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FENCE PANEL
ZAUNPLATTE
PANNEAU DE CLÔTURE

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Proprietor: Zaun Limited Wolverhampton WV10 9ED (GB)

Inventors:
• PAINTER, Paul, Antony Wolverhampton WV10 9ED (GB)
• HENMAN, Alastair, Roy Wolverhampton WV10 9ED (GB)

Representative: Blower, Timothy John et al
IP-Active.com Ltd The TechnoCentre Coventry University Technology Park Puma Way Coventry CV1 2TT (GB)

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Description

[0001] The present invention relates to fence panels and fence assemblies, particularly, but not exclusively, fence panels and fence assemblies for providing a high level of security and/or enclosing high impact sports areas. The present invention further relates to apparatus and a method of manufacturing such fence panels and fence assemblies.

[0002] There are a wide variety of fencing constructions/systems known to those skilled in the art and these have various applications. One known type of fencing system comprises a length of fencing mounted on upright posts secured to the ground, wherein the fencing comprises wire which is arranged in a woven mesh. The wire is made of aluminium or steel having a low tensile strength so as to allow the wire to be readily bent through an angle of approximately 90° and woven. Typically, the woven mesh is then stored on a roll and may be subsequently unwound from the roll as required and cut to length so as to form a fencing construction. Documents US-A-3363389, JP-A-2006152616, DE-A-3512115 describe different fence constructions.

[0003] High security fencing should be difficult for an intruder to climb, and difficult for intruders to break through. These requirements are achieved by careful spacing of the wires forming the fencing to provide apertures which are relatively small in at least one direction, and use of high strength wires which resist cutting, cropping and grinding. Because of the low tensile strength of the wire, conventional woven mesh fencing is only suitable for low and medium security applications preventing access to an area beyond the fencing system. Furthermore, the weaving process used does not permit the formation of apertures which are relatively small in at least one direction, which are required in high security fencing.

[0004] Another known type of woven mesh is referred to as chain link fencing. In chain link fencing, wires run vertically and are bent into a zig-zag pattern so that each "zig" hooks with the wire immediately on one side and each "zag" with the wire immediately on the other, forming a characteristic diamond pattern. The disadvantage of this type of fencing is that, if one of the wires is broken or severed, either deliberately or through wear or impact, the fence can unzip or be unzipped along the length of the severed wire, opening a large gap to permit intruder entry. For this reason, chain link fencing is generally regarded as being unsatisfactory for high security or high energy impact applications.

[0005] Fencing for enclosing high impact sports areas is required to provide both enclosure and security, and also withstand the high energy impact of fast moving objects such as hockey balls and cricket balls, which are hard and can travel at speeds of up to 145 km/h (90 mph). Conventional woven fencing has been used in such applications but does not provide sufficient long term impact resistance because of the relatively low tensile strength of the wire.

[0006] A further problem of conventional woven fencing is that the weaving process cannot be used for galvanised high tensile steel as the high forces required to hold and bend the wire tend to damage the galvanised coating. Galvanising after weaving would not be acceptable because potential movement between the wires would damage the galvanising, and due to the cost and the quality of the surface finish.

[0007] Another known type of fencing is the welded mesh fence, which is produced on rolls or in flat panels. Typically, panels are manufactured from straight elongated steel rods which are arranged in a grid-like configuration with rods extending in a first direction being overlaid by, and welded to, rods extending in a second direction. Typically, the two directions are at 90° to one another so that, when a panel is mounted to a fence post, one group of rods extends horizontally and a second group of rods extends vertically. The rods may be galvanised as required.

[0008] In respect of welded mesh fences, the tensile strength of the steel rods used must also be limited due to problems with the integrity of the welded joints between the first and second groups of rod. Specifically, steel having a tensile strength greater than 800 N/mm² is not generally used in welding, as the welds formed are relatively brittle and quickly fail. A further constraint of the welded system is that it is impractical to weld the preferred rod spacing configuration of 12.7 mm x 12.7 mm for very high security applications. This is because the high energy input of the welding process warps the panel. Also, the high cost of machinery and power infrastructure to permit such a configuration to be welded is prohibitive. Furthermore, welded mesh fencing is susceptible to damage under repeated high energy impacts such as those described above in relation to high impact sports areas, as the welds break under repeated high energy impact, and the fence can then quickly lose its integrity. Thus, the strength, security and high energy impact resistance provided by conventional welded mesh and welded mesh fencing arrangements is, in practice, unsatisfactory due to limitations of conventional forming processes.

[0009] It will be appreciated therefore that providing a fencing panel for security applications which is more effective than the known flat welded panels is problematic. The strength of a panel cannot be readily increased merely by using a steel of greater tensile strength because the welds between abutting rods tend to weaken as tensile strength increases and become too weak for security applications. If the gauge (i.e. diameter) of the rods is increased, then this can have an adverse affect on the aesthetic appearance and overall weight of the fencing construction. More specifically, the additional weight increases the cost of the steel and also the cost of assembly. Also, the increased gauge reduces the size of the holes between the rods and this reduces the ease with which one can see through the panel, thereby compromising the security characteristics of the fencing system.

[0010] Furthermore, for the same reasons explained
above in respect of the problems with providing an improved security fencing panel, there has also been a long standing need for a fencing panel for sports applications that will not degrade when hit repeatedly by balls - particularly hockey balls which are very hard and travel at speeds of up to 145 km/h (90 mph).

[0011] In addition, there has been a need for a high strength panel which may be conveniently configured to a required rake angle on site so as to follow sloping or uneven terrain.

[0012] It is an object of the present invention to provide a high strength security fencing panel.

[0013] It is a further object of the present invention to provide a high strength mesh panel for high impact applications.

[0014] It is yet further object of the present invention to provide a fencing panel which may be conveniently and comparatively inexpensively manufactured.

[0015] It is also a further object of the present invention to provide a fencing system which may be readily constructed on site.

[0016] The present invention provides a high energy impact resistant, high security fence panel as recited in the appended independent claim 1.

[0017] Further possible features of the present invention are provided as recited in any of the appended dependent claims.

