Nov. 28, 1967 R. E. EASTERDAY 3,355,529

METHOD OF FORMING POST TENSIONED CONCRETE LINERS IN CONDUITS

Filed June 24, 1965 3 Sheets-Sheet 1

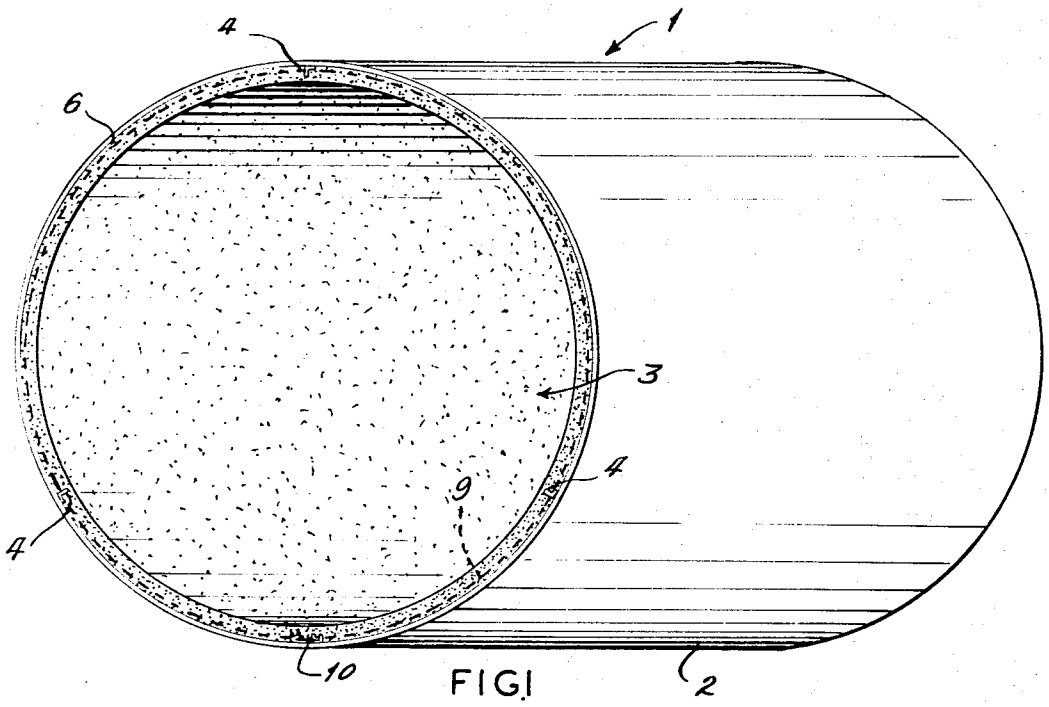


FIG.1

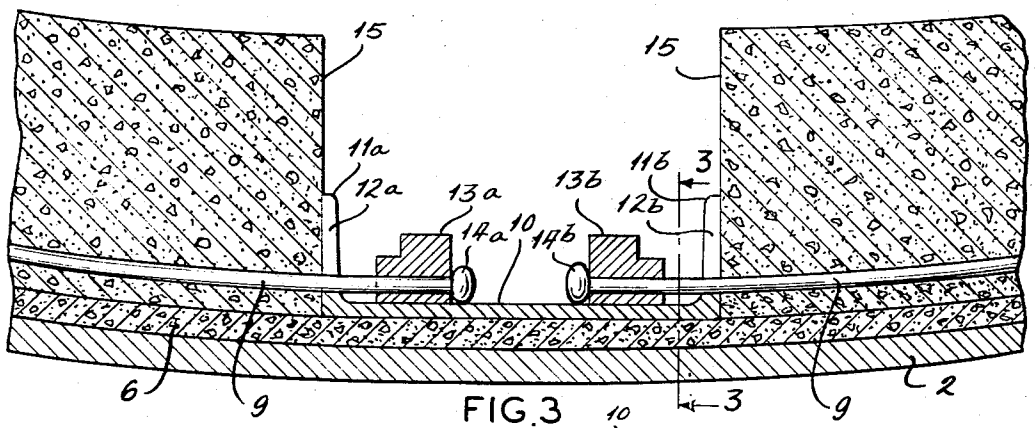


FIG.3

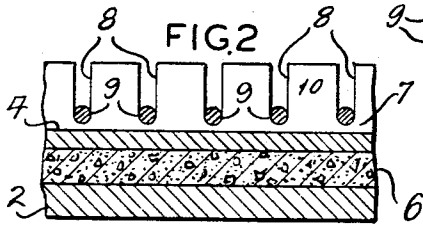


