June 4, 1935. R. C. WALKER 2,003,670

BOOK STACK

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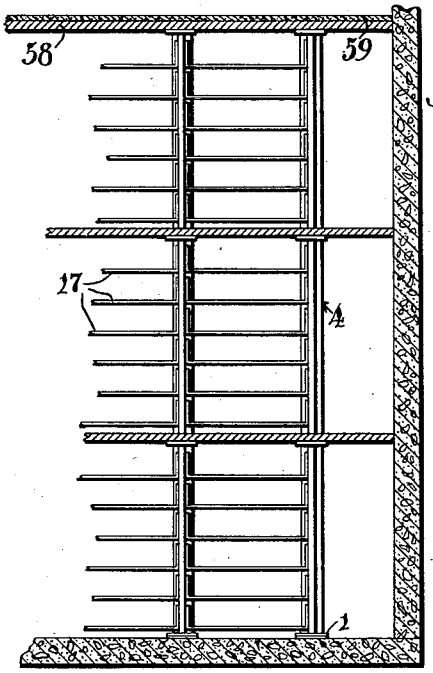


Fig. 1.

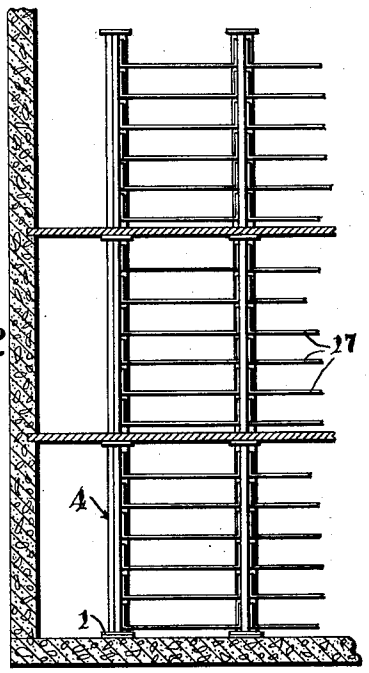
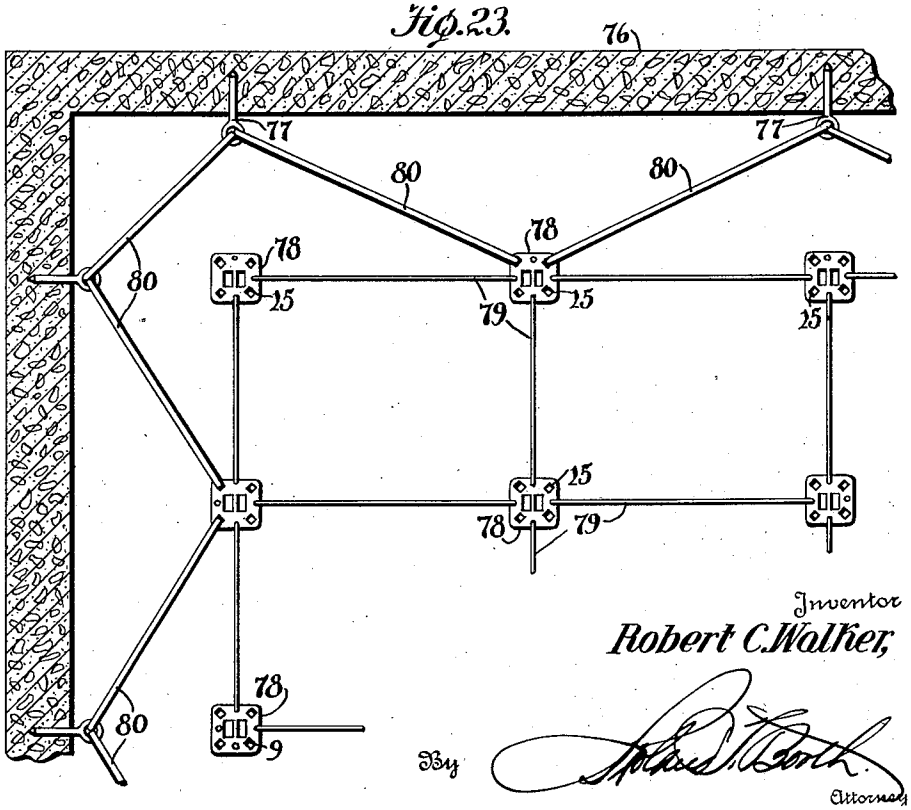


Fig. 2.

Fig. 23.



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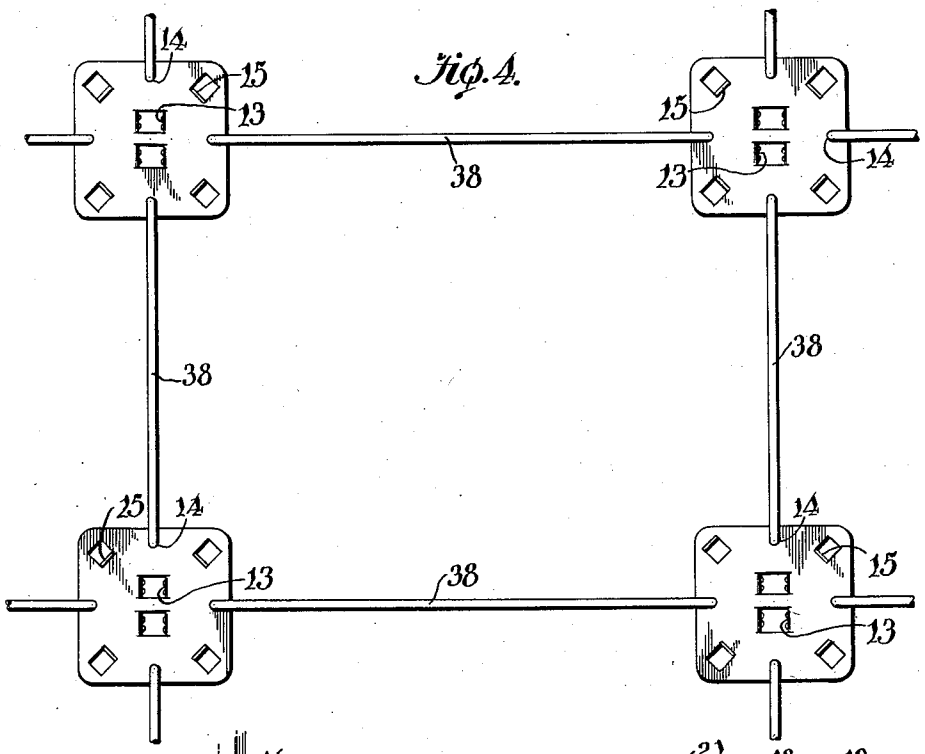

Fig. 4.

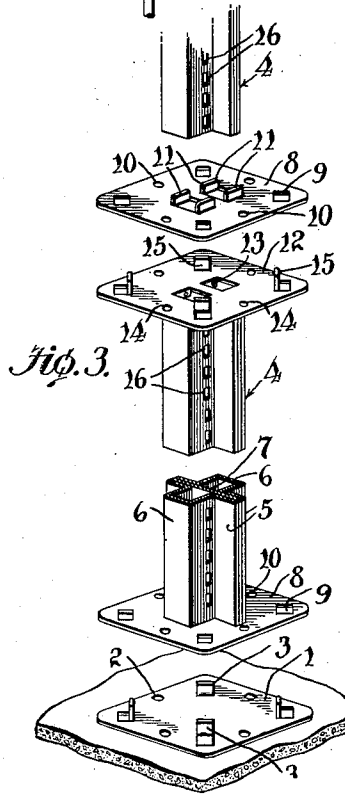

Fig. 3.

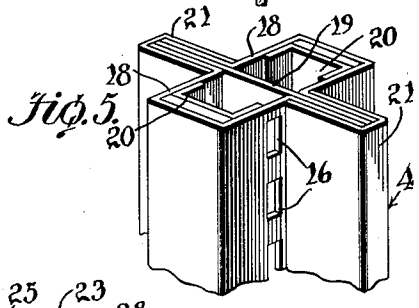

Fig. 5.

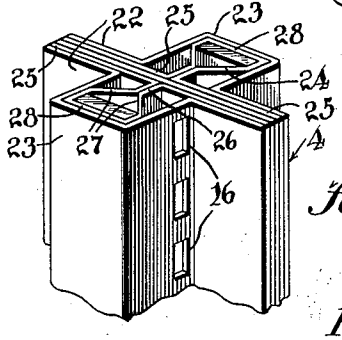

Fig. 6.

