July 26, 1949. F. N. KNEAS 2,477,256

CANTILEVER FLOOR STRUCTURE

Filed Sept. 17, 1947 4 Sheets-Sheet 1

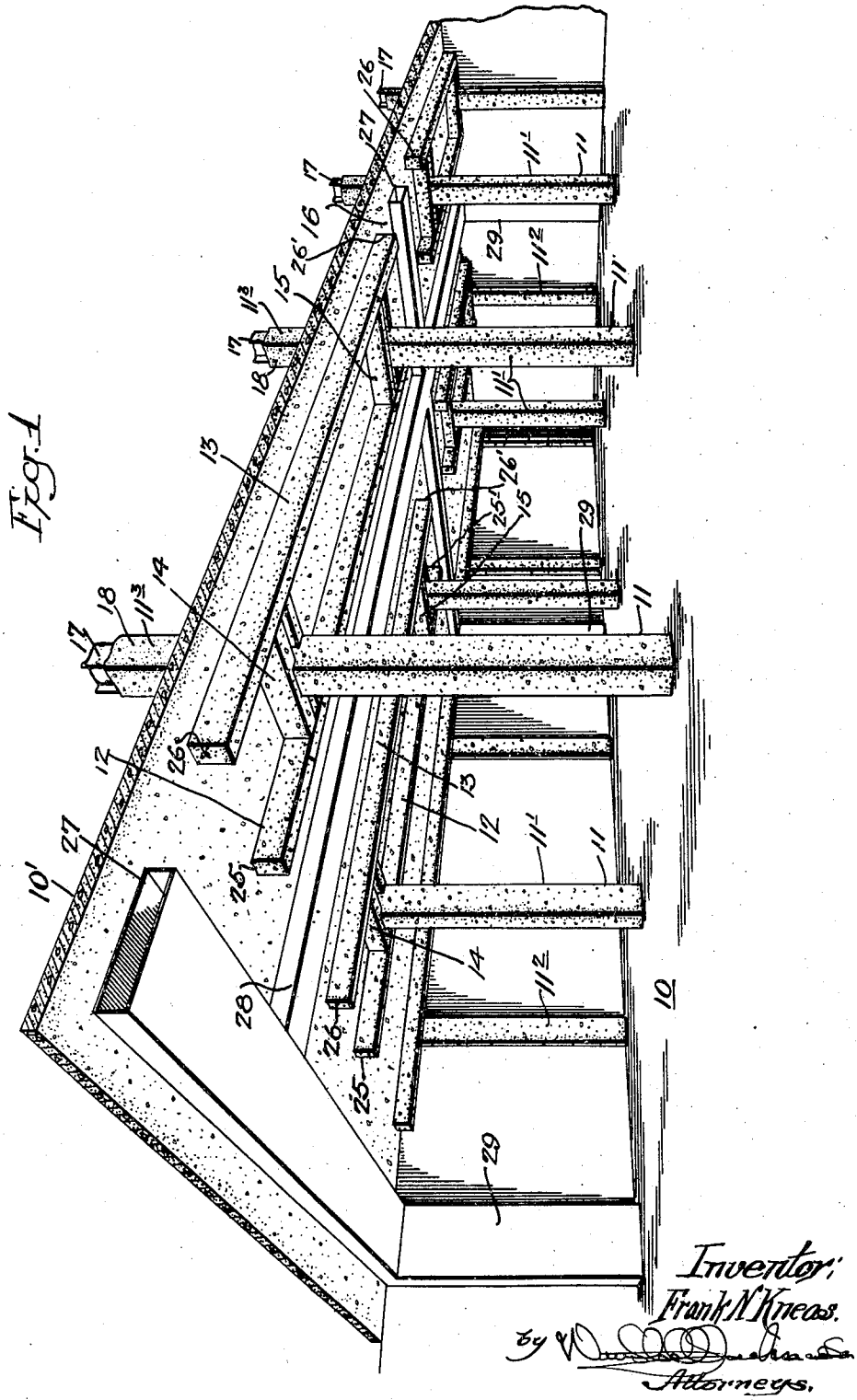

Fig. 1

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Fig. 2.

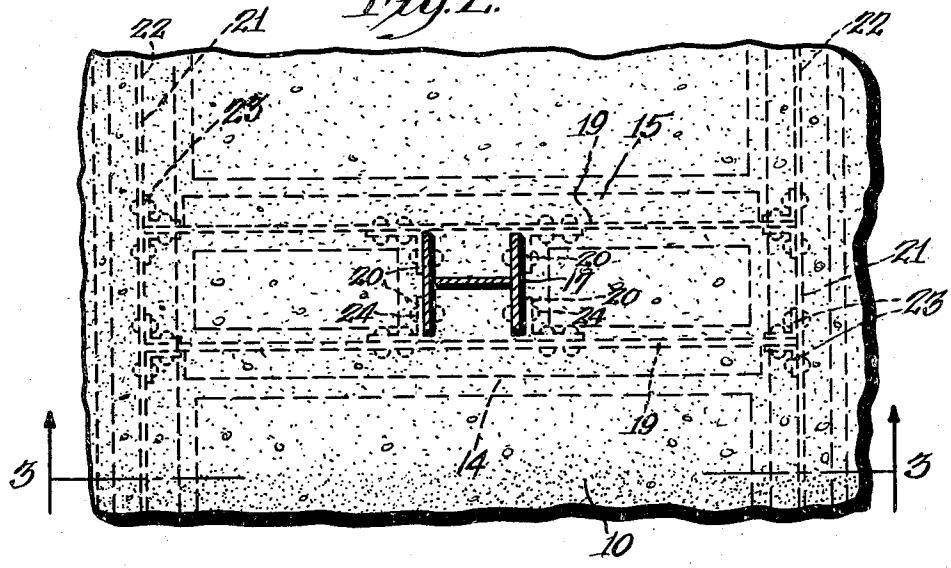
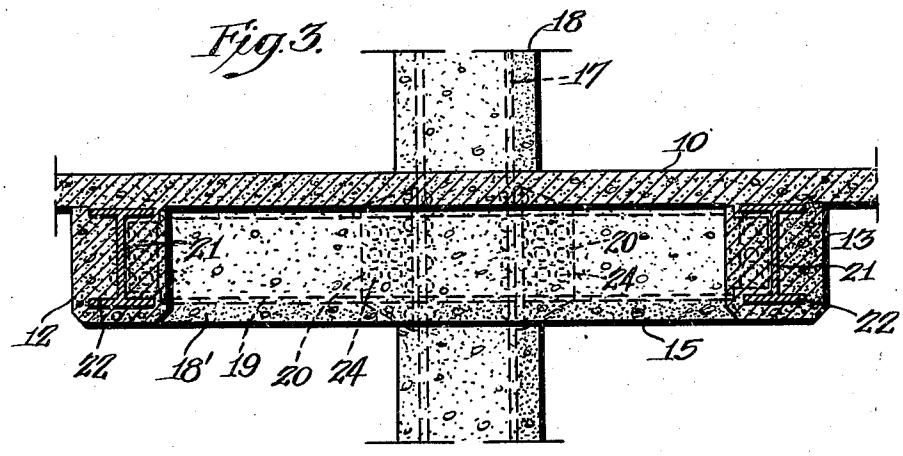