FIG.2

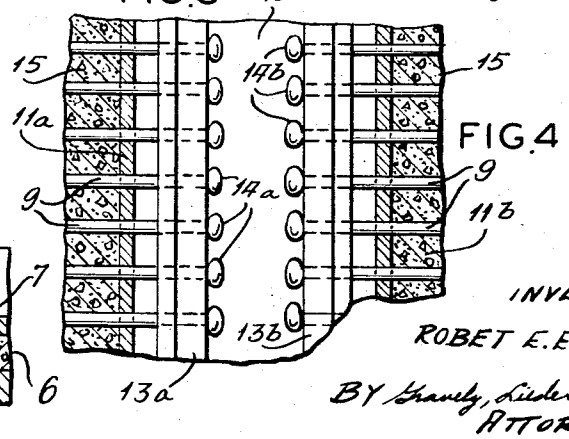


FIG.4

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METHOD OF FORMING POST TENSIONED CONCRETE LINERS IN CONDUITS

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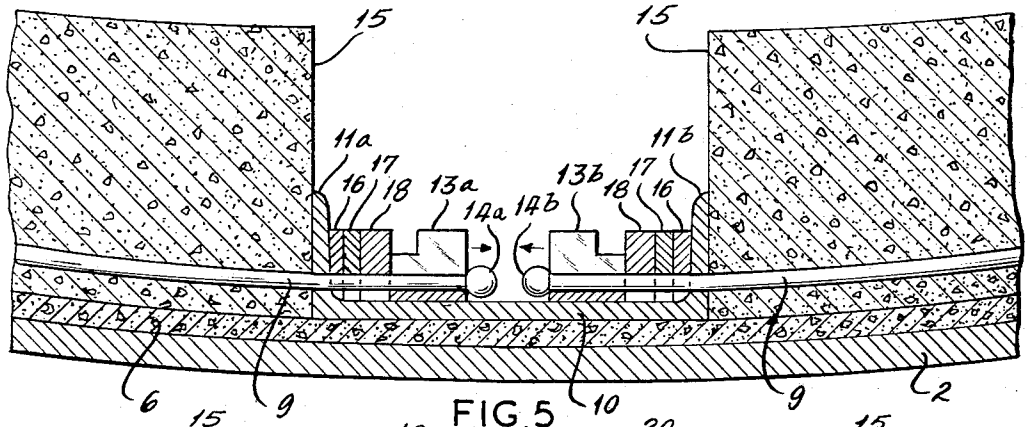


