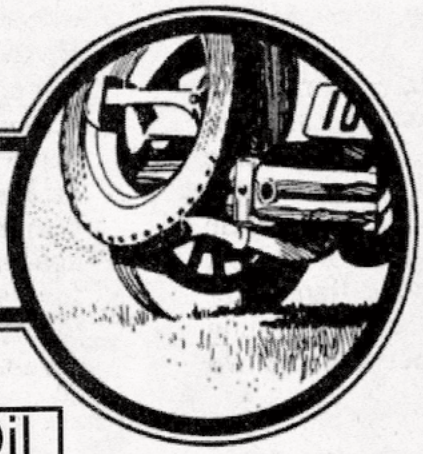
VIEWPOINT



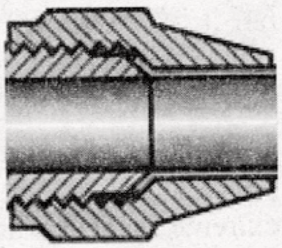
Viewpoint Editor ~ Bill Cannon

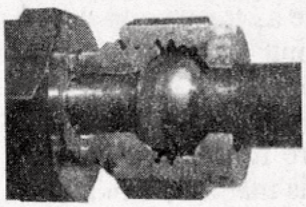
Fuel, Brake and Oil Line Fittings

The following article is a composite of a 2-part series originally published in 1996. In reviewing the two original articles it seemed to make sense to combine both articles and to add information on high-pressure brake fittings subject matter.

There are only a few basic types of fittings used on fuel, oil, vacuum, brake or other fluid lines on automobiles and trucks, but if they are not used correctly, work that is otherwise excellent will be unsatisfactory to the owner. No matter how precise or carefully done a job may be involving tubing lines such as the replacement or repair of carburetor, fuel pump, oil filter, etc., if there are leaks at any of the joints in the connecting tubing, the work is not satisfactory.

There are two general types of fittings: flare fittings and compression fittings. Flare fittings require a flare on the end of the tube. Compression fittings depend on deforming a part of the fitting to make a tight seal around the tubing itself as well as a tight joint between mating fitting parts.





Two basic types of fittings: above - flare fitting, the end of the tube is flared to provide a secure seal, and left - compression, slight deformation provides a tight seal.

A fundamental fact in connection with the use of tubing fittings that cannot be emphasized too much is this -- none of the parts of any one type of fitting are interchangeable with parts of another type. This is where most mistakes are made. You simply cannot make a joint that will not leak trying to make one part of a given type of a fitting mate with a part from one of the other types.

In order to focus more clearly on these questions, it is necessary to go back several decades in the history of the Society of Automotive Engineers (SAE). It was recognized very early in the automotive industry that because of the high production volume involved it was necessary for manufacturers to purchase common parts such as nuts, bolts, washers, tubing, wire, springs, cables, etc. from outside suppliers. To reduce inventories of parts, and to insure that a replacement part from one car would fit another, standardization of some parts was highly desirable. It has been estimated that basic standardization resulted in at least a fifteen percent savings in the annual retail cost of common American automotive parts.

The first standardization was initiated by the Association of Licensed Automobile Manufacturers (ALAM), a long defunct organization set up to license manufacturers under the Selden patents. In 1910 the SAE took over the standardization work and has been at it ever since. Specifications are issued by the SAE to promote interchangeability, eliminate excessive variety, facilitate production, and promote safety. Methods of testing are also established as an aid in disseminating engineering knowledge and in comparing performance. Work is carried out by various committees staffed by engineers and technicians from the various auto manufacturers and suppliers of parts and raw materials.

SAE Flared Tube Fittings

The two designs of flare fittings are: SAE flare fittings and inverted flare fittings. The flare fitting has a nut with a female thread slipped over the end of the tube before it is flared. The nut screws on to the male thread on the union, half union, elbow, or tee. A beveled projection fits into the flared tubing end. The tight joint is made by clamping the flange of the tubing flare between the two parts of the fitting.

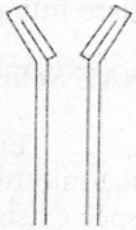
The SAE 45 degree flared tube fitting is an example of a long-established SAE standard. It was first adopted in June, 1912 and revised in 1915 and 1916 in basically the same form as seen today. The origin of this tube fitting goes back to 1905 when it was invented by the Imperial Brass Company. This should answer the question related to authenticity, since the 45 degree SAE flared fitting was in use since 1905, or thereabouts, and is still in use today in its basic form; therefore, these parts should be authentic for nearly any vehicle made since that date.

