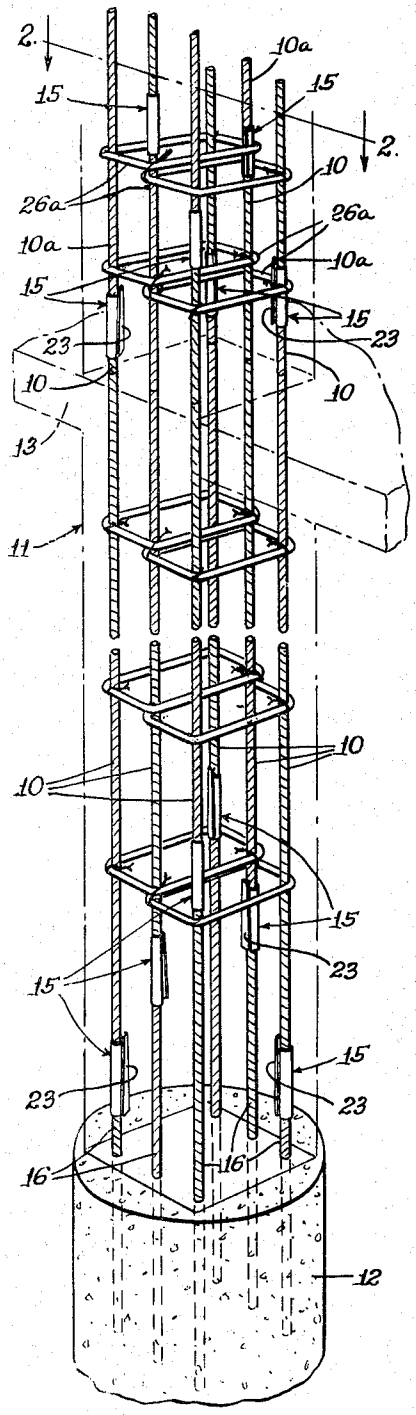
April 12, 1966 F. D. REILAND 3,245,190

METALLICALLY REINFORCED CONCRETE STRUCTURES

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Fig. 1.



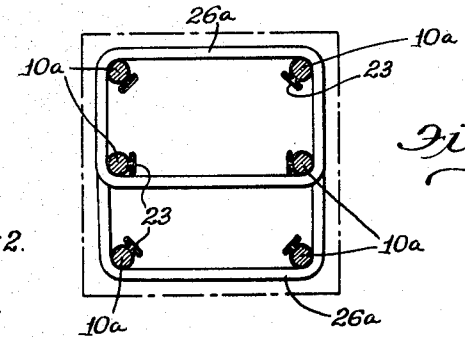


Fig. 2.

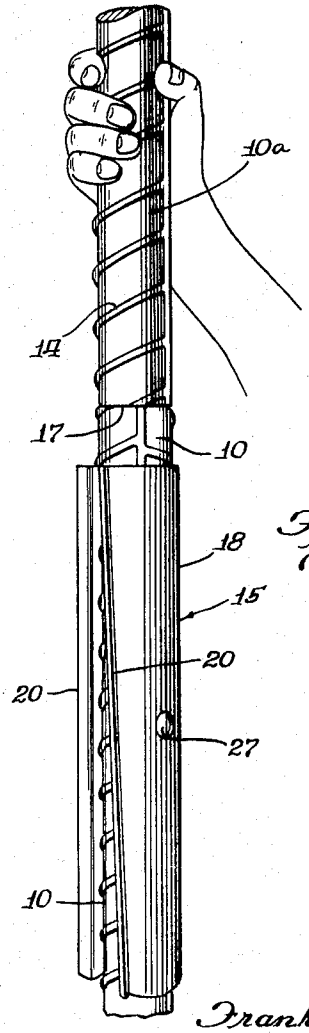


Fig. 3.

