Parker Hannifin Plc
Product Training

Hydraulic Tube Fittings

Level 1

List of figures

Figure Number	Description	Page
2.1	Inline Tube Fitting	4
2.2	Port Tube Fitting	5
3.2.1	British Standard Pipe Parallel	6
3.2.2	British Standard Pipe Taper	6
3.2.3	DIN 24 Form B	7
3.2.4	National Pipe Taper Fuel	7
3.3.1	DIN Bite Ring	8
3.3.2	JIC Flare Fitting	9
3.4.1.1	Soft Seal Port Fitting	10
3.4.2.1	Soft Seal Port Thread Options and Standards	10
3.5.1.1	EO-2 Soft Seal	11
3.5.1.2	O-Lok Soft Seal	12

Contents

List of figures ……2

1.0 Introduction……4

2.0 What is a tube fitting?……..4

3.0 Port and Tube Sealing Methods……5

3.1 Metal to Metal……5

3.2 Metal to Metal Port Sealing……6

3.2.1 British Standard Pipe Parallel……6

3.2.2 British Standard Pipe Taper……6

3.2.3 Deutsches Insitut fur Normung……..6

3.2.4 National Pipe Taper Fuel……7

3.3 Metal to Metal Tube Sealing……..8

3.3.1 DIN 24 degree Bite Type Fitting……8

3.3.2 JIC 74 degree Flare Type Fitting…….. 9

3.4 Port and Tube sealing Methods – Soft Seal……10

3.4.1 Soft Seal - Port Fittings……10

3.4.2 Port Fittings and Port Standards……10

3.5 Soft Seal – Tube Sealing……11

3.5.1 DIN EO-2……11

3.5.2 SAE O-Lok……11

4.0 Applications……13

Summary Points ……14

1.0 Introduction

Level One training has been devised as a 'self teach' module for persons who have no, or very little, prior knowledge of the subject matter. The aim is for persons to work through the information provided at their own pace and in their own time. When they have completed the module and feel confident that they have increased their knowledge they can complete a test that accompanies the module. Successful completion of the module test permits progress onto Level Two.

2.0 What is a tube fitting?

A tube fitting connects a hose or tube to another part of a hydraulic or pneumatic system. A tube fitting can be produced as a one-piece component from steel bar or a forging or it may be produced from several pieces, which are assembled together to form an adjustable type of fitting. A tube fitting generally screws into the port of a valve, filter, pump or cylinder. The system pipe-work, which can be a hose or a steel tube, is then connected to the fitting in order to make the connection between the various components within the system. Not all tube fittings screw into the system components, some are used purely to connect lengths of tube or hose together and are known as in-line fittings or connectors. Many forms and different types of tube fittings exist in the world. The one thing which port tube fittings have in common is that they have a port thread form (the part that screws into the system component, e.g. a pump), and a tube or hose thread form (the end that connects to the tube or hose). These are usually different, and once again, there are many different types available. In-line fittings usually have the same thread form on both ends of the adaptor. The difference between in-line fittings and port fittings is shown in figures 2.1 and 2.2. The most popular materials used for tube fitting manufacture are steel, stainless steel and brass.

