

Feb. 14, 1967

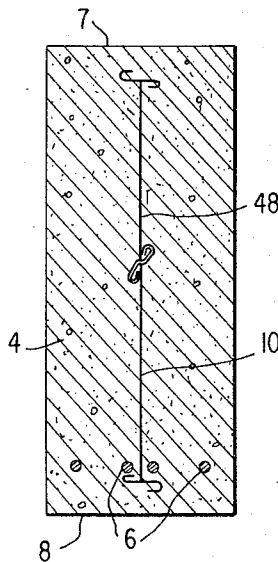
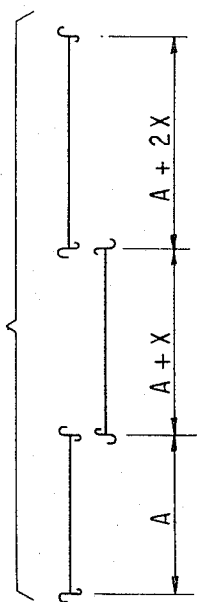
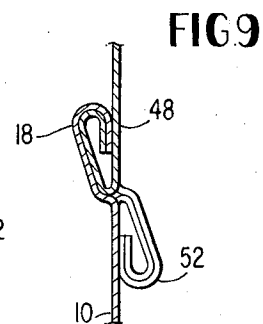
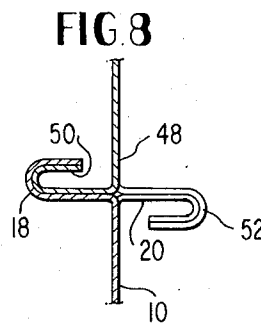
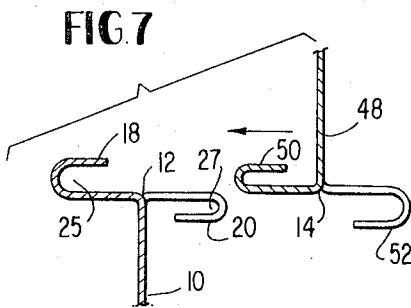
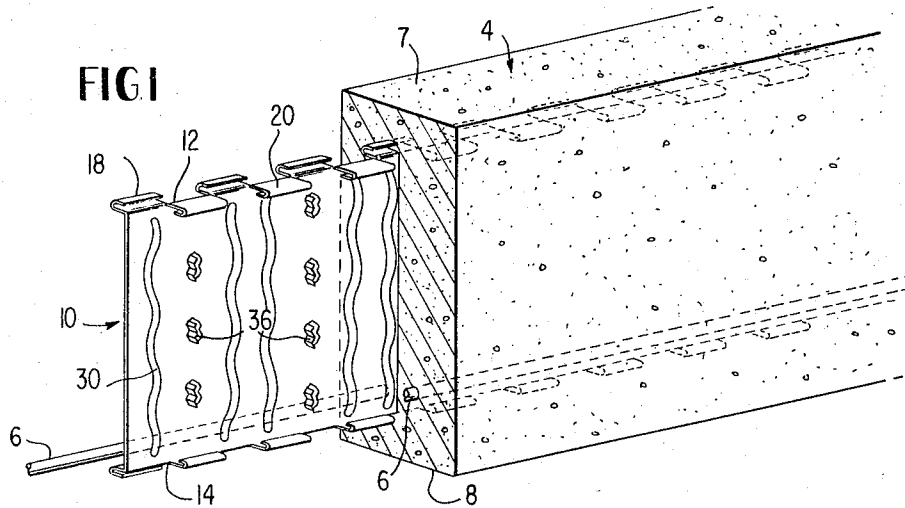
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3,303,627

