This invention is a column of a composite nature wherein acceptable construction materials of steel and concrete are brought together in a novel relation to produce a structure possessing the requisite stability and strength for carrying the loads, and which structure does not present a massive appearance so characteristic of concrete columns commonly erected as parts of concrete buildings and other structures.

Among other objects, my invention seeks to facilitate the assembling of the steel utilized with concrete as integral parts of the column; to distribute the steel relatively to the concrete so as to effect a material reduction in the cross sectional area of the resulting composite column without, however, impairing the capacity of the column for carrying the loads imposed on said column; to install and erect the column in sections or lengths each of a determined height whereby the progressive increase in the height of each column or a number of columns is concurrent with the installation of the various floors at different levels; to assemble the steel elements with the concrete at the different stages in the erection of the column in such manner that such steel is substantially continuous throughout the height of the column, to secure the strength and stability of the column requisite for carrying the loads; to provide for the association of the floor beams with the steel of the composite columns in a way to impose the floor loads directly on the steel element or elements of said column; and to attain economy of time, labor and material in the installation of the composite column.

According to my invention, a metal core and a skeletonized metal cage are employed with a mass of concrete to produce a column adapted to be associated with floor beams or girders in the erection of a building or other structure, for factory and other uses.

The metal core is composed of units adapted for assembling with facility and by unskilled labor, said metal core extending substantially continuously throughout the height of the column, and said metal core being centrally within the mass of concrete.

The metal cage for the column is composed of units assembled in vertical alignment and in such relation to the metal core as to surround said core.

Characteristic features of the skeletonized cage are: (a) it is a factory or mill product all parts of which cage are assembled together and united in fixed relation at the mill or factory so as to result in a unit of a determined length and cross section, whereby unitary cages are adapted to be shipped from the mill to the place of installation, and such unitary cages are assembled or installed speedily and, if required, by unskilled labor; and (b) the successive metal cages required for the column of a determined height are positioned in such relation one to the other that the adjacent ends of superposed cages are united solidly in end to end order whereby the cages are extended for the full height of the ultimate column.

The superposed cages and the superposed units of the metal core thus extend lengthwise of the column for the full height of said column, and the metal elements are ensased within the masses of concrete which are molded one after the other at the succeeding stages in the erection of the building. The metal core functions as the initial weight carrying element of the composite column, said metal core being proportioned according to the load imposed on the floors. The metal cages stiffen and bind the moldable material and add stability to such moldable material, whereby the assembled components of the ultimate structure are characterized by a reduced cross sectional area as compared with usual concrete columns, to the end that my column does not present a massive appearance within the floors, and is free from light-obstructing tendencies so objectionable in the usual reinforced concrete columns.

A desirable feature of my composite column is the capacity for assembling therewith of the floor beams or girders, whereby the loads are imposed on the metal elements of the composite column. Such assemblage of the metal floor beams with the metal column-elements reduces the stresses upon the moldable column-elements, and results in the imposition of the floor loads at the places where they belong, i.e., on the metal column-elements. The floor beams are attachable either to the metal column-cages or to the metal column-cores; but in the latter event, I prefer to employ metal elements in the form of collars, plates or disks so related to the units of the column-core as to perform the functions of couplings for the core units, and for sustaining the downward thrust of the moldable material ensased within the metal column-cages, and to serve as carriers for the floor beams adapted to rest upon, and to be attached fixedly to, said collars, plates or disks.

Other functions of and utilities for my composite column will appear from the following description taken in connection with the drawings, wherein—

Figure 1 is a view in side elevation of one form...
of unitary metal cage of skeletonized formation usable as one of a series of elements for a composite column embodying my invention.

Figure 2 is a horizontal cross section on the line 1--2 of Figure 1. Figure 3 is a view in side elevation of another form of skeletonized cage, and Figure 4 is a horizontal cross section thereof on the line 4--5 of Figure 3.

