United States Patent [19]

Trautner et al.

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[54] **VIBRATORY CORE FOR CONCRETE PIPE MAKING MACHINE**

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[73] Assignee: **Concrete Pipe Machinery Company,** Sioux City, Iowa

[22] Filed: **Aug. 1, 1975**

[21] Appl. No.: **601,036**

Related U.S. Patent Documents

Reissue of:

[64] Patent No.: **3,752,626**
Issued: **Aug. 14, 1973**
Appl. No.: **867,344**
Filed: **Oct. 17, 1969**

U.S. Applications:

[63] Continuation-in-part of Ser. No. 638,010, May 12, 1967, abandoned.

[52] **U.S. Cl.** **425/262;** 425/432; 425/421

[51] **Int. Cl.²** **B28B 21/28**

[58] **Field of Search** 425/262, 432, 421

[56] **References Cited**

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937,178	10/1909	Rentzsch	425/DIG. 22
1,504,834	8/1924	Robbins	425/431
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[57] **ABSTRACT**

A novel vibrating core apparatus for use with a concrete pipe making machine. The novel apparatus includes a core, vertically movable into and out of a pipe form, a series of vibrators attached along the interior side wall of the core, an upwardly movable system operative by fluid pressure for raising and lowering the core, and an interlocking connection between a standard packerhead, which distributes cementitious material about the interior of the pipe form, and the upper portion of the core. The packerhead is designed to rotate while forming the pipe; the core does not rotate and the connecting means between the two is easily attached and disengaged from the packerhead.