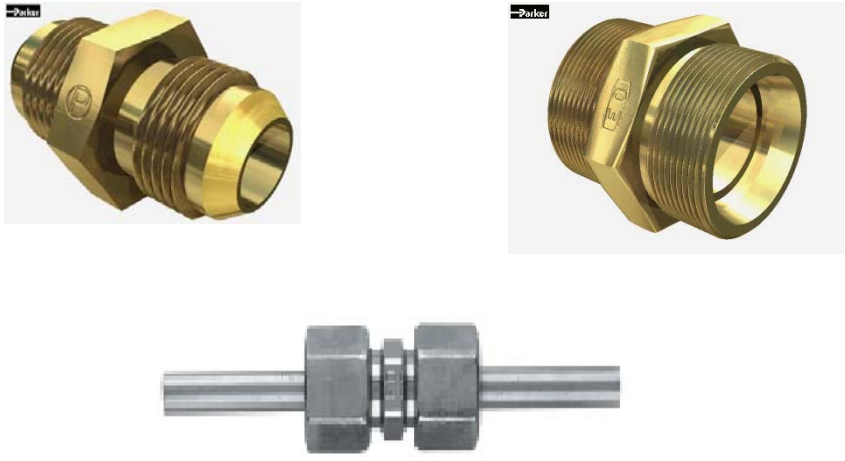


Figure 2.1 – (*Parker Hannifin*) - In-line connectors used for connecting tube to tube or hose to tube.

Figure 2.2 – (*Parker Hannifin*) - Port fittings screw into a system component before having a tube or hose connected to them.

As well as connecting the various parts of the hydraulic circuit together, tube fittings must also form a good seal between the connecting components. Many methods of sealing between fitting and ports and between fitting and tube or hose exist. As a starting point they can generally be classed into two groups; metal to metal sealing and 'soft seal' sealing.

Metal to metal fittings are the traditional types, where the sealing capability of the fitting is achieved by various thread forms, cutting faces, copper or aluminium washers; or various tube or fitting cones and flares. These types have been around for many years and continue to be used in many applications. They have their limitations however, and require more skill and training to ensure correct assembly.

'Soft seal' fittings are so called, because unlike the 'metal to metal' fittings, they rely on some form of rubber or synthetic seal at every joint to ensure a leak free joint is achieved. Their development and use has gained ground greatly over the last decade as more companies become aware of the ecological problems associated with leaking connections. In general, 'soft seal' connections are easier to assemble due to the fact that they remove some of the skill required to correctly assemble 'metal to metal' fittings.

3.0 Port and Tube Sealing Methods

3.1 'Metal to Metal'

Metal to metal joint sealing is found on fittings such as British Standard Pipe (BSP), British Standard Pipe Taper (BSPT), Deutsches Institut fur Normung (DIN), Joint Industry Conference (JIC), National Pipe Taper (NPT) and National Pipe Taper Fuel (NPTF) and Japanese Industry Standard (JIS). BSP, BSPT, and DIN are historically European styles. JIC, NPT and NPTF are typically USA styles, whilst JIS is Japanese, based on the British BSP format. All of these joints can be assembled to achieve a leak free joint, however, they require near perfect surface finishes, high torque, and a good assembly skill level, with the use of thread sealants in some cases. They are also less tolerant of the higher vibration levels, pressures and temperature cycles, which machines operate at today. The price for such fittings is usually lower when compared to the soft seal fitting options.

3.2 Metal to Metal Port Sealing

3.2.1 British Standard Pipe Parallel (BSPP) DIN From A

This is a very popular thread form in the UK, Japan, European and Commonwealth countries. Requires a bonded seal, fiber or copper washer to form a seal between the fitting and the port. The thread angle is 55°. Figure 3.2.1.1 shows only the port thread end of the fitting. (Blue)

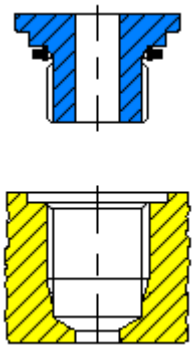


Figure 3.2.1.1 - British Standard Pipe Parallel (BSPP)

3.2.2 British Standard Pipe Taper (BSPT)

A taper pipe thread which is still encountered in the UK (especially pneumatic applications), and commonwealth countries. A 1 in 16 taper with a 55° thread angle has to be coated with a sealant in order to create a leak free path between the port and fitting. Great care has to be exercised when assembling this type of fitting as over tightening can cause the threads of the fitting or the port to be stripped. In some cases ports machined into valves or manifolds made from aluminium alloys have been known to crack if they are too close to the edge. Figure 3.2.2.1 shows only the port thread end of the fitting. (Blue)