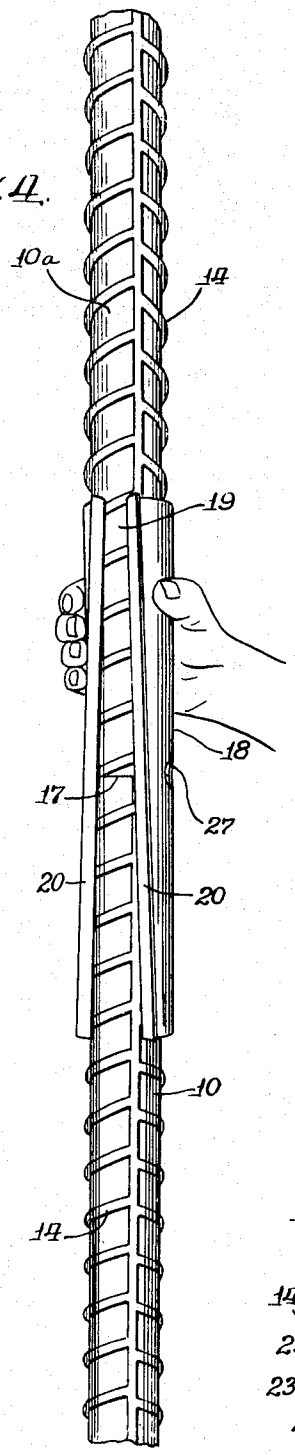
INVENTOR.
Frank D. Reiland
BY
Harvey M. Gillespie
Atty.

April 12, 1966 F. D. REILAND 3,245,190

METALLICALLY REINFORCED CONCRETE STRUCTURES

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Fig. 4.



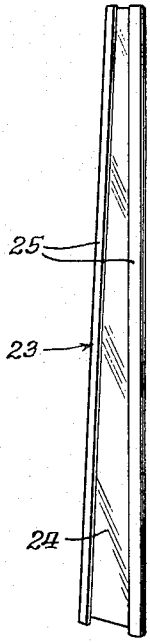


Fig. 4a.

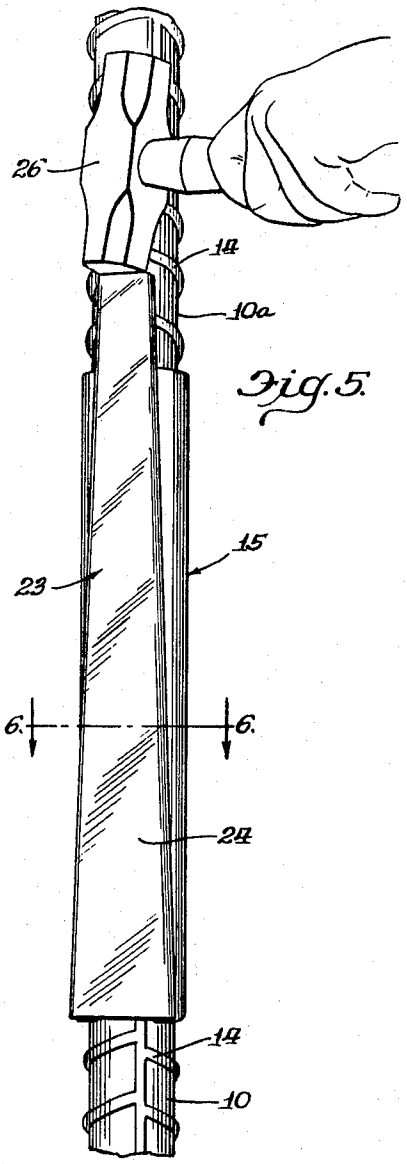


Fig. 5.

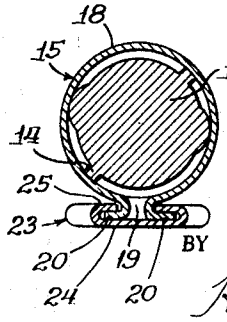


Fig. 6.

INVENTOR.
Frank D. Reiland
BY
Harvey M. Gillespie
Atty.

April 12, 1966 F. D. REILAND 3,245,190

METALLICALLY REINFORCED CONCRETE STRUCTURES

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Fig. 7.

