relates to a novel method of forming resilient spring members, such for example as coil springs or the like, from relatively non-resilient materials such, for example, as so-called spring steel wire, i. e., wire having sufficient carbon to permit subsequent tempering of a spring formed therefrom, the particular improvement of the present method residing in the provision for the individual heat treatment of the spring members after being formed from such wire.

Prior to the present invention it was customary to provide for the heat treatment of resilient spring members formed from wire stock in order to secure a tempering or normalizing of the wire in the finished spring member after it was formed from the wire stock.

While the terms "tempered," "annealing" and "normalizing" are used somewhat loosely in this art, the terms as used herein are intended to designate any heat-treating operation which has for its purpose or effect the elimination of stresses and strains in the wire due to either the wire-drawing or the spring-forming operations or the heat treatment of the completed spring to impart the desired strength and resiliency characteristics to the spring.

Prior to the present invention it was a common practice to treat the formed springs by heating such springs in an oven where they were subjected to the desired temperatures for the desired length of time, the springs in such instances being usually placed in baskets and carried through the oven by a suitable conveyor mechanism. It has been found difficult to control the heat treatment of the completed springs under such conditions and the operation was further complicated in that the springs which may be treated in the oven at any one time may be of different sizes and different shapes. This makes it difficult to assure a uniform treatment of the springs of each kind since the effect of the heat on the springs varies with the amount of metal which has been used in the forming of the spring and the time that the spring is in the oven. Thus a spring of small gauge wire subjected to the same heat treatment as a larger spring of heavier gauge wire will not be satisfactorily heat treated and vice versa. The heating of the springs in such oven caused the ends of the springs to move in the direction of the coiling and caused the springs to become very badly entangled with each other so that a large amount of unproductive time was required for the purpose of disentangling the springs after they had been subjected to the heat treatment.

While the present invention is concerned primarily with the treatment of coil springs, it is to be understood that the invention is likewise applicable to other types of springs and the term "springs" as used herein is intended to refer to any type of metallic spring members which are subjected to a heat-treating operation subsequent to the formation of the spring from the metallic stock.

It is therefore a principal object of the present invention to provide a novel method of manufacturing springs wherein each spring is subjected to a separate and individual heat treatment for the purpose of normalizing, annealing or tempering the metal in the spring.

A further object of the invention is to provide a method of manufacturing springs particularly but not exclusively adapted to the manufacture of coil springs from steel wire stock having sufficient carbon content to permit a subsequent tempering of a spring formed therefrom and in which each spring is separately heat treated under controlled conditions whereby uniformity of size, strength and resiliency of the springs is achieved which renders the method economical and practical to carry out in production on a commercial scale.

Other objects and advantages of this invention will appear in the following description and appended claims, reference being had to the accompanying drawing forming a part of this specification, wherein like reference characters designate corresponding parts in the several views.

The drawing accompanying the present application is intended to be somewhat schematic and to show a method embodying the present invention. In such drawing:

Fig. 1 is a side elevation of a machine embodying the present invention;

Fig. 2 is a top plan view of the machine shown in Fig. 1; and

Fig. 3 is an elevation of a completed spring.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawing, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

For purposes of the present application no claim is made to the machine or apparatus shown in the drawing as representing an embodiment of the method herein claimed. The machine per se is disclosed and claimed in my co-pending joint application with Bernard Heilman, Serial No. 295,352, filed September 18, 1939, now Patent No. 2,254,525, issued on September 2, 1941, and is not here claimed.

The method of the present invention consists essentially in forming the metallic spring members, in the embodiment here disclosed these being coil spring members formed from steel wire spring stock, and comprises the placing of the spring member under compression after the spring member has been formed from the wire and heating the spring while the spring is under compression until the desired annealing, normalizing or tempering of the metal forming the spring is completed, and thereafter releasing the compression forces on the spring and permitting the spring to return to its normal uncompressed condition while gradually cooling to atmospheric temperatures.

Referring to the drawing, this method is seen to be embodied in the machine there shown. In carrying out the method, steel wire is placed on a reel **10** and is drawn through a wire straightening member indicated generally at **11** and through feed rolls **12** and **13** to the forming die **14** of a conventional type of spring-forming machine. As the wire is coiled by contact with the die **14** and the spring takes form, the separate springs are cut from the supply of wire by the cut-off **15**. The operation just described is that of a conventional type of machine and no claim is made herein for any novelty in this feature of the present invention.

The spring, after it is cut from the wire stock, is identified by the numeral **16** and falls into a distributing hopper member **17** which discharges the spring **16** into an electrically insulated heat-treating chamber **18** or **19**. When the spring **16** drops, for example into the chamber **18**, a movable pressure-exerting electrode **20** is brought in contact with one end thereof and the spring is compressed while at the same time it is heated by the flow of electric current therethrough. As shown in Fig. 2, the spring **16** when so compressed forms a contact between the movable electrode **20** and a fixed electrode **21**, the electrodes being suitably connected electrically with a transformer or similar control member **22**, which in turn is connected with a suitable source of electric current (not shown). While the spring is in this compressed condition, it acts as the resistance element between the electrodes **20** and **21** and is electrically heated to the desired extent by the flow of electric current therethrough.