Fig. 3.



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CANTILEVER FLOOR STRUCTURE

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Fig. 4.

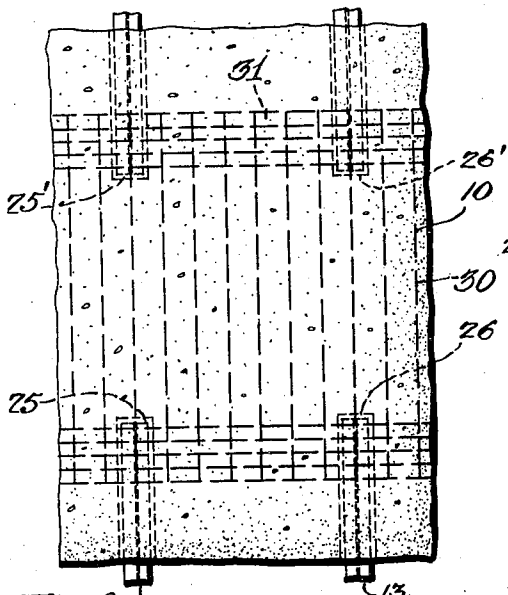


Fig. 5.

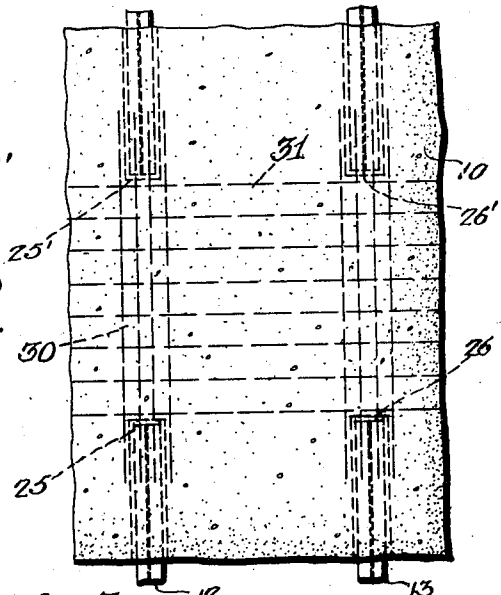


Fig. 6.

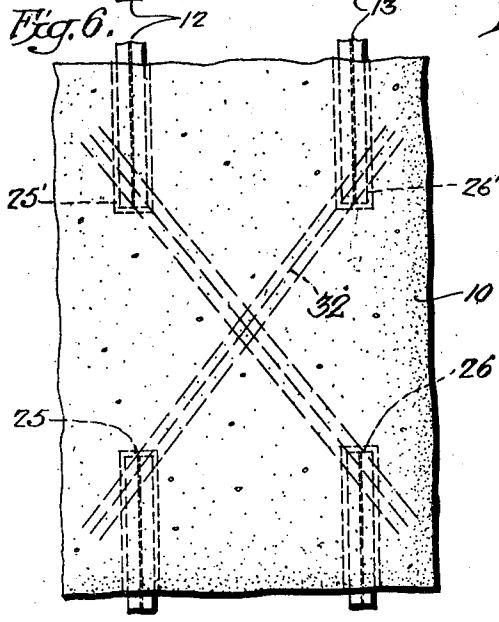
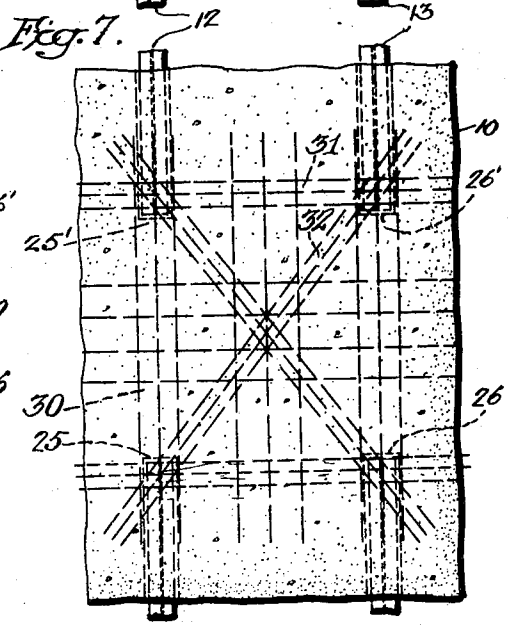


Fig. 7.



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CANTILEVER FLOOR STRUCTURE

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Fig. 8.