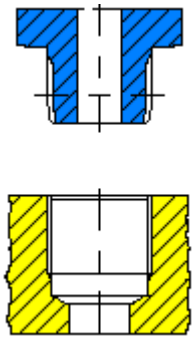


Figure 3.2.2.1 - British Standard Pipe Taper (BSPT)

3.2.3 Deutsches Institut fur Normung (DIN)

This particular fitting, known as DIN Form B, utilizes a special machined profile on the shoulder of the fitting nearest the port. As the fitting is assembled into the port, metal to metal contact is made as the cutting profile bites into the spot face of the port creating a metal to metal seal. This style is still fairly common throughout

Europe but its selection and use on new builds is declining. Figure 3.2.3.1 shows only the port thread end of the fitting. (Blue)

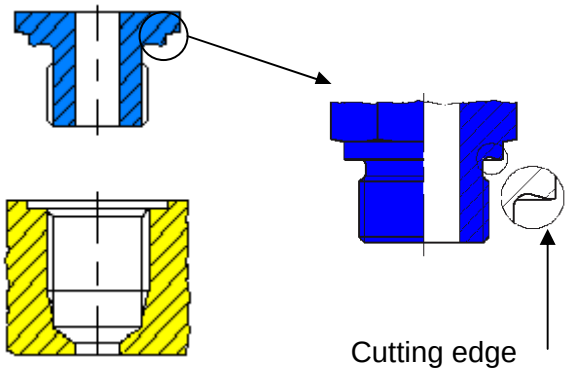


Figure 3.2.3.1 - Deutsches Institut fur Normung (DIN) – Form B

3.2.4 National Pipe Taper Fuel (NPTF)
Widely used throughout the USA. A 1 in 16 taper with a 60° thread angle. As shown in figure 3.2.4.1, with first assembly sealing is achieved by the crest, root and flanks of the fitting and port threads interfacing with each other. Any reassembly, will require the use of a thread sealant to achieve a leak free connection.

National Pipe Thread Taper (NPT) is almost identical to NPTF, the only difference being that the thread crests and roots do not make contact; only the flanks. This means that there is a spiral leak path between the fitting and port thread requiring a sealant to prevent leakage.

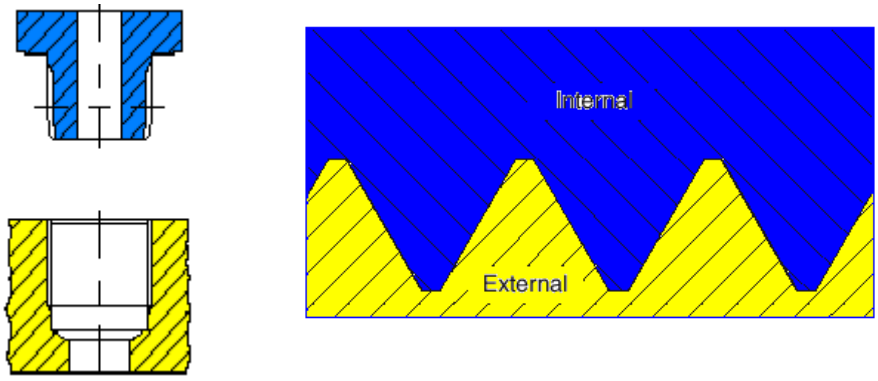


Figure 3.2.4.1 - National Pipe Taper Fuel (NPTF) – sealing on first assembly is achieved by the interference fit between the threads

3.3 Metal to Metal Tube Sealing

3.3.1 DIN 24 Degree Bite Type Fitting

This tube fitting connection is known as a bite type fitting. The reason for this is that the hardened steel ring (shown in brown in figure 3.3.1.1) is forced to bite down into the steel tube during assembly. This is what enables the tube to be retained in the fitting body. Sealing between the bite ring and the fitting body is achieved at the surface to surface contact point between the inner angle of the fitting and the outer angled edge of the bite ring. The ring therefore serves two functions; (1) tube retention, (2) tube/fitting sealing. The included angle of the sealing face on the fitting is 24°.

