Abstract: Provided is a cross-arm for supporting an electrical line, the cross-arm including an elongate tubular body for fitment to a utility pole and an internal web structure arranged inside the body, said web structure being shaped and configured to strengthen the body against bending, crushing and torsion forces.
AN ELECTRIC LINE CROSS-ARM

Background of the Invention

This invention relates to a cross-arm for supporting an electrical line, and an associated method of manufacturing a cross-arm.

Description of the Prior Art

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that the prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

Electrical cross-arms are used to support electrical conductors or conductors for transferring electrical energy across a distance. Such cross-arms are usually mounted at a top end of utility poles to position the electrical conductors away from the ground and other objects. A key requirement of any cross-arm is strength and resiliency, as cross-arms are subjected to a number of different forces and environmental factors over extended periods of time.

For example, timber cross-arms are known and often include some manner of coating or treatment to prevent insect or environmental damage. Such coatings or treatments can be cumbersome and expensive. Timber cross-arms are also heavy and require high-quality timber, which can be expensive or suffer from availability problems. An additional problem with timber cross-arms is dampness, which can lead to rotting. Dampness also degrades the electrical insulating properties of timber cross-arms.

To overcome some of the problems associated with timber cross-arms, composite cross-arms have been developed that typically make use of fibre-impregnated resin configurations. U.S. patent no. 5,505,036 to Wiles describes such a composite cross-arm which has an outer casing of resin impregnated fiberglass. This design attempts to overcome the problem of shear stresses through the use of cross pins that distribute applied forces to sidewalls of the cross-arm. Similarly, U.S. patent no. 5,605,017 to Fingerson proposes a pultruded cross-arm
having bushings inserted through transverse holes and a hollow inner member inserted into
the cross-arm to distribute stresses.

U.S. patent no 6,347,488 to Koye describes a bar member molded from synthetic material
and having a groove for receiving wire or conductor. The bar member is further molded to
conform to a shape of a utility pole. U.S. patent no. 3,884,442 to Breeden describes a cross-
arm manufactured from sheet aluminium which is folded to form an L-shape with
overlapping tabs to strengthen the cross-arm.

A problem with these prior art cross-arms is that they are typically labor-intensive and
expensive to manufacture. A further drawback is that cross-arms featuring sophisticated
composite structures require specific care during installation to avoid damage and to ensure
proper operation thereof. This can increase installation costs and time. Furthermore, cracking
due to incorrect installation and fatigue resistance or mechanical degradation over time can
lead to moisture problems and failure of the cross-arm. Ultraviolet degradation is another
problem, as cross-arms are typically subjected to harsh environmental conditions over
extended periods of time, which can also lead to weakening of the cross-arm, making the arm
more vulnerable to mechanical failure. In addition, the electrical performance of these
composite cross-arms may be deteriorated when used around air-borne pollutants for lengthy
periods of time, often resulting in faults to ground.

None of the prior art cross-arms provides a simple-to-manufacture and inexpensive cross-
arm which provides good structural strength along a length thereof as well as resistance to
crushing forces resulting from installation of the cross-arm to a utility pole, and which has a
long lifetime and is also resistant to moisture without requiring specific care to install.

Summary of the Present Invention

According to one aspect of the invention there is provided a cross-arm for supporting an
electrical line, the cross-arm including:

   an elongate tubular body for fitment to a utility pole; and
   an internal web structure arranged inside the body, said web structure being shaped
   and configured to strengthen the body against bending, crushing and torsion forces.

Typically, the cross-arm is manufactured from aluminium.
Typically, the cross-arm is manufactured using an extrusion process.

Typically, the tubular body has a polygonal cross-section.

Typically, the tubular body has a square cross-section.

Typically, the tubular body is configured for fitment to a utility pole by defining apertures for receiving suitable attachment means.

Typically, the internal web structure is extruded together with the body during manufacture of the cross-arm.

