Sept. 4, 1956 S. R. WOOLCOCK 2,761,649

MEANS FOR TENSIONING RODS AND THE LIKE

Filed March 2, 1954 5 Sheets-Sheet 1

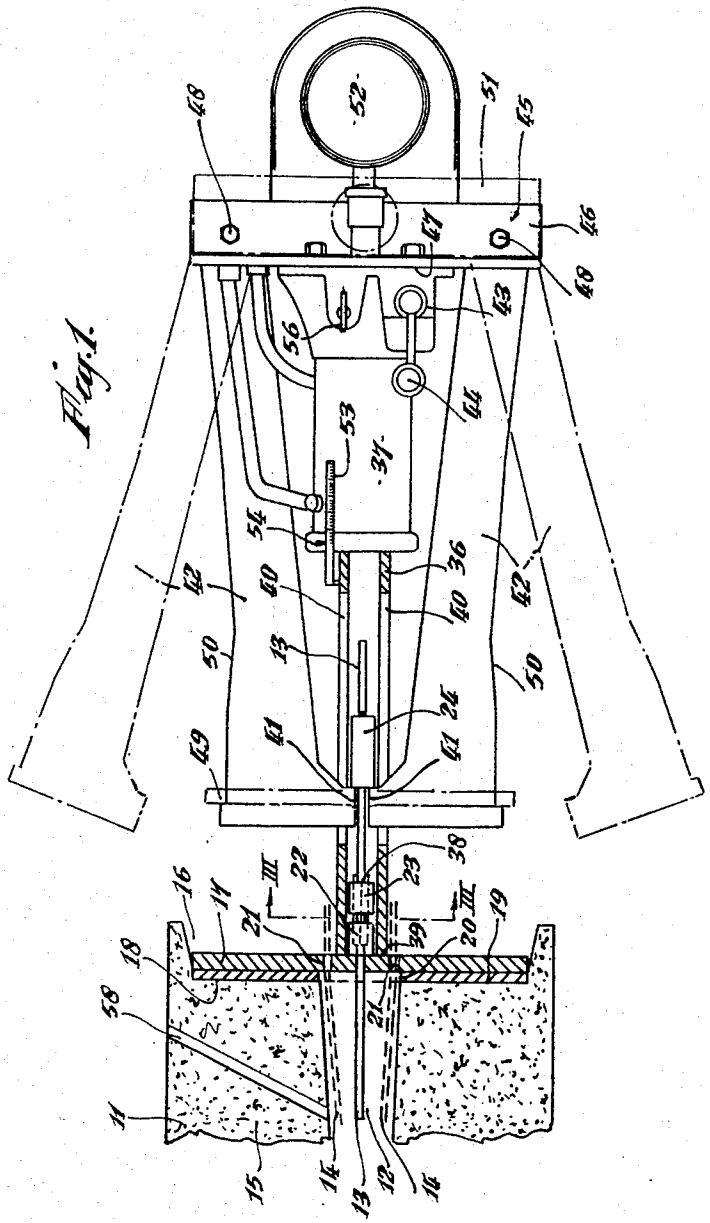


Fig. 1.

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MEANS FOR TENSIONING RODS AND THE LIKE

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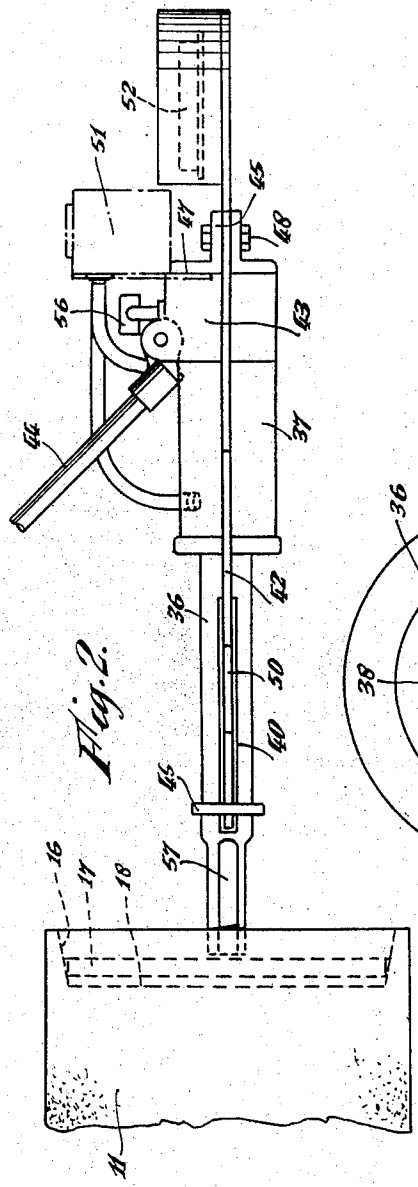


Fig. 2.

