Sept. 6, 1966 L. WORSON 3,270,636

METHOD AND APPARATUS FOR FORMING JOINTS IN CONCRETE

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FIG. 1

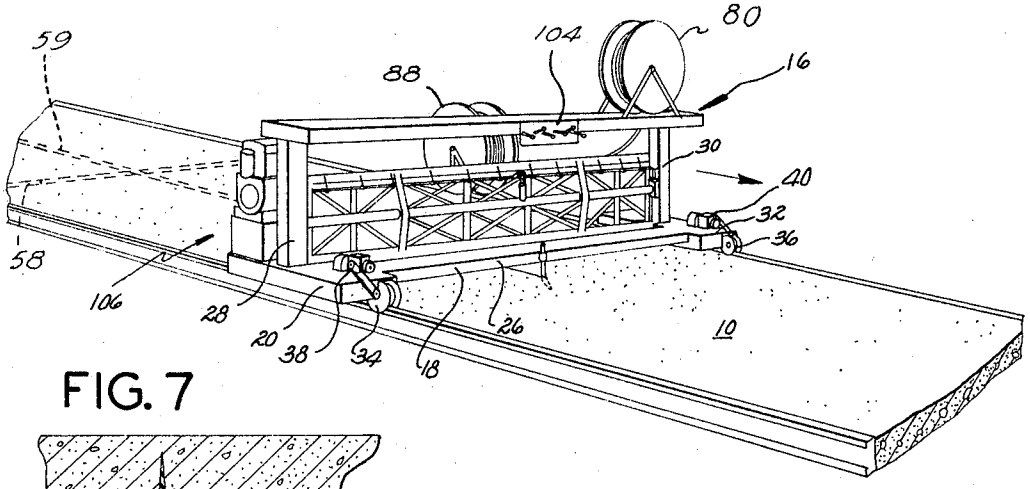


FIG. 7

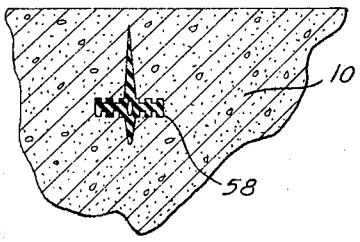
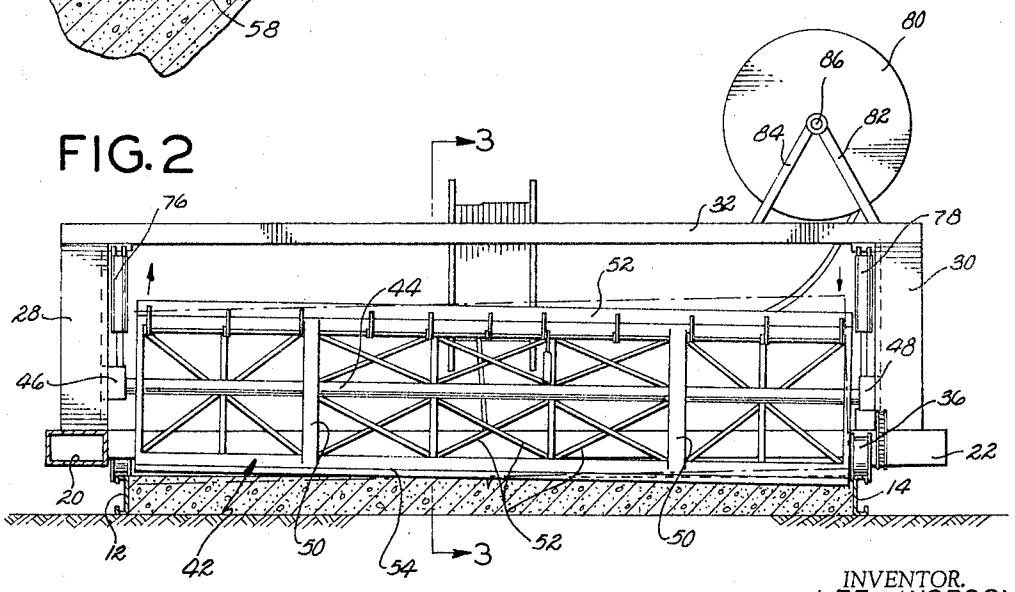