Typically, the internal web structure includes a number of members arranged in a grid along a length of the cross-arm.

Typically, the internal web structure includes an inner offset portion having the same cross-sectional profile of the body, the offset portion attached to the body by fillet portions.

Typically, the cross-arm includes an insulative coating.

Typically, the cross-arm defines corner portions shaped and dimensioned to receive an insulative sleeve or cover in a complementary manner.

Typically, the cross-arm includes an insulative sleeve or cover.

Typically, the cross-arm includes an insulative bushing for isolating an insulator or fastener from the cross-arm.

Typically, the bushing includes two parts, each for fitment through an aperture from opposed sides of the cross-arm, each part having a flange portion for operatively resting on an external surface of the cross-arm to insulate an insulator or fastener from the cross-arm.

Typically the cross-arm includes an insulative bushing and a cover, and wherein at least part of the bushing is for engaging the cover to thereby retain the cover in position.

Typically the cover includes shaped edge pieces, and wherein the bushing includes a bushing part having end edge pieces for insertion into the shaped edge pieces, thereby retaining the cover in position.
According to a further aspect of the invention there is provided a method of manufacturing a cross-arm, said method including the step of extruding an elongate tubular body for fitment to a utility pole, the body including an internal web structure shaped and configured to strengthen the body against bending and crushing forces.

Typically, the step of extruding includes extruding the body from aluminium.

Typically, the method includes the step of coating the cross-arm with an insulative coating.

**Brief Description of the Drawings**

An example of the present invention will now be described with reference to the accompanying drawings, in which: -

Figure 1A shows a front-sectional view of one example of a cross-arm;
Figure 1B shows a side view of the cross-arm of Figure 1A;
Figure 2A shows a front-sectional view of a further example of a cross-arm;
Figure 2B shows a side view of the cross-arm of Figure 2A;
Figure 3 shows a schematic front representation of a cross-arm installed on a utility pole;
Figure 4A shows a schematic side representation of the cross-arm installation of Figure 3;
Figure 4B shows an enlarged section of the cross-arm section of Figure 4A;
Figure 4C shows an enlarged section of a further example of the cross-arm section of Figure 4A;
Figure 5A shows a front-sectional view of another example of a cross-arm;
Figure 5B shows a front-sectional view of a yet further example of a cross-arm;
Figure 6 shows a front-sectional view of a further example of a cross-arm;
Figure 7A shows an example of a cross-arm having an insulator bushing;
Figure 7B shows the cross-arm of Figure 7A in use;
Figure 8 shows one example of an insulative cover fitted to the cross-arm;
Figure 9 shows a side view of a cross-arm including the insulative cover of Figure 8;
Figure 10 shows a perspective view of a bottom part of a bushing usable with the cross-arm;
Figure 11A shows a perspective view of a top part of a bushing usable with the cross-arm; and
Figure 11B shows a side-sectional view of the top part of the bushing of Figure 11A.
Detailed Description of the Preferred Embodiments

Figures 1A and 1B show an example of a cross-arm 10 for supporting an electrical line. The cross-arm 10 includes an elongate tubular body 12 which is shaped and configured for fitment to a utility pole, as described below. The cross-arm 10 also includes an internal web structure 14 arranged inside the body 12. This web structure 14 is shaped and configured to strengthen the body 10 against bending and crushing forces, as described in more detail below.

The cross-arm 10 is typically manufactured from aluminium using an extrusion process. As shown, the tubular body 12 has a rectangular cross-section. In one example, the tubular body 12 has a square cross-section, although the design can vary depending on requirements. Generally, the tubular body 12 is configured for fitment to a utility pole by the body 12 defining apertures (not shown) for receiving suitable attachment means, such as bolts, straps, clamps, or the like.