22 Claims, 10 Drawing Figures

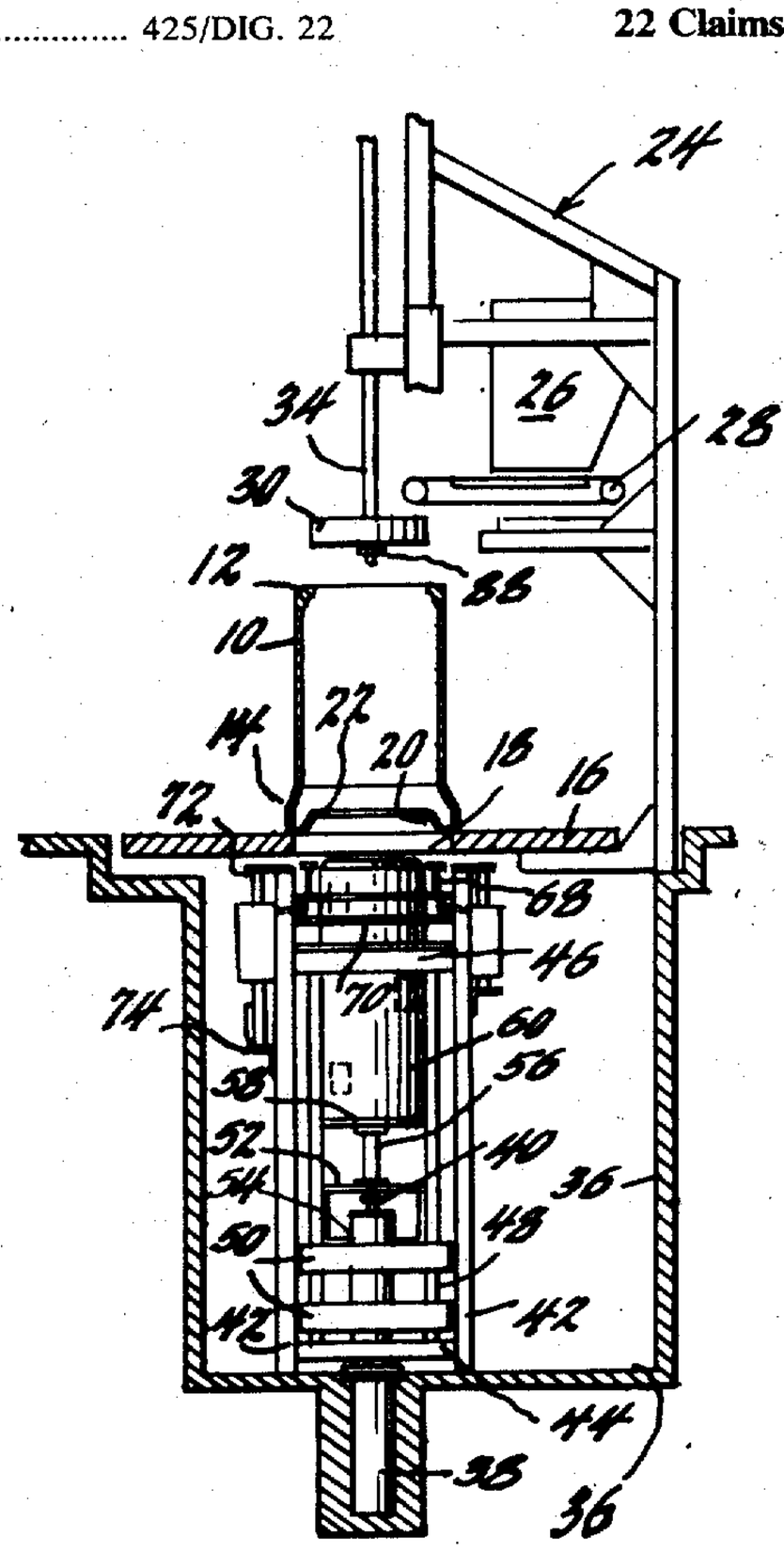

FIG. 5.

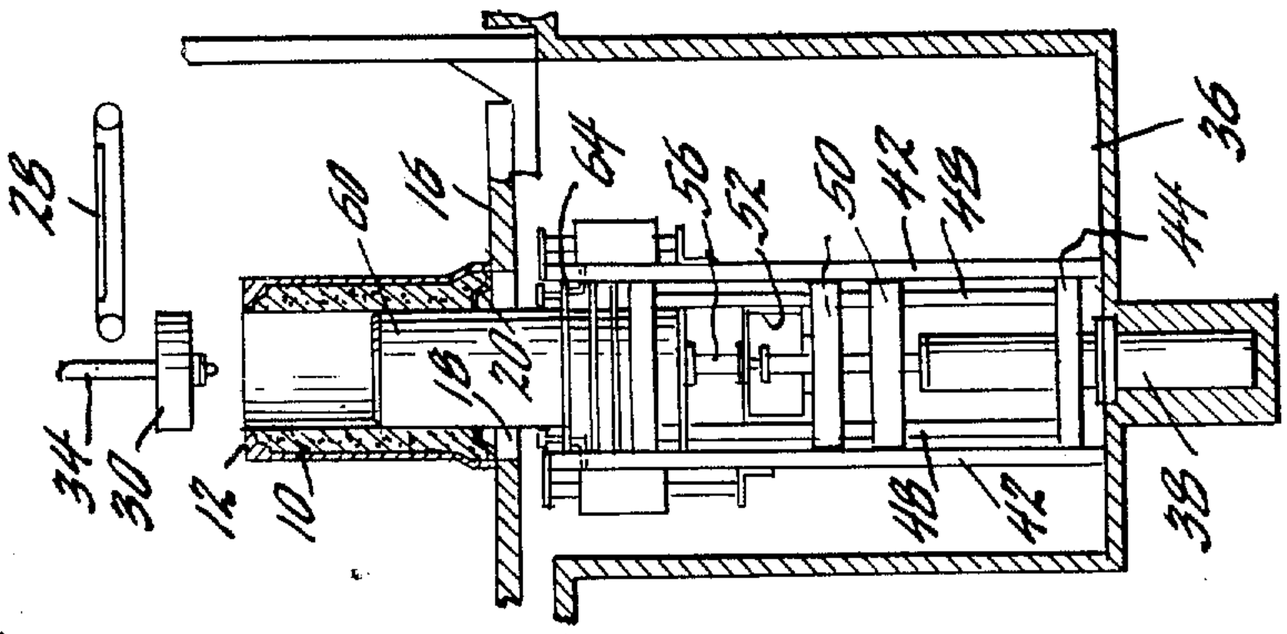

FIG. 4.

