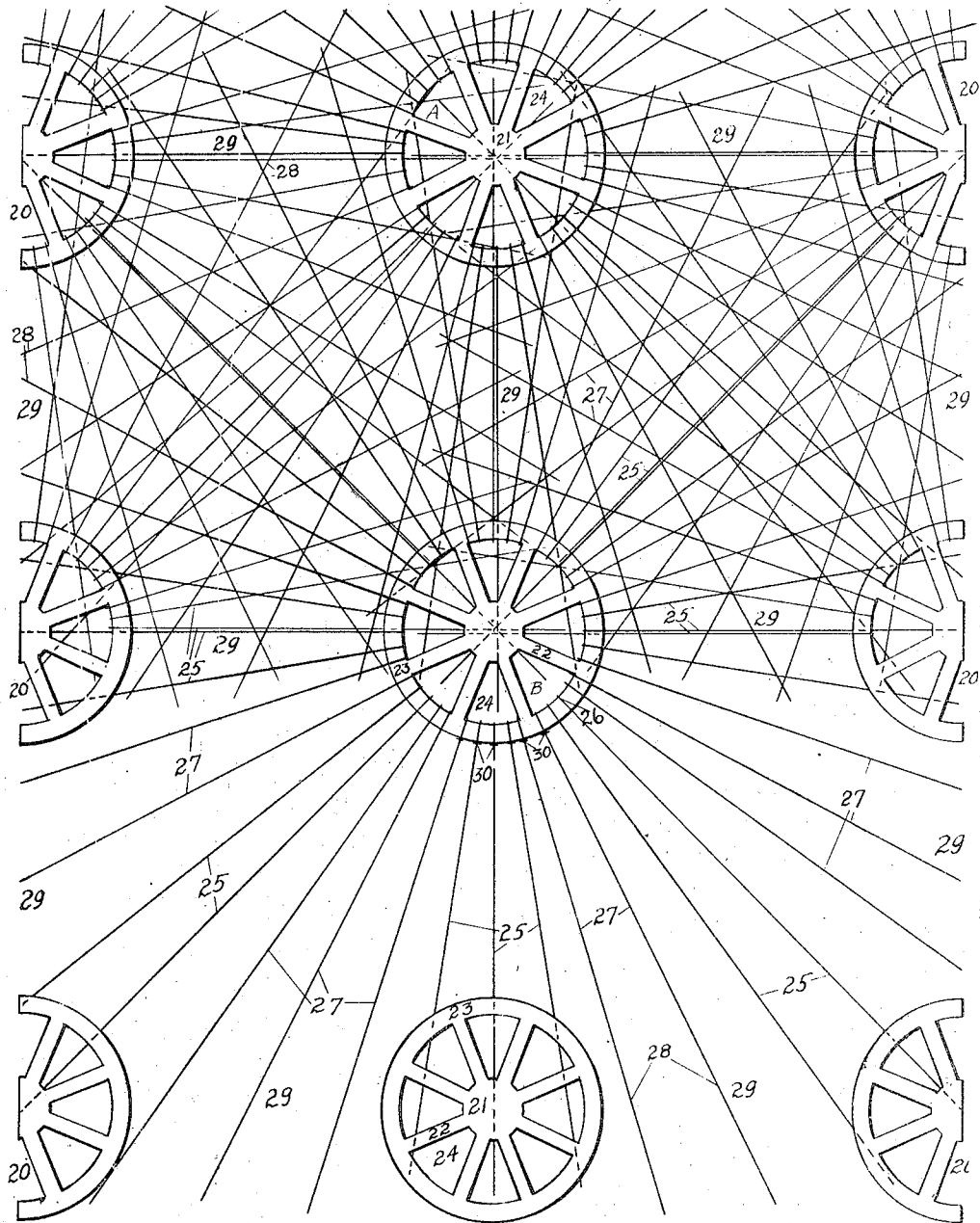


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3 SHEETS-- SHEET 1



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J. Seales
D. H. Hockensmith

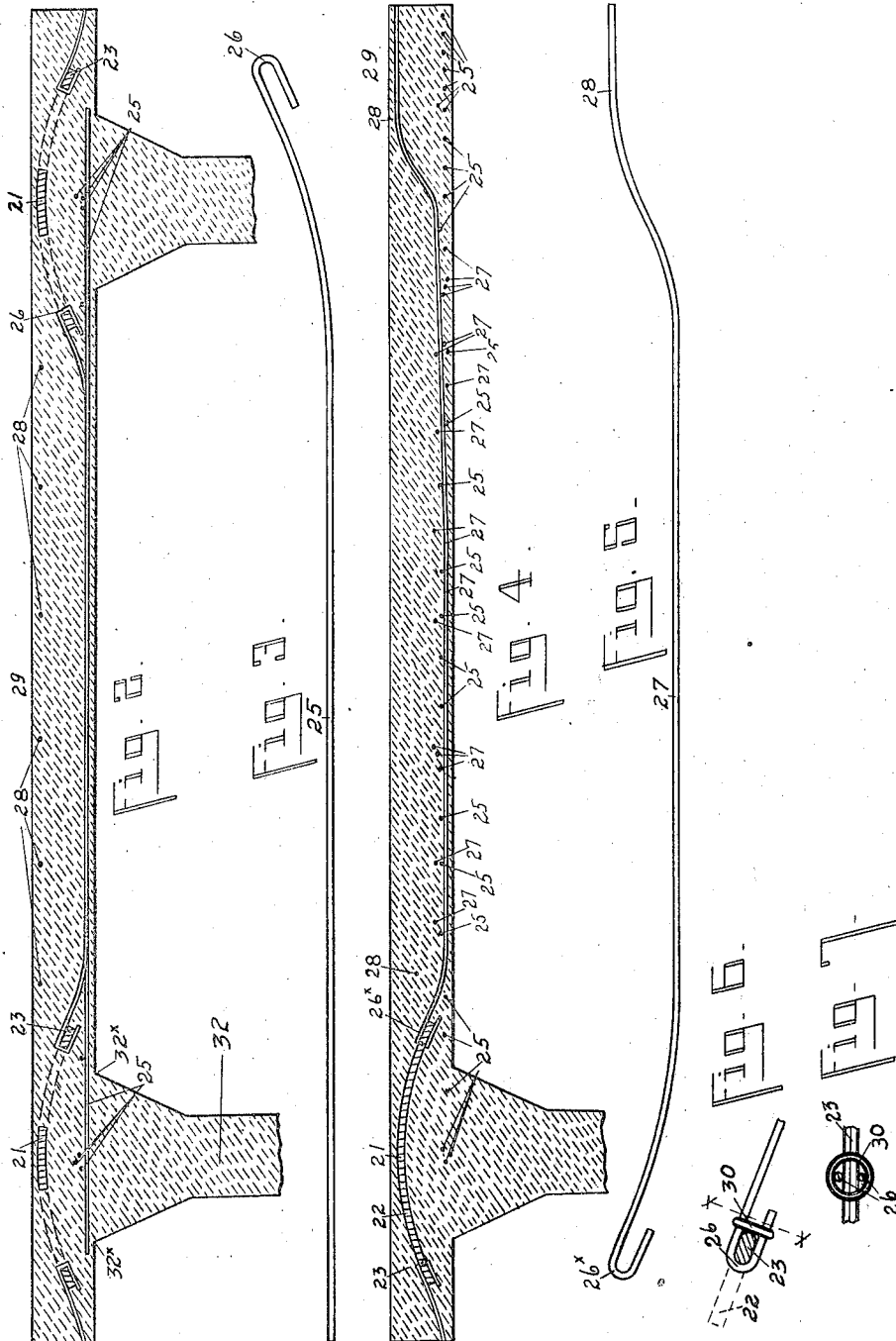
William F. Edwards

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 REINFORCEMENT FOR CONCRETE FLAT SLABS.
 APPLICATION FILED JULY 31, 1912.

Patented Apr. 1, 1913.

3 SHEETS-SHEET 2.

1,057,531.



