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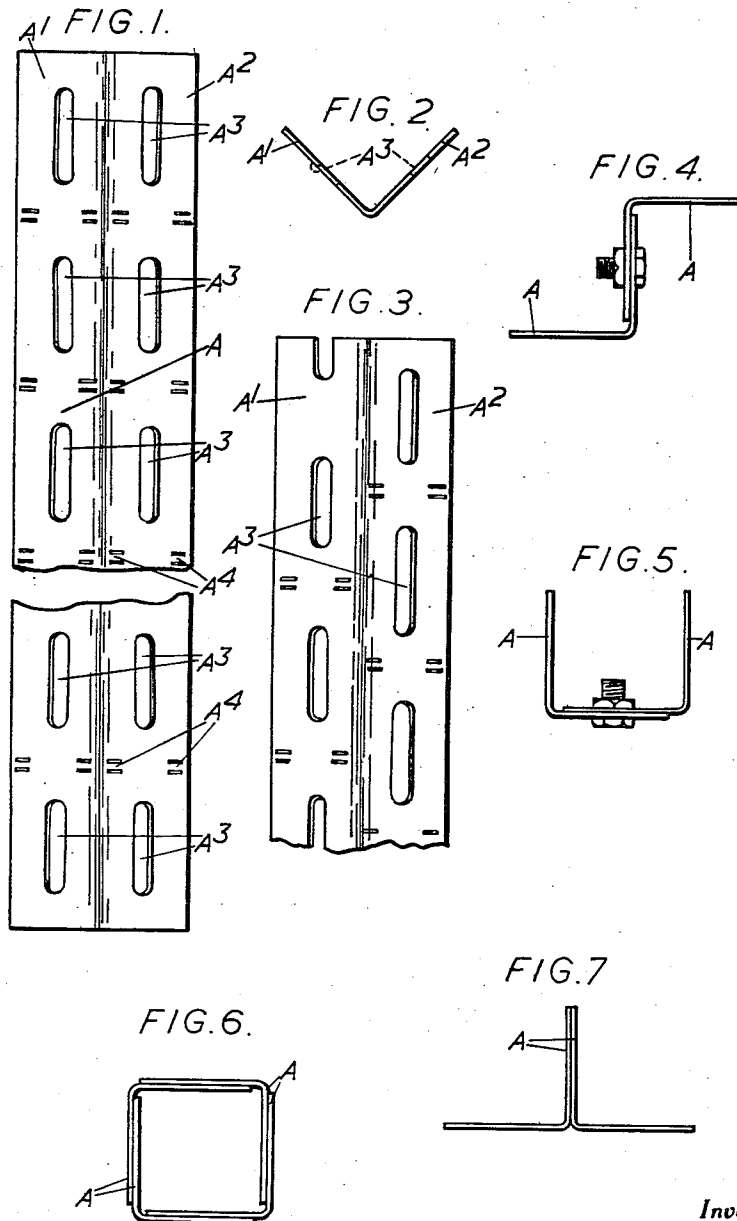
J. E. KINNEAR

