Nov. 26, 1935.

T. P. SCOTT

2,022,255

BUILDING CONSTRUCTION

Filed June 12, 1934

5 Sheets-Sheet 1

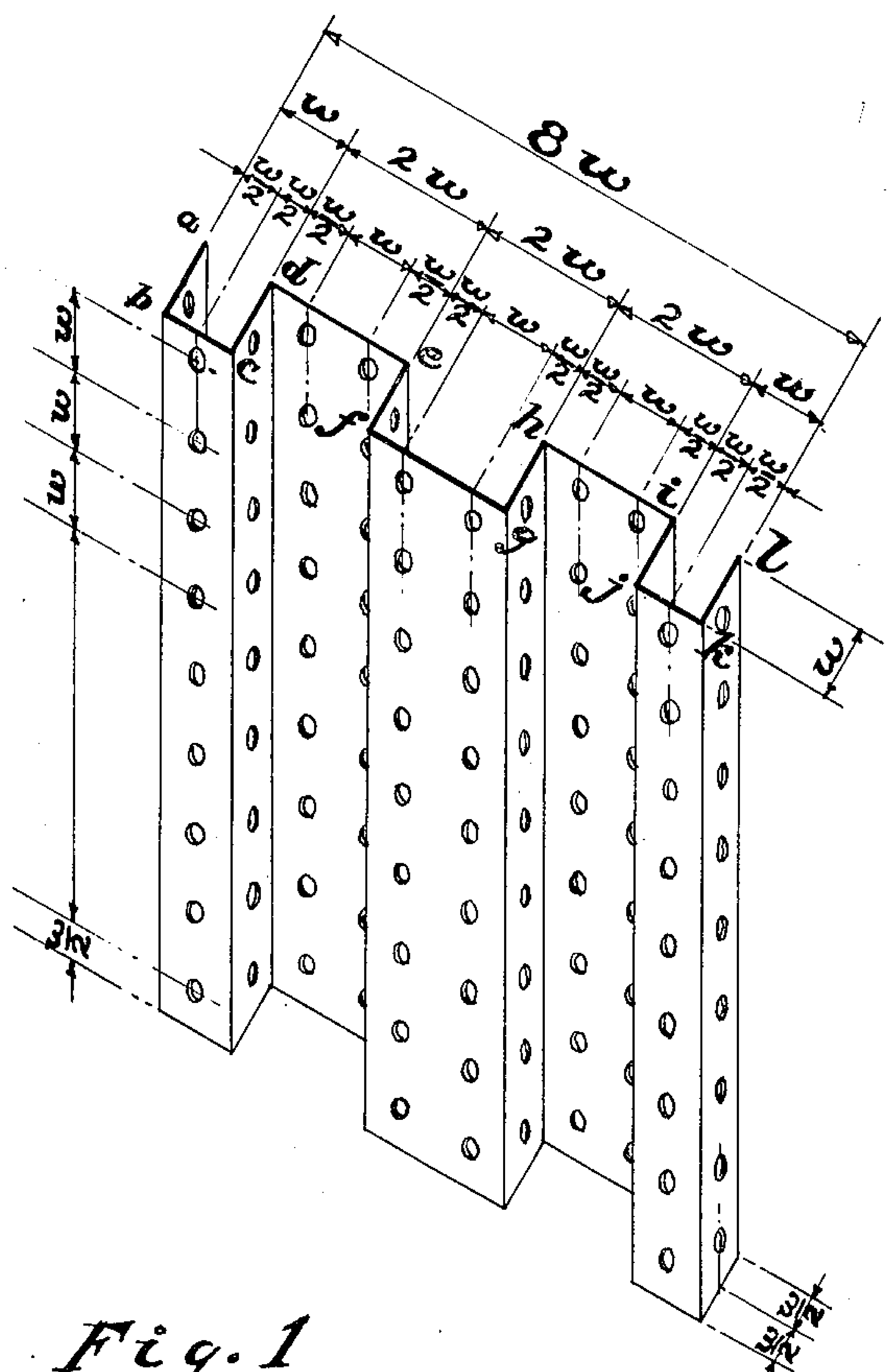

Fig. 1

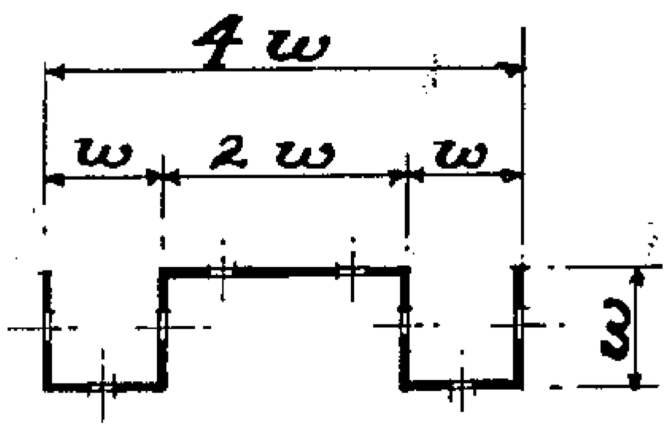

Fig. 2

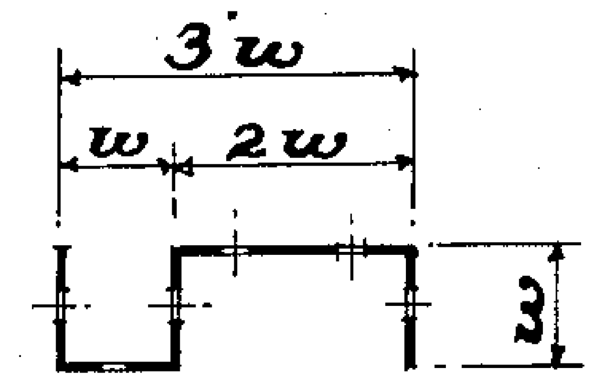

Fig. 3

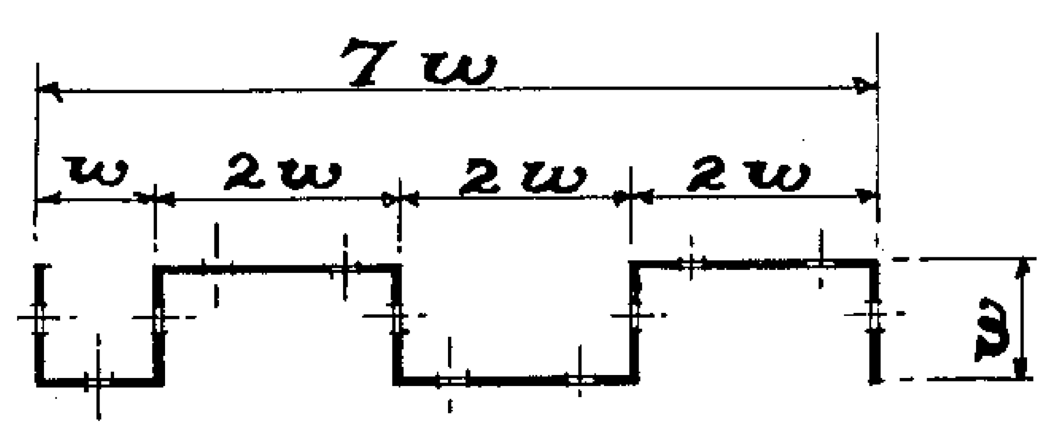

Fig. 4

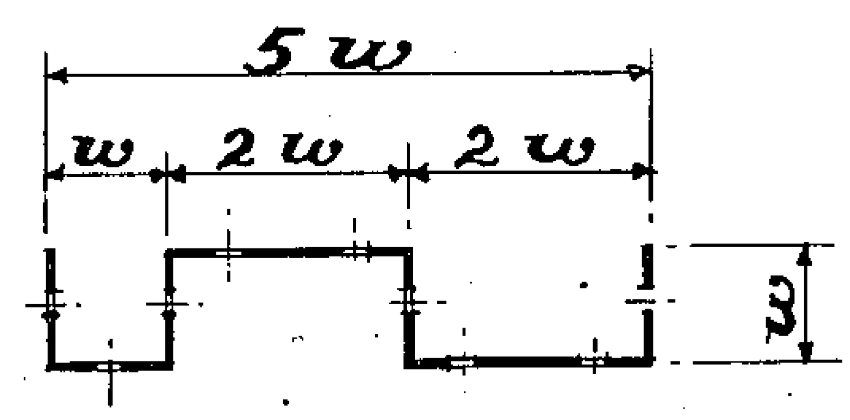

Fig. 5

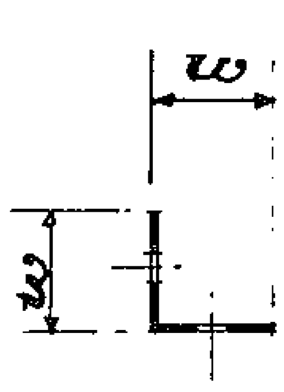

Fig. 6

