Abstract:
A high temperature industrial plant metal alloy tube for use in high temperature industrial plant such as a reformer tube having lower creep comprises around the tube one or more layers of reinforcement material for example wire or mesh of a refractory material. A method of producing the tube and plant comprising the tube are also claimed.

Title: IMPROVED TUBES FOR HIGH TEMPERATURE INDUSTRIAL APPLICATION AND METHODS FOR PRODUCING SAME
IMPROVED TUBES FOR HIGH TEMPERATURE INDUSTRIAL APPLICATION
AND METHODS FOR PRODUCING SAME

FIELD

The invention relates generally to a tube construction for high temperature industrial application such as for example in reformer tubes.

BACKGROUND

Pipe work in industrial plant which operates at high temperature and is also subjected to stress will experience a progressive damage mechanism known as creep. For example in vertical runs of pipework or tubes (hereinafter referred to as tube(s)) creep can occur downwardly i.e., in-axis due to gravity. This may occur in plant carrying out direct reduction of iron ore (DRI plant) for example. Creep may also occur across the tube axis where the tubes are subjected to internal pressure as well as high temperature, such as in reformer plant such as in catalytic or steam reforming.

By creep is meant slow migration of material of the tube wall so that after a period of operation of the plant, a tube (or tubes) of, for example, constant wall thickness over its length at the beginning of its life, at the end of its life will have exceeded allowable dimensions or even rupture, thus requiring replacement.

SUMMARY OF THE INVENTION

In a first aspect, the invention broadly comprises a metal alloy tube forming part of or for use in high temperature industrial plant, comprising around the tube a layer of reinforcement material of lower creep at temperatures above about 40% of the absolute melting point of the metal alloy tube.

In one embodiment the reinforcement material comprises a refractory material such as tungsten, molybdenum, niobium, tantalum, columbium, hafnium, boron, or rhenium, or metal oxides such as alumina (Al₂O₃), or carbides such as tungsten carbide (WC) in filamentary form which may, for
example, be in wire form wound around the outside of the metal alloy tube. Alternatively, the reinforcement material may be in mesh or woven form or other sheet form.

Where the reinforcement material comprises a filamentary reinforcement around the tube, the filament(s) may be wound around the tube transverse to the axis of the tube or at an angle to the axis of the tube, particularly where the tube will be subject to internal pressure as well as high temperature, or will be horizontally mounted or mounted at an angle to the horizontal or vertical even in low pressure applications. Alternatively again, the reinforcement may comprise filaments on the outside of the tube which extend along the axis of the tube.

In some embodiments the tube may comprise a second reinforcement layer such as a second wire layer wound around the tube over the first layer and preferably at an angle to the first layer. Where the reinforcement material is in mesh or woven form the tube may comprise a second mesh or woven layer, which may be applied to the tube so that the warp and weft of the second layer extend at an angle to the warp and weft of a first mesh or woven reinforcement layer.

In a second aspect, the invention broadly consists in a method of manufacture of a metal alloy tube for use in high temperature industrial plant, comprising forming the tube with a layer of a reinforcement material around the tube, the reinforcement layer having lower creep at temperatures above about 40% of the absolute melting point of the metal alloy tube.

In one embodiment, the manufacturing method comprises forming a layer of a reinforcement material into a tubular form or pre-forms of various geometry and subsequently centrifugally casting a metal alloy tube within and to the tubular reinforcement material.

In another embodiment the manufacturing method comprises casting or extruding a metal alloy tube and applying a layer of a reinforcement material around the tube. Plasma or thermal spraying of a metal alloy (or various different alloys) around the layer(s) of reinforcement may be applied to further consolidate the reinforcement and to provide additional properties, such as functional graded properties, to the final tube assembly.

By 'high temperature' in this specification is meant typically temperatures above 500°C and typically in the range of 750-1500°C.
By 'refractory material' is meant materials which will retain their strength at temperatures above 1000°F (538°C).

The term "comprising" as used in this specification means "consisting at least in part of". When interpreting each statement in this specification that includes the term "comprising", features other than that or those prefaced by the term may also be present. Related terms such as "comprise" and "comprises" are to be interpreted in the same manner.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described with reference to the drawings and by way of example only, in which:

Figure 1 shows one embodiment of a high temperature industrial plant tube of the invention.

Figure 2 shows another embodiment of a high temperature industrial plant tube.

