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METAL DECKING

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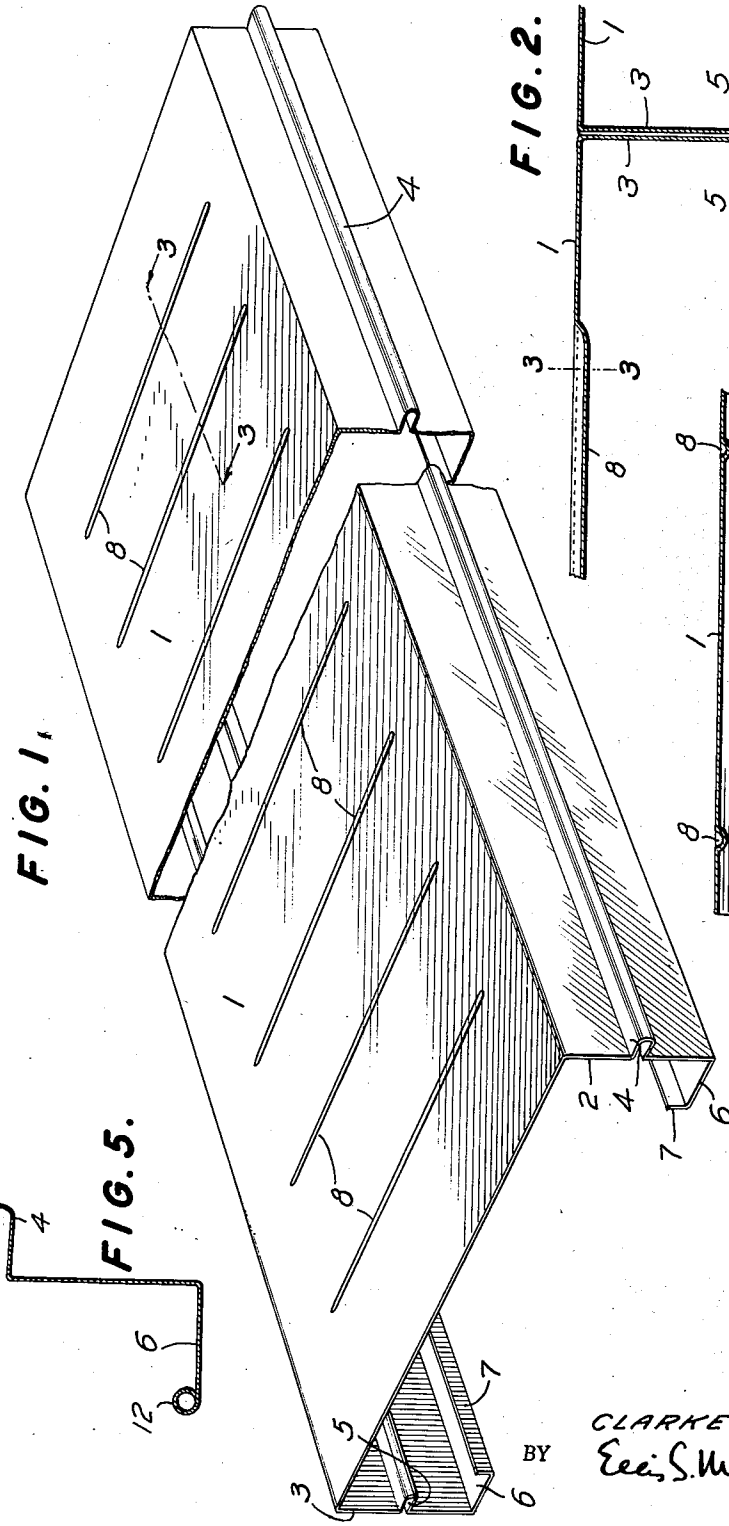

FIG. 1.

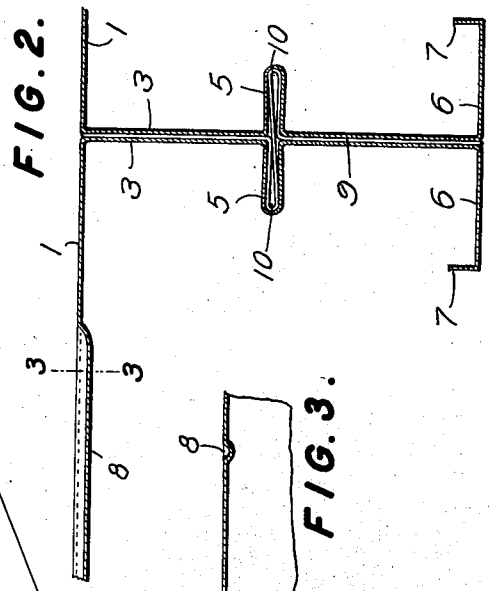

FIG. 2.

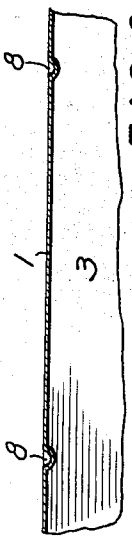

FIG. 3.

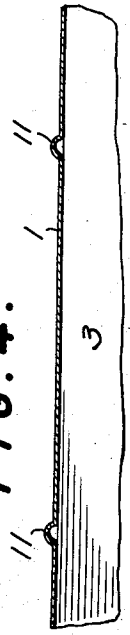

FIG. 4.

FIG. 5.

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CLARKE F. DAVIS,
BY Ellis S. Middleton
ATTORNEY.

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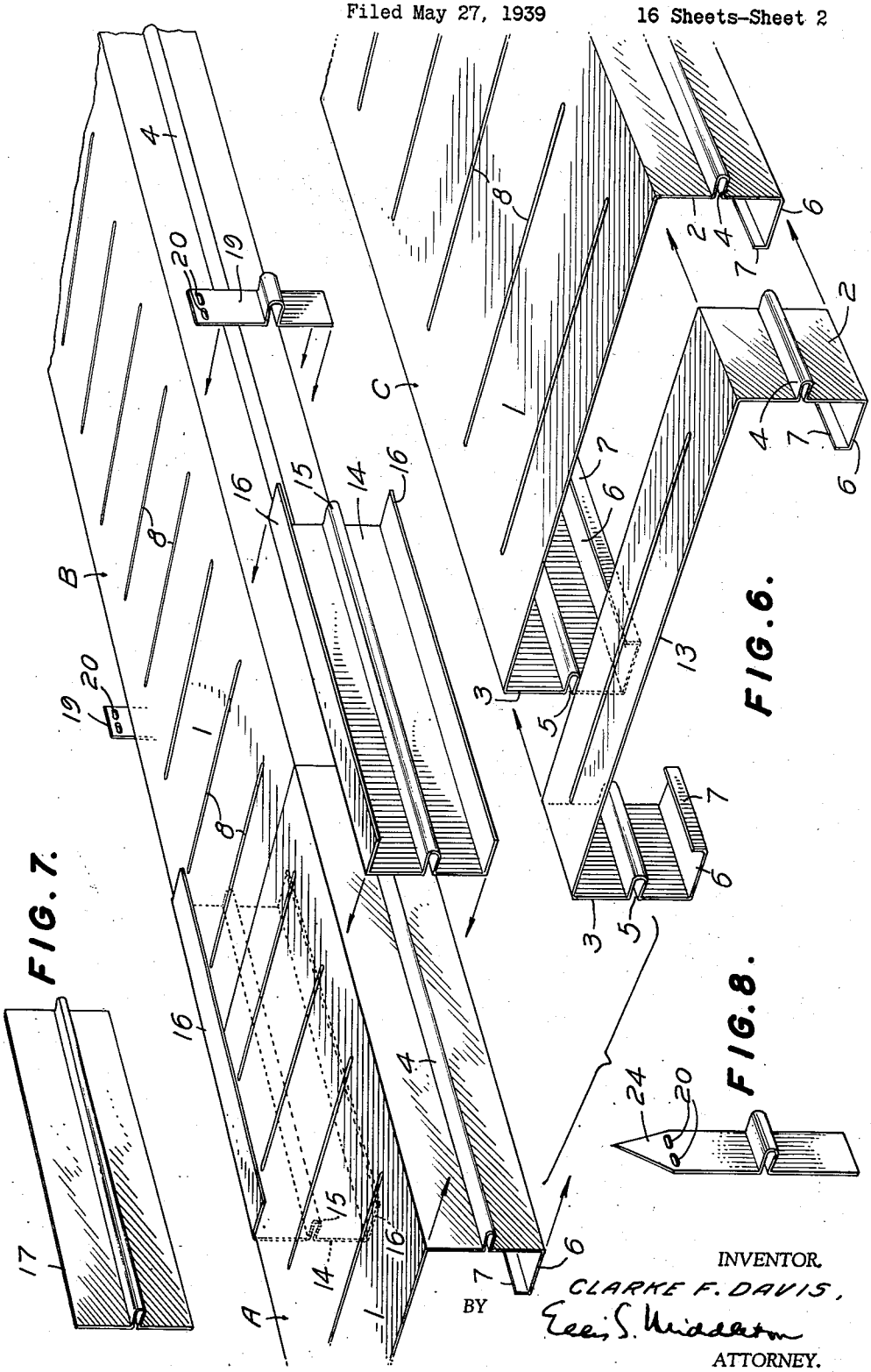

FIG. 6.

FIG. 7.

FIG. 8.

INVENTOR.
CLARKE F. DAVIS,
BY Eric S. Middleton
ATTORNEY.

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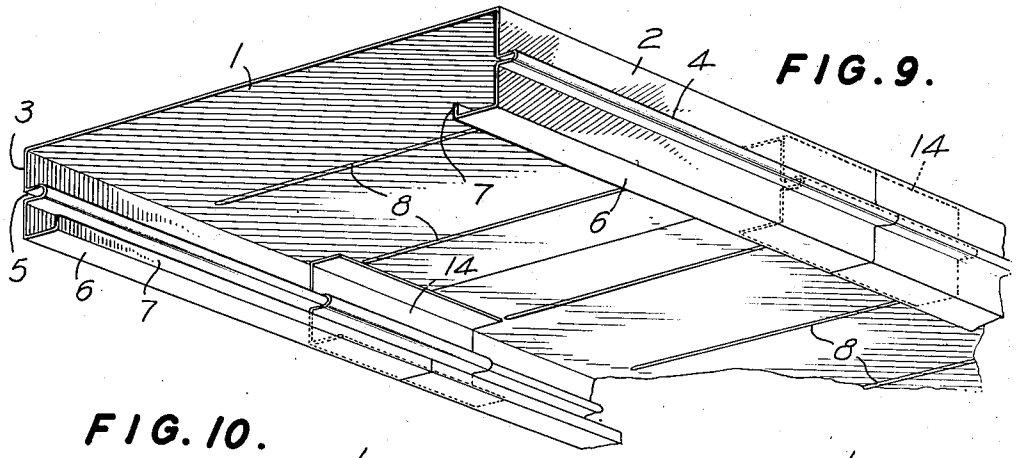
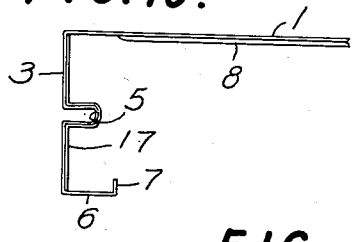


FIG. 9.

FIG. 10.



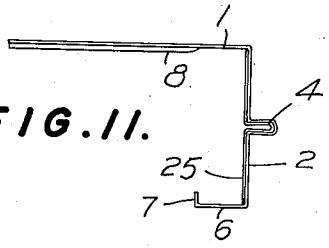
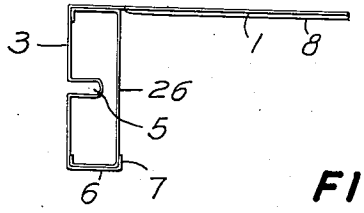


FIG. 11.

FIG. 12.



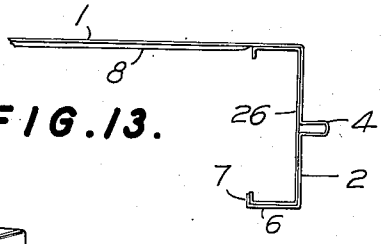


FIG. 13.

FIG. 15.

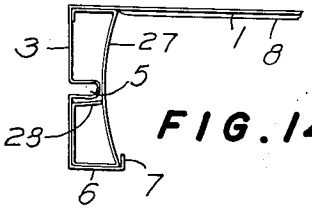
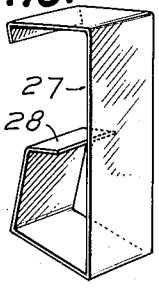


FIG. 14.



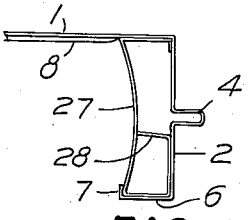


FIG. 16.

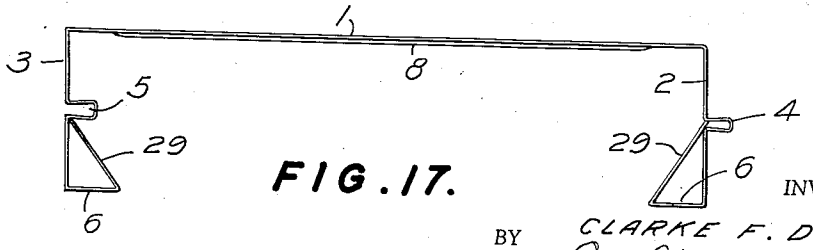


FIG. 17.

INVENTOR.

BY CLARKE F. DAVIS,

Ellis S. Middleton

ATTORNEY.