[0018] Embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a first fencing panel of the present invention;
Figure 2 is a side view of the first fencing panel;
Figure 3 is a bottom view of the first fencing panel;
Figure 4 is a perspective view of the first fencing panel;
Figure 5 is a plan view of a second fencing panel of the present invention;
Figure 6 is a side view of the second fencing panel;
Figure 7 is a bottom view of the second fencing panel;
Figure 8 is a plan view of the second fencing panel of the present invention arranged in a first configuration;
Figure 9 is a plan view of the third fencing panel arranged in a second configuration;
Figure 10 is a plan view of the third fencing panel arranged in a third configuration;
Figure 11 is a cross-sectional top view of a first fence assembly comprising a fencing panel as shown in Figure 1, mounted to a fencing post;
Figure 12 is a cross-sectional top view of a second fence assembly comprising a fourth fencing panel according to the present invention mounted to a fencing post;
Figure 13 is a partial perspective view of the arrangement shown in Figure 12;
Figure 14 is a perspective view of the first fencing panel having a modified side end for locating within a fence post;
Figure 15 is a partial cross-sectional side view of a third fence assembly comprising the fencing panel shown in Figure 14 located in a fence post, the cross section being taken through the centre of the fence post;
Figure 16 is a partial plan view of the modified side end of the panel shown in Figure 14;
Figure 17 is a partial perspective view of the fencing panel shown in Figure 14;
Figure 18 is a schematic side view of apparatus for crimping the members of the fencing panels shown in Figures 1 to 17;
Figure 19 is an enlarged partial view of Figure 18;
Figure 20 is a partial cross-sectional view taken along line A-A in Figure 19;
Figure 21 is a front view of a part of a fifth fencing panel of the present invention arranged in a first configuration;
Figure 22 is a partial side view of the part of the fifth fencing panel of Fig 21; and
Figure 23 is a front view of the part of the fifth fencing panel arranged in a second configuration.

[0019] A first, high energy impact resistant, high security fence panel 2 is shown in Figures 1 to 4 of the accompanying drawings. The panel 2 comprise a first group of members in the form of first rods 4 which are woven with a second group of members in the form of second rods 6. Each of the first and second groups 4,6 of rods includes a total of thirty two rods. The panel therefore includes a total of sixty four rods 4,6. It will be understood however that alternative numbers of rods may be used and that the number of rods 4 in the first group can be different to the number of rods 6 in the second group. A typical fence panel may be considerably larger than the one shown in the accompanying drawings and may include a larger number of rods 4,6.

[0020] The first rods 4 of the first group are arranged parallel to one another, and do not cross one another, whilst the second rods 6 of the second group are also arranged parallel to one another, and also do not cross one another. The first rods 4 and the second rods 6 are arranged to cross each other. In one example, and more specifically, the first group of rods 4 are arranged perpendicularly to the rods 6 of the second group. When the fencing panel 2 is mounted to a fencing post (not shown in Figures 1 to 4), the first group of rods 4 is oriented horizontally and the second group of the rods 6 is consequently oriented vertically.

[0021] Furthermore, each rod 4 of the first group is woven with each rod 6 of the second group so as to pass over one rod 6a of the second group, under the next rod 6b, over the next rod 6c and so on (see Figure 1). Similarly, each rod 6 of the second group is woven with each rod 4 of the first group so as to pass over one rod 4a of the first group, under the next rod 4b, over the next rod 4c and so on (again, see Figure 1). Whilst a rod 4,6 of
one group may first pass over a rod 4, 6 of the other group, the next rod 4, 6 in said one group will first pass under a rod 4, 6 of said other group. A one-up-one-down crisscross pattern is thereby created. However, it will be appreciated by a person skilled in the art that other weave patterns may be used.

[0022] In this example, the spacing between neighbouring rods 4, 6 of the first and second groups is the same. A checkerboard-like appearance is thereby created with square-shaped apertures 8 being formed by, and between, the rods 4, 6. The spacing 10 between the centre-lines of neighbouring rods 4 of the first group is 12.7 mm, and the spacing 12 between the centre-lines of neighbouring rods 6 of the second group is also 12.7 mm.

[0023] In this example, the two groups of rods 4, 6 are identical, having the same length, diameter, material and tensile strength. Specifically, the rods 4, 6 each have a diameter 14 of 4 mm and are of a high tensile material (specifically a high tensile galvanised steel). The thickness 28 of the fencing panel 2 is, therefore, 8 mm. The tensile strength of the rods 4, 6 is 1800 N/mm². Rods of other tensile strengths may be used, however the rods should have a tensile strength of at least 800 N/mm², but preferably of at least 1050 N/mm² and ideally in the range of 1200 N/mm² to 1800 N/mm².

[0024] First clear gaps 11 are defined between adjacent first rods 4, and second clear gaps 13 are defined between adjacent second rods 6. In this example, both first and second clear gaps 11, 13 are approximately 8.7 mm. In other examples, the clear gaps could be of different sizes. However, the applicants have found that for high security fencing, at least one of the first and second clear gaps 11, 13 should be no more than 10 mm, as this substantially prevents the entry of fingers (making climbing by an intruder difficult) and tools such as bolt croppers (making breaking through by an intruder difficult). The relative high number density of rods (4, 6) and the high strength of the rods (4, 6) also increases the time it takes for an intruder to break through using a tool such as a hack saw blade or a grinder, increasing the chances of the intruder being discovered while breaking through.

[0025] Each rod 4, 6 is crimped, and optionally then painted or coated with some other protective material (such as a plastics material e.g. PVC), prior to being woven into the fencing panel. The crimping is provided as a series of bends which are spaced equidistant along the length of the rod. Each successive bend along the rods 4, 6 is in an opposite direction to the previous bend and, in this way, each rod bends back and forth in the same plane along its length and essentially remains centred on a straight longitudinal axis 16, 18. The portion 20 of rod 4, 6 extending between a successive pair of bends 22, 24 (see Figure 2 in particular) is straight and the included angle 26 between two neighbouring portions 20 is 160°. In other embodiments of the invention, the geometry of the panel may be modified so that this included angle is different but is nevertheless between 135° and 175°, and preferably between 150° and 175°.