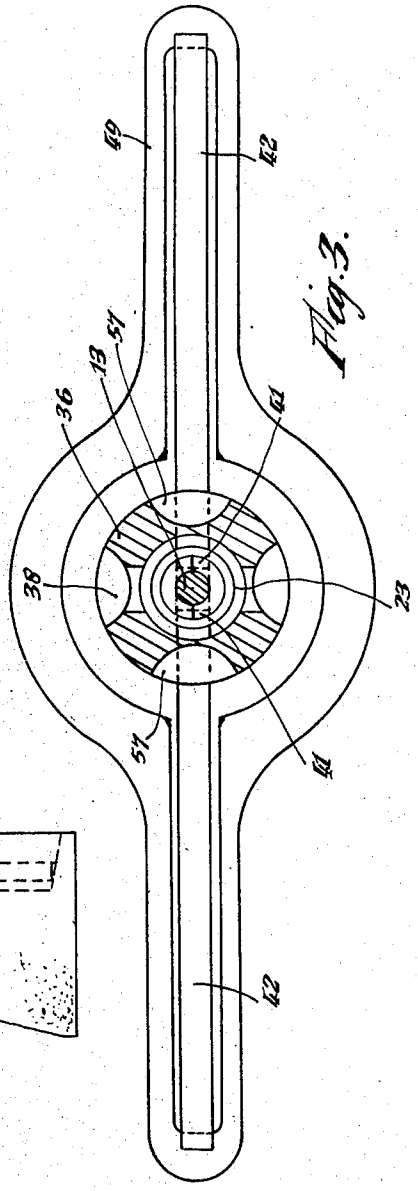


Fig. 3.

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MEANS FOR TENSIONING RODS AND THE LIKE

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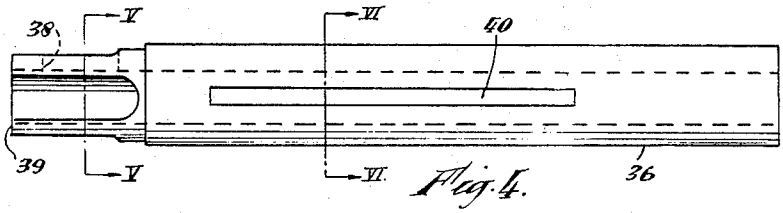


Fig. 4.

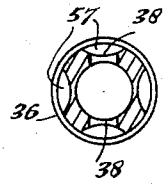


Fig. 5.

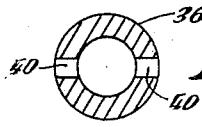


Fig. 6.

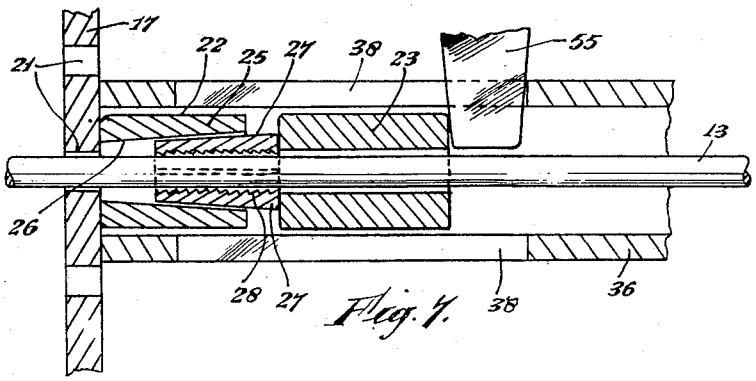


Fig. 7.

