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(54) JOINT FOR STEEL TUBES

(71) We, VALLOUREC (USINES A TUBES DE LORRAINE-ESCAUT ET VALLOUREC REUNIES), a French Body Corporate, of 7, Rond Point Bugeaud, Paris 16^e, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention refers to a joint for steel tubes, intended in particular to be employed in the petroleum industry, which exhibits the special feature of being not very sensitive to the phenomenon of embrittlement by hydrogen.

Joints for steel tubes intended for the petroleum industry are already known, of the type in which assembly is effected by means of a thread produced on a frustoconical surface at the tip of the male member, which engages with a thread of corresponding form produced on the frustoconical surface of the inner surface of the tip of the female member. In an embodiment of this type of joint tightness is ensured by the fact that the tip of the male member comes to abut against a shoulder of corresponding shape located at the end of the thread on the female member, the said shoulder consisting in its central zone of a frustoconical surface the crown of which points towards the tip of the female member, and in its peripheral zone of an abutment surface, for example, frustoconical, the taper of which points in the reverse direction, so that when the tip of the male member comes to abut against the shoulder on the female member the central zone of the shoulder has the tendency to force the tip of the male member back towards the outside, whilst the peripheral zone of the shoulder acts in the reverse direction.

In this known type of joint the relative dimensions of the threaded frustoconical portions are such that during assembly there is produced binding of the threaded male portion against the threaded female portion, whilst the tip of the male member comes to abut against the shoulder on the female member in order to ensure tightness of the joint.

This joint gives every satisfaction in current employment and it is not particularly sensitive to the phenomenon of embrittlement by hydrogen when the acid embrittling fluid circulates inside the joint as in the case in the greatest number of cases.

In fact the tip of the male member as well as the portion of the female member which lies in the vicinity of the shoulder forming the abutment are subjected solely to bi- or tridimensional compression stresses which oppose cracking by embrittlement by hydrogen.

On the other hand, when the acid embrittling fluid circulates outside a joint of the type of those which have just been described, there is a risk of fairly rapid embrittlement which leads to bursting of the part which bears the female thread.

This phenomenon can be explained by the fact that the portion of the female member which has the frustoconical thread is subjected during assembly and still more under the service conditions of the joint to perpendicular tension stresses.

In fact the portion carrying the female thread is first of all subjected to longitudinal tension to balance the force exerted by the tip of the male member against the internal shoulder on the female member. Furthermore the binding which is exerted during the screwing together of the two frustoconical threads exerts forces of elongation upon the periphery of the female member in directions perpendicular to the axis of the joint.

The stresses in service such as the axial tension on the tubes due to the suspended weight and the possible internal overpressure of the flowing medium increase still more the assembly stresses. In addition, because of the variations in thickness due to the mechanical necessities of production localized stress concentration zones are observed, which may increase the said stresses considerably.

This combination of two elongative stresses arranged perpendicularly is very favourable to the phenomenon of embrittlement by hydrogen.

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The present invention refers to a new joint of the aforesaid type which avoids this disadvantage and which enables a resistance to hydrogen embrittlement which is as good outside as inside the tubular assembly and in the body of the tubes as between the threaded joints.

According to the present invention a joint for steel tubes, capable of being assembled and dismantled, of the type in which the tightness is obtained by the fact that the tip of a male member comes to abut against a shoulder produced inside a female member, the said shoulder comprising a central zone in the shape of a truncated cone the apex of which points towards the outside of the female member and a peripheral zone having a shape like a truncated cone the taper of which points in the opposite direction, the tip of the male member having a central zone with a shape complementary to that of the central zone of the shoulder on the female member, and a peripheral zone with a shape identical or complementary to the shape of the peripheral zone of the shoulder on the female member, the assembly of the male member and the female member being effected by threads of corresponding shape, produced inside the tip of the female member and on the outside of the male member, the dimensions of the thread on the male member and of the thread on the female member being such that when the joint is tight the largest diameters of the tops and grooves of the male member thread within the range of machining tolerances remain throughout smaller or at most slightly larger than the smallest diameters of the corresponding grooves and tops of the female member thread so as to avoid formation of any substantial radial stress in the threads when the male and female members are coupled together.

