May 28, 1968 J. A. SHAW ET AL 3,384,942

APPARATUS FOR MAKING PRESTRESSED CONCRETE BODIES

Filed Nov. 17, 1965

FIG. 1

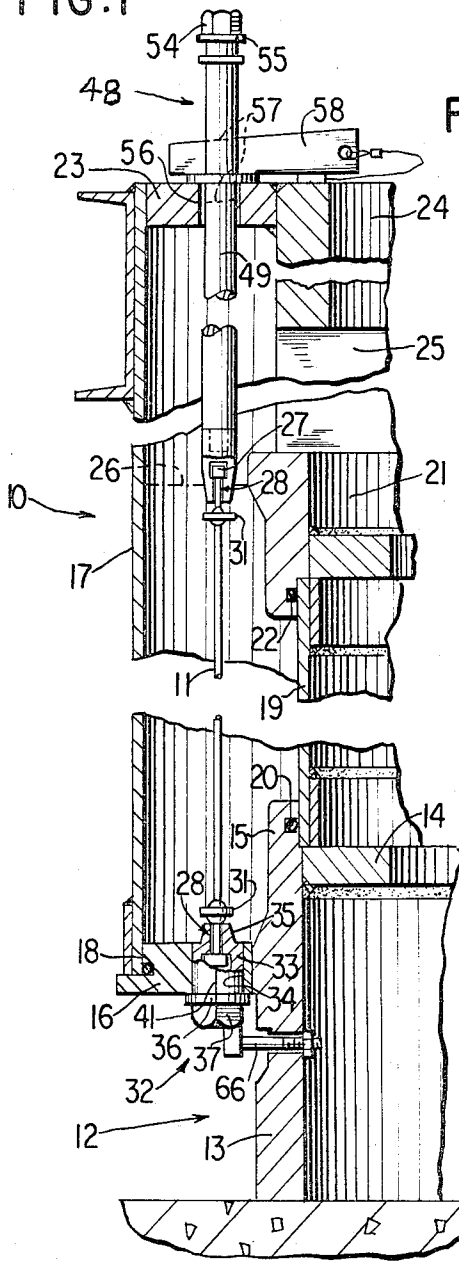


FIG. 2

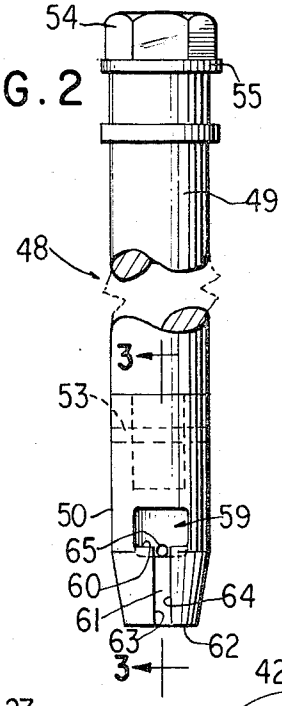


FIG. 8

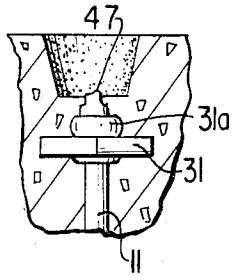
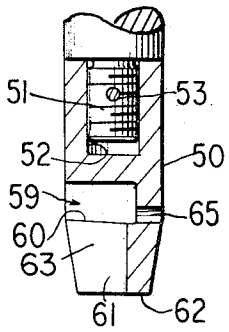


