From Easy Fastening to Polyfunctionality

從簡易鎖固到多功能扣件

by Jozef Dominik

Fig. 1

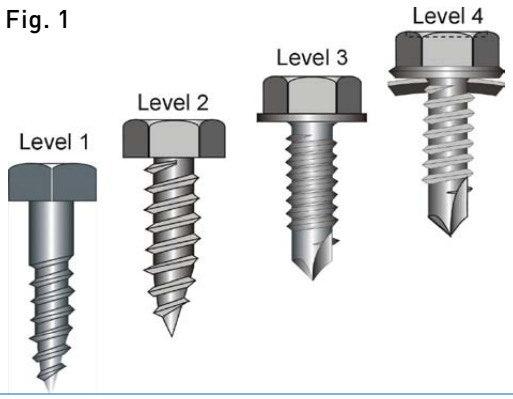


Fig. 2

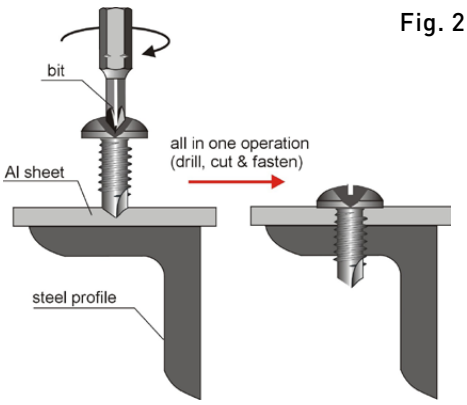
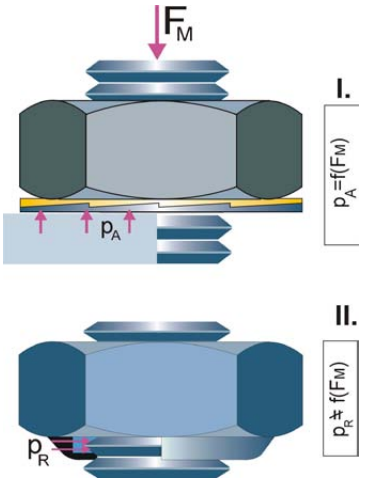


Fig. 3



What is Polyfunctionality?

What "fastening" means is clear to everyone, but polyfunctionality in mechanical fasteners technology is less so. Nevertheless, this term is encountered almost daily. So, what exactly is it?

Polyfunctionality is in fact the ability of a structural element to perform other functions in addition to the basic function. This can be understood from **Fig. 1** and **2**.

Experienced readers have certainly recognized the difference between level 1 and 3 for example. In the first case, it is a primitive screw which, in addition to connecting, does not have any additional capabilities. However, level 3 already has the ability to drill a hole, cut a counter thread and replace the washer. This washer can even be rubberized, so it also serves as a seal (Level 4).

It can be said that polyfunctional is no longer just a classic joining element, but as a tool-created screw (TCS), which has brought unprecedented economic benefits in the montage technology (**Fig. 2**) and in logistic.

And, we find several such cases in the current assortment of threaded fasteners. Recently, the attention of designers has focused on the development of so-called locking nuts. **Fig. 3** shows details of two locking nuts operating on different principles (I. and II). It is a response to the frequent cases of spontaneous disintegration, often with fatal consequences, of screw joints due to vibration and variable mechanical stress of a given structural unit.

And, the development continued in the field of materials and their heat- and surface-treatment. The current peak can be considered a level 3 screw, made from special stainless steel of the martensitic type, which has anti-corrosion protection at the level of classical austenitic steels A2 (Cr, Ni) and mechanical properties comparable to hardened steels. The combination of the ability to drill and cut a thread with high corrosion resistance ranks these TCS screws among a highly sophisticated construction element. And maybe we'll see in the future more similar pleasant surprises. However, one thing is certain - the screw as such, despite its efforts, has not yet been fully replaced.

Metamorphoses of Screws

Paradoxically, while the oldest thread history is relatively well known and documented, the transformations of screw joints in the post-technical revolution period are not systematically addressed. In some of our previous works, we have proved that the characteristic element of the screw - thread (spiral) is an autochthonous geometric element; that is, it wasn't invented, it means, it is not a product of the human brain but like a circle. For example, it has existed since time immemorial, it has been observed by nature. One had plenty of opportunities to do so. Just keep one's eyes open and look. Such spirals are known, from human DNA to various galaxies, from simple to complex substances. It is not surprising, therefore, that people noticed them and began to use them to their advantage. C.O. Bauer, the author of "Handbuch der Vebindungstechnik" (Handbook of Connection Technology) considers screws to be the most widely used method of joining in the mechanical engineering and automotive industry.

How did It All Go (Table 1)?

Table 1

Archetypal geometric paradigm (ab origine)	→	Creation of brain (intelligence)	
		Transport helix (Archimedes, born BC 287)	Fastening screws, da Vinci and end of 17th century

Archimedes (287 BC–212 BC) who developed the screw principle and used it to construct devices to raise water, Leonardo da Vinci (1452 – 1519, Italy), later Joseph Whitworth (1803 -1887, UK), William Sellers (1827 – 1905, USA) and many unnamed pioneers have contributed to the fact that screw, based on the spiral, is currently one of the most common elements used in construction and machine design. Without them and without the friction, all machines and structures would fall into pieces.

Of course, they have made tremendous progress over the years. This applies not only to their construction, but also to their materials and surface treatment. The first screws were made of wood (**Fig. 4**). They were mainly used for the pressing of olive oil or grape wine.

The development of high strength steels (800 - 1400N/mm^2), various heat treatment technology such as case-hardening in sophisticated case-hardening furnaces added to the screw the hardness and toughness necessary to screw or drill into various materials.

Especially stainless steels brought a literally revolutionary change. Stainless steels deserve special attention in connection with the corrosion of screw joints (**Table 2**).

The basic alloying element of stainless steels is Cr (ca 18%), which has a high affinity for oxygen, so it very quickly forms a thin protective passivation layer on the steel surface. However, the condition is the presence of O^2 in the surrounding atmosphere. Failure to comply with this condition can have fatal consequences (**Fig. 5**).

What to Say in Conclusion?

As shown, the screw is a fascinating structural element. A typical symbol - the thread/spiral has been known since time immemorial. One only observed him and used his own intelligence capacity to his advantage. Screws during the technical revolution (Guttenbeg, Wat, Ford, etc.) experienced the greatest expansion. In fact, without them, it would not even be possible. No wonder the author, together with his collaborators practically from all over the world, is trying to include screw connections on the UNESCO list. They certainly deserve it. ◘

Fig. 4

Fig. 5

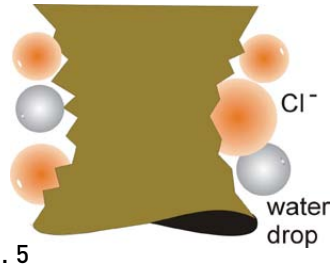


Table 2

Symbol	Signification
F1, F2, F3	Ferritic
C1, C3, C4	Martensitic
A1	Austenitic with the addition of sulfur
A2	Austenitic Cr - Ni
A4	Austenitic Cr – Ni - Mo
A5	Austenitic Cr – Ni – Mo, stabilized Ti, Nb or Ta