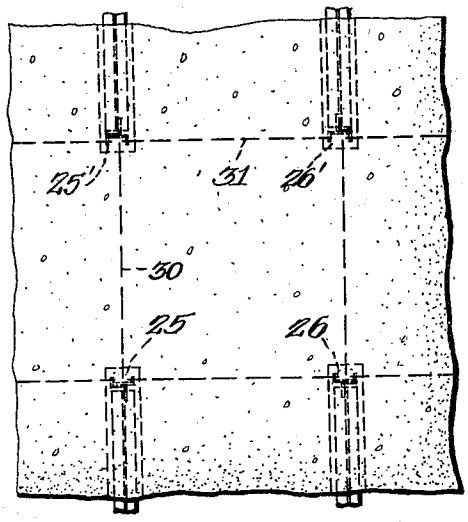


Fig. 9.

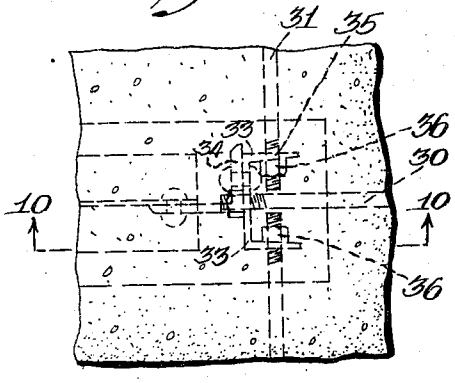
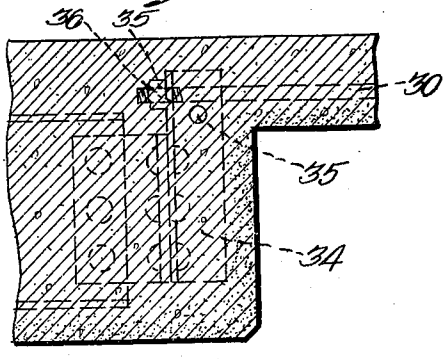


Fig. 10.



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Patented July 26, 1949 2,477,256

UNITED STATES PATENT OFFICE

2,477,256

CANTILEVER FLOOR STRUCTURE

Frank N. Kneas, Philadelphia, Pa.

Application September 17, 1947, Serial No. 774,616

9 Claims. (Cl. 72—15)

1

The present invention relates to a system of floor framing accurately spaced metal platforms of novel design for the support of erection loads during the construction of reinforced concrete floor slabs resting on the platforms, the spaces under the floor slab between the platforms facilitating the installation of ducts longitudinally and transversely in a building.

My invention differs from, and offers improvements over any type heretofore used. By using structural metal columns of 2 or 3 story lengths with projecting structural metal yard-arms at each floor level attached to them in the fabricating shops it speeds erection and obtains maximum usable floor space.

By using cantilever-ended floor beams, it reduces the maximum moments in the floor beams and in the columns without incurring the dangers inherent in continuous beams and allows all stresses to be computed by simple formulas. It provides a series of structural metal platforms or panels formed by pairs of cantilever-ended floor beams spanning between and supported by yard arms and connecting two or more columns at each floor level which, during erection will support men and erection equipment and after erection will form the supports of the permanent floor slabs.

My invention provides spaces in which longitudinal and transverse slots can readily be provided without cutting main reinforcement or setting up unknown stresses in the slabs.

My invention further provides a system of floor framing facilitating the installation of ducts longitudinally and transversely under the floor slab without passing under a grid-iron of beams and girders and without incurring the disadvantages of the flat slab system.

Further purposes of my invention will appear in the development of the specification and claims.

Figure 1 is a perspective view showing a partial building frame of encased metal columns supporting pairs of longitudinally extending cantilever beams with spaces in line with and between them.

Figure 2 is an enlarged fragmentary sectional plan view parallel to the floor, showing part of the structure of Figure 1.

Figure 3 is a fragmentary section of Figure 2 taken upon line 3—3.

Figures 4 to 7, inclusive, are fragmentary top plan views showing a few different reinforcements of a concrete floor slab in its location between the ends of the cantilever beams.

Figure 8 is a fragmentary top plan view showing adjusting members.

Figure 9 is an enlargement of one of the adjustments of Figure 8.

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Figure 10 is a section of Figure 9 on the line 10—10.

In the drawings similar numerals indicate like parts.

For the purpose of description, I call the direction along the axes of the cantilever-ended floor beams, the longitudinal direction of the building, and the direction at right angles, the transverse direction.

In my invention, I use structural metal columns, each of which is composed of a single self-contained unit such as a rolled structural metal section of H shape adapted both to carry vertical loads and to resist lateral forces.

Each H-shaped column is composed of a single unit having flanges on each side extending from a central web a sufficient distance to receive rivets, bolts, or other connecting devices for the atachment of the horizontal projecting members which I call yard arms, and which do away with the necessity for transverse steel girders extending from column to column. Each yard arm is a channel shaped member composed of a vertical web with flanges projecting from the top and bottom edges, and is attached to the column in the fabricating shop by angle shaped structural metal members. This offers a great advantage over ordinary beam and girder construction in which it is impractical to attach the girders to the columns in the fabricating shop. After the columns with their yard arms are erected, floor beams are attached in the field to the ends of the yard arms of pairs of structural metal columns and extend beyond the yard arms to become cantilever ended floor beams to form structural metal platforms at each floor level. Reinforced concrete slabs span between the floor beams.

The cantilever-ended floor beams, of uniform depths throughout their lengths, are spaced by the yard arms away from the columns and by their rigid attachment to the ends of the yard arms are prevented from revolving around their longitudinal axes; they thus form rigidly fixed, and uniformly spaced, abutments for the transverse concrete slabs that span the clear spaces from beam to beam.