In accordance with the invention and for a metal selected of an ordinary or special anti-embrittling quality the stress thresholds not to be exceeded in service are defined and the concept of the joint must be such that at no point on either of the members male and/or female are these maximum stresses exceeded, not only after screwing up but also under service conditions.

The threads on the male member and female member may be frustoconical threads or they may be cylindrical threads, in the latter case ending possibly in a portion of frustoconical thread in the direction opposite to the tip of male member or in the direction of the tip of the female member.

In this variant likewise the cylindrical threads and possibly the frustoconical threads have dimensions such that during assembly of the joint no significant binding of the female member onto the male member is produced.

When it is pointed out that in accordance with the invention no significant binding of the female member onto the male member is produced during assembly of the joint it is understood by that that in the position of abutment of the tip of the male member against the shoulder on the female member the diameters of the tops and bottoms of the threads on the male member are not systematically greater than those of the bottoms and tops of the threads on the female member. (The dimensions being of course measured before assembly, because after assembly the binding or the dilation of the male member by the internal overpressure can have the effect of making these dimensions equal).

In the case where the largest possible diameters of the male member are only slightly greater than the smallest possible corresponding diameter of the female member a deliberately limited reduced partial binding is obtained which is only produced in the case in which at some point under consideration there has been produced at statistical random a maximum diameter of the male member and a minimum diameter of the female member.

By way of example for a tube of about 100 millimetres diameter, when at any point the difference between the largest and smallest possible diameters of the male member or the female member is two tenths of a millimetre the machining dimensions can be determined so that the largest possible diameter of the male member is greater at most by about a tenth of a millimetre (for example, a few hundredths of a millimetre) than the optimum possible diameter of the female member.

Furthermore, in accordance with the invention, when that is the case it is preferable that the minimum possible diameter of the female member exceed by only a small amount (for example, less than 5 hundredths of a millimetre) the maximum possible diameter of the male member.

The differences of dimension indicated above may vary in a manner which is substantially proportional to the diameter of the tube.

Because during screwing up little or no binding is exerted by the female thread on the male, the torque resisting the assembly torque is essentially due to the torque necessary for fitting the tip of the male member against the shoulder in the female member.

Both when the thread is totally conical and when it is cylindro-conical, the taper of the male member may be deliberately differentiated from that of the female member, taking into account tolerances of production of the diameters and the conical zones, in order to control the possibilities of binding or diametral clearance in a different manner

along the threaded conical length. In fact since the machining of conical threads on cylindrical tubes produces variable thicknesses and variable rigidities connected with these thicknesses there can result variable transverse and longitudinal stresses keeping of which below the maxima predetermined by the steel may necessitate a differentiation in the clearances or variations in the dimensions along the conical thread.

In this way one can determine with greater precision the tightening torque which must be applied during assembly.

This torque must be as small as possible but it must at the same time be sufficient for the tip of the male member to remain fitted with a certain force against the shoulder on the female member when the tube is subjected as a whole to longitudinal tension such as that which results from gravity when a column of tubes is hung vertically in a well.

In accordance with the invention it is preferable for the case of an abnormal excessive tightening of the joint to see to it that in the right section of the joint at the level of the abutment the section of the female member has an area of about 10 to 20% greater than the area of section of the male member. The result of this is that in the case of excessive tightening only the tip of the male member and the abutment on the female member undergo permanent deformations.

The lateral clearance which is produced in accordance with the invention between the threads on the male member and those on the female member likewise offers the advantage of enabling better centring of the tip of the male member in the shoulder on the female member and thus in spite of the machining tolerances and the defects in alignment which result therefrom, of obtaining excellent tightness in all cases, as well as the most uniform possible distribution of the stresses set up in the female member by the thrust of the abutment surfaces.

It is understood that thanks to the characteristics of the joint in accordance with the invention the threaded portion of the female member is subjected only to hoop stress systematically limited below predetermined maximum values which are selected in accordance with the metal employed.

On the other hand when the joint is subjected to longitudinal tension as, for example, under the conditions which have just been called to mind above, the force of elongation which the male portion exerts on the female portion causes a phenomenon of constriction which tends to reduce the diameter of the female portion whilst creating at the periphery of the latter forces of compression (that is to say, forces which act in a direc-

tion the reverse of the forces caused by ferruling).

