**Title**: IMPROVEMENTS RELATING TO SCREWS AND THREADFORMS

A screw thread having a threadform comprising a ridge (21) rising from root (23) to crest (26) with the crest having two peaks (27, 28) separated by a through (29) the depth of which is less than the height of the ridge from root to crest. It has particular use as a screw for timber, and is especially suited to fixing railway rails to sleepers.
### FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

<table>
<thead>
<tr>
<th>Code</th>
<th>Country</th>
<th>Code</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>AL</td>
<td>Albania</td>
<td>LS</td>
<td>Lesotho</td>
</tr>
<tr>
<td>AM</td>
<td>Armenia</td>
<td>LT</td>
<td>Lithuania</td>
</tr>
<tr>
<td>AT</td>
<td>Austria</td>
<td>LU</td>
<td>Luxembourg</td>
</tr>
<tr>
<td>AU</td>
<td>Australia</td>
<td>LV</td>
<td>Latvia</td>
</tr>
<tr>
<td>AZ</td>
<td>Azerbaijan</td>
<td>MC</td>
<td>Monaco</td>
</tr>
<tr>
<td>BA</td>
<td>Bosnia and Herzegovina</td>
<td>MD</td>
<td>Republic of Moldova</td>
</tr>
<tr>
<td>BB</td>
<td>Barbados</td>
<td>MG</td>
<td>Madagascar</td>
</tr>
<tr>
<td>BE</td>
<td>Belgium</td>
<td>MK</td>
<td>The former Yugoslavia</td>
</tr>
<tr>
<td>BF</td>
<td>Burkina Faso</td>
<td>ML</td>
<td>Mali</td>
</tr>
<tr>
<td>BG</td>
<td>Bulgaria</td>
<td>MN</td>
<td>Mongolia</td>
</tr>
<tr>
<td>BJ</td>
<td>Benin</td>
<td>MR</td>
<td>Mauritania</td>
</tr>
<tr>
<td>BR</td>
<td>Brazil</td>
<td>MW</td>
<td>Malawi</td>
</tr>
<tr>
<td>BY</td>
<td>Belarus</td>
<td>MX</td>
<td>Mexico</td>
</tr>
<tr>
<td>CA</td>
<td>Canada</td>
<td>NE</td>
<td>Niger</td>
</tr>
<tr>
<td>CF</td>
<td>Central African Republic</td>
<td>NL</td>
<td>Netherlands</td>
</tr>
<tr>
<td>CG</td>
<td>Congo</td>
<td>NO</td>
<td>Norway</td>
</tr>
<tr>
<td>CH</td>
<td>Switzerland</td>
<td>NZ</td>
<td>New Zealand</td>
</tr>
<tr>
<td>CI</td>
<td>Côte d'Ivoire</td>
<td>PL</td>
<td>Poland</td>
</tr>
<tr>
<td>CM</td>
<td>Cameroon</td>
<td>PT</td>
<td>Portugal</td>
</tr>
<tr>
<td>CN</td>
<td>China</td>
<td>RO</td>
<td>Romania</td>
</tr>
<tr>
<td>CU</td>
<td>Cuba</td>
<td>RU</td>
<td>Russian Federation</td>
</tr>
<tr>
<td>CZ</td>
<td>Czech Republic</td>
<td>SA</td>
<td>Saint Lucia</td>
</tr>
<tr>
<td>DE</td>
<td>Germany</td>
<td>SD</td>
<td>Sudan</td>
</tr>
<tr>
<td>DK</td>
<td>Denmark</td>
<td>SE</td>
<td>Sweden</td>
</tr>
<tr>
<td>EE</td>
<td>Estonia</td>
<td>SG</td>
<td>Singapore</td>
</tr>
<tr>
<td>SI</td>
<td>Slovenia</td>
<td>SK</td>
<td>Slovakia</td>
</tr>
<tr>
<td>SN</td>
<td>Senegal</td>
<td>SZ</td>
<td>Swaziland</td>
</tr>
<tr>
<td>TD</td>
<td>Chad</td>
<td>TG</td>
<td>Togo</td>
</tr>
<tr>
<td>TJ</td>
<td>Tajikistan</td>
<td>TR</td>
<td>Turkey</td>
</tr>
<tr>
<td>TM</td>
<td>Turkmenistan</td>
<td>TT</td>
<td>Trinidad and Tobago</td>
</tr>
<tr>
<td>UA</td>
<td>Ukraine</td>
<td>US</td>
<td>United States of America</td>
</tr>
<tr>
<td>UG</td>
<td>Uganda</td>
<td>UZ</td>
<td>Uzbekistan</td>
</tr>
<tr>
<td>VN</td>
<td>Viet Nam</td>
<td>YU</td>
<td>Yugoslavia</td>
</tr>
<tr>
<td>ZW</td>
<td>Zimbabwe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IMPROVEMENTS RELATING TO
SCREWS AND THREADFORMS