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FRAMEWORK STRUCTURES AND ELEMENTS FOR USE THEREIN

Original Filed Jan. 5, 1953

3 Sheets-Sheet 1



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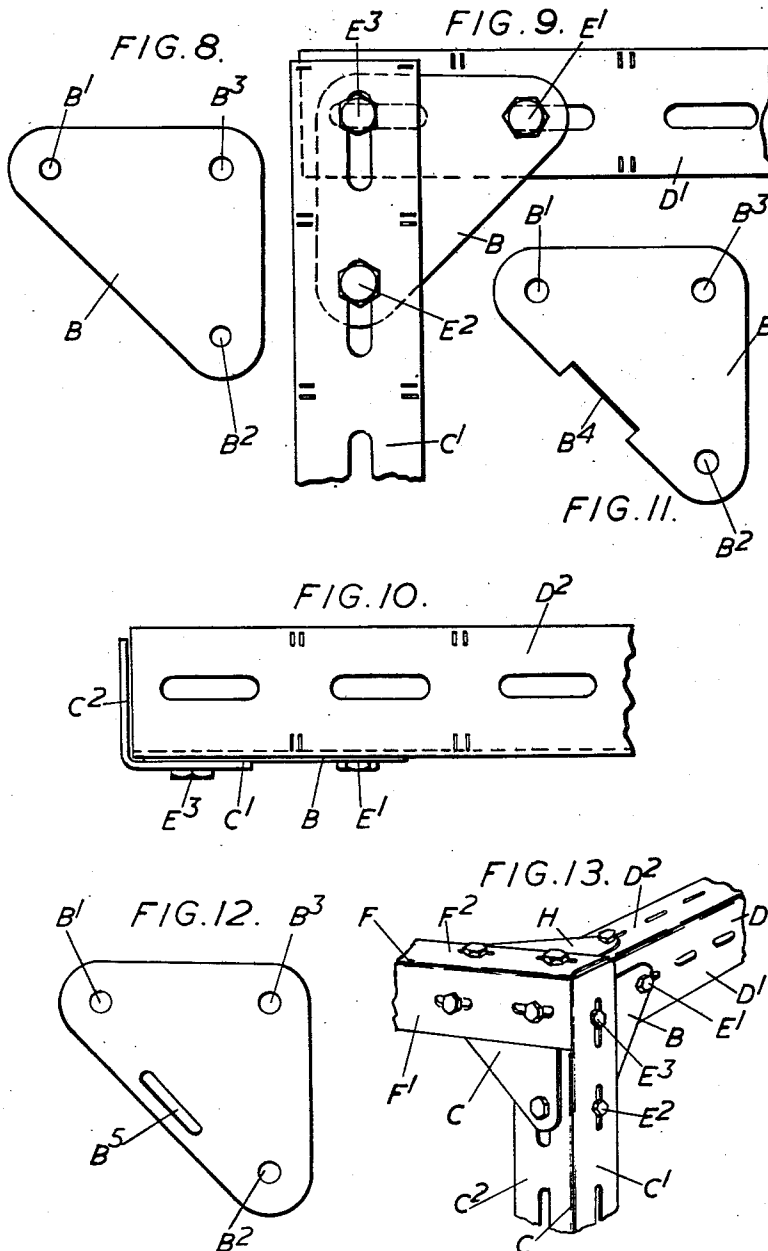
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FRAMEWORK STRUCTURES AND ELEMENTS FOR USE THEREIN

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Continuation of application Ser. No. 329,493, Jan. 5, 1953. This application Apr. 4, 1960, Ser. No. 30,395
Claims priority, application Great Britain Jan. 14, 1952
14 Claims (Cl. 189—36)

This application is a continuation of application Serial No. 329,493, now abandoned.

This invention relates to framework structures built up from elements provided with perforations through which the elements can be bolted together, and also to elements for use in such structures.

The invention has for its primary object to effect improvements in such structures and elements, and more especially in respect of the jointing of the elements in the structures, whereby highly satisfactory structures can be built up more rapidly and easily than hitherto, whilst at the same time effecting considerable economy in the quantity of metal (or other material), of which the elements are made, needed for a given structure.

A framework structure according to the present invention, includes two strips each having a row of aligned equally spaced elongated slots, the two strips being arranged with their lengths at right angles to one another, and a generally triangular anchor plate having three bolt-holes spaced at the corners of a right-angled triangle, the length of each of the shorter sides of which is not less than that required to accommodate two bolts respectively passing through the adjacent ends of two consecutive slots in the strips and is not greater than that required to accommodate two bolts passing through the remote ends of such two consecutive slots, the anchor plate being sandwiched between the strips and being bolted to them by three bolts passing through its three holes and through the slots in the strips.

Each of the two slotted strips preferably consists of an angle strip having an L-shaped cross-section, with two rows of similar strips, one in each of the two webs. The slots in the two rows may be positioned in register with one another, or alternatively the slots in the two rows may be positioned in staggered relationship with one another, so that the mid-point of a slot in one web is in register with the mid-point of a space between slots in the other web.

The non-engaging webs of the two strips preferably project on the same side of the engaging webs. For this purpose, it is convenient so to arrange the slots in each web of each angle strip that the space between each pair of consecutive slots has a length less than twice the space between the inner side edge of a slot and the inner surface of the other web of the strip.

The slots are preferably so positioned in the webs of the angle strips that the space between the free edge of the web and the nearer side edge of a slot is less than that between the other slot edge and the inner surface of the other web of the strip.

The bolt-hole triangle of the anchor plate preferably consists of an isosceles right-angled triangle, and in such case it is usually most convenient for the length of each of the shorter sides of such triangle to be equal to the pitch of the slots in the angle strips, that is to the distance of any point of one slot to the corresponding point of the next slot.