It is to be appreciated that the internal web structure 14 is generally extruded along with the body 12 during manufacture of the cross-arm 10. As such, the internal web structure 14 typically extends along the length of the body 12, or at least along portions thereof. However, in further examples, the internal web structure 14 and body 12 may be separately extruded and subsequently bonded together. In the example shown in Figure 1, the internal web structure 14 comprises a number of members arranged in a grid along a length of the cross-arm 10. The grid provides transverse channels 11 and 13 along the cross-arm 10 through which a fastener, such as a bolt, can be passed to secure the cross-arm 10 to a utility pole. In addition, fasteners, such as bolts, for fastening an electrical conductor and/or insulator to the cross-arm can also be passed through channels 11 and 13, as described in more detail below.

The internal web structure 14 strengthens the cross-arm 10 against bending, crushing and/or torsion forces as generally indicated by reference numeral 20. Bending forces 20.1 are generally forces that are applied perpendicular to a longitudinal axis 16 of the cross-arm. For example, attaching the cross-arm 10 to a utility pole and fixing electrical conductors thereto (shown in Figure 3) typically leads to such bending forces 20.1 perpendicular to the longitudinal axis 16 of the cross-arm 10. Such forces 20.1, 20.2 can also result in a bending moment, generally indicated by reference numeral 22, about a portion where the cross-arm...
10 is fixed to the pole 32. The internal web structure 14 facilitates in strengthening the cross-arm 10 against such bending forces 20.1.

In addition, the internal web structure 14 also strengthens the cross-arm 10 against any compressive or crushing forces 20.2 that generally act along transverse axes 18. For example, a compressive or crushing force is applied to the cross-arm 10 when a bolt is passed through channels 11 or 13 to fasten the cross-arm 10 to a utility pole, or to fasten a fastener or insulator for an electrical conductor to the cross-arm. This is described with reference to Figure 4 below.

The internal web structure 14 further strengthens the cross-arm 10 against possible torsion forces, schematically indicated by reference numeral 20.3. Such torsion 20.3 typically results due to forces working to produce co-axial rotation of the outer body 12 relative to the internal web structure 14, i.e. the outer body 12 tries to rotate about the internal web structure 14. As such, it is to be appreciated that the internal web structure 14 generally increases the cross-arm's polar moment of inertia or second moment of area. In general, the internal web structure 14 strengthens the cross-arm 10 against any forces resulting from tension or vibration on conductors supported by the cross-arm, including weight of the conductor, wind acting on said conductors, temperature expansion and contraction of the conductors, etc.

Figure 2 shows a further example of a cross-arm 10 wherein the internal web structure 14 includes an inner offset portion 17 having a similar cross-sectional profile as the body 12, with the offset portion attached to the body 12 by fillet portions 15, as shown. Similar to the example of Figure 1, the web structure 14, inclusive of fillet portions 15, strengthens the cross-arm 10 against bending, crushing and torsion forces 20.

The fillet portions 15 and inner offset portion 17 cooperate to provide a load path to any crushing forces. The fillet portions 15 are positioned at an angle to the outer body 12 and the internal web structure 14 to provide additional structural stiffness against torsion forces 20, as well as to assist in the even distribution of crushing forces through the cross-arm.

The cross-arm 10 can be directed at low-voltage (50-1 000V AC or 120-1 500V DC) or high-voltage (>1000V AC or >1500V DC) applications. Figure 3 shows an example of the cross-arm 10 fastened to a utility pole 32 by means of a bolt 36 in a typical application. Electrical conductors 30 are attached to the cross-arm 10 by means of fasteners 34, as shown. Fasteners
34 are typically insulators as is known in the art. It is to be appreciated that different examples can feature different arrangements of the conductors 30 and fasteners/insulators 34.

For example, high-voltage applications generally include a more advanced insulator design to ensure proper and safe operation of the cross-arm 10. In such an example, the fastener or insulator 34 can include a glass, porcelain or ceramic string insulator, or a cycloaliphatic epoxy resin insulator, a composite insulator, or other similar insulators generally known in the art.

