

Feb. 7, 1956

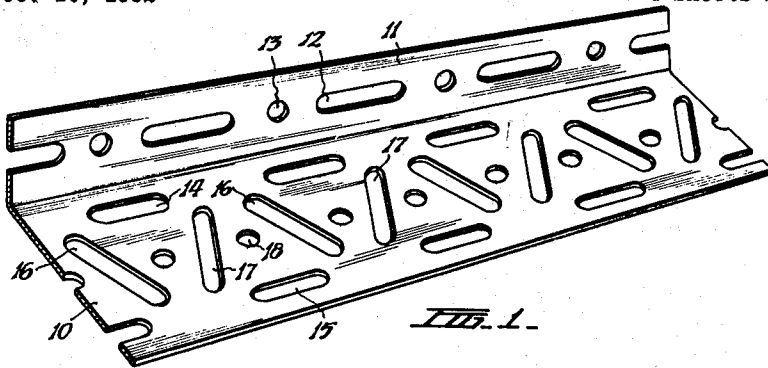
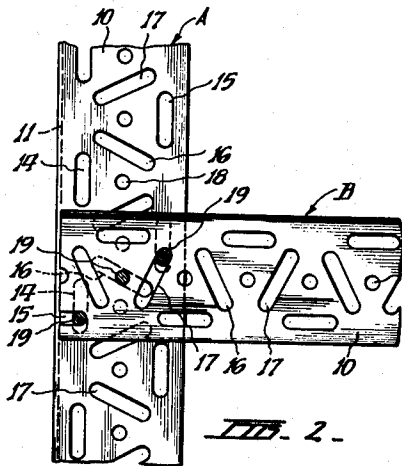
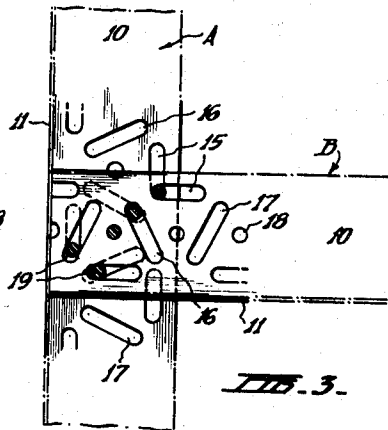
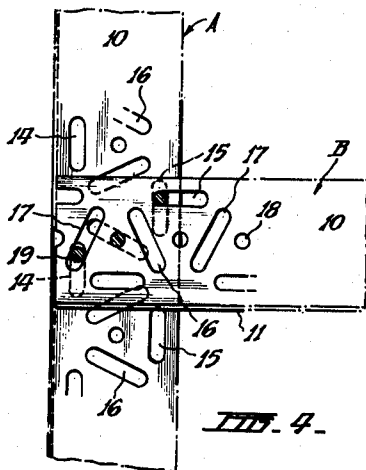
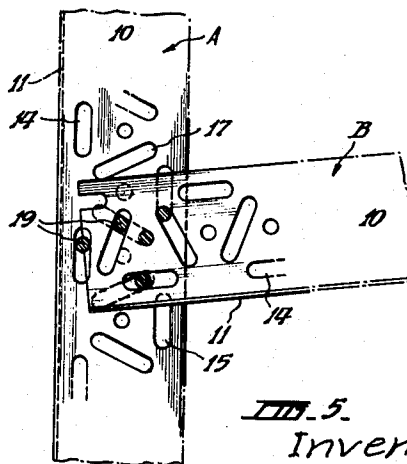
P. DRAKE

2,733,786

BUILDING ELEMENT

Filed Dec. 10, 1952

4 Sheets-Sheet 1



Inventor
Peter Drake
By *Robert E. Burns*
Attorney

Feb. 7, 1956

P. DRAKE
BUILDING ELEMENT

2,733,786

Filed Dec. 10, 1952

4 Sheets-Sheet 2

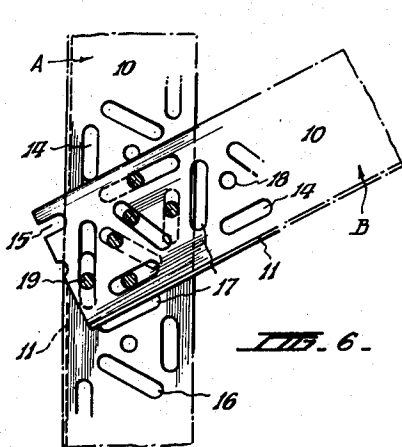


FIG. 6.

