Aug. 28, 1962 H. DIAMOND 3,050,831

METHODS OF MAKING STRUCTURAL BEAMS

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Fig. 1.

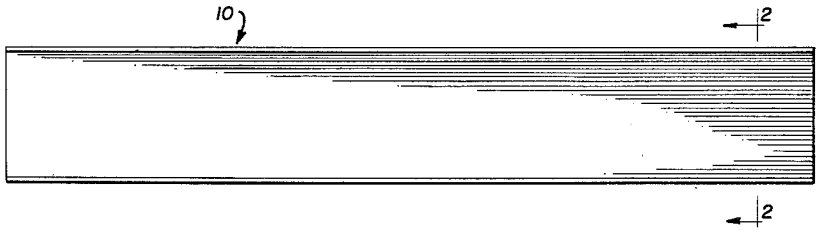


Fig. 2.

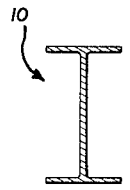
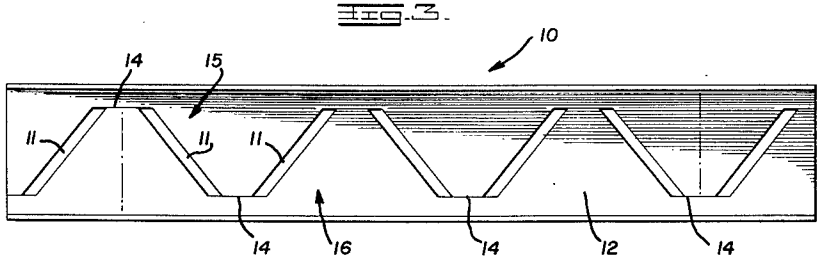


Fig. 3.



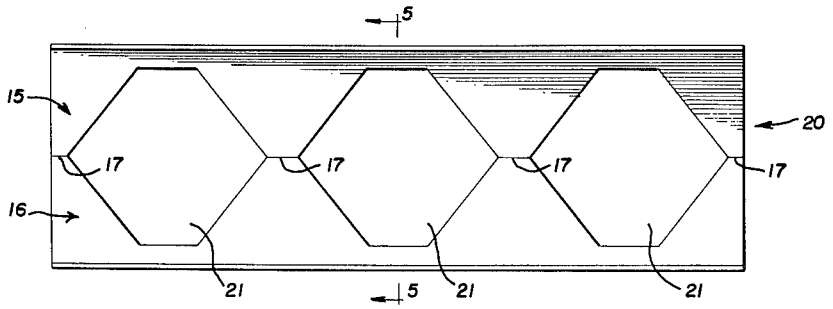


Fig. 4.

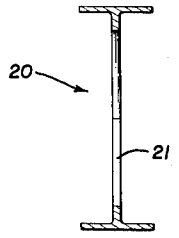


Fig. 5.

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Fig. 6.

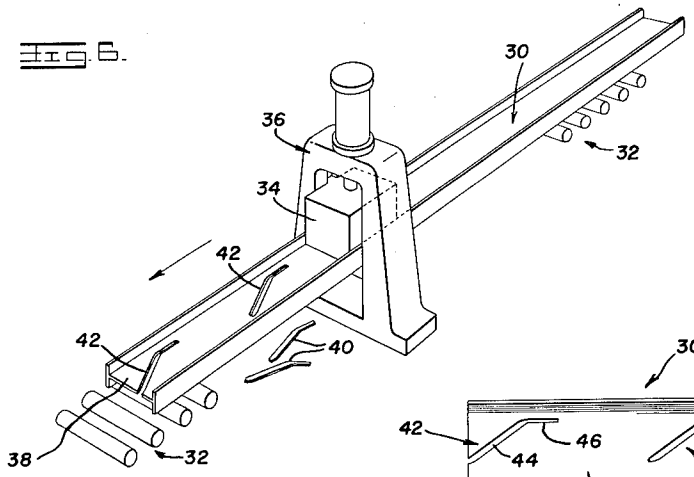


Fig. 7.

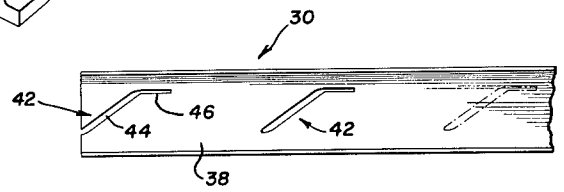


Fig. 8.