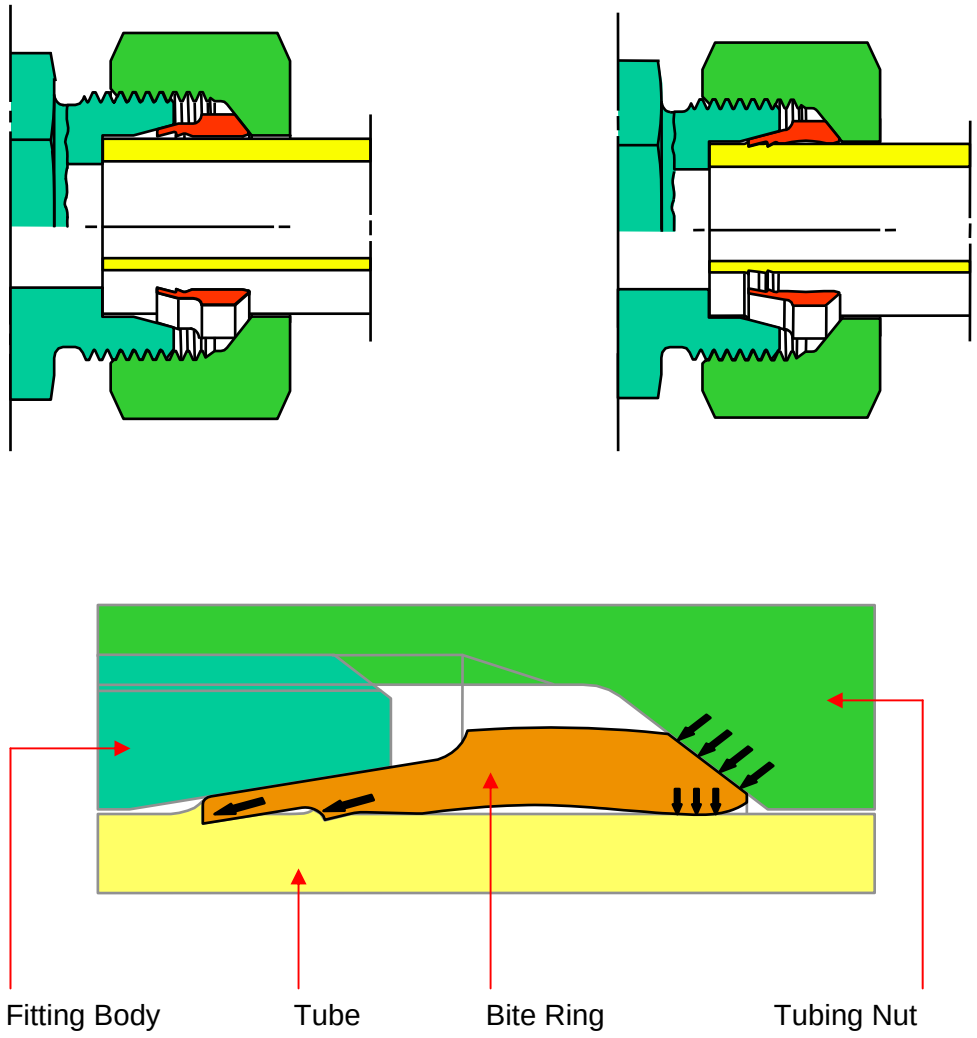


Figure 3.3.1.1 – Deutsches Institut fur Normung (DIN) 24° bite ring arrangement. Top images showing the unassembled (left) and assembled (right) conditions.

3.3.2 JIC 74 Degree Flare Fitting

Known as a flare fitting, the included angle of the fitting sealing face is machined to 74°. This means that the mating tube must be flared to the same angle in order to ensure a mating fit. The tube, when assembled to the fitting, as shown in figure 3.3.2.1, is retained by the flare. Very good surface finishes and concentricity have to be achieved on the fitting face and the tube flare in order to ensure a leak free connection.

