R. A. CUMMINGS.

REINFORCED CONCRETE PILE OR COLUMN.

APPLICATION FILED JUNE 11, 1909.

975,514. Patented Nov. 15, 1910.

FIG.3

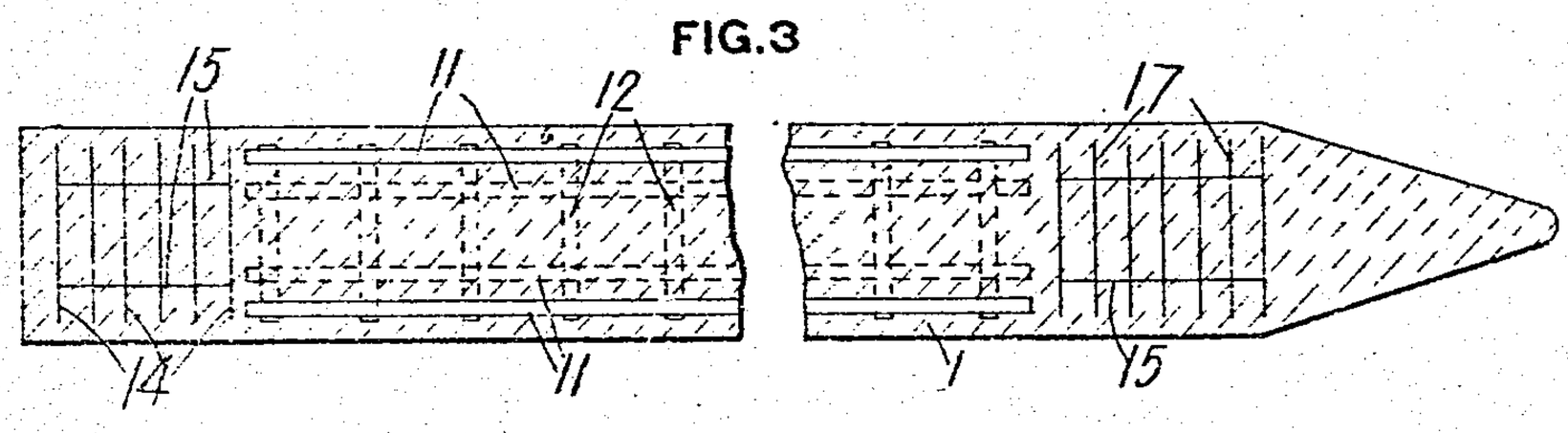


FIG. 4

