Summary of Coil Spring Production Process

Introduction

This is a document I have created after my understanding and analysis of the coil spring production process, detailing each step involved, the methodologies used, and the mechanical and physical justifications for each process. This summary is designed to offer a comprehensive understanding of how coil springs are engineered, produced, and treated to meet specific performance standards.

1. Coiling

Process Description

The coiling process begins with the use of a large rod made of stainless steel as the raw material, which is fed into a coiling machine. This machine is equipped with five arms, each serving a specific function. One arm act as the feeder, pulling the rod into the machine's mouth. The remaining four arms manipulate the rod, heating it to increase its malleability, and bending it into the desired coil shape. The movement of these arms determines the coil's radius and the frequency of the turns. When producing a new spring with specific dimensions, operators use a 'master' coil for reference, making incremental adjustments to the arms' movements to achieve the precise measurements required, including length, radius, coil spacing, and the number of turns.

Mechanical Justification

Heating the rod makes it more malleable, allowing it to be bent without breaking. Precise control of the arm movements ensures that the coils have consistent dimensions, which is crucial for the spring's performance. Accurate measurements ensure that the spring meets design specifications and performs reliably under load.

2. Stress Relieving

Process Description

After coiling, the springs undergo stress relieving by being placed on a conveyor belt that passes through a heated chamber. This chamber maintains a specific temperature and time duration to relieve the residual stresses induced during coiling. The heat causes microscopic plastic deformation, reducing the residual stress within the material.

Mechanical Justification

Residual stress can lead to component distortion during machining, unpredictable spring back during use, reduced fatigue life, and stress corrosion cracking. Stress relieving enhances the spring's dimensional stability and durability, improving its overall performance and lifespan.

3. Grinding

Process Description

Post heat-treatment, the spring ends are ground to achieve the desired shape. A milling machine grinds the top and bottom of the springs to even out any deformations. This step is particularly important for springs that need to fit inside a confined compartment, requiring them to be square from the top. Grinding also helps in maintaining the spring's length.

Mechanical Justification

Grinding ensures that the spring ends are flat and square, which is essential for certain applications where precise fitting is required. This process also helps in maintaining the overall length of the spring, ensuring it meets the specified dimensions.

4. Chamfering

Process Description

Chamfering involves cleaning off the side edges of the spring at an angle. The springs are transported on a conveyor belt and chamfered one side at a time. This process is done to order and aims to remove sharp edges, enhance the spring's appearance, and make it easier to handle.

Mechanical Justification

Chamfering improves the handling and assembly of the springs by removing sharp edges that could cause injury or damage. It also enhances the aesthetic appeal of the springs and can contribute to better fitting and performance in certain applications.

5. Shot Peening

Process Description

Shot peening involves striking the spring surface with round metallic, glass, or ceramic particles to create plastic deformation. The springs are placed in a chamber where this action occurs. This process induces residual compressive stress, significantly enhancing the spring's service life.

Mechanical Justification

Shot peening improves the fatigue life of the springs by introducing compressive stresses on the surface, which counteract tensile stresses that cause failure. This process is crucial for enhancing the durability and reliability of the springs under cyclic loading conditions.

6. Scragging

Process Description

Scragging subjects the springs to vertical force, compressing them to their solid height. The springs are placed between two parallel plates and pressed using a hydraulic press. This process ensures that the springs do not shrink further during their service life.

Mechanical Justification

Scragging stabilizes the spring dimensions by pre-setting them to their solid height. This prevents further shrinkage and ensures that the springs maintain their designed dimensions and performance characteristics during use.

7. Coating

Process Description

The coating process varies based on the order requirements. Common coatings include:

a) Phosphating

Phosphating involves chemically treating the spring surfaces with an aqueous phosphate solution, creating a thin, adherent layer of metal phosphate. The springs are dipped in the solution and electrolyzed.

b) Zinc Plating (MZP)

Zinc plating coats the spring with a thin layer of zinc, similar to the phosphate process, to enhance corrosion resistance.

c) Painting

Springs can be painted based on order specifications. The paint can be applied using various methods, including spraying, depending on the spring size and requirements.

d) Oiling

Springs are dipped in oil to coat them, providing corrosion resistance.

Mechanical Justification

Coating processes are essential for protecting the springs from corrosion, enhancing their durability, and improving their aesthetic appearance. Each coating type offers different levels of protection and cost-efficiency, suitable for various applications and environmental conditions.

Conclusion

The production of coil springs involves a series of meticulously controlled processes, each contributing to the final product's performance and reliability. From coiling to coating, each step is designed to ensure the springs meet stringent specifications and perform optimally in their intended applications. Understanding these processes and their mechanical justifications provides a solid foundation for appreciating the complexities involved in coil spring manufacturing.