The cantilever-ended structural metal floor beams are preferably constructed of rolled structural metal sections which are readily obtainable with vertical webs, having flanges extending laterally at their top and at their bottom edges. Thus they obviate the necessity of using bent, or perforated, trough shapes, and provide broad flat surfaces at their tops to form bearings for the transverse slabs and the transverse bands of reinforced concrete. The bottom flanges form shelves from which reinforced concrete haunches can be formed to provide further support for the transverse slabs and bands. The top and bottom flanges of the structural metal floor beams being

solidly connected to the web by fillets, provide lateral support against arch action, that may be imposed by the transverse slabs and bands and they also provide resistance against torsion in the transverse direction. The bending moments that occur in the said transverse slabs and bands, whether caused by vertical loads on the floor slabs or by lateral transverse wind, or other pressures, on the structure, are reduced by this torsional resistance.

Transverse, or cross-bands of reinforced concrete run in the transverse direction of the building and are supported on the cantilever ends of the cantilever-ended floor beams. These cross-bands carry floor slabs which are called suspended slabs, and span longitudinally between the cross-bands. The load from the suspended slab and from the transverse bands are thus applied on the cantilever ends of the cantilever-ended floor beams. Great economy in the use of structural metal is obtained by my invention, because the end moment due to loads on the cantilever portion of the cantilever-ended floor beam reduces the moment due to loads on the central portion of the floor beam. Shallower and lighter beams can be used on account of these reduced moments, as compared with beams which are simply supported at each end in the ordinary type of structural metal skeletons.

By properly proportioning the lengths of the cantilevers, and the lengths of the suspended slabs, bending moment to a greater or less degree can be induced in the cantilevers, reducing, or increasing, the bending moments in the central portions of the cantilever-ended floor beams, until the most favorable balance of moments is reached in the design, which is generally when the moment on the cantilever portion of the floor-beam becomes the same as the moment on the central portion.

This is a great improvement over floor construction, such as used in so-called flat slab construction, in which single, free-standing, reinforced concrete columns are used, having flared heads, or brackets, which project from the faces of the column and support the floor slab. In the latter case, an unbalanced floor load placed on the slab on one side of the column, tends to depress the slab on that side and causes bending in the column without favorable reduction in moments in the slab on the other side of the column.

The H-shaped columns are less resistant in the direction of the axes of the flanges than in the direction of the webs. I, therefore, place the axes of the flanges parallel to the longitudinal floor beams whose continuity between columns, and their extension into cantilever ends, reduces the bending in the columns, should any unequal loading on the floor occur in the longitudinal direction. The greater resistance of the columns is in the transverse direction, where it is best adapted to resist the bending moments that occur, should any unequal loading occur in the transverse direction. The bending moments in the transverse direction are further resisted by the heavily reinforced transverse bands.

Furthermore, since the columns continue uninterrupted through the connections for the yard arms into the story above, the bending is divided at each floor level between the column section that extends below the floor and the column section that extends above the floor.

At the top of the building, the snow load is light, and may be considered as uniformly distributed, so that no bending occurs in the top section of the column, which does not continue above the roof.

In the completed construction, all of the structural metal members are generally encased in reinforced concrete. The encasements of the beams and yard arms are integrally connected with the reinforced concrete floor slabs. Each pair of steel columns, with their yard arms, connected by cantilever-ended floor beams, provides at each floor level a structural metal supported reinforced concrete platform, or island, which is connected to other similar platforms by reinforced concrete slabs spanning transversely. The longitudinal axis of each platform is located by the center-line of the two columns connected by the pair of cantilever-ended floor beams. The length of the platform is equal to the length of the cantilever-ended floor beams, and the width is determined by the dimension out-to-out of the pair of concrete encased floor beams supported by the yard arms on each of the connected columns.

At the ends of the cantilevers, which form the structural metal platform, a large and abrupt change in the depth of construction is provided between the deep structural metal beam and the shallow reinforced concrete longitudinal floor slab that is suspended between the transverse bands. The equivalent of a hinge is thus obtained at each end of the cantilever-ended floor beams. The transverse bands, which are also shallow, allow a certain amount of torsional rotation around their axes, without causing serious internal stresses.

In the transverse direction, assuming that the center-to-center distance of adjacent concrete platforms is predetermined, the span of the transverse slab and the transverse bands between adjacent platforms can be altered by altering the length of the yard arms. If the lengths of the yard arms are increased, the span of the transverse slab and bands between adjacent platforms is reduced. At the same time, lengthening the yard arms increased the span of the platform slab between the beams supported from the ends of the yard arms on each side of the columns. The most economical and desirable ratio of spans of slabs and transverse bands can thus be obtained by altering the lengths of the yard arms.

In the transverse direction, there is an abrupt change in depth between the concrete encased structural metal beams at the edges of the platform and the transverse slab that spans between the beams.

There is thus produced, in effect, a series of rigidly supported, reinforced concrete, platforms or panels connected, both in the longitudinal and transverse directions with other similar platforms by reinforced concrete slabs of much less depth than the beams providing a hinged effect on all edges of the platform by abrupt changes in depths and deflection coefficients.

There is thus provided a safeguard against unknown stresses that would be set up if the beams were made continuous, and if changes in alignment were caused by unequal settlements in column footings, or caused by unequal compression in the supporting columns, due to unequal loadings on the floors of a multi-story building.

The yard arms can be connected to the column in the fabricating shop where more accurate assembly is possible than in the field. Each column may be of two or three story lengths with

yard arms attached at intervals that correspond to the accurate story heights. This shop fabrication also reduces the amount of work necessary in the field. Each column is fabricated as a continuous unit without the necessity for interruption for the insertion of short sections to carry brackets to the column.

The columns of each connecting pair are accurately spaced on column centers and held there by the cantilever-ended beams which are connected to the ends of the yard arms at each floor level. The beams form rigid bents with the columns which are thus kept plumb and true during erection.

It is necessary during the construction of a multi-story building to raise the hoisting apparatus, such as derricks, etc., to the upper floor levels as the erection proceeds. The rigid bents or platforms formed by the cantilever-ended floor beams, connecting the yard arms and columns at each floor level, form platform frames on which timbers and planks can be erected to form working spaces on which the hoisting apparatus can be placed and around which the raising gangs can work.