REINFORCED STRUCTURAL MEMBERS

Filed April 9, 1964

3 Sheets-Sheet 1



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FIG 2

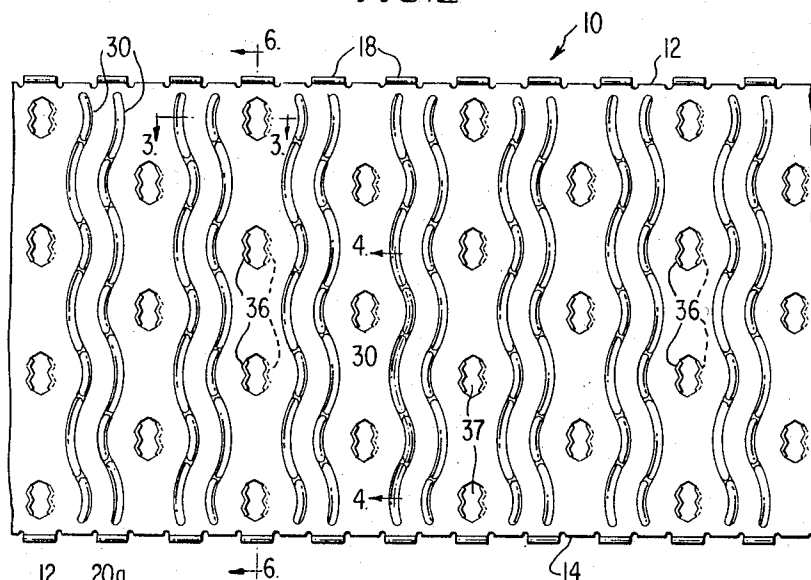


FIG 6

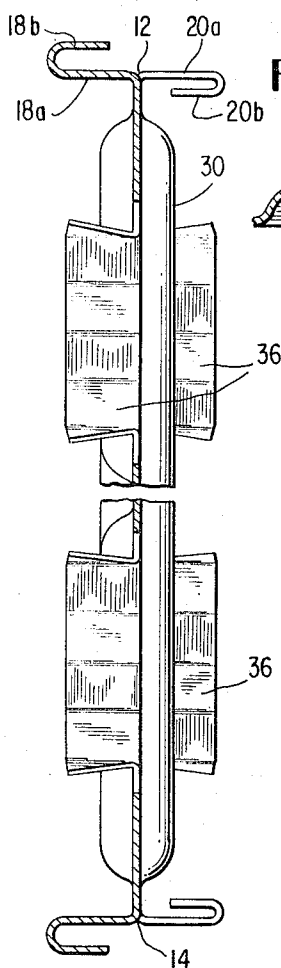


FIG 3

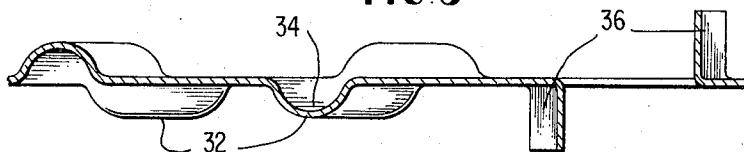


FIG 4

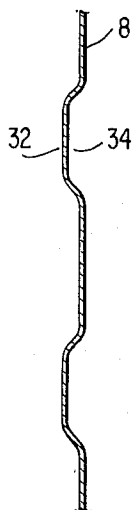
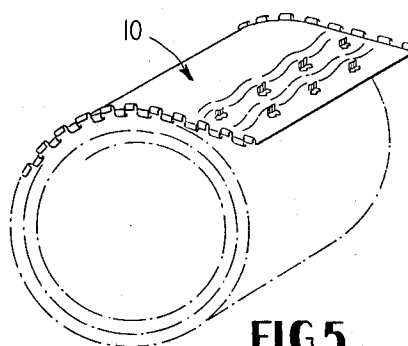


