Dec. 24, 1968 W. G. MOEHLENPAH 3,417,651

CONNECTOR PLATES

Filed Oct. 21, 1966 2 Sheets-Sheet 1

FIG. 1

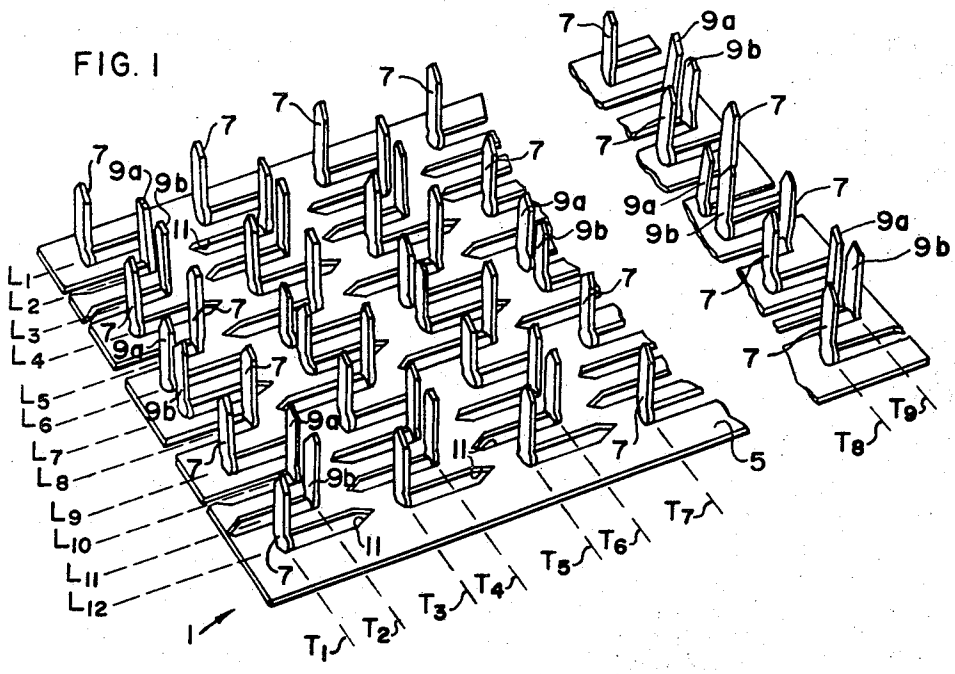


FIG. 2

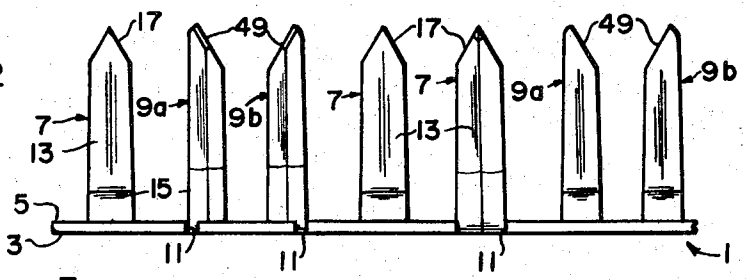
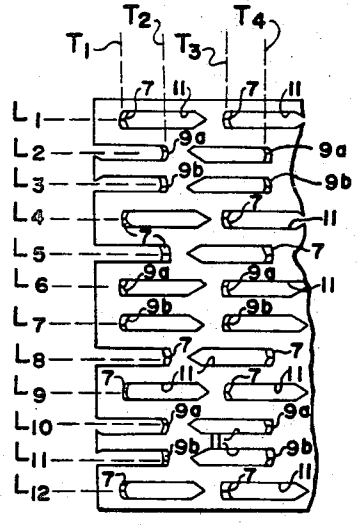


FIG. 3



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CONNECTOR PLATES

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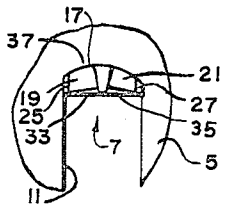