In my invention I provide against wind moments during construction in the longitudinal directions by connecting pairs of columns through their yard arms by the cantilever-ended beams; each pair of the cantilever-ended beams in joint action with the connected columns forming a bent that will resist the wind. Heavy anchors between the bases of the columns and the footing resist lateral forces in the transverse direction.

These bents formed by columns connected by the cantilever-ended floor beams through the yard arms not only resist wind during construction, but also after completion. In the transverse direction, after the structure is completed, additional wind resisting bents are formed by the reinforced cross-bands between the cantilever ends of the cantilever-ended floor beams. Furthermore, when transverse forces act against the completed structure, the cantilever-ended floor beams being rigidly spaced and held away from the columns by the yard arms tend to be deflected downward for their full length on the leeward side and upward on the windward side producing uniform bending stresses in the transverse bands and slabs for the full lengths of the cantilever-ended floor beams. This provides more resistance to lateral forces than the limited areas of floor slabs around the column heads in typical reinforced concrete flat slab construction.

In my invention, while both yard arms and beams extend below the bottom of the floor slab, spaces or gaps are provided both in the longitudinal and the transverse direction, where there is no projection below the floor slab. Ducts attached to the underside of the slab can pass through these spaces or gaps without projecting below the bottom of the longitudinal floor beams or the transverse yard arms, so that the clear head room from the underside of the duct will approximate the clear heights from the underside of the beams to the floor below.

In the longitudinal direction spaces or gaps are provided under the slab between the ends of the cantilevers of consecutive platforms, in which transverse ducts can be placed under the slab but above the level of the bottoms of the floor beams.

In the transverse direction spaces are provided under the slab between the sides of the floor beams of adjacent bents, in which longitudinal

ducts can be erected under the slab and above the level of the bottoms of the floor beams. These clear spaces between the platforms are not interrupted as they are in ordinary framed buildings with beams and cross girders either of structural metal, or of reinforced concrete.

In modern buildings with large areas of floor space, with desks arranged in longitudinal and transverse rows, it is necessary to provide telephone connections at each desk and to make provision for other services such as electric light and electric service for adding machines, comptometers, and other modern office devices. To avoid overhead wiring, it is desirable to run conduits, or under-floor ducts, in longitudinal and transverse rows, in the floor slab, to line up with the desks. It is very necessary that the reinforcement in the floor slab be so arranged as to allow the placing of the conduits without interference with the reinforcement. This is made difficult in flat slab construction because the main reinforcement occurs radially, or at right angles, or in diagonals, in checkerboard areas over the floor areas where the reinforcement is concentrated over the column heads.

In my invention the main reinforcement spans transversely from structural metal platform to structural metal platform across the full width of the building. There is thus formed a broad strip of floor slab as wide as the cantilever-ended floor beams are long, in which the main reinforcement spans in the transverse direction. The transverse bands across the cantilever end form a kind of selvage at the edges of the strip.

From the transverse bands the main reinforcement of the suspended slab spans in the longitudinal direction. There is thus formed a broad strip of floor slab extending the full width of the building in which the reinforcement spans in the longitudinal direction.

In many spacial types of buildings it is necessary to provide longitudinal openings or slots through the floor slabs through which inter-communication cables, or ducts, may be passed. Since, in my invention, longitudinally reinforced suspended slabs occur at regular intervals between transverse bands, these slabs form ideal locations for the longitudinal slots. In these suspended slabs the slots require that only one or two rods parallel to the slot be omitted. Neither omission nor cutting of the main transverse reinforcement is necessary in the full length of the slot which may extend from band to band. Since the bands extend the full width of the building, numerous longitudinal slots can be provided in the building without weakening of the construction.

It frequently becomes necessary to have vertical runs of pipes, ducts, or down-spouts, or other mechanical features through successive floors in the interior bays. The least interference is caused to the occupancies and users of the building when these required runs can be placed closely adjacent to the columns, preferably where they can be included in the furring around the columns, or in the partitions abutting the columns, the most desirable location being generally close to the center of one of the faces of the columns.

In the ordinary framed construction of structural metal or concrete the beams and girders frame into the columns on the center lines and thus block the desired locations for the runs.

In the flat-slab construction it is not desirable to provide the holes through the deep flared heads

or through the brackets which normally occur on the center lines.

In my invention the desired spaces for the vertical runs are kept clear because the channel yard arms are spaced away from the center lines of the columns beyond the edges of the flanges, thus providing spaces which allow holes through the floors opposite the column flanges without weakening the structure in any way.

In the other direction, the yard arms space the longitudinal beams away from the columns in the transverse direction, allowing ample spaces for holes without weakening the structure.

In structural metal framed structures with beams and girders framing between the columns, it is often difficult to bring the columns to plumb, true lines, because of minor discrepancies and tolerations in the shop work and because of the lack of adjustment in the lengths of the beams and girders. Therefore, to make field corrections, it is necessary to drift and ream the holes connecting the members and to use oversize rivets, filler plates, or other costly means for making adjustments. In my invention the successive columns with their platforms are connected by adjustable members in both the longitudinal and the transverse directions. These adjustable members are preferably made in the form of rods with long threads on each end on which nuts operate to draw the platforms into true and correct relation to each other and to hold them firmly in position. These adjustable members are installed within the limits of the thicknesses of the slabs and the transverse bands, and after the concrete is poured, they form additional reinforcement.

Rivets have numerous advantages over other connecting devices, but the noise of riveting in the field is objectionable and riveting should be done as far as possible in the fabricating shop. In my invention the number of rivets necessary to be driven in the field is reduced because the yard arms, which take the place of girders used in beam and girder construction, are riveted to the columns in the shop.

Upon or beneath the floor 10 are mounted a plurality of columns 11, of which columns 11' are "interior" columns and columns 11^2 are "exterior" columns. The columns and the other metallic parts to be described are made of structural metal, such as structural steel or structural aluminum alloy.