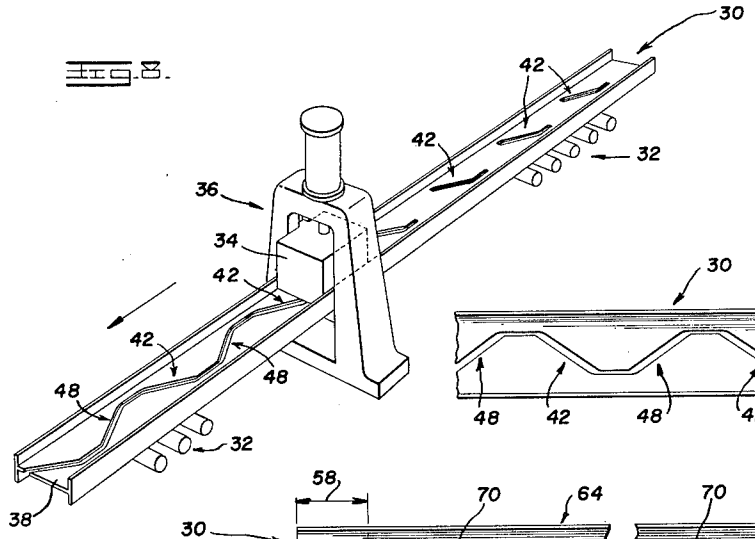


Fig. 9.

Fig. 10.

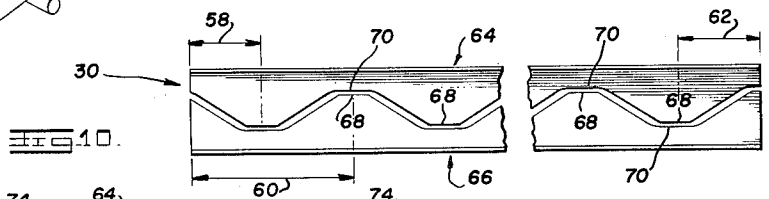
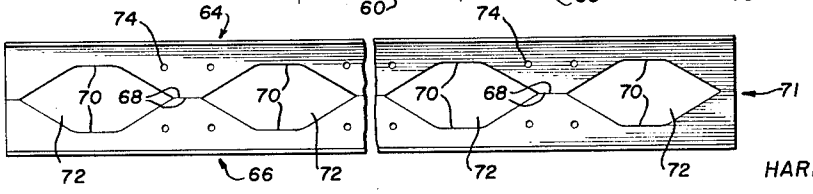


Fig. 11.



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Fig. 12.

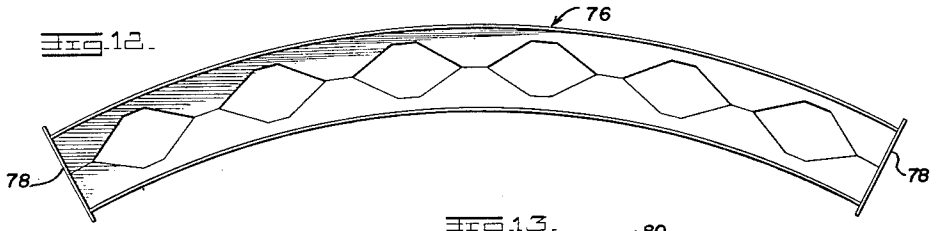


Fig. 13.

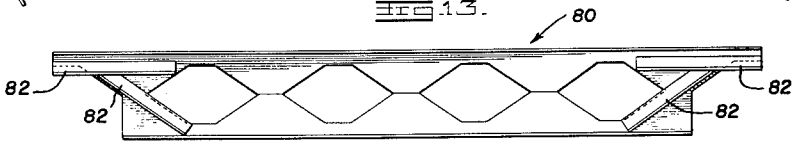


Fig. 14

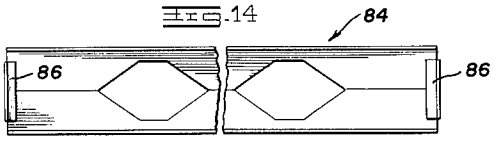


Fig. 15.

