Dec. 29, 1970 L. V. THOMASON 3,551,537

METHOD FOR FORMING MONOLITHIC PIPE IN SITU

Filed April 12, 1968 3 Sheets-Sheet 1

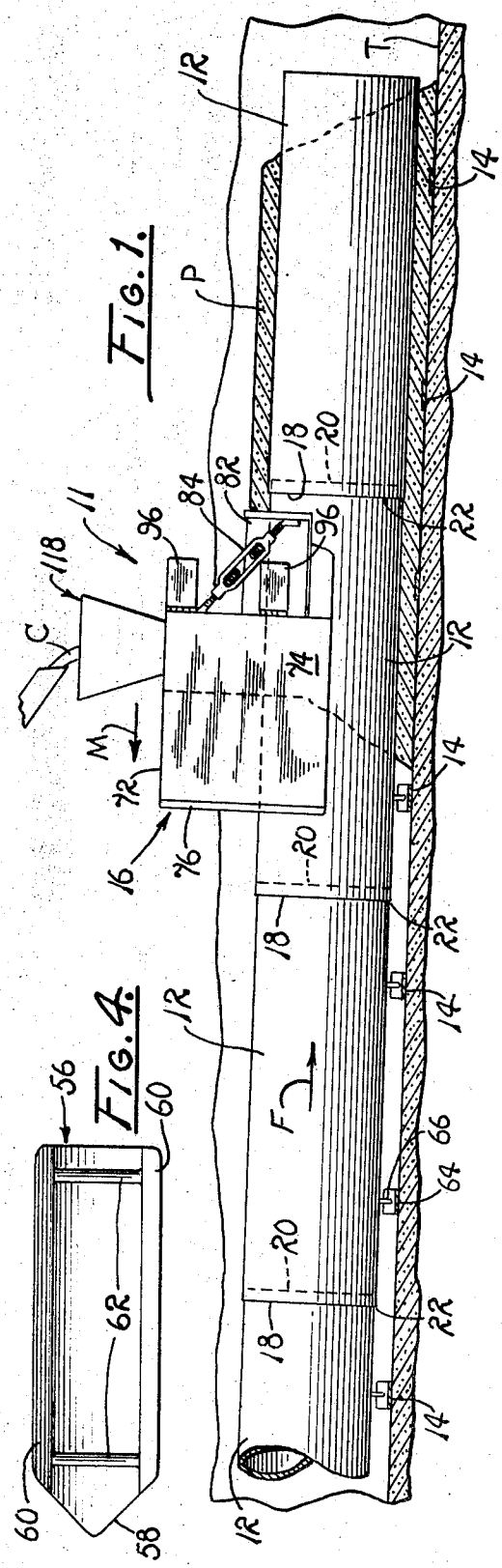


FIG. 1.

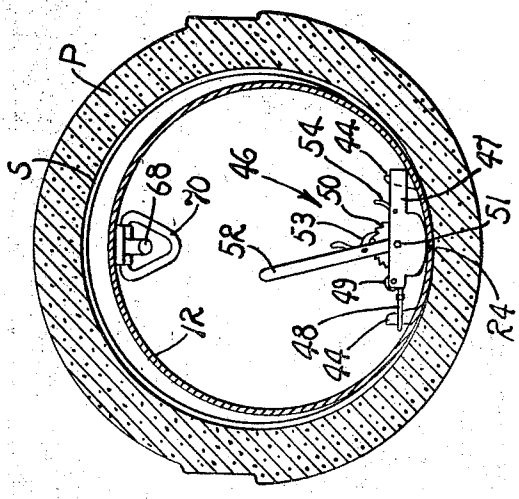


FIG. 3.

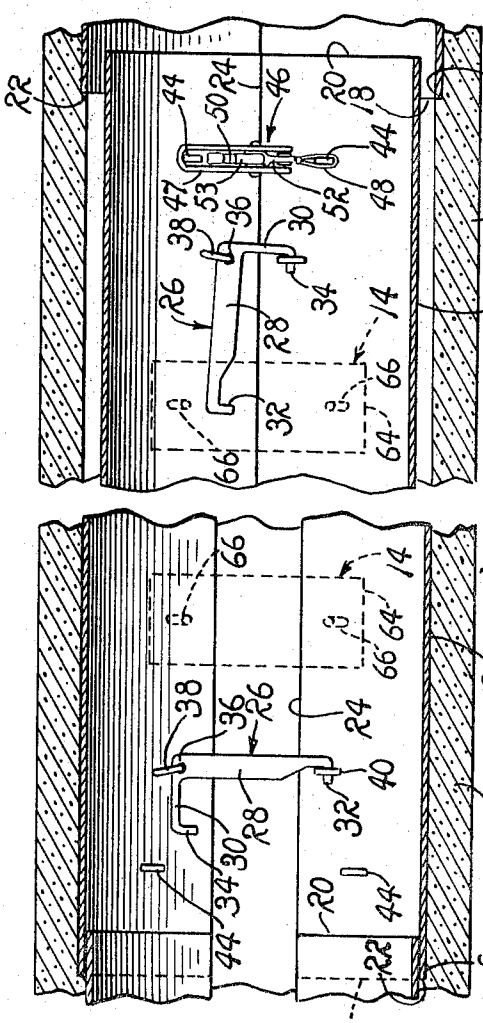


FIG. 2.