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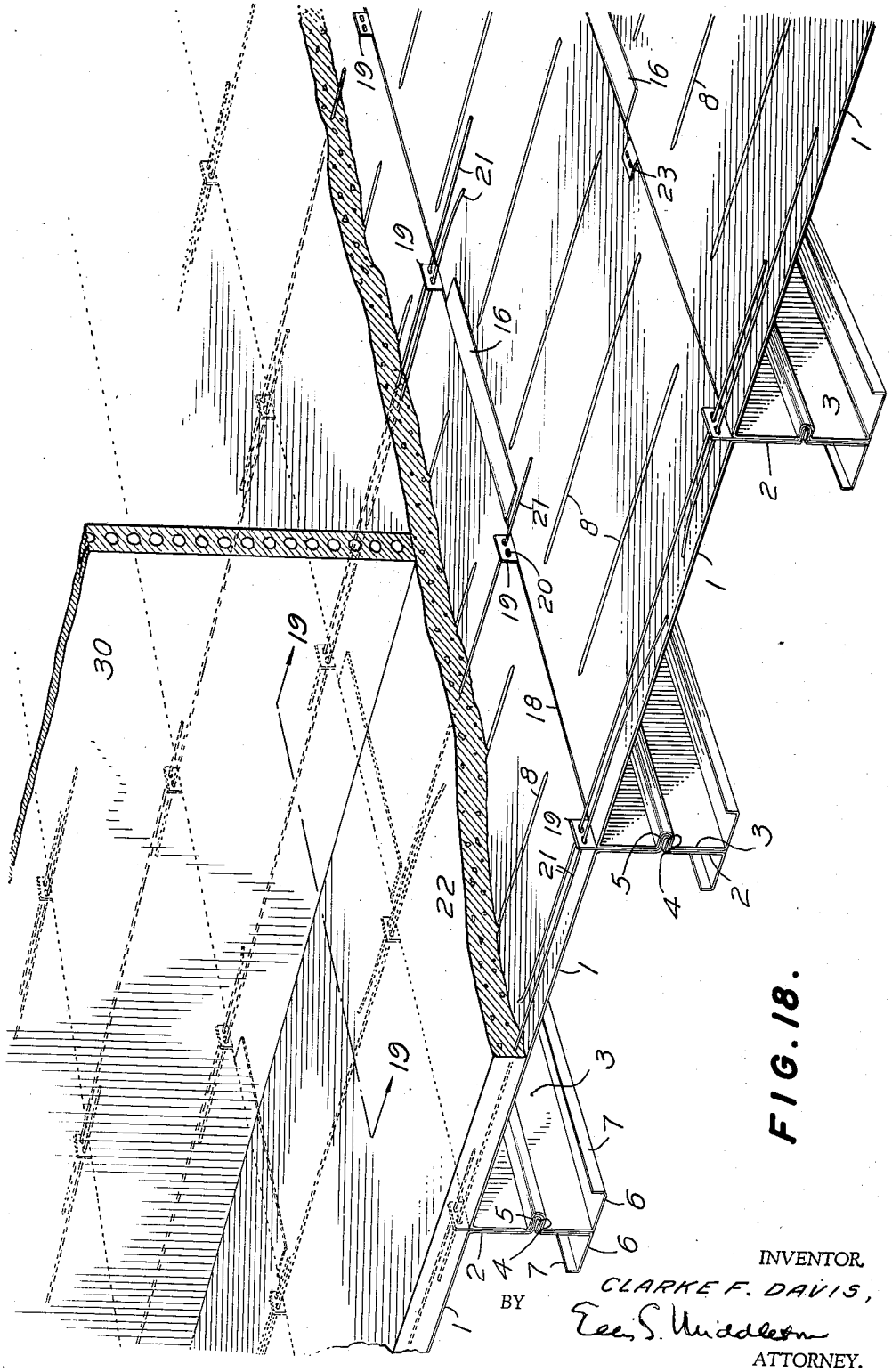

FIG. 18.

INVENTOR.
CLARKE F. DAVIS,
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FIG. 19.

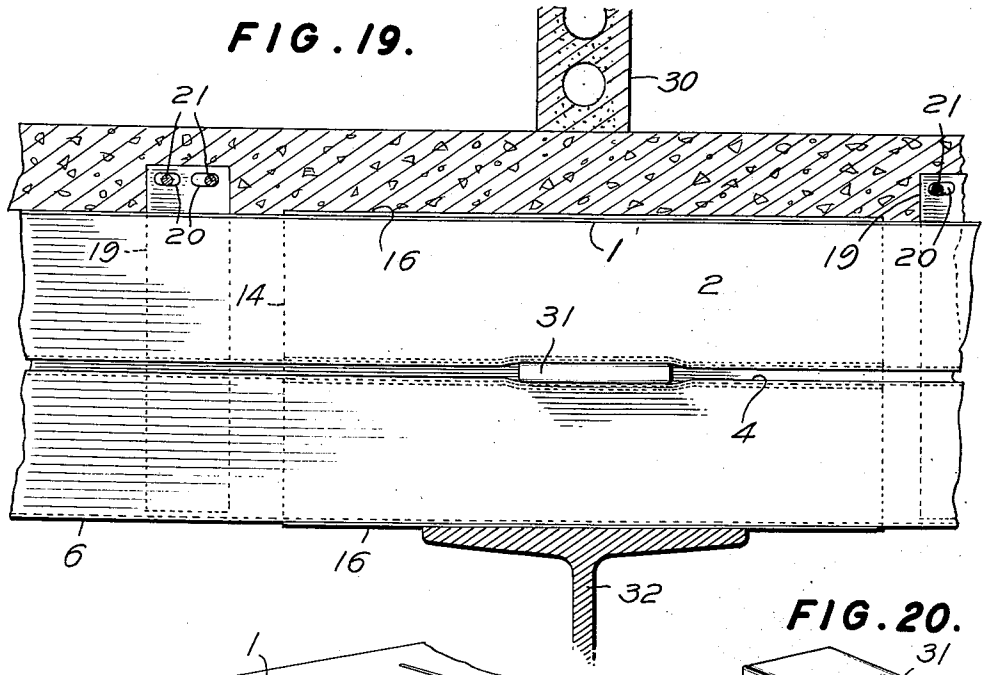

FIG. 20.

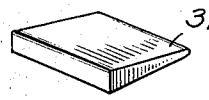

FIG. 21.

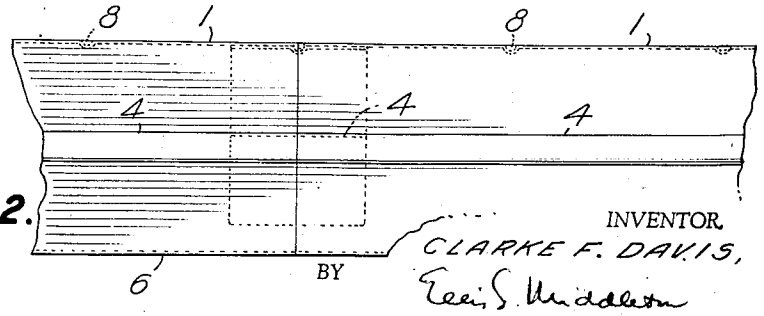

FIG. 22.

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BY
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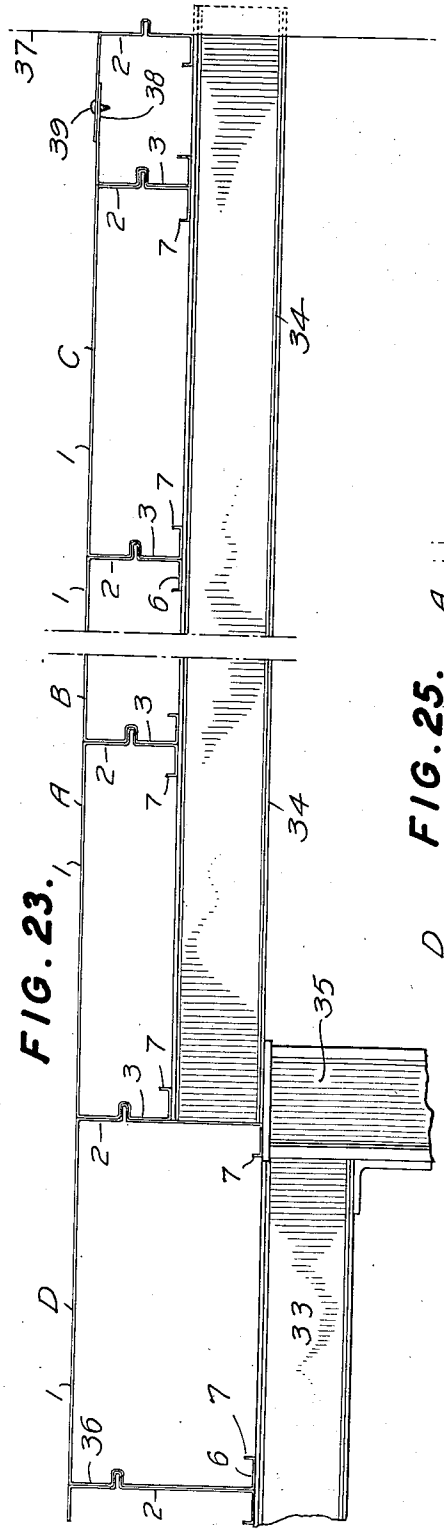

FIG. 23.

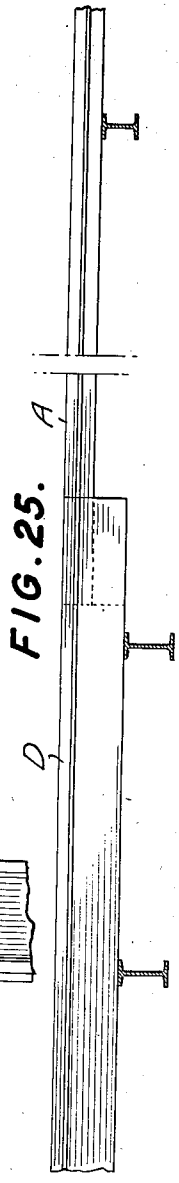

FIG. 25.

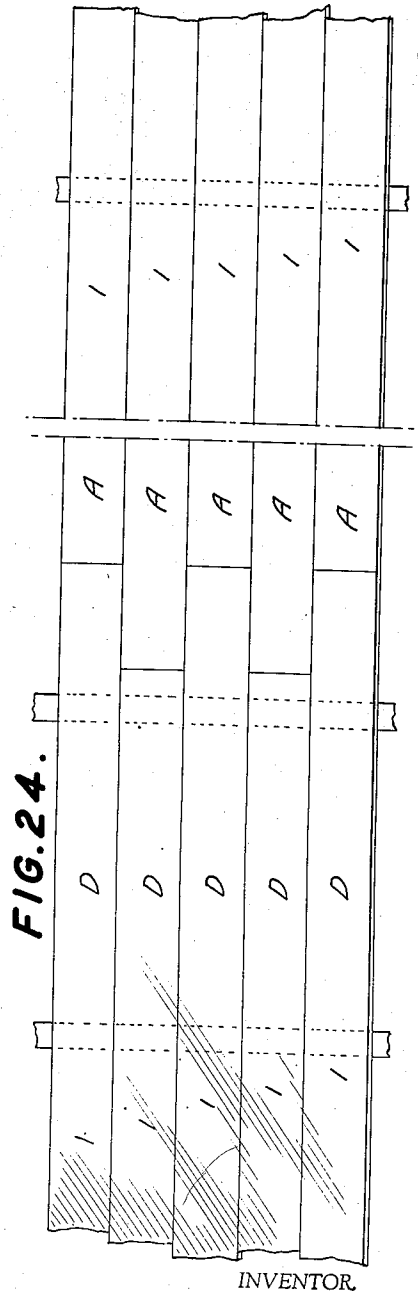

FIG. 24.

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ATTORNEY.

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FIG. 26.

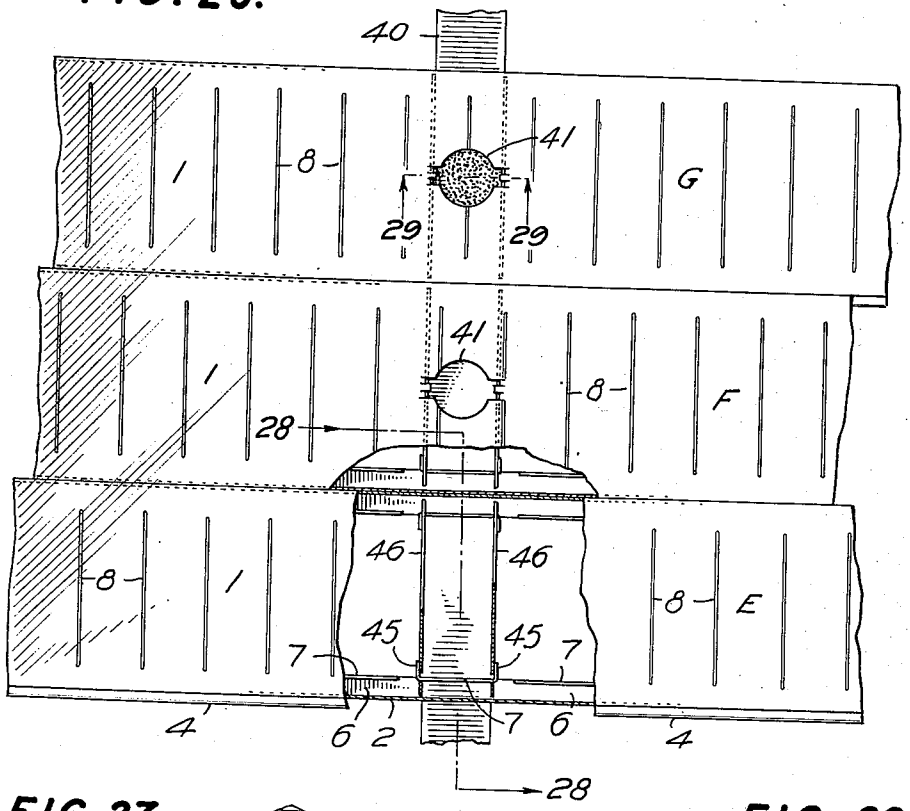


FIG. 27.

