

PATENT SPECIFICATION

966,362



Date of Application and filing Complete
Specification: May 3, 1963.

No. 17598/63

Application made in United States of America (No. 250663) on
January 10, 1963.

Complete Specification Published: August 12, 1964.

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Index at Acceptance:—F2 H33.

International Classification:—F 06 b.

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements in or relating to Plates for Connecting Wooden Members

We, AUTOMATED BUILDING COMPONENTS, INC., a corporation organised under the laws of the State of Florida, United States of America, of 7525 N.W. 37th Avenue, Miami, Florida, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to metal connectors and structural wooden joints and more particularly relates to connectors, and joints of the butt type incorporating such connectors used in prefabricated wooden structures such as roof trusses.

For many centuries mankind has been concerned with the problem of properly joining structural load bearing wooden members. In more recent years, with the advent of various types of prefabrication, structural wooden joints have been developed which are connected solely by means of metal plates having slender, elongated, nail-like teeth struck therefrom and embedded in the wooden members. A joint of this type is illustrated in Jureit U.S. Patent No. 2,877,520. Similar joints of the same type are shown in Menge U.S. Patent No. 3,011,226 and Atkins U.S. Patent No. 3,016,586. The plates of this type which have been used to date, wherein the teeth of the plates serve as the only means holding the plates onto the wooden members, have been formed of sheet steel of a thickness of at least 16 U.S. Standard gauge (nominal thickness .0598 inch) and the vast majority have been of a thickness of 14 U.S. Standard gauge (nominal thickness .0747 inch).

According to the invention there is provided a connector for transmitting a structural load between butted wooden members comprising a plate of a thickness less than

16 U.S. Standard gauge, having a plurality of slender elongated nail-like teeth struck therefrom to leave a plurality of rows of slots, said teeth extending away from one side of a plate substantially perpendicular thereto, said teeth having a curvate cross section and being so disposed that there are at least approximately 3 teeth per square inch of plate surface, the said teeth being so disposed that a line drawn across said plate perpendicular to said slots at any place on said plate other than through said teeth will intersect each row of slots, and each tooth having a punch face facing the direction of its slot and a back face facing in the opposite direction, the teeth on adjacent rows being staggered so that in any three adjacent rows the most closely spaced group of three teeth are two outermost teeth having their punch faces facing in one direction, and a centre tooth having its punch face facing in the opposite direction.

In this way, by using an even thinner metal, such as 18 U.S. Standard gauge (nominal thickness .0478 inch) in conjunction with the combination of tooth shape and disposition of teeth on the plate set forth above, a considerable saving in joint cost can be effected. It has been further found that this reduction in cost can be achieved without sacrificing adequate structural strength in the joint. Thus, with joints constructed according to the present invention, the amount of metal per joint is very considerably reduced as compared to that necessary with the older heavier plates, but without any impairment of the strength or utility of the joints. While the plate and joint of the present invention have broad utility in structural load bearing elements, their most common usage lies in the field of residential home construction, and most particularly, in the manufacture of roof trusses

[Price 4s. 6d.]



said

for houses.

Certain embodiments of the invention will now be described by way of example and with reference to the appended drawings, wherein:

FIGURE 1 is a plan view of a connector and joint constructed according to the present invention;

FIGURE 2 is a side elevation of the joint of FIGURE 1;

FIGURE 3 is a vertical section through one of the teeth of the connector of FIGURE 1;

FIGURE 4 is a front elevation of one of the teeth of the connector of FIGURE 1;

FIGURE 5 is a plan view of a portion of the connector of FIGURE 1 showing a tooth in horizontal cross section;

FIGURE 6 is a vertical section through another embodiment of a tooth for use with a connector of the type shown in FIGURE 1;

FIGURE 7 is a front elevation of a tooth of the type shown in FIGURE 6; and

FIGURE 8 is a plan view of a portion of a plate embodying a tooth of the embodiment of FIGURES 6 and 7 showing a horizontal tooth cross section.