As the illustration is intended to be a general one, floor 10 represents but one floor of a number of floors which might be served by the same columns extending above it as at 11^3, Figure 1, to the height of the building. It is assumed that both floors, 10 and 10', illustrated are intermediate floors.

Longitudinally extending facing spaced pairs of beams 12, and 13 are illustrated along with their supporting yard arms 14 and 15. Between the facing ends of each pair is a space or gap 16. In this particular illustration, the columns comprise structural metal shapes 17 such as H-beams, protected by concrete fire resisting encasements 18, which may be reinforced concrete, if desired.

For the purpose of showing one way in which the yard arms may be supported from the structural metal columns and one way in which the beams are supported from the yard arms, without suggesting that either is the only way, Figures 2 and 3 have been inserted to illustrate an acceptable structure of the type. The columns 17 are illustrated as H columns or I columns, which are united to the webs, back to back, of transverse channels 19 by angles 20. Correspondingly the channel webs 19 are united to the webs 21 of H-beams or I-beams 22 by angles 23.

The yard arms are intended to represent an acceptable and generally preferred form of connection between columns and cantilever beams and have been selected for that reason as a generic form.

The fire resistant encasement 18 has been broken away in Figure 2 to show the metal column 17 and the bracketing 20 by which the yard arm channels 19 are connected to the metal column. No point has been made of the character of connection, whether it be by bolts or by rivets or by welding. However, rivets 24 are shown as a desirable form. The joint is also fully encased in fire resistant concrete at 18.

The yard arm itself is encased also in fire resistant concrete at 18'.

The bracketing of the yard arm channels to the cantilever-ended beams—here shown as of I-beam form appears also in Figures 2 and 3, where the brackets 23 are riveted respectively to the channels and to the I-beam, riveting again being considered as a desirable form.

The structure shown in Figures 2 and 3 has been used by me before. However, in the present invention numerous improvements have been made.

The cantilever ends of the cantilever-ended beams form shelves and abutments for the transverse bands. The transverse bands form supports for suspended slabs which have main reinforcement only in the longitudinal direction, thus affording facilities for providing longitudinal slots in the floor construction. At the ends of the cantilevers there are formed large and abrupt changes in the depth of construction which with the transverse bands form the equivalent of a hinge in the longitudinal direction of the construction. There is thus provided a safeguard against unknown and perhaps dangerous stresses that would be set up if changes in alignment and level are caused by unequal settlements in column footings or caused by unequal compression in the supporting columns. There is also provided at the ends of the cantilevers means of adjustment to bring the columns into true plumb lines during construction.

It has not been considered necessary to show any fastening for the floor slab which may be an integral part of the entire unit as in Figures 1 and 2, or may simply rest upon the cantilever beams or yard arms, and thus form a suspension between the adjacent facing ends of the cantilever beams.

It has not been considered necessary to show support for the ducts which may be suspended from the slab or may be separately supported in any manner which does not interfere with free ceiling space for the floor below.

The lateral ducts 27 are connected in any suitable manner with longitudinal ducts 28 extending parallel with the cantilever beams and between the adjoining beams of adjacent pairs.

The duct system as so far described is supplied by vertical ducts 29 so as to provide inlet or outlet, as the case may be, bttween the horizontal and longitudinal ducts, whichever may be connected, and a fan system by which inlet or outlet may be provided for the ducts as intended. The duct system shown is designed to be equally suitable for inlet or outlet as the case may be, no difference being made between them except as to

size or the special exigencies of the design planned. Some of the space provided can be used for electrical conduits, water pipes, etc.

One use intended for the present construction—among a large number of uses to which it is suited—comprises supply of cold air in considerable quantity, not for ventilation alone but for ventilation plus cooling of electrical communication equipment.

In whatever use, the ducts may have the usual apertures or nozzles at the sides, tops or bottoms, for distribution of inlet air within the room, and this distribution may be made at any height in any of the ducts as desired. It has not been considered necessary to illustrate this separately as this feature is well known in the art.

The cantilever-ended beams of each of the platforms terminate abruptly at **25**, **26** and **25'** and **26'** in Figures 4 to 8, inclusive.

In Figures 4 and 5 I illustrate reinforcing rods **30** parallel to the lengths of the cantilever beams and reinforcing rods **31** transverse thereto. These figures differ only in respect to whether the longitudinal or transverse reinforcing is uppermost. In Figure 4 the longitudinal rods lie above the transverse rods, and in Figure 5 the transverse rods are on top of the longitudinal rods. Long slots can be provided parallel to the reinforcing rods in whichever direction they lie.

Reinforcements may be entirely diagonal as shown by the rods **32** in Figure 6. The diagonal reinforcing may also be employed with the longitudinal and transverse reinforcing as shown in Figure 7, but the arrangements in Figures 4 and 5 are preferred.

Figures 8, 9 and 10 illustrate a construction in which threaded members are employed to adjust the positions of the columns and beams. Suitable anchorages **33** are provided extending in one direction and suitable anchorages **34** are extending in the direction transverse thereto at the end of each canilever beam. The anchorages here take the form of a channel which have openings **35** for threaded members **30** and **31** which are adjusted by nuts **36**, as best seen in Figure 9.

The adjustable construction as shown in Figures 8 to 10 is preferred.

In all of the discussion of reinforcement preceding it is the intention that the engineer shall be free to use any reinforcement which is required.

It will be evident that whatever form of reinforcement be used, adequate fire protection for the reinforcement will be provided.

Were reference is made in the claims to beams generally, without further explanation, it is the intention that the physical beam used shall be intended with or without encasement as may be required.

It will be evident that though the discussion in this case has included primarily encased structural metal beams, the same features which make it desirable for structural metal encased beams, make the invention desirable also for reinforced concrete beams of whatever character since the same objections arise to ducts below the lower level of reinforced concrete beams as arise from ducts below the encased structural metal beams.

It will be evident that ducts for air passage, for example, running in opposite directions do not need to pass each other but can be connected within the limits of the bottom of the beams and the bottom of the slab but that with conduits of different character such as water and gas or water and electric cable, the conduits must

be flattened or otherwise adjusted one to another so as to permit them to pass.

