May 14, 1963 A. H. STUBBS 3,089,215

APPARATUS FOR PRESTRESSED CONCRETE CONSTRUCTION

Filed July 12, 1960 2 Sheets-Sheet 1

FIG. 1.

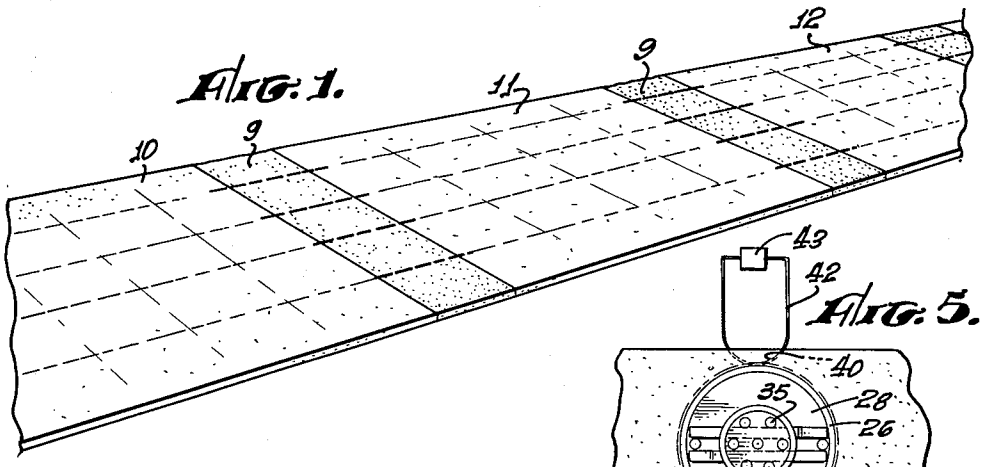


FIG. 5.

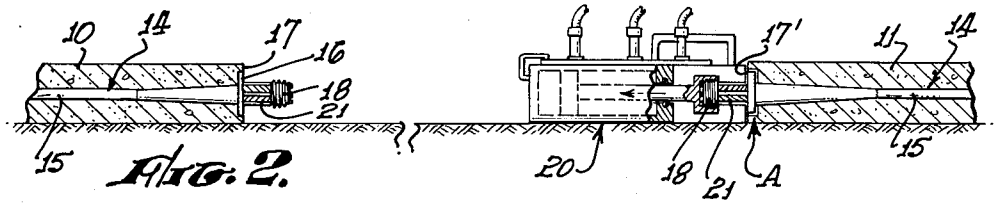


FIG. 2.

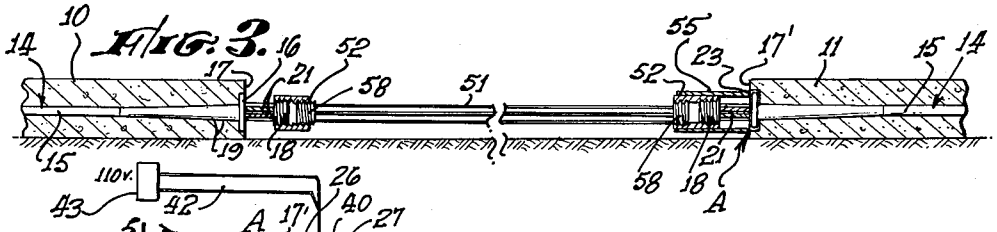


FIG. 3.

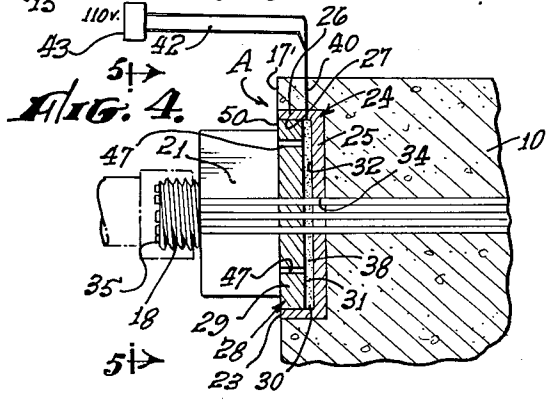


FIG. 4.

ALLAN H. STUBBS,
INVENTOR.

BY Spensley & Horn

ATTORNEYS.

May 14, 1963 A. H. STUBBS 3,089,215

APPARATUS FOR PRESTRESSED CONCRETE CONSTRUCTION

Filed July 12, 1960 2 Sheets-Sheet 2

FIG. 6.