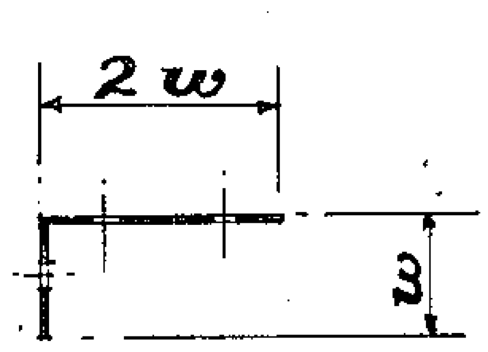

Fig. 7

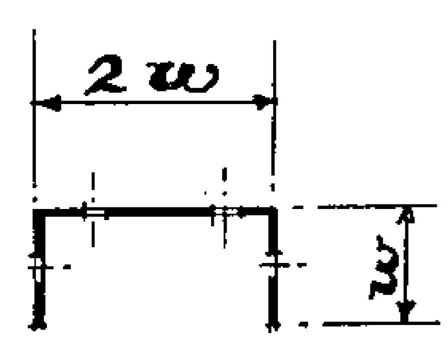

Fig. 9

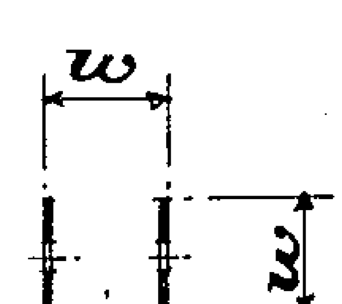

Fig. 10

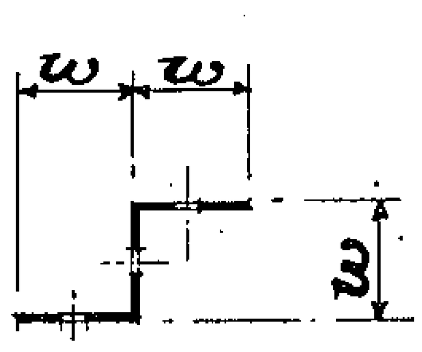

Fig. 8

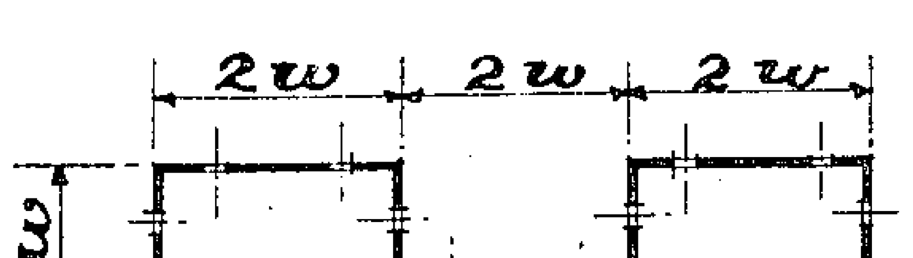

Fig. 10 a

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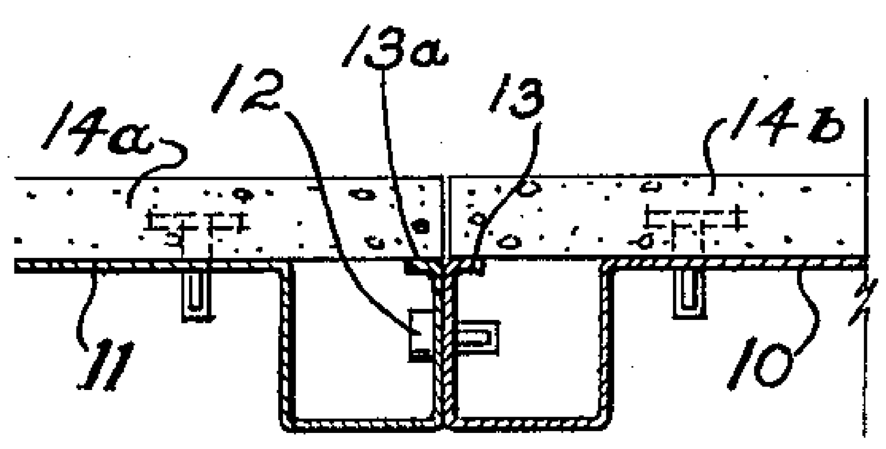

Fig. 11

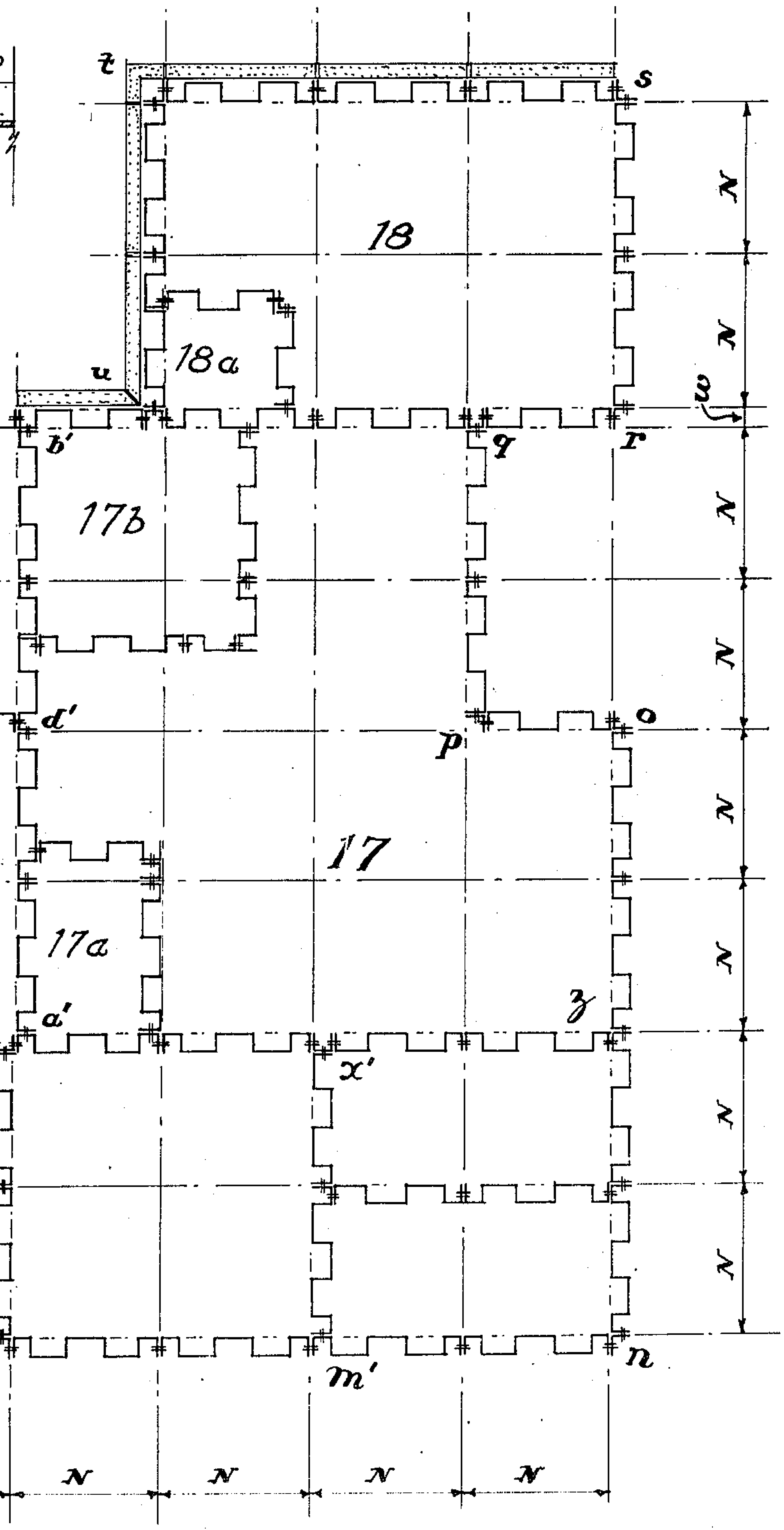
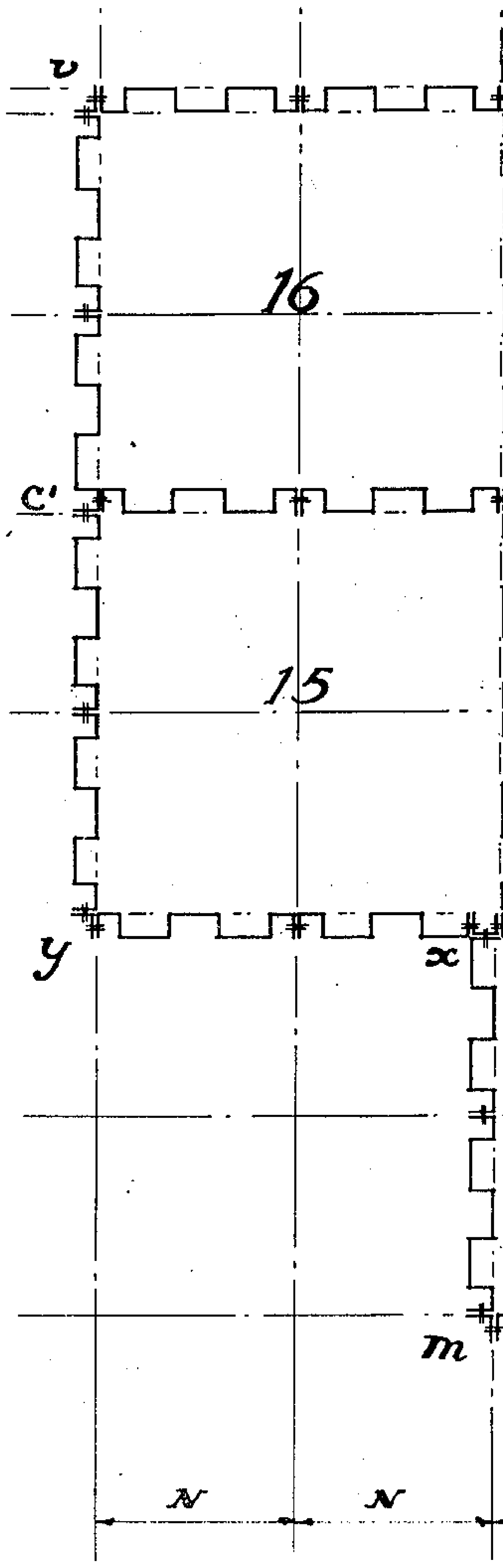