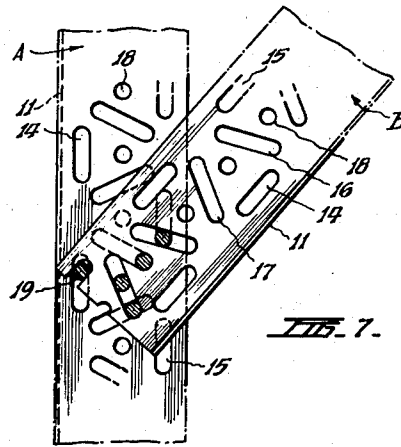


FIG. 7.

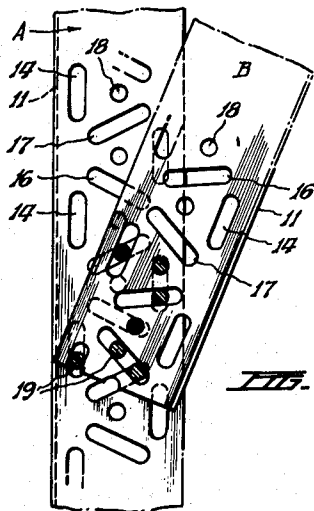


FIG. 8.

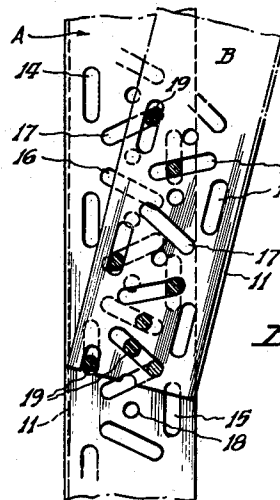


FIG. 9.

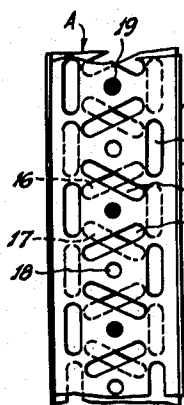


FIG. 10.

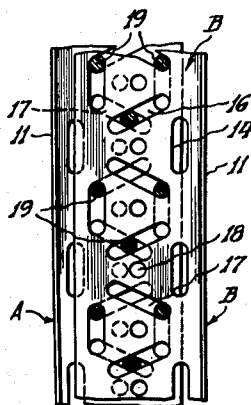


FIG. 11.

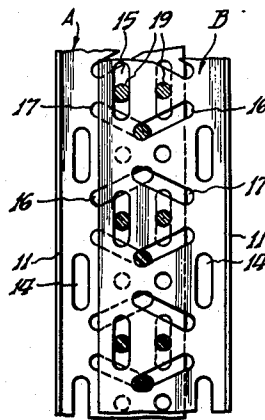


FIG. 12.