Whilst bolts and nuts of ordinary construction can be used for securing the slotted strips and anchor plates together, it is preferred to employ for this purpose a bolt comprising a threaded shank for receiving a nut, a head,

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and an integral shoulder between the head and the shank having flat sides such that when the shoulder is engaged within a slot in the strip rotation of the bolt relatively to the strip is substantially prevented. When such a bolt is used, the bolt-holes of the anchor plate at least at the two acute corners of the triangle preferably have flat sides such that the shoulder on the bolt when engaged therein will be substantially prevented from rotating relatively to the anchor plate. The axial length of the shoulder on the bolt is preferably greater than the thickness of the anchor plate, so that the shoulder can engage through the bolt-hole in the anchor plate into a slot in the strip to be bolted to the anchor plate, thereby substantially preventing relative rotation between the anchor plate and the strip. The thickness of a slotted strip is preferably greater than the axial length of the shoulder on the bolt.

With the use of the angle strips and the anchor plates, it is possible to build up a wide variety of framework structures, and further features of the invention are concerned with especially convenient practical forms of such elements.

Thus an angle strip according to one such further feature comprises two similar webs at right angles, each having a row of aligned equally spaced elongated slots, wherein the space between the inside surface of one web and the near edge of a slot in the other web exceeds the space between the other edge of the slot and the free edge of the web and also exceeds half the space between adjacent ends of two consecutive slots. Such an angle strip can be cut to length, as required, and in practice it is found that a range of specified lengths differing from one another in small steps will be adequate to meet the large majority of requirements. For this purpose, the angle strip is preferably provided with cutting marks adjacent to the mid-points of the spaces between the slots, with or without further cutting marks adjacent to the mid-points of the lengths of the slots. It is intended that normally the strips should only be cut to length at such cutting marks.

An anchor plate according to a further feature of the invention for use with such angle strips, comprises a plate of generally triangular form having bolt-holes spaced at the corners of a right-angled triangle, whose shorter sides each have a length not less than that required to accommodate two bolts respectively passing through the adjacent ends of two consecutive slots in the angle strips and not greater than that required to accommodate two bolts passing through the remote ends of such slots. The shorter sides of the bolt-hole triangle are preferably each equal to the pitch of the slots in the angle strips. Such an anchor plate may be strengthened along the middle portion of its hypotenuse by means of a flange or rib.

It is often convenient to employ, in addition to the angle strips and anchor plates, a shelf element comprising a rectangular sheet which constitutes the surface of the shelf and has at each edge a turned-down flange provided at each end with two slots shaped and spaced similarly to the slots in the strips, for securing to a slotted strip by means of an anchor plate sandwiched between such flange and the strip. Each shelf flange is preferably of double thickness formed by bending the material back on itself, the slots passing through both layers.

The invention may be carried into practice in various ways, but a preferred practical arrangement is illustrated (together with some modifications) by way of example in the accompanying drawings, in which:

FIGURES 1 and 2 show respectively in elevation and in end view a preferred form of slotted angle strip, FIGURE 3 illustrates a modified form of angle strip, FIGURES 4 to 7 respectively illustrate four alterna-

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tive ways of bolting angle strips together to form useful girder-like members.

FIGURE 8 shows a simple form of anchor plate,

FIGURES 9 and 10 are views at right angles illustrating the use of the anchor plate at a right-angled joint between two angle strips,

FIGURES 11 and 12 illustrate two modified forms of anchor plate,

FIGURE 13 shows an extension of the arrangement of FIGURES 9 and 10 to make a three-dimensional joint,

FIGURES 14 and 15 illustrate the mounting of a shelf element, FIGURE 15 being a sectional view on the line 15—15 of FIGURE 14,

FIGURES 16 and 17 respectively show side and end elevations of a preferred form of bolt,

FIGURE 18 shows a preferred form of anchor plate for use with the bolt of FIGURES 16 and 17,

FIGURE 19 is a sectional view illustrating the bolting of the anchor plate of FIGURE 18 to an angle strip.

In this arrangement, the basic elements from which a framework structure can be built up consist of slotted angle strips and triangular anchor plates, together with the necessary bolts and nuts for securing them together.

