

Preface

As it is known, an uncontrolled tightening of bolted fasteners with hand or with unprecise torque wrench is mostly used in common mechanical engineering practice. The reason is not only unwillingness to invest in quality tools, but mainly fixed idea, that it is sufficient to control tightening by senses. Both reasons are irrelevant. It is easy to prove, that to invest in exact tightening is effective and the sense by hand can not be considered a technical category. That is why it is important to tighten exactly to the set level of assembly preload determined by the strength of screw and the nut and to the prediction about the change of preload during operation. It is an object of the present assembly method to provide a threaded fastening system that is torque resistant.

According to classic opinions, represented in particular by the recommendation of VDI 2230, screw connections should be tightened to a maximum level of 0.9 Rp0.2, which means with a 10% security reserve. The latest knowledge, especially from the automotive industry (ŠKODA Auto, VW), however, but also from some screw manufacturers (RIBE), is to not give much recognition with this rule. They recommend using the effect of mechanical cold hardening by tightening above the yield point.

# SMART MONT

by Jozef Dominik

## Stepped Assembly of Bolted Joints

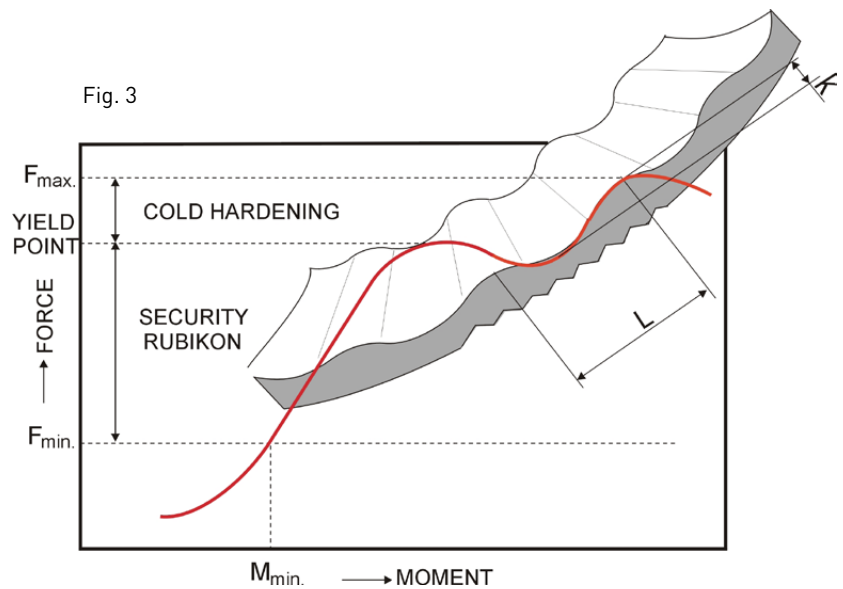
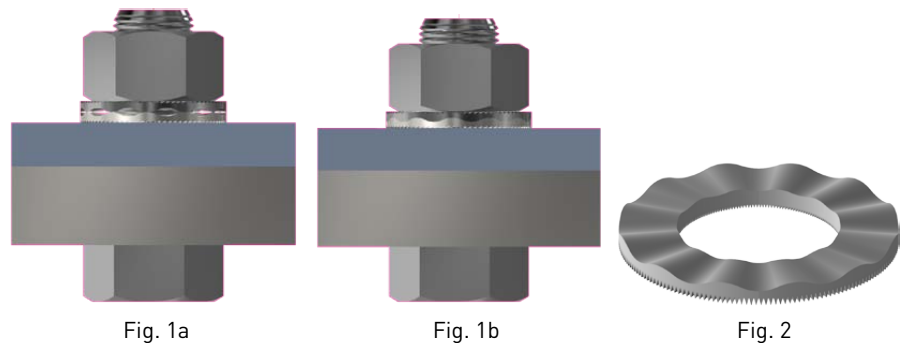
### Theory and Principle of SMART MONT Tightening

One of the methods of using mechanical cold hardening effect and controllable, not chaotic montage of bolted fasteners and of the preservation of preload at the same level is the promoted system named SmartMont (SM - in short from smart montage). In principle it is a pair of counter-mounted case-hardened washers (Fig. 1a and b), which are wavy on the inside and grooved on the outside (Fig. 2, 3). The height of the wavy lines  $k$  (Fig. 3) to which the cold hardening level depends is important.

