April 6, 1954

M. CHALOS

FLEXIBLE PRETENSIONED REINFORCEMENT FOR PRESTRESSED STRUCTURES

2,674,115

Filed June 9, 1950

3 Sheets-Sheet 1

Fig.1.

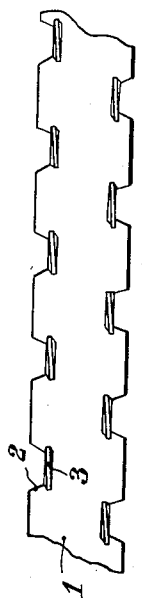


Fig.2.

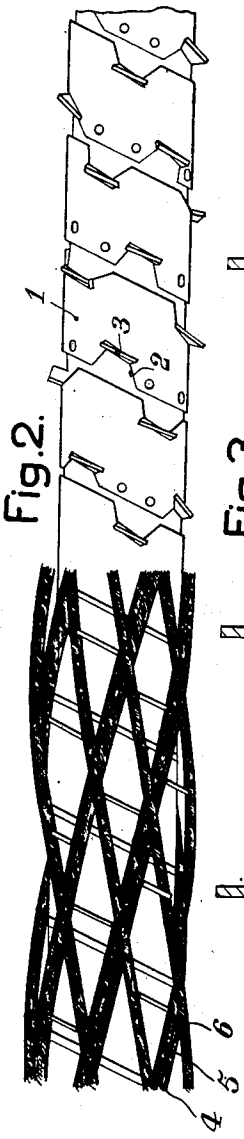
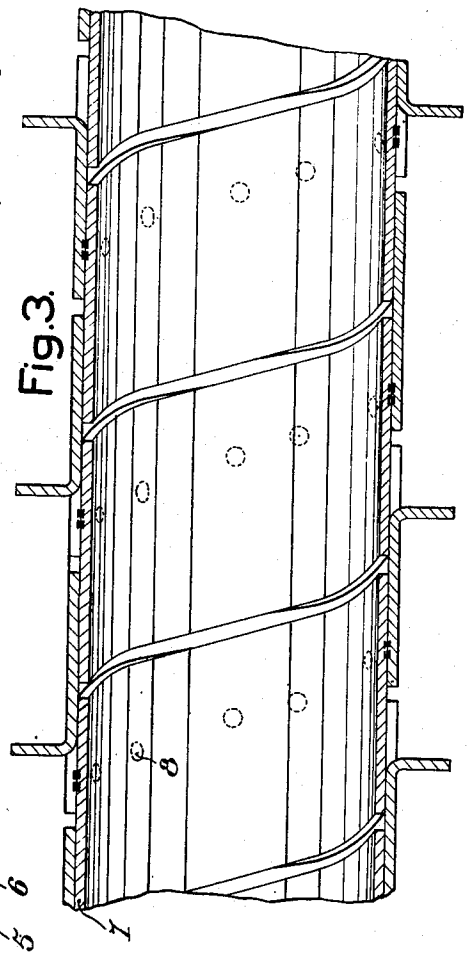


Fig.3.



