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(54) Title: IMPROVEMENTS IN AND RELATING TO COUPLERS

(57) Abstract: According to the present invention there are provided couplers. In a preferred embodiment a coupler (100) comprises a polymeric material and is adapted for use with structural tubes. Also provided are structures and methods of erecting structures.

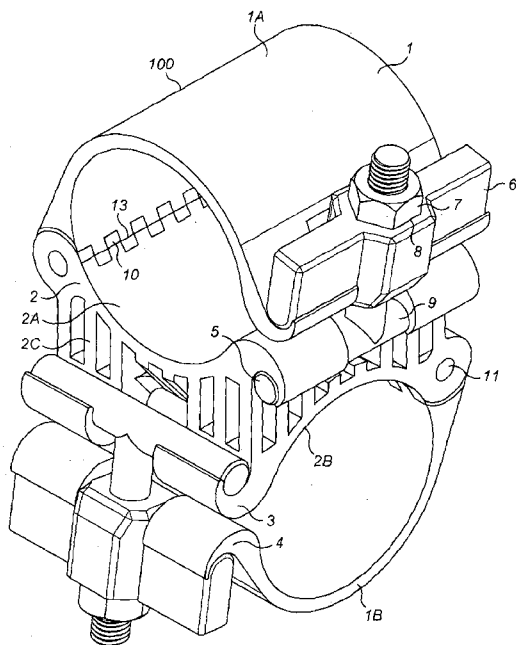


FIG. 11

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## IMPROVEMENTS IN AND RELATING TO COUPLERS

### FIELD OF INVENTION

- 5 The present invention relates to couplers, particularly but not exclusively to scaffold couplers, and to structures comprising couplers.

### BACKGROUND TO THE INVENTION

- 10 Detachable couplers are known for a number of applications. One known application of structural couplers is as couplers of scaffold tubes. Couplers used in for example tube and fit scaffold are extensively employed for the construction and repair of buildings and other infrastructure. Current tube and fit scaffolds use metallic couplers. However, the use of metallic scaffold couplers presents problems. As a result of their high density they are heavy to  
15 transport and awkward to handle during erection and dismantling. Their high thermal capacity means that they can be very uncomfortable to handle when operating in environments of extreme heat or cold. As a result of their sensitivity to atmospheric corrosion they require regular and expensive maintenance. Furthermore, in some chemically hostile environments, such as marine locations, they suffer high rates of corrosion rendering them unfit for purpose,  
20 sometimes after quite short periods of service. Operators attempting to remove badly corroded couplers are exposed to considerable health and safety hazards.

Accordingly, the present invention aims to address at least one disadvantage associated with the prior art whether discussed herein or otherwise.

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### SUMMARY OF INVENTION

According to a first aspect of the present invention there is provided a coupler wherein the coupler comprises a polymeric material.

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Suitably, there is provided a coupler wherein the coupler comprises a polymeric resin.

Suitably, the coupler is adapted for use with structural tubes. Suitably, the coupler is adapted for use with scaffold tubes. Suitably, the coupler is adapted to couple structural tubes.

- 35 Suitably, the coupler is adapted to couple scaffold tubes. Suitably, the coupler is adapted to couple two structural tubes to one another. Suitably, the coupler is adapted to couple two scaffold tubes to one another. Suitably, the coupler comprises a scaffold coupler.

Suitably, there is provided a coupler wherein the coupler comprises a polymeric resin and wherein the coupler is adapted to couple scaffold tubes.

5 Suitably, the coupler comprises a structural coupler. Suitably, the coupler comprises a detachable coupler. Suitably, the coupler comprises a detachable structural coupler. Suitably, the coupler is adapted such that it can be releasably coupled to a tube.

10 Suitably, the coupler comprises first coupling means for connecting to a first tube. Suitably, the coupler comprises second coupling means for connecting to a second tube, Suitably, the coupler comprises first coupling means for connecting to a first tube and second coupling means for connecting to a second tube, Suitably, the coupler comprises first coupling means for connecting to a first structural tube, for example a scaffold tube, and second coupling means for connecting to a second structural tube, for example a scaffold tube.

15 Suitably, the first coupling means is adapted to be releasably coupled to a tube in use. Suitably, the first coupling means is adapted to be detachably coupled to a tube in use. Suitably, the first coupling means is adapted such that, in use, a user can selectively couple or decouple it from a tube.

20 Suitably, the second coupling means is adapted to be releasably coupled to a tube in use. Suitably, the second coupling means is adapted to be detachably coupled to a tube in use. Suitably, the second coupling means is adapted such that, in use, a user can selectively couple or decouple it from a tube.

25 Suitably, the coupler comprises a coupler body. Suitably, the coupler comprises first and second coupling means which are connected by a coupler body. The coupler body may form part of said first and/or second coupling means.

30 Suitably, the coupler comprises an attachment strap. The coupler may comprises a first attachment strap. The coupler may comprise a second attachment strap.

Suitably, the first coupling means comprises a first attachment strap. Said first attachment strap may be adapted to cooperate with a coupler body to encircle a first tube in use. Suitably, the second coupling means comprises a second attachment strap. Said second attachment strap may be adapted to cooperate with a coupler body to encircle a second tube in use.

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The coupler may comprise an attachment strap which is integrally formed with a coupler body, for example the coupler may comprise a first and/or second attachment strap which are integrally formed with a coupler body, for example both first and second straps may be

integrally formed with the body. Alternatively, the coupler may comprise an attachment strap which is formed separately from a coupler body and connected thereto, for example by a pin.

5 Suitably, the coupler is adapted such that it can be clamped onto tubes in use. Suitably, the coupler is adapted such that tension can be applied to an attachment strap to hold it in place relative to a tube. Suitably, the coupler is adapted such that tension can be applied to first and second attachment straps to hold it in place relative to first and second tubes.

10 Suitably, the coupler comprises tensioning means. Suitably, the coupler comprises a tensioning component. Suitably, said tensioning component is adapted to apply tension to an attachment strap in use.

15 Suitably, in use, the first coupling means may be coupled to a tube such that the tube is held in substantially fixed position relative thereto. Suitably, in use, the second coupling means may be coupled to a tube such that the tube is held in substantially fixed position relative thereto.

20 Suitably, the coupler is adapted such that in use it can couple to two tubes to hold said tubes in substantially fixed position relative to one another. The coupler may be adapted to hold two tubes such that, in use, the tubes are coupled at a predetermined fixed angle relative to one another. Alternatively, the coupler may be adapted to allow a user to adjust the angle at which two tubes are coupled relative to one another in use.

25 Suitably, the coupler comprises a polymeric resin and reinforcing fibres. Suitably, the coupler comprises a polymeric resin comprising reinforcing fibres. Suitably, the coupler comprises reinforcing fibres orientated randomly within the polymeric resin. The coupler may comprise a polymeric resin which is substantially free of reinforcing fibres. The coupler may comprise a polymeric resin which does not comprise reinforcing fibres.

30 Suitably, the coupler comprises a coupler body which comprises polymeric resin and which may comprise reinforcing fibres. The coupler body may consist of polymeric resin or of polymeric resin and reinforcing fibres. Suitably, the coupler comprises a first attachment strap which comprises polymeric resin and which may comprise reinforcing fibres. The first attachment strap may consist of polymeric resin or of polymeric resin and reinforcing fibres. Suitably, the coupler comprises a second attachment strap which comprises polymeric resin and which may comprise reinforcing fibres. The second attachment strap may consist of  
35 polymeric resin or of polymeric resin and reinforcing fibres.

Suitably, there is provided a detachable structural coupler comprised of a polymeric resin that may or may not be strengthened with reinforcing fibres.

Suitably, there is provided a polymeric detachable structural coupler comprised of a polymeric based resin material with reinforcing fibres randomly orientated to provide sufficient strength in each of its component parts.

5

Suitably, there is provided a coupler wherein the attachment straps are comprised of a polymeric based resin material with reinforcing fibres randomly orientated to provide it with sufficient strength.

10 Suitably, there is provided a coupler with a coupler body comprised of a polymeric based resin material with reinforcing fibres randomly orientated to provide it with sufficient strength.

Suitably, there is provided a coupler wherein the attachment straps are integrally formed with the coupler body or are attached through a pin connection to the coupler body. The attachment  
15 strap and the coupler body may be comprised of a polymeric based resin material with reinforcing fibres randomly orientated to provide it with sufficient strength.

Suitably, there is provided a coupler wherein the attachment straps are integrally formed with the coupler body.

20

Suitably, there is provided a coupler wherein the attachment straps are attached through a pin connection to the coupler body.

Suitably, the coupler comprises an attachment strap comprising a strap hinge shear plate.  
25 Suitably, said plate is provided at one end of the strap. Suitably, said plate is integrally formed. Suitably, the coupler comprises first and second attachment straps each having such plates.

Suitably, the coupler comprises a coupler body comprising a hinge shear plate. Suitably, said  
30 plate is integrally formed. Suitably, the coupler body comprises two hinge shear plates. Suitably, the coupler body comprises hinge shear plates and the coupler comprises attachment straps also having hinge shear plates and which are connected to the body by hinge pins or hinge rods.