WITNESSES

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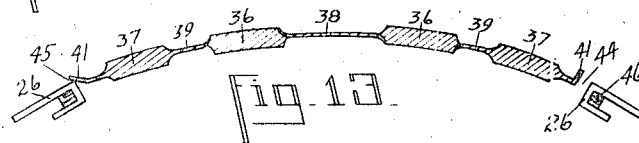
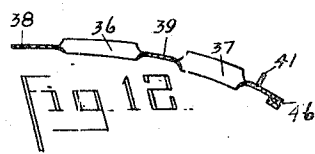
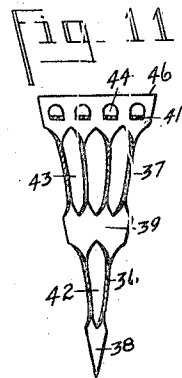
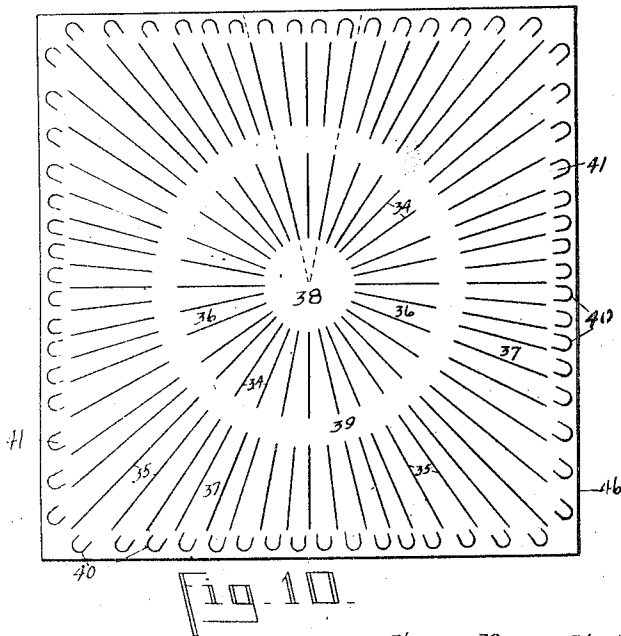
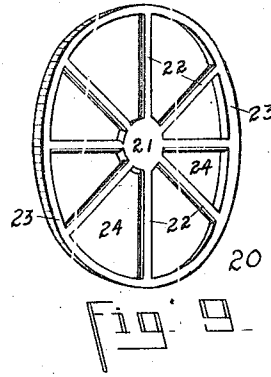
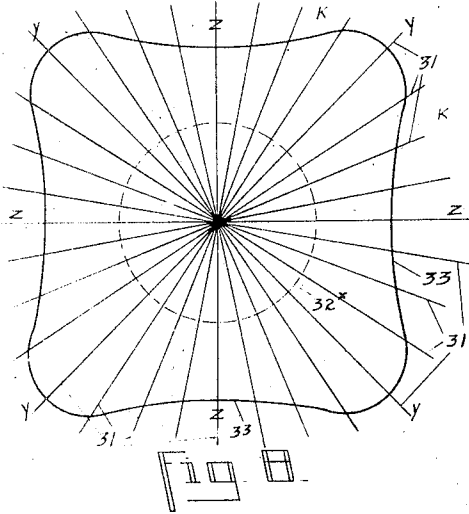
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3 SHEETS—SHEET 3.



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REINFORCEMENT FOR CONCRETE FLAT SLABS.

1,057,531.

Specification of Letters Patent.

Patented Apr. 1, 1913.

Application filed July 31, 1912. Serial No. 712,436.

To all whom it may concern:

Be it known that I, WILLIAM C. EDWARDS, JR., a citizen of the United States of America, residing at Kansas City, in the county of Jackson and State of Missouri, have invented certain new and useful Improvements in Reinforcements for Concrete Flat Slabs; and I do hereby declare that the following is a full, clear, and exact description of the invention, such as will enable others to make and use the same, reference being had to the accompanying drawings, forming a part of this specification.

The principal objects of the invention are, to provide an arrangement of steel reinforcement in flat slab concrete construction so that all stresses will be provided for, and a true monolithic structure obtained; to carry the tension steel over the columns in a single layer or plate thereby increasing the effective depth at this critical point; to care for all tension stresses in flat slab construction by means of reinforcing members integral with and radiating from a metallic hub or disk situated in said slab concentric with the axis of a supporting column.

