sciendo

Műszaki Tudományos Közlemények vol. 13. (2020) 95–100.
DOI: Hungarian: https://doi.org/10.33895/mtk-2020.13.16
English: https://doi.org/10.33894/mtk-2020.13.16

EME MTSZ MTK

DEVELOPMENT IN MANUFACTURING OF BELTED AIR SPRING

Gábor József KISS,[1] Ferenc SZIGETI,[2] Dezső GERGELY[3]

University of Nyíregyháza,Institute of Engineering and Agriculture,Department of Physics and Production Engineering, Nyíregyháza, Hungary

[1] *kissgaborjozsef97@gmail.com*

[2] *szigeti.ferenc@nye.hu*

[3] *dezso.gergely@nye.hu*

Abstract

Nowadays, due to increasing environmental regulations, public transport is developing rapidly. Therefore, the companies who manufacture railway fittings have to keep up. As a result, factories need to develop and expand their capacity by modernizing existing machines and installing new machines. The author is involved in this capacity expansion, at ContiTech Hungary Ltd, where production of the rail belted air spring had to be increased. In order to do this, improvements were made to the structure drum to build the carcass, for which two suggestions were made regarding the fold back unit. Other goals are the improvement of the air spring and the development of ergonomics.

Keywords*: train air spring, bellow production, capacitive improvement.*

1. Introduction

With railway air springs, we dampen large horizontal forces and sudden movements. The air spring absorbs the vibrations caused by the unevenness of the track during the journey , reduces the dynamic forces, thus increasing the feeling of travel comfort. Its vertical movement is negligible, for which reason the traditional spiral springs have survived The construction of a modern bogie consists of combining these systems (**Figure 1**).

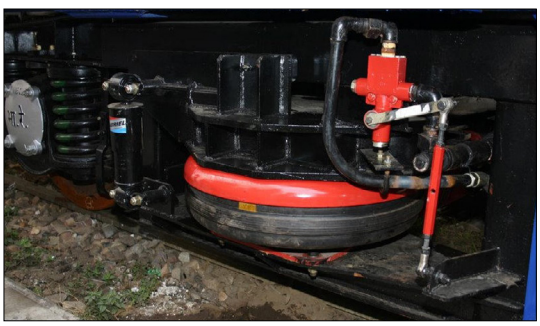

Figure 1. *A bogie of a railway vehicle assembled with a spiral and a belted air spring.* **[1]**

2. The construction drum

The need to expand production capacity arose with the belt railway air spring product family, therefore the developments were carried out for the construction drums required for the production of this type (**Figure 2**).

Operation of the construction drum: the construction drum can be attached to the construction machine with a conical adapter. When mounting, attention is paid to the position of the air connections on the adapter shaft of the

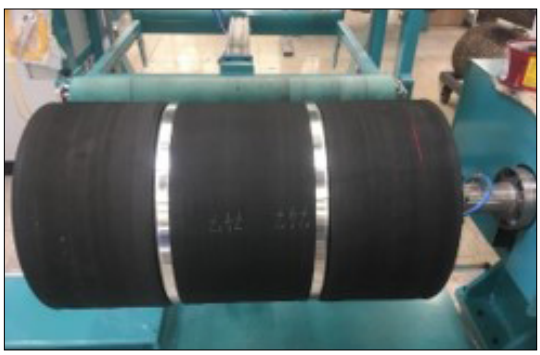

Figure 2. *Construction drum.*

construction machine and on the mounting disc of the construction machine. If the drum is properly secured, we can control the two air supplies through the interface of the build machine. With one connection we can operate the segment opening left (see **Figure 3**), and with the other supply we can fold back the two edges of the carcass (see **Figure 4**).

2.1. Description of present procedure of membrane edge backfolding

In order to increase production capacity, production time had to be optimized. During construction, the foldback of the membrane edge was the most critical point. Currently we're using two single chamber bellows for the drive,

this was developed in such a way so that the least possible amount of manpower is necessary and thus the manufacturing process is faster.