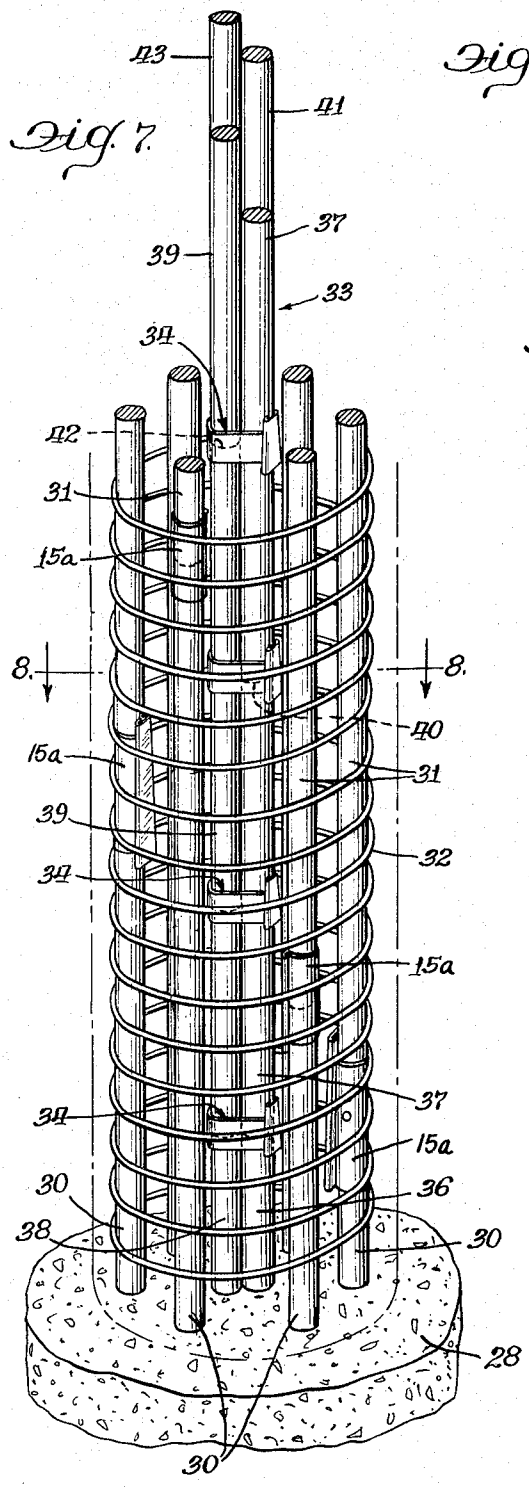


Fig. 8.

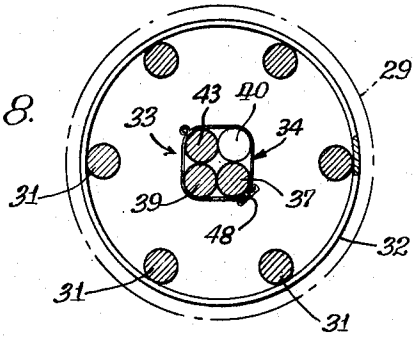


Fig. 9.

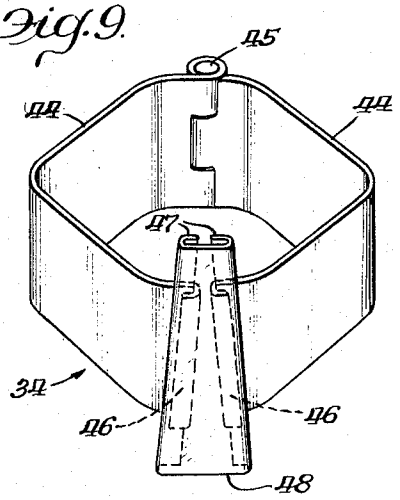
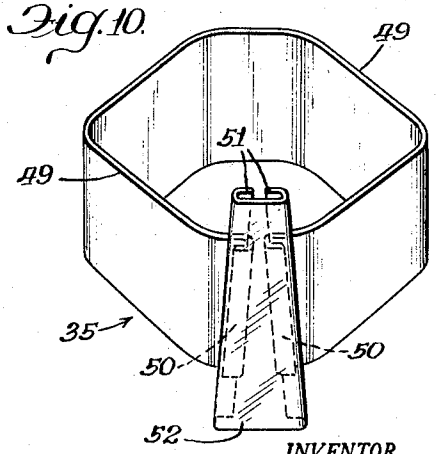


Fig. 10.



