With the following treatise the modern pipe joint according to the Verax Compact Flange System (= VCF-joint) is being presented. For the novel principles of the design and for the special features of it to become readily understandable, the VCF-joint is described against the background of the conventional one.

(1) Description

(1.1) A conventional pipe joint

A conventional pipe joint in compliance with codes and standards, is characterised by forces being transmitted from one flange to another one via a gasket of some kind, see **Fig. 1**. As bolts are being tightened, the flanges typically warp about a center located in a section through the axis, appr. 1/3 of the gasket width from its outer edge. The angle of rotation is directly proportional to the level of bolt preload achieved.

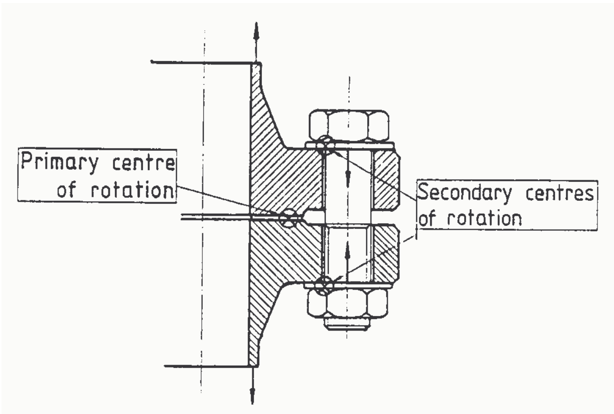

Fig. 1 : A conventional pipe joint

However, when exposed to loads such as fluid pressure, axial/lateral forces and/or bending moments, flanges rotate about two other centres, one at the inside under the bolt head and the other under the nut. Depending on bolt preload being sufficient or not, external loads will cause the angle of rotation to vary, creating a dynamic situation in the joint.

It follows that -- apart from high tensile stress being induced in the fillet between the flange proper and its neck -- concentrated stress does ensue in the transition zone between the bolt head and its stem, as well as in the first thread outside the nut. In so far as fluid pressure, forces and moments vary with time, a dynamic situation does rule in the bolted joint, that sonner or later may result in failure from fatigue.

An important feature, typical for the conventional pipe joint is, that bolts are exposed to the surrounding environment, aggressive fluids, gases, and such, what can support corrosion, brittle fracture, etc.

(1.2) A VCF-joint

A VCF-joint is characterised by forces being transmitted from one flange to the other with no elastic gasket of any kind between them.

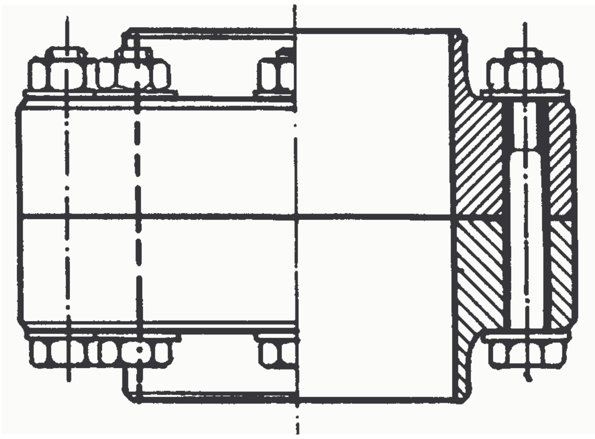

Fig. 2 : A VCF-joint

For certain applications, a seal, viz. a barrier against leakage such as an O-ring or a similar device, may be installed in a groove in one of the flanges. The joint futher is characterised by flanges being in direct, metal-to-metal contact, all the way from the outer edge to the inner one. From bolt preload, flanges typically warp only about 0,03 degrees, but fluid pressure, axial/lateral loads plus bending moments, do not induce further flange rotation.

Consequently -- and apart from compressive stress being superimposed in the fillet between the flange proper and its neck, reducing the level of stress to way below that in the pipe itself, **Appendix 1**, -- bolts are not exposed to bending. In so far as fluid pressure, loads and moments vary with time, a static situation does rule in the bolted joint, **Appendix 2**, such that failure from fatigue can not possibly occur.

An important feature, typical for the VCF-joint is, that bolts are put in closed chambers, such that they are protected against the surrounding environment, aggressive fluids, gases, fire and such.