FIG. 4.

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METHOD FOR FORMING MONOLITHIC PIPE IN SITU

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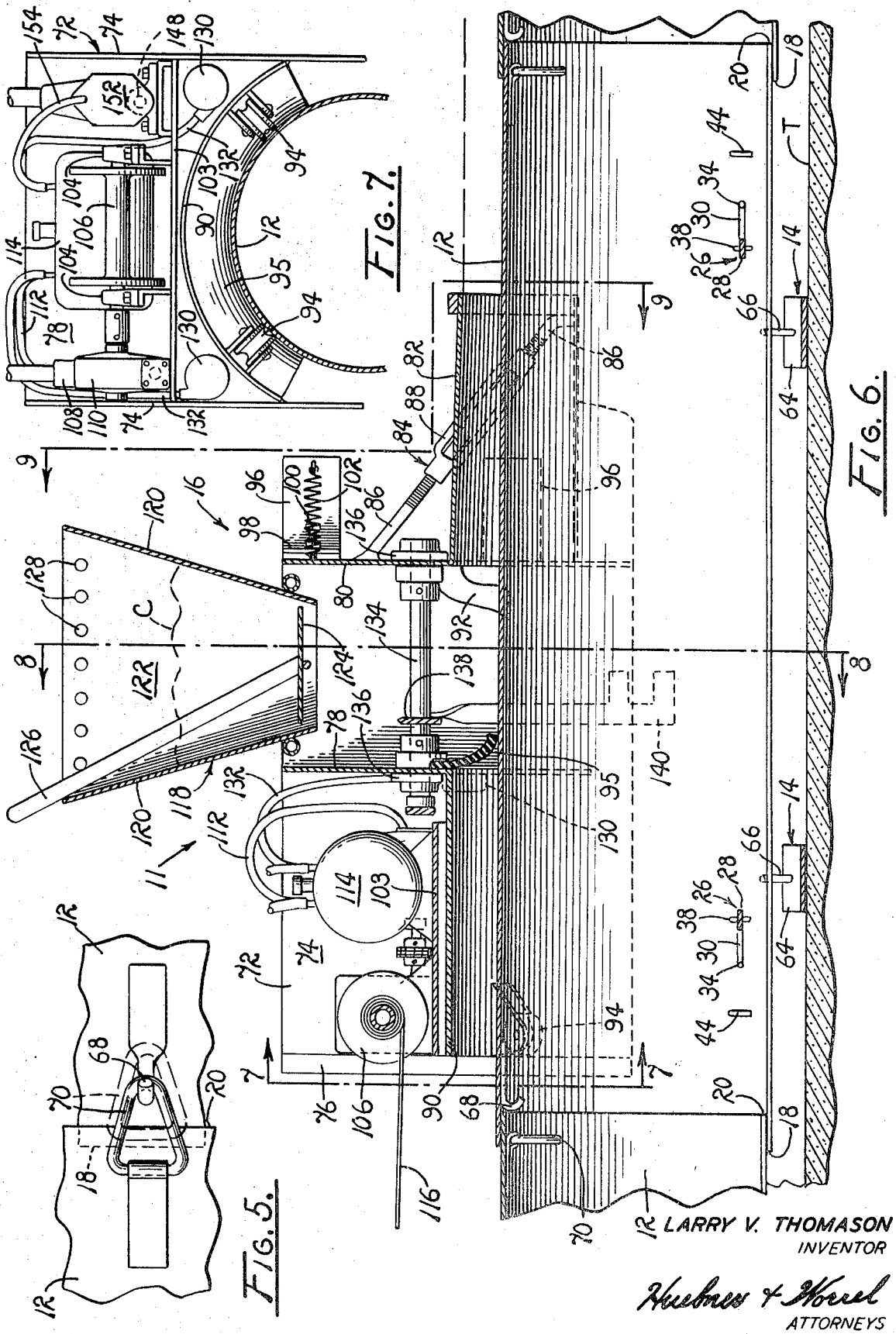


FIG. 6.

FIG. 7.

FIG. 5.