FIG. 2



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FIG. 3

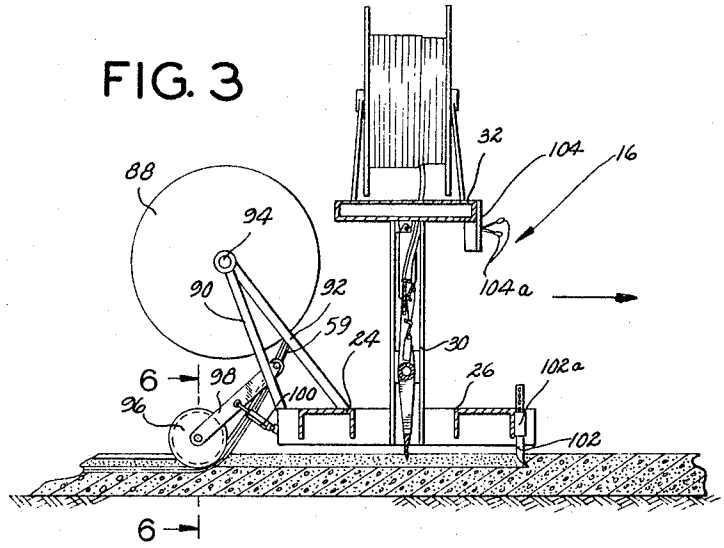


FIG. 4

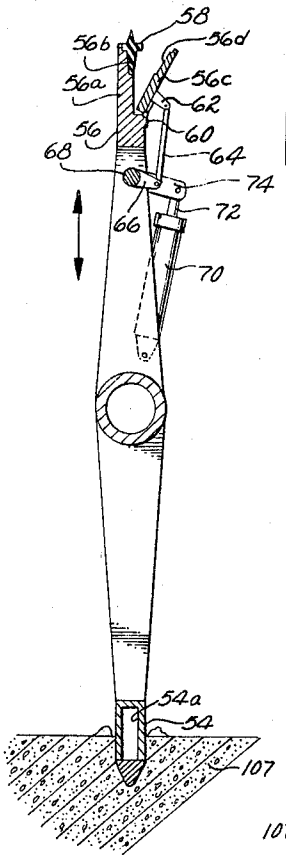


FIG. 5

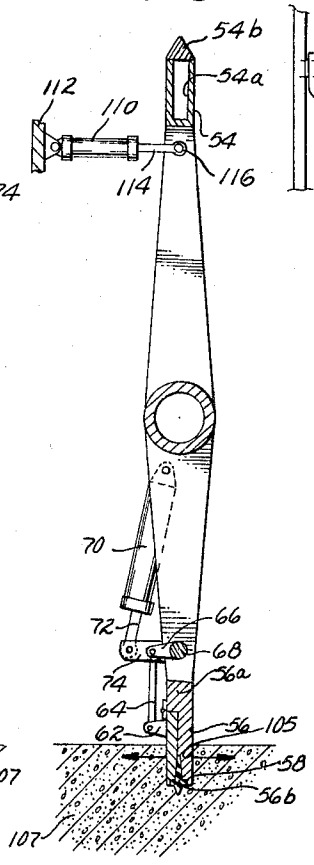
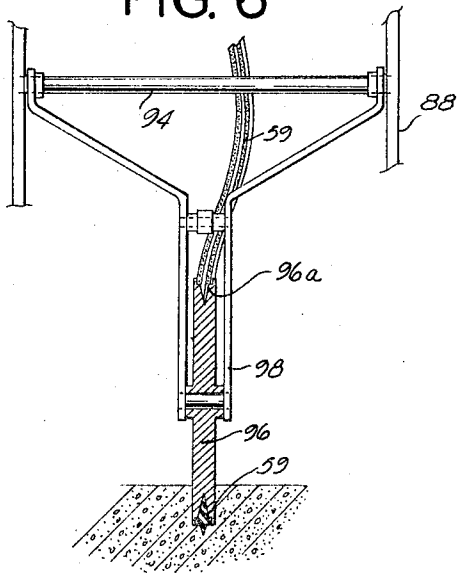


FIG. 6



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METHOD AND APPARATUS FOR FORMING JOINTS IN CONCRETE

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3 Claims. (Cl. 94—51)

The present invention relates to a method of forming joints in concrete and the apparatus for forming such joints, but more particularly it pertains to methods and apparatus for embedding flexible sealing and expansible joint forming means in uncured concrete.