DETAILED DESCRIPTION OF EMBODIMENTS

Referring to the drawings a metal alloy tube 1 is formed of a corrosion resistant alloy such as for example, an alloy comprising in the range 23-26% by weight chromium, 32-36% by weight nickel, and 0.35-0.4% by weight carbon, and the alloy may also comprise about 1.5% by weight manganese and about 1.5% by weight silicon. The alloy may also optionally comprise other micro-alloying additions. The balance of the alloy comprises iron. In one particular embodiment metal alloy tube 1 is formed of a corrosion resistant alloy comprising approximately 25% chromium, 35% nickel, 0.4% carbon, and 39.6% iron. Typically, the unreinforced metal alloy is suitable for use at temperatures above 500°C and typically at temperatures in the range of 750-1100°C and the tube may be suited for use with internal pressures of 45 bars, for example. The tube may be a reformer tube for a catalytic reformer, for example, which contains a catalyst which is contacted by a process gas stream flowing through the reformer tube.

Around the exterior of the tube over at least a part of the length of the tube is a reinforcement material. In the embodiment of Figure 1 the reinforcement material comprises a first layer 2 of a wire of a refractory metal such as tungsten, molybdenum, niobium, tantalum, or rhenium, or of alumina, which is wound at an angle to the axis of the tube as shown, and a second layer 3 which is wound at an angle to both the tube axis and the first layer, as shown. For example the first
reinforcement layer 2 may be wound at an angle of approximately +55° and the second layer 3 at an angle of approximately -55° to the tube axis. The wire may be of diameter 0.1-5mm for example.

Figure 2 shows a second embodiment in which the first layer 2 of filamentary reinforcement extends in the tube axis and a second layer 3 is wound transverse to the tube axis.

The reinforcement has inherently significantly higher creep resistance than the metal alloy tube, such as 20%, 50%, 100% or higher creep resistance, and possibly 2-3 orders of magnitude higher of creep resistance, at temperatures above about 40% of the absolute melting point of the metal alloy tube. The reinforcement thus assists in inhibiting downward (i.e., longitudinal or axial) creep where the tubes are vertically mounted, and in both of the embodiments described also assists in reducing diametral creep where the tubes are subject to internal pressure during plant operation. The reinforcement thus acts to prolong the effective working life of the tubes and the plant of which the tubes are a part.

In the embodiments shown there are two layers of reinforcement, in wire form. In alternative embodiments the filamentary reinforcement may be in the form of a mesh or otherwise woven refractory or alumina material. Instead of the two layers shown there may be a single layer perhaps where the tube is in use not subject to internal pressure leading to transverse creep, or there may be three or more reinforcement layers.

Tubes of the invention may be used in catalytic reformers in oil refineries, in which the tube may carry a vaporising crude oil and hydrogen mixture at a temperature up to 1000°C and pressure up to 45 bars, or in reformers in hydrogen production, methanol production, ammonia production, or ethylene production for example, or in other industries. Tubes of the invention may be used in steamcatalytic reformers. In such applications the tubes may exhibit increased creep resistance, higher strength, and/or higher resistance to corrosion such as oxidation, at temperatures of use, relative to the equivalent un-reinforced metal alloy tube. Tubes of the invention may also be used in high temperature heat exchangers, for example in hydrogen production in jet engines, or in solar thermal energy production, for example in solar diurnal high temperature collectors.

Reinforced industrial tubes of the invention may be manufactured by centrifugal casting and filament winding. Molten metal alloy may be centrifugally cast to a tube and then placed on a filament winding machine to wind one or more reinforcement layers around the tube.
Alternatively after casting the tube, a mesh of other-sheet reinforcement material may be wound around the tube. Optionally a gas diffusion barrier layer may be applied to the interior of the tube, for example, thermal spraying, or to the exterior before the reinforcement is applied to the tube.

In another form, reinforcement material is first shaped to a tubular form, for example by winding or wrapping about a mandrel, and the reinforcement tube is then placed inside a centrifugal casting mold. A metal alloy tube is then centrifugally cast against the interior of the tube of the reinforcement material. A gas diffusion barrier may then be applied to the interior of the tube.

The tubes may also be manufactured by extrusion and reinforcement winding or wrapping, in which the metal alloy tube is extruded and then placed on for example a filament winding machine where one or more layers of fibrous reinforcement material are wound around the tube. The tubes may also be manufactured by co-extrusion, by passing the reinforcement winding or wrapping through an extrusion die as the metal alloy tube is extruded, so that the reinforcement is encased within the metal material of the tube wall. Optionally after co-extrusion a further layer or layers of reinforcement may be formed around the exterior of the tube. A gas diffusion barrier layer may be applied to the interior or exterior of the tube before or after the reinforcement material.