Inventor
Peter Drake
By Robert E. Burns
Attorney

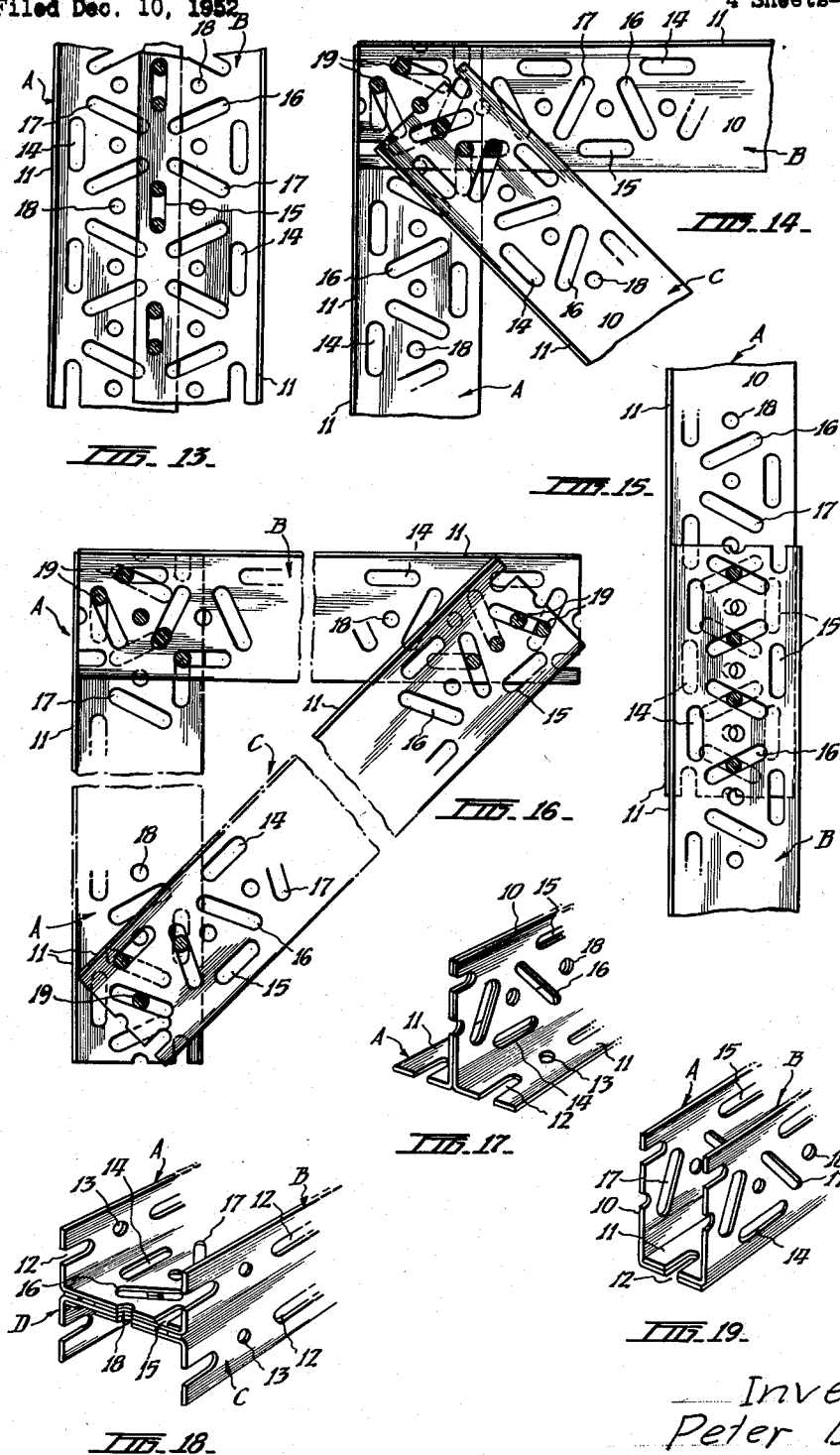
Feb. 7, 1956

P. DRAKE
BUILDING ELEMENT

2,733,786

Filed Dec. 10, 1952

4 Sheets-Sheet 3



Inventor
Peter Drake
By *Robert E. Burns*
Attorney

Feb. 7, 1956

P. DRAKE
BUILDING ELEMENT

2,733,786

Filed Dec. 10, 1952

4 Sheets-Sheet 4

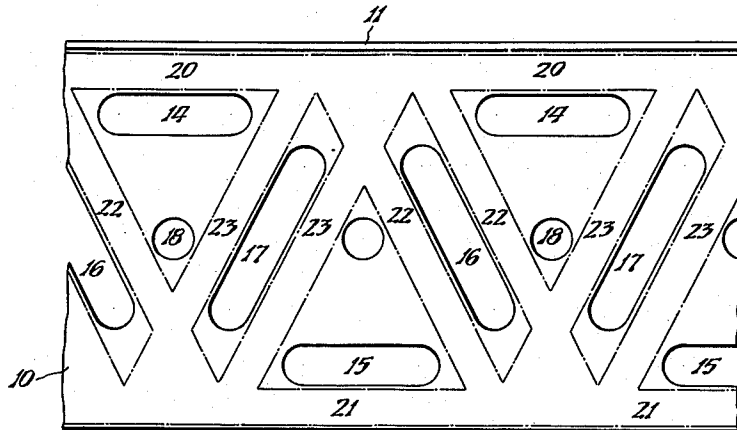


Fig. 20.