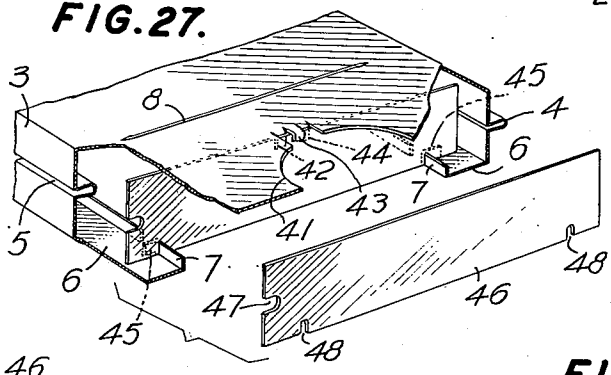


FIG. 29.

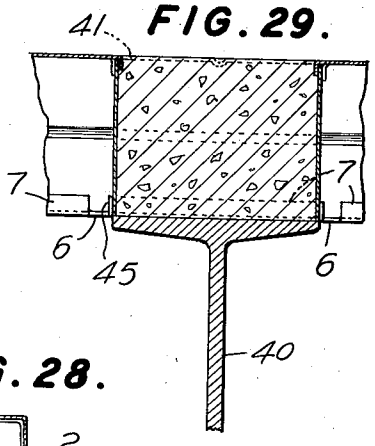
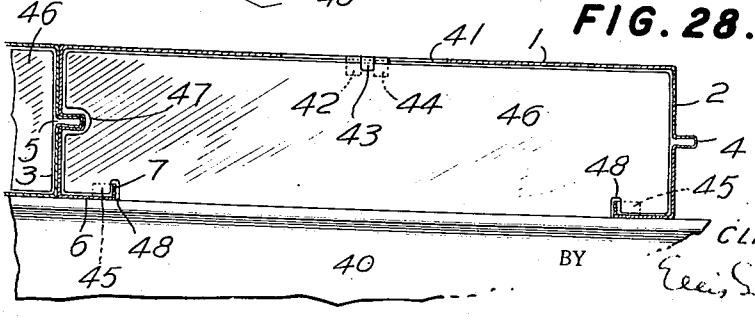


FIG. 28.



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BY
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FIG.30.

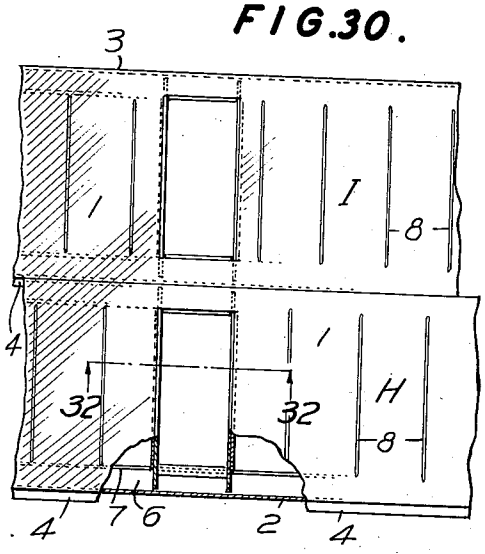

FIG.34.

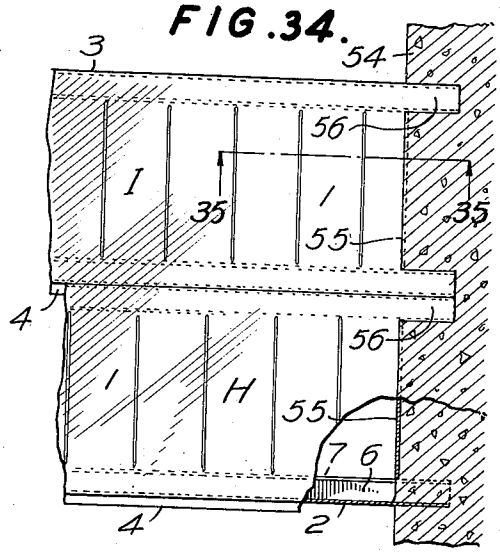

FIG.32.

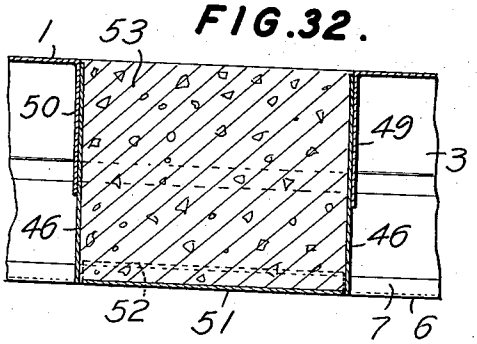

FIG.35.

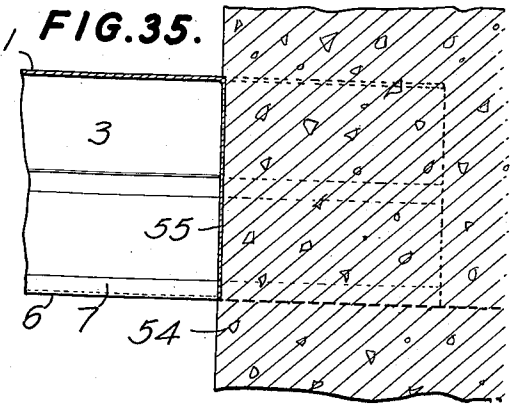

FIG.31.

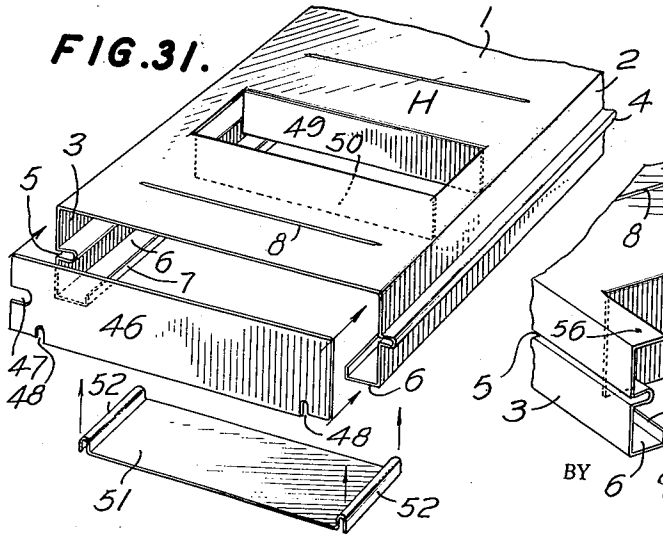

FIG.33.

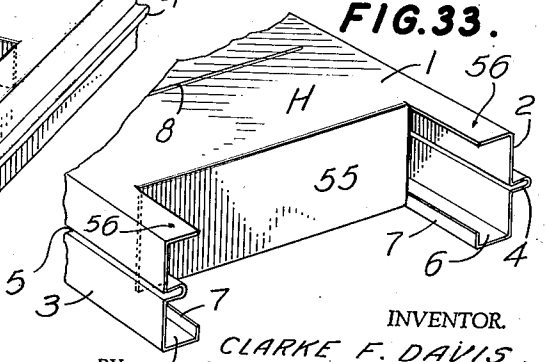

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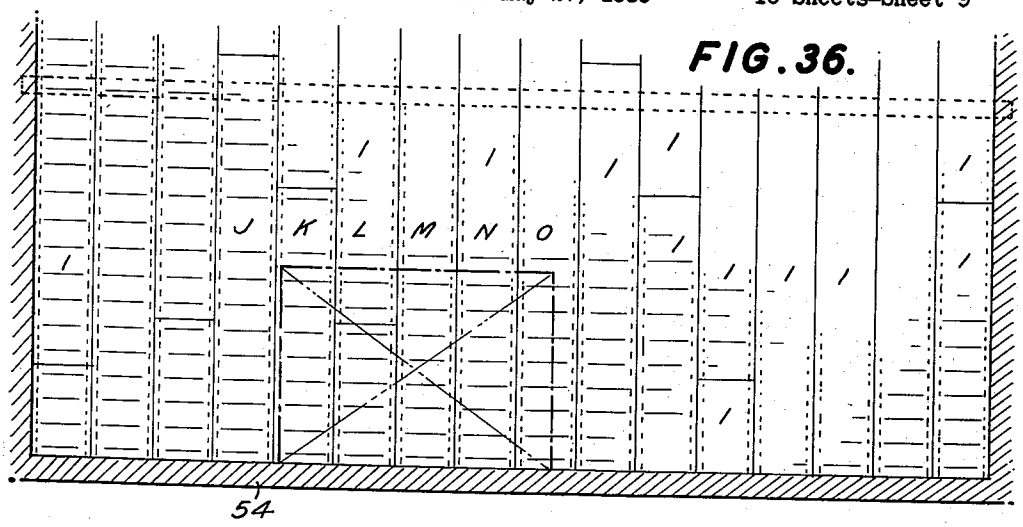
FIG. 36.



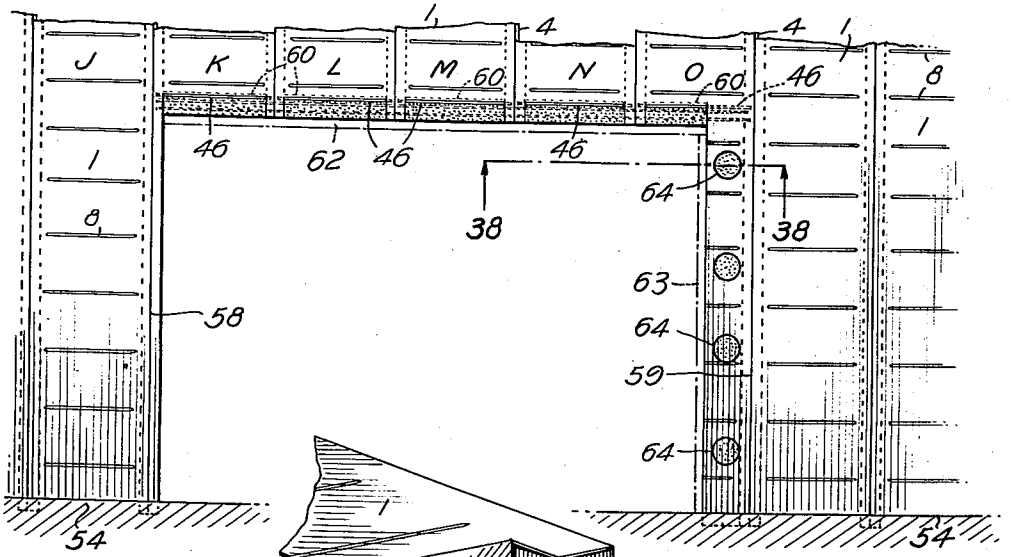


FIG. 37.

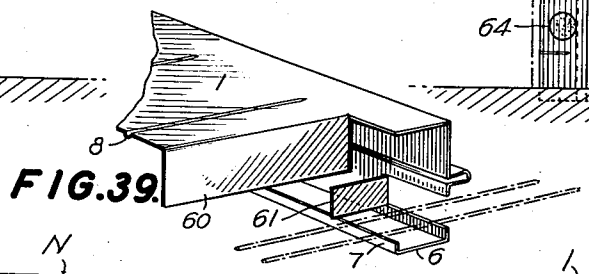


FIG. 39.

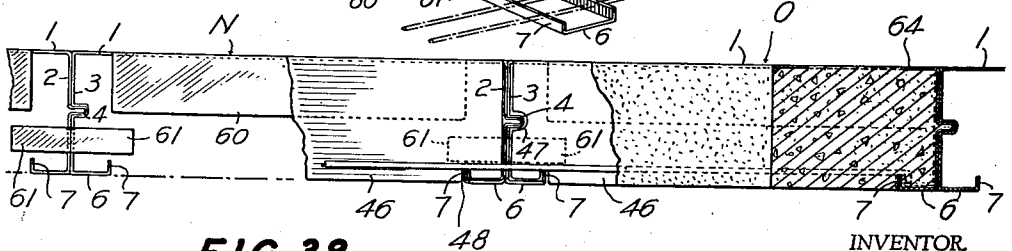


FIG. 38.

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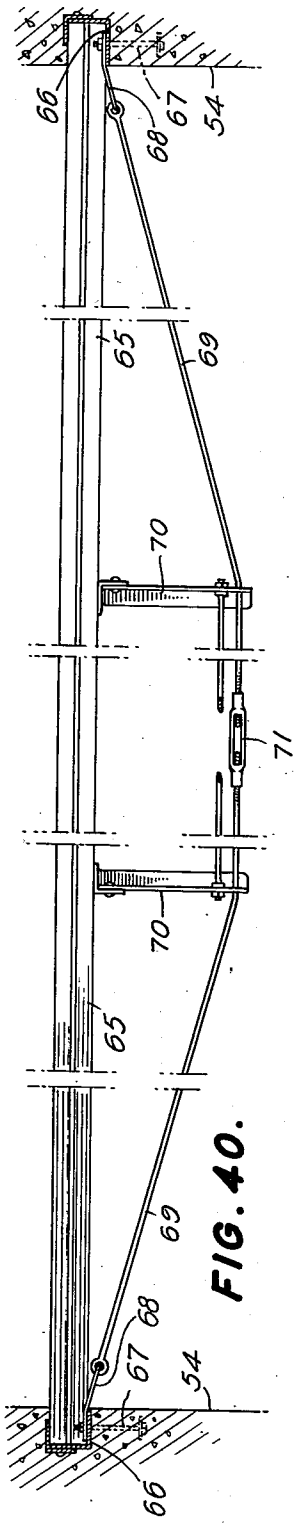

FIG. 40.