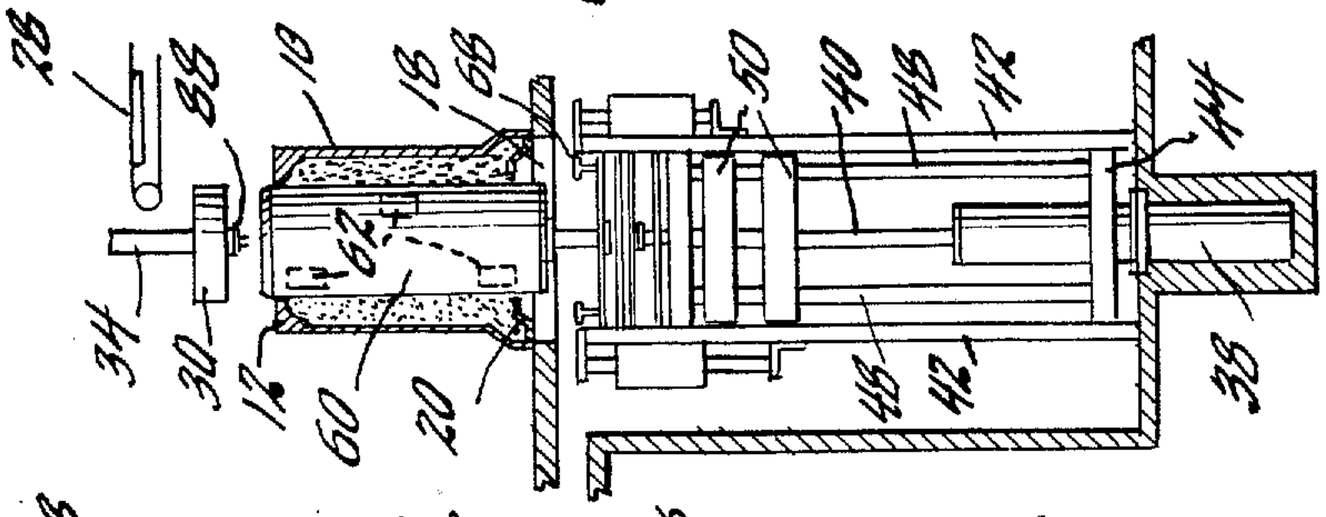

FIG. 3.

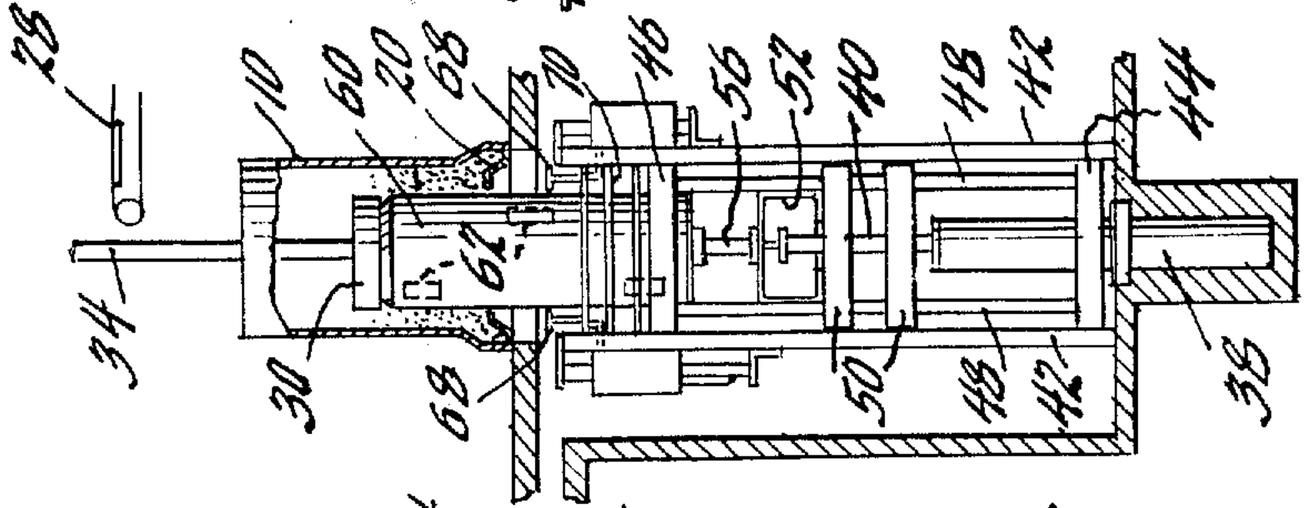

FIG. 2.