The filaments layers may be made up of different refractor' materials, so a functionally graded composite may result.

The tubes shown in the drawings have a circular cross section but in other embodiments the tubes may have an oval or multi-segmented cross-sectional shape. While in describing the tubes, vertical mounting applications thereof have been referred to and the tubes are suitable for use in industrial plant in which the tubes extend horizontally or at an angle between the vertical and horizontal.

The reinforcement may be applied over substantially the full length of a tube such as a reformer tube or over a major part of the length of the reformer tube. Alternatively the reinforcement may be applied over a minor part of the length of the tube, at or towards one end for example, and typically an end further along the tube length in the direction of gas flow through the tube in use! The number of layers of the reinforcement may also vary over the length of a tube to provide for optimum performance of the tube under operating temperature and pressure.
Typically for mounting the tube the tube will have flanges or other mechanical mounts at either end thereof.

5 EXPERIMENTAL
The invention is further illustrated by the following description of experimental work.

Example 1
A 1 meter length of 42mm-outside diameter and 6mm wall thickness metal tube made of alloy 800H (comprising approximately 30-35wt%Ni, 19-23wt%Cr and small additions of aluminium and titanium with the remaining balance of iron) was reinforced with commercially available tungsten wire of 0.38mm diameter. First, the tube was turned on a lathe to reduce the outside diameter by 1.5-mm. The reinforcing wires were wound edge-to-edge along a 700-mm section with 4 layers of windings superimposed on each other. The assembly was metal arc sprayed with approximately 1.5 mm thickness of Metallisation Wire 79E (comprising approximately 36wt%Ni, 20wt%Cr, 1%Mn, 2.25%Si with the remaining balance of iron) to provide oxidation protection to the tungsten wire. The final assembly was approximately 43.5 mm diameter.

For comparison, a second 1 meter length of 42mm-outside diameter and 6mm wall thickness metal tube made of alloy 800H was metal arc sprayed with approximately 1.5 mm thickness of Metallisation alloy 79E but did not have tungsten wire reinforcement. This tube will be referred to as the 'Reference Tube'.

The two tube lengths were place in a furnace side-by-side and heated to 1030C, then pressurized to 500 psig with argon. These conditions were calculated to cause failure in the Reference Tube after 1000 hours.

The Reference Tube endured 680 hours before a leak was detected. The tube of the invention endured 2720 hours under the same conditions (tested in parallel) with no leak detected, which is a 4-times improvement over actual performance of the Reference Tube. Subsequent examination revealed nil creep while the Reference Tube showed through-wall creep cracks.

Example 2
A HP alloy tube (comprising approximately 25wt%Cr, 35wt%Ni, 0.4wt%C, 39.6wt%Fe,
1.5wt%Mn and 1.5-wt%Si) with dimensions 1 meter length, 137mm outside diameter and inside diameter of 110mm was reinforced with tungsten wire as in Example 1 with the following differences: the HP alloy tube was cleaned but not reduced in diameter; the tungsten wire was 0.5mm diameter; a final wrap of 0.9 mm alloy 625 (comprising approximately 20-23wt%Cr, 58wt%Ni, 0.1wt%C, 5wt%Fe, 3.15-4.15wt%Co and Ta) was wound.

Test conditions were 750 psig and a temperature of 1020°C, which was calculated to cause rupture in an ordinary (unreinforced) tube made of the same tube material in 491 hours. The tube of the invention endured 1600 hours without failure and had not failed after 1600 hours, which is a 3.3-times improvement over calculated performance of an ordinary (unreinforced) tube of the same tube material.

The foregoing description of the invention includes preferred forms thereof. Modifications may be made thereto without departing from the scope of the invention as defined in the accompanying claims.
CLAIMS:

1. A metal alloy tube forming part of or for use in a high temperature industrial plant, comprising around the tube (externally, internally, and/or within the tube wall) at least a first layer of reinforcement material of lower creep at temperatures above about 40% of the absolute melting point of the metal alloy tube.

2. A metal alloy tube according to claim 1 comprising a second layer of a reinforcement material around the tube over said first layer of reinforcement material.

3. A metal alloy tube according to either claim 1 or claim 2 wherein the first layer of the reinforcement material and the second layer of the reinforcement material (if present) has/have at least 20% higher creep resistance than the metal alloy tube.

