To all whom it may concern:

Be it known that I, Edgar D. Martin, a citizen of the United States, and a resident of Chicago, Cook county, and State of Illinois, have invented certain new and useful Improvements in a System of Integrally-Cast Reinforced-concrete Pitched-Roof Construction for Buildings, of which the following is declared to be a full, clear, and exact description.

This invention relates to a system of integrally cast reinforced concrete pitched roof construction for buildings and its principal object is to provide a reinforced concrete roof of substantial, rigid and comparatively light construction provided with improved ventilating and lighting features. This invention is particularly desirable in factories, foundries, mills, shops, round houses and other large concrete structures where efficient ventilation, roof lighting by abundant glass area so arranged as to admit light to all parts of the building are necessary. Other objects and advantages will appear in the course of this specification and with all of said objects and advantages in view, this invention consists in the several novel features hereinafter fully described and claimed.

The invention is clearly illustrated in the accompanying drawings.

Figure 1, is a vertical cross section through a roof construction embodying a simple form of the present invention; Fig. 2, is a diagrammatic view showing one arrangement of the reinforcement employed in the present invention; Fig. 3, is a vertical, longitudinal section taken on line 3—3 of Fig. 1; Fig. 4, is a vertical cross section of a fragment of a roof showing a modified form of the invention; Fig. 5, is a vertical cross section of a fragment of a roof, showing a second modification of the invention; Fig. 6, is a vertical cross section of a third modification of the invention illustrating a plurality of joined roofs; Fig. 7, is a vertical cross section of a fourth modification of the invention, illustrating a plurality of joined roofs, and certain portions being broken out to show the metal reinforcements; Fig. 8, is a detail, vertical cross section taken on line 8—8 of Fig. 6.

Referring to said drawings and first to Figs. 1, 2 and 3, the reference character 10, designates the columns or walls of a building which may be constructed of concrete or masonry as desired and 11, designates the roof, which is supported by said columns or walls.

The roof comprises reinforced concrete roof slabs supported on a series of statically rigid structures consisting of opposing, inclined, intersecting ribs 13°, 13°, of reinforced concrete, the thrust of which is restrained either by tie rods 16, or by lateral girders 14, in combination with tie rods. In cases where the free ends of the ribs 13°, are unprovided with any support, said ribs form cantilevers.

The roof slabs are located in several planes, the upper roof slab 19°, may be in one plane or in two diverging planes as shown in Fig. 1, and the two lower roof slabs 18, are adjacent to the supporting walls or columns. By this arrangement the distribution of weight of the roof is such that the resulting stresses are minimum and are resisted by the relatively light members, thereby reducing the dead load and effecting still further economy of material. The joined cantilever ribs are balanced so far as dead load is concerned thereby inducing only direct compression stresses on the supporting structure.

The reinforcement rods for the ribs 13°, 13°, are arranged therein in such manner as to give tensile strength to the ribs; the exact arrangement of the rods is immaterial so far as this invention is broadly considered, but the one illustrated in Fig. 2, has been found particularly desirable; the upper rods 12, of the ribs may extend down into the columns and their upper ends may extend beyond the intersections to the ends of the ribs 13°, other rods 12°, may be used in the upper sides of the ribs 13°. The lower rods 12°, or part of them may run through the intersections and extend part way into the rib extensions 13°, and additional rods 12°, may be employed, at the intersecting places. The rods 12°, 12°, in the columns or part of them may have end portions extending into the ribs. The reinforcement rods are preferably disposed around the peripheries of the ribs and columns.

The angle between the ribs 13°, 13°, is immaterial, and by changing the angle be-
between said ribs, other shapes may be given the upper roof slab; neither is the width of the upper roof slab 13°, or the other roof slabs 13, material, and by varying them, the spaces between their adjacent edges may be increased or decreased as desired. Such spaces provide openings in which are placed windows, (not shown), to provide a continuous unbroken opening for ventilation and light at the roof. The ribs 13, throughout the extent of this opening and to their point of intersection are free extending and do not obstruct light. The tie rods 16, extend through and connect the ribs and tie the structure together. In some cases reinforcement rods 15, are employed in the lower edge portions of the roof structure, said rods running lengthwise of the roof, and in such cases, the tie rods 16, may be spaced far apart because of the lateral stiffness afforded when the reinforcement rods 15 are used, but when reinforcement rods 15 are omitted, the tie rods 16 are spaced closer together, preferably through each rib. While the exact proportions of the parts shown are immaterial to the invention broadly considered, those proportions are such as are well adapted for a building eighty feet wide and over.