BACKGROUND

This invention concerns the construction of threads for screw fasteners, particularly those for screwing into timber, and has particular application to fasteners for attaching railway track to timber sleepers.

Many forms of screws have been proposed and used for holding railway track to timber sleepers. They have been used with new sleepers and for insertion into holes previously created by spike fasteners, where the holes had enlarged to the point where the spikes were loose, or for so-called spike killed sleepers where no further sound timber was available on a sleeper to drive in a further spike.

It has now been found that a screwed fastening with the novel thread characteristics described hereunder has significant advantages during installation and in track operation performance compared with existing alternatives. Although developed particularly for rail track application, the thread has much wider applications.

SUMMARY OF THE INVENTION

In one aspect the present invention provides a screw thread having a threadform comprising a ridge rising from root to crest with the crest having two peaks separated by a trough the depth of which is less than the height of the ridge from root to crest. Preferably the trough depth is between 10% and 40% of the ridge height, more preferably between 15% and 35%.

In another aspect the invention provides a screw thread having a twin start helical thread configuration consisting of two ridges helically winding around a shank, each
of the ridges having flanks rising from a root to a crest, and at least one of the crests having a pair of peaks. The crests of both of the helically wound ridges may have a pair of peaks. One of the ridges may be higher than the other ridge. Preferably the lower ridge is between 30% and 70% of the height of the higher ridge.

In another aspect the invention provides a twin start screw thread for a fastener, the thread having a repeated threadform profile comprising:

- a first crest, having a first pair of peaks, rising from a first root and falling to a second root, and

- a second crest, having a second pair of peaks, rising from the second root and falling to the first root.

The first crest may be higher than the second crest. Preferably the second crest is between 30% and 70% of the height of the first crest.

In another aspect the invention provides a screw fastener for securing a railway track rail to a timber sleeper, the fastener having a thread as described above.

In a further aspect the invention provides a method of rolling a helical screw thread onto a cylindrical shank of a metal workpiece comprising:

- rolling into the shank initial helical grooves by plastically deforming the metal into a hump immediately to either side of the grooves,
- subsequently deepening and widening the initial grooves by further rolling which increases the size of the humps and displaces the humps increasingly further from the initial grooves,
- further deepening and/or widening the grooves to press the two humps between adjacent grooves into each other until they produce a single ridge with a crest carrying a pair of peaks, and
- finish rolling the crest to more uniformly define the two peaks along the crest of the ridge.
Preferably the height of each pair of peaks, when measured from a trough between said pair, is between 10% and 40% of the height of their respective ridge. More preferably it is between 15% and 30% of the height of the ridge.

Preferably:

- the screw thread has a twin start with said two initial helical grooves axially offset from each other by less than 45% (160°) of their lead,
- the finished thread has the helical crests of the ridges offset by substantially 50% (180°) of their lead, and
- as one helical groove is displaced axially relative to the other helical groove during the rolling process, one helical ridge is produced which is taller than the other.

More preferably the axial offset is between 20% (70°) and 35% (125°) of the thread lead.

In a further aspect the invention provides a screw fastener for securing a railway track rail to a timber sleeper, the fastener having a thread as described above. Preferably the fastener has a head for applying torque to the fastener and a collar integrally formed with the head, the collar having a sloping face facing the thread, said slope matching that of the upper surface of the foot of the rail.

The invention will now be described with reference to the attached drawings which illustrate particular embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an illustration showing a rail fastening screw carrying a thread according to one embodiment of the present invention.

Figure 2 is a diagram showing in detail the threadform on the screw shown in Figure 1.
Figures 3 to 7 show diagrammatically steps in a thread rolling process which produces
the threadform shown in Figure 2.

Figure 8 is an illustration showing a rail fastening screw carrying a thread according
to another embodiment of the invention.

Figure 9 is a diagram showing in detail a threadform similar to that formed on the
screw shown in Figure 8.