Fig. 12

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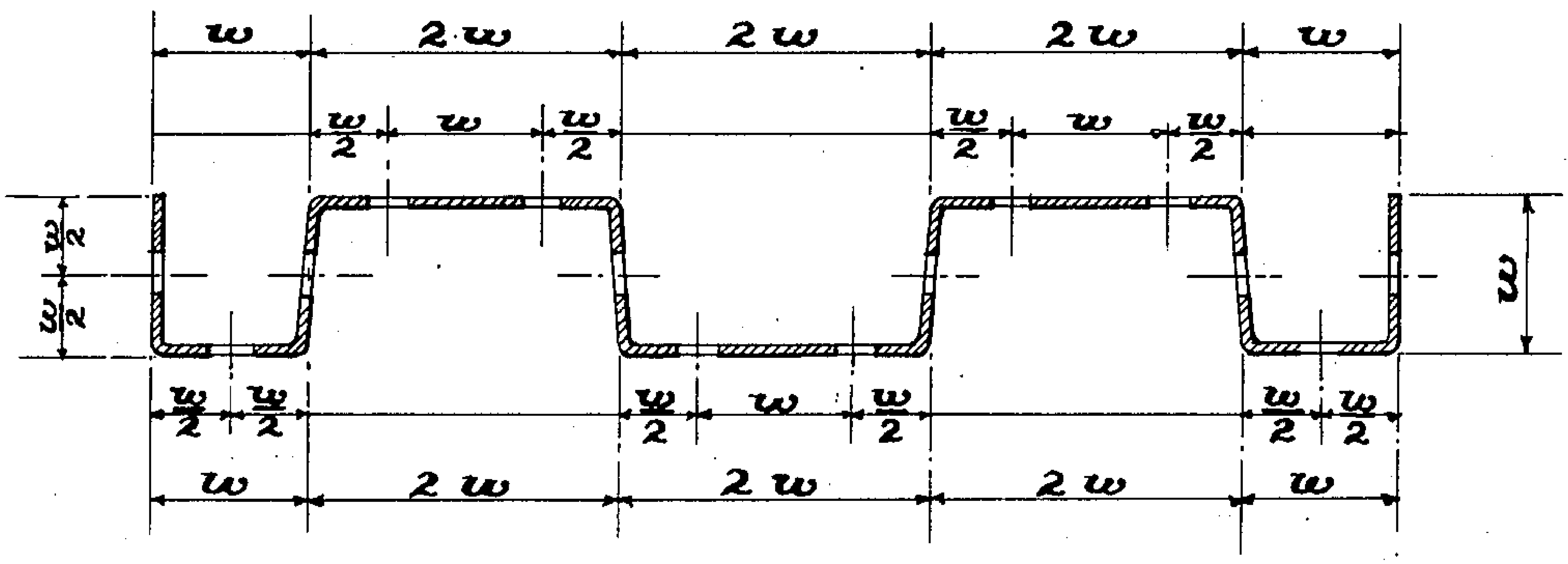