INVENTOR.
Frank D. Reiland
BY
Harvey M. Gillespie
Atty.

April 12, 1966 F. D. REILAND 3,245,190

METALLICALLY REINFORCED CONCRETE STRUCTURES

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Fig. 11.

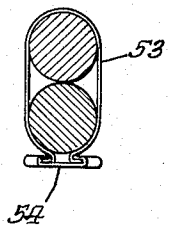


Fig. 12.

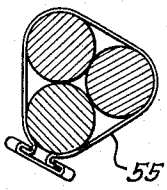


Fig. 13.

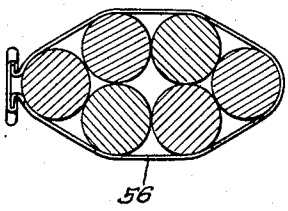
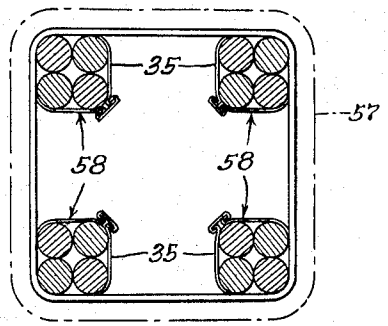


Fig. 14.



INVENTOR.
Frank D. Reiland
BY
Harvey M. Gillespie
Atty.

United States Patent Office

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METALLICALLY REINFORCED CONCRETE STRUCTURES

Frank D. Reiland, Chicago, Ill., assignor to Gateway Erectors, Inc., Chicago, Ill., a corporation of Delaware

Filed June 5, 1962, Ser. No. 200,204
9 Claims. (Cl. 52—653)

The basic principles of the present invention together with certain of the structures herein disclosed were originally shown and described in connection with applicant's copending method application Serial No. 125,538, filed July 20, 1961, of which the present application is a continuation-in-part.

The present invention relates generally to improvements in metallically reinforced concrete structures and more particularly to improvements in the metallic reinforcements per se, whereby the improved features of the concrete structure as a whole are attained.

One important object of the invention is to provide, for imbedment in a concrete column or the like, formed in situ, a simplified reinforcement assembly comprising at least a pair of conventional reinforcement bars arranged in end to end axial alignment and securely clamped together with their abutting end faces held in coplanar total contact with each other, whereby an economical and highly effective butt splice of the bars is effected; the butt splice serving to transmit forces directly from one bar to another and at the same time avoids the objectionable displacement of concrete such as occurs when the adjacent ends of reinforcement bars are overlapped to form a conventional lap splice.

A further and more specific object of the invention includes the provision of clamp means having sufficient radial flexibility and contraction to exert a circumferential wrap around or constrictive clamping force on the bars as distinguished from a directly transverse clamping action, whereby the clamp is adapted to conform to and thereby compensate for slight differences in the diameters and configurations of the connected bars. This type of clamping action serves also to move the abutting ends of the reinforcement bars into said axial alignment during the tightening of the clamp, whereby perfect alignment is attained.

Prior to this invention, the reinforcement bars for concrete structures have been spliced by either butt welding the bars together or by lap splicing, that is to say the bars are overlapped—usually a distance equal to 20 times the diameter of the larger bar—and the overlapped ends are tied together by means of wire wrapped around the overlapped ends of the connected bars.

The butt weld splicing of reinforcement bars is not entirely satisfactory, since it involves excessive cost and is not always practical because of the special chemical properties required in the steel to insure acceptable welded connections. Furthermore, it is necessary to X-ray all welded splices to make certain that there are no voids present. Because of the above conditions, the lap splicing of bars has been the more prevalent of the two general methods followed in the construction of reinforced concrete, even though the production of a satisfactory lap weld is time consuming and also presents various other objections including excessive localized displacement of concrete at the splice, because of the overlap arrangement of the bars. This is particularly true in connection with the use of the larger size bars (Nos. 14 and 18) which are frequently specified as substitutes for structural steel.