Figures 10 to 13 show diagrammatically steps in a thread rolling process which
produces the threadform shown in Figure 8.

DETAILED DESCRIPTION OF THE DISCLOSED EMBODIMENTS

Referring to Figure 1, the rail fastening screw 2 has a head 4, flange 6, plain shank 11,
tapered shoulder 12 and tip 13. Between the shoulder 12 and tip 13 the screw has a
portion into which a thread 15 is rolled.

For the embodiment shown, the screw has the following approximate dimensions:

- total length = 125 mm
- diameter of shank 11 = 16 mm
- pre-roll diameter for thread 15 = 14.5 mm
- diameter of flange 6 = 40 mm
- head = 18 mm diameter 6-lobe head

The flange 6 is tapered, with its top face 8 perpendicular to the major axis 17 of the
screw and its bottom face 9 angled at about 11.5° to the top face. This taper is to
conform with the corresponding taper on the foot of railway rails which the bottom
face 9 bears against in use. The screws may be used to affix a rail with or without the
use of a tie plate between the rail and sleeper.

The thread 15 has a 5mm pitch and 10mm lead. Accordingly it is a twin start thread
with two ridges 21 and 31 of equal height helically winding around a core 19. The
thread is continuous for its length on the screw. The crest of each ridge 21 and 31
carries a pair of peaks along its length and these will now be described.
With reference to Figure 2, the threadform is indicated as the solid line in the illustration. It should be noted that the cross section through the thread so illustrated is not parallel to the axis 17 of the screw, but is instead at the helix angle to the axis 17 in order to be at right angles to the line of the ridges 21 and 31. The illustration shows the twin start thread consisting of identical of ridges 21 and 31 respectively separated by roots 23 where the thread rolling process has pressed most deeply into the metal of the shank 14. The distance of the roots 23 from the axis 17 defines the radius of the core 19 of the threaded shank 14.

Working from the left side of Figure 2, the threadform profile rises from a root 23 to the ridge 21 by way of a flank 24 which rises to a crest 26. This crest carries two peaks 27 and 28 with a trough 29 between them. From peak 28 the ridge falls down a flank 25 to the root 23 which is of the same depth as the root on the other side of the ridge 21. The threadform then repeats its sequence for ridge 31. Ridges 21 and 31 are the two ridges which form the twin start thread.

Figure 3 illustrates diagrammatically the positioning of initial tips 71 to 73 of contact upon a cylindrical workpiece by a die in a thread rolling operation which is to produce a twin start thread with evenly spaced, evenly sized ridges in the threadform. The tips 71 to 73 are evenly spaced along the workpiece. Another way of expressing this is to say the helical grooves the tips would produce are offset from each other by 180° or 50% of their lead.

Referring to Figure 4, when the tips 71 to 73 are rolled into the surface of the workpiece, two helical grooves 177 and 178 are produced. The thread rolling die is configured so that the groove 77 made by tip 71 is contiguous with the groove made by tip 73. Grooves 177 and 178 are evenly spaced along the workpiece.

To either side of grooves 177 and 178 is a hump of metal 122 to 125 which has been plastically deformed from the groove area. Figures 5, 6 and 7 illustrate successive stages in the thread rolling operation as the grooves 177 and 178 are deepened and
widened through their stages 277 and 278, to 377 and 378 and to 477 and 478. The skilled person will be able to follow the operations from the illustrations without further detailed description. As the grooves are deepened and widened, the humps show an increased size and increased displacement of position in successive stages, and in Figures 3 to 7 their identifying numerals have been changed only by the hundreds digit in order to identify them more easily.

Of particular relevance is that hump 122/222/322 and hump 123/223/323 converge to form a ridge, with its two peaks separated by the shallow trough 328, and that similarly hump 124/224/324 and hump 125/225/325 converge to form the other ridge with its two peaks separated by the shallow trough 329.

The final stage of the rolling operation is for the rolling dies to finish roll the crests, including down into the troughs 428 and 429, to more uniformly define the peaks 422 to 425 and the troughs 428 and 429 between the peaks.