35 Suitably, the coupler comprises an attachment strap comprising a strap bearing seat. Suitably, said seat is integrally formed. Suitably, said seat is provided at one end of the strap. Suitably, said strap bearing seat is adapted such that, in use, a mechanical tensioning component can apply a tension force to the strap.

Suitably, the coupler comprises a strap bearing seat adapted to cup part of a tensioning component. Suitably, the bearing seat comprises an arcuate surface. Suitably, the bearing seat comprises a concave surface. Suitably, the bearing seat is adapted to abut a convex surface of a tensioning component.

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Suitably, the coupler comprises a coupler body comprising a bearing seat. Suitably, said seat is integrally formed. Suitably, the coupler body comprises two bearing seats. Suitably, said bearing seat is adapted such that, in use, a mechanical tensioning component can apply a tension force to the body. Suitably, the coupler body comprises bearing seats and the coupler  
10 comprises attachment straps also having bearing seats and the coupler is adapted such that, in use, a tensioning component can engage a bearing seat of a strap and of the body and apply a force thereto to tension the strap around a tube.

Suitably, the coupler comprises a coupler body having a bearing seat adapted to cup part of a  
15 tensioning component. Suitably, the bearing seat comprises an arcuate surface. Suitably, the bearing seat comprises a concave surface. Suitably, the bearing seat is adapted to abut a convex surface of a tensioning component.

Suitably, there is provided a coupler wherein the attachment straps are at one end provided  
20 with integral strap hinge shear plates suitably comprised of a polymeric based material with reinforcing fibres randomly orientated to provide sufficient strength.

Suitably, there is provided a coupler wherein the attachments straps are provided at the other  
end with integrally cast strap bearing seats suitably comprised of a polymeric based material  
25 with reinforcing fibres randomly orientated to provide sufficient strength, and within which the mechanical tensioning component can apply a tension force to the contiguous attachment straps.

Suitably, there is provided a coupler wherein the coupler body is attached through pin  
30 connections to the attachment straps suitably comprised of a polymeric based resin material with reinforcing fibres randomly orientated to provide it with sufficient strength.

Suitably, there is provided a coupler wherein the coupler body is provided with hinge shear  
plates suitably comprised of a polymeric based material with reinforcing fibres randomly  
35 orientated to provide sufficient strength.

Suitably, there is provided a coupler wherein the coupler body hinge shear plates provide force transfer through a hinge rod comprised of a high strength material.

Suitably, there is provided a coupler wherein the coupler body is connected to the attachment straps with a hinge rod comprised of high strength stainless steel.

5 Suitably, there is provided a coupler wherein the coupler body has integral bearing seats, suitably comprised of a polymeric based material with reinforcing fibres randomly orientated to provide sufficient strength, within which the mechanical tensioning component is attached.

10 Suitably, there is provided a coupler wherein the coupler body bearing seats, allow the tension force from the mechanical tensioning component to be transferred into coupler body.

Suitably, the coupler comprises surfaces adapted to conform to the outer face of tubes. Suitably, the coupler comprises a first coupling means adapted to conform to the outer face of a first tube. The first coupling means may comprise an arcuate face for engaging a tube in use. Suitably, the coupler comprises a second coupling means adapted to conform to the  
15 outer face of a first tube. The second coupling means may comprise an arcuate face for engaging a tube in use.

Suitably the coupler body comprises an arcuate face for engaging a first tube and an arcuate face for engaging a second tube. Suitably, said arcuate faces are connected by a ribbed  
20 section of the body. Said arcuate faces may be in fixed relationship to one another. The faces may for example be arranged such that tubes engaging said faces extend at 90 degrees relative to one another. Alternatively, the body may comprise a hinge part to allow the position of said arcuate faces relative to one another to be adjusted. The connector may thus be such that the angle at which tubes engaged by the faces extend relative to one another may be  
25 adjusted.

The coupler body may comprise a region connecting first and second coupling means and which region comprises one or more cavities. The body may for example comprise ribs connecting first and second coupling parts of the body to one another.

30 The body may comprise ribs formed in a cruciform pattern. The body may comprise ribs formed in a chequered pattern.

Suitably, there is provided a coupler wherein the coupler body contains two circular cylindrical  
35 shell bearing surfaces, suitably comprised of a polymeric based material with reinforcing fibres randomly orientated to provide sufficient strength, placed at right angles to each other.

Suitably, there is provided a coupler wherein the coupler body comprises two circular cylindrical shell bearing surfaces and said two circular cylindrical shell bearing surfaces may allow uniform pressures to be transferred in the tubes to which the coupler is connected.

- 5 Suitably, there is provided a coupler wherein the coupler body comprises two circular cylindrical shell tube bearing surfaces which are integrally connected together, so that the tube axes are at fixed at  $90^{\circ}$ , by means of an arrangement of ribs, suitably comprised of a polymeric based material with reinforcing fibres randomly orientated to provide sufficient strength.
- 10 Suitably, there is provided a coupler having two circular cylindrical shell tube bearing surfaces on each half of the coupler body which are connected through a rotational hinge allowing the axes of the tubes to be orientated at any angle.

- Suitably, there is provided a coupler having a mechanical tensioning component which can be tightened to transfer force into an integrally cast strap bearing seat of an attachment strap and an integrally cast coupler body bearing seat.
- 15

- Suitably, the coupler comprises a tensioning component comprising a clamping component adapted to draw an end of an attachment strap towards part of the coupler body. Suitably, a tensioning component comprises a bolt, a bearing/distribution part and a nut. Suitably the bearing/distribution part comprises a bearing shoulder and a distribution arm. Suitably, the coupler comprises two tensioning components. Suitably, the coupler has a tensioning component adapted to tension each of the attachment straps around a tube.
- 20

- 25 Suitably, a tensioning component comprises a bolt. Suitably, a tensioning component comprises a nut. Suitably a tensioning component comprises a nut and bolt. Suitably, a tensioning component comprises a T-bolt. Suitably, a T-bolt comprises a bearing shoulder. Suitably, a T bolt comprises a distribution arm.

- 30 Suitably, the coupler comprises a bearing/distribution part adapted to interpose a nut and a bearing seat of a strap in use. Suitably, the bearing/distribution part is adapted to abut a bearing seat of a strap in use. Suitably, the bearing/distribution part has a contact area with the strap which is significantly greater than the surface area of a face of the nut, for example at least 1.5 times greater, for example 2 times greater or more. Suitably, the bearing/distribution part has a rounded face adapted to contact the bearing seat of a strap in use. Suitably said face is arcuate. Suitably, said face is convex.
- 35

Suitably, the mechanical tensioning component is comprised of a T bolt with a tightening nut that bears upon a bearing shoulder that distributes the load evenly through a distribution arm/beam onto the strap bearing seat.

5 Suitably, the T bolt and tightening nut are constructed from high strength material.

Suitably, the T bolt and nut are constructed from high tensile strength stainless steel.

Suitably the bearing shoulder and distribution beam are comprised of a high strength material.

10

The bearing shoulder and distribution beam may be comprised of polymeric material. Suitably, said polymeric material is similar to that of the coupler body, attachment strap, and seats for the mechanical tensioner. The bearing shoulder and/or distribution beam may be comprised of polymeric material that is substantially the same as that of the coupler body and/or attachment straps.

15

The bearing shoulder and distribution arm/beam may be comprised of a high strength stainless steel.

20 Suitably, the coupler body bearing seats are arranged to cup around the T bolt cross arms. Suitably, the attachment strap bearing seats are adapted to cup around the bearing shoulder.

Suitably, the coupler body bearing seats holding the T bolt cross arms of the mechanical tensioner component are provided with the appropriate balance between strength and flexibility that allow the cross arms to be popped into place with a force low enough for manual insertion but high enough to prevent the T bolt from falling out when not in use.

25

Suitably, an attachment strap is hinged to the coupler body. Suitably each attachment strap is hinged to the coupler body. Suitably, the hinge parts of the body comprise fins and the hinge parts of the attachment straps comprise fins which intermesh with the fins of the body. Suitably, said fins comprise an aperture through which a hinge pin locates. Suitably, the hinge parts of the body comprise shear plates and the hinge parts of the attachment straps comprise shear plates which intermesh with the shear plates of the body. Suitably, said shear plates comprise an aperture through which a hinge pin locates.

30

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Suitably, the coupler is a scaffold coupler.

Suitably, attachment straps have a wall thickness T of between 1 and 5mm, suitably between 2 and 4mm, for example 3mm.

Suitably, the attachment straps are arcuate. The attachment straps suitably have the form of a part circle. Suitably, circular attachment straps allow the development of sufficient bearing pressure on the outer surface of a circular tube having an outer diameter D of between 35 and 105mm, suitably between 45 and 75mm, for example 48.3mm.

Suitably, the attachment straps have a wall width W of between 20 and 70mm, suitably between 40 and 60mm, for example 54.3mm.