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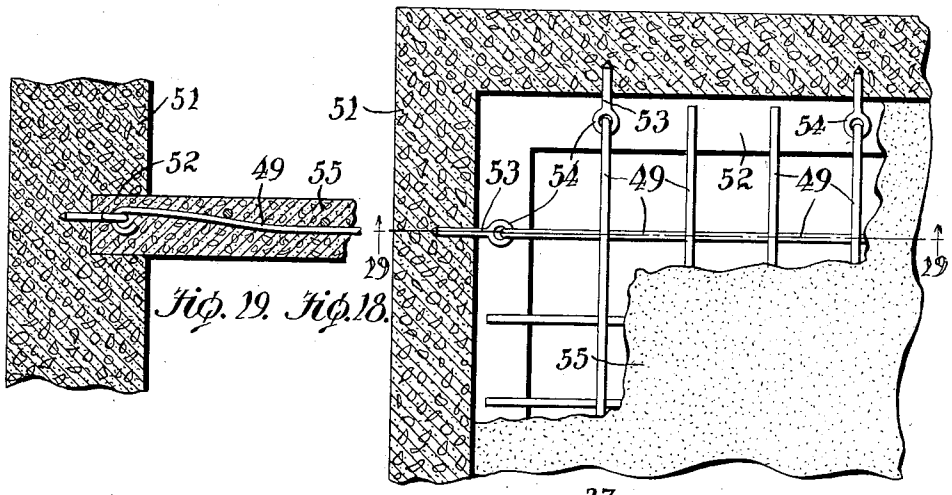

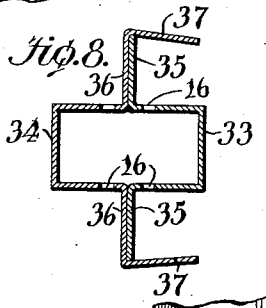

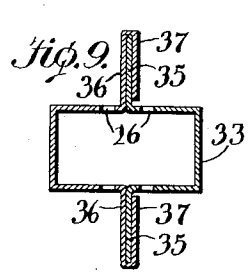

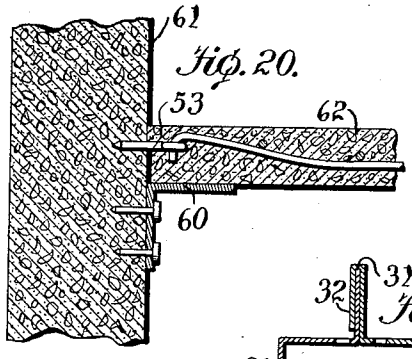

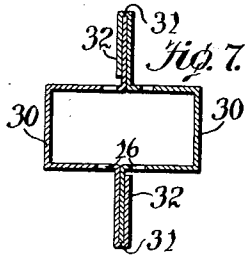

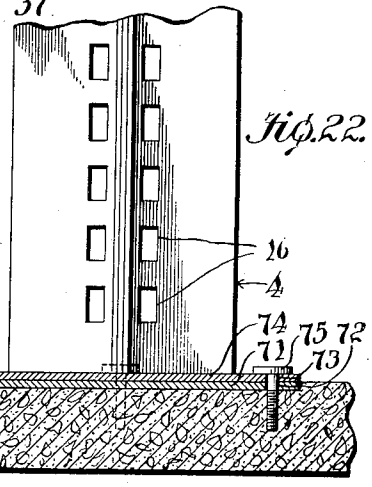

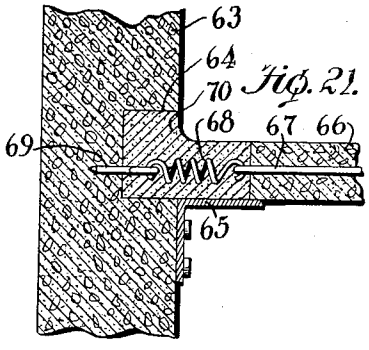

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Fig. 10.

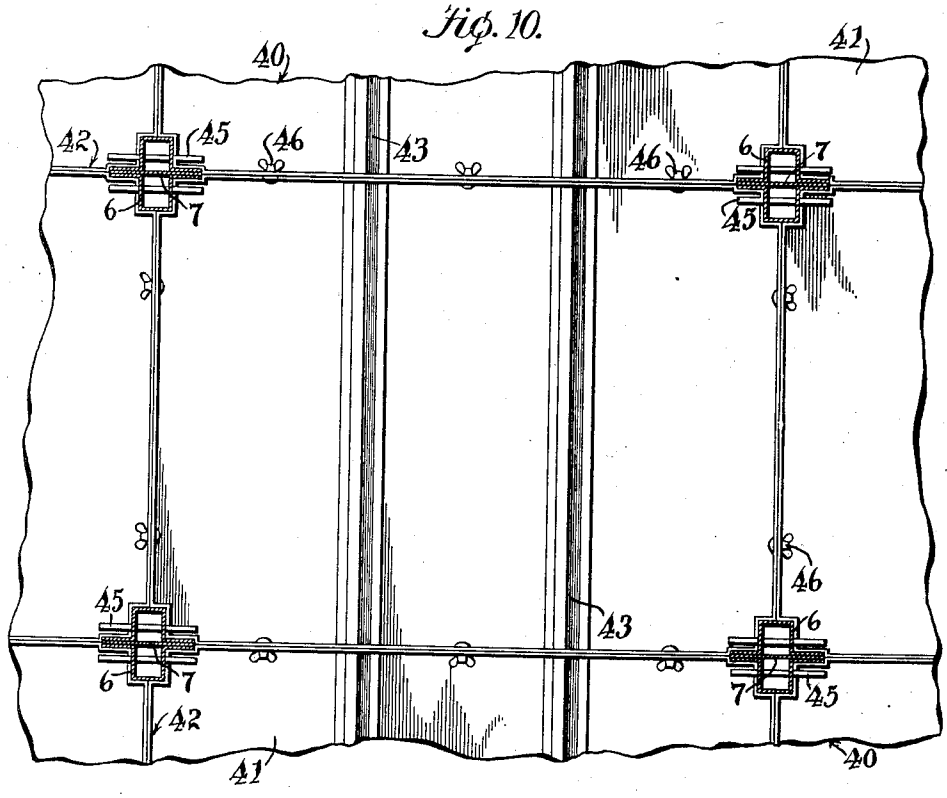
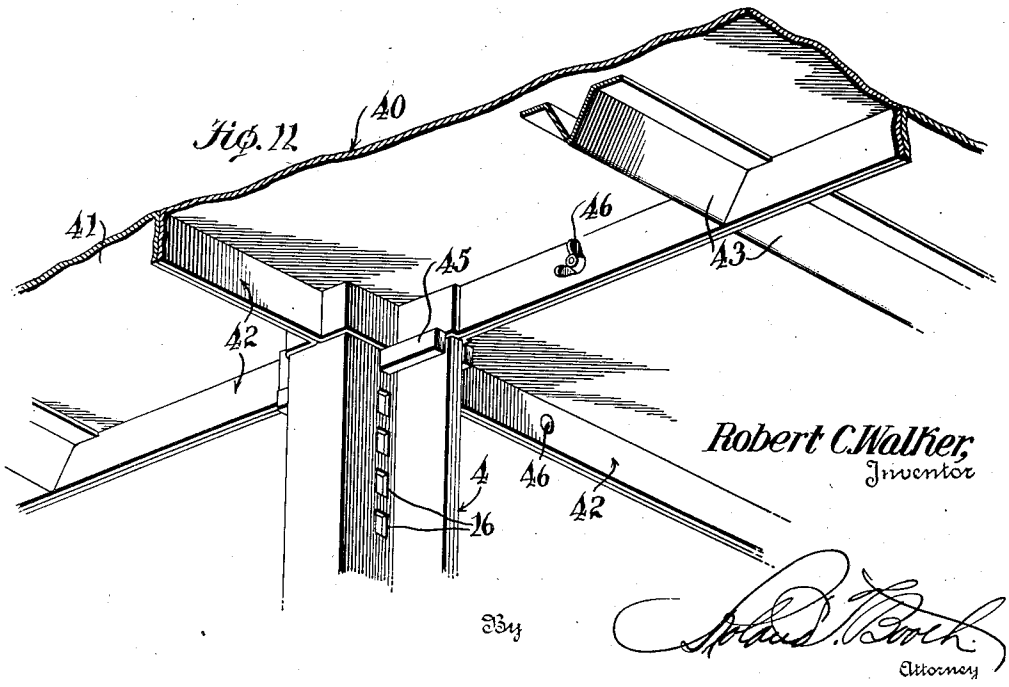


Fig. 11.



