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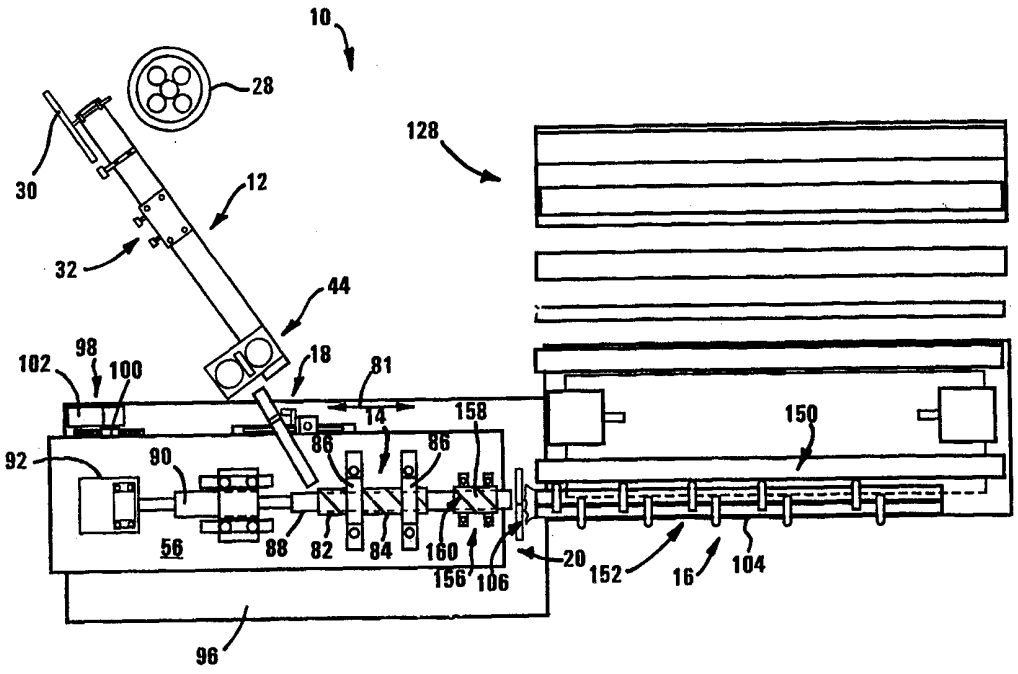

(57) Abstract

A method and apparatus for making a barrier material. The method includes forming barbed tape at a barbed tape forming means (12) and feeding the barbed tape to bending means (14). At the bending means (14), the barbed tape is provided with a plurality of longitudinally spaced apart kinks and the portions of the barbed tape between the kinks is bowed outwardly. The kinked barbed tape is then interlaced with a previously formed kinked barrier element at an interlacing station (16) to manufacture the barrier material.

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METHOD OF MAKING A BARRIER MATERIAL

THIS INVENTION relates to barriers. More particularly it relates to a method of making a barrier material and to a barrier material. It also relates to barrier material forming apparatus and to a barrier.

According to one aspect of the invention there is provided a method of making a barrier material which includes the steps of

feeding barbed tape to a bending station in which a series of longitudinally spaced apart kinks or bends is formed into the barbed tape; and

rotating and advancing the kinked barbed tape longitudinally relative to a previously formed elongate kinked barrier element to interlace the kinked barbed tape and the previously formed barrier element.

According to another aspect of the invention there is provided a method of making a barrier material which includes the steps of

at a bending station forming a series of longitudinally spaced apart kinks or bends into a length of barbed tape; and

as it is formed, interlacing the kinked barbed tape with a previously formed elongate kinked barrier element.

In a preferred embodiment of the invention, the previously formed barrier element is in the form of a length of kinked barbed tape.

The method may include cutting the length of barbed tape fed from the bending station after it has been interlaced with the previously formed barrier element, advancing the barrier material, feeding a subsequent length of kinked barbed tape from the bending station and interlacing the subsequent length of barbed tape with the previous length of barbed tape, thereby increasing the length

of the barrier material. By repeating this process barrier material of a desired length can be formed.

In the context of this specification, the term "barbed tape" or "razor wire" is to be understood in its ordinary sense in the art of fencing, i.e. as indicating an elongate strand of wire, typically galvanised wire, on which a metallic tape which is provided with sharp barbs is mounted. The barbed tape may be of different types. In one type, the barbs may be trapezoidal in shape and arranged in opposed pairs along the strand to provide pairs of barbs which are typically of butterfly shape, or they may be arranged at mutually staggered locations along the strand.

The kinked barbed tape may be formed with a plurality of alternating peaks and troughs, the method including deforming the lengths of barbed tape intermediate the peaks and troughs such that they are bowed outwardly providing the kinked barbed tape with a generally rhomboidal profile when viewed from an end thereof. This, the Inventors believe, will increase the clearance between lengths of barbed tape being interlaced thereby reducing the risk that the barbs of the lengths of barbed tape will snag.

The method may include the prior step of forming the barbed tape and feeding the barbed tape as it is formed in a more-or-less continuous manner to the bending station.

Forming the barbed tape may include feeding core wire and metallic tape from supplies of core wire and metallic tape to a forming station and crimping the metallic tape onto the core wire. Typically, the metallic tape extends partway around the core wire, the barbs protruding from the edges of the metallic tape, the method including bending the barbed tape such that the metallic tape is innermost at each of the bends. This arrangement ensures that at, or adjacent a bend, the barbs are outermost thereby improving the clearance between and reducing the risk of snagging when interlacing lengths of barbed tape.

According to another aspect of the invention there is provided a method of making a barrier material which includes the steps of

forming a barrier element which comprises a length of barbed tape having alternating peaks and troughs with the portions of the barrier tape intermediate the peaks and troughs being non-linear for at least part of their lengths; and

interlacing the barrier element with a previously formed barrier element.

The method may include the step of laterally compressing the barrier material.

By interlacing each successive barrier element with the preceding barrier element a barrier material in the form of a woven mesh, in particular a diamond mesh, is built up. The method may include forming the barrier material into a roll as it is formed.

According to yet another aspect of the invention there is provided a barrier material which includes a plurality of interlaced elongate barrier elements each of which has a plurality of oppositely disposed longitudinally spaced apart kinks therein, at least some of the barrier elements being formed of barbed tape and at least some of the portions of at least some of the barrier elements intermediate the kinks being non-linear for at least part of their lengths.

According to yet another aspect of the invention there is provided a barrier material which includes a plurality of interlaced elongate barrier elements each of which has a plurality of oppositely disposed longitudinally spaced apart kinks therein, at least some of the barrier elements being formed of barbed tape, the barrier elements of barbed tape being kinked such that the metallic tape is innermost at each of the kinks.

The portions of the barbed tape intermediate the kinks may be bowed outwardly thereby providing the barrier element with a generally rhomboidal profile when viewed from an end thereof.

The portions of the barbed tape may be bowed outwardly a distance of between 5 and 15%, preferably 10%, of the perpendicular distance between two parallel lines defined by the kinks in the barbed tape, i.e. the width of the kinked barbed tape.

Preferably, each barrier element is formed of barbed tape.

According to still another aspect of the invention there is provided a barrier material forming apparatus which includes

bending means for forming longitudinally spaced apart bends or kinks into a length of barbed tape; and

an interlacing station at which kinked barbed tape from the bending means is interlaced with a previously formed elongate kinked barrier element.

The apparatus may include barbed tape forming means configured to form barbed tape from supplies of wire and metal tape which barbed tape is then fed, in use, to the bending means. The barbed tape forming means may include a channel forming means for forming a longitudinally extending wire receiving channel formation in the metal tape and crimping means for positioning wire in the channel formation and crimping the metal tape onto the wire positioned in the channel formation.

The bending means may include a circular cylindrical housing in which a helically extending barbed tape receiving slot is provided and an elongate bending member rotatably mounted with little clearance in the housing. The bending member may be generally rectangular in shape having a pair of opposed major faces, the bending member being twisted about its length which results in the kinks or bends in the barbed tape being substantially coplanar. The bending means may include secondary bending formations which are centrally disposed and protrude outwardly from the major faces of the bending member and which serve, in use, to deform portions of the barbed tape intermediate the kinks outwardly to provide the barbed tape leaving the bending means with a generally rhomboidal

profile when viewed from an end thereof. The Inventors have found that the size of the secondary bending formations affects the pitch of the kinks in the kinked barbed tape. The sizes of the secondary bending formations may be adjustable.

Each secondary bending formation may protrude from the bending member by an amount which is between 5% and 15%, preferably 10%, of the width of the bending member.

The apparatus may include pitch adjustment means intermediate the bending means and the interlacing station whereby the pitch of the bends or kinks is adjustable.

When forming a barrier material in the form of a mesh, in particular a diamond mesh, the kinks forming the peaks of each length of kinked barbed tape engage the troughs of the preceding length of kinked barbed tape. In other words, each length of barbed tape is longitudinally staggered by a distance equal to half of the pitch of the peaks relative to the adjacent lengths of barbed tape. To achieve this, the bending means may be mounted for reciprocation between first and second positions, the distance between which is equal to the longitudinal offset of adjacent lengths of barbed tape in the barrier material, the apparatus including displacement means for displacing the bending means between its first and second positions.

The interlacing station may include an upwardly open channel member which is generally circular in cross-section, the channel member having at its one end a feed opening which is positioned in register with the housing of the bending means to receive kinked barbed tape leaving the bending means.

The apparatus may include locating means configured to locate a previously formed length of kinked barbed tape at a desired position within the channel member.