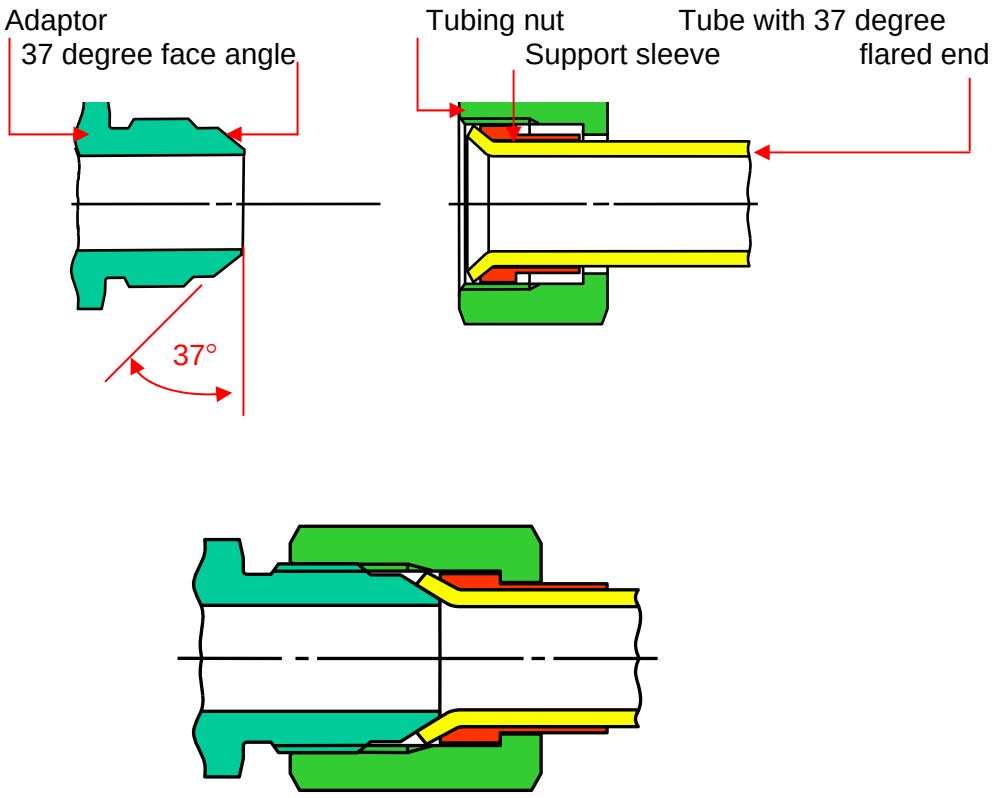


Figure 3.3.2.1– *Parker Hannifin plc* – Top image shows the JIC adaptor and tube end with support sleeve prior to assembly. The lower detail shows the components assembled. Due to the external angle on the adaptor, the opportunities for damage to the sealing surface are greatly increased. Correct tube flare is vital for effective sealing of the joint.

3.4 Port and Tube Sealing Methods - Soft Seal

'Soft Seal' connections employ some form of elastomeric seal between the port and fitting and between the fitting and tube or hose connection. Because a seal is used at every joint the term 'soft seal' connections is often used as a general term to describe the different forms. 'Soft seal' are more tolerant of surface imperfections and tolerate any slight miss-alignment or movement in the joint during operation better than the more traditional metal to metal connection. The applied assembly torque has only to stop the connection from vibrating loose.

Although more costly when compared directly to 'metal to metal' seal fittings, the assembly procedure is generally easier with the possibility of assembly error greatly reduced. These factors generally help to eliminate the refit work, often associated with 'metal to metal' connections when assembled incorrectly, thereby offsetting the higher cost.