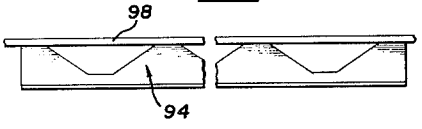


Fig. 16.

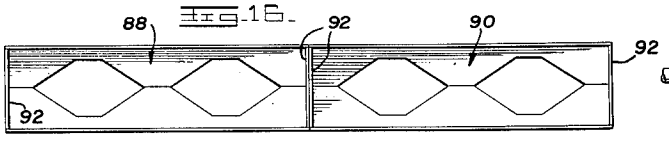


Fig. 17.

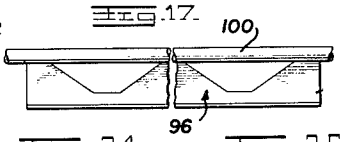
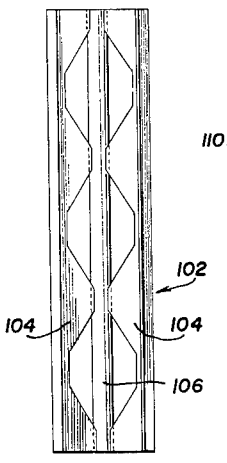
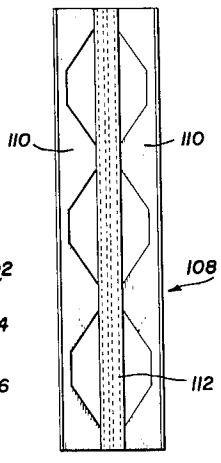
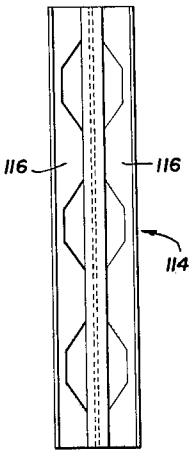
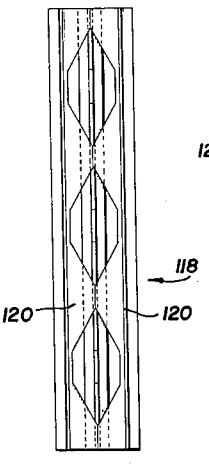


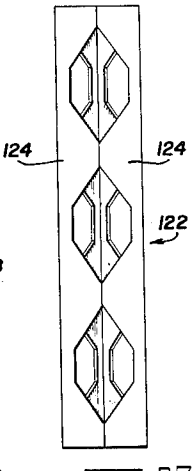
Fig. 18. Fig. 20. Fig. 22. Fig. 24. Fig. 26.

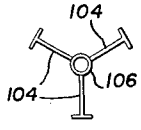


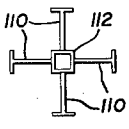


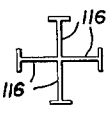


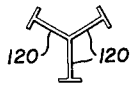












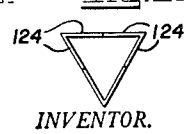


Fig. 19. Fig. 21. Fig. 23. Fig. 25. Fig. 27

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United States Patent Office 3,050,831 Patented Aug. 28, 1962

3,050,831

METHODS OF MAKING STRUCTURAL BEAMS

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Original application May 29, 1959, Ser. No. 817,441, now Patent No. 2,990,038, dated June 27, 1961. Divided and this application Mar. 28, 1960, Ser. No. 17,994
9 Claims. (Cl. 29—155)

This invention relates to methods of making structural beams, particularly beams of the lightweight type from which certain portions of the web are removed. This application is a division of Serial No. 817,441 filed May 29, 1959, now Patent No. 2,990,038 granted June 27, 1961, which is itself a continuation-in-part of Serial No. 766,646 filed October 13, 1958, now abandoned.

As set forth in the aforesaid application, Serial No. 766,646, it is well known that beams over a certain length have a tendency to sag under their own weight. If such beams are used in floors or ceilings, the tendency to sag will upset the surface of the structure which the beams are supposed to support.

As further stated in the aforesaid application, Serial No. 766,646, it is well known that the resistance to stress depends to a great degree on the height of a beam. If an I beam of approximately 14 inches in height weighs about 17.2 pounds per foot, a similar beam 22 inches in height would deflect considerably less if it weighed the same. The 22 inch beam would normally weigh considerably more per foot than the 14 inch beam, however. It is an object of the invention to provide methods of making a beam having the advantages of the 22 inch beam but weighing less than the 14 inch beam.