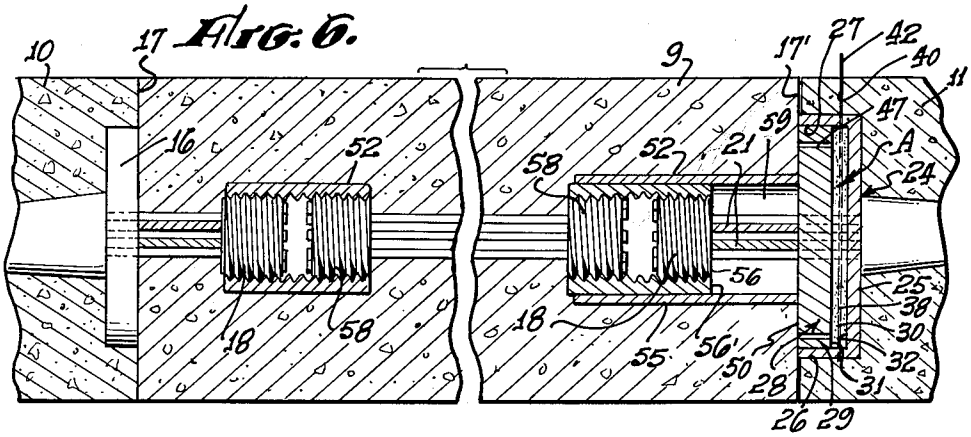


FIG. 7.

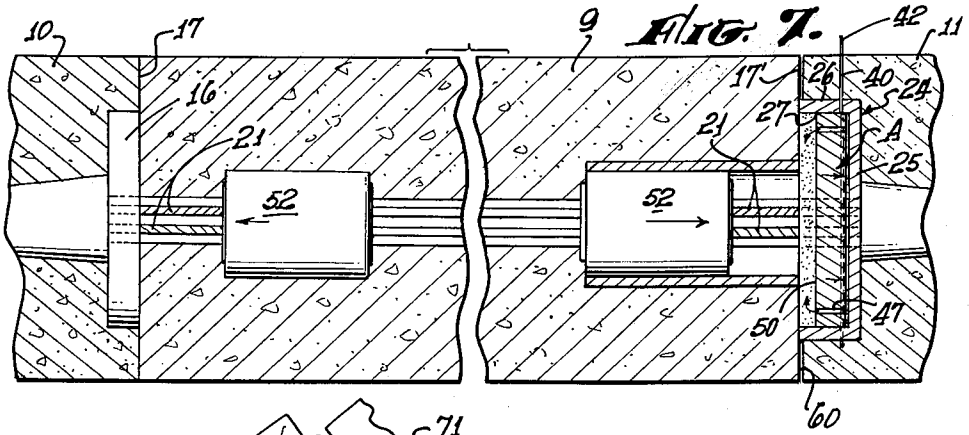
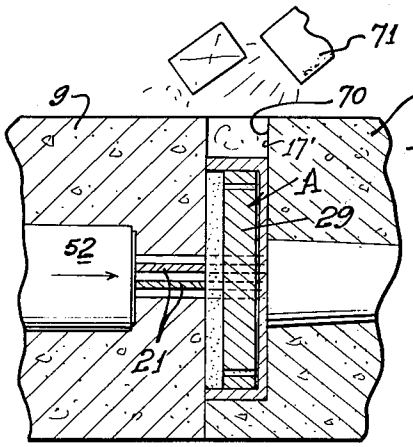


FIG. 8.



ALLAN H. STUBBS,
INVENTOR.

BY Spensley & Horn

ATTORNEYS.

United States Patent Office 3,089,215 Patented May 14, 1963

3,089,215
APPARATUS FOR PRESTRESSED CONCRETE CONSTRUCTION

Allan H. Stubbs, 5543 Bradna Drive, Los Angeles 43, Calif.

Filed July 12, 1960, Ser. No. 42,418
3 Claims. (Cl. 25—118)

This invention relates to prestressed concrete construction and more particularly to an improved apparatus for forming post-tensioned concrete members.

Prestressed concrete has become increasingly well-known in the construction art and relates to concrete structures in which there have been introduced internal stresses of such magnitude and distribution that the stresses resulting from given external loadings are counteracted to a desired degree. One method of prestressing concrete members is the post-tensioning method by which steel tendons are positioned in a relaxed condition within the concrete member. After the concrete has hardened, the steel tendons are placed under tension to exert compressive forces upon the concrete. The term tendon as used throughout the following specification is meant to include all the members which are tensioned such as wires, bars, cables or strands.