FIG.5

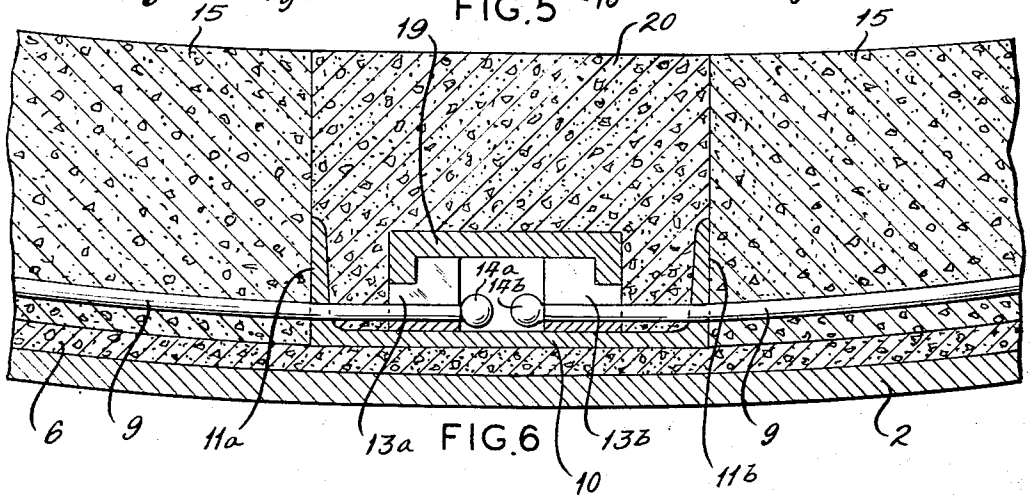


FIG.6

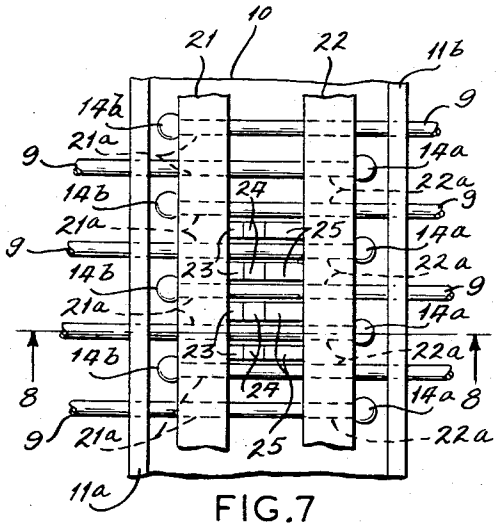


FIG.7

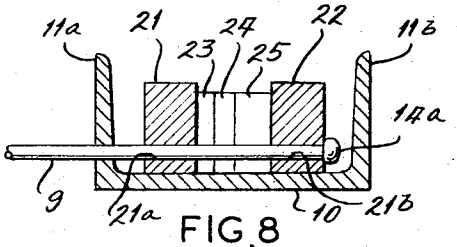


FIG.8

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METHOD OF FORMING POST TENSIONED CONCRETE LINERS IN CONDUITS

Filed June 24, 1965 3 Sheets-Sheet 3

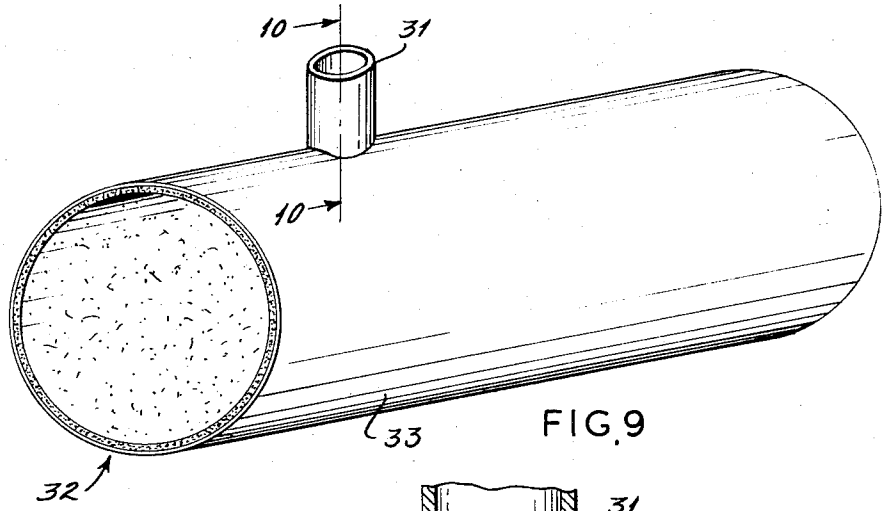


FIG. 9

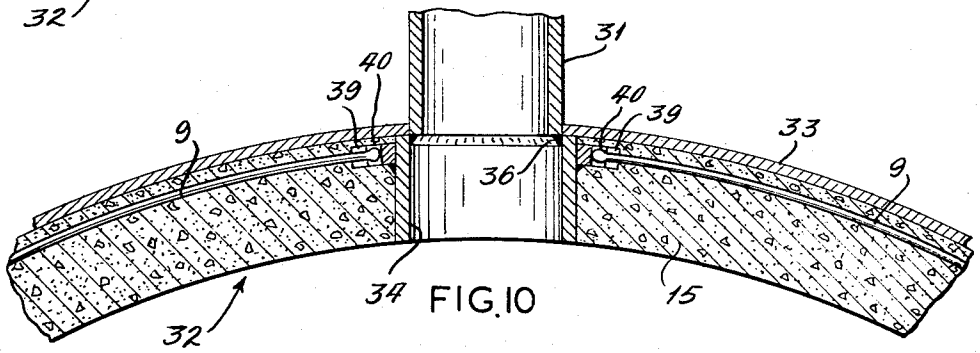


FIG. 10

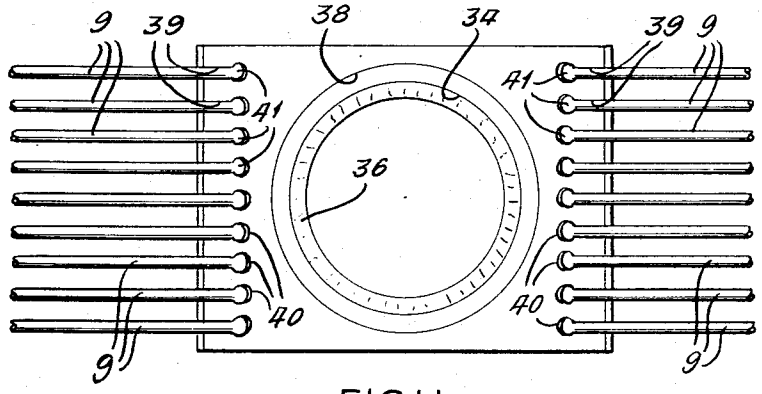


FIG. 11

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3,355,529

METHOD OF FORMING POST TENSIONED CONCRETE LINERS IN CONDUITS

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10 Claims. (Cl. 264—32)

This invention relates to a method of installing and post tensioning concrete liners and more particularly to techniques for strengthening existing conduits by providing liners of post tensioned concrete within the conduit.

Heretofore various methods and techniques have been devised for making post tensioned concrete structures including concrete conduits. However, none of the techniques are applicable to strengthening existing conduits by installing a post tensioned concrete liner therein. Moreover, in making such post tensioned concrete conduit, tensioning rods were positioned about the outer area of the continuous concrete conduit and tensioned by tightening the tensioning rods to create compressive force in the concrete. The prior methods are not adaptable to post tensioning concrete structures by internal access to the existing conduit. Obviously, the concrete interior of a conduit cannot be continuous where access to post tensioning rods is achieved solely by internal access to the conduit.

The present invention provides an unique technique for forming a layer of post tensioned concrete within the existing conduit with only internal access to the conduit. Briefly, the invention contemplates installing post tensioning rods about the circumferential interior of an existing conduit and forming a layer of concrete over the tensioning rods with the exception of an area for providing a post tensioning stress bearing channel or member where the ends of the post tensioning rods may be drawn together to apply tension to the rods and compression to the concrete. The stress bearing channel or member provides a compression stress transfer member for the concrete. Moreover, the invention contemplates providing a stress transfer plate to permit lining the area of an existing conduit near manhole openings with post tensioned reinforced concrete.