It is understood under these conditions that the female member which is subjected only to forces of elongation deliberately limited as a function of the metal employed (and this both in the longitudinal sense and in the transverse sense) can resist in a satisfactory manner the phenomenon of embrittlement by hydrogen.

In certain usages it can even be imagined that during screwing up (and of course before being put into service with suspended weight and internal overpressure) the bidirectional stresses in the female member are practically nil provided that the result is not increased risk for the male member.

In accordance with a preferred embodiment of the invention a slight lateral clearance is allowed to persist between the portion of the male member located between its tip and the start of its thread, and the corresponding portion of the female member.

In this way there is obtained a better distribution of the stresses at the outside periphery of the female member as will be explained later.

In accordance with another special embodiment of the joint in accordance with the invention, there is effected on the outside of the female member a slight progressive diminution of the diameter at right angles to the portion of the female member which is located beyond the shoulder.

As will be explained later there is likewise obtained in this way a better distribution of the stresses at the periphery of the female member.

In accordance with another preferred embodiment of the invention a good distribution of the stresses at the periphery of the female member is obtained by giving the axial length of the female abutment which forms the shoulder for the tip of the male member a value at least equal to 1.10 times the thickness of the female tube at the level of the flange, in the case of a simple joint comprising a tube with a female tip and a tube with a male tip.

In the case of a sleeve joining two male members the distance between the two shoulders on the sleeve must preferably be at least equal to 2.2 times the thickness of the sleeve between the two shoulders.

In both cases the axial length of the abutment must be greater the thinner the tube for a given diameter.

In accordance with another embodiment of the invention as set forth assembly of the joint as therefore described is effected by applying only a very low screwing-up torque which sets up only very low assembly stresses but which could be insufficient to maintain assembly when the joint is subjected to longitudinal tension in service, during putting in

place of the column of assembled tubes or during its withdrawal before dismantling, and this disadvantage is compensated by employing for effecting the assembly a polymerizable lubricant which hardens a certain time after being put in place, forming an adhesive.

Such a polymerizable lubricant must have chemical neutrality towards the agents circulating in and around the assembly. It must also have sufficient resistance to the pressures and temperatures at which the joint is employed. Finally it must enable unscrewing of the joint without damaging the members of the latter.

With this object polymerizable lubricants may be employed such as epoxy resins or urethanes charged with anti-seizing and anti-friction solids, plasticizer products enabling their mechanical characteristics to be adjusted and catalyst products for regulating the required polymerization conditions.

One can thus obtain a low-strength solid product capable of being destroyed during unscrewing without damaging the steel of the two assembled members.

In accordance with another special embodiment of the invention the polymerizable lubricant is employed as a filling agent for the diametral clearance between the male member and the female member, in order that after hardening the disappearance of this clearance prevents one of the members from undergoing alone a deformation without the other member being concerned.

For example, for a joint of very small dimensions for which the state of machine-tool technique does not enable sufficiently close tolerances to be effected the risk of excessive clearance may be chosen rather than that of excessive ferruling, the excessive clearance then being nullified by a polymerizable lubricant of a strength adapted to this use.

Joints in accordance with the invention may be of the type in which the tip of a tubular member is shaped as a male member whereas the tip of the other tubular member is shaped as a female member.

However, the invention is particularly interesting to apply in the case in which the male tips of two tubular members are joined by means of a double female threaded sleeve.

With the object of making the invention better understood a number of embodiments will now be described by way of illustration and without any restrictive character, as illustrated in the attached drawing.

In this drawing:—

Figure 1 is a diagrammatic section of a joint in accordance with the invention, including frustoconical threads,

Figure 2 is a variant upon the joint as

Figure 1, in which assembly is effected by means of cylindro-conical threads,

Figure 3 is a diagrammatic view illustrating the clearance existing in a joint in accordance with the invention between the thread on the male member and the thread on the female member,

Figures 4 and 5 show diagrammatically how the distributions of the machining tolerances are to be arranged on the male member and on the female member,

Figure 6 is a diagrammatic view on a larger scale showing the deformations which the female member undergoes when a longitudinal tension is exerted on the joint,

Figure 7 shows diagrammatically a variant in accordance with the invention which enables the stresses to be better distributed at the outside periphery of the female member.