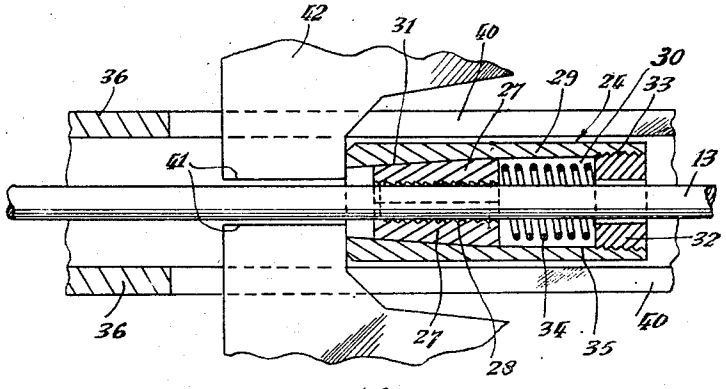


Fig. 8.

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MEANS FOR TENSIONING RODS AND THE LIKE

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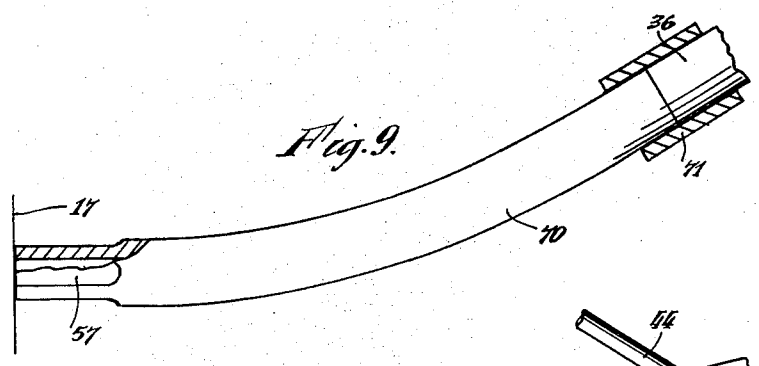


Fig. 9.

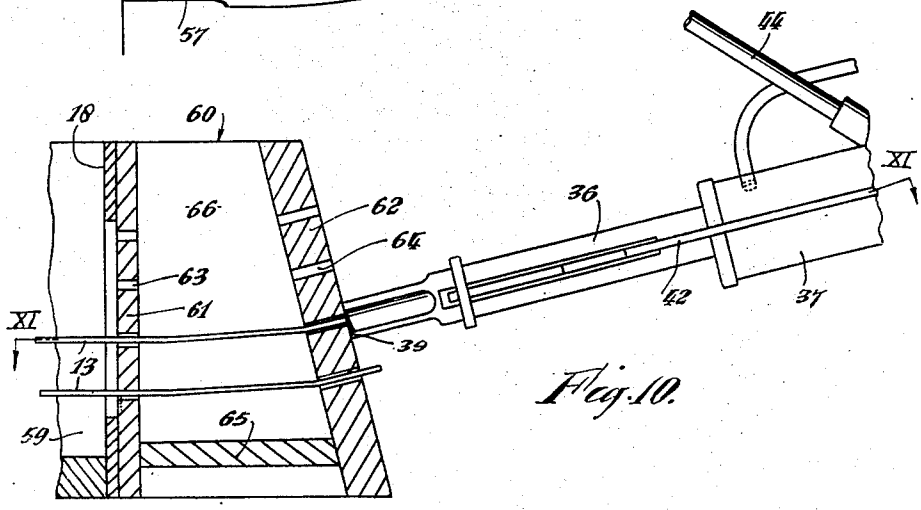


Fig. 10.

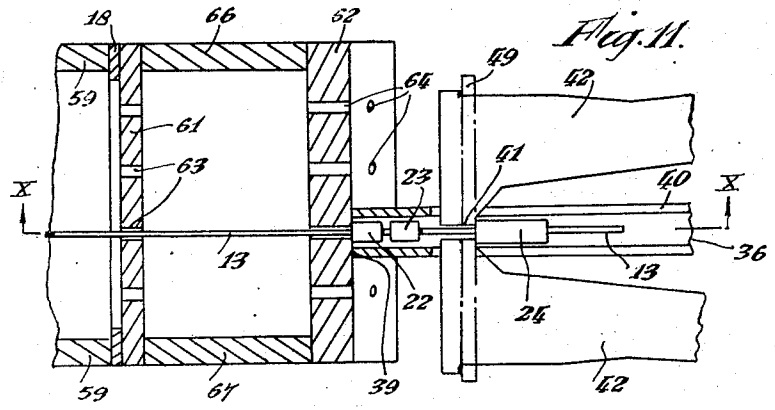


Fig. 11.