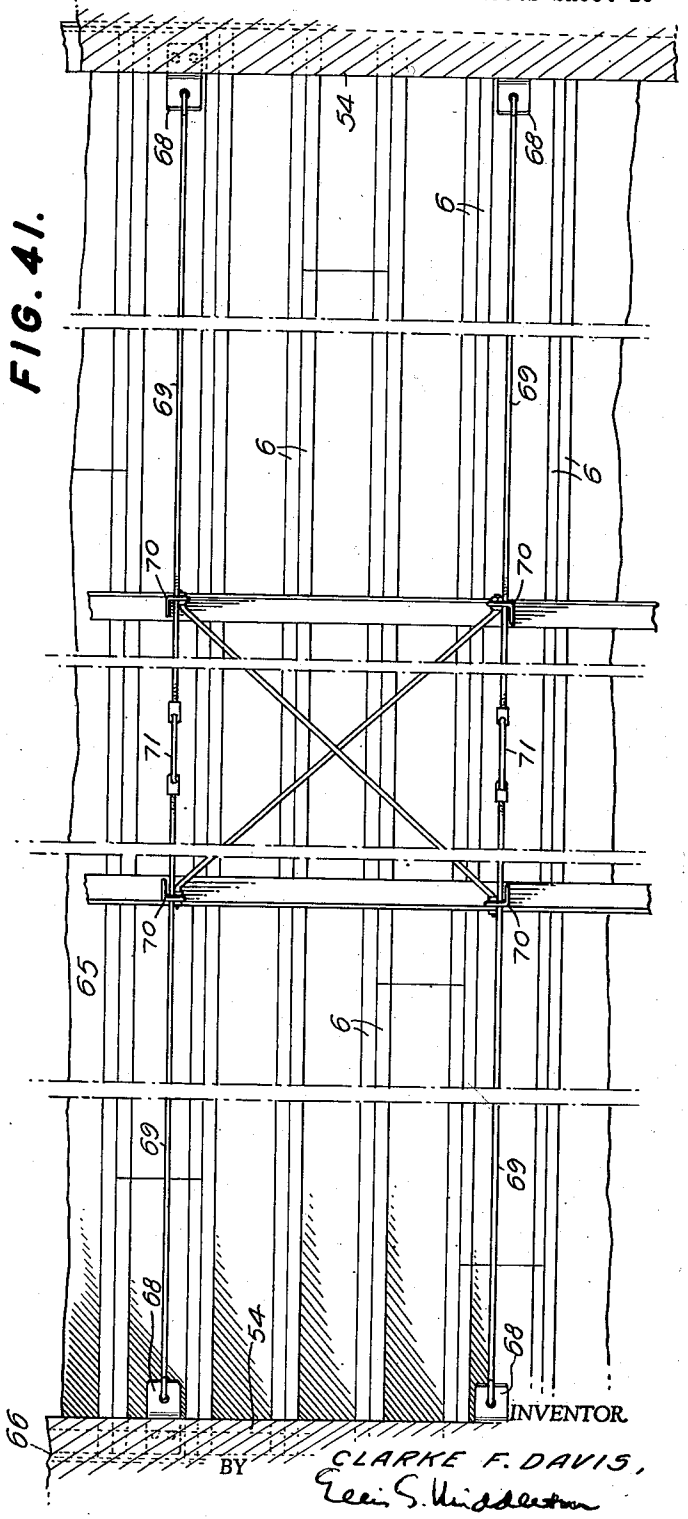

FIG. 41.

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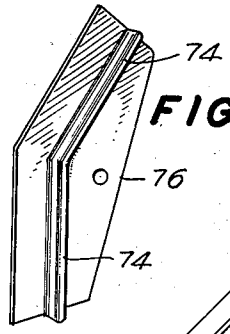

FIG. 44.

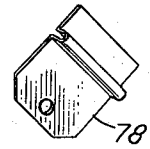

FIG. 46.

FIG. 43.

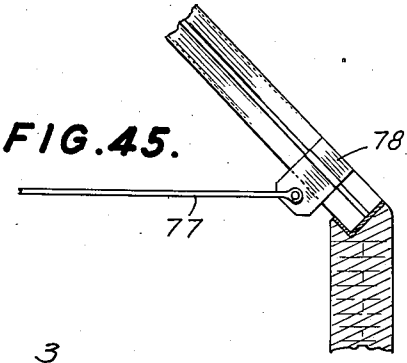

FIG. 45.

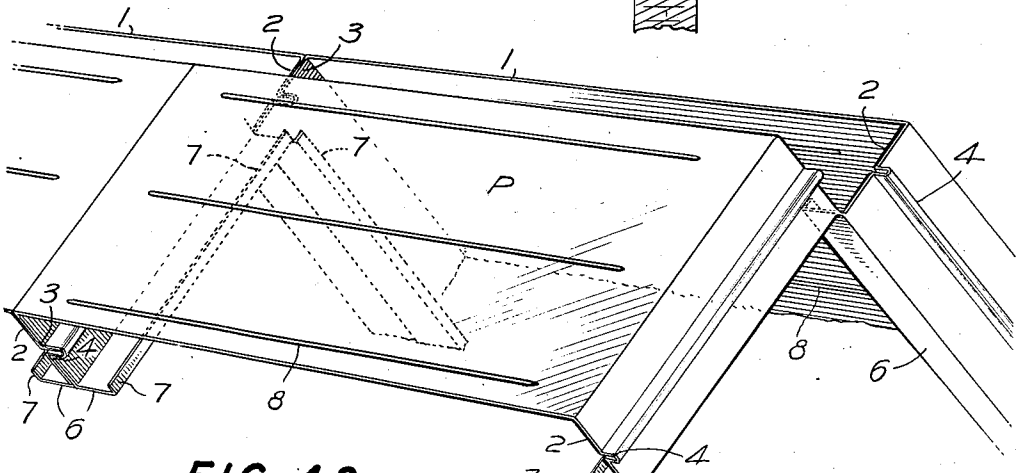

FIG. 42.

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FIG. 47.

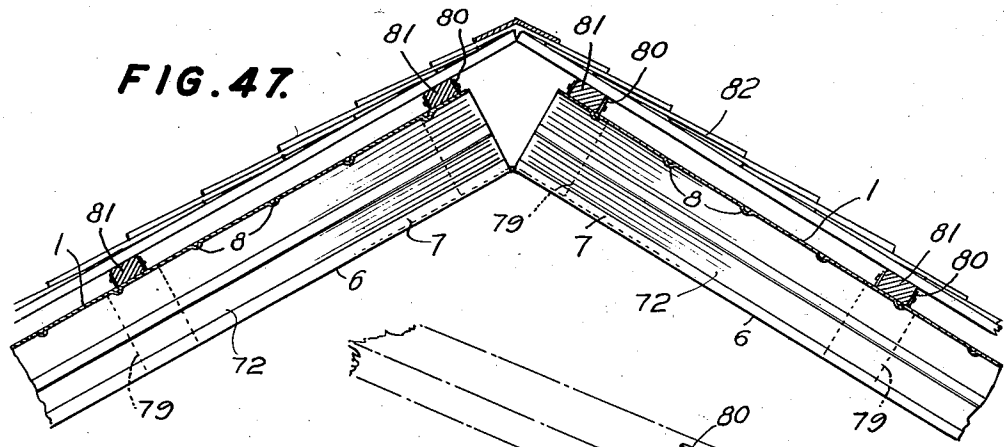

FIG. 48.

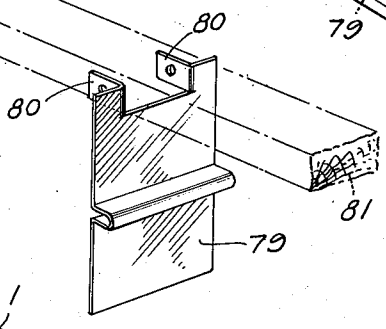

FIG. 49.

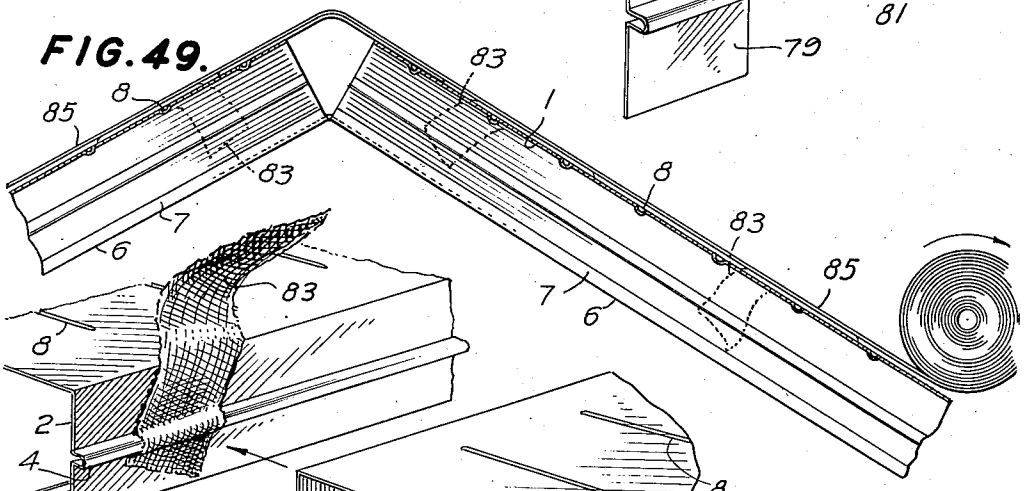

FIG. 50.

FIG. 51.

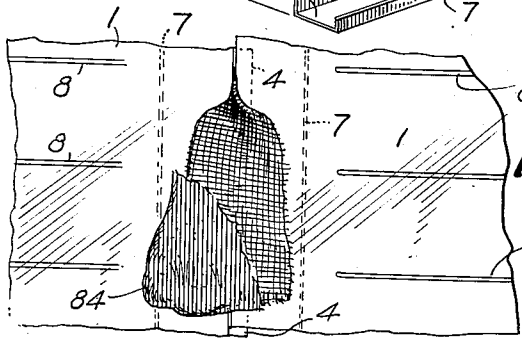

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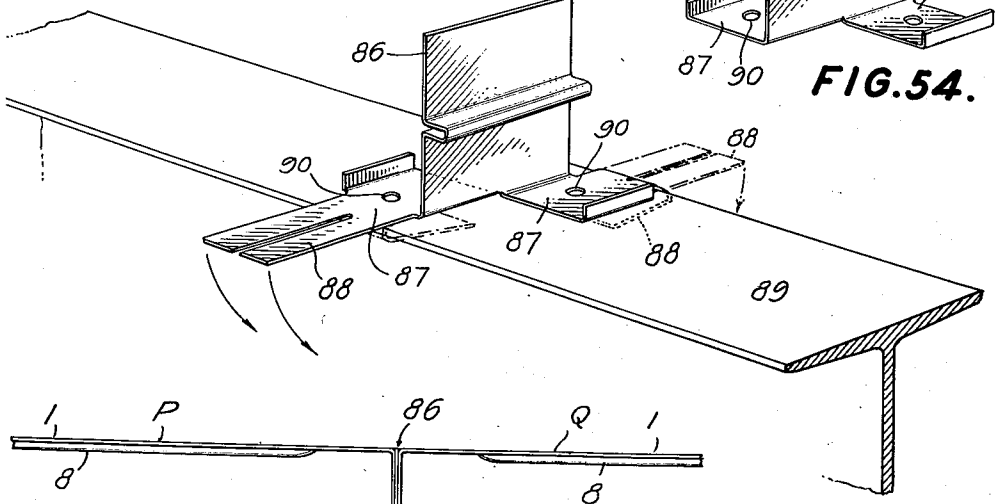
FIG.52.



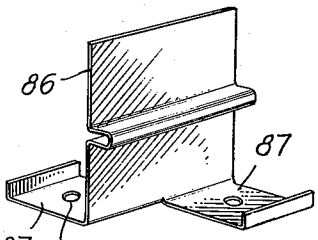


FIG.54.

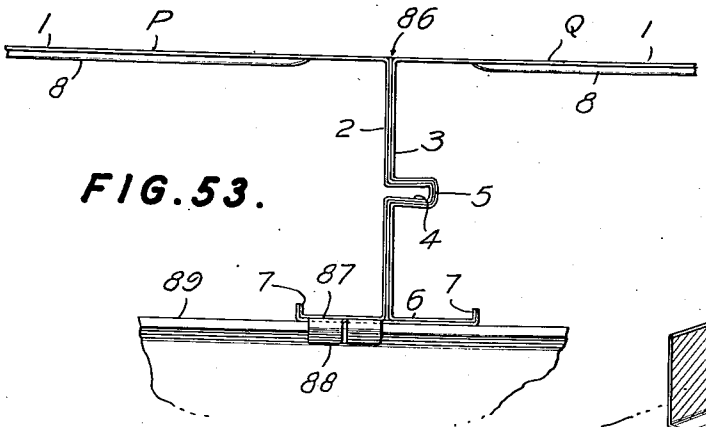
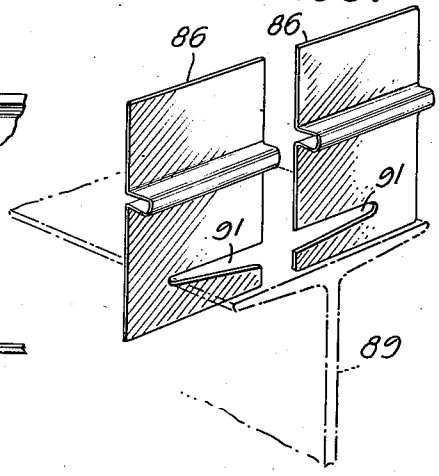


FIG.53.