The locating means may include two sets of retaining fingers positioned adjacent to the open top of the channel member releasably to engage the barrier material. The sets of retaining fingers may be oppositely disposed and at least that portion of each retaining finger which engages the barrier material having a diameter which is greater than the spacing between adjacent ends of adjacent barbs.

Instead, or in addition, the locating means may include two sets of locating formations, each set of locating formations including a plurality of longitudinally spaced apart locating formations which is displaceable between a locating position in which the formations protrude into the channel member to locate the troughs of a length of kinked barbed tape adjacent a bottom of the channel and a released position in which the formations are clear of the channel, the spacing between the formations of one set and the formations of the other set being equal to half of the pitch of the peaks and/or troughs of the kinked barbed tape. Hence, the sets of locating formations serve, in use, to locate alternate lengths of kinked barbed tape or barrier elements in position in the channel member.

The locating means may include, associated with each locating formation, a slot in the channel member through which the locating formation is displaced into and out of the channel member. The slots may extend obliquely relative to the length of the channel member.

The apparatus may include cutting means positioned intermediate the bending means and the interlacing station to cut kinked barbed tape fed from the bending means to the interlacing station to the desired length.

The apparatus may further include guide means for guiding the barbed tape from the barbed tape forming means to the bending means. The guide means may include a guide arrangement configured to feed the barbed tape to the bending means at a desired angle with the position of the metal tape which extends around

the wire being radially innermost. The guide arrangement may include an elongate support member having a longitudinally extending slot therein and a plurality of longitudinally spaced apart rollers positioned such that the barbed tape is snugly receivable between the support member and the rollers.

The Inventors have found that the angle at which the barbed tape is fed to the bending means affects the pitch of the kinked barbed tape. Accordingly, the pitch adjustment means may include guide means the position of which is adjustable relative to the bending means.

The compression means may include a pair of compression members which define between them a working gap through which the barrier material is fed, and displacement means for displacing the compression members relative to one another to compress the portion of the barrier material positioned therebetween.

The barrier material forming apparatus may include roll forming means for forming the barrier material into a roll.

The barrier material forming apparatus may include compression means for laterally compressing the barrier material to reduce its thickness.

According to still yet another aspect of the invention there is provided a barrier which includes

barrier material of the type described above; and

support means for supporting the barrier material in a desired orientation.

The support means may be configured to support the barrier material such that it lies in a generally vertically extending plane in the manner of a fence.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings.

In the drawings,

Figure 1 shows a schematic plan view of barrier material forming apparatus in accordance with the invention;

Figure 2 shows channel forming means forming part of a barbed tape forming means;

Figure 3 shows a side view of crimping means forming part of the barbed tape forming means;

Figure 4 shows an end view of the crimping means of Figure 3;

Figure 5 shows a side view of guide means forming part of the apparatus of Figure 1;

Figure 6 shows an end view of the guide means of Figure 5;

Figure 7 shows a plan view of the guide means of Figure 5;

Figure 8 shows a three-dimensional view of bending means forming part of the apparatus of Figure 1;

Figure 9 shows a front view of an interlacing station forming part of the apparatus of Figure 1;

Figure 10 shows an end view of the interlacing station of Figure 9;

Figure 11 shows a plan view of part of the interlacing station illustrating the displacement of locating formations forming part of the interlacing station;

Figure 12 shows, on an enlarged scale, a sectional view of part of the interlacing station of Figure 9;

Figure 13 shows, on an enlarged scale, the intersection of two barrier elements forming part of a barrier in accordance with the invention;

Figure 14 shows an oblique end view of a kinked length of barbed tape formed by the bending means; and

Figure 15 shows a schematic side view of compression means for compressing the barrier material to reduce its thickness.

In the drawings, reference numeral 10 refers generally to barrier material forming apparatus in accordance with the invention.

The barrier material forming apparatus 10 includes barbed tape forming means, generally indicated by reference numeral 12, bending means, generally indicated by reference numeral 14 for receiving barbed tape from the barbed tape forming means 12 and providing it with a plurality of longitudinally spaced apart bends or kinks. The apparatus 10 further includes an interlacing station, generally indicated by reference numeral 16 positioned to receive kinked barbed tape from the bending means 14 and to interlace it with a previously formed kinked barrier element so as to form a barrier material. Guide means, generally indicated by reference numeral 18 is provided between the barbed tape forming means 12 and the bending means 14 to guide the barbed tape. Further, cutting means, generally indicated by reference numeral 20 is provided intermediate the bending means 14 and the interlacing station 16 to cut the kinked barbed tape leaving the bending means 14 to desired lengths.

As can best be seen in Figure 4 of the drawings, barbed tape, generally indicated by reference numeral 22, formed by the barbed tape forming means 12 comprises a core wire 24, typically of galvanised steel, to which a metal tape 26 is attached as described herebelow.

The core wire 24 and metal tape 26 are supplied to the barbed tape forming means 12 from reels 28, 30 (Figure 1), respectively.

With reference to Figure 2 of the drawings, the metal tape 26 is fed from its associated reel 30 to channel forming means, generally indicated by reference numeral 32. The channel forming means 32 includes a pair of forming rollers 34, 36 which are mounted for rotation about parallel axes. The roller 34 is provided with an annular recess 38 at the base of an annular channel and the roller 36 is provided with a complementary annular protrusion 40. The metal tape 26 is fed between the rollers 34, 36 which results in the formation of a longitudinally extending wire receiving channel formation 42 in the tape 26.

Referring now also to Figures 3 and 4 of the drawings, the barbed tape forming means 12 includes crimping means, generally indicated by reference numeral 44. The crimping means 44 includes a guide wheel 46 and a pair of crimping wheels 48 which cooperate to position the core wire 24 in the channel formation 42 and to crimp the channel formation 42 onto the core wire 24. Hence, barbs 50 protrude outwardly from an off center position.

Referring now to Figures 5, 6 and 7 of the drawings, the guide means 18 includes a guide arrangement, generally indicated by reference numeral 52 which is connected via a mounting arrangement 54 on a table 56. The guide arrangement 52 includes an elongate support member 58 having a longitudinally extending slot 60 therein. A pair of plates 62 protrude upwardly from opposite sides of the support member 58 and a plurality of longitudinally spaced apart rollers 64 is positioned between the plates 62. The rollers 64 are spaced from the upper surface of the support member 58 so that barbed tape is snugly receivable therebetween, the portion of the tape 22 extending around the wire 24 being received in the slot 60.

The mounting arrangement 54 includes a plate 66 which is connected to a support structure 68 by means of a pair of bolts 70. The operatively lowermost bolt 70 extends through an arcuate slot 72 which permits the plate 66 to be tilted about an axis defined by the uppermost bolt 70 as indicated by arrow 74. In addition, the mounting arrangement 54 includes a connector 76 whereby the guide arrangement 52 is connected to the plate 62, the connector 76 being configured to permit pivotal displacement of the guide arrangement 52 about a vertical axis 78 and a horizontal axis 80. Further, as can best be seen in Figure 1 of the drawings, the guide means 18 is longitudinally displaceable relative to the bending means 14 in the direction of arrow 81. The guide means 18 is also angularly displaceable relative to the bending means 14. This permits the angle at which barbed tape is fed to the bending means to be varied which in turn permits the pitch of the kinked barbed tape formed by the bending means as described herebelow to be varied.

Referring now to Figure 8 of the drawings, the bending means 14 includes a circular cylindrical housing 82 in which a helically extending barbed tape receiving slot 84 is provided. The housing 82 is clamped to a pair of pedestals 86 mounted on the table 56. The bending means 14 further includes an elongate bending member 88 which extends through and protrudes from opposite ends of the housing 82. The bending member 88 is in the form of an elongate generally rectangular element which has been twisted about its longitudinal axis. One end of the bending member 88 is drivingly connected via a connector 90 to an electric motor 92 whereby the bending member 88 is rotatable within the housing 82. The bending member 88 includes a pair of opposed major faces to each of which is connected a centrally disposed secondary bending formation 94 in the form of a length of square bar. In a preferred embodiment of the invention, the bending member 88 has a width of 100 mm and each secondary bending formation 94 is formed from 10 x 10 mm square bar. The width of the slot 84 is such that the barbed tape is snugly receivable therein.

The table 56 is mounted on a support 96 and is longitudinally displaceable relative thereto between first and second positions by means of a rack and pinion arrangement 98. The pinion 100 is drivingly connected to an electric motor 102, operation of which is controlled by limit switches (not shown) positioned to sense when the table is in its first and second positions. Guides and rollers (not shown) are provided to facilitate displacement of the table 56 relative to the support 96.

As can best be seen in Figures 9, 10, 11 and 12 of the drawings, the interlacing station 16 includes an upwardly open channel member 104 which is generally circular in cross-section. The channel member 104 has, at its one end, a feed opening 106 which is flared to facilitate the introduction of kinked barbed tape fed from the bending means 14 into the channel member 104. The interlacing station 16 further includes locating means, generally indicated by reference numeral 108 for locating a length of kinked barbed tape at a desired position within the channel member 104.

The locating means includes two sets of retaining fingers 150, 152 which serve to locate the kinked barbed tape as described in more detail below.

The locating means includes two sets of locating formations 110, 112, each including a plurality of longitudinally spaced apart locating formations 114. The locating formations 114 are arranged alternately such that the locating formations 114 of the set 110 are positioned intermediate the locating formations 114 of the set 112. Associated with each locating formation 114 is a slot 116 (Figure 12) in the channel member 104 through which the associated locating formation 114 is displaceable between a locating position in which it serves to locate a length of kinked barbed tape in the channel member 104 and a released position in which it is clear of the channel member 104. As can best be seen in Figure 12 of the drawings, the slots 116 extend obliquely relative to the length of the channel member 104. In this drawing, the locating formations 114 of the set 110 are shown in their locating position and the locating formations 114 of the set 112 are shown in their released position.