Referring now to the embodiment in Figure 8, this shows a rail fastening screw 43 similar to the screw in Figure 1, the only significant difference being the thread configuration. The thread 45 of this screw 43, like the thread of the screw in Figure 1, has a 5mm pitch and 10mm lead. Accordingly it is a twin start thread with two ridges 51 and 61 helically winding around a core 49. Ridge 51 is significantly higher than ridge 61 and both maintain their heights for the length of the thread, so the thread is continuous for its length on the screw. The dimensions of the screw are the same as those given above for the embodiment shown in Figure 1, except that for the Figure 8 embodiment, the pre-roll diameter for the thread 45 is somewhat smaller being approximately 12mm. The crest of each ridge 51 and 61 carries a pair of peaks along its length and these will now be described with reference to Figure 9.

The threadform shown in Figure 9 is slightly different to that in Figure 8. In particular, the root 53 in Figure 9 is more squared off than the corresponding part of the threadform in Figure 8. However this difference may be allowed for by the skilled reader.
With reference to Figure 9, the threadform is indicated as the heavy line highest in the illustration. It should be noted that the cross section through the thread so illustrated is not parallel to the axis 47 of the screw, but is instead at the helix angle to the axis 47 in order to be at right angles to the line of the ridges 51 and 61. The threadform can be seen to consist of alternating high and low ridges 51 and 61 respectively separated by roots 53 where the thread rolling process has pressed most deeply into the metal of the shank 44. The distance of the roots 53 from the axis 47 defines the radius of the core 49 of the threaded shank 44.

Working from the left side of Figure 9, the threadform profile rises from a root 53 to the ridge 51 by way of a flank 54 which rises to a crest 56. This crest carries two peaks 57 and 58 with a trough 59 between them. From peak 58 the ridge falls down a flank 55 to the root 53 which is of the same depth as the root on the other side of the ridge 51. The threadform profile then rises to the ridge 61 by way of a flank 64 which rises to a crest 66. The ridge 61 is significantly lower than the ridge 51. The crest 66 carries two peaks 67 and 68 with a trough 69 between them. From the peak 68 the ridge falls down a flank 65 to the root 53 from where the threadform repeats its sequence. The trough 69 has a shallower form than trough 59.

The scales on the axes of Figure 9 indicate the dimensions in mm for the threadform. The higher ridge 51 rises 2.5mm from the root while the lower ridge 61 rises 1.25mm. The higher trough 59 is 0.7mm deep while the lower trough 69 is 0.25mm deep. The lower ridge is thus 50% of the height of the higher ridge, and thus within the preferred range of 30% to 70%. Also, the higher trough is 28% of the height of the higher ridge, while the lower trough is 20% of the height of the lower ridge, thus within the more preferred range of 15% to 35%.

The threadform profile may be defined such that it resembles a compound of sinusoidal wave forms. Two such curves are shown in the lower portion of Figure 9.
Curve 40 illustrates the relationship:

\[ f(t) = a_1 \sin \omega t \quad \text{for } 39^\circ \leq t \leq 219^\circ \]

Curve 42 illustrates the relationship:

\[ f(t) = a_2 \sin 3\omega t \quad \text{for } 39^\circ \leq t \leq 219^\circ \]

Accordingly the threadform can be approximated by the compound relationship:

\[ f(t) = A(a_1 \sin \omega t + a_2 \sin 3\omega t + C) \quad \text{for } 39^\circ \leq t \leq 219^\circ \quad \text{and} \]
\[ f(t) = 0 \quad \text{for } 219^\circ \leq t \leq 219^\circ + \phi \]

where \( a_1 \geq a_2 \)

This relationship defines a single cycle of the threadform which is repeated along the threaded shank 44.

Alternatively the threadform can be approximated by defining as linear dimensions the height, width and separation of the ridges and defining their shape by a series of straight lines at set angles connected by radiused curves.

Figure 10 illustrates diagrammatically the positioning for initial tips 81 to 84 to make contact upon a cylindrical workpiece by a die in a thread rolling operation where the intent is to produce a twin start thread with evenly spaced, unevenly sized ridges in the threadform in accordance with one embodiment of the present invention. When the tips 81 to 84 are rolled into the surface of the workpiece, two helical grooves 187 and 188 are produced. The thread rolling die is configured so that the groove 187 made by tip 81 is contiguous with the groove made by tip 83. In the same way the tips 82 and 84 together make groove 188. Grooves 187 and 188 are not evenly spaced along the workpiece. They are axially offset from each other by 90° or 25% of their lead.