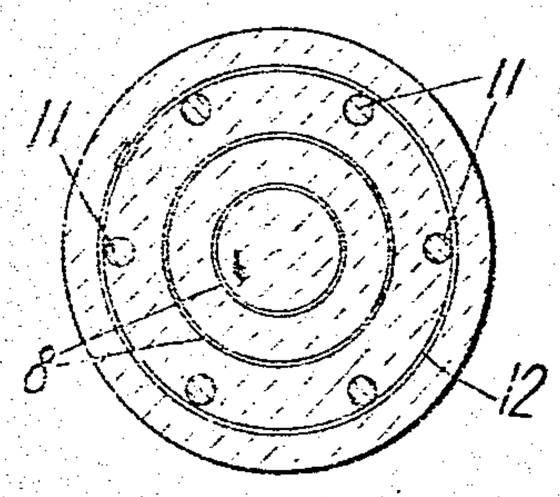


FIG.7

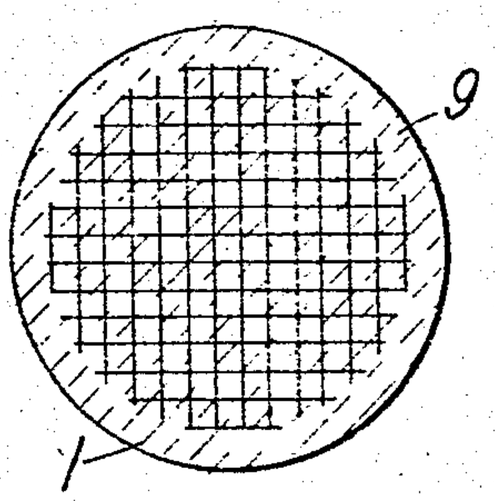


FIG.8

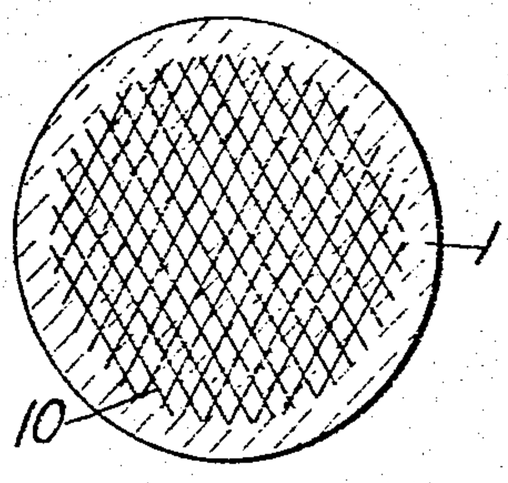
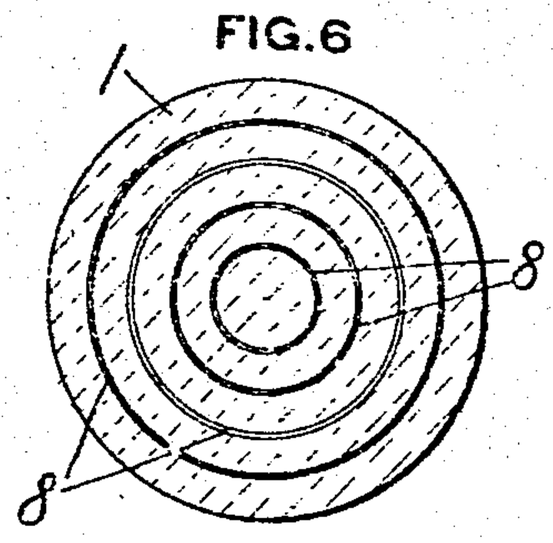