As mentioned above, over a period of time, the conductors 30 will exert a number of different forces on the cross-arm 10. For example, the weight of the conductors 30 exerts a downward force on the cross-arm 10, temperature related expansion and contraction of the conductors will lead to longitudinal forces on the cross-arm 10, and movement of the conductors 30 when affected by wind will cause forces, such as torsion forces. These forces, generally indicated by reference numeral 20, will also result in a bending moment 22 about a portion where the cross-arm 10 is fastened to the utility pole 32, as shown. The internal web structure 14 provides structural stiffness to the cross-arm 10 so that the cross-arm 10 is better able to withstand such bending forces 20 and bending moment 22 without subsequent damage to the cross-arm 10.

Figure 4 shows the cross-arm installation of Figure 3 in more detail. The cross-arm 10 is fitted to the utility pole 32 by means of a bolt 36. Figure 4B shows a closer view of the cross-arm 10 as fixed to the pole 32. As the bolt 36 is inserted into the pole 32 and tightened, this results in a crushing force 24. Similarly, Figure 4C shows a closer view of an example of the fasteners/insulators 34 used to attach the electrical conductors 30 to the cross-arm 10. As shown, the fastener/insulator 34 can include a nut-and-bolt arrangement passing through the cross-arm 10 to secure the fastener/insulator 34 thereto. Again, a crushing force 25 can be caused by bolting the fastener/insulator 34 to the cross-arm 10, as shown.

However, the internal web structure 14 strengthens the cross-arm against such crushing forces 24 and 25. This is an important feature, as it simplifies installation time and effort required. For example, hydraulic or pneumatic tools or torque wrenches are often used to fasten bolts 36 and fasteners/insulators 34. It is not uncommon for technicians fastening the bolts 36 and fasteners 34 to use an incorrect torque setting on a torque wrench or to use
excessive force when fastening the bolts or fasteners. The internal web structure 14 provides sufficient structural support so that the use of excessive force does not deform or otherwise damage the cross-arm 10. Even in the event that damage occurs, this will tend to be in the form of minor deformation of the arm material so that excessive force will not lead to cracking of the cross-arm, as is common with known composite cross-arms.

It is to be appreciated that the cross-arm 10 and internal web structure 14 can have any number of different configurations. Figures 5A and 5B show further examples of cross-arms having different configurations. Figure 5A shows a cross-arm 10 having a body 12 with a generally square cross-section with a tilted square cross-sectional internal web structure 14 as shown. The internal web structure 14 strengthens the cross-arm 10 against bending and crushing forces, as described above.

Figure 5B shows a yet further example of a cross-arm 10 having a hexagonal shaped cross-section with a square cross-sectional internal web structure 14. Once again, the internal web structure 14 strengthens the cross-arm 10 against bending and crushing forces, as described above. One advantage of the cross-arm of Figure 5B is that the cross-arm includes a sloped upper surface, allowing water to flow off the upper surface of the cross-arm.

In one example, generally dictated by design and application requirements, the cross-arm 10 includes an insulative coating. Such a coating can be applied according to a number of different techniques, including immersion coating, hot melt coating, spray coating, a slip-on sleeve coating, a heat shrink coating, etc. The coating is typically used to electrically insulate the cross-arm 10 and can include any number of insulating materials, e.g. silicon, rubber, epoxy resin, polymers, etc. The coating may partially or fully enclose the cross-arm 10.

Similarly, Figure 6 shows one example of a cross-arm 10 which defines corner portions 38 that are shaped and dimensioned to engage a slip-fit insulative sleeve or cover 42 in a complementary fashion, as shown in more detail in Figures 8 and 9. In this example, the insulative cover 42 includes edge portions 44 that are shaped and dimensioned to engage the corner portions 38 to secure the cover 42 to the cross-arm 10. In a further example, the insulative cover 42 may define suitable channels in which the corner portions 38 can be slid so that the cover 42 is fixed about the cross-arm 10 along a length thereof. In a yet further example, described in more detail below with reference to Figures 7, 10 and 11, a similar
insulative cover 58 can be incorporated into, or coupled to, part of a washer-type arrangement or bushing used when attaching the fastener or insulator 34 to the cross arm 10.