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METHOD FOR FORMING MONOLITHIC PIPE IN SITU

Filed April 12, 1968 3 Sheets-Sheet 3

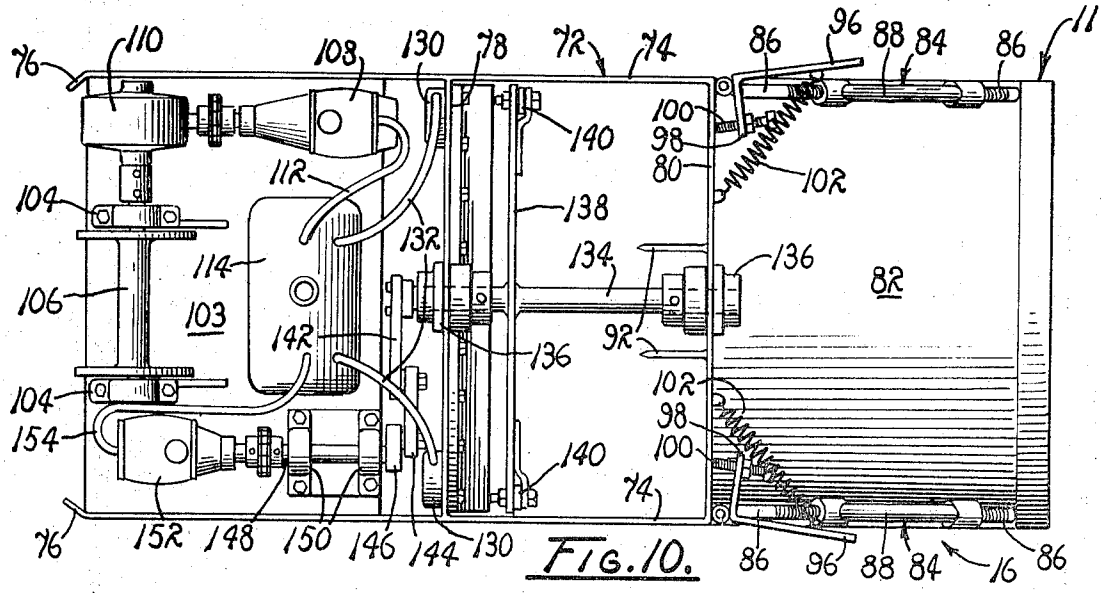


FIG. 10.

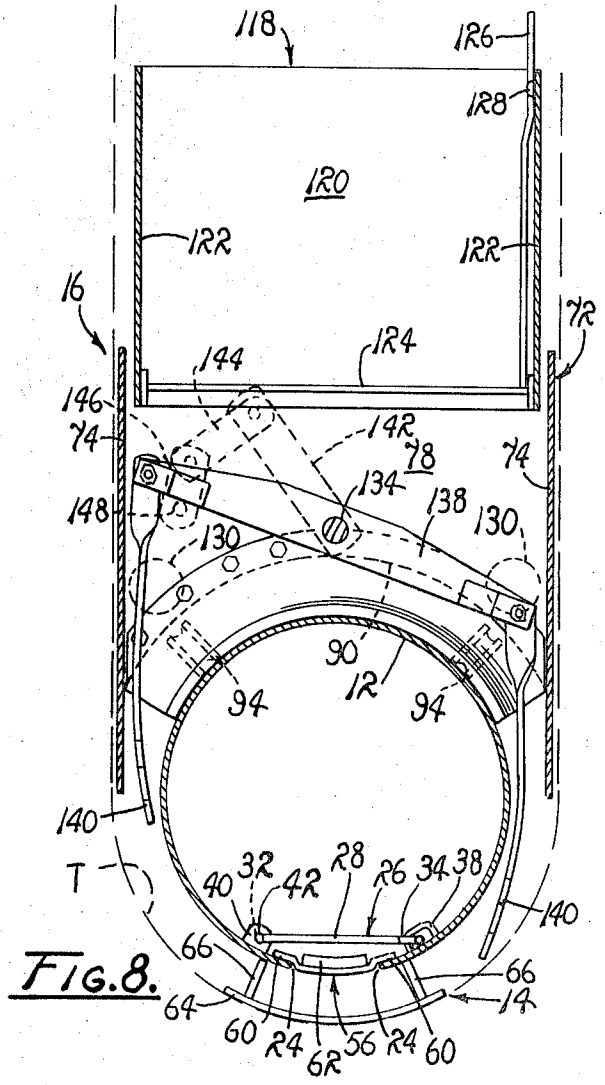


FIG. 8.