Figure 5 is a view partly in side elevation and partly in vertical section illustrating a portion of the metal elements of my column at one stage of its installation, and showing the assembly of floor beams at one floor level of the structure, and prior to the stage of molding the concrete.

Figure 6 is a vertical sectional elevation of Figure 5 with the concrete material molded within and around the metal elements.

Figure 7 is a view in side elevation illustrating a further stage in the installation of the columns, at which another unit of the metal core and a second unitary cage are brought together in the required relation to the first part of the column.

Figure 8 is a horizontal cross section on the line 8--5 of Figure 7.

Figure 9 is a detail view of a coupling member between adjacent units of the metal core, the floor beams being shown in dotted lines.

Figure 10 is an elevation of my column as it appears in connection with the floor beams at different floor levels in a building.

Figure 11 is an elevation, partly in section, illustrating the metal core and a succession of metal cages assembled with beams at a succession of floor levels, the moldable material (concrete) being omitted, and showing a different assembly of core-couplings which in this embodiment are in staggered relation to the floor beams, the latter being attached to the column cages.

Figure 12 is a cross section on the line 12--12 of Figure 11, illustrating the union of the floor beams to one of the column cages.

Figures 13, 14, and 15 are views of other forms of unitary metal cages adapted to be used in my invention.

Figure 16 is an elevation of still another form of my unitary cage wherein longitudinal plate-like bars are in fixed relation to a series of metal hoops or bands.

The composite column of my invention is shown in its entirety in Figure 10, and the components of said column at the different stages of the installation and of the production of the metal elements are illustrated in Figures 1 to 9, inclusive. Generally speaking, the column embodies a metal core A, metal cages B of skeletonized formation and of a unitary character, and moldable material C, usually concrete, installed for encasing the metal elements and for occupying the interior of the skeletonized cages as well as being molded to exteriorly envelop the metal cages and also to envelop the metal core, all of which elements A, B, C (Figures 6, 7, 8), are assembled at various stages with floor beams D to ultimately produce a composite structure capable for carrying the floor loads and of presenting an appearance free from that massive construction so objectionable in the usual all concrete column.

The metal core designated as a whole by reference letter A is of itself the column, the cross section of which is considerably less than the cross section of the composite column constituting the ultimate product of my invention, and as one result of this reduction in the area of the core A, a very considerable saving in metal is attained, with corresponding economy. Again, the metal core is a factory product, being produced at the mill and requiring to be shipped to the place of installation, at which place no further work is required to be performed on the column, and it is available for assembly with the other required column elements for which purposes unskilled labor may be utilized.

The metal core is composed of units adapted to be assembled into vertical alignment so as to superpose one unit upon the unit next below it, as seen in Figures 5, 9, and 11. Said units of the metal core may be the same in cross section, but it is also possible to provide units which decrease in cross section as the height increases; thus in Figures 5 and 11, the lowermost unit a is larger in diameter than the unit a' next above it, whereas the second unit a' is somewhat larger in diameter than the third unit a" of the series, and so on toward the upper units of the building, but while such reductions in the cross section of the core units are desirable, still the variation in cross section is not essential, for the reason that all the units, or substantially all of them, may be the same in cross section, as shown in Figure 9.

The core A is either solid or tubular, and its parts a, a', a" are united at their adjacent ends by appropriate means. Couplings suitable for uniting the core parts are shown in Figures 5, 6, 8, and 11. The coupling E shown in Figures 6 and 7 is in the form of a plate or disk provided with a depending collar e and with a bore or socket e' of two diameters corresponding to the diameters of the core units a, a', and producing an internal shoulder e" adapted for lodgment upon the upper end portion of its core unit a'. The coupling E is larger than the bore and of appreciable extent than the diameter of the core, whereby said coupling extends outwardly from the core, Figures 5 and 6. Such enlargement of the coupling imparts to it two functions, (a) a capacity for supporting the floor beams, and (b) it sustains the down thrust of the concrete adapted to envelop the core within the metallic cage, as will presently appear. As shown in Figures 5 and 6, the floor beams D extend at their ends inwardly with respect to the composite column, said inwardly positioned end portions resting directly upon the couplings when the metal column elements and the floor beams are assembled in the course of erecting the column and the building. At this stage in the assembly, the floor beams are held in assembled relation by bolts e adapted to fasten the base flange of the beam to the coupling, see Figures 5 and 6.

