Title: AN IMPROVED RELEASABLE COLLET TYPE TUBE COUPLING SYSTEM

Abstract

The present invention provides a simplified and easily manufacturable collet type tube coupling. The preferred embodiment provides a first fluid fitting body having a substantially straight inside bore which may be stepped or unstepped, and an engagement member (26), such as a radial opening (27), that may be engaged by a rib on a separate collet to form the assembly of the collet type tube coupling. A tube may be restrained in the first fluid fitting body by action of the collet. A key to the present invention and its manufacturing simplicity is that an engagement member (26) may be made that does not require a larger inner bore cavity dimension than the entrance bore, such as a reverse inside taper so prevalent in the marketplace. The first fluid fitting body may include a radius slide (48) to assist the engagement and disengagement of the rib with the engagement member (26). In the preferred embodiment, the first fluid fitting body and collet may be unitary pieces. The invention may also include an integral skirt and a swivel member.
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AN IMPROVED RELEASABLE COLLET TYPE TUBE COUPLING SYSTEM

I. TECHNICAL FIELD

This invention relates to improvements for tube couplings and particularly collet type tube coupling systems. More specifically, it relates to molded fittings for a releasable collet type tube coupling.

The need for tube couplings has long been established. For many years, attempts have been made to provide an efficient, simple apparatus and method for connecting two tubes, especially one in which no stem or barb is inserted into the tube inner diameter to restrict flow. In many circumstances, a desire for a releasable connection has been noted. In attempting to provide a releasable coupling, significant efforts have been made in providing a connection that would restrain the tube from disengaging from the coupling. Typically, such fittings involve a first piece that may comprise several sub-parts into which a second piece is presscd or fitted.

II. BACKGROUND

By way of background, Figure 1 shows a typical example of a commonly used collet type tube coupling (which some believe to be a unique subset of tube couplings), particularly those made of molded material, and are generally assembled by pressing two pieces in an axial direction toward one another ("axially pressed") along some central longitudinal axis. This could occur for instance when pressing a main body and a collet together until they are engaged in the axial direction. One of the advantages of this type of tube coupling is that the tube needs minimal or no preparation other than simply having a substantially perpendicular face on its end. The main body (1) has a smaller entrance bore (2) through which the collet (3) with its arms are inserted. As the collet engages the smaller entrance bore (2), it is squeezed in a radial direction. As the collet arms pass through the smaller entrance bore, they begin increasing in the radial direction as they engage the taper (4) and finally the inner bore (6). This may be referred to as a reverse inside taper. An O-ring (8) is typically used to rest against the end of the collet (3). The length of the collet in relation to the length of the inner bore (6) is typically adjusted so that in the assembled state, the O-ring is compressed against the end of the collet. This compression may also act as a spring force against the end of the collet, biasing it outwardly against the reverse inside taper. Thus, the collet is restrained in this fashion against the taper (4) and the

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smaller entrance bore (2). Typically at this point, a tube (7) is inserted through the inner bore of the collet (3) through the O-ring (8) and is restrained by a projection or projections (11) in the collet. If pressures occurring in the tube try to force the tube away from the collet, the projections (11) frictionally restrain the tube in the collet. The frictional restraint moves the collet with the tube outwardly in an axial direction until the arms (10) engage the taper (4). At this point, further movement outwardly in the axial direction again squeezes the arms of the collet radially, yielding a progressive clamping effect, but this time, the radial movement is restricted by the presence of the tube. So, neither the tube nor the collet is readily disengaged from the main body. Typically, to remove or release the tube, the collet is pushed inwardly toward the main body portion and the larger inward diameter and thus the arms are in a more relaxed state while the tube is pulled outwardly. Once the tube is removed, then the collet may be removed from the main body portion. Thus, the system readily locks the tube in place by interaction with the collet and main body. While variations exist, particularly of molded plastics, such a typical arrangement has been generally well received within the industry for a variety of applications. Examples of the collet type tube couplings and variations thereof include U.S. Patent Number 4,178,023, U.S. Patent Number 4,005,883, U.S. Patent Number 4,657,286, and U.S. Patent Number 4,573,716. However, it has escaped those in the industry in the manufacturing of such couplings to provide a simpler coupling for efficient manufacture. The present invention provides such a device.

The difficulty has been in the manufacturing of such a typical system shown in Figure 1. This difficulty occurs in that an entrance bore (2) smaller than the larger inner bore (6) cavity diameter is required. Special features thus are needed to extricate the tooling after the part has been molded. For instance, the mandrel may need to be a collapsible mandrel that can form the larger inner cavity and yet collapse to a smaller diameter for extrication through the smaller entrance bore. Such an arrangement adds complexity to the molding process and expense to the molds themselves. If the cavity is too small for a collapsible mandrel, in some instances, the cavity can be machined out. In contrast, the collet may be readily molded in a variety of shapes because it primarily has external features such as tapers, angles, chamfers and so forth with a generally straight or somewhat smooth inner diameter. The opposite is true of the typical arrangement for the main body of the tube coupling, such as is shown in the U.S. Patent Number 4,178,023. Such an arrangement, while being sufficiently simple to use, is not sufficiently simple to manufacture.
A variation of the above style is shown in U.S. Patent Number 5,437,483, which, instead of using a taper such as the above patents use, uses an inwardly stepped diameter. However, this design suffers from the same deficiencies in that a larger inner diameter is used to restrict the movement of the collet. Such a larger inner diameter results in the need for a variety of specialty molds, collapsible inner mandrels, machining, and so forth.

Realizing the manufacturing deficiencies of the collet type coupling shown in Figure 1, those with skill in the art attempted to solve the problems by using an arrangement such as shown in Figure 2, having a main body section using two pieces to restrain the collet. In this arrangement, the manufacture of the main body (1) could be done more easily and did not require the same type of specialty tooling and manufacturing steps that the embodiment of Figure 1 required. Here, a secondary piece (5) was added which could be made and attached to or connected with the main body (1). Such a connection could even involve ultrasonically welding the two pieces together. Obviously, this involves not only the extra manufacture of the secondary piece (5), but the extra step of connecting the secondary piece (5) to the main body (1). The arrangement was deemed necessary to create a smaller entrance bore (2) as opposed to the larger inner bore (6) and still have a tapered restraining connection (4). This underlying two-piece arrangement is shown in U.S. Patent Number 4,722,560, U.S. Patent Number 4,804,213, U.S. Patent No. 4,650,529, U.S. Patent Number 4,606,783, and U.S. Patent Number 4,923,220, in which the secondary piece provides a tapered surface. A variation of this type is shown in U.S. Patent Number 4,867,484. In that reference, the assembly is made with a main body portion and a subsidiary section. To restrict the collet from becoming disengaged, a section of the main body is formed from a deformable metal that is then swaged around the subsidiary section to form the tapered wall and restrain the collet. Obviously, this style has its own extra steps and complexities to manufacture.

The fact that those in the art realized that there was a manufacturing problem of making a smaller entrance bore and a larger inward bore as a unitary piece was realized at least as early as 1972 in U.S. Patent Number 3,653,689. In that reference, the main body utilizes a two-piece arrangement to solve the unitary piece problem of the reverse inside taper. A separate secondary piece is used to provide the cam surface to retain the collet. It notes in column 2, line 32 that the separate secondary piece arrangement allowed the manufacturing of the main body to "be produced by single machining operation or in a mould requiring no special release technique."
In other words, it was an attempt by those in the art to provide a supposedly simplified manufacturing technique for the main body using two separate pieces (to be later joined) without the special mold release techniques needed for a larger inward bore in a unitary main body. Yet, those in the art failed to recognize the solution offered by the present invention. In using a separate secondary piece to the main body, to "simplify" the manufacturing of the main body, some of those in the art believed that special processes were necessary to secure an adequate connection. For instance, in U.S. Patent Number 4,650,529, the respective parts were manufactured separately, then assembled, and through ultrasonic vibrations the ridges were softened to cause the surfaces to weld together. It noted the difficulties of making a smaller entrance bore in the one piece construction of Figure 1. Starting at column 1, line 40 it states,

"Heretofore it has not been possible to mould a body member for such a coupling out of plastics material with the required degree of accuracy necessary for making an effective coupling. The reason for this is that the body member essentially has a through-bore which is necessarily narrower at its two ends than is the centre part."

That reference then discusses the advantages of its solution to provide a separate secondary piece that may be welded to the main body and not using complex core structures by stating in column 2, line 8:

"Using this method a coupling member can be formed with a bore which tapers from an internal larger diameter down to a smaller diameter at or near the exit using simple moulding techniques without employing any complex core structure by forming the body member in two parts and welding them together; . . . ."