The question pursuant to the apparent variation in the appearance of the 45 degree flare fitting probably stems from the fact that the various makers of the fittings are allowed a certain degree of tolerance in the shape of the tapered part of the nut. As long as the interchangeability requirement of the SAE is satisfied, the nut may taper smoothly or have a concavity in the taper. The nut may also have different lengths. For example, the nut for 1/4 inch tubing is normally 15/16 inch long, but a shorter 3/4 inch nut is permissible. There is even a shorter nut 1/2 inch long made, but I don't believe that an SAE spec exists for it.

Common commercial SAE flare nuts. Short one at right is not covered by SAE specs.

Double-Flare For High Pressure Lines

Whereas fuel and oil lines are low pressure, hydraulic brake lines are often under extremely high pressure. As we discussed in the November 2015 issue, a flare in tubing stretches the metal and weakens it considerably. To withstand the high pressure exerted on the fittings upon aplication of the brakes, a special flare must be used which is designed to provide adequate resistance against the pressure. The double flare actually folds the metal over itself, providing a much more durable joint.

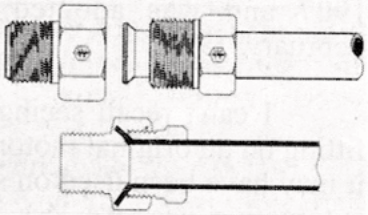


Double flaring is not difficult to achieve, but it does require some special tooling. The single flare is fine for low pressure, but it has a tendency to fail under extreme pressure.

Formation of the double flare begins similarly to the single flare, but before the flare is complete, a special die is used to fold the metal over itself.

Inverted Flare Type

I have been unable to determine when the first SAE specification was issued covering the inverted flare type tube fitting, but it was in very common use by 1939. Note that the flare on the nut is 45 degrees, while the body flare is 42 degrees. There may be a sound engineering reason for this, but it escapes me. Probably the deformation of the fitting when assembled with the flared tube gives a better fit.



The inverted flare fitting has the advantages of greater compactness and extreme reliability in automotive use. It uses the same 45 degree flare as the standard SAE flared fitting. This fitting is made for tube sizes from 1/8 to 5/8 inches.

The inverted flare fitting, as might be judged from the name, is made just the oppo-

site way. The nut has a male thread and is slipped over the end of the tubing; this thread screws into a female thread on the fitting itself. As with the flared fitting, the tight seal is made by clamping the flange of the tube between the two parts of the fitting. The flare is just the same whether used on the inverted flare fitting or the SAE standard flare fitting.

SAE Soldered Type Fitting

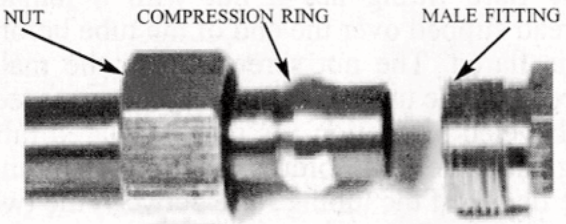
This type was available up until about the mid-twenties, but I don't believe an SAE spec exists for it since about that time. It was probably withdrawn, and rarely have I seen one. You may find these on older vehicles and especially motorcycles, which were prone to vibrate excessively. This fitting consisted of a ferrule which was soldered to the tubing. The assembly was then clamped to the body with a nut. It was apparently made only in 5/16 inch tube sizes.

Three-Piece Compression Type Fitting

The three-piece compression type fitting (the SAE refers to it as the ball sleeve compression type) is another with a lengthy history. It was originated by Imperial Brass in 1907 and was adopted by the SAE in February, 1925.

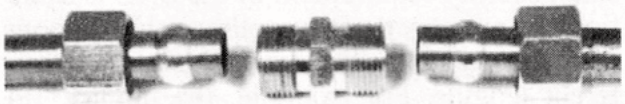
I can't recall seeing this type of tube fitting on an original motor car, but I suppose it may have been used on some. Anyway, for automotive use, it's less common than the SAE flare fitting.