In figure 1 there is illustrated diagrammatically in section a joint in accordance with the invention comprising the tip of a male member 1 onto which has been screwed a tubular sleeve 2. The righthand portion of the tubular sleeve does not include the other male member which is to come and engage with it.

As is already known, the tip of the male member has a frustoconical surface 3 which comes to bear against a shoulder 4 of corresponding shape on the sleeve 2 and of which the main purpose is to ensure limitation of the screwing up.

On the outside periphery of the tip of the member 1 is a surface 5 of, for example, frustoconical shape which during tightening comes to bear against a surface 6 on the sleeve 7 of corresponding or substantially corresponding shape.

There is likewise seen in Figure 1 how the frustoconical thread 7 on the male member engages with the frustoconical thread 8 of corresponding shape which is produced on the female member.

Again on Figure 1 is seen how the surfaces 9 and 10 which join the ends of the threads on the one hand to the tip of the male member and on the other hand to the shoulder on the female sleeve leave between them a slight clearance in accordance with a preferred embodiment of the invention.

During tightening of the joint limitation of the screwing up is determined by the bearing of the tip of the male member against the surfaces 4 and 6 on the female member.

The action of the surfaces 3 of the male member against the zone 4 of the shoulder on the female member has the effect of throwing outwards the tip of the male member the surface 5 of which bears against the surface 6 on the female member to ensure tightness of the joint.

The angle of the generatrix of the surface

4 with respect to the plane perpendicular to the axis of the joint must be greater than the angle of slip of the tip of the male member against the shoulder on the female member. This angle is for example between 10 and 30° and is preferably selected between 15 and 20°.

The slope and shape of the surfaces 5 and 6 may vary within wide limits on the sole condition of enabling tightness of the joint to be effected by elastic and/or plastic deformation of the surface 5 against the surface 6.

In Figure 2 is illustrated a variant upon the joint illustrated in Figure 1.

In this variant the threads 7 and 8 on the male and female members instead of being produced on a frustum of a cone are produced for the greater part on a cylindrical surface I and in the embodiment illustrated, likewise on a frustoconical surface II which is located in the vicinity of the tip of the female sleeve.

As may be seen in Figure 2 the cylindrical portion of the threads is the more important. In a variant the frustoconical portion could possibly be eliminated although this frustoconical portion enables more rational employment of the metal by making use of threads the height of which is progressively reduced in the direction of the tube constituting the male member.

A portion of the threads on the male member 7 and the female member 8 is illustrated diagrammatically in section on a larger scale in Figure 3.

In order to provide the necessary radial clearance the frustoconical generatrix 11 of the thread 7 on the male member is located below the frustoconical generatrix 12 of the thread 8 on the female member so as to allow a mean clearance which corresponds with the spacing between the generatrices 11 and 12 to persist between the two threads.

It is seen in fact that the tops 13 of the threads on the male member 7 are at a diameter smaller than that of the grooves 14 of the threads on the female member 8. The same goes for the grooves 15 of the threads on the male member 7 and the tops of the threads on the female member 8.

Similarly the rear faces 17 and 18 leave a clearance between them and screwing up and assembly are ensured solely by the action of the front faces 19 and 20 of the male threads and the female threads.

It can be seen that under these conditions assembly of the joint causes no binding of the female member 8 onto the male member 7.

In order to let it be better understood how the clearance between the male threads and the female threads must be produced two possible cases have been illustrated dia-

grammatically in Figures 4 and 5 for the distribution of the manufacturing tolerances.

In these two Figures are shown the frustoconical generatrix 11 of the thread on the male member and the frustoconical generatrix 12 of the thread on the female member.

The lines 11 and 12 correspond with the theoretical positions of the male and female threads.

In practice, however, it is impossible to produce threads strictly in the position in which they should be.

Thus there is illustrated between the lines "11 mini" and "11 maxi" the variations in positioning of the generatrix 11 due to manufacturing tolerances.

Thus, in words other, when theoretically the male thread must be determined by the generatrix 11, the latter is located in practice and as a function of the chances of machining, between the generatrix "11 mini" and the generatrix "11 maxi". The same goes for the generatrix 12.