A variation of Figure 2, shown in Figure 3, uses stepped bores. Here, the secondary piece (5) is similarly connected to the main body (1), such that the collet (3) connects and engages the secondary piece (5). Noteworthy, in Figures 2 and 3, because the taper is on the secondary piece, the collet (3) does not rely on nor directly engage the main body to restrain the collet to the main body. Similar to the above described difficulties in Figure 2, these tend to rely upon an inserted secondary piece after the main body is manufactured to provide a tapered surface and to restrict the collet from disengaging from the main portion. In this variation, the above problem of manufacturing a reverse inside taper on the main body may be solved. However, the complexity is added in that a secondary piece is necessary to provide the restricting taper to restrain the collet from disengaging from the main portion. Examples are shown in U.S. Patent Number 3,999,783,

Other alternatives include a threaded arrangement. Such threaded arrangements are shown, for instance, in U.S. Patent Number 4,303,263 and U.S. Patent Number 4,183,560. However, it is desirable to have a collet type tube coupling for speed and release. Apparently, this alternative was seen as less desirable for many applications because of the increased time in assembly and disassembly, and increased manufacturing complexities. (The collet type of tube coupling also contrasts to other styles which have their own purposes, such as a lug-type connection in which the two mating pieces are rotated to engage a mating lug to lock the assembly in place, such as U.S. Patent Number 1,259,684.)

On the other hand, others recognized the deficiency of the multiple piece main body to produce the reverse inside taper. U.S. Patent Number 4,005,883 attempts to improve on the two part construction by making a single part main body. It recognized the disadvantages and complexities of the two-piece arrangement of the main body. For instance, in column 2, line 31, it states: “In the first place the body of the tube coupling can be made as a unitary structure incorporating the cam surface instead of having to be made in at least two parts as heretofore. This obviously simplifies the construction.” It states the rationale for requiring two pieces of the main body in column 1, starting at line 40:

In prior types of couplings, the taper on the cam surface, which taper is such that the diameter reduces from the inner end toward the outer end, has necessitated that the collet should be inserted into the member forming the cam surface from the inner end of that member. This then leads to the requirement that the main body of the coupling must be formed in two parts so as to permit the assembly of the collet into a part having the required cam surface and then the securing of this member into a main part of the body. . . . One is thus led to a construction in which the main body is formed in two parts.

However, that reference retained the difficulties of manufacturing a unitary piece by having a larger inner bore compared to the entrance bore. So, even this invention was inadequate in simplifying the manufacturing. It also mentions the disadvantage of the U.S. Patent Number 3,743,326 in swaging the outer end of the collet which results in the collet being permanently secured onto the member surrounding it and thus preventing dismantling of the assembly. Thus, the industry has realized the difficulties in such a manufacture and sought to compensate, although unsatisfactorily, for such difficulties.

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There remains, then, a need for a restraining connection in a tube coupling that may also be releasable and can be easily molded, preferably in a single piece. The restraining connection generally may include gripping surfaces to assist in frictionally restraining the tube from disengaging from the coupling and a substantially straight, generally untapered, inside bore for manufacturing simplicity. The arrangements as described above solve various problems but yield their own complexities in either assembly, use, or manufacture.

Thus, there has been a long felt but unsatisfied need for the present invention in providing a simplified, easily manufactured and assembled collet type tube coupling. Certainly, the needed implementing arts and elements have long been available and those in the art appreciated that a problem existed and indeed attempted to resolve them through a variety of ways described above. However, there was a basic assumption made by those in the industry that a larger inner diameter was necessary compared to the smaller entrance bore. This fundamental belief influenced essentially all those in the field to develop a variety of systems and yet still base their design upon this belief. The substantial attempts by those in the art to fill the need were based on this fundamental conceptualization of the problem. They essentially failed to understand the realistic alternatives to the problems that the present invention fulfills. Those prior to the present invention even taught away from the technical direction in which the patentee pursued the solution. The patentee has changed this fundamental belief by showing that a larger inner diameter is unnecessary to restrain the tube in this type of connection. The unexpected simplicity of the present invention apparently escaped all those in this field prior to the present invention.

III. DISCLOSURE OF THE INVENTION

Accordingly, the present invention provides a simplified and easily manufacturable collet type tube coupling. In the preferred embodiment, it provides a first fluid fitting body, typically the main body, having a substantially straight inside bore which may be stepped or unstepped. A key to the present invention is in realizing that an engagement member may be made that does not require a larger inner dimension than the entry end, and in doing so, provides an engagement member that may be easily molded from the external radial direction toward the inside, instead of the reverse as others with skill in the art presumed necessary in producing a reverse inside taper. In the preferred embodiment, such an engagement member comprises a radial opening which extends through the sidewall of the first fluid fitting body into the substantially straight
inside bore. Thus, the manufacturing is simplified immensely. To engage this engagement
member, such as the radial opening, a collet having a radially extending rib (which may be
tapered) can be positioned to engage the substantially straight inside bore where the rib is aligned
with the engagement member and can be pressed together in an axial direction to form a
restraining connection. In the preferred embodiment, the first fluid fitting body may be a unitary
piece not requiring the inserted secondary piece mentioned above in the other references.
Likewise, the collet may be a unitary piece such that the entire coupling (other than such
ancillaries as a sealing element and swivel element) may comprise only two pieces, the first fluid
fitting body and collet, that can be easily molded and easily assembled without any necessary
gluing, welding, threading, and so forth.

Another goal of the present invention is to provide a first fluid fitting body having a
central axis, at least one substantially straight inside bore in the first fluid fitting body, at least
one radial opening extending through the sidewall of the first fluid fitting body, a collet having
a second central axis, and at least one radially extending rib connected to the collet and
positioned to engage the radial opening along the substantially straight inside bore where the rib
and radial opening may be pressed together in an axial direction to form a restraining connection
between the first fluid fitting body and collet. An object of this goal is to directly engage the first
fluid fitting body with the rib, which may be specifically at a radial opening or other engagement
member, along the straight inside bore instead of relying on intermediate sub-parts and secondary
pieces. Another object is to provide an inside bore that extends a sufficient distance in a straight
manner, at least from an entry end of the first fluid fitting body to an inward edge of the
engagement member (such as a radial opening). This distance may allow for a sufficient
engagement of the rib with for instance the radial opening. Another object is to provide at least
one arm connected to the collet and an arm slit such that as the collet is inserted into the first
fluid fitting body in a typical arrangement, the arms may bend in an inward radial manner toward
the second central axis to allow for easier insertion of the collet into the first fluid fitting body.
Another object is to provide a collet primarily composed of molded resilient material so that such
resilient bending may occur. Another object is to provide a sealing member such as an O-ring
to seal at least some portion of the first fluid fitting body to assist in reducing any leakage that
could occur around a tube inserted into the first fluid fitting body. Another object is to provide
a seal step to allow the sealing member to abut against such step and perhaps a tube step to allow
the tube, typically inserted through the collet, to abut against the tube step. In some
embodiments, a swivel member may be provided to allow at least a portion of the first fluid
fitting body and rotatable body member to rotate or otherwise move with respect to each other.
This rotation could occur while the rotating body member is retained axially to the first fluid
fitting body. A gripping member may be provided in some embodiments to assist the collet in
gripping the tube inserted through the body. Another object is to provide a rib that is tapered
toward an entry end of the collet to form an engaging taper and in another embodiment to provide
a rib that is tapered toward an inward end of the collet to form an activating taper. The activating
taper could assist in activating the progressive clamping mentioned earlier. It could also assist
in slidably disengaging the rib from the engagement member such as a radial opening. Another
object is to provide a radial opening that has an outside opening width that is greater in width
than an inner opening width. Another object is to provide a radius slide which interacts with the
rib to assist the rib to slidably engage the radial opening. This radius slide may be adapted to
bend and form a radius, for instance, when the rib engages the radius slide. The radius slide may
also form a resilient radius in that it may resiliently move as the rib engages or disengages the
first fluid fitting body. Another object of the invention is that the restraining connection be the
primary restraining connection such that it is generally deemed unnecessary to have other
restraining connections. Another object is to provide a substantially straight stepped bore;
typically, in this invention, the straight stepped bore would progressively reduce to smaller
dimensions, starting from the entry end toward the inward end of the fitting body. Again, this
may be for manufacturing simplicity. Another object of the present invention is to provide an
integral skirt connected to, for instance, the collet. This integral skirt may assist in the handling
as well as the protection of the rib and the collet.

In manufacturing or using such an embodiment, typically, a manufacturer may
appropriate, or otherwise secure, a first fluid fitting body and a collet and assemble them in the
manner described herein. Naturally, the term "appropriate" could also include the manufacturing
of a fitting body or member. The collet could be inserted into the first fluid fitting body and
pressed together in an axial direction by altering a radial distance of the rib as it is inserted into
the first fluid fitting body, pressing the rib along this substantially straight inside bore of the first
fluid fitting body, and then engaging a radial opening with the rib. Typically, this would be
followed by pressing a tube into the collet and then, through such an arrangement, restraining the tube in the collet.

Another goal of the present invention is to provide a first fluid fitting body with a first central axis, a substantially straight inside bore in the first fluid fitting body, an engagement member associated with the first fluid fitting body, a collet, at least one radially extending rib that may directly engage the first fluid fitting body (without unnecessary intermediate sub-parts and secondary pieces for manufacturing simplicity) along the substantially straight inside bore so that the rib and engagement member are pressed together in an axial direction and form a restraining connection between the first fluid fitting body and collet.