The present invention is particularly adapted to be used in connection with prestressed, post-tensioned concrete and will be described in detail in connection with such construction. However, other uses of the apparatus of the present invention and its use in connection with other materials will be apparent to those skilled in the art. As defined above, pre-stressed concrete contemplates the introduction of internal stresses in a concrete member to offset external loading stresses to a required degree. As a simple example, by one method of post-tensioning a concrete slab, a plurality of tendons are suspended within the form used for pouring the slab and are encased such that they can be stretched within the concrete after the concrete has hardened. The tendons are extended through bearing plates which are positioned against the opposed edges of the slab. After the concrete has been poured and allowed to set, the tendons are stretched to the desired tension by means such as hydraulic jacks which engage the tendons and pull them outward from the edge of the slab. The elongated tensioned tendons are then anchored against the bearing plates thereby exerting a compressive force at the edges of the slab. In order to properly post tension a concrete member, such as a slab, it is necessary to exert compressive forces from all edges of the slab. In addition, the length of tendons that can be tensioned, and thus the length of the prestressed concrete members that can be formed, is limited. Prior to the present invention, the length of the slabs or concrete members which could be prestressed by post-tensioning has been limited by various factors including the maximum convenient size of a single concrete pour and the maximum size and weight of a single slab to be lifted in a lift slab operation. Also, the maximum length of the tendons is determined by the stressing friction in that the amount of elongation and the stress loads required is governed by the mechanical capabilities of the jacks or other stressing means. Accordingly, it is necessary in post-tension construction to employ closure strips between slabs as more fully discussed hereinafter in connection with illustrative embodiments of the present invention. Briefly, however, when a prestressed concrete structure is formed from a plurality of slabs it is necessary to leave a gap between slabs which is sufficient in size to allow the operation of the tensioning jacks or other equipment. Such gaps, are, for example, four to six feet in width. In order to form

a continuous structure it is the practice of the prior art to pour the concrete forming the closure strip at the final position of the prestressed slabs. As an illustration, in lift-slab construction, a plurality of prestressed slabs are raised to a position above ground level, and the closure strips between the slabs are poured in place at the final level of the slabs. Since the closure strip will abut the edges of the prestressed slabs, no means have been available in the prior art to post-tension the closure strip and reinforced concrete has been used. As opposed to prestressed concrete, reinforced concrete merely has steel embedded therein for support. Thus, a continuous slab structure of appreciable length or width is necessarily made up of a series of spaced apart prestressed concrete slabs which are merely reinforced concrete rather than prestressed concrete. The disadvantages inherent in such a structure are well known to the art. Principally, the closure strips do not have the strength or flexibility of the prestressed slabs. In addition, it is necessary that the widths of the gap left between adjacent prestressed slabs be greater than the space required for the operation of the tensioning apparatus since a minimal width is necessary to allow positioning and proper utilization of the reinforcing steel.

Accordingly, it is an object of the present invention to provide an improved apparatus for post-tensioning concrete structures.

It is another object of the present invention to provide an apparatus for forming prestressed concrete structures greater in length than has been heretofore possible by means of the prior art.

It is a further object of the present invention to provide an apparatus whereby a post-tensioned concrete member can be formed in segments but which is post-tensioned over the complete area thereof with stressing tendons extending therethrough which are composed of coupled segments all of which are under tension loads throughout the overall length of the tendons.

It is a further object of the present invention to provide an apparatus for post-tensioning closure strips positioned between adjacent edges of prestressed concrete members.

Another object of the present invention is to provide an apparatus for forming a continuous length of post-tensioned concrete slabs.

Yet another object of the present invention is to provide an apparatus for post-tensioning a length of concrete in which the edges of the concrete are abutted against previously poured and prestressed concrete members such that no edge is available for the operation of tensioning equipment.

A still further object of the present invention is to provide an apparatus for applying tension forces to tendons embedded within hardened concrete when the ends of the tendons are also embedded therein.

Yet another object of the present invention is to provide an apparatus for prestressing the closure strip formed between adjacent spaced apart concrete members which apparatus is simple and economical of manufacture and use.

The method in which the invention apparatus is used comprises in general the steps of forming first and second concrete slabs spaced apart by a closure strip defined by first and second opposed edge surfaces respectively of said slabs. The slabs are prestressed by extending a first stressing tendon through the first slab and an oppositely disposed second tendon through said second slab and tensioning the tendons by exerting a tensile force to elongate the tendons proximate the respective edge of the slabs. The tendons are then anchored in the tensioned condition against first and second bearing plates in bearing contact with the first and second slabs respectively.