The flat slab concrete floor by its elimination of beams and girders affords many advantages to the owner and builder. The story height can be decreased without reducing the effective headroom. The cost of installing sprinkler systems is decreased and over head machinery is more easily installed. Expensive girder form work is eliminated and the concrete can be handled and placed more rapidly. The interior can be better illuminated having no beams to interfere with the distribution of light, and the windows can be placed flush with the ceiling. The entire load of a flat slab type of floor is carried directly by the columns. By enlarging the column heads, increased resistance in shear and bending is obtained.

In the drawings, Figure 1. is a plan or top view of a partially completed reinforcement for concrete flat slab construction. Fig. 2. shows a vertical section of a completed concrete flat slab taken on a line through the centers of two rectangularly positioned columns in Fig. 1. such as A and B. Fig. 3. shows a side view of the reinforcing rods seen in Fig. 2. linked to the rim of the unit, cantaliver reinforcing device at a column and radiating outward, toward and under the cantaliver reinforcement

over an adjacent column. Fig. 4. shows a vertical section of a completed concrete flat slab taken through the axis of a column in Fig. 1. and on a line radiating therefrom and crossing the slab portion between columns as seen in Fig. 2. Fig. 5. shows a side view of the reinforcing rods seen in Fig. 4. linked to the unit cantaliver reinforcement at the columns and radiating outward therefrom and crossing the upper part of the slab between outer columns as seen in Fig. 1, and Fig. 2. Fig. 6. represents a vertical cross-section taken through the rim portion of the unit device of the slab reinforcement as seen at 30 in Fig. 1. Fig. 7. represents a section taken along the line $x-x$ in Fig. 6. Fig. 8. is a view showing the approximate location of the line of inflection for imaginary beams radiating from the axis of a supporting column. Fig. 9. shows a perspective view of a fabricated steel structural unit cantaliver reinforcing device of wheel-like construction for the flat slab as seen in Fig. 1. placed concentric with the columns. Fig. 10. shows a blank slitted metal plate from which is fabricated a modified form of reinforcement to that seen in Fig. 9. Fig. 11. represents a plan view of that portion of the metal plate included within the dotted lines in Fig. 10, shown in its finished fabricated condition. Fig. 12. represents a side view of the sectional reinforcing device seen in Fig. 11. Fig. 13. shows a section through the center of a reinforcing device formed from the slitted plate seen in Fig. 10 and shown in its finished condition by views indicated in Figs. 11 and 12, together with portions of the slab rod reinforcement engaged therewith and means for preventing disengagement of the said rod members.

Similar numerals of reference indicate corresponding parts in all figures of the drawings.

Referring to the drawings: In Fig. 1. is seen a plan view of a partially completed reinforcement, for monolithic concrete flat slab construction, consisting of a number of fabricated wheel-like steel unit cantaliver reinforcing devices 20, (see Fig. 9.) each placed horizontally with their hub portions 21 concentric with the vertical axis of a supporting column. A plurality of spoke members 22 radiate from the hub member 21, said spoke members terminate at their outer ends in the rim or band

23. leaving the openings 24 in the unit device. Each device of such cantaliver reinforcement is forged, cast or otherwise formed as a solid steel unit, the hub portion 21, being the central portion of each pair of opposite spoke members 22 and 22, is thus formed as a disk of such size that a sufficiently large amount of steel can be concentrated in a single layer near the upper part of the slab directly over the center of the supporting column for the purpose further set forth. The spoke members 22 may be of any desired number to the end that the unit reinforcement shall best fulfil its office hereinafter described; the openings 24 however being such as will permit the concrete to be easily placed in position around the hub, spoke and rim portions of the device. Hooked to the rim portion 23 of the devices in the upper portion of Fig. 1. are the rod members 25 (see Fig. 3.) and 27 (see Fig. 5.) which rods extend outwardly through the flat slab on lines radiating from the axis of the column. For a clear understanding of Fig. 1. the rods are omitted from the unit devices in the lower portion of the drawing.