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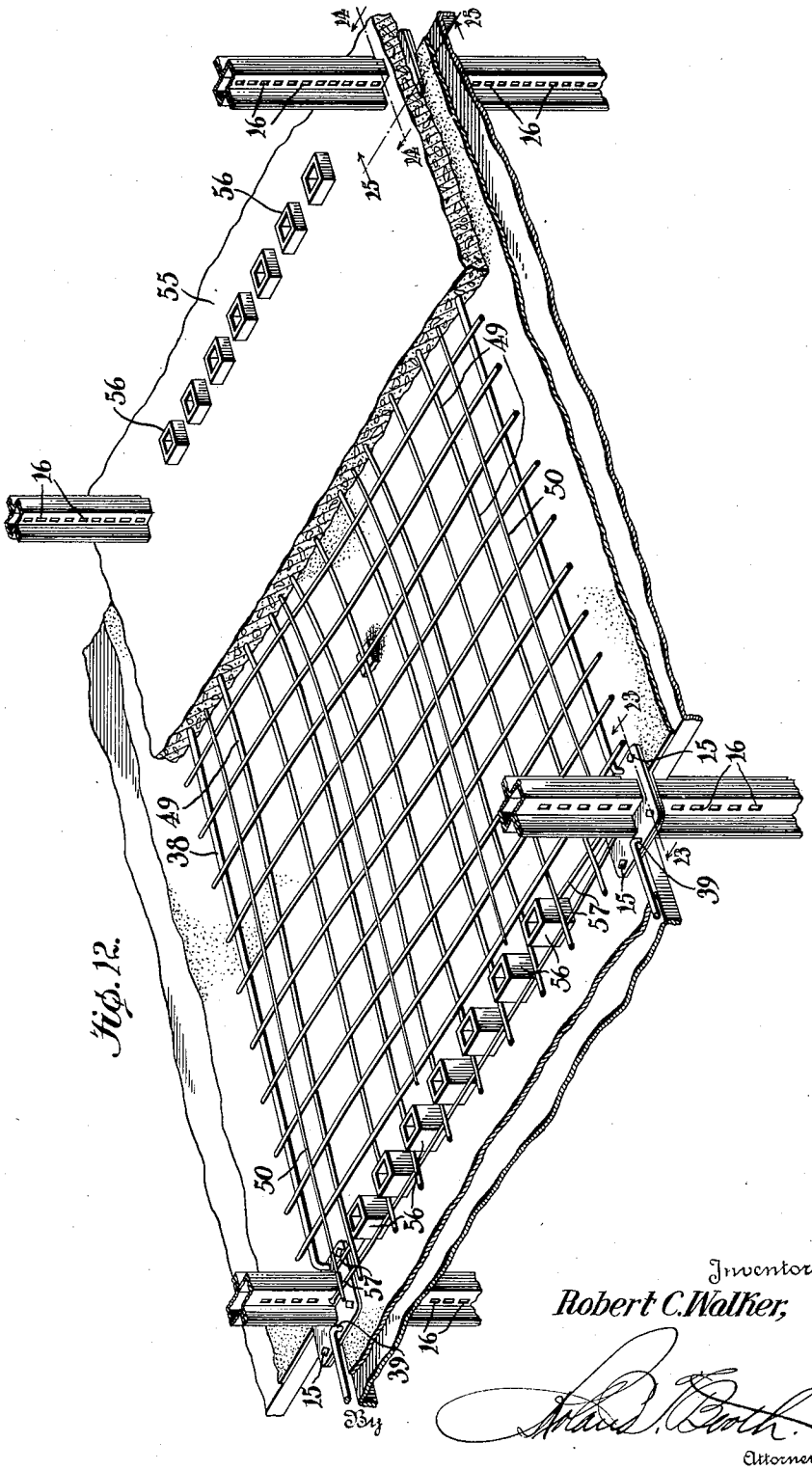

Fig. 12.

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Fig. 13.

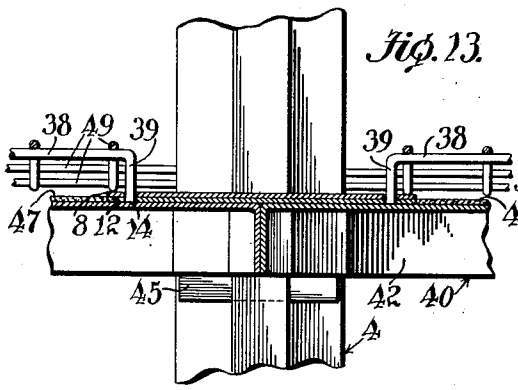
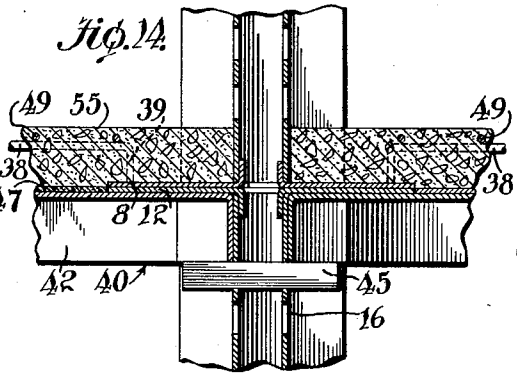


Fig. 14.



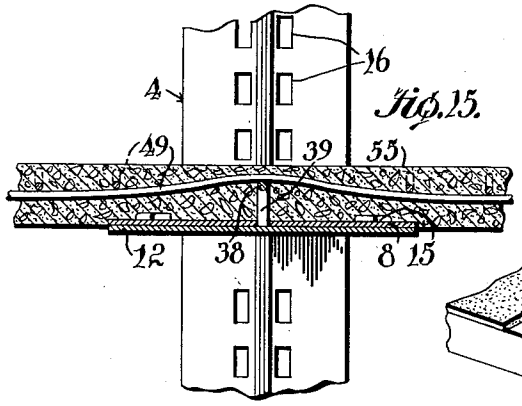


Fig. 15.

Fig. 16.

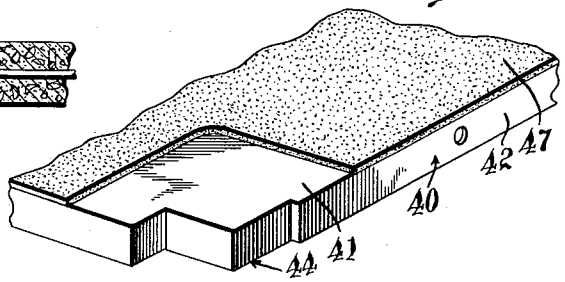
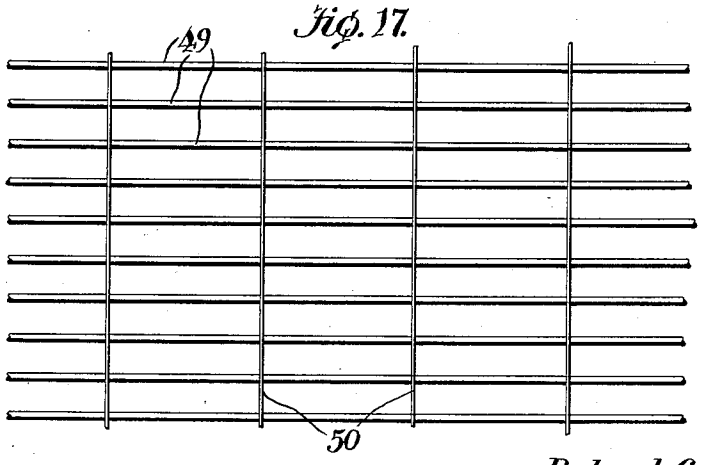


Fig. 17.



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Patented June 4, 1935

2,003,670

UNITED STATES PATENT OFFICE

2,003,670

BOOK STACK

Robert C. Walker, Scarsdale, N. Y., assignor to Remington Rand Inc., Buffalo, N. Y.

Application April 5, 1933, Serial No. 664,575

15 Claims. (Cl. 72—1)

This invention relates to a book stack and method of making the same.

It has been customary heretofore to design and construct a book stack to fit the building in which it is to be placed. This has required the special construction of each book stack for its particular building and as a result it has been impractical to use standard parts of uniform dimension in building book stacks in different buildings. Considerable difficulty is also experienced in building book stacks in buildings due to the variations in the structure of buildings as well as variations and unevenness in the foundation and foundation floor structure that requires the use in numerous instances of specially designed parts for the book stack construction in order to properly support the floors of a book stack in a horizontal plane, and secure the arrangement of columns in proper spaced relation to receive detachable book shelving.

The present invention overcomes a substantial number of the difficulties experienced in the construction of book stacks through providing a book stack construction using parts of substantially uniform size that can be built in any building regardless of the variations in the walls, floors and foundations of the building, and in which the book stack can be adapted to any type of building structure in any location.

