April 11, 1972 F. A. TRAUTNER 3,655,842

METHOD OF VIBRATING CORE IN CONCRETE PIPE MAKING MACHINE

Original Filed May 27, 1967 3 Sheet-Sheet 1

FIG. 5.

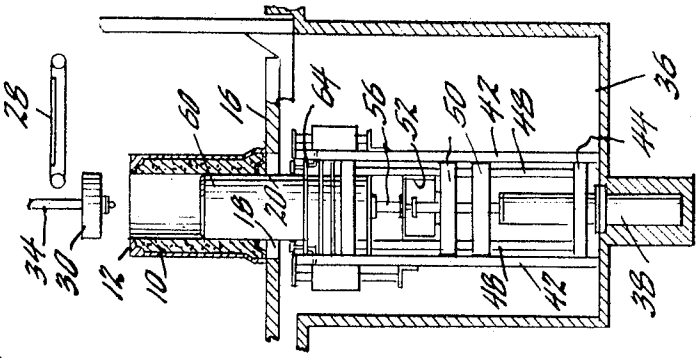


FIG. 4.

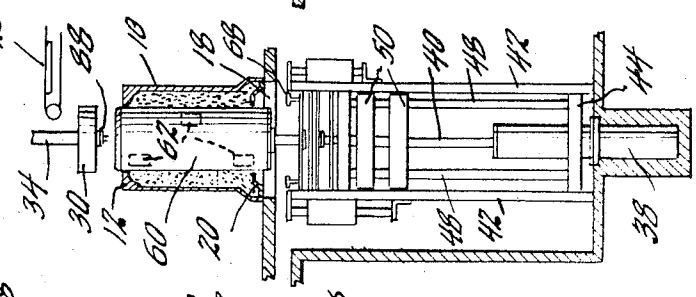


FIG. 3.

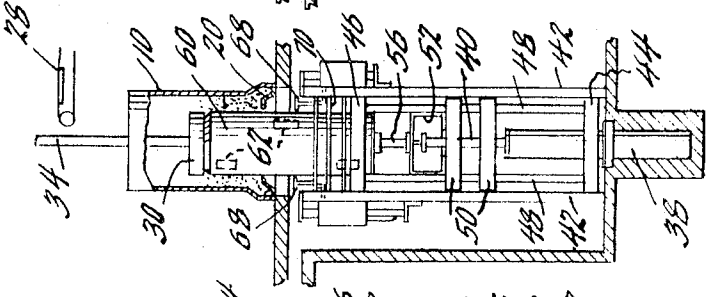


FIG. 2.

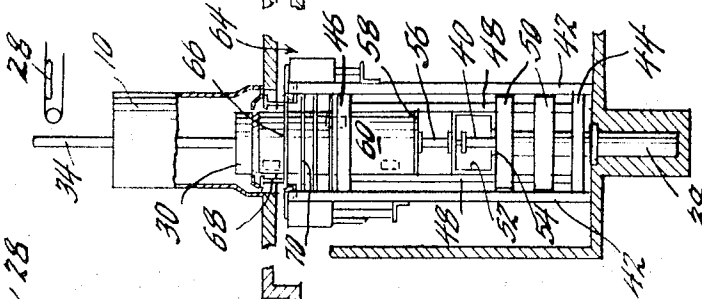
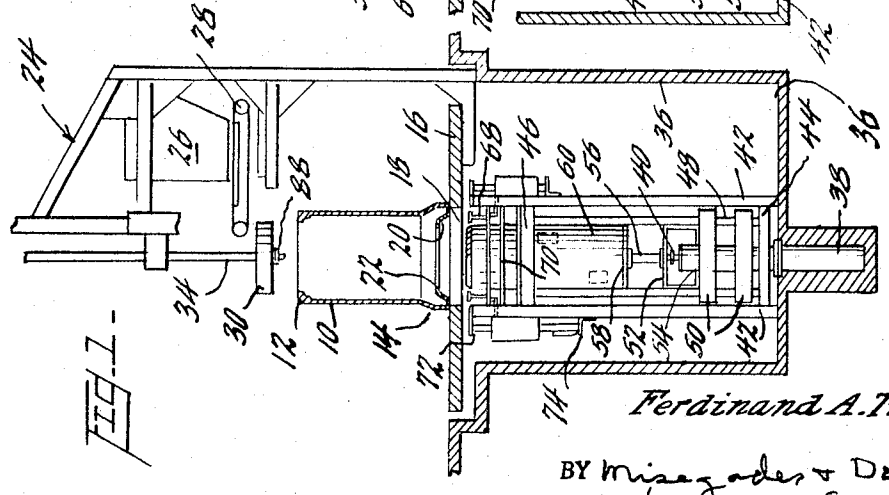


FIG. 1.



