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DRAWINGS ATTACHED

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(54) IMPROVEMENTS IN REINFORCEMENTS FOR PRE-STRESSED CONCRETE PIPES, AND THE LIKE, AND METHOD AND APPARATUS FOR THE INTERCONNECTION AND MANUFACTURE OF THE REINFORCEMENTS

- (71) We, NIPPON CONCRETE INDUSTRIES Co., LTD., a Japanese Corporate Body, of No. 8-3, 1-chome, Shinbashi, Minato-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- The present invention relates to reinforcements for prestressed concrete pipes, and the like, and method of interconnecting the reinforcements and apparatus for the manufacture thereof.
- In the production of prestressed pipes, prestressed poles and the like, by a so-called independent moulding frame method, a set of parts for making up the interconnected product, including tension and non-tension reinforcements, are collected in the reinforcement assembly factory for manufacturing a cylindrical concrete-reinforcing cage by assembling these parts together by a hand-rolling operation or by an electric welding operation. The cage is then transported to the concrete-applying factory, in a condition which prevents deformation of the cage, where metal fittings are anchored to both ends of the tension reinforcements for stressing them to the required tension, the cage being inserted within the moulding frame in which the concrete is subsequently placed.
- In the reinforcements interconnected by such a conventional method, tension reinforcements are secured to non-tension arranged reinforcements (e.g. vertical or longitudinal reinforcements, spiral or transverse reinforcements, ring reinforcements, or the like) by binding or welding. Thus, respective parts of the tension reinforcements are assembled not in a free state but a bound and coupled state, and this results in certain disadvantages as will be described below:
- (1) In the method of hand-rolling operation, many steps are required for

- binding or connecting the reinforcements.
- (2) Since the tension reinforcements are directly connected or welded, it is difficult to retain the tension reinforcements linearly and finish them in a desired precise shape. 50
- (3) In order to retain the tension reinforcements in a precise shape and facilitate the transportation thereof, various kinds of prefabricated reinforcements, such as ring reinforcements and spacers are required. 55
- (4) In the case of welding the tension reinforcements, there is a danger of deterioration in the strength of the welded portions. 60
- An object of the present invention is to eliminate the aforementioned disadvantages of the conventional method of interconnecting the reinforcements. 65
- According to this invention, reinforcements for prestressed pipes, poles, and the like, have a cage-shaped body comprising non-tension reinforcements extending generally longitudinally and generally transversely of the cage-shaped body, metal end fittings located at both ends of said cage-shaped body for movement longitudinally thereof, and a plurality of tension reinforcements having both ends connected to and supported by the metal end fitting so that the tension reinforcements are freely supported in the cage-shaped body, whereby tensile force can be imparted only to the tension reinforcements by moving said metal end fittings relative to one another so as to increase the distance therebetween. 70
- The invention also includes a method and apparatus for producing the reinforcements as will become apparent from the following description and appended claims. 75
- In the present invention, a cage body may be formed in advance merely by non-tension reinforcements, and said cage may be constituted generally by the combination of a 80
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coil or helix shaped spiral reinforcement with a few vertical or longitudinal reinforcements. The components of said cage are preferably of mild steel so that processing by welding can be easily carried out. Hence, the steps required for binding the reinforcements are no longer necessary. The cage body need not necessarily be formed by the combination of the coil or helix shaped horizontal reinforcement with the vertical reinforcements, but may be formed by the combination of a number of ring-shaped horizontal reinforcements with vertical reinforcements.

In the present invention, each tension reinforcement which will be prestressed later on is merely hooked so as to be supported on the metal end fittings located at the ends of the cage irrespective of the other non-tension reinforcements which merely retain the cage shape, and therefore each tension reinforcement is free along its entire part. Accordingly, precise position and dimension of the shape are ensured without being restricted by other members.

When the method of the present invention is employed, the operational efficiency in the interconnecting method is remarkably improved and therefore manpower and period of production time are substantially reduced.

With the present invention, the time taken to interconnect the reinforcements is considerably reduced and as a result it is possible to carry out the interconnecting operations in assembly-line production during the complete production method, including the placement of the concrete. This is an advantage since the entire method can be carried out in the assembly-line production.

The invention is further described with reference to the accompanying drawings which illustrate several embodiments by way of example and in which:

Figs. 1(A) to (I) are a series of views illustrating certain steps in the interconnecting method with apparatus according to one embodiment of the invention;

Figs. 2(A) and (B) are respectively an end view and a perspective view of the completed interconnected reinforcement;

Figs. 3 and 4 are respectively a perspective view and an end view of a part of apparatus used in this embodiment;

Figs. 5 and 6 are respectively a front view and a sectional end view, drawn to an enlarged scale, of apparatus for carrying out the interconnecting method according to a second embodiment of the invention;

Figs. 7, 8 and 9 are three side views showing certain steps in the interconnecting method with an apparatus according to a third embodiment of the invention;

Fig. 10 is a part of the apparatus of Figs. 7, 8 and 9;

Figs. 11(A) to (F) and Figs. 12(A) and (B)

are fragmentary views for explaining the interconnecting method with an apparatus according to a fourth embodiment of the invention;

Fig. 11(G) is a further modification,

Figs. 13(A) and (B) are respectively a side view and an end view showing the main parts of apparatus according to the first embodiment of the invention; and

Figs. 14(A) to (E) are respectively a side view and an end view showing apparatus according to the second embodiment, two end views and a fragmentary view drawn to an enlarged scale, showing a main part of the apparatus.