FIG 5



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FIG 12

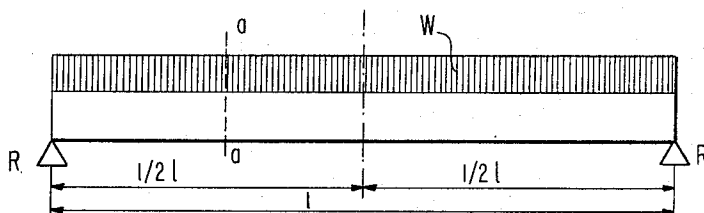


FIG 13

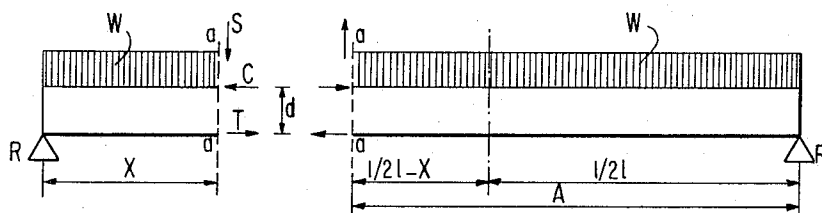


FIG 14

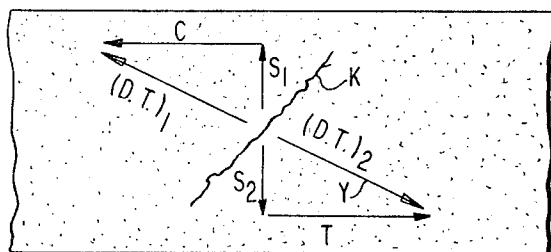
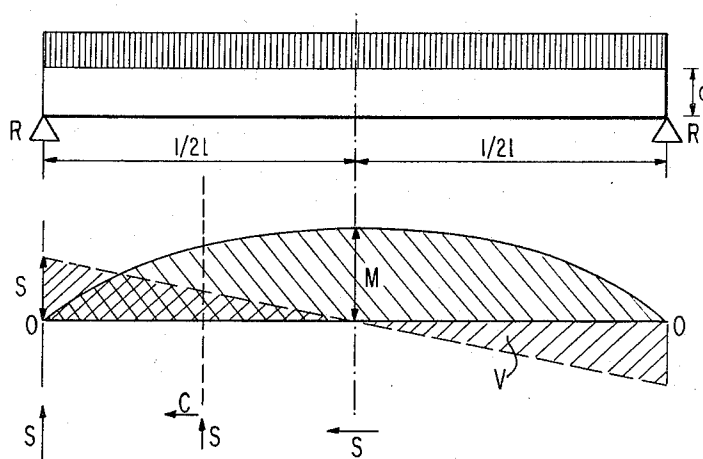


FIG 15

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REINFORCED STRUCTURAL MEMBERS

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18 Claims. (Cl. 52-723)

This invention generally relates to the reinforcement of structural supporting members such as concrete beams and the like and more specifically to a novel reinforcing web and an improved reinforced structural member incorporating the same.

The internal reinforcement of concrete beams and the like to provide them with resistance to flexural and shearing stresses occasioned by external applied loads is well known. One of the most common methods of reinforcing concrete beams is to employ longitudinal steel rods together with a series of vertical stirrups which are tied to the rods at spaced intervals. The theory here being that the longitudinal rods provide the resistance to flexure or bending while the stirrups provide the resistance to shear.

While such use of longitudinal rods to resist flexure has proven satisfactory, use of stirrups to resist shear has several significant disadvantages. One of the most serious disadvantages is that, stirrups, because placed at spaced intervals along the beam, are incapable of providing uniform and continuous resistance to shear throughout the full longitudinal extent of the beam. As a result, the areas of the beam between the stirrups are unreinforced and thus susceptible to rupture or cracking which of course, can drastically reduce the overall strength of the beam.

Other methods, in attempting to supply this deficiency of stirrups, have utilized the flexural reinforcement to additionally provide the shearing reinforcement such as may be done for example by employing a single I beam. However, this as well as other similar methods, by their very nature, often result in inefficient use of the reinforcing material thereby increasing the cost of construction.

Another serious disadvantage of conventional stirrups is that they must be individually positioned and then individually connected with additional wire material, to the longitudinal reinforcing rods. As can be readily appreciated, this is a rather elaborate process necessitating a relatively expensive amount of manual labor.