In carrying out the present method in the formation of coil springs to have a finished length of approximately 3¾ inches and formed of 18 gauge (Washburn & Moen) so-called "Premier" wire having a carbon content ranging between approximately .50% to approximately .70%, it has been found adequate to heat the springs for approximately 1 second while compressed approximately ½ inch. The untreated coil spring is approximately 4 inches in length and during the heat treating is compressed to approximately 3½ inches in length. After the heat treating is completed, the pressure is released and the spring returns to the finished length of approximately 3¾ inches. Under such conditions and using an alternating electric current of from 110 to 220 volts and 60 cycles transformed through a dry type transformer to 6 to 40 volts, a temperature of approximately 450° to 525° F. is created in the springs within the 1 second heating interval.

The details of construction and operation of the machine here shown are found disclosed in the co-pending application of myself and Bernard Heilman, Serial No. 295,352, filed September 18, 1939, now Patent No. 2,254,525, issued on September 2, 1941, and reference is here made to said application for further details of said machine.

After the spring is heated to the desired extent and for the desired length of time, the movable electrode **20** is moved and the spring is allowed to return to its uncompressed state. After being compressed and heated it will be found that a spring such as that previously described will have taken its initial set. Accordingly such springs when assembled in a completed article such as an automobile seat cushion will have at all times a definite and predetermined length which will not vary due to the springs taking an "initial set" after their incorporation in such an assembly.

After the spring has been given a suitable heat treatment it is then discharged from the heat-treating chambers to a conveyor **23**, which in turn carries the spring to the conveyor **24**. While the springs are carried on the conveyors **23** and **24**, they are gradually cooled through radiation of the heat therein to the atmosphere. When discharged from the conveyor **24**, they are ready for further use in the manufacture of fabricated articles utilizing such springs. If desired, the springs may be cooled in the atmosphere or quenched in a water or other fluid bath so as to reduce abruptly the temperatures to the temperature of the quenching bath.

Springs when treated according to the method of the present invention have been found to possess many desirable characteristics not found in comparable springs treated by conventional heat-treating processes. When compared to springs treated by conventional heat-treating processes, it was found that the metal in the springs was more properly annealed and that localized stresses were more completely eliminated. Also, the springs were found to be more resistant to rust and corrosion than wire springs formed of similar wire but treated according to conventional heat-treating methods. It was also found that such springs, while being more uniform in both strength and resiliency characteristics than springs treated by conventional heat-treating methods, are superior both as to life of the spring and its lack of fatigue in use. The springs were also found to be but slightly magnetic shortly after their discharge from the heat-treating chamber. There was no scale formation and upon photomicrographic examination of a section of the wire in the springs after the heat treatment for the purpose of annealing the coiled wire in the springs, it was found that the wire possessed a grain structure which was comparable to the grain structure of properly annealed wire prior to the coiling operation and the forming of the wire into the spring. In checking the distribution of stresses in the finished spring, it was found that such stresses are more uniformly distributed throughout the spring than is true of comparable springs when subjected to conventional types of heat-treating operations.

Since each spring is subjected to separate heat treating and is handled separately, it will be seen that there is no opportunity for the springs to become entangled and consequently that the machine eliminates the need for the consumption of a large amount of non-productive time in disentangling the springs.

While the method of the present invention has been described herein as directed essentially to the treatment of coil spring members formed from steel wire, it is to be understood that the invention is also applicable to the heat treatment generally of springs formed either of wire or sheet stock and wherein it is desired to subject each spring to an individual heat treatment by utilizing the spring as a resistance element in an electric circuit and that the invention is therefore not to be limited to the particular arrangement of parts or details of operation above described.

While the scientific phenomenon underlying the present invention is in part unknown to me, I believe that the results achieved in carrying out the present invention are due in part to a molecular rearrangement of the several constituent elements of the metal. This apparently causes a modification of the sizes of the crystalline structures in the metal as well as compacting said particles which provides a metal mass of more uniform crystalline shapes and sizes and arrangement than exists prior to the heat treating. I prefer the use of alternating electric current in carrying out the method of the present invention as it has been my observation that the alternating directional changes of current flow which are characteristic of alternating electric currents apparently are beneficial in accelerating the rate of the molecular rearrangement within the metal. Thus springs undergoing an individual heat treatment in accordance with the present invention are subject to external mechanically imposed compression forces and to internal compression forces due to the internal heating of the metal.

I claim:

1. In a method of making springs from steel wire having carbon content of less than 1%, the steps of bending the wire to spring shape and cutting off the bent piece, immediately thereupon flexing the bent piece and subjecting it to heating for a period of less than three seconds at a temperature of 450° F. to 525° F., and cooling the piece in the air.

2. In a method of making springs from steel wire having carbon content of approximately .50% to .70%, the steps of bending the wire to spring shape and cutting off the bent piece, immediately thereupon flexing the piece and inserting it as a resistance element in a circuit carrying alternating electric current and thus subjecting said piece to the action of said current and producing simultaneous heating of said piece for a period of about one second at a temperature of about one-half of the temperature constituting the lower limit of the critical thermal range of the wire steel.

3. In a method of making coil springs from steel wire having carbon content of approximately .50% to .70%, the steps of coiling the wire to spring shape and cutting off the coiled piece, immediately thereupon flexing said coiled piece and inserting it for a period of about one second as a resistance element into a circuit carrying alternating electric current with the degree of alternation being of about 60 cycles per second, the character of said current being such as to heat said piece to a temperature of about 450° F. to 525° F., whereby the steel of said piece is subjected in flexed and heated condition to the action of alternating current, and thereupon cooling said piece in the air in an unflexed condition.

HUBERT B. HATHAWAY.