Referring to the drawings, Figs. 1(A) to (I) indicate a series of steps in the interconnecting method with the first embodiment. Fig. 1(A) illustrates the step of interconnecting a central cage, in which a spiral reinforcement 1 is formed into a coil or helix shape by way of a spiral-forming and welding device A and is extruded in a state where portions of the helix in contact with an interconnected longitudinally extending reinforcement 2 are welded together and cut to required length by means of a cutter B to form a cage C which constitutes the central portion. Fig. 1(B) illustrates the forming of a cage end E having an outer diameter slightly larger than that of the cage C and convolutions at a smaller pitch. Fig. 1(C) illustrates a cage-assembling step in which cage ends E and E are arranged one at each end of the central cage C. Fig. 1(D) illustrates a step in the mounting of metal end fittings, in which the cage ends E and E are respectively outwardly telescoped over both ends of the cage C arranged on a base and supported by metal end fittings T mounted on the base. Fig. 1(E) illustrates a tension reinforcement-inserting step in which tension reinforcements 3 having a hooking portion at their left hand ends are inserted from the left side through corresponding holes formed in the periphery of the end fitting T around a pitch circle having a diameter equal to that of the cage at the end fittings T. Accordingly, each tension reinforcement 3 is merely supported at both its ends by the holes formed in the end fittings T and the central portion of the tension reinforcement 3 is in a completely free state within the central cage C and extending between the cage ends E. In the tension-reinforcement inserting step it is convenient to use a guide base G (Figs. 3 and 4) for guiding the tension reinforcements 3 in the cage, as will be later described, so as to prevent the advancing ends of the tension reinforcements 3 from coming into contact with the helical reinforcement 1 and intermingling with each other. Fig. 1(F) illustrates the state of completing the insertion of the tension reinforcement. Fig. 1(G) illustrates an upsetting step, in which an anchoring or

hooking portion, such as a rivet head, or the like, is formed at the right hand ends of the tension reinforcements 3 by means of an upsetter U. Fig. 1(H) illustrates the completed state. Fig. 1(I) illustrates a tensioning step, in which the end fittings T and T at both ends of the cage are pulled in opposite directions and each tension reinforcement 3 is maintained at a state where rivet heads at both of its ends come into contact with the outsides of the end fittings T at the respective insertion holes. At this stage, the outwardly fitted cage ends E and E double into the central cage C and assume a state where the major part thereof is pulled out. It is to be noted that, while tension is being exerted on the tension reinforcement rods 3, in a manner similar to that of the conventional method, they are located within a circular frame wherein concrete is placed.

Figs. 2(A) and (B) show a detailed structure of the reinforcements produced by the steps described above.

Figs. 3 and 4 show the guide base G used in the step of inserting the tension reinforcements in Fig. 1(E) and, when cages C and E are placed thereon, the spiral or helical reinforcement 1 is positioned between spaced apart transverse frames 4 having a pitch equivalent to that of the helical reinforcement 1, the cages C and E being supported in the axial direction by the interconnected reinforcement 2. Accordingly, the central portion of the transverse frame 4 is located inside the cages C and E, and therefore when each tension reinforcement 3 is passed through the upper side of a transverse frame 4 in the central portion of guide members 5 and 5, the tension reinforcement 3 can pass without colliding with the helical reinforcement 1. When the second tension reinforcement 3' is passed, there is a possibility of it becoming entangled with the first tension reinforcement 3. In order to prevent this from occurring, it is preferable to provide a suitable number of devices at suitable positions on the guide base G. Each device comprises a pivotal pawl 8 which is constantly maintained outwardly opened by means of a spring and mounted at both ends of a fork 7 vertically movable by means of a piston operating in a cylinder 6. Before the second tension reinforcement 3' is inserted, the fork 7 is lifted by introducing a fluid, such as air, into the cylinder 6. Thus, the first tension reinforcement 3 is raised by means of the fork 7 so that when the second tension reinforcement 3' is passed through the side of a supporting rod at the lower part of the fork 7, the entanglement of both reinforcements is prevented because the second reinforcement 3' is separated from the first tension reinforcement 3. Then, when the fork 7 is lowered, the second tension reinforcement 3'

slides on the outer side of the fork 7 and positions itself at the upper part thereof. When the fork 7 is lifted again at this state, the second tension reinforcement 3' is placed at the inner part of the fork 7 by the pawl 8 and therefore assumes the same state as the first tension reinforcement 3. In this manner, it is possible to pass the required number of reinforcements 3 while preventing mutual entanglement thereof. When the end fittings T and T at both ends are rotated, the tension reinforcement 3 already inserted also rotates, and hence by repeating the similar tension reinforcement passing operation at the rotated state, the required number of the tension reinforcements can be passed without entanglement with each other.