Fig. 13

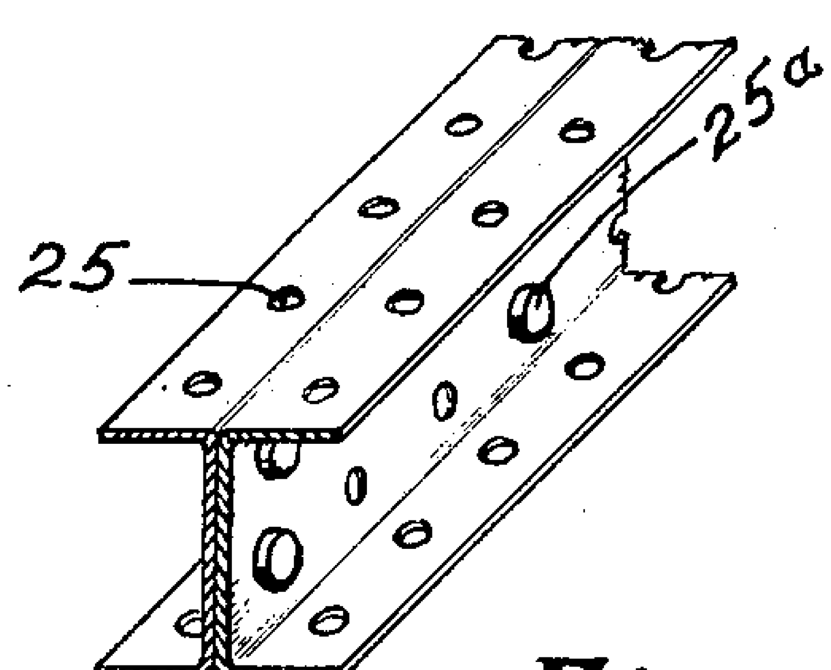

Fig. 15

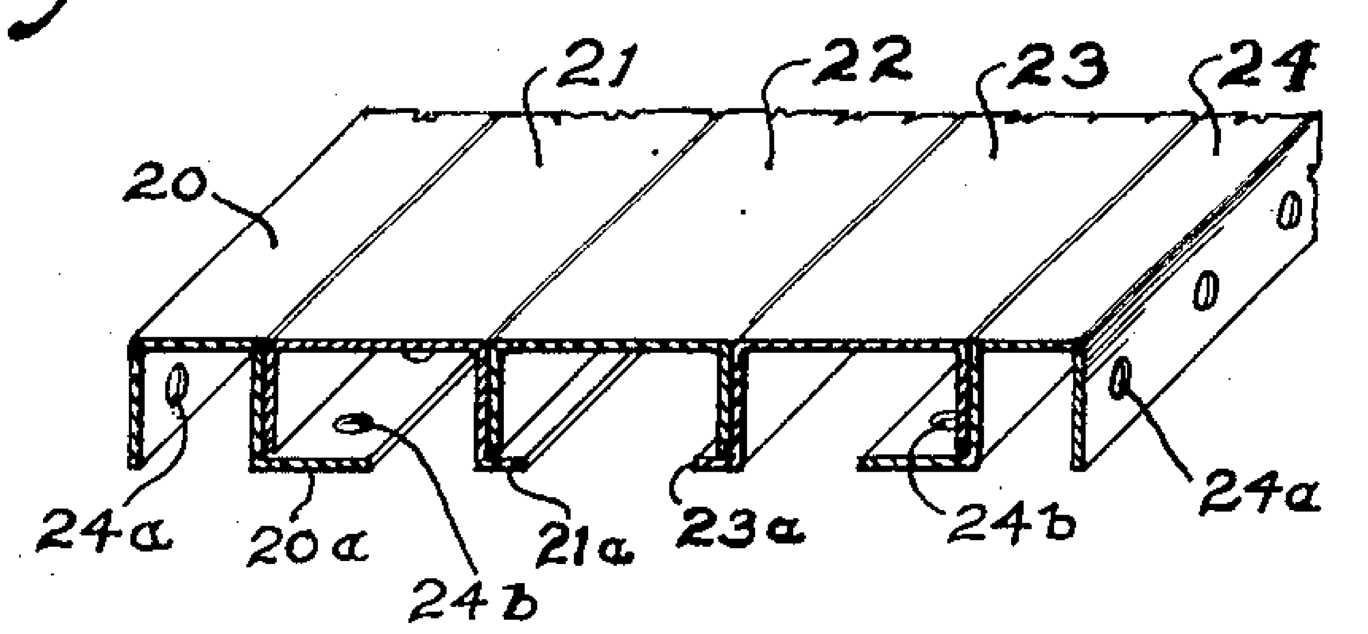

Fig. 14

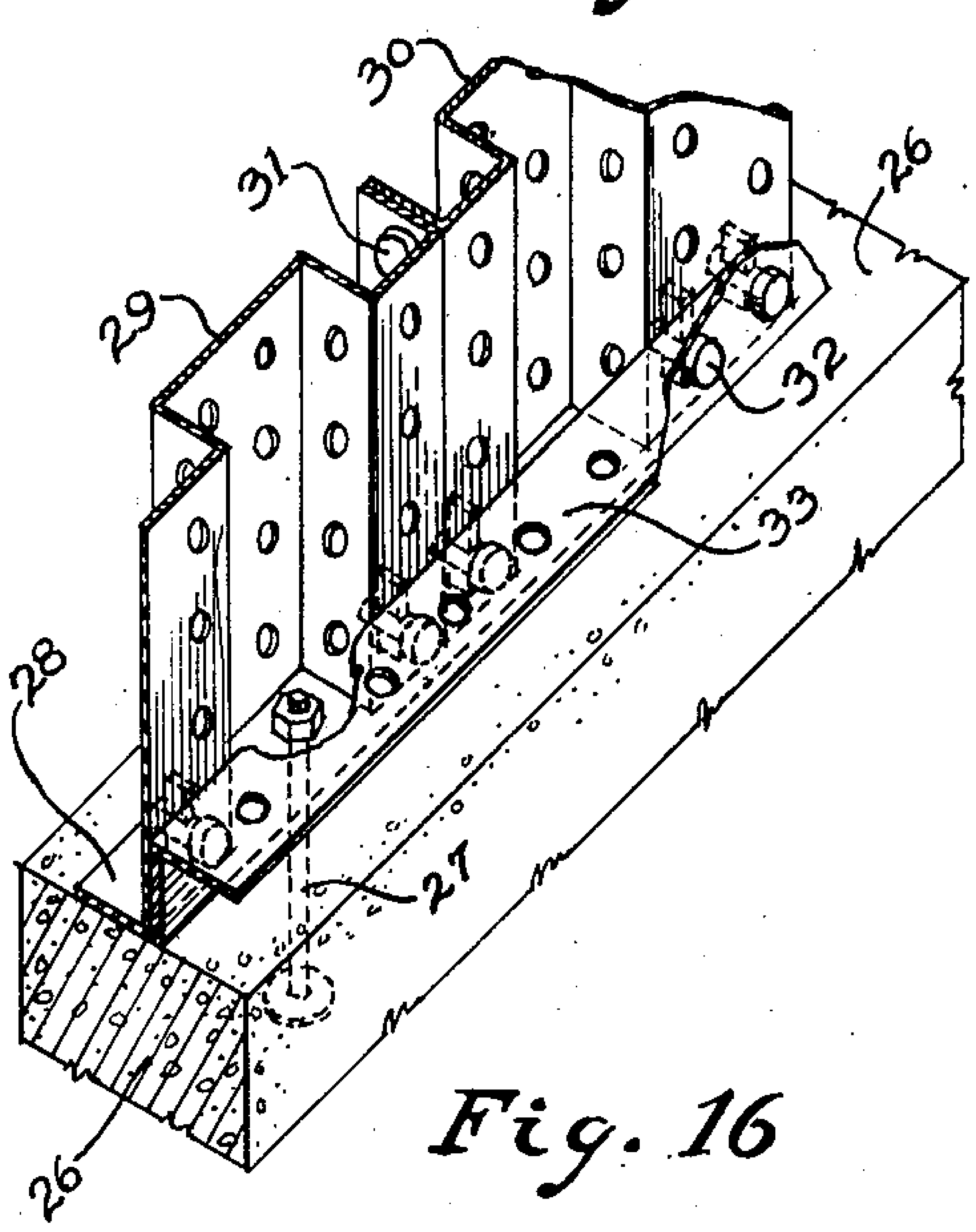

Fig. 16

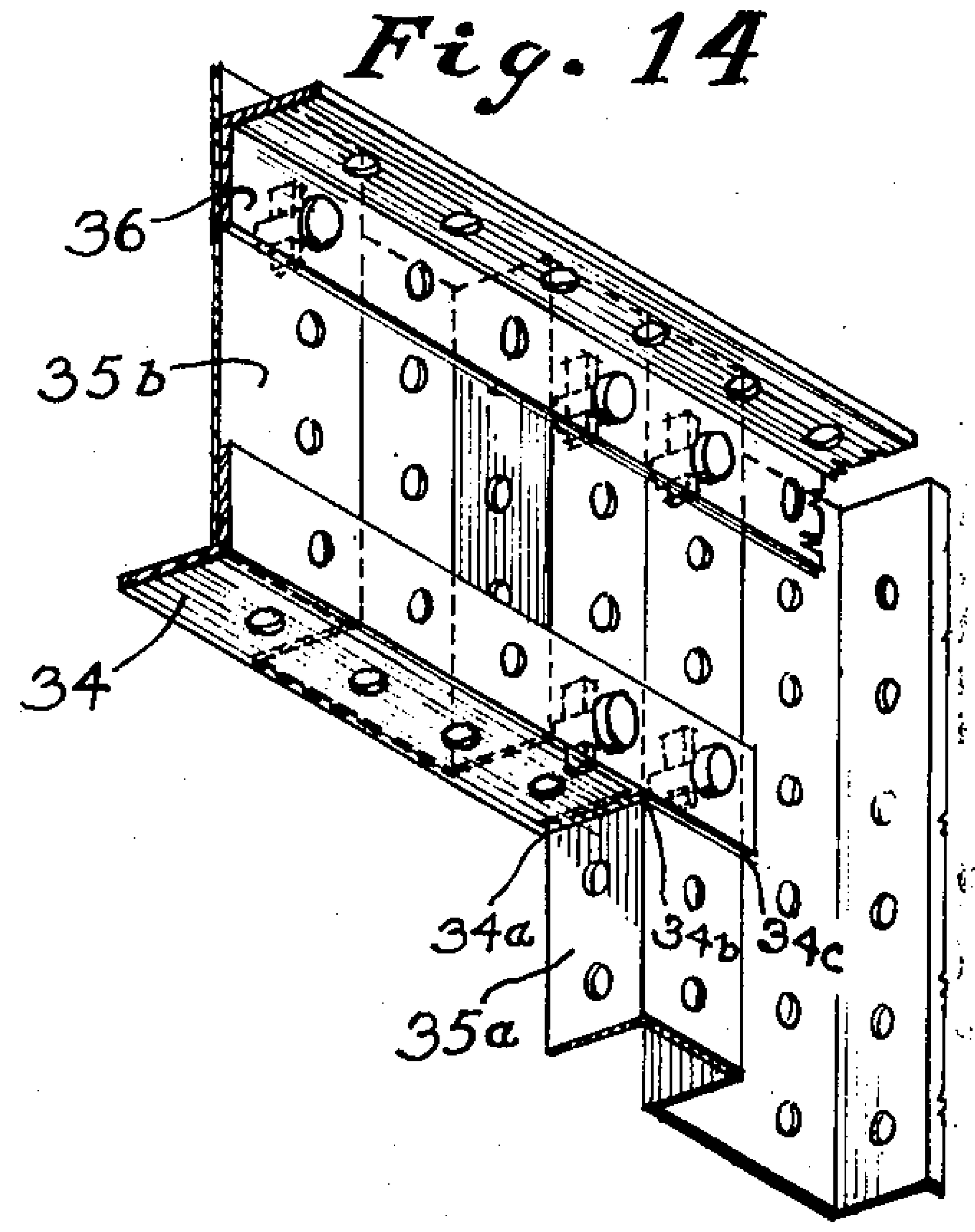

Fig. 17