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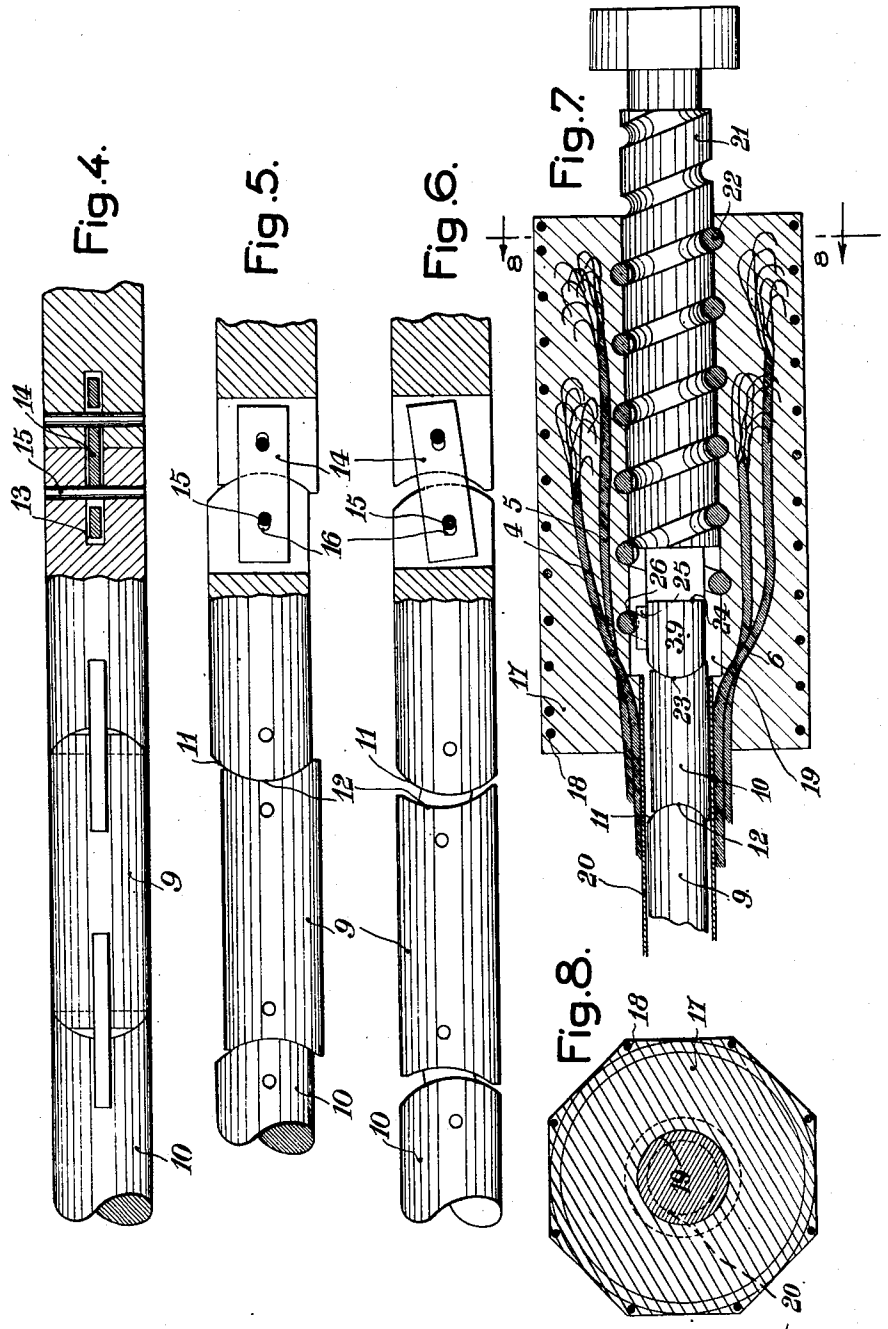

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Filed June 9, 1950 3 Sheets-Sheet 3

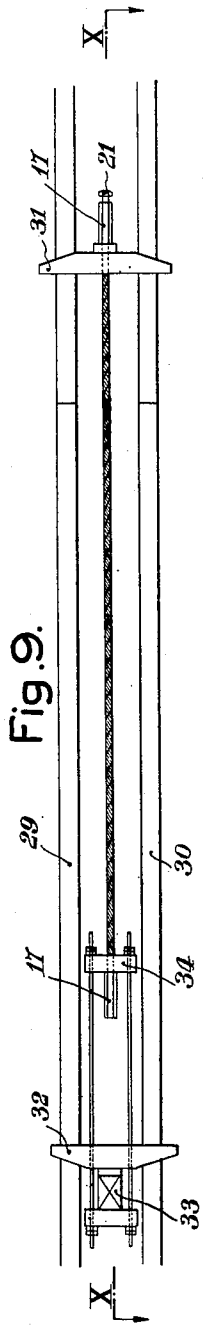

Fig. 9.