It will be evident that even where full advantage of my invention is not possible by reason of the fact that a portion of the depth of a duct must project below the beams, even partial projection of the duct height into the gap between the beams is correspondingly of value.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In building construction, a series of parallel independent isolated building frames, each building frame comprising a pair of columns, yard arms extending transversely of each column in both transverse directions and ending abruptly, and two longitudinal floor beams spaced away from the columns and rigidly held on either side of the columns at the ends of the yard arms, each floor beam consisting of a center portion between the yard arms and free-ended cantilever portions extending beyond the yard arms in each direction, the floor beams and yard arms forming in plan a floor panel in the form of an elongated H with two cross bars, the floor beams terminating before adjacent floor panels are encountered in either the longitudinal or transverse horizontal direction, there being wide open spaces between the floor panels in both longitudinal and transverse directions which allow ventilating ducts and other equipment to completely encircle each panel without interference by floor beams, the floor loads on the cantilever portions of the floor beams reducing the floor load moments in the center portions, each floor panel being continuous over only two columns and spacing the columns of each pair from one another during erection, and the building frames formed by the panels rigidly attached to the columns through the yard arms resisting distortion from horizontal or longitudinal forces, and a floor slab supported on the floor panels and above the level thereof spanning longitudinally from each cantilever portion of each floor beam to the adjoining cantilever portion of the adjoining floor beam of the next floor panel, and spanning transversely over the panel between the yard arms and over the spaces between adjacent panels.

2. In building construction, a series of parallel independent isolated building frames, each building frame comprising a pair of columns, yard arms extending transversely of each column in both transverse directions and ending abruptly, and two longitudinal floor beams spaced away from the columns and rigidly held on either side of the columns at the ends of the yard arms, each floor beam consisting of a center portion between the yard arms and free-ended cantilever portions extending beyond the yard arms in each direction, the floor beams and yard arms forming in plan a floor panel in the form of an elongated H with two cross bars, the floor beams terminating before adjacent floor panels are encountered in either the longitudinal or transverse horizontal direction, there being wide open spaces between the floor panels in both longi-

tudinal and transverse directions which allow ventilating ducts and other equipment to completely encircle each panel without interference by floor beams, the floor loads on the cantilever portions of the floor beams reducing the floor load moments in the center portions, each floor panel being continuous over only two columns and spacing the columns of each pair from one another during erection, and the building frames formed by the panels rigidly attached to the columns through the yard arms resisting distortion from horizontal or longitudinal forces, and a floor slab spanning longitudinally and transversely over each floor panel and two adjoining floor panels above the level thereof, the junctions between the floor slab and the panels being characterized by abrupt changes of depth and stiffness factors resulting in elastic connections between the floor slab and each panel, providing elasticity of action between the adjacent building frames avoiding the indeterminate action of continuous panel and girder construction over more than two supports.

3. In building construction, a series of parallel independent isolated building frames, each building frame comprising a pair of columns, yard arms extending transversely of each column in both transverse directions and ending abruptly, and two longitudinal floor beams spaced away from the columns and rigidly held on either side of the columns at the ends of the yard arms, each floor beam consisting of a center portion between the yard arms and free-ended cantilever portions extending beyond the yard arms in each direction, the floor beams and yard arms forming in plan a floor panel in the form of an elongated H with two cross bars, the floor beams terminating before adjacent floor panels are encountered in either the longitudinal or transverse horizontal direction, there being wide open spaces between the floor panels in both longitudinal and transverse directions which allow ventilating ducts and other equipment to completely encircle each panel without interference by floor beams, the floor loads on the cantilever portions of the floor beams reducing the floor load moments in the center portions, each floor panel being continuous over only two columns and spacing the columns of each pair from one another during erection, and the building frames formed by the panels rigidly attached to the columns through the yard arms resisting distortion from horizontal or longitudinal forces, a floor slab supported on each elongated H-shaped floor panel above the level thereof and spanning between adjacent floor panels, and ventilating ducts below the floor slab and around the floor panels both longitudinally and transversely.

4. In building construction, a series of parallel independent isolated building frames, each building frame comprising a pair of columns, yard arms extending transversely of each column in both transverse directions and ending abruptly, and two longitudinal floor beams spaced away from the columns and rigidly held on either side of the columns at the ends of the yard arms, each floor beam consisting of a center portion between the yard arms and free-ended cantilever portions extending beyond the yard arms in each direction, the floor beams and yard arms forming in plan a floor panel in the form of an elongated H with two cross bars, the floor beams terminating before adjacent floor panels are encountered in either the longitudinal or transverse horizontal direction, there being wide open spaces between the floor panels in both longitudinal and transverse directions which allow ventilating ducts and other equipment to completely encircle each panel without interference by floor beams, the floor loads on the cantilever portions of the floor beams reducing the floor load moments in the center portions, each floor panel being continuous over only two columns and spacing the columns of each pair from one another during erection, and the building frames formed by the panels rigidly attached to the columns through the yard arms resisting distortion from horizontal or longitudinal forces, a two-way flat reinforced concrete floor slab above the level of the floor panels spanning between longitudinal floor beams and extending by cantilever action over transverse spaces between the floor panels, the torsion resistance of the center portion of the longitudinal floor beam reducing the transverse bending moment on the floor slab, a two-way flat reinforced concrete floor slab spanning from the free cantilever ends of one floor panel to the free cantilever ends of the next floor panel in a longitudinal direction, the torsion resistance of the cantilever portions of the floor beams resisting the transverse bending moments in the slab while the bending resistance in the longitudinal direction of the cantilever portion increases the resistance to the longitudinal bending moments in the flat slab over the longitudinal space between the beams.