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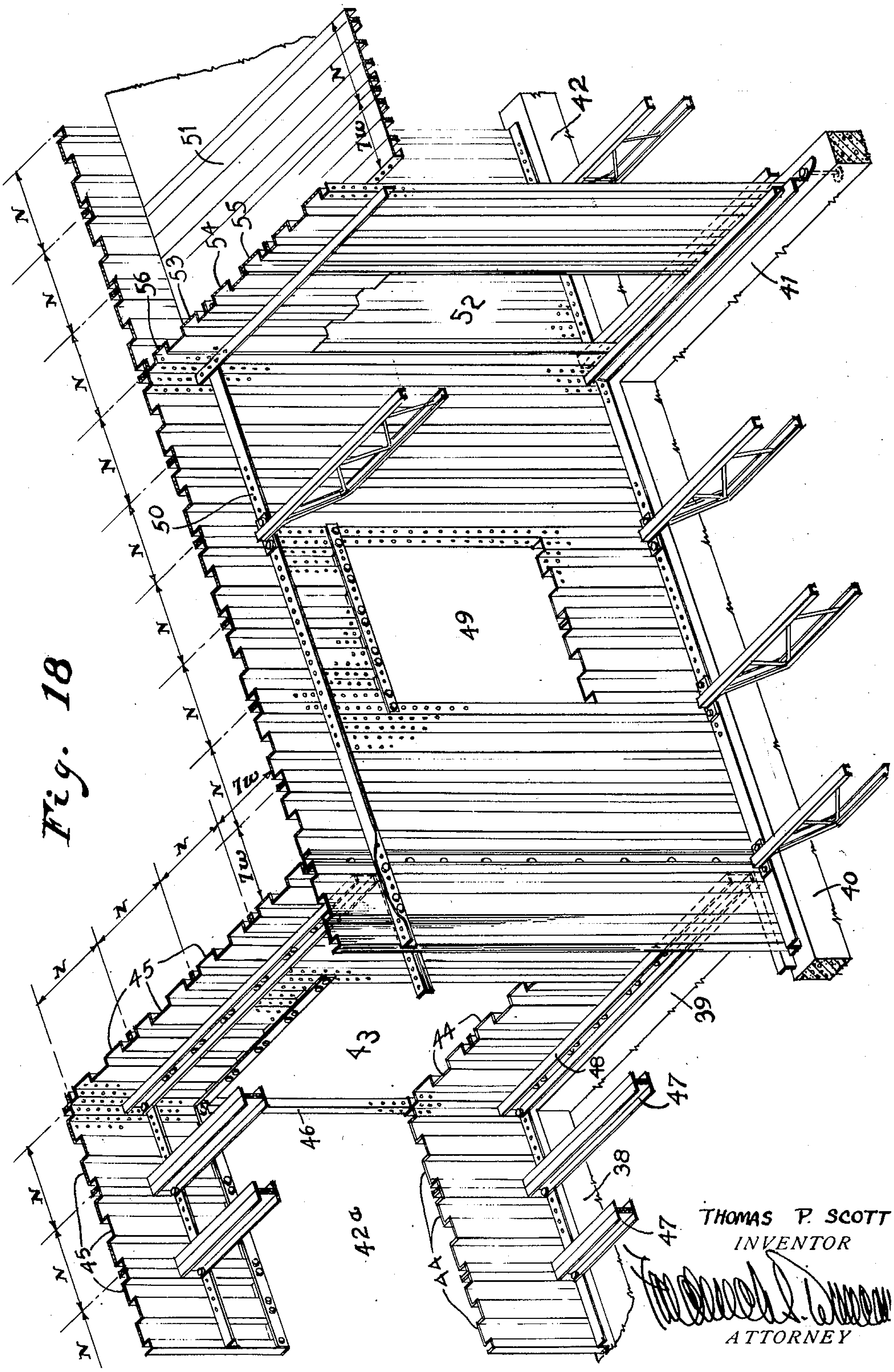
Fig. 18



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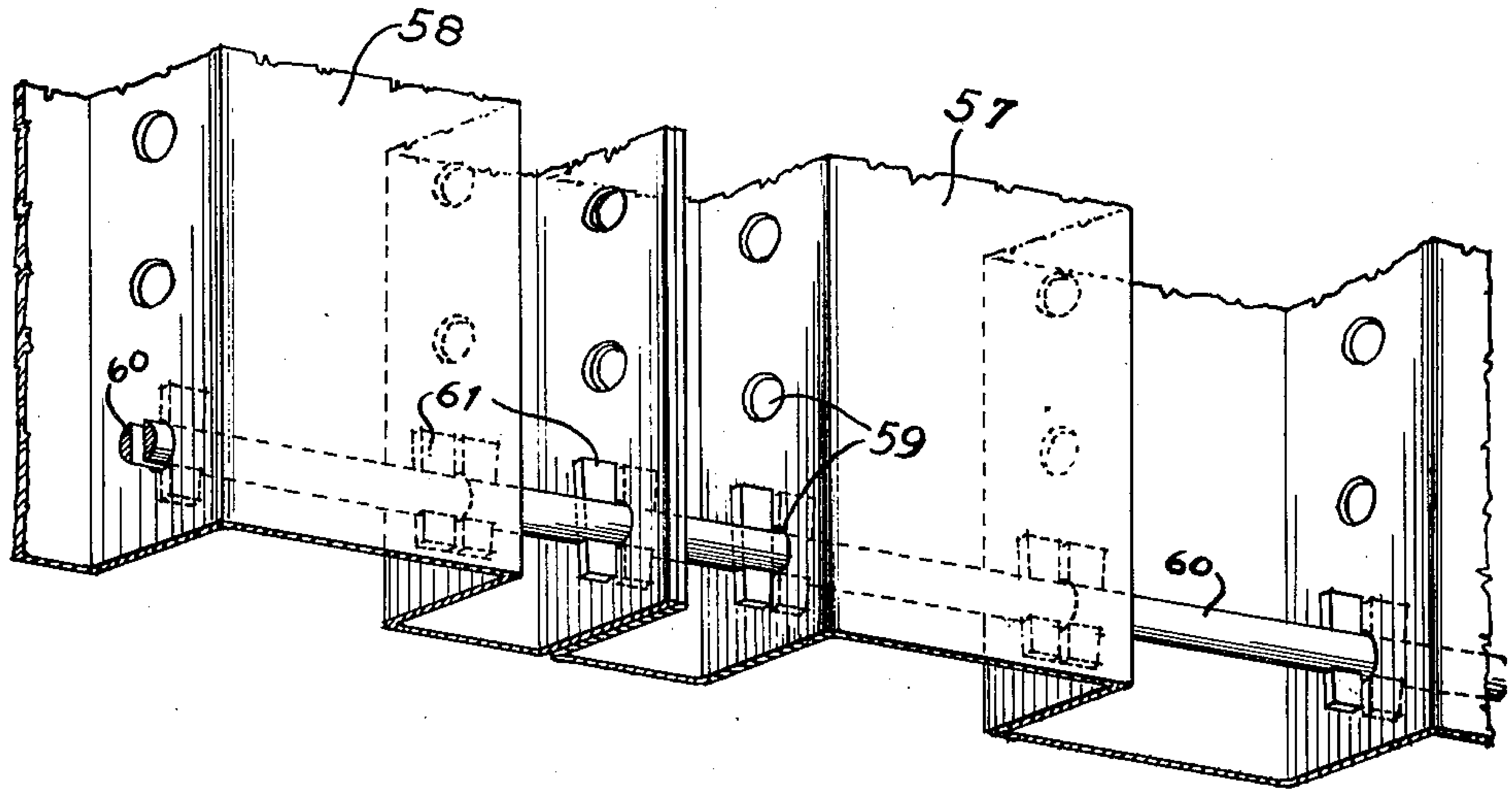
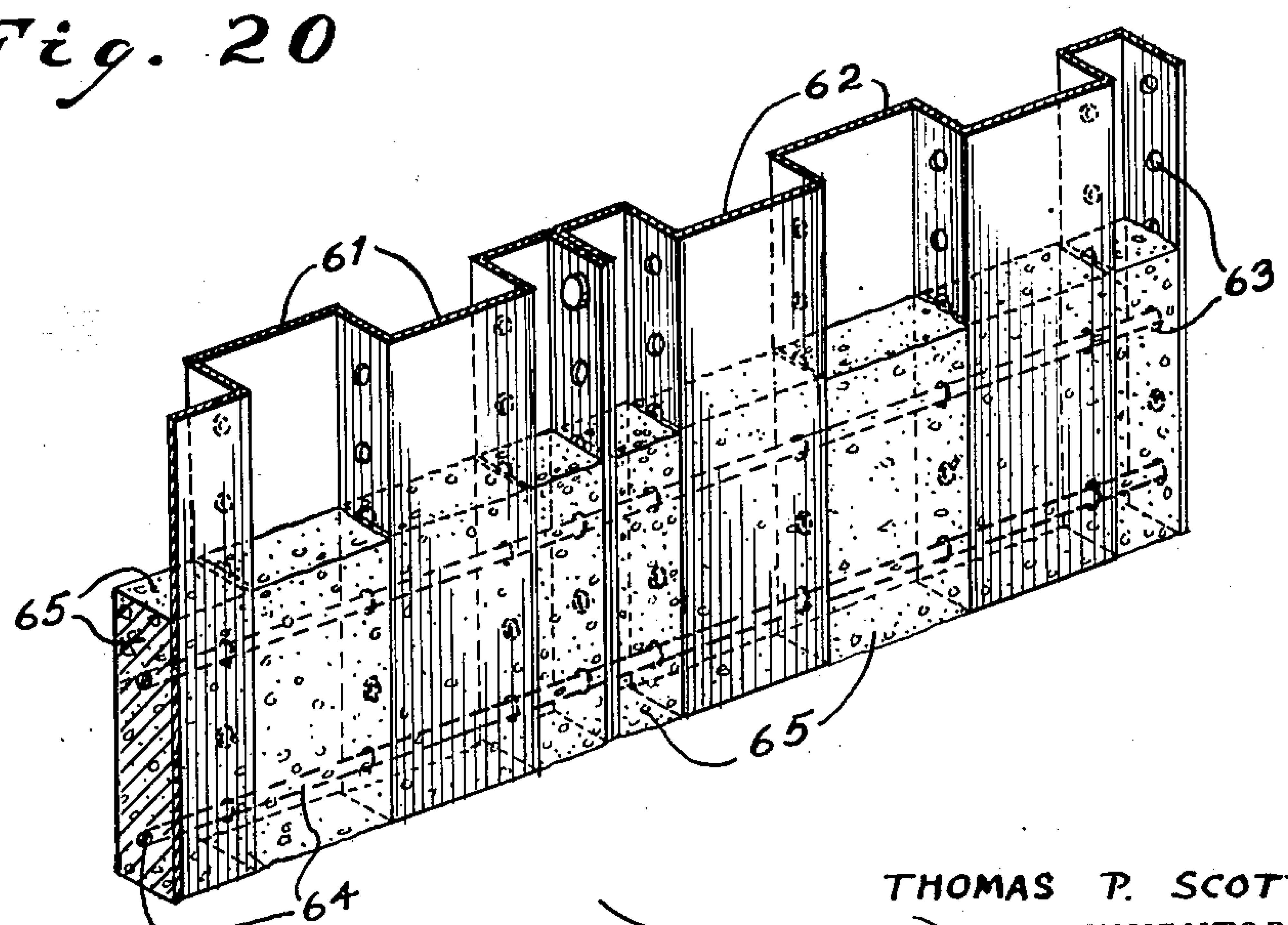