FIG.6



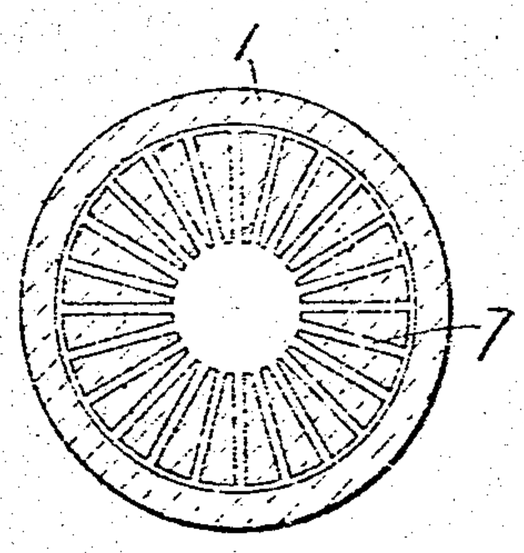


FIG.5

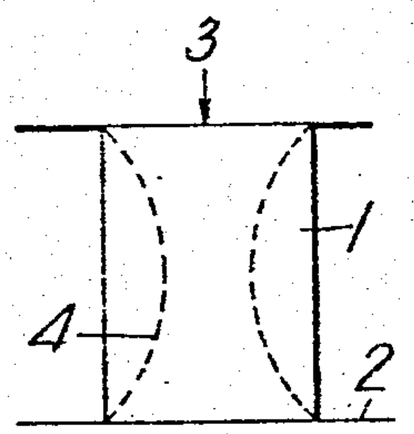


FIG.1

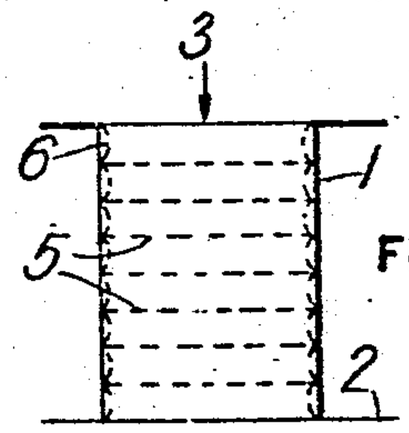


FIG.2

WITNESSES

Chas. Foderman

J. C. Hutchinson Jr.

INVENTOR

Robert A. Cummings.

By Fred'k W. Hinitz.

Attorney.

UNITED STATES PATENT OFFICE.

ROBERT A. CUMMINGS, OF BEAVER, PENNSYLVANIA.

REINFORCED-CONCRETE PILE OR COLUMN.

975,514. Specification of Letters Patent. Patented Nov. 15, 1910

Application filed June 11, 1909. Serial No. 501,628.

To all whom it may concern:

Be it known that I, ROBERT A. CUMMINGS, a resident of Beaver, in the county of Beaver and State of Pennsylvania, have invented new and useful Improvements in Reinforced-Concrete Piles or Columns, of which the following is a specification.

This invention relates to reinforced concrete and similar piles or columns.

The object of the invention is to provide a pile or column of the character specified of greater strength than those heretofore used, and particularly a pile having its upper end so constructed that it can be driven without the necessity of special protectors and so that the top can be readily broken off or otherwise removed to bring all the piles of a group to a substantially uniform level.

Generally stated the invention consists of a pile or column comprising a series of laminæ of concrete and metal so arranged as to take care of the lateral tension stresses induced by the compressive loads on the pile or column.

In the accompanying drawing Figure 1 is a diagrammatic view illustrating the manner in which a pile or column fractures under a load or blow; Fig. 2 is a similar view illustrating how my invention overcomes the same; Fig. 3 is a longitudinal section through a pile constructed according to my invention; Fig. 4 is a transverse section taken on the line 4—4, Fig. 3; and Figs. 5, 6, 7 and 8 are cross sections of the column showing various forms of transverse reinforcements.

It has been demonstrated that when a concrete pile or column is placed under a destructive load the fracture begins by the spalling or breaking out of a portion of the side faces of the pile and extending around the same, or at least on the side faces at the ends of the shortest diameter. Such portions never break out at the base or support of the column, nor at the upper end or where the load is applied, but only intermediate these points, and the parts broken out are deepest or thickest substantially intermediate the ends of the columns. For instance, if in Fig. 1 we take 1 to represent a section of a concrete column resting on support 2 and have a load applied on its top 3 the fracture takes the form of a curve 4 starting at the points of support and of application of the load and gradually increasing in depth and reaching maximum depth substantially intermediate these points, this broken out portion in the case of square or circular columns extending entirely around the column, and in the case of rectangular columns being on the broader faces thereof, in either case reducing the cross-sectional area thereof to the point of failure. This form of fracture is due to the fact that when a load is applied to the column the vertical compression stresses in the column induce lateral stresses tending to spread or flatten out the column, the same as when a compressive load is applied, for instance, to a rubber cylinder, said cylinder tends to flatten out, thereby inducing horizontal or lateral stresses, which are tension stresses. In concrete columns the same lateral tension stresses are induced, and if these can be effectively taken care of the unit strength of the concrete will be very greatly increased.

I have discovered that by placing in the pile reinforcement extending transversely thereof the fracture will be limited to the spaces between such transverse reinforcements. For instance, if in Fig. 2 transverse reinforcements shown at 5 are placed in the section of column between its ends, and load applied in the same manner as in Fig. 1 the broken out or spalled portions extending around the column are confined to the spaces between the reinforcements, that is, to comparatively narrow bands as indicated at 6. Since the depth of the broken out portion depends upon the distance between the reinforcements or the points of support where the concrete is held it is quite evident that by placing the reinforcements sufficiently close together the fracture can be reduced to small annular grooves around the pile which for practical purposes are negligible.