In the construction of large concrete surfaces, as for instance roadways, airport runways and the like, it is necessary to provide joints in the concrete for systematic control of expansion and contraction of the concrete with changes in temperature. If provision is not made for such systematic control, as the concrete contracts during final curing thereof random cracks will occur throughout the entire surface. Eventually such cracks become enlarged due to wear and further expansion and contraction of the concrete.

In addition to controlling the occurrence of cracks in the concrete, it is necessary that sealing means be provided in the resulting joints or cracks to prevent moisture from washing away the bed beneath the road and to prevent the creation of excessive pressures within the concrete due to changes in temperature of such moisture. Accordingly, as set forth in my copending application Serial No. 729,743, filed April 21, 1958 for Combined Weakened Plane Joint Former and Water Stop, now Patent No. 3,023,681 elongated flexible sealing and joint forming strips are embedded in the concrete before it is cured. However, due to the necessary flexibility of such strips, it is difficult to introduce them into the concrete to a position beneath the surface thereof. This, of course, is due to the lack of firmness of the flexible strips and to the thickness or heavy consistency of the concrete, the latter of which, as is well known in the art, is composed of many large objects as for instance rocks or stones which comprise gravel, a necessary element of concrete. Also, cement itself when mixed with the proper amount of water is relatively thick and heavy, and hence offers considerable resistance to objects.

Due to the above-noted characteristics of both cement and concrete, it is extremely difficult to insert an elongated light weight flexible member to an embedded position therein. The flexibility of such strips is necessary to insure that the strips firmly engage the sections of concrete to form a water-tight seal therebetween.

It is therefore an object of this invention to provide a method for embedding elongated flexible joint forming means in uncured concrete.

Another object of this invention is to provide a method of embedding elongated flexible strips beneath the surface of uncured concrete.

Another object of this invention is to provide the method as characterized above wherein a predetermined path is initially formed through the aggregate of the concrete, and thereafter said strips are forcibly inserted into the concrete along such predetermined path.

Another object of this invention is to provide a method of inserting flexible strips in concrete which comprises the application of localized pressure to said strip, such localized pressure being applied progressively along said strip to thereby effectively insert the entire flexible strip.

Another object of this invention is to provide the method as characterized above wherein the elongated strips are rocked back and forth as they are inserted to prevent deformation of the strips.

Another object of this invention is to provide apparatus for embedding both longitudinal and lateral combined waterstop and joint forming strips in uncured concrete.

Another object of this invention is to provide apparatus as characterized above having releasable insertion means for retaining said strips while they are being inserted into the concrete and thereafter effecting release of said strips to permit the same to remain embedded in the concrete.

Another object of the present invention is to provide apparatus as characterized above having means for rocking the insertion tool end-for-end during the insertion operation.

Another object of this invention is to provide apparatus as characterized above which is mobile for movement relative to the area of concrete to be provided with joint forming means.

Another object of this invention is to provide apparatus as characterized above having automatic hydraulic operating means.

Another object of this invention is to provide apparatus as characterized above which is simple and inexpensive to manufacture and rugged and dependable in operation.

The novel features which I consider characteristic of my invention are set forth with particularity in the appended claims. The device itself, however, both as to its organization and mode of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view of apparatus according to the present invention shown in operating position relative to a large area of concrete;

FIGURE 2 is a front elevational view of the apparatus of FIGURE 1;

FIGURE 3 is a sectional view taken substantially along line 3—3 of FIGURE 2 of the drawings;

FIGURE 4 is a fragmentary sectional view through the insertion tool of the apparatus of FIGURE 1;

FIGURE 5 is a fragmentary sectional view similar to FIGURE 4 showing a combined waterstop and weakened plane joint former inserted into the concrete;

FIGURE 6 is a fragmentary sectional view taken substantially along line 6—6 of FIGURE 3 of the drawings; and

FIGURE 7 is a fragmentary sectional view of a combined waterstop and weakened plane joint former that has been embedded in concrete by means of the method and apparatus of the present invention.