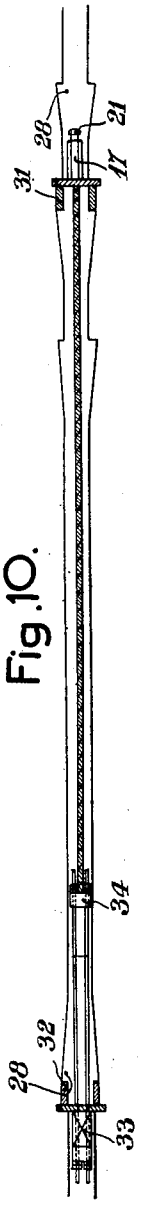

Fig. 10.

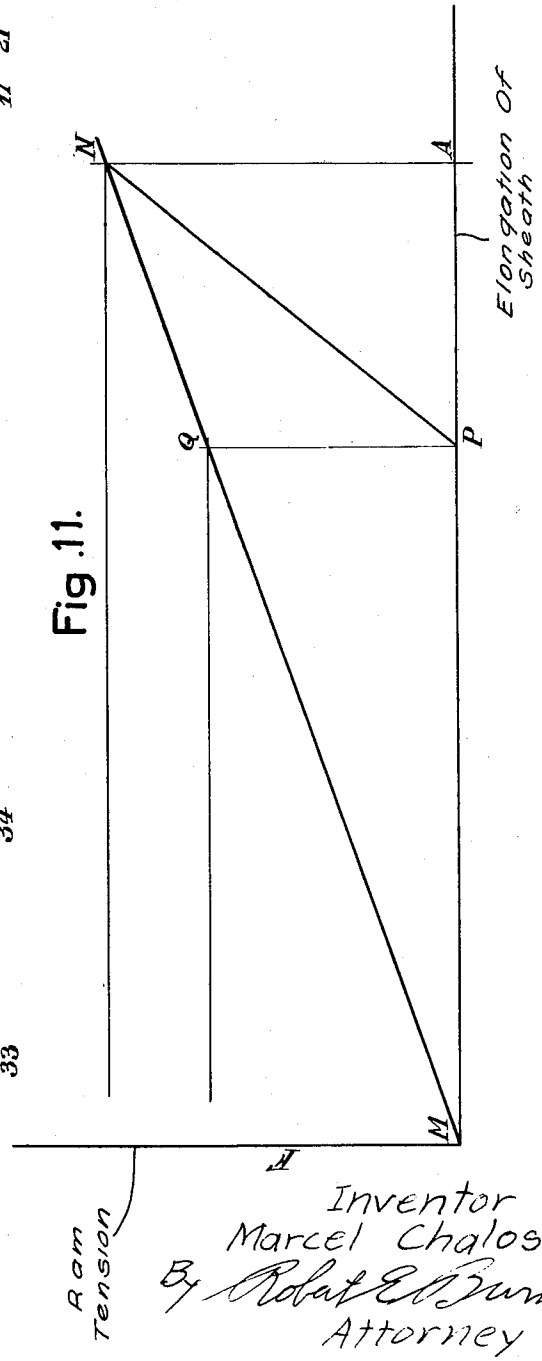

Fig. 11.

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2,674,115

UNITED STATES PATENT OFFICE

2,674,115

FLEXIBLE PRETENSIONED REINFORCEMENT FOR PRESTRESSED STRUCTURES

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Application June 9, 1950, Serial No. 167,148

Claims priority, application France June 23, 1949

2 Claims. (Cl. 72—50)

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Reinforcements are already known which are intended to remain embedded in the concrete with a view to pre-stress the same and which comprise a tensionally stressed part and a compressively stressed part; the latter is surrounded and supported by the former and can be disengaged from the same, with the result that once the concrete in which the outer part is embedded has hardened it is pre-stressed by the said tensionally stressed part.

In a Patent No. 2,449,276 issued September 14, 1948 to Marcel Chalos for: "Pretensioned Reinforcement" a reinforcement is described the outer portion of which consists of a fluid-tight sheath comprising small cables.

The present invention relates to a reinforcement of the kind just described of which the components are so improved that it can be used generally wherever a flexible reinforcement must be resorted to.