FIG. 3



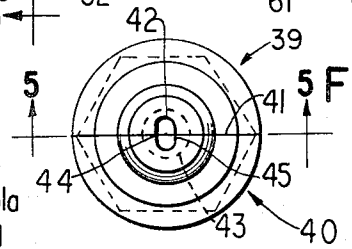


FIG. 4

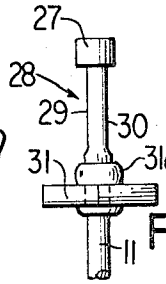


FIG. 7

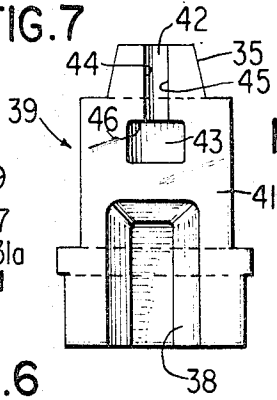


FIG. 5

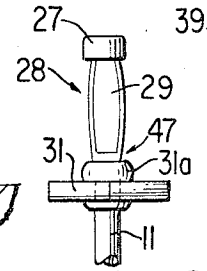


FIG. 6

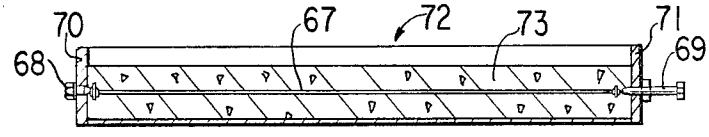


FIG. 9

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APPARATUS FOR MAKING PRESTRESSED CONCRETE BODIES

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8 Claims. (Cl. 25—118)

This invention relates to apparatus for making prestressed concrete bodies.

Methods commonly used for manufacturing prestressed concrete bodies such as prestressed pipes, columns, beams, slabs and the like involve placing concrete in a mold through which wires have been strung. Traction is applied to the wires and they are held strained until the concrete sets. The strain in the wires is generally maintained by anchoring devices which frictionally grip onto the wires. Because of the character of the anchoring devices more wire is used than is necessary for a given length of a concrete body. The economic loss in the manufacture of a prestressed product containing many wires can be considerable. Moreover, such devices which rely on a frictional grip are not wholly dependable to avoid slipping and reduction of tension in a wire before the concrete has set. The available anchoring devices are expensive, shortlived and require frequent replacement. It is a purpose of the present invention to improve upon the shortcomings of prior practices and to effect economies in the manufacture of prestressed concrete bodies.

Among the objects of the invention is to provide forms of a wire and of anchors therefor whereby an individual wire can be stressed to a predetermined tension and its ends broken off inside of a concrete body through which the wire extends. The wire is provided with heads at its ends. The anchors engage the heads to stress the wire. Deformed sections of the wire adjacent the heads and the anchor at either end of the wire are provided with cooperating faces extending crosswise of and substantially parallel to the wire. These faces provide a positive bearing by which torsional force may be transmitted from the anchors to the wire to break end portions from the portion thereof encased in concrete. The ends of the wire are broken off simply by rotating the anchors about the axis of the wire.

According to the present invention, prestressing wires are individually strained and supported in tension by anchors which are constructed and arranged to enable the use of wires no longer or only a little longer than the length of a molded concrete body.

A feature of the invention resides in the construction of elements of an anchor and of a cooperating element of a wire to provide a non-slippable, positive engagement between the anchor and the wire to assure that the wire remains under the stress to which it is initially subjected when the mold is prepared and until the concrete has hardened.

Another feature of the invention is in the adjustability of at least one of the anchors in the axial direction of an engaged wire whereby the anchor is positionable relative to the mold for applying a desired degree of stress to the wire.

Other objects, features and advantages of the present invention and preferred ways of employing it will be evident from the accompanying drawing and the following detailed description of illustrative embodiments of the invention.

In the drawing:

FIG. 1 is a longitudinal sectional view to one side of the axis of a pipe mold;

FIG. 2 is an elevational view of one of the anchors;

FIG. 3 is a sectional view on line 3—3 of FIG. 2;

FIG. 4 is an end view of another anchor;

FIG. 5 shows one of the halves of the anchor of FIG. 4 as viewed on line 5—5 of FIG. 4;

FIG. 6 is illustrative of an end portion of a wire;

FIG. 7 shows the wire end of FIG. 6 turned through ninety degrees on its axis;

FIG. 8 illustrates an encased prestressing wire from which an end portion has been removed; and

FIG. 9 is a vertical section through a horizontal mold for molding a slab or the like.

The invention is described herein as applied to a stationary mold for molding a prestressed concrete pipe on a vertical axis, but it will be apparent that the principle embodied may be utilized in molding procedures utilizing rotating molds of various types, as well as with molds for molding prestressed products other than pipes.

FIG. 1 illustrates a longitudinal section of an upright pipe mold **10** to one side of the axis of the mold. The view shown is in a plane containing the central longitudinal axis of the mold and a tensioned wire **11**. It is illustrative of any one of several other longitudinal sections containing tensioned wires. As is well understood, the number of wires which are employed varies for different sizes of pipes and for pipes designed for different uses.