In **Figure 5** the extent to which the edge of the carcas can be folded back with the presently used unit can be seen. **Figure 6** shows that the worker

Figure 3. *Open segment.*

Figure 4. *Folding back the edge of the carcass.*

Figure 5. *Pre-folding with bellow.*

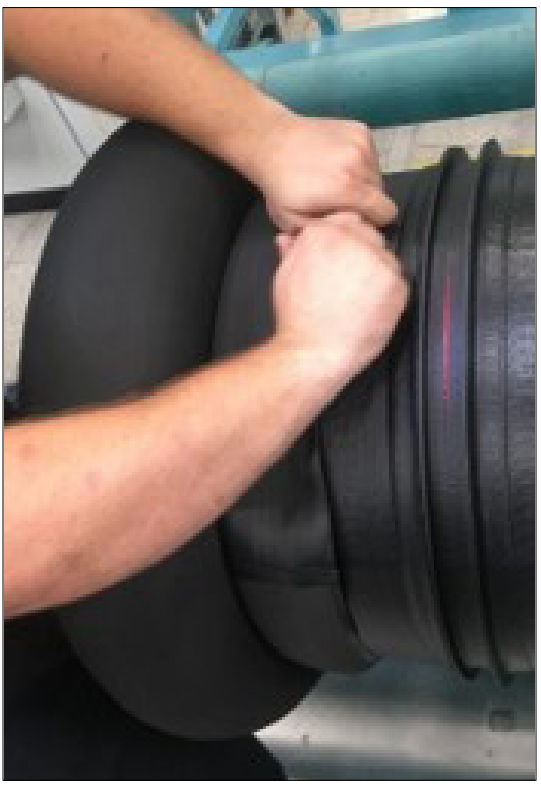

Figure 6. *Manual folding back.*

can only fully fold back the edge of the membrane with both hands, which puts quite a strain on the operator's fingers during a shift

3. Double bellow vesion

At the end of this paper there is a mini dictionary explaining special expressions such as „bellow".

In this chapter we introduce the buildup of a double bellow unit, sketch the energy supply needed for its function, and describe construction drums used for manufacturing rubber parts and bellows built up on them. **Figure 7** shows 3D model of the double bellow version. For the sake of better visualization each part has its own color, excepting the double backfolding bellow.

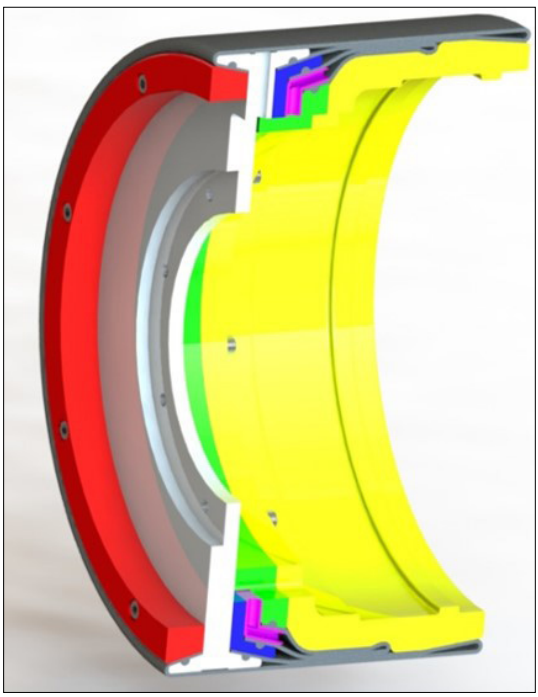

Figure 7. *Backfolding unit with double bellow.*

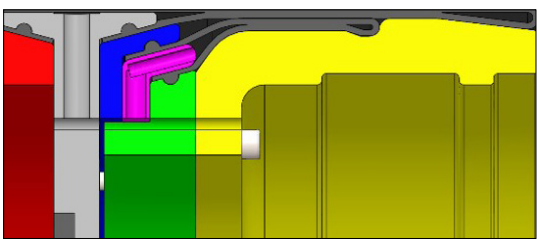

Figure 8. *The structure of a backfolding unit with double bellow.*

3.1. The structure of a double bellow backfolding unit

The workpiece marked in gray in **Figure 8** is the central part. The parts marked in red, blue, purple and green are the conical left clamps. The danamide adapter is shown in yellow.