Inventor
Peter Drake
By *Robert E. Birns*
Attorney

1

2,733,786

BUILDING ELEMENT

Peter Drake, Coogee, New South Wales, Australia

Application December 10, 1952, Serial No. 325,053

Claims priority, application Australia December 21, 1951

3 Claims. (Cl. 189—34)

This invention relates to an improved building element and refers especially to a building element of the type which comprises a steel angle, one flange of which is wider than the other, and in which slots are formed in the flanges to enable the elements to be bolted together in various positions.

Constructional elements of this type have previously been constructed which consist of a steel angle having a wide and a narrow flange and having a single row of slots in the narrow flange, and two rows of slots in the wide flange. Elements of this type have been found to be subject to the disadvantage that there is a relatively small number of different positions in which they can be set up, and furthermore the slots are so located that relative movement of the joined elements tends to occur owing to sliding of the bolt along its slot. Various attempts have been made to obviate the above difficulties, but as far as I am aware the elements so produced have not been entirely satisfactory, and in particular have possessed inadequate structural strength.

It is an object of this invention to provide an improved building element which is substantially free from the abovementioned disadvantages, which can be erected in a large number of different positions, which is firmly locked together against movement when erected in any of such positions, and which possesses substantial structural strength.

The invention broadly resides in a building element comprising a right-angle section member having a wide flange and a narrow flange, a row of inclined slots disposed substantially centrally in the wide flange, the inclined slots being inclined alternately in opposite directions, a row of holes each of which is disposed substantially centrally between adjacent inclined slots, an inner row of longitudinal slots in the wide flange disposed between the row of inclined slots and the junction of the wide flange and narrow flange, an outer row of longitudinal slots in the wide flange disposed between the row of inclined slots and the free edge of the wide flange, the ends of the inclined slots being in substantial longitudinal alignment and being spaced inwardly of the inner and outer rows of longitudinal slots, the longitudinal slots of the inner row being staggered relative to the longitudinal slots of the outer row whereby each pair of adjacent inclined slots form an approximate triangle with a longitudinal slot of the inner row or outer row, and a row of longitudinal slots in the narrow flange.

Each of the inclined slots is preferably inclined at an angle between 60° and 68° to the longitudinal axis of the element. A series of holes may be formed between adjacent longitudinal slots in the narrow flange. Each longitudinal slot in the wide flange is of substantially shorter length than the longitudinal distance between adjacent longitudinal slots. The longitudinal slots on the side of the wide flange remote from the narrow flange are disposed directly opposite to the slots in the narrow flange, while the longitudinal slots on the side of the wide flange adjacent to the narrow flange are staggered relative to the

2

slots in the narrow flange. The inclined slots are at substantially the same angle to the longitudinal axis of the element. The ends of said inclined slots are spaced inwardly by a short distance from lines joining the inside edges of the outer and inner rows of longitudinal slots.

Each pair of adjacent inclined slots is disposed so as to form an approximate triangle with a longitudinal slot of one of the rows of longitudinal slots. Thus, considering any three successive inclined slots, the first and second of these may form a triangle with a longitudinal slot of one row, and the second and third inclined slots will form a triangle with a longitudinal slot of the other row, the ends of the inclined slots being spaced at uniform distances from the ends of the longitudinal slots. The inclined slots are of slightly greater length than the longitudinal slots in the wide flange.

A series of circular holes of diameter approximately equal to the width of a slot are disposed along the centre line of the wide flange, one of said holes being disposed centrally between each pair of inclined slots. Each second circular hole in the wide flange is thus directly opposite a circular hole in the narrow flange.

The inclined slots are preferably arranged at approximately an angle of 64° to the longitudinal axis of the element.

By the arrangement of slots which is comprehended by this invention, it is possible to obtain a substantially greater choice of available positions of the building elements, and in addition greater rigidity is obtained owing to the fact that any turning motion in the joint is constrained by the locking of the bolts in the slots and/or holes of the element.

A further important feature of this invention is that the arrangement of slots is such as to produce a lattice structure in the wide flange of the element, whereby the element has a high load-carrying capacity combined with low weight, the load-carrying capacity being not substantially less than that of an unslotted angle-section member of the same dimensions. The element of this invention will be found to possess amply adequate structural strength for all normal requirements, together with a large variety of available bolting positions and positive locking against movement in any of such positions.

Reference will now be made to the accompanying drawings wherein:

Figure 1 is a perspective view of a building element constructed according to this invention;

Figures 2 to 19 are views showing various positions and arrangements in which two or more elements of the type shown in Figure 1 may be coupled together for building or constructional purposes. These views are more fully described hereinafter.