The principle of my invention therefore consists in providing piles, columns or similar cement or concrete structures with a series of transverse reinforcements arranged to take care of the lateral tension stresses induced in the column and placed sufficiently close together to reduce the tendency to fracture to a negligible quantity; or in other words, to construct the pile or column in whole or in part of a series of laminæ of concrete and metal so arranged as to take care of the lateral tension stresses induced by the compression on the pile or column. Gener-

ally stated the distance between such transverse metal reinforcements of laminæ must be less than the diameter or thickness of the pile or column. These transverse reinforcements may be variously arranged, but since in circular or square columns the lateral stresses are equal in all directions the preferred arrangement is a radial one, such as shown in Fig. 5, wherein there is a reinforcement member having a series of radially arranged members 7. Fig. 6 shows a series of concentric bands 8 for this purpose, such bands being sufficiently broad and placed concentrically to form an efficient transverse reinforcement to take care of the lateral stresses. Fig. 7 shows a rectangular mesh 9 for the same purpose and Fig. 8 shows a diagonal or diamond shaped mesh 10 for the same purpose, such as might be formed from expanded metal. Metal lathing is also suitable for the purpose. Various other forms of reinforcement members may be employed.

In rectangular columns the spalling is greatest on the broad faces, 12 at the ends of the shorter cross section. Here a rectangular mesh or cross bars alone gives excellent results. These transverse reinforcements are entirely embedded and enveloped in the concrete, and are placed sufficiently close together to reduce the tendency to fracture to a negligible quantity, and while no fixed rule can be followed as to the distance between such reinforcements it should in all cases be less than the diameter or thickness of the pile or column, and where great strength is required, will be very much less than this distance. Such transverse reinforcements can be applied either to a circular, square or other cross-sectional shape of pile or column, and will act in the same manner in each. When the reinforcement is used in a column which is built up in place and subjected to a uniform load these transverse reinforcements may constitute the entire reinforcement for the column. For all columns or piles which are first molded and must afterward be handled, or which are subjected to eccentric loads, longitudinal reinforcements are also preferably provided to withstand the bending stresses induced when the pile or column is lifted by the crane or stressed by the eccentric load.

In Fig. 3 the invention is shown applied to a pile which for a portion of its length is provided with longitudinal reinforcing bars 11 which may be of any suitable form, and transverse hoops or bands 12 which preferably are flat bands of metal united to the longitudinal bars in any suitable way. The longitudinal bars give the necessary strength against bending stresses when the pile is lifted by the crane. This part of a column or pile may be similar to any of the forms shown in my Patents Nos. 822,587 of June 5, 1906 or 828,931, August 21, 1906, or any other suitable longitudinal reinforcements having a similar function may be employed. If it is desired that this part of the column shall have greater unit strength than given by the longitudinal bars 11 and bands 12, any one of the forms or transverse reinforcements above described may be applied at intervals, such as the concentric bands 8 shown in Fig. 4.

The upper end of the pile is subjected to battering by the hammer when driving the pile, and this must be very materially strengthened. Consequently, said upper end is provided with the transverse reinforcements indicated generally at 14, placed close together so as to give the maximum unit strength in this part of the pile. The upper end of the pile, however, is not provided with longitudinal reinforcements, in order to permit the same to be readily cut or broken off to bring the pile to the level of the other piles of the group. Piles are usually molded in horizontal position, and to hold the transverse reinforcing members 14 proper distances apart they are united by the longitudinal spacing members 15 which are wired or otherwise secured to the transverse reinforcements. These spacing members 15, however, are very light metal so that they do not interfere with the cutting or breaking off of the top portion of the pile. The transverse reinforcements give to the concrete the necessary strength so that the pile can be driven without any special protector and with only a limited amount of battering or fracture of the top thereof. At the same time the upper end of the column can be readily broken off which is necessary because it is impossible to drive the piles down to the same degree.