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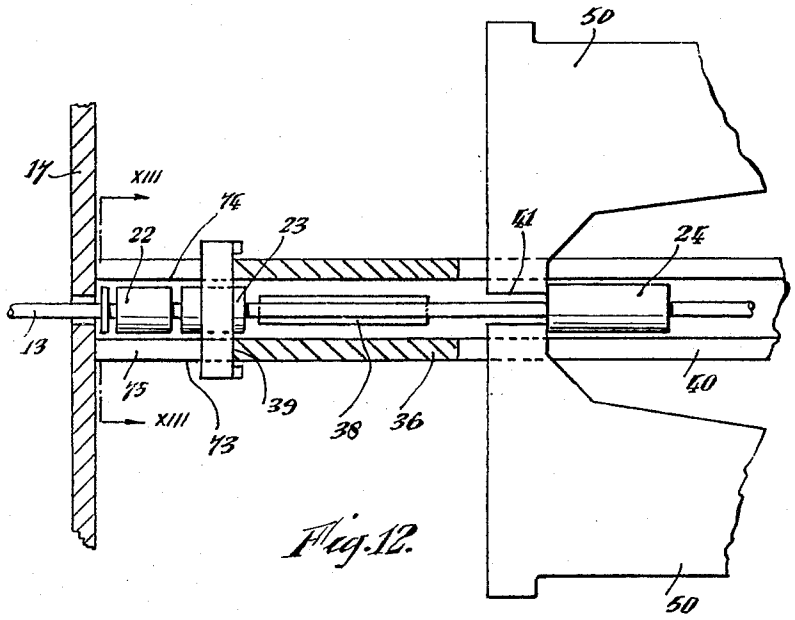


Fig. 12.

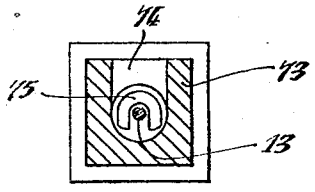


Fig. 13.

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2,761,649

MEANS FOR TENSIONING RODS AND THE LIKE

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Application March 2, 1954, Serial No. 413,668

Claims priority, application Great Britain March 3, 1953

7 Claims. (Cl. 254—29)

This invention relates to means for tensioning rods, wires and the like, hereinafter referred to as rods, the object being to provide improvements therein.

According to this invention apparatus for tensioning rods, as above defined, comprises a tension applying element, a tubular compression element, the tubular compression element being adapted to receive a rod which is to be tensioned and also adapted to be disposed between said tension applying element and an abutment on a structure containing said rod, a first gripping device adapted to be mounted on and secured to said rod disposed in said tubular compression member, elements mounted on said tension applying element and adapted to engage said first gripping device, and a second gripping device adapted to be secured to said rod in abutting relation to said abutment on the said structure.

The apparatus may comprise a fluid-operated jack, a tubular compression element providing an extension of the ram of said jack and having slots in its wall, a first gripping device adapted to be mounted on and secured to a rod and also adapted, when secured to said rod, to be inserted into said tubular compression element, claw elements pivotally mounted on said jack and adapted to enter said slots in said tubular compression element whereby to engage said first gripping device, and a second gripping device adapted to be disposed on and secured to said rod. The apparatus may also comprise an abutment element, which may be a plate or a member having two walls spaced apart, adapted to be disposed between and in abutting relation to said tubular compression element and a structure.

In this specification any reference to ends of a structure or formwork should be construed to include sides or other faces or parts of the structure or formwork between which rods, wires and like members are disposed and are tensioned or are to be tensioned.

In the accompanying drawings:

Fig. 1 is a diagrammatic plan view of one form of the invention adapted for post-tensioning reinforcing rods in a reinforced concrete structure.

Fig. 2 is a side elevation of Fig. 1.