Figs. 5 and 6 show an interconnecting step with apparatus according to the second embodiment of the present invention. In the method of the first embodiment, non-tension and helical reinforcements are combined to form a reinforced cage, and thereafter the tension reinforcements are inserted into the inner part thereof. Since this necessitates two stage steps, it is difficult to automate these steps, and particularly in the production of a concrete pole of small diameter there is a drawback that the subsequent insertion of the tension reinforcement is difficult. In the apparatus of Figs. 5 and 6, a tension reinforcement is introduced simultaneously with the arrangement of a reinforced cage comprising vertical or longitudinal and spiral or helical reinforcements. Namely, in the second embodiment illustrated in Figs. 5 and 6, the tension reinforcements are inserted into the inner part of the reinforced cage so that the tension reinforcements may be stressed to a required tension by locating metal end fittings T at both ends of said reinforced cage in a longitudinally movable manner and anchoring the respective ends of each tension reinforcement to said metal end fittings in the same manner as in the first embodiment. Referring now to Figs. 5 and 6, reference numeral 1 designates the helical reinforcement, 2 the non-tension vertical or longitudinal reinforcement, and 3 the tension reinforcement. Reference numeral 9 designates a base for supplying steel wire for the tension reinforcement 3 and non-tension longitudinal reinforcement 2, which base 9 is provided with a roller 10 or the like at its upper surface. Reference numeral 11 designates a bobbin for the helical reinforcement 1, which bobbin rotates about a central axis and has on both sides plates provided with gears. One side of the bobbin 11 is provided with an electric welding apparatus 12 and in its hollow portion there is inserted welding apparatus 12 and in its hollow portion there is inserted and secured a steel wire guiding device (not shown). Reference numeral 13 designates an electric motor

which rotates the bobbin 11, for use in forming the helical reinforcement, through a speed reduction mechanism 14 and gears 15. Reference numeral 16 designates a slidable base, 17 a traction device which travels on rails (not shown) of said slidable base 16. Mounted on said device 17 is a disc 18 for fitting reinforcing materials. In the centre of said disc 18 there is mounted a chuck 19 which secures the ends of the tension reinforcements 3 and around the peripheral portion of the disc 18 there are mounted a required number of chucks 20 which secure the non-tension vertical or longitudinal reinforcement 2. The disc 18 also carries a chuck 21 which secures the forward end of the helical reinforcement 1. Reference numeral 22 indicates rollers for supporting the reinforced cages.

The tension reinforcement 3 and the non-tension longitudinal reinforcement 2 are selectively divided in a steel wire guide device (not shown) in the hollow inner part of the bobbin 11, by means of the roller 10 or the like for supplying the steel wire and thereafter the tension reinforcement 3 is collected and retained at its end by the chuck 19 in the centre of the disc 18 of the traction device 17, whilst the non-tension longitudinal reinforcement 2 is retained by the chuck 20 of said disc 18 and the helical reinforcement 1 by the chuck 21 at their ends, respectively.

Then, when the motor 13 is operating, the bobbin 11 for the helical reinforcement rotates at a low speed, through the reduction mechanism 14 and gears 15, and supplies the helical reinforcement 1. The motor 13 rotating the bobbin 11 also causes the traction device 17 to move, in the direction indicated by the arrow, at a speed relative to the rotational speed of the bobbin by means of a wire rope, or the like, whereby the helical reinforcement 1 is wound relative to the non-tension longitudinal reinforcement 2 in a helical shape as shown in the drawings, and is welded at a series of points to the non-tension reinforcement 2 by means of the electric welding device 12 which operates intermittently to form the reinforced cage.

Figs. 7, 8, 9 and 10 show cage-forming steps with apparatus according to the third embodiment of the present invention. In the second embodiment, the non-tension longitudinal reinforcement is shifted in the axial direction without any rotation, and the bobbin for the helical reinforcement and the electric welding device are rotated outside the bobbin. The apparatus of the third embodiment is not so complicated and provides a simpler method in which the non-tension reinforcement 2 as well as the tension reinforcement 3 are shifted in the axial direction while rotating, and the bobbin for the helical reinforcement and the electric welding device are not rotated.

Referring to Figs. 7 to 10, reference numeral 1 designates a helical reinforcement, 2 a non-tension vertical or longitudinal reinforcement (hereinafter referred to as vertical reinforcement), and 3 a tension reinforcement. Reference numeral 24 designates a bobbin for a vertical reinforcement 2, 25 a coil for the helical reinforcement 1, 26 a rotary plate, 27 feed rollers for a vertical reinforcement 2, 28 a straightening roller, 29 a motor for driving the feed roller 27, 30 a brush, 31 an oil-pressure chuck for the tension reinforcement 3, 32 an electrode holder, 33 a traction device, 34 and 34' metal end fittings, 35 supporting rollers, 36 a plate for drawing the tension reinforcement 3, and 37 (Fig. 9) an upsetter. Also, reference E denotes cages of smaller pitch at both ends of cage C which is of larger pitch and forms the central portion.