Another goal of the present invention is to provide a first fluid fitting body, an inside bore to the first fluid fitting body, at least one engagement member connected or otherwise associated with the first fluid fitting body, at least one radius slide connected to the engagement member, a collet, and at least one radial rib where the radius slide is adapted to interact with the rib to assist the rib in slidably engaging the engagement member.

Another goal of the present invention is to provide a first fluid fitting body, at least one engagement member associated with the first fluid fitting body, a collet, at least one rib connected to the collet so that the rib and engagement member may be pressed together to form a restraining connection, and an integral skirt integrally connected to the collet. Naturally, other goals and objects of the invention are disclosed throughout other areas of the specification and claims.

IV. BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a typical arrangement of a collet type tube coupling, showing a restricted entrance bore enlarging through a tapered bore, which may be termed a reverse inside taper, to a final larger inner bore cavity.

Figure 2 shows another typical arrangement of a collet type tube coupling, similar to Figure 1, except that it shows a secondary piece attached to the main body for manufacturing reasons, used to generate through multiple pieces the reverse inside taper to form a tapered connection between the collet and the secondary piece.
Figure 3 shows a variation of Figure 2 of a typical collet type tube coupling in which the collet engages a secondary piece which is attached to the main body to create a restraining connection.

Figure 4 is an exploded view of the present invention, including both a first fluid fitting body and a collet disengaged from each other along their respective axes.

Figure 5 is a cross sectional assembly view of both pieces partially engaged along the substantially straight inside bore.

Figure 6 is a cross sectional view of both pieces along the substantially straight inside bore sufficiently engaged to produce a restraining connection.

Figure 7 is an end section view of the radial opening without a radius slide showing the outer and inner opening widths of the radial opening.

Figure 8 is a side section view of the radial opening having a radius slide with a rib pressing against the slide.

Figure 9 shows a section view of a variation of the collet having an integral skirt.

Figure 10 is a detail cross sectional side view of an embodiment utilizing a swivel element.
V. BEST MODE FOR CARRYING OUT THE INVENTION

As mentioned earlier, the present invention includes a variety of components that may be used in different combinations, depending on the application that needs to be addressed. The invention is designed primarily to take advantage of simple and efficient manufacturing, typically molding, of two pieces of a collet type tube coupling having a novel design which can be combined and modified in its various elements, shapes, sizes, and orientations with its various sub-parts as explained in more detail as the figures are described. The invention is intended to encompass a variety of uses in a variety of industries where the use of collet type tube couplings or other similar fittings are useful. Elements, functions, and procedures that distinguish the present invention will be noted where appropriate.

As can be easily understood, the basic concepts of the present invention may be embodied in a variety of ways. It involves both methods and devices to accomplish the appropriate method. In this patent, the methods are disclosed as part of the results shown to be achieved by the various devices described and as steps that are inherent to utilization. They are simply the natural result of utilizing the devices as intended and described. In addition, while some devices are disclosed, it would be understood that these not only accomplish certain methods, but also can be varied in many ways. Importantly, as to the foregoing, all these facets should be understood to be encompassed by this disclosure.

The present invention is shown in Figures 4-10 in various embodiments. It contrasts starkly to Figures 1-3 of typical collet type tube couplings and the above references and discussion on the deficiencies of those references. Figure 4 shows a perspective exploded view of the preferred embodiment. The first fluid fitting body (20) is typically the female fitting of the tube coupling. It may be symmetrically aligned about a first central axis (22). It may have an inside bore (24), which may be substantially straight, without the tapered arrangement shown in the above described references. The term "bore" may include a variety of cross sections, including circular, rectangular, elliptical, and so forth. The term "substantially straight" is intended to mean straight along the engaging surface, whether outer or inner, and may include steps that progressively narrow inwardly as appropriate. In other words, it may mean that there is no need for a smaller entrance bore such as is shown in Figures 1-3. The term substantially straight is not meant to exclude the normal manufacturing tolerances, draft angles necessary for molding the parts, and so forth. It is meant to contrast with the typical intentional reverse inside

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taper that was heretofore thought to be necessary, such as is shown in Figures 1-3 and the above references. Referring again to Figure 4, central to the functioning of the present embodiment is an engagement member (26). The engagement member (26) can comprise a variety of arrangements. The one shown is a preferred embodiment having a radial opening (27) which extends through the side wall into the inside bore (24) of the first fluid fitting body. The one shown may have a rectangular shape. Naturally, other shapes could be used, including circular, elliptical, and so forth. In general, therefore, the engagement member could be said to be "associated" with the first fluid fitting coupling, and specifically, the inside bore, in that it may be in the proximity of the inside bore, and typically molded into or otherwise connected with the fitting. The term "connected" herein includes molding together, integrally manufacturing, as well as attaching, welding, and so forth.

On the right side of Figure 4 is the collet (28). The collet may be both used to make a restraining connection to the first fluid fitting body to form the coupling and may be used to restrain a tube typically in the inner bore of the collet, such as by the progressive clamping described above. By "restraining", it is meant primarily to include axially restraining the collet with the first fluid fitting body. While it can have a variety of configurations, the one shown is a preferred embodiment and is aligned about a second central axis (30). The collet (28) may have a rib (32), shown as a radially extending rib (typically extending in a radial direction from the central axis), which is connected to the collet. The molding of the collet with the integral skirt (70) as shown in Figure 4 may be done in a conventional manner and may use the integral skirt slot (18) to assist in molding the rib or ribs (32) from the outside of the integral skirt. Typically, this would involve making a mold whose core could be pulled through the integral skirt slot in forming the rib or ribs, or alternatively, may be done by allowing the collet with its arms and ribs to flex upon ejection from the mold.

One of the important features of this embodiment is that the rib (32) may be positioned to engage the radial opening (27) in the first fluid fitting body along the inside bore (24) without the reverse inside taper arrangement of the above described references. This concept is unique to this invention. This unique arrangement makes manufacturing significantly more efficient and easier. When the rib (32) is engaged with the radial opening (27), the rib (32) may expand radially outward as it engages the radial opening (27) and forms a restraining connection (which in the preferred embodiment could be releasable, but could be fixed) between the first fluid
fitting body and collet and is thus considered to have been "pressed together in an axial direction," as opposed to threaded together or twisted together with a lug arrangement, described in some of the other attempts to resolve the difficulties of manufacturing.

An arm (34), which may be resilient, is shown connected to the collet (28). As can be readily understood, the radial distance (62) of the rib (32) from the second central axis (30) may be altered as the collet is pressed toward and inward on the first fluid fitting body. To allow or assist this radial alteration of the distance, at least one arm slit (36) may be included. (This is shown in more detail in Figure 5.) The arm slit (36) may be connected to an arm and may be longitudinally oriented along the arm. The arm slit may be adapted to allow the arm to bend as the arm engages the inside bore (24), thus reducing or otherwise altering the radial distance from the second central axis (30) of the arm (34) as the collet is pressed or slid down the inside bore (24) until the rib (32) engages the engagement member, shown as a radial opening (27), whereupon the rib (32) expands radially into the radial opening to form a restraining connection between the first fluid fitting body and collet. To accommodate such movement, in the preferred embodiment, the collet may be made from resilient material which would allow the arm to resiliently bend. Also, in the preferred embodiment, four ribs are attached to four arms with four arm slits. Naturally, other variations are possible such as one, two, three, and so forth. A key is that the rib might be able to slide into the first fluid fitting body inside bore at typically a reduced radial dimension. Thus, in this context, a rib is segmented in the preferred embodiment about the circumference of the collet. If a multiple of arms are used, the arms may be spaced apart circumferentially with the use of the arm slits such that, without the tube in place, the collet may be withdrawn or disengaged from the first fluid fitting body.

For the purposes of the present disclosure, the entry end (50) of the first fluid fitting body opposes the entry end (51) of the collet (28). In a direction inwardly from each entry end are the inward ends (52) and (53) of the first fluid fitting body and collet, respectively.

As shown in Figure 4, a radius slide (48) may be connected to the first fluid fitting body in the vicinity of the engagement member (26), such as the radial opening (27). The radius slide is described in more detail in Figure 8.

A sealing member (38) may be used between the first fluid fitting body and a tube (64) inserted into the first fluid fitting body (typically through the collet). The term "tube" as used herein includes flexible tubes, rigid tubes, conduits, hoses, pipes, and so forth of circular,
rectangular, and other cross sectional designs, and may include solid as well as hollow cross sections. The sealing member may be situated sufficiently inward from the entry end (50) of the first fluid fitting body (20) so that the collet (28) may sufficiently engage the engagement member (26) and yet allow the sealing member to act as an effective seal. The sealing member could be dimensioned to seal against the inner surfaces of the first fluid fitting body on the outer dimension of the sealing member and against the outer surfaces of the tube on the inner dimension of the sealing member. In the preferred embodiment, the sealing member (38) may be positioned a sufficient distance (40) from the radial opening (27), so that the radial opening, which may be open to an outside environment, does not create a substantial leak in the assembly. This distance (40) is also relevant to the movement of the sealing member as it is engaged and disengaged by the entry end (51) of the collet as the rib engages and disengages the engagement member (27).