In the flat slab type of floor, it is assumed that a flat circular plate portion of the slab, fixed to a supporting column, extends outwardly therefrom in every direction, to the line of inflection of the slab, as a cantaliver; and that the central portion of the flat slab panel lies between and is supported by the outer edges of such column supported cantaliver circular plate portions. In Fig. 8 are seen imaginary cantaliver beams, 31, passing through the axis of a supporting column, whose enlarged head is designated 32*, as in Fig. 2, and the approximate location of the line of inflection, 33, of the flat slab has been plotted. The beams 31 at Z, Z, extending toward adjacent columns rectangularly situated, the beams at Y, Y, extending toward diagonally situated columns, leaving other beams, 31, extending as at K, toward those portions of the flat slab included between the axes of adjacent rectangularly and diagonally situated columns.

By reference to Fig. 4, a vertical section is shown, taken through the axis of a supporting column, showing a cantaliver beam, such as 31 in Fig. 8, reinforced by the continuous steel reinforcing members 22, 21, 22 of the unit wheel-like cantaliver device. If it were practical to run rod reinforcement directly over and through the axis of each supporting column, on the lines 31 in Fig. 8, and continue such rod members out through the flat slab on these lines produced, not only would the cantalivers themselves be positively reinforced, but tension stresses in the central portion of the flat slab would be likewise taken care of. This however would necessitate the rods crossing each

other at the axis of the column, causing them to pile up one on another so that the center of gravity of the mass of the assembled steel would be greatly lowered. Since the center of gravity of the steel must be near the surface of the slab over the columns, in order to secure the longest possible moment arm and thereby obtain the thinnest slab possible, such radiating rod reinforcement is impractical.

As will be seen in Figs. 4 and 9, the hub or disk portion, 21, of the unit device is formed of such size and character that a sufficient area of steel is concentrated between the radiating members 22 so that under all conditions, each single cantaliver beam 31 in Fig. 8 shall be positively reinforced by the unit members, 22, 21, 22, to the end that the composite plate of concrete and steel shall act as a homogeneous cantaliver circular plate. The center of gravity of the hub or disk, 21, is, as seen, near the surface of the slab over the column, which obviates the impractical feature referred to above with reference to radiating rod reinforcement; also, a unit device can thus be fabricated in which the radiating members corresponding to such radiating rod reinforcement are an integral part of one another at their point of crossing, so that all will act as a unit in the completed structure. It would not be practical to make the radiating members 22 of a unit device of such length as to actually cover the entire panel between columns; I therefore prefer to fabricate the unit wheel-like reinforcing devices of such size, that they will approximately cover the column supported cantaliver circular plate; the rods 25 and 27 extending out through the floor slab, are in reality extensions of the members 22, of the unit device, the member 23, of the device, furnishing a means for transmitting the stresses, carried by the rods 25 and 27 directly into the members 22 and to the central hub member 21. This then furnishes in every direction, a continuous reinforcing member, such as 25, 23, 22, 21, 22, 23, 25 or 27, 23, 22, 21, 22, 23, 27, passing directly over and through the center of the supporting column. This is a very important feature of my invention since the stresses being brought directly over and to the center of the column, the column is not eccentrically loaded as it would be if individual rods radiating through the slab were merely wrapped around the periphery of the column or if not run in a straight line from such column axis. Not only do the supporting columns of a certain loaded panel receive their proper share of such load, but a continuous monolithic action is produced, portions of the stresses passing out from the central disk or hub portions 21, through the branching members 22 into the rods 25 and

27 in adjacent panels, so that these adjacent panels assist the loaded panel and its supporting columns to carry the load, by transmitting such stresses to outer columns or other supports.

As seen in Figs. 2 and 4, the unit cantaliver reinforcing devices are shown preferably fabricated in a "dished" fashion being inverted in the final disposition of said devices in the combined reinforcement, and together with the rod members are, as seen in section, approximately on the line of the catenary. In these "dished" shape reinforcing devices, the parts 21 and 23 lie preferably in substantially parallel planes, in order that the connecting intermediate radiating portions 22 may be inclined or curved and thereby more nearly follow the said line of the catenary.

In Figs. 2 and 3 are seen rod members 25 with the hook 26 formed on one end for engagement with the rim 23 of the cantaliver reinforcing device as previously stated. The outer end of the rod 25 is seen in Figs. 1, 2, and 4 passing under the cantaliver device over an adjacent rectangularly positioned column, thereby placing steel in a lower plane over the column head which steel will assist the concrete to take the compression. This will act to reduce the thickness of the concrete over the entire floor thereby saving in both cost and weight of the structure.