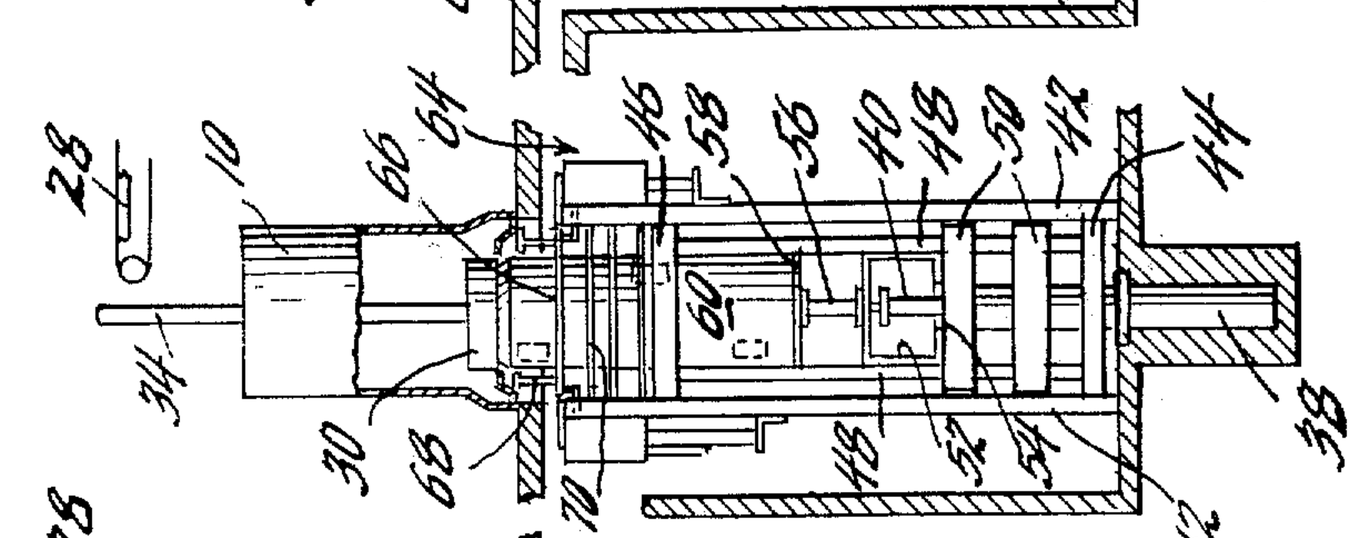

FIG. 1.