By virtue of the improvements of the present invention, it presents various advantages over the prior art in that: The clamp effected "butt splicing" of bars displaces less concrete than the old form of lapped splices and therefore, by virtue of the direct butt end contact of the bars, makes it practical to form a concrete structure with reduced cross-section without sacrificing strength and rigidity.

The clamp per se is preferably formed with thin walls. This promotes flexibility and also makes it practical to design a column, or the like, of smaller cross section than heretofore possible.

Other improvements and advantages of the invention not at this time enumerated will become readily apparent as the following description ensues.

The invention is illustrated in certain preferred embodiments in the accompanying drawings wherein:

FIG. 1 is a fragmentary view of a column reinforcement structure constructed in accordance with the present invention;

FIG. 2 is a cross-sectional view taken on line **2—2** of FIG. 1;

FIG. 3 is a view in side elevation of two bars positioned in substantial longitudinal alignment preliminary to being engaged by an improved clamp sleeve element of the invention;

FIG. 4 is a view similar to FIG. 3 but illustrating a sleeve element of the clamp moved to its normal position to embrace the adjacent ends of both bars being spliced;

FIG. 4*a* shows a companion wedge element of the clamp;

FIG. 5 shows both of the clamp elements positioned to embrace the abutting ends of the bars and in the process of flexing the sleeve element into tight gripping engagement therewith;

FIG. 6 is a cross-section through the clamp and one bar section, the section being taken on line **6—6** of FIG. 5;

FIG. 7 is a view in perspective of a concrete structure in the form of a cylindrical column having a series of reinforcement bars arranged in circular relation to each other and also having a group or bundle of parallel bars forming a central core of the column;

FIG. 8 is a cross-sectional view taken on line **8/8** of FIG. 7;

FIG. 9 shows a hinged form of clamp for clamping together the bundle of bars forming the central core of the column shown in FIGS. 7 and 8;

FIG. 10 is a similar view in perspective of a clamp composed of a unitary sleeve or band and an associated wedge for clamping together a similar bundle of core reinforcement bars and;

FIGS. 11, 12, 13 and 14 are cross-sectional views showing different forms of clamp devices suitable for clamping together bundles of bars having various modified arrangements.

Referring first to FIGS. 1 to 6, inclusive, of the drawings: In FIG. 1, a group of six pairs of vertical reinforcement bars of circular cross-section designated **10**, **10***a* are assembled in accordance with the principles of this invention to provide a cage-like structure for reinforcing a vertical concrete structure, for example a column **11**. The column extends vertically from a pier **12** or other base support to an upper floor **13** and thence, if desired, to other floors at higher levels.

For the purpose of clearness the disclosure of the column **11** and the upper floor **13** are shown in dot-and-dash lines and the reinforcing structure, as a whole, is shown in full lines. The reinforcement bars **10**, **10***a* are provided with conventional deformation ribs **14** defining the perimeters of the bars and the bars are arranged in axial alignment with their adjacent end faces in total coplanar contact (abutting engagement). The bars are claimped in this position by means of clamps designated generally at **15**, the bars **10** being clamped to dowels **16**

inserted in the concrete pier or base **12**, and the bars **10***a* being clamped to the upper ends of the bars **10**. The dowels **16** are positioned to extend different distances above the base **12** as shown in FIG. 1, and reinforcement bar sections **10***a* being preferably of uniform length, extend above the floor **13**. The upper ends of the bar sections **10***a* will therefore constitute dowels of different lengths extending above the surface of the floor **13** to which reinforcement bars **10***a* are connected by means of like clamps **15**.

The flat end faces of the bars **10**, **10***a* and the dowels **16** are perpendicular to the axis of the bars so as to insure flat coplanar engagement of the end faces with each other when the bars are clamped together in their operative positions. The flat coplanar engagement of the end surfaces of the bars insures direct axial transmission of the compression load from one bar to another in the column as distinguished from the off-center compression thrust existing when the bars are lap spliced.

The primary function of a column is to support a compression load as distinguished from lateral or shear stresses. However, the special sleevelike construction of the clamp, as hereinafter described, together with the staggered relationship of the several splices, afford resistance to such lateral or shear forces which may be imposed on a column of a building structure since the joints of the several bars are never located in a single plane transversely of the column.