During the design, it was necessary to take into account the function of the parts, so only the material of the central part uses steel, which is directly connected to the conical clamp placed on the shaft of the building drum. Attached to this part are the tapered bellows and the bellows they enclose, as well as the danamide adapter. The conical bellow clamping adapters are made of aluminum, as they fully perform their function and can reduce weight, which is very important for the construction drums so as not to overload the construction machine. The disadvantage of aluminum, on the other hand, is that the threads placed in the clamps would be damaged quickly during assembly, so all parts are fixed on the central element **[2]**.

When designing, great attention should also be paid to the outer diameter of the retraction unit, which should not be larger than 440 mm, as then the carcass would be difficult or impossible to remove from the drum. In the case of the bellows shown in the figure, it can be observed that a vacuum is formed at the base of the fold back, It is deliberately represented this way because, based on the existing drums, this is an known behavior of the bellows. This can be compensated by lightening the danamide adapter.

3.2. Power supply

During the capacity expansion, a new building machine was installed, which allows us to use more than 2 air feeds to operate the building drums. In this case, 3 connections would have to be used, two of which would be required by the new version. In order to be able to use 3 power supplies, the existing construction machine adapter would have to be modified or a new one would be made, which would increase the cost of commissioning.

If this version is used, we lose the possibility of transitions between the machines in the event of failure, so that we could use drums in accordance with other construction machines, if for some reason the latest construction machine went wrong.

In **Figure 8** it can be seen that the larger bellow receives compressed air at the central adapter and the smaller bellow receives it through the conical left clamp marked in purple.

3.3. Bellow

We distinguish two types of bellow. One type used in the vulcanization is called the forming bellow, thanks to the fact that its material can age, but it can't become vulcanized. Structurally, it contains only this special rubber [3, 4].

Another type of bellow is the rubber elements used for the auxiliary functions. They are similar in construction to air springs and are made of air-tight cover layers and fabric. The only difference is that the auxiliary bellows are always designed for the given task, so the shape of each piece is completely different.

The double-bellow version requires two auxiliary bellows. Their structure is exactly the same, they only differ in geometrical dimensions.

3.4. Bellow construction drum

We need two drums to build the bellows. Figure 8 shows that the bellow rim diameters do not match. They could only be constructed on a conical and a cylindrical drum. Manufacturing a conical drum would greatly increase costs.

4. Twin bellow solution

In this chapter an alternative propsal is demonstrated. It is visualized on Figure 9.

Figure 9. *Twin bellow solution.*

4.1. Structure of twin bellow unit

With the twin bellow solution, the components required for operation are less complicated than in the previous version and fewer parts are required to assemble it, as the bellows only need to be attached to the unit in two places.

Furthermore, the length of the backfolding unit is increased by 40 mm so that we could save material so that the structure still remained quite stable. In addition, there is enough space left for the structure and with this modification we can even reduce the weight. Furthermore, we also increase the lifespan of the bellows, as this way there is less chance that workers will puncture it.

4.2. Advantages of the twin bellow solution

By developing the backfolding unit, the goal is to reduce production time. Currently, both sides need to be folded back manually, which is time consuming. By folding back the edge of the membrane with bellows, we could save time.