Broadly, it is an object of the invention to provide methods of making beams which are stronger per pound and lighter per foot of length for their height than comparable prior beams, and which are more economical in production and use.

It is known that a beam may be converted to one of greater height by dividing the web of the beam longitudinally along a line of serration and then reuniting the divided parts by mating and joining the peaks of the serrations. The resultant beam has openings in its web, which reduce the weight of the beam and which provide convenient passage for pipes, conduits, ducts, and wires. Such beams have not been economical to produce, however, because of the need for an intricate flame cutting operation, and they have not had the desired strength, because of the weakening effects of the flame heat upon the metal. Moreover, the prior beams of this type have been heavier than necessary, and when welding has been employed to reunite the beam parts, an unduly large amount of welding has been necessary. Thus, even the availability of newer lightweight I beams suitable for conversion has not made the converted beams truly competitive with joists such as the truss type.

It is accordingly a primary object of the invention to provide methods of making a lightweight beam which overcomes the foregoing disadvantages.

Another object of the invention is to provide methods of making novel lightweight beams without flame cutting.

A further object of the invention is to provide methods of making lightweight beams by a conversion process which actually results in the work-hardening of the final beam.

Still another object of the invention is to provide methods of making lightweight beams by unique cold-punching operations.

An additional object of the invention is to provide unique methods of making structural members.

A still further object of the invention is to provide methods of making a converted beam that is lighter in

weight for its type than anything produced heretofore.

Another object of the invention is to provide improved methods of converting beams, in which material is actually removed from the beam webs.

An additional object of the invention is to provide unique processes in which beam parts are united by welding and in which the amount of welding required is minimized.

Still another object of the invention is to provide novel methods of making structural members comprising beam parts having openings formed by cold-punching operations.

The foregoing and other objects, features, and advantages of the invention, and the manner in which the same are accomplished will become more readily apparent upon consideration of the following detailed description of the invention taken in conjunction with the accompanying drawings, which illustrate preferred and exemplary embodiments, and wherein:

FIGURE 1 is an elevation view of an I beam to be converted in accordance with the invention;

FIGURE 2 is a transverse sectional view of the I beam taken along line 2—2 of FIGURE 1;

FIGURE 3 is an elevation view of the I beam after the performance of certain converting operations in accordance with one form of the invention;

FIGURE 4 is an elevation view of the converted beam;

FIGURE 5 is a transverse sectional view taken along line 5—5 of FIGURE 4;

FIGURE 6 is a perspective view, somewhat diagrammatic, illustrating certain steps in another conversion method of the invention;

FIGURE 7 is a truncated elevation view of a beam after the performance of certain conversion steps;

FIGURE 8 is a perspective view, somewhat diagrammatic, illustrating the performance of additional conversion steps in accordance with the invention;

FIGURE 9 is a truncated elevation view of a beam on which additional conversion steps have been performed;

FIGURE 10 is a contracted elevation view of a partially converted beam illustrating the prospective removal of portions of the ends of the beam;

FIGURE 11 is a contracted elevation view illustrating a completely converted beam;

FIGURES 12 through 18, 20, 22, 24, and 26 are elevation views of different forms of structural members which may be made in accordance with the methods of the invention; and

FIGURES 19, 21, 23, 25, and 27 are end views of the forms illustrated in FIGURES 18, 20, 22, 24, and 26, respectively.

Briefly stated, the invention is concerned with the production of structural beams by dividing original beams longitudinally in such a way that the web is given a serrated edge. The serration process includes cold-punching operations which remove web material and work-harden the serrated edge. The divided parts of the beam may then be staggered and reunited to form a beam of greater depth or may be assembled with other structural elements to form different types of members.

Referring to the drawings, FIGURES 1–5 are taken from the aforesaid prior application, Serial No. 766,646. As set forth in that application, the I beam of FIGURES 1 and 2 is converted by cold-punching out sections 11 therefrom along spaced elongated zones which extend diagonally across the longitudinal median line of the web 12 and which together define a zig-zag zone. The punching operations may be carried out on a hydraulic press, and the amount punched out may vary with the purpose for

which the beam is to be employed. Successive sections **11** are oriented oppositely. The beam is sheared into two T sections **15** and **16** by shearing the web material between the adjacent ends of sections **11** along the lines **14**. Thereupon the two sections are staggered longitudinally and are welded together at the sheared portions **14** to form weld **17**. The converted beam designated **20** is considerably higher in depth than the original beam **10** and is provided with a series of openings **21**, thus reducing the weight per foot considerably.