Suitably, the coupler comprises one or more polymers. Suitably, the coupler comprises a polymer resin. Suitably, the coupler comprises a polymeric matrix. Suitably, the coupler comprises one or more polymers reinforced with fibres. Suitably, the coupler comprises one or more polymers binding fibres together. Suitably, the coupler comprises a polymer matrix binding fibres together. Suitably, the coupler comprises a polymeric matrix binding fibres together. Suitably, the coupler comprises a fibre reinforced polymer in which the polymer forms a matrix binding fibres together.

Suitably, the coupler comprises thermoplastic polyester polymer. Suitably, the coupler comprises thermoplastic polyester resin. Suitably, the coupler comprises thermoplastic polyamide polymer. Suitably, the coupler comprises thermoplastic polyamide resin. Suitably, the coupler comprises thermoplastic vinylester polymer. Suitably, the coupler comprises thermoplastic vinylester resin. Suitably, the coupler comprises thermoplastic polyurethane polymer. Suitably, the coupler comprises thermoplastic polyurethane resin.

Suitably, the coupler comprises thermoplastic polyvinylchloride (PVC) polymer. Suitably, the detachable structural coupler comprises thermoplastic polyvinylchloride (PVC) resin. Suitably, the coupler comprises thermoplastic polyamide (PA) polymer. Suitably, the coupler comprises thermoplastic polyamide (PA) resin. Suitably, the coupler comprises thermoplastic polyimide (PI) polymer. Suitably, the coupler comprises thermoplastic polyimide (PI) resin. Suitably, the coupler comprises thermoplastic polyamide-imide (PAI) polymer. Suitably, the coupler comprises thermoplastic polyamide-imide (PAI) resin. Suitably, the coupler comprises thermoplastic polyethylene terephthalate (PET) polymer. Suitably, the coupler comprises thermoplastic polyethylene terephthalate (PET) resin. Suitably, the coupler comprises thermoplastic polyphenylene (SRP) polymer. Suitably, the coupler comprises thermoplastic polyphenylene (SRP) resin. Suitably, the coupler comprises thermoplastic polyarylether ketone (PEAK) polymer. Suitably, the coupler comprises thermoplastic polyarylether ketone (PEAK) resin.

Suitably, the coupler has reinforcing fibres comprising one or more of: glass fibres, aramid fibres, boron fibres, natural fibres, carbon fibres. For example the fibres may comprise e-glass or s-glass fibres.

- 5 Suitably, the coupler comprises a single polymeric matrix bonding all the fibres. The coupler may comprise a single polymer bonding all the fibres.

10 Suitably, the coupler comprises between 0 and 50% fibre by volume. Suitably, the coupler comprises between 20 and 40% fibre by volume. For example, the coupler may comprise 30% by volume of fibre.

15 Suitably, the coupler comprises between 0 and 70% fibre by volume. Suitably, the coupler comprises between 20 and 60% fibre by volume. For example, the coupler may comprise 50% by volume of fibre.

Suitably, the coupler comprises a single material that is homogeneous and at a macroscopic level isotropic. Suitably, all components of the detachable structural coupler are made from the same material.

20 Suitably, the coupler comprises a heat stabilised, flame retardant, self-extinguishing engineering thermoplastic reinforced with glass-fibre. Suitably, the coupler comprises a thermoplastic based on a semi-crystalline Polyamide-66-Polyamide-6-alloy. Suitably, the coupler comprises a thermoplastic free of halogens and/or red phosphorous. The coupler may comprise Grilon TSG-30/4 V0 (TM) available from EMS-GRIVORY (TM).

25 Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises a heat stabilised, flame retardant, self-extinguishing engineering thermoplastic reinforced with glass-fibre. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises a thermoplastic based on a semi-crystalline Polyamide-66-Polyamide-6-alloy.

30 Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises a thermoplastic free of halogens and/or red phosphorous. One or more of, suitably each of, the coupler body and attachment straps may comprise Grilon TSG-30/4 V0 (TM) available from EMS-GRIVORY (TM).

35 Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises one or more polymers. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises a polymer resin. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises a polymeric matrix. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises one or more polymers

reinforced with fibres. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises one or more polymers binding fibres together. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises a polymer matrix binding fibres together. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises a polymeric matrix binding fibres together. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises a fibre reinforced polymer in which the polymer forms a matrix binding fibres together.

Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises thermoplastic polyester polymer. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises thermoplastic polyester resin. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises thermoplastic polyamide polymer. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises thermoplastic polyamide resin. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises thermoplastic vinylester polymer. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises thermoplastic vinylester resin. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises thermoplastic polyurethane polymer. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises thermoplastic polyurethane resin.

Suitably, one or more of, suitably each of, the coupler body and attachment straps has reinforcing fibres comprising one or more of: glass fibres, aramid fibres, boron fibres, natural fibres, carbon fibres. For example the fibres may comprise e-glass or s-glass fibres.

Suitably, the one or more of, suitably each of, the coupler body and attachment straps comprises a single polymeric matrix bonding all the fibres. One or more of, suitably each of, the coupler body and attachment straps may comprise a single polymer bonding all the fibres.

Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises between 0 and 50% fibre by volume. Suitably, one or more of, suitably each of, the coupler body and attachment straps comprises between 20 and 40% fibre by volume. For example, one or more of, suitably each of, the coupler body and attachment straps may comprise 30% by volume of fibre.

Suitably, the coupler can be manufactured using an injection moulding process. Suitably, an injection moulding manufacturing process can be used for the production of the components of the detachable structural coupler.

The coupler may comprise a detachable advanced composite structural coupler. The coupler may comprise a fibre reinforced thermoplastic polymeric (frp) advanced composite detachable structural coupler.

- 5 Suitably, the coupler is resistant to chemical corrosion. Suitably, the coupler has low electrical conductivity. Suitably, the coupler has low thermal conductivity.

10 Suitably, the coupler is adapted to be compatible in a scaffold system comprising metallic tubes. The coupler may have a tube bearing seat equivalent to that of metallic scaffold couplers.

15 Suitably, the coupler is adapted to be compatible in a scaffold system comprising composite tubes. The coupler may have a tube bearing seat equivalent to that of a composite scaffold tube. For example, the coupler may be particularly suited to scaffold systems comprising stoob® composite tubes. The coupler may have a contact diameter equivalent to that of a stoob® composite scaffold tube.

20 The coupler may be lighter than a metallic detachable structural coupler. For example the coupler may be about one fifth the weight of a known steel detachable structural coupler.

The detachable coupler may be resistant to even quite hostile working environments which may allow its safe use to be extended to periods measured in decades rather than years.

25 The coupler may be suitable for use in a tube and fit scaffold system. The coupler may be suitable for use in a modular scaffold system.

The coupler is suitably adapted to be compatible with the requirements of structural tubes, of the type used in for example, the scaffold industry.

30 The coupler may have a strap diameter adapted to suit its use. The coupler may for example have a strap diameter that is compatible with more conventional steel and aluminium scaffold tubes.

35 The coupler may be such that it can be used interchangeably with composite tubes stoob® or more conventional steel and aluminium scaffold tubes.

The coupler may be resistant to the corrosive effects of air and water. The coupler may consequently be likely to require much less frequent replacement than conventional metallic scaffold detachable structural coupler.

The coupler may be resistant to the effects of chemical and biological attack. The detachable advanced composite structural coupler may consequently be attractive for use in corrosive marine and industrial environments.

5

The coupler may be an insulator to electricity and may reduce the risk of accidental electrocution for all those working with and on for example the scaffold structure. The coupler may be an insulator to electricity preventing electric current from being transmitted from one tube to another. Consequently the risk of accidental electrocution even on metal scaffold structures may be greatly reduced.

10

The coupler may have low specific heat capacity and may consequently be comfortable to handle in extremes of hot and cold weather.

15

The coupler may have a low modulus of elasticity. This may mean that when such detachable structural coupler impact each other they emit lower frequency sound than a metallic detachable structural coupler meaning that handling during erection and demolition may be less noisy and environmentally intrusive than for a metallic detachable structural coupler.

20

The coupler may be constructed from high strength and stiffness fibres integrally embedded in a thermoplastic polymeric resin.

The coupler may be adapted to be used compatibly with more conventional metallic scaffold couplers and ancillary jointing equipment.

25

The coupler may be adapted to form part of a modular scaffold system.

The coupler may comprise a connection block which may connect first and second coupling means of the coupler to one another. The coupler may comprise a connection part which forms part of one or both of first and second coupling means of the coupler.

30

The coupler may be provided with variously coloured pigments. The coupler may have colours chosen to suite a particular client. The coupler may be coloured to represent a particular form of use.

35

The coupler may be translucent. The coupler may be semi translucent. The detachable advanced composite structural coupler may be adapted such that a light source can be located within and transmit light to the exterior of the detachable advanced composite structural coupler.

The detachable advanced composite structural coupler may comprise a light source. The detachable advanced composite structural coupler may comprise a light source located within the cavity defined by the connection block.