Furthermore, if the edges of each carcass were folded back uniformly with the fold-back bellows, we would ensure that each fold-back would be uniform everywhere. This would improve the quality of the membranes, as it would be folded back much tighter and no air would remain at the rim rings. Moreover, ergonomics would also be improved compared to the current one, as the worker would not have to exert much force with his fingers.

4.3. Bellow

The structure of the bellow is much more complicated compared to the double bellow version. When it was built, another bellow was built on the base left. Figure 10. shows where is the position of the second bellow overlaps and how wide it is. Punching will be located between the two laps, which will ensure airflow between the two bellows.

The menufacturing of the bellow is performed by this drawing. A single drum is needed to build the bellows. When making a drum, it is necessary to focus on two main dimmensions, the diameter and the distance between the rim rings. These dimensions can be determined from the drawing. In addition, a shrinkage factor of 3% must be taken into account, which must be added to the dimensions.

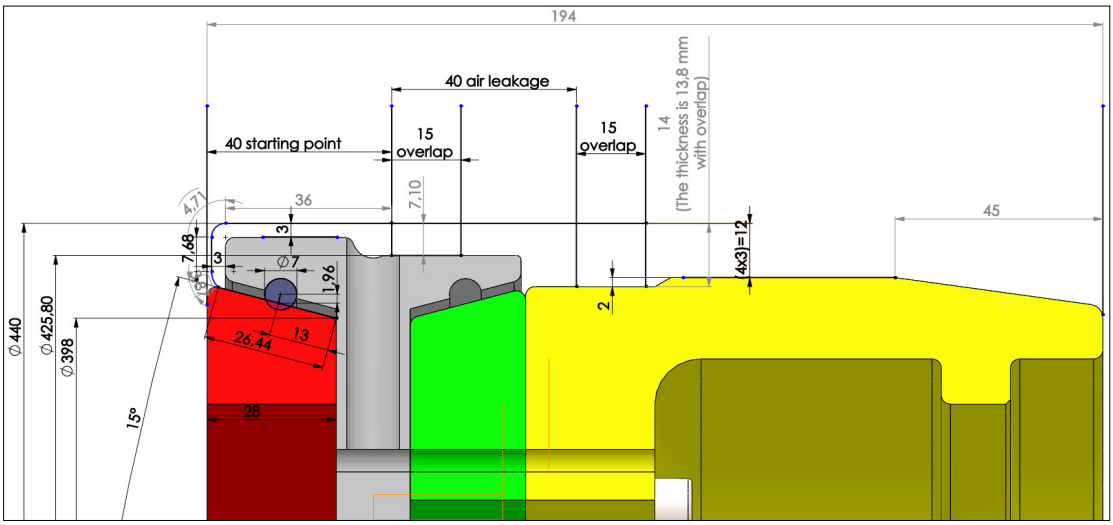

Figure 10. *A guide for building up a bellow..*

5. An experiment on backfolding the edge of a membrane with the twin bellow unit

Thanks to the design of the belt air spring building drum, we were able to carry out an experiment in which we tested the operation and function of the twin bellow return unit.

It is shown in **Figure 11** how the carcass is folded back by the twin bellow unit. It can be seen in the figure that with this new technique we can fold back the edges of the membranes almost completely.

Furthermore, the quality of the folds is noticeably better as no air remains at the base of the folds. This is due to the fact that the bellow stretches the carcass completely from the base of the flange to the edge of the segments, thus causing a much tighter fold back. As it is showed on **Figure 12** the operator only has to smooth the carcass edge.

6. Comparison of developments

Before selecting the appropriate development, a comparison was made based on the main considerations shown in **Table 1.**

Figure 11. *Backfolding with bellow.*

Figure 12. *Smoothing.*

Among the improvements, the twin belt solution was selected due to the more favorable conditions of the choice. 3 building drums have already been converted on the site and additional drums will be converted.