Like reference characters indicate corresponding parts throughout the several views of the drawings.

Referring to FIGURE 1 of the drawings, the embodiment chosen for illustration of the present invention is shown in operating position immediately above a section of uncured concrete **10**. Such concrete may be part of a roadway, airport runway, flood control or irrigation canal, or substantially any other structure having large areas of concrete.

In building the forms for receiving and defining the shape of the concrete, it may be desirable to employ means such as side form rails **12** and **14** which can also serve as a track along which the subject apparatus can be propelled as will hereinafter be explained. However, the particular means of locomotion for the subject apparatus does not form a limiting part of this invention, it merely being necessary that any desired means for moving the apparatus relative to the concrete, as will hereinafter appear in detail, be provided for successful practice of this invention.

With the forms for the concrete suitably positioned, the concrete **10** can be poured in any desired manner. Before the concrete has cured, the subject apparatus

identified generally with the numeral **16** should be positioned for relative movement with respect to the longitudinal strip of freshly-poured concrete.

Apparatus **16** is formed of various types of steel structural members. The body or frame thereof includes a base or platform **18** which is composed of a pair of longitudinally extending box or U-shaped end members **20** and **22** which are joined together by a pair of elongated inverted U-shaped channel members **24** and **26**. As will hereinafter become more readily apparent, the subject apparatus must be extremely rugged and dependable in operation thus necessitating the use of relatively strong steel members welded with a unitary structure. At either end of platform **18** is positioned a vertical support **28** and **30** respectively, each of which may take any desired form in accordance with the support function to be performed. Attached to the upper end portions of support members **28** and **30** is a box section channel member **32** which is positioned transversely on apparatus **16**.

To support the entire apparatus while permitting movement thereof, there are provided suitable wheels, as shown at **34** and **36**, attached to the box members **20** and **22** in any appropriate manner. Any desired number of wheels may be employed, to adequately support the apparatus. As shown most clearly in FIGURES 1 and 2, the wheels shown in the disclosed embodiment are formed to straddle the C-shaped rails **12** and **14** to insure that the apparatus remains in the proper position with respect to the concrete **10**.

Any suitable means, as for instance motors **38** and **40**, may be employed for rotating wheels **34** and **36** respectively, there being suitable chain or belt drive means for transmitting power therebetween. The energy for operating motors **38** and **40** may be supplied from any suitable source as for instance a gasoline engine-driven generator carried on the apparatus.

An insertion tool identified generally with the numeral **42** is mounted on the apparatus laterally or transversely of the direction of the latter. Tool **42** is formed with a shaft **44** the opposite ends of which are rotatably mounted in suitable brackets or bearing members **46** and **48**, which are slidable vertically in the support members **28** and **30** respectively. Due to this arrangement, support members **28** and **30** should be formed with channels for receiving the bearing members and permitting vertical movement thereof while preventing rotation or horizontal relative movement.

The shaft **44** carries a predetermined number of transverse vertical arm members as at **50** and a predetermined number of angularly diposed structural members as at **52**. The resulting structure is substantially coplanar, parallel to the axis of rotation of shaft **44**. Along the opposite side edges of insertion tool **42** are a pair of tool members **54** and **56**, shown most clearly in FIGURES 4 and 5 of the drawings.

Tool member **54** extends the entire length of insertion tool **42** and is disposed transversely of the direction of movement of the apparatus **16**. As shown most clearly in FIGURES 4 and 5 of the drawings, tool member **54** does not have any moving parts and may, if desired, be formed with a hollow as shown at **54***a*. For purposes to be hereinafter explained in detail, tool member **54** is preferably provided with an elongated tip or edge as at **54***b*.

Insertion tool **56** is formed with an abutment member **56***a* which extends the entire length of tool **42** for receiving an elongated combined waterstop and joint forming strip **58**. To facilitate this, abutment member **56***a* is shaped throughout its length with a surface **56***b* which corresponds to one side of strip **58**.

