

UNITED STATES PATENT OFFICE

2,271,111

METHOD OF MANUFACTURING SPRINGS

Cal W. Wulff, Chicago, Ill., assignor to Holland Company, a corporation of Illinois

No Drawing. Application April 16, 1938,
Serial No. 202,472

3 Claims. (Cl. 29—173)

This invention relates to the treatment of springs and more particularly to the heat treatment of volute springs and other resilient metal structures and the like.

One of the objects of the invention is the provision of a new and improved method of heat treating high capacity metallic springs in such manner as to impart to them superior characteristics at a great saving in time and expense.

A further object of the invention is the provision of a new and improved volute spring having superior qualities and improved characteristics.

A further object of the invention is the provision of a new and improved method of manufacturing springs so that the treated spring will have greater uniform Brinell hardness and uniformity of grain structure throughout the material of the spring.

Other and further objects and advantages will appear from the following description.

In heat treating volute springs and other coiled resilient metallic constructions, it is common practice to first heat the material to the desired temperature and then coil the same on a mandrel to form the spring or to give it the desired shape. Immediately after the coiling operation, the spring is quenched. But this method is objectionable, especially for forming volute springs or articles formed on a mandrel for the reason that in coiling, the first end of the bar comes in contact with a relatively cold mandrel and its heat is imparted to the mandrel to a greater extent than the subsequently formed turns, hence, uneven cooling of the different portions of the spring results. Furthermore, where the bar is of varying thickness throughout its length, the different portions of the spring after the coiling operation will vary in temperature and hence when quenched will not have uniform properties. Such lack of uniformity in the heated condition of the spring in different portions thereof when it is quenched will result in excessive internal strains; varying hardness in the several active turns; and, lack of uniformity of structure within the turns themselves. Furthermore, there will be non-uniform micro or molecular structure and grain size throughout the entire spring and incipient cracks which, upon subsequent use of the spring, become foci of detrimental fatigue areas.

In volute springs, for instance, where a single heat treatment was employed, that is, where the spring was quenched immediately after coiling,

it was discovered that when breaks occurred during use, the breaks were confined to the first active coil, that is, the coil of smallest diameter. An analysis disclosed that the non-uniform conditions mentioned above existed in the spring structure.

In the use of volute springs, the material, which is rectangular in cross-section, is torsionally stressed edgewise and since the coils are of different diameters, it is of prime importance that the spring coils or turns be uniform in structural condition. But this is extremely difficult because of this lack of uniformity in the structural forms of the different turns.

In order to remedy such non-uniformity in the structure of the resilient coil or turns, it has been proposed to give the same a double heat treatment. This double heat treatment consists in heating the bar to a desired temperature suitable for coiling the bar, then coiling the bar and afterward permitting the same to cool below the critical temperature. After the cooling operation, the spring is reheated to the proper temperature and then quenched. This reheating process is expensive and in many cases so expensive as to be impractical. Furthermore, where the bar is coiled and then permitted to cool, on reheating the spring has a tendency to uncoil thus separating the coils. This is a serious objection, especially in the manufacture of volute springs where it is desirable that the turns frictionally engage each other for dampening the vibration of the spring and of the entire spring assembly in which the spring is employed.

The present invention seeks to so treat the material and the spring made therefrom that its qualities and characteristics will be uniform throughout every coil of the spring and there will be no unwinding or loosening of the coils during the final heat treatment of the material or spring.

In the manufacture of volute springs in conformity with the present invention, the bar from which the spring is to be formed, is placed in a heat treating furnace of a predetermined temperature and brought up to furnace temperature. It is then permitted to remain in the furnace a predetermined length of time, usually about one hour per inch thickness of the bar at the furnace or required temperature. The temperature of the furnace will vary for different materials but is that conventionally employed.

After the bar has reached the desired temperature or the temperature of the furnace, as the case may be, and has remained at that temperature the required length of time, it is removed from

the furnace and coiled about the mandrel in the conventional manner. Usually, in the coiling of volute springs, only the inner or smaller end coil of the spring is in contact with the mandrel, but the forming or coiling of the volute may be on a mandrel of such shape that it will contact all of the turns or coils. The spring, after being coiled, is promptly removed from the mandrel and immediately thereafter, and before it cools to the critical temperature, subjected to what will be termed an equalizing furnace in order to equalize the temperature throughout the entire spring construction. Since the spring has not cooled to the critical temperature, prolonged heating after reaching the temperature of the furnace is unnecessary as is required in the double heat treatment. It is only necessary to bring the entire spring up to the temperature of the equalizing furnace and then quench.