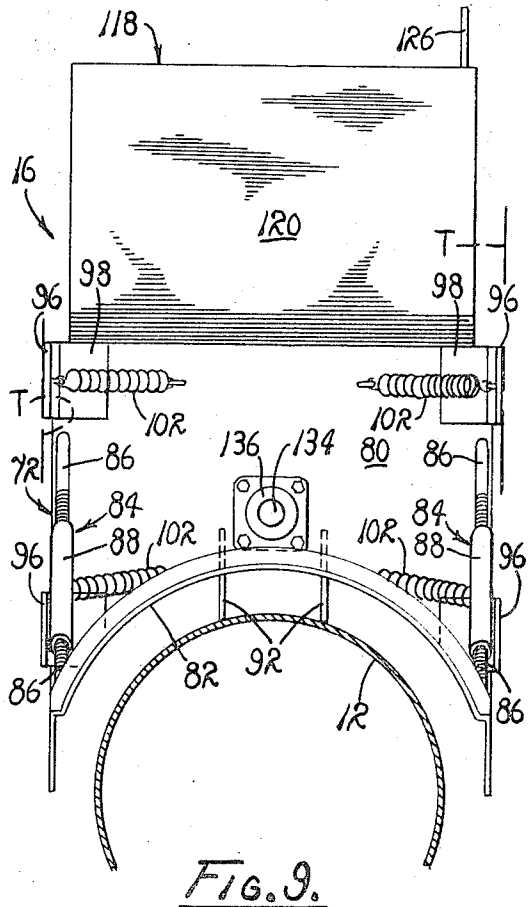


FIG. 9.

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3,551,537

METHOD FOR FORMING MONOLITHIC PIPE IN SITU

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Int. Cl. B28b 21/88; E04b 1/16
U.S. Cl. 264—33 9 Claims

ABSTRACT OF THE DISCLOSURE

A method for forming monolithic pipe utilizing a tubular shell having a longitudinal gap extending the length thereof and telescopically related at its ends to other similar shells, the shells so related being supported in the bottom of a formed trench on stable supports and in turn supporting a traveling hopper receiving plastic cementitious material and flowing it around the shells, the shell being made of a flexible material and having latch devices therewithin for selectively maintaining the shells in open gap position, the shells being contractible to relatively closed gap position for reducing the diameter thereof and held in such position by the latch devices for shell removal after the formed pipe has hardened, the contracted shells being interconnected at adjacent ends to produce a lost motion effect for reducing the amount of adjacent shell overlap in response to pulling of the shells from an end thereof.

BACKGROUND OF INVENTION

The present invention relates to the manufacture of monolithic pipe in situ, typified by U.S. Pat. Nos. 2,731,698 and 3,205,550, and more particularly to a method and apparatus for forming extensive lengths of such pipe about a plurality of pipe supporting form members or shells in a trench and withdrawing such shells in considerable lengths for later reuse in making more pipe.

Various attempts have been made to provide methods and machines for continuously forming pipe of plastic cementitious materials. Such methods and machines have heretofore possessed merit to varying degrees but also have possessed disadvantages inherent in their manner of use. For example, in machines where the placing of supporting forms ahead of the formed pipe is carried on simultaneously with the formation of such pipe, the speed with which a pipe may be formed is limited to the speed at which the additional forms may be placed. In other cases, the speed of pipe formation is affected because of the requirement that only a small section of pipe can be formed at a time, rather than continuously. In still other cases, where the pipe supporting forms are of the reusable knock-down type, they usually involve a multiplicity of separate parts which require additional handling and possess the attendant possibility of loss with a resultant hampering of the progress of the work. Such forms also require considerable labor for their assembly and disassembly, particularly, the withdrawal thereof one at a time from the finished pipe. Further, many such machines have been unable to form such pipe with desired precision and control and thus have not been able to attain necessary quality in the pipe produced.

SUMMARY OF INVENTION

It is therefore an object of the present invention to provide a method and apparatus for forming pipe in situ which is simpler in operation and involves a minimum number of separate parts.

Another object is to provide an apparatus for forming pipe by which various phases of the work can be carried out simultaneously with attendant economies in construction.

Another object is to provide an apparatus for forming a continuous length of pipe in a rapid and reliable manner.

Another object is to provide an apparatus for producing a monolithic pipe having good flow characteristics.

Another object is to provide a pipe supporting form in which the several parts thereof are interconnected to preclude loss or misplacement of detached parts.

Another object is to provide pipe supporting forms which can be contracted and connected together for withdrawal of a considerable length of such forms at one time from the finished pipe.

Another object is to provide pipe supporting forms which are connected with a predetermined amount of end overlap for forming the pipe and are withdrawn from the formed pipe in connected relation but with a reduced amount of end overlap for facilitating such withdrawal.

Another object is to provide a support device for supporting a pipe form in a stable and reliable manner for maintaining the same in proper relation to the bottom and sidewalls of a trench.