Fig. 19

Fig. 20



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Patented Nov. 26, 1935 2,022,255

UNITED STATES PATENT OFFICE

2,022,255

BUILDING CONSTRUCTION

Thomas P. Scott, Montclair, N. J.

Application June 12, 1934, Serial No. 730,233

10 Claims. (Cl. 189—1)

This invention relates to an improved method and means of erecting buildings of the so-called "pre-fabricated" type—that is, the type which is constructed of parts, all or many of which are manufactured to fixed dimensions previous to erection. More particularly, it relates to the species of this type in which the component parts not only serve as walls and partitions, but also combine with those functions the function of supporting the structure as distinguished from the species which employs columns, posts, studs, and the like for supporting the enclosing walls and partitions. The main object of the invention is to make it possible to manufacture the component wall parts in large quantities and of stock dimensions and shapes, that may nevertheless be assembled without cutting and fitting into a building having wide flexibility in dimensions, design, and room arrangement and which may be also assembled or used singly to serve as beams, columns, posts, girts, joists, studs, and the like. One of the advantages of the invention is the great range of variation in design and dimensions that is thus made possible, the ease and cheapness of erection which largely arises out of facility of attachment as well as avoidance of cutting and fitting, and the ease and cheapness with which the stock parts may be manufactured, transported, and handled. The factors which are most important in reducing cost are the adaptability for manufacture of parts in large quantities and the avoidance of cutting and fitting.

Another feature of this invention is the provision for standard forms of light sheet metal which may be bolted together, at points determined by a standardized location of bolt holes to form a continuous bearing wall having wide flexibility in dimensions without having recourse to elements which differ in essential form from each other.

The invention includes provision for standard units of preformed sheet material so formed that a multiplicity of these units may be easily joined to each other and to other related elements by means of attachment such as bolts that require a predetermined location of points of attachment, whereby great flexibility in design is made possible without the necessity of cutting, fitting, punching or drilling at the job, and whereby a minimum of variation and a similarity of character in the component stock elements are made possible.

It is further a purpose of this invention to provide a method of combining certain of these stock elements in a manner conformable to a modular system of design where the module is of a size conformable to dimensions of finish panels, floor slabs, and like elements which may be factory-fabricated in stock sizes.

It is an additional purpose of this invention to so interrelate various elements used in the construction that these said elements may be formed in one series of rolls or in one press.

A further purpose of this invention is to provide a structure which may be easily altered or added to after erection and one which has the advantage of high salvage value of its component parts on being dismantled.

In the accompanying drawings,

Fig. 1 is an isometric view of one of the full width panels;

Figs. 2–10*a*, both inclusive, are views of modified sections of panels which are elements of that shown in Fig. 1;

Fig. 11 is a view of a modification of the section showing lateral edges turned inwardly so that, when abutted, a backing is formed for finish units whose joints coincide with joints of structural panels;

Fig. 12 is a horizontal section through the walls of a building shown diagrammatically as assembled from panels shown in Figs. 1–10*a*, inclusive;

Fig. 13 is a section of a panel of the general shape of Fig. 1 but with the gauge of the material shown as of exaggerated thickness to demonstrate a method of precisely proportioning the related elements of the panel;

Fig. 14 is an isometric view of an illustrative method of assembling various derivative sections to constitute a continuous system of floor or roof framing;

Fig. 15 is an isometric view of an illustrative combination of derivative sections to form an I-beam;

Fig. 16 is an isometric view showing an illustrative method of anchoring a wall to a concrete or masonry foundation;

Fig. 17 shows an illustrative method of assembling the sections to increase the load-carrying ability of panels spanning wall openings;

Fig. 18 is an isometric view of an illustrative assemblage of panels and/or related derivative elements to constitute a building structure embodying my invention;

Fig. 19 is an isometric view showing a method of reinforcing a series of assembled panels;

Fig. 20 is an isometric view of an assemblage of panels provided with reinforcing rods embedded in cementitious material placed within the channel forms.

Referring to the drawings, the panel of Fig. 1 is composed of sheet material, preferably metal, which has been rolled, pressed or otherwise formed to a section indicated by the line *a, b, c. d, e, f, g, h, i, j, k, l,* and which as shown in the drawings is composed of a series of connected alternately-reversed channels of uniform depth and preferably of approximately rectangular cross-section. The dimensions of the several elements of the section, i. e., backs and legs of the channels, are all either equal to or are an integral multiple of the dimensions *k—l,* which is the measure of the thickness *w* of the panel (i. e., the overall depth of the channels) and may be termed the "primary module *w*"—that is, in the particular case of Fig. 1, the elements *a—b, b—c, c—d, e—f, g—h, i—j, j—k,* and *k—l* are all equal to the primary module, while each of the dimensions *d—e, f—g,* and *h—i* are equal to twice the primary module. The entire width N of the panel is equal to eight primary modules *w,* and panel sections may consist of any desired number of primary modules from one to eight. It is also to be understood that the absolute magnitudes of the primary module and of the component elements of the section and of the overall width N of the section may be whatever the fabricator chooses, although I would state that for many if not most purposes a primary module of 3'' is suitable.

Figs. 2–10*a,* both inclusive, show sections containing a varying number of elements of the panel section of Fig. 1, all, however, containing an integral number of primary modules *w*—that is, Fig. 2 is of a width of four primary modules *w,* Fig. 3 of three, Fig. 4 of seven, Fig. 5 of five, Fig. 6 of one, Fig. 7 of two, Fig. 8 of two but being of so-called Z shape, Fig. 9 of two, Fig. 10 of one, and Fig. 10*a* of six. Fig. 9, although having two primary modules, differs from Figs. 7 and 8 in shape of the section as shown. Fig. 10, while having only one module, differs from Fig. 6 in shape.