[0026] It will also be understood that, in alternative embodiments, some of the rods 4, 6 may not be crimped. Also, in alternative embodiments, one or more rods may be partially crimped in that only one or more lengthwise portions of the overall length of the rod are crimped.

[0027] The bends of a rod 4 of the first group locate in abutment with a bend of each rod 6 of the second group. The arrangement of the crimping is such that the rods 4 of the first group and the rods 6 of the second group press forcefully against one another. The inherent stiffness of the rods 4, 6 ensures that the panel 2 tends to resist deformation. However, the rods 4, 6 are of a resiliently and elastically deformable material, and a force applied to the panel 2 will tend to displace a rod away from its location within a bend of an abutting rod. This displacement is resisted by a biasing force which results from a bending of a rod as it moves away from said location. The biasing force is generated by a camming action between the abutting rods and tends to bias the displaced rods back towards their original positions.

[0028] Drawing an analogy with textile weaving, the first group of rods 4 may be regarded as "weft" members and the second group of rods 6 may be regarded as "warp" members, which are arranged to provide a "balanced plain weave" construction as shown in Figures 1 to 4.

[0029] Advantageously therefore, the weaving of the high tensile steel rods 4, 6 permits resilient deformation of one or some of the rods 4, 6 under high energy impact. The high energy impact could be provided for example by an intruder attacking the panel 2 with a tool such as a hammer, or could be provided by repeated impact of fast moving objects such as hockey balls and cricket balls. Such action could break the welds of conventional welded mesh panels. In the fence panel of the invention, the combination of high tensile steel rods interconnected by weaving provides a panel with increased resistance to such high energy impacts. The resilient deformation of one or some of the rods 4, 6 permits the panel 2 to absorb such high energy impacts without sustaining damage.

[0030] Unlike chain link fencing, in which all of the members are essentially orientated in the same direction, the severing of one of the members of the fence of the invention does not lead to unzipping along the length of that member, because the two groups of rods are orientated in different directions so that one group crosses the other group. Thus, any one member will be crossed by many members of the other group along its length, which prevent unzipping.

[0031] Although the rods 4, 6 of the two groups are identical, it will be appreciated that, in alternative embodiments, different characteristics for the rods may be provided between the two groups or even within one of the groups (or within both groups). For example, one group may have rods of a different length, diameter, material, and/or tensile strength to the rods of the other group. In
addition, or alternatively, the length, diameter, material, and/or tensile strength of the rods of a group may be varied within the group. For example, the tensile strength of the rods 4 located in a lower part of the fencing panel may be greater than that of the rods located in an upper part of the panel.

[0032] A second, high energy impact resistant, high security fence panel 2' is shown in Figures 5 to 6 of the accompanying drawings. The second fencing panel 2' is a modified version of the first fencing panel 2 of Figures 1 to 4. Accordingly, like components or features of the two panels 2,2' are denoted in the accompanying drawings with like reference numerals. The second fencing panel 2' differs from the first fencing panel 2 only in that the number of rods 6' of the second group is reduced to nine and the spacing 12' between centre-lines of neighbouring rods 6' is increased from 12.7 mm to 50.8 mm. In addition, the crimping of the rods 4' of the first group is modified so that the spacing between a successive pair of bends 22',24' is increased from 12.7 mm to 50.8 mm so as to match the spacing (or pitch) of the rods 6' of the second group. As a consequence, it will be understood that the included angle 26' between two neighbouring portions 20'(extending from a bend of a rod 4' of the first group) is appropriately larger than the included angle 26 of the bends in the rods 6' of the second group (which are the same as for the bends of the rods 4,6 of the first fencing panel 2).

[0033] In this example, the first gaps 11 are still 8.7mm, but the second gaps 13 are somewhat larger, at 46.8mm. The relatively small first gaps 11 provide a high security fence panel as previously described, since they prevent finger entry, but the larger apertures 8 make the fence panel 2' somewhat more vulnerable to attack by tools. This is balanced by lower material usage, less complexity and hence lower manufacturing cost, and greater visibility through the fence panel 2'.

[0034] A third, high energy impact resistant, high security fence panel 2" is shown in Figures 8 to 10 of the accompanying drawings. The third fencing panel 2" is constructed using the same rods 4,6 as in the first fencing panel 2, however the number and spacing of the rods 4,6 in the first and second groups is different. The first group includes a total of fifteen rods 4 with a first centre-line spacing 310 from one another. The second group includes a total of eight rods 6 with a second centre-line spacing 312, which is twice the first spacing 310. In one example, the first spacing 310 could be 25.4 mm and the second spacing 312 could be 50.8 mm. Since the rods of the third fencing panel 2" are identical to those of the first fencing panel 2, it will be appreciated that the crimping of the rods 4,6 in the third fencing panel 2" is identical to that of the rods 4,6 of the first fencing panel 2. However, the crimping may be modified so that the spacing of the bends in the rods 4,6 matches the spacing of the woven rods 4,6. For example, the rods 4 of the first group in the third fencing panel 2" may be replaced with the rods 4' of the second group used in the fencing panel 2' shown in Figures 5 to 7. A similar modification to the pitch of the second group of rods 6 of the third fencing panel 2" may also be made. However, it will be understood that, by retaining the same crimping pitch as for the first fencing panel 2, the included angle 26 remains 160° which assists in maintaining a high level of force biasing the rods 4,6 back towards their original location within the bend 22,24 of an abutting rod 4,6 when displaced therefrom. If the pitch of the crimping is increased and the included angle 26 thereby also increased, then the camming action referred to above, and therefore the biasing force generated, tends to be reduced.

[0035] Nevertheless, the reduced number of rods 4,6 and their increased spacing from one another does reduce the strength and rigidity of the third fencing panel 2" as compared with that of the first fencing panel 2. Effectively therefore, the invention permits a lower security, lower strength panel to be provided by utilising the same rods 4,6 but only interconnecting the rods 4,6 in a proportion of the crimp bends provided.