The lower end of the mold is supported on a base assembly **12**, including a ring **13** and a central shelf **14** attached to the ring by welds. In the present instance, the ring **13** is formed to project upwardly to provide a form **15** for shaping the inside surface of a bell or socket at the lower end of a pipe. A transverse mold wall **16** is immovably fixed to the ring **13** by welding, and this wall supports an outer mold shell **17** which is removable therefrom for stripping a pipe from the mold. A gasket **18** is provided to seal between the wall **16** and the outer shell **17**.

A collapsible inner mold shell **19** in the form of a sleeve is supported on the base assembly, and a gasket **20** effects a seal between the lower end of the shell and the ring **13**. A mold ring **21** rests on the upper end of the inner mold shell **19** and is sealed with respect thereto by a gasket **22**. While the form **15** and the ring **21** are shaped to form the inner surfaces of sockets for a double bell pressure pipe, it is evident that a straight walled pipe may be molded in a similar mold having a cylindrical sleeve like the inner mold shell **19** for forming the inner cylindrical surface of the pipe.

The upper ends of the inner and outer mold shells are spaced apart at a desired distance by an end wall **23** of the mold which is in the form of a ring. The ring is fixed to a circular wall **24** supported concentrically upon the top of the ring **21**. The circular wall **24** is provided with openings **25** through which concrete material may be introduced into the cavity of the mold between the shells.

The lower and upper rings **16** and **23** are substantially perpendicular to the wire **11** and provide the support required for applying and maintaining tension in the several wires employed. In making a double bell pipe the mold cavity is filled with a concrete mix up to the level indicated at **26**.

Lengths of wire are initially cut to an appropriate length for use in making a given length of pipe and the ends of each length are upset to form a head **27** at each end. The head may be described as having the form of a generally circular button enlarged laterally from the diameter of the wire.

A deformed section **28** is formed adjacent each head by laterally compressing the wire between dies to form

opposite faces 29, 30, in a manner well known in the art.

Before a wire is upset to form a head 27 and a deformed section 28, a washer 31 is placed upon the wire and fixed tightly in place thereon by upsetting the wire toward the sides of the washer. In upsetting the wire, the metal of the wire is forced radially outwardly beyond the diameter of the hole in the washer. A bead 31a, formed in this manner, prevents the wire from pulling away from the washer in the finished product. While a circular washer may be used, a square or polygonal washer is preferred as it is more resistant to turning in concrete and thus augments the resistance to torque of a wire bonded to concrete.

One end of a wire 11 is secured in place by an anchor 32 supported by the lower wall 16. The anchor 32 has a cylindrical shank portion 33 rotatable in a cylindrical bore 34 in its supporting wall 16, and a tapered nose 35 projecting into the mold cavity. A flange 36 bears upon the outside of the wall and holds the anchor in an axially fixed position when the wire is tensioned. Either a bolt head 37 or an hexagonal recess 38 may be engaged by a wrench for rotating the anchor to break the wire, as will be explained more fully hereinafter.

Each of the several anchors used at the lower end of a mold is constituted of two like halves 39 and 40, FIGS. 4 and 5, each piece having a flat face 41 in a plane containing the axis of the anchor.

The interior of the anchor 32 is formed to receive an end portion of a wire 11. For this purpose the anchor is provided with a longitudinal recess 42 opening toward the mold cavity at one end and extending into a widened circular chamber 43 at its other end. Shoulder 46 provides an abutment surface for engaging and bearing upon the laterally extending underside of a head on a wire.

As more clearly appearing in FIGS. 4 and 5, one half of the recess 42 and of the chamber 43 is disposed in each half-piece 39 and 40. The opposite walls 44 and 45 of the recess are spaced apart a distance slightly greater than the minimum thickness of a deformed section 28 (FIG. 7), but no greater than the broadest width thereof (FIG. 6) so that the side walls 44 and 45 will engage the deformed section upon rotation of the anchor. Breakage of the wire occurs at or close to the end face of the nose 35 in the general vicinity indicated at 47, FIG. 6. The wider walls of the recess are preferably disposed perpendicularly to the plane of division between the two halves 39 and 40 of the anchor.