Each angle strip A, as shown in FIGURES 1 and 2, consists of a strip of steel, of any desired length and having a width which may for example be of the order of three inches, bent through a right angle along its centre line so as to form an angle strip of L-shaped cross-section. Each of the two webs A^1 A^2 has a row of aligned elongated slots A^3 extending along its whole length, the slots all being of the same length and being equally spaced from one another. The slot width is chosen to suit the bolts used, say of a quarter of an inch diameter, with just sufficient clearance for ready and easy insertion of the bolts.

Whilst (as shown in FIGURE 3) the slots A^3 in the two webs A^1 A^2 of the angle strip A may be arranged in staggered relationship (that is such that if the angle strip were transversely cut through the mid-point of the length of one slot A^3 in one web A^1 , the cut would pass through the mid-point of a space between two consecutive slots A^3 in the other web A^2), it will usually be preferable, as in FIGURE 1, to arrange the two rows of slots A^3 in register with one another, that is such that a transverse cut through the mid-point of a slot A^3 in one web A^1 would also pass through the mid-point of a slot A^3 in the other web A^2 .

The row of slots A^3 in each web is located slightly nearer to the free edge of the web than to the inside surface of the other web. This permits two angle strips A to be bolted together to form a composite strip of right-angled Z-section (as shown in FIGURE 4) or a composite strip of channel-section (as shown in FIGURE 5), the width of the web being such that, when strips are bolted together in this way, the free edge of one of the engaging webs will lie clear of the slight rounding of the angle of the other angle strip. It will be clear that, if desired, two such channel-section composite strips can be bolted together to form a composite strip of rectangular box-section (as shown in FIGURE 6). Another useful constructional form consists of two angle strips bolted together to form a composite strip of T-section (as shown in FIGURE 7).

It is intended that the angle strips A should be cut to the desired length for use, and for this purpose cutting marks A^4 are provided on the webs adjacent to the mid-points of the spaces between the slots A^3 , to indicate where the strips should preferably be cut. If these cutting marks A^4 are strictly adhered to, the available lengths of strip after cutting will differ from one another in regular steps equal to the pitch of the slots, and this has been found to provide an adequate range of possible variation for the large majority of practical uses. The preferred pitch for the slots is of the order of two inches.

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It is, however, important that the length of the space between consecutive slots should be less than twice the distance between the inner side edge of one slot and the inside surface of the other web of the strip. With this arrangement it is possible when one strip, cut off at one of the cutting marks, is placed with its length at right angles to that of another strip, a bolt can then be inserted through the slots to secure a web of one strip to a web of the other strip, whilst leaving the end of one strip clear of the rounded angle of the other strip, the non-engaging webs of the two strips projecting on the same side of the pair of engaging webs.

In order to provide a strong right-angled joint of this kind between two angle strips, the anchor plate is used. This anchor plate B (as shown in FIGURE 8) consists of a flat thin steel plate of generally triangular shape having three bolt-holes B^1 B^2 B^3 located at the corners of a right-angled triangle. Whilst it is not essential that the bolt-hole triangle should be isosceles, it is usually preferable that it should be so, and the length of each of the shorter sides of such triangle should then be such that the two bolts through its holes can engage in two consecutive slots A^3 in one of the angle strips A. Thus the minimum distance between the two bolt-hole centres in the anchor plate B is equal to that between bolt centres at the adjacent ends of two consecutive slots A^3 , and the maximum distance is that between bolt centres at the remote end of two consecutive slots. The preferred distance between bolt centres of either shorter side of the bolt-hole triangle of the anchor plate B is equal to the pitch of the slots A^3 in the strips A, this arrangement giving maximum adjustability of the position of the joint along the length of one angle strip. The corners of the anchor plate B are rounded about the adjacent bolt-hole centres, the radius of such rounding being less than the distance between the slot centre line of a strip A and the inner surface of the other web of the strip.