4. A metal alloy tube according to either claim 1 or claim 2 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both has/have at least 50% higher creep resistance than the metal alloy tube.

5. A metal alloy tube according to either claim 1 or claim 2 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both has/have at least 100% higher creep resistance than the metal alloy tube.

6. A metal alloy tube according to any one of claims 1 to 5 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both is/are in a filamentary form.

7. A metal alloy tube according to claim 5 wherein the Erst layer of the reinforcement material or the second layer of the reinforcement material (if present) or both is/are in wire form wound around the outside of the metal alloy tube.

8. A metal alloy tube according to claim 6 wherein the Erst layer of the reinforcement material or the second layer of the reinforcement material (if present) or both is/are in mesh or woven form or other filamentary sheet form around the outside of the metal alloy tube.
9. A metal alloy tube according to any one of claims 6 to 8 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both comprise(s) filament(s) around the tube transverse to the axis of the tube.

10. A metal alloy tube according to any one of claims 6 to 8 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both comprise(s) filament(s) around the tube at an angle to the axis of the tube.

11. A metal alloy tube according to any one of claims 6 to 8 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both comprise(s) filament(s) which extend along the axis of the tube.

12. A metal alloy tube according to claim 10 wherein the second reinforcement layer comprises which extend around the tube over the first reinforcement layer at an angle to filament(s) of the first reinforcement layer.

13. A metal alloy tube according to any one of claims 1 to 12 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both comprise(s) tungsten, molybdenum, niobium, tantalum, columbium, hafnium, boron, or rhenium, or a metal oxide or carbide.

14. A metal alloy tube according to any one of claim 13 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both comprise(s) alumina or tungsten carbide.

15. A metal alloy tube according to any one of claims 1 to 14 wherein the absolute melting point of the metal alloy tube is in the range about 750°C to about 1500°C.

16. A metal alloy tube according to any one of claims 1 to 15 forming part of a high temperature industrial plant.

17. A metal alloy tube according to any one of claims 16 to 18 and wherein the tube extends vertically.
18. A metal alloy tube according to any one of claims 16 to 18 and wherein the tube extends horizontally or mounted at an angle to the horizontal or vertical.

19. A method of manufacture of a metal alloy tube for use in high temperature industrial plant, comprising forming the tube with a layer of a reinforcement material around the tube (externally, internally, and/ or within the tube wall), the reinforcement layer having lower creep at temperatures above about 40% of the absolute melting point of the metal alloy tube.

20. A method according to claim 19 which comprises forming a layer of the reinforcement material into a tubular form and subsequently centrifugally casting a metal alloy tube within and to the tubular reinforcement material.

21. A method according to claim 19 which comprises casting or extruding a metal alloy tube and applying a layer of the reinforcement material around the tube.

22. A method according to claim 19 which comprises co-extruding the reinforcement material with the metal alloy tube.

23. A method according to any one of claims 19 to 22 comprising forming a second layer of reinforcement material around the tube over the first layer of reinforcement material.

24. A method of manufacture of a metal alloy tube according to any one of claims 19 to 23 which comprises applying metal alloy over the first layer of reinforcement material or the second layer of reinforcement material (if present).

25. A method according to any one of claims 19 to 24 wherein the first layer of the reinforcement material and the second layer of the reinforcement material (if present) has/have at least 20% higher creep resistance than the metal alloy tube.

26. A method according to any one of claims 19 to 24 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both has/have at least 50% higher creep resistance than the metal alloy tube.
27. A method according to any one of claims 19 to 24 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both has/have at least 1000% higher creep resistance than the metal alloy tube.

28. A method according to any one of claims 19 to 27 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both is/are in a filamentary form.

29. A method according to any one of claims 19 to 27 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both is/are in wire form wound around the outside of the metal alloy tube.

30. A method according to any one of claims 19 to 27 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both is/are in mesh or woven form or other filamentary sheet form around the outside of the metal alloy tube.

31. A method according to any one of claims 19 to 30 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both comprise(s) filament(s) around the tube transverse to the axis of the tube.

32. A method according to any one of claims 19 to 30 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both comprise(s) filament(s) around the tube at an angle to the axis of the tube.

33. A method according to any one of claims 19 to 30 wherein the first layer of the reinforcement material or the second layer of the reinforcement material (if present) or both comprise(s) filament(s) which extend along the axis of the tube.

