

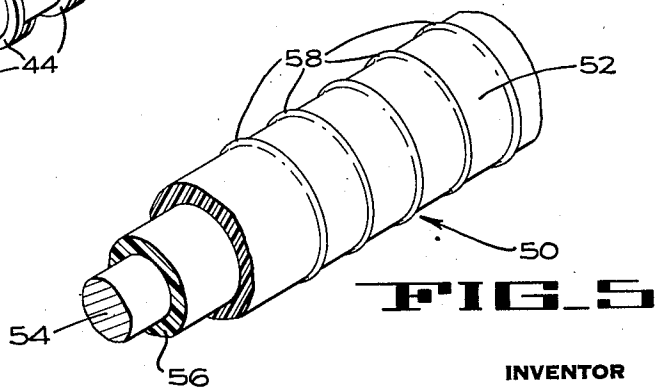
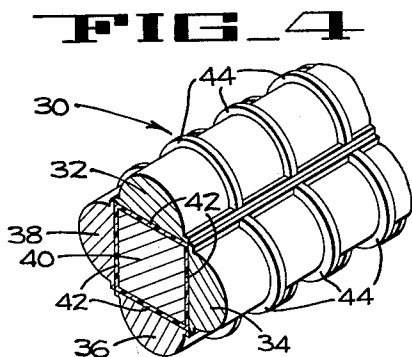
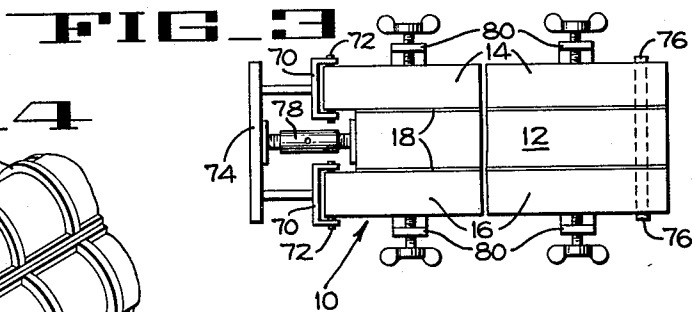
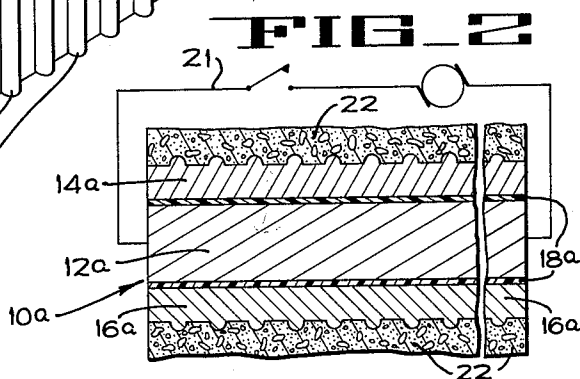
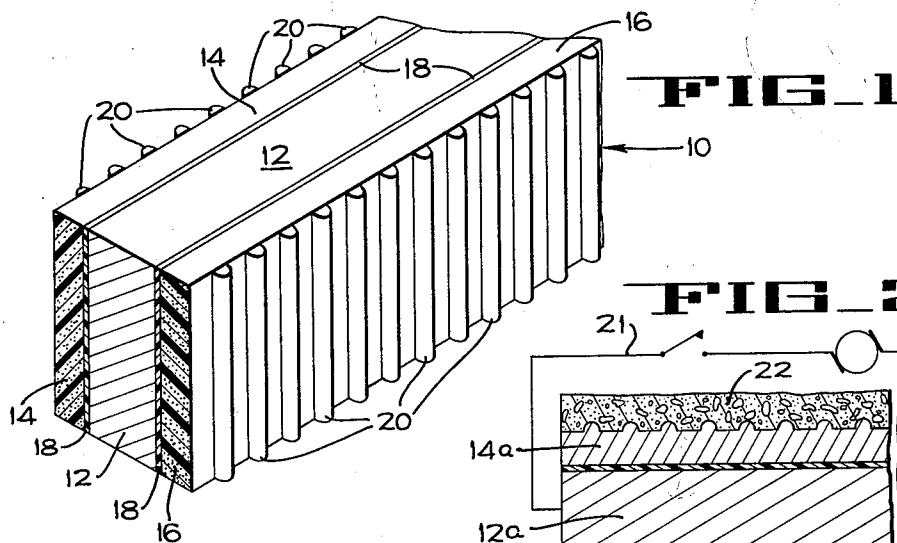
Feb. 2, 1965

J. A. ABBOTT

3,167,882

MEANS FOR AND METHOD OF PRESTRESSING CONCRETE

Filed Dec. 14, 1960



INVENTOR
JOHN A. ABBOTT

BY *Hans G. Hoffmeister*
ATTORNEY

1

3,167,882 MEANS FOR AND METHOD OF PRESTRESSING CONCRETE

John A. Abbott, Menlo Park, Calif., assignor to FMC Corporation, a corporation of Delaware
Filed Dec. 14, 1960, Ser. No. 75,856
9 Claims. (Cl. 50—128)

This invention pertains to the art of prestressing concrete elements. More particularly, the invention relates to rods for prestressing concrete structural members and to methods of their use.