In use (as shown in FIGURES 9 and 10) this anchor plate B is sandwiched between the engaging webs C^1 and D^1 of the two angle strips C D to be bolted together, and the three bolts E^1 E^2 E^3 provide an adequate joint for securing the two strips rigidly in position at right angles to one another. With the dimensions above mentioned, it will be clear that a very large proportion of the area of the anchor plate B in the joint lies in close engagement with the web C^1 or D^1 of at least one of the strips, and there is only a relatively small exposed unsupported triangle. So long as the hypotenuse of the anchor plate triangle is in tension, it will have great strength, even though it is made of quite thin metal, and it will be appreciated that in an elaborate framework having a number of right-angled joints most of the stresses will be taken up tensionally by one or more of the anchor plates, so that an anchor plate will not very often have to withstand a buckling load. The fact that a large proportion of the area of the anchor plate is directly supported by an angle strip web greatly increases the resistance of the plate to buckling and in practice even a thin plate will withstand quite a big buckling stress before its small exposed triangle begins to buckle. The resistance to buckling can be still further increased by providing the middle portion of the hypotenuse of the triangle (that is the part within the exposed small triangle) with a flange B^4 (FIGURE 11) formed by turning part of the edge of the plate through a right angle or by pressing a rib B^5 (FIGURE 12) of curved section extending in the direction of the hypotenuse. If desired, small projections can be formed by punching in the lines of the shorter sides of the bolt-hole triangle in the anchor plate to engage with the edges of the slots in the angle strips, in order to hold the parts of the joint properly in position while the bolts are being inserted and tightened up. It is important to ensure that any such projections are so arranged as not to prevent the plate from being usable at all corners, whether "right-handed" or "left-handed."

A "three-dimensional" joint (see FIGURE 13), wherein the lengths of three angle strips are mutually at right angles, is formed from the "two-dimensional" joint of FIGURES 9 and 10, by bolting the webs F¹ and F² of the third angle strip F to the two non-engaging webs C² and D² in the simple joint, two further anchor plates G and H being sandwiched between the engaging webs in the manner above described.

It should be mentioned that, in a large and complicated built-up structure, it is seldom necessary to put an anchor plate in every corner, for, if this were done, several of the plates would be redundant, not contributing to the strength of the structure.

It will be clear that with the arrangement above described, it is possible to build up easily and rapidly, a wide variety of framework structures suitable for many purposes, and a well-designed framework structure of this kind is capable of supporting quite heavy loads, either on the angle strips themselves or on shelves or other supports mounted on them.

FIGURES 14 and 15 show a preferred form of shelf element and method of mounting it. In this arrangement, the shelf element comprises a rectangular steel sheet J with a turned-down flange J¹ at each edge. Each flange J¹ is of double thickness formed by bending back the metal on itself, as shown at J², in order to provide added strength. Each double flange J¹ is provided at each end with two slots J³ of the same shape and spacing as the slots in the angle strip. The shelf element is supported at each of its four corners by means of an angle strip K fitting outside the corner and extending with its length at right angles to the shelf surface, FIGURES 14 and 15 showing the mounting at one corner. Each web K¹ or K² of the angle strip is bolted to one of the shelf flanges J¹, with an anchor plate L or M sandwiched between, in a manner similar to that described with reference to FIGURES 9 and 10. If the shelf element J is attached, as shown, to the top end of each supporting angle strip K, it can be used as a table, and in such case it will be clear that the angle strips could be attached inside the corners of the shelf element instead of outside, if preferred.

In the above-described arrangements, as illustrated, the bolts and nuts employed have been of the usual well-known type, but in practice it is preferred to employ the special bolt shown in FIGURES 16 and 17. This bolt consists of a screw-threaded shank N of usual form, a head N¹ preferably having a smoothly rounded surface, and between the head and the shank an integral square shoulder N². The size of the square shoulder N² is such that it will fit within any one of the slots in the angle strips with only just enough clearance to permit of its ready insertion and withdrawal, and it will be appreciated that when so inserted it will act substantially to prevent any relative rotation between the bolt and the angle strip, so that the nut can be tightened on the threaded shank N without any need to hold the bolt-head N¹ against rotation. The axial length of the square shoulder N is preferably made less than the thickness of a web of an angle strip, so that it will not interfere with the screwing of the nut into the desired tight clamping engagement.

FIGURE 18 illustrates the preferred form of anchor plate for use when the bolt of FIGURES 16 and 17 is employed. This anchor plate O differs from that shown in FIGURE 8 solely in that the bolt-holes O¹ and O² at the acute corners of the right-angled triangle are made square to suit the square shoulder N on the bolt. Since the axial length of the shoulder N is less than the thickness of the web of an angle strip, and the anchor plate is always sandwiched between such webs, it will be clear that the shoulder N can never penetrate through a web into the bolt-hole O³ at the right-angle corner of the triangle. There is no need therefore for this hole O³ to be