Also shown in Figure 4 is the seal step (42). The seal step (42) may be positioned to allow the sealing member (38) to abut against it so that as the collet (28) engages the first fluid fitting body, the collet may push against the outward face of the sealing member (38) to position the sealing member toward the seal step. Naturally, an intermediate item such as a washer could be placed between the collet and the sealing member to assist the collet in pushing against the sealing member.

Inward from the sealing member may be a tube step (44). The tube step (44) may be configured to allow the tube (64) to abut against the end of the tube and form a stop for the tube as it is inserted through the collet (28). Naturally, variations could occur which might not include the tube step or even the sealing member.

A gripping member (46) may grip the tube through friction or otherwise. It is generally considered that the gripping member may be appropriately positioned on the collet; however, other alternatives are available. It could even be a separate entire member such as might fit inwardly from the collet toward the first fluid fitting body. Naturally, other combinations and variations are possible.

Figure 5 shows a cross sectional view of the first fluid fitting body and collet partially engaged along the inside bore (24). Notice that the inside bore (24) may be substantially straight. Thus, the manufacturing is much easier and less complex and the tooling may be simple solid molds which can be readily extricated from the molded part. This realization apparently has gone
unnoticed by those with skill in the art that the reverse inside taper having a reduced diameter entrance bore was in fact not needed.

In this embodiment, the arm (34), perhaps with the addition of the arm slit (36), may readily be reduced in a radial distance (62) to accommodate the inside bore (24). In the preferred embodiment, the inside bore (24) may be substantially straight at least a distance from the entry end of the first fluid fitting body to the inward edge (25) of the radial opening (27) or other engagement member. This distance may allow the rib to be pressed or slid along a substantially straight bore until at least engagement with the radial opening (27) occurs without having to rely on a reverse inside taper as in the embodiments of the above described references. Also, the preferred embodiment allows the rib to directly engage the first fluid fitting body along the inside bore without having to rely on secondary pieces to form a restraining connection, in contrast to those in the described references shown in Figures 2 and 3.

Figure 6 shows the first fluid fitting body and collet in a sufficiently engaged position to form the restraining connection. In comparison with Figure 5, the rib (32) has now sufficiently engaged the engagement member, specifically shown in the embodiment of Figure 6 as a radial opening (27). The radial distance (62) of the arm (34) has now increased. The radius slide (48) has been engaged by the rib (32) and in the preferred embodiment now has a radius (56). The radius slide may be said to interact with the rib to assist the rib to slidably engage the radial opening. For instance, this occurs as the radius slide presses against the rib or perhaps as the radius slide is allowed to bend to form a radius. By making and using the radius slide from resilient material, the radius (56) may be a resilient radius that can flex as the collet (28) engages and disengages the first fluid fitting body (20).

The arrangement forms a restraining connection between the first fluid fitting body and the collet. In the preferred embodiment, this restraining connection is the primary restraining connection in that no other restraint may be necessary such as threadable engagements, welding, or adhesively attaching. Thus, the connection may be released at appropriate and intentional instances.

Furthermore, the simplicity of this design allows the first fluid fitting body to be a unitary piece, independent of secondary pieces, secondary operations (such as machining the reverse taper after molding), and special manufacturing techniques. (Likewise, the collet may be a unitary piece.) Because the first fluid fitting body may be unitary, it may be completely molded,
and may be even completely molded at a single manufacturing step, thus reducing the manufacturing cost and complexity. Naturally, it could be made from a variety of materials suitable for the particular purpose or purposes, including metal.

In a typical assembly arrangement, the tube (64) may be pressed or otherwise inserted into the collet after the collet is sufficiently engaged with the first fluid fitting body (20). As the tube is inserted through the bore of the collet (28), it may be restrained through the action of the gripping member (46). In the preferred embodiment, the gripping member may not be a locking member in and of itself in that the tube may be pushed past the gripping member with some frictional resistance. The gripping member may be of sufficient design such that as pressure inside the tube might attempt to force the tube axially outward from the tube coupling, the gripping member (46) may restrain the tube enough in the collet to cause the rib (32) to be forced against the radial opening (27). The gripping member may be placed at one or several locations along the collet. If the rib (32) were forced against the radial opening (27), which may include the radius slide (48), then it would be disposed to contract radially and progressively clamp the tube; however, the contraction would be resisted by the presence of the tube (64). In this manner, the assembly as a whole could serve to maintain the tube in a connected or attached relationship with the tube coupling.

To remove the tube from the coupling, pressure might be exerted in a direction (68) on the collet. While maintaining some force inwardly so that the rib (32) does not try to force the arm (34) to contract radially, the tube (64) may be removed from the collet and past the gripping member (46), if present. After removal of the tube (64), then the collet (28) may be disengaged from the first fluid fitting (20) in an opposite fashion of the manner shown in Figure 5.

Thus, the assembly offers a viable alternative to those prior efforts in attempting to provide among other things, a molded and unitary fitting that could be releasably engaged and yet simple to manufacture without the complicated tooling required for a reverse inside taper arrangement. By "unitary", it is meant that obviously other pieces could be attached to the first fluid fitting body and collet, including holders, grips, and so forth. However, for simplicity in commercial manufacturing, the primary parts of the first fluid fitting body and collet may be unitary.

Also shown in Figure 6 is the entry end (51) of the collet engaging the sealing member (38), which may abut against the seal step (42) on an inward face. The dimension of the sealing
member (38) may be such that as the tube (64) is inserted past it, leakage is reduced by the interaction between the tube outer surface and the inner diameter of the sealing member. In such an embodiment, the seal could be said to abut against the seal step inwardly from the engagement member, which may be the radial opening, so the sealing would occur away from the radial opening. It could also seal the first fluid fitting body at an outer radial portion of the sealing member.

Naturally, such embodiments could have variations. For instance, one variation could be simply having an engagement member with a substantially straight inside bore where the collet and its rib directly engage the first fluid fitting body along the inside bore. In that embodiment, the inside bore could be substantially straight at least a distance from the entry end of the first fluid fitting body to an inward edge of the engagement member. The length of the bore in conjunction with the length of the collet would typically be coordinated so that if the sealing member were present, the entry end (51) of the collet would press against the sealing member. In such instance, the sealing member could be compressed to assist in sealing and perhaps to provide a bias against the entry end that in turn could press the rib outwardly against the engagement member in an assembled condition.

In other embodiments, less emphasis upon the straightness of the inside bore may be made and more emphasis be placed upon simply providing a radial opening in combination with the radius slide to provide a restraining connection. In this variation, the rib and the radial opening might be adapted to press together in an axial direction during assembly to form the restraining connection, typically a primary restraining connection, where the radius slide was adapted to interact with the rib to slidably engage the radial opening. The rib could slide along at least a portion of the radius slide which in turn may form the radius such as is shown in Figure 6.

Figure 7 shows a detail of the radial opening from an end view. In the preferred embodiment, it may be useful to make the radial opening with an outer opening width (73) greater than an inner opening width (71). These outer and inner opening widths may be radially positioned with respect to the inside bore (24) and the first central axis (22). Furthermore, the walls of the radial opening may be tapered radially outward from the inside bore on at least two wall surfaces of the radial opening as shown. The tapers, \( \beta_1 \) and \( \beta_2 \), may be each varied from
typically zero to 60 degrees with a preferred angle of approximately 40 to 50 degrees, although other angles may be used.

Figure 8 shows a detail of the radial opening with the radius slide pressing against the rib from a side view. As is shown, the radius slide (48) may bend as the rib (32) engages the radius slide and the radial opening (27). The radius (56) may be a resilient radius or may be a fixed radius. For manufacturing simplicity, it may simply be a resilient radius that flexes as the rib engages the slide.

Also shown in Figure 8 is a variation of the radius slide in that the cross sectional area of the radius slide may vary in a tapered or stepped fashion. Naturally, other variations and shapes may be used. Also, as shown in Figure 8, the rib (32) may be tapered. It may be tapered toward the inward end (53) of the collet with an activating taper (67). The activating taper may assist in slidably disengaging the rib (32) from the engagement member, such as a radial opening (27). The activating taper (67) may also assist in activating the progressive clamping on the tube as various forces attempt to disengage the tube from the fitting described. The rib might also have an engaging taper (69), facing toward the entry end (51) of the collet. The engaging taper might assist in assembly of the collet to the first fluid fitting body, especially if the radial distance of the rib is altered and the collet is pressed or slid inward along the inside bore of the first fluid fitting body. However, other configurations are possible. For instance, it could be rounded; it could be tapered in both directions; it could be tapered in a stepped fashion; and in some instances it might not be tapered at all, especially if the material were of a resilient nature.