Figure 20 is a view showing diagrammatically the lattice structure of an element constructed according to Figure 1.

Referring to Figure 1 of the drawings the building element comprises an angle-section steel bar having a wide flange 10 and a narrow flange 11 at right angles to one another. A series of alternate longitudinal slots 12 and holes 13 is formed centrally in the narrow flange 11.

Two rows of longitudinal slots 14, 15 are formed in the wide flange 10, the slots 14 being disposed at a short distance from the junction of the wide flange and narrow flange 11, and the slots 15 being disposed at a short distance from the outer or free edge of the wide flange 10.

A series of inclined slots 16, 17 is formed centrally in the wide flange 10, the slots 16 being inclined in one direction and the alternate slots 17 being inclined in the opposite direction. The inclined slots 16, 17 form approximate triangles with the longitudinal slots 14, 15, the said triangles being alternately directed towards the inner and outer edges of the flange 10. A series of holes 18 is disposed between the inclined slots 16, 17 and the

3

said holes 18 are located centrally between said slots and between the side edges of the flange 10.

Each longitudinal slot 14, 15 is of shorter length than the longitudinal distance between adjacent slots or than the transverse distance between the rows of slots 14, 15. The slots 15 in flange 10 are directly opposite the slots 12 in the flange 11. The inclined slots 16, 17 are substantially longer than the slots 14, 15.

Referring to Figure 2, this figure illustrates an arrangement in which two elements A and B are disposed at right angles to one another with their wide flanges 10 in contact with one another and with their narrow flanges 11 facing in opposite directions. In this arrangement it is possible for three bolts 19 to be passed through corresponding slots and/or holes in the wide flanges 10 of the two elements. Thus one bolting position is through a slot 15 in element B and a slot 14 of element A, another is through a hole 18 of element B and a slot 16 of element A, while the third is through a slot 17 of element B and a slot 15 of the element A. Two of the bolts shown may well be found sufficient to lock the elements firmly against relative movement, but a greater number may be employed if thought desirable and if the bolting positions are available. In this and the arrangements described below, the disposition of the slots and holes is such that sliding movement of a bolt along a slot is effectively prevented and locking of the elements firmly together in the various positions is thus achieved.

Figure 3 illustrates an arrangement in which two elements A and B are disposed at right angles to one another with their wide flanges 10 in contact with one another and with their narrow flanges 11 facing in the same direction. In this arrangement the end of element B abuts against the narrow flange 11 of element A. In the arrangement shown in the figure five bolting positions are provided. These are between a slot 17 of element B and a slot 14 of element A, between a slot 16 of element B and a slot 17 of element A, between a slot 14 of element B and a slot 16 of element A, between a slot 15 of element B and a slot 15 of element A, and between a hole 18 of element B and a hole 18 of element A. Bolts 19 are shown passing through the elements in each of these positions but in this as in other arrangements shown in the drawings it would not be necessary in practice to employ bolts in all of the available bolting positions.

Figures 4 to 9 illustrate the attachment of two elements A and B with their wide flanges 10 in contact, the element B being shown in a variety of positions at decreasing angles to the element A. In Figure 4 three available bolting positions are provided. In Figure 5 there are five available bolting positions; in Figure 6 six available bolting positions; in Figure 7 five available bolting positions; in Figure 8, seven available bolting positions; and in Figure 9, eight available bolting positions. Although bolts are shown in all such positions two or three bolts would normally be found adequate to lock the elements firmly against linear or angular movement relative to one another.

The arrangements shown in Figures 4 to 9 demonstrate that a pair of elements may be disposed at a wide variety of angles to one another for the purpose of carrying out different building operations, and in each case the said elements may be firmly locked together by inserting bolts or the like in a suitable number of bolting positions which are available.