According to the present invention, the sheath consists of cables wound in helices about a tube; the said cables provide the effective portion of the sheath which is subjected to the tensional stresses imposed upon the reinforcement while the tube is subjected to the pressure exerted by the tensioned cables and protects the core from any contact with the concrete newly cast about the reinforcement.

The said cables are arranged in two layers in each of which the individual cables intersect those in the other layer; the number of cables is larger in the inner than in the outer layer in order to account for the difference in the distances to the axis; the pitch and the overall section in each layer of cables must satisfy the three following conditions:

(*a*) The moments of the tensional forces with respect to the longitudinal axis of the sheath must balance one another exactly.

(*b*) At the intersection of an outer cable portion with an inner cable portion those peripheral wires of both cable portions which contact each other should run in parallel directions to prevent the wires of one cable portion from being sheared by those of the registering cable portion.

(*c*) Where the reinforcement is intended to be reeled up in the stressed state the pitch of the outer layer must be so short that the curvature of any cable in said layer shall not change sign in the course of the reeling process.

The tube according to the invention consists of a pair of flexible sheet metal bands wound in overlapping helices; the outer band is formed with lugs spaced according to the pitch at which

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the cables are to be wound on the tube between these lugs. The latter may be formed by stamping and bending the band with a press.

The inner metal band is coiled into a tube just the same as the outer band and may be connected therewith, for example by spot welding; the turns of the metal band providing the inner tube are offset with respect to those providing the outer tube, for example an amount equal to half their pitch; the provision of such an inner tube contributes to the strength of the whole structure and to the sealing of the joints between the successive turns of the outer tube notably opposite the lugs.

The core constitutes the compressively stressed portion of the reinforcement; according to the invention, it is composed of cylindrical hardened-steel sections connected with and bearing on one another.

The surfaces of engagement between the sections are cylindrical sectors the axes of which are directed at right angles to the longitudinal axis of the reinforcement.

The said sections are smaller in diameter than the inner diameter of the inner tube in order that they can be pulled out easily once they have performed their pre-stressing duty.

With the reinforcement under stress and as a consequence of the manipulations to which the same is subjected (notably the successive reeling up and unreeling of the same) the sections comprising the core may be expected to crowd together in zizzag fashion in view of the play existing therebetween. In such circumstances the radial forces set up could only be resisted by the sheath at the cost of a deformation of the latter.

With a view to compensate the aforementioned effects of such a play, the centers of the cylindrical end bearing surfaces of the sections are offset in each successive section. Owing to this arrangement the reinforcement can be stretched to a practically straight structure.

According to the invention, the junction members consist of concrete blocks formed with an axial bore and having circumferential reinforcing hoops; the end of the sheath is inserted through the one end of said bore, the tube being sealed to the concrete and the cables embedded in the mass of the block. The other end of the bore is formed with an inner thread designed to cooperate with a steel screw adapted to resist the thrust exerted by the core.

In setting the reinforcement under stress a bench is used which is composed of a pair of

parallel beams provided with cleats capable of resisting the action of cross bars.

The empty sheath is mounted in position on the bench, the one of the blocks being rested on one of the cross bars and the other block being caught by an equalizer which is subjected to the action of a jack rested on the other cross bar. The sheath is then subjected progressively to a tensional stress amounting to about 1.4 times the rated value (for example 70 tons with a 50-ton reinforcement).

With the sheath thus tensioned, the core sections and the end piece are introduced into the tube and the screw is tightened as much as necessary to bring their end bearing surfaces into engagement with one another.

Thereafter the stress exerted by the jacks is released progressively.

The reinforcement thus stressed is then ready for use. For convenience in transport, it can be reeled or rolled up, bending in a plane at right angles to the axes of the cylindrical end bearing surfaces of the core sections being permitted by the slip that occurs at the joints between core sections and the play provided between the convolutions of the strips forming the tubes.

After the concrete cast about the reinforcement has set, the core can be pulled out of the tube and re-used.

A reinforcement according to this invention will now be described more specifically, reference being had to the appended drawings in which:

Figure 1 is a plan view of a sheet metal band providing a component part of the sheath.

Figures 2 and 3 are an elevation and a longitudinal section respectively of the sheath partly provided with the cables.