Figure 9 shows another embodiment of the integral skirt (70) with the collet. While not necessary to the restraining connection between the first fluid fitting body and collet, the integral skirt may provide enhancements to the coupling assembly. For instance, typically, conventional collet type tube couplings may leak with side-to-side movement of the tube. This leakage is perhaps due to the disengagement of the sealing member with the end of the tube caused by the side deflection. The present invention with the use of the integral skirt acts to minimize this side deflection. It may assists in keeping the collet aligned with the main body and the sealing member and thus reduce the likelihood of leakage. Prior to the present invention, apparently no one at least in this field disclosed an integral skirt. Some of those in the art even taught away from an integral skirt, believing that a separate skirt was necessary. For instance, in U.S. Patent Number 4,923,220 in column 2, line 60, it describes a cover that slides (and therefore is not
integral) to a position clear of the collet. This is "in order to protect the collet from inadvertent release and at the same time to facilitate release of the collet when it is desired to do so . . ." This same philosophy of not having an integral skirt is described in U.S. Patent Number 4,573,716. In that arrangement, the end cover is not integral to the collet; in fact, it has engaging portions that limit "axial inward movement of the end cover so as to prevent the collet being pressed inwardly to release a tube by pressure on the end cover . . ." (Column 1, line 44-47.)

In contrast, the present invention allows, at least in this embodiment, an integral skirt (70) connected to the collet (28). The integral skirt may be allowed in the present invention, in contrast to the separate end covers of other inventions, in part because of the unique nature of the present invention. The integral skirt may be used to protect the engagement area around the radial opening. In the preferred embodiment, the integral skirt may be molded at the same time and in the same step as the rest of the collet, although it could be connected in some other appropriate manner. Naturally, in molding the collet, perhaps with the integral skirt, the arms may resiliently bend or fold or otherwise flex around the mold as it is ejected from the mold. As shown, the integral skirt may be radially outward from the rib (32). Typically, it would be dimensioned such that the first fluid fitting body would engage the rib and be within the inner diameter (72) of the integral skirt when the coupling was assembled. Thus, it could be said that the integral skirt at least partially surrounds the first fluid fitting body in this position. Furthermore, the presence of the integral skirt may assist in the handling and assembly of the collet with the first fluid fitting body. The length of the skirt may extend beyond the entry end (51), although certainly other arrangements are possible. By using an integral skirt, again simplicity may be realized. Thus, the integral skirt could be used with a variety of configurations including a variety of engagement members, ribs, and first fluid fitting body and collet in conjunction with other aspects of the present invention or separate from them.

Figure 10 shows one embodiment in a side view of a swivel member (74) positioned between the first fluid fitting body (20) and the rotatable body member (76). The swivel member (74) may be axially restrained in relation to the first fluid fitting body (20) and perhaps connected to the rotatable body member (76) so that the rotatable body member may turn about the first fluid fitting body. The swivel member (74) is intended to be described in a functional aspect; thus, it may not be a separate element, but can be a design that allows the rotatable body member to swivel with respect to the first fluid fitting body, typically about the first central axis (22).
the embodiment shown, it may swivel about the outer radial surfaces of the first fluid fitting body. The swivel member may be designed in the form of an indentation to which the rotatable body member mates (such as by pressing on) and that allows such swiveling. This arrangement is especially suitable for resilient materials that could flex, such as for the rotatable body member (the first fluid fitting body could be less resilient and even metal; naturally a variety of resilient and nonresilient materials could be used for the various members and elements). At least one slit (80) with at least one arm (similar to the arm and arm slit arrangement of the collet described above, as in Figures 4-5) could be used to assist in the flexing of the rotatable body member as it may be pressed onto the first fluid fitting body. As shown, the rotatable body member may also be retained axially to the first fluid fitting body while being allowed to swivel. One unique aspect of the swivel member is that it may have little or no effect on the sealing member (38) and its respective sealing surfaces on the first fluid fitting body and the tube (64). In this embodiment, the sealing member could be inward of the engagement member (26) similar to the embodiment described above. Thus, typical challenges with a swivel member breaching the pressurized areas and requiring its own seal is avoided with this feature. In this embodiment, the first fluid fitting body may terminate at the inward edge (25) of the radial opening (27) and the rotatable body member (76) may continue to the entry end (78), similar to the entry end (50) of the first fluid fitting body in the embodiment described above in Figure 4.

Each of these tube coupling embodiments could include various facets of the present invention. Some may include a radius slide, while others may not include such elements. Some may include varieties of a radial opening, others may include a swivel member, while others may be more generic depending upon the particular needs of the market place and in keeping with the goals and objects of the present invention. The market place and manufacturing concerns may dictate the appropriate embodiments for the present invention.

The foregoing discussion and the claims that follow describe only the preferred embodiments of the present invention. Particularly with respect to the claims, it should be understood that a number of changes may be made without departing from the essence of the present invention. In this regard, it is intended that such changes — to the extent that they substantially achieve the same results in substantially the same way — will still fall within the scope of the present invention.
Although the methods related to the system are being included in various detail, only initial claims directed toward the tube coupling have been included. Naturally those claims could have some application to the various other methods and apparatus claimed throughout the patent. The disclosure of the system or method context is sufficient to support the full scope of methods and apparatus claims with for instance, the radial opening, the radius slide, the substantially straight inside bore, the unitary first fluid fitting body, the unitary collet, the sealing member, the swivel member, and so forth. While these may be added to explicitly include such details, the existing claims may be construed to encompass each of the other general aspects. Without limitation, the present disclosure should be construed to encompass sub-claims, some of which are presented in an apparatus, system or method context as described above for each of the other general aspects. In addition, to the extent any revisions utilize the essence of the invention, each would naturally fall within the breadth of protection encompassed by this patent. This is particularly true for the present invention since its basic concepts and understandings may be broadly applied.

As mentioned earlier, this invention can be embodied in a variety of ways. In addition, each of the various elements of the invention and claims may also be achieved in a variety of manners. This disclosure should be understood to encompass each such variation, be it a variation of an embodiment of any apparatus embodiment, a method or process embodiment, or even merely a variation of any element of these. Particularly, it should be understood that as the disclosure relates to elements of the invention, the words for each element may be expressed by equivalent apparatus terms or method terms — even if only the function or result is the same. Such equivalent, broader, or even more generic terms should be considered to be encompassed in the description of each element or action. Such terms can be substituted where desired to make explicit the implicitly broad coverage to which this invention is entitled. As but one example, it should be understood that all action may be expressed as a means for taking that action or as an element which causes that action. Similarly, each physical element disclosed should be understood to encompass a disclosure of the action which that physical element facilitates. Regarding this last aspect, as an example, the disclosure of a “sealing member” should be understood to encompass disclosure of the act of “sealing” — whether explicitly discussed or not — and, conversely, were there only disclosure of the act of “sealing”, such a

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disclosure should be understood to encompass disclosure of a “sealing member.” Such changes and alternative terms are to be understood to be explicitly included in the description.

In addition, it should be understood that the term “comprising” is meant to have an inclusive meaning rather than an exclusive one. It should be interpreted in its most expansive form so as to afford the applicant the broadest coverage legally permissible. Therefore, in Australia, this term is not intended to have an exclusive, or more limited, meaning.

It is simply not practical to describe in the claims all the possible embodiments to the present invention which may be accomplished, generally, in keeping with the goals and objects of the present invention in this disclosure and which may include separately or collectively such aspects as appropriating a first fluid fitting body, pressing together in an axial direction a collet with the first fluid body, engaging an engagement member such as a radial opening with a rib, restraining the tube, providing an integral skirt, utilizing a sealing member, providing or utilizing a radius slide, and other aspects of the present invention. While these may be added to explicitly include such details, the existing claims should be construed to encompass such aspects. To the extent the methods claimed in the present invention are not further discussed, they are natural outgrowths of the system or apparatus claims. Therefore, separate and further discussion of the methods are deemed unnecessary as they otherwise claim steps that are implicit in the use and manufacture of the system or the apparatus claims. Furthermore, the claims and elements of the claims are organized in a more logical fashion; however, other sequences can and do occur. Therefore, the method claims should not be construed to include only the order of the sequence and steps presented.

Furthermore, any references mentioned in the application for this patent as well as all references listed in any information disclosure originally filed with the application are hereby incorporated by reference. However, to the extent statements might be considered inconsistent with the patenting of this/these invention(s), such statements are expressly not to be considered as made by the applicant(s).
VI. CLAIMS

We claim:

1. A collet type tube coupling system comprising:
   a. a first fluid fitting body having a first central axis;
   b. at least one substantially straight inside bore in said first fluid fitting body;
   c. at least one radial opening extending through a side wall of said first fluid fitting body into said substantially straight inside bore of said first fluid fitting body;
   d. a collet having a second central axis;
   e. at least one radially extending rib connected to said collet and positioned to engage said radial opening in said first fluid fitting body along said substantially straight inside bore wherein said rib and said radial opening are adapted to be pressed in an axial direction together to form a restraining connection between said first fluid fitting body and said collet.

2. A collet type tube coupling system as described in claim 1 wherein said rib connected to collet is adapted to directly engage said first fluid fitting body along said straight inside bore.

3. A collet type tube coupling system as described in claim 1 wherein said straight inside bore extends substantially straight at least a distance from an entry end of said first fluid fitting body to an inward edge of said radial opening.

4. A collet type tube coupling system as described in claim 1 further comprising at least one resilient arm connected to said collet and at least one longitudinal arm slit along said resilient arm adapted to allow said resilient arm to resiliently bend.