The first and second tendons are connected by a coupler tendon and concrete is poured and allowed to set to form the concrete closure strip abutting the slabs and surrounding the coupler tendon which is longitudinally movable therein. One of the bearing plates is then moved away from the coupler tendon through a sufficient distance to place continuous tensile stress on the first tendon, second tendon and coupler tendon and compressive loads on the first and second slabs and the closure strip.

The apparatus of the present invention in its presently preferred embodiment for carrying out the above method includes a bearing plate through which a tendon is extended. The bearing plate is longitudinally movable within a cylinder positioned proximate the edge of one of the slabs and having a bearing surface defining a void between the surface and the face of the bearing plate away from the end of the tendon extended therethrough. A fluid flow path is provided through the bearing plate and the void is filled with a solid substantially incompressible material which can be liquified. Means are provided for liquifying the material such that the material flows through the path and allows the bearing plate to move toward the bearing surface under a tensile load on the tendon.

The novel features which are believed to be characteristic of the invention both as to its organization and method of operation, together with further objects and advantages thereof will be better understood from the following description considered in connection with the accompanying drawings in which presently preferred embodiments of the method and apparatus of the present invention are illustrated by way of example. It is to be expressly understood, however, that the drawing is for the purpose of illustration and example only, and is not intended as a definition of the limits of the invention.

In the drawings:

FIGURE 1 is a view in perspective of a prestressed slab of extended length having closure strips formed therein and is shown to illustrate the operation and utility of the present invention;

FIGURE 2 is a partial view in cross-section showing the spaced apart edges of adjacent prestressed slabs with the tensioning apparatus shown partially schematically to illustrate the prior art method of post-tensioning and the necessity of a working gap between adjacent slabs;

FIGURE 3 is a view corresponding to FIGURE 2 with a coupler in accordance with the present invention positioned within the working gap prior to the pouring of the closure strip;

FIGURE 4 is a partial view in cross-section of a presently preferred form of closure stressing hardware in accordance with the present invention;

FIGURE 5 is a view taken along line 5—5 of FIGURE 4;

FIGURE 6 is a partial view in cross-section of the closure strip after the concrete has been cast but prior to post-tensioning thereof;

FIGURE 7 is a view corresponding to FIGURE 6 after the closure strip has been post-tensioned in accordance with the present invention; and

FIGURE 8 is a partial view in cross-section of an illustrative alternative embodiment of the present invention.

Referring now to the drawings, there is shown in FIGURE 1 an illustrative concrete structure to which the present invention is particularly adaptable. The concrete slab shown in FIGURE 1 is of extended length, such as, for example, an airport runway in which the use of prestressed concrete is particularly desirable for increased strength of the concrete. For practical purposes the maximum length of a concrete slab which can be formed by a post-tensioning is approximately 200 feet for reasons discussed above. Due to this fact the problems inherent in the formation of slabs of extensive length, such as an airport runway, are apparent. That is, for example, the runway could be constructed by pouring or casting simultaneously the slabs 10, 11 and 12 with gaps between the slabs for the tensioning of the tendons subsequent to the hardening of the concrete. As discussed hereinbefore, it has been necessary in the prior art to utilize reinforced concrete to form the closure strips. Thus, the runway would constitute the spaced-apart slabs 10, 11 and 12 of prestressed construction with reinforced concrete closure strips 9 positioned between adjacent slabs. The portions of the runway formed by the reinforced concrete would not have the advantages of the prestressed construction and would be weaker and less flexible than the prestressed slabs. As an alternative to the employment of closure strips, a runway could theoretically be formed by first pouring one slab, tensioning the slab and then pouring a second slab adjacent thereto such that the second slab would abut the first, and all tensioning forces would be applied at the one exposed edge of the last poured slab. It can be readily appreciated that such a method would be impractical due to the time expended. That is, it would be necessary to allow each slab to set before the next was poured, and the total time consumed would be very great.

By means of the present invention the extended runway of FIGURE 1 can be formed by casting all of the slabs 10, 11 and 12 simultaneously after which they are allowed to set and are prestressed by post-tensioning. The closure strips are then poured simultaneously and tensioned such that two pours only are necessary to form such a runway. Although a slab of extended length which rests upon the ground surface is shown in FIGURE 1 and will be described throughout the specification as illustrative, the present invention is equally applicable to lift-slab construction and all prestressed concrete construction in which it is necessary to provide closure strips between adjacent slabs or members.