Accordingly, a principal object of the present invention is to provide a reinforced concrete construction or the like which possesses throughout the full longitudinal extent thereof, highly effective resistance to both flexural and shearing stresses while at the same time incorporating reinforcing members that are efficiently utilized so as to significantly lessen the overall fabrication cost thereof.

A further object of the present invention is to provide such an improved reinforced construction that obviates the placement and securement problems heretofore attendant to conventional stirrups.

Another important object of the present invention is to provide a novel and improved reinforcing web that may be efficiently incorporated into a concrete beam and the like where it will provide uniform and continuous resistance to shearing stresses occasioned by externally applied loads.

A still further object of the present invention is to provide such a reinforcing web that may be quickly and conveniently joined to one or more similar webs to increase the amount of reinforcing material depending on the strength requirements of the beam to be reinforced thereby.

A still further object of the present invention is to provide a reinforcing web which will obtain the above objects and yet is economical to manufacture, light in weight

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and easy to handle both in shipment and in application.

Other objects and the entire scope of the present invention will become apparent from the following detailed description and by reference to the accompanying drawings. It should be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent as the description herein progresses.

Reference now being made to the accompanying drawings wherein like numerals refer to similar parts throughout, and in which:

FIG. 1 is a fragmental perspective view, partly broken away, of a beam constructed in accordance with the present invention;

FIG. 2 is an enlarged side view, in fragment, of a novel reinforcing web embodying the invention;

FIG. 3 is an enlarged cross-sectional view taken generally along lines 3-3 of FIG. 2.

FIG. 4 is an enlarged cross-sectional view taken generally along lines 4-4 of FIG. 2;

FIG. 5 is a perspective view partially in phantom showing the web as may be supplied in a roll;

FIG. 6 is an enlarged cross-sectional view, partly broken away, taken generally along lines 6-6 of FIG. 2;

FIG. 7 is a cross-sectional assembly view, in fragment, illustrating the connection of two reinforcing webs;

FIG. 8 is a view similar to FIG. 7 but showing the webs in connected condition prior to final attachment;

FIG. 9 is a view similar to FIG. 8 but showing the webs in their finally interconnected condition;

FIG. 10 is a cross-sectional view of a beam incorporating two reinforcing webs;

FIG. 11 is a diagrammatic view illustrating the use of three reinforcing webs;

FIG. 12 is a diagrammatic view of a simply supported beam;

FIG. 13 is a view similar to FIG. 12 but with the beam broken away to illustrate internal stresses;

FIG. 14 shows bending moment and vertical shear diagrams associated with the beam of FIG. 12; and

FIG. 15 is an enlarged longitudinal sectional view of the beam of FIG. 12 illustrating diagonal tension.

Before describing the invention in detail, it is believed that a brief review of some of the basic internal stress characteristics of beams will be helpful to an understanding of the invention and the problems which it has solved. Accordingly referring to FIG. 12, there is diagrammatically illustrated a simply supported beam having a length l and external load of w per unit of l . Referring to FIG. 13, the internal stresses at a point, x distance from the support R , are represented by c , designating compression occurring in the upper half of the beam, t designating tension occurring in the lower half of the beam, and s designating shear acting vertically in the beam. Referring to FIG. 14, the bending moment or flexure imposed on the beam by load w is illustrated by the diagram m while the vertical shear imposed on the beam is illustrated by the diagram v . It will be remembered that the magnitude of the bending moment at any point, x distance from R , may be determined by algebraically summing the moments of the force $w x$ and the reaction force at R about said given point, x distance from R while the magnitude of the shearing stress may be determined by algebraically summing the forces of $w x$ and R .

Referring to FIG. 15, the resultant of the flexural and shear stresses has often been expressed by what is known as "diagonal tension" which acts at an angle of y with respect to the horizontal axis of the beam. It will be apparent that when the diagonal tension developed in the beam, by virtue of the external loading w thereon, ex-

ceeds the strength of the beam, the beam will rupture or crack along a line k which extends generally normal to a direction of the diagonal tension (see FIG. 15).