In the case of Figure 4, the theoretical positioning of the generatrices 11 and 12 has been chosen so that the "12 mini" dimensions are always greater than the "11 maxi" dimensions. The result is that one thus obtains a compulsory clearance over the whole of the points on the male and female threads. The minimum amount of this clearance is shown by the distance 21.

In accordance with the invention it is preferable to select this clearance 21 to be of small amount and if possible to select it close to zero.

Figure 5 illustrates the case in which the dimensions of the generatrix "11 maxi" have been selected greater than the dimensions of the generatrix "12 mini", whence results an interpenetration of the domains of manufacturing tolerance by a slight distance which is shown by 22 in Figure 5.

It will be understood that in the case of Figure 5 a clearance exists between the male thread and the female thread at all points, constituting a great majority, at which the effective production of the generatrix 11 is located below the effective production of the generatrix 12.

In practice, by admitting a slight interpenetration of the zones of machining tolerance screwing-up is effected without appreciable binding or with a very much reduced binding which does not thwart the ends sought by the present invention.

By way of example, if the machining tolerances radially are of the order of 1 tenth of a millimetre (distance between "11 mini" and "11 maxi" or between "12 mini" and "12 maxi") the interpenetration of the zones of machining tolerance which corresponds with the distance 22 may be, for example, a few hundredths of a millimetre.

In Figure 6 there is illustrated diagram-

atically the stresses which are exerted when two male members 1 are assembled into a tubular sleeve 2 and an axial tensile force is exerted on the joint assembly, for example, by tension along the male members. Such tension may be produced in practice by hanging the tube in a well.

It will be observed that during tightening of the joint there is exerted in the central portion 3 of the sleeve on the one hand a series of forces $F1$ which are compressive forces and which are located at the internal periphery of the sleeve, and on the other hand a series of forces $F2$ which are tensile forces and which are located at the outside periphery of the sleeve.

It is the equilibrium of these forces which ensures assembly of the joint.

When this joint is subjected progressively to axially tensile forces exerted on the male members it is understood that the forces $F1$ diminish progressively whilst the forces $F2$ increase so as to be able to oppose the longitudinal tensile forces.

In accordance with the invention it is preferable that the forces $F1$ always remain present in order to ensure tightness.

The existence of the forces $F2$ which occur over the whole length of the sleeve and in particular up to the lefthand tip of the latter (as seen in Figure 6), have the effect of producing a slight constriction of the sleeve, that is to say, a reduction in its diameter, which is effected the more easily since a clearance has been produced between the thread on the male member and that on the female member, as described above.

This constriction of the metal has the object of causing to appear at the periphery of the sleeve light compressive forces arranged perpendicular to the axis of the tube.

The deformation which results from this constriction has been represented in broken line in the vicinity of the outside of the sleeve. Of course this deformation has been considerably exaggerated in order to enable better understanding.

It will be observed that at the tips of the sleeve and over a fairly long distance one has a reduction in diameter which is substantially constant as represented by the line 23. On the other hand at the level of the central zone 3 of the sleeve the reduction in diameter represented by the line 24 is of much smaller amount because this portion of the sleeve is much thicker and it is compressed by the pressure against the abutment (forces $F1$) and can consequently effectively resist the constrictive action.

Finally it will be observed that the line 23 joins up with the line 24 by a line 25 having a point of inflection.

It is at the level of this line 25 having a point of inflection that points might possibly

occur at the surface of the sleeve at which a slight tensile stress exists in a direction perpendicular to the axis of the joint.

In order to reduce the possibility of encountering such tensile stresses which are harmful to good resistance to embrittlement by hydrogen it is preferable in accordance with a special embodiment of the invention to provide a clearance between the surfaces 9 and 10 so as to enable good distribution of the stresses between the central zone 3 of the sleeve and the zone which bears the threads. In this way the creation is facilitated of a kind of rounding on the outside of the sleeve due to possible pivoting of the metal about the outside edge of the male member.

It will be observed furthermore that this good distribution of the stresses on the outside of the female member is the more easy to obtain the more the forces $F1$ are reduced. This is the reason why it is preferable to reduce to a minimum the tightening torque.

In Figure 7 a variant is illustrated which enables avoidance to a large degree of the curve 25 having a point of inflection at the outside of the sleeve subjected to longitudinal tension.