The interlacing station 16 includes displacement means, generally indicated by reference numeral 118 for displacing the locating formations 114 between their locating and their released positions. As can best be seen in Figure 12 of the drawings, in order to displace a locating formation 114 from its released position to its locating position, the locating formation 114 is displaced upwardly through the associated slot 116 and then pivoted about a vertical pivot axis and lowered into its locating position. The reverse procedure is followed when returning the locating formation to its released position. Accordingly, the displacement means 118 includes an electric motor 122 which is drivingly connected, e.g. by a ball-screw drive, to the set of locating formations 110 to displace the locating formations in the set 110 vertically. The displacement means 118 further includes an electric motor 120 drivingly connected, e.g. by a ball-screw drive, to the locating formations 114 in the set 110 in order to displace them pivotally.

Similarly, the displacement means 118 includes electric motors 124, 126 which are drivingly connected to the locating formations 114 of the set 112 so as to displace them pivotally and vertically, respectively.

It will be appreciated that instead of making use of the electric motors, displacement of the locating formation could be achieved by means of a pressurised fluid, for example, pneumatically or hydraulically. In addition, instead of making use of separate electric motors or pressurised fluid actuators for each set 110, 112 of locating formations common motors or actuators could be used making use of suitable connecting arrangements.

The cutting means 20 is in the form of a mechanised wire cutter.

The apparatus 10 includes roll forming means, generally indicated by reference numeral 128 configured to wind barrier material formed in the apparatus 10 into a roll.

As mentioned above, when a locating formation is being returned from its locating position to its released position, it is initially displaced upwardly and is then pivoted about a vertical pivot axis until it is in register with the associated slot 116 after which it is displaced downwardly through the slot 116 so that it is clear of the channel member 104. It will be appreciated, however, that as the locating formation 114 is displaced upwardly, as a result of the tension applied to the barrier material by the roll forming means 128 there will be a tendency for the length of kinked barbed tape which is retained in position by the locating formations 114 also to move upwardly which could result in one or more of the locating formations 114 snagging against the length of kinked barbed tape as it is displaced pivotally. In order to avoid this, it is desirable that the length of kinked barbed tape be retained in position with the lowermost kinks or troughs at the bottom of the channel member 104. To this end, as can best be seen in Figure 1 of the drawings, the two sets 150, 152 of retaining fingers mentioned above are positioned adjacent to the open top of the channel member 104. The sets 150,

152 of fingers protrude inwardly from opposite sides of the channel member 104 and are connected to a common shaft (not shown) positioned below the channel member 104. The fingers of the sets 150, 152 are longitudinally spaced apart and are arranged alternately such that the fingers of the set 150 are positioned between the fingers of the set 152. The spacing between adjacent fingers in the sets 150, 152 corresponds to half of the pitch of the kinks in the kinked barbed tape so that the fingers can engage the troughs of alternate lengths of kinked barbed tape. In this way, tension applied to the barrier material by the roll forming means 128 is not transmitted to the lengths of kinked barbed tape positioned within the channel member 104 so that the lengths of kinked barbed tape do not move upwardly when the locating formations 114 are displaced upwardly. The shaft to which the sets of fingers 150, 152 are connected is pivotally displaceable between a first position in which the fingers in the set 150 are in an engaging position above the open top of the channel and the fingers in the set 152 are in a released position clear of barrier material exiting the channel member, and a second position in which the fingers in the set 152 are in the engaging position and the fingers in the set 150 are in the released position. The fingers in each set 150, 152 typically each have a diameter which is greater than the spacing between adjacent ends of adjacent barbs which reduces the risk of the barbs snagging on the fingers.

Further, with reference to Figure 1 of the drawings, if desired, the apparatus 10 includes pitch adjusting means, generally indicated by reference numeral 156. The pitch adjusting means 156 includes a circular cylindrical housing 158 having a helical barbed tape receiving slot 160 therein. The housing 158 is mounted on a support which is longitudinally displaceable relative to the housing 82 whilst maintaining the housing 158 in register with the housing 82. The bending member 88 is extended and extends through the housing 158. By adjusting the relative spacing between the housing 158 and the housing 82 the pitch of the kinked barbed tape being fed to the interlacing station 16 can be adjusted. The Inventors have found that varying the size of the secondary bending formation 94 also results in the pitch of the kinked barbed tape being adjusted.

Accordingly, the pitch adjustment means may in addition or instead comprise an arrangement whereby secondary bending formations 94 of different sizes are interchangeable and/or the actual sizes of the secondary bending formations 94 are adjustable.

In use, metal tape 26 is drawn off the reel 30 and fed between the forming rollers 34, 36 such that the channel formation 42 is formed therein, the formed tape is then fed, to the crimping means 44 and the wire 24 is fed from the reel 28 into the channel formation 42. The tape and wire are then fed together between the guide wheel 46 and crimping wheels 48 which crimp the metal tape onto the core wire to form the barbed tape. The barbed tape is then fed through the guide arrangement 52 and through the slot 84 in the housing 82. The bending member 84 is rotated by the electric motor 92 which serves to draw the barbed tape into the housing 82 and at the same time to form longitudinally spaced apart kinks 130 in the barbed tape. The forming rollers 34, 36 and the guide wheel 46 and crimping wheels 48 are undriven, the tape and core wire being drawn therethrough by the rotation of the bending member 88. It is to be appreciated, however, that if desired, one or more of the forming rollers 34, 36, the guide wheel 46 and the crimping wheels 48 can be driven. The twist in the bending member 88 serves to ensure that the kinks 130 are generally co-planar. In addition, the provision of the secondary bending formations 94 serve to bow the lengths of barbed tape intermediate the kinks 130 outwardly providing the kinked barbed tape with a generally rhomboidal appearance when viewed from an end thereof, as can best be seen in Figure 14 of the drawings. Further, as mentioned above, the size of the formations 94 has an affect on the pitch of the kinked barbed tape. In addition, the guide arrangement 52 is configured so as to feed the barbed tape to the bending member 88 such that the portion of the tape extending around the wire is innermost which in turn serves to ensure that the tape is innermost at the kinks 130 as shown in Figure 13 of the drawings.

As the kinked barbed tape leaves the housing 82 it is optionally fed to the housing 158 such that the pitch of the kinks is adjusted to a desired pitch.

As the bending member 88 rotates it displaces the kinked barbed tape in the direction of the channel member 104. In addition to being displaced in the direction of the channel member 104, the kinked barbed tape is rotated.

On start-up, the bending member is rotated until a length of kinked barbed tape of the desired length is positioned within the channel member 104. The cutting means 20 is then operated to cut the barbed tape and the length of barbed tape is secured in position in the channel member by the locating formations 114 of the set 110 abutting against the lowermost kinks or troughs 130 of the length of barbed tape. The electric motor 102 is then operated to rotate the pinion 100 and in turn displace the table 56 from its first position to a second position spaced longitudinally from the first position by an amount equal to $L/2$, i.e. half the pitch of the peaks of the kinked barbed tape. The electric motor 92 is once again operated which rotates the bending member 88 and the kinked barbed tape formed by the bending member is fed into the feed opening 106 of the channel member 104. As the kinked barbed tape is fed longitudinally it is simultaneously rotated which, by virtue of the fact that it is out of phase with the length of barbed tape secured in the channel member, results in the kinked barbed tape leaving the pitch adjustment means 156 being interlaced with the length of barbed tape secured in position in the channel member 104. Once again, when sufficient of the kinked barbed tape has been fed into the channel member and interlaced with the length of barbed tape secured therein, operation of the electric motor 92 is interrupted. The locating formations 114 of the set 112 are then displaced via the displacement means 118 from their released positions to their retaining positions, in which they engage the troughs of the newly formed length of kinked barbed tape. The locating formations 114 of the set 110 are then displaced to their released positions and the first formed length of barbed tape is drawn upwardly out of the channel member 104. The barbed tape is once again cut by the cutting means 20. The electric motor 102 is once again energised to return the table to its first position. Subsequently, the electric motor 92 is energised to rotate the bending member and the kinked barbed tape which is formed thereby is fed into the channel member 104 and interlaced with the length

of barbed tape secured therein in the manner described above. By repeating this procedure, a barrier material of any desired length can be formed.

As the barrier material is formed and drawn upwardly out of the channel member it is wound into a roll by the roll forming means 128 to facilitate the further handling and transportation thereof.

When the barrier material is of sufficient length that the roll forming means 128 can begin to form it into a roll, the tension applied to the barrier material by the roll forming means would tend to cause the kinked barbed tape positioned within the channel member 104 to be drawn upwardly when the associated locating formations 114 are displaced to their released positions. In order to counter this, use is made of the sets of fingers 150, 152 which engage the troughs of alternate lengths of kinked barbed tape. This ensures a degree of slack in the portion of the barrier material positioned below the fingers 150, 152 and within the channel member 104 thereby permitting displacement of the locating formations 114 between their retaining positions and their released positions without snagging on the barrier material.

In the embodiment of the invention where the locating formations 114 are omitted, the kinked barbed tape formed by the bending member is interlaced with a previously formed length of kinked barbed tape positioned in the channel member. Initially, the barrier material formed in this way is drawn upwardly out of the channel member manually. Once the barrier material is of sufficient length to reach the roll forming means 128 it is drawn upwardly by the roll forming means. The sets 150, 152 of retaining fingers serve to locate the length of kinked barbed tape positioned in the channel member 104 by permitting the barrier material, as it is formed to be wound stepwise into a roll and at the same time preventing the tension applied to the barrier material from being applied to the barbed tape in the channel member.