FIG. 4

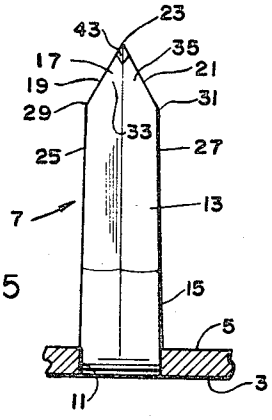


FIG. 5

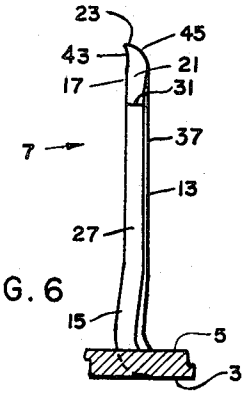
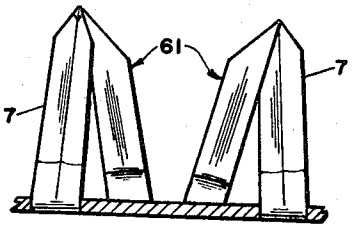


FIG. 6

FIG. 11



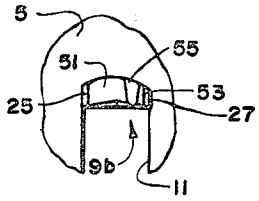


FIG. 7

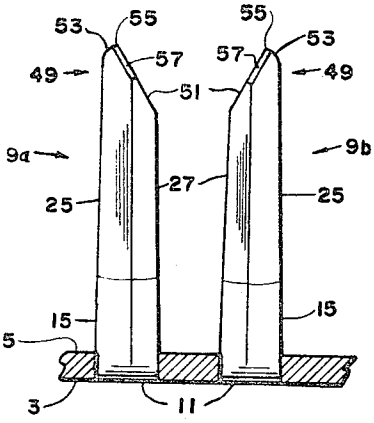


FIG. 8

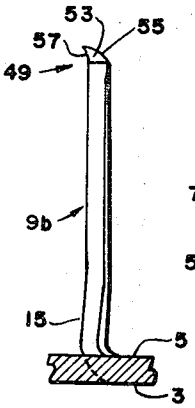


FIG. 9

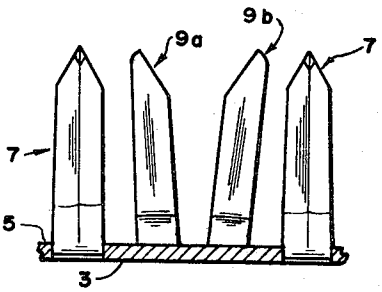


FIG. 10

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3,417,651

CONNECTOR PLATES

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Filed Oct. 21, 1966, Ser. No. 588,510
8 Claims. (Cl. 85—13)

ABSTRACT OF THE DISCLOSURE

Toothed integral metal connector plates for securing together wood members. Each of the teeth has a shank portion joint at one end to the face of the plate and a tip portion at its other end. The tip portions have side edges converging to a point. Some of the teeth have their points centered and are therefore symmetrical teeth, while the points of other of the teeth are offest from the center and are unsymmetrical teeth. The teeth are arranged in rows of unsymmetrical teeth and rows of symmetrical teeth with the latter rows lying to the sides of the rows of unsymmetrical teeth. When the teeth are driven into wood members the unsymmetrical teeth bend transversely to a controlled or limited degree toward an adjacent row of symmetrical teeth and cooperate with the symmetrical teeth to grip the wood member.

This invention relates to connector plates having a plurality of projecting teeth, the plates being used for securing together adjacent wood structural members.

Among the several objects of this invention may be noted the provision of connector plates which have high resistance to withdrawal from wood members; the provision of connector plates having high shear strength not only when the shear test is performed by pulling connected wood structural members along a line parallel to the face of the teeth projecting from the plate but also when the test is performed by pulling the wood members at an angle to the face of the teeth; the provision of a connector plate having projecting teeth constructed so that controlled lateral bending of some of the teeth occurs when the teeth are driven into a wood member; the provision of a connector plate having teeth constructed to minimize tearing of the teeth at the base or root portions thereof where they are joined to the plate; and the provision of a connector plate whose teeth can be driven into wood members without matting or balling-up of wood fibers and which reduce splitting particularly in edge grained harder woods. Other objects and features will be in part apparent and in part pointed out hereinafter.

