

THE HISTORY OF COMPONENTS

This section of the journal will deal with one of the metal components used in the automotive industry, recording the changes in its design. At the same time, the many ways in which the techniques and materials employed in its manufacture have developed will be described.

This approach will also serve to emphasize the vital role played by metal component manufacturers in developing the basic materials and working out production processes.

The article in this issue deals with screws and bolts.

Screws and Bolts

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Abstract

The development of these types of fasteners, which are traditional simple components has been very slow until recently, when the competition of other systems of joining has required better service properties and improved quality. As a consequence, great innovations in materials, design and production technology have been made.

Riassunto

Viti e bulloni

Nel quadro generale dei « fasteners », lo sviluppo delle viti e dei bulloni è stato piuttosto lento fino a quando, negli ultimi decenni, è sopraggiunta la concorrenza di altri sistemi di giunzione. Pertanto, l'esigenza di aumentare le prestazioni e di migliorare la qualità di questi componenti tradizionalmente semplici ha portato grosse innovazioni nei materiali, nella forma dei pezzi e nelle tecnologie di produzione.

The screw, which when its threaded end engages a nut is more correctly called a bolt, is one of the traditional simple components like the lever, the wheel and axle, the pulley, the inclined plane and the wedge. It can have the task of joining together units which must be easy to dismantle or must have functions of cut-off, adjustment, safety, reference, and can be used for the transmission of motion. One of the first screws on record is that of Archimedes, with which we can raise water from one level to a higher one.

The screw is one of the so-called "fasteners", meaning by this term any means of system of joining, fastening, clamping, closing etc., such as screws, cotters, nuts, washers, pins, rivets, inserts, hooks, springs, zip fasteners, locks, glues, adhesives, magnets, welding etc. The development of "fasteners" has been very slow, only to rocket during the last few decades in an astonishing way. Bindings and nails are the oldest, screws are fairly recent, while the other "fasteners" are very recent and their development has progressed at breakneck speed, with interests in every field.

There are more than 700 families of "fasteners". The modern ones, compared with the traditional ones

(screws, nails and rivets) generally offer exceptional characteristics of economy, ease of application, safety. Often, an assembly can only be made through the existence of a particular "fastener".

The concept of the screw is that of a shaft on which a thread is cut, which can be engaged in an identical but female thread, and at the end of which there is a head which enables us to manoeuvre the screw itself. Today, because of the competition of other elements of union, and through the greater responsibility placed on the assemblies achieved, the screw is required to have even better service properties, lower weight, 100% perfect production quality to allow assembly by automatic machines.

These demands have led to great innovations in materials, in the form of components, and in production technology. There is a tendency towards simplification of the form and towards a reduction in tolerances. Bolts are generally designed for use under shearing or, preferably, tensile loads which are transmitted through the joint (Fig. 1). In both cases, the strength of the bolt is of primary importance. This is evaluated in terms of yield strength and tensile strength. These values are included in the specifications and vary according to the levels of

strength of the actual bolts.

When referring to fatigue stress conditions, kept at the lowest level, given the frequent uncertainty of calculated cyclic forces, a safety factor is generally used (coefficient of ignorance).

Analysis of the joints achieved by means of bolts has made notable progress in the last few years. For example, a complete study on the subject has been published by the Society of German Engineers (VDI) under the title "Systematic Calculation of High Strength Joints by Means of Bolts".

Another example is represented by the application of the principles stated in the above-mentioned report to the assembly of large bearings.

The new method analyses the design of the joint to determine the elongation of the bolt and, in this way, enables us to go back to fatigue strains.

As a result of better knowledge of the relations existing between the loads imposed and the strains tolerated by the bolts, special means of electronic checking have been developed, which indicate the progression of the process of clamping and provide an accurate control of the stresses.