Another method of joining the units of the core A is shown in Figure 8, wherein a coupling E' is used, said coupling having a socket e for receiving the upper end of the core unit a and provided, also, with a tapering socket e" into which is stepped the core unit a', whereby the connection between coupling E' and core unit a' may be coupled at e' to effect a rigid non-separable carrying of the coupling and the core A. As in Figures 5 and 6, the coupling E' of Figure 9 exceeds the diameter of the metal core, and it affords a bearing for the floor beams D attachable by bolts or rivets to the coupling, the latter also affording a support for the down thrust of that mass of concrete which envelops the metal core and occupies the space within the skeletonized cage.

An important feature of my invention is the
cage B assembled in series for surrounding the core in a manner to leave an appreciable space for the moldable material. Each cage is a factory or mill product, the same being a complete part when it is shipped from the factory or mill to the place of utilization for the installation or the column, whereby said cages are continuous or substantially continuous throughout the height of the column.

Different constructional forms of unitary cages are shown in the drawings, more particularly in Figures 1, 2, 3, 4, 5, 6, 7, 11, and 13 to 16, inclusive.

Essentially, each cage embodies a series of longitudinal members b associated with different forms of binders, b', whereby the longitudinal members b and the binders b' are assembled and welded or riveted in any of the usual methods. The cage is shown as plates or bars positioned in parallel relation and spaced relatively to leave openings between them, said plates or bars extending the full length of the cage.

The member or members b' of the cage extend transversely to the longitudinal members b, and the members b, b', are joined, connected or united in a desirable manner, the work of assembling the members b, b', being performed at a mill in conformity to a predesigned schedule so that the cage is complete, or substantially complete, before it leaves the mill and said complete cage is a unit in the steel schedule required for the erection of a building or other structure. In the form of cage shown in Figures 1 and 2, the transverse cage member b' is a substantially continuous strap, band, or hoop, extending spirally around the members b, and in contact exteriorly therewith, said member b' and longitudinal members b being united by rivets, welding or other modes of fastening. The cage shown in Figures 3 and 4 is similarly constructed except that in Figures 3 and 4 two spiral bands, straps or hoops b', b", extend around the longitudinal plates or bars, with one band b" in lapping relation to the other band b', and said bands b', b", and plates b are appropriately joined as, by welding or riveting the several members into a homogeneous unitary structure. The cage with the double spirally wound bands or hoops b" is circular in cross section, and such a form of cage is shown in Figures 3, 4, 5, 6, 7, 8, 11 and 12. Usually, the length of the cage exceeds the height between two adjacent floors of a building or other structure, it being preferred to use longitudinal plates or bars b in the cage the length of which exceeds the space intervening between said bars or longitudinal plates. The cage may be substantially square in cross section, as in Figure 13, wherein angle plates or bars b" are positioned at the several corners of the cage, and said angle bars are spaced with respect to each other, and said angle bars are united by appropriate hoops or bands b' or b". Again, the bars or plates of curved cross section may be approximately T-shaped or U-shaped. In this regard the plates or bars b having the inwardly extending flanges or webs b", see Figure 14. Again, the bands, straps or hoops may be positioned within the space bounded by the longitudinal bars or plates b, as depicted in Figure 15 wherein the transverse connectors or members b' are within the cage and the plates or bars b are outside of members b", the whole being suitably united. Further, the connecting members may be in the form of individual hoops or bands b" arranged crosswise of the plates or bars, and welded or riveted thereto as shown, the individual hoops being annular in form and separated by appropriate intervals.