5. A collet type tube coupling system as described in claim 2 wherein said collet further comprises an integral skirt having at least one integral skirt slot.

6. A collet type tube coupling system as described in claim 5 further comprising a sealing member to seal between said first fluid fitting body and a tube inserted into said first fluid fitting body.

7. A collet type tube coupling system as described in claim 6 wherein said radial opening is axially located a sufficient distance from said sealing member to allow said sealing member to seal against said inside bore of said first fluid fitting body.
8. A collet type tube coupling system as described in claim 6 wherein said inside bore 
   further comprises a seal step in said bore inward of said sealing member and wherein said 
   sealing member is adapted to abut against said seal step.

9. A collet type tube coupling system as described in claim 7 wherein said inside bore 
   further comprises a tube step in said bore inward of said radial opening and wherein said 
   tube step is adapted to abut against a tube inserted in said collet.

10. A collet type tube coupling system as described in claim 1 further comprising a rotatable 
    body member and a swivel member wherein said swivel member is connected to said first 
    fluid fitting body and to said rotatable body member and is adapted to allow said rotatable 
    body member to swivel with respect to said first fluid fitting body.

11. A collet type tube coupling system as described in claim 10 wherein said rotatable body 
    member is retained axially to said first fluid fitting body.

12. A collet type tube coupling system as described in claim 9 further comprising a gripping 
    member connected to said collet and adapted to grip a tube inserted into said body.

13. A collet type tube coupling system as described in claim 12 wherein said rib comprises 
    an engaging taper.

14. A collet type tube coupling system as described in claim 13 wherein said rib comprises 
    an activating taper.

15. A collet type tube coupling system as described in claim 1 wherein said radial opening 
    comprises an outer opening width greater than an inner opening width.

16. A collet type tube coupling system as described in claim 1 further comprising a radius 
    slide adapted to interact with said rib to assist said rib to slidably engage said radial 
    opening.

17. A collet type tube coupling system as described in claim 16 wherein said radius slide is 
    adapted to bend to form a radius to assist said rib to slidably engage said radial opening.

18. A collet type tube coupling system as described in claim 16 wherein said radius slide is 
    adapted to form a resilient radius to assist said rib to slidably engage said radial opening.

19. A collet type tube coupling system as described in claim 16 wherein said radius slide is 
    adapted to press against said rib when said rib is engaged with said radial opening.
20. A collet type tube coupling system as described in claim 14 wherein said restraining connection comprises a primary restraining connection between said first fluid fitting body and said collet.

21. A collet type tube coupling system as described in claim 1 wherein said substantially straight inside bore comprises a substantially straight stepped bore.

22. A collet type tube coupling system as described in claim 20 wherein said first fluid fitting body comprises a substantially completely moldable unitary body.

23. A collet type tube coupling system as described in claim 1 wherein said collet comprises an integral skirt connected to said collet.

24. A collet type tube coupling system as described in claim 23 wherein said collet comprises a unitary piece.

25. A collet type tube coupling system as described in claim 22 wherein said radial opening comprises an outer opening width greater than an inner opening width and further comprising a radius slide adapted to bend to form a radius and to interact with said rib to assist said rib to slidably engage said radial opening.

26. A method of restraining a tube in a collet type tube coupling system comprising:
   a. appropriating a first fluid fitting body having a first central axis and a substantially straight inside bore;
   b. pressing together in an axial direction a collet having a second central axis with said first fluid fitting body comprising:
      i. altering a radial distance from said second central axis of at least one radially extending rib connected to said collet;
      ii. pressing said radially extending rib along said substantially straight inside bore of said first fluid fitting body;
      iii. engaging at least one radial opening extending through a side wall of said first fluid fitting body into said substantially straight inside bore of said first fluid fitting body with said radially extending rib;
   c. pressing a tube into said collet; and
   d. restraining said tube in said collet.
27. A method of restraining a tube in a collet type tube coupling system as described in claim 26 wherein engaging said radial opening with said radially extending rib comprises directly engaging said first fluid fitting body along said straight inside bore.

28. A method of restraining a tube in a collet type tube coupling system as described in claim 26 wherein pressing said radially extending rib along said substantially straight inside bore comprises pressing along a substantially straight bore at least as long as a distance from an entry end of said first fluid fitting body to an inward edge of said radial opening.

29. A method of restraining a tube in a collet type tube coupling system as described in claim 26 wherein said rib is connected to a resilient arm which is connected to said collet and wherein said collet comprises a longitudinal arm slit adjacent said arm and wherein altering said radial distance from said second central axis comprises resiliently bending said arm in a vicinity of said arm slit.

30. A method of restraining a tube in a collet type tube coupling system as described in claim 27 further comprising utilizing resilient material for substantially all of said collet.

31. A method of restraining a tube in a collet type tube coupling system as described in claim 30 further comprising sealing between said first fluid fitting body and a tube inserted into said first fluid fitting body.

32. A method of restraining a tube in a collet type tube coupling system as described in claim 31 further comprising sealing between first fluid fitting body inward of said radial opening.

33. A method of restraining a tube in a collet type tube coupling system as described in claim 31 wherein sealing between some portion of said first fluid fitting body and said tube comprises abutting a seal against a seal step inward of said radial opening.

34. A method of restraining a tube in a collet type tube coupling system as described in claim 32 wherein pressing said tube into said collet comprises pressing said tube to a tube step in said first fluid fitting body.

35. A method of restraining a tube in a collet type tube coupling system as described in claim 26 further comprising allowing a rotatable body member to swivel with respect to said first fluid fitting body.

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36. A method of restraining a tube in a collet type tube coupling system as described in claim
   35 further comprising retaining said rotatable body member axially to said first fluid
   fitting body.

37. A method of restraining a tube in a collet type tube coupling system as described in claim
   34 further comprising gripping a tube inserted into said collet with a gripping member.

38. A method of restraining a tube in a collet type tube coupling system as described in claim
   37 wherein engaging said radial opening with said radially extending rib comprises
   utilizing an engaging taper on said rib.

39. A method of restraining a tube in a collet type tube coupling system as described in claim
   38 further comprising activating progressive clamping of a tube inserted into said collet
   by utilizing an activating taper on said rib.

40. A method of restraining a tube in a collet type tube coupling system as described in claim
   26 wherein engaging said radial opening extending through said side wall comprises
   utilizing a radial opening with an outer opening width greater than an inner opening
   width.

41. A method of restraining a tube in a collet type tube coupling system as described in claim
   26 wherein engaging said radial opening with said rib comprises interacting said rib with
   a radius slide.

42. A method of restraining a tube in a collet type tube coupling system as described in claim
   41 wherein interacting said rib with said radius slide further comprises allowing said
   radius slide to bend.

43. A method of restraining a tube in a collet type tube coupling system as described in claim
   41 wherein interacting said rib with said radius slide further comprises allowing said
   radius slide to form a resilient radius.

44. A method of restraining a tube in a collet type tube coupling system as described in claim
   41 wherein interacting said rib with said radius slide further comprises allowing said
   radius slide to press against said rib.

45. A method of restraining a tube in a collet type tube coupling system as described in claim
   39 wherein restraining said tube in said collet comprises primarily restraining said tube
   by engaging said radial opening with said radially extending rib.
46. A method of restraining a tube in a collet type tube coupling system as described in claim 26 wherein pressing said radially extending rib along said substantially straight inside bore comprises pressing said rib along a substantially straight stepped inside bore.

47. A method of restraining a tube in a collet type tube coupling system as described in claim 45 wherein appropriating said first fluid fitting body comprises appropriating a substantially completely moldable unitary body.

48. A method of restraining a tube in a collet type tube coupling system as described in claim 26 wherein pressing together in said axial direction said collet comprises utilizing a collet having an integral skirt.

49. A method of restraining a tube in a collet type tube coupling system as described in claim 48 wherein pressing together in said axial direction said collet comprises utilizing a unitary collet.

50. A method of restraining a tube in a collet type tube coupling system as described in claim 47 wherein engaging said radial opening extending through said side wall comprises utilizing a radial opening with an outer opening width greater than an inner opening width and interacting said rib with a radius slide and allowing said radius slide to bend.

51. A collet type tube coupling system comprising:
   a. a first fluid fitting body having a first central axis;
   b. at least one substantially straight inside bore in said first fluid fitting body;
   c. at least one engagement member associated with said substantially straight inside bore of said first fluid fitting body;
   d. a collet having a second central axis;
   e. at least one radially extending rib connected to said collet and positioned to directly engage said first fluid fitting body along said substantially straight inside bore wherein said rib and said engagement member are adapted to be pressing together in an axial direction to form a restraining connection between said first fluid fitting body and said collet wherein said substantially straight inside bore extends substantially straight at least a distance from an entry end of said first fluid fitting body to an inward edge of said engagement member.
52. A collet type tube coupling system as described in claim 51 further comprising at least one resilient arm connected to said collet and at least one longitudinal arm slit along said resilient arm adapted to allow said resilient arm to resiliently bend.

53. A collet type tube coupling system as described in claim 51 wherein said collet primarily comprises molded resilient material.