It is therefore an object of the invention to provide a method of forming a post tensioned concrete liner in existing conduits;

It is another object of the invention to provide a method for strengthening existing conduits by forming a liner of post tensioned reinforced concrete within the conduit by internal access to the conduit;

It is a further object of the invention to provide a method of reinforcing existing conduits by internal access thereto for forming a post tensioned concrete liner within said conduit;

It is another object of the invention to provide a method of post tensioning concrete formed within existing conduit by providing post tensioning rods within the concrete liner which terminate within a stress bearing member adapted to transfer compressive stress to the concrete liner;

It is a further object of the invention to provide a method of post tensioning existing conduits by internal access thereto in areas having entrant manholes by providing a stress transfer plate and a stress bearing channel or member with post tensioning wires extending from the stress transfer member into the stress bearing channel for applying compressive stress to the concrete surrounding the reinforcing wire in the area of the entrant manholes.

These and other objects and advantages of the invention will become apparent from the ensuing descriptions taken in conjunction with the drawings wherein:

FIG. 1 illustrates a portion of an existing conduit having post tension concrete applied by the method of the invention;

FIG. 2 is an expanded part sectional view of the conduit of FIG. 1 illustrating the stressing rod support bracket;

FIG. 3 is an expanded part sectional view of the conduit of FIG. 1 illustrating the stress bearing member;

FIG. 4 is a plan view of the stress bearing member in FIG. 3;

FIG. 5 illustrates one method of tensioning the reinforcing wires and compressing the concrete;

FIG. 6 illustrates another method of tensioning the reinforcing wires and compressing the concrete;

FIG. 7 is a broken away portion of a stress bearing channel or member illustrating still another method of post tensioning the reinforcing wires and compressing the concrete;

FIG. 8 is a cross sectional view taken along the line 8—8 of FIG. 6;

FIG. 9 illustrates a section of an existing conduit in FIG. 1 having an entrant manhole for access to the conduit post tensioned by the method of the invention;

FIG. 10 is a sectional view taken along the lines 10—10 of FIG. 9; and

FIG. 11 illustrates the stress transfer plate utilized in the invention to permit post tensioning of the conduit in the area of an entrant manhole.