With this object, on the outside of the zone 3 of the sleeve a slight throat 26 is produced, which connects progressively with the outside of the sleeve.

Having thus weakened the central portion of the sleeve one counterbalances the deformation which is due to the thickening of this central portion of the sleeve.

Due to that, lines of deformation 23, 24 and 25 can be obtained which are substantially aligned in the case of a longitudinal tension in the tubes which are thus assembled.

In this way one arranges that at no point on the outside of the sleeve is encountered a superconcentration of stress through change of shape, greater than the mean tensile stresses in the thickness considered, which have been controlled by the arrangements in accordance with the invention.

In accordance with a preferred variant upon the invention the sleeve in Figure 1 is produced in such a way that the distance between the two shoulders 4 on the sleeve is equal to at least 2.2 times the thickness of the sleeve 2 between the shoulders 4. In this way a very favourable distribution of the stresses in the sleeve is obtained.

In the case of a joint without a sleeve the female member advantageously has a shoulder 4 which is extended axially along a cylindrical surface of a length at least equal to 1.1 times the total thickness of the female member at the level of the shoulder.

In another variant in any of the constructions described it is possible to improve the distribution of the stresses on the outside

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of the female member by employing a joint tightening torque which is very much reduced and which would be insufficient to ensure of itself alone the tightness of the joint when the latter is subjected to longitudinal tension. In this case for effecting the assembly a polymerizable lubricant is employed, which through hardening ensures adhesion of the joint, avoiding its coming unscrewed in service and reinforcing its tightness. Preferably this lubricant must enable unscrewing of the joint under deterioration of the metal.

Of course the embodiments which have been described above display no restrictive character and they could receive any desirable modifications without thereby departing from the scope of the invention.

WHAT WE CLAIM IS:—

1. A joint for steel tubes, capable of being assembled and dismantled, of the type in which the tightness is obtained by the fact that the tip of a male member comes to abut against a shoulder produced inside a female member, the said shoulder comprising a central zone in the shape of a truncated cone the apex of which points towards the outside of the female member and a peripheral zone having a shape like a truncated cone the taper of which points in the opposite direction, the tip of the male member having a central zone with a shape complementary to that of the central zone of the shoulder on the female member, and a peripheral zone with a shape identical or complementary to the shape of the peripheral zone of the shoulder on the female member, the assembly of the male member and the female member being effected by threads of corresponding shape, produced inside the tip of the female member and on the outside of the male member, the dimensions of the thread on the male member and of the thread on the female member being such that when the joint is tight the largest diameters of the tops and grooves of the male member thread within the range of machining tolerances remain throughout smaller or at most slightly larger than the smallest diameters of the corresponding grooves and tops of the female member thread so as to avoid formation of any substantial radial stress in the threads when the male and female members are coupled together.

2. A joint as claimed in claim 1 in which the threads on the male member and the female member are frustoconical threads.

3. A joint as claimed in claim 1 in which the threads on the male member and the female member are cylindrical threads.

4. A joint as claimed in Claim 3 in which the cylindrical threads end in a portion of frustoconical thread pointing towards the tips of the female member.

5. A joint as claimed in any one of the preceding Claims, in which a slight lateral clearance is produced between the portion of the male member which is located between its tip and the start of its thread, and the corresponding portion of the female member.

6. A joint as claimed in any one of the preceding claims, in which there is effected on the outside of the female member a slight progressive diminution of the diameter at right angles to the thickened portion of the female member which is located beyond the shoulder.

7. A joint as claimed in any one of the preceding claims in which during assembly a polymerizable lubricant is employed, which hardens after assembly.

8. A joint as claimed in any one of the preceding claims, in which the tip of one annular member is formed into a male member and that the tip of another tubular member is formed into a female member.

9. A joint as claimed in any one of Claims 1 to 7 which comprises two tube tips consisting of male members which are connected together by a tubular sleeve consisting of two female members.

10. A joint as claimed in any one of the preceding claims, in which at the tip of the male member the right section of the female member has an area about 10 to 20% larger than that of the male member.

11. A joint as claimed in claim 8, in which the shoulder on the female member is extended axially by a length equal to at least 1.1 times the total thickness of the female member.