It's simple and relatively inexpensive, easy to install, compact, and therefore is often used for replacement purposes. No flare is required -- all that is necessary is to cut the tube off square at the end and deburr. I have used many hundreds of this type of fitting for quick and easy laboratory lashups, but I don't consider it as reliable as a flare type fitting, and definitely I would not recommend it for a critical application, and never for brake lines. Note that the support of the tube by the comparatively short nut is much less than that provided by the longer 45 degree flare nut. The ball compression fitting is best used on copper or aluminum tubing and is generally not satisfactory for steel tubing.



The three-piece type uses a sleeve with a double taper. To use this fitting, the sleeve is slipped over the end of the tubing and located about 3/8 of an inch from the end of the tube. When the fitting is tightened, the edges of the beveled cone are swaged into the tubing, making a tight seal at the point and forming the seat of the seal in the two parts of the fitting. The nut on this fitting has a female thread. The advantage in the use of this type of fitting lies in the fact that it can be opened up and retightened as many times as necessary without loss of tightness. Neither of the compression type of fittings requires any treatment of the tube other than to have the end cut off square. No flare is required.

A tubing cutter will do a better job of cutting ends square than a hacksaw will. Deburring of the cut end, inside and out is a crucial step.

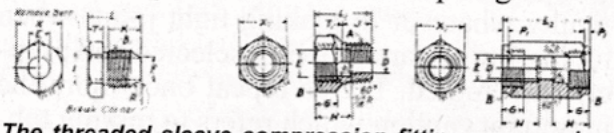


The advantage of this type of fitting is that it can be opened up and retightened as many times as necessary without loss of tightness.

Threaded Sleeve Compression Fittings

The threaded sleeve compression fitting was first introduced on some GM cars in the mid- to late-thirties, but I was unable to determine when the first SAE spec was issued. This fitting has been criticized for being difficult to make leak-tight once it has been taken apart. This fitting may still be available, but I haven't found a source for it.

The threaded sleeve type is a two-piece fitting and is used in many places on General Motors cars. It consists of a nut which is tapered down to a sharp edge.



The threaded sleeve compression fitting was used on some GM applications during the 'thirties.

This nut has a male thread and screws into the female thread of the fitting, which is tapered around the tube so that the sharp edge of a male plug or nut will be forced tightly against the tubing. As the fitting is tightened up, the sharp edge is swaged into the tubing, sealing around the tube and at the same time making the fitting tight. *The disadvantage of this kind of tubing fitting is that if it is opened up after being tightened, the joints of the nut around the tube will wear slightly and it is sometimes difficult to make the joint tight again.* For joints that are once tightened up and then left undisturbed, the fitting does a very good job.

General Specifications

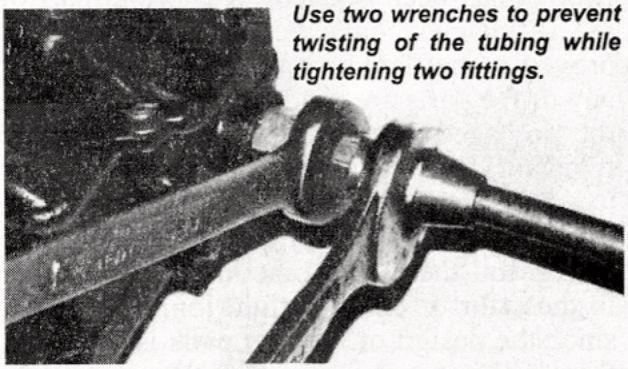
General SAE specifications call for all types of fittings described so far to be made of brass, forged, cast, or machined from bar stock. Fittings for marine or refrigeration service should be special close-grained, non-porous forged or extruded brass.

A precaution that must not be overlooked when using a flare fitting is to be sure that you slip the nut over the end of the tube before flaring it, as otherwise it will be impossible to put the nut on and the flare cannot be used. There are two styles of flaring used on tubing: the single flare and the double flare. For copper tubing, which is tough and malleable, a single flare can be used satisfactorily. On steel tubing, which is much stiffer, the flare will usually split, if the single flare is used; therefore, the so-called double flare is put on the end of the tube. The double flare is made by using special flaring tools designed especially for this purpose. Two operations are required -- the first being to upset the end of the tube by means of a specially shaped punch and the second is to complete the flare with a V-shaped tool. It is advised for brake line applications. The double flare type is best to use in either the copper or the steel tubing, though it takes a little more time to put the double flare on (page 36). The single flare is usually used in connection with copper tubing.