square, and indeed it is preferred to make it round, as shown, in order to prevent the anchor plate from being used wrongly and not sandwiched between two webs. It has already been mentioned that the anchor plate is made quite thin and the axial length of the shoulder N on the bolt is made greater than the thickness of the anchor plate and less than that of the angle strip web. Thus, when the bolt is passed first through the anchor plate and then through the angle strip web (as shown for example in FIGURE 19), the square shoulder N will penetrate right through the bolt-hole O¹ or O² in the anchor plate into engagement in a slot in the angle strip. This has the advantage of substantially locking the anchor plate and the angle strip against relative rotation. The edges of the square bolt-holes O¹ O² in the anchor plate are of course parallel to the shorter sides of the right-angled triangle, so as to be in the correct orientation relatively to the angle strip slots. With this arrangement, it is practicable in most instances to arrange that the smoothly rounded bolt-heads N¹ are on the sides of the finished structure most exposed to view, thus greatly improving the appearance of the structure in that the relatively unsightly screwed shanks N of the bolts will for the most part be obscured from view.

What I claim as my invention and desire to secure by Letters Patent is:

1. A framework structure built up from perforated elements bolted together, and including two angle strips arranged with their lengths at right angles to one another and each having an L-shaped cross section with a single row of aligned equally spaced elongated slots in each of the two webs of the strip, one end portion of one of the webs of one of said strips lying in a plane parallel to and overlapping one web of the other strip with the non-overlapping webs of said angle strips projecting in the same direction away from said overlapping webs, a generally triangular flat anchor plate sandwiched between and directly supported against buckling by the overlapping webs of the two strips and having three bolt holes spaced at the corners of a right-angled triangle, the length of each of the shorter sides of which is not less than that required to accommodate two bolts respectively passing through the adjacent ends of two consecutive slots in the strips and is not greater than that required to accommodate two bolts respectively passing through the remote ends of such two consecutive slots, and three bolts passing respectively through the three bolt holes in the anchor plate and also through slots in the angle strips for tightly bolting the strips and the anchor plate together, said structure comprising also a third similar angle strip having its webs bolted to the non-overlapping webs of said two angle strips so as to extend at right angles thereto, and at least one similar angle plate sandwiched between a web of said third strip and the web to which it is bolted.

2. A framework structure as claimed in claim 1, in which the length of the unsupported edge portion of the anchor plates measured along the hypotenuse of the bolt-hole triangle thereof is less than the length of either of the portions thereof (also measured along the said hypotenuse) which are supported by one of the angle strip webs.

3. A framework structure as claimed in claim 2, in which the peripheral edge of each anchor plate lies wholly outside the triangle formed by the three bolt holes in the plate, whereby the material of the plate is continuous and uninterrupted along each of the three sides of the bolt hole triangle.

4. A framework structure as claimed in claim 1, in which the slots in the two rows in each angle strip are positioned in register with one another, and the space between each pair of consecutive slots in the row in each web of each angle strip has a length less than twice the space between the inner side edge of a slot and the inner surface of the other web.

5. A framework structure as claimed in claim 4, in which the slots are so positioned in the webs of the angle strips that the space between the free edge of the web and the nearer side edge of a slot is less than that between the other slot edge and the inner surface of the other web of the strip.

6. A framework structure as claimed in claim 1, in which the slots in one web in each angle strip are positioned in register with the slots in the other web thereof, and consecutive slots in the row in each web are spaced apart by a distance less than twice the space between the inner side edge of a slot and the inner surface of the other web of the strip, such space in turn being not less than the space between the outer side edge of a slot and the free edge of the web.

7. A framework structure as claimed in claim 1, in which the bolt hole triangle of the anchor plate consists of an isosceles right-angled triangle, the length of each of the shorter sides of which is equal to the pitch of the slots in a web of the angle strip.

8. A framework corner construction of the type comprising perforated angle strips, said corner construction including two L-sectioned flanged members arranged with their lengths at right angles and their meeting ends secured together with one end portion of one of the flanges of one of said strips lying in a plane parallel to and overlapping one flange of the other strip with the non-overlapping flanges of said angle strips projecting in the same direction away from said overlapping strips and a flat anchor plate sandwiched between and supported by both of said last-mentioned flanges, said anchor plate having at least three perforations spaced at the corners of a right-angled triangle having its two shorter sides respectively extending parallel to the lengths of the flanged members, each flanged member having at least two spaced perforations one of which registers with the right-angle corner perforation of the anchor plate and the other of which registers with one of the other corner perforations of the anchor plate, and fastening members extending through said registering perforations and securely clamping said flanged members in fixed position, the length of the unsupported edge portion of said anchor plate measured along the hypotenuse of said right-angled triangle being less than the length of either of the adjacent edge portions thereof (also measured along the said hypotenuse) supported by said parallel flanges, said construction comprising also a third similar angle strip having its flanges fastened to the non-overlapping flanges of said two angle strips so as to extend at right angles thereto and at least one similar anchor plate sandwiched between a flange of said third strip and the flange to which it is fastened.