Tension stresses exist in the upper face of the slab between columns on rectangular lines due to the deflection there being less than in the center of the slab because of the shorter span. A very important feature of my invention is seen in the provision I make for caring for such stresses. In Figs. 1, 2, 4 and 5 are seen the rod members 27 with the hook 26* formed on one end for engagement with the rim 23 of the cantaliver reinforcement as previously stated. The outer end of the rod 27 is bent into the position seen in Fig. 5 forming an upper portion 28. The rods 27 linked to the rim 23 of the unit device radiate therefrom outwardly, the part 28 of the rod 27 being placed in the upper part or face of that zone of the floor slab extending between columns as seen at 29 in Figs. 1, 2 and 4. These rods in the completed structure as in Fig. 1, therefore care for the stresses referred to above, thereby preventing cracking along the edges of the panels from column to column. The total cross sectional area of steel of all the members 25 and 27 linked to a rim 23 of a unit device is approximately equal to the area in cross-section of all the radiating members 22 of such device, to the end that such device may act as a true link between all such radiating members 25 and 27 attached thereto and produce a continuous reinforcement in every direction around the supporting column. A vertical section of a completed

flat slab taken through diagonally situated columns in Fig. 1, would be similar to the section seen in Fig. 2, omitting the members 23 therein seen; the rod members 25 and 27 cut by such section would be seen lying near the bottom of the slab similar to those shown in section in the central portion of Fig. 4.

In the practical application of my invention, in order that each supporting column of a loaded panel shall sustain its proper proportionate part of such loading, the rods 25 and 27, while distributed through the panels as seen in Fig. 1, are preferably arranged so that the inner half of said rods lie nearest the under surface of the flat slab, as illustrated in the left hand portion of Fig. 4, where the rod 27 passes beneath rods 25 and 27 shown in section, which rods are radiating from unit devices over adjacent columns. Similarly as this rod 27, therein seen, passes out into the slab, as shown in the right hand portion of Fig. 4, it is slightly raised in order to permit the inner half of the rods 25 and 27, there seen in section, to pass beneath it. Thus at any point in the flat slab, the steel rods are preferably arranged in the order of their distances from their supporting column. Such weaving of the rods mechanically binds them together, making them self-supporting between columns and also preventing displacement during the pouring of the wet concrete.

To fasten the hooks 26 and 26* of the bars 25 and 27 to the rim 23 of the unit device in such a manner that the connection at that point will not be easily disengaged during the placing of the concrete as well as to insure that the unit device 20 shall act as a true link between the several radiating rods, allowing no slackness in the complete tensile reinforcement, I may employ various methods such as electric welding or wiring the assembled parts, or I may employ the ring device indicated at 30 in Fig. 1, and shown in detail in Figs. 6 and 7 wherein a ring 30 is slipped over the hook portion 26, and the parts of the hook 26 and the ring 30 driven tight against the rim 23 of the unit device 20. Such other modifications may be employed for transmitting the stresses from the rods 25 and 27 to the unit device 20 as are properly a part of this invention, the rods 25 and 27 may be unprovided with the hook portions 26 and 26* respectively and merely assembled about the device in the lighter construction work, but I prefer to give an absolutely rigid mechanical bond or tie to the parts as above described.

At the sides of a building structure I prefer to use half unit devices built into the wall structure, likewise at the corners a quarter unit device would be employed, the rod members 25 and 27 being run from these fractional devices to each other and to outer columns in manner seen in Fig. 1.

In Fig. 10, is seen a sheet metal plate with slits 34 and 35 therein, said slits being made on lines radiating from the center of the plate thereby forming the portions 36 and 37 between said slits and leaving a central hub portion 38 and band 39 unslitted. I may however employ several non-slitted portions similar to 39. In the periphery or outer band of the plate are made the U shaped slits 40 thereby forming a lip 41. The parts 36, 37 and 41 are now twisted or bent as seen in Figs. 11 and 12 thereby producing openings 42, 43 and 44 in the entire plate structure, the lip 41 being struck up for the purpose hereinafter set forth. During the process of manufacture I prefer to form the plate structure in the inverted "dished" fashion seen in Figs. 12 and 13.