Fig. 3 is a transverse section on line III—III of Fig. 1.

Fig. 4 is an enlarged elevation of a detail.

Figs. 5 and 6 are transverse sectional elevations on lines V—V and VI—VI, respectively, of Fig. 4.

Figs. 7 and 8 are enlarged fragmentary sectional elevations of details.

Fig. 9 is an elevation of a modified form of a detail of the apparatus.

Fig. 10 is a sectional side elevation, on line X—X of Fig. 11, of a modified form of apparatus for tensioning reinforcing rods, and

Fig. 11 is a sectional plan view on line XI—XI of Fig. 10.

Fig. 12 is a fragmentary sectional elevation showing a modified arrangement of apparatus, and

Fig. 13 is a transverse section on line XIII—XIII of Fig. 12.

In Figs. 1 and 2, the concrete structure **11**, which may be a beam, has been partially constructed, but a passage **12** has been left therein for the reception of reinforcing wires **13**, **14**. When these reinforcing wires have been tensioned, the passage **12** will be filled with cement grouting to bind the wires and to transmit the tension in the wires to the concrete **15** of the structure. A recess **16** is formed in the end of the structure, and an anchorage plate **17**, made of mild steel, is placed in said recess, a packing or thrust plate **18**, which may be made of metal, hardboard or other material, being disposed between said anchorage plate and the face **19** of the concrete so as to take up any irregularities in the surface of said face. The thrust plate **18** has in it a large hole **20**, whilst the anchorage plate **17** has an array of holes **21**, one for each reinforcing wire **13**, **14** which is to be provided in the structure. The reinforcing wires are threaded through the passage **12** in the concrete structure **11**, through the hole **20** in the plate **18**, and one wire through each hole **21** in the plate **17**.

The reinforcing wire **13** is the one which is about to be tensioned, the other wires **14** being disposed loosely in position until it is required that they be tensioned, the array of holes **21** in the plate being arranged in the desired pattern or arrangement of the reinforcing wires in the structure.

A gripping device **22**, hereinafter referred to as the anchorage grip, is disposed loosely on the wire **13** adjacent the outer face of the anchorage plate **17**.

The anchorage grip **22** comprises (Fig. 7) an outer short steel sleeve **25** having a tapered bore **26**, and two wedge shaped inserts **27** which each are substantially semi-circular in cross-section to form a tubular inner member and have a serrated inner surface **28** which provides, a serrated bore to said inner member. The wire **13** is threaded through the outer sleeve **25**, and the two inserts **27** are then placed inside the sleeve so as to embrace the wire and, when the device is to be secured to the wire, are then driven into the sleeve so that the serrated inner surfaces **28** of the two inserts are forced into contact with the wire **13**; thereby the complete grip **22** is attached to the wire **13**.

A spacer **23**, provided by a tubular sleeve, is disposed loosely on the wire adjacent that end of the gripping device **22** which is remote from the plate **17**. At some distance from the spacer **23**, and nearer the end of the wire **13**, a second gripping device **24**, hereinafter referred to as the stressing grip, is disposed on the said wire in secure gripping engagement therewith.

The stressing grip **24** is of the form shown in Fig. 8, wherein two wedge shaped inserts **27**, similar to those comprised in the grip **22**, are disposed within a long steel sleeve **29** which has a bore **30** which is partially tapered at **31** at one end. A plug **32** is screwed into the wide end **33** of the bore of the sleeve **29**, and a helical compression spring **34** is disposed in the portion **35** of the bore **30**, which portion is cylindrical, and between and abutting the inner end of the plug **32** and the inner or wide end of the tapered tubular member formed by the two inserts **27**. When the reinforcing wire **13** is threaded through the sleeve **29**, the spring **34** and the plug **32**, and the two inserts **27** are placed in the sleeve and in embracing engagement with the wire, the action of screwing the plug **32** into the sleeve **29** will cause the spring to urge the inserts **27** tightly into the tapered bore portion **31** so as to secure the grip **24** tightly on to the wire **13**.

Any other suitable form of gripping device may be used for the anchorage grip and the stressing grip.

