PRODUCTION OF SHAPES OF VARIABLE CROSS SECTION IN THE ROLLING-FINISHING DIVISION OF THE AUTOMOBILE SPRING SHOP

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At the beginning of the 1960s, automobile manufacturers in the leading Western nations (Germany, Italy, the U.S., etc.) became the first in the world to equip the suspensions of their automobiles with springs having a small number of leaves (SLS). The number of leaves is in fact the main difference between those springs and ordinary springs, which contain many leaves. The leaves of an SLS have a complicated cross section that varies in the length direction. Also, there are gaps between adjacent leaves over their entire length, except for the working sections. With respect to engineering characteristics, an SLS has several advantages over standard springs:

- a 7–10% reduction in the weight of the spring;
- an increase in the service life of the spring resulting from the absence of friction between the leaves, which is due to the fact that they are separated by gaps;

- an improvement in the elastic-dynamic characteristics, which makes it possible to reduce tire wear, reduce fuel consumption by 0.05 g for each 1 kg of automobile weight over a 1-km section of road (this amounts to 25 kg for a 5-ton vehicle over 100 km of road), and make driving conditions easier.

Abroad, the leaves for SLSs are made on special automated rolling-forging machines equipped with positional numerical control (an example is the German firm Hauser). The principle behind the production of the leaves on these machines is shaping of the ends of the semifinished product in succession by the rolls over the course of several passes, with additional heat being supplied in order to obtain a finished leaf of the required form.

Since it began to make springs, the Chusovoi plant has conducted research to improve their design. This research has allowed the plant to make strips which have a variable cross section in the length direction and are suitable for use in SLS production. The idea of using longitudinal rolling to make a shape of variable cross section for SLS can be credited largely to specialists at the Chelyabinsk Polytechnic Institute (ChPI), who designed the T-shaped form of the cross section of the rolled product. This form ensures uniform spreading of the piece as it is rolled with variable reductions.

I. N. Gubaidullin, the former director of the Chusovoi plant, was the chief proponent of this idea and was able to foresee its effectiveness as the basis for a new product. It was at his urging that research was begun in the mid-1970s on the whole range of problems related to the production of SLSs at the Chusovoi plant. His closest collaborators in this research were K. I. Samoilov (Chief Engineer of the Automobile Spring Shop, who retired in 1997), M. F. Gavrilyuk (head of the shop’s laboratory), and, somewhat later in the project, V. N. Zelenov (the second-ranking process engineer in the shop). Also involved in the technical-engineering aspects of the work were specialists from the ChPI (Chelyabinsk Polytechnic Institute, now Chelyabinsk State Technical University), MosavtoZIL (I. A. Likhachev Moscow Automobile Plant), GAZ (Gorky Automobile Plant), Chelyabinsk KTIAM, UralGIPROMEX (Ural Division of the State All-Union Institute for the Planning of Metallurgical Plants), and other organizations.

The Chusovoi plant began preparations in 1997 for the first experimental rolling of periodic T-shaped strips on its 370 mill. The plant was the first in the world to master the rolling of T-shaped sections with a variable cross section in the length direction, these sections having been developed by the ChPI. At that time, the factory did not have any specialists capable of performing engineering calculations of the elastic-mechanical parameters of the SLS leaves. As a result, the calculations were performed and the first SLS for a ZIL-130 automobile were designed by specialists at the ChPI. However, subsequent tests of
a ZIL-130 equipped with the new SLSs did not show the expected advantages over springs with many leaves. The main reasons were the flawed design of the initial SLSs and their lower-than-expected service life. The management of the ZIL factory stopped using the SLSs in the suspensions of the automobiles they produced.

In 1982, V. N. Zelenov, heavily involved in the problem of the durability (service life) of the springs during tests of the latter, enlisted the help of young engineer N. F. Talantsev (now head of the engineering laboratory of the shop) in designing springs with leaves of variable cross section. Talantsev calculated the parameters of the leaves for SLSs on programmable calculators, which were then a recent invention. After the design of the first SLS – a spring for the GAZ-53 automobile – the first experimental lots were produced. The profile of the leaves of the Chusovoi SLSs differed from the profile of the leaves made by the Chelyabinsk Forge and Rolling Mill. The width of the top flange of the T-shaped profile of the Chusovoi leaves (Fig. 1) was constant over the entire length of the period, while on the Chelyabinsk springs it varied with the thickness of the cross section. This allowed specialists at Chusovoi to secure authorship rights, in the form of Author's Certificates, for T-shaped SLS leaves with a radically new profile.

A spring designed and made for the GAZ-53 automobile at the Chusovoi passed stand tests and road tests. Thus, the period 1982-1983 can be considered to mark the beginning of the introduction of SLSs with leaves whose cross section varies over their length.

Enough metal to make more than 2500 tons of rolled products a year has been saved by replacing many-leaf springs for the rear suspension of GAZ-53 automobiles by springs with leaves of variable cross section in the length direction. In addition, the process being used to produce the replacement springs is 2–3 times more productive than the methods used by Western manufacturers. This is because the Chusovoi plant makes the leaves by longitudinal rolling, while abroad the leaves are made on rolling-forging machines.

Stand tests of all types of experimental SLSs at different stress levels showed a durability considerably greater than that of normal serial springs. For example, the fatigue life of the new springs at the maximum stresses used in the tests was about 1 million cycles in the overwhelming majority of cases, while the fatigue life of the serial springs (with many leaves) was no greater than 200,000 cycles.

Rolling-mill rolls of large diameter must be used to obtain semifinished products suitable for making leaves for long SLSs. Only limited use can be made of large-diameter (greater than 400 mm) rolls in the 370 rod mill of the plant. In light of this, after a detailed analysis of the situation, the plant decided to construct a special line in the automobile spring shop for the batch rolling and finishing of leaves for SLSs. The line includes a 580 rolling mill which can be operated with rolls having bodies ranging in diameter from 380 to 580 mm.

The entire rolling-finishing line for making SLS leaves with a variable cross section was designed by Chelyabinsk KTIAM. The equipment of the line includes the following:

- a four-stage resistance heater for heating rolled semifinished products;
- a thermostat for equalizing the temperature of the semifinished products heated by the resistance heater;