Figures 10, 11, 12 and 13 illustrate arrangements in which two elements A and B are connected together with their wide flanges 10 in contact and with their narrow flanges 11 parallel to one another and facing in the same direction. In these figures different areas of the wide flanges 10 of the two members are in contact so as to enable the formation of structural members of different widths and of channel shape in cross section. In Figure 10 the wide flanges 10 of the two elements are in contact over their whole width and the elements are locked to-

4

gether by bolts passing through the holes 18 of one element and the holes 18 of the other element, said holes being disposed in register with one another. In Figure 11 the elements are spaced at a greater distance apart and bolting positions are provided between the longitudinal slots 15 of one element and the inclined slots 16, 17 of the other element, and also between the inclined slots 16 (or 17) of one element and the inclined slots 17 (or 16) of the other element. In Figure 12 these elements A and B are disposed further apart, and bolting positions are provided between the longitudinal slots 15 of one element and the holes 18 of the other element, and between the inclined slots 16 (or 17) of one element and the inclined slots 17 (or 16) of the other element. Figure 13 shows another arrangement in which the elements A and B are at their maximum distance apart and in which bolting positions are provided between the slots 15 of one element and the slots of the other element.

Figure 14 shows an arrangement in which two elements A and B are joined together at right angles and a third element C is disposed at an acute angle to the elements A and B and is joined to said elements at the junction thereof. This arrangement is useful in cases where the third element C is required to function as a brace. It will be seen that five bolting positions are provided between the elements A and B and three bolting positions are provided between the third element C and the other two elements, thus enabling the elements to be locked rigidly together.

In Figure 15 two elements A and B are arranged with their wide flanges 10 in contact, and with their narrow flanges 11 also in contact and facing in the same direction. Bolting positions are provided between the inclined slots 17 (or 16) of element B and the inclined slots 16 (or 17) of element A.

In Figure 16 the elements A and B are shown joined together at right angles and a third element C extends between the elements A and B so as to function as a corner brace. Three bolting positions are provided between one end of the brace C and the element A, and four bolting positions are provided between the other end of the brace C and the element B. Secure locking of the brace is thus ensured.

Figure 17 is a perspective view showing a pair of elements A and B arranged with their wide flanges 10 in contact and their narrow flanges 11 disposed adjacent to one another and facing in opposite directions, thus providing a structural member of T-shape in cross section. It will be observed that bolting positions are provided between the corresponding slots 14 and 15 and corresponding holes 18 of the two elements, and also between the slots 16 of one element and the slots 17 of the other element.

In Figure 18 a member of I-shape in cross section is formed from four elements A, B, C, D, the wide flanges 10 of which are in contact. Bolting positions are provided through the slots 14 of elements A and D and the slots 15 of elements B and C and also through the slots 14 of elements B and C and through the slots 15 of elements A and D. Further bolting positions are provided through the holes 18 of the elements and also through the inclined slots 16, 17 of said elements. The elements are preferably arranged so that the four inclined slots through which each bolt is passed are inclined alternately in different directions, thus increasing the locking effect.

In Figure 19 a channel-shaped member is constructed by arranging two elements A and B with their narrow flanges 11 in contact with one another and with their wide flanges 10 parallel to one another and extending in the same direction from the juxtaposed narrow flanges. Bolting positions are provided between the corresponding slots 12 and corresponding holes 13 of the narrow flanges 11.

Figure 20 illustrates the lattice structure of an element of the form shown in Figure 1. The chain-dotted lines

5

in Figure 20 are intended to illustrate diagrammatically the outlines of longitudinal members 20, 21 and of lattice or diagonal members 22, 23, the longitudinal member 20 being formed by the portion of the flange 10 between the row of slots 14 and the narrow flange 11, the longitudinal member 21 being formed by the portion of the flange 10 between the row of slots 15 and the edge of the flange 10, and the lattice members 22, 23 being formed by portions of the flange 10 between or adjacent to the inclined slots 16, 17 and the holes 18. The lattice members 22, 23 are inclined alternately in opposite directions, thus forming a series of triangular structures between the longitudinals 20, 21.

Structurally the element is statically determinate. If the element of Figure 20 is supported at each end and loaded centrally, it may be regarded as having point loads applied to the apex of each triangle, and under these conditions the longitudinal member 20 is under compression, the bottom longitudinal member 21 is under tension, and the lattice members 22, 23 are subjected to alternate compressive and tensile stresses.