These and other objects and advantages are achieved by the provision of a method and apparatus for forming monolithic pipe of plastic cementitious material which utilizes a pipe supporting form member consisting essentially of a tubular shell having a longitudinal gap extending the length thereof, the shell being made of a stiffly resiliently flexible material whereby it may be contracted to close the gap and reduce the cross section thereof, the shell having therewith latch means disposable across the gap for holding it in open gap or closed gap condition, the shells being adaptted to be telescopically connected in open gap condition with a predetermined amount of end overlap determined by abutment means within the shell. After the pipe has been formed around the shells, they are contracted and the overlapped ends the shells are interconnected by hooks and pivoted D-rings which provide a lost motion effect for reducing the amount of end overlap in response to the pulling apart or tensioning of the shells whereby the shells can be easily pulled out of one end of the formed pipe. The connected shells are supported in proper relation to a trench on stable supporting plates of unique shape and serve to support a traveling frame having a hopper which receives the cementitious material and flows it around the connected shells, the traveling frame having adjustable wings for engaging the sidewalls of the trench for centering and stabilizing the frame as it travels along on the interconnected forms.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary side elevation of an apparatus embodying the principles of the present invention and utilized to practice the method thereof.

FIG. 2 is a foreshortened horizontal section of a tubular form shell member of the apparatus of the present invention showing the manner of latching the member to provide different cross sectional dimensions thereof.

FIG. 3 is a vertcal section showing the shell member within the formed pipe and contracted to its smaller cross sectional dimension.

FIG. 4 is a plan view of a hand operated trowel of the apparatus.

FIG. 5 is a fragmentary detail plan view showing the connection made between the shell members for withdrawal thereof from the formed pipe.

FIG. 6 is a larger scale longitudinal vertical section of a portion of FIG. 1 illustrating structural details thereof.

FIG. 7 is a fragmentary vertical section taken generally along line 7—7 of FIG. 6.

FIG. 8 is a vertical section taken generally along line 8—8 of FIG. 6 and further including the hand operated trowel.

FIG. 9 is a fragmentary vertical section taken generally along line 9—9 of FIG. 6.

FIG. 10 is a top plan view of the traveling hopper mechanism with parts thereof omitted.

DESCRIPTION OF EMBODIMENT

Referring to the drawings, there is illustrated in FIG. 1 an apparatus **11** embodying the principles of the present invention and for practicing the method thereof. The apparatus consists essentially of a plurality of tubular pipe supporting forms or shells **12** disposed on spaced apart supports **14** in a ditch or trench T and supporting a traveling hopper mechanism **16** for flowing plastic cementitious material C around the shells to form a monolithic pipe P therearound. The trench T is formed in the usual manner with vertical sidewalls and semi-cylindrical bottom having a center line on a gradient declining in the desired direction of flow in the pipe to be formed, indicated by the arrow F. The supports **14** are placed in the trench bottom at predetermined intervals and proper grade to support the shells **12** above the bottom concentrically thereof in accordance with the desired thickness of the pipe P. The ends of the shells **12** are telescopically related and overlap a predetermined amount with the outer overlapping end **18** of each shell disposed upstream from the inner overlapped end **20** thereof. The telescoped ends of the shells thus create minute steps or shoulders **22** which face upstream and cause the pipe P to be formed with slight steps or shoulders S which face downstream and hence do not impede the flow of fluids in the pipe. The hopper mechanism **16** is made to travel upstream in the direction of the arrow M so as to cross each step **22** in a descending fashion and not disturb the overlapped relation of the shells. As will later appear, the shells can be contracted to smaller cross sectional dimensions and interconnected for removal from the pipe P in sections for later reuse in forming more pipe.

FIG. 2 shows one of the shells **12** in horizontal section on a larger scale. It is to be noted that each shell is slitted lengthwise to provide a longitudinal slot or gap **24** which is coextensive the length of the shell. Each shell is of substantially cylindrical shape and is made of a stiffly flexible material permitting deformation of the member so that the cross sectional shape or diameter thereof can be reduced by closing the gap, as shown in the righthand portion of FIG. 2 and in FIG. 3. Latch devices **26** are provided for maintaining the shells in open or closed gap condition. In the use of the shells to form pipe in the 24–36 inch diameter range, shells eight feet long made from 0.14 inch thick steel or 0.19 inch thick aluminum have been successfully employed, the aluminum shell providing an extremely smooth pipe interior. The gap **24** can vary in width, as desired, from six to eight inches, being excellently suited to most situations.

Each of the latch devices **26** has a pair of legs **28** and **30** angularly related and generally defining the letter L. Leg **28** is sufficiently rigid to resist compression and has a hook-like projection or finger **32**, whereas leg **30** is of lighter construction for resisting tension and has a projection or finger **34**. At the juncture of the legs **28** and **30**, the latch device is provided with a perforation **36** in which is loosely received a U-shaped member **38**, such as a staple or the like, suitably secured to the inner surface of the shell **12**, as by welding or the like. The staple **38** is disposed to one side of the gap **24** and serves as a pivot for the latch device. Secured to the shell on the opposite side of the gap is a keeper **40** having an aperture **42**, best seen in FIG. 8. The latch device can be pivoted to dispose leg **28** thereof across the gap **24** with the finger **32** in the aperture **42** for maintaining the shell in expanded or open gap condition and providing a greater cross sectional shape or configuration. The latch device can also be disposed so that the short leg **30** thereof is across the gap **24** with the finger **23** inserted in the aperture **42**. With such disposition, it is readily apparent that the gap **24** is substantially closed and the cross sectional shape or diameter of the shell is considerably reduced.