To either side of grooves 187 and 188 are ridged humps of metal 102 to 105 which have been plastically deformed from the groove area. Figures 10 to 13 illustrate successive stages in the thread rolling operation as the grooves 187 and 188 are
deepened and widened through their stages 287 and 288, to 387 and 388, and to 487 and 488. From the study of Figures 10 to 13 the skilled person will be able to follow the operations without further detailed verbal description. For the purposes of explaining the process, as the humps develop an increased size and increased displacement of position in successive stages, their respective identifying numerals in Figures 10 to 13 have been changed only by the hundreds digit in order to identify them more easily.

Of particular relevance is that hump 102/202/302/402 and hump 103/203/303/403 converge to form the low ridge, with its two peaks separated by the shallow trough 411, and that similarly hump 104/204/304/404 and hump 105/205/305/405 converge to form the high ridge with its two peaks separated by the shallow trough 412.

The final stage of the rolling operation is for the rolling dies to finish roll the crests, including down into the troughs 411 and 412, to more uniformly define the peaks 402 to 405 and the troughs between them.

The embodiment of the invention described with reference to Figures 10 to 13 involves the initial helical grooves 187 and 188 being axially offset from each other by 90° or 25% of their lead. The extent of offset chosen for other embodiments is greatly influenced by the intended difference in size wanted between the sizes of the final ridges. The size difference becomes significantly beneficial at an offset less than 45%, and even more so at less than 35% offset. But at less than 20% the amount of metal relocation required in the thread rolling process tends to become too high. A 20% offset corresponds to about 70° of lead, 35% to about 125° and 45% to about 160°.

Although the above descriptions with reference to Figures 3 to 7 and Figures 10 to 13 refer to stages of a thread rolling operation, such an operation need not be a series of separate steps. In fact the stages preferably form a continuous procedure by careful design of the thread rolling dies and this will be understood by the skilled worker.
RAMIFICATIONS AND CONCLUSION

While testing has confirmed screw fasteners incorporating the present threadform perform better than conventionally threaded fasteners of the same size, the full reasons are not completely understood. However a possible explanation for at least part of the advantage has been developed. While it is now offered in order to explain the physical effects at work in a screwed fastener’s operation, it is not intended to limit the scope of the invention thereby.

Conventional threads for wood screws have crests which have a single sharp edge. It has previously been thought that this is advantageous because it cuts through the wood fibres and so achieves maximum penetration. Failure of the fastening system usually occurs by tearing of the timber as the screw pulls out, bringing with it a torn plug of timber the diameter of which is the same as the outside diameter of the thread. In contrast the present invention attempts to reduce the degree to which the wood fibres are cut. Instead, the penetration of the threadform into the adjacent timber is more by way of compressing the timber rather than cutting it. This leaves the wood fibres longer and more intact, thereby causing less weakening of the timber’s structure. Also, because the timber is significantly compressed, the timber exhibits a higher strength. The process of compressing the timber instead of cutting into it is particularly prevalent at the crest 66 of the lower ridge 61 of the threadform shown in Figure 9.

It will be appreciated that fasteners incorporating the threadform described above are not restricted to rail track applications. The characteristics which make them desirable for that purpose make them similarly useful for fastening to any timber item or to other similar types of dense fibrous or fibre reinforced materials. Particular applications are envisaged in landscaping and in fastening planks on piers and jetties for example. Fasteners incorporating the threadform may also be screwed into non fibred materials, such as plastic plugs inserted into spike killed timber sleepers, and
may be installed in other applications where conventional screws would have otherwise been used.

Throughout this specification, unless the context requires otherwise, the word “comprise”, and variations such as “comprises” and “comprising”, will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Finally, it is to be understood that various alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention.
CLAIMS

1. A screw thread having a threadform comprising a ridge rising from root to crest with the crest having two peaks separated by a trough the depth of which is less than the height of the ridge from root to crest.

2. A screw thread according to claim 1 wherein the trough depth is between 10% and 40% of the height of the ridge.

3. A screw thread according to claim 2 wherein the trough depth is between 15% and 35% of the height of the ridge.

4. A screw thread having a twin start helical thread configuration consisting of two ridges helically winding around a shank, each of the ridges having flanks rising from a root to a crest, and at least one of the crests having a pair of peaks.

5. A screw thread according to claim 4 in which the crests of both of the helically wound ridges have a pair of peaks.

6. A screw thread according to either claim 4 or 5 in which one of the ridges is higher than the other ridge.

7. A screw thread according to claim 6 in which the lower ridge is between 30% and 70% of the height of the higher ridge.