The wire 11 is tensioned between the anchor 32 and an anchor 48 supported from the opposite end of the mold. Referring to FIGS. 1, 2 and 3, the anchor 48 includees a round bar 49 and a member 50 which are coupled together by the engagement of a threaded stem 51 at the lower end of the bar with a threaded socket 52 in the member. A removable pin 53 prevents rotation of the member 50 relative to the bar 49 when the bar is rotated. The bar and the member may be constituted in one piece, if desired.

The upper end of the bar 49 is provided with a bolt head 54 and a flange 55 for engagement by the claws of a traction device (not shown). The traction device may consist of any conventional hydraulic jack having legs for bearing against the upper end of the mold. The bar 49 fits slidably in a circular opening 56 in its supporting wall 23. An axial slot 57 in the bar 49 is engaged by a wedge 58 for holding the bar in a set position after the wire has been tensioned.

The member 50 is a solid one-piece member having a recess in the form of T-slot 59 extending radially inwardly from the circumference of the member a distance sufficient to locate a headed wire on the central axis of the anchor. The recess provides a chamber for receiving a head 27 and a laterally extending surface providing an abutment shoulder against which the underside of the head bears when the wire is stressed.

Shoulder 60 slopes downwardly toward the back of the recess. The abutment surface thus provided assures that the wire will not move laterally from the axis of the anchor when the anchor is rotated to break a wire. In lieu of a sloping surface, the central position of a wire can be fixed by providing a countersink in a surface square to the axis of an anchor for seating the head of a wire.

The axial stem 61 of the T-slot extends from the shoulder to the end face 62 a distance approximating the distance of a desired break-off point from the head of the wire. The broad side walls 63, 64 of the T-slot are spaced apart sufficiently for the insertion of a deformed section 28 edgewise into the slot. A hole 65 enables the entry of a tool to eject a broken-off end portion of a wire from the slot.

In assembling a wire in a mold, one end of the wire is attached to an upper anchor 48 which is then lowered to permit the lower end of the wire to be extended downwardly through the bore 34 in the lower mold wall 16. The two halves of a lower anchor 32 are placed about the head and the deformed section at the lower end of the wire. The lower anchor, thus assembled, is then inserted in the bore 34. A bolt 66 may be used as a temporary support for the lower anchor.

The upper anchor 48 is then raised and attached to a traction device which is operated to apply the force necessary to tension the wire to the degree of unit stress desired. Tension in the wire is maintained by a wedge 58 when the traction device is disconnected from the upper anchor.

A mold containing the number of tensioned wires requisite for a particular prestressed concrete body is filled with a suitable concrete mix. Upon the hardening of the concrete the length of each wire extending between the anchors becomes bonded to the concrete.

The tensile stress in a wire becomes effective to prestress the concrete in compression when the anchors are relieved of the pull of the wire thereon. This is accomplished simply by rotating the anchors to break the end portions of the wire contained therein from the length of wire embedded in the concrete. The loosened anchors may then be withdrawn axially from their supports and the broken-off end portions removed from within the anchors.

The wires and the procedure described may be used for casting prestressed concrete slabs. As demonstrated in FIG. 9, the ends of a tensioned wire 67 are engaged by anchors 68 and 69, which are respectively mounted on and supported by the respective end walls 70 and 71 of a mold 72. The anchors 68 and 69 are respectively constructed like the anchors 32 and 48. After the concrete 73 has set, the anchors are rotated to break off the end portions of the wire contained therein and so free the anchors and end walls from the restraining forces theretofore brought to bear thereon by the anchored wire.

In practising the invention it is advantageous to apply a waterproof lubricant, such as a lithium soap grease, to all surfaces of the anchors which come into contact with concrete or the mold, and also to the superposed surfaces of the two halves of the split anchors. The coating prevents leakage around the anchors and facilitates dismantling.

A hard drawn, spring steel wire having a tensile strength of the order of 200,000 p.s.i. (140.6 kg./sq. mm.) and upwards is customarily used in the construction of prestressed concrete pipes. For making pipes, the wires are prepared in lengths which provide for breaking the wire short of the end face of a pipe. To effect this result, the wire lengths should be such that at least a portion of the length of each deformed section is located inside of the mold cavity or inward from the inner face of an end wall of a mold.