The shell **12** can be contracted to its reduced cross sectional configuration by any suitable means. Since such reduction must be accomplished from within the shell, secured to the interior thereof is a pair of upstanding posts **44** to which any tension producing means can be connected, preferably a winching device **46**, as shown in FIG. 3. The device **46** has a U-shaped frame **47** in which one of the posts **44** is received, best seen in FIG. 2, the other post **44** being received in the looped end of a line or cord **48**. The line passes under a roller **49** on the frame **47** and is wound about a spool, not shown, to which a ratchet wheel **50** is secured. The spool and wheel are journaled on a shaft **51** which also serves as pivot for a lever **52** carrying a pawl **53** engaged with the ratchet wheel for imparting motion thereto in response to swinging of the lever. A detent **54** pivoted to the frame **49** also engages the ratchet wheel. Thus, swinging of the lever causes the line **48** to be wound up and tensioned for drawing the posts **44** together to close the gap **24** after which the finger **34** of the latch device **26** is inserted in the aperture **42** in the keeper **40**. After the latch device is in place, the detent **54** is released and the winching device is removed from the posts **44**.

Inviting attention to FIGS. 4 and 8, there is shown a smoothing tool or trowel **56** of low silhouette or shallow U-shaped cross section with a leading end **58**, side lips or wings **60** and a pair of handle bars **62**. During formation of the pipe P, the trowel is disposed in the gap **24** supported on the edges thereof by the lips or wings. The trowel is grasped by a workman within the shell for smoothing the cementitious material below the gap, the low silhouette thereof providing for passage of the trowel under the latch devices **26**. It will be appreciated that the trowel **56** can be manipulated to round off or practically eliminate the step S in that portion of the pipe P between the edges of the gap **24** for further improving the flow characteristics of the pipe, if so desired.

Referring to FIGS. 2 and 8, it will be noted that each support **14** is made up of a concavo-convexly curved plate **64** and a pair of posts or studs **66** projecting from the concave surface thereof, the plate having a curvature conforming to the outer surface of the finished monolithic pipe P, the posts being disposed substantially radially and of a length equal to the thickness of the finished pipe. The plates **64** are placed in the trench T with the posts **66** located substantially equidistantly from the center line thereof whereby the respective shell **12** is centered and supported thereon in a stable manner concentrically of the curved bottom of the trench. The supports **14** are incorporated into the finished pipe P.

Referring to FIG. 6, fixedly secured to the shell **12** opposite its gap **24** and adjacent to its end **18** is an angular bracket or hook **68** against which the end **20** of the next shell abuts for predetermining the amount of overlap of these ends. As indicated earlier after formation of the pipe P, the shells are contracted and interconnected for removal in sections. It is therefor desirable to reduce the amount of end overlap to provide a degree of articulation between the ends for easier withdrawal of the shells from the pipe, particularly, where the pipe has been formed in a curving trench. Accordingly, there is pivotally mounted on each shell, adjacent to its end **20**, a D-ring **70** which engages with the hook **68** on the next shell, as shown in FIG. 5, to define the amount of such reduced overlap. Initially, the D-ring depends out of connection with the hook, as shown in FIG. 6, and is swung upwardly to encompass the hook, as shown in dotted lines

in FIG. 5. The pivotal mount of the D-ring is provided with a degree of friction and is sufficiently stiff to retain the D-ring in hook encompassing position. It will be appreciated that in such position the shells can move relative to each other a predetermined amount before the hook and D-ring make engaging contact. The interconnection thus possesses a lost motion effect.

Inviting attention to FIGS. 6–9, the traveling hopper mechanism **16** is provided with a body or box frame **72** having parallel side walls **74** with inwardly bent front ends, **76**, and transverse intermediate and rear walls **78** and **80**, respectively. The walls **74**, **78** and **80** define a chamber or hopper which receives the cementitious material C. The lower edge of the rear wall **80** is curved to be substantially concentric with the shell **12**, to which edge an arcuate trowel or molding portion **82** is secured, as by welding or the like. The molding portion **82** is further interconnected with the rear wall **80** by a pair of braces **84**, each including threaded rods **86**, welded or otherwise secured to the rear wall and the molding portion respectively. The threaded rods are interconnected by a turnbuckle **88** for adjusting the molding portion relative to the shell to provide a degree of convergence for effecting a molding or troweling effect upon the top portion of the pipe P as it is being formed.