12. A joint as claimed in Claim 11, in which the distance between the two shoulders on the sleeve is at least equal to 2.2 times the thickness of the sleeve between the shoulders.

13. A joint as claimed in claim 1 in which, for a tube of about 100 mms diameter the largest possible diameters of the male element are greater by a maximum of about one tenth of a millimetre to the said minimum female diameters, the said difference varying proportionally with the diameter of the tube.

14. A joint as claimed in claim 1 in which, for a tube of about 100 mms diameter the said minimum female diameters are greater at the most by five hundredths of a millimetre than the maximum male dia-

of the female member by employing a joint tightening torque which is very much reduced and which would be insufficient to ensure of itself alone the tightness of the joint when the latter is subjected to longitudinal tension. In this case for effecting the assembly a polymerizable lubricant is employed, which through hardening ensures adhesion of the joint, avoiding its coming unscrewed in service and reinforcing its tightness. Preferably this lubricant must enable unscrewing of the joint under deterioration of the metal.

Of course the embodiments which have been described above display no restrictive character and they could receive any desirable modifications without thereby departing from the scope of the invention.

WHAT WE CLAIM IS:—

1. A joint for steel tubes, capable of being assembled and dismantled, of the type in which the tightness is obtained by the fact that the tip of a male member comes to abut against a shoulder produced inside a female member, the said shoulder comprising a central zone in the shape of a truncated cone the apex of which points towards the outside of the female member and a peripheral zone having a shape like a truncated cone the taper of which points in the opposite direction, the tip of the male member having a central zone with a shape complementary to that of the central zone of the shoulder on the female member, and a peripheral zone with a shape identical or complementary to the shape of the peripheral zone of the shoulder on the female member, the assembly of the male member and the female member being effected by threads of corresponding shape, produced inside the tip of the female member and on the outside of the male member, the dimensions of the thread on the male member and of the thread on the female member being such that when the joint is tight the largest diameters of the tops and grooves of the male member thread within the range of machining tolerances remain throughout smaller or at most slightly larger than the smallest diameters of the corresponding grooves and tops of the female member thread so as to avoid formation of any substantial radial stress in the threads when the male and female members are coupled together.

2. A joint as claimed in claim 1 in which the threads on the male member and the female member are frustoconical threads.

3. A joint as claimed in claim 1 in which the threads on the male member and the female member are cylindrical threads.

4. A joint as claimed in Claim 3 in which the cylindrical threads end in a portion of frustoconical thread pointing towards the tips of the female member.

5. A joint as claimed in any one of the preceding Claims, in which a slight lateral clearance is produced between the portion of the male member which is located between its tip and the start of its thread, and the corresponding portion of the female member.

6. A joint as claimed in any one of the preceding claims, in which there is effected on the outside of the female member a slight progressive diminution of the diameter at right angles to the thickened portion of the female member which is located beyond the shoulder.

7. A joint as claimed in any one of the preceding claims in which during assembly a polymerizable lubricant is employed, which hardens after assembly.

8. A joint as claimed in any one of the preceding claims, in which the tip of one annular member is formed into a male member and that the tip of another tubular member is formed into a female member.

9. A joint as claimed in any one of Claims 1 to 7 which comprises two tube tips consisting of male members which are connected together by a tubular sleeve consisting of two female members.

10. A joint as claimed in any one of the preceding claims, in which at the tip of the male member the right section of the female member has an area about 10 to 20% larger than that of the male member.

11. A joint as claimed in claim 8, in which the shoulder on the female member is extended axially by a length equal to at least 1.1 times the total thickness of the female member.

12. A joint as claimed in Claim 11, in which the distance between the two shoulders on the sleeve is at least equal to 2.2 times the thickness of the sleeve between the shoulders.

13. A joint as claimed in claim 1 in which, for a tube of about 100 mms diameter the largest possible diameters of the male element are greater by a maximum of about one tenth of a millimetre to the said minimum female diameters, the said difference varying proportionally with the diameter of the tube.

14. A joint as claimed in claim 1 in which, for a tube of about 100 mms diameter the said minimum female diameters are greater at the most by five hundredths of a millimetre than the maximum male dia-



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(15)

meters, the said difference varying proportionally with the diameter of the tube.

15. A joint for steel tubes substantially as described herein with reference to and as shown in the accompanying drawings.

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