The cover 42, 58 is typically manufactured from an insulating material and generally serves two important features. Firstly, the cover 42, 58 prevents potential electrical short circuit faults by isolating wildlife, such as birds, from the cross-arm 10 should the wildlife bridge the insulator/s 34. Secondly, the cover 42, 58 prevents potential electrical faults in circumstances where the conductor 30 becomes detached from the insulator 34 and comes to rest directly on the cross-arm 10. For this reason, the cover 42, 58 is manufactured from a material having suitable insulating properties.

In the shown example, the cover 42 is U-shaped to cover an upper surface of the cross-arm 10 along with upper portions of the sides thereof, as shown in Figure 8. This U-shaped cover is useful in preventing potential electrical faults where an animal, such as a bird, rests on an edge of the cross-arm 10 with toes or claws of the animal coming into contact with the sides thereof. The cover 42, 58 finds particular application to isolate wildlife from the cross-arm 10 when such wildlife is sitting or perched on the cross-arm 10.

The above described arrangement provides for a light but strong aluminium cross-arm 10 which has the internal web structure 14 providing structural strength to the cross-arm 10. This enables the cross-arm 10 to withstand changing load-induced forces 20 for extended periods of time, as well as crushing forces 20 due to installation of the cross-arm 10 to a utility pole or similar structure. The cross-arm 10 is further strengthened against torsion forces 20.

The cross-arm 10 is typically manufactured from marine-grade aluminium (in one example grade 6351 Temper T6) using an extrusion process. Aluminium offers good structural strength whilst minimizing weight. The cross-arm 10 can further be designed to ensure resistance to metal fatigue, as aluminium has known fatigue characteristics. Various grades of aluminium have enhanced corrosion resistance, as it forms an oxide layer on its outer surface, which is particularly useful in outdoor cross-arm applications. However, the cross-arm 10 can also be manufactured from other materials, such as steel, polymers, or the like.

As briefly mentioned above, it is to be appreciated that the cross-arm may 10 also be used in conjunction with a bushing 40, as shown in Figure 7. The bushing 40 is typically made from
an insulating material and fits through suitable transverse apertures in the cross-arm 10, as shown. With reference to Figures 10 and 11, the bushing 40 typically includes a top part 46 and a lower part 48, each for fitment through a respective aperture from opposed sides of the cross-arm, with each part 46, 48 typically having a flange portion 50, 52 for operatively resting on an external surface of the cross-arm to insulate the insulator or fastener 34 from the cross-arm.

The bushing parts 46, 48 include a hollow aperture 54, 56 for receiving a bolt and or insulator pin and the flange portions 50, 52 form integral washers arranged on opposite sides of the cross-arm 10 when in use. These integral washers seal against the outer surface of the cross-arm 10 when the bolts 36 and/or fasteners/insulators 34 are fastened, as described above. The integral washers also typically form part of an insulating barrier between the cross-arm 10 and the insulator 34 mounted thereto.

Similarly, the bushing 40 itself isolates the insulators or fasteners 34 from the cross-arm 10 which provided two important features. Firstly, the bushing 40 prevents potential electrical faults where the line insulator 34 can crack or fail prematurely, which results in a conductive path through the supporting pin of the insulator 34 when the pin comes in contact with the cross-arm 10. This would lead to dangerous potential voltages on the cross-arm 10 if the supporting pin of the insulator 34 is not isolated via the washers defined by the bushing 40. Secondly, the bushing 40 provides a galvanic barrier between the dissimilar metals of the supporting pin of the insulator or fastener 34 and the cross-arm 10.