Each tension reinforcement 3 is provided with a hook portion at one end *a* (Fig. 7) and its other end is secured to the rotary plate 26 by the chuck 31, the reinforcement passing through the hole in the metal end fitting 34 rotatably mounted on the traction device 33. The cages E of smaller pitch for fitting to both ends of the central cage C are formed in advance and one cage E is inserted over the reinforced bars *b* on the metal end fitting 34, said tension reinforcement 3 being inserted in the inner part of the cage. When the traction device 33 is initially shifted to the left at this stage, the tension reinforcement 3 is initially stretched between the metal end fitting 34 and the rotary plate 26. Then, while the vertical reinforcement 2 of the bobbin 24 is extruded by the feed rollers 27 driven by the motor 29, the rotary plate 26 and the end fitting 34 are rotated in synchronism with each other by means of a motor 38. In this case, while the vertical reinforcement 2 is extruded at one pitch, the rotary plate 26 and the parts it carries make one revolution. At this stage, as the helical reinforcement 1 is pulled out of the coil 25, it is wound about the outside of the vertical reinforcement 2 and successively welded at the points of intersection. A series of cages C each having a required pitch can be formed one after the other as shown in Fig. 8. Any tendency for the cages C to twist is prevented by the rotatable rollers 35 driven by a motor 39 and which serve as straightening rollers.

When the central cages C are completed, the vertical or longitudinal reinforcement 2 and the helical reinforcement 1 are cut at the right hand end thereof so as to separate this end of the tension reinforcement 3 from the oil-pressure chuck 31 and the cage end E at the right hand end is engaged by the metal end fitting 34' also at the right hand end. Also, the metal end fitting 34 at the left hand end is disengaged from the traction device 33. At this stage, as shown in Fig. 9, both metal

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end fittings 34 and 34' are rotated, and the right hand end of the tension reinforcement 3 is gradually heated and compressed by means of the upsetter 37 to form a hooked or head portion at the leading end *a*.

Figs. 11(A) to (F) and Figs. 12(A) and (B) show interconnecting steps with apparatus according to the fourth embodiment of the invention. This example particularly shows steps in the formation of a cage-shaped body suitable for reinforcing a concrete pole. In this case, the tension reinforcements are inserted into the inner part of the cage-shaped body and both ends of the tension reinforcements are anchored to metal end fittings, so that the tension reinforcements may be stressed to a required tension after setting all these members inside the moulding frame in which the concrete is subsequently placed. Fig. 11(A) shows a step for cutting the tension reinforcement to a predetermined length. The tension reinforcement wire 42 is drawn from a coil 41 and passes through a straightening device 43, so as to become linear, and is cut to the predetermined length by means of a cutter 44 whereby the tension reinforcements 3 of predetermined length are obtained as shown in Fig. 11(B) and placed in the reinforcement storage shop. In the tension-reinforcement setting step shown in Fig. 11(C), a required number (fourteen pieces in this case) of tension reinforcements 3 are drawn from storage and one end of each is heated and compressed by an upsetter 46 to be shaped into a rivet head form and hooked to a hooking member in the form of a tension-applying plate 47, the opposite end of each reinforcement 3 being retained by another hooking member in the form of a clamp 48 which is smaller than the plate 47 so that the reinforcements assume a frusto-conical shape.

In the initial step for effecting the interconnection, as shown in Fig. 11(D), the tension plate 47 is secured to a supporting base 49 and the clamp 48 is supported by a fitting base 50, and a restrictor ring 52, which may be in two parts, is provided whereby the major parts of the tension reinforcements 3 are squeezed relatively to one another so that they become parallel with the portions in the clamp 48. At said parallel portions, a traction device 53 provided with a squeezing roller 51 for the vertical or longitudinal reinforcements (non-tension reinforcements) is provided. Said traction device 53 may also be made in two separable parts as shown in Fig. 11(G), and said tension reinforcements 3 are easily located by positioning them between the two separable portions of the traction device. Reference numeral 54 designates a vertical or longitudinal reinforcement guide device and its detailed structure is indicated in Figs. 12(A) and (B).

In the second step for preparing the interconnection shown in Fig. 11(E), when one end of each vertical reinforcement (non-tensioned reinforcement) 2 is secured to the traction device 53, the latter is shifted to the right hand end.