Briefly, a connector of this invention comprises a thin-gauge metal plate having a plurality of elongate integral teeth extending from one face thereof. Each of the teeth is constituted by a struck-out portion of the plate which vacates an elongate slot in the plate with each tooth projecting from the one face of the plate at one end of its respective slot in the plate. The teeth each have a shank portion formed with a tip portion that converges to a point. The points of some of the teeth are at the center thereof thereby forming symmetrically tipped teeth, while the points of the other of the teeth are offset from the center of the teeth thereby to form unsymmetrically tipped teeth. The teeth are arranged in laterally spaced apart rows with the teeth in each row being spaced apart. The elongate slots vacated by the teeth in adjacent rows are generally parallel. The unsymmetrically tipped teeth and the symmetrically tipped teeth are relatively staggered in the direction of the length of the rows. The tip portion of each unsymmetrically tipped tooth

comprises a long straight side edge and a shorter generally arcuate side edge converging at a rounded point offset in a direction toward an adjacent row of teeth and thereby having a camming edge. Upon driving the teeth into a wood member the unsymmetrical tipped teeth are thereby caused to bend transversely to a limited degree toward an adjacent row of teeth and cooperate with the symmetrically tipped teeth to grip the wood member.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

FIG. 1 is a perspective of the toothed side of a connector plate of this invention;

FIG. 2 is an enlarged fragmentary end view of the FIG. 1 plate;

FIG. 3 is a fragmentary plan on a smaller scale;

FIG. 4 is an enlarged plan of one tooth of the plate;

FIG. 5 is a front elevation of the FIG. 4 tooth;

FIG. 6 is a side view of the FIG. 4 tooth;

FIG. 7 is a plan of another tooth of the plate;

FIG. 8 is an elevation of the FIG. 7 tooth and a similar tooth;

FIG. 9 is a side view of the FIG. 7 tooth;

FIG. 10 is a fragmentary view of a plate of the invention showing a typical positioning of teeth after they have been driven into a wood member and the wood burned away; and

FIG. 11 is a view similar to FIG. 10 but showing the positioning of teeth resulting from driving into a piece of wood a connector plate quite similar structurally to that of this invention but markedly inferior in operation.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now to FIGS. 1–3 of the drawings, a connector plate of the present invention comprises a metal plate, indicated generally by the reference numeral **1**, having an outer face **3** and an inner face **5**. A plurality of elongate teeth are struck or punched from the plate **1** and extend in a direction generally perpendicular to faces **3** and **5** of the plate. The teeth comprise generally symmetrical teeth designated **7** and unsymmetrical teeth designated **9***a* and **9***b*, the latter being identical except that they are mirror images of each other. Each tooth struck from the plate leaves an elongate vacated opening or slot **11** which generally conforms to the shape of the tooth.

The teeth are struck from plate **1** so that they are arranged in successive series of generally parallel longitudinally extending rows indicated in FIGS. 1 and 3 by phantom lines L1–L12. The teeth are also located in generally parallel transverse rows nine of which are indicated by phantom lines T1–T9. It will be understood that a representative plate has been shown in the drawings to illustrate the repeating pattern of the teeth and that more or fewer rows of teeth can be provided as required. For example, for a plate having overall dimensions of about $3\frac{1}{64}$ inches by about six inches there are twelve longitudinal rows of teeth and sixteen transverse rows of teeth.