Referring now to the drawings, wherein like numerals indicate like parts, and particularly to FIGS. 1–5, an existing conduit **1** having a steel wall **2** has a reinforced concrete interior wall, generally designated **3**, which is installed and post tensioned in accordance with the invention.

To facilitate installation of the reinforced concrete interior wall **3**, support brackets **4** (see FIG. 2) having an angle shape are provided. The brackets **4** are positioned longitudinally around the internal periphery of steel wall **2**, and may be secured internally by a thin concrete layer **6** coating the steel wall **2**. Obviously other methods, such as epoxy glue, could be used to secure brackets **4** to steel wall **2**. The projecting flanges **7** of brackets **4** have a number of slots **8** which support reinforcing rods or wires **9** circumferentially about and spaced from steel wall **2**. A stress bearing channel or member **10** (see FIGS. 3 and 4), having a pair of flanges **11***a* and **11***b*, is also secured to steel wall **2** by concrete layer **6**, or epoxy glue. Flanges **11***a* and **11***b* have slots **12***a* and **12***b* respectively which support the wires **9**. The ends of wires **9** are passed through bores in stressing heads **13***a* and **13***b*, and are formed with beads **14***a* and **14***b*, respectively.

Next, concrete section **15**, which forms part of interior wall **3**, is formed surrounding stressing wires **9** and of the required thickness for the designed final loading. The concrete section **15** does not fill the channel **10**. The stressing wires **9** are coated with releasing material to prevent adhesion to concrete section **15**. After concrete wall **15** has cured properly, the post tensioning of wires **9** is accomplished by any of several techniques. As illustrated in FIG. 5, a series of shims **16**, **17** and **18** of various sizes are wedged between flanges **11***a* and **11***b* and their respective stressing heads **13***a* and **13***b* to move the ends of wires **9** towards each other placing the wires **9** in tension. The tension strain is transferred from beads **14***a* and **14***b* to stressing heads **13***a* and **13***b*, respectively, and through the shims to flanges **11***a* and **11***b* of channel **10**. In this manner tension stress of wires **9** creates uniform compressive stress in the concrete **15**. Another means for tensioning wires **9**, hence applying compression stress to concrete **15**, is illustrated in FIG. 5. The stressing heads **13***a* and **13***b* of FIG. 5 are jacked towards each other placing wires **9** under tension and compres-

sing concrete 15. After the desired tensioning of wires 9, clamping plate 19 is placed to secure stressing heads 13*a* and 13*b* in the proper position. After the post tensioning has been completed, concrete filler 20 is placed within the area around stress bearing member 10 to complete interior wall 3 for conduit 1. Further, concrete filler 20 will prevent damage to the channel 10.

In FIGS. 7 and 8 another method of tensioning wires 9 is illustrated. As shown the ends 9*a* and 9*b* of each wire 9 overlap in channel 10. Ends 9*a* of each wire 9 are passed through bores in flange 11*a*, slots 21*a* in stressing head 21, and then through bores in stressing head 22. The ends 9*a* are then formed with heads 14*a*. Likewise, the ends 9*b* of each wire 9 are passed through bores in flange 11*b*, slots 22*a* in stressing head 22, and then through bores in stressing head 21. The ends 9*b* are then formed with beads 14*b*. It will be understood that slots 21*a* and 22*a* in stressing heads 21 and 22, respectively, may extend from either the bottom or top. A series of shims 23, 24 and 25 are positioned between the ends 9*a* and 9*b* of wires 9 and intermediate stressing heads 21 and 22. In this manner heads 21 and 22 are forced apart, and apply tension to stressing wires 9, hence apply uniform compression stress to the concrete 15.