As a result uniformity is secured in a book stack constructed according to the present invention and it provides means for readily building the book stack in any type of building due to the provision of foundation plates that are arranged in advance of the construction of the book stack thereon in proper spaced relation to determine the positioning and spacing of all of the stack columns for the book stack. The foundation plates can be readily mounted in co-planar relation so that the book stack erected thereon can be readily assembled with all of the parts uniformly spaced so they may be easily assembled and constructed with the floors in a horizontal plane. The invention provides in building a book stack of this character, for fitting the marginal portion of the stack construction to the building in a simple and economical manner to compensate for differences and variations in dimension between different parts of the building and the book stack.

The invention further provides a book stack having foundation plates that are readily arranged in predetermined spaced relation in the same horizontal plane to provide a foundation support for the entire book stack; stack columns of uniform dimension constructed for detachable interlocking engagement with the foundation plates and each other, so that the foundation plates will gauge the positioning of all stack columns and the interlocking means between the columns, and the plates will secure uniformity in the spacing of the columns; means for gauging the spacing of columns at each floor level and retention of the columns in proper spaced relation through the use of the gauging means at the juncture between adjacent column sections or members that occur at each floor level, and facilitates temporary support of the columns in proper spaced relation during the building of the floors; and concrete floors reinforced by suitable mesh or reinforcing fabric embedded in the floor and having the floors arranged at the joints between column sections or members in their detachably engaged relation, by which the concrete floors operate to rigidly secure the columns in assembled relation, as well as connect them together to form the stack structure in its completed assembled form with the column members provided to receive and support the book shelving.

The invention secures the provision of a book stack wherein the floors have all of the parts of the ceiling structure between the columns in all directions lying in the same horizontal plane so as to provide a smooth unobstructed ceiling surface in each stack floor, thereby providing uniform head room in all parts of the stack.

The invention further provides temporary floor forming members that are placed in position between and supported by the stack columns, through mounting adjacent the ends thereof, and so arranged, that the temporary floors comprise a plurality of sections that are assembled together and hold the upper ends of stack column members in rigid spaced relation. The columns are properly spaced throughout the stack and provide for the use of the floors temporarily during the construction of the stack until the concrete floors are placed in position, the floor forming members being used as molds for the concrete floor and subsequently removed after the concrete floors are in place.

A novel method of constructing a book stack is provided by this invention so as to effect substantial economy in erection costs through the preliminary setting of the foundation plates in their proper spaced and co-planar relation within the building in which the stack is to be erected, then erecting the stack column members on these foundation plates by simply placing the columns in position on the plates with the inter-engaging parts in engaged relation, then gaug-

ing the positions of the upper ends of the columns erected on the foundation plates, placing the forms for the floor molds in position by mounting them on the upper ends of the columns, arranging the reinforcing fabric strips in position after the next set of columns are arranged in engaged relation with the upper ends of the first columns placed on the foundation plates, and then placing the concrete floors in position by pouring so that the stack columns are rigidly held in assembled relation by the concrete floors and the engaged stack column members are interlocked together by the floors so that a complete and rigid stack structure is provided after all the columns and the floors supported thereby are in place. The columns are secured in uniform spaced relation in this construction of the stack so that the book shelves can be readily placed in position by engaging the supporting or connecting parts thereon with the complementary parts carried by the column members.

The invention provides improvements in the structure of the stack column members wherein the exterior dimensions of the columns can be maintained substantially uniform so that they may be readily spaced predetermined distances apart to receive book shelves of standard dimensions, and yet, at the same time, incorporate stress distributing structure so that the columns will carry substantial loads with a wide margin of safety. In constructing columns in this manner, the main column forming structural members remain substantially uniform while the stress distributing parts may be added to provide an assembled structure having the necessary load capacity.

The invention comprehends other features that reside in the details of construction of the stack column members, the plate members used in conjunction therewith together with the cooperation obtained between the parts in assembled relation to form the stack structure that are all more particularly pointed out in detail in the following description and claims.

In the drawings:

Fig. 1 is a vertical cross section through a book stack constructed according to this invention showing it in associated relation with a building that encloses the stack, the details of construction of the stack and building being omitted because of the small scale of the figure and for clearness in illustration, the figure for this reason being somewhat diagrammatic.

Fig. 2 is a vertical cross section through a book stack constructed according to this invention, illustrating the book stack in the manner disclosed in Fig. 1 showing a different type of connection between the floors and walls.

Fig. 3 is a disassembled perspective showing a foundation plate, a stack column member with the central portion broken away and shown in section, and a bottom plate for another stack column member disassembled from the lower end of the member, for the purpose of showing the details of construction and method of assembly of the several parts.

Fig. 4 is a plan view showing the top plate on a plurality of stack column members connected by the gauge bars to illustrate how the stack column members are held in position during the construction of the book stack.

Fig. 5 shows a portion of a stack column member in perspective to illustrate a cross section of a stack column member having added stress distributing sections incorporated in the structure thereof.

Fig. 6 is a view similar to Fig. 5 showing a stack column member with a different type of stress distributing structure.

Fig. 7 and Figs. 8 and 9 are cross sections of two other types of stack column members incorporating stress distributing sections in the assembly thereof.

Fig. 10 is a horizontal cross section through a plurality of stack column members looking upwardly at the bottom of a plurality of temporary floor forming members assembled thereon.

Fig. 11 shows a plurality of temporary floor forming members and the details of construction of the corners thereof and manner of assembly with a stack column member, on an enlarged scale, and in perspective.

Fig. 12 shows the arrangement of the reinforcing fabric strips or webs in supported relation over the temporary floor forming members in their assembled relation with a plurality of stack column members with a portion of the completed floor, all of the parts being shown in perspective and portions being broken away for convenience in illustration.

Fig. 13 is a cross section through a partially completed floor structure as shown in Fig. 12 taken substantially on line 13—13 of Fig. 12.

Fig. 14 is an enlarged cross section through one stack column joint structure with one floor similar to that shown in Fig. 13 but taken substantially on line 14—14 of Fig. 12.

Fig. 15 is a cross sectional view through the completed stack structure showing the details of construction of one joint between column members and one floor on an enlarged scale and taken substantially on line 15—15 of Fig. 12.

Fig. 16 is a fragmentary perspective looking downwardly at one corner of one of the temporary floor forming members showing how the corner is constructed to fit a stack column member.

Fig. 17 is a plan view of a portion of a reinforcing fabric strip or web that is used to provide a reinforcement for the concrete floor.

Fig. 18 is a horizontal cross section through a corner of a building incorporating the stack structure of this invention, illustrating the manner of anchoring the ends of the reinforcing fabric and the concrete floors to the walls of the building, the concrete floor being broken away for clearness in illustration.

Fig. 19 is a sectional view taken substantially on the line 19—19 of Fig. 18.

Fig. 20 is a view similar to Fig. 19 showing another method of attaching the concrete floors and reinforcing fabric therein to the building walls.

Fig. 21 is a view similar to Fig. 19 illustrating a resilient connection between the building wall and the concrete floors of the stack construction.

Fig. 22 is a vertical sectional view through a foundation plate and the adjacent portion of a stack column member showing a slightly different method of anchoring the stack column member to the foundation plate from that shown in Fig. 3.

Fig. 23 is a horizontal section through the corner of a building construction illustrating a plurality of stack column members in assembled relation with the connecting gauge bars, and illustrating connecting links between the plates on selected stack column members and anchors carried by the building wall for tying the building wall to the stack column structure to provide a

substantially rigid stack and building structure, the connecting link being arranged so as to be embedded in the concrete floors in the completed stack structure.

Foundation plates 1 as shown in Figs. 1 to 3 are provided by this invention and are placed in position in advance of the erection of the stack thereon. Whether the stack is erected on a suitable foundation floor structure or on specially arranged foundation blocks or posts of cement or the like, the foundation plates will in all cases be arranged on such structure by accurately measuring the spacing between the edges or centers of plates 1 and by building up any uneven portions of the foundation floor or other structure used so that the foundation plates can be accurately located in the same horizontal plane in their anchored position on the foundation structure. Each of these foundation plates comprises a piece of sheet metal in the form of a plate having a plurality of openings for receiving suitable anchor members 2 indicated in Fig. 3 and having tongues 3 formed in the corner portions of the plates and extending laterally from the plates so that in the anchored position they will project upwardly as shown in Fig. 3. These tongues 3 provide interlocking and positioning means for accurately centering stack column members thereon, and for holding them in properly centered relation, as well as providing a means for detachably locking the column members thereto so that they will be anchored to the foundation through the medium of foundation plates 1.

Only one foundation plate 1 is shown in Fig. 3 and a pair of these plates are illustrated in Figs. 1 and 2 respectively but it will be understood that these foundation plates will be arranged in rows both longitudinally and transversely within the building where the stack is to be erected and spaced in each direction according to the desired spacing for the columns.

Stack column members 4 of the character illustrated in Figs. 3, 5 and 6 are provided by this invention for erection upon the foundation plates 1 and upon each other in end to end relation in the building of a stack structure. These column members have a length equal to the height of one floor so that one set of column members is provided for each floor.