In relation to the above, the design of the bolt has undergone various

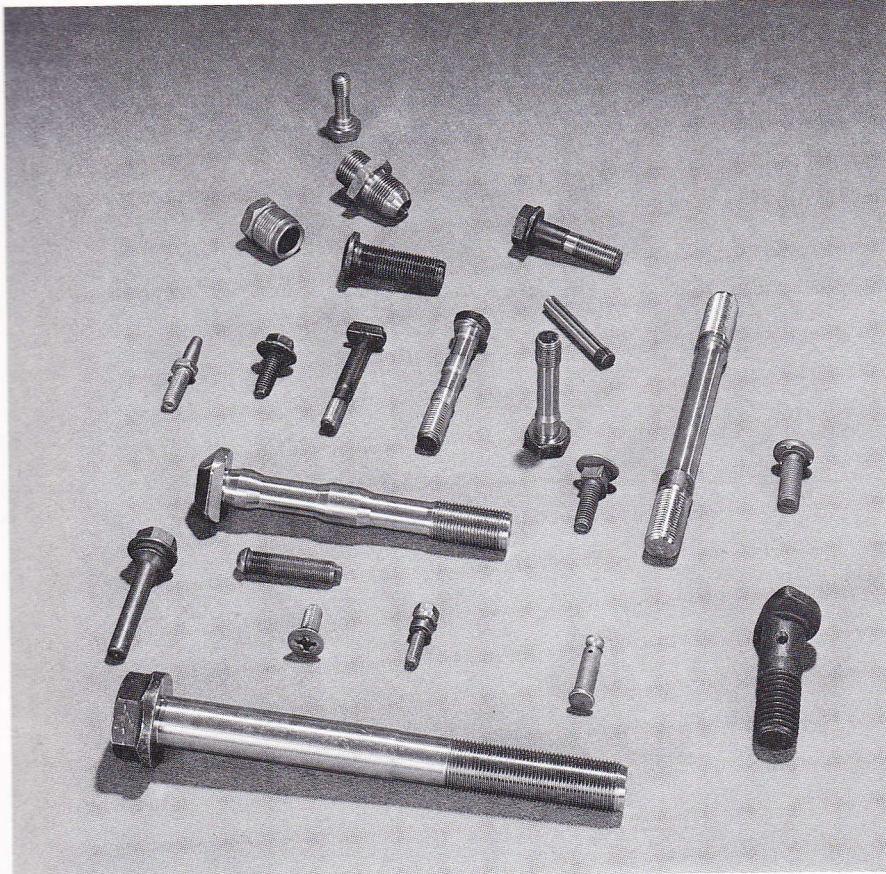


Fig. 1 - Teksid special bolts.

improvements which were previously envisaged only for special nuts and bolts used, for example, in aviation. The importance of the method of clamping is proved. The preload which can be attained is a function of the bolt and of its degree of clamping. The choice of the method of clamping and of the design of the bolt must match the method as closely as possible, so as to ensure the minimum load under the worst conditions of service of the joint. The choice of the material for obtaining a particular level of performance in the finished product varies notably, and the geometry of the product can also have an influence.

The prescriptions in the specifications and service demands may require an inspection of surface defects, the chemical composition, and the processes of manufacture

of the base material. There is a correlation between the base material and the ductility and strength of the bolt; but the ductility and strength of the bolt also depend on the geometry of the coupling device, on the number of exposed threads, on the characteristics of the threads, on the method of testing and on other variables.

The capacity for tolerating static loads depends to a large extent on the rupture load and on the ductility. To guarantee the desired load/elongation curve, the yield load, rupture load, hardness and elongation are controlled through the most appropriate heat-treatment.

The fatigue characteristics are generally better with materials and processes which control surface discontinuities, the propagation of cracks, notch sensitivity, ductility, grain size and surface decarburisation. Most of the specifications do not guarantee the fatigue strength of the joints, but on the whole they have a significant effect on the most important causes of fatigue rupture.

Fig. 2 - Teksid automatic pickling line for wire.