Referring to FIGS. 9, 10 and 11, a section 30 of conduit 1 with a manhole access housing 31 is provided with a reinforced concrete interior wall 32, similar to interior wall 3 in the other areas of conduit 1, surrounding the access housing that is installed and post tensioned in accordance with the invention. The section 30 has a steel wall 33. In order to facilitate post tensioning concrete interior wall 32, an access housing extension 34 is placed within section 30 surrounding access housing 31, and is welded in place along weld line 36. After installing housing extension 34, the optional concrete layer 6, as described with respect to FIGS. 1–5, may be coated on the interior of steel wall 33 to secure support brackets 4 and stress bearing channel 10 thereto. Next, a curved plate 37 having a central opening 38 is positioned around extension 34, and is welded in place. The curved plate 37 has a series of slots 39 which communicate with enlarged openings 40. Enlarged heads 41 at one end of stressing wires 9 seat in enlarged openings 40 with wires 9 in slots 39. Of course, the other ends of wires 9, although not illustrated, extend into channel 10. The wires 9 are supported by support brackets 4 positioned around the interior of steel wall 33, similarly as with respect to steel wall 2. Next, concrete section 15, forming part of interior wall 32, is provided surrounding stressing wires 9 exteriorly of housing extension 34 and channel 10. When cured, concrete section 15 is post tensioned by any of the techniques mentioned heretofore. The interior wall 32 is completed by placing concrete filler 20 within the area of channel 10.

From the foregoing it will be appreciated that applicant's method contemplates supporting stressing wires around the interior of an existing conduit which wires terminate in stress bearing channels or members, covering the stressing wires with a concrete wall exteriorly of the stress bearing channel or members, and thereafter post tensioning the wires to compress the concrete wall. Moreover, applicant's method permits transfer of post tensioning stress past manhole access housings in the conduit. By this technique, it will be appreciated that applicant's method permits post tensioning to provide a reinforced concrete interior wall within an existing conduit solely by internal access thereto.

It will be appreciated that various modifications and changes to applicant's techniques will be readily apparent to those skilled in the art, and therefore all such modifications and changes are deemed to be within the scope of the invention as defined by the appended claims.

What is claimed is:

1. A method of forming post tensioned concrete liners in existing conduit comprising the steps of applying a thin coating of cementitious material to the internal surface of the conduit securing a stress bearing member by said cementitious material to said conduit, supporting stressing wires around the interior of said conduit with the ends thereof extending into said stress bearing member, forming a layer of concrete around said stressing wires exteriorly of said bearing member, and post tensioning said wires.

2. A method of forming post tensioned concrete liners in existing conduit comprising the steps of applying a thin coating of cementitious material to the internal surface of the conduit securing a stress bearing member by said cementitious material to said conduit, supporting stressing wires peripherally around the interior of said conduit with the ends of said wires terminating in said stress bearing member, forming a layer of concrete around said stressing wires exteriorly of said bearing member, and forcing the ends of said wire in opposed directions to post tension said wires.

3. A method of forming post tensioned concrete liners in conduit members by internal access thereto comprising the steps of applying a thin coating of cementitious material to the internal surface of the conduit securing a stress bearing member by said cementitious material to said conduit, extending stressing wires peripherally around the interior of said conduit with the ends of the stressing wires terminating in said stress bearing member, forming a layer of concrete around said stressing wires exteriorly of said bearing member, and forcing the ends of said wires in opposed directions to apply compressive force to said layer of concrete.

4. A method of forming post tensioned concrete liners in conduit members by internal access thereto comprising the steps of applying a thin coating of cementitious material to the internal surface of the conduit securing a stress bearing member by said cementitious material to said conduit, extending stressing wires circumferentially around the interior of said conduit with the ends of the stressing wires overlappingly terminating in said stress bearing member, forming a layer of concrete around said stressing wires exteriorly of said bearing member, and forcing the ends of said wires away from each other to apply compressive force to said layer of concrete.

5. A method of forming post tensioned concrete liners in existing conduit by internal access to the conduit comprising the steps of applying a thin coating of cementitious material to the internal surface of the conduit securing a stress bearing member by said cementitious material to said conduit, securing support members within said conduit, placing stressing wires around the interior of said conduit supported by said support members with the ends of the stressing wires extending into said bearing member, forming a layer of concrete over said stressing wires exteriorly of said bearing member, drawing the ends of the wires toward each other in said stress bearing member to post tension said wires, and thereafter filling said stress bearing member with a layer of concrete.