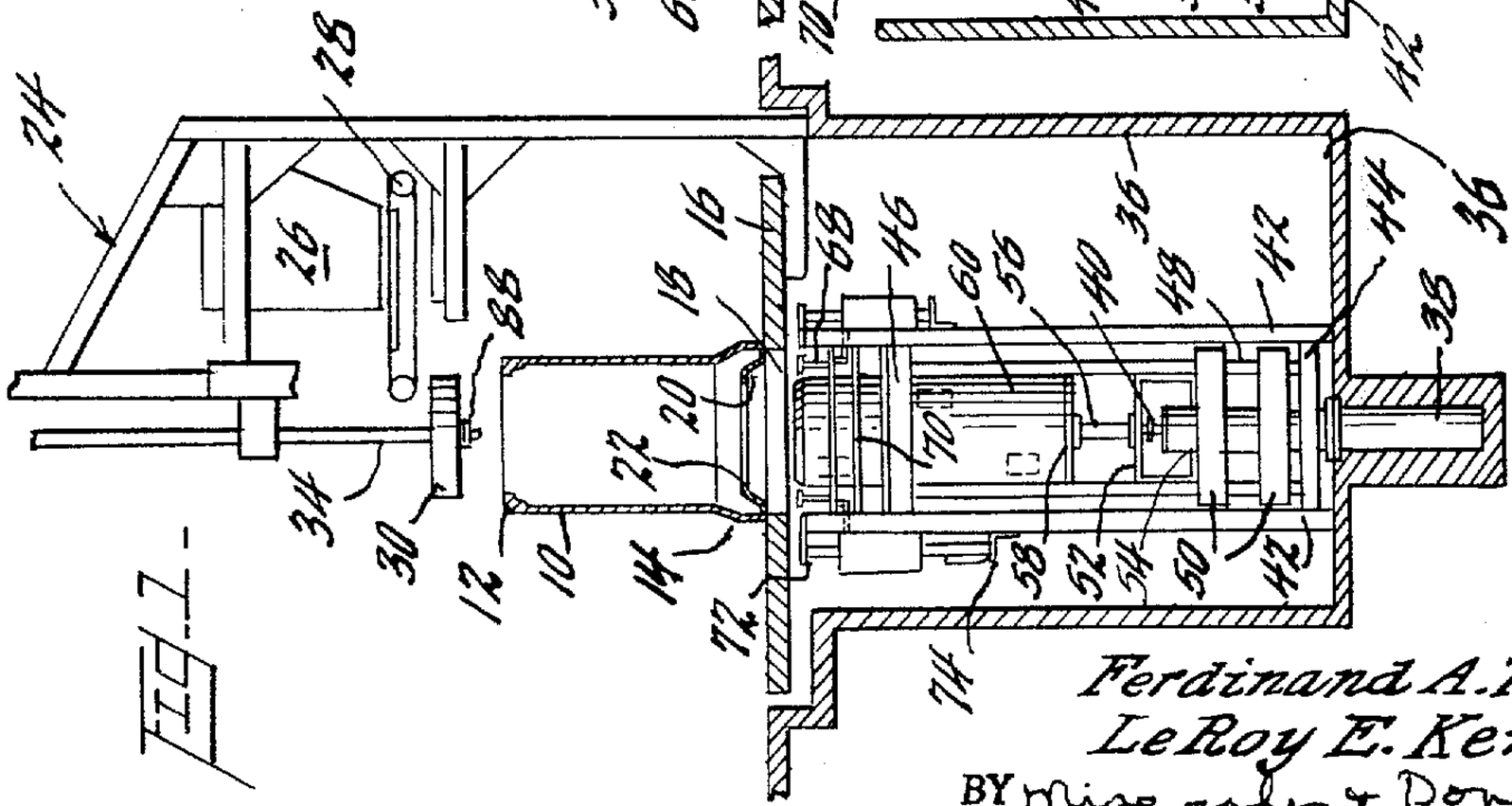

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FIG. 5.