A latching member **56***c* is pivotally fixed to abutment member **56***a* by means of spaced hinges as shown at **60** and is formed with a surface **56***d* which conforms to the other side of the strip **58**. A plurality of spaced lugs **62** are fastened to latching member **56***c*. Each lug **62** is connected to one end of an actuating lever **64**, the opposite end of which is fastened to a bell crank **66** firmly fastened to a rotatable rod **68**. Rod **68** as shown most clearly in FIGURES 2, 4 and 5, is mounted within suitable openings in the transverse structural members **50** of insertion tool **42**. For rotation of rod **68**, there is provided one or more hydraulic operating cylinders **70** secured to the transverse structural members **50**. Each hydraulic cylinder **70** is provided with a piston (not shown) and piston rod **72** which is rotatably connected to a pivot arm **74**. Each arm **74** is non-rotatably fastened to rod **68**, to transmit the operation of the respective cylinder **70** to rod **68**.

At the opposite ends of tool **42** there is provided hydraulic rocking cylinders **76** and **78**. Such cylinders are firmly anchored to transverse support member **32** and are provided with piston rods which are connected to the respective bearing members **46** and **48**. As will be readily apparent to those persons skilled in the art, this arrangement enables either or both of the opposite ends of shaft **44** to be moved in a vertical direction in accordance with the particular function to be performed as will hereinafter be explained in detail.

Mounted on support member **32** is a spool or drum **80** on which is wound a suitable length of strip material **58** for providing the transverse joints in the concrete **10**. Such spool **80** is rotatably supported by means of bracket members **82** and **84** carrying a shaft **86**.

A similar spool **88** is mounted on the rear of the apparatus for supplying strip material **59** identical to the strip material **58** to be positioned longitudinally in the concrete **10**. Spool **88** is rotatably mounted by means of bracket members **90** and **92** which are fastened to inverted channel member **24** and which carry a shaft **94**.

A rotatable insertion wheel **96** carried by a lever mechanism **98** projects from the rear of the apparatus. Lever mechanism **98** is pivotally fastened relative to the bracket members which support spool **88**. A hydraulic actuating cylinder **100** is interposed between channel member **24** and lever mechanism **98** for controlling the position of wheel **96** with respect to the section of concrete **10**.

Mounted on the front of the apparatus is path forming means comprising an adjustable tool **102** which slidably fits within a sleeve **102***a* welded to channel member **26**. Any appropriate means may be employed for permitting adjustment of the height of tool **102** relative to concrete **10**, as for instance a shaft or thumb screw which can be inserted into suitable openings in tool **102** for engagement with the upper edge of sleeve **102***a*.

A control panel **104** for mounting suitable control levers as at **104***a* is fixed to the forward edge of member **32**. An operator stands on the platform **18** as provided by channel member **26** for manipulation of the control members mounted on panel **104**.

A source of power for operating the apparatus is mounted on platform **18** as shown at **106**. Although such power source may take substantially any desired and appropriate form in accordance with the type of actuating devices employed in the apparatus, FIGURE 1 shows a gasoline engine drivingly connected to both a hydraulic pump and an electric generator. The hydraulic pump, of course, affords the necessary hydraulic pressure for operation of the various aforedescribed hydraulic cylinders, whereas the electric generator affords the electric power for operation of the drive motors **38** and **40**.

The method of embedding the strips **58** and **59** in the concrete is substantially as follows.

By suitably controlling the energization of the electric motors connected to the drive wheels, the apparatus can be caused to move on rails **12** and **14** longitudinally of the concrete **10**. As the apparatus moves, tool **102**, which previously has been adjusted to the proper vertical position, forms a longitudinal path through the aggregate of the concrete **10**. That is, due to the viscosity of the fine ingredients of the concrete, as for instance the cement, sand, water and the like, a path cannot be formed

therein which will remain for any appreciable length of time. However, the larger and heavier ingredients of concrete, such as gravel, which is commonly termed aggregate, can be pushed to one side or the other as the desired path is being formed. As such, a path can be formed through the heavier materials to greatly facilitate the subsequent insertion of the joint forming means.