Concrete has great strength in compression loads but little tensile strength. It has been found, if concrete structural elements are prestressed, i.e., placed under compressive stresses prior to installation in a structure, little or no tensile stress will develop within the element when a normal load is applied thereto.

A common method of producing prestressed concrete structural members is to place a number of steel rods or wires in a form and to subject them to high tensile stress. The concrete is then poured into the mold form around the wires. After the concrete has cured and has bonded to the wires, the wires are disconnected from the tensioning device, as by cutting the wires near their ends. The recovery force of the stressed rods or wires is thus imposed upon the concrete, placing the same under compression.

This method requires heavy, complicated, and expensive manufacturing facilities to accomplish the initial stressing of the wires, thus making impractical the manufacture of prestressed concrete structural members at the construction site where they are to be used. Accordingly, members prestressed by this method usually are manufactured at a central point and then shipped to the construction site.

Another method of producing prestressed concrete structural members is the so-called "post-tensioning" method. In this method, the concrete is allowed to cure before any stress is applied to the embedded steel wires or rods, which are coated with a suitable material to prevent them from becoming bonded to the concrete. Both ends of the steel wires are anchored in special end plates. When the concrete has cured, the steel is stressed between these plates, thereby placing the concrete under compression.

The use of the "post-tensioning" process often makes it possible to cast concrete at the construction site, but the labor involved is expensive, and it is difficult or impossible to distribute the tension evenly throughout the steel, thus making the tensioning operation unreliable.

It is, therefore, an object of the present invention to provide an improved method of prestressing structural members made of concrete or other material having high compressive strength but low tensile strength.

Another object is to provide an improved type of tensioning rod for use in prestressing concrete structural members.

Another object of the present invention is to provide a pretensioned rod assembly which can be cast in concrete in the same manner as ordinary structural steel, and which can subsequently, by a simple operation, be made to transfer the restoring force resulting from its pretension stress to the concrete and thus to impose compressive stress thereupon.

Another object is to provide a pretensioned rod assembly which can be factory produced in stock lengths from which the desired lengths may be severed at the place of use.

Another object of the present invention is to provide a pretensioned rod assembly which is adapted to convert

2

the energy of its tension into compression of the concrete in response to the application of heat thereto.

These and other objects and advantages of the present invention will become apparent from the following detailed description and the accompanying drawings wherein:

FIG. 1 is a fragmentary isometric of a pretensioned rod constructed in accordance with the principles of the present invention.

FIG. 2 is a fragmentary longitudinal section of a modified form of the pretensioned rod of the invention, showing the same embedded in concrete as in actual use and showing diagrammatically an electric circuit arranged for use in carrying out the method of the invention.

FIG. 3 is a fragmentary plan showing schematically how the constituent members of a composite rod may be stressed to produce the pretensioned concrete prestressing rod of the present invention.

FIGS. 4 and 5 are fragmentary isometric views of further modified forms of pretensioned rods embodying the principles of the present invention.

Referring to FIG. 1 of the drawings, the pretensioned concrete prestressing rod 10 of the present invention comprises an elongate core member 12 which is prestressed in compression. The member 12 may be of any electrically conductive material having a high modulus of elasticity in compression, such, for example, as steel or cast iron. Two members 14 and 16 are located one on either side of the member 12. The members 14 and 16 are prestressed in tension and are bonded to the member 12 throughout their length by a bonding agent 18. The tension members 14 and 16 are made of any suitable material having a high tensile strength and a high modulus of elasticity wherein they may be elastically stressed under large tensile loads, such as a suitable alloy steel or a self hardening material reinforced with fiberglass. In the form of the invention shown in FIG. 1, the tension members 14 and 16 are made of glass fibers embedded within an epoxy resin.

According to the present invention, the bonding agent 18 is an adhesive resin of a type which is capable of having its bonding ability destroyed by heat, and may be one of many resins commercially available.

A plurality of protuberances such as transversely extending beads 20 are provided on the outer surfaces of the tension members 14 and 16 to insure a good bond between the tension members and a concrete mass within which they are cast, throughout the full length of their interengagement.