FIG.55.



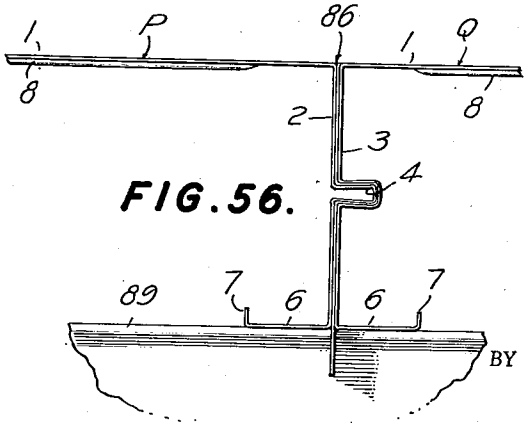


FIG.56.

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BY Ellis S. Middleton
ATTORNEY.

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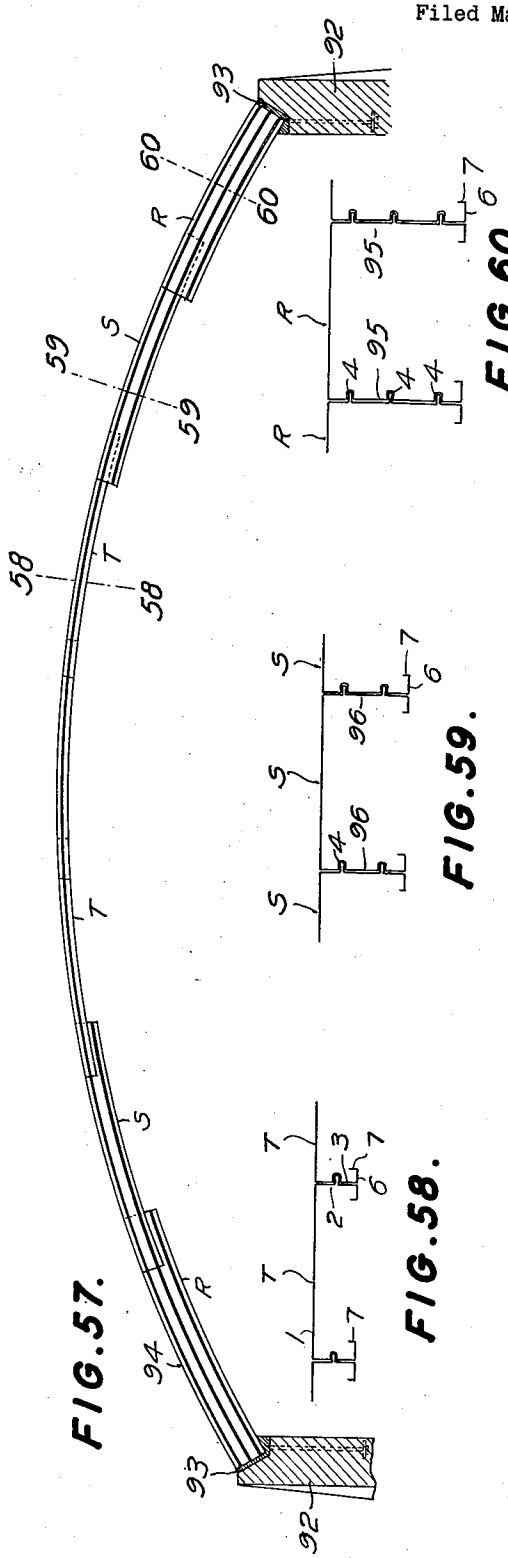

FIG. 57.

FIG. 58.

FIG. 59.

FIG. 60.

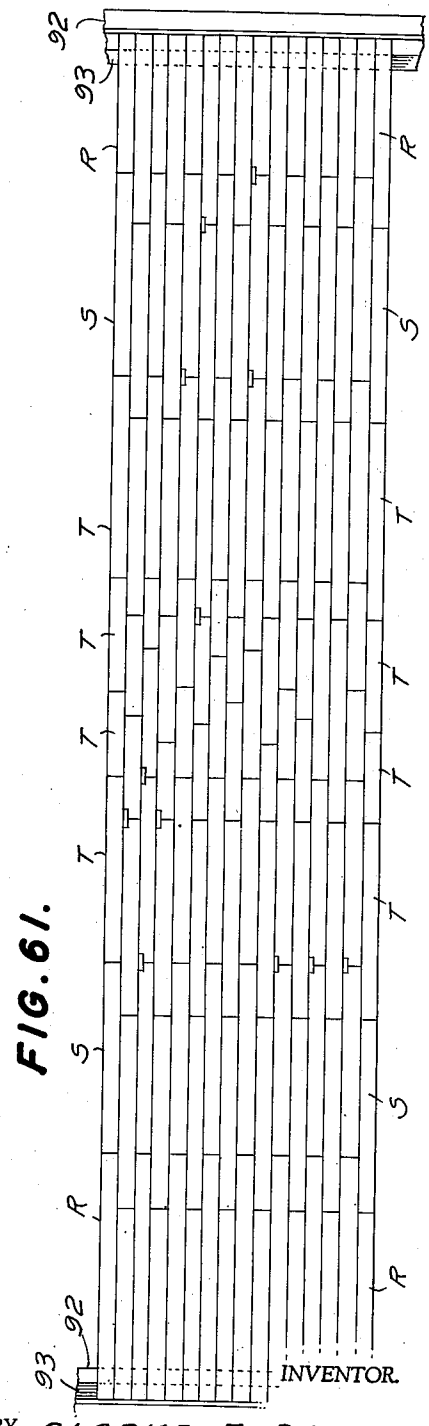

FIG. 61.

INVENTOR.

BY CLARKE F. DAVIS,

Ellis S. Middleton

ATTORNEY.

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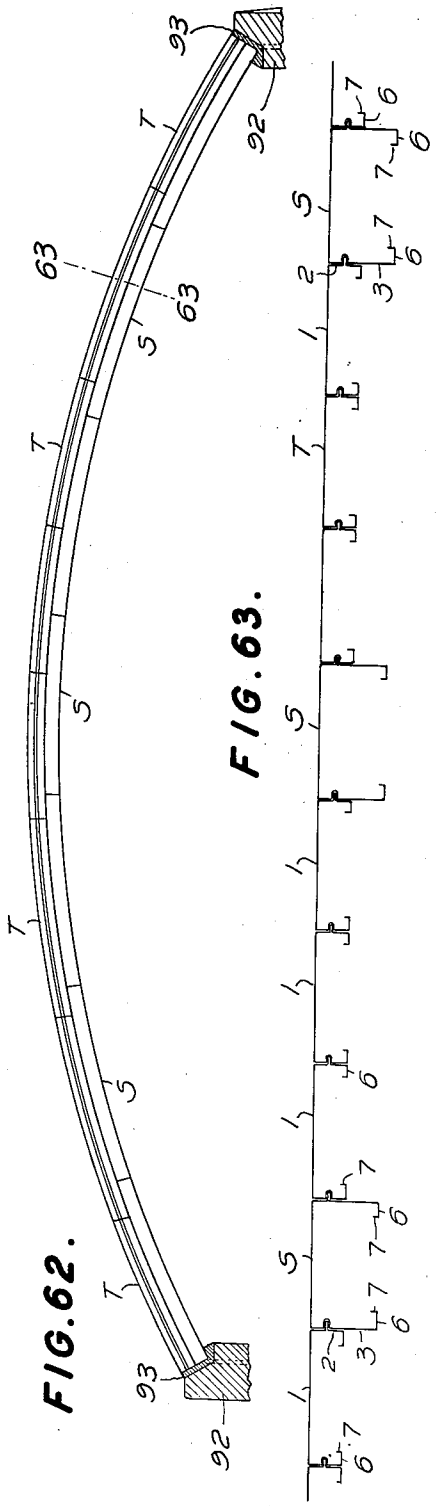

FIG. 62.

FIG. 63.

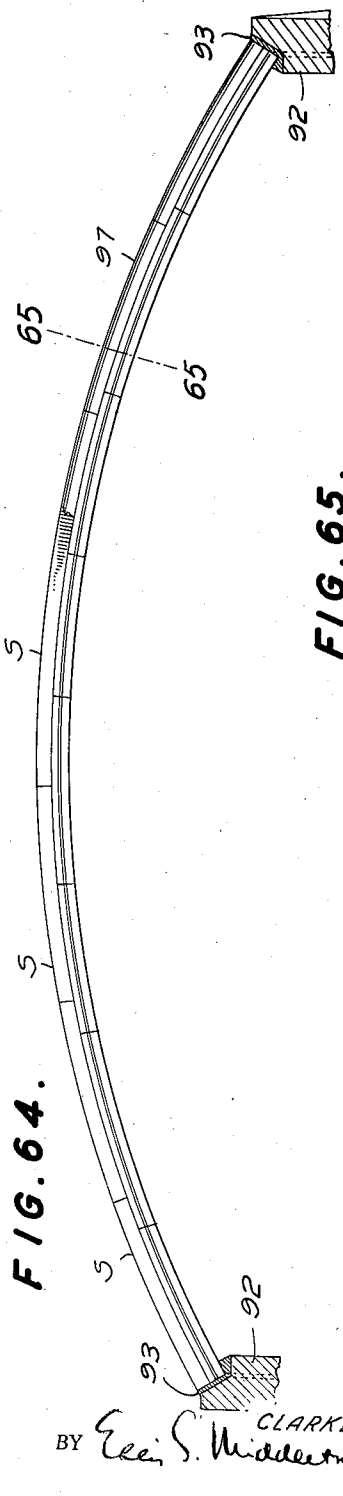

FIG. 64.

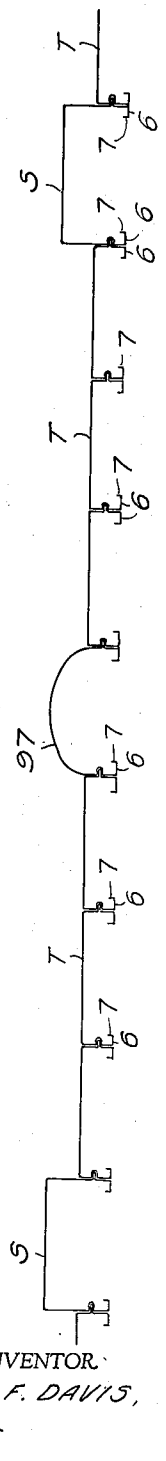

FIG. 65.

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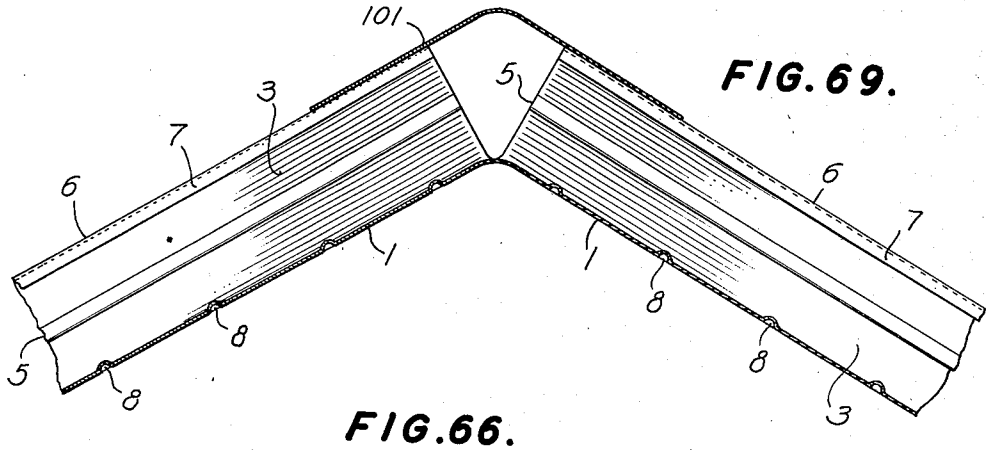


FIG. 69.

FIG. 66.

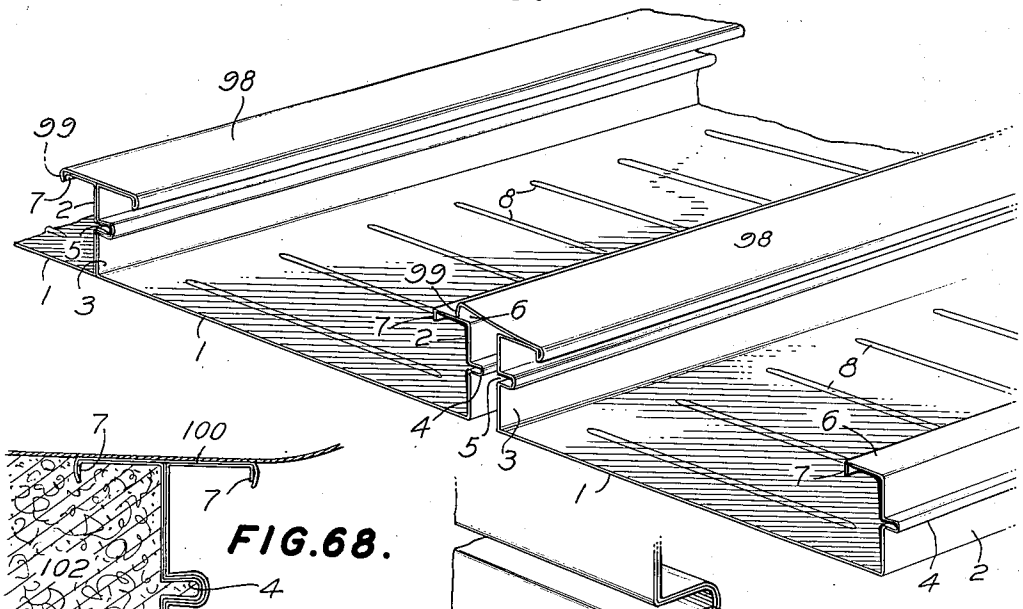


FIG. 68.