Referring more particularly to FIGURES 1 and 2, there is shown, generally indicated at 10, a structural butt joint comprising a pair of structural load bearing wooden members shown in phantom at 12 and 14 which are fastened together by a connector generally indicated at 16. The connector 16 comprises a steel plate 18 having struck therefrom a plurality of rows 20, 22 and 24 of slender, elongated nail-like teeth 26 which leave rows of elongated slots. The teeth 26 are embedded in the wooden members 12 and 14 in any suitable manner, preferably by the application of pressure to the plate 18 by a suitable press. While only a single plate is shown in FIGURE 2, it is to be understood that two plates may be used, with one plate on each side of the wooden members with the teeth in the opposed plates extending towards one another within the wooden members.

Referring to FIGURES 3, 4 and 5, each tooth 26 is generally V-shaped in cross section (as best seen in FIGURE 5) and has a concave punch face 28, which is formed by the punch in the connector manufacturing operation, and a convex back face 30. In order to obtain the advantages of the present invention, the teeth must terminate in pointed ends which are shown in FIGURE 4 as chisel-pointed ends 32 with an angle A between the chisel surfaces which is preferably no greater than 60 degrees. While other types of pointed ends may be utilized, such as scarf-pointed ends or rounded points, the chisel points shown in the drawings are to be preferred.

With connectors according to the present

invention an unusually high ratio of joint strength per unit weight of metal utilized in the joint has been obtained through the utilization of a higher tooth density (i.e. at least approximately per square inch of plate surface) than has heretofore been thought possible without causing undue splitting of the wooden members which would cause a decrease in joint strength and erratic joint performance. This density of teeth in itself has become possible only through the particular arrangement of teeth defined in the claims, which was itself discovered only after long experimentation. The tooth arrangement which was thus discovered, and the relationships to be presently discussed have been found to be empirical in nature so that the unusual high strength per unit weight of metal connector which is obtained cannot be explained in or predicted by terms of precise mathematical formulae.

According to the invention, the teeth in adjacent rows such as rows 20 and 22 in FIGURE 1, are struck in opposite directions to provide teeth which fall in groups of threes, such as the group comprising teeth 34, 36 and 38, teeth 34 and 38 of which also form a second group of three, comprising teeth 34, 38 and 40. It will be seen that the teeth 34, 36 and 38 whose punch faces 28 face towards one another, lie at the corners of a triangle having an altitude a . Similarly, the teeth 34, 38 and 40, whose back faces 30 face one another, lie at the corners of a triangle having an altitude b . According to a specific and preferred embodiment of the invention, the altitude a is $1/4$ inch while the altitude b is $17/32$ inch. The distance between adjacent teeth in one row, namely the altitude a plus the altitude b is $25/32$ inch. The ratio of b/a in this particular embodiment is 2.124 and preferably should be no less than 2. When this arrangement is provided, it will be noted that the pointed ends of the slots are substantially in register transversely across the connector as indicated by the broken lines 42 and 44 in FIGURE 1. In this specific preferred embodiment, the width of the slots indicated at c in FIGURE 1, and therefore the nominal width of the teeth, is $1/8$ inch while the spacing between the edges of adjacent slots, indicated at d in FIGURE 1 is .1565 inch. The ratio of d/c is thus 1.25. This ratio has been found to be an approximate minimum below which wood might split and joint strength is deleteriously affected. Exceeding this ratio introduces additional metal into the joint which has been found unnecessary for an optimum strength per unit weight of metal in the connector.

According to the specific preferred embodiment, the length of the teeth indicated at e is $9/16$ inch while the spacing between



70 13 teeth

75 1 high



80

85



90

95

100

105

110

115

120

125

130

the end of the slot and the adjacent tooth, indicated at *f*, is 7/32 inch. The ratio of *e/f* is therefore 2.57 and is preferably not less than 2. The length of the teeth is also related to the thickness of the plate which, in the preferred specific embodiment, is 18 gauge plate having a nominal thickness when galvanized of .0510 inch. Such plate is normally provided within the tolerances of .0486 inch minimum and .0533 inch maximum thickness. The use of thin plate is essential to the cost advantage resulting from the unusual high strength per unit weight of metal ratio obtainable through the invention and therefore a plate thickness of no greater than approximately .0533 inch is desirable. The ratio of tooth length to plate thickness in the preferred specific embodiment is approximately 11 and should not be less than 8, whilst the teeth are so disposed as to provide approximately 4.5 teeth per square inch of plate.

It will be seen that with a connector constructed according to the preferred specific embodiment any line drawn transversely across the connector perpendicular to the rows of slots, other than a line through a transverse row of teeth, will intersect slots in each row of slots.