8. A twin start screw thread for a fastener, the thread having a repeated threadform profile comprising:
   - a first crest, having a first pair of peaks, rising from a first root and falling to a second root, and
   - a second crest, having a second pair of peaks, rising from the second root and falling to the first root.
9. A screw thread according to claim 8 wherein the first crest is higher than the second crest.

10. A screw thread according to claim 9 wherein the second crest is between 30% and 70% of the height of the first crest.

11. A screw fastener for securing a railway track rail to a timber sleeper, the fastener having a thread according to any one of the previous claims.

12. A method of rolling a helical screw thread onto a cylindrical shank of a metal workpiece comprising:
   - rolling into the shank initial helical grooves by plastically deforming the metal into a hump immediately to either side of the grooves,
   - subsequently deepening and widening the initial grooves by further rolling which increases the size of the humps and displaces the humps increasingly further from the initial grooves,
   - further deepening and/or widening the grooves to press the two humps between adjacent grooves into each other until they produce a single ridge with a crest carrying a pair of peaks, and
   - finish rolling the crest to more uniformly define the two peaks along the crest of the ridge.

13. A method according to claim 12 wherein the height of each said pair of peaks, when measured from the bottom of a trough between each pair, is between 10% and 40% of the height of their respective ridge.

14. A method according to claim 13 wherein the height of each said pair of peaks, when measured from the bottom of a trough between each pair, is between 15% and 35% of the height of their respective ridge.
15. A method according to any one of claims 12 to 14 wherein:
   – the screw thread has a twin start with two said initial helical grooves axially offset from each other by less than 45% (160°) of their lead,
   – the finished thread has the helical crests of the ridges offset by substantially 50% (180°) of their lead, and
   – as one helical groove is displaced axially relative to the other helical groove during the rolling process, one helical ridge is produced which is taller than the other.

16. A method according to claim 15 wherein the axial offset of the two initial helical grooves is between 20% (70°) and 35% (125°) of the thread lead.

17. A screw fastener according to claim 11 having a head for applying torque to the fastener and a collar integrally formed with the head, the collar having a sloping face facing the thread, said slope matching that of the upper surface of the foot of the rail.

18. A screw fastener as herein described with reference to Figures 1 and 2.

19. A screw fastener as herein described with reference to Figure 8.

20. A method of rolling a helical screw thread onto a cylindrical shank of metal as herein described with reference to Figures 3 to 7.

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl: B21H 3/02 E01B 29/28 F16B 33/02

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC B21H 3/02 E01B 29/28 F16B 33/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

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

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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Derwent Abstract Accession no: 96-504109/50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Class Q41 Q61</td>
<td></td>
</tr>
<tr>
<td></td>
<td>JP 8261221 A (SHIKOKU RYOKYAKU TETSUDO KK)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 October 1996</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Abstract</td>
<td>1-3</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>4-21</td>
</tr>
</tbody>
</table>

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
"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: 2 December 1998
Date of mailing of the international search report: 11 DEC 1998

Name and mailing address of the ISA/AU
AUSTRALIAN PATENT OFFICE
PO BOX 200
WODEN ACT 2606
AUSTRALIA
Facsimile No.: (02) 6285 3929

Authorized officer
D.G. FRY
Telephone No.: (02) 6283

Form PCT/ISA/210 (second sheet) (July 1998) copcas
<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>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 4144795 A (GITSHALL) 20 March 1979 Whole document</td>
<td>1-21</td>
</tr>
<tr>
<td>A</td>
<td>DT 2550817 A (INDUSTRIAL FASTENERS Corp) 20 May 1976 Whole document</td>
<td>1-21</td>
</tr>
<tr>
<td>A</td>
<td>GB 548516 A (EVERY) 13 October 1942 Whole document</td>
<td>1-21</td>
</tr>
</tbody>
</table>
INTERNATIONAL SEARCH REPORT
Information on patent family members

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.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DE 2550817</td>
<td>AT 8318/75</td>
</tr>
<tr>
<td></td>
<td>CH 606839</td>
</tr>
<tr>
<td></td>
<td>FR 2291397</td>
</tr>
<tr>
<td>GB 1494015</td>
<td>NL 7513258</td>
</tr>
<tr>
<td></td>
<td>NO 753781</td>
</tr>
<tr>
<td>SE 7512754</td>
<td>US 4046051</td>
</tr>
</tbody>
</table>