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METHOD OF VIBRATING CORE IN CONCRETE PIPE MAKING MACHINE

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FIG. 5.

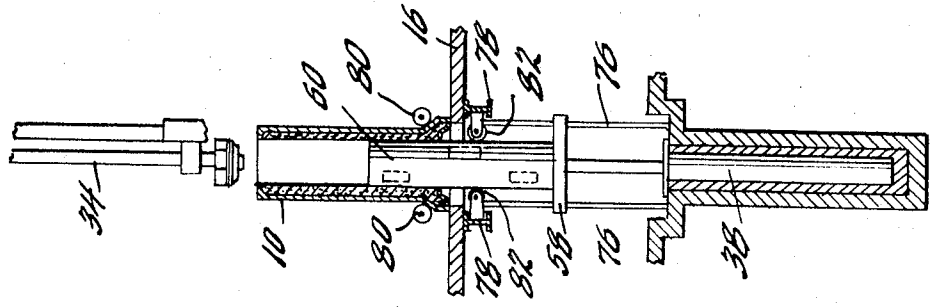


FIG. 8.

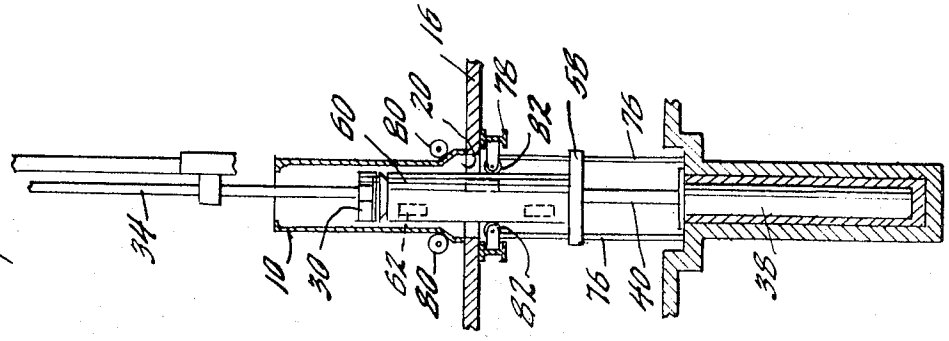


FIG. 7.

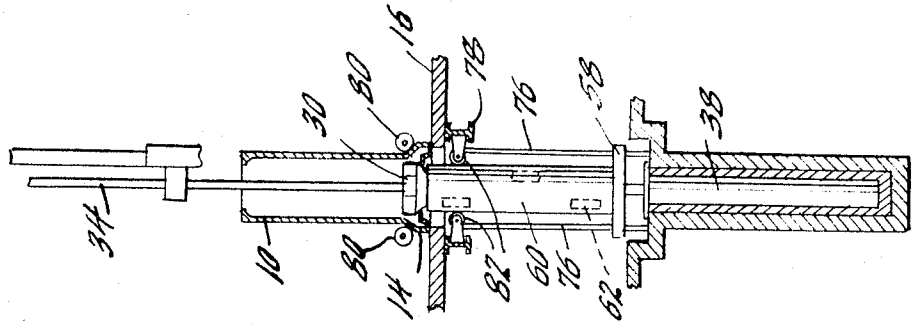
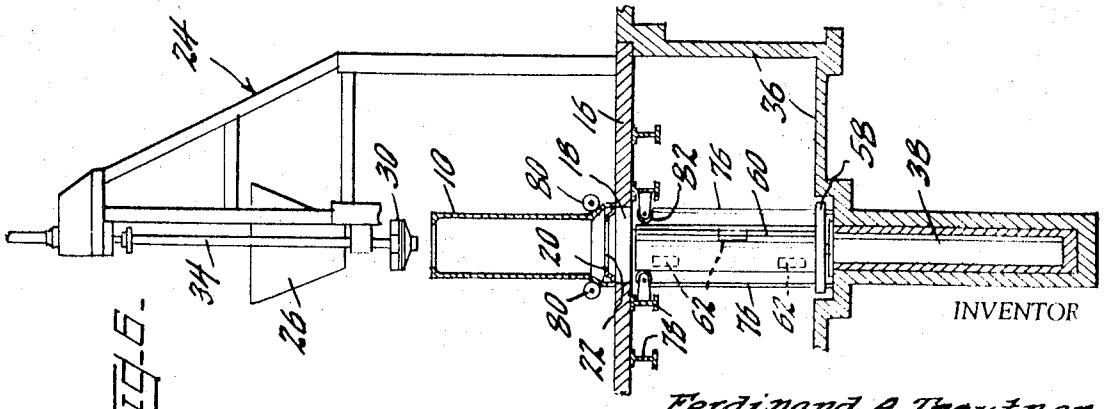