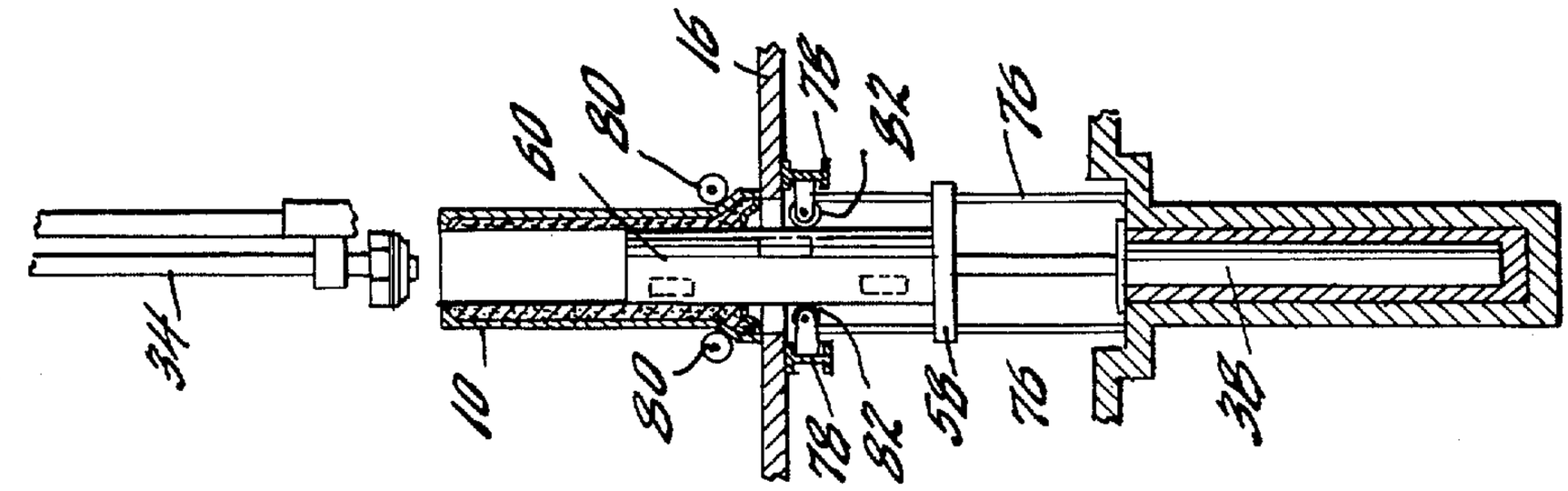

FIG. 6.

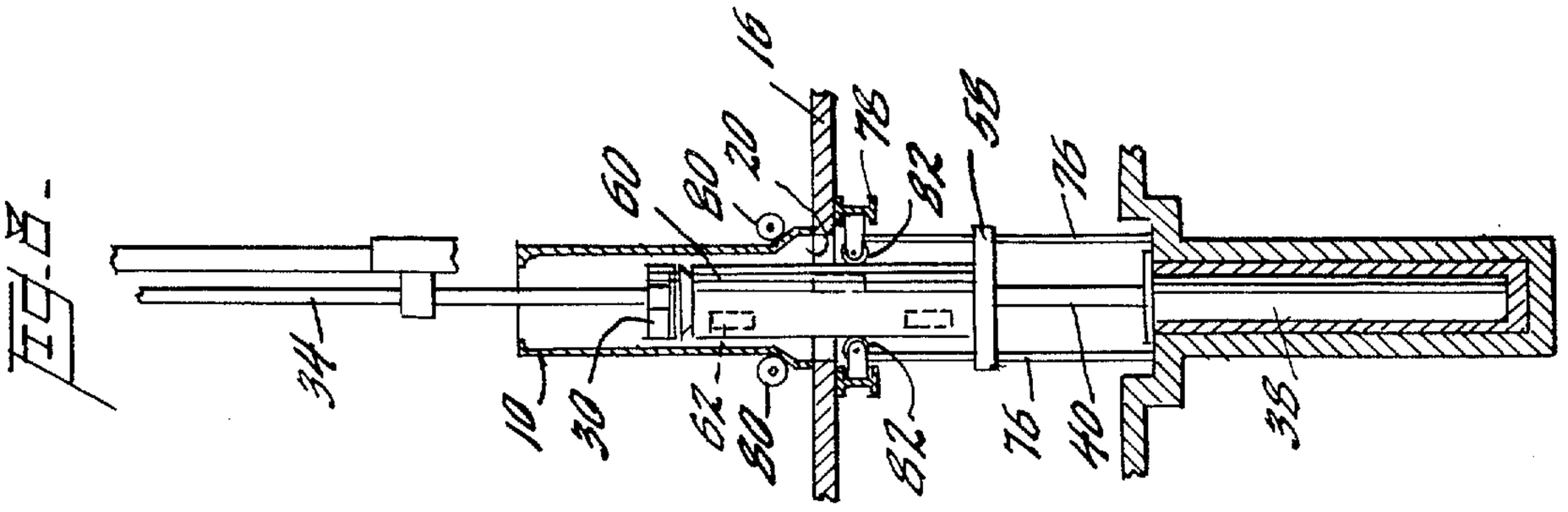

FIG. 7.