The improved clamp **15** shown in detail in FIGS. 3 to 6, inclusive, includes certain basic structural features which are present in the other clamp embodiments shown in FIGS. 7 and 16, inclusive. These basic structural features include a sleeve element **18** having some flexibilty and a wedge element **23**, which together embrace the abutting end portions of aligned bars, for example, bars **10**, **10***a*. The sleeve element **18** has a smooth inner face throughout its length for engaging the deformation ribs **14**. The sleeve is also split along one side to provide an opening extending the entire length of the sleeve, which opening together with the flexibility of the sleeve facilitates contraction of the sleeve into constrictive clamping engagement with the perimeters of the abutted end portions of both bars. The marginal portions of the sleeve adjacent said opening are turned outwardly in opposite directions to provide hooks **20**, **20** and the edges of the said opening diverge from top to bottom of the sleeve so that the outturned hooks **20**, **20** constitute wedge flanges which cooperate with the separate wedge element **23**. The wedge **23** is a unitary member and comprises a flat plate **24** having diverging edges which are bent inwardly to provide hook-shaped flanges **25** for interlocking in wedging engagement with substantially the entire length of the outturned flanges **20**, **20** of the sleeve, as shown best in FIG. 6. The function of the wedge **23** is to radially contract or draw the flexible side walls of the sleeve element **18** in a wrap-around constrictive fashion about the abutting end portions of the spliced rods **10**, **10***a*. The said wedge **23** is adapted to be driven in one direction only by a hammer **26**, as indicated in FIG. 5, to its applied position. Preferably the wedge element **23** of the clamp is longer than the sleeve element **18** so that the hammer blows can be applied to the upper end of the wedge and the wedge will assume its final position while the upper edge remains above the upper edge of the sleeve. The fact that the wedge **23** is spaced laterally from the reinforcement bar **10***a*, as shown in FIG. 6, makes it practical to apply the impact force to the wedge without striking the sleeve element **18**. The fact that the sleeve element **18** embraces the major portion of the circumference of the abutting bars **10**, **10***a* sufficient friction is obtained by virtue of the area contact with the bars, after the initial tightening of the sleeve, to prevent slippage of the sleeve **18** lengthwise of the bars during the driving of the wedge element **23** to its final position.

The workmen can inspect the character of abutment contact of the bars **10**, **10***a* through the side opening **19** of the sleeve preliminary to the installation of the wedge **23**. However, the sleeve element **18** is provided with an opening **27** which is normally positioned at the junction of the two bars and facilitates supervisory inspection of the joint after the wedge element **23** is applied and the side opening **19** is covered thereby.

The length of the sleeve clamp as shown herein is approximately seven times the diameter of the larger of the bars being connected, but the length can obviously be varied to meet special conditions and, of course, the diameter of the sleeve **18** and the size of the wedge **23** will be varied to meet the requirements of larger or smaller reinforcement bars.

In accordance with steps of the method for placement and butt splicing of the bars **10**, **10***a*, as disclosed and claimed in copending application Serial No. 125,538, the sleeve element **18** of the clamp is normally slipped over the upper end of the lower bar or dowel substantially as shown in FIG. 3, prior to the placement of the upper bar in position. After the upper bar **10** or **10***a*, as the case may be, is seated on the upper end of the lower bar, the sleeve element **23** is moved upwardly to the position shown in FIG. 4 wherein it embraces the adjacent ends of both bars **10**, **10***a*. The wedge **23** is then fitted over the outturned ends **20**, **20** of the sleeve so as to project laterally from the bars **10**, **10***a* toward the interior of the concrete structure as shown in FIG. 2 and is driven into tight wedging engagement with the sleeve **18** by means of the hammer **26** as shown in FIG. 5. The constructing clamping action of the sleeve on the abutting ends of the bars automatically moves the upper bar into an axially centered relationship with the lower bar and by virture of the flexibility, conforms to and thereby compensates for tolerance variations in the diameters and the perimeter contours of the bars. After the clamps **15** are applied to all bars of the group shown in FIG. 1, transverse ties such as shown at **26***a* or other conventional form of reinforcements are slipped over the upper end of the group of bars and moved longitudinally of the bars and over the thin walled clamps to suitable positions for holding the free ends of the bars in parallel relation and thereby form a cage-like assembly.