FIG. 6.



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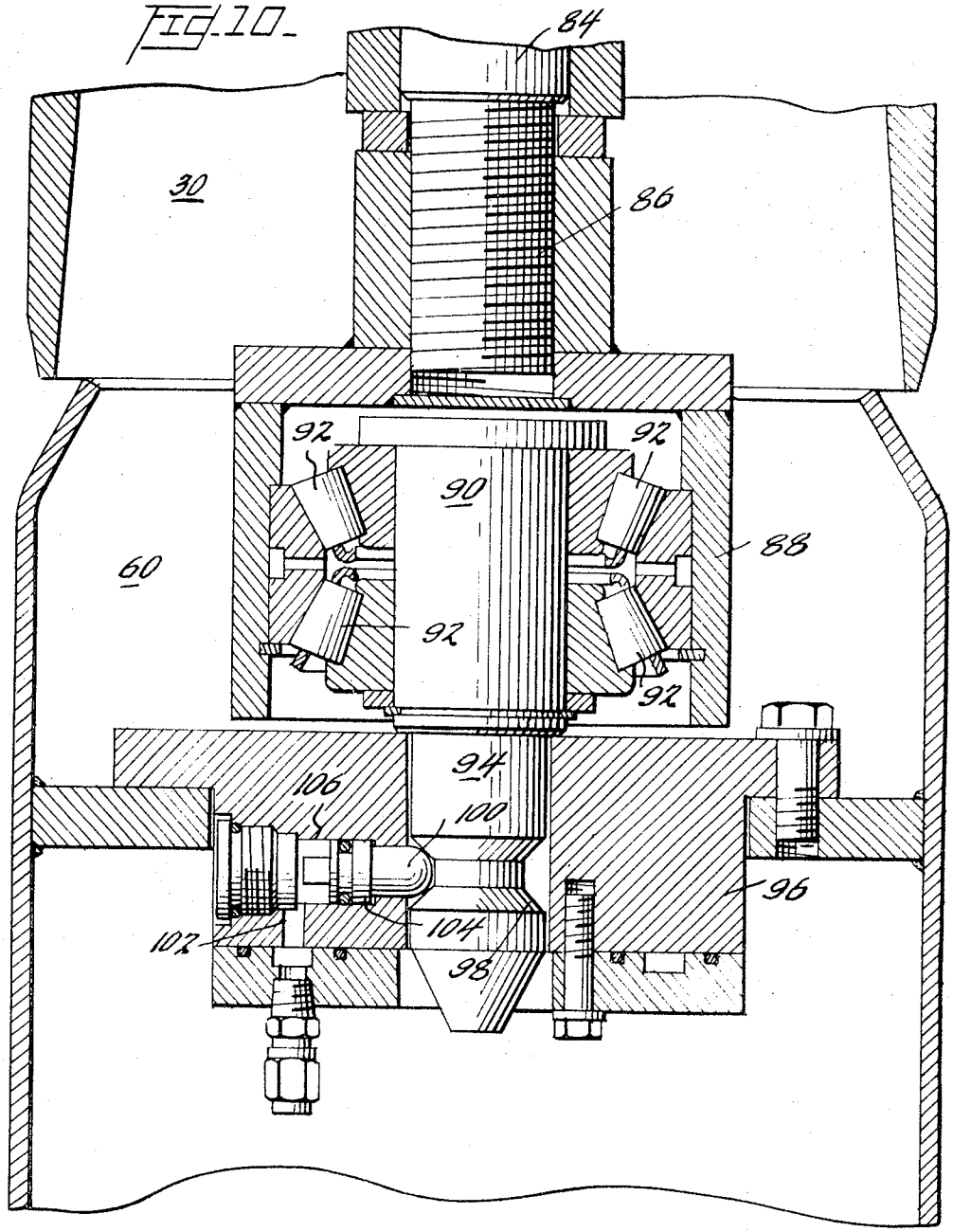
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METHOD OF VIBRATING CORE IN CONCRETE PIPE MAKING MACHINE