The modified form 10a of the pretension rod shown in FIG. 2 is similar to that of FIG. 1, but differs therefrom to the extent that whereas the inner, compression member 12a is made of steel, the outer, tension members 14a and 16a are made of a suitable alloy steel rather than of glass fiber reinforced plastic material.

Since the pretensioned rod of the present invention includes members which are bonded to each other throughout their length, the rod may be made in standard stock lengths and may be cut to the desired lengths at the construction site.

In the performance of the method of the invention by means of the predetermined rod 10a of FIG. 2 for example, paint, grease, or other suitable material capable of inhibiting a bond between the compression member 12a and concrete in contact therewith, is applied to the exposed surfaces of the member 12a. The rod 10a is then placed in the form in much the same manner that structural steel is normally used in unstressed installations. The ends of the unit are left exposed, and the inner, compression member 12a is connected into an electric circuit 21 as indicated diagrammatically in FIG. 2. The concrete 22 is cast around the rod 10a and is per-

3

mitted to set and cure. The concrete 22 bonds itself to the outer surfaces of the two side members 14a and 16a. After the concrete has cured, the electric circuit 21 is completed so that an electric current is passed through the central member 12a, the electrical resistance of which effects the generation of heat, thereby raising the temperature of the rod 10a, and destroying the bond 18a or at least effectively weakening its bonding ability. Since the member 12a then no longer holds the outer members 14a and 16a in tension, the tension in said members is exerted as a compressive force on the concrete 22 within which they are cast.

When the bonding agent is weakened to the extent that its bonding action is destroyed, substantially all of the recovery force stored in the members 14a and 16a is transmitted to the concrete 22 as compressive force therein, since very little of the force is lost through the slight contraction of the members 14a and 16a which results in applying the force to the concrete.

Steel is advantageous as the material for the tension members 14a and 16a because of its high tensile strength. However, glass fibers embedded within an epoxy resin likewise possesses distinct advantages for use as the outer tension members. The high tensile strength of such material enables it to exert the desired tension load, and since such material has a high strength to weight ratio, the composite structure employing glass fibers impregnated with an epoxy resin as the outer, tension members, likewise is characterized by an advantageous strength to weight ratio. In addition, the fiber reinforced resin provides an efficient protective coating for the core, protecting the same from the corrosive effects of moisture and other constituents of the concrete throughout all those areas of the core that are covered by the resinous material.

FIG. 3 illustrates schematically a simple and yet effective method of producing the pretension concrete prestressing rod 10 of the invention. Whereas the form of rod shown in this figure corresponds to that of FIG. 1, it will be understood that the method is applicable to other forms of pretensioned rods incorporating the principles of the present invention. When the inner compression member 12 and the outer tension members 14 and 16 are assembled, they are so related to one another that one end of each of the outer members 14 and 16 projects beyond the corresponding end of the inner member 12. A clevis 70 is connected to each projecting end of the members 14 and 16 as by a pin 72 and each clevis 70 is rigidly connected to a crosshead 74.

The other ends of the three members 12, 14 and 16 are immobilized with respect to one another as by a suitable rod or pin 76 extending through aligned holes in the three members. A longitudinally expansible jack member 78 is interposed between the crosshead 74 and the adjacent end of the inner, compression member 12. The jack member 78 is then actuated to expand longitudinally, thus imposing compression upon the inner member 12 and tension upon the two outer members 14 and 16. The bonding agent 18 may then be injected into the space between the member 12 and the member 14 and the space between the member 12 and the member 16. (Alternatively, the bonding agent may have been applied to the appropriate surfaces of these members before the members are assembled.) Clamps 80 are then applied to the assembled composite rod at suitably spaced points throughout the length thereof and are tightened so that the members 12, 14, and 16 are pressed intimately against each other while the bonding agent hardens. After the bonding agent 18 has become properly hardened, the clamps 80 and the pin 76 may be removed. The pins 72 and the tensioning mechanism 70, 74, 78 may then be disconnected from the rod 10, which then is ready for use.

The pretensioned rod 30 illustrated in FIG. 4 comprises four tension members, 32, 34, 36, and 38 clustered around a square compression member 40, each bonded to one of the four sides of the core 40 by a suitable bonding agent

4

42. It will be noted that in this instance, the tension members are semi-circular in cross section and are provided on their outer surfaces with outwardly projecting protuberances 44. This form of the pretensioned rod may be made and used in the same manner as explained above with respect to the rods 10 and 10a illustrated in FIGS. 1 and 2, respectively.

The pretensioned rod 50 illustrated in FIG. 5 comprises a tubular tension member 52 within which a cylindrical compression member 54 is received and to which it is bonded throughout its length by a suitable bonding agent 56. As in the previous described forms of prestressing rod of the invention, suitable protuberances 58 are provided on the outer surface of the tension member 52 to strengthen the bond between the tension member and the concrete within which it is cast. The pretensioned rod 50 illustrated in FIG. 5 may be made and used in the same manner as the forms of prestressing rod previously described herein.