In the interconnecting step shown in Fig. 11(F), the traction device 53 travels to the left while pulling the vertical or longitudinal reinforcements 2 and, as illustrated in Fig. 12A, the vertical reinforcement guide device 54 travels to the right due to its interlocking connection with the motion of traction device 53 and the outer diameter of the bundle of vertical reinforcements 2 is gradually reduced and shaped into a frusto-conical form, and while electrodes (not shown) are guided by said device 54 in the same manner, interlock with said motion and travel around the axis to weld the helical reinforcement 1 and vertical or longitudinal reinforcements 2 at predetermined portions. Thus, the reinforced cage having a predetermined length and taper is formed. Since the tension reinforcement 3 set by the tension plate 47 and clamp 48 is inserted in the inner part of the cone-shaped reinforced cage, formed at this stage, it is possible to move the cage to where the subsequent concrete-pouring step is performed and, in the case of a concrete pole, it is possible to increase considerably the operational efficiency by carrying out the interconnecting steps in the fabrication of the reinforced cage as a series of assembly-line operations.

An example of a vertical or longitudinal reinforcement guide device and welding apparatus will be explained with reference to Figs. 12(A) and (B). Reference numeral 61 designates a screw to one end of which is fixed a sprocket wheel 62 which is rotated by means of a driving chain 63. A bearing 64 is mounted on part of the screw 61, and the screw 61 is supported by the bearing 64, in a freely rotatable manner, against a stationary guide plate 65. The plate 65 is provided with a number of radial slots *d*, and taper plates 66, inserted in said radial slots in a freely slidable manner, are respectively secured to guide nuts 67 fitted on the screws 61. Reference numeral 68 designates electrode receivers which are inserted into the radial slots *d* of the stationary guide plates 65 in a freely slidable manner and each receiver has a tapered inner surface *e* in contact with the outer surface of the taper plate 66 and a protruberant angle *f* engaged with the stationary guide plate 65. Reference numeral 69 designates electrodes.

In this construction, when the vertical or longitudinal reinforcement 2 is shifted to the left by the traction device 53 and the chain 63 is driven in interlocking association therewith as has been previously described, the electrode receiver 68 accompanied by the

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reinforcement 2 moves radially inwardly in accordance with the rotation of the sprocket wheel 62 and also in the axial direction in accordance with the movement of the guide nuts 67 driven on the screw 61 with the taper plate 66. The electrode receiver 68 moves radially in the central direction with the reinforcement 2 and with the electrode 69. As the reel of spiral or helical reinforcement 1 gradually moves intermittently around the axis by a mechanism (not shown) the spiral or helical reinforcement 1 is gradually welded with the vertical or longitudinal reinforcement 2 at the desired outer diameter positions, whereby conically shaped reinforced cages of required taper are automatically fabricated and, at the same time, tension reinforcements 3 can be inserted thereinto.

Figs. 13(A) and (B) show an example of a device, for continuously supplying vertical or longitudinal reinforcements, forming component parts of the first embodiment of the present invention. In Figs. 13(A) and (B), reference numeral 1 designates a helical transverse reinforcement, and 2 a vertical or longitudinal reinforcement. By arranging both reinforcements, reinforced cages are formed. A main body 83 is rotated through a speed reduction machine 82 driven by a motor 81 and a gear mechanism. The front part *a* of the main body 83 is supported by a machine body 84. Several gears 85 which engage with gears *b* in the machine body 84 are supported by a protruberant portion of the main body 83 in a freely rotatable manner. A worm 86 which is coaxial with each gear 85 engages with a worm wheel 87. Three sets of rolls 88 are driven and rotated by each worm wheel 87. There are three bobbins 89 for the vertical or longitudinal reinforcement and these parts are mounted on the main body 83. Reference numeral 90 designates a welding electrode which is mounted on the machine body 84, and 91 indicates one of the rollers for supporting the fabricated reinforced cage.

In the aforementioned structure, when the motor 81 is rotated, the main body 83 rotates together with the attached equipments, and simultaneously the three sets of rolls 88 are each rotated and driven through gear 85, worm 86 and worm wheel 87, whereby the vertical or longitudinal reinforcement 2 is fed at a linear speed adapted to suit the pitch of the helical transverse reinforcement 1. The fed vertical or longitudinal reinforcement 2 travels to the left through feeding holes *d* in the main body 83, and comes into contact gradually with the helical transverse reinforcement 1 directly below the electrode 90, where the reinforcements are welded and fabricated to a cage-like shape. The completed reinforced cage is pushed so as to travel to the left by the vertical or

longitudinal reinforcement 2 as it is supplied while rotating upon the support rollers 91, the reinforcement being cut to required length.