The wall **78** has a lower curved edge and secured thereto and to the sidewalls **74** is an arcuate platform **90**. The frame **72** is supported for travel on the shells **12** by a pair of spaced apart skids **92**, secured to the read wall **80**, and a pair of rollers **94** mounted on the underside of the platform **90**. As seen in FIGS. 9 and 10, the skids **92** are vertically disposed and have a thin blade shape with sharpened front and rear edges for facilitating the flow of cementitious material therearound. To preclude the cementitious material from flowing under the platform and fouling the rollers **94**, an arcuate skirt or seal **95** is attached to the wall **78** and has a curvature which is conformed to the upper portion of the shell **12**. The rollers **94** are located on each side of the skids **92** and are radially disposed so that the axes of rotation thereof are perpendicular to longitudinal planes intersecting generally at the axis of the shell, as will be appreciated on viewing FIG. 7. Such an arrangement supports the frame **72** on the shells in a stable manner.

For centering the frame **72** in the trench T, adjustable guiding wings **96** are pivotally mounted on the rear edges of the sidewalls **74** and engage the sidewalls of the trench, as shown in FIG. 9. Each wing has an arm **98** at an angle thereto and rigid therewith with which a setscrew **100** is threadedly connected and engages the rear wall **80** for maintaining the wing at any desired position of adjustment. A coil spring **102** is interconnected between the wall **80** and the wing for maintaining the setscrew in such engagement.

Secured to the sidewalls **74**, over the platform **90**, is a flat floor **103** on which a pair of bearing mounts **104** are fastened which journal a winching drum **106** driven by a compressed air motor **108** through a gear reduction mechanism **110**, as shown in FIG. 10. The motor is connected by a hose **112** to a container **114** supported on the floor **103** and having compressed air therein. As will be appreciated from viewing FIG. 6, a line or cable **116** has one end thereof anchored to a point ahead of the hopper mechanism and the other end thereof connected to the drum **106** whereby rotation of the drum winds the line thereabout for advancing the hopper mechanism toward the anchor point.

The cementitious material C is received in a hopper defined by the walls **74**, **78** and **80**. Such material can be delivered directly into such hopper or through the intermediary of a feed control bin or funnel **118** removably supported on the sidewalls **74** over the hopper in any suitable manner. As shown in FIG. 6, the funnel has downwardly converging walls **120** and end walls **122** to which a bottom plate **124** is pivoted. A control lever **126** is fixed to the bottom plate for tilting it and controlling the flow of material passing between its edges and the walls **120**. The bottom plate may be held at any desired position of feed adjustment by engaging the control lever with projections or stops **128** on an end wall of the funnel.

Plastic cementitious material C from the funnel **118** passes to the receiving hopper and flows gravitationally around the shell **12** therebelow. Such flow is assisted by means of a pair of compressed air vibrators **130** attached to the wall **78** and connected by hoses **132** to the container **114**. For further assisting the flowing of the cementitious material around the shells, there is provided a power driven tamping mechanism which includes a rock shaft **134** journaled in bearing mounts **136** secured to the walls **78** and **80**. Fixed to the shaft **134** and disposed transversely thereof is a double-ended cross arm **138** having a pair of tamping legs or tampers **140** pivoted to the ends thereof, as shown in FIG. 8.

Viewing FIGS. 8 and 10, fixed to one end of rock shaft **134** is a rock arm **142** which is pivoted to one end of a link **144**, the other end of the link being pivoted to a crank arm **146** fixed to one end of a rotatable shaft **148** journaled in a pair of bearing mounts **150** secured to the floor **103**. The shaft **148** is driven by a compressed air motor **152** connected by a hose **154** to the compressed air container **114**. Thus, operation of the motor **152** serves to rock the shaft **134** and impart oscillation to the arm **138** for moving the tamping legs **140** up and down for flowing and tamping the cementitious material around the shells **12**.

It is understood, of course, that the apparatus of the present invention can be used in a U-shaped form, instead of a trench, and that the supports **14** and wings **96** can function to center and stabilize the shells **12** and the traveling hopper mechanism **16** therein.

OPERATION

The operation of the apparatus of the present invention is believed to be clearly apparent and is briefly summarized at this point. After the trench T has been excavated to the desired shape with a substantially semi-cylindrical bottom having a central line at desired gradient, the supports **14** are located at intervals in the bottom of the trench, about four feet apart in the case where the length of the shell **12** is eight feet. Each support is set at the proper grade with the posts **66** located substantially equidistantly from the center line of the bottom of the trench and radially with respect to the center of curvature thereof. Shells **12** are then placed on the supports **14** in open gap condition with the gaps **24** substantially centered between the posts **66** and the ends of the shells thereof overlapping the maximum extent as defined by abutment of the end **20** of each shell with the hook **68** of the adjoining shell, as shown in FIG. 6. A sufficient number of shells are usually interconnected in this manner for forming an approximately 300 foot length of monolithic pipe. The traveling hopper mechanism **16** is placed on the downstream end of the length of interconnected shells and the guiding wings **96** are adjusted to dispose the mechanism centrally with respect to the shells and the trench. The line or cable **116** is anchored to a point upstream. The apparatus is now ready to commence the formation of monolithic pipe about the shells.

Cementitious material such as plastic concrete or the like is delivered into the funnel **118** which controls the feed thereof into the hopper therebelow. With the vibrators **130** and the tamper legs **140** functioning, the cementitious material flows around the shells for forming the monolithic pipe P thereabout, rotation of the winch **106** serving to move the mechanism **16** upstream in the direction of the arrow M at a controlled speed. In the meantime, a worker inside the shell manipulates the trowel **56** for forming that part of the pipe P between the edges of the gap **24**. If desired, the formation of the pipe P may commence before the full 300 foot length of shells have

been laid, thus permitting placing of the supports **14** and the completion of the interconnection of the shells upstream while pipe is being formed downstream.

After the cementitious material has set to form a hardened pipe, a worker or workers operate inside the shells **12** for progressively unlatching, contracting and relatching the shells and placing each D-ring **70** in encompassing relation to the hook **68** of the adjoining shell. About 100 feet of the contracted shells are normally so interconnected, after which a line is attached to the downstream shell and such length of shells is withdrawn from the downstream end of the finished pipe P at one time. This results in the D-rings progressively engaging the respective hooks for reducing the amount of end overlap of the shells. The shells thus pass over the steps S in descending fashion and are carried downstream for use in forming more pipe, as necessary. Another 100 foot length or so of shells is withdrawn in a similar manner until the shells have been withdrawn completely from the finished pipe.

In the meantime, the shells previously withdrawn are reconnected downstream in open gap condition and supported on new supports **14** at the proper grade and desired interval. The upstream shell of such new length of interconnected shells is expanded within the downstream end of the previously finished pipe. Again, starting from the downstream end of the new length of connected shells, cementitious material is flowed about the shells to form a new length of monolithic pipe which is joined to the hardened pipe. After the new length of pipe has hardened, the process is repeated until the job is completed. If desired, the shells withdrawn from the downstream end of the finished pipes can be carried upstream and attached to the expanded shell projecting from the finished pipe for progressively interconnecting the shells in open gap condition on supports **14** previously laid by a party working ahead of the shell interconnecting party. Thus, various phases of the work may be engaged in and proceed simultaneously.

There has thus been provided a method and apparatus for forming monolithic pipe in situ which operates in a simple manner for rapidly forming extensive lengths of monolithic pipe.

Although the invention has been herein shown and described in what is conceived to be the most practical and preferred method and apparatus, it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent methods and apparatus.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A method of forming monolithic pipe in situ comprising forming a trench, interconnecting a plurality of elongated transversely contractible internal forms in end-to-end substantially rigid overlapping relation, positioning the forms in the trench in spaced relation to the bottom and sides thereof, flowing a hardenable material into the trench around the forms, contracting the forms after the material has hardened, disconnecting said forms, reconnecting the forms with relatively loose connections for relative flexing and drawing the interconnected forms longitudinally from the hardened material while contracted.

2. The method of claim **1** wherein the forms are interconnected in telescopic relation with a predetermined amount of overlap for the flowing of the hardenable material therearound, and are drawn from the hardened pipe interconnected by lost motion interconnections for reducing the amount of overlap and facilitating the drawing thereof.

3. The method of claim **1** wherein the ends of the interconnected forms overlap in a common direction and the forms are positioned in a trench having a bottom at a desired flow gradient, and the outer overlapping end of each form is disposed upstream and with the adjoining shell forms a shoulder in the pipe which faces downstream.

4. The method of claim **3** wherein the interconnected contracted forms are drawn from the downstream end of the hardened pipe for traversing the shoulders therein in a descending fashion.

5. The method of claim **1** wherein the trench has a semi-cylindrical bottom, the forms are substantially cylindrical shells positioned on supporting means which include arcuate plates having curvatures substantially conforming to the bottom of the trench and converging members extending substantially radially therefrom for supporting the associated shell in substantially centered relation with the bottom of the trench, the supporting means being incorporated into the pipe in the formation thereof.

6. The method of claim **1** further including withdrawing the interconnected contracted forms from the downstream end of the pipe formed by the hardened material, positioning the withdrawn forms in interconnected expanded condition with the upstream shell thereof expanded within the downstream end of the hardened pipe, and producing a pipe of hardenable material about the forms from the downstream end thereof to a juncture with the previously hardened pipe.

7. The method of claim **1** in which the forms are contracted from internally thereof.

8. The method of claim **1** in which the forms are of substantially cylindrical resiliently flexible sheet material having longitudinal gaps defined by spaced edges of the sheet material and the forms are disposed in the trench with the gaps downwardly disposed.

9. The method of claim **8** in which the forms are latched internally in expanded position before the hardenable material is flowed into the trench and latched internally in contracted position after the material has hardened and before the forms are drawn therefrom.

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U.S. Cl. X.R.

25—32, 128, 131.5; 249—11, 179; 264—333