Each column member is of duplicate form and of uniform length so as to be interchangeable and adapted for mounting upon any other column member or any foundation plate by reason of its uniform construction.

The column member 4 illustrated in Fig. 3 comprises a pair of strip members 5 having the central portions offset in opposite direction to provide channel portions 6. A stress distributing strip member 7 is interposed between the strip members 5 and the edge portions of strip members 5 and strip 7 are secured together by welding or other equivalent means to provide a rigid post construction. A bottom plate 8 is mounted on each column member 4 and comprises a sheet metal plate that is substantially square and conforms in size and shape to the foundation plate 1, having openings 9 in the corner portions for receiving the tongues 3 on the foundation plate. The bottom plate 8 is also provided with a plurality of openings 10 to receive gauging means or other spacing devices of a character that will be hereinafter described. Each bottom plate 8 has the central portion of the plate formed to provide opposite pairs of laterally extending ears 11 arranged to engage on either the inside or the outside of the channel portions 6, these ears being shown in Fig. 3 to engage on the inside of channel portions 6 so they may be suitably secured to the ends of the strip 5 in the channel portions 6, by welding, or other equivalent means.

A top plate 12 is provided on each column member and is of the same shape and size as the bottom plate, having tongues formed from the central portion thereof, indicated at 13 in Fig. 3, similar to tongues 11 on the bottom plate and extending into channel portion 6 at the upper end of column member 4 and suitably welded or otherwise secured to the strips 5, in the channel portions, to rigidly secure the top plate in position. Each top plate is provided with a plurality of openings 14 in the side edges for a purpose to be hereafter described. The corner portions of each top plate are formed to provide upwardly extending tongues 15 that provide interengaging and interlocking means between one column member and an adjacent superposed column member through engaging in the openings 9 in the bottom plate of a superposed column member in a manner that can be clearly understood from the illustration in Fig. 3. The manner in which a top plate and bottom plate on column members interengage with each other is further illustrated in Figs. 12 to 15 inclusive.

The offset portions of strips 5 forming channel portions 6 of each column member are provided adjacent to the edges of the channel portions of the strip, on each side, with a series of slots 16 extending throughout the length of each column member to receive the supporting lugs carried by book shelves 17, diagrammatically illustrated in Figs. 1 and 2.

This method of mounting the book shelving on the stack column members is already well known in the art, and further illustration and description thereof is therefore, believed unnecessary except to point out that in the use of uniform sized book shelving, it is necessary that the stack column members be uniformly spaced and arranged in order that the slots in each adjacent column in a row will be uniform distances apart to readily receive the book shelving which is adjustable and interchangeable with the stack structure through this uniform spacing and mounting of the stack column members as herein described.

As this invention provides for the construction of book stacks including one or more floors, and may be readily used in the construction of book stacks including twenty to thirty or more floors, it will be understood that in the construction of a stack having a substantial number of floors, for example twenty, the stack columns carried by the foundation plates and forming the support for the first floor as well as carrying the load on the entire stack structure, are subjected to a substantially greater load than stack column members at the top portion of the stack structure. As a result it is found desirable in some cases to use stack column members having additional stress distributing structure incorporated therein such as the various forms illustrated in Figs. 5 to 9 inclusive, depending on the type and size of loads the column member is to carry.

The outside dimensions of the stack column incorporating such stress distributing structure will be uniform in all cases, the length of the columns will be uniform and the top and bottom plates will be of uniform size and structure. In this way the invention provides for the struc-

ture of a book stack having ample load carrying qualities including the provision of the proper factor of safety for carrying the necessary load in all parts of the stack and at the same time providing column members of unit structure for assembly.

The column structure shown in Fig. 5 includes strip members 18 having channel portions formed in the same manner as the strip members 5 illustrated in Fig. 3. The strip members 18 are assembled in the same manner as the strip members 5 with a stress distributing strip member 19 interposed between the opposed strip members 18. Auxiliary channel shaped members 20 of sheet metal are mounted in the channel portions of the strip members 18 as shown in Fig. 5 with the opposite edge portions secured to the opposite sides of the channel portions of strip members 18 and the intermediate portion in spaced parallel relation to the offset central portion of strip members 18. In this way a stress distributing structure is obtained through the rectangular tubular structure provided by the combination of strip members 18, 19 and 20, all of these strip members extending in parallel relation throughout the length of each column member and the cross sectional illustration in Fig. 5 showing the relative transverse position of these parts.

Edge embracing strips 21 of suitable sheet metal having a channel shaped cross section are engaged over the opposite edges of strip 18 and 19 in the manner illustrated in Fig. 5, the entire structure being rigidly secured together by the welding of the several members together or through securing them in rigid assembled relation through any other suitable means so as to provide a column structure of the character clearly shown in Fig. 5. The edge embracing members 21 have been found through tests to have a high efficiency in stress distributing cooperation with strip members 18 and 19 and are also found to be highly efficient in the provision of a column member using strip members similar to members 18 but omitting the intermediate stress distributing member 19.

The stack column structure illustrated in Fig. 6 has substantial strength obtained through the use of a plurality of sheet metal strip members including a pair of strip members 22 formed to provide channel sections 23 arranged in opposed relation and having interposed therebetween a pair of longitudinally extending filler strips 24 and an intermediate flat strip member 25. The strip members 24 are positioned on opposite sides of the flat strip member 25 that extends between opposite edges of the column and terminates in coincident relation with the edges of strip members 22 and 24. The central portion of strip members 24 are offset in opposite directions to provide a pair of longitudinally extending sections 26 in the central portion of the column projecting laterally from the central portion of strip member 25, these sections merging into diverging portions 27 terminating at their outer ends in channel shaped portions 28.

This structure is welded or otherwise suitably secured together at the edge portions of the respective strip members and at other points of contact if desired so that they are all united to form a rigid assembled structure. The channel portions 28 have surface contact with the channel portions 23 of strip members 22 and through the use of the diverging sections 27 and the sections 26, the column structure is provided with substantial stress distributing parts that cooperate in the assembled structure to carry a substantial weight for the type of material used without likelihood of buckling or bending.

Fig. 7 provides a stack column member having channel shaped strip members 30 of duplicate form arranged in opposed relation similar to the strip members 5. Each of the strip members 30 have marginal sections 31 on opposite sides of the channel portion, the marginal section 31 at one side having an extension 32 folded back upon the section 31 in spaced parallel relation thereto, so that the marginal portion 31 having the extension 32 of each of the channel-shaped strip members 30 will receive and embrace the other marginal extension 31 of the opposite member 30. This results in providing a structure wherein a tubular post construction is obtained having a marginal section 31 and its extension 32 on each side of the channel section of the members 30 as illustrated in Fig. 7.

The sections 31 and 32 at opposite sides of the channel portions of the members 30 are rigidly secured together in an appropriate manner, by welding or the like, to provide a rigid post construction for the column member in which the portions 31 and 32 cooperate to provide an efficient stress distributing structure in the column for carrying substantial loads. The column member constructed as shown in Fig. 7 will be provided with top and bottom plates in the same manner as illustrated in connection with the column member shown in Fig. 3.

Figs. 8 and 9 illustrate a column member constructed in a manner somewhat similar to that shown in Fig. 7. Fig. 8 illustrates the partial assembly of the structure, and Fig. 9 illustrates the column sections in complete assembled relation. Referring to Fig. 8 the column comprises channel-shaped strip members 33 and 34. The ends of channel-shaped strip member 33 are provided with lateral extensions in opposite directions indicated at 35, and channel member 34 is provided with similar laterally extending sections 36. The extensions 36 terminate in angular flange sections 37 that are folded back toward channel member 34 in the manner illustrated in Fig. 8 so that they extend in angular relation to the portion 36. This provides for the assembly of a channel member 33 with a channel member 34 by engaging flanges 35 of channel member 33 between flanges 36 and 37 of channel member 34 as illustrated in Fig. 8. After these channel members are assembled in this manner, flanges 37 are pressed into engagement with flanges 35 of member 33 to rigidly secure the two channel members in assembled relation, the flanges 33, 36 and 37 being suitably welded or secured together in rigid assembled relation to provide a rigid post structure having similar stress distributing properties to the structure illustrated in Fig. 7, and being adapted to carry substantially large loads in comparison with the type of material used. Columns constructed as illustrated in Fig. 9 will also have top and bottom plates similar to the column illustrated in Fig. 3.

After the foundation plates 1 are laid as hereinbefore described, for all of the columns of the book stack to be installed in any one building, the next step is to construct the stack structure thereon. As the parts of the stack structure are all of uniform size and the foundation plates are laid in co-planar relation, it will be readily understood that the resultant stack structure will have substantially uniform dimensions through-

out. The stack is built upon the foundation plates in a progressive manner by arranging a series of stack columns with the bottom plates engaged with foundation plates 1 and projections 3 on the foundation plates engaged in openings 9 on bottom plates 8, one stack column member being placed on each foundation plate with its bottom plate in registering relation therewith. This will provide a series of columns for supporting the first floor to be erected in the stack.