[0036] Advantageously, the weaving of the rods 4,6 permits relative movement between the first rods 4 and the second rods 6 which will be illustrated as follows. The third fencing panel 2" can be twisted (i.e. raked) within the plane in which it lies so that the angle between the rods 4 of the first group and the rods 6 of the second group is changed from 90° (as shown in Figure 8). With reference to Figure 9 of the accompanying drawings, it will be seen that the included angle 30 between the rods 4 of the first group and the rods 6 of the second group has been reduced to 80°. A third configuration is shown in Figure 10 wherein the third fencing panel 2" has been raked still further (as compared with the second configuration of Figure 9) so that the included angle 30 has been reduced to 70°.

[0037] The relative twisting of the rods 4 of the first group and the rods 6 of the second group generates a biasing force which tends to move the fencing panel 2" back to the original stable configuration shown in Figure 8 wherein the rods 4 of the first group are arranged perpendicularly with the rods 6 of the second group. However, a raked configuration such as those shown in Figures 9 and 10 may be maintained once the fencing panel 2" is securely mounted to a fencing post (not shown in Figures 9 and 10). It will be appreciated that the fencing panel 2" may, in practice, be raked so as to suit a slope of the ground against which the panel 2" is located. Specifically, the rods 6 of the second group may be arranged vertically and parallel with a vertical fence post, whereas the rods 4 of the first group may be arranged at an angle so as to be parallel with, and have the same slope as, the ground.

[0038] It will be appreciated that the first and second fencing panels 2,2' may be raked, however the greater pitch of the rods 4,6 in these panels 2,2' as compared with the pitch of the third fencing panel 2", makes the first and second panels 2,2' more rigid and more difficult to rake.
[0039] Fig 11 shows a cross-sectional top view of a first fence assembly 31 comprising two fencing panels 32, 34 mounted to a fence post 36. The two fencing panels 32, 34 are as shown in Figures 1 to 4, but comprise a larger number of rods 4, 6. More specifically, the panels 32, 34 shown in Figure 11 have a width of 2.50 metres. As such, a complete fencing system makes use of fencing posts 36 as shown in Figure 11 which has a centre-line spacing 38 of 2.55 metres.

[0040] The fence post 36 is rolled from 3 mm sheet steel (which may be optionally heavily galvanised). The sheet steel is rolled into a post 36 which has a top-hat cross-sectional shape as shown in Figure 11. More specifically, the cross-section of the fencing post 36 has a generally rectangular shape with a minor side of the rectangular shape being omitted so as to create an opening 40 into the region defined by the remaining minor side 42 and two opposite major sides 44, 46 of the generally rectangular shape. The length 48 of the minor side 42 is 70 mm and the length 50 of the major sides 44, 46 is 120 mm. The top hat shape of the posts 36 is completed by two flange portions 52, 54 which lie in the same plane as one another parallel with said minor side 42 and which extend outward from the free edge 56 of said major sides 44, 46 defining said opening 40. The distance 58 between the outer edges of the flange portions 52, 54 is 142 mm.

[0041] It will be understood that a post having a top-hat section of a different size and/or of different proportions may be used. Indeed, a different type of post having an entirely different shape of cross-section to that shown in the accompanying drawings may be used, for example, a square or rectangular cross-section which may be hollow (i.e. a box-section) or solid.

[0042] Each flange portion 52, 54 is provided with holes 60 along the length or height of the fence post 36 for receiving threaded bolts 62. The bolts are M8x30 mm galvanised cup square bolts which each receive a washer 64 and a shear nut 66 at the rear surface of the associated flange portion 52, 54.

[0043] In the first fence assembly 31, the fencing panels 32, 34 are secured to a respective flange portion 52, 54 of the post 36 by means of a clamp plate 68. The clamp plate is manufactured from galvanised sheet steel having a thickness of 5 mm. The clamping plate has a width 70 of 140 mm. Ideally, the plate 68 has a length sufficient to cover the opening 40 along the full height of the post.

[0044] Side portions of the fencing panels 32, 34 are located between the flange portions 52, 54 and the clamping plate 68 and clamped therebetween by means of the bolts 62. The bolts 62 extend through holes 72 in the clamping plate, through the apertures 8 formed between the rods 4, 6 of the panels 32, 34, and through the holes 60 in the flange portions 52, 54. The holes 60, 72 have an elongate shape (see Figure 13), which allows adjustment of the location of the bolt 62 to avoid the first (horizontal) rods 4.

[0045] The distance 74 between the centre of the hole 60 in one flange portion 52 and the centre of the corresponding hole 60 (at the same height) in the other flange portion 54 is 115 mm. The holes 72 in the clamping plate 68 align with the holes 60 in the flange portion 52, 54.

[0046] In order to ensure the fence panels 32, 34 cannot be readily pulled from between the flange portion 52, 54 and the clamping plate 68, the bolts 62 are located at least two vertical rods 6 from the side of the panel.

[0047] Figures 12 and 13 show a second fence assembly 231 which is similar to that shown in Figure 11. In the second fence assembly 231, the same post 36 and clamping plate 68 are used as in the arrangement of Figure 11. The only difference between the arrangement of Figure 11 and the arrangement of Figures 12 and 13 is the use of a different fencing panel 76. Each fencing panel 76 uses the same rods 4, 6 as in the first fence panel 2, however the spacing of the first group of rods 4 is 12.7 mm (as in the first fence panel 2) whereas the spacing of the second group of rods 6 is 38.1 mm. However, the pitch of the second group of rods 6 decreases at the sides of each panel 76 in the region which is located between the flange portions 52, 54 of the post 36 and the clamping plate 68. In this region, the spacing of the second group of rods 6 is 12.7 mm. More specifically, five rods 6 in the second group are positioned in said region with a spacing of 12.7 mm between neighbouring rods 6. Each fencing panel 76 is positioned so that the bolts 62 locate between the third and fourth rods 6 in from the side edge of the panel 76. In this way, the fence panel 76 cannot be readily pulled from between the post 36 and the clamping plate 68. Whilst the panel 76 shown in Figure 13 has three rods 6 (of the second group) located between the bolts 62 and the edge of the panel secured to the post, a larger number of rods 6 may be so located to thereby increase the force required to pull the panel from between the post 36 and the clamping plate 68. However, to ensure a minimum level of security, there should be no less than two rods 6 (of the second group) located between the bolts 62 and the edge of the panel.

[0048] It will be noted that the arrangement of Figure 12 differs slightly from that of Figure 13 in that a fifth vertical rod 6 in from the side edge of the panel 76 is not provided.

[0049] The invention thus provides a woven mesh panel 76 in which the spacing of the rods 4, 6 can vary across the height and/or width of the panel. This permits vulnerable areas of the panel to be effectively reinforced by increasing the number density of rods (i.e. the number of rods per unit area) in those areas. Thus the number density of rods could be increased in the areas along or adjacent to the top edge; and/or in the area along or adjacent at the bottom edge; and/or in the area along or adjacent the top edge. Such selective reinforcement is economical, while being effective. Such panels with selective reinforcement have increased visibility over a panel which is uniformly at the higher number density.

[0050] Figs 14 to 17 show a third fence assembly 331
comprising a fourth fence panel 80, having the same construction as the first fencing panel 2, but modified so as to extend through a post opening 40.

[0051] The integrity of the mounting of a fencing panel to the post 36 may be further enhanced, or alternatively provided, by providing bends 82 in some or all of the ends of rows 81 of the first group of rods 4 so that said rod ends 81 form a gripping portion 78 at an angle to the plane of the rest of the panel 80, which in use, extends through the opening 40 and into the space between the major sides 44, 46 of the post 36 to form the third fence assembly 331. This arrangement is particularly useful in circumstances where the width of a panel is reduced to a required length on-site by cutting off one or both ends of the panel. This action may adversely affect the strength of the fixing between the panel and post due to a removal of the original side edge/end section of panel having the aforementioned rods 6 of decreased pitch.

[0052] The bend 82 in the rods 4 is ideally a bend through 90° and located between rods 6 of the second group. The bend 82 may be located in such a way that the gripping portion 78 locates in abutment with one of the adjacent major sides 44, 46 of the post 36 as shown in the drawings. A side end of the fencing panel 80 is modified so that the first rods 4 of the first group are bent through 90° (for extending through a post opening 40). The 90° bend 82 of each rod 4 is located between the outermost and next outermost second rods 6 (of the second group) from the side end of the panel 80. The bend 82 could, however, be positioned further from said side of the panel so that two or more vertical rods 6 of the second group are located within the post 36 between the major sides 44, 46. It will be noted that, in the arrangement of Figures 14 to 17, some of the rods 4 of the first group are severed rather than bent and are thereby shortened. The portion of the vertical rod 6 (of the second group) which would be woven with the severed/removed portion of the first rods 4 is also severed and removed, as shown in Figures 14, 15 and 17 in particular.

[0053] Partial views of a fifth fencing panel 200 are shown in Figures 21 to 23. The fifth fencing panel 200 shown in these drawings is of a type which may be readily raked in a similar fashion to that described above in relation to the panel of Figures 8 to 10. The fencing panel 200 is constructed using first and second groups of rods 204, 206 as in the first fencing panel 2, however the rods have a different diameter of 6 mm, and the spacing of the rods 204, 206 in the first and second groups is different (with the arrangement of the crimps in the rods 204, 206 also being different accordingly).

[0054] The first group of rods 204 are arranged in pairs with a centre-line spacing 200 from one pair to another of 200 mm. The centre-line spacing 210 of the rods 204 within a pair is 15 mm. Since the crimps in the second group of rods 206 determine the position of the first group of rods 204 relative to the second group of rods 206, it will be understood that the rods of the second group are provided with crimps which have the same spacing (i.e. the crimps are arranged in pairs spaced by 200 mm, with the spacing of the crimps within a pair being 15 mm). The second group of rods 206 are arranged with a centre-line spacing 212 between one another of 50 mm. Again, the crimps in the rods 204 of the first group are spaced from one another by the same amount (i.e. 50 mm).

[0055] The portion 214 of rod 206 extending between successive pairs of crimps is straight, parallel and coincident with the longitudinal axis of the rod 206. However, the portions of rod forming the crimps are arranged at an angle to one another as mentioned above in relation to Figure 2.

[0056] The fencing panel 200 shown in Figures 21 to 23 may be modified by using rods 204 for the second group which are not crimped and are, therefore, straight prior to being woven with the rods 206 of the second group.

[0057] Reference is now made to Figs 18 to 20.

[0058] Conventionally, the high tensile strength of the rods used in the aforementioned fencing panels presents difficulties with regard to the step of crimping the rods during the manufacturing of the panels. More specifically, the high tensile strength of the rods results in a comparatively large force being required to bend/crimp the rods and it has been found that the application of this force through the use of, for example, teeth elements mounted on the circumference of counterrotating wheels, can cause a thinning or other degradation/wearing of the galvanising provided on the rods. This compromising of the galvanising adversely affects the life of a panel.

[0059] Galvanising the rods after crimping is not a practical solution and galvanising after weaving would be costly and would adversely affect the ability of the panel to rake or otherwise move without damaging/cracking the galvanising (this is because the galvanising would tend to adhere the rods to one another, thereby preventing them from moving relative to one another).

[0060] This problem is addressed by the apparatus and method shown in Figures 18 to 20 of the accompanying drawings. With regard to Figure 18 in particular, apparatus for forming a fence panel includes a crimping machine 100, which is shown applying crimps (alternating bends) to a blank rod, whereby forming a crimped rod 4, 6 for use in the first fencing panel 2. The crimping machine 100 is shown schematically in Figure 18 as comprising a first rotatable support 102 in the form of a wheel and a second rotatable support 104 in the form of a wheel. Each rotatable wheel 102, 104 is mounted on a separate spindle 106, about the axis of which the respective wheel 102, 104 is rotatable. A motor (or other driving means) is provided for rotating the wheels 102, 104. The driving means is not shown in the accompanying drawings but a skilled person will understand how the wheels 102, 104 and driving means may be coupled to one another.

[0061] Each wheel 102, 104 includes a plurality of formers 108 which are arranged around the circumference of the respective wheel. In the example shown, the formers 108 are in the form of rollers which are rotatably
mounted around the circumference of the respective wheel.