Figs. 14(A), (B), (C), (D) and (E) indicate an example of a device for continuously supplying the vertical or longitudinal reinforcement in the second embodiment of the present invention, i.e. an arrangement where the tension reinforcement 3 is inserted simultaneously with the fabrication of the reinforced cage. In these figures, reference numeral 101 indicates a speed reduction mechanism which is driven by a motor (not shown) and which rotates a rotary cylinder 102 at low speed. A suitable number of bobbins 103 for use in feeding vertical or longitudinal reinforcements 2 are arranged in parallel with each other on said rotary cylinder 102. At the forward end of the cylinder 102 there is mounted a straightening roller mechanism consisting of freely rotatable stationary rollers 104 and 104', a shifting roller 104' and an adjusting screw 105, all the rollers being arranged in parallel. Reference numeral 106 designates a rotary disc secured to the forward end of the rotary cylinder 102, a hole *a* for entry of each vertical or longitudinal reinforcement 2 being formed in the rotary disc 106. Reference numeral 107 designates a frame housing in which the rotary disc 106 is mounted in a freely rotatable manner, and 108 a rotary cylinder to which an electrode receiver 109 is fitted. Reference numeral 110 designates a chuck which snaps over the vertical or longitudinal reinforcement 2 and is driven in by an adjustable screw 112 attached to a disc 111. Said disc 111 is axially supported on a slidable base 113 in a freely rotatable manner. Reference numeral 114 designates a motor, the rotation of which moves push electrode 118 which welds the helical transverse reinforcement 1 to the vertical or longitudinal reinforcement 2, the slidable base 113 and the disc 111 through a speed reduction mechanism 115, a clutch 116 and a pulley 117. Reference numeral 119 designates a bobbin for the transverse reinforcement material which supplies the helical transverse reinforcement 1, said bobbin being axially supported on a supporting base 120. Reference numeral 121 designates a frame on which the slidable base 113 is mounted in a freely slidable manner.

In the aforementioned arrangement, the vertical or longitudinal reinforcement 2 is drawn out of the bobbins 103 and passes through a space formed between the stationary rollers 104 of the straightening mechanism and the shifting rollers 104' thereof. The reinforcement 2 then passes through the bores in the rotary disc 106, to extend alongside the electrode receiver 109 fitted to the rotary cylinder 108,

and is finally snapped to the chuck 110 attached to the disc 111. Then, the material for the helical transverse reinforcement 1 is drawn out of a bobbin 119 and has one end secured to the vertical reinforcement 2 by spot welding or the like. When the speed reduction mechanism 101 is driven by means of a motor (not shown) the cylinder 102 is rotated, and simultaneously the motor 114 is put into operation and shifts the slidable base 113 to the left, by means of a rack and pinion mechanism or an endless chain mechanism, or the like, through the speed reduction mechanism 115, clutch 116 and pulley 117, and the same rotational speed as that of the rotary cylinder 102 is imparted to the disc 111 by means of a chain and sprocket mechanism. Also, the rotation caused by the pulley 117 overlaps the push electrode 118 on the electrode receiver 109 such that the vertical reinforcement 2 and the helical transverse reinforcement 1 are overlapped between both electrodes 118 and 109 to be gradually welded together. In this manner, the vertical reinforcement 2 is drawn on the slidable base 113 so that, while the helical transverse reinforcement 1 is being gradually welded to the vertical reinforcements 2, reinforced cages are fabricated and when they reach a required length, both reinforcements 1 and 2 are cut off from their respective supply bobbins. Then, by switching the lever of the clutch 116, the pulley 117 is caused to rotate in the reverse direction so as to shift the slidable base 113 to the right. Upon this occasion, it is possible to shift said base 113 to the right at a speed greater than that of the shift to the left in the cage fabrication step, by operation of the lever of the speed reduction mechanism 115. It is also possible to vary the pitch of the convolutions of the reinforced cage by varying the shifting speed of the base 113 in the cage-fabrication step by means of the switchover of said lever.

The automatic insertion device for the tension reinforcement 3 in the aforementioned example will now be described. An end fitting plate 123 for the tension reinforcement 3 is mounted centrally within the disc 111 in a freely detachable manner. The outer periphery of this plate 123 has a suitable number of recessed portions *b* (Fig. 14(E)) for insertion of the tension reinforcements 3. Also, the outside of the plate 123 is provided with a binding device 124, such as a band or the like. The end of the rotary cylinder opposite to said disc 111 is provided with a supporting plate 125 which is substantially similar to that of said end fitting plate 123 and which is also freely detachable. Said supporting plate 125 is also provided with the clamping device 126. Said rotary cylinder 102 is hollow as far as its forward

end and the tension reinforcement 3 is inserted from the right hand end.

In the aforementioned arrangement, at the initial stage of the reinforced cage-fabricating operation, the tension reinforcement 3 of predetermined length is inserted in a space which exists at a stage where the disc 111 and the rotary cylinder 108 approximate with each other, and the end portion of the reinforcement 3, loosely supported on the supporting plate 125 by the clamping device 126, is secured to the end fitting plate 123 by the clamping device 124. At this stage, the reinforced cage-fabricating operation is carried out as previously described in the foregoing. With this arrangement, reinforced cages are fabricated at the outside and simultaneously the tension reinforcement 3 can be automatically inserted into the already fabricated reinforced cage.