With a series of columns placed on the foundation plates, the next step is to secure the upper ends of these columns in proper spaced relation so that the distance between the portions of the columns provided with the slots 16 will be uniform. This is done through the use of gauge bars 38 as shown in Fig. 4 having laterally extended terminals 39 thereon, (Figs. 13 to 15), engaged in openings 14 in top plates 12 on all of the column members. These gauge bars extend between adjacent columns in each row both longitudinally and transversely of the stack as clearly shown in Fig. 4.

Where the stack structure is to consist of more than one floor, it is usually customary to erect the next set of stack columns on top of the first group erected on the foundation plates 1, with the bottom plates of the upper stack columns in engaged relation with the top plates of the first set of stack columns as illustrated in Figs. 1, 2, 3 and Figs. 13 to 15. In this engagement of the bottom plate of one stack column member with the top plate of another stack column member, the projections 15 on the top plate are engaged through openings 9 on the bottom plate and serve to position the stack column members in interengaged and uniform relation in end to end position. Then, the gauge bars are inserted through the registering openings 10 and 14 in the bottom and top plates respectively so as to connect the stack column members in the manner illustrated in Fig. 4 at each floor level in the stack. These gauge bars 38 hold the stack column members in uniform spaced relation at all times.

As soon as the second set of stack column members is arranged on the first set as above described, and the gauge bars are all in position, the next step is to arrange the temporary floor forming members 40 in position as illustrated in Figs. 10 to 14 inclusive. The floor forming members 40 as illustrated herein, comprise sheet metal plates 41 of rectangular form adapted to extend between four adjacent columns in adjacent parallel rows both transversly and longitudinally of the stack. A continuous marginal flange 42 is formed on around the side edges of the plate as illustrated in Figs. 10, 11 and 16. This flange has opposite side portions thereof connected by a pair of angular strip members 43 secured to plate 41 in spaced parallel relation intermediate the side edges of the plate parallel thereto.

These angular strip members provide laterally projecting portions on the bottom of the plate 41 as clearly illustrated in Figs. 10 and 11 and carry the weight of the load imposed on the plate 41 to prevent sagging, cooperating with the plate 41 and continuous flange 42 to retain the plate 41 in flat form. Each corner of the plate is specially formed with a series of cut-out and stepped portions indicated at 44 in Fig. 6 to fit the contour of one end portion of a stack column member with the face of the plate 41 engaged with the underside of the top plate on the column member. The corners of the plate 41 with the continuous flange 42 as illustrated in Fig. 16 accurately fit the contour of the column, and a series of the floor forming members 40 arranged in position on the column member have the corners engaging and fitting the column members, and have the edges of adjacent floor forming members engaging each other in line with the rows of columns both longitudinally and transversely of the stack.

The floor forming members 40 are supported with the upper faces of plates 41 in contact with the lower faces of the top plate 12 on the stack column members and are retained in this position by means of wedge members 45 (Fig. 11), inserted through the uppermost slots 16 in the stack column members. The flanges 42 on each floor forming member are rigidly secured together at a plurality of points by suitable bolt connections 46. All the floor forming members 40 being secured together by means of the bolt connections 46 and supported on the stack column members by wedge members 45, provides a temporary floor structure at the upper end of the first set of column members supported on the foundation plate.

Each of the floor forming members 40 has a sheet of composition material 47 applied to the upper face of plate 41 in the manner illustrated in Figs. 13 to 16 inclusive, the corner portions being cut out as indicated at 48 to receive and fit the edge portions of the top plates on stack column members. The upper face of sheet 47 as shown in Figs. 13 to 15 terminates in the plane of the upper face of the top plate on the column members and is formed of material that will provide a smooth surface on the ceiling of the concrete floors when they are poured onto the floor forming members in a manner to be described.

Around the marginal portions of the stack structure between the outer row of stack column members and the walls of the building, floor forming members 40 are not used on account of the variations in the building structure from the uniformity of the stack structure. Ordinary wooden forms are built into place around the edges of the stack and secured to the building wall in order to form a surface and form for the concrete floors having the ceiling surface for the floor co-planar to the ceiling surface provided by the floor forming members 40. These wooden forms are built up in any suitable well known manner and may be secured to the stack columns by means of wedges extending through slots 16 in any desired manner, the upper face of the forms being covered with the same material as used for the sheets 47.

After all of the forms are in place for the first floor of the stack structure, the reinforcing fabric that is to be embedded in the concrete floor is placed in position. This invention provides a reinforcing fabric for the concrete floors consisting of strips of wire fabric, one form of fabric used for this purpose being shown in Fig. 17. This wire fabric as shown in Fig. 17 consists of a plurality of parallel reinforcing wires or rods 49 held in spaced relation by relatively small transverse connecting wires 50 that are spot welded or otherwise secured to rods 49 at rather wide intervals. The reinforcing fabric is made up in this form in long strips, the rods 49 running lengthwise of the fabric strip. These strips are made up in rolls in any desired manner, and in constructing the stack, they are unrolled and laid over the floor forming members, one strip extending between each adjacent row of columns throughout the length of the stack, the

rods 49 engaging over the gauge rods 38 which supports the rods 49 and in fact the entire reinforcing web or strip at spaced intervals in line with the rows of columns in the manner illustrated in Figs. 12 to 15 inclusive. As shown in these figures one series of reinforcing strips are laid longitudinally between rows of columns in the stack, and where the rods 39 are unsupported by gauge bars 38, they will sag in the central portion between the rows of stack columns, a feature that is desired due to the greater reinforcement obtained in the concrete floor as a result of this sagging.

A second series of reinforcing strips is run transversely between rows of columns to the first series and overlies the first series of strips, being also supported on the gauge bars extending between the rows of columns. The two transversely extending sets of strips of reinforcing fabric may be secured together at intervals if desired, although it is not necessary and the drawings do not illustrate such connection.

The ends of the strips of reinforcing fabric have some of the rods 49 thereof anchored to the walls of the building. Figs. 18 to 22 illustrate several different types of anchors for the ends of the reinforcing strips and the joint construction between the marginal portions of the stack floors and the walls of the building. In Figs. 18 and 19 the building wall 51 is provided with a recess 52 to receive the marginal portion of the concrete floor and anchor members 53 are firmly anchored or otherwise attached to the wall 51 in these recesses, at spaced intervals. These anchor members have eyes 54 and are arranged at spaced intervals so that a number of the rods 49 in each reinforcing strip can have their ends extended through eyes 54 and bent to securely attach these rods to the anchor members, as illustrated. After the ends of the reinforcing fabric strips are thus anchored, the structure for the first floor of the stack is ready for the pouring of the concrete. The entire surface of all of the floor forming members is covered with concrete so as to completely embed the reinforcing strips therein, and so as to fill the recess in the wall 51 as shown in Figs. 18 and 19 to form the concrete floor indicated by numeral 55 in Figs. 12, 14, 15 and 19.

Referring particularly to Fig. 12, a plurality of short tubular members 56 are shown arranged in rows between stack column members so that the lower ends rest on the upper faces of the floor forming members. These are secured together in spaced relation by rods 57 secured to opposite sides of tubular members 56 in any suitable manner. The tubular members 56 are of a length sufficient to extend through the concrete floor with the upper ends extending above the surface of the floor as shown at the right hand side of Fig. 12. These tubular members 56 will provide for ventilation between stack floors and may be arranged at any desired intervals, the arrangement being made so that the tubular members will extend between stack column members in a row in the same direction as the book shelving when placed in position, so that tubular members 56 will be arranged under the bottom shelves of the stack. The ends of the wires 57 retaining the tubular members in position will be attached to the stack column members in any suitable manner, such as by having the ends engage on opposite sides of the channel portions thereof as shown in Fig. 12. Where the tubular members are arranged between adjacent column members, the gauge bars will be removed and rods 57 will provide the necessary support for the wires or rods 49 of the reinforcing strips. This will usually be done after the floor forming members are in place in order that the floor forming members will be used to retain the upper ends of the stack column members in proper spaced relation.

As soon as the concrete has set and hardened to the proper degree to carry its normal load, the floor forming members will be removed from the under surface of the concrete floor through removal of the bolt connections 46 and the wedges supporting the floor forming members in position on the column members, and these same floor forming members can then be used to provide temporary flooring at the upper end of another set of stack columns built upon this stack structure so as to form another one of the upper floors of the stack.