5

The detachable advanced composite structural coupler may comprise a power source. The detachable advanced composite structural coupler may comprise a photo electric cell. The detachable advanced composite structural coupler may comprise one or more photo electric cells embedded within the body of the detachable advanced composite structural coupler.

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The detachable advanced composite structural coupler may comprise one or more photo electric cells coupled to one or more light source and may be adapted to store solar energy during the daytime to power the light source(s) at night time.

15 The detachable advanced composite structural coupler may be electromagnetic interference neutral.

Suitably, the coupler is such that it does not "snap fit" into place over a tube. Suitably, the coupler is adapted to be fixed in place relative to a tube in use by being tightened around the tube.

20

Suitably, the coupler comprises an attachment strap having an arcuate face for abutting a tube in use and which face turns through 180 degrees or less. Suitably, the coupler comprises an attachment strap having a concave face for abutting a tube in use and which face turns through 180 degrees or less. Suitably, the coupler comprises two such straps.

25

Suitably, the coupler comprises a coupler body having an arcuate face for abutting a tube in use and which face turns through 180 degrees or less. Suitably, the coupler comprises a coupler body having a concave face for abutting a tube in use and which face turns through 180 degrees or less. Suitably, the coupler body comprises two such faces.

30

Suitably, the coupler comprises a fixed coupler. Suitably, the coupler comprises a double coupler. Suitably, the coupler comprises a 90 degree coupler. The coupler may comprise a fixed 90 degree double coupler.

35

According to a second aspect of the present invention there is provided a coupler comprising a coupler body, an attachment strap and a tensioning component.

Suitably, the coupler comprises two attachment straps. Suitably, the coupler comprises two tensioning components.

5 Suitably, a tensioning component comprises a bolt, a bearing shoulder, a distribution arm and a nut. Suitably, the bolt comprises a T-bolt. Suitably, a tensioning component comprises a bolt, a bearing/distribution part and a nut. Suitably, the bearing/distribution part comprises a bearing shoulder and a distribution arm. Suitably, the distribution arm and the bearing shoulder are integrally formed. Suitably, the bearing arm and bearing shoulder are a single part. Suitably, the bolt, nut and bearing arm/shoulder are distinct parts and are able to move  
10 relative to one another.

The coupler may comprise any feature as described in relation to the first aspect.

15 According to a third aspect of the present invention there is provided a structure comprising one or more couplers according to the first and/or second aspect.

The structure suitably comprises two or more tubes. Suitably, the structure comprises a plurality of tubes and a plurality of couplers.

20 Suitably, the structure comprises at least one coupler according to the first aspect coupling two tubes to one another.

Suitably, said tubes comprise scaffold tubes. Suitably, said structure comprises a scaffold structure.  
25

The structure may comprise any feature as described in relation to the first and/or second aspect.

30 According to a fourth aspect of the present invention there is provided a method of erecting a structure, wherein the method comprises connecting first and second tubes using a connector according to the first and/or second aspect.

Suitably, the method comprises forming a structure according to the third aspect.

35 The method may comprise any feature as described in relation to the first and/or second and/or third aspects.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will now be illustrated by way of example with reference to the accompanying drawings in which:

5 Figure 1 shows a plan view of a coupler with a strap attached but not a mechanical tensioning component;

Figure 2 shows a first side elevation of the coupler, upon which one of the attachment strap hinges is located;

10 Figure 3 shows a second side elevation of the coupler, upon which one of the mechanical tensioning components is located;

Figure 4 shows a first vertical section through the coupler body, showing the opening for the mechanical tensioning component;

15 Figure 5 shows a second vertical section through the coupler body, showing the bearing seats of the attachment straps and coupler body;

20 Figure 6 shows a first horizontal section through the coupler body, showing the orthogonal ribs;

Figure 7 shows a second horizontal section through the coupler body, showing the shear plates at one of the strap hinges;

25 Figure 8A-8B show details of a mechanical tensioning component;

Figure 9A-9B show details of a T-bolt used in a mechanical tensioning component;

30 Figures 10A-10C show details of a mechanical tensioning component shoulder and distribution arm; and

Figure 11 shows an isometric view of a coupler.

#### DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

35

As illustrated by Figure 11, a coupler 100 which can be used as a detachable structural coupler comprises a coupler body 2 which together with attachment straps 1 (first strap 1A and second strap 1B) provides first and second coupling means for coupling to first and second

tubes (not illustrated). The coupler 100 is arranged such that it can couple two tubes to extend at 90 degrees relative to one another in substantially parallel planes.

5 The coupler body 2 comprises arcuate faces 2A, 2B, for abutting tubes in use and said arcuate faces 2A, 2B are joined by a ribbed region 2C. The attachment arms 1 are hingedly connected to the coupler body at one end of each strap 1 by hinge rods/pins 11. The coupler body 2 has shear plates 10 at the hinges which intermesh with shear plates 13 of the attachment strap. The other end of each strap 1 comprises a bearing seat 4 and the coupler comprises a  
10 tensioning component which bears against the bearing seat 4 and a bearing or clip-in seat 3 of the coupler body 2 to tension the strap 1 in use. The tensioning component comprises a T-bolt 9 and a distribution/bearing part having a distribution arm 6 as well as a nut 8. The distribution arm 6 has a bearing shoulder 7 against which the nut 8 can be tightened in use and the T-bolt has a cross arm 5. In use, tightening the nut 7 draws the bearing arm 6 and cross arm 5 towards one another thus drawing the bearing seat 4 and clip-in seat 3 towards one another.  
15 The coupler 100 has two such tensioning components, one to tension each strap 1.

The construction of an exemplary embodiment will become clearer from the discussion of Figures 1 to 10. These illustrate a differently handed but otherwise corresponding coupler to that of Figure 11 and thus like parts are numbered accordingly.

20 Figure 1 is a plan of the coupler which can be used as a detachable coupler and which comprises an advanced composite. The attachment straps 1 having thickness  $T=3\text{mm}$  and width  $W=54.3\text{mm}$  are moulded to have an inner diameter  $D=48.3\text{mm}$  that matches the outer diameter of the scaffold tubes to which they are to be attached. The clip-in seat 3 for the T-bolt cross arm and the bearing seat 4 for the bearing shoulder and distribution arm are shown  
25 without the T-bolt 9 and the distribution arm 6 in place. The integral shear plates 10 of the coupler body are shown with the strap hinge rod 11 in place but without the shear plates 13 of the attachment strap shown.

30 Figure 2 is a side elevation A of the coupler, upon which one of the attachment strap hinges is located. The continuous attachment straps 1 generally have a thickness  $T=3\text{mm}$  that is gradually thickened as it passes into the shear flanges 13 to accommodate the hinge rod 11 connecting the straps to the shear flanges 10 of the coupler body 2. The attachment straps 1 are also gradually thickened as they merge into the strap bearing seat 4 housing the  
35 mechanical tensioning component cross arm 6. The circular cylindrical shell 2S which forms an integral part of the coupler body 2 has a minimum thickness of  $T=3\text{mm}$  but is gradually thickened as it merges into the shear flanges 10 connecting the coupler body 2 through the pin 11 to the shear plates 13 of the attachment straps 1. The circular cylindrical shell 2S which forms an integral part of the coupler body 2 is also gradually thickened as it merges into the

coupler body bearing seat 3 for the mechanical tensioning T-bolt 9 cross arm 5. The T-bolt 9 is shown in place on the upper strap 1 along with the distribution arm 6, the bearing shoulder 7 and the tightening nut 8. The coupler body 2 is provided with ribs 12 to reduce mass and to reduce the required curing time for the injection moulding process (these ribs are shown in greater detail in Section B<sub>1</sub>-B<sub>1</sub> of Figure 6).

Figure 3 is a second side elevation B of the coupler, upon which one of the mechanical tensioning components is located. The lower part of the elevation is similar to the upper part of the elevation shown in Figure 2. The continuous attachment straps 1 have thickness T=3mm that is gradually thickened as it passes into the strap bearing seat 4 and the shear flange plates 13 at the pin connection. The circular cylindrical shell 2S which forms an integral part of the coupler body 2 has a minimum thickness of T=3mm but is gradually thickened as it merges into the shear flanges 10 at the pin connection and as it merges into the coupler body bearing seat 3 for the mechanical tensioning T-bolt 9 cross arm 5. In the upper part of this elevation the bearing seats 4 and 3 of respectively the attachment strap 1 and the coupler body 2, have gaps of C=17mm to allow the rotation into place of the T-bolt 9. T-bolts 9 are shown in place on the upper and lower straps 1 along with the shoulders 7, the distribution arms 6 and the tightening nuts 8. The coupler body 2 is provided with ribs 12 to reduce mass and to reduce the required curing time for the injection moulding process (these vanes are shown in greater detail in Sections A<sub>2</sub>-A<sub>2</sub> of Figure 4 and B<sub>1</sub>-B<sub>1</sub> of Figure 6).