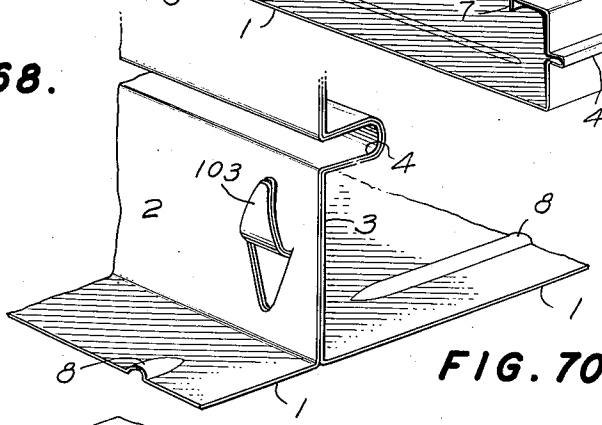
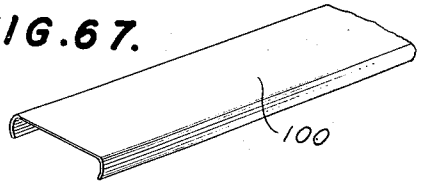


FIG. 70.

FIG. 67.



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Patented Nov. 14, 1939

2,180,317

UNITED STATES PATENT OFFICE

2,180,317

METAL DECKING

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Application May 27, 1939, Serial No. 276,213

20 Claims. (Cl. 189—34)

The present invention relates to building units and constructions involving the same, together with accessories usable therewith.

The principal object of the invention is to produce a building unit of simple construction which may be produced in quantity, which will be light in weight yet capable of sustaining workable live loads with adequate sheer resistance.

There are on the market today a large number of types of so-called "metal decks" composed of steel sheets formed to shape, the individual units being designed to interengage a neighboring unit to form an extended area. An important object of the invention resides in a construction which will be an improvement thereover, particularly in that the present improved units are stronger, lighter without sacrificing ability to withstand load and sheer, and also capable of being positively interlocked with each other so as to prevent accidental relative movement in all directions, not heretofore possible.

Another important object of the invention resides in the provision of a building system which may be used for floor or roof decks or vertical walls capable of great flexibility of application, and with which other building materials such as wood, gypsum, concrete, insulation and covering or protecting materials may readily cooperate to form an efficient type of construction.

Still another object of the invention includes the design of units so interengaged along longitudinal edges as to form therebetween I-beams. As a consequence of such a construction, extensive spans may be made between supports, inasmuch as the integral I-beam feature lends distinctive load supporting ability to such construction apart from supporting beams, girders, purlins or the like usually thought necessary. As a matter of fact, a construction involving the herein described units has the ability for self support to such an extent that in arched constructions, such for instance, as in roofs or the like, spans up to several hundred feet may be accomplished without intermediate supports, relying entirely upon the interengagement and cooperative support between the units.

Other objects and advantages will appear as the description proceeds.

To this end, the invention contemplates in its broadest aspect a building unit of metal or the like, of hot or cold rolled sheets or cast as the case may be, depending upon the circumstances in which it is to be used. Such unit may comprise a span portion suitably strengthened or not as by use of ribs or grooves, such portion having at each of two opposite sides, preferably longitudinally, a web extending at right angles to the span portion. Each web is provided with a locking portion adapted to cooperate with a complementary portion on an adjacent unit or with such web by reason of an independent and intermediate locking device to prevent accidental displacement of the units and to positively fasten the units together. Preferably this interlocking system comprises an outstanding tongue on one web with a corresponding inwardly projecting groove on the opposite web so arranged that the two may interengage or interlock in a secure, spring or friction joint. In all cases, the webs are provided with angular flanges at the end portions thereof substantially parallel with the span portion. Thus, the unit has at each longitudinal edge thereof an adequate base for contact with supporting walls, beams, purlins or the like, where these are desirable. The flange terminates in a strengthening edge portion which may take the form of an angularly bent rim or edge or a rolled bead or the like. As a consequence, a particularly strong construction results which resists collapsing or bending stresses to an optimum degree.

The invention also contemplates a building construction involving such units where a series of them are erected adjacent each other in an interengaging manner, either by reason of the interlocking portions of the units themselves or an interlock through the instrumentality of separate devices.

Such building constructions are of remarkable rigidity and have interesting load sustaining ability by reason of the fact that the interengaging webs constitute an I-beam construction known to be efficient from an engineering standpoint.

The invention further contemplates the use of splice plates or reinforcing sections located either between the webs of adjacent units or inside of an individual unit, that is, between the flange on the web and the span portion, as circumstances will dictate. Such strengthening devices may take various forms as will be more fully hereinafter described.

The invention additionally contemplates a floor or room deck of such units where a finish material will overlie the area made of the adjacent span portions, such finish material being attached to or tied into the unit construction so as to make the combination fixed and permanent.

Due to the fact that such units may be readily made from formed sheet material, they may be

made of any depth desired and where there is a uniformity of dimension between the interlocking tongue and/or groove and the surface of the span, units of different depth may be readily interlocked together to form a flush surface. This is particularly desirable in building constructions where supporting beams occur at different levels, or where it is desired to have a heavier and deeper deck area at certain locations to withstand additional loads.

Another very important aspect contemplated by the invention resides in the ability of these units to be incorporated into a building construction involving set cementitious material such as gypsum, concrete or the like. As in situations where the units are made of sheet metal, they may be readily cut, and fitted around columns, beams, stairways or the like with facility and pieced, filled out, reinforced or covered with poured-in-place cementitious constructions. This construction is very important from the standpoint of floor or roof decks where large areas may be quickly laid down and thereafter the desired openings marked out and the necessary sections of the deck removed to form the desired openings.

Another important consideration of units of the present type made from sheet metal is that they may be readily cut or split longitudinally and therefore telescopically collapsed both longitudinally or laterally to make narrower or shorter units as the case may be. This enables the user to fill out a floor or roof construction to the edge and if perchance the area to be covered will not take a whole unit, one may be cut down to the desired size without sacrifice of the I-beam feature.

In constructions involving long spans, the invention contemplates the production of units having one or more series of tongues and grooves or interlocking portions arranged at equal or unequal distances along the web. As a consequence, a single span may involve a plurality of types of units, each of which have a different number of interlocking portions, preferably, however, arranged so that these interlocks may be engaged serially. Such a construction enables a flush surface to be obtained and either the flat or curved type even though different depths of units are involved.

The flexibility of application of the units herein described will be appreciated from the fact that they may be used with the span portion either constituting the top or bottom of the building construction. In the latter case, the webs and their flanges project upwardly from the span portion and form what may be termed a standing seam deck, the seam being constituted by the adjacent flanges on the ends of the webs.

The invention further contemplates the novel combination, construction and arrangement of units and their accessories more fully hereinafter described and shown in the accompanying drawings.

In the drawings, which are illustrative of preferred forms only,—

Fig. 1 is a perspective view of a unit embodying my invention;

Fig. 2 is a fragmentary sectional view of interlocked units showing a modified form of interconnection;

Fig. 3 is a sectional elevation along the line 3—3 of Figs. 1 and 2;

Fig. 4 is a sectional elevation showing a slightly modified form of strengthening rib over that of Fig. 3;

Fig. 5 is a fragmentary sectional end view of a unit having a modified form of strengthening bead at the end of the flange;

Fig. 6 is a composite perspective view showing the method of assembly of a plurality of units both endwise and laterally with strengthening joint members and finish attached clips;

Fig. 7 is a perspective view of a modified form of joint splice plate;

Fig. 8 is a similar view of a modified form of finishing clip;

Fig. 9 is a perspective underside view of a deck section showing a joint splice arranged within the confines of the span portion, web and web flange;

Figs. 10, 11, 12, 13, 14, 15, 16 and 17 show modified forms of internal support;

Fig. 18 is a perspective view partly in section of a floor deck carrying a finished cementitious floor on top of the herein described decking units showing the method of bonding of the floor to the units and the interlock and reinforcements between the units themselves;

Fig. 19 is a sectional view along the line 19—19 of Fig. 18;

Fig. 20 is a perspective detail of a wedge used beneath a partition to prevent collapse of the tongue and groove;

Fig. 21 is a perspective view showing the method of end to end joint of units with a modified form of telescoping joint section;

Fig. 22 is a side elevation of the units of Fig. 21 when joined;

Fig. 23 is a side view of a deck constructed of units of different depths;

Fig. 24 is a plan view of a deck of the type shown in Fig. 23;

Fig. 25 is a front elevation of the deck of Fig. 24;

Fig. 26 is a plan view partly broken away of a deck construction arranged to incorporate poured cementitious material therewith;

Fig. 27 is a perspective detail showing the method of application of a diaphragm to a building unit to act as a form for poured cementitious material;

Fig. 28 is a sectional view along the line 28—28 of Fig. 26;

Fig. 29 is a sectional view along the line 29—29 of Fig. 26 showing the cementitious material in place;

Fig. 30 is a plan view partly broken away showing openings through the spans of adjacent units ready for the pouring of cementitious material thereinto;

Fig. 31 is an assembled perspective view of a unit similar to those shown in Fig. 30 and showing the manner of applying the diaphragms and bottom plates;

Fig. 32 is an enlarged sectional view along the line 32—32 of Fig. 30 showing the cementitious material in place;

Fig. 33 is a fragmentary perspective of the end of a unit showing the method of using a portion of the span as a diaphragm preliminary to the pouring of cementitious material;

Fig. 34 is a plan view of two units prepared as in Fig. 33 with the cementitious material in place as a wall;

Fig. 35 is a sectional view along the line 35—35 of Fig. 34;

Fig. 36 is a plan view of a deck construction with a proposed opening marked out thereon;

Fig. 37 is an enlarged plan view of that portion of the deck of Fig. 36 after the opening has been cut and the edges framed with cementitious material;

Fig. 38 is a sectional view along the line 38—38 of Fig. 37;

Fig. 39 is a fragmentary perspective detail showing the method of cutting an end of a unit to hold a diaphragm form for cementitious bridging material;

Fig. 40 is a side view of a deck supported between walls, using a hog rod truss;

Fig. 41 is a bottom plan view of the construction of Fig. 40;

Fig. 42 is a perspective view of a dihedral construction, such as a roof peak showing the manner of carrying a unit integrally over the ridge;

Fig. 43 is a diagrammatic end view of a roof construction embodying the arrangement of Fig. 42;

Fig. 44 is a perspective detail of the tie-clip used in Fig. 43;

Fig. 45 is a fragmentary end view of the support end of a roof construction showing a thrust rod and clip;

Fig. 46 is a perspective detail of the thrust clip of Fig. 45;

Fig. 47 is a fragmentary end view of a roof peak using the construction of Fig. 42 showing one type of finish material applied thereto;

Fig. 48 is a perspective detail of the clips used to hold the shingle battens of Fig. 47;

Fig. 49 is a view similar to Fig. 47 showing a modified form of roofing material;

Fig. 50 is a perspective view showing the manner of fastening the finish attaching material between units;

Fig. 51 is a plan view of the construction of Fig. 50 when assembled;

Fig. 52 is a perspective detail showing the manner of attaching an intermediate clip to a beam, the clip to be located between unit sections;

Fig. 53 is a side view of the construction of Fig. 52;

Fig. 54 is a perspective view of a modified form of attaching clip;

Fig. 55 is a similar view of still another form;

Fig. 56 is a side elevation of a construction embodying the clip of Fig. 55;

Fig. 57 is a diagrammatic end view of an arch roof span showing the use of units of different depths;

Fig. 58 is a fragmentary sectional view along the line 58—58 of Fig. 57;

Fig. 59 is a fragmentary sectional view along the line 59—59 of Fig. 57;

Fig. 60 is a fragmentary sectional view along the line 60—60 of Fig. 57;

Fig. 61 is a plan view of the roof construction of Fig. 57;

Fig. 62 is a diagrammatic end view of an arch roof span showing a modified construction;

Fig. 63 is a sectional view along the line 63—63 of Fig. 62;

Fig. 64 is a view similar to that of Fig. 62 showing still another form of construction;

Fig. 65 is a sectional view along the line 65—65 of Fig. 64;

Fig. 66 is a perspective view of a deck using units of this invention in a so-called "upside down" manner;

Fig. 67 is a partial perspective view showing a form of clip for an upstanding seam;

Fig. 68 is a fragmentary sectional view showing the method of using the clip of Fig. 67, together with insulation between the upstanding seams;

Fig. 69 is a fragmentary end view of a roof peak showing the units used in a so-called "upside down" manner; and

Fig. 70 is a fragmentary perspective view showing an additional manner of fastening the units together.

Referring now with particularity to the figures, Fig. 1 shows perhaps the most preferred form of unit. As shown, it consists of a span portion 1 having at each of two opposite longitudinal sides thereof webs 2 and 3 containing a tongue and groove 4 and 5, respectively. Flanges 6 are located at the end portion of each web, which terminate in an angularly bent stiffening portion 7.

Such unit may advantageously be constructed from sheet metal, the gauge of which may run from, say 8 to 20, although in special locations lighter or heavier gauges may be used. As a matter of fact, for particularly heavy loads, the unit may be made of cast metal although ordinarily cold or hot rolled sheet material will be found satisfactory. Where desired, concave corrugations 8 may be formed in the span portion 1, in any desired manner in order to lend the required stiffness.