As mentioned above, the configuration of the bending member 88 serves to provide the kinked barbed tape with a generally rhomboidal appearance when viewed from an end thereof. Although this assists with the interlacing of the lengths of kinked barbed tape in the manner described above, it will be appreciated that the thickness of the barrier material will be increased by virtue of the shape of the lengths of kinked barbed tape. With reference now to Figure 15 of the drawings, in order to permit the barrier material to be wound into a compact form, compression means, generally indicated by reference numeral 200 is provided between the interlacing station 16 and the roll forming means 128, part of which is shown in Figure 15. The compression means includes a lower compression member 202 defining an upwardly directed compression surface 204 and an upper compression member 206 defining a downwardly disposed compression surface 208. The upper compression member 206 is slidably supported for vertical displacement relative to the lower compression member 202 by guides 210, displacement of the upper compression member 206 being effected by a pressurised fluid, typically hydraulic, piston and cylinder assembly 212. The compression surfaces 204, 208 define between them a working gap 214 through which the barrier material is fed. The piston and cylinder assembly 212 is actuated periodically to displace the upper compression member 206 towards the lower compression member 202 so that the portion of the barrier material positioned in the working gap 214 is laterally compressed between the surfaces 204, 208, thereby reducing the extent to which the lengths of barbed tape intermediate the kinks 30 are bowed, which in turn results in a reduction of the thickness of the barrier material. This enables the barrier material to be wound into a more compact roll than would otherwise be the case.

If desired, the apparatus may include a pair of tools (not shown) for twisting together the ends of interlaced lengths of kinked barbed tape.

Operation of the various components of the apparatus may be controlled electronically thereby ensuring correct sequencing.

The Inventors believe that barrier material in accordance with the invention will form an effective security barrier.

In addition, the automated method of manufacturing the barrier material serves to produce barrier material quickly and cost effectively.

The Inventors believe that by bowing the lengths of barbed tape intermediate the kinks 130 outwardly, greater clearance will be provided between lengths of barbed tape as they are interlaced in the channel member 104 thereby reducing the risk of snagging. In addition the provision of the slots 116 at an oblique angle further serves to reduce the risk that the barbs will snag on the slots and/or the locating formations. In addition, the fact that at each of the kinks, the material of the tape is innermost and consequently the barbs are outermost, the clearance between the barbs in the lengths of barbed tape is further enhanced thereby reducing the risk of snagging.

CLAIMS:

1. A method of making a barrier material which includes the steps of feeding barbed tape to a bending station in which a series of longitudinally spaced apart kinks or bends is formed into the barbed tape; and

rotating and advancing the kinked barbed tape longitudinally relative to a previously formed elongate kinked barrier element to interlace the kinked barbed tape and the previously formed barrier element.

2. A method of making a barrier material which includes the steps of at a bending station, forming a series of longitudinally spaced apart kinks or bends into a length of barbed tape; and

as it is formed, interlacing the kinked barbed tape with a previously formed elongate kinked barrier element.

3. A method as claimed in claim 1 or claim 2, in which the previously formed barrier element is in the form of a length of kinked barbed tape.

4. A method as claimed in any one of the preceding claims, which includes cutting the length of barbed tape fed from the bending station after it has been interlaced with the previously formed barrier element, advancing the barrier material, feeding a subsequent length of kinked barbed tape from the bending station and interlacing the subsequent length of barbed tape with the previous length of barbed tape, thereby increasing the length of the barrier material.

5. A method as claimed in any one of the preceding claims, in which the kinked barbed tape is formed with a plurality of alternating peaks and troughs, the method including deforming the lengths of barbed tape intermediate the peaks and troughs such that they are bowed outwardly providing the kinked barbed tape with a generally rhomboidal profile when viewed from an end thereof.

6. A method as claimed in any one of the preceding claims, which includes the prior step of forming the barbed tape and feeding the barbed tape as it is formed in a more-or-less continuous manner to the bending station.

7. A method as claimed in claim 6, in which forming the barbed tape includes feeding core wire and metallic tape from supplies of core wire and metallic tape to a forming station and crimping the metallic tape onto the core wire.

8. A method as claimed in claim 7, in which the metallic tape extends partway around the core wire, the barbs protruding from the edges of the metallic tape, the method including bending the barbed tape such that the metallic tape is innermost at each of the bends.

9. A method of making a barrier material which includes the steps of

forming a barrier element which comprises a length of barbed tape having alternating peaks and troughs with the portions of the barrier tape intermediate the peaks and troughs being non-linear for at least part of their lengths; and

interlacing the barrier element with a previously formed barrier element.

10. A method as claimed in claim 5 or claim 9, which includes the step of laterally compressing the barrier material.

11. A method as claimed in any one of the preceding claims, which includes forming the barrier material into a roll.

12. A barrier material which includes a plurality of interlaced elongate barrier elements each of which has a plurality of oppositely disposed longitudinally spaced apart kinks therein, at least some of the barrier elements being formed of barbed tape and at least some of the portions of at least some of the barrier elements intermediate the kinks being non-linear for at least part of their lengths.

13. A barrier material which includes a plurality of interlaced elongate barrier elements each of which has a plurality of oppositely disposed longitudinally spaced apart kinks therein, at least some of the barrier elements being formed of barbed tape, the barrier elements of barbed tape being kinked such that the metallic tape is innermost at each of the kinks.

14. A barrier material as claimed in claim 13, in which each barrier element has a generally rhomboidal profile when viewed from an end thereof.

15. A barrier material as claimed in claim 14, in which the barrier elements are bowed outwardly intermediate the kinks.

16. A barrier material as claimed in claim 15, in which the barrier elements are bowed outwardly by a distance of between 5 and 15% of the perpendicular distance between two parallel lines defined by the kinks.

17. A barrier material as claimed in claim 16, in which the barrier elements are bowed outwardly by a distance of 10% of the perpendicular distance between two parallel lines defined by the kinks.

18. A barrier material as claimed in any one of claims 12 to 17, inclusive, in which each barrier element is formed of barbed tape.

19. A barrier material forming apparatus which includes

bending means for forming longitudinally spaced apart bends or kinks into a length of barbed tape; and

an interlacing station at which kinked barbed tape from the bending means is interlaced with a previously formed elongate kinked barrier element.

20. A barrier material forming apparatus as claimed in claim 19, which includes barbed tape forming means configured to form barbed tape from supplies

of wire and metal tape which barbed tape is then fed, in use, to the bending means.

21. A barrier material forming apparatus as claimed in claim 20, in which the barbed tape forming means includes a channel forming means for forming a longitudinally extending wire receiving channel formation in the metal tape and crimping means for positioning wire in the channel formation and crimping the metal tape onto the wire positioned in the channel formation.

22. A barrier material forming apparatus as claimed in any one of claims 19 to 21, inclusive, in which the bending means includes a circular cylindrical housing in which a helically extending barbed tape receiving slot is provided and an elongate bending member rotatably mounted with little clearance in the housing.

23. A barrier material forming apparatus as claimed in claim 22, in which the bending member is generally rectangular in shape having a pair of opposed major faces, the member being twisted about its length which results in the kinks or bends in the barbed tape being substantially coplanar.

24. A barrier material forming apparatus as claimed in claim 23, in which the bending means includes secondary bending formations which are centrally disposed and protrude outwardly from the major faces of the bending member and which serve, in use, to deform portions of the barbed tape intermediate the kinks outwardly to provide the barbed tape leaving the bending means with a generally rhomboidal profile when viewed from an end thereof.

25. A barrier material forming apparatus as claimed in claim 24, in which each secondary bending formation protrudes from the bending member by an amount which is between 5 and 15% of the width of the bending member.

26. A barrier material forming apparatus as claimed in claim 25, in which each secondary bending formation protrudes from the bending member by an amount which is equal to 10% of the width of the bending member.

27. A barrier material forming apparatus as claimed in any one of claims 19 to 26, inclusive, which includes pitch adjustment means intermediate the bending means and the interlacing station whereby the pitch of the bends or kinks is adjustable.

28. A barrier material forming apparatus as claimed in any one of claims 19 to 27, inclusive, in which the bending means is mounted for reciprocation relative to the interlacing station between first and second positions, the apparatus including displacement means for displacing the bending means between its first and second positions.

29. A barrier material forming apparatus as claimed in any one of claims 19 to 28, inclusive, in which the interlacing station includes an upwardly open channel member which is generally circular in cross-section, the channel member having at its one end a feed opening which is positioned in register with the housing of the bending means to receive kinked barbed tape leaving the bending means.

30. A barrier material forming apparatus as claimed in claim 29, which includes locating means configured to locate a previously formed length of kinked barbed tape at a desired position within the channel member.

31. A barrier material forming apparatus as claimed in claim 30, in which the locating means includes two sets of retaining fingers positioned adjacent to the open top of the channel member releasably to engage the barrier material.

32. A barrier material forming apparatus as claimed in claim 31, in which the sets of retaining fingers are oppositely disposed and at least that portion of

each retaining finger which engages the barrier material having a diameter which is greater than the spacing between adjacent ends of adjacent barbs.

33. A barrier material forming apparatus as claimed in any one of claims 30 to 32, inclusive, in which the locating means includes two sets of locating formations, each set of locating formations including a plurality of longitudinally spaced apart locating formations which is displaceable between a locating position in which the formations protrude into the channel member to locate the troughs of a length of kinked barbed tape adjacent a bottom of the channel and a released position in which the formations are clear of the channel, the spacing between the formations of one set and the formations of the other set being equal to half of the pitch of the peaks and/or troughs of the kinked barbed tape.