Figure 4 shows a first vertical section A<sub>1</sub>-A<sub>1</sub> through the detachable advanced composite structural coupler (see Figure 1 and 2 for the location of the section). This shows on the lower part, the opening within the coupler body 2 and straps 1 within which the mechanical tensioning component 9 (not shown) can be rotated. It also shows the nature of the cavities between the ribs 12 within the coupler body 2, and the cruciform section 14. Also shown are the thickenings of the attachment straps 1 to provide adequate strength to the shear flanges 13 connecting to the hinge rod 11.

Figure 5 shows a second vertical section A<sub>2</sub>-A<sub>2</sub> through the detachable advanced composite structural coupler body (see Figure 1 and 2 for the location of the section). This shows on the lower part the body bearing seats 3 and strap bearing seats 4 to allow the cross arms 5 and the distribution arms 7 of the mechanical tensioning component 9 (not shown) to be seated. It also shows the nature of the ribs 12 and the cruciform 14 within the coupler body 2. Also shown are the thickenings of the coupler body 2 to provide adequate strength to the shear flanges 10 connecting to the hinge rod 11.

Figure 6 shows a first horizontal section B<sub>1</sub>-B<sub>1</sub> through the detachable advanced composite structural coupler body, showing the orthogonal ribs 12 and cruciform 14. With 8 ribs of

thickness  $T_R=3.4\text{mm}$  the approximately  $T_G=3.9\text{mm}$  gaps between the ribs there is sufficient separation between the extension of the body ribs 12 to the shear flanges 10 at the hinge, to allow the shear flanges 13 of the attachment strap 1 to rotate freely about the hinge rod 11.

- 5 Figure 7 shows a second horizontal section  $B_2-B_2$  through the detachable advanced composite structural coupler body, showing the shear flanges 10 and 13 at one of the strap hinge rods 11 (for clarity the strap shear flanges 13 have been displaced laterally relative to the coupler body shear flanges 10. With 8 ribs of thickness  $T_R=3.4\text{mm}$  in the coupler body 10 and 7 of thickness  $T_R=3.4\text{mm}$  in the strap 13, there is sufficient separation between the shear flanges of the  
10 coupler body 10 to allow the shear flanges 13 of the attachment strap 1 to rotate freely about the pin 11.

- Figures 8A-8B have details of the mechanical tensioning arrangement. A T-bolt 9 may be manually inserted into the clip-in seat 3 adjacent to the coupler body 2. Once inserted the T-  
15 bolt 9 may be rotated within the clip-in seat but is prevented from falling out on account of the opening being slightly smaller in width than the diameter of the T-bolt cross arm 5. For tensioning, the T-bolt 9 is rotated until the T-bolt shoulder 7 and cross-arm 6 are above and aligned with the bearing seat 4 at the free end of the attachment strap 1. Alignment may be made easier through the incorporation of a keyway 15 cut into the thread of the T-bolt 9 as  
20 shown in Figure 9. The correct alignment is achieved by incorporating into the T bolt shoulder 7 a nib 16 protruding into the keyway 15 cut into T-bolt 9. Tightening is then achieved by screwing up the nut 8 with the torque required to achieve the desired tension in the attachment strap 1.

- 25 Figures 9A-9B has details of the T-bolt 9 used in the mechanical tensioning arrangement. The cross arm 5 and the shank 16 of the T-bolt 9 are constructed from 8mm high tensile stainless steel circular rod welded together. Into the thread 17 may be cut a keyway 15 intended to allow automatic rotational alignment of the T-bolt shoulder 7 and distribution arm 6 into the strap bearing seat 4 at the free end of the attachment strap 1.

- 30 Figures 10A-10C show details of the mechanical tensioning component shoulder and distribution arm. A clearance hole of 8.5mm in the T-bolt shoulder 7 allows the shank of the T-bolt 9 to move freely within. The two distribution arms of 8mm HTSS 6 are butt welded to the HTSS distribution shoulder 7. A rib 16 is be incorporated into the shoulder to constrain any  
35 relative rotation between the shoulder 7 and distribution arms 6, and the T bolt shank 16 and thread 17.

In the illustrated embodiment the coupler body and attachment straps comprise a thermoplastic polymeric resin with fibre reinforcement therein as do the remaining components with the exception of the T-bolt and nut.

- 5 In alternative embodiments (not illustrated) materials may be varied. A thermoplastic polymeric resin may be used as the matrix binding together any fibre reinforcement in the body and attachments straps of the coupler, providing an integral composite material for coupler except the T-bolt. The thermoplastic polymeric resin may be a thermoplastic polyester, a thermoplastic vinyl ester thermoplastic, polyurethane, a thermoplastic polyamide, nylon.

10

In the illustrated embodiment the attachment strap has a thickness  $T$  of 3mm and width 54.3mm, but in other embodiments (not illustrated) different thicknesses,  $T$ , and width  $W$  may be used to provide the specific load carrying requirements for a scaffold system.

- 15 In the illustrated embodiment the fibres of reinforcement are e-glass fibres, namely alumino-borosilicate glass with 1%wt alkali-metal oxides. In other embodiments (not illustrated) the fibrous reinforcement can be formed from glass, aramid, boron, natural or carbon. In the illustrated embodiment the volume fraction of the fibre relative to the total material volume is 30% but in other embodiments (not illustrated) the fibrous reinforcement
- 20 may be chosen as more or less or none at all, depending upon required strength and stiffness of the various components of the detachable advanced composite structural coupler.

- In the illustrated embodiment the attachment straps are connected to the coupler body through a hinge pin. In other embodiments (not illustrated) the attachment straps may be integrally
- 25 connected to the coupler body.

- In the illustrated embodiment the attachment straps have a fixed  $90^\circ$  orientation with respect to each other. In other embodiments (not illustrated) the coupler body may be split into two parts that are provided with a hinged connection allowing the attachment straps to be placed at any
- 30 orientation with respect to each other.

It will be appreciated that other preferred embodiments of the present invention may provide couplers with beneficial properties.

- 35 Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

5

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

10

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

**Claims**

1. A coupler wherein the coupler comprises a polymeric material and is adapted for use with structural tubes.  
5
2. A coupler wherein the coupler comprises a polymeric material.
3. A coupler according to claim 1 or 2, wherein the coupler is adapted to couple two scaffold tubes to one another.  
10
4. A coupler according to any preceding claim, wherein the coupler comprises a structural coupler.
5. A coupler according to any preceding claim, wherein the coupler comprises a detachable coupler.  
15
6. A coupler according to any preceding claim, wherein the coupler comprises first coupling means for connecting to a first tube.
7. A coupler according to any preceding claim, wherein the coupler comprises second coupling means for connecting to a second tube.  
20
8. A coupler according to any preceding claim, wherein the first coupling means is adapted such that, in use, a user can selectively couple or decouple it from a tube.  
25
9. A coupler according to claim 6, wherein the second coupling means is adapted such that, in use, a user can selectively couple or decouple it from a tube.
10. A coupler according to claim 7, wherein the coupler comprises a coupler body.  
30
11. A coupler according to claim 10, wherein the coupler body forms part of first and/or second coupling means.
12. A coupler according to any preceding claim, wherein the coupler comprises an attachment strap.  
35
13. A coupler according to any preceding claim, wherein the coupler comprises first coupling means comprising a first attachment strap adapted to cooperate with a coupler body to encircle a first tube in use.

14. A coupler according to any preceding claim, wherein the coupler comprises second coupling means comprising a second attachment strap adapted to cooperate with a coupler body to encircle a second tube in use.
- 5
15. A coupler according to any preceding claim, wherein the coupler is adapted such that it can be clamped onto tubes in use.
16. A coupler according to any preceding claim, wherein the coupler comprises tensioning means.
- 10
17. A coupler according to any preceding claim, wherein the coupler comprises a tensioning component adapted to apply tension to an attachment strap in use.
- 15
18. A coupler according to any preceding claim, wherein the coupler is adapted such that in use it can couple to two tubes to hold said tubes in substantially fixed position relative to one another.
19. A coupler according to any preceding claim, wherein the coupler is adapted to hold two tubes such that, in use, the tubes are coupled at a predetermined fixed angle relative to one another.
- 20
20. A coupler according to any of claims 1 to 18, wherein the coupler is adapted to allow a user to adjust the angle at which two tubes are coupled relative to one another in use.
- 25
21. A coupler according to any preceding claim, wherein the coupler comprises a coupler body which comprises polymeric resin and which may comprise reinforcing fibres.
22. A coupler according to any preceding claim, wherein the coupler comprises a first attachment strap which comprises polymeric resin and which may comprise reinforcing fibres.
- 30
23. A coupler according to any preceding claim, wherein the coupler comprises a second attachment strap which comprises polymeric resin and which may comprise reinforcing fibres.
- 35
24. A coupler according to any preceding claim, wherein attachment straps are attached through a pin connection to the coupler body.