The symmetrical teeth **7** are all located in longitudinal rows L1, L4, L5, L8, L9 and L12. The teeth **7** in longitudinal rows L1, L4, L9 and L12 are in the odd-numbered transverse rows, and the teeth **7** in the longitudinal rows L5 and L8 are in the even-numbered transverse rows. The slots resulting from formation of teeth **7**, **9***a* and **9***b* in the odd-numbered transverse rows are to the right (FIG. 1) of teeth **7** while the slots resulting from the formation of teeth **7**, **9***a* and **9***b* in the even-numbered transverse rows are to the left of the teeth. Thus

the teeth in the odd-numbered transverse rows face in the opposite direction from the teeth in the even-numbered rows. On the other hand, all of the teeth in any one longitudinal row face in the same direction. The pattern of teeth in the lower half of the plate (i.e., longitudinal rows L7–L12) is the mirror image of the pattern of teeth in the upper half of the plate and the pattern of teeth in each two adjacent transverse rows is repeated throughout the length of the plate. The pattern or arrangement of teeth is such that the plate shown can be segmented by cutting the plate along lines located between any even-numbered transverse row and the next higher odd-numbered transverse row to form a plurality of smaller plates. In other words, the teeth can be segmented between transverse rows T2 and T3, between rows T4 and T5, etcetera. Normally at least four transverse rows of teeth are provided in a connector plate. The plate can be segmented longitudinally between longitudinal rows L4, L5 or between rows L8, L9 to form plates containing multiples of four longitudinal rows of teeth.

The plate dimensions given herein are those presently preferred when the plate is made from 18 U.S. standard gauge steel. Within each longitudinal row of teeth there is a regular or constant spacing between adjacent teeth, preferably about ¾ inch. Also, the spacing between the teeth in any longitudinal row is the same as the spacing between the teeth in all other longitudinal rows. Concerning the pattern of spacing between adjacent longitudinal rows of teeth, there is a $\frac{9}{64}$ inch web between any two longitudinal rows comprising one row containing teeth **7** and another row containing either teeth **9***a* or **9***b*, there is a $\frac{7}{64}$ inch web between any two adjacent longitudinal rows containing teeth **9***a* and **9***b*, and there is a ¼ inch web between any two adjacent longitudinal rows of teeth **7**. Thus rows L1 and L2 are spaced apart about $\frac{9}{64}$ inch, rows L2 and L3 are spaced apart about $\frac{7}{64}$ inch, rows L3 and L4 are spaced apart about $\frac{9}{64}$ inch, rows L4 and L5 are spaced apart about ¼ inch, etcetera. The outer longitudinal rows (L1 and L12) are preferably spaced about $\frac{3}{32}$ inch from the side edges of the plate. This tooth spacing has been found to be satisfactory when the individual teeth **7**, **9***a* and **9***b* are about $\frac{9}{16}$ inch high and about $\frac{7}{64}$ inch wide at the base end of the tooth where it meets face **5** of the plate.

As each tooth **7** is of a substantially indentical configuration, a detailed description of one tooth will suffice for all. Each tooth **7** is constituted by a struck-out portion of the plate and it projects above face **5** at one end of its respective slot **11** in the plate. Tooth **7** has a shank portion **13** joined through a root or base portion **15** at its lower end to face **5** of the plate. Preferably the base portion **15** is arcuate and overbent as shown in FIG. 6 to prevent tearing at the base of the tooth when the tooth is struck from the plate. The projecting end of the tooth terminates in a tip portion **17**. The tip portion has generally straight side edges **19** and **21** which converge from the shank and meet at the center of the tooth in a point **23** and thereby form symmetrically tipped teeth. The shank portion **11** has straight edges **25** and **27** which diverge at a small angle from tip portion **13** to plate face **5**. The edges **19**, **25** and **21**, **27** of the tip and shank portions intersect at shoulders **29** and **31**.

Sides **25** and **27** form an angle of about 1° relative to a plane perpendicular to face **5**. This taper of sides **25** and **27** makes it easier to punch the teeth from the plate but does not significantly reduce the resistance to withdrawal or pull-out of the nailing plate. The edges **19** and **21** are preferably disposed at an included angle of about 60°. The pointed configuration of the tip permits the tooth to pierce and spread wood fibers instead of pushing the fibers in front of the tooth which tends to cause balling of the wood as the tooth is driven into the wood.