It will also be observed that each element of each panel is provided with a row of uniformly spaced holes so that panels may be readily bolted together without the necessity of boring, drilling, punching, or the like. These holes are disposed in a row at a distance

$$\frac{w}{2}$$

from the adjacent bend which locates them on the longitudinal centerline of the element where the width of the element is equal to one module. In instances such as dimensions *de, fg,* and *hi,* where the element is of the width of two modules, the rows of holes are disposed along the centerline of each primary modular area of the element. In all cases it is preferable that the holes be uniformly spaced so that the holes in any panel will register with the holes in any other panel and, for convenience in assembling, it is preferable that the spacing be at intervals of one primary module between centers or at convenient multiples thereof. By so arranging the holes, any panel may be connected to any element of another panel at intervals as frequent as one primary module.

Fig. 11 shows two panels **10** and **11** joined together by key bolts **12** and provided with inturned flanges **13** and **13*a*,** against which the joints of the preformed finish material, such as the slabs **14*a*** and **14*b*,** may abut.

Fig. 12 illustrates some of the many ways in which the various panels hereinbefore described may be assembled to constitute both bearing and non-bearing walls, interior and exterior, of a building. It should be explained, however, that buildings of the ordinary size used for habitation would require more panels than are shown, if it is to be assumed that the panels are of the measurements above suggested—namely, of a width of 24'' or anything approximating such dimensions. However, it is believed that the figure, taken together with its description, will amply illustrate diagrammatically the application of the invention to actual construction.

The exterior walls *mn* and *no* as shown are composed of four panels, each of the width of eight primary modules. The wall *op* is composed of one panel of 7 modules. The wall *pq* is composed of 1 eight module panel and 1 seven module panel. The wall *qr* is composed of 1 seven module panel. The walls *rs* and *tu* are each composed of 2 eight module panels. The wall *st* is composed of 3 eight module panels. The wall *uv* is composed of 2 eight module panels and 1 seven module panel. The wall *vy* is composed of 4 eight module panels. The walls *yx* and *xm* are each composed of 1 eight module panel and 1 seven module panel.

The interior bearing wall *a'b'* is composed of 4 eight module panels, and the wall *c'd'* is composed of 2 eight module panels, thus forming in combination with the outer walls two rooms **15** and **16**, room **15** having dimensions of 16 primary modules by 16 primary modules, and the room **16** having the dimensions of 16 primary modules by 15 primary modules. Obviously, the junctions either of the partitions *c'd'* or *a'b'* could be shifted a distance of one module or any integral multiple thereof, and the dimensions of the respective rooms be altered accordingly. In other words, any desired dimensions of these two rooms could be obtained provided the variations were not less than one primary module, which, in the case of a primary module of 3'', would answer the needs of practically all building construction.

The smaller enclosures **17*a*, 17*b*,** and **18*a*,** which may be assumed to be closets, bathrooms, or the like, show methods of utilizing some of the narrower panels of Figs. 2–10*a,* both inclusive. In the room **17*a*,** there are employed an 8 module panel, the 1 module panel of Fig. 10, and the 7 module panel of Fig. 4.

The inner walls of the room **17*b*** are composed of two 8 module panels, the 4 module panel of Fig. 2, and the 3 module panel of Fig. 3.

The small room **18*a*** is made up from the 5 module panel of Fig. 5 and the 6 module panel of Fig. 10*a*.

It will be seen from Fig. 12 that the various wall intersections and joints are accomplished with elements which are integral parts of one standard section.

Exteriorly convex corners may be formed by the use of an angle section, such as shown in Fig. 6. This same member may also serve at exteriorly concave corners as shown at P, where there is no intersecting interior wall. Where an interior wall intersects the junction of two exterior walls at an exteriorly concave corner as at *q*, a channel-section member such as shown in Fig. 10 may be used. Other possible connections and joints will be evident from the character of the sections.

In Fig. 12 exterior walls *v—y—x—m—n—o—*

p—q—r—s—t—u enclose a space resolvable into areas defined by a secondary module N equal to the standard panel width 8w, which may be considered to be a convenient size for the determination of preformed floor slabs, wall and ceiling finishes and the like. With the exception of panels adjacent to certain intersections all the panels are 8w in width, and consequently present a horizontal extension uniformly divided into units of a size convenient to preformed finishes. It will be seen that, if desired, the only variation from the 8w panel may be a 7w panel and that a building may be erected on this secondary modular basis of 8w and 7w panels alone. Of necessity, if an unbroken modularly divided exterior wall is to be maintained, where the secondary module is greater than w, any interior bearing wall, such as a′b′, a′z intersecting this exterior wall must break the regular modular division of its interior surface and of the area enclosed by an amount equal to the thickness of the intersecting wall, i. e., by the dimension w.

It will be seen that all interior walls as shown in Fig. 12 have one surface intersecting the adjacent line of secondary modular division. Consequently, the modularly defined area adjacent to one side remains uninterrupted while that adjacent to the other side is interrupted by an amount equal to w or the thickness of the wall. Hence, where another interior bearing wall or partition such as m′x′ connects interior bearing wall a′z and exterior wall mn, a 7w panel in conjunction with an 8w panel is required.

It will be obvious that any interior bearing wall connecting two exteriorly concave corners such as wall uq does not interrupt either of the adjacent modularly defined areas since it does not fall under the condition of a wall intersecting another wall of regular modular division along its continuity.

Since w is a determining factor in the location of bolt holes as well as of the form of the panels and derivative sections, any required variation in a design conforming to a secondary modular spacing, due to wall thickness, is conformable to the standard panel and its derivatives.

Furthermore, preformed finish units, floor slabs, etc., need be made of two sizes only N and N—W. It will be seen in Fig. 12, disregarding walls enclosing areas 17a, 17b, 18a which are not conformable to a secondary modular system, that the two sizes required have horizontal dimensions of 7w and 8w.

If it is desired to erect a structure or part of a structure not conforming to a secondary modular system and consequently not directly adapted to preformed finishes, preformed floor slabs, and the like, a variation in any dimension may be achieved limited only by the quantity w which in the case of w being equal to 3″ would allow sufficient flexibility in design for almost any desired result.

It has been previously noted that the channels constituting any panel are "approximately" rectangular in cross-section. It should, however, be explained that they can be precisely rectangular in cross-section if the thickness gauge of the material be so small as to become negligible. Such would ordinarily be the case in practice, but, if extreme accuracy is desired even in the case of thin material, it is necessary that the legs of the channels be flared as shown in Fig. 13, where I show for illustrative purposes a sectional view of an 8w panel composed of material of substantial thickness. It will be noted that each vertical line marking a primary modular distance or an integral multiple of the primary modular distance intersects the outer corners of adjacent channels. In other words, the overall width of the back of each channel is equal to one primary module or a multiple thereof, as the case may be. This is accomplished by flaring the legs of the channels just enough so that the line dividing each primary module of a channel or each integral number of primary modules of a channel, as the case may be, passes through the outer corner of adjacent channels, as shown in the drawings. This flaring would not be necessary in the case of the outer legs of the outermost channels, which may be rolled perpendicular with the backs, although, if desired, they could be flared as in the case of the other channel legs. If such were done, the error would be so small as to be negligible even though it would be cumulative with the addition of each panel. As a matter of practice, it would make little difference as the stock would ordinarily be sufficiently flexible so that any flaring of the end legs would be overcome by the tension of the bolts connecting adjacent panels.

Fig. 14 illustrates a structure which may be assumed to be a flooring, roofing, or the like, made up of several of the sections shown in Figs. 2–10a, both inclusive, some of them being somewhat modified. For example, the element 20 is the section shown in Fig. 10 with the flange 20a integral therewith. Section 21 is the section shown in Fig. 9 with one leg somewhat shorter in order that it may be joined to the element 20 and result in an unbroken surface. It is also provided with the flange 21a to stiffen it and to serve as bearing means and anchorage, if necessary. The element 22 is that of Fig. 9 with both legs somewhat shortened in order that they may rest on the flanges 21a and 23a and result in an unbroken plain surface. The element 23 is similar to the element 21 except that it is reversed, and the element 24 is similar to the element 20 reversed.

While various combinations of derivative elements of the standard section shown in Fig. 1 could be made to form this type of continuous floor or roof framing the combination here shown illustrates one possibility. It is intended that the elements 20, 21, 22, 23, and 24 be spot-welded through their contacting flanges at the factory. Openings 24a are bolt holes through which composite sections such as this are bolted to each other and to adjacent wall panels. Openings 24b are bolt holes serving as means of attachment to the supporting bearing angles and, if continuous throughout the length of each flange, may serve as means for attachment of ceiling finishes, metal lath or the like.