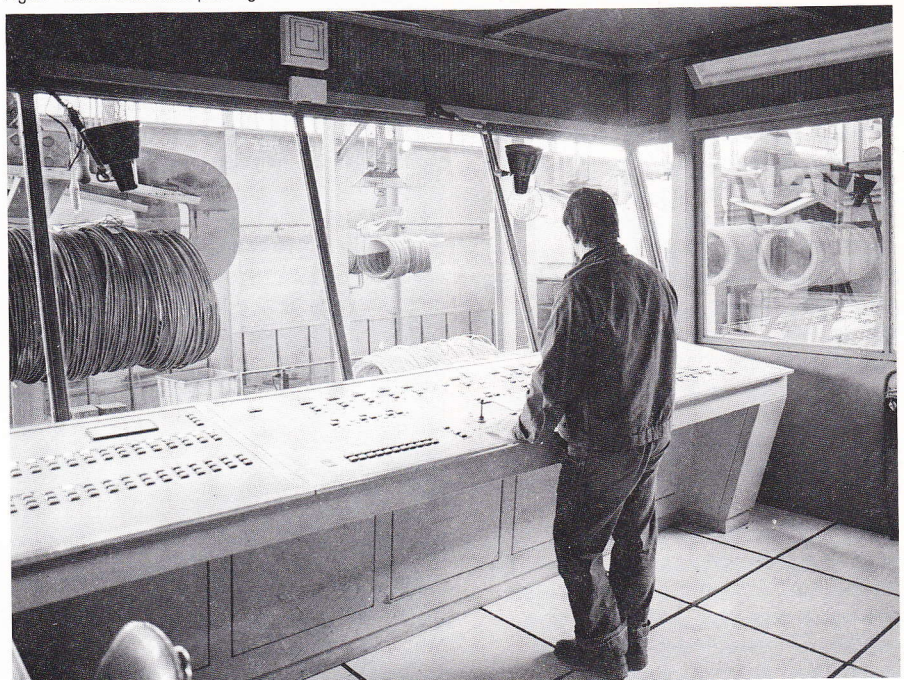


Fig. 3 - Cold forming of the screw: sequence in progression for different screws. Teksid Fasteners Division.

Screws were once manufactured from a bar with the same dimensions and form as the head. The bar was reduced in size along the entire length of the shaft by turning; a subsequent turning process was effected to obtain the thread; this was followed by cutting the slot for the screw-driver, if necessary, and the finishing operations.