Referring now to FIGURE 2, there is shown a typical method of forming the spaced-apart post-tensioned slabs 10 and 11 in accordance with the prior art. The slabs 10 and 11 are cast with the plurality of prestressing tendons 14 positioned within the slab and contained with the conduit 15. When the concrete is cast the tendons are in an unstretched condition with a bearing plate 16 positioned at or near the edge 17 and 17' of the slabs 10 and 11 respectively. The stressing washer 18 is positioned against the bearing plate prior to tensioning of the tendon. In the embodiment shown, the tendon is formed of a plurality of quarter inch high tensile wires 19 which are extended through the bearing plate and through openings in the stressing washer as shown in FIGURE 5. The ends of the stressing wires 19 are greater in diameter than the openings through the stressing washer such that each of the wires is retained at the surface of the washer and is pulled uniformly when the stressing washer is pulled away from the bearing plate 16. In post-tensioning the slab 10 or 11 the hydraulic jack 20 is utilized to engage the stressing washer 18 and to exert a force upon the stressing washer to move the washer outwardly from the edge 17 of the slab through a distance required to exert the necessary tension upon the tendon 14. When the stressing washer 18 has been pulled away from the edge 17 of the slab by the required distance, shims 21 are inserted between the stressing washer and the bearing plate to retain the stressing washer at the required distance from the edge 17 of the slab after the force exerted by the hydraulic jack is removed. Thus, the stressing washer is anchored to the bearing plate 16 through the shims 21 and the bearing plate is in turn in compressive contact with the slab proximate the outer edge 17 thereof. It is to be understood, of course, that similar bearing plates are disposed against the opposed edge of each slab at the opposed end of the respective tendon. By reference to FIGURE 2, it can be seen that in utilizing the particular method of post-tensioning as described above, it is necessary that a space of sufficient width exist between the edges 17 and 17' of adjacent

slabs 10 and 11 to allow the insertion and operation of the hydraulic jack 20 or other tensioning means. The length of the prestressed slabs 10, 11 and 12 would typically be of the order of sixty to one hundred and fifty feet, while the gap between the adjacent edges of the strips would be of the order of four to six feet as a typical illustration.

In FIGURES 2 and 3, there is shown a bearing plate 16 utilized in connection with the slab 10 which is similar to that commonly used in the prior art, while at the edge 17' of the slab 11 the prestressing apparatus utilized for prestressing the closure strip in accordance with the present invention is shown. As will become more apparent hereinafter, in connection with the detailed discussion of the present invention, the hardware and other apparatus used for stressing the tendons in the closure strip may be employed at both ends of the tendon, i.e., at both the edges 17 and 17' of the slabs 10 and 11. However, in most instances, it will be sufficient to provide such closure stressing hardware at one end only of the tendons. One end of the closure tendons remains fixed while the other end is moved to stretch the tendons and place them under the necessary tension forces. If the width of the closure strip is sufficiently great to require more elongation of the tendons in the closure strip than is possible by stressing apparatus at one end thereof, the stressing apparatus may be placed at both ends of the closure tendons by using the hardware at both the edges 17 and 17' as shown in FIGURES 6 and 7. As an example of the elongation of the tendons required to accomplish post-tensioning, a typical elongation is 0.0625" per foot of length of the tendons.

Referring now to FIGURES 3, 4 and 5, the present invention utilizes apparatus referred to hereinafter as closure stressing hardware A. Such closure stressing hardware is shown in a presently preferred embodiment in FIGURES 3, 4 and 5 and is positioned proximate one edge 17' of the slab 11 that forms one side of the closure strip to be formed.

The closure stressing hardware A includes a bearing unit 24 comprising a bearing plate 25 which is circular in this embodiment with an upstanding annular flange 26 at the periphery thereof. The flange 26 defines by the inner surface 27 thereof a cylinder 28 which is open at the outer end of the closure hardware. A movable piston bearing plate 29 is positioned within the bearing unit 24 and is circular in configuration with a diameter substantially equal to but less than the inside diameter of the cylinder 28, such that the piston bearing plate is longitudinally movable within the bearing unit 24. The thickness of the piston bearing plate 29 is substantially less than the longitudinal depth of the cylinder 28. Thus, when the piston bearing plate 29 is positioned within the cylinder 28 a void 30 is defined between the inside surface 31 of the piston bearing plate and the outside surface 32 of the bearing plate 25. The thickness of the void, that is, the difference between the thickness of the piston bearing plate 29 and the depth of the cylinder 28 is predetermined to provide the desired amount of movement during the prestressing of the closure strip as defined more fully hereinafter. Since the prestressing wires 19 forming the prestressing tendon 14 must move relative to the slab 11 and the bearing unit 24 embedded therein, a plurality of openings 34 are provided through the bearing plate 25 to allow the insertion of the wires 19 through the bearing plate and the movement of the wires relative thereto. The prestressing wires extend outwardly from the slab and bearing unit 24 through the prestressing washer 18 where they are anchored by upsetting the ends 35 thereof. Accordingly, it is necessary that the wires 19 extend through and beyond the movable piston bearing plate 29, but it is not essential that the wires be movable relative to the piston plate 29 as will become more apparent hereinafter.

Positioned in the void 30 is a quantity of material which is solid in form at normal temperatures encountered during the prestressing operation. In addition, however, the material must be one which can be rendered liquid without damage to the prestressing wires 19 or any surrounding hardware. For example, in the presently preferred embodiment the material 38 contained within the void 30 is one which can be melted by the application of heat to raise the material 38 to a temperature which is substantially below any temperature which would change the characteristics of, or in any way damage, the prestressing wires 19. Examples of such materials which will be solid at normal operating temperatures but which can be easily liquified are sulfur and Woodsmetal. The material in its solid state must have sufficient compressive strength to withstand the compressive forces exerted by the piston bearing plate after the prestressing load has been applied to the tendon 14 and transferred to the bearing plate 29 through shims 21 inserted between the stressing washer and bearing plate 29. In the illustrative embodiment the diameter of the piston bearing plate 29 is approximately 5 inches and the load encountered in prestressing a tendon 14 is typically 50,000 pounds, such that the load upon the material 38 filling the void 30 is approximately 2,550 pounds per square inch in compression.

In the presently preferred embodiment of the present invention means are provided for furnishing heat to the material 38 in the void 30 to melt the material by defining an opening 40 which extends from the upper surface of the slab 11 and through the annular flange 26 to the void 30. A resistance heating unit is inserted through the opening 40 and extended into the material such that the temperature of the material can be raised by passing current through the heating element. In the embodiment shown, a resistance heating wire 42 is extended into the void 30 through the opening 40. The resistant heating wire is positioned within the void with the opposite ends thereof connected to a source of electricity 43 to provide the heating current for the resistance wire. Various means and types of resistance heating elements well known to the art can be utilized, it being necessary only that the heating element be capable of raising the temperature of the material 38 contained within the void 30 above the melting point thereof.

A series of longitudinally extending openings or ports 47 are provided through the piston bearing plate 29 in communication with the void 30. The ports 47 are of sufficient size to allow the passage of the material 38 therethrough when the material is in liquid form. The opening 47, is, however, sufficiently small that none of the material 38 can pass through the opening when the material is in solid condition under the pressure applied by the piston bearing plate 29 when the tendon 14 is prestressed.

Further details of the construction of the closure prestressing hardware in accordance with this invention will become more apparent in connection with the description of the method of the present invention and the operation of the apparatus. Accordingly, referring now to FIGURES 3, 4, 5, 6 and 7, as an illustrative example, the slab 11 is prestressed by disposing therein a series of tendons 14 as described hereinbefore with the closure stressing hardware A positioned at the surface 17' of the slab 11. Prior to tensioning the tendon 14, the stressing washer 18 is disposed against the piston bearing plate 29 and the tendon 14 within the slab 11 is in a relaxed condition. The piston bearing plate 29 is positioned within the cylinder 28 with the outer surface 50 thereof substantially flush with the outer surface of the flange 26 and the surface 17' of the slab 11. Thus, the material 38 which fills the void 30 will be between the piston bearing plate 29 and the bearing unit plate 25. The concrete forming the slab 11 is poured and allowed to set with the tendon 14 therein being movable within the casing 15 after the concrete has hardened. The slab 11 is then prestressed by stretching the tendons 14 composed of the plurality of prestressing wires 19. This

stressing or tensioning is done by means of the hydraulic jack **20** as described hereinbefore. By means of the jack the stressing washer **18** and consequently the ends **35** of the prestressing wires **19** are pulled away from the surface **17'** of the slab by a distance sufficient to exert the necessary tension forces upon the tendon **14**. At the required distance from the slab **17'** the shims **21** are inserted as shown in FIGURES 4, 6 and 7 to anchor the stressing washer **18** at a fixed distance from the piston bearing plate **29**. Thus, when placed under a tension load, the stressing washer **18** acts upon the shims **21** which in turn are in bearing contact with the piston bearing plate **29**. The piston bearing plate then exerts a compressive force upon the material **38** in the cylinder **28**, and in turn upon the bearing plate **25**. Since the bearing unit **24** is stationary with respect to the hardened concrete the compressive load is transmitted to the concrete and the slab **11** is in a post-tensioned condition. A typical distance by which the stressing washer **18** is moved outward from the relaxed condition of the tendon is six inches, for example. In connection with the present invention, it is sometimes expedient to elongate the tendon **14** by an amount greater than that required for the post-tensioning of the slab **11** since the stressing washer will move toward the plate **25** as described hereinafter.

After the slabs **10** and **11** have been cast and post-tensioned, the stressing washers **18** are at the position shown in FIGURE 3 and are maintained at that position by presence of the shims **21** bearing against the bearing plate **16** at the slab **10** and the piston bearing plate **29** in the slab **11**. A closure stressing tendon or coupler tendon **51** is then connected between the stressing washers **18** by means of couplers **52** at each end thereof as shown in FIGURES 3, 6 and 7. That is, the coupler tendon **51** is affixed at each end thereof to a stressing washer **58** similar to the conventional stressing washers **18**. Both the stressing washers **18** and **58** have male threads formed thereon. Stressing washers **58** are then connected to the stressing washers **18** by means of the female thread couplers **52** as shown in the figures. The tendon **51** when connected to the tendons **14** in the slabs **10** and **11** is drawn taut by turning the couplers to draw together the oppositely threaded washers **18** and **15**.

A sleeve **55** is then positioned to surround each coupler **52** between the coupler and the piston bearing plate **29**. The sleeve **55** is connected to the surface of the piston bearing plate and surrounds the coupler **52** to prevent the admission of concrete into the space between the stressing washer **18** and the piston bearing plate **29**. Since the shims **21** are greater in length than the diameter of the coupler **52** it is necessary to provide an opening through the sleeve in the illustrative embodiment shown, in order that the cavity between the coupling **52** and the piston bearing plate **29** can be maintained. Although a sleeve **55** is shown in the illustrative embodiment, other suitable means can be employed to prevent appreciable quantities of concrete from becoming positioned between the faces **56** and **56'** of the stressing washer **18** and coupler **52**, respectively, and the piston bearing plate **29**. That is, it is necessary that the stressing washer and coupler be relatively free to move toward the slab **11**. Such other suitable means would include positioning a compressible material such as a felt washer of sufficient thickness against the surfaces **56** and **56'** or positioning a compressible material such as polystyrene foam between the surfaces **56** and **56'** and the piston bearing plate **29**.

In addition, it is preferable to spray the tendon **51** with parting compound to prevent bonding thereof with the closure strip concrete.

The concrete is then poured into the space between the slabs **10** and **11** to form the closure strip **9** as shown in FIGURES 6 and 7. After the concrete has set the apparatus is in the orientation as shown in FIGURES 4 and 6, wherein the piston bearing plate **29** is separated from the bearing plate **25** by the material **38** in the cylinder. The closure strip **9** is then prestressed by heating the material **38** within the void **30** to a temperature above the melting point of the material. As the material becomes fluid it is capable of passing through the ports **47** to allow movement of the piston bearing plate **29** within the cylinder **28**. Thus, since the tension in the tendon **14** is subjecting the piston bearing plate to high forces in the direction toward the bearing plate **25** a high compressive force is exerted upon the material **38**. The material therefore flows through the ports **47** and allows the piston bearing plate to travel toward the bearing plate **25**. As the piston bearing plate **29** travels away from the coupler tendon **51** it elongates the coupler tendon and subjects it to tension forces. When the tension in the coupler tendon equals that in the tendons **14** the system is in equilibrium and a constant tensile force exists throughout the combined length of the tendons. Thus, the apparatus assumes the orientation as shown in FIGURE 7 at which part of the material **38** has moved through the piston bearing plate to fill the void now existing between the surface **60** of the closure strip and the outer surface of the plate **29**. The material will then resolidify at both sides of the piston bearing plate **29**. Thus, the complete length of concrete including the slabs **10** and **11** and closure strip **9** is equivalent to a single post-tensioned slab of this combined length. From the foregoing it can be seen that the depth of the cylinder **28** and of the void **30** is determined such that the piston bearing plate **29** can travel through a sufficient distance to elongate the coupler tendon **51** by the required amount to reach equilibrium conditions. Thus, the depth of the void must be somewhat greater than the required amount of travel. As discussed hereinbefore, the stressing apparatus of the present invention at one end of the coupler tendon, as shown in FIGURES 3, 4 and 5, is usually sufficient to obtain the required elongation of the coupler tendon, although two can be used when required. Referring now to FIGURE 8, an alternative embodiment is shown in which an opening **70** is provided through the slab **11** to the annular flange **26**. In this embodiment the material **38** is liquified by applying a source of heat directly to the flange to melt the material. For example, a blow torch **71** can be used by directing the flame through the opening **70**. Other means for melting the material or otherwise converting the material from a solid to a fluid will be apparent to one skilled in the art from the foregoing.

Accordingly, the present invention provides an improved apparatus for post-tensioning structures greater in length than has been heretofore possible. By means of the present invention a post-tensioned concrete member can be formed in segments and post-tensioned over the complete area thereof.

What is claimed is:

1. Apparatus for post tensioning a closure strip of concrete positioned between first and second spaced apart post-tensioned concrete slabs comprising: first and second corresponding pluralities of tendons extending in tension respectively through said first and second slabs with an end of each of the tendons in said first and second slabs extended into the space defined by the opposed edge surfaces of said first and second slabs; means affixing the end of each of said second plurality relative to the edge of said second slab; a bearing plate affixed to said end of each of said tendons of said first plurality; a cylinder positioned surrounding each of said bearing plates within said first slab, said cylinder having an open end at said edge surface of said first slab and extending longitudinally therein, said bearing plate being longitudinally movable within said cylinder with the respective tendon; means for releasably affixing each of said bearing plates in a first longitudinal position within the respective cylinder; a

coupler tendon connected between the fixed end of a tendon in the second plurality and the releasable end of the corresponding tendon in the second plurality; means for releasing each of said bearing plates from the exterior of said slab after concrete has been poured and hardened between said edge surfaces whereby each of said bearing plates is released from said first longitudinal position.

2. Apparatus for post-tensioning a closure strip of concrete positioned between first and second spaced apart post-tensioned concrete slabs comprising first and second corresponding pluralities of tendons extended in tension through said first and second slabs respectively with an end of each of the tendons in each of said first and second slabs extended into the space defined between opposed edge surfaces of said first and second strips; means affixing the ends of said second plurality to the edge of said second slab; a bearing plate affixed to each of said ends of said first plurality of tendons; a plurality of cylinders positioned within said first slab surrounding said ends of each of said tendons, said cylinder having an open end at said surface and extending longitudinally into said slab, said bearing plate being longitudinally movable within said cylinder with said tendon, said tendon extending into said cylinder through the end thereof opposite said open end; a volume of solid material positioned between said bearing plate and said end of said cylinder opposite said open end for affixing said bearing plate in a first longitudinal position within said cylinder, said bearing plate being spaced thereby from said opposite end of said cylinder; said bearing plate defining a fluid passage longitudinally therethrough; said material being adapted to be melted; a coupler tendon connected between the end of a tendon in said first plurality and a corresponding tendon in said second plurality, means for isolating said tendon and said connected end at said tendon in said first plurality whereby the coupler tendon and interconnected end with said tendon in said first plurality are longitudinally movable after concrete in said closure strip has hardened; means for supplying heat from the exterior of said slab and closure strip to said material for melting said material after concrete has been poured and hardened in said closure strip, whereby said material when molten flows through said longitudinal opening to release said bearing plate and allow travel thereof toward said opposite end of said cylinder to place said coupler tendon in tension.

3. Apparatus for post-tensioning a closure strip of concrete positioned between the opposed edges of first and second spaced apart post-tensioned concrete slabs, comprising: a first tendon extended in tension through said first slab with an end of said tendon extended from the edge thereof into the space defined by the opposed edge surfaces of the first and second slabs, a second tendon extended in tension through said second slab with an end of said tendon extended into said space opposite the end of said first tendon; means for releasably affixing the end of said first tendon relative to the edge of said first slab including a bearing plate connected to said end, a cylinder surrounding said bearing plate and said tendon, said bearing plate being longitudinally movable within said cylinder, said cylinder having a bearing end toward which said bearing plate is normally urged by the tension of said first tendon; a volume of solid material positioned between said bearing plate and said bearing end of said cylinder, said bearing plate being spaced from said bearing end by said material, said material being aadpted to be melted; said bearing plate defining a fluid passage longitudinally therethrough; a coupler tendon extended through said space and connected to the ends of said first and second tendons in said space, means surrounding said coupler tendon and end of said first tendon to isolate said coupler tendon and end from concrete poured into said space to form said closure strip; means for supplying heat to said material from the exterior of said slabs and closure strip to said material for melting said material after concrete has been poured and hardened in said closure strip, whereby said material when molten flows through said longitudinal opening to release said bearing plate and allow travel thereof toward said bearing end of said cylinder to place said coupler tendon in tension after the concrete in said closure strip has hardened.

References Cited in the file of this patent

UNITED STATES PATENTS

2,413,990	Muntz	Jan. 7, 1947
2,483,175	Billner	Sept. 27, 1949
2,825,957	Von Heidenstam	Mar. 11, 1958
2,886,875	Anderson	May 19, 1959

FOREIGN PATENTS

155,756	Australia	Mar. 18, 1954