The temperature of the equalizing furnace will also vary depending on the metal under treatment. Due to the heated condition of the spring, it takes only a fraction of the time required in the first heating. After the spring is brought up to the quenching temperature, it is removed and quenched in a suitable media.

It is of the utmost importance that the material be subjected to the quenching media as quickly and thoroughly as possible after the reheating or after the spring has reached the quenching temperature. In order that a more uniform quench may be had, a media of low viscosity and high volatilization should be used. A good grade of cotton-seed oil gives satisfactory results.

The spring is permitted to remain in the quenching media until a temperature of around 400° F. has been reached. This may vary somewhat with the material used. It is then placed in the drawing or tempering furnace.

The drawing temperature depends, of course, on the hardness desired in the spring material and this hardness is in turn dependent on the material of the spring.

The length of time the spring should remain in the draw furnace depends on circumstances. A good rule is that a longer time at a lower temperature is preferable to a shorter time at a higher temperature. For example, in the use of plain carbon steel, in order to secure a predetermined hardness, heating the material in the furnace to approximately 750° F. and holding it at that temperature in the furnace for one and one-half hours is preferable to treating the spring to a temperature of 800° F. for one hour.

After the spring is removed from the drawing furnace, it is immediately cooled in a prescribed media, usually in water.

The method of the present "equalizing" heat treatment is superior to either the "single" or the "double" heat treatment. In the "single" heat treatment, the "forming temperature" is the only temperature used before "drawing." In other words, after the material has been thoroughly heated for the forming process, the material is formed, and after forming, is subjected

to the quenching media. This is not desirable as uneven temperatures exist throughout the material at the time of quenching, and the result is internal stresses and possible incipient quenching cracks.

In the "double" heat treatment, after the material has been formed, it is cooled below the critical temperature, usually in the air, and then reheated to the proper temperature for quenching, and held at that temperature for one hour per inch thickness. After the allotted time at furnace temperature, the material is then placed in the quenching media. In this method, considerable time is wasted, additional furnace equipment is necessary, and much of the material thicknesses lost through excessive scaling on reheating.

By the present method of heat treating the material, but little more time is required than in the "single" heat treatment, without the undesirable condition connected with it. Considerably less time is required than in the "double" heat treatment; there is practically no tendency to uncoil during subsequent heat treatment; and, the subsequent scaling of the material obtained from the treatment is avoided. Furthermore, the equalizing method of heat treatment gives practically as satisfactory a product as the double heat treatment at a very greatly reduced cost.

I claim as my invention:

1. A method of manufacturing volute springs which comprises heating a steel bar from which the spring is to be made to a predetermined temperature suitable for coiling and above its critical temperature, then coiling the bar about a mandrel, immediately thereafter removing the coiled bar from the mandrel and before any portion of the bar cools below its critical temperature, reheating the same to a predetermined quenching temperature, and then immediately thereafter quenching the coiled bar in a medium of low viscosity and high volatilization until the temperature of the bar is lowered to around 400° F. and then tempering the coiled bar.

2. A method of manufacturing volute springs which comprises heating a steel bar from which the spring is to be made to a predetermined temperature suitable for coiling and above its critical temperature, then coiling the bar about a mandrel, immediately thereafter and before any portion of the bar cools below its critical temperature, removing the coiled bar from the mandrel and reheating the same to a predetermined quenching temperature, and then immediately thereafter quenching the coiled bar in a medium of low viscosity and high volatilization.

3. A method of manufacturing volute springs from a steel bar comprising heating the steel bar to coiling temperature above its critical temperature, then coiling the bar while above its critical temperature, before the bar cools to the critical temperature, reheating the same to the quenching temperature, then immediately thereafter quenching the coiled bar, and finally promptly tempering the coiled bar.

CAL W. WULFF.