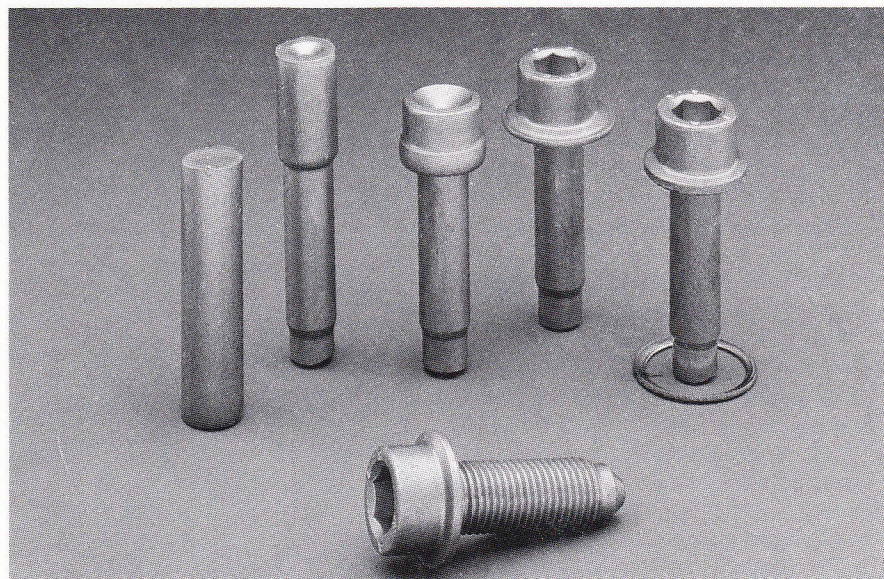
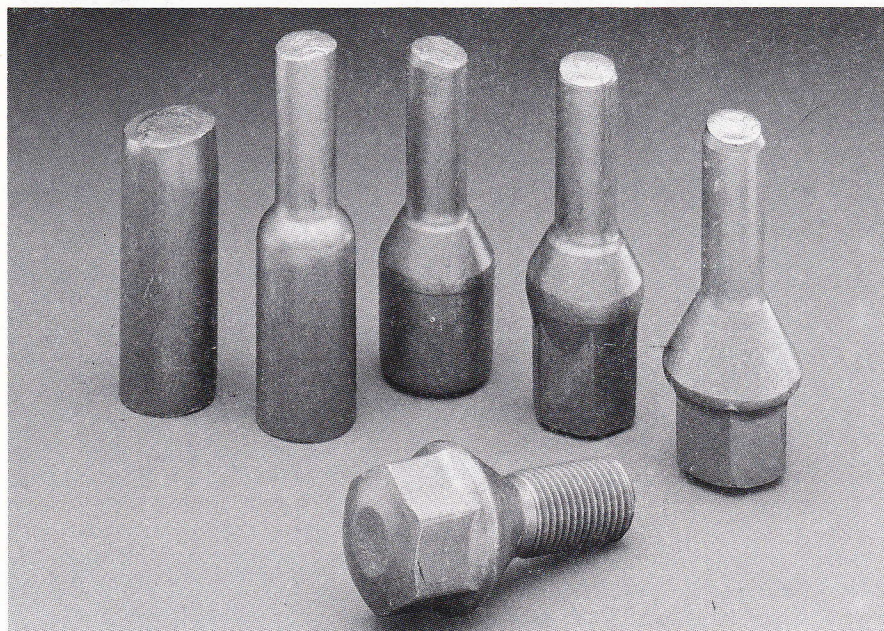
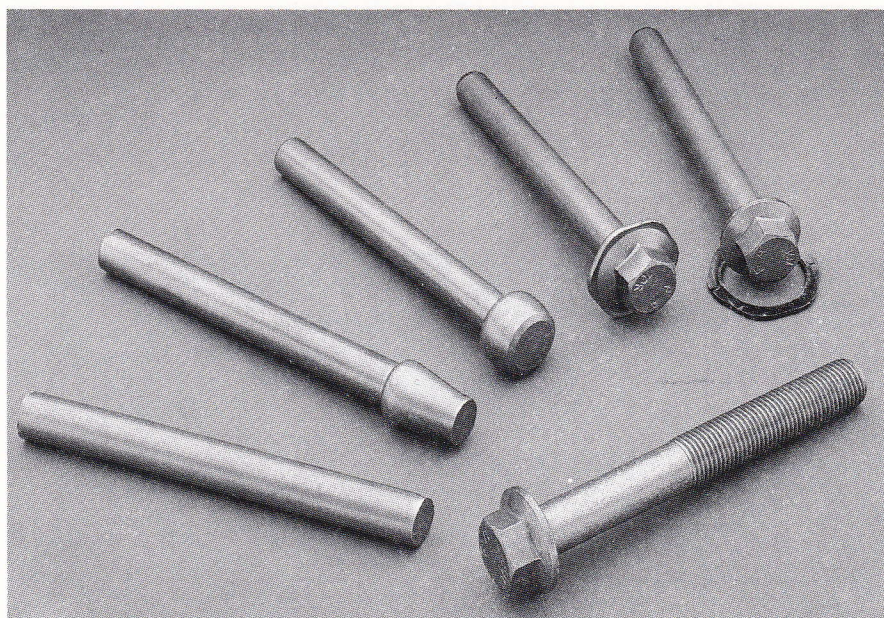
Today, for general screw manufacture, we start with a bar or wire rod with the dimensions of the shaft (Fig. 2). The head is upset by cold-heading for small screws, and by hot-heading for large screws, and then the thread is rolled (Fig. 3). In the second process, the fibres of the material are not cut, but are forced to bend continuously. Thus, there is a notable increase in strength as compared with manufacture by turning.

Even the number of materials from which we can manufacture screws and bolt has increased.