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FIG. 10



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3,655,842

METHOD OF VIBRATING CORE IN CONCRETE PIPE MAKING MACHINE

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Original application May 27, 1967, Ser. No. 638,010. Divided and this application Oct. 17, 1969, Ser. No. 3,264

Int. Cl. B28b *1/46, 7/00, 21/00*

U.S. Cl. 264—72 9 Claims

ABSTRACT OF THE DISCLOSURE

The invention comprises a novel method of vibrating a core in a concrete pipe making machine. In a preferred embodiment, a novel core is inserted and vibrated simultaneously with formation of the cementitious pipe. Vibration may continue for a short period after pipe formation in order to insure complete compaction of material and elimination of voids.

CROSS REFERENCE TO RELATED APPLICATION

This is a divisional application of Ser. No. 638,010, filed May 27, 1967, now abandoned.

BACKGROUND OF THE INVENTION

The invention relates generally to the formation of concrete pipe, and particularly presents a solution to the problem of residual strain created by the troweling of zero slump concrete with rotary motion. In the usual pipe forming apparatus, the outer form of the pipe is stationary. Thus, rotary motion by the packerhead imparts a stress to the concrete mix, such stress being particularly disturbing in the event the concrete pipe is supplied with reinforcing wire. It has been found that such wire may be strained beyond its yield point causing permanent bending as well as deflection of the wire, making the completed pipe product unsatisfactory. Furthermore, because of the difference in modulus of elasticity between steel and concrete relieving such undesirably induced stress after the pipe is formed causes unnecessary voids to be formed in the concrete pipe. Obviously, such voids reduce the strength of cured pipe and allow leakage in the pipe through the voids.

In the case of non-reinforced pipe residual stress movement of the concrete causes cracks to form in the pipe thereby reducing strength of the pipe and permitting leaks. As a result of these encountered problems, many purchasers of concrete pipe refuse to accept pipe formed by a rotating packerhead or rollerhead method.

The prior art is not entirely devoid of vibrating cores used in the manufacture of concrete pipe. For example, the U.S. patent to E. Robbins, No. 1,504,834, illustrates a core for a pipe form inserted into and withdrawn from the form therebeneath by means of controlled fluid pressure. U.S. Pat. No. 1,961,981 to Pechstadt also discloses a movable core for a pipe form, and a tamper for compacting the cementitious material. A further improvement to the basic concept of these two patents is disclosed by U.S. Pat. No. 2,544,453 to Gaudin which illustrates a vertically movable vibrating core insertable into and withdrawable from a pipe form.

However, none of these patents nor any material presently available in the art of forming concrete pipe discloses a solution to the residual stress problem discussed above

which is encountered in the current practice of the manufacture of pipe which employs the use of a vertically disposed form and a packerhead which moves slowly along the axis of the form while rotating and while concrete is poured in to form the pipe.