Because the converted beam is considerably lighter than the original beam and considerably higher, it does not deflect as much as the original beam. Because of the strength of the welding and the additional height, the converted beam is stronger. Such a beam is more economical in building use, saving considerable money in the support of floors or ceilings. In addition to being lighter in weight the beam has a better section modulus for equivalent spans.

FIGURES 6–11 illustrate the production of a beam in accordance with a modified and preferred form of the invention. In FIG. 6 an I beam **30** is taken from a stock pile (not shown), as by an overhead crane, and is placed on a conveyor **32** (shown diagrammatically as a series of rollers) with one side of the web **38** facing upward and with the left-hand end of the beam under the die **34** of a punch press (shown diagrammatically). The end of the beam is then gripped by a carriage (not shown) and is advanced through the punch press in the direction of the arrow in a series of accurately spaced steps. Each time the carriage stops, the press cold-punches the beam, piercing the thickness of the web and removing a slug **40** so as to leave an elongated slot zone **42**. The conveyor structure at the left of the punch press in FIGURE 6 may be part of a spacing table so that the intervals at which the slots **42** are produced may be accurately measured. As shown in FIGURE 7, the slots **42** have the general shape of a hockey stick with a leg portion **44** and a narrower foot portion **46**. The leg portions are arranged diagonally and cross the longitudinal median line of the web. The foot portions are approximately parallel to the median line. In FIGURE 7 two of the slots **42** have been punched, and the next slot to be punched is shown in phantom lines.

When a series of slots **42** has been punched along the length of the beam, the carriage is reversed and the beam is moved back to the right side of the punch press. The beam is then turned over side-to-side so that the side of the web which previously faced upward faces downward. The beam is then moved through the punch press again in the direction of the arrow in a series of accurately spaced steps, and the cold-punching process is repeated, so that a second series of slots **48** is produced. During the punching of the second series, clamps are employed to hold the beam together and maintain the proper flange spacing. The slots **48** alternate with the slots **42**, being punched in the web material between them. The foot of each slot **48** joins the leg of the next slot **42** and vice versa, so that slots **42** and **48** become continuous. FIGURE 9 illustrates the beam after several of the slots **48** have been punched, the next slot to be punched being shown in phantom lines.

The formation of the continuous slot divides the beam longitudinally into halves as shown in FIGURE 10. After the beam is divided longitudinally the portions spanned by the arrows **58**, **60**, and **62** are removed.

The slot formation gives a serrated edge to each of the beam parts **64** and **66** and produces interdigitated generally triangular projections and recesses. The projections have blunted tips **68** which lie adjacent the recess bottoms **70**. It can be seen that the tips **68** are shorter in length than the recess bottoms **70** in the direction of the longitudinal axis of the beam.

After the division of the original beam into two parts **64** and **66**, a beam of greater height may be formed by shifting one part longitudinally relative to the other until the blunted tips **68** of the respective parts assume an abutting relationship as shown in FIGURE 11. The beam parts are then reunited by welding along the lines of abutment, preferably on both sides of the web, so as to form a new beam **71** of greater height. Jig clamps may be employed to hold the halves of the beam in proper position during the welding. The converted beam may be provided with holes **74** in the web for use in conjunction with rod-type bridging.

When the conversion of the beam is complete, the recesses of the opposed beam part edges form openings **72** in the web. Since the recess bottoms **70**, which define part of these openings, are longer than the welded tips **68** as the result of the punching operations, the openings **72** are larger, and the amount of welding required along the blunted tips **68** is less than would be possible by flame cutting the beam along a line of serration. The removal of slugs by punching the beam also reduces the beam weight, as compared with flame cutting. Moreover, it has been discovered that while flame cutting of the web weakens the beam, cold-punching actually strengthens the converted beam by work-hardening the serrated edges.

FIGURE 12 illustrates a modified beam **76** which may be produced by the methods of the invention. The basic beam of FIG. 11 is bent into an arch after being formed in the manner previously described and is provided with end plates **78**.