Thus in the design of concrete beams and the like, in order to reinforce the same against diagonal tension, the concrete, which has virtually unlimited compressive strength, is utilized to sustain the compression acting in the upper half of the beam while, as mentioned above, reinforcing rods are placed in the lower half of the beam so as to sustain the tension or flexural forces, it being understood that concrete has effectively no tensile strength. The problem that arises however, is with respect to the shear component of diagonal tension, because while stirrups will resist shearing stresses at their points of location in the beam, the areas in the beam between adjacent stirrups are unreinforced and thus susceptible to cracking or rupture as illustrated in FIG. 15. It will be apparent that once a concrete beam cracks at a certain area, the stress formerly taken by that area is shifted to other areas which thus become stress concentrated or overburdened until they in turn rupture, further reducing the strength of the beam and causing another shifting of the stresses. This process repeats until the beam is no longer useful.

The present invention successfully deals with this problem regarding diagonal tension and now referring to FIG. 1, there is shown for illustrative purposes a structural beam 4 formed of concrete or the like which is reinforced in accordance with the present invention. The beam 4 which is shown as having a rectangular cross-section, is provided with a plurality of longitudinal steel rods 6 that extend adjacent the bottom face 8 of the beam 4 in typical fashion. The number and cross-sectional area of the steel rods 6 are designed to provide adequate resistance only to flexural stresses and moments to which the beam will be subjected in use.

In accordance with the invention, the shearing reinforcement is provided by a novel web, generally designated 10, formed from sheet steel or the like having parallel longitudinal edges 12 and 14 and which may be conveniently supplied at the job site in the form of a roll such as illustrated in FIG. 5. The web 10 is entirely embedded in the beam 4 along the vertical axis thereof with the longitudinal edges 12, 14 of the web disposed adjacent the upper and lower faces 7 and 8 of the beam and the lower edge 14 disposed slightly below the rods 6. The specific gauge or thickness of the web 10 depends on the amount of shear reinforcement required in a particular beam and therefore may be designed accordingly.

Referring to FIGS. 1 and 2, there is integrally formed on each of the longitudinal edges 12 and 14 of the web, a series of flanges 18 and 20 alternately projecting oppositely in lateral directions from the web 10. In the preferred embodiment the flanges 18 and 20 have a generally hook shaped cross-section and include first portions 18a and 20a which project generally perpendicularly from the web 10 and second inturned portions 18b and 20b which are bent inwardly from portions 18a and 20a in opposite directions so as to lie in spaced overlying and underlying relationship with portions 18a and 20a respectively and so as to terminate in laterally spaced relationship from the plane of the web 10.

The flanges 18 and 20 have several important functions, one of which is to anchor the web 10 in the concrete against relative movement particularly in the vertical direction as shown in FIG. 1. Another important purpose of the flanges 18 and 20 is for joining one or more webs, one above the other, as will be subsequently described in greater detail.

In order to increase the stiffness of the web 10, a plurality of serpentine ribs 30 are integrally formed transversely in the web. The ribs 30, as viewed on one side of the web 10, each comprise alternate projections 32 and depressions 34 extending across the web 10 substantially to the opposite edges 12 and 14 thereof. Although

the ribs 30 are illustrated as being provided in spaced pairs (see FIG. 1) it will be appreciated that other arrangements may be employed as desired. Added interlocking action between the concrete and the web, is also provided by the ribs 30.

Referring to FIGS. 2 and 6, the web 10 is provided with a plurality of teeth 36 to further insure against relative movement between the web and concrete, particularly in the longitudinal direction. The teeth 36, which are preferably corrugated in shape, are provided in pairs at locations 37 between adjacent clusters of the serpentine ribs 30. Formation of the teeth 36 in the shown embodiment is accomplished by first appropriately piercing the web 10 and outwardly bending the pierced segments in opposite directions at right angles to the web and then again bending the segments into the corrugated shape. It will again be appreciated that the specific number and arrangement of the teeth 36 may be varied as desired.