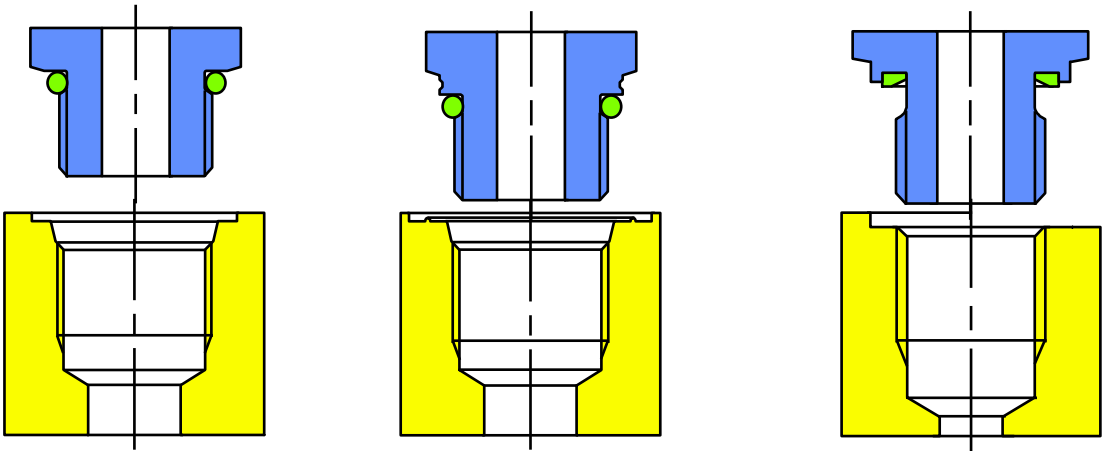
3.4.1 Soft Seal Port Fittings

These fitting types tend to have parallel thread forms and very often come with an integral seal already fitted. Figure 3.4.1.1 shows such a fitting with the seal in place.

Fig 3.4.1.1 (*Parker Hannifin)* - Showing a soft seal port fittings with seal fitted.

3.4.2 Port Fittings and Port Standards

Ports in fluid power components should be machined to international standards. Four hydraulic port options are shown in fig 3.4.2.1, you will notice that all the ports have a parallel thread. Although there are only two sealing methods shown, (O-ring and ED seal), there are in fact four different thread / sealing combinations. It is important to ensure a correct match when considering these facts. If a fitting is mounted into the wrong port it will leak. Figure 3.4.2.1 shows the fitting thread form and sealing method, in blue, and the corresponding port form shown in yellow.



Parallel (UNF) thread form ISO 11926

ISO 6149, DIN 3852-F Parallel (metric) thread form

ISO 1179-2 Parallel (BSPP) thread form, - ISO 9974-2 Parallel (metric) thread form DIN 3852-E

Figure 3.4.2.1 'Soft seal' fitting port thread options and standards

3.5 Soft Seal Tube Sealing

Many companies now produce some form of 'soft seal' tube fitting covering the ranges mentioned previously in the 'metal to metal' sealing methods. There are many variations which utilize the traditional bite type fitting technology and others which depend on some form of tube end preparation in order to form a 'soft seal' connection. At this level, only two methods will be discussed. Other styles and methods will be incorporated into the Level 2 training.

3.5.1 Din - EO-2 (*Parker Hannifin*)

The Parker 'soft seal' bite type fitting is known as EO-2. It is a unique sub assembled system contained within the tubing nut. The sub assembly is shown in figure 3.5.1.1. The traditional bite type retaining ring, as mentioned previously, serves two functions; tube retention and sealing. The EO-2 arrangement has separated these two functions allowing the bite ring to control only the tube retention whilst a changeable elastomeric seal performs the sealing action. The assembly method is much easier and more controllable than the traditional bite type fitting procedure, enabling correct assembly every time with a visible check. These features will be covered in more detail during assembly training in Level 2.