In Fig. 15 I show a frame member made up of sections shown in Fig. 9 placed back to back, which may or may not have openings 25 as indicated. They may be joined by bolts 25a or the like or may be welded together.

In Fig. 16 I show a portion of a foundation 26 to which the Z section 28 of Fig. 8 is anchored by means of the bolts 27 extending into the material of the foundation. The panels 29 and 30 bolted together by bolts or the like such as are shown at 31 are in turn anchored to the member 28 by bolts 32. The flange 33 of the member 28 may serve as a support for floor beams, floor slabs or anything else that it may be desired to use it for.

Fig. 17 is an isometric view showing a method of spanning wall openings in bearing walls where the load and length of span require greater strength than would be ordinarily required over the usual door or window opening in a small house. Member **34** is of the same section as shown in Fig. 6, having a portion of its bottom flange cut out along the line **34a**, **34b**, **34c** enabling the upright flange to engage and be bolted to the adjacent channel of panel **35a** and being welded or otherwise attached at the factory or bolted as the building is erected to member **35b**. Here member **35b** acts as a web element between element **34** which acts partly as a tension member, and the second floor or roof bearing angle **36** which acts partly in compression. Thus the area over the opening acts as a built-up girder.

Fig. 18 is an isometric view designed to show more graphically than is shown in Fig. 12 an assemblage of panels into an illustrative method of construction. The walls are erected on the foundation composed of the members **38**, **39**, **40**, **41**, and **42**, of concrete blocks, poured concrete, or any other desired material laid in the desired arrangement. The openings **42a** and **43**, which together may be assumed to constitute a corner window, are formed by erecting and bolting together the short panels **44** and anchoring them in the manner hereinbefore described or in any other suitable manner to the foundations **38** and **39**. The window openings are spanned by assembling the panels **45**, the corner being supported by the post **46** having the section of Fig. 6. Floor beams **47** of the form shown in Fig. 15 may be used as intermediate supports for floor slabs not shown, and the member **48** of the section shown in Fig. 9 may be used to support the edges of the flooring. I also show in this view another window **49** and a member **50** consisting of the section shown in Fig. 6 for the support of horizontal framing. It is to be observed that the window is of the width of sixteen primary modules. The flooring or roof decking **51** may be of the construction shown in Fig. 14 and described in connection therewith or an assemblage of such construction. In this drawing, in order to render it more graphic, w may be taken as equal to 3 inches, and, therefore, the standard $8w$ panels would be 2 feet in width; windows **49** and **43** would be 4 feet in width; the opening of the door **52** would be 2 feet, 6 inches in width, while the panels **53** and **54** would each be of a width equal to $5w$—that is, 15 inches. The panels **55** and **56** would each be of a width equal to $3w$—that is, 9 inches.

In Fig. 19 I show a method of fastening together and reinforcing channel sections as herein described, in a direction at right angles to the long axis of the channels. It is particularly adaptable to the spanning of openings where the imposed load is carried in part only by a lintel or beam, or where no lintel, beam or other horizontal supporting member is to be used.

The numerals **57** and **58** indicate alternately reversed channel sections having openings **59** centrally disposed and mutually registering in their transverse elements. **60** is a rod passing through openings **59** and slotted at points which register with the transverse members through which they pass so that wedges **61** may be driven into these slots on either side of the transverse members thus forming a rigid connection.

In Fig. 20 I show means of the reinforcing a wall or portion of wall made up of elements such as shown in Figs. 1 to 10a inclusive. It is particularly adaptable to the spanning of openings in the building wall or to the formation of a horizontal support where the wall rests upon isolated bearing points such as piers. Numerals **61** and **62** indicate elements such as shown in Figs. 1–10a having centrally disposed openings **63** in the transverse elements through which are passed reinforcing rods **64**, embedded in cementitious material **65** placed within the channel forms.

It is recognized that the present invention may be embodied in other constructions than those herein specifically illustrated, and therefore it is desired that the constructions disclosed shall be considered as illustrative and not in a limiting sense.

I claim:

1. A panel for use as a component part of a wall or partition of a building, said panel consisting of a series of laterally adjacent, integrally connected, alternately reversed channels of sheet material, said channels being of uniform depth and of approximately rectangular cross-section, the overall width of the said panel being equal to an integral multiple of a primary module w, which said primary module w is equal to the overall depth of the said channels and is also equal to width dimensions of the backs of some of said channels and is an aliquot part of the width dimensions of other of said channels.

2. A panel for use as a component part of a wall or partition of a building, said panel consisting of a series of three or more laterally adjacent, integrally connected, alternately reversed channels of sheet material, said channels being of uniform depth and of approximately rectangular cross-section, the overall width of the said panel being equal to an integral multiple of a primary module w, which said primary module w is equal to the overall depth of the said channels and is equal to the width dimension of the backs of the two end channels and is an aliquot part of the width dimension of the backs of the intermediate channels.

3. A panel for use as a component part of a wall or partition of a building, said panel consisting of an odd number of laterally adjacent, integrally connected, alternately reversed channels of sheet material, said panels being of uniform depth and of approximately rectangular cross-section, the overall width of the said panel being equal to an integral multiple of a primary module w, which said primary module w is equal to the overall depth of the said channels and is equal to the width dimension of the backs of the two end channels and is an aliquot part of the width dimension of the backs of the intermediate channels.

4. A building comprising bearing walls composed of a plurality of panels of sheet material, each of which is composed of a series of laterally adjacent, integrally connected, alternately reversed channels of uniform depth and of approximately rectangular cross-section, the horizontal dimensions of said walls being equal to an integral multiple of a primary module w, which said primary module w is equal to the overall depth of said channels and is equal to the width dimension of the backs of some of said channels and is an aliquot part of the width dimension of the backs of other of said channels.

5. A building comprising bearing walls composed of a plurality of panels of sheet material, each of which is composed of a series of laterally adjacent, integrally connected, alternately reversed channels of uniform depth and of approximately rectangular cross-section, the hori-

zontal dimensions of said walls being equal to an integral multiple of a primary module w, which said primary module w is equal to the overall depth of said channels, the width dimension of the marginal channels being equal to w and the width dimensions of the intermediate channels being equal to $2w$.

6. A building comprising bearing walls composed of a plurality of panels of sheet material, each of which is composed of a series of integrally connected, alternately reversed channels of uniform depth and of approximately rectangular cross-section, the horizontal dimensions of said walls being equal to an integral multiple of a primary module w, which primary module w is equal to the width dimension of the backs of some of said channels and is an aliquot part of other of said channels.

7. A panel for use as a component part of a wall or partition of a building, said panel consisting of a series of laterally adjacent, integrally connected, alternately reversed channels of sheet material, said channels being of uniform depth and of approximately rectangular cross-section, the overall width of the said panel being equal to an integral multiple of a primary module w, which said primary module w is equal to the overall depth of the said channels and is also equal to width dimensions of the backs of some of said channels and is an aliquot part of the width dimensions of other of said channels, the said panel being provided with apertures spaced along the longitudinal centerline of some of the modular areas thereof.

8. A panel for use as a component part of a wall or partition of a building, said panel consisting of a series of laterally adjacent, integrally connected, alternately reversed channels of sheet material, said channels being of uniform depth and of approximately rectangular cross-section, the overall width of the said panel being equal to an integral multiple of a primary module w, which said primary module w is equal to the overall depth of the said channels and is also equal to width dimensions of the backs of some of said channels and is an aliquot part of the width dimensions of other of said channels, the said panel being provided with apertures spaced along the longitudinal centerline of some of the modular areas thereof, the spacing of said holes being at intervals of one primary module or a multiple thereof.

9. A panel for use as a component part of a wall or partition of a building, said panel consisting of a series of three or more laterally adjacent, integrally connected, alternately reversed channels of sheet material, said channels being of uniform depth and of approximately rectangular cross-section, the overall width of the said panel being equal to an integral multiple of a primary module w, which said primary module w is equal to the overall depth of the said channels and is equal to the width dimension of the backs of the two end channels and is an aliquot part of the width dimension of the backs of the intermediate channels, said panel being provided with apertures spaced along the longitudinal centerline of the modular area of the two end elements thereof.

10. A panel for use as a component part of a wall or partition of a building, said panel consisting of a series of three or more laterally adjacent, integrally connected, alternately reversed channels of sheet material, said channels being of uniform depth and of approximately rectangular cross-section, the overall width of the said panel being equal to an integral multiple of a primary module w, which said primary module w is equal to the overall depth of the said channels and is equal to the width dimension of the backs of the two end channels and is an aliquot part of the width dimension of the backs of the intermediate channels, said panel being provided with apertures spaced along the longitudinal centerline of the modular area of the two end elements thereof, the spacing of said apertures being at intervals of one primary module or a multiple thereof.

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