FIGURE 13 illustrates another structural member formed in accordance with the methods of the invention. The beam **80** is similar to the beam of FIG. 11 but has angle members **82** welded to its ends to support the beam on walls or girders. One of the beam halves forming this beam may have its ends shaped to a configuration different from that illustrated in FIGURE 10, so as to provide an overhanging web and flange portion at each end which is reinforced by the angles **82**.

FIGURE 14 illustrates another structural member constructed in accordance with the methods of the invention. Here the beam **84** is like beam **71** but is provided with angle plates **86** on each side of the web at its ends for framing the beam to a girder.

In FIGURE 16 a beam made in accordance with the methods of the invention is constructed from short sections **88** and **90** for ease in transporting the beam by air or pack animals. The sections may then be assembled by joining end plates **92** welded to the beam.

FIGURES 15 and 17 illustrate modified forms of structural members produced in accordance with the methods of the invention, and which employ one-half of the beam of FIGURE 11. In these forms the beam half **94** or **96** is employed for reinforcing plates, decks, or hulls as indicated at **98** in FIGURE 15, or pipe lines such as **100** of FIGURE 17. The beam elements may be fixed to the respective members **98** and **100** by welding the serration tips thereto.

FIGURES 18–27 illustrate further structural members produced in accordance with the methods of the invention, and in which beam elements may be employed to form poles, stanchions, braces, shoring, or reinforcing, generally for use in upright position. As shown in FIGURES 18 and 19, a structural member **102** may be formed by arranging several beam halves **104** so as to radiate from a central pipe **106** of circular cross-section. The blunted tips of the serrations may be welded to the external surface of the pipe.

In FIGURES 20 and 21, a structural member **108** is formed by arranging four beam halves **110** so as to radiate from a central pipe **112** of square cross-section, the blunted serration tips being welded thereto.

In FIGURES 22 and 23, a structural member **114** is formed by arranging four beam halves **116** radially and welding their serration tips directly together. FIGURES 24 and 25 illustrate a similar structural member **118** formed by three beam halves **120**.

FIGURES 26 and 27 illustrate a decorative polygonal member **122** of triangular cross-section produced by the methods of the invention. Round, hexagonal, octagonal, flat, or other cross-sections are also possible. In the embodiment shown, the beam halves **124** are formed from plate stock without flanges. The beam halves are united in pairs in the manner of FIGURE 11 and are then joined to similar elements to form the triangular member shown, as by welding along adjacent longitudinal edges.

It is apparent from the foregoing description of the invention that unique methods of producing structural beams are provided. While preferred embodiments of the invention have been shown and described, it will be appreciated by those skilled in the art that changes can be made without departing from the principles and spirit of the invention, the scope of which is defined in the appended claims. Accordingly, the foregoing embodiments are to be considered illustrative, rather than restrictive of the invention, and those modifications which come within the meaning and range of equivalency of the claims are to be included therein.

The invention claimed is:

1. The method of re-forming a beam which comprises the steps of cold-punching out a first series of diagonally disposed slugs of material from the web of said beam at intervals along its length, cold-punching out a second series of diagonally disposed slugs of material from the web of said beam at intervals between said first-named intervals, so as to divide said beam longitudinally into halves having interfitting generally triangular portions, separating said halves, moving said halves relative to each other to a position in which the tips of said triangular portions on one half come into abutting relationship with the tips of said triangular portions on the other half, and welding said tips to each other along the points of abutment thereof, thereby producing a deeper, lighter beam than the original.

2. The method of re-forming a beam which comprises the steps of cold-punching a first series of hockey stick shaped slots in the web of said beam at intervals along its length, turning said beam over side-to-side, cold-punching a second series of hockey stick shaped slots in said beam at intervals between said first-named intervals with the foot part of the slots of the first series joining the leg part of the slots of the second series and vice versa, so as to form a continuous slot dividing said beam longitudinally into halves having interfitting generally triangular projecting portions and corresponding recesses, the projecting portions having blunted tips shorter in length than the adjacent recess bottoms, separating said halves, moving said halves relative to each other to a position in which the blunted tips on one half come into abutting relationship with the blunted tips on the other half, and welding said blunted tips to each other along the lines of abutment thereof, thereby producing a deeper, lighter beam than the original.