The instant invention overcomes the disadvantages of the prior art by permitting the formation of concrete pipe by the rotating packerhead method without inducing residual stress either in the concrete or in the reinforcing wire, if used. By employing a vibrating core together with a rotating packerhead as the concrete pipe is formed, residual stresses are avoided due to vibratory motion being imparted to the concrete and reinforcing wire during the pipe forming operation. Of further significance is the fact that the vibrating core of this invention may be used on concrete pipe formed by a variety of other methods such as by spinning, vibration, or tamping, before the pipe is cured so as to relieve all residual stress, fill voids, compact and densify the concrete and induce a more intimate bond between reinforcing wire and the concrete mix prior to curing of the pipe. Finally, desirably larger aggregate may be used in the concrete mix for concrete pipes resulting in a decrease in absorption of the pipe wall because vibration by the core will cause thorough mixing of the concrete as well as a better coating of sand and aggregate particles with cement.

SUMMARY

The object of the invention is to provide a concrete pipe making method which completely negates residual strain caused by the standard pipe forming apparatus by employing a vertically movable internal vibrating core to the pipe as it is formed. In the primary embodiment, the vibrating core is adapted for use with a rotating packerhead as the concrete pipe is formed. A series of vibrators are attached internally of the core, preferably, and are activated sequentially as the core enters the pipe form. Once the pipe is formed, the core is lowered and raised again through the green pipe, and is vibrated to assure elimination of residual voids and stresses. Then the core is lowered only a short distance from the top, or spigot end of the green pipe, and raised, while vibrating, three more times to even further assure complete compaction of the green pipe. Settling near the spigot end will occur, so a small amount of cementitious material is added to complete the spigot end of the pipe. After the third terminal pass, the core is lowered and the completed pipe removed for curing.

BRIEF DESCRIPTION OF THE DRAWINGS

Details of construction and operation according to the preferred embodiments of the invention will become readily apparent by reference to the following drawings wherein:

FIGS. 1 through 5 are front elevational views showing the invention as applied to a concrete pipe making machine of the type commonly used in the industry; these figures show the sequence of operations in forming concrete pipe;

FIGS. 6 through 9 are similar to FIGS. 1 through 5 and show the sequence of operations in forming a concrete pipe according to this invention in another embodiment; and

FIG. 10 is a sectional view of the means interengaging the vibrating core and the rotating packerhead and applies to both embodiments of the invention as shown by FIGS. 1 through 5 and by FIGS. 6 through 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings by reference character and in particular to FIGS. 1 through 5 thereof, the invention is shown in combination with a modified pipe making machine of the type commonly used in the industry today. The pipe making machine comprises a pipe form **10** of generally cylindrical configuration, which may have circular corrugations therein. Form **10** includes an upper, spigot end **12** and a lower, diverging frusto-conical skirt forming a bell end **14**. A platform **16** is provided for form **10**, and includes a circular opening **18** centrally located beneath bell end **14**. Platform **16** may be a turntable for indexing of work.

Interiorally of bell end **14** is a pallet **20** having a circular opening **22** therein, generally concentrically spotted with respect to opening **18** in platform **16**. Pallet **20** is slightly movable vertically within bell end **14** for initial formation of the bell end of the pipe.

A frame superstructure generally indicated by **24** is located above platform **16** and includes a cementitious material boot or hopper **26** and a conveyor **28** for filling form **10**. Numeral **30** indicates a packerhead, rollerhead, or circular, powered trowel, each of which is known in the art, which distributes and compacts material against the form from bell end **14** upwardly to form the pipe, travelling through mix provided from boot **26** and conveyor **28**. Frame **24** supports a vertically movable crosshead (not shown) which drives shaft **34** and distributor **30**.

A pit designated at **36** contains the major portion of the instant invention. For ease of explanation, parts will be described from the base of pit **36**, upwardly to turntable or platform **16**. Mounted in the base of pit **36** is a caisson or hydraulic cylinder **38** having an internal vertically travelling piston (not shown) operatively connected to a piston rod **40** (FIG. 2). A frame assembly comprising a plurality of radially spaced vertical standards **42, 42** is arranged concentrically about cylinder **38** and beneath opening **18** in platform **16**. A circular base block plate **44** is secured about cylinder **38** at the floor of pit **36** to standards **42, 42**. A similar upper block plate **46** is mounted near the upper ends of standards **42, 42**. Between plates **44** and **46** are located a series of radially spaced guide rods **48, 48**. Plates **44** and **46** serve additionally as the lower and upper limits respectively of the travel of a bearing block assembly **50**, having bearing sleeves formed therein (not shown) about guide rods **48, 48**, for free movement therealong. Block assembly **50** cooperating with guides **48, 48** also serves to prevent axial rotation of the vibrating core **60** of the invention.