34. A barrier material forming apparatus as claimed in claim 33, in which the locating means includes,associated with each locating formation, a slot in the channel member through which the locating formation is displaced into and out of the channel member.

35. A barrier material forming apparatus as claimed in claim 34, in which the slots extend obliquely relative to the length of the channel member.

36. A barrier material forming apparatus as claimed in any one of claims 19 to 35, inclusive, which includes cutting means positioned intermediate the bending means and the interlacing station to cut kinked barbed tape fed from the bending means to the interlacing station to the desired length.

37. A barrier material forming apparatus as claimed in any one of claims 20 to 36, inclusive, which includes guide means for guiding the barbed tape from the barbed tape forming means to the bending means.

38. A barrier material forming apparatus as claimed in claim 37, in which the guide means includes a guide arrangement configured to feed the barbed tape

to the bending means at a desired angle with the portions of the metal tape which extends around the wire being radially innermost.

39. A barrier material forming apparatus as claimed in claim 38, in which the guide arrangement includes an elongate support member having a longitudinally extending slot therein and a plurality of longitudinally spaced apart rollers positioned such that the barbed tape is snugly receivable between the support member and the rollers.

40. A barrier material forming apparatus as claimed in any one of claims 19 to 39, inclusive, which includes roll forming means for forming the barrier material into a roll.

41. A barrier material forming apparatus as claimed in claim 40, which includes compression means for laterally compressing the barrier material to reduce its thickness.

42. A barrier material forming apparatus as claimed in claim 41, in which the compression means includes a pair of compression members which define between them a working gap through which the barrier material is fed,and displacement means for displacing the compression members relative to one another to compress a portion of the barrier material positioned therebetween.

43. A barrier which includes

barrier material of the type claimed in any one of claims 12 to 18; and

support means for supporting the barrier material in a desired orientation.

44. A barrier as claimed in claim 43, in which the support means is configured to support the barrier material such that it lies in a generally vertically extending plane in the manner of a fence.

45. A new method of making a barrier material substantially as described and illustrated herein.

46. A new barrier material substantially as described and illustrated herein.

47. A new barrier material forming apparatus substantially as described and illustrated herein.

48. A new barrier material substantially as described and illustrated herein.

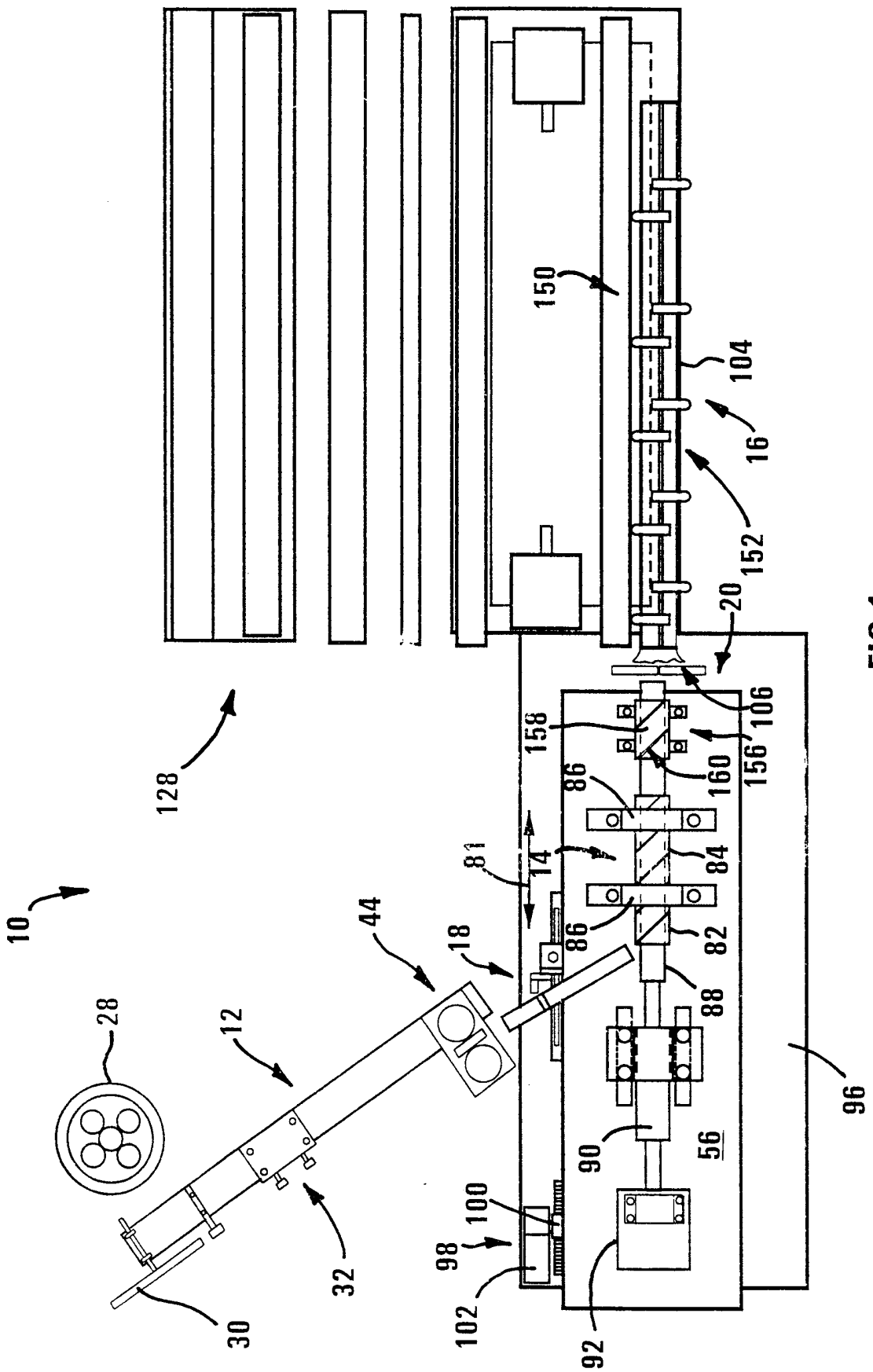
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FIG 1