In fabricating the beam, the web 10 need only be tied, at the opposite ends thereof by any suitable means and without the problems of placement that have typically attended the use of stirrups. After the web is so positioned, the longitudinal reinforcing rods are then laid on opposite sides of the web, preferably in equal numbers, whereupon the assembly is ready for pouring the concrete.

From the foregoing it will be seen that the web 10 as incorporated in the beam 4 will provide continuous and uniform reinforcement against internal shearing stresses and thus will cooperate with the longitudinal rods 6 to provide the necessary reinforcement against diagonal tension. In this manner, the steel rods 6 and web 10 may be designed so as to provide maximum efficiency in absorbing diagonal tension resulting in economy of construction.

The web 10 of the present invention is adaptable to situations, such as illustrated by the beam 48 of FIG. 10 where a greater vertical dimension of webbing material is required than that offered by a single web 10. In such instances, one or more webs may be connected one above the other in co-planar relationship by means of the flanges 18 and 20.

Referring to FIG. 7, it will be noted that flange 18 which will hereinafter be referred to as the "female flange," is formed so as to define a greater recess 25 than that 27 defined by the flange 20 which will hereinafter be referred to as the "male flange." This is done so as to permit the male flanges 50 of another similar web 52 to be inserted in the female flanges 18 of web 8 and the male flanges 20 of the web 8 to be received in the female flanges 54 of the web 48 with the webs 8 and 48 positioned in the same plane as shown in FIG. 8. Preferably the flanges 18 and 20 are dimensioned so that when registered with the respective flanges of another web, they will engage the same in contour relationship (shown in FIG. 8) whereby a firm final attachment will be attained.

The mated flanges 18, 20, 50, 54 are finally attached or interlocked by deforming them, in a clockwise direction (as viewed in FIG. 9) into engagement with the webs 8 and 48; actually only the female flanges engage the web as shown in FIG. 9. This final joining operation may be quickly and easily accomplished at the job site such as with a hammer and without special skill.

As illustrated in FIG. 11, the webs may be formed with various vertical dimensions whereby several different vertical dimensional combinations of two or more webs may be obtained as desired.

It is to be understood that, although several preferred embodiments of the invention have been shown in the drawings and described with considerable particularity in the foregoing specification, the invention is not limited to the specific details of construction, shown and described, but includes all modifications coming within the scope of the appended claims and their equivalents.

What is claimed is:

1. In a structural member formed from concrete-like material having reinforcing means extending longitudinally

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in the lower portion thereof for resisting flexural stresses, a means for reinforcing the member against vertical shear occasioned by external loads applied transversely to the member including a continuous web of sheet metal entirely embedded in the member generally along the longitudinal axis thereof and terminating substantially at the ends of said member, the opposite longitudinal edges of said web each having a series of generally hooked shaped male and female flanges alternately projecting laterally in opposite directions from the plane of said web with adjacent flanges respectively positioned transversely beyond and inwardly of the longitudinal edge of said web from which they project said flanges being constructed and dimensioned to be connected with complementary flanges of another similar reinforcing web by reception of the male flanges in the female flanges.

2. The combination as defined in claim 1 wherein said web is provided with a plurality of serpentine ribs extending transversely thereof, each of said ribs comprising a plurality of alternate projections and depressions.

3. A structural member as defined in claim 2 wherein the web has a plurality of corrugated lateral projections provided in pairs at locations between said ribs and with the projections of each pair disposed on opposite sides of said web.

4. For use in reinforcing a concrete structural member and the like against diagonal tension, an elongated web of sheet material having on each of its longitudinal edges a plurality of alternate male and female deformable flanges laterally projecting in opposite directions from the plane of the web, each of said flanges having oppositely directed intumed portions spaced on opposite sides of the edge of said web with the intumed portion of the female flanges positioned transversely beyond the adjacent edge of said web and the intumed portions of said male flanges positioned transversely inwardly from the adjacent edge of said web, said flanges being constructed and dimensioned to be connected with complementary flanges of another similar reinforcing web by reception of the male flanges in the female flanges and then deforming each connected pair of flanges towards the web.