Table 1. *Comparison of development alternatives*

Double bellow development		Twin bellow developments	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Simple rubber parts	Complex structure Larger weight More complicated to install and Two bellow construction drums are required	Simple structure Less weight Easier to install A single bellow construction drum is required	Complicated rubber element

7. Conclusions

In order to increase the production capacity of railway air springs, improvements were carried out in the backfolding unit of the building drum carcass required for the construction . Two solutions were developed, of which the twin bellow version was chosen. With this solution, based on the experiments already performed, the efficiency and quality of the backfolding can be increased, and at the same time the manual work reduced. Seeing the results, additional building drums will also be redesigned.

Explanation of terms

In this paper we use some special rubber industry terms, we would like to explain them briefly [3, 4].

Carcass: The condition of the constructed raw product before vulcanization.

Construction: : the assembly of the product by winding the raw rubber and the strength-bearing fabric on a cylindrical surface, and then folding both sides of the tube thus obtained back into a hoop made of flexible or fixed wire. The structure can be single or two phase.

In a single-phase operation, the product is built complete, in a two-phase operation, we first build a tube and then place the flange rings on the other machine in the appropriate position. The constructed rubber element: Airtight (inner rubber layer (**Figure 14**)) – Strength carrier (2 or more rubberized fabric layers (**Figure 13**)) – Cover (outer rubber layer (**Figure 14**)) - Edge wires.

Construction drum: A cylindrical device on which the raw semi-finished product is wound.

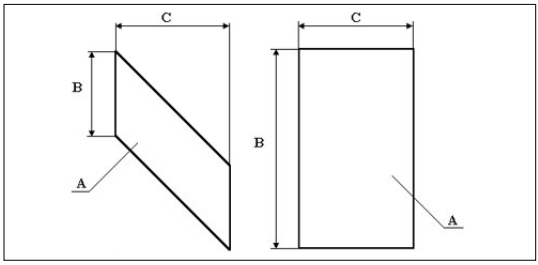

Figure 13. *Carcass.* **Figure 14.** *Airtight and cover insert.*

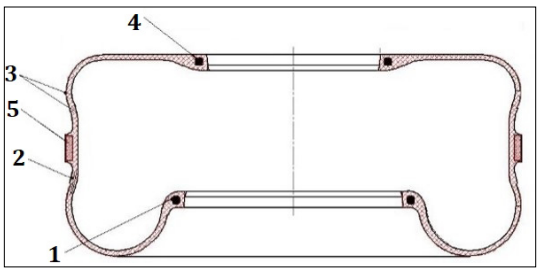

Figure 15. *1. Large rim wire; 2. Fabrics; 3. Air barrier cover; 4. Small rim wire; 5. Rubberized belt wiret.*

Bellow (bag): There are two types:

Vulcanization bellow: A rubber product that can be stretched, with a thickness of about 4–10 mm. Available in several different sizes, it is made of a kind of rubber that's difficult to vulcanize (Br butyl) so that it can be used to vulcanize a larger number of products. It's function is to press the product from the inside to the wall of the mold and by doing so to maintain the necessary pressure for the vulcanization.

Construction Bellow: An elongated textile-rubber combination that is mounted on the end of the construction drum to help fold back the end of the carcass.

Vulcanization: Vulcanization is all the processes in which a plastic, viscoelastic rubber compound is transformed into an elastic rubber.

Belted railway air spring: The center of the diaphragm is reinforced with wire, so it can absorb a larger load without increasing space requirements (**Figure 15**).

References

[1] https://indiarailinfo.com/blog/post/489191/16 (accessed on: 2019.11.21)
[2] Fenyvessy T., Fuchs R., Gürtler M., Plósz A.: *Műszaki Táblázatok.* TCS Media Kft, Budapest, 2015.
[3] Bartha Z.: *Gumiipari kézikönyv. I.* Taurus-OMIKK, Budapest, 1988.
[4] Bartha Z.: *Gumiipari kézikönyv. II.* Taurus-OMIKK, Budapest, 1989.