In the progressive building of a stack in this way, it will be understood that a number of floor forming members for the second floor of the stack will be placed in position in the same manner as hereinabove described for the structure of the first floor as soon as the floor forming members for the first floor are in place and the second set of stack column members are erected in position as illustrated, and connected by the gauge members. The building of the stack progresses from the first floor to the second and so on up to the top floor according to the number of floors desired in the completed stack structure, the columns for each floor being erected successively in the manner described above. A set of stack column members is erected on the upper floor of the stack structure to provide support for the book shelving on the upper tier of the stack and the upper ends of these stack column members will provide the necessary support for the roof of the building as shown in Fig. 1, through the provision of a concrete floor corresponding to the stack flooring at the upper ends of the uppermost set of stack column members. This uppermost floor is indicated at 58 in Fig. 1 and is usually provided with the usual slag roofing 59 or any other suitable type of roof construction used on a substantially flat roof.

Where the building is provided with an independent roof structure, and it is not desired to support the roof on the stack structure, then the uppermost set of stack column members will have their upper ends left unconnected, or where it may be desired, the gauge bars may be used to provide a connection between the upper ends or some other sort of strip connection may be provided. It has been found, however, that it is not necessary to connect the upper ends of the stack column members because the concrete floor on the upper floor level will rigidly interlock the lower ends of the upper set of stack column members in position so as to hold them in rigid upright spaced relation. This type of construction is illustrated in Fig. 2.

Instead of having the margins of the floor seated in a recess in the wall of the building, a construction as shown in Fig. 20 may be used instead. In this form of construction an angle plate 60 is suitably anchored to the wall 61 around the inside face of the wall with an upwardly directed face of the angle positioned at the ceiling surface of the concrete floor. The mold forms for the concrete floor are constructed so that the ceiling surface of the floor will be in co-planar relation with the upper face of the angle member 60 as clearly shown in Fig. 20,

while the anchors 53 for the reinforcing strip embedded in the floor 62 will be anchored in the same manner as shown in Figs. 18 and 19 except that the eyes will project beyond the inside wall to receive the ends of the rods in the reinforcing fabric strips.

Where it is desirable or necessary to provide an expansion joint between the margin of the stack floors and the building wall, a structure such as shown in Fig. 21 may be provided. The wall 63 is formed with the recess 64 and an angle strip 65 is placed below the lower edge of the recess 64 so as to have the upper face of one flange flush with the bottom of the recess. The concrete floor 66 will have its marginal portion engaged on the upper face of the angle member 65 and the ends of the reinforcing rods embedded in the floor and indicated at 67 in Fig. 21 will be attached to one end of coil springs 68 that have the opposite ends anchored to the wall through the medium of anchor members 69. After the reinforcing members for the floor are placed in position and anchored to spring 68, the expansion joint material may then be placed in position, suitable resilient material indicated at 70 being used to fill the recess 64 in the wall and embed the coil springs 68, so as to provide the joint between the flooring and the wall 63. The concrete floors are then placed in position by pouring in the usual manner so that the outer edge of the floor of the stack will engage the material 70 forming the expansion joint. Differences in expansion between the stack and wall structure of the building are thus compensated for through the action of the springs 68 and the material 70 which is extensible and compressible to the necessary extent to provide for this difference in expansion that may occur. It is to be understood in this connection that this joint may be used in any stack structure where desired, and may be used in conjunction with the constructions shown in Figs. 18, 19 and 20 for connecting the floors to the wall of a building, if desired, in which some of the walls may be connected by the methods shown in Figs. 19 and 20, and others by that shown in Fig. 21.

This type of joint structure will be used in conjunction with the stack column and floor structure hereinabove described in constructing a book stack to provide the desired number of floors in the stack structure to form a complete book stack unit in any building.

Fig. 22 illustrates a slightly different method of anchoring the first group of stack column members on the foundation plates from that illustrated in Fig. 3. Instead of providing the foundation plates with the tongues 3, the foundation plates used in Fig. 22 indicated at 71, are provided with openings 72 to register with openings 73 provided in the bottom plate 74 attached to a stack column member. Suitable headed anchoring members 75 are then inserted through the registering openings 72 and 73 with their heads engaging the upper face of the bottom plate and the shank portions anchored in the foundation structure under the foundation plate 71.

There are some instances in the construction of book stacks where it will be desired to use the book stack construction to support the building walls or to provide for the distribution of stresses and loads on the building, between the building walls and the stack structure. Fig. 23 illustrates one means for tying the walls to the stack structure so as to obtain a cooperation and distribution of loads between the stack and the buildings, in which the stack will carry a portion of the building load.

In Fig. 23 the building wall is indicated at 76, and is provided at spaced intervals with anchors 77 that are aligned with alternate rows of stack column members the top plates of which are indicated in this figure of the drawings by the numeral 78. These column members are connected by the gauge members 79 in the same manner heretofore described, the figure illustrating the parts in horizontal section and arranged in the form, as heretofore described, in which the columns are erected ready for the application of the forms for the concrete floor and before the reinforcing fabric for the concrete floor is applied to the structure. Tie bars 80 extend diagonally between the anchor members 77 and the top plates 78 of column members arranged in rows intermediate the rows with which the anchor members 77 are aligned. In this way the tie bars 80 extend in diagonal relation between the building wall 76 and the book stack structure in the manner illustrated in Fig. 23. As a result of this means for connecting the building wall to the stack structure, the tie rods 80 provide for the distribution of stresses and loads on the building wall 76 to the book stack, and the distribution of this load around the book stack structure, as well as through the body of the structure in substantially horizontal relation, due to the cooperation of the floors with the column members and the gauge bars 79 therewith. After the tie bars 80 are placed in position in the manner shown in Fig. 23 it will be understood that in the further construction of the book stack in this manner, the temporary floor members will be placed in position under the top plates of the column members and temporary floor forms will be built around the edge of the book stack structure between the columns and the wall 76.

Then the reinforcing strips for the floors will be applied in the manner hereinbefore described and anchored to the wall 76, and the concrete for forming the concrete floors subsequently poured in position to embed tie rods 80 in the body of the floor as well as the reinforcing strips and the gauge bars 79.

From the foregoing description and with particular reference to Figs. 12 to 15, it will be readily appreciated that the concrete floors when in position as shown in Figs. 14 and 15 will cooperate with adjacent stack column members and the interengaging portions on the top and bottom plates thereof to rigidly lock these column members in assembled relation with the concrete floors and each other, so as to provide a rigid stack structure in the completed form. By erecting a series of stack column members for the first floor on the foundation plates, after the foundation plates have been located and placed in position, it will be understood that all of the stack column members will always be in their proper spaced relation for receiving the book shelving of standard length and that the erection of the floors will progress upwardly beginning with the first floor and then the second until the entire book stack structure is completed.

In doing this the forms used for the molding of the first floor of the concrete floor can be removed as soon as the floor is finished and used in the building of some of the upper floors. If desired, one set of forms to provide enough for

one floor of the stack structure may be used to build one floor, and then taken down and used in building each successive floor above the first one, but of course, it is preferable to have a larger number of floor forming members than merely that number sufficient for one floor, and in this way two or three or more floors can be constructed at almost the same time so as to provide for a progressive method of erecting the stack structure by which a substantial economy in the cost of construction is obtained. It is, of course, to be understood that the stack structure will be provided at desired points with stairways between the floors of the stack, and for other types of well known equipment used in connection with a book stack. These accessories or attachments used in conjunction with book stack constructions are not illustrated here because their use and application in connection with the book stack provided by this invention will be clear to those skilled in the art.

The invention claimed is:

1. In a library stack construction, the combination of a plurality of foundation plates formed with positioning lugs, said plates being mounted in co-planar relation and spaced predetermined distances apart both longitudinally and transversely in rows to fix the spacing of stack columns, a plurality of stack columns of substantially uniform dimension, each having a top plate on one end and a bottom plate at the other end, each top plate being provided with a plurality of positioning lugs corresponding to the positioning lugs on a foundation plate, each base plate having openings to receive said lugs, said lugs cooperating to interlock each lower stack column with one of said foundation plates, and each stack column above the lower columns with the top plates of an adjacent stack column extending between adjacent floors, gauge bars connecting the top plates of adjacent stack columns in both directions in said longitudinally and transversely arranged rows of columns at each floor level and retaining said columns in predetermined spaced relation in the stack, independent reinforcing webs extending longitudinally and transversely between said columns in superposed relation to each other and supported on said gauge bars, and concrete floors embedding said webs and gauge bars reinforced thereby, and extending between columns in alignment with said top plates.