For the purpose of affording longitudinal stiffness, lengthwise extending concrete ribs 17 may be provided at the upper edge portions of the roof slabs 13, and one or more concrete ribs 18, may be provided along the intersections of the ribs 13°, 13°; other strengthening ribs may be provided as may be found necessary in the designing of any particular structure. In the form illustrated in Fig. 4, an arched roof construction is shown, the ribs 13°, being of arched formation carried by the columns 10. One half of the roof is illustrated, but it is understood that the other half is a duplicate thereof. In other respects the structure is substantially the same as that illustrated in Figs. 1 and 2.

In Fig. 5, the roof section 13°, is illustrated as constructed of a thick slab (lateral girder) of reinforced concrete, capable of resisting horizontally acting forces prohibiting the spreading of the roof. This form may be found desirable at the ends of the structure, in place of the ribbed roof section, shown in Figs. 1 and 4, otherwise the roof structure may be substantially the same as that shown in Figs. 1 and 4.

In the modification shown in Figs. 6 and 8, a plurality of adjoining reinforced concrete roof constructions are illustrated which embody the invention shown in Fig. 1; in this case as far as the dead load is concerned, the thrust of each roof neutralizes the thrust of the adjacent ones and therefore, when the joints are cast integrally, consolidating adjacent structures, and the steel reinforcement is continuous and in the arrangement I use, the tie rods may be omitted. As in the form illustrated in Fig. 1, the roof is supported by columns 10°, of reinforced concrete or other suitable material, and the reinforced concrete ribs 13°, 13°, incline upwardly from the tops of said columns and intersect each other. The upper roof slabs 13°, are cast integral with the cantilever extensions 13°, and the lower roof slabs 13°, are cast integral with the portions of the adjoining ribs 14° adjacent the supports. One form of reinforcement rods for the roof construction illustrated in Fig. 6, is shown, and it will be seen that all or some of the reinforcement rods 12°, for the ribs are continued across upper ends of the columns, and that the column reinforcement rods 12°, or some of them extend into the ribs.

It is to be understood that the roof slabs, ribs and columns together with the adjacent roof construction are all molded together to form a unitary structure and reinforced by reinforcement rods extending from one section to another. Conterminous reinforcing does not imply necessarily single lengths of rods, but includes rods efficiently spaced; the reinforcement rods which extend from one roof section to adjoining ones across the tops of the columns resisting by rigid articulation the action of distortion induced by eccentricity of live load. This form of the invention forms a very satisfactory structure capable of use for round houses or where extremely long and wide buildings are required. The openings between the middle roof section and other roof sections provide window spaces, whereby the building may be well lighted and ventilated, the free standing supports beneath affording no interference to the passage of light.

In the modification illustrated in Fig. 7, adjoining roof constructions are shown supported on columns, or other upright supports 10°, 10°. As in the other forms of the invention, intersecting reinforced concrete ribs 13°, 13°, 13°, employed which extend up from and are cast integral with the columns and with girders 14°. Roof slabs 11°, are cast integral with certain of the ribs 13°, and other roof slabs 11°, are cast integral with the rib extensions 13°, 13°. As in the other forms of the invention, continuous window spaces, are left between the roof slabs 11°, 11°. In this form the ribs 13°, besides carrying a portion of the roof 11°, act as restraining members between the adjacent portions of the roof. The structure between the columns 10°, is a complete roof, and by joining a number of these structures, a building of indefinite length may be roofed, each structure neutralizing the other as described with reference to Fig. 6.
If desired, however, tie rods 16, may be employed between the girders 14, of the outer or end members of the roof.

More or less variation of the exact detail of construction is possible without departing from the spirit of this invention; I desire, therefore, not to limit myself to the exact form of the construction shown and described, but intend, in the following claims, to point out all of the invention disclosed herein.

I claim as new and desire to secure by Letters Patent:

1. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing members that intersect each other, and supports therefor at their lower ends, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

2. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing inclined members that intersect each other, and supports therefor at their lower ends, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

3. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures consisting of opposing inclined members that intersect each other, which are conterminous and integral at the points of intersection, and supports therefor at their lower ends, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

4. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing inclined, intersecting members, the extensions beyond the intersections being in the form of cantilevers, and supports therefor at their lower ends in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

5. A system of reinforced concrete roof construction, comprising a plurality of a conterminous series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing inclined members that intersect each other and supports therefor at their lower ends, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

6. A system of reinforced concrete roof construction, comprising a plurality of a conterminous series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing inclined members that intersect each other and supports therefor at their lower ends, said intersecting members being conterminous and integral across said supports, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

7. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing inclined members that intersect each other, and supports therefor at their lower ends, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass, there being window openings between the upper and lower roof slabs.