A cylindrical support casing **52** is mounted on top of block assembly **50** and is affixed to the free end of piston rod **40**. A circular opening **54** is provided in the lower face of casing **52** to entry of cylinder **38** when the invention is in a static, initial stage as shown in FIG. 1. A thrust rod **56** is fixed to piston rod **40** through the upper portion of casing **52** having core platform support **58** mounted thereon. Thus axial stability and limitation of travel of core **60** are imparted substantially beneath the lower terminal end of core **60** so that complete insertion into form **10** is allowed, without interfering with the other operating parts of the apparatus, as shown in FIG. 4. Vibrating core **60** is mounted directly on platform **58** being provided with a series of internally spaced vibrators **62** (FIG. 3).

Immediately beneath platform **16** is a pallet lift assembly **64** (FIG. 2) for forming the bell end of the pipe in the initial stage of operation. Such an assembly is described in detail in U.S. Patent No. 3,083,433 to M. Tiller. For purposes of the instant invention, assembly **64** (FIG. 2) includes a vibrating plate **66** having legs **68** thereon for contacting, lifting and vibrating pallet **20**. A drive plate **70** is secured to and immediately beneath vibrating plate **66**, plates **66** and **70** being rotatably mounted in frame **42**. A motor with suitable gearing drives plate **70** to rotate pallet **20** during the bell forming stage of the pipe making operation. Assembly **64** is raised and lowered by suitable lift means (not shown) and is limited in travel by a pair of limit stops **72, 74**.

A second embodiment of the invention is shown in FIGS. 6 through 9 wherein the pipe is formed without aid of pallet lift assembly **64**. As in the embodiment illustrated in FIGS. 1 through 5, the pipe making machine includes a bell-down form **10**, super-structure **24**, packerhead **30** with drive shaft **34** a, material hopper **26** and platform or turntable **16**. In pit **36** is a caisson or hydraulic cylinder **38** having a piston rod **40** actuated by fluid pressure. Core platform **58** is mounted directly on piston rod **40** (FIG. 8). Controlled movement for platform **58** is provided by a plurality of radially spaced rods **76, 76** mounted directly in the floor of pit **36** and secured at their upper ends to frame portions **78** beneath platform **16**. Vibrators **80, 80** are attached to bell end **14** of form **10** to compact material in the bell of the pipe, formed between pallet **20** and form **10**. Finally, rollers **82, 82** are mounted beneath platform **16** to frame **78** to guide core **60** into and out of form **10**.

FIG. 10 illustrates the specific connection between rotating packerhead **30** and non-rotating core **60**. Packerhead **30** includes an internal rotating drive shaft **84** which is threaded at its terminal end **86** to receive a bearing and pilot stud housing **88**. Non-rotating support shaft **90** is mounted internally of rotating housing **88** by means of a twin series of inclined roller thrust bearings **92, 92** which are adapted to receive both axial and radial stress on the order of 20,000 pounds and 10,000 pounds respectively. A pilot stud **94** is formed on the lower end of support shaft **90** and is tapered at its thrust end so as to guide itself into lock housing **96** of non-rotating core **60** without aid of external guide means. Pilot stud **94** is formed with a lock recess **98** which cooperates with radially spaced locking studs **100**, each actuated by hydraulic pressure through lines **102** against piston **104**. Studs **100** and recess **98** are formed with cambered abutting faces so that upon relief of pressure in lines **102**, pilot stud **94** will separate from core lock housing **96** by axial movement above, forcing lock studs **100** into their receiving chambers **106**.

The operation of the two embodiments of the invention are similar. In the embodiment shown in FIGS. 1 through 5, the invention is depicted first, in FIG. 1, in a static position prior to the pipe making operation. In this position, platform or turntable **16** may be moved (now shown) to place form **10** into position, centrally beneath packerhead **30** and above core **60**.