If desired, the concrete forming the upper portion of the pile and which receives hammer blows may be mixed with saw-dust or other yielding material so that it will be somewhat resilient and cushion the blows of the hammer. The lower end of the column is also shown as provided with transverse reinforcements at 17. The longitudinal reinforcement in the pile illustrated extends for a part of the length of the pile only, just enough to take care of the bending stresses when lifted by the crane but if desired it may extend for the full length thereof. As above stated in case of a column which is built up in place and need not be handled the structure from top to bottom may be similar to that shown in the upper end of the pile illustrated in Fig. 3. In other words, these transverse reinforcements may extend for the whole or only a portion of the length of the pile or column.

By the reinforcements described the unit strength of the concrete is very materially increased, and failure of the pile or column

is to a large extent avoided, and columns or piles may be made much lighter than without these reinforcements.

What I claim is:

1. A pile or column comprising a series of laminæ of concrete and metal, said laminæ being disposed alternately, and the metal laminæ each comprising a substantial portion of the cross-section of the pile or column in any one plane thereof and being located horizontally therein and located sufficiently close together to reduce surface fracture and arranged to take cars of lateral tension stresses in substantially all transverse directions induced by compressive loads on the pile or column.

2. A reinforced concrete pile or column comprising a series of transversely arranged metal reinforcements comprising a substantial portion of the cross-section of the pile or column in any one plane thereof and embedded in the cementitious material and spaced apart a distance less than the diameter or thickness of said pile or column.

3. A reinforced concrete pile or column comprising a series of horizontally arranged metal mesh members placed in different horizontal planes and located close together and embedded in the cementitious material and comprising a substantial portion of the cross-section of the pile or column in any one plane and in order to take care of lateral tension stresses in substantially all transverse directions induced by compressive loads on the pile or column.

4. A reinforced concrete pile or column provided with longitudinal metal reinforcement members and with a series of transverse reinforcing members each comprising a substantial portion of the cross-section of the pile or column in any one plane thereof and embedded in the cementitious material in order to take care of lateral tension stresses induced by compressive loads on the pile or column and spaced sufficiently close together to reduce surface fracture.

5. A reinforced concrete pile provided at its upper end with a series of transverse reinforcements each comprising a substantial portion of the cross-section of the pile or column in any one horizontal plane and spaced sufficiently close together to reduce surface fracture and embedded in the cementitious material and arranged to take care of lateral tension stresses induced by compressive loads on the pile.

6. A concrete pile having its upper end formed of yielding cementitious material and having embedded therein a series of transverse metal reinforcements each located in different transverse planes and comprising a substantial portion of the cross-section of the pile in any one plane so as to take care of lateral tension stresses in substantially all transverse directions induced by compressive loads on the pile.

7. A reinforced concrete pile provided with longitudinal reinforcing members therein extending through a portion of its length, and at its upper end having embedded therein a series of transverse reinforcing members only, said reinforcing members being spaced sufficiently close together to reduce surface fracture and each comprising a substantial portion of the cross-section of the pile in any one plane so as to take care of lateral tension stresses induced by compressive loads on the pile.

8. A reinforced concrete pile provided with longitudinal reinforcing members embedded therein and terminating some distance from the upper end of said pile, and a series of transversely arranged metallic reinforcements embedded in the cementitious material at the upper end of the pile, said transverse reinforcements being placed sufficiently close together to reduce surface fracture.

9. A reinforced concrete pile comprising a body of cementitious material having embedded in its upper end a series of transverse metallic reinforcements, each comprising a metal mesh member arranged to take care of lateral tension stresses and placed sufficiently close together to reduce surface fracture.

In testimony whereof, I have hereunto set my hand.

ROBERT A. CUMMINGS.

Witnesses:
JOHN S. CORT,
F. W. WINTER.