Tooth **7** is crimped along its medial longitudinal axis whereby the tooth is generally V-shaped in transverse cross section throughout the extent of its shank and tip portions, thereby forming a generally concave inner surface comprising generally flat faces **33** and **35** and a generally concave outer surface **37** which extends substantially the full length of the shank and tip portions. Surface **37** is substantially perpendicular to the face **5** except at base **15** and at point **23** of the tooth. The included angle between faces **33** and **35** across shoulders **29**, **31** is preferably approximately 160° to 170°.

The distal end of the tip portion of each tooth has a flat generally diamond shaped surface **43** (FIG. 5) on the inside of the tooth which surface is angularly inclined toward the respective slot **11** at an included angle of about 160° relative to the line of intersection of faces **33** and **35**. The other surface of the distal end of the tip portion curves toward surface **43** as shown at **45**. This distal end configuration provides a sharp point which easily pierces the wood as the teeth are driven into a piece of wood. Teeth of this construction even though formed from very thin gauge metal are quite strong and rigid and will not collapse or fail when driven into wood.

Referring to FIGS. 7–9, the teeth **9***a* and **9***b* are substantially identical except for being the mirror images of each other, therefore a detailed description of one tooth will suffice for both, and the same reference numerals have been used to designate the same parts of both teeth. These teeth comprise a tip portion designated **49** which comprises a relatively long straight side edge **51** constituting a camming edge, and a shorter side edge **53** which is curved slightly as shown in FIG. 8. The edges **51** and **53** converge from the sides **25** and **27** of the tooth and meet at a slightly rounded point **55** which is offset both from the center line of the teeth and from both side edges **25**, **27** of the shank portion of the tooth to form unsymmetrical teeth i.e., unsymmetrically tipped teeth. The included angle formed by edges **51**, **53** is preferably about 75° and the angle formed by sides **27** and **51** is about 150°.

The unsymmetrical teeth are arranged in rows and two of the rows of unsymmetrical teeth are located immediately adjacent to each other. The points **55** at the tip of the teeth in each of the two adjacent rows of unsymmetrical teeth are offset away from the teeth in the other row of the two rows of unsymmetrical teeth, and toward an adjacent row of symmetrical teeth. Also, the teeth in the two rows of unsymmetrical teeth lying side-by-side are arranged in pairs comprising one tooth from each of the two rows of teeth and these two teeth are laterally aligned with each other. Also, the unsymmetrical teeth are staggered relative to the symmetrical teeth lying in the immediately adjacent rows of teeth. There is a narrow flat surface **57** on the inside of each tooth **9***a* and **9***b* which is inclined toward the respective slot **11**. Except for its shape, surface **57** is similar to the surface **43** on the tooth **7** described before. Point **55** is preferably located approximately $\frac{2}{7}$ of the distance across the tooth from one edge of the shank portion of the tooth. For example, when the tooth is approximately $\frac{7}{64}$ inch wide at the base of the tooth, the tip **55** is preferably about $\frac{1}{32}$ inch to about $\frac{3}{128}$ inch from one side edge of the tooth. This location of the point provides the desired amount of side bending or drift described in connection with FIG. 10. By moving the point nearer side edge **25** the drift is increased and by moving the point nearer the center of the tooth the drift can be reduced. Except for the location of point **55**, the surface **57** and the rounded edge **53**, the teeth **9***a*, **9***b* are substantially the same as the teeth **7** described above.

Plates **1** of this invention are preferably fabricated from very thin metal, such as 18 U.S. standard gauge steel which has a thickness of about 0.051 inch. This gauge metal may range in thickness from about 0.054 to about 0.048 inch. The metal is preferably zinc coated (galvanized) in a conventional manner. It is to be understood that these plates may also be fabricated from thinner gauge metal, e.g., 20 gauge, in which event the teeth would be somewhat shorter in proportion and the intertooth

spacing varied somewhat relative to the exemplary dimensions given above in regard to 18 gauge plates. The plate may be of any desired length or width, depending upon the size of the wood members to be joined by the various plates and their location in the wood structure, such as a truss, to be formed.