6. A method of forming post tensioned concrete liners in existing conduit by internal access to the conduit comprising the steps of applying a thin coating of cementitious material to the internal surface of the conduit securing a stress bearing member by said cementitious material to said conduit, securing support members within said conduit, placing stressing wires around the interior of said conduit supported by said support members with the ends of the stressing wires overlappingly extending into said bearing member, forming a layer of concrete over said stressing wires exteriorly of said bearing member, forcing the ends of the wires away from each other interiorly of said stress bearing member to post tension said wires, and thereafter filling said stress bearing member with a layer of concrete.

7. The method of forming post tensioned concrete liners in existing conduits having an entrant access opening comprising the steps of applying a thin coating of

cementitious material to the internal surface of the conduit positioning a stress transfer member within said access opening, securing a stress bearing member by said cementitious material to said conduit peripherally aligned with said stress transfer member, supporting stressing wires around the interior of said conduit intermediate each side of said stress transfer member and said stress bearing member with one of the ends of the stressing wires secured to said stress transfer member and the other ends of the stressing wires extending into said stress bearing member, forming a layer of concrete around said stressing wires exteriorly of said stress transfer member and said stress bearing member, and post tensioning said stressing wires to apply compressive force to said concrete liners.

8. The method of forming post tensioned concrete liners in existing conduits having an entrant access opening comprising the steps of applying a thin coating of cementitious material to the internal surface of the conduit positioning a stress transfer member within said access opening, securing a stress bearing member by said cementitious material to said conduit peripherally aligned with said stress transfer member, supporting first stressing wires around the interior of said conduit intermediate said stress transfer member and said stress bearing member with one of the ends of the stressing wires secured to said stress transfer member and the other ends of the stressing wires extending into said stress bearing member, forming a layer of concrete around said stressing wires exteriorly of said stress transfer member and said stress bearing member, post tensioning said stressing wires to apply compressive force to said concrete liners, and thereafter filling said stress bearing member with a layer of concrete.

9. A method of forming post tensioned concrete liners in an existing conduit having an entrant access opening comprising the steps of applying a thin coating of cementitious material to the internal surface of the conduit positioning a stress transfer member within said access opening, securing a stress bearing member by said cementitious material to said conduit peripherally aligned with said stress transfer member, supporting a first series of stressing wires around the interior of said conduit from one side of said stress transfer member to one side of said stress bearing member with one end of the first series of stressing wires secured to said one side of said stress transfer member and the other ends of the first series of stressing wires extending into said one side of stress bearing member, supporting a second series of stressing wires around the interior of said conduit from the other side of said stress transfer member to the other side of said stress bearing member with one end of the

second series of stressing wires secured to the other side of said stress transfer member and the other ends of said second series of stressing wires extending into said other side of said stress bearing member, forming a layer of concrete around said first series of stressing wires and said second series of stressing wire exteriorly of said stres transfer member and said stress bearing member, and forcing said other ends of said first series of said stressing wires and said other ends of said second series of stressing wires in opposed directions to post tension said first series of stressing wires and said second series of stressing wires.

10. A method of forming post tensioned concrete liners in an existing conduit having an entrant access opening comprising the steps of applying a thin coating of cementitious material to the internal surface of the conduit positioning a stress transfer member within said access opening, securing a stress bearing member by said cementitious material to said conduit peripherally aligned with said stress transfer member, supporting a first series of stressing wires around the interior of said conduit from one side of said stress transfer member to one side of said stress bearing member with one end of the first series of stressing wires secured to said one side of said stress transfer member and the other ends of the first series of stressing wires extending into said one side of said stress bearing member, supporting a second series of stressing wires around the interior of said conduit from the other side of said stress transfer member to the other side of said stress bearing member with one end of the second series of stressing wires secured to the other side of said stress transfer member and the other ends of said second series of stressing wires extending into said other side of said stress bearing member, forming a layer of concrete around said first series of stressing wires and said second series of stressing wires exteriorly of said stress transfer member and said stress bearing member, forcing said other ends of said first series of said stressing wires and said other ends of said second series of stressing wires in opposed directions to post tension said first series of stressing wires and said second series of stressing wires, and thereafter filling said bearing member with a layer of concrete.

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