9. A framework corner construction as claimed in claim 8, in which the bolt-hole triangle of the anchor plates consist of an isosceles right-angled triangle and the peripheral edge of each anchor plate lies wholly outside such triangle, whereby the material of each anchor plate is continuous and uninterrupted along each of the three sides of such triangle.

10. A framework structure built up of perforated elements bolted together, and including two angle strips arranged with their lengths at right angles to one another and each having an L-shaped cross-section with a single row of perforations in each of its two webs, a generally triangular anchor plate sandwiched between webs of the two angle strips and having three bolt holes spaced at the corners of an isosceles right-angled triangle and registering with perforations in the angle strips, and three bolts passing respectively through the three bolt holes of the anchor plate and through the registering perforations in the angle strips for tightly bolting the webs of the angle strips together with the anchor plate sandwiched between them, the thickness of the anchor plate being less than that of the webs of the angle strips and the size of the anchor plate bearing such relationship to the

webs of the angle strips that only a small portion of the anchor plate adjacent to the middle portion of the hypotenuse of the bolt-hole triangle is unsupported by engagement with an angle strip web, the lengths of the end portions of such hypotenuse supported by engagement with the angle strip webs each being greater than any unsupported middle portion thereof, and the bolt holes of the anchor plate at the two acute corners of the bolt hole triangle having flat sides parallel to the shorter sides of the bolt hole triangle.

11. A framework structure as claimed in claim 10, in which each of the bolts used for bolting the angle strip webs and the anchor plate together comprises a threaded shank for receiving a nut, a head, and an integral shoulder of square section between the head and the shank such that when the shoulder is engaged within a flat-sided bolt-hole in the anchor plate rotation of the bolt relatively to the anchor plate is prevented.

12. A framework structure as claimed in claim 11, in which the axial length of the shoulder on the bolt is greater than the thickness of the anchor plate but less than the thickness of an angle strip web, whereby the shoulder can pass through a flat sided bolt hole in the anchor plate into engagement in a perforation in an angle strip but cannot pass through an angle strip perforation into engagement in a bolt hole of the anchor plate, the bolt hole at the right-angled corner of the bolt hole triangle of the anchor plate consisting of a round hole capable of receiving the shank of a bolt but not the square shoulder thereof.

13. A corner joint for a framework structure built up from perforated elements bolted together, said corner joint including two angle strips arranged with their lengths at right angles to one another and overlapping at their adjacent ends, each angle strip having an L-shaped cross-section with a single row of aligned slots in each of the two webs thereof, a generally triangular anchor plate of thickness less than that of the angle strip webs which is sandwiched between the parallel portions of the latter at their overlapping ends and has three bolt holes spaced at the corners of a right-angled triangle and registering each with a different slot of said angle strips, the bolt holes at the two acute corners of such triangle being square in shape and the bolt hole at the right angled corner being round and being large enough to receive the threaded shank of a bolt, and three bolts passing respectively through the three bolt holes in the anchor plate and also through different slots in the angle strips for bolting the strips and the anchor plate together, each such bolt comprising a threaded shank for receiving a nut, a head, and an integral shoulder between the head and the shank, such shoulder being of square section of a size fitting within a square hole in the anchor plate or a slot in an angle strip but not within the round hole at the right-angled corner of the anchor plate triangle and having an axial length greater than the thickness of the anchor plate but less than the thickness of an angle strip web, whereby such bolts can be assembled in said corner joint only with said anchor plate in sandwiched relation to such angle strips.

14. A corner joint for a framework structure as claimed in claim 13, in which the length of each slot in each angle strip is not less than the length of the space between consecutive slots in the row in each web of the strip, and the pitch of the slots in such row is not less than the width of either web of the strip, whilst the length of each of the shorter sides of the bolt hole triangle in the anchor plate is not less than that required to accommodate two bolts respectively passing through the adjacent ends of two consecutive slots in a row of the angle strip and is not greater than that required to accommodate two bolts respectively passing through the remote ends of such two consecutive slots.

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