5. The reinforcing web as defined in claim 4 wherein said flanges each have a generally hook shape and wherein the intumed portions of said female flanges are spaced a greater distance from the adjacent edge of said web than that of the intumed portions of said male flanges.

6. The reinforcing web as defined in claim 5 wherein there is provided in the web a plurality of transversely extending ribs each including a plurality of alternate projections and depressions.

7. The reinforcing web as defined in claim 6 wherein the web has a plurality of laterally extending corrugated projections provided in pairs at locations between said ribs and with the projections of each pair disposed on opposite sides of the web.

8. The reinforcing web as defined in claim 7 wherein said male and female flanges, ribs, and corrugated projections are integrally formed with the web from sheet metal.

9. A reinforcing web assembly for use in reinforcing a concrete beam and the like against diagonal tension comprising at least two elongated webs formed from sheet material, each of the webs having on at least one of its longitudinal edges a series of alternate male and female flanges projecting laterally with the female flanges located on one side of the web and the male flanges located on the other side of the web, the female flanges having intumed portions disposed transversely beyond the longitudinal edge of the beam and forming recesses dimensioned to receive the male flanges, said male and female flanges of one web being received in and receiving respectfully the female and male flanges of the other web with one web located above the other web in the same plane thereof, and said female flanges together with the male flanges

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received therein being deformable towards the web so as to engage the web with the intumed portions of the female flanges thereby locking the webs against relative movement.

10. The reinforcing assembly as defined in claim 9 wherein the male flanges have intumed portions spaced transversely inwardly from the adjacent longitudinal edge of said web and oriented oppositely with respect to the intumed portions of said female flanges.

11. The reinforcing assembly as defined in claim 9 wherein said male and female flanges are provided on both of the longitudinal edges of each web.

12. For use in reinforcing a concrete structural member or the like against diagonal tension, an elongated web of sheet metal having on each of its longitudinal edges a series of alternate male and female flanges projecting laterally outwardly on opposite sides of the web, said female flanges having a generally hooked shape cross-section with the extremities thereof located transversely beyond the adjacent edge of the web so as to define a recess dimensioned to receive the male flanges of another similar web to be connected thereto in co-planar relationship.

13. For use in reinforcing a concrete structural member, an elongated web of sheet metal having on at least one of its longitudinal edges a number of oppositely and laterally extending male and female projections with adjacent projections respectively positioned transversely beyond and inwardly of the longitudinal edge of the web, said male and female projections being constructed and dimensioned to be interengaged with similar complementary male and female flanges of another web to connect the webs one above the other along their longitudinal edges.

14. For use in reinforcing a concrete structural member, a pair of elongated webs of sheet metal each having on adjacent longitudinal edges a number of oppositely and laterally extending male and female projections formed with adjacent projections on one web respectively positioned transversely beyond and inwardly of the longitudinal edge of the web, said male and female projections on one web being interengaged with corresponding complementary projections on the other web to interconnect the webs one above the other along their said longitudinal edges.

15. The webs defined in claim 14 wherein the interengaged male and female flanges are deformed inwardly towards the webs.

16. For use in reinforcing a concrete structural member, an elongated web of sheet metal having on at least one of its longitudinal edges a number of oppositely and laterally extending male and female projections constructed and dimensioned to be interengaged with similar complementary male and female flanges of another web to connect the webs one above the other along their longitudinal edges, said female flange defining a recess positioned transversely outwardly of said one longitudinal edge of the web and said male flange being positioned transversely inwardly of the said one longitudinal edge.

17. The web defined in claim 21 wherein said male and female flanges both have a generally hook shape.

18. For use in reinforcing a concrete structural member, a pair of elongated webs of sheet metal each having on adjacent longitudinal edges a number of oppositely and laterally extending male and female projections interengaged with corresponding complementary projections on the other web to interconnect the webs one above the other along their said longitudinal edges, said male and female flanges having a generally hook shape and the female flanges being positioned transversely outwardly from the longitudinal edge of the associated web and the male flanges being positioned transversely inwardly from the longitudinal edge of the associated web.

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