The invention is not to be restricted to any particular dimensions of building unit inasmuch as the particular circumstances under which this element is to be used will determine the requisite size. Ordinarily speaking, sections six inches deep by fifteen inches wide and ten feet long will be found to fit most circumstances, although obviously these dimensions may vary at will.

It is to be noted from an inspection of Fig. 1 that the tongue 4 and groove 5 are complementarily shaped, so that when two such units are erected adjacent each other into a building construction or deck, they may readily engage and interlock, such as in the manner shown in Fig. 23. Under such circumstances, the interlocked webs, together with their adjacent flanges and span portions form I-beams which constitute an important feature of the present construction. This will be readily appreciated when it is remembered that due to the fact that an effective I-beam occurs in such decking along parallel lines and at closely spaced intervals, considerable loads may be carried by such decking even though the unit is constructed of a very light gauge material. The stiffening angular end 7 is of particular importance in this consideration in that it lends a strength and resistance to bending considerably in excess of a construction in which this feature is absent.

This I-beam effect is enhanced by the interlock between units. In this connection, it is to be noted with particular reference to the tongue 4 shown in the enlarged view of Fig. 5 that the configuration thereof is such that it has a restricted neck. Under these circumstances, the slightly enlarged end of the tongue may be forced into corresponding groove 5 and be securely held therein both by reason of the frictional joint between the parts and also because of the shape of the parts.

While it is desirable that each unit carry complementary locking tongues and grooves, yet this is not necessary as an inspection of Fig. 2 will indicate. There each web 2 is shown to carry a groove 5 and the interlock between the parts is constituted by an elongated latch member 9 having oppositely bent doubled portions 10 adapted to tightly fit and be held within the grooves 5

when the two units are pushed together. Other modes of interlocking within the purview of the invention will occur to those skilled in the art.

Fig. 4 shows stiffening corrugations 11 of the convex variety which are considered to be the full equivalent of those indicated at 8.

In Fig. 5 a modified form of stiffening portion for the flange 6 is shown to consist of a rolled bead 12.

In assembling such units into a building construction, one lengthwise series will ordinarily be erected in an end to end relationship. In order to adequately support the joint therebetween, the telescoping member 13, shown in Fig. 6, may be used. It may conform in close detail to the configuration of a unit except that it will be of such a size as to readily fit within the end thereof, such for instance as is shown in Fig. 21. Obviously, such telescopic member may also contain full webs 2 and 3 with flanges 6 and stiffening portions 7 as shown in Fig. 6 or the flanges and stiffening portions 6 and 7 may be omitted as in Fig. 21. In the latter case, the tongue 4 and groove 5 engage the corresponding parts in the full unit so as to fit closely thereinto. By moving another full unit in the direction of the arrows shown in Fig. 21, the two units may abut in an end to end relationship with adequate support to the joint between their span portions.

Having erected a single line of units into a deck construction, a second row of units is then installed in an interlocking manner with the first row of units, preferably in a break-joint arrangement so as to distribute any weakness that may occur at the joint. In Fig. 6, the method of erection is indicated, it being assumed that the units A and B are those in the first line. In order to strengthen the longitudinal edge of such units and to distribute load and develop sheer, a splice member indicated generally at 14 is moved in the direction of the arrows so that its groove 15 overlies the tongues 4 on the units A and B. The splice member 14 is provided with flanges 16 sufficiently far apart so that when the unit C is moved in the direction of its arrows, its flange 6 and span portion 1 will lie between the flanges 16 of the splice member much as is shown at the opposite side of Fig. 6. Such a construction is particularly effective where light gauges of metal are used and/or where special loads are to be carried.

Fig. 7 illustrates another form of splice plate 17 without flanges as these will not always be required. It is used in exactly the same way as the splice member 14 and serves the same purpose.

In addition to the function of the splice plate which is to strengthen the joint between units, it provides a slight space or groove between the longitudinally extending webs of rows of units such, for instance, as is indicated at 18 on Fig. 18. This is sometimes desirable in that it permits the attachment to a construction embodying these units of clips and nails which may be inserted or driven thereinto and frictionally held therein. This feature will be more fully described hereinafter.

Referring back to Fig. 6, there is shown at 19 a clip having a configuration similar to the splice plate of Fig. 7 and provided with apertures 20 which may be used to receive rods 21 or the like shown in Fig. 18 where it is desired to overlay the deck with a cementitious finish material. Such a finish or floor is shown at 22 in Fig. 18. When such clips are not in use, they may be bent down flush with the desk as shown at 23.

The use of a floor finish such as cementitious material of which concrete is a type is advantageous in that it raises the neutral axis of the structure and the overlay forms the top of a T so as to put the concrete under compression and the steel combination in tension. Without the concrete, the neutral axis is located approximately on a line with the tongue and groove and, consequently, the metal parts are both in compression and tension, which is not always desirable.

Where sheet finish material is to be overlaid onto a deck, the clip of Fig. 8 may be used, which is similar in all respects to that shown in Fig. 6 except that it is provided with a penetrating point 24.

While in Fig. 6 the splice plate 14 is shown as being inserted between units for strengthening purposes, it need not always be so located. For instance, in Fig. 9 the splice plate 14 is shown as being inserted within the confines of a unit defined by its span portion 1, web 3 and flange 6.

In some cases it will be found desirable to strengthen the I-beam effect of the tongued and grooved edges by internal fittings. Such fittings may occur either across a joint and thus serve a double purpose or not, as desired. Fig. 10 shows a splice plate 17 such as is used in Fig. 7 for this purpose. In Fig. 11, a similar plate 25 is indicated having, however, a tongue of such a size as will fit within the tongue 4 on that unit.

In Fig. 12, an open box type of support 26 is shown, the mounting of which is self evident, while in Fig. 13 the same support is shown applied to that side of a unit containing a tongue.

Fig. 15 illustrates a modified form of support 27 applied as in Figs. 14 and 16. There the configuration is such that when the main body of the support is flexed against its end 28, a particularly rigid construction results.

On the other hand, the normally strengthening terminal edge 7 of a flange 6 of a unit may be extended upwardly as at 29 to engage the underpart of the groove 5 and the tongue 4 as shown in Fig. 17. In addition to the function as a support, this construction may be found desirable where the inner surface of the flanges 6 are to be protected from accumulating dust or moisture.

Where a partition, such as shown at 30 in Fig. 18 is to be erected onto a floor 22, it may be necessary or desirable to more completely support and prevent collapse of the engaging tongue and groove of meshed units therebeneath. This may be done as in Fig. 19 by providing a wedge 31 of any desired material driven into the tongue and/or groove over the supporting beam or the like 32 and beneath partition 30.

One of the important features of the use of these units in a building construction is their complete flexibility of application to various circumstances. Fig. 23 shows, for instance, a situation in which a low beam 33 and a high beam 34 are supported on a column 35 at different horizontal levels whereas a deck on a single level is to be mounted thereon. Instead of providing separate framing to carry out the supporting level of beam 34, it only becomes necessary to use a unit such as that shown at D, which is similar in all respects to units A, B and C, except that its web 36 is of greater depth than those of units A, B and C, although the tongue and groove therein occur at the same distance below the span 1 as in the other units. As a con-

sequence, units A and D may be erected with their tongues and grooves interlocking in exactly the same manner as in units A and B. This provides a continuity of deck surface without resorting to additional expensive framing. It is contemplated that in practice units of varying depth will be provided to take care of just such situations as this which occur with considerable frequency in extended building constructions.

At the extreme right hand end of Fig. 23, a situation is illustrated in which, as the units are erected from left to right, when the wall 37 is reached, the space left between the unit C and the wall is less than the normal width of a full unit. Under these circumstances, a unit may be split longitudinally inasmuch as it is of relatively light material and the span overlapped as at 38 so as to fit. Where desired, a self threading screw 39 or the like may be used to securely fix the parts together.

Figs. 24 and 25 show a situation somewhat similar to that of Fig. 3, that is, where units of different depth are to be incorporated into a single deck. In such circumstances, the deep sections are shown at D and the shallower units at A in a break-joint arrangement so that there is a lateral overlap, which results in adequate support for the entire structure.

In present day building constructions, it is frequently found that difficulties arise when an attempt is made to fit any kind of deck material around openings such as stairwells, shafts or the like, around columns or any other type of irregularity. If deck material is to be factory made to fit these varying conditions, a considerable amount of expensive detailing is necessary. With the decking of the present invention, however, this detailing is avoided to a large degree in that the units are of standard dimensions with but few variations, all types of units readily lending themselves to such irregularities.

A typical situation is illustrated in Fig. 26, where for some reason it is desired to lend additional strength laterally of several units in the form of bridging. This may be readily accomplished by combining such cementitious material as concrete therewith.

In this figure, units E, F and G are laid down in the usual manner, without regard to where the bridging is eventually to be located. Assuming in this case that the bridging is to be located directly over the beam 40, circular holes 41 are cut through the span portion of the decking units and four slots cut outwardly from the periphery of the aperture 41 so as to form three ears 42, 43 and 44. This is shown clearly in Fig. 27. The same operation is performed at a point diametrically opposed thereto. The next operation is to slit a portion of the stiffening end portion 7 of the bottom flanges 6 to form additional ears 45. A diaphragm plate or form 46, preferably of metal, is then inserted in place so as to abut at the bottom the ears 45 and be held at the top between ears 43 and the pair of ears 42 and 44. The diaphragm is provided with a cutaway portion 47 to clear the inwardly projecting metal forming the groove 5 on the web 3 and a similar cutout 48 to clear the upstanding stiffening portion 7. Upon similarly applying another diaphragm on the other side of the hole 41, a form is obtained in which the diaphragms 46 constitute the sides, and the top of beam 40, the bottom. Concrete may then be poured directly through the aperture to fill the space inside of each of the units E, F and G. Upon setting, a continuous, rigid bridge results extending laterally across the deck to any desired extent.

Where such bridging is desired other than directly over a beam, it may be similarly constructed in the manner shown in Figs. 30, 31 and 32. In Fig. 31, the unit H is cut laterally along its span portion to form areas 49 and 50 which are then bent inwardly and at substantially right angles to the span portion 1. A bottom plate 51 having deformed supporting ends 52 is then inserted beneath the aperture cutting in the span portion of the unit so as to constitute the bottom of the form to receive cementitious material. Two diaphragms 46 are then inserted so as to abut the areas 49 and 50 and lie alongside each edge of bottom plate 51, thus held in that position. Concrete or other cementitious material 53 may then be poured. This may be repeated over as many units as is desired to give the bridging effect of the necessary extent.

In Figs. 33, 34 and 35, a situation is illustrated where the decking units are to be tied into a poured-in-place wall structure where the decking units themselves furnish not only a portion of the form for pouring the concrete but also the I-beam support for the deck. This is accomplished by splitting the units which are to abut the wall 54 so as to form a flap 55 and bending the same downwardly until it occupies a position substantially at right angles to the span portion. This then constitutes one part of the pouring form. The projecting webs may then be rigidly tied into the wall 54 when the concrete is poured therearound. Wherever two units such as shown at H and I in Fig. 34 abut, the interlocked edges indicated generally at 56 form the I-beam, the end of which is embedded in the wall to adequately support the decking. This illustrates the extreme flexibility of the system to meet unusual conditions.

To further indicate the ease with which an extended deck area may be erected regardless of eventual openings therein to be located later, reference is made to Figs. 36 to 39, inclusive. In Fig. 36, a series of decking units is erected in the usual manner, the ends thereof being tied into the wall 54 as shown in Fig. 34. A series of these units is indicated at J, K, L, M, N and O. Assuming now that an eventual opening is to be made in the deck as indicated by the dotted lines in Fig. 36, the deck is cut along these lines with a saw so as to form the opening. It then becomes necessary to frame in this opening so as to form a concrete bridge along the side 57 so as to distribute the load between effective I-beams 58 on one side and 59 on the other and also to distribute the load from the thus formed bridge along the cut edge of unit O to the wall 54. This may be readily accomplished by slitting the ends of units K, L, M, N and O to form flaps 60 and cutting tongues 61 from the unit webs to support therebetween diaphragm plates 46. By applying a temporary wood form 62, concrete may be poured along the entire edge 57 and embedding the tension rods as shown, to constitute a continuous bridge from I-beam 58 to I-beam 59. Similarly, a temporary wood form 63 may extend along the side and bottom of the opening adjacent I-beam 59 and concrete poured through opening 64 in unit O. As a result of these operations, a complete concrete bridge extends across the cut edges of slabs K, L, M, N and O between effective I-beams 58 and 59 and from that bridge to the wall 54. Of course, where the opening does not terminate

intermediate the unit O, the operation is much simplified as in that case, no longitudinally extending bridging would be necessary.

On extended spans, additional bracing may be obtained for such decking by the use of trusses of the king or queen post type, the latter being illustrated in Figs. 40 and 41. There the deck is indicated generally at 65, the ends of which rest upon angle iron 66 anchored in the wall 54 by means of bolts 67 which also carry clevices 68 to which are attached sag rods 69. These rods pass over queen posts 70 and are connected as by a turn buckle 71. Thus any desired degree of medial support may be obtained without the use of intermediate beams supported on columns.

As illustrative of the ready adaptability of the decking of this invention to form extended surfaces other than those of a horizontal nature, reference is made to Figs. 42 to 51, inclusive. In Fig. 43, a peaked roof section is shown generally at 72 made up of intermeshed decking units. The method of treatment of units in order to pass them over the roof peak in integral manner is shown in Fig. 42.