(1.3) Codes and standards

Existing Codes and standards are not applicable to VCF-joints, primarily because of their muddled mis-representation of the mechanics of the conventional and of the VCF-joint. In the conventional joint flanges warp, and there is a pronounced dynamic condition. In the modern joint flanges warp little when assembled, bolts are loaded in symmetry and there is an almost perfect static condition. ASME Codes, stemming from Waters & Taylor (1937), do consider the flanges to be continuous, annular plates, whose flexural characteristics can be approximated by beam theory, by considering the flanges to be comprised of a series of discrete, radial beams. In contrast, the VERAX flange is a solid, continuous ring, its cross-section being near quadratic, making its stiffness against warpage immense.

In several places in the swedish Pressure Vessel Code -- as well as in other Codes -- "allowable" stress levels, "safety factors" and such are stipulated, for instance regarding bolting, their properties classified acc to international standard. No authority has ever been able to assigne a positive reason, why the strength of exquisite bolting may not be fully utilized. VCF-joints are delivered complete with bolting, its strength and quality being especially assured and documented.

In a VCF-joint, being an application of the principle of the preloaded structure, the effect from fluid pressure, external loads and such, is appr. 2% at a maximum, provided that the preload is high enough. It is readily appreciated, that the higher the preload -- the safer the bolted joint, **Fig. 3** and **Appendix 2**. This is a fact since many years utilized by the automobile industry.

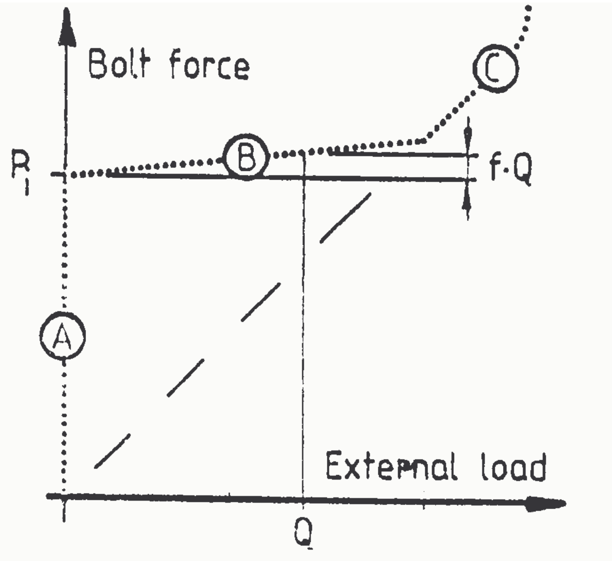

Fig. 3 : Bolt force as a function of external load

Consequently, with VCF-joints the compliance with a design Code, that prescribes low bolt preload, in reality would impair its functional safety.

Our instructions for the assembly of VCF-joints, regarding the preloading of bolts, require, that such shall be tensioned to above the level specified. This is a requirement of paramount importance. It is so important a reason, that it does justify, why established Codes and Standards, which only allow low preload, are not applicable to VCF-joints.

(1.4) Thermal shock

A piping system built with conventional, gasketed pipe connections, is likely to break down if exposed to abnormal temperature. Two different cases can be identified. Firstly, at high temperature, from a fire, for instance, and secondly, at low temperature, from chill condensate entering a hot pipe.

In the first case the small dimensions of a VCF-joint do permit the use of bolting made from a sophisticated, heat-resistant, expensive material, what does enhance its safety in case of a fire.

In the second case, the low mass of the VCF-joint does reduce the difference in temperature between the flange itself and the bolts, while it does make the temperatures become level in shorter time. It follows, that although some bolt preload may disappear as a result of the shock, such that the joint does begin to leak, it quickly stops as soon as the differens in temperature has evened out. In such a case, the gasket in a conventional joint normally will blow out, forming a major leak, that does persist also after the thermal shock has ceased.

(1.5) Other particulars

Any VCF-joint is "generic", what means, that it has an "ancestor" in common. Accordingly the geometry is typically one and the same, what does make the topography of stress the same regardless of dimensions and loads, such that the results from measurements and experiments are significant/typical for any VCF-joint.

(2) Summary & Conclusion

In a VCF-joint, bolts are not subject to bending. Under the bolt head and at the first thread outside the nut there are no concentrated stresses from loads ascew.

In any VCF-joint a near static condition does rule, such that no shock-load can break the bolts and such that failure from fatigue can not possibly occur. The part of the bolt most highly strained, , viz. its stem, is not exposed to the surrounding environment and accordingly it does not corrode, what is a major advantage of the VCF-joint.

In conlusion we maintain, that we have shown, that the functional safety of the VCF-joint, is adequate and at least equivalent to that of conventional, gasketed pipe joints.