In one example, the bushing parts 46, 48 can be inserted into and engage apertures in the cross-arm 10, thereby allowing the bushing parts 46, 48 to be retained therein. This could be achieved using any suitable mechanism, such as through the use of a suitable clip or friction fit arrangement. Alternatively, however, the bushing parts can extend across the entire width of the cross-arm 10 and arranged to clip together when joined in the middle of the cross-arm. It will also be appreciated that in use, the bushing parts 46, 48 will be retained by the bolt 36 or fastener 34 inserted therethrough, so engagement of the bushing parts with the cross-arm 10 may not be required, although this typically assists with installation and transport by ensuring the bushing parts 46, 48 are held in position before the bolt 36 is inserted therethrough.
In one example, the top bushing part 46 includes a bushing cover 58 formed integrally with the flange 50, which can be designed to assist in retaining the cover 42 in place. To achieve this, the bushing cover 58 includes a ridge 60, defining an end piece 62, having end edge pieces 64. In use, the top bushing cover 58 and the cover 42 are arranged so that the end piece 62 is provided between the cover 42 and the cross-arm 10, with the cover 42 abutting against the ridge 58. In this arrangement, the end edge pieces 64 are positioned within the cover edge portions 44, so that the end edge pieces 64 prevent the cover 42 from being removed.

The above described arrangement also includes a method of manufacturing the cross-arm 10. The method generally includes the step of extruding the elongate tubular body 12 which is shaped and configured for fitment to the utility pole, the body 12 including the internal web structure 14 shaped and configured to strengthen the cross-arm against bending, crushing and torsion forces, as described above.

Persons skilled in the art will appreciate that numerous variations and modifications will become apparent. All such variations and modifications which become apparent to persons skilled in the art should be considered to fall within the spirit and scope of the invention broadly appearing and described in more detail herein.

It is to be appreciated that reference to "one example" or "an example" of the invention is not made in an exclusive sense. Accordingly, one example may exemplify certain aspects of the invention, whilst other aspects are exemplified in a different example. These examples are intended to assist the skilled person in performing the invention and are not intended to limit the overall scope of the invention in any way unless the context clearly indicates otherwise.

Features that are common to the art are not explained in any detail as they are deemed to be easily understood by the skilled person. Similarly, throughout this specification, the term "comprising" and its grammatical equivalents shall be taken to have an inclusive meaning, unless the context of use clearly indicates otherwise.
The claims defining the invention are as follows:

1) A cross-arm for supporting an electrical line, the cross-arm including:
   a) an elongate tubular body for fitment to a utility pole; and
   b) an internal web structure arranged inside the body, said web structure being shaped
      and configured to strengthen the body against bending, crushing and torsion forces.

2) The cross-arm of claim 1, which is manufactured from aluminium.

3) The cross-arm of either one of claims 1 or 2, which is manufactured using an extrusion
   process.

4) The cross-arm of any one of claims 1 to 3, wherein the tubular body has a polygonal
   cross-section.

5) The cross-arm of claim 4, wherein the tubular body has a square cross-section.

6) The cross-arm of any one of claims 1 to 5, wherein the tubular body is configured for
   fitment to a utility pole by defining apertures for receiving suitable attachment means.

7) The cross-arm of any one of claims 1 to 6, wherein the internal web structure is extruded
   together with the body during manufacture of the cross-arm.

8) The cross-arm of any one of claims 1 to 7, wherein the internal web structure includes a
   number of members arranged in a grid along a length of the cross-arm.

9) The cross-arm of any one of claims 1 to 7, wherein the internal web structure includes an
   inner offset portion having the same cross-sectional profile of the body, the offset portion
   attached to the body by fillet portions.

10) The cross-arm of any one of claims 1 to 9, which includes an insulative coating.

11) The cross-arm of any one of claims 1 to 10, which defines corner portions shaped and
    dimensioned to receive an insulative sleeve or cover in a complementary manner.

12) The cross-arm of claim 11, which includes an insulative sleeve or cover.