Connector plates **1** of the present invention are particularly useful in forming strong reliable joints between adjacent wood members such as are used in fabricating various wooden structures (e.g., trusses, box beams, wall panels, boxes and pallets) preferably by positioning two plates on opposite sides of the wood members to be joined, each spanning or bridging the area of contact between the members, and then pressing the plates so that the teeth **7**, **9***a* and **9***b* are entirely embedded in the wood and inner faces **5** of the plates are in contact with the wood surfaces. The continuous longitudinal V-groove throughout the length of each tooth stiffens and reinforces the teeth so that as the plates are forced against the wood the teeth will not bend or collapse toward or away from the respective slots even when the plates are formed from thin gauge metal stock, e.g., 18 U.S. standard gauge zinc coated steel. The tip end portion of each tooth pierces the wood and avoids balling of the wood fibers. As the nose or tip portion of each tooth is narrower than the shank portion, the teeth tips are rather easily forced into the wood for initial penetration. This anchors or fixes the teeth ends in the wood. Each tooth becomes firmly fixed in the wood due to the shape and construction of the teeth. The shape of the teeth, particularly the V-shape cross section, prevents any significant undesirable bending toward or away from slots **11** and collapsing of the teeth as the plate is forced into the wood.

As the teeth **7**, **9***a* and **9***b* are forced into a wood member the teeth **7** enter in a direction substantially perpendicular to faces **3** and **5** of the plate and there is very little or no deformation or bending of the teeth. On the other hand, the unsymmetrical tip portions **49** of teeth **9***a* and **9***b* produce unequal forces on the sides of the unsymmetrical teeth causing them to bend laterally as they enter the wood. This is illustrated in FIG. 10 of the drawings which shows the position of typical teeth after a connector plate of the invention has been driven into a wood member and the wood burned away to show the relative positions the teeth occupy in the wood. The teeth **7** in the outer two rows are substantially perpendicular to faces **3** and **5** of the plate but the teeth **9***a* and **9***b* have been bent laterally outwardly away from each other and toward the teeth **7**. The teeth **9***a*, **9***b* are not bent enough to be in line with teeth **7**, which indicates proper control of the bending. The laterally bent teeth **9***a*, **9***b* cooperate with the upright symmetrical teeth **7** to grip portions of the wood structure therebetween and tightly hold the plate against withdrawal of the teeth from the wood member, thereby providing a very high withdrawal resistance. Also, it will be noted that as the path of the unsymmetrical teeth into the wood is at an angle to the perpendicular it will not coincide with the grain direction in edge grained wood, and thus splitting is minimized particularly in edge grained harder woods.

In testing the shear strength of a joint formed using connector plates of the invention, the wood members are pulled apart by exerting a force along a line generally parallel to the longitudinal rows of teeth **L1–L12**, (i.e., perpendicular to the faces of the teeth) or by pulling them at an angle to the rows **L1–L12**. Normally a substantially higher shear resistance is obtained by pulling directly in line with the rows **L1–L12**. However, it has been found unexpectedly that the tooth construction of the invention results in not only a very high shear resistance when the samples are pulled along a line parallel to the rows **L1–L12** of teeth, but that substantially the same shear resistance is obtained when pulling them at an angle 45° thereto. This is important since many joints formed using the connector plates of the invention will in use encounter loads which are applied at an angle to the longitudinal lines **L1–L12**.

The arcuate overbent base portion **15** of each tooth minimizes the possibility of tearing of the teeth at the point where the base joins the surfaces **3** and **5** of the plate. This helps in obtaining a high shear strength since any initial tearing at these points would result in rapid separation of the teeth from the plate in the presence of substantial loads.