When a joint made by means of tubing fittings has been opened up and one part of the fitting may have been damaged or has proved to be defective, be very sure that if any of the parts are used, that parts to replace the damaged ones are exactly of the same type and size. The nut on the General Motors two-piece compression fitting has the same size of thread as the nut on the inverted flare fitting and these are sometimes put together in the effort to make a tight joint. However, since the design of the two parts is different, they will not mate properly or make a tight seal and will cause leaks. All the threads on the parts of the fitting that screw into each other are straight threads. The threads that go into parts such as the carburetor, fuel pump, etc. are pipe threads in most cases. Pipe threads are tapered, having a standard taper of ¾ of an inch per foot of thread.

When a fitting joint is to be opened up and reassembled, it is sometimes difficult to get the threads to catch. As these threads are of brass, they are very easily damaged, if they get crossed; therefore, it is important to be sure that they become properly engaged. Where difficulty is experienced, be sure that the two parts of the joint are exactly in line. If the threads have not previously been damaged and the parts are in correct alignment, they will go together very easily, though it is sometimes hard to get the accurate alignment, and this must be carefully watched. If the threads do not seem to go together properly, do not force them, as the ends of the threads may be crossed and, if forced, will be damaged beyond repair. The time required to replace fittings that become damaged is much greater than the few additional moments that might be required to put a fitting together properly by using a little bit of care.

When putting tubing fittings together or taking them apart, always use two wrenches. If this is not done and the joint in the tubing itself is tighter than the pipe thread joint going into the fuel pump, carburetor, etc., it is very possible that the tubing may be twisted and ruined. This precaution should be carefully observed so that tightness will be applied to the joint at the proper place and there will be no danger of twisting the tubing.



Use two wrenches to prevent twisting of the tubing while tightening two fittings.

A little care and time spent in connection with learning the characteristics of the four commonly used types of tubing fittings will pay handsome dividends. There is no difficulty whatever in making tight joints when tubing fittings are properly selected and properly assembled. Let us repeat once more the important caution which refers to mixing tubing fittings. The important thing to say here is -- DON'T!

EDITOR'S NOTE: The two types of flare fittings and two types of compression fittings described in this article were in general use on cars and trucks up to World War II. Since then a wide variety of new tube fittings has come into industrial use. If your early car is equipped with more modern fittings, consult the manufacturer's literature for information. The general admonition against mixing tube fittings still applies, of course.

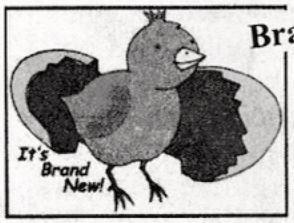
S.K.

UNUSUAL PRODUCTS

This column is designed to showcase a product which can make your restoration job a little better, a little faster, or just a little easier. Products shown here are not necessarily new, but they might fall into the less-than-common usage category. We are not necessarily endorsing the product or the manufacturer, but just passing the information along to you.

We would like to add several points to this 1996 article. In 1996 two basic materials were available for tubing: copper and steel. Although stainless steel was available, most home-shops did not have the special equipment required to bend and flare stainless. That has changed. In addition, an alloyed metal called 'cunifer' was available in Europe but difficult to locate within the United States, and it was quite expensive. Today the Eastwood Company has come to the rescue for both of these problems.

Let's deal with the 'cunifer' tubing first. Copper tubing, although easy to work, has a serious shortcoming. It is called work-hardening. As the copper is worked, through intentional bending, handling or vibration, the molecules are 're-arranged' making the copper very brittle. To illustrate this, a paper clip can be bent several times before it work hardens. Suddenly it breaks. The same happens with copper tubing, and in a fuel or brake line, it could be serious. Cunifer is an alloy of copper (cu), nickel (ni) and iron (fe). It retains the advantages of copper but the nickel and iron tend to minimize the work-hardening. Despite the addition of nickel and iron, it is still easy to bend and form, but provides a more secure conduit for brake or fuel lines. The Eastwood Company now stocks a U.S.-made cunifer tubing which they call BrakeQuip Copper Nickel Tubing.



Brake Flaring Tool

In our November 2015 issue we discussed the method of using a small flaring tool and a double flaring tool. We had been satisfied with the results until we tried a new and better product. We have tried the Eastwood Pro Brake Tubing Flaring Tool. This is a nice product: it comes in a fitted storage case - the turret-head flaring tool, five sized tube-retaining dies and instructions. It is a