5. In building construction, a series of parallel independent isolated building frames, each building frame comprising a pair of columns, yard arms extending transversely of each column in both transverse directions and ending abruptly, and two longitudinal floor beams spaced away from the columns and rigidly held on either side of the columns at the ends of the yard arms, each floor beam consisting of a center portion between the yard arms and free-ended cantilever portions extending beyond the yard arms in each direction, the floor beams and yard arms forming in plan a floor panel in the form of an elongated H with two cross bars, the floor beams terminating before adjacent floor panels are encountered in either the longitudinal or transverse horizontal direction, there being wide open spaces between the floor panels in both longitudinal and transverse directions which allow ventilating ducts and other equipment to completely encircle each panel without interference by floor beams, the floor loads on the cantilever portions of the floor beams reducing the floor load moments in the center portions, each floor panel being continuous over only two columns and spacing the columns of each pair from one another during erection, and the building frames formed by the panels rigidly attached to the columns through the yard arms resisting distortion from horizontal or longitudinal forces, concrete encasement of the floor panels, first reinforced concrete floor slabs extending over the spaces between the longitudinal floor beams of the floor panels above the level thereof and having integral connection of the concrete with the concrete encasement of the floor panels, second reinforced concrete floor slabs at the same level as and integral with the first, extending transversely over the spaces between the sides of the elongated H-shaped floor panels and making in effect elastic connections with the floor panels, having the main reinforcement extending transversely, and third reinforced concrete floor slabs at the same level as and integral with the first

and second floor slabs, extending longitudinally over the spaces between the longitudinal ends of the floor panels, making in effect elastic joints with the floor panels and having the main reinforcement extending longitudinally.

6. In building construction, a series of parallel independent isolated building frames, each building frame comprising a pair of columns, yard arms extending transversely of each column in both transverse directions and ending abruptly, and two longitudinal floor beams spaced away from the columns and rigidly held on either side of the columns at the ends of the yard arms, each floor beam consisting of a center portion between the yard arms and free-ended cantilever portions extending beyond the yard arms in each direction, the floor beams and yard arms forming in plan a floor panel in the form of an elongated H with two cross bars, the floor beams terminating before adjacent floor panels are encountered in either the longitudinal or transverse horizontal direction, there being wide open spaces between the floor panels in both longitudinal and transverse directions which allow ventilating ducts and other equipment to completely encircle each panel without interference by floor beams, the floor loads on the cantilever portions of the floor beams reducing the floor load moments in the center portions, each floor panel being continuous over only two columns and spacing the columns of each pair from one another during erection, and the building frames formed by the panels rigidly attached to the columns through the yard arms resisting distortion from horizontal or longitudinal forces, concrete encasement of the floor panels, adjustment bars connecting the floor panels with adjoining floor panels longitudinally and transversely above the level of the floor panels, and a reinforced concrete floor slab including the adjustment bars within the slab extending over the floor panels and having the concrete integral with the concrete encasement around the floor panels, spanning over the spaces both longitudinally and transversely between the floor panels and supported on the floor panels.

7. In building construction, a series of parallel independent isolated building frames, each building frame comprising a pair of columns, yard arms extending transversely of each column in both transverse directions and ending abruptly, and two longitudinal floor beams spaced away from the columns and rigidly held on either side of the columns at the ends of the yard arms, each floor beam consisting of a center portion between the yard arms and free-ended cantilever portions extending beyond the yard arms in each direction, the floor beams and yard arms forming in plan a floor panel in the form of an elongated H with two cross bars, the floor beams terminating before adjacent floor panels are encountered in either the longitudinal or transverse horizontal direction, there being wide open spaces between the floor panels in both longitudinal and transverse directions which allow ventilating ducts and other equipment to completely encircle each panel without interference by floor beams, the floor loads on the cantilever portions of the floor beams reducing the floor load moments in the center portions, each floor panel being continuous over only two columns and spacing the columns of each pair from one another during erection, and the building frames formed by the panels rigidly attached to the columns through the yard arms resisting distortion from horizontal or longitudinal forces, each column being continuous through at least two stories, and bending stresses transmitted to the columns at each floor panel through the yard arms being resisted by the strength of the column above a given floor panel and the strength of the column below the given floor panel.

8. In building construction, a reinforced concrete floor slab, a plurality of horizontal panels below and supporting the floor slab and each including transverse yard arms and longitudinal beams rigidly united to the yard arms near the ends of the yard arms and extending as cantilevers beyond the transverse supporting yard arms, and columns connected to and supporting the yard arms and each pair of columns with yard arms and beams forming a rigid frame capable of resisting horizontal forces, the floor loads on the cantilever portions of the beams reducing the bending moments in the portions of the beams spanning between the yard arms, the cantilever portions forming shelves and abutments for carrying the reinforced concrete slab which extends transversely between the panels, the yard arms and beams projecting below the bottom of the slab, but having wide open spaces between the ends of the cantilever-ended beams of successive platforms forming a discontinuous construction so that slight settlement or compression of one of the supporting columns will not cause unknown stresses in the construction and the spaces between the cantilever ends of the beams below the bottom of the slab providing transverse channels in which ducts can be installed without projecting below the bottoms of the beams, the spaces between the sides of the cantilever-ended beams of successive panels providing longitudinal channels in which ducts can also be installed without projecting below the bottoms of the beams.

9. In building construction, a plurality of sets of parallel spaced columns, yard arms rigidly attached to and extending transversely from said columns, generally parallel spaced floor beams between the ends of the yard arms with extensions, cantilever fashion, beyond the ends of the yard arms stopping abruptly short of the ends of adjacent floor beams, there being wide open gaps in the longitudinal direction connecting with wide open transverse spaces between the parallel cantilever-ended floor beams thus allowing ventilating ducts and other equipment to extend longitudinally and to connect with ducts or equipment extending transversely without interference by floor beams or girders and a reinforced concrete floor slab extending above the yard arms and floor beams, tied in therewith and extending over the transverse and longitudinal spaces between the floor beams and supported by the floor beams.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,084,648	MacMillan	June 22, 1937

FOREIGN PATENTS

Number	Country	Date
588,838	France	1924