[0062] The first wheel 102 is provided with fourteen rollers 108 provided equidistant along the circumference of the first wheel 102. Each roller 108 is mounted to the first wheel 102 so as to be rotatable about a longitudinal axis 110 of the roller 108. The longitudinal axis 110 of each roller 108 is parallel with the longitudinal axis of the spindles 106 of the wheels 102, 104.

[0063] The second rotatable wheel 104 is similarly provided with fourteen rollers 108 as for the first rotatable wheel 102. The arrangement and geometry of the rollers 108 is the same for each of the two wheels 102, 104. However, the arrangement of the two wheels 102, 104 relative to one another is such that the rollers 108 of one wheel locate adjacent to the space between neighbouring rollers 108 of the other wheel. In this way, the rollers 108 of the two wheels 102, 104 interact with one another in a similar fashion to the teeth of a pair of mating gears. However, the rollers 108 of the two wheels 102, 104 remain spaced from one another so as to press on and thereby impart a crimp on a blank rod whilst avoiding a crushing of said rod.

[0064] It will be appreciated that, as the two rotatable wheels 102, 104 are counter rotated relative to one another as indicated by arrows 112, 114 and the blank rod is drawn between the wheels 102, 104 in the direction indicated by arrow 116, the rollers of the first and second wheels 102, 104 rotate relative to their respective wheels in the direction as indicated by arrows 118, 120 (see the enlarged partial view of Figure 19). This rotation of the rollers 108 is driven by the movement of the rod as it passes between the wheels 102, 104 and ensures that the relative movement between the rod and the wheels 102, 104 at the point of contact of the rod with wheels is minimised. In this way, a tendency for the galvanising on the surface to be worn thin by the action of pressing and crimping is reduced or eliminated.

[0065] The partial cross-sectional side view of the counter rotating wheels 102, 104 of Figure 20 shows that each wheel 102, 104 comprises two identical disks, the first wheel 102 comprising two disks 122, 124 and the second wheel 104 comprising two disks 126, 128. The rollers 108 are located between the radially outermost circumferential portion of the disks 122, 124 and 126, 128. The disks 122, 124 of the first wheel 102 are positioned closer to one another than the two disks 126, 128 of the second wheel 104. The disks 122, 124 of the first wheel 102 are located sufficiently close to one another and are suitably dimensioned so as to be locatable between the two disks 126, 128 of the second wheel 104 at the point where the two wheels 102, 104 interact with one another to crimp a rod.

[0066] The crimp of a member (or, more particularly, a rod 4, 6) is made as a bend arranged such that the portion of said member forming said bend is displaced laterally from the longitudinal axis 16, 18 of the member by a distance 300 (see Figure 18) no greater than the lateral dimension of the member. Alternatively, the crimp of a member 4 is made as a bend arranged such that the portion of said member 4 forming said bend is displaced laterally from the longitudinal axis 16, 18 of said member 4 by a distance 300 (see Figure 18) no greater than the lateral dimension of a second member 6 with which said member 4 is to be subsequently woven. This latter arrangement is used when a member 4 is to be woven with a member 6 having a different cross-section to the said member 4. The portion of said member 4 forming said bend is displaced laterally as described when the member is in a relaxed condition (i.e. not resiliently and elastically deformed as is the case when a member is woven with other members to form a panel). The lateral dimension of the rods 4, 6 is the diameter of the rods. Each crimp of the panels described herein is provided in this way.

[0067] Each of the rollers 108 has a reduced diameter at its midsection, increasing symmetrically in diameter towards the ends. Thus, when viewed in profile, the contact surface 130 defines a rod receiving recess 132. The contact surface 130 could be, for example, concave, V-shaped or U-shaped. In one example, the contact surface 130 could be part circular in profile. In this way, the contact area between a roller 108 and a rod is increased, and the pressure applied to the rod by the roller 108 is consequently reduced. Any tendency for the rollers 108 to flatten the curved surface of the rod, as the rod is cramped, is reduced or eliminated, and the risk of damaging the galvanising is also reduced.

[0068] Optimally, as shown in Fig 20, the contact surface 130 is matched to the cross sectional profile of the surface of the rod 4, 6, so that the contact surface 130 has a radius equal to the external radius of the rod to be cramped. In this way, the contact area between a roller 108 and a rod is maximised, and the pressure applied to the rod by the roller 108 is consequently minimised. The tendency for the rollers to thin or otherwise damage the galvanising on the rod is also thereby minimised.

[0069] The use of the rollers 108 therefore contributes significantly to minimising damage to the rods and the galvanising of the rods.

[0070] To further reduce or assist in eliminating damage to a rod as it is cramped, lubricating fluid (for example, oil) may be applied between the rod and the rollers 108.

[0071] It will be understood that the method and apparatus recited herein for crimping rods may be modified by using different wheels wherein the arrangement of the rollers 108 along the circumference of each wheel is different to that shown in Figure 18. For example, the circumference of each wheel may be provided with rollers in such a way that the spacing between the rollers varies along the length of the circumference so that crimps are provided in rods with different spacings between crimps. In one example, one wheel may be provided with just two rollers having the spacing shown in Figure 18, and the second wheel may be provided with just three rollers having the spacing shown in Figure 18. In this example, the
rotation of the two wheels is coordinated so that the rollers of the first wheel locate between the rollers of the second wheel as the two wheels rotate. In this way, a rod may be made for use as the vertically oriented rods in the fifth wheel as the two wheels rotate. In this way, a rod may of the first wheel locate between the rollers of the second rotation of the two wheels is coordinated so that the rollers of elements or teeth have a curved surface (ideally having a part-cylindrical shape - circular in cross-section) which, in use, contacts a rod during crimping. Use of fixed elements or teeth reduces the cost and complexity of the apparatus/method used in the crimping process, but can also increase the likelihood of the rods being damaged during crimping.

Prior to assembly of the rods into a panel, and preferably after the crimping process, each rod may be painted or otherwise coated (for example, by a dipping process in a material such as PVC). The paint or other coating is allowed to dry/solidify before the rod is assembled into a panel. In this way, it will remain possible for certain arrangements of panel to be readily moved/raked between different configurations.