When the anchorage grip **22** and the spacer **23** are placed loosely on the wire **13**, and the stressing grip **24** has been secured firmly on to the said wire, the said wire **13** together with the grips **22** and **24**, and the

spacer 23, are threaded into a steel tube 36. The steel tube 36 is formed as an extension of the ram of a hydraulic jack 37, either as a fixed or removable extension of said ram.

Two diametrically opposed slots 38 (Figs. 1 and 7) are provided in the tube 36 near to its outer end 39. The loose anchorage grip 22 and spacer 23 are so positioned on the wire 13 that when the tube is placed with its outer end 39 abutting the anchorage plate 17, as in Figs. 1 and 7, the grip 22 and spacer 23 are accessible through the slots 38.

Two further diametrically opposed slots 40 (Figs. 1 and 8) also are disposed in the tube 36 between the slots 38 and the body of the jack 37. The stressing grip 24 is so positioned on the wire 13 that when the tube 36 is placed with its outer end 39 abutting the anchorage plate 17, as in Fig. 1, the said grip is accessible through the slots 40, and the claws 41 of arms 42, hereinafter described, can be passed through the said slots 40 at positions between the said grip 24 and the outer end 39 of the tube.

The jack 37 comprises a pump 43 having a handle 44 for manual actuation. A harness 45 is provided which comprises a cross-head 46 for disposal laterally across and in engagement with the base 47 of the jack, and two arms 42 which are each pivotally connected by one end to the cross-head at 48 and which extend along two opposite sides of the jack, the other or free end of each said arm being provided with a claw 41, the said two claws being passed through the slots 40 in the steel tube 36 for the purpose described. The two arms 42 form jaws, and a locking sleeve 49 is disposed over said jaws so that when the sleeve is pushed towards the claws 41 the two jaws are closed towards each other so as to retain both claws projected through the slots 40 into the interior of the tube 36; conveniently, a suitable taper 50 is provided on the outer edges of the two jaws so that when the locking sleeve 49 is pushed along the jaws the two claws 41 will close on to each other. The two jaws are also shown dotted, in an exaggerated open position in Fig. 1 for clarity.

A liquid container 51 is mounted on the crosshead 46 and is suitably connected to the jack 37 so that on operation of the pump 43 the liquid is forced into the jack so as to project the tube 36 therefrom. A pressure gauge 52 is mounted on the crosshead for indicating the hydraulic pressure in the jack. A scale 53 is mounted on the tube 36 and co-operates with an indicating mark 54 on the body of the jack so as to indicate the extent of projection of the tube from the jack; the scale may be attached to the tube 36 in the position indicated in Fig. 1, or in any other suitable position, for example, between the jaws 41 and the outer end 39 of the tube so as to avoid fouling of the connection of the scale to the tube by the jaws when extension of the jack exceeds the distance between the jaws and the body of the jack.

In use, the jack 37 is suitably supported in a position, which may be horizontal, so that the axis of the ram of the jack and of the tube 36 is substantially aligned with the axis of the hole 21 in the plate 17 through which the reinforcing wire 13 passes. The outer end of said wire 13, together with the anchorage grip 22, spacer 23 and stressing grip 24 are inserted into the tube 36, the jaws comprised by the arms 42 and claws 41 are closed upon the tube 36 so that the said claws enter the slots 40 at positions between the grip 24 and the outer end 39 of the tube, the locking sleeve 49 is pushed over the outer ends of the arms 42 so as to retain the claws in position in the tube slots, and the said outer end 39 of the tube 36 is placed in abutment with the outer face of the plate 17.