34. A method according to claim 33 wherein the second reinforcement layer comprises which extend around the tube over the first reinforcement layer at an angle to filaments of the first reinforcement layer.

35. A method according to any one of claims 19 to 34 wherein the reinforcement material comprises tungsten, molybdenum, niobium, tantalum, columbium, hafnium, boron, or rhenium, or a metal oxide or carbide.
36. A method according to any one of claim 35 wherein the reinforcement material comprises alumina of tungsten carbide.

37. A method according to any one of claims 23 to 36 wherein the absolute melting point of the metal alloy tube is in the range 750-1500°C.

38. An industrial plant comprising as part thereof one or more metal alloy tubes according to any one of claims 1 to 18 or produced by the method of any one of claims 19 to 37.

39. An industrial plant according to claim 38 which is a reformer plant.

40. An industrial plant according to claim 39 which is a catalytic reformer plant.

41. An industrial plant according to claim 40 wherein the catalytic reformer plant comprises part of an oil refinery, or a reformer plant for hydrogen, methanol, ammonia, or ethylene production.

42. An industrial plant according to claim 39 which is a steam reformer plant.

43. An industrial plant according to claim 38 which is arranged to carry out direct reduction of iron ore.

44. A high temperature heat exchanger comprising as part thereof one or more metal alloy tubes according to any one of claims 1 to 18 or produced by the method of any one of claims 19 to 37.

45. A high temperature industrial plant tube formed of a metal alloy having an absolute melting point in the range 750 to 1500°C and comprising around the tube as a filamentary reinforcement a refractory material having at least higher creep resistance at the melting point of the metal alloy tube.

46. A high temperature industrial plant-tube according to claim 45 wherein the reinforcement material comprises wire wound around the tube.
47. A high temperature industrial plant tube according to claim 45 wherein the reinforcement material comprises is in mesh or woven form or other filamentary sheet form around the tube.

48. A metal alloy tube according to any one of claims 45 to 47 wherein the reinforcement material comprises tungsten, molybdenum, niobium, tantalum, columbium, hafnium, boron, or rhenium, or a metal oxide or carbide.

49. A metal alloy tube according to any one of claims 45 to 47 wherein the reinforcement material comprises alumina or tungsten carbide.
FIGURE 1

FIGURE 2
SUBSTITUTE SHEET (RULE 26)
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.
F16L 9/04 (2006.01)  F16L 9/14 (2006.01)  F16L 11/10 (2006.01)

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)

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 practicable, search terms used)

WPI & EPODOC: IPC/ECLA Marks: F16L9 & F16L11; keywords: filament, thread, wire, fiber, fibre, mesh, woven, weave, wrap, wind, wound, heat, proof, melt, temperature, creep, deform, stress, strain, fatigue, distortion, metal, alloy, steel, ferrous, iron, pipe, tube, hose, layer, laminate, lining, reinforce, molybdenum, tungsten, niobium, tantalum, columbium, hafnium, rhenium, carbide, oxide, transverse, longitude and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>Patent Abstracts of Japan, JP 07-233886 A (KUBOTA CORP) 5 September 1995 Para. 0001, 0004, 0006-0007, Fig. 1 and 2.2; machine translation from Internet &lt;URL: <a href="http://www4.ipdl.inp.go.jp/Tokujitu/PAJ_detail1.ipdl%3E">http://www4.ipdl.inp.go.jp/Tokujitu/PAJ_detail1.ipdl&gt;</a></td>
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[X] Further documents are listed in the continuation of Box C  [X] See patent family annex

* Special categories of cited documents
'AA' document defining the general state of the art which is not considered to be of particular relevance
'EA' earlier application or patent but published on or after the international filing date
'LA' document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
'OA' document referring to an oral disclosure, use, exhibition or other means
'PA' document published prior to the international filing date but later than the priority date claimed

Date of the actual completion of the international search 27 July 2010

Date of mailing of the international search report 12 August 2010

Name and mailing address of the ISA/AV

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INTERNATIONAL SEARCH REPORT

International application No
PCT/NZ20 10/00003 8

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 3-5, 25-27
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
   The claims do not meet the requirements of Article 6 of the PCT because they are not fully supported by the description. The scope of the claims is broader than is justified; it is considered that it is not reasonable to predict all variants covered by the claims, that is, a sound prediction cannot be made in respect of the entire scope of the claims. These claims are not limited by the use of the term 'creep' as it is a parameter dependent on the properties of the 'reinforcement material' and the reinforcement material is unknown.

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims, it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.
This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.