Once a rod has been crimped and optionally painted or otherwise coated, it is aligned parallel with other rods and arranged in a common plane. Every other rod is then lifted out of said plane and a rod from a second group is arranged perpendicularly to the rods of the first group and inserted between the lifted rods and the un-lifted rods. The lifted rods are then returned to their original positions and the unlifted rods are then lifted. A further rod from the second group is then inserted and the presently lifted rods are allowed to return to their original positions. The process is then repeated to produce a woven mesh fencing panel.

The present invention is not limited to the specific embodiments described above. Alternative arrangements and suitable materials will be apparent to a reader skilled in the art.

Various other modifications could be made without departing from the scope of the invention. The fence panel, the fence assembly, the crimping machine and the various components of each thereof could be different to those described, and could be of any suitable size and shape, and could be formed of any suitable material.

Any of the features or steps of any of the embodiments shown or described could be combined in any suitable way, within the scope of the overall disclosure of this document.

There is thus provided apparatus and a method for forming woven high tensile steel fence panels which have a high number density of rods or wires and relatively small clear gaps therebetween to provide high security fencing with improved resistance to high energy impacts and which can be economically manufactured.

Claims

1. A security fence panel (2) for resisting high energy impact such as that provided, for example, by an intruder with a tool such as a hammer, or a fast moving hard object such as a hockey ball, the panel (2) comprising a plurality of first members (4) which are arranged substantially parallel to one another so that they do not cross one another, a plurality of second members (6) which are arranged substantially parallel to one another so that they do not cross one another, the first and second members (4,6) being arranged to cross each other and being interconnected with one another by means of the members (4,6) being woven together, the members being cramped, a crimp of a first member locating in abutment with a crimp of a second member with which the first member is woven, each member comprising a portion extending between successive crimps which is straight and coincident with the longitudinal axis (16,18) of the members, and the interconnected members (4,6) have a tensile strength of at least 800 N/mm².

2. A fence panel, according to claim 1, wherein each member is a rod, each rod having a circular cross-section of a 4 mm to 6 mm diameter.

3. A fence panel according to claims 1 or 2, wherein the members are cramped so as to form a bend having an included angle of between 135° and 175°.

4. A fence panel according to any of claims 1 to 3, wherein the spacing (10) of adjacent first members (4) and/or the spacing (12) of adjacent second members (6) is between 6 mm and 15 mm.

5. A fence panel according to any of the preceding claims, wherein the members (4,6) are galvanised before crimping.

6. A fence panel according to any of the preceding claims, wherein the crimp of a member (4,6) is a bend arranged such that the portion of said member forming said bend is displaced laterally from the longitudinal axis (16, 18) of the member by a distance no greater than the lateral dimension of the member, or wherein the crimp of a member (4) is a bend arranged such that the portion of said member (4) forming said bend is displaced laterally from the longitu-
7. A fence panel according to any of the preceding claims, wherein the first members are arranged at an angle of about ninety degrees with respect to the second members (6).

8. A fence panel according to any of claims 1 to 6, wherein the first members (4) are arranged at an angle other than 90° with respect to the second members (6).

9. A fence panel according to any of the preceding claims, wherein the weave of the first members (4) with the second members (6) is such as to permit relative movement between the first and second members (4,6) from a first configuration, in which the first members (4) are arranged at a first angle with respect to the second members (6), to a second configuration, in which the first members (4) are arranged at a second angle with respect to the second members (6), wherein the first angle is different to the second angle.

10. A fence panel according to claim 9, wherein the first angle is 90° and the second is variable from 90° to 50°.

11. A fence panel according to any of the preceding claims, wherein adjacent first members (4) and/or the second clear gap (13) defined between adjacent second members (6) is no more than 10mm.

12. A fence panel according to claim 11, wherein one of the clear gaps (11, 13) is greater than the other of the clear gaps (11, 13).

13. A fence panel according to any of the preceding claims, wherein the number density (the number per unit area) of the first and/or the second members (4,6) varies across the panel.

14. A fence panel according to claim 13, wherein the number density of the first and/or the second members (4, 6) is increased in an area adjacent or along an edge of the panel.

15. A fence panel according to any of the preceding claims, wherein the panel includes one or more gripping portions, which extend at an angle to the plane of the rest of the panel, the or each gripping portion comprising one or more ends of a respective one or more members (4, 6) which are bent to form the respective gripping portion.

16. A fence panel according to any of the preceding claims, wherein a first clear gap (11) defined between adjacent first members (4) and/or the second clear gap (13) defined between adjacent second members (6) is no more than 10mm.

17. A fence panel according to claim 16, wherein one of the clear gaps (11, 13) is greater than the other of the clear gaps (11, 13).

18. A fence panel according to any of the preceding claims, wherein the number density (the number per unit area) of the first and/or the second members (4,6) varies across the panel.

19. A fence panel according to claim 18, wherein the number density of the first and/or the second members (4, 6) is increased in an area adjacent or along an edge of the panel.

20. A fence panel according to any of the preceding claims, wherein the panel includes one or more gripping portions, which extend at an angle to the plane of the rest of the panel, the or each gripping portion comprising one or more ends of a respective one or more members (4, 6) which are bent to form the respective gripping portion.
als das seitliche Maß eines zweiten Elements (6) ist, mit welchem besagtes Element (4) verwoben ist.

7. Zaunplatte nach irgendeinem vorhergehenden Anspruch, worin die ersten Elemente unter einem Winkel von etwa neunzig Grad mit Bezug auf die zweiten Elemente (6) angeordnet sind.

8. Zaunplatte nach irgendeinem Anspruch 1 bis 6, worin die ersten Elemente (4) unter einem anderen Winkel als 90° mit Bezug auf die zweiten Elemente (6) angeordnet sind.


10. Zaunplatte nach Anspruch 9, worin der erste Winkel 90° ist und der zweite von 90° bis 50° veränderlich ist.

11. Zaunplatte nach irgendeinem vorhergehenden Anspruch, worin eine erste klare Lücke (11), die zwischen benachbarten ersten Elementen (4) definiert ist, und/oder die zweite klare Lücke (13), die zwischen benachbarten zweiten Elementen (6) definiert ist, nicht mehr als 10 mm beträgt.