Referring now to FIGS. 7 to 14 inclusive: The concrete structure shown in FIGS. 7 and 8 comprises a pier or other form of base **28** and a column **29** of cylindrical form extending upwardly from the base. The column is reinforced by a series of axially aligned reinforcement bars comprising dowel sections **30** supported in the concrete of the base **28** extending upwardly different distances therefrom. Full length bar sections **31** are positioned in axial alignment with the several dowels and are clamped to the upper ends thereof by means of clamps **15***a*. These clamps are of the same construction as the clamps **15** show in FIGS. 1 to 6, inclusive, and they are installed in the same manner, as previously described, to move the abutting bars **30**, **31** into axial alignment and to maintain them in that position during the pouring of the concrete. Additional conventional reinforcement in the form of a continuous spiral **32** surrounds the bars **30**, **31** collectively to form a cage-like structure.

The modified reinforcement assembly (FIGS. 7 and 8) thus far described, is the equivalent of the assembly shown in FIGS. 1 and 2, but the structure as a whole is distinguished therefrom by the provision of a central regidifying core **33** composed of a bundle of bars clamped together by means of a clamp structure **34**, the details of which will be described.

The core **33** comprises 4 pairs of bars **36–37**, **38–39**, **40–41**, and **42–43**. Each pair is arranged in axial alignment with the abutting ends in total coplanar contact in the same manner as the said bars **30**, **31**.

The clamp structure **34** for clamping the bars together collectively, comprises a hinged sleeve or band, including sections **44** hinged together at **45**. The free ends of the

clamp sections **44** are formed with out-turned wedge shaped flanges adapted to have wedging engagement with inturned wedge flanges **47** of a wedge element **48**.

The hinge type of clamp **34** is advantageous in situations where it is desirable to apply the clamp to a bundle of rods intermediate their ends, for example when it is difficult or inconvenient to spread a unitary band or sleeve (see FIG. 10) sufficiently to pass it around or over the group or bundle of bars. When the reinforcement assembly is such that the sleeve portion of a clamp may be slipped over the ends of a group of bars to be spliced or when the bundle of bars is small enough to permit a clamp having a unitary split sleeve to be opened sufficiently to be passed laterally around the bundle, a clamp of the construction shown in FIG. 10 may be used. The clamp shown in FIG. 10 includes a unitary split sleeve **49** having some flexibility adapted to embrace the bundle of bars. The free edges of the sleeve are turned outwardly to provide wedge-like flanges **50** for interlocking with inwardly turned wedge flanges **51** of a wedge element **52**. The flexibility of the clamps **34**, **35** accommodate bundles which vary in size because of tolerance variations in the sizes and shapes of the bars connected therein.

One of the clamps **34** or **35** is positioned to embrace the bundle of bars at the abutting ends of each pair of bars to be spliced. It will be observed therefore that, inasmuch as the central core or bundle shown in FIGS. 7 and 8 is composed of four pairs of axially aligned bars—**36–37**, **38–39**, **40–41**, and **42–43**, and the several splices are staggered relative to each other, there are four clamp structures **34** or **35**, as the case may be, applied to the bundle, one at the abutting ends of each pair of spliced bars included in the bundle.

The number of bars to be included in a reinforcing bundle may be varied in accordance with the size and nature of the concrete structure to be reinforced. For example, FIG. 11 shows two parallel bars clamped together by means of an adjustable sleeve clamp, including a unitary sleeve **53** and wedge **54**. However, in all situations where one or more pairs of bars are butt spliced together and are also clamped together collectively, there will be a clamp located at each butt splice in accordance with the principle described in connection with the bundle of pairs of bars **36–37**, **38–39**, **40–41**, and **42–43** shown in FIG. 7. FIG. 12 shows an arrangement of three bars secured together by means of a sleeve clamp **55**, and FIG. 13 shows six bars clamped in a bundle by means of a clamp **56**.