As the apparatus **16** continues to move, such motion causes the flexible strip **59** from spool **88** to be inserted longitudinally into the concrete **10**. That is, such strip **59** is caused to unwind from the spool **88** and to pass under the insertion wheel **96**. As shown in FIGURE 6 of the drawings, wheel **96** is formed with a suitably configured outer periphery for receiving the strip **59**. Due to this feature, the wheel **96** does not deform the strip **59** but rather applies pressure thereto at the predetermined strongest sections. The depth of insertion of the longitudinal strip **59** is determined by the operation of hydraulic cylinder **100**, the latter being controlled by suitable control levers mounted on panel **104**.

The insertion wheel **96** is aligned with the path forming tool **102** so that the strip **59** from spool **88** is inserted to the proper depth along the path formed thereby. Thus the strip material is inserted without engaging relatively hard immovable objects such as the aggregate of the concrete **10**.

At predetermined intervals during the travel of apparatus **16** relative to concrete **10**, the entire apparatus is brought to rest for purposes of inserting lateral strips **58**. After the apparatus is stopped, the insertion tool **42** is rotated within bearing members **46** and **48** until the path forming tool member **54** is disposed downwardly. While in this position, the operator, by suitable manipulation of the appropriate controls on panel **104** causes the entire tool **42** to be moved downwardlly so as to cause tool member **54** to provide a transverse path in the aggregate of the concrete **10**. Such action of tool **42** can be accomplished by simultaneously actuating hydraulic cylinders **76** and **78** to cause the entire length of tool member **54** to be inserted instantaneously in the concrete. In the alternative, the hydraulic cylinders **76** and **78** may be operated separately so as to cause first one end of tool member **54** to be inserted into the concrete and thereafter the other end to be inserted. Ultimately, however, the entire tool member **54** is pressed downwardly into the concrete so as to form a predetermined transverse path through the aggregate thereof.

While the tool **42** is so positioned as shown in FIGURE 4, the strip **58** from spool **80** can be cut to the proper length and positioned in the tool member **56**. To accomplish this, tool member **56** is opened by suitable actuation of hydraulic cylinder **70**. That is, such cylinder is suitably energized to cause latching member **56***c* to pivot in a clockwise direction as shown in FIGURE 4. The section of the strip **58** is then positioned in the abutment member **56***a* and the latching member **56***c* is returned to closed position. The latter operation, of course, is effected by suitable actuation of hydraulic cylinder **70** by the operator at control panel **104**.

After the strip **58** is mounted in the insertion tool member **56**, the entire insertion tool **42** is rotated within journal members **46** and **48** until the tool member **56** is disposed downwardly as shown in FIGURE 5 of the drawings.

Thereafter, the hydraulic cylinders **76** and **78** are alternately actuated so as to cause the entire insertion tool **42** and the strip **58** attached thereto to rock end-for-end upon the pivot afforded by the connections between the two extremities and the brackets **46** and **48**, respectively, which slide vertically in the support members **28** and **30**. As this action continues, the tool **42** is caused to progressively "creep" downwardly until the strip **58** is at the proper position within the concrete. The aforedescribed rocking and "creeping" action is necessary to prevent collapse and deformation of the strip **58**. Such strip is generally made of plastic or other suitable elastomeric materials to insure that it will yieldably engage the sections of concrete to provide the necessary seal therebetween. Also, such end-for-end rocking motion causes the strip to "knife" its way through the concrete to further insure that said strip will maintain its intended size and shape. This action will be recognized by persons skilled in the art as being substantially identical with the action of insertion wheel **96** in progressively exerting pressure along the length of the longitudinal strip **58**.

Due to the previously formed path through the aggregate of the concrete as formed by tool member **54**, the flexible strip **58** is ultimately forcibly inserted into the concrete to the desired position. Then by suitable actuation of the appropriate control lever, the hydraulic cylinder **70** releases the strip **58**. In this regard, latching member **56***c* of tool **56** need not be actuated to its extreme open position but rather need only be moved a small distance to permit strip **58** to remain within the concrete **10** as tool member **56** is removed. After this has been accomplished, and the entire insertion tool **42** is in its retracted position the apparatus **16** is moved forward to continue laying the longitudinal strip **59** until the next position for a lateral strip **58** is reached.

It should be noted that under certain conditions it is desirable that the tool **56** be given a fore-and-aft rocking motion as it effects insertion of the lateral strip **58**. This motion will help enlarge the strip-receiving groove **105** formed in the uncured concrete **107**. Thus, as indicated in FIGURE 5, a hydraulic cylinder **110** is removably interposed between a fixed element **112** of the apparatus **16** and the upper portion of each of the arms **50**. With continued reference to this figure, one end of the cylinder **110** is pivotally connected to the fixed element **112** while the piston rod **114** associated with cylinder **110** is detachably connected to the upper portion of arm **50** as by a removable pin **116**. The cylinder **110** is operated in a conventional manner to effect reciprocation of piston rod **114**. This serves to effect a fore-and-aft rocking of the insertion tool **56**, as indicated by the directional arrows in FIGURE 5. Such fore-and-aft rocking may be independent of or concurrent with the end-for-end rocking of the entire insertion tool **42**.

Although not mandatory for successful practice of the present invention, it may be found desirable to provide suitable notches or cutouts in the vertical webs of the strips **58** and **59** at their intersection.

It is thus seen that the present invention provides a novel method for inserting elongated flexible joint forming means into uncured concrete. Also, this invention provides apparatus for inserting both longitudinal and lateral joint forming means into suitable positions beneath the surface of the concrete. As explained in my aforementioned copending application, as the concrete cures the joint forming means causes the contraction of the concrete to provide a vertical fracture line at the joint forming means. Also, such joint forming means, due to the flexibility thereof and the cross-sectional configuration, is caused to resiliently engage the adjacent sections of concrete to thereby effect a suitable moisture seal therebetween.

Although I have shown and described specific embodiments of my invention, I am fully aware that many modifications thereof are possible. The invention itself, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim:

1. Apparatus for embedding lateral joint forming means in an elongated section of uncured concrete comprising:

a frame movable longitudinally with respect to said concrete;

an elongated, rotatable transversely oriented tool having a groove forming portion operable to form a lateral groove through the aggregate of said concrete, said tool further having an insertion portion

operable to hold and insert joint forming means into said concrete along said lateral groove;

a pair of support means vertically slidably carried by said frame at opposite ends of said tool and mounting said opposite ends of said tool thereto; and

a pair of fluid actuated means carried by said frame and alternately operative upon said pair of support means to effect end-to-end rocking of said tool to thereby facilitate formation of said groove and insertion of lateral joint forming means by said tool.

2. Apparatus for embedding elongated, transversely oriented flexible joint forming means in a longitudinal strip of uncured concrete, said apparatus comprising:

a frame adapted to be positioned in overlying relationship to the uncured concrete;

an elongated, transversely oriented tool having a groove forming portion and an insertion portion, said insertion portion being adapted to carry joint forming means;

support means vertically movably carried by said frame and rotatably mounting said tool to alternately position said groove forming portion and said insertion portion thereof into substantially vertical orientation immediately above the uncured concrete; and

force transmitting means carried by said frame and operable on said support means to effect vertical movement of said tool and insertion into the uncured concrete of the operatively positioned one of said portions.

3. Apparatus for embedding elongated, transversely oriented flexible joint forming means in a longitudinal strip of uncured concrete, said apparatus comprising:

a frame adapted to be positioned in overlying relationship to the uncured concrete;

an elongated, transversely oriented tool having a groove forming portion and an insertion portion, said insertion portion being adapted to carry joint forming means;

a pair of support means vertically slidably carried by said frame at opposite ends of said tool, respectively, and including pivot means rotatably mounting said tool to permit positioning of said groove forming portion and said insertion portion thereof in substantially vertical orientation immediately above the uncured concrete; and

a pair of force transmitting means carried by said frame and alternately operative upon said pair of support means to effect end-to-end rocking of said tool and insertion into the uncured concrete of the operatively positioned one of said portions.

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