12. Zaunplatte nach Anspruch 11, worin eine der klaren Lücken (11, 13) größer als die andere der klaren Lücken (11, 13) ist.

13. Zaunplatte nach irgendeinem vorhergehenden Anspruch, worin die zahlenmäßige Dichte der ersten und/oder der zweiten Elemente (4, 6) über die Platte variiert.

14. Zaunplatte nach Anspruch 13, worin die zahlenmäßige Dichte der ersten und/oder der zweiten Elemente (4, 6) in einem Bereich nebene oder entlang einer Kante der Platte erhöht ist.

15. Zaunplatte nach irgendeinem vorhergehenden Anspruch, worin die Platte einen oder mehr Greifabschnitte beinhaltet, welche sich unter einem Winkel zur Ebene des Rests der Platte erstrecken, wobei der oder jeder Greifabschnitt ein oder mehr Enden jeweils eines oder mehrerer Elemente (4, 6) umfasst, die gebogen sind, um den jeweiligen Greifabschnitt zu bilden.

Revendications

1. Panneau de clôture de sécurité (2) destiné à résister à un impact à forte énergie tel que celui fourni, par exemple, par un intrus muni d’un outil, tel qu’un marteau, ou d’un objet dur mobile, tel qu’une balle de hockey, le panneau (2) comprenant une pluralité de premiers éléments (4) disposés essentiellement parallèlement les uns par rapport aux autres de manière à ne pas se croiser mutuellement, une pluralité de seconds éléments (6) disposés essentiellement parallèlement les uns par rapport aux autres de manière à ne pas se croiser mutuellement, les premiers et seconds éléments (4, 6) étant disposés pour se croiser les uns avec les autres et étant interconnectés les uns avec les autres au moyen de l’entrelacement des éléments (4, 6), les éléments étant sertis, un sertissage d’un premier élément étant situé en appui sur un sertissage d’un second élément avec lequel le premier élément est entrelacé, chaque élément comprenant une partie s’étendant entre des sertissages successifs qui est droite et qui coïncide avec l’axe longitudinal (16, 18) des éléments, et les éléments interconnectés (4, 6) ayant une résistance à la traction d’au moins 800 N/mm².

2. Panneau de clôture selon la revendication 1, dans lequel chaque élément est une tige, chaque tige ayant une section circulaire de 4 mm à 6 mm de diamètre.

3. Panneau de clôture selon la revendication 1 ou 2, dans lequel les éléments sont sertis de manière à former un noeud présentant un angle inclus compris entre 135° et 175°.

4. Panneau de clôture selon l’une quelconque des revendications 1 à 3, dans lequel l’espacement (10) de premiers éléments (4) adjacents et/ou l’espacement (12) de seconds éléments (6) adjacents est compris entre 6 mm et 15 mm.

5. Panneau de clôture selon l’une quelconque des revendications précédentes, dans lequel les éléments (4, 6) sont galvanisés avant d’être sertis.

6. Panneau de clôture selon l’une quelconque des revendications précédentes, dans lequel le sertissage d’un élément (4, 6) est un noeud prévu de telle sorte que la partie dudit élément formant ledit noeud soit déplacée latéralement par rapport à l’axe longitudinal (16, 18) de l’élément d’une distance non supérieure à la dimension latérale de l’élément, ou dans lequel le sertissage d’un élément (4) est un noeud prévu de telle sorte que la partie dudit élément (4)
formant ledit noeud soit déplacée latéralement par rapport à l’axe longitudinal dudit élément (4) d’une distance non supérieure à la dimension latérale d’un second élément (6) avec lequel ledit élément (4) est entrelacé.

7. Panneau de clôture selon l’une quelconque des revendications précédentes, dans lequel les premiers éléments sont disposés à un angle d’environ quatre-vingt-dix degrés par rapport aux seconds éléments (6).

8. Panneau de clôture selon l’une quelconque des revendications 1 à 6, dans lequel les premiers éléments (4) sont disposés à un angle différent de 90° par rapport aux seconds éléments (6).

9. Panneau de clôture selon l’une quelconque des revendications précédentes, dans lequel l’entrelacement des premiers éléments (4) avec les seconds éléments (6) permet le mouvement relatif des premiers et des seconds éléments (4, 6) d’une première configuration, dans laquelle les premiers éléments (4) sont disposés à un premier angle par rapport aux seconds éléments (6), à une seconde configuration, dans laquelle les premiers éléments (4) sont disposés à un second angle par rapport aux seconds éléments (6), le premier angle étant différent du second angle.

10. Panneau de clôture selon la revendication 9, dans lequel le premier angle est de 90° et le second angle varie entre 90° et 50°.

11. Panneau de clôture selon l’une quelconque des revendications précédentes, dans lequel un premier espace de dégagement (11) défini entre des premiers éléments (4) adjacents et/ou un second espace de dégagement (13) défini entre des seconds éléments (6) adjacents sont inférieurs à 10 mm.

12. Panneau de clôture selon la revendication 11, dans lequel l’un des espaces de dégagement (11, 13) est supérieur à l’autre des espaces de dégagement (11, 13).

13. Panneau de clôture selon l’une quelconque des revendications précédentes, dans lequel la densité numérique (nombre par unité de surface) des premiers et/ou des seconds éléments (4, 6) varie dans le panneau.

14. Panneau de clôture selon la revendication 13, dans lequel la densité numérique des premiers et/ou des seconds éléments (4, 6) est augmentée dans une région adjacente ou le long d’un bord du panneau.

15. Panneau de clôture selon l’une quelconque des revendications précédentes, le panneau comportant une ou plusieurs parties de préhension, qui s’étendent à un certain angle par rapport au plan du reste du panneau, la ou les parties de préhension comprenant chacune une ou plusieurs extrémités d’un ou plusieurs éléments (4, 6) respectifs qui sont pliés pour former la partie de préhension respective.
FIG. 8

FIG. 9
FIG. 17
REFERENCES CITED IN THE DESCRIPTION

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