The pump handle 44 is operated to cause liquid to enter the jack 37, whereupon the ram of the jack is projected from the jack, together with the tube 36. Thereupon, the tube 36 operates as a compression element to force the jack 37 and the concrete structure 11 apart. As the jack moves away from the structure 11, the claws 41 engage the end of the stressing grip 24 which is nearer the structure 11 and apply tension to the wire 13. The end of the wire 13 which is remote from the jack 37 is anchored in any suitable manner to the end of the structure 11 which also is remote from the jack; for example, anchorage and packing plates may be disposed at said other end of structure 11, the wires are passed through holes in said plates, and anchorage grips, similar to the grips 22, are secured to each wire outwardly of the anchorage plates. The anchorage grip 22 and spacer 23 are retained adjacent the plate 17 during tensioning of the wire 13 by a locating key 55 which is passed into a slot 38 so as to abut the ends of the slot 38 and spacer 23 remote from the plate 17. When the appropriate tension has been applied to the wire 13, which can be determined by reading the gauge 52 and/or the scale 53, the locating key 55 is replaced by a wedge, drift or other tool which is driven so as to drive the spacer 23 against the inserts 27 of the grip 22 and force said inserts into the sleeve 25, and the whole grip 22 is driven tightly up to the outer face of the plate 17, the inserts 27 being locked tightly on to the wire 13 by the tension in said wire. Thereupon, the hydraulic pressure in the jack 37 is released, for example, by opening a valve 56, and the tension applied to the wire 13 is transferred from the jack to the anchorage grip 22. The jaws of the jack are opened, upon withdrawal of the sleeve 49, and the jack together with the tube 36 are withdrawn from the wire 13. The wire is then severed, between the grip 22 and spacer 23, and the spacer 23 and grip 24 are recovered, the grip 22 being left in position and, in some cases, subsequently being encased in concrete filling in the end recess 16 of the concrete structure 11.

Each of the other reinforcing wires 14 are similarly tensioned. The end 39 of the steel tube 36 is fluted longitudinally on its outer surface at 57, Fig. 3, to enable it to be placed between adjacent reinforcing wires whilst tension is being applied to one wire.

When all of the reinforcing wires, or all those wires which are to be tensioned, have been tensioned, concrete grouting may be poured into the passage 12 in the structure 11, through a duct 58, and allowed to set or harden.

In the event of the ends of the concrete structure being disposed in awkward positions, where it is not possible to accommodate the jack in axial alignment with the holes in the anchorage plates through which the reinforcing wires pass, the steel tube 36 may be bent suitably longitudinally, or a suitably bent tubular adaptor may be disposed between the tube 36 and the anchorage plate 17, to enable the jack to be placed in a suitable operating position. For example, as illustrated in Fig. 9, a curved tubular adaptor 70, having one end shaped or adapted similar to the end of the tube 36 with orifices 38 and flutes 57, is disposed between the plate 17 and the tube 36, being connected to the tube 36 by a sleeve or collar 71 which may be secured to said tube or adaptor. Thereby, the jack may be inclined to the structure at an angle, for example, of 45 degrees.

The apparatus may be used for applying pretension to the reinforcing wires. For example, in the construction illustrated in Figs. 10 and 11, a substantially rectangular box-like member 60 is provided. The box comprises two opposed end walls 61, 62 which both are orificed at 63 and 64, respectively, to allow reinforcing wires 13 to be threaded therethrough. The box is made of steel and the end wall 62 is considerably thicker than the wall 61. The top of the box is open, and a bottom closing wall 65 is provided, whilst the other two walls 66, 67 which are vertical are of sufficient thickness to resist endwise compression and so prevent the two end walls 61 and 62 being pressed towards each other. The walls 66 and 67 may be ribbed or otherwise reinforced to increase the said compression strength.

In use, the box **60** is placed in position at one end of the shuttering or other formwork **59** for a concrete beam which is to be constructed, with the thinner end wall **61** abutting said end of the formwork. A thrust or packing plate **18** is placed between the wall **61** and the end of the formwork so as to take up any irregularities in the end surface of the formwork. The reinforcing wires **13** are laid in the required positions in the formwork and one end of each wire is threaded through a hole **63** in the wall **61**, then passed across the interior of the box and threaded through a hole **64** in the thicker wall **62**, whereupon the gripping devices **22** and **24** and spacer **23** are applied to the end of the wire outside of the thicker end plate **62**. The jack **37** and tube **36** are then applied in the manner described, with the end **39** of the tube abutting the outer face of the wall **62**.

The end walls **61** and **62** of the box **60** are provided with a suitable array of holes so that suitable ones may be selected to suit the arrangement of reinforcing wires in the beam; or the walls may be specially orificed to suit the beam which is being constructed.

After the tension of all reinforcing wires has been taken by the anchoring grips **22** on said wires, the said grips being disposed tight up against the outer face of the wall **62** of the box **60**, concrete is poured into the formwork **59** and allowed to set or harden.