WHAT WE CLAIM IS:—

1. Reinforcements for prestressed concrete pipes, poles, and the like, having a cage-shaped body comprising non-tension reinforcements extending generally longitudinally and generally transversely of the cage-shaped body, metal end fittings located at both ends of said cage-shaped body for movement longitudinally thereof, and a plurality of tension reinforcements having both ends connected to and supported by the metal end fittings so that the tension reinforcements are freely supported in the cage-shaped body, whereby tensile force can be imparted only to the tension reinforcements by moving said metal end fittings relative to one another so as to increase the distance therebetween.

2. A method of fabricating reinforcements as claimed in claim 1, which comprises the steps of arranging and interconnecting said generally longitudinally and transversely extending non-tension reinforcements so as to form said cage-shaped body, locating said metal end fittings one at each end of said cage-shaped body, passing into the cage-shaped body a required number of said tension reinforcements, simultaneously or one by one, with each end of said passed tension reinforcements inserted into aligned holes formed in the respective metal end fittings, anchoring or hooking the ends of the tension reinforcements to said metal end fittings, and then pulling both metal end fittings in opposite directions so as to put these reinforcements under the required tension.

3. A method as claimed in claim 2, in which the tension reinforcements are fed into the cage-shaped body during the course of its fabrication by the non-tension reinforcements.

4. Apparatus for fabricating reinforcements as claimed in claim 1, comprising a



and is finally snapped to the chuck 110 attached to the disc 111. Then, the material for the helical transverse reinforcement 1 is drawn out of a bobbin 119 and has one end secured to the vertical reinforcement 2 by spot welding or the like. When the speed reduction mechanism 101 is driven by means of a motor (not shown) the cylinder 102 is rotated, and simultaneously the motor 114 is put into operation and shifts the slidable base 113 to the left, by means of a rack and pinion mechanism or an endless chain mechanism, or the like, through the speed reduction mechanism 115, clutch 116 and pulley 117, and the same rotational speed as that of the rotary cylinder 102 is imparted to the disc 111 by means of a chain and sprocket mechanism. Also, the rotation caused by the pulley 117 overlaps the push electrode 118 on the electrode receiver 109 such that the vertical reinforcement 2 and the helical transverse reinforcement 1 are overlapped between both electrodes 118 and 109 to be gradually welded together. In this manner, the vertical reinforcement 2 is drawn on the slidable base 113 so that, while the helical transverse reinforcement 1 is being gradually welded to the vertical reinforcements 2, reinforced cages are fabricated and when they reach a required length, both reinforcements 1 and 2 are cut off from their respective supply bobbins. Then, by switching the lever of the clutch 116, the pulley 117 is caused to rotate in the reverse direction so as to shift the slidable base 113 to the right. Upon this occasion, it is possible to shift said base 113 to the right at a speed greater than that of the shift to the left in the cage fabrication step, by operation of the lever of the speed reduction mechanism 115. It is also possible to vary the pitch of the convolutions of the reinforced cage by varying the shifting speed of the base 113 in the cage-fabrication step by means of the switchover of said lever.

The automatic insertion device for the tension reinforcement 3 in the aforementioned example will now be described. An end fitting plate 123 for the tension reinforcement 3 is mounted centrally within the disc 111 in a freely detachable manner. The outer periphery of this plate 123 has a suitable number of recessed portions *b* (Fig. 14(E)) for insertion of the tension reinforcements 3. Also, the outside of the plate 123 is provided with a binding device 124, such as a band or the like. The end of the rotary cylinder opposite to said disc 111 is provided with a supporting plate 125 which is substantially similar to that of said end fitting plate 123 and which is also freely detachable. Said supporting plate 125 is also provided with the clamping device 126. Said rotary cylinder 102 is hollow as far as its forward

end and the tension reinforcement 3 is inserted from the right hand end.

In the aforementioned arrangement, at the initial stage of the reinforced cage-fabricating operation, the tension reinforcement 3 of predetermined length is inserted in a space which exists at a stage where the disc 111 and the rotary cylinder 108 approximate with each other, and the end portion of the reinforcement 3, loosely supported on the supporting plate 125 by the clamping device 126, is secured to the end fitting plate 123 by the clamping device 124. At this stage, the reinforced cage-fabricating operation is carried out as previously described in the foregoing. With this arrangement, reinforced cages are fabricated at the outside and simultaneously the tension reinforcement 3 can be automatically inserted into the already fabricated reinforced cage.

WHAT WE CLAIM IS:—

1. Reinforcements for prestressed concrete pipes, poles, and the like, having a cage-shaped body comprising non-tension reinforcements extending generally longitudinally and generally transversely of the cage-shaped body, metal end fittings located at both ends of said cage-shaped body for movement longitudinally thereof, and a plurality of tension reinforcements having both ends connected to and supported by the metal end fittings so that the tension reinforcements are freely supported in the cage-shaped body, whereby tensile force can be imparted only to the tension reinforcements by moving said metal end fittings relative to one another so as to increase the distance therebetween.