54. A collet type tube coupling system as described in claim 51 further comprising a sealing member between some portion of said first fluid fitting body and said collet and wherein said engagement member is axially located a sufficient distance from said sealing member to allow said sealing member to seal against said inside bore of said first fluid fitting body.

55. A collet type tube coupling system as described in claim 51 further comprising a rotatable body member and a swivel member wherein said swivel member is connected to said first fluid fitting body and to said rotatable body member and is adapted to allow said rotatable body member to swivel with respect to said first fluid fitting body.

56. A collet type tube coupling system as described in claim 55 wherein said rotatable body member is retained axially to said first fluid fitting body.

57. A collet type tube coupling system as described in claim 51 wherein said engagement member comprises a radial opening having an outer opening width greater than an inner opening width.

58. A collet type tube coupling system as described in claim 51 further comprising a radius slide adapted to interact with said rib to assist said rib to slidably engage said engagement member.

59. A collet type tube coupling system as described in claim 58 wherein said radius slide is adapted to bend to form a radius to assist said rib to slidably engage said engagement member.

60. A collet type tube coupling system as described in claim 58 wherein said radius slide is adapted to form a resilient radius to assist said rib to slidably engage said engagement member.

61. A collet type tube coupling system as described in claim 58 wherein said radius slide is adapted to press against said rib when said rib is engaged with said engagement member.
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62. A collet type tube coupling system as described in claim 51 wherein said substantially straight inside bore comprises a substantially straight stepped bore.

63. A collet type tube coupling system as described in claim 51 wherein said first fluid fitting body comprises a substantially completely moldable unitary body.

64. A collet type tube coupling system as described in claim 51 wherein said collet comprises an integral skirt connected to said collet.

65. A collet type tube coupling system as described in claim 64 wherein said collet comprises a unitary piece.

66. A collet type tube coupling system as described in claim 57 further comprising a radius slide adapted to interact with said rib to assist said rib to slidably engage said engagement member.

67. A method of restraining a tube in a collet type tube coupling system comprising:
   a. appropriating a first fluid fitting body having a first central axis, a substantially straight inside bore, and an engagement member;
   b. appropriating a collet having a second central axis and a radially extending rib;
   c. pressing together in an axial direction said collet with said first fluid fitting body comprising:
      i. urging said first fluid fitting body and said collet together;
      ii. altering the radial distance of said radially extending rib from said second central axis from a relaxed state to a reduced state;
      iii. further urging said first fluid fitting body and said collet together by urging said engagement member and said radially extending rib together through said substantially straight inside bore;
      iv. engaging said engagement member with said radially extending rib;
      v. pressing together said first fluid fitting body and said collet by increasing said radial distance of said radially extending rib from said reduced state while said rib is engaged with said engagement member;
   d. inserting a tube in said collet; and
   e. restraining said tube in said assembly of said first fluid fitting body and said collet.

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68. A method of restraining a tube in a collet type tube coupling system as described in claim 67 wherein engaging said engagement member with said radially extending rib comprises directly engaging said engagement member along said straight inside bore.

69. A method of restraining a tube in a collet type tube coupling system as described in claim 67 wherein at least a portion of said rib is connected to a resilient arm which is connected to said collet and wherein said collet comprises a longitudinal arm slit adjacent said arm and wherein altering said radial distance of said radially extending rib comprises resiliently bending said arm in a vicinity of said arm slit.

70. A method of restraining a tube in a collet type tube coupling system as described in claim 67 further comprising utilizing resilient material for substantially all of said collet.

71. A method of restraining a tube in a collet type tube coupling system as described in claim 67 further comprising sealing said first fluid fitting body inward of said engagement member.

72. A method of restraining a tube in a collet type tube coupling system as described in claim 67 further comprising allowing a rotatable body member to swivel with respect to said first fluid fitting body.

73. A method of restraining a tube in a collet type tube coupling system as described in claim 72 further comprising retaining said rotatable body member axially to said first fluid fitting body.

74. A method of restraining a tube in a collet type tube coupling system as described in claim 67 wherein engaging said engagement member comprises utilizing a radial opening with an outer opening width greater than an inner opening width.

75. A method of restraining a tube in a collet type tube coupling system as described in claim 67 wherein engaging said engagement member with said rib comprises interacting said rib with a radius slide.

76. A method of restraining a tube in a collet type tube coupling system as described in claim 75 wherein interacting said rib with said radius slide further comprises allowing said radius slide to bend.

77. A method of restraining a tube in a collet type tube coupling system as described in claim 75 wherein interacting said rib with said radius slide further comprises allowing said radius slide to form a resilient radius.
78. A method of restraining a tube in a collet type tube coupling system as described in claim 75 wherein interacting said rib with said radius slide further comprises allowing said radius slide to press against said rib.

79. A method of restraining a tube in a collet type tube coupling system as described in claim 67 wherein further urging said first fluid fitting body and said collet together by urging said engagement member and said radially extending rib together through said substantially straight inside bore comprises urging said rib along a substantially straight stepped inside bore.

80. A method of restraining a tube in a collet type tube coupling system as described in claim 67 wherein appropriating said first fluid fitting body comprises appropriating a substantially completely moldable unitary body.

81. A method of restraining a tube in a collet type tube coupling system as described in claim 67 wherein appropriating said collet comprises appropriating a collet having an integral skirt.

82. A method of restraining a tube in a collet type tube coupling system as described in claim 81 wherein appropriating said collet comprises appropriating a unitary collet.

83. A method of restraining a tube in a collet type tube coupling system as described in claim 74 wherein engaging said engagement member with said rib comprises interacting said rib with a radius slide.

84. A collet type tube coupling system comprising:
   a. a first fluid fitting body having a first central axis;
   b. at least one inside bore in said first fluid fitting body;
   c. at least one engagement member associated with said substantially straight inside bore of said first fluid fitting body;
   d. at least one radius slide connected to said radial opening;
   e. a collet having a second central axis;
   f. at least one radial rib connected to said collet and positioned to engage said radial opening in said first fluid fitting body at said inside bore

wherein said radial rib and said engagement member are adapted to be pressed together in an axial direction to form a restraining connection between said first fluid fitting body
and said collet and wherein said radius slide is adapted to interact with said rib to assist
said rib to slidably engage said engagement member.

85. A collet type tube coupling system as described in claim 84 wherein said inside bore
extends substantially straight at least a distance from an entry end of said first fluid fitting
body to an inward edge of said engagement member.

86. A collet type tube coupling system as described in claim 84 further comprising at least
one resilient arm connected to said collet and at least one longitudinal arm slit along said
resilient arm adapted to allow said resilient arm to resiliently bend.

87. A collet type tube coupling system as described in claim 84 further comprising a sealing
member to seal between said first fluid fitting body and a tube inserted into said first fluid
fitting body and wherein said engagement member is axially located a sufficient distance
from said sealing member to allow said sealing member to seal against said inside bore
of said first fluid fitting body.

88. A collet type tube coupling system as described in claim 84 further comprising a rotatable
body member and a swivel member wherein said swivel member is connected to said first
fluid fitting body and to said rotatable body member and is adapted to allow said rotatable
body member to swivel with respect to said first fluid fitting body.

89. A collet type tube coupling system as described in claim 88 wherein said rotatable body
member is retained axially to said first fluid fitting body.

90. A collet type tube coupling system as described in claim 84 wherein said engagement
member comprises a radial opening having an outer opening width greater than an inner
opening width.

91. A collet type tube coupling system as described in claim 84 wherein said radius slide is
adapted to bend to form a radius to assist said rib to slidably engage said engagement
member.

92. A collet type tube coupling system as described in claim 84 wherein said radius slide is
adapted to form a resilient radius to assist said rib to slidably engage said engagement
member.

93. A collet type tube coupling system as described in claim 84 wherein said radius slide is
adapted to press against said rib when said rib is engaged with said engagement member.
94. A collet type tube coupling system as described in claim 84 wherein said inside bore comprises a substantially straight stepped bore.

95. A collet type tube coupling system as described in claim 84 wherein said first fluid fitting body comprises a unitary piece.

96. A collet type tube coupling system as described in claim 84 wherein said collet comprises an integral skirt connected to said collet.

97. A collet type tube coupling system as described in claim 96 wherein said collet comprises a substantially completely moldable unitary body.

98. A collet type tube coupling system as described in claim 84 wherein said engagement member comprises a radial opening.

99. A method of restraining a tube in a collet type tube coupling system comprising:
   a. appropriating a first fluid fitting body having a first central axis, an inside bore, at least one engagement member associated with said inside bore of said first fluid fitting body, and a radius slide connected to said first fluid fitting body in the vicinity of said engagement member;
   b. appropriating a collet having a second central axis and at least one radial rib;
   c. pressing in an axial direction said first fluid fitting body and said collet together to form an assembly comprising:
      i. urging said first fluid fitting body and said collet together;
      ii. engaging said radius slide with said radial rib;
      iii. sliding said radial rib along at least a portion of said radius slide;
      iv. engaging said engagement member with said radial rib;
   d. inserting a tube in said collet; and
   e. restraining said tube in said assembly of said first fluid fitting body and said collet.

100. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein pressing together in said axial direction said first fluid fitting body and said collet together comprises pressing along a substantially straight bore at least as long as a distance from an entry end of said first fluid fitting body to an inward edge of said engagement member.
101. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein at least a portion of said rib is connected to a resilient arm which is connected to said collet and wherein said collet comprises a longitudinal arm slit adjacent said arm and wherein pressing in said axial direction said first fluid fitting body and said collet together comprises resiliently bending said arm in a vicinity of said arm slit.

102. A method of restraining a tube in a collet type tube coupling system as described in claim 99 further comprising sealing said first fluid fitting body inward of said engagement member.

103. A method of restraining a tube in a collet type tube coupling system as described in claim 99 further comprising allowing a rotatable body member to swivel with respect to said first fluid fitting body.

104. A method of restraining a tube in a collet type tube coupling system as described in claim 103 further comprising retaining said rotatable body member axially to said first fluid fitting body.

105. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein appropriating said first fluid fitting body having said engagement member comprises appropriating said first fluid fitting body with a radial opening having an outer opening width greater than an inner opening width.

106. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein engaging said radius slide with said rib further comprises allowing said radius slide to bend.

107. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein engaging said radius slide with said rib further comprises allowing said radius slide to form a resilient radius.

108. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein engaging said radius slide with said rib further comprises allowing said radius slide to press against said rib.

109. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein urging said first fluid fitting body and said collet together comprises urging said rib along a substantially straight stepped inside bore of first fluid fitting body.
110. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein appropriating said first fluid fitting body comprises appropriating a substantially completely moldable unitary body.

111. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein appropriating said collet comprises appropriating a collet having an integral skirt.

112. A method of restraining a tube in a collet type tube coupling system as described in claim 111 wherein appropriating said collet comprises appropriating a unitary collet.

113. A method of restraining a tube in a collet type tube coupling system as described in claim 99 wherein appropriating said first fluid fitting body having said engagement member comprises appropriating said first fluid fitting body with a radial opening.

114. A collet type tube coupling system comprising:
   a. a first fluid fitting body having a first central axis;
   b. at least one engagement member in said first fluid fitting body;
   c. a collet having a second central axis;
   d. at least one rib connected to said collet and positioned to engage said engagement member associated with said first fluid fitting body wherein said rib and said engagement member are adapted to be pressed together to form a restraining connection between said first fluid fitting body and said collet; and
   e. an integral skirt integrally connected to said collet.

115. A collet type tube coupling system as described in claim 114 wherein said rib connected to said collet is adapted to directly engage said first fluid fitting body along a substantially straight inside bore of said first fluid fitting body.

116. A collet type tube coupling system as described in claim 115 wherein said straight inside bore extends straight at least a distance from an entry end of said first fluid fitting body to an inward edge of said engagement member.

117. A collet type tube coupling system as described in claim 114 further comprising at least one resilient arm connected to said collet and at least one longitudinal arm slit along said resilient arm adapted to allow said resilient arm to resiliently bend.

118. A collet type tube coupling system as described in claim 117 wherein said collet primarily comprises molded resilient material.

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119. A collet type tube coupling system as described in claim 118 further comprising a sealing member to seal between said first fluid fitting body and a tube inserted into said first fluid fitting body and wherein said engagement member is axially located a sufficient distance from said sealing member to allow said sealing member to seal against said inside bore of said first fluid fitting body.

120. A collet type tube coupling system as described in claim 114 further comprising a rotatable body member and a swivel member wherein said swivel member is connected to said first fluid fitting body and to said rotatable body member and is adapted to allow said rotatable body member to swivel with respect to said first fluid fitting body.

121. A collet type tube coupling system as described in claim 120 wherein said rotatable body member is retained axially to said first fluid fitting body.

122. A collet type tube coupling system as described in claim 114 wherein said engagement member comprises a radial opening having an outer opening width greater than an inner opening width.

123. A collet type tube coupling system as described in claim 114 further comprising a radius slide adapted to interact with said rib to assist said rib to slidably engage said engagement member.

124. A collet type tube coupling system as described in claim 119 wherein said radius slide is adapted to bend to form a radius to assist said rib to slidably engage said engagement member.

125. A collet type tube coupling system as described in claim 123 wherein said radius slide is adapted to form a resilient radius to assist said rib to slidably engage said engagement member.

126. A collet type tube coupling system as described in claim 124 wherein said radius slide is adapted to press against said rib when said rib is engaged with said engagement member.

127. A collet type tube coupling system as described in claim 115 wherein said substantially straight inside bore comprises a substantially straight stepped bore.

128. A collet type tube coupling system as described in claim 114 wherein said first fluid fitting body comprises a substantially completely moldable unitary body.

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129. A collet type tube coupling system as described in claim 114 wherein said collet comprises an integral skirt connected to said collet.

130. A collet type tube coupling system as described in claim 129 wherein said collet comprises a unitary collet.

131. A collet type tube coupling system as described in claim 122 further comprising a radius slide adapted to interact with said rib to assist said rib to slidably engage said engagement member.

132. A method of restraining a tube in a collet type tube coupling system comprising:
   a. appropriating a first fluid fitting body having a first central axis, an inside bore, and an engagement member;
   b. appropriating a collet having a second central axis, an integral skirt, and a radially extending rib;
   c. pressing together in an axial direction said collet with said first fluid fitting body comprising:
      i. urging said first fluid fitting body and said collet together;
      ii. altering the radial distance of said rib from said second central axis from a relaxed state to a reduced state;
      iii. further urging said first fluid fitting body and said collet together by urging said engagement member and said rib together;
      iv. engaging said engagement member with said rib;
      v. axially pressing in position by increasing said radial distance of said rib from said reduced state;
      vi. at least partially surrounding said first fluid fitting body with said integral skirt on said collet;
   d. inserting a tube in said collet and axially inside said integral skirt; and
   e. restraining said tube in said assembly of said first fluid fitting body and said collet.

133. A method of restraining a tube in a collet type tube coupling system as described in claim 132 wherein engaging said engagement member comprises directly engaging said first fluid fitting body along a substantially straight inside bore of said first fluid fitting body.
A method of restraining a tube in a collet type tube coupling system as described in claim 133 wherein further urging said first fluid fitting body and said collet together by urging said engagement member and said rib together comprises pressing along a substantially straight bore at least as long as a distance from an entry end of said first fluid fitting body to an inward edge of said engagement member.

A method of restraining a tube in a collet type tube coupling system as described in claim 132 wherein at least a portion of said rib is connected to a resilient arm which is connected to said collet and wherein said collet comprises a longitudinal arm slit adjacent said arm and wherein altering said radial distance of said rib from said second central axis comprises resiliently bending said arm in a vicinity of said arm slit.

A method of restraining a tube in a collet type tube coupling system as described in claim 135 further comprising utilizing resilient material for substantially all of said collet.

A method of restraining a tube in a collet type tube coupling system as described in claim 136 further comprising sealing said first fluid fitting body inward of said engagement member.

A method of restraining a tube in a collet type tube coupling system as described in claim 132 further comprising allowing a rotatable body member to swivel with respect to said first fluid fitting body.

A method of restraining a tube in a collet type tube coupling system as described in claim 138 further comprising retaining said rotatable body member axially to said first fluid fitting body.

A method of restraining a tube in a collet type tube coupling system as described in claim 132 wherein engaging said engagement member comprises utilizing a radial opening with an outer opening width greater than an inner opening width.

A method of restraining a tube in a collet type tube coupling system as described in claim 132 wherein engaging said engagement member with said rib comprises interacting said rib with a radius slide.

A method of restraining a tube in a collet type tube coupling system as described in claim 137 wherein interacting said rib with said radius slide further comprises allowing said radius slide to bend.
143. A method of restraining a tube in a collet type tube coupling system as described in claim 141 wherein interacting said rib with said radius slide further comprises allowing said radius slide to form a resilient radius.

144. A method of restraining a tube in a collet type tube coupling system as described in claim 142 wherein interacting said rib with said radius slide further comprises allowing said radius slide to press against said rib.

145. A method of restraining a tube in a collet type tube coupling system as described in claim 132 wherein further urging said first fluid fitting body and said collet together by urging said engagement member and said rib together comprises urging said rib along a substantially straight stepped inside bore.

146. A method of restraining a tube in a collet type tube coupling system as described in claim 132 wherein appropriating a first fluid fitting body comprises appropriating a substantially completely moldable unitary body.

147. A method of restraining a tube in a collet type tube coupling system as described in claim 132 wherein appropriating said collet comprises appropriating a collet having an integral skirt.

148. A method of restraining a tube in a collet type tube coupling system as described in claim 147 wherein appropriating said collet comprises appropriating a unitary collet.

149. A method of restraining a tube in a collet type tube coupling system as described in claim 140 wherein engaging said engagement member with said rib comprises interacting said rib with a radius slide.
FIG. 1
PRIOR ART

FIG. 2
PRIOR ART
FIG. 3
PRIOR ART
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16L37/092

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search
31 May 1999

Date of mailing of the international search report
09/06/1999

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Budtz-Olsen, A

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