The mode of assembling the steel required for one column at one floor level is depicted in Figure 5, and of therefrom a determination of the cross section and length of each cage is shown in Figures 6 and 8, and thereafter proceeding with the steel assembled for the same column for co-operation with other floor beams at an upper floor level is shown in Figure 7. The cage A and cage B for one column at the ground floor are assembled by installing the assembled unit a in a vertical position and on a suitable foundation, and by placing the cage B around the column unit a substantially concentric therewith, it being noted that the members b of said cage extend upwardly for appropriate distances above the upper end of said unit a. An assembled unit a' and a coupling E are now assembled into operative positions relatively to the first core unit a and to the first cage, and floor beams D are placed in position by having their inner ends extending into the cage, in the spaces between the plates or bars b, with the result that said inner ends of the beams are imposed upon the coupling E, said floor beams and coupling being fixedly joined as by bolts or rivets e, Figures 5 and 6.

Appropriate concrete forms, indicated generally at G in Figure 6, enclosing the assembled core and concrete filling the intervals between the spaced plates or bars b and the spaces between the connecting members of the cage, whereby a solid mass of concrete is produced for adding to the stability of the resulting composite column. As is the usual practice, the moldable material is tamped within the form or mold, and permitted to set or harden, with the result that the steel elements A, B, and concrete material so unite as to produce a monolithic structure the dimensions of which are such that my improved column does not present an unreasonably massive appearance and yet its strength and stability are amply sufficient for carrying the floor loads.

With the plates or bars b of the cage B extending above the beams D at the first floor level, and with the second or core a first assembled, the next step in the procedure is to bring the second cage for the column into operative relation to the second core unit a' and to the cage B first to
be installed. This assembly is carried on by placing the second cage around the second core unit \( a' \) as shown in Figure 7, with the bars or plates \( b \) of said second cage in register with the corresponding bars or plates \( b \) of the cage \( a \) fixed to the first core unit \( a \) and \( a' \) as shown in Figure 7. The bars or plates \( b \) of the second cage \( B \) are placed in register with the bars or plates \( b \) of the core unit \( a \) as shown in vertical alignment, whereupon bridge plates \( f \) are fastened in a substantial manner to the proximate ends of the bars or plates \( b \) of the superposed cages \( B \) as shown in Figure 7, extending to the upwardly extending ends of the bars or plates of the cage first to be installed and also bolted or riveted to the lower ends of the bars or plates \( b \) of the second installed cage. The second cage \( B \) is thus superposed upon the first cage, and by extending the bars or plates \( b \) of the second cage \( B \) above the floor beams \( D \), it is made practicable to assemble the second cage with facility, and to rigidly couple the assembled cages one to the other in a manner to retain the second cage at the installation thereof in the beam and the column to mold the concrete. With the second cage and the second core unit assembled above the first floor level, then the coupling \( E \) is used to couple the third core unit to the second unit \( a \) and \( a' \) and beams \( D \) for the second floor level are positioned on the second coupling, after which the concrete above the first floor level is molded for encasing that length of the core unit and the cage extending from the first floor level to the second floor level, such molding of the concrete enveloping the second core and the second cage, and the second installation of concrete being continuous with the first concrete installation, whereby the inner end portions of beams \( D \) are encased within the concrete of the column. The concrete covers the couplings \( E \) which are positioned within the concrete to sustain the down thrust of the mass molded within the cages.

The described assembly of core units, cages, couplings, and beams, and the described installation of concrete, progresses until the column attains a desired height for supporting the beams and different floor levels of a building. It is to be noted that the parts of the core \( A \) and the successive cages are required to be assembled by using the couplings \( E \) and the bridge plates \( f \), and the reinforcement passing from the cage to the building. Stages of installation are made at successive stages, and concurrently with the increase in the height of the columns and the building, the whole of the work being performed with speed and by the use of unskilled labor, if required.