The principle results from Fig. 3. As can be seen from this figure, the classic tension diagram is supplemented by another assembly cycle. This is achieved by counter-rotating the washers. It is a matter of further research to find the optimal ratio between the height of the wavy lines  $k$  and the distance between their peaks  $L$ . The base condition of correct SM operation is that the friction on the outer bearing surface  $F_o$  is higher than the friction between both washers  $F_b$ .

$$F_o > F_b$$

This is achieved by appropriate gearing or by ribbing the outer contact surface of both washers (Fig. 3). One washer can advantageously be integrated directly with the nut (Fig. 4). This variant makes sense especially when joining parts are hardened max. on the class 8.8 or in the annealed state of 5.6 only. In this case the opposite washer is not required because the necessary opposite depressions are created automatically during assembly.

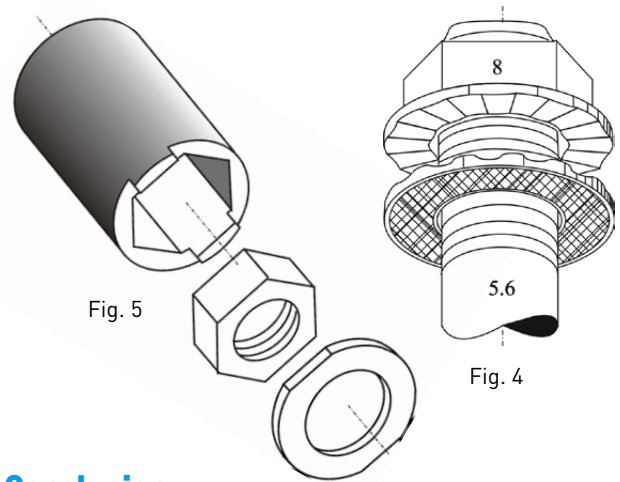


The actual assembly takes place in three stages: Preload to FM, overload to Fmax and come back to FM. This cycle can be freely repeated.

A preferred variant of the SM system solution is shown in **Fig. 5**. This variant allows, similarly to nuts with integrated flange, to rotate one structurally slightly modified washer together with the nut during assembly. The washer is in this case provided on the outer diameter with at least two driving surfaces. However, special tightening tools are required.

### Main benefits:

- (1) Cold hardening directly during assembly of bolts and comeback to the area of "Security Rubikon" (**Fig. 3**).
- (2) Possibility of using lower alloy steel 5.6 instead of 8.8 for screws (**Fig. 4**). In the case of the application of screws 5.6, a significant economic effect would be obtained, as the expensive hardening operation would be eliminated.
- (3) Reliable locking against spontaneous loosening. This ability of a pair of SM washers is a basic condition for the safe operation of the screw joint and thus of the entire structure.
- (4) Using the flange nut according to **Figure 4**, represents simplified logistics as well as the assembly itself. This advantage is manifested mainly in reassembly.
- (5) And last but not least the Smart Mont system can also be used for nutless screw connections. In this case, the corrugation must be applied directly under the screw head with integrated flange. That is the best option. However, the joined parts must not be made of high-alloy structural steels.



### Conclusion

As can be seen the presented new method of assembling bolted joints represents an alternative to commonly known used securing methods. The main benefit of this assembly compared to them is the use of cold hardening effect during tightening which makes it possible to replace hardened steels of strength 8.8 with steels of strength 5.6. The ideal combination is the application of a flange nut according to **Figure 4** and the SM washer. All this gives the designer a good chance to rationalize production and increase product safety wherever structural nodes are dynamically stressed during operation as presses and forging machines, rolling mills, high pressure cleaning systems locomotives, machine tools, etc. ▣

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