To mild steel and brass, we can add special steels with high and very high strengths, which enable us to notably reduce the diameters of the screws and the dimensions and weight of the assembled unit.

Stainless steels allow the manufacture of screws which resist corrosion by chemical substances and are weatherproof.

In other cases, it is from special bronzes that the most suitable screws are obtained. We must not overlook screw manufacture using nylon and other plastic materials, which are unrivalled in many cases. The form and the gauge of the thread help to determine the final characteristics of the bolt. The concentration of forces largely depends on the form of the base of the thread: a bigger radius reduces the depth of the thread and increases the dimensions of the internal diameter of the thread. The cold-deformation resulting from the process of thread rolling increases the hardness, the strength in the vicinity of the rolled surface, the resistance to additional plastic



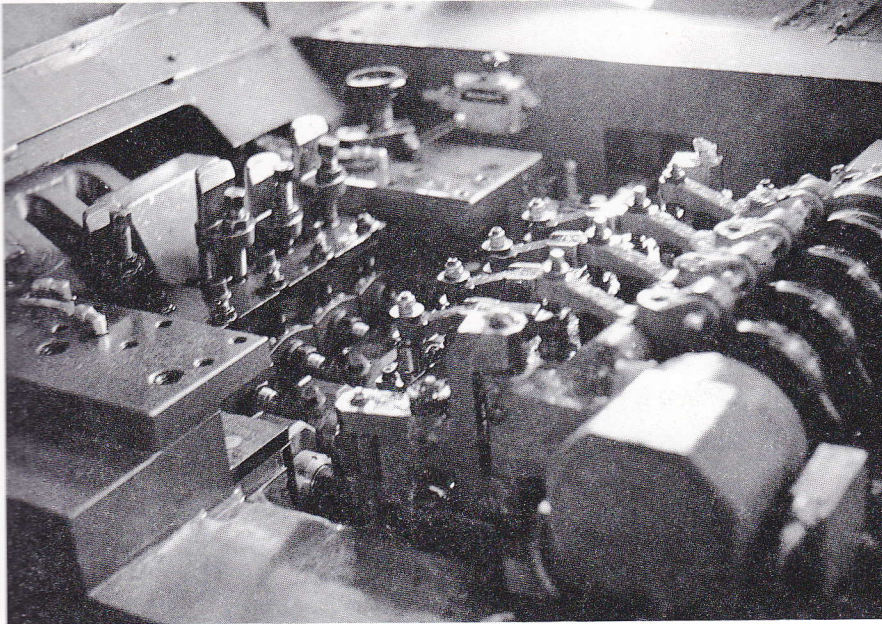


Fig. 4 - Cold bolts progressive upsetting machine. Teksid Fasteners Division.

deformation and to rupture through static and fatigue strain. The choice of the gauge is made, considering the advantages and disadvantages of fine and coarse threads. A fine thread gives the bolt a greater transverse section, greater resistance against loosening and a greater angular tolerance with the system of rotational clamping. A coarse thread is more resistant to stripping, has a shorter clamping time, is simpler to roll etc. We must take into account the means of production available today (Figs. 4, 5 and 6), particularly the presses for moulding the screws which, starting from a reel of wire rod, cut a crop end from it and, using a transfer, form the complete screw in four successive dies, including rolling the threads.

Production rates can reach 300/400 pieces a minute.

The final coatings of bolts consist essentially in galvanising, phosphating, and painting with special products. The different materials exhibit different behaviour in the fastening of the bolt, either through their thickness or through their lubricating and anticorrosive action.

Joints made by means of screws, besides being influenced by the type of material, are also influenced by the surface finish and by its hardness. In some cases, we must take into account the expansions and possible galvanic couples.

"The world holds together because there are screws and bolts". The old saying is no longer completely accurate, but the screw and bolt industry still has a lot to say in the construction of today and tomorrow, provided that it will be careful to follow technological developments and the demands of old and potential users.



Fig. 5 - Nuts tapping machine. Teksid Fasteners Division.