Figures 4, 5 and 6 are elevational views of a sectional chain providing the core, parts being shown in section.

Figures 7 and 8 are a longitudinal and a cross sectional view respectively of a junction member, Fig. 8 being taken approximately on the line 8—8 in Fig. 7.

Figures 9 and 10 illustrate the armature-stressing bench respectively in plan view and in vertical sectional view taken on line X—X in Fig. 9.

Figure 11 is an explanatory diagram of the stressing process.

The cylindrical tube providing the support of the cables and the shield of the core is composed of a pair of sheet metal bands coiled spirally about one another. The outer band (see Fig. 1) is made of flexible sheet metal in either margin of which a series of cuts 2 are punched which define lugs 3 which are bent up at right angles to the surface of the band and which keep the cables 4, 5, 6 in position once they have been coiled in spirals about the tube. The spacing of the said lugs and also the pitch of the band-metal spirals are dependent on the pitch of the cable spirals.

The inner band 7 is made of the same metal as and is equal in breadth with the outer band; it is coiled just like the latter, however, in such a manner that it will equally overlap the two abutting margins of any two successive turns of the same and bridge the notches left by the bent-up lugs. The two band metal coils are assembled by spot-welding as shown at 8 in Fig. 3, or by a continuous seam or in any other suitable manner.

In the example described and as shown in Fig. 2 a first layer of twin cables 4, 5 are coiled in right-handed spirals about the flexible tube thus constituted, about which a second layer of single cables are coiled in left-handed spirals.

The core of the reinforcement (see Figs. 4, 5, 6) consists of a chain composed of loosely assembled and alternatingly male and female cylindrical sections 9 and 10 which are smaller in diameter than the inner diameter of the tube. Said cylindrical sections are made of hardened steel and they are milled at their ends to provide cylindrical ball-and-socket joints 11, 12 the axes of which are directed at right angles to the longitudinal axis of the chain. It follows that the several sections are slidably movable with respect to one another at the joints therebetween while their longitudinal axes remain in one and the same plane at right angles to the axes of the cylindrical joint surfaces. Cut in the said plane at either end of each section is a slot 13 for the accommodation of the one end of a tie-plate 14; milled in either end of each tie-plate is an oblong hole 16 through which projects a connecting pin 15.

A play is thus provided in the linkage of the sectional chain whereby each element of the latter is enabled to assume an offset position with respect to the adjacent ones as shown in Fig. 5.

Effectively, in view of the clearance designedly provided between the chain of sections and the tube, the sections may well be expected to set themselves in zigzag fashion within the tube. It has been found in practice that with sections having a diameter of 42 mm. enclosed in a tube having a diameter of 43.5 mm. for use in a 50-ton reinforcement, with a 1.5 mm. clearance between the core and the tube, undulations may occur in the stressed reinforcement in the plane at right angles to the axes of the cylindrical section end joints amounting to 6–8 mm. and the period of which is twice the length of a section.

In order to decrease such a clearance in the tensioned reinforcement, the sections are set out of alignment with the longitudinal axis of the sheath owing to the play of the pins 15 within the oblong holes 16 and to the offsetting of the axes of the cylindrical end bearing surfaces 11, 12. In the example considered such a clearance is thus reduced to 0.5 mm.

The junction elements (see Figs. 7 and 8) consist of concrete blocks 17 of any desired shape which have circumferential reinforcements 18 and are provided with a central through bore 19.

Embedded in the concrete at the one end of the bore are the end 20 of the tube and the ends of the cables 4, 5, 6.

Through the opposite end of the block can be inserted a screw 21 the threads of which cooperate with a steel wire coil 22 partly embedded in the concrete.

The reinforcement is designed to be coiled in a plane at right angles to the axes of the cylindrical end surfaces of the sections.

This means that the said axes must be kept parallel. Now, in order to set the reinforcement under tension, it is necessary to tighten the screw 21 in the junction block 17 into engagement with the linked core 9, 10 in such a manner that they will engage one another at their end bearing surfaces at the same time as they will assume the positions assigned to them within the tube as a result of the particular clearance-decreasing arrangement described hereinbefore.