25. A coupler according to any preceding claim, wherein the coupler comprises an attachment strap comprising a strap hinge shear plate.
26. A coupler according to any preceding claim, wherein the coupler comprises a coupler  
5 body comprising a hinge shear plate.
27. A coupler according to any preceding claim, wherein the coupler comprises an attachment strap comprising a strap bearing seat.
- 10 28. A coupler according to any preceding claim, wherein the coupler comprises a coupler body comprising a bearing seat.
29. A coupler according to any preceding claim, wherein the coupler comprises surfaces adapted to conform to the outer face of tubes.  
15
30. A coupler according to any preceding claim, wherein the coupler body comprises a region connecting first and second coupling means and which region comprises one or more cavities.
- 20 31. A coupler according to any preceding claim, wherein the coupler has a mechanical tensioning component which can be tightened to transfer force into an integrally cast strap bearing seat of an attachment strap and an integrally cast coupler body bearing seat.
- 25 32. A coupler according to any preceding claim, wherein a tensioning component comprises a nut and bolt.
33. A coupler according to any preceding claim, wherein the coupler comprises a bearing/distribution part adapted to abut a bearing seat of a strap in use.  
30
34. A coupler according to any preceding claim, wherein the coupler comprises a heat stabilised, flame retardant, self-extinguishing engineering thermoplastic reinforced with glass-fibre.
- 35 35. A coupler according to any preceding claim, wherein the coupler comprises a fibre reinforced thermoplastic polymeric (frp) advanced composite detachable structural coupler.

36. A coupler according to any preceding claim, wherein the coupler is adapted to be compatible in a scaffold system comprising metallic tubes.
- 5 37. The coupler is adapted to be compatible in a scaffold system comprising composite tubes.
38. A coupler according to any preceding claim, wherein the coupler is adapted to be fixed in place relative to a tube in use by being tightened around the tube.
- 10 39. A coupler comprising a coupler body, an attachment strap and a tensioning component.
40. A coupler according to claim 39, wherein the coupler comprises a coupler according to any of claims 1 to 39.
- 15 41. A structure comprising one or more couplers according to any preceding claim.
42. A structure according to claim 41, wherein the structure comprises a plurality of tubes and a plurality of couplers.
- 20 43. A structure according to claim 41 or 42, wherein said structure comprises a scaffold structure.
44. A method of erecting a structure, wherein the method comprises connecting first and second tubes using a connector according to any of claims 1 to 40.
- 25 45. The method of claim 44, wherein the method comprises forming a structure according to any of claims 41 to 43.
- 30 46. A coupler, structure or method substantially as herein described with reference to any of the accompanying drawings.