FIG. 14 illustrates in diagrammatic cross-section, a concrete strucutre **57**, for example a square column in which four bundles **58** of reinforcement bars are embedded, each bundle comprising four pairs of aligned bars similar to the bundle **33** of FIGS. 7 and 8, but having an arrangement, in the present instance, of a bundle at each of the four corners of the column. The bars of each bundle are clamped together collectively by means of clamps **35**, according to the principles shown in FIG. 7.

The reinforcements and clamp structure shown in FIGS. 1 and 14, inclusive, have been illustrated as vertical reinforcements for concrete columns. The splice connections of the several bars are arranged in staggered relation so that only part of the bars are spliced at any one point, thus leaving sufficient unspliced bars to provide a continuity of reinforcement for resisting any possible tension to which the structure may be subjected. However, the primary function of the vertical bars is to transmit compression forces in the column directly from one bar to another through the butt end splicing of the bars.

While the invention is illustrated in connection with certain preferred and modified embodiments, it will be obvious that other variations in structure may be made without departure from the spirit of the invention. It is to be understood, therefore that the present invention contemplates all such structural variations that come within the scope of the appended claims.

I claim:

1. In combination with a vertical concrete structure, a metallic reinforcement therefor comprising at least one pair of vertically extending reinforcement bars of circular cross-section embedded therein in endwise abutting relation and provided with deformation ribs defining the perimeters of the bars, clamp means including a radially contractable sleeve member having a smooth inner face throughout its length and positioned to embrace and grip the perimeters of the adjacent end portions of both bars and being sufficiently thin and flexible to conform to and thereby compensate for normal tolerance variations in the diameters and perimeter contours of the bars, the sleeve member being provided with a side opening throughout its length to facilitate the radial contraction thereof and provided along opposite edges of the opening with outwardly and laterally turned flanges which diverge from each other to provide wedges, and a unitary wedge member having inturned wedge flanges engaging substantially the entire length of the flanges on the sleeve member and movable therealong to contract the sleeve throughout its length into constricting gripping engagement with the perimeters of the abutted end portions of both bars to connect and automatically axially align the end portions of the bars.

2. A reinforced concrete structure as defined in claim **1**, wherein the radially contractable sleeve embraces substantially the entire perimeter of the abutted end portions of an individual pair of bars and is effective, by its contracting movement, to automatically axially align the abutted end portions of both bars.

3. A reinforced concrete structure as defined in claim **2**, wherein plural pairs of said abutted bars are arranged inwardly from, but in close relation to, the perimeter of said concrete structure and wherein each clamp means is so positioned that its wedge member faces inwardly toward the interior of the concrete structure.

4. A reinforced concrete structure as defined in claim **1**, wherein the said wedge member when in its applied position covers the open side of the sleeve and the sleeve is provided with an opening therein at the location of the abutted end faces of the bars to facilitate unobstructed visual inspection of the endwise contact of the bars.

5. A reinforced concrete structure as defined in claim **1**, wherein a series of pairs of said reinforcement bars are grouped in longitudinal contact to form a vertically extending bundle in which the abutted ends of the several pairs of bars are positioned at different elevations and wherein a series of the clamp means embrace and clamp the bundle as a whole with constricting pressure, the several clamps being located to embrace the bundle at the abutted ends of different pairs of bars.

6. A reinforced concrete structure as defined in claim **5**, wherein the bundle of vertically extending pairs of bars is centrally located in the concrete structure to form a reinforcing core therein.

7. A reinforced concrete structure as defined in claim **5**, wherein a plurality of bundles of bars are positioned in spaced relation to each other in the column.

8. A reinforced concrete structure as defined in claim **5**, wherein the sleeve member of each clamp means includes hinged side sections adapted to be inserted over the reinforcement bars intermediate their ends and the wedge member of each clamp engages the free ends of the hinged side sections of its associated sleeve to effect said contraction of the sleeve.

9. A reinforced concrete structure as defined in claim **5**, wherein the sleeve member of the clamp is a unitary device and is sufficiently flexible to facilitate lateral application thereof about the bundle of bars at locations intermediate the ends of the bundle.

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FRANK L. ABBOTT, *Primary Examiner.*

WILLIAM I. MUSHAKE, HENRY C. SUTHERLAND, *Examiners.*

J. L. RIDGILL, *Assistant Examiner.*