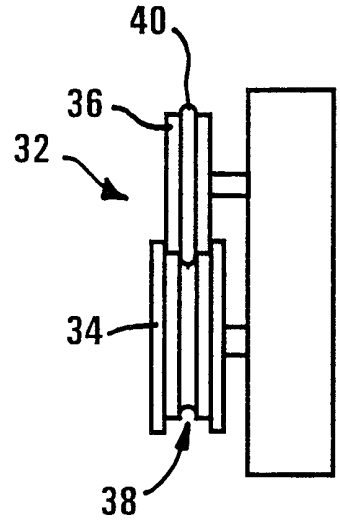

FIG 2

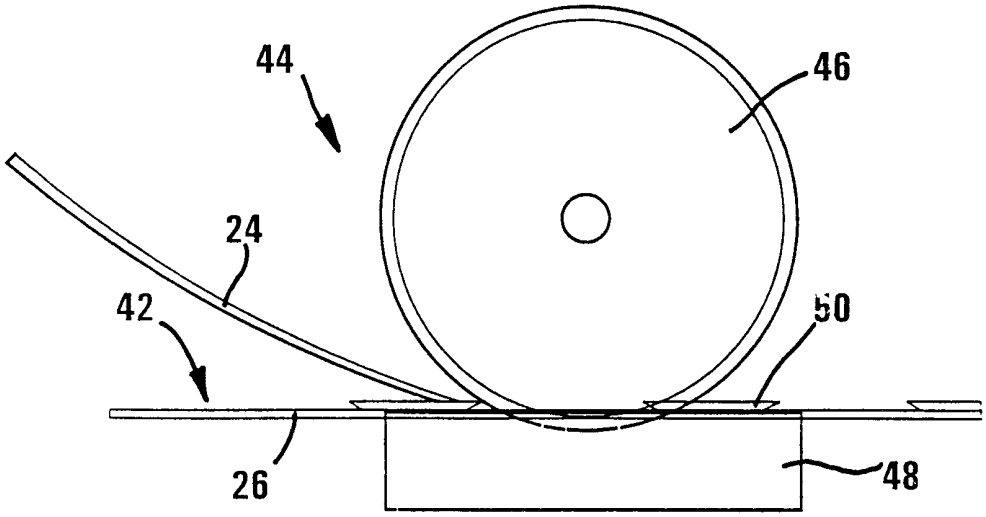

FIG 3

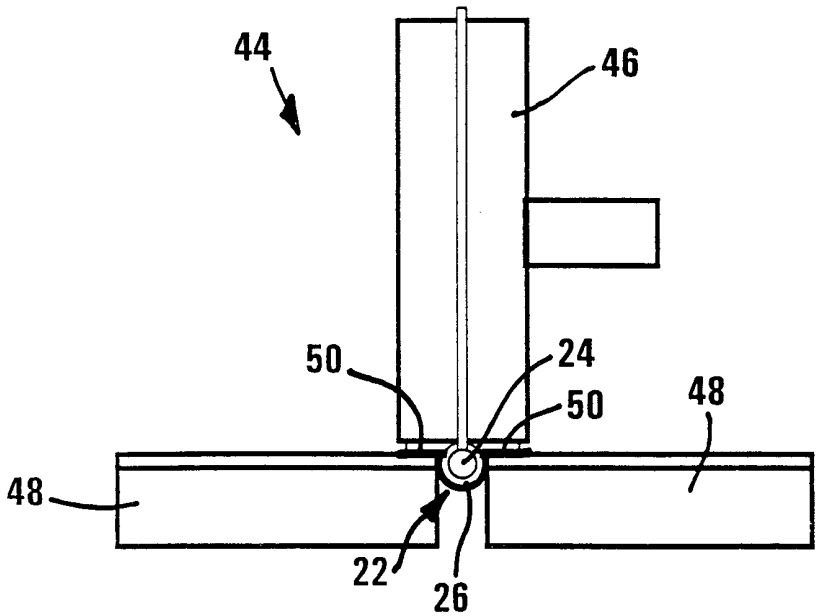

FIG 4

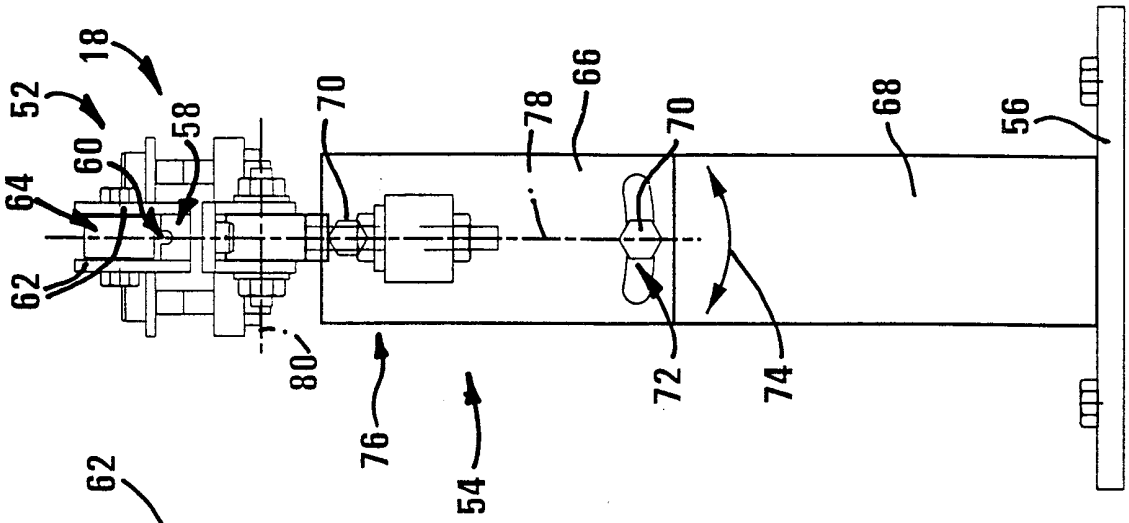
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FIG 6

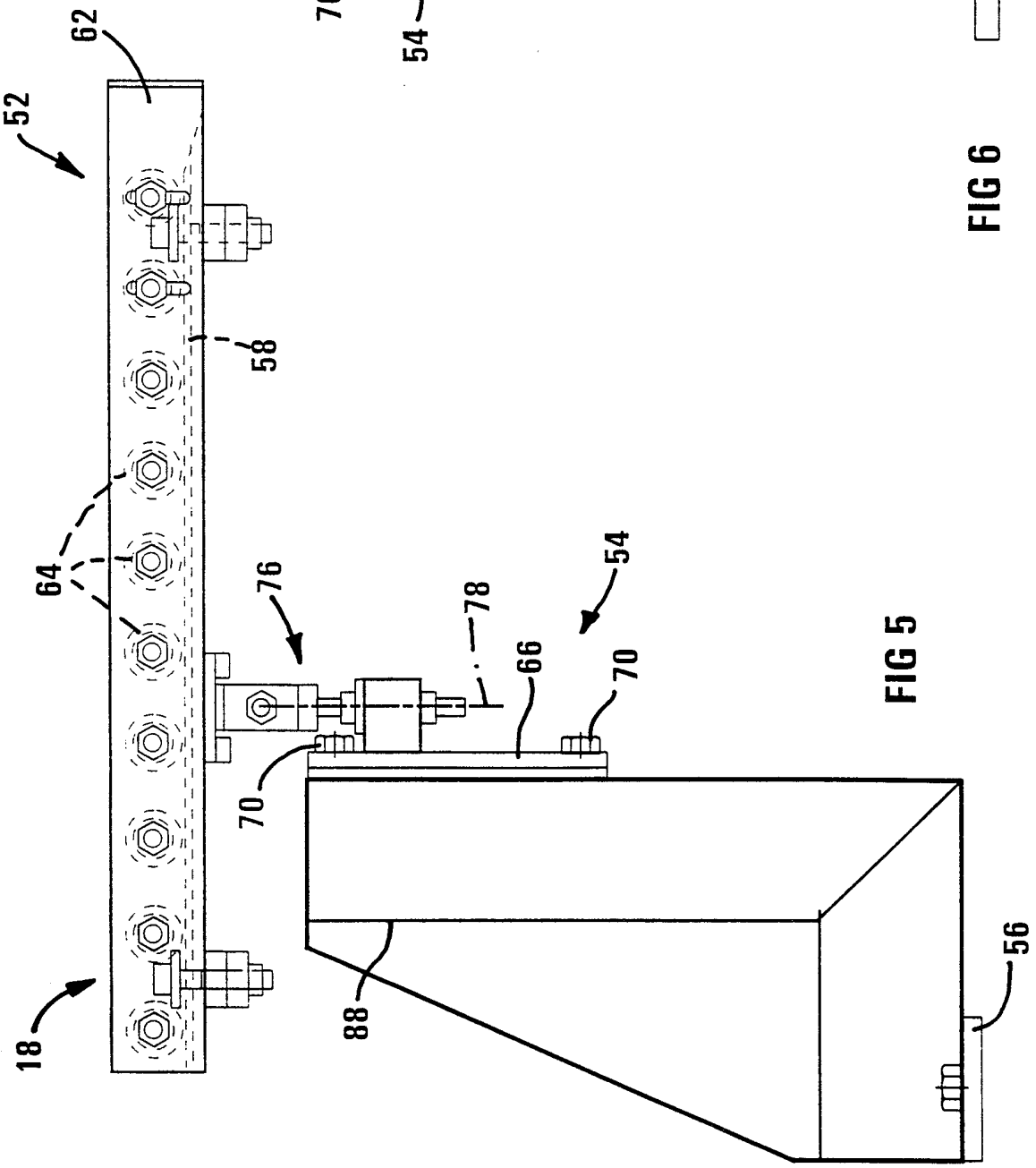
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FIG 5