13) The cross-arm of any one of claims 1 to 12, which includes an insulative bushing for
    isolating an insulator or fastener from the cross-arm.

14) The cross-arm of claim 13, wherein the bushing includes two parts, each for fitment
    through an aperture from opposed sides of the cross-arm, each part having a flange
    portion for operatively resting on an external surface of the cross-arm to insulate an
    insulator or fastener from the cross-arm.

15) The cross-arm of any one of the claims 1 to 14, wherein the cross-arm includes an
    insulative bushing and a cover, and wherein at least part of the bushing is for engaging
    the cover to thereby retain the cover in position.
16) The cross-arm of claim 15, wherein the cover includes shaped edge pieces, and wherein the bushing includes a bushing part having end edge pieces for insertion into the shaped edge pieces, thereby retaining the cover in position.

17) A method of manufacturing a cross-arm, said method including the step of extruding an elongate tubular body for fitment to a utility pole, the body including an internal web structure shaped and configured to strengthen the body against bending and crushing forces.

18) The method of claim 17, wherein the step of extruding includes extruding the body from aluminium.

19) The method of either of claims 17 or 18, which includes the step of coating the cross-arm with an insulative coating.

20) A cross-arm, or method of manufacturing a cross-arm, substantially as hereinbefore described.

21) A cross-arm, or method of manufacturing a cross-arm, substantially as hereinbefore described and illustrated with reference to the accompanying drawings.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.
E04H 12/24 (2006.01)  H02G 7/20 (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 E04H 12/-, H02G H-*, E04C J- and keywords (cross, horizontal, arm, web, internal, wall, rib, stiff, aluminium, extrude, pultrude, sleeve, sheath, shield, cover, insulate) and like terms;

WPI & EPODOC - keywords (electric, power, utility, line, cable, wire, pole, aluminium, web, horizontal, cross, arm, member) and like terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>X</td>
<td>US 5197253 A (JOHNSON) 30 March 1993 Figs. 14, 25 &amp; 26, abstract</td>
<td>1=3,7,8</td>
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<tr>
<td>Y</td>
<td>AU 2002223738 B2 (TECHNILUM) 2 November 2006 Figs. 1, 2 &amp; 6, abstract, page 4 lines 16 to 21</td>
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<td>Y</td>
<td>GB 1179950 A (BRITISH INSULATED CALLENDE &amp; CABLES LTD) 4 February 1970 Figs. 1-3, page 1 lines 61 to 65, page 2 lines 38 to 41 &amp; 47 to 50</td>
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<td>Y</td>
<td>US 5605017 A (FINGERSON et al) 25 February 1997 Figs. 1-3, abstract</td>
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X Further documents are listed in the continuation of Box C

* Special categories of cited documents:

‘A’ document defining the general state of the art which is not considered to be of particular relevance

‘E’ earlier application or patent but published on or after the international filing date

‘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)

‘O’ document referring to an oral disclosure, use, exhibition or other means

‘P’ document published prior to the international filing date but later than the priority date claimed

“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

“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

“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

“&” document member of the same patent family

Date of the actual completion of the international search
23 August 2010

Date of mailing of the international search report
08 SEP 2010

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Form PCT/ISA/210 (second sheet) (July 2009)
<table>
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<td>Y</td>
<td>US 5809734 A (TURNER) 22 September 1998 Figs. 1-3d &amp; 10</td>
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<td>Derwent Abstract Accession No. 1976-E03 17X</td>
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<td>DE 2436547 A1 (ORNO) 22 April 1976 Abstract, Figs 1-18</td>
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<td></td>
<td>JP 2007-68252 A (CHUGOKU DENRYOKU KK ) 15 March 2007 Abstract, Figs 1-7</td>
<td>11,12</td>
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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. [X] Claims Nos.: 20 & 21
   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 20 & 21 do not comply with Rule 6.2(a) because they rely on references to the description and/or drawings.

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)

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.

END OF ANNEX