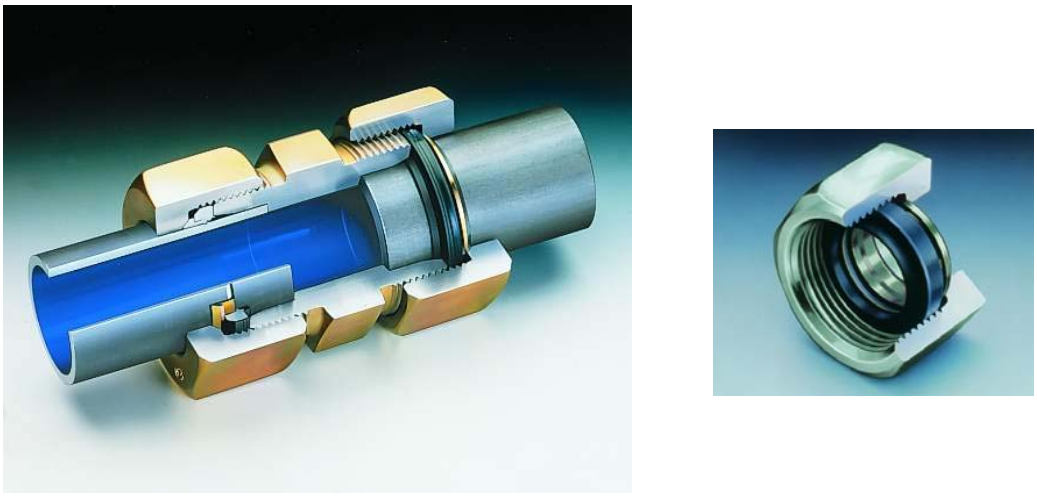


Figure 3.5.1.1 – (*Parker Hannifin*) – EO-2 'soft seal' 24° bite type fitting

3.5.2 SAE - O-Lok (*Parker Hannifin*)

Section 3.3.2 introduced the flare type fitting with an included angle of 74°.
'Soft Seal' versions of this style fitting are available where an O-ring is incorporated into the cone of the fitting. Another fitting with a higher working pressure capability and 'soft seal' sealing has also been developed and has been in use for many years. This style of fitting has taken the flare style fitting a stage further by having a flat faced fitting which incorporates an elastomeric seal. The mating tube however has to be formed to produce a flat, flange style face, which is coupled to the flat face of the fitting by a tubing nut. Figure 3.5.1.2 shows such an arrangement. Several different manufacturers produce versions of this fitting. *Parker Hannifin* however is one of the few manufacturers who have developed a flanging system and machinery for tube end preparation, others use brazing or welding techniques to generate the flange face on the tube by affixing a machined end piece onto the tube.

Figure 3.5.1.2 – (*Parker Hannifin*) O-Lok– Mechanical tube end preparation in the form of a flat face flange enables the tube to sit squarely against the face of the fitting seal enabling positive assembly and a ‘soft seal’ leak free connection

4.0 Applications

Tube fitting are used on practically every hydraulic or pneumatic machine or piece of equipment. They are every often overlooked and ignored but without them many of the everyday operations and tasks we take for granted would not be possible.

Summary Points

- Tube fittings are used with hose and tube to connect different parts of a hydraulic or pneumatic circuit together
- They can be made from steel, stainless steel, or brass
- Nowadays tube fittings fall into two general groups – 'metal to metal' or 'soft seal' types
- Many different types and styles of tube fitting exist in the world. In Europe the main styles are, DIN 24° bite type, DIN 24° with tube end formation, SAE 74° flare type, SAE 180° flange face type
- A tube fitting can be port mounted (fitted into a valve or cylinder) or line mounted (connecting two parts of the same tube or hose) together
- Port mounted fittings will be machined with one thread form for the port and a second thread form for the tube or hose connection. These are usually different to one another, (e.g. BSPP port thread and metric tube or hose thread)
- Tube fittings can be straight or adjustable styles
- Many manufacturers building equipment today are using 'soft seal' fittings in preference to 'metal to metal' fittings
- 'Soft seal' fittings are more tolerant of surface imperfections than metal to metal fittings
- Taper threads require some form of sealant to achieve a leak free connection. The only exception to this is NPTF but only for the first assembly. If it is removed and then re-fitted, thread sealant will have to be used to achieve a leak free connection