While the teeth shown in the embodiment of the invention illustrated in FIGURES 1-5 have a generally V-shaped cross section, it is possible to provide other arcuate cross sections. As an example of a tooth formed in one such manner is illustrated in the embodiment of the invention shown in FIGURES 6-8. Referring to those figures, there is seen a plate 46 from which a tooth generally indicated at 48 is struck. The tooth 48 has its punch side 50 formed with a central groove 52. A pair of inclined surfaces 54 lie on each side of the groove 52 and the back surface 56 of the tooth is generally arcuate. The tooth is provided with a point 58 of the chisel type similar to that found in the embodiment of the invention illustrated in FIGURES 1-5. As in the preceding embodiment of the invention, the curvate cross section of the tooth provides rigidity.

Actual tests show that when forming structural butted wooden joints with the connectors of this invention it is possible to achieve a considerable increase both in longitudinal tensile and transverse withdrawal strength per unit weight of metal utilized in the joint. This makes it possible to form joints with the same strength as prior joints while utilizing a considerably smaller amount of metal and thereby concomitantly reducing the cost of the joint. The device of the invention thereby makes it possible to prefabricate structural wooden members, such as roof trusses, at a lower cost than heretofore possible.

WHAT WE CLAIM IS:—

1. A connector for transmitting a structural load between butted wooden members comprising a plate of a thickness less than 16 U.S. Standard gauge, having a plurality of slender elongated nail-like teeth struck therefrom to leave a plurality of rows of slots, said teeth extending away from one side of said plate substantially perpendicular thereto, said teeth having a curvate cross section and being so disposed that there are at least approximately 3 teeth per square inch of plate surface, the said teeth being so disposed that a line drawn across said plate perpendicular to said slots at any place on said plate other than through said teeth will intersect each row of slots, and each tooth having a punch face facing the direction of its slot and a back face facing in the opposite direction, the teeth on adjacent rows being staggered so that in any three adjacent rows the most closely spaced group of three teeth are two outermost teeth having their punch faces facing in one direction, and a centre tooth having its punch face facing in the opposite direction.

2. A connector as claimed in claim 1, in which said teeth terminate in pointed ends and the points of said slots, left by the striking of the pointed ends of the teeth, lie substantially along a transverse line across said plate substantially perpendicular to said slots.

3. A connector as claimed in claim 2 in which said teeth with pointed ends leave a plurality of substantially parallel rows of pointed slots, the points of the slots in adjacent rows being directed in opposite directions.

4. A connector as claimed in any of the preceding claims, wherein each said group of three teeth form a first triangle having a base perpendicular to said slots and an altitude extending along the slot from said centre tooth, and a second centre tooth in the same row as said first centre tooth and immediately adjacent the pointed end of the slot from said first centre tooth, and said outermost teeth form a second triangle having the same base as said first triangle and having an altitude which is colinear with but greater than the altitude of said first triangle.

5. A connector as claimed in claim 4 wherein the altitude of said second triangle is at least twice as great as the altitude of said first triangle.

6. A connector as claimed in claim 5 wherein the thickness of said plate is approximately 18 U.S. Standard gauge and the length of said teeth is at least 8 times the thickness of said plate.

7. A connector as claimed in claim 5 or 6 wherein the length of each slot is at least twice the space between the point of a slot and the adjacent tooth in the same row.

the end of the slot and the adjacent tooth, indicated at *f*, is $7/32$ inch. The ratio of *e/f* is therefore 2.57 and is preferably not less than 2. The length of the teeth is also related to the thickness of the plate which, in the preferred specific embodiment, is 18 gauge plate having a nominal thickness when galvanized of .0510 inch. Such plate is normally provided within the tolerances of .0486 inch minimum and .0533 inch maximum thickness. The use of thin plate is essential to the cost advantage resulting from the unusual high strength per unit weight of metal ratio obtainable through the invention and therefore a plate thickness of no greater than approximately .0533 inch is desirable. The ratio of tooth length to plate thickness in the preferred specific embodiment is approximately 11 and should not be less than 8, whilst the teeth are so disposed as to provide approximately 4.5 teeth per square inch of plate.

It will be seen that with a connector constructed according to the preferred specific embodiment any line drawn transversely across the connector perpendicular to the rows of slots, other than a line through a transverse row of teeth, will intersect slots in each row of slots.