In the connector plates of this invention the lateral bending of teeth **9***a* and **9***b* is advantageously controlled so that after the teeth have been driven into a piece of wood the teeth **7**, **9***a* and **9***b* occupy the relative positions indicated in FIG. 10 where the tip portions **49** of teeth **9***a* and **9***b* are spaced from the tip portions **17** of symmetrical teeth **7** in the adjacent rows. This is achieved by the arcuate surface **53** and by proper location of the point **55** of the unsymmetrical teeth. Location of the point **55** at a position which is in line with the side edges of shank portions of the teeth results in excessive lateral bending of the teeth, not only causing them to bend laterally into the line of the adjacent symmetrical teeth but also tending to cause tearing at the base portion of the teeth. This excessive bending is illustrated in FIG. 11 of the drawing where rows of symmetrical teeth **7** substtantially the same as the teeth in the plate of the invention are located beside rows of unsymmetrical teeth **61** which are substantially the same as the teeth **9***a* and **9***b* except that the points of the teeth are in line with side edges of the shank portion of the teeth. In this instance the tip portions of the unsymmetrical teeth **61** bend laterally into alignment with the rows of symmetrical teeth **7** substantially the same as the base portions of the teeth **61**. Plates made in this manner produce joints which have comparatively low shear strength and caused separation of portions of the wood members which they were joining.

While connector plates of this invention are useful in many types of wood, they are particularly desirable with Eastern Spruce, a Canadian wood, and European woods such as types of pine found in Scandinavian countries, Poland, Russia, etc. These woods are relatively soft and spongy and are particularly prone to balling in front of the tooth when nailing plate teeth are driven into them.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A connector for securing together adjacent wood structural members comprising a thin-gauge metal plate having a plurality of elongate integral teeth extending from one face thereof, each of said teeth being constituted by a struck-out portion of the plate vacating an elongate slot in the plate with each tooth projecting from said one face of the plate at one end of its respective slot in the plate, each of said teeth having a shank portion formed with a tip portion that converges to a point, the points of some of the teeth being at the center of the teeth to form symmetrically tipped teeth, the points of others of the teeth being offset from the center of the teeth to form unsymmetrically tipped teeth, the teeth being arranged in laterally spaced apart rows with the teeth in each row being spaced apart and with the slots vacated by the teeth in adjacent rows all being generally parallel, the unsymmetrically tipped teeth and symmetrically tipped teeth being relatively staggered in the direction of the length of the rows, the tip portion of each unsymmetrically tipped tooth comprising a long straight side edge and a shorter generally arcuate side edge converging at a rounded point offset in a direction toward an adjacent row of teeth and thereby having a camming edge adapted, upon driving of the teeth into a

wood member, to cause the unsymmetrically tipped teeth to bend transversely to a limited degree toward an adjacent row of teeth and cooperate with the symmetrically tipped teeth to grip the wood member.

2. A connector as set forth in claim 1 wherein two of the rows of unsymmetrically tipped teeth are located immediately adjacent to each other, the point at the tip of each tooth in each of said two rows of unsymmetrically tipped teeth being offset away from the teeth in the other row of said two rows of unsymmetrically tipped teeth.

3. A connector as set forth in claim 2 wherein the teeth in said two rows of unsymmetrically tipped teeth are arranged in pairs with the teeth of each pair being laterally aligned with each other, each said pair of teeth comprising one tooth from each of said two rows of teeth.

4. A connector as set forth in claim 1 wherein the shank portion of each tooth has an arcuate overbent base portion at its said one end which portion is convex toward the slot vacated by said tooth, and the shank portion of each tooth between the overbent portion and the tip portion is substanially perpendicular to said one face of the plate.

5. A connector as set forth in claim 1 wherein the included angle formed by the long and shorter side edges of the unsymmetrical teeth is at least approximately seventy-five degrees.

6. A connector as set forth in claim 1 wherein the point at the tip portion of each unsymmetrically tipped tooth is located about two-sevenths of the distance across the tooth from one side edge of the shank portion of the tooth.

7. A connector as set forth in claim 1 wherein each tooth is curved from one side edge to the other side edge thereof to form a generally concave surface facing its respective slot in the plate and to form a generally convex surface facing in the opposite direction, each tooth has a flat surface in the tip portion near the point thereof, and the distal end of the tip portion being angularly inclined toward its respective slot with the concave surface of the tip portion having a flat area adjacent the point thereof.

8. A connector as set forth in claim 7 wherein two of the rows of unsymmetrically tipped teeth are located immediately adjacent to each other, the point at the tip of each tooth, in each of said two rows of unsymmetrically tipped teeth being offset away from the teeth in the other row of said two rows of unsymmetrically tipped teeth.

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