Whilst setting is taking place the jack may be used on other beams, but the box **60** will have to remain in position until the required degree of setting of the concrete is achieved. When the concrete has set sufficiently to hold the reinforcing wires **13** in contact therewith without releasing the tension therefrom, the portions of the wires which are disposed between the end walls **61** and **62** of the box are severed, whereupon the tension in the wires is transferred from the anchor grips **22** to the concrete.

Preferably, the wires are severed by applying an oxy-acetylene or other cutting flame thereto; the action of the heat necessary to gradually burn through the steel of the wire is sufficient to release the stress on the wire in a manner which will not apply appreciable shock to the concrete, or at least sufficient shock as would rupture the bond between the concrete and the stressed wire.

By inclining the two end walls **61** and **62** in relation to each other, the reinforcing wires may be flexed slightly after leaving the end of the formwork **59**, if it is desired to do this in order to splay the wires apart sufficiently to allow the steel tube **36** to be disposed between adjacent wires, whilst applying the tension to the wires substantially perpendicularly to the outer thicker end wall **62**.

The apparatus described may be applied to the construction of any pre-stressed concrete structure; for example, it may be applied to the construction of a beam which has anchor units incorporated in it at each end, together with preformed concrete or other moulding units disposed between and in abutment with said anchor units, in which case the pre-tensioned wires may be severed as soon as concrete in the anchor units has been bonded to the wires, the main body of the concrete of the beam being filled into the moulding units afterwards so that said concrete is inert.

The apparatus may also be applied to the tensioning of rods, wires and like members in any other form of structure.

In the event of additional tension being required in the wire, for example, due to loss of tension when the gripping device **22** takes the load from the jack and the inserts **27** are drawn into the sleeve **25** by the wire, the wire is again tensioned with the grip **22** secure thereon, and a suitable shim, spacer or the like is placed between

the said grip and the plate **17**. This may be achieved by making the end **39** of the tube **36** U-shaped in section, or by disposing an adaptor so shaped, so as to provide an open side through which the shim or spacer may be passed. For example, an adaptor **73**, Figs. 12 and 13, is disposed between the plate **17** and the tube end **39**. The adaptor is U-shaped in section and is assembled with an open side **74** on top, or otherwise suitably, so that a shim or spacer **75** may be placed around the wire **13** and between the plate **17** and the grip **22** when additional tension has been applied to the wire, for example, by reattaching the ram thereto before the wire is severed.

What I claim and desire to secure by Letters Patent is:

1. Apparatus for individually tensioning each of a plurality of rods comprising a tension applying element, a compression element adapted to be disposed between and in abutting relation with said tension applying element and an abutment on a structure containing said rod, and a first gripping device adapted to be mounted on and secured to said rod and to be connected to said tension applying element, said compression element being tubular and being open at that end adjacent said structure whereby said first gripping device and the portion of said rod on which said device is mounted may project from said structure and pass into and be disposed within said compression element, said tubular compression element being provided in its walls with first longitudinal slots, and said tension applying element being provided with connecting elements adapted to project through said longitudinal slots in the compression element whereby to be connected to said first gripping device and to enable said rod to be drawn longitudinally within said compression element upon tension being applied to said rod by said tension applying element.

2. Apparatus according to claim 1 wherein said tension applying element is a fluid-operated jack, and each said connecting element is pivotally mounted by one end on said jack and has a claw on its other end, said claw being adapted to project through a said slot in said tubular compression member and to engage said first gripping device.

3. Apparatus according to claim 1 further characterized in that said tubular compression element is provided in its walls with second longitudinal slots whereby to allow access to a second gripping device which is mounted on said rod and disposed within said tubular compression member between said first gripping device and said abutment on said structure so that said second gripping device may be moved along said rod into abutting relation with said abutment and into gripping engagement with said rod to retain tension which has been applied to said rod.

4. Apparatus according to claim 1, further comprising an abutment element for disposition between and in abutting relation to said tubular compression element and a structure.

5. Apparatus according to claim 4, wherein said abutment element is an orificed plate.

6. Apparatus according to claim 4, wherein said abutment element is a member having two walls spaced apart and orificed.

7. Apparatus according to claim 1, wherein said tubular compression element is curved longitudinally.

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