While the teeth shown in the embodiment of the invention illustrated in FIGURES 1-5 have a generally V-shaped cross section, it is possible to provide other arcuate cross sections. As an example of a tooth formed in one such manner is illustrated in the embodiment of the invention shown in FIGURES 6-8. Referring to those figures, there is seen a plate 46 from which a tooth generally indicated at 48 is struck. The tooth 48 has its punch side 50 formed with a central groove 52. A pair of inclined surfaces 54 lie on each side of the groove 52 and the back surface 56 of the tooth is generally arcuate. The tooth is provided with a point 58 of the chisel type similar to that found in the embodiment of the invention illustrated in FIGURES 1-5. As in the preceding embodiment of the invention, the curvate cross section of the tooth provides rigidity.

Actual tests show that when forming structural butted wooden joints with the connectors of this invention it is possible to achieve a considerable increase both in longitudinal tensile and transverse withdrawal strength per unit weight of metal utilized in the joint. This makes it possible to form joints with the same strength as prior joints while utilizing a considerably smaller amount of metal and thereby committantly reducing the cost of the joint. The device of the invention thereby makes it possible to prefabricate structural wooden members, such as roof trusses, at a lower cost than heretofore possible.

WHAT WE CLAIM IS:—

1. A connector for transmitting a structural load between butted wooden members comprising a plate of a thickness less than 16 U.S. Standard gauge, having a plurality of slender elongated nail-like teeth struck therefrom to leave a plurality of rows of slots, said teeth extending away from one side of said plate substantially perpendicular thereto, said teeth having a curvate cross section and being so disposed that there are at least approximately 3 teeth per square inch of plate surface, the said teeth being so disposed that a line drawn across said plate perpendicular to said slots at any place on said plate other than through said teeth will intersect each row of slots, and each tooth having a punch face facing the direction of its slot and a back face facing in the opposite direction, the teeth on adjacent rows being staggered so that in any three adjacent rows the most closely spaced group of three teeth are two outermost teeth having their punch faces facing in one direction, and a centre tooth having its punch face facing in the opposite direction.

2. A connector as claimed in claim 1, in which said teeth terminate in pointed ends and the points of said slots, left by the striking of the pointed ends of the teeth, lie substantially along a transverse line across said plate substantially perpendicular to said slots.

3. A connector as claimed in claim 2 in which said teeth with pointed ends leave a plurality of substantially parallel rows of pointed slots, the points of the slots in adjacent rows being directed in opposite directions.

4. A connector as claimed in any of the preceding claims, wherein each said group of three teeth form a first triangle having a base perpendicular to said slots and an altitude extending along the slot from said centre tooth, and a second centre tooth in the same row as said first centre tooth and immediately adjacent the pointed end of the slot from said first centre tooth, and said outermost teeth form a second triangle having the same base as said first triangle and having an altitude which is colinear with but greater than the altitude of said first triangle.

5. A connector as claimed in claim 4 wherein the altitude of said second triangle is at least twice as great as the altitude of said first triangle.

6. A connector as claimed in claim 5 wherein the thickness of said plate is approximately 18 U.S. Standard gauge and the length of said teeth is at least 8 times the thickness of said plate.

7. A connector as claimed in claim 5 or 6 wherein the length of each slot is at least twice the space between the point of a slot and the adjacent tooth in the same row.



The



* C L M S *

8. A connector as claimed in claim 7 wherein the spacing between the adjacent edges of slots in adjacent rows is approximately one and a quarter times the width of a slot. 5
9. A connector as claimed in claim 8 wherein the thickness of said plate is approximately 18 U.S. Standard gauge and the length of said teeth is approximately 11 times the thickness of said plate. 10
10. A connector as claimed in claim 9 wherein said teeth are so disposed as to provide approximately 4.5 teeth per square inch of plate, and so that a line drawn across said plate perpendicular to said slots at any place on said plate other than through said teeth will intersect each row of slots. 15
11. Connectors substantially as described with reference to the accompanying drawings. 20
12. A structural joint for transmitting a structural load, comprising a pair of butted wooden members fastened together solely by means of at least one connector as claimed in any of the preceding claims. 25

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Berwick-upon-Tweed: Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd.—1964
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2 from which copies may be obtained.