2. A method of fabricating reinforcements as claimed in claim 1, which comprises the steps of arranging and interconnecting said generally longitudinally and transversely extending non-tension reinforcements so as to form said cage-shaped body, locating said metal end fittings one at each end of said cage-shaped body, passing into the cage-shaped body a required number of said tension reinforcements, simultaneously or one by one, with each end of said passed tension reinforcements inserted into aligned holes formed in the respective metal end fittings, anchoring or hooking the ends of the tension reinforcements to said metal end fittings, and then pulling both metal end fittings in opposite directions so as to put these reinforcements under the required tension.

3. A method as claimed in claim 2, in which the tension reinforcements are fed into the cage-shaped body during the course of its fabrication by the non-tension reinforcements.

4. Apparatus for fabricating reinforcements as claimed in claim 1, comprising a



device for forming said cage-shaped body by interconnecting a non-tension helical transverse reinforcement to a non-tension longitudinal or vertical reinforcement, a device for supporting said end fittings at both ends of said cage-shaped body in a freely axially movable manner, a guide base having a plurality of transverse frames disposed at a pitch equivalent to that of the helical transverse reinforcement of said cage-shaped body, said transverse frames being provided with a plurality of guide members in alignment on the upper parts, an upsetter for forming rivet-like heads on said tension reinforcements, when inserted in the cage-like body, for anchoring to said end fittings, and a device for pulling both of the end fittings in opposite directions.

5. Apparatus for fabricating reinforcements as claimed in claim 1, comprising a welding device and a bobbin from which material is supplied for forming a helical non-tension transverse reinforcement of the cage-shaped body, which bobbin and welding device are rotatable about the central axis of the bobbin, a reinforcement material fitting plate, which is movable in the axial direction but not rotatable, said reinforcement material fitting plate being provided with means for fitting and anchoring one end of the tension reinforcements, the non-tension longitudinal and helical transverse reinforcements and a device for pulling said material fitting plate in the axial direction at a desired speed, and said welding device and bobbin for helical transverse reinforcement being provided with a driving mechanism for rotating said bobbin and welding device around the central axis of the bobbin at a speed relative to the speed in which said reinforcement material fitting plate is moved in the axial direction.

6. Apparatus for fabricating reinforcements as claimed in claim 1, comprising a traction device for supporting metal end fittings mounted for rotational and axial movements, means for anchoring or hooking an end of the tension reinforcements to the end fittings, a rotary plate for supporting the other end of the tension reinforcements, a device adapted to be rotated at the same speed as that of said rotary plate for extruding non-tension vertical or longitudinal reinforcements, a bobbin for supplying a helical transverse reinforcement, and an electric welding device mounted in a stationary position, and interlocking and driving mechanism for effecting said rotational and axial movements.

7. Apparatus for fabricating reinforcements as claimed in claim 1, comprising large and smaller hooking members adapted to hook and support the respective ends of a desired number of tension reinforcements cut to a predetermined length, means for supporting said hooking members so that

the tension reinforcements assume a frusto-conical shape, a ring adapted to squeeze the major parts of the tension reinforcements extending from the smaller hooking member so as to bring said major parts into substantially parallel relation with the smaller hooking member, a traction device axially shiftable whilst supporting one end of the non-tension vertical or longitudinal reinforcement, a guide device for supporting and radially shifting the non-tension vertical or longitudinal reinforcement in relation to the axial shifting of said traction device, electrodes for welding the non-tension reinforcements together, a reel for supplying non-tension helical transverse reinforcement rotatable around the central axis with respect to said rotatable and axial movements, and interlocking driving mechanism for effecting the rotational guiding and axial movements.

8. Reinforcements for use in the production of prestressed concrete poles, pipes, and the like, constructed substantially as herein described with reference to and as illustrated in Figs. 1 (A) to (I), Figs. 2 (A) and (B) and Figs. 3 and 4 of the accompanying drawings.

9. Apparatus for making reinforcements for use in the production of prestressed concrete poles, pipes, and the like, constructed substantially as herein described with reference to and as illustrated in Figs. 5 and 6 of the accompanying drawings.

10. Apparatus for making reinforcements for use in the production of prestressed concrete poles, pipes, and the like, constructed substantially as herein described with reference to and as illustrated in Figs. 7 to 10 of the accompanying drawings.

11. Apparatus for making reinforcements for use in the production of prestressed concrete poles, pipes, and the like, constructed substantially as herein described with reference to and as illustrated in Figs. 11 (A) to (F) and Figs. 12 (A) and (B) of the accompanying drawings.

12. Apparatus for making reinforcements for use in the production of prestressed concrete poles, pipes, and the like, constructed substantially as herein described with reference to and as illustrated in Figs. 13 (A) and (B) of the accompanying drawings.

13. Apparatus for making reinforcements for use in the production of prestressed concrete poles, pipes, and the like, constructed substantially as herein described with reference to and as illustrated in Figs. 14 (A) to (E) of the accompanying drawings.

14. Reinforcements when made by the method as claimed in claim 2 or 3.

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