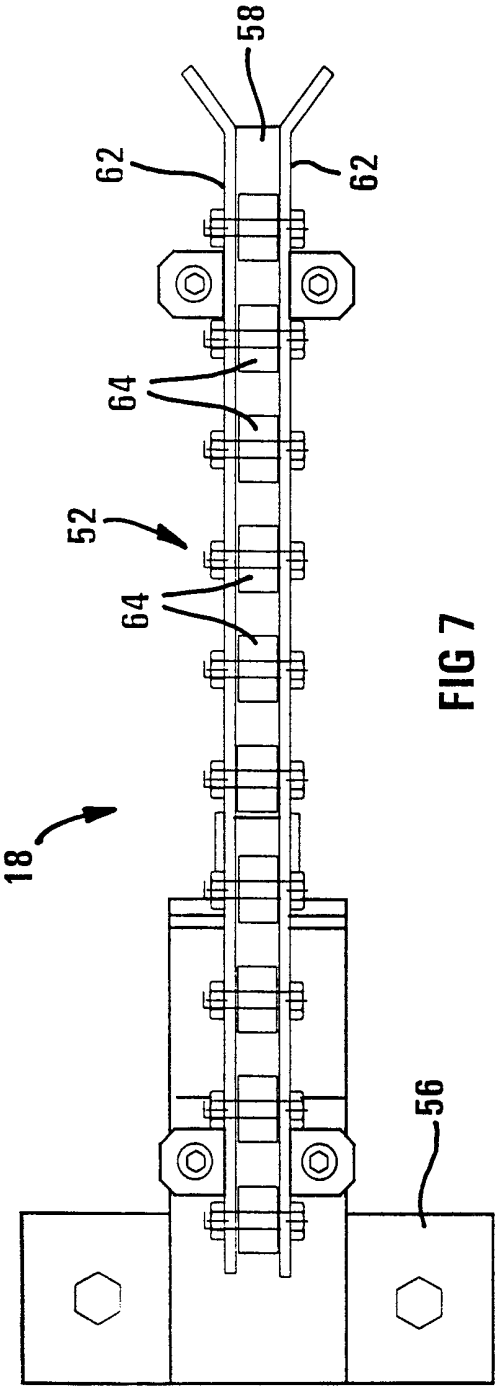

FIG 7

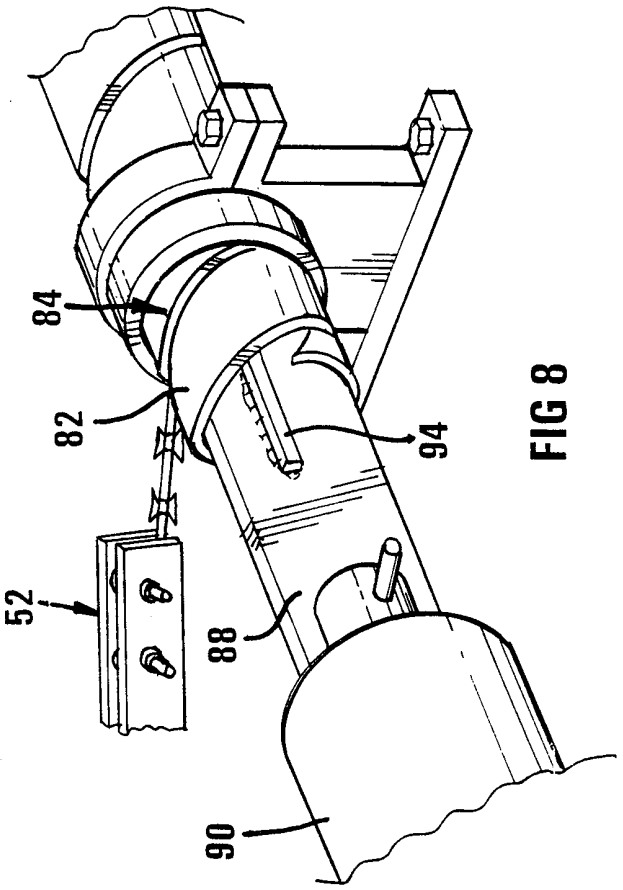

FIG 8

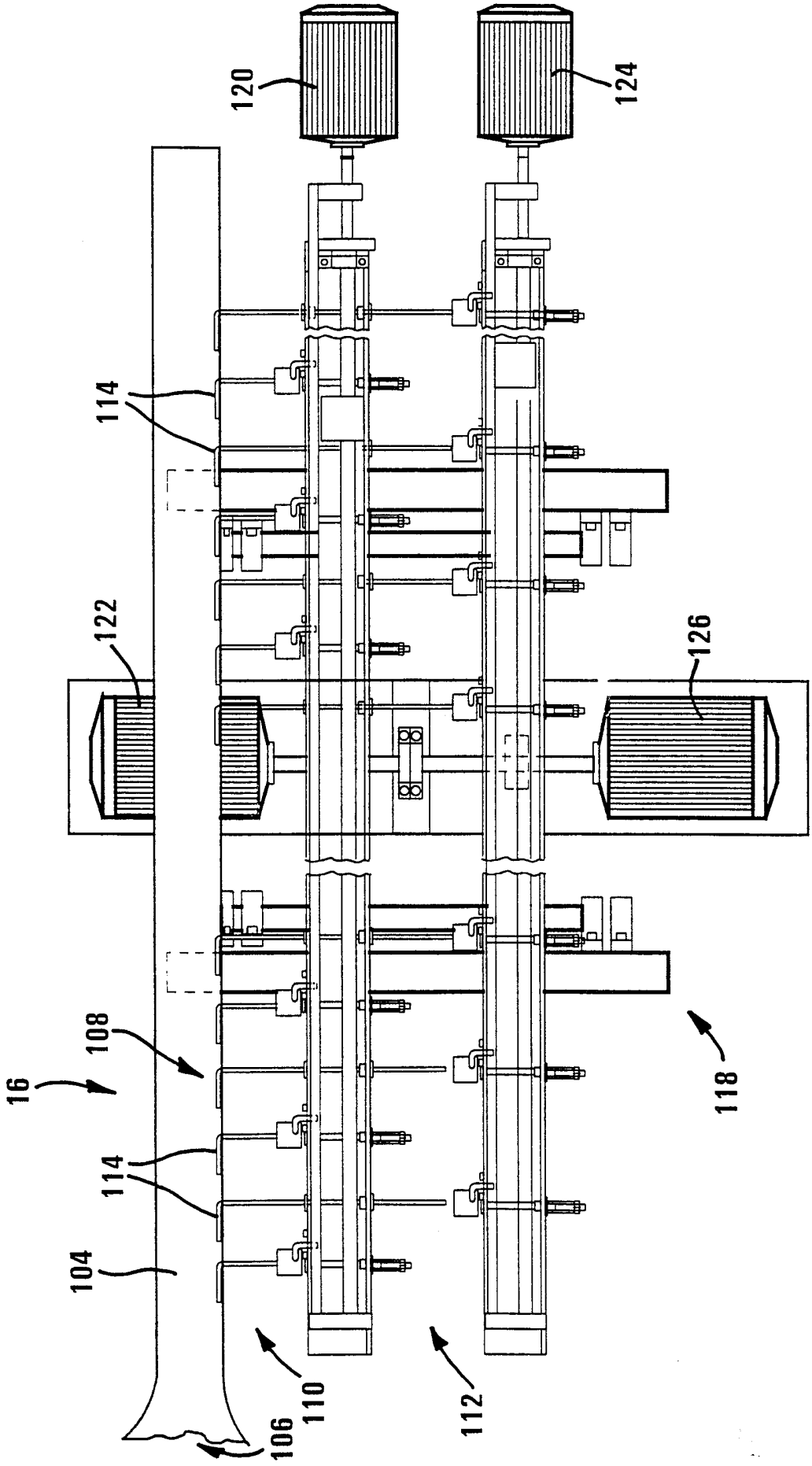

FIG 9

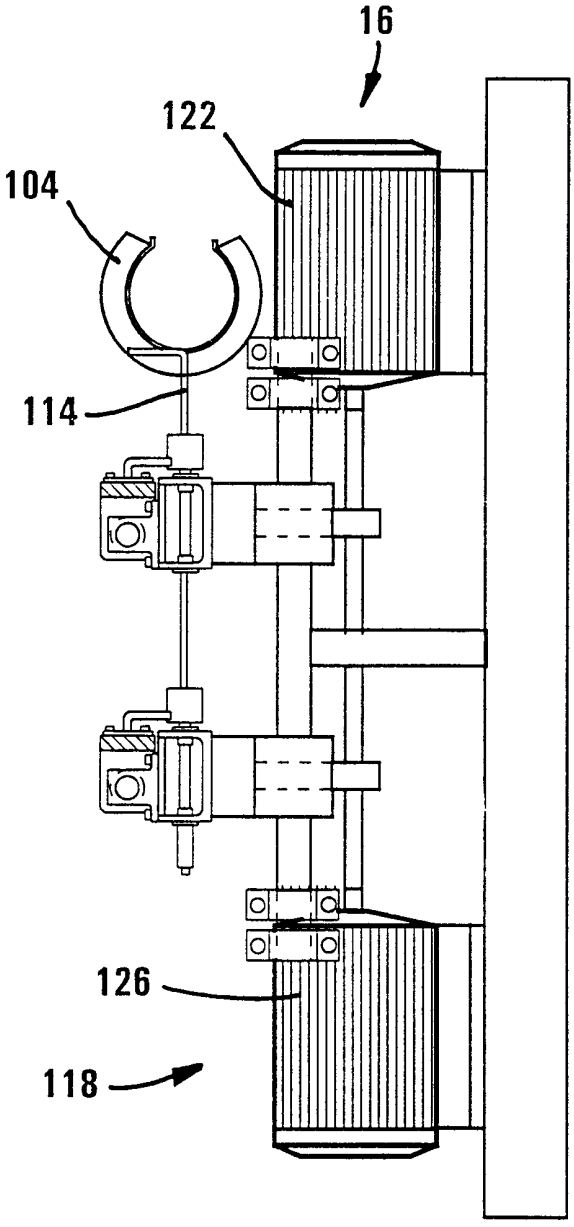

FIG 10

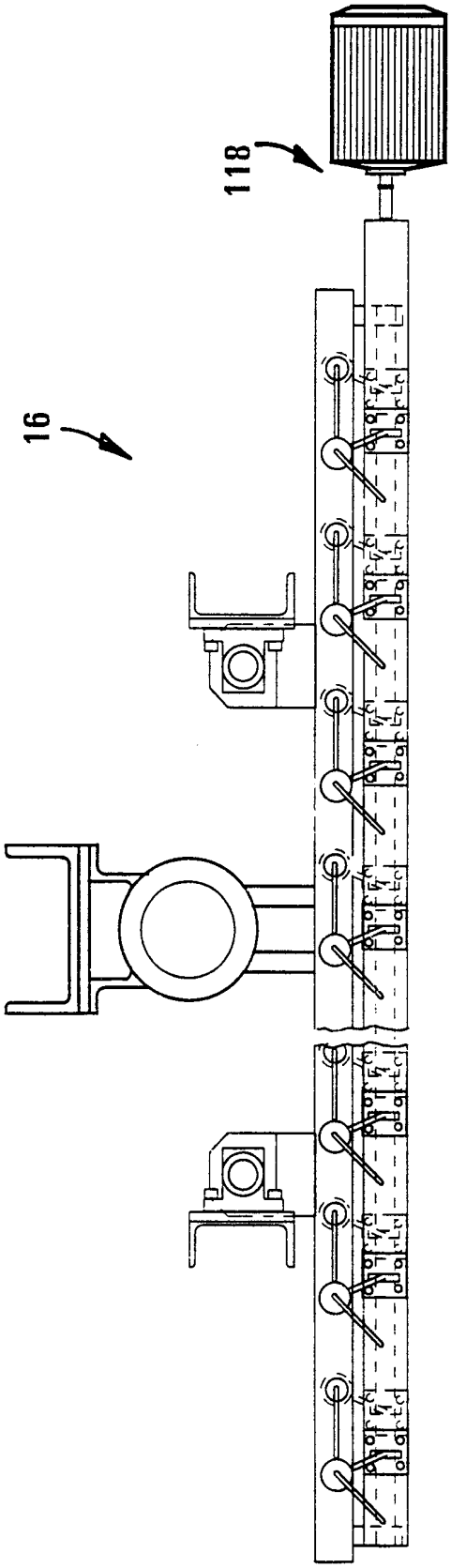

FIG 11

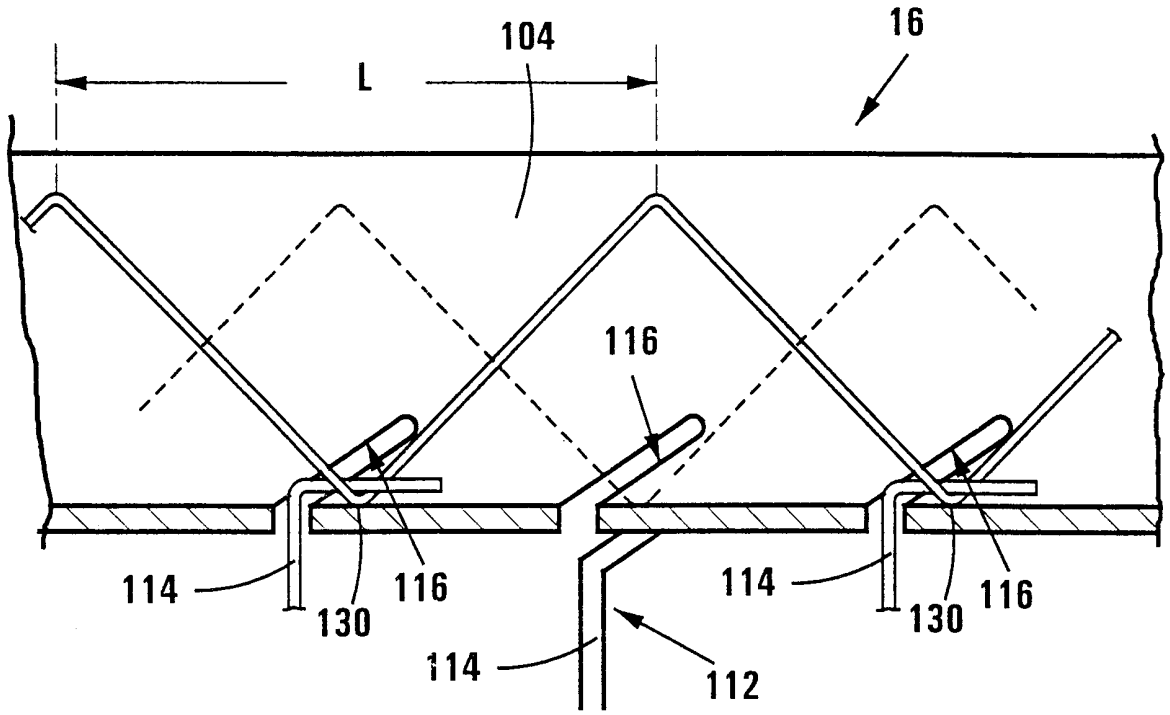

FIG 12

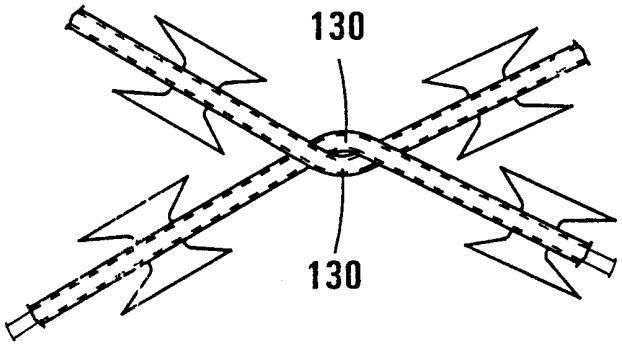

FIG 13

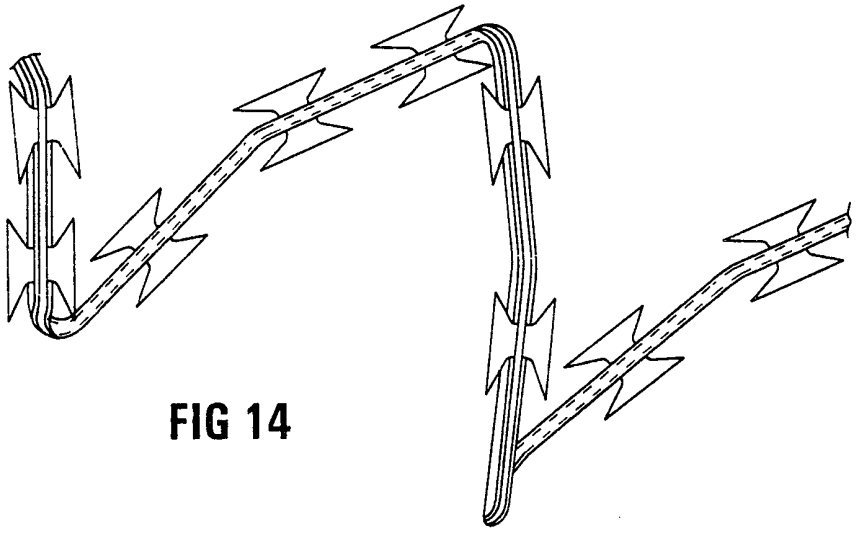

FIG 14

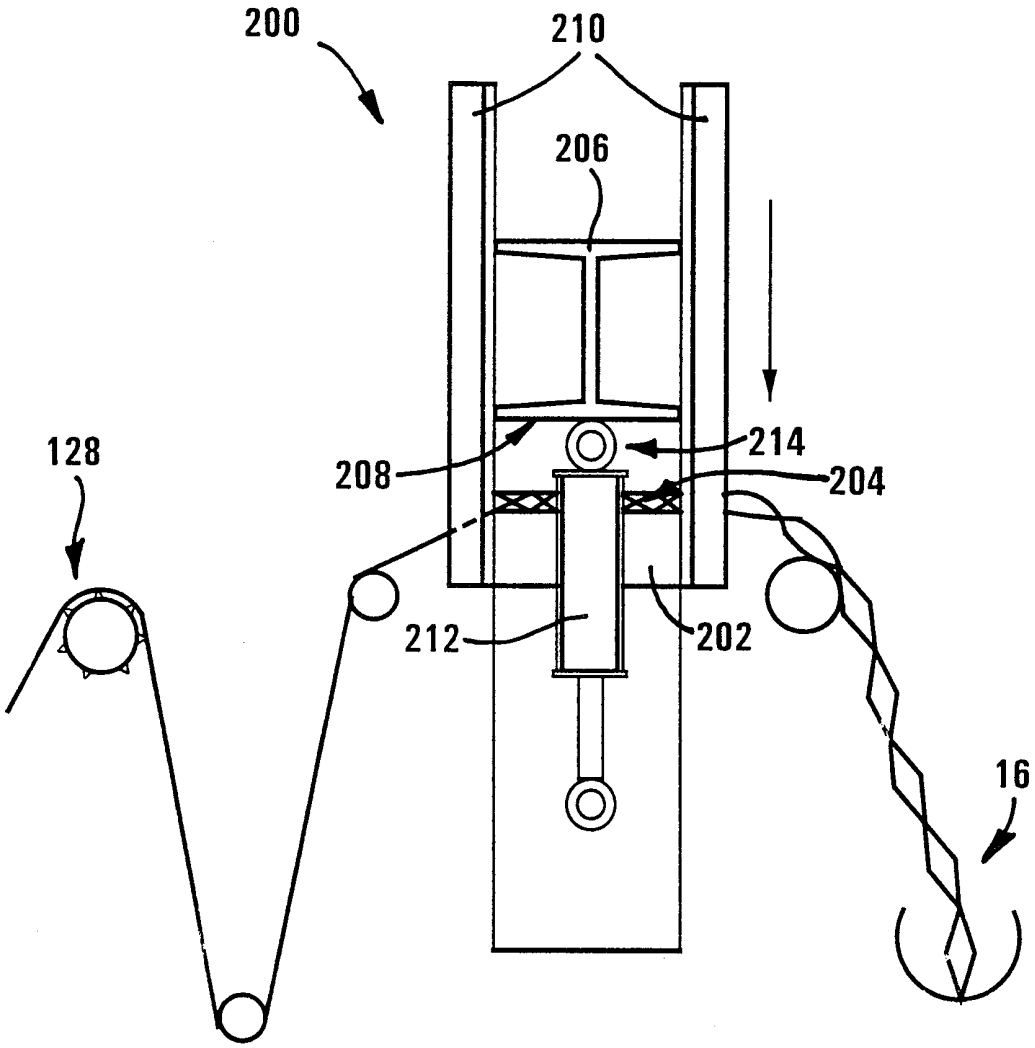

FIG 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/00799

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :B21F 25/00; B23P 17/00
US CL :Please See Extra Sheet.
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)

U.S. : Please See Extra Sheet.

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,818,972 A (MAINIERO ET AL) 04 April 1989, See figs. 1-13	12-18, 43-44
Y	GB 2,162,879 A (MAINIERO ET AL) 12 February 1986, See page 4, lines 65-105	12-18, 43-44
A	US 364,754 A (CURTIS) 14 June 1887, See entire document	1-44
A	GB 2,240,351 A (COCHRANE) 31 July 1991, See entire document	1-44

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be of particular relevance	"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
"E"	earlier document published on or after the international filing date	"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
"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)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search	Date of mailing of the international search report
07 APRIL 1999	22 APR 1999

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	for Hughes, S. Thomas Sheila Veney Paralegal Specialist Technology Center 3700
Facsimile No. (703) 305-3230	Telephone No. (703) 308-1806

Form PCT/ISA/210 (second sheet)(July 1992)★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/00799

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

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

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

2. ☒ Claims Nos.: 45-48
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 are omnibus

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

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

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

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

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

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.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/00799

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

140/63; 29/417

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

140/59, 60, 63, 70, 62, 102, 106, 149, 139, 122, 58, 92.6, 92.7, 92.3, 92.4;
29/7.1, 417, 514, 412, 429, 509