The complete column with floor beams at three different floor levels are shown in Figure 10, from which it appears that the size of the column does not present an appearance disproportionate to the spacing of the floor levels, but, of course, it is to be understood that the composite column may be carried to an indefinite height for supporting floor beams of the building.

In the column shown in Figures 5, 6, 7, and 8, the couplings \( E \) for the lengths of the core are positioned at or about the levels of the different floors, to the end that the floor beams are imposed upon and carried by the couplings instead of being transmitted to the core and the mass of the concrete. The metal cages function primarily as reinforcements for the massed concrete to preclude spreading under the stresses, and also to carry a part of the load, but my invention may be embodied in other ways, as shown in Figures 11 and 12, wherein the loads are imposed in a direct manner upon the metal cages. As there shown, I employ a core \( A \) the lengths \( a, a', a'' \), from which are joined in vertical alignment by couplings \( E', E'' \), the latter being at elevations other than at the floor beams, said couplings being in alternate or staggered form.
in a constructional column, a metal core, skeletonized cages coupled in series, floor beams supported by the core, and molded material encasing said core and the cages.

In combination a constructional column, a metal core, skeletonized cages in concentric relation to the core, floor beams supported by the core, means whereby the cages are connected in series, and molded material enveloping said core and the cages.

In a constructional column, metal cages extending lengthwise of the column, a core positioned within said cages, molded material filling said cages, and floor beams extending into said cages and supported by the core.

In combination a constructional column, a series of metal cages extending lengthwise of a column, floor beams entering the cages and supported by the core, a core within the cages and lengthwise of the column, molded material encasing the core and the cages, and coupling means for said metal cages.

In combination a constructional column, a metal core composed of members in aligned relation lengthwise of the column, couplings whereby said core members are united, floor beams imposed upon and supported by said couplings, and molded material encasing said core and the couplings.

In combination in a building construction, a plurality of unitary cages arranged in endwise alignment, a sectional core positioned within said cages, a plurality of floor beams positioned between said cages and supported thereby and forming coupling means therebetween, and molded material co-operative with said core in said cages to form an open-work cage, said cages being arranged in endwise alignment, floor beams positioned between said cages and supported thereby and providing coupling means between said cages, and a core extending continuously through said aligned cages.

In combination in a building construction, a plurality of separate cages, each cage being composed of a plurality of longitudinal members with members connecting said longitudinal members to form an open-work cage, said cages being arranged in endwise alignment, floor beams positioned between said cages and supported thereby and providing coupling means between said cages, and a core extending continuously through said aligned cages.

In combination in a building construction, a plurality of separate cages, each cage being composed of a plurality of longitudinal members with members connecting said longitudinal members to form an open-work cage, said cages being arranged in endwise alignment, floor beams positioned between said cages and supported thereby and providing coupling means between said cages, and a core extending continuously through said aligned cages.

In combination in a building construction, a plurality of separate cages, each cage being composed of a plurality of longitudinal members with members connecting said longitudinal members to form an open-work cage, said cages being arranged in endwise alignment, floor beams positioned between said cages and supported thereby and providing coupling means between said cages, and a core extending continuously through said aligned cages.

In combination in a building construction, a plurality of separate cages, each cage being composed of a plurality of longitudinal members with members connecting said longitudinal members to form an open-work cage, said cages being arranged in endwise alignment, floor beams positioned between said cages and supported thereby and providing coupling means between said cages, and a core extending continuously through said aligned cages.
and a core positioned in the lower portion of said column.

16. In a construction of the character described, a column comprising a plurality of skeletal cages, each cage having a plurality of spaced longitudinal members and a transverse strip member connecting said longitudinal members and gained and secured thereto for producing a skeleton cage, said longitudinal members and transverse strip member being spaced apart to provide openings, beams supported by said cages, and means for connecting said beams and said cages.