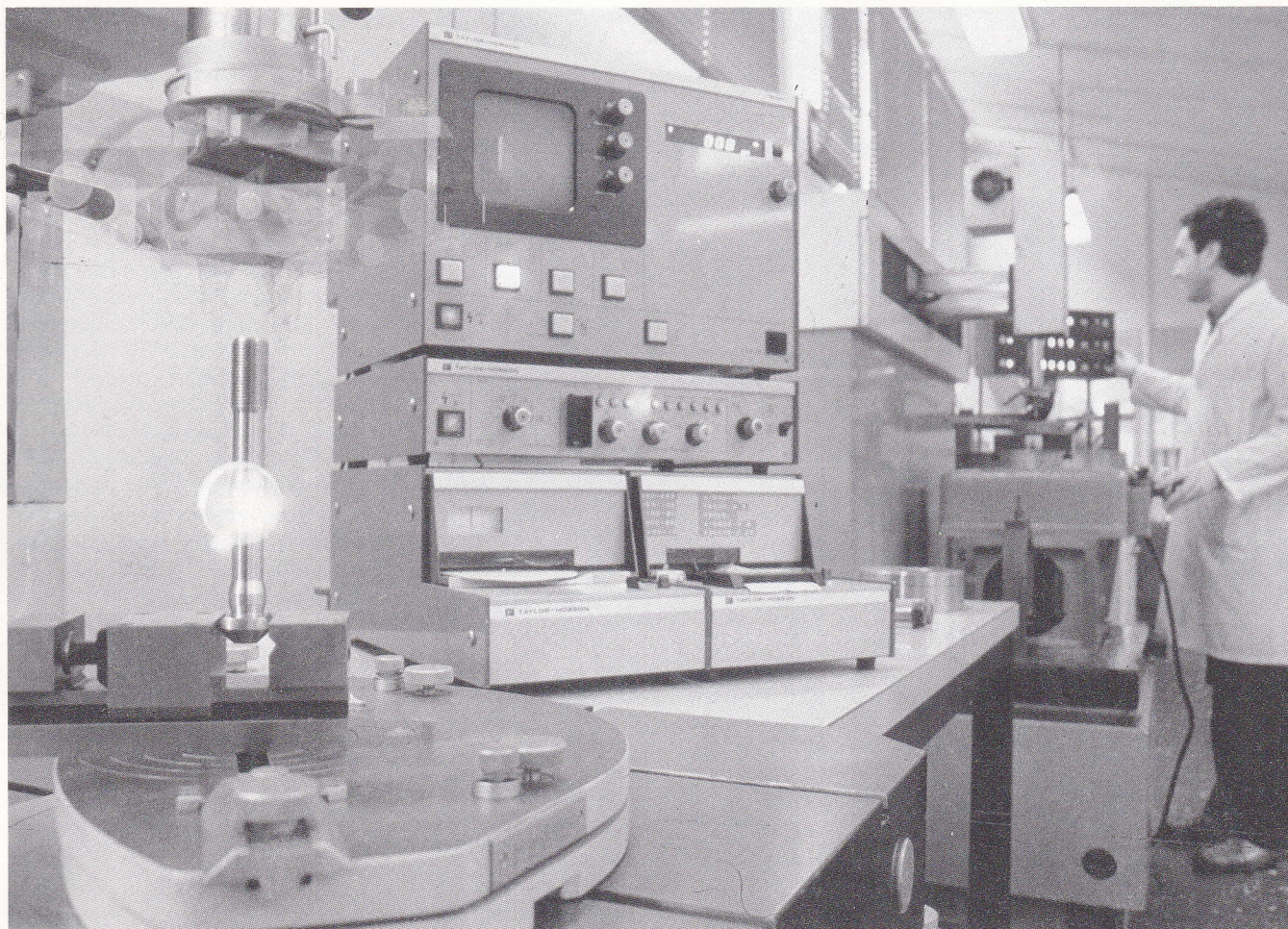


Fig. 6 - Special bolts dimensional checking. Teksid Fasteners Division.

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