The load-carrying capacity of an element constructed in accordance with this invention is demonstrated by the following tests:

Two elements each 6 feet long were arranged as shown in Figure 17 so as to form a T-section. Two elements of the same dimensions and having parallel inclined slots were bolted together in a similar manner. Two angle-section members of the same dimensions but without slots were similarly bolted together. The T-section members were supported at their ends, loads were applied to their centres, and the deflection of each member at its centre was measured. The following results were obtained:

Load in lbs.	Element according to this invention	Deflection (in inches); Element with parallel slots	Unslotted element
108-----	$\frac{1}{16}$	$\frac{3}{32}$	$\frac{1}{16}$
216-----	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{8}$
324-----	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{32}$
432-----	$\frac{1}{4}$	Failed	$\frac{7}{32}$

It will be seen from these results that the element of this invention possesses a structural strength not appreciably less than that of an unslotted angle-section member of the same dimensions.

I claim:

1. A building element comprising a right-angle-section member having a wide flange and a narrow flange, a row of inclined slots disposed substantially centrally in the wide flange, the inclined slots being inclined alternately in opposite directions at an angle between 60° and 68° to the longitudinal axis of the element, an inner row of longitudinal slots in the wide flange disposed between the row of inclined slots and the junction of the wide flange and narrow flange, an outer row of longitudinal slots in the wide flange disposed between the row of inclined slots and the free edge of the wide flange, the ends of the inclined slots being in substantial longitudinal alignment and being spaced inwardly of the inner and outer rows of longitudinal slots, and the length of each longitudinal slot in each of the inner and outer rows being less than the distance between adjacent longitudinal slots in the said row, a row of alternate longitudinal slots and holes in the narrow flange, a series of holes each of which is disposed substantially centrally of the wide flange and between adjacent inclined slots and which is also disposed substantially centrally within the triangle formed by the continuation of the said inclined slots and of a longitudinal slot of one of said inner and outer rows, a longitudinal

6

member being defined by that portion of the wide flange located between the inner row of longitudinal slots and the said junction, a second longitudinal member being defined by that portion of the wide flange between the outer row of longitudinal slots and the free edge of the wide flange, and diagonal members being defined by those portions of the wide flange located between the inclined slots and extending between the inner row and outer row of longitudinal slots, said longitudinal members and diagonal members forming between them a lattice structure the load-carrying capacity of which is not substantially less than that of an unslotted right-angle-section member of the same dimensions.

2. A building element comprising a right-angle-section member having a wide flange and a narrow flange, a row of inclined slots disposed substantially centrally in the wide flange, the inclined slots being inclined alternately in opposite directions at an angle between 60° and 68° to the longitudinal axis of the element, an inner row of longitudinal slots in the wide flange disposed between the row of inclined slots and the junction of the wide flange and the narrow flange, an outer row of longitudinal slots in the wide flange disposed between the row of inclined slots and the free edge of the wide flange, the ends of the inclined slots being in substantial longitudinal alignment and being spaced inwardly of the inner and outer rows of longitudinal slots, and the length of each longitudinal slot in each of the inner and outer rows being less than the distance between adjacent longitudinal slots in the said row, a row of alternate longitudinal slots and holes in the narrow flange, the longitudinal slots in the outer row being disposed laterally opposite to the spaces between the longitudinal slots in the inner row and to the longitudinal slots in the narrow flange, each pair of adjacent inclined slots forming an approximate triangle with a longitudinal slot of one of said inner and outer rows, a series of holes each of which is disposed substantially centrally of the wide flange and between adjacent inclined slots and which is also disposed substantially centrally within the triangle formed by the continuation of the said inclined slots and of a longitudinal slot of one of said inner and outer rows, a longitudinal member being defined by that portion of the wide flange located between the inner row of longitudinal slots and the said junction, a second longitudinal member being defined by that portion of the wide flange between the outer row of longitudinal slots and the free edge of the wide flange, and diagonal members being defined by those portions of the wide flange located between the inclined slots and extending between the inner row and outer row of longitudinal slots, the said longitudinal members and diagonal members forming between them a lattice structure and load-carrying capacity of which is not substantially less than that of an unslotted right-angle-section member of the same dimensions.

3. A building element according to claim 2, wherein the inclined slots are inclined at an angle of 64° to the longitudinal axis of the element.

References Cited in the file of this patent

UNITED STATES PATENTS

2,632,533 MacKenzie ----- Mar. 24, 1953

FOREIGN PATENTS

383,087 Great Britain ----- Nov. 10, 1932
592,063 Germany ----- Jan. 31, 1934
594,781 Germany ----- Mar. 22, 1934
620,696 Great Britain ----- Mar. 29, 1949