17. In combination in a construction, a plurality of skeleton cage units arranged in endwise alignment, each cage unit comprising a plurality of spaced elongated members and strip or band means extending around said elongated members, said strip or band means being fixedly attached to said elongated members to produce a cage unit of predetermined dimensions, said cage unit being of an open-work construction, a beam for spacing certain of said cage units and forming coupling means between said cage units and said beam, said beam being associated with one of said cage units.

18. In combination in a construction, a plurality of skeleton cage units arranged in endwise alignment, each cage unit comprising a plurality of spaced elongated members and strips associated with said elongated members, said strips being fixedly attached to said elongated members to form an open-work cage unit of predetermined dimensions, a plurality of beams for spacing said cage units, said beams being supported by said cage units, and means for connecting said beams to said cage units.

19. In combination in a construction, a skeleton cage unit comprising a plurality of elongated spaced members and strip or band means associated with said elongated members, said strip or band means being fixedly attached to said elongated members to produce an open-work cage unit, a beam positioned on top of said cage unit and supported by said cage unit, and means for connecting said beam to said cage unit.

20. A device of the character described adapted for use in structures, including a skeletonized cage member, said cage member comprising a plurality of spaced elongated members and strip or band means associated with said elongated members, said strip or band means being fixedly attached to said elongated members to produce a unitary cage member of predetermined dimensions adapted for use as a unit, said elongated members and said strip or band means being associated so as to form an open-work construction.

21. A device of the character described, adapted for use in structures, including a skeleton cage unit, said cage unit being substantially cylindrical in form and comprising a plurality of spaced elongated members and a spiral strip or band extending around said elongated members, said strip or band being fixedly attached to said elongated members and extending from a point adjacent one end of said cage unit to a point adjacent the other end of said cage unit to produce a cage unit of predetermined dimensions, said elongated members and said strip or band being assembled so as to form an open-work construction.

22. In combination in a construction, a plurality of separated cage units arranged in endwise alignment, each cage unit comprising a series of elongated members with open-work means connecting said elongated members, said open-work means being fixedly attached to said elongated members for producing a unitary cage of a predetermined length and cross section, a plurality of beams spacing said cage units, said beams being supported by said cage units, and means for connecting said beams to the ends of said cage units to form a skeleton structure before any concrete or the like is applied to the construction.

23. In combination in a construction, a skeletonized cage member comprising a plurality of spaced elongated members and strip or band means associated with said elongated members, said strip or band means being fixedly attached to said elongated members to form a unitary cage member of predetermined dimensions adapted for use as a unit, said elongated members and strip or band means being associated so as to form an open-work construction, and a beam associated with one end of said cage member.

24. In combination in a construction, a succession of spaced skeleton cages arranged in endwise alignment, a plurality of beams in the spaces between said cages, said beams being supported by said cages, and means for rigidly connecting said beams and said cages whereby a skeleton construction is formed before any concrete or the like is applied to the construction.

25. In combination in a construction, a plurality of spaced unitary cages arranged in endwise alignment, a plurality of beams in the spaces between said unitary cages and forming coupling means between said unitary cages whereby a rigid skeleton construction is formed before any concrete or the like is applied to the construction.

26. In combination in a construction, a plurality of spaced unitary cages arranged in endwise alignment, a plurality of beams in the spaces between said unitary cages and forming coupling means between said unitary cages whereby a rigid skeleton construction is formed before any concrete or the like is applied to the construction.

27. In combination in a construction, a cage unit comprising a plurality of elongated spaced members and strip or band means associated with said elongated members, said strip or band means being fixedly attached to said elongated members to produce an open-work or skeleton cage unit, a beam associated with one end of said cage unit, and molded material for encasing said open-work or skeleton cage unit and said beam to form a rigid construction.

28. In combination in a construction, a plurality of skeleton cage units, each unit comprising a plurality of elongated spaced members and strip or band means associated with said elongated members, said strip or band means being fixedly attached to said elongated members to produce an open-work cage unit, and beams positioned on top of said cage units.

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