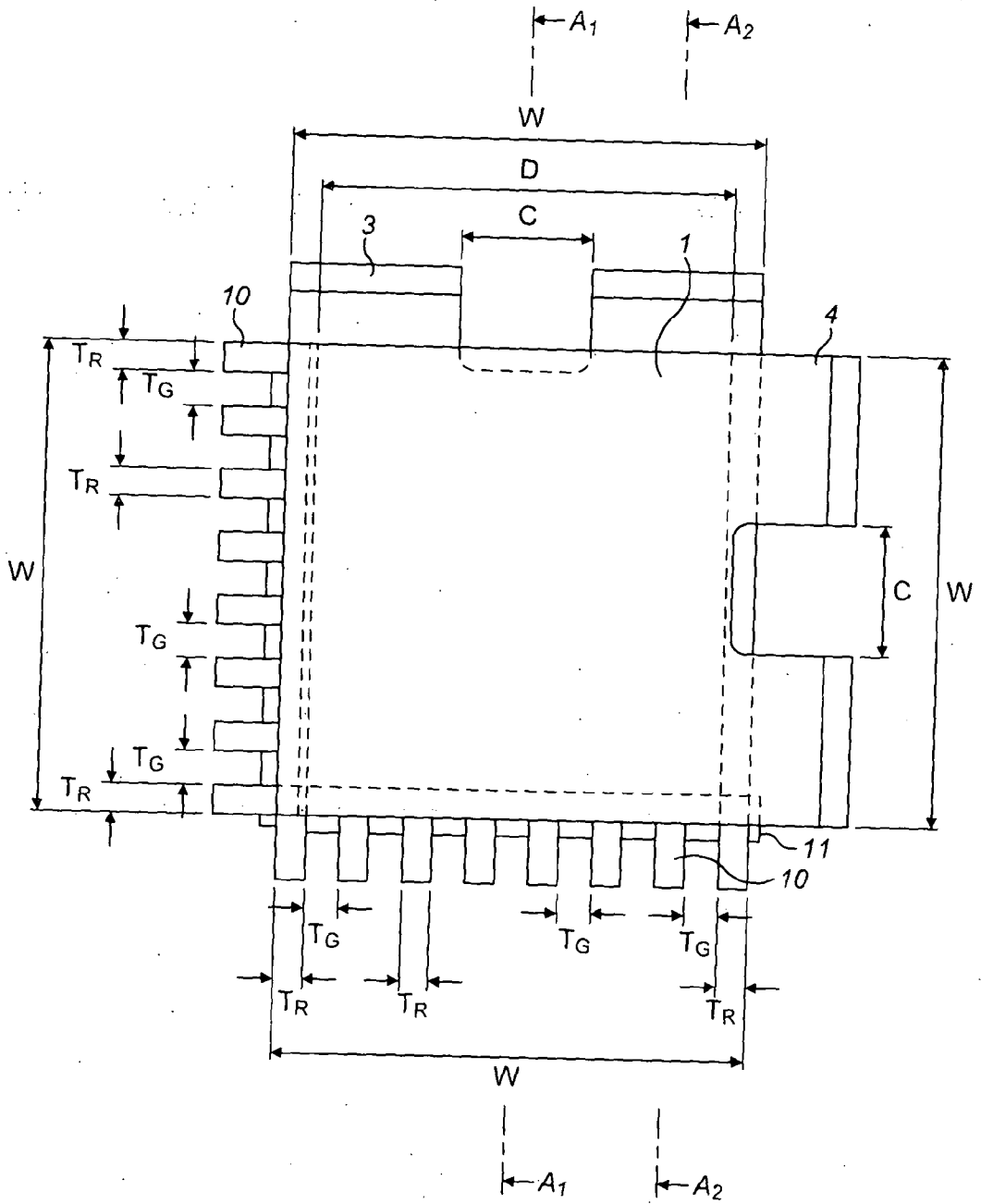


FIG. 1

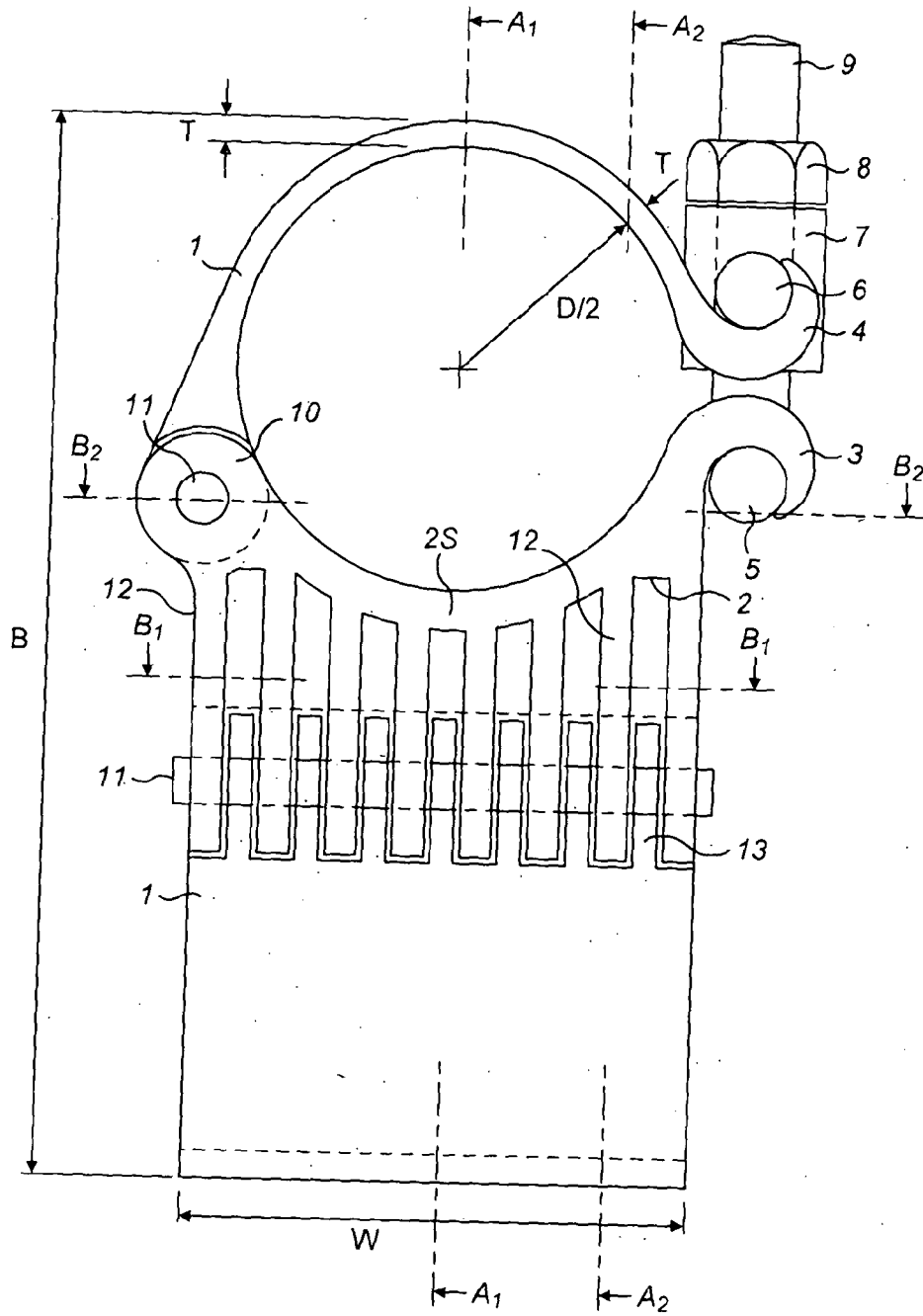


FIG. 2

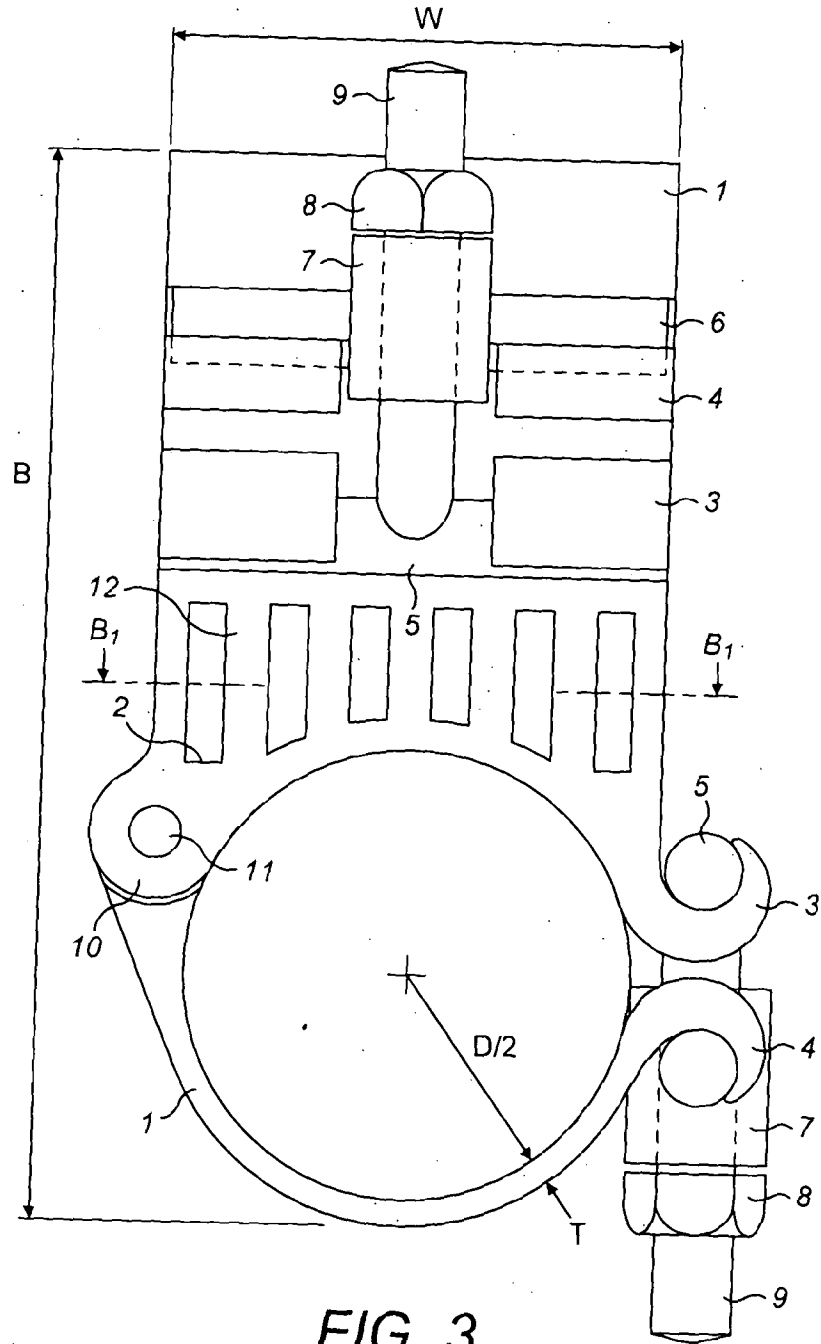


FIG. 3



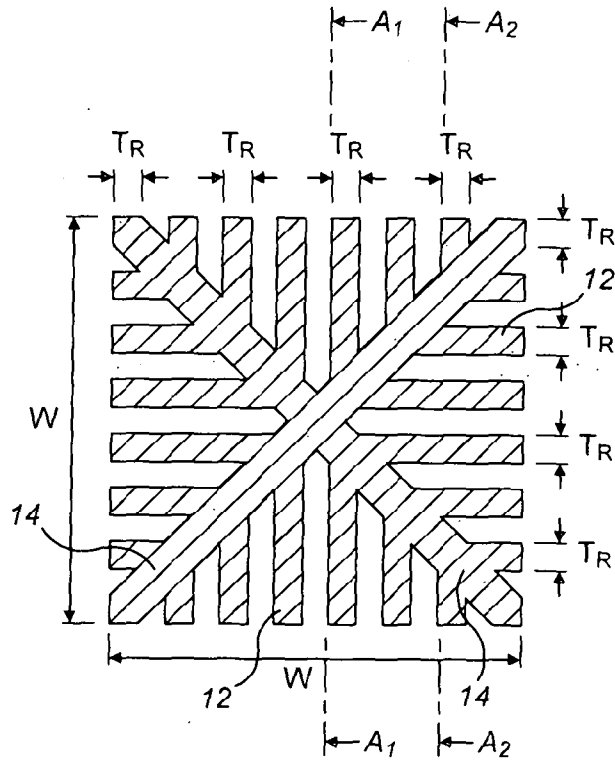


FIG. 6

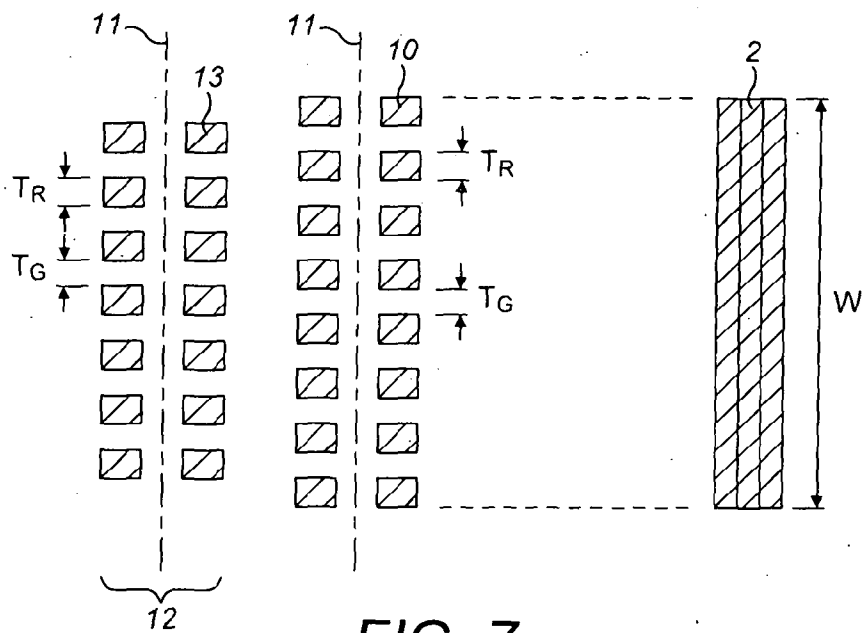


FIG. 7

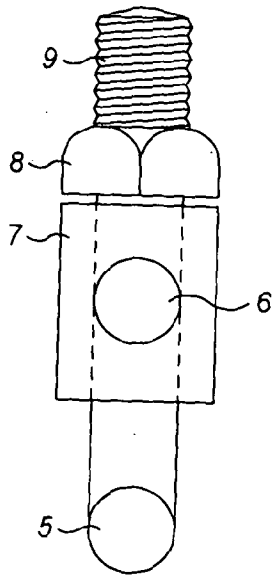


FIG. 8A

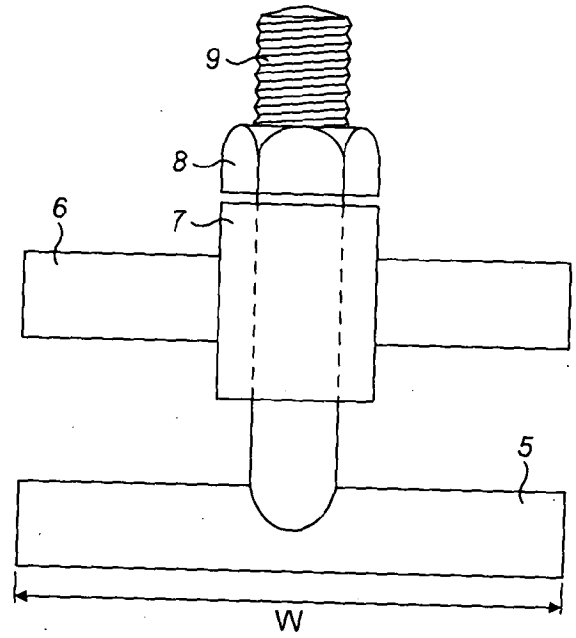


FIG. 8B

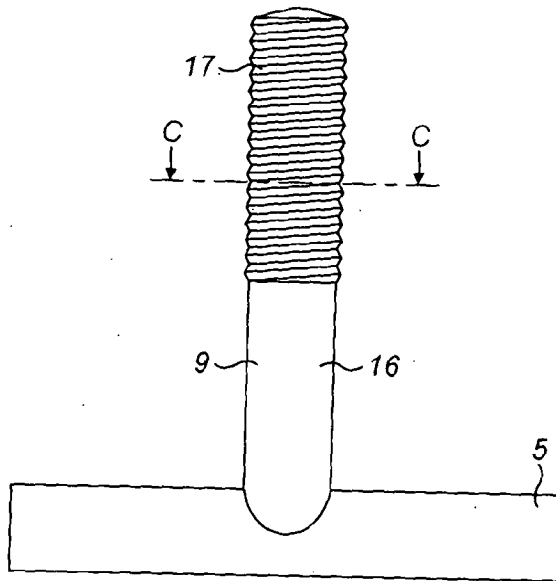


FIG. 9A

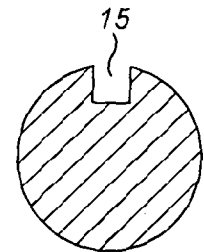


FIG. 9B

7/8

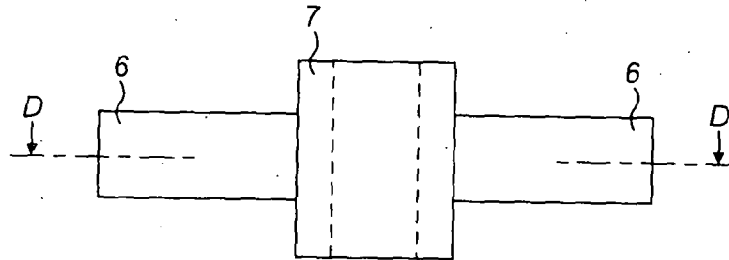


FIG. 10A

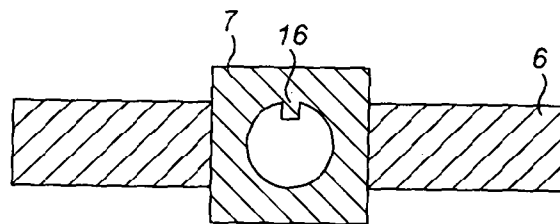


FIG. 10B

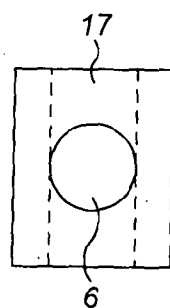


FIG. 10C

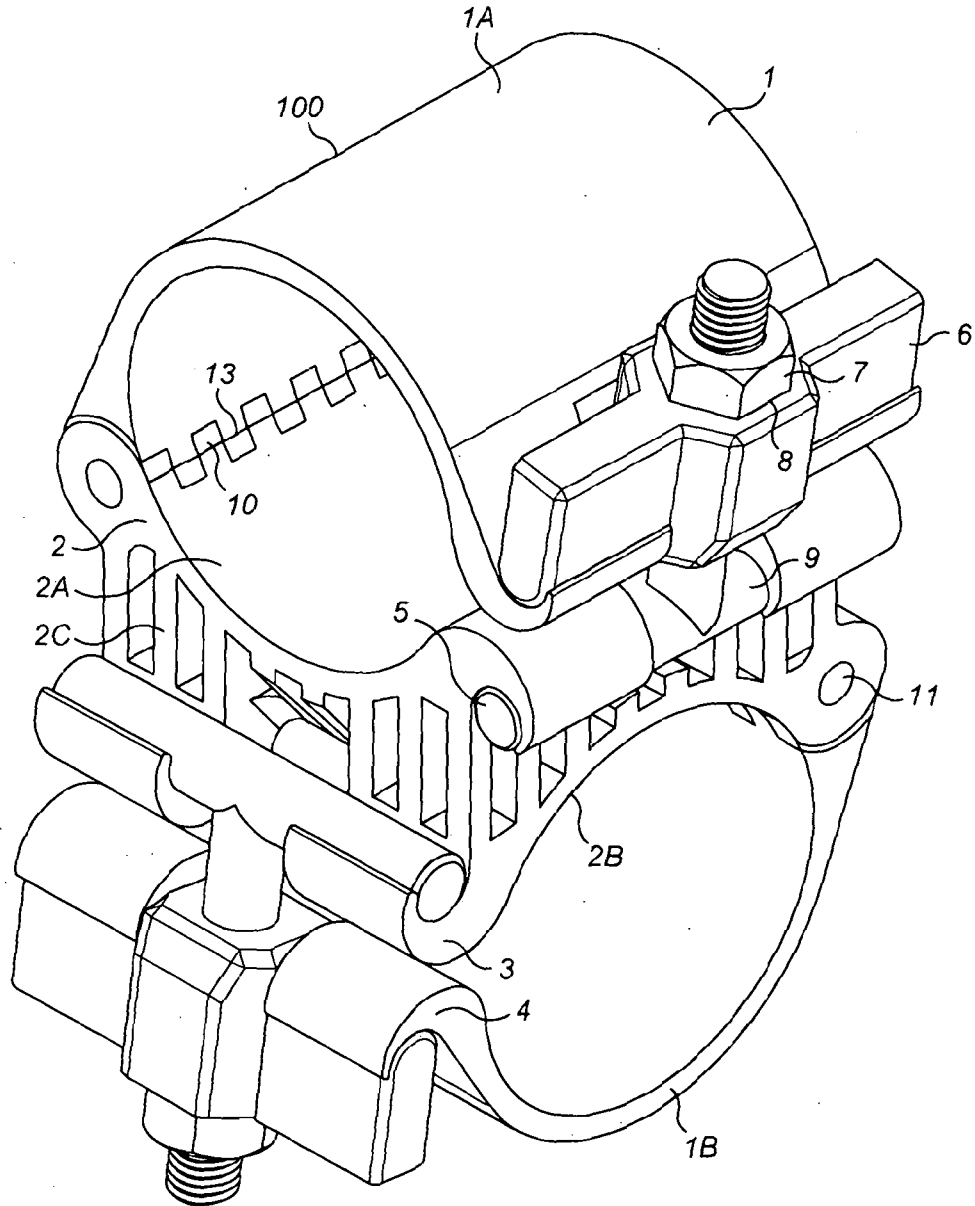


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No  
PCT/GB2013/050564

A. CLASSIFICATION OF SUBJECT MATTER  
INV. E04G7/14 E04G7/00  
ADD.  
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)  
E04G  
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)  
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 91/10027 A1 (LEGGE PHILIP [GB]) 11 July 1991 (1991-07-11)	1-26,29, 34-46
Y	page 1, line 4 - line 20; figures 1-5,9 page 2, line 6 - line 9 page 3, line 31 - page 4, line 4 page 4, line 9 - line 30 page 5, line 6 - line 28 page 7, line 31 - page 8, line 8 page 10, line 13 - page 11, line 4 page 14, line 7 - line 16	27,28, 30-33
X	----- GB 2 282 177 A (STANDARDS INST SINGAPORE [SG] STANDARDS INST SINGAPORE [SG]; SINGAPORE) 29 March 1995 (1995-03-29)	1,2,5, 18-20,44
A	page 1, paragraph 2; figure 1 page 6, paragraph 1 - paragraph 3 ----- -/--	3,21-23

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" 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)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search <b>25 July 2013</b>	Date of mailing of the international search report <b>31/07/2013</b>
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer <b>Manera, Marco</b>
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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/GB2013/050564

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y A	GB 908 266 A (SPREEUWENBERG S AANNEMINGSBEDR) 17 October 1962 (1962-10-17) page 2, line 32 - line 34; figure 1 -----	30 3
A	EP 0 447 199 A2 (TAKAMORI SEIMITSU GIKEN KK [JP]) 18 September 1991 (1991-09-18) column 4, line 10 - line 16; figure 4 column 4, line 51 - column 5, line 10 line 24 - column 6, line 38 -----	34,35

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/GB2013/050564
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