In Fig. 13 are seen the hook portions 26 of the slab rod reinforcement engaging with the unit structural device through the openings 44, the lip 41 is then driven down upon the hook 26 as seen at 45, thus firmly attaching the rod member in the desired position. The edge of the unit device may be folded or otherwise thickened as seen at 46 which will impart extra strength and stiffness at the rod engaging parts.

The unit structural reinforcing device seen in Figs. 10, 11, 12 and 13 being a modification of the wheel-like unit device seen in Fig. 9, is adapted to be used in lieu thereof, and is preferably made as seen in Fig. 10 from a rectangular or square plate, in which event it would be placed with the corner parts extending toward the columns diagonally disposed to the column over which it is situated, thereby substantially occupying the position indicated by the plotted line of inflection seen in Fig. 8. By the expression "cantilever circular plate" used by me is meant that portion of a column supported concrete flat slab, included within the line of inflection, 33, seen in Fig. 8, the word "circular" not being used in its strict sense. The openings 42 and 43 like 24 in the device 20, Fig. 9, permit the concrete to flow around the spoke members 36 and 37, the hub member 38 and the bands or rims 39 and 46; also vertical column reinforcement may readily pass through such openings 24 and 42 of the unit devices. Such other modifications may be employed as are within the scope of the appended claims.

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

1. In a column supported concrete flat slab or girderless floor structure, a reinforcement comprising an inverted solid steel, "dished" shaped plate or unit reinforcing device, horizontally disposed over and concentric with the supporting column,

openings in said device, the parts remaining between said openings thereby forming a central portion integrally connected by intermediate radiating portions with a surrounding band portion, situated in a lower parallel plane, said band portion lying within the slab without the column, said reinforcing device thereby substantially covering the column supported cantilever circular plate portion of the slab.

2. In a column supported concrete flat slab or girderless floor structure, a reinforcement comprising an inverted, solid steel, "dished" shaped plate or unit reinforcing device, horizontally disposed over and concentric with the supporting column, openings in said device, the parts remaining between said openings thereby forming a central portion integrally connected by intermediate radiating portions with a surrounding band portion, said band portion lying within the slab, without the column, said reinforcing device thereby substantially covering the column supported cantilever circular plate portion of the flat slab; and members connecting with said surrounding band portion of the device, extending outwardly therefrom on lines radiating from the supporting column, some of said radiating members extending toward and through those portions of the slab lying between adjacent outer columns, and the remainder of said members extending into those portions of the slab over such adjacent outer columns.

3. Reinforcement for a column supported concrete flat slab or girderless floor structure, consisting of a number of inverted solid steel, "dished" shaped plates or unit reinforcing devices, each device being horizontally disposed, in the slab, over and concentric with a supporting column, openings in each of said devices, the parts of a device remaining between such openings constituting a central portion integrally connected by intermediate radiating portions with a surrounding band portion situated in a lower parallel plane, said band portion lying within the slab without the column, said reinforcing device thereby substantially covering the column supported cantilever circular plate portion of the slab; and outer rod members connecting with said surrounding band portion of the device, extending outwardly therefrom through the bottom of the slab on lines radiating from the supporting column, some of said rods terminating beneath the unit devices over adjacent outer columns, and the remainder of said rods being bent at their outer ends into the top of the slab portions included between opposite outer columns.

4. A reinforcement for column supported, concrete cantilever circular plates, comprising a metal plate, slits therein radiating from a central non-slitted portion, and band

portions in said plate surrounding said central portion, and integrally connected thereto by means of the parts contained between said slits; these slitted parts having twists or bends thereby forming openings within said plate.

5. A perforated unit reinforcing device for concrete construction comprising a "dished" shaped metal plate having a central portion integrally connected with sur-

rounding band or rim portions by intermediate portions formed by slitting the plate on lines radiating from the central portion, the said intermediate portions having twists or bends thereby forming openings in the said unit reinforcement.

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Witnesses:

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H. W. McNUTT.