2. A library stack comprising the combination of a plurality of foundation plates mounted in rows longitudinally and transversely in horizontal relation and spaced predetermined distances apart, a plurality of stack column members each having a base plate and a top plate on opposite ends, said plates having interengaging parts for detachably connecting the base plate of a column member with a foundation plate, and the base plate of superposed column members with corresponding top plates in vertical alignment, gauge means connecting the connected base and top plates of each column with corresponding portions of adjacent columns in the rows, and concrete floors of substantially uniform cross section providing continuous and smooth ceiling surfaces extending substantially horizontally between all of said column members in the plane of said top plates and cooperating to retain said column members in rigid assembled stack forming relation, said column members being provided with means to receive and support book shelving.

3. A library stack comprising in combination, a plurality of foundation plates mounted in rows longitudinally and transversely in co-planar and predetermined spaced relation, a plurality of stack column members of substantially uniform dimension having base plates and top plates on opposite ends, all of said plates having cooperating parts for detachably connecting a base plate with a top plate and foundation plate respectively and providing for the mounting of a plurality of column members in vertically aligned relation end to end on each foundation plate detachably connected together, a plurality of uniform sized gauge members connecting the top plates in horizontal relation in said rows to retain said column members in predetermined spaced relation horizontally, and concrete floors joining said column members in horizontal alignment with said top plates and cooperating to retain said column members in rigid assembled stack forming relation, said gauge members being embedded in said floors and said floors providing smooth ceiling surfaces between said column members.

4. A library stack comprising in combination a plurality of foundation plates mounted in rows longitudinally and transversely in co-planar and predetermined spaced relation, a plurality of stack column members of substantially uniform dimension formed to interengage in end to end relation, and with said foundation plates to form a plurality of columns extending upwardly from each of said plates, means for connecting said columns at the interengaged portions of said column members to retain said members in predetermined spaced relation, and concrete floors connecting all of said column members in the plane of said interengaged portions for rigidly retaining said column members in stack forming relation, said floors having said means embedded therein and having continuous smooth ceiling surfaces between columns.

5. A library stack comprising in combination, a plurality of foundation plates mounted in rows longitudinally and transversely in substantially horizontal, co-planar and predetermined spaced relation, a plurality of stack column members of substantially uniform dimension mounted in end to end relation and extending vertically from each of said foundation plates, and concrete floors uniting said column members in the horizontal plane of the joints between the ends and cooperating to interlock said columns in asembled relation and provide a rigid stack assembly with smooth substantially horizontal continuous ceiling surfaces.

6. A library stack comprising in combination, a plurality of vertical stack column members of substantially uniform dimension and formed to interengage in end to end relation, gauge means detachably connecting adjacent column members both longitudinally and transversely of said stack at the ends of each of said column members for holding said column members in predetermined spaced relation, and concrete floors embracing said gauge means, extending horizontally between column members in the plane of the ends thereof and cooperating with said column members and gauge means to interlock said column members in rigid stack forming relation therewith in said predetermined spaced relation for receiving book shelving, said floors having smooth and continuous ceiling surfaces between column members.

7. A library stack comprising in combination, a plurality of vertical stack column members of substantially uniform dimension arranged in rows longitudinally and transversely and formed

for detachable connection in end to end relation, gauge members detachably connecting the ends of adjacent column members in said rows in both directions and retaining said column members in predetermined spaced relation, reinforcing fabric strips extending in between rows of column members both transversely and longitudinally of the stack and supported by said gauge members, and concrete floors extending horizontally of said column members in the plane of the ends thereof and embedding said fabric strips and gauge members and cooperating therewith to rigidly retain said column members, and gauge members in assembled stack forming relation, said floors having continuous smooth ceiling surfaces with all parts of the ceiling surface of each floor lying in the same plane.

8. A library stack comprising in combination, a plurality of vertical stack column members of substantially uniform dimension arranged in rows longitudinally and transversely, each column member having a base plate and a top plate mounted on opposite ends, each of said plates being formed with cooperating parts to detachably connect with other similar stack column members in end to end relation, gauge members connecting the plates of said members horizontally in said rows in both directions for holding said members in predetermined spaced relation, reinforcing fabric strips extending between rows of columns both longitudinally and transversely and supported by said gauge members in superposed relation, and concrete floors embracing said reinforcing strips, and reinforced thereby, said gauge members being embedded in said floors, said concrete floors cooperating with said column members and plates to embed said plates therein and retain said column members in rigid assembled stack forming relation with all portions of the ceiling surface of each floor between column members lying in the same plane.

9. A library stack construction comprising a plurality of stack column members arranged longitudinally and transversely in rows in uniform spaced relation, floors at predetermined levels rigidly connecting said stack column members for cooperation to provide a rigid stack structure, said stack column members being formed to mount bookshelves, said floors having the ceiling surfaces thereof formed with all parts lying in the same horizontal plane to provide continuous smooth ceiling surfaces between stack column members, walls enclosing said stack column members and spaced outwardly beyond stack column members at the ends of said rows, said floors having the edge portions connected with said walls, and a plurality of connecting links in the plane of said floors secured at one end to stack column members at the ends of said rows and at the opposite ends to said walls at spaced intervals, and cooperating to rigidly secure said walls in assembled relation with said stack column members and floors.

10. A library stack construction, comprising a plurality of stack column members arranged longitudinally in rows in uniform spaced relation, floors at predetermined levels rigidly connecting said stack column members for cooperation to provide a rigid stack structure, said stack column members being formed to mount book shelves, said floors having the ceiling surfaces thereof formed with all parts lying in the same horizontal plane to provide continuous smooth ceiling surfaces between stack column members, walls enclosing said stack column members and spaced outwardly beyond stack column members at the ends of said rows, said floors having the marginal portions thereof connected with said walls, said connection between said floors and walls having cooperating parts connecting said floors to said walls, said parts having limited relative movement in assembled relation.

11. A library stack construction, comprising a plurality of stack column members arranged longitudinally and transversely in rows in uniform spaced relation, concrete floors extending horizontally between said stack column members at intervals and cooperating with said column members to rigidly connect them in assembled relation to provide a rigid stack structure, reinforcing fabric strips embedded in said concrete floors and extending longitudinally and transversely between rows of columns, walls enclosing said stack structure and spaced outwardly beyond stack column members at the ends of said rows, said floors having the edge portions extending to said walls, and resilient anchor means connecting the ends of said reinforcing fabric strip to said walls, said floors being relatively movable with respect to said walls.

12. A library stack construction, comprising a plurality of stack column members arranged longitudinally and transversely in rows in uniform spaced relation, said column members being of substantially uniform dimensions and having a plurality of shelf supporting members provided thereon and extending from end to end of each of said members, a plurality of floor forming members, each comprising a plate section having corner portions formed to fit the contour of a portion of said column members adjacent the ends thereof, said plate members having depending marginal flanges, securing adjacent plate members together between said posts in floor forming cooperation, and means detachably engaged with said shelf supports adjacent the end of said column, having engagement with said floor forming members and rigidly supporting them in floor forming cooperation with said column members.

13. A method of constructing book stacks, consisting in locating and leveling a plurality of foundation plates in spaced co-planar relation in rows longitudinally and transversely to form a foundation support for the book stack, interengaging a plurality of stack column members on said plates in vertical relation, applying gauging means to the upper ends of said stack column members for holding said column members in predetermined spaced relation, applying a plurality of floor forming members between the upper ends of said columns, detachably applying supporting brackets to said columns to hold said floor forming members in assembled relation with said column members, interengaging a second series of columns with the upper end of the first-mentioned columns, applying gauging means to the upper ends thereof, placing reinforcing fabric strips over said floor forming members on said gauging means for support thereby, pouring a concrete floor on top of said floor forming members to interlock said column members together, and to embed said fabric strips therein, and subsequently removing said supporting brackets and floor forming members for re-use in a similar manner in forming other floors.

14. A floor forming member for book stacks, comprising a sheet metal plate having corner sections formed to provide a plurality of angu-

larly arranged portions formed to fit the contour of and form sockets to receive and position a stack column member, a continuous marginal flange on the periphery of said plate extending laterally from one side, and sheet metal strip members extending laterally from one face of said plate and transversely of intermediate portions of said plate in spaced relation to the marginal flange on two of the sides of said plate, said strip members having the ends engaged with the marginal flanges on the other two sides of said plate, and said strip members having stress distributing cooperation with said marginal flange and plate.

15. A method of building book stacks, consisting in providing foundation plates for support upon and adjacent a suitable supporting surface over which the stack is to be erected, mounting said plates upon said surface in coplanar relation by building up uneven portions of the surface under said plates with a suitable filler, at the same time arranging and anchoring said plates in uniform spaced relation in rows longitudinally and transversely on said surface, erecting stack columns on each foundation plate in upwardly extending relation, and successively constructing floors above one another in spaced parallel relation, the first floor being constructed above said supporting surface a distance equal to the distance between any two other floors to provide shelving space and convenient access thereto above said surface and each floor, each floor extending between and being connected to and supported by all of said stack columns and cooperating to secure said columns in rigid assembled relation.

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