Interposed between the end of the screw and the last link in the chain of sections is a special

section 39 of which one end surface 23 is cylindrical while the other one 24 is flat. As the screw is tightened, a torque will consequently be applied about the longitudinal axis of the section that will tend to twist the whole chain of linked sections. Unless special precautions were taken to prevent such a twisting action the reinforcement once tensioned could only be coiled to a warped spiral, which consequence must be avoided.

With this end in view, the end section 39 is provided with a key 25 which is guided by grooves 26 in the steel wire thread, whereby any twisting action on the part of the said end section upon the core is prevented.

The reinforcement is tensioned on a bench composed of a pair of parallel beams 29, 30 provided with cleats 28 capable of resisting the forces transmitted thereto by cross bars 31, 32.

The empty sheath, namely, the tube with the cables helically wound thereon, is set in position on the bench, the one end block 17 resting on the one cross bar 31 while the other end block is caught by an equalizer 34 which is pulled by means of a jack 33 rested on the cross bar 32. The sheath is thus subjected to a tensional stress amounting to 1.4 times the rated tensional stress.

The variations in the sheath length, depending on the ram tension, are illustrated in Fig. 11 through the line MN.

While the sheath is under tension the chain 9, 10 is introduced and the bolt 21 screwed home into the block 17, and then the ram is progressively released. The line NP (Fig. 11) represents the variation in length of the reinforcement according to the invention with the tension applied by the ram 38, P being the zero point of this tension. The elongation MP of the sheath shows the stress value supported by the core, which is equal to PQ.

Thus, the sheath is put under tensional stress during the period of time corresponding to the line N—P. During the said period the respective lengths of the core and the sheath undergo no relative variation and no displacement occurs of the one relative to the other. It follows that no friction is created and that the tensional stress to which the sheath is subjected and which is equal to the ordinate P—Q is actually uniform over the entire length of the reinforcement.

Besides, the reinforecement thus stressed is flexible in a plane at right angles to the axes of the cylindrical end bearing surfaces of the sections and can be transported or shipped in a coiled state.

With the sheath thus held in tension by the core, it is embedded in concrete, e. g. in a concrete beam or column. After the concrete has set, the screw 21 is screwed out and the core is removed.

Of course, the cable-supporting tube may be designed, or the sections linked to one another, or the cables mounted, otherwise than in the manner described without thereby departing from the scope of the invention.

What I claim is:

1. Flexible pretensioned reinforcement for prestressed structures comprising a tensioned element consisting of a tube made of a pair of helically wound metal bands and a plurality of steel wire cables supported by said tube and wound therearound so as to form two helical layers of opposite direction, a compressed element consisting of a chain of contiguous cylindrical steel links the diameter of which is smaller than the inside diameter of said tube, the adjacent end surfaces of said links being alternately convex and concave, and a pair of junction members disposed at the ends of the reinforecement and consisting of internally screw-threaded concrete prisms in which the end portions of said cables are embedded, and bolts screwed into said prisms supporting the thrust of said compressed element, said bolts being adapted to be unscrewed to transfer the tension of the tensioned element to the structure to be prestressed.

2. Flexible pretensioned reinforcement for prestressed structures comprising a tensioned element consisting of a flexible tube made of a pair of helically wound metal bands, lugs being formed at spaced intervals along the external surface of the outermost of said metal bands, and a plurality of steel wires supported by said tube and wound therearound so as to form two helical layers of opposite direction, the pitches of said helical layers being a function of said lug spacing; a compressed element consisting of a chain of contiguous cylindrical steel links the diameter of which is slightly smaller than the inside diameter of said tube, said links having cylindrical end surfaces the axes of which are perpendicular to the tube axis, the two end surfaces of a same link being respectively concave and convex; and a pair of junction members disposed at the ends of the reinforcement and consisting of reinforced concrete prisms in which the end portions of said wires are embedded, said prisms being formed with an axial screw-threaded bore, a steel screw-bolt screwed into said prism and exerting on said compressed member a compression stress equal to the tension of said tensioned element, said bolt being adapted to be unscrewed to release said compressed element to transfer the tension of said tensioned element to the structure to be prestressed.

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