8. A system of reinforced concrete roof construction, comprising a series of statically rigid, metal reinforced, concrete structures, consisting of opposing inclined members that intersect each other, supports therefor at their lower ends, and transverse restraining members, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

9. A system of reinforced concrete roof construction, comprising a series of statically rigid, metal reinforced, concrete structures, consisting of opposing inclined intersecting members, the extensions beyond the intersections being in the form of cantilevers, supports therefor at their lower ends and
transverse restraining members, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

10. A system of reinforced concrete roof construction, comprising a series of statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined intersecting members, the extensions beyond the intersections being in the form of cantilevers, supports therefor at their lower ends, said intersecting member being continuous and integral across said supports and transverse restraining members, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

11. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined members that intersect each other, and supports therefor at their lower ends, and transversely extending tie rods, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

12. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined members that intersect each other, co-incident lateral restraining members therefor, and supports at said restraining members, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

13. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined members that intersect each other, co-incident lateral restraining members therefor, supports at said restraining members and tie rods connecting said restraining members, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

14. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined, intersecting members, and supports therefor at their lower ends, the metal reinforcement in the supports being disposed around the peripheries thereof, and elements of said reinforcement being continued over the supports and extending into the intersecting members, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

15. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing inclined, intersecting members, and supports therefor at their lower ends, the metal reinforcements in the intersecting members being disposed around the peripheries thereof and elements thereof extending down into the supports, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

16. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined members that intersect each other, and supports therefor at their lower ends, the metal reinforcements in the intersecting members extending into the extensions beyond the intersections and adjacent one of the faces thereof, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

17. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing inclined members that intersect each other, and supports therefor at their lower ends, the metal reinforcements in the intersecting members extending into the extensions beyond the intersections and arranged adjacent the upper faces thereof, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which
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18. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined members that intersect each other, and supports therefor at their lower ends, the metal reinforcements in the intersecting members being disposed around the peripheries thereof and extending into the extensions beyond the intersections, and arranged adjacent at least one face of the intersecting members, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

19. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined members that intersect each other, and supports therefor at their lower ends, the metal reinforcements in the intersecting members extending into the extensions beyond the intersections, and certain elements thereof extending from end to end of said extensions near their upper faces, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

20. A system of reinforced concrete roof construction, comprising a series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined members that intersect each other, and supports therefor at their lower ends, the metal reinforcements in the intersecting members extending into the extensions beyond the intersections and certain elements thereof extending across the intersections and into the extensions close to the lower faces thereof, in combination with an upper roof slab, supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

21. A system of reinforced concrete roof construction, comprising a plurality of contiguous series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined members that intersect each other, and supports for their lower ends, the metal reinforcements in the intersecting members extending across said supports, from one contiguous member to another, adjacent at least one face thereof, in combination with upper roof slabs supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

22. A system of reinforced concrete roof construction, comprising a plurality of contiguous series of successively arranged, statically rigid, metal reinforced, concrete structures, consisting of opposing, inclined members that intersect each other, and supports for their lower ends, the metal reinforcements in the intersecting members extending across said supports, from one contiguous member to another, adjacent the lower faces thereof, in combination with upper roof slabs supported above the intersections by the portions of the intersecting members which extend beyond the intersections, and lower roof slabs adjacent said supports, the whole being cast integrally and forming a unified mass.

23. A roof, comprising reinforced concrete girders, a series of concrete upwardly inclined and intersecting roof supporting members, extending up therefrom, the free ends outside of the intersections acting as cantaliers supporting a middle concrete roof slab.

24. A roof, comprising concrete girders, upwardly inclined and intersecting reinforced concrete ribs extending therefrom and having cantalier end portions, concrete roof slabs adjacent the girders, and a middle concrete roof slab carried by the cantalier ends of the ribs, there being window openings between the adjacent edges of the roof slabs and all of said members being molded into one solid unitary structure.

25. A roof, comprising reinforced concrete girders, upwardly inclined and intersecting reinforced concrete ribs extending therefrom, and having cantalier end portions, concrete roof slabs adjacent the girders, a middle concrete roof slab carried by the cantalier ends of the ribs, there being window openings between the adjacent edges of the roof slabs, and all of said members being molded into one unitary structure, and tie rods extending through and connecting said girders.

26. A roof construction comprising a plurality of adjoining roof structures, each comprising upwardly inclined and intersecting reinforced concrete ribs, having cantalier end portions, the lower ends of the ribs of one roof structure joining with the lower
ends of the ribs of adjoining roof structure, girders, one common to each of two adjoining roof structures, roof slabs adjacent the girders and roof slabs carried by the cantilever ends of the ribs, there being window openings between the adjacent edges of the roof slabs, and all of said members being molded into one solid integral mass.

27. A roof construction comprising a plurality of adjoining roof structures, comprising reinforced concrete girders, upwardly inclined, reinforced concrete roof slabs, extending up from said girders, certain of the reinforcement rods thereof extending from one roof slab to the other over the columns.

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