There, decking unit E is shown as having been cut through its span 1, webs 2 and 3 and upstanding stiffening portion 7, leaving flange 6 uncut. The unit is then bent as shown, the integral flange 6 carrying the decking over the peak in a rigid manner. An angular ridge plate 73 having complementary portions 74 to fit the tongues 4 of the unit P may then be applied as shown to lend additional support to the structure.

In the same way, the unit P or units abutting it in an end to end relationship may be likewise cut and extended from the roof area 72 into the wall area 75, an angular plate 76 being applied to rigidly join the roofing and wall sections together. A thrust rod 77 may connect angle plate 76.

As an alternative method of taking up this thrust, tie-plates 78 pinched between the intermeshed edges of adjacent units may be used to carry the thrust rod 77.

While above we have mentioned that the wall 75 may be constructed of decking embodying the present invention yet this obviously may be any other kind of a wall including that of the type shown in my U. S. Patent 2,083,987.

In Fig. 47, a method of roof treatment is shown wherein batten clips 79 are pinched between the units constituting the roof section 72. These clips are provided with outwardly bent ears 80 to receive between them wood battens 81. To these battens, shingles 82 or other finish material may be readily applied.

In Fig. 49, the application of sheet material to the roof section 72 is shown. Such a finish may be rigidly attached to the metal decking as, for instance, by pinching a piece of burlap or other fabric 83 between units, tarring or asphalting the same as at 84 and then applying the roofing material 85 directly thereto. While additional asphaltic or tarring material may be used as the binder directly between the roofing material and the metal decking, yet in some cases it will be more desirable to use the spot attachment method shown in Figs. 50 and 51.

Inasmuch as perhaps the widest use of the decking of the present invention is that of extended roof areas, the units being of comparatively light material with no separate ceiling thereunder, it may be desirable to tie the roof deck to the beams or purlins to prevent lifting therefrom by interior air currents in the building. Figs. 52 to 56 inclusive show such methods of attachment. They may consist of a clip having an upstanding portion 86 adapted to be pinched between units P and Q and having bottom flanges 87 with extended portions 88 adapted to be bent down beneath the top flange and beam 89. On the other hand, the extensions 88 may be eliminated, leaving the clip in the form shown in Fig. 54 and the flanges 87 secured to the beam as by bolts passing through apertures 90 or the flanges may be spot welded to the beam.

In Figs. 55 and 56, the pair of clips is shown which may be used either in such pairs or singly, the clips having an upstanding portion 86 as in the forms above described and a slot 91 adapted to straddle the upper flange of beam 89.

In Figs. 57 to 61 inclusive, there is shown a roof area of extended span which may be constructed of units according to the present invention without intermediate supports. Such a construction takes advantage of the fact that decking units may be produced in different depths with one or more series of interlocking tongues and grooves, all so uniformly arranged that the tongued and grooved interlock may be provided at will between sections of different depths.

Extended areas of this kind obviously require units of sufficient strength at the opposite thrust points to withstand the load of the roof between them while units progressively nearer the top of the arch require progressively less strength. Consequently, the units may be made of lighter weight and/or depth from opposite thrust points toward the top of the arch.

Such a construction is shown in Fig. 57 in which walls 92, suitably braced to withstand the thrust of the roof, are provided with saddles 93 to receive the base decking units 94. Such a unit is shown in Fig. 60 to consist of a span portion 1 with an especially deep pair of webs 95 terminating in flanges 6 with strengthening portions 7. Intermediate the flange 6 and span portion 1 is a series of tongues and grooves, three for instance, symmetrically arranged of the web. As shown in this figure, such units R may be interconnected together in exactly the same manner as the units heretofore described. However, due to the fact that each unit has six interlocks with its neighboring units and is of a considerable depth, it is obvious that a particularly strong construction results from the use thereof. A series of R units is shown at the extreme ends of the arch and seated in saddles 93 on the walls 92.

Abutting the R series of units in an end to end relationship with some overlap and intermeshing at the overlap on each side with two or three interlocks is a series of units S similarly constructed but having a lesser number of interlocks in their webs 96. It is to be noted that the end joints between the R and S series of units are staggered so as to distribute the load. Where desired, the splice plates heretofore described may be used to cover the end joints between units and such plates may contain a single set of tongues and grooves or a plurality thereof dependent upon circumstances. While a single R series and a single S series are shown at each end of the arch, yet more than one series may be used as this will be dependent upon the length of each unit and the length of the span or the load to be carried thereby.

In the embodiment illustrated, additional series of slabs indicated at T are located between the S series and these units may be substantially those shown in Fig. 1. Inasmuch as this T series of units is not called upon to bear any great amount

of load, there may be more than one series thereof. Three such series are shown. The T series of units mesh with the S series of units in the manner illustrated so that the single tongue and groove of the former meshes with but a single tongue and groove of the latter series.

As a consequence, the plurality of series of units produces a smooth unbroken area though constructed of units of different depths, all interlocked together in a rigid manner. Due to the high degree of friction developed in this interlocked joint, there is no excessive tendency for a telescopic collapse. The three series of T units may have their end joints broken at random so that long and short sections may be used at will, all of which makes for economy.

In some instances, it may be found desirable to use a combination of units of different depth in a long span arch construction, such for instance as that shown in Figs. 62 and 63. There the roof is constructed principally of T units, every fourth row of units being of the S or deep type and extending from end to end of the span. Where desired, the unused tongues and grooves of the S units may be omitted.

It is to be noted that in the roofs of Figs. 57 and 63, the outside surface is substantially unbroken while the inside surface is more or less irregular due to the fact that units of different depths have been used. If it is found desirable to provide a construction in which the reverse condition exists, the construction of Figs. 64 and 65 may be resorted to. There the units S and T are so arranged that their bottom flanges 6 lie in substantially the same surface of revolution.

In particularly long spans there may be some tendency to buckle or pull the joints apart under the influence of expansion and contraction, a form of unit may be used in which its span portion 97 takes substantially the form of a surface of revolution. Such a construction is shown in Fig. 65.

It will be obvious, of course, that the units to be used in the arch roofs of Figs. 57 to 65, inclusive, will be fabricated on a combination of dies and rolls such as will lend the necessary curve to the decking. This is a simple matter of engineering practice.

In all the horizontal or angular decks heretofore described, the span portion of the units has been arranged above the web and flanges thereof. This is not an essential requirement, however, inasmuch as the units may be reversed so that their webs and flanges project above the span point. Such a construction is shown in Figs. 66 to 70, inclusive.

In order to adequately lock the standing seam formed by the intermeshing tongues and grooves of the unit webs, the expedient shown in Fig. 66 may be resorted to. In this case, one flange on each unit may be elongated and the thus extended portion 98 bent back upon the portion 6 and terminating in a deformed snap lock portion 99 adapted to fit over and engage the strengthening edge 7 of the neighboring unit as shown at the left hand end of Fig. 66. This effectively ties the two units together. In Fig. 67, a separate cap member 100 is shown which may be used to replace the construction shown in Fig. 66 as in Fig. 68.

In Fig. 69, a roof deck is shown of these so-called "upside down" units, the entire web and flanges being split down to the span portion 1 which is left integral. In this manner, a solid piece of metal may be carried over the roof peak in much the same manner as is shown in Fig. 42 excepting that a much stronger construction results due to the greater area of the integral carry-over. A suitable cap plate 101 of any desired material may be used and obviously the roof may have applied thereto finish material of various types.

In any of these upside down constructions, fills of one kind or another may be located between the upstanding seams such as is shown in Fig. 68 in which the fill 102 may be of insulating material or the like. Such insulation, strengthening material or the like may be included between upstanding seams of all units or only between the seams of some units.

Where it is thought desirable to supply other fastening members between the webs of adjacent units, the modification shown in Fig. 20 may be resorted to. Ears 103 are punched out of the webs to form the interlock as shown. Ordinarily this will not be required as the friction joint or snap interlock between the tongues and grooves on the webs will be found to be amply sufficient.

From the above, it will be noted that a particularly flexible construction has been designed.

Obviously these decking units may be made of any type of metal, whether ferrous, non-ferrous or alloys thereof and of any dimensions. As a matter of fact, units up to 24 feet in length have been constructed and tested in a deck system which was adequately satisfactory.

The fact that the units may be interlocked in tight joints by reason of frictionally engaging or snap locked tongues and grooves is of paramount importance in that no additional locking members are needed on the job. This makes for ease of construction and rapidity of erection. Moreover, the tongued and grooved interlock, even without the snap locking feature, that is, where tongues and grooves have either angular or parallel surfaces, forms when engaged a definite weather stop. Consequently, even though moisture should seep beneath the finish material applied on top of the deck, it will not pass such a joint.

Another most important feature of the invention resides in the strengthening edge portions 7 on the flanges. This will be readily apparent from the fact that the decking units will, in the vast majority of instances, be made of light sheet metal. Consequently, for standardization of manufacture, they should be made of the same weight of metal throughout. Inasmuch as such flanges are in tension and are also called upon to withstand bending, this strengthening edge portion is of inestimable value in successfully accomplishing this purpose. Without it, it would be necessary to make the flanges of heavier material which immediately introduces complications into the manufacturing picture.

While the invention has been shown and described with particular reference to specific embodiments, it is to be understood that the invention is not to be limited thereto but is to be construed broadly and restricted solely by the scope of the appended claims.

I claim:

1. A metallic building unit comprising a metallic span portion having at each of two opposite sides thereof a web, each metallic web having a tongue or groove adapted to engage with a groove or tongue respectively in a unit erected adjacent thereto, said tongue and groove each being arranged longitudinally of its web, the greatest thickness of the outside of the tongue

being less than the greatest thickness of the inside of the groove by an amount substantially equal to twice the thickness of the web, each web having an end flange substantially parallel to the span portion, the end of each flange terminating in a strengthening edge portion.

2. The building unit of claim 1 in which each web is provided with a plurality of deformed portions complementary to corresponding deformed portions of the other web.

3. The building unit of claim 1 in which the strengthening portion at the end of one web flange extends upwardly and engages beneath the metal forming the groove in that web, and the other strengthening portion at the end of the other web flange extends upwardly and engages the metal at the mouth of the tongue in that web.

4. A building construction including two metal building units erected in an end to end manner, with a third metallic building unit erected laterally of the first two and extending on each side of the lateral joint therebetween, each unit having a span portion, and longitudinal webs each of which have a flange substantially parallel to the span portion, each flange terminating in a strengthening portion, the adjacent webs on adjacent units interengaging in a tongued and grooved joint, and a splice plate bridging the lateral joint between end abutting units, said plate including a web with a deformed portion conforming to the corresponding portion of the webs of the units with which it engages, the web of the plate being parallel to the webs of the units.

5. The construction of claim 4 in which the splice plate lies inside the end abutting units.

6. The construction of claim 4 in which clips are interlocked between the webs of the units, with rods at right angles to the unit length and carried by the clips, and set cementitious material overlying the spans of the units and in which the rods are embedded.

7. The construction of claim 4 in which the depth of one unit is greater than that of its adjacent neighbor, the span portion of both units being substantially flush, and supports for the flanges of each unit.

8. The construction of claim 4 in which the depth of one unit is greater than that of its longitudinally adjacent neighbor, the span portion of both units being substantially flush, and supports for the flanges of each unit, the interengagement of the web tongues and grooves between units of lesser and greater depth being in substantial alignment.

9. The construction of claim 4 with a narrow mass of set cementitious bridging material extending between the webs and span portions of one unit and intermediate the ends of a unit.

10. A deck construction including a plurality of metallic building units each having a span portion and longitudinal webs having flanges with strengthening ends, the webs of longitudinally adjacent units being interlocked together to form I-beams, spaced apart supports for the ends of two thus formed I-beams, with a unit therebetween terminating short of said support, and a set cementitious bridging extending between said I-beams and including the end of the unit which terminates short of the support.

11. An arched deck construction including a plurality of metallic building units, each having a span portion and longitudinal webs having flanges with strengthening edges, the webs of longitudinally adjacent units being interlocked together to form I-beams, said deck including two series of deep units having a plurality of interlocks in their webs, a support for said series of units and an intermediate series of shallower units having a lesser number of interlocks in their webs, between the series of deep units, the deep units and shallower units being interlocked through the instrumentality of their webs, the units of the two series overlapping in a direction at right angles to a unit length.

12. The construction of claim 4 in which one of the units carries a generally rectangular metallic bridging diaphragm arranged laterally of the unit and contacting with and at right angles to its span and web portions.

13. The construction of claim 4 in which one of the units carries a generally rectangular metallic bridging diaphragm arranged laterally of the unit and contacting with and at right angles to its span and web portions, in which the diaphragm is held in place at the top by a deformed portion of the span, and at the bottom by a deformed portion of the strengthening edge.

14. The construction of claim 4 in which each unit carries a generally rectangular metallic bridging diaphragm arranged laterally of the unit and contacting with and at right angles to its span and web portions, diaphragms on the two units being in lateral alignment.

15. The construction of claim 4 with a finish attaching element pinched between the tongue and groove of the webs of adjacent units and projecting beyond the surface of the spans thereof, and finish material overlying the spans of the units and held by the attaching element.

16. The construction of claim 4 with a support for the interengaged webs of the two units, a portion of the span of one unit being cut and deformed at right angles to the remainder of said span and set cementitious material overlying and contacting the support, and included between the deformed portion of the span and the webs of said unit.

17. The construction of claim 4 in which the span of one unit is split longitudinally and telescoped laterally to produce an overlap and means to secure the overlaps together.

18. The construction of claim 4 with a horizontal metallic plate extending laterally of the unit, the ends of the plate being supported on and straddling a strengthening edge portion of the flanges of said unit.

19. The construction of claim 4 with a support for the interengaged webs, said support having a flange, and an attaching clip located between the tongue and groove of the webs and engaging said flange.

20. The construction of claim 4 with a lock engaging the flanges on two interengaging webs whereby said webs are prevented from accidental separation.

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