While several preferred embodiments of the present invention are described herein, it should be noted that various changes may be made therein without departing from the spirit of the invention as defined in the appended claims.

The invention having thus been described, what is claimed and desired to be protected by Letters Patent is:

1. A composite rod for applying compressive stress to concrete in which the rod is cast, comprising an elongate, thermally conductive element formed of a material having a high compressive strength, a concrete compressing element extending along said first named element and being formed of a material having a high modulus of elasticity, and a bonding agent bonding said elements together substantially along their entire length, said first named element being under compression and maintaining the concrete compressing element under tension while the elements are bonded together, said bonding agent being of a type that forms a bond which is substantially weakened by the application of heat to the compressed element for transferring the restoring force of said concrete compressing element from the compressed element to the concrete in which the rod is cast, said concrete compressing element being formed with external concrete gripping means.

2. A composite rod as set forth in claim 1 wherein said bonding agent is comprised of an adhesive resin.

3. A composite rod as set forth in claim 1 wherein said element under compression is formed of steel.

4. A composite rod as set forth in claim 1 wherein both said element under compression and said element in tension are comprised of steel.

5. A composite rod as set forth in claim 1 including means on said compressed element for inhibiting a bond between the compressed element and the concrete in which the rod is cast.

6. A composite rod for applying compressive stress to concrete in which the rod is cast, comprising an elongate, thermally conductive core element formed of a material having a high compressive strength, a pair of oppositely disposed concrete compressing elements extending along the length of said core element and being formed of a high tensile strength material having a high modulus of elasticity, and an adhesive bonding agent bonding said outer elements to said core element substantially along their entire lengths, said core element being under compression and said outer elements being under tension while said elements remain bonded together, said bonding agent producing a bond that is destructible by the application of a predetermined amount of heat thereto to transfer the restoring force of said outer elements to the concrete in which the rod is cast, said outer elements being formed with external concrete gripping means.

7. A composite rod for applying compressive stress to concrete in which the rod is cast, comprising an elongate, thermally conductive core element being formed of a

5

material having a high compressive strength, a tubular concrete compressing element surrounding said core element and being formed of a high tensile strength material having a high modulus of elasticity, and a bonding agent bonding said elements together substantially along their entire length, said core element being under compression and maintaining the tubular concrete compressing element under tension through said bonding agent, said bonding agent producing a bond of a type adapted to be substantially weakened by the application of a predetermined amount of heat thereto to transfer the restoring force of said concrete compressing element from said core to the concrete in which the rod is cast.

8. The method of prestressing a structural member of concrete or like material which comprises disposing in side-by-side relation a thermally conductive first member having a high compression strength and a second member having a high tensile strength, stressing said first and second members in compression and tension, respectively, adhesively uniting said members throughout their lengths while they are in said stressed conditions, embedding the assembled and adhesively united members within said concrete or like material and allowing the material to set to thereby permit said second member to become attached to said material, and, after said material has set, heating said first member to weaken the bond between said members and thereby releasing said second member from said first member so that the restoring force of the tensioned second member is transferred from the first member to said material.

9. The method of prestressing a concrete structural member which comprises disposing in side-by-side relation

6

and electrically conductive first elongate member having a high compression strength and a second elongate member having a high tensile strength, stressing said first and second elongate members in compression and tension, respectively, adhesively uniting said elongate members throughout their lengths while they are in said stressed conditions, embedding the assembled and bonded elongate members within concrete and allowing the concrete to set to permit said second member to become attached to the concrete, and, after the concrete has set, connecting said first member into an electric circuit to heat the same and weaken the bond between said elongate members and thereby to release said second elongate member from said first elongate member so that the restoring force of the tensioned second elongate member is transferred from said first elongate member to the concrete.

References Cited in the file of this patent

UNITED STATES PATENTS

20	1,599,873	Caldwell	Sept. 14, 1926
	1,684,663	Dill	Sept. 18, 1928
	2,303,394	Schorer	Dec. 1, 1942
	2,319,105	Billner	May 11, 1943
	2,360,925	Wyman	Oct. 24, 1944
25	2,414,011	Billner	Jan. 7, 1947
	2,674,115	Chalos	Apr. 6, 1954
	2,737,802	Bakker	Mar. 13, 1956
	2,963,273	Lane	Dec. 6, 1960
30	3,022,713	Friberg	Feb. 22, 1962

FOREIGN PATENTS

206,635	Austria	Dec. 10, 1959
---------	---------	---------------