The pipe forming operation begins by the lowering of packerhead **30** together with housing **88** and pilot stud **94** into form **10** and the raising of core **60** by fluid pressure in cylinder **38**. Hydraulic pressure is introduced through lines **102** to force studs **100** into recess **98** so that rotating packerhead or rollerhead **30** and core **60** are firmly engaged. Mix is then poured into form **10** from conveyor **28**, and pallet lift assembly **64** is raised to the position shown in FIG. 2. The bell end of the pipe is then formed in the manner disclosed in U.S. Patent 3,083,433, as discussed above, by rotating and vibrating the pallet assembly **64**. Rotation of packerhead **30** is initiated, in a direction opposite the rotation of pallet **20**.

When the bell end portion of the pipe has been completed, assembly **64** is lowered to the static position shown in FIG. 3. Packerhead **30** is then raised through the mix, together with core **60** which is forced upwardly by fluid pressure in cylinder **38** acting through piston rod **40**, thrust rod **56**, and core platform **58**. As each vibrator **62** passes bell-end **14** of form **10**, it is activated by a trip switch or other suitable energizing means (not shown) to vibrate that portion of the core. When packerhead **30** has reached the top or spigot end **12** of form **10**, rotation

ceases, fluid pressure in line **102** is relieved, and packerhead **30** is lifted from core **60**, as illustrated in FIG. 4. Vibration of core **60** by vibrators **62** is continued for a short time to complete compaction of mix, particularly around spigot end **12** of form **10**, and to assure the complete elimination of any residual stress in the completed pipe which may have been caused by the rotation of packerhead **30**.

Once vibration is satisfactorily completed core **60** is withdrawn from the finished pipe by cylinder **38**, turntable **16** is moved to place a new form **10** into position and to remove the newly completed green pipe.

Of course, vibrators **62** might be replaced by or supplemented with vibrators located externally of the invenion, as on form **10** (not shown). The important point is that vibratory motion be imparted to the mix as the pipe is being formed to assure complete compaction of the mix.

The general methodology outlined above may be supplemented by additional steps if desired. These steps will assure an even more satisfactory product. Once packerhead **30** has reached the top or spigot end **12** of form **10**, packerhead **30** together with core **60** may be lowered back to the initial position. A second pass, or vertical movement of core **60** through the newly formed green pipe is made, with the vibrators energized, in order to even further densify smooth and compact the concrete pipe. Once the second pass is complete, and core **60** has reached its uppermost vertical status, the vibrators are left activated with the core **60** remaining in a static position for a period of from one to three minutes depending upon the slump rating of the concrete. The drier the mix, the longer this period of vibration should be. Then core **60** and packerhead **30** should be lowered once more, but only a short distance, such as from one and one-half to two feet, and raised again to the upper most vertical status in order to further settle and compact spigot end **12** of the pipe being formed. This short or terminal pass should be repeated three times, with the vibrators **62** activated, adding a little mix at end **12** of the form as the newly formed pipe settles due to the vibration. At the moment of completion of the third termina pass, all vibraors should be deactivated immediately to terminate settling. Then packerhead **30** is released from core **60** and core **60** is withdrawn from the pipe as outlined previously.

Of course, packerhead **30** and core **60** may be raised either by cylinder **38**, thrust rod **56** and piston rod **40**, or they may be lifted from above by the vertically movable crosshead (not shown) which drives the shaft **34** and distributor **30**.

The operation of the second embodiment of the invention shown in FIGS. 6 through 9 is similar, except that bell end **14** of the pipe is formed by vibration induced by vibrators **80** located therearound. Once the bell end is formed, vibrators **80** are turned off, and the remainder of the operation discussed above is completed.

Green pipe formed from cementitious material by a rotary trowel method or other methods common in the art may be transferred to the invention while still in its mold to be vibrated by inserion of core **60** thereinto. This operation will remove residual stress in the gree pipe and give the cured pipe the structural integrity assured by use of the present invention during the initial forming stage of the pipe.