3. The method of converting a structural beam which comprises the steps of progressively removing by cold-punching a series of similar pieces of material from the web of said beam and thereby forming slots in said web at substantially equally spaced points along the length of said beam, turning said beam over side-to-side, progressively removing by cold-punching a second series of similar pieces from the web of said beam in the spaces between said slots so as to cause said beam to be divided longitudinally into similar halves having interdigitated projections, moving said halves relative to each other until the projections on one half are brought into register with the projections on the other half, and welding said projections together to produce a new beam of greater depth and less weight than the original beam.

4. The method of manufacturing structural beams of T section which comprises the steps of progressively removing by cold-punching a series of similar pieces of material from the web of an I beam and thereby leaving slots in said web at substantially equally spaced points along the length of said beam, turning said beam over side-to-side, progressively removing by cold-punching a second series of similar pieces from the web of said beam in the spaces between said slots so as to cause said beam to be divided longitudinally into halves.

5. The method of manufacturing an I beam of greater depth from an I beam of relatively shallow depth comprising feeding said shallow beam through a punch press lengthwise with one web surface of the beam facing upwardly to remove, by cold-punching, a series of slugs of material from the web of the beam and thereby form slots in said web at spaced intervals along the length of said beam; said slots each comprising a main diagonal part crossing the median line of said web and an end part at one of said diagonal part generally parallel to the median line of said web, returning said beam to its original position relative to the punch press, turning said beam over side-to-side with the previously upwardly facing portion of said web facing downwardly, again feeding said beam lengthwise through said punch press to remove, by cold-punching, a second series of slugs of material from the web and thereby form a second series of slots in said web at spaced intervals between the locations of said first-mentioned slots, the slots of the second series being in continuous relation with said first-formed slots, thereby dividing said beam longitudinally into halves, said divided halves of the original beam being characterized by a series of interdigitated serrations, thereafter moving said beam halves apart transversely until said interdigitated serrations clear each other, moving one half of said beam relative to the other half until the peaks of said serrations are in alignment, and welding said aligned peaks to each other, thereby forming a beam of greater depth than said original beam but of lighter weight due to the removal of material therefrom.

6. The method of manufacturing T beams which comprises the steps of feeding an I beam through a punch press lengthwise with one web surface of the beam facing upwardly to remove, by cold-punching, a series of slugs of material from the web of the beam and thereby form slots in said web at spaced intervals along the length of said beam; said slots each comprising a main diagonal part crossing the median line of said web and an end part at one end of said diagonal part generally parallel to the median line of said web, returning said beam to its original position relative to the punch press, turning said beam over side-to-side with the previously upwardly facing portion of said web facing downwardly, again feeding said beam lengthwise through said punch press to remove, by cold-punching, a second series of slugs of material from the web and thereby form a second series of slots in said web at spaced intervals between the locations of said first-mentioned slots, the slots of the second series being in continuous relation with said first-formed slots, thereby dividing said beam longitudinally into halves, said divided halves of the beam being characterized by a series of serrations which are interdigitated.

7. A method of forming a beam, comprising serially cold-punching from the web of an original beam a plurality of spaced narrow slugs thereby leaving a plurality of corresponding slots in said web, turning said beam over side-to-side, again serially cold-punching from the web of said beam a plurality of narrow slugs thereby leaving a plurality of corresponding slots in said web, the last-mentioned slots together with the first-mentioned slots forming a long, continuous slot dividing said original beam into halves having interfitting serrations, moving the halves of said beam longitudinally relative to one another to bring the peaks of said serrations into abutment, and welding the abutting portions.

8. The method of converting an existing structural beam and the like into a structural beam and the like of greater depth and lighter weight, which comprises the steps of

cold-punching a series of slugs from the web of the existing beam along a zig-zag pattern which successively traverses the web diagonally and which defines successive projections and recesses of trapezoidal configuration with the tips of the projections parallel to the length of the web, separating the existing beam along said zig-zag pattern into two parts each having an edge defined by said projections and recesses, and reuniting the separated parts by mating the tips of the projections of one part with the tips of the projections of the other part and fixing them to each other.

9. The method of making a structural member from an existing beam and the like, which comprises the steps of cold-punching a series of slugs from the web of the existing beam along a zig-zag pattern which defines successive projections and recesses of trapezoidal configuration with the tips of the projections parallel to the length of the web, separating the two parts of the beam on opposite sides of said zig-zag pattern, and fixing an elongated structural element to the tips of the projections of at least one of said parts.

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