A deformed section about ¾" (19.1 mm.) long and having flat faces spaced at about 7/10 of the diameter of

a wire is productive of satisfactory results. Upset heads having a diameter of about 1.75 times the diameter of the wire are adequate to resist the pull of the wires on the anchors. As explained hereinabove, the recesses in the anchors are so proportioned as to contain the heads and a sufficient length of a deformed section to effect breakage close to the anchors.

While the form of apparatus herein shown and described is admirably adapted to fulfill the objects primarily stated, it is to be understood that it is not intended to confine the invention to the forms herein disclosed, for it is susceptible of embodiment in various forms all coming within the scope of the claims which follow.

What is claimed is:

1. Apparatus for making a prestressed concrete body, comprising a mold, a wire strung across said mold, means for supporting said wire, said supporting means including an anchor at each end of said wire, said wire having at each of its ends an end portion including a head and a deformed section adjacent the head, said head projecting laterally beyond the diameter of the wire, said deformed section having flat faces formed by compressing the wire radially, each of said anchors having a recess to receive one of said end portions of the wire, said recess having side walls extending axially inward from an end of the anchor and a wall extending laterally to said side walls, said laterally extending wall providing an abutment shoulder, said abutment shoulder engaging the head of the end portion to transmit force from said anchor to said wire to tension the wire, said side walls of said recess spaced apart a distance greater than the minimum width of said deformed section but no greater than its maximum width, said side walls engaging the flat faces on the end portion upon rotation of said anchor to transmit torque to the end portion.

2. Apparatus according to claim 1, one of said anchors comprising two like members separable at a plane passing through the axis of the anchor.

3. Apparatus according to claim 1, one of said anchors comprising a solid member in which said recess is in the form of a T-slot opening to a side of the member.

4. Apparatus according to claim 1, said wire having a washer fixed thereto in the vicinity of each of said anchors.

5. Apparatus for making a prestressed concrete body comprising a mold, anchoring means attached to each end of a wire extended across the molding cavity of the mold, a support for each of said anchoring means, each of said anchoring means having a shank portion extending through an opening in the one of said supports on which it is supported and an end part extending into the mold cavity, each anchoring means having a recess open-toward the mold cavity, said recess providing a shoulder disposed laterally to said wire, said recess having side walls extending from said shoulder to the mold cavity, a head at each end of said wire, said shoulder engaging one of said heads to prevent axial separation of said anchoring means from said wire when said wire is taut, a deformed section of the wire adjacent each of said heads, each deformed section having faces extending generally crosswise of the wire, said side walls of said recess spaced apart a distance greater than the minimum width of said deformed section but no greater than its maximum width, said side walls engaging said faces on the wire to transmit torque thereto upon rotation of the anchoring means.

6. Apparatus according to claim 5, said shank portion of one of said anchoring means having means for attaching traction means thereto whereby to apply tension to said wire.

7. Apparatus according to claim 5, said end part of one of said anchoring means coupled to said shank portion thereof.

8. Apparatus for making a prestressed concrete body, said apparatus comprising a mold having walls oppositely spaced from one another, a first anchoring means supported on one of said walls, a second anchoring means supported on the other of said walls, said first and said second anchoring means each having a cylindrical shank portion extending through an opening in its associated one of said walls, a wire extended lengthwise between said first and said second anchoring means, a head at each end of said wire, a deformed section on said wire adjacent each of said heads, each deformed section having faces extending crosswise of the wire, said first and said second anchoring means each having a longitudinal recess opening at one end thereof toward the mold cavity and opening into a chamber at its other end, a shoulder extending laterally from said recess, said deformed section and said head at one end of the wire respectively contained in said recess and said chamber in said first anchoring means, said deformed section and said head at the other end of the wire respectively contained in said recess and said chamber in said second anchoring means, the head at the respective ends of the wire bearing on said shoulder of said first and second anchoring means respectively, said first anchoring means comprising two like pieces having coextensive faces engaged at a plane containing the central axis of the anchoring means, each of said pieces providing one-half of the said recess and chamber of said first anchoring means, said second anchoring means comprising a bar and a member in which the said recess and chamber of the second anchoring means are disposed, means for coupling said member to said bar, whereby when a mid-portion of said wire is embedded in hardened concrete the wire may be broken close to said anchoring means by rotating said anchoring means.

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