Three-edge bearing tests were made on concrete pipe formed by the invention and results were compared with results obtained from testing pipe manufactured without the aid of the instant invention. Five test specimens were manufactured having only 74% of the steel reinforcement used in our specimens manufactured by the older process. These tests were conducted to specifications for three-edge bearing tests contained in Tentative Specifications for Reinforced Concrete Culvert, American Society for Testing and Materials in 1963. The values listed in the D-load columns below are test loads expressed in pounds per linear foot per foot of pipe diameter. The four specimens manufactured by the older process were made according to the ASTM requirements for Class IV reinforced concrete pipe. The test results of the pipe manufactured according to the invention were as follows:

Tested	D-load 0.01" crack, lbs.	D-load ultimate, lbs.	Vibrated, mins.
Made:			
x---------- x+2 days-----	2,200	3,380	5
x---------- x+3 days-----	2,024	3,705	5
x---------- x+3 days-----	2,102	3,477	5
x---------- x+3 days-----	2,124	3,306	4
x---------- x+3 days-----	1,893	3,293	2

Each pipe was eight feet long, two feet in diameter and had a wall thickness of three inches, and was given ten hours of moist curing.

The four specimens manufactured in the manner known in the art yielded the following test results:

Tested	D-load 0.01" crack, lbs.	D-load ultimate, lbs.
Made:		
x----- x+50 days-----	2,400	3,280
x----- x+20 days-----	2,020	3,100
x----- x+10 days-----	1,970	3,320
x----- x+25 days-----	2,100	3,470

These latter specimens compare precisely in size to the former, save that these four specimens contained a significantly greater amount of reinforcing steel, and were aged for a considerably longer period of time. Yet the pipes formed according to the present invention performed as well as those made in a usual manner.

I claim:

1. A method of relieving residual torroidal strain in green cementitious pipe being formed by rotary trowel action exerting radial outward pressure comprising:

(a) inserting of a core having an external diameter approximating the internal diameter of said green pipe, and a length corresponding to that of said pipe; and

(b) vibrating said core during insertion into said green pipe whereby the material of said pipe is settled and voids formed therein during manufacture are filled.

2. The method as recited in claim **1** wherein insertion and vibration of said core are made to occur simultaneously with the formation of said cementitious pipe.

3. The method as recited in claim **1** wherein vibration of said core is made to occur simultaneously with the formation of said cementitious pipe, and to continue after completion of pipe formation, while said core remains inserted completely in said formed pipe.

4. The method as recited in claim **1** wherein the step of vibrating the core during insertion into the green pipe comprises the further steps of:

(a) inserting and vibrating the core simultaneously with the formation of said cementitious pipe; and

(b) withdrawing the core and reinserting and vibrating the core again once the green pipe is formed.

5. The method as recited in claim **4** wherein the step of withdrawing the core and reinserting and vibrating the core once the green pipe is formed comprises the further steps of:

(a) continuing vibration of the core once reinsertion of the core is completed until further densification and compaction of the green pipe is completed;

(b) terminating vibration of the core; and

(c) removing the core from the green pipe.

6. The method as recited in claim **5** wherein the step of continuing vibration once reinsertion of the core is completed comprises the further steps of:

(a) partilaly withdrawing the core again as it continues to vibrate, a distance less than the length of said green pipe, and

(b) fully reinserting the core into the green pipe as vibration of the core continues.

7. The method as recited in claim 6 wherein the steps of partial withdrawal and full reinsertion of the vibrating core into the green pipe are repeated at least once.

8. The method as recited in claim 6 wherein the steps of partial withdrawal and full reinsertion of the vibrating core into the green pipe are conducted three times.

9. The method according to claim 1 wherein the pipe being formed is provided with wire reinforcement.

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ROBERT F. WHITE, Primary Examiner

J. R. THURLOW, Assistant Examiner

U.S. Cl. X.R.

25—30 R, 36, 41 J; 264—312

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,655,842 Dated April 11, 1972

Inventor(s) F. A. Trautner

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 41, change "termina" to --terminal--.

, line 60, change "gree" to --green--.

, line 71, insert quotation marks (") before "Tentative

, line 72, after "Culvert," insert--Storm Drain and Sewer Pipe" (C-76-63T), published by the--.

Column 6, line 72 (claim 6) change "partilaly" to --partially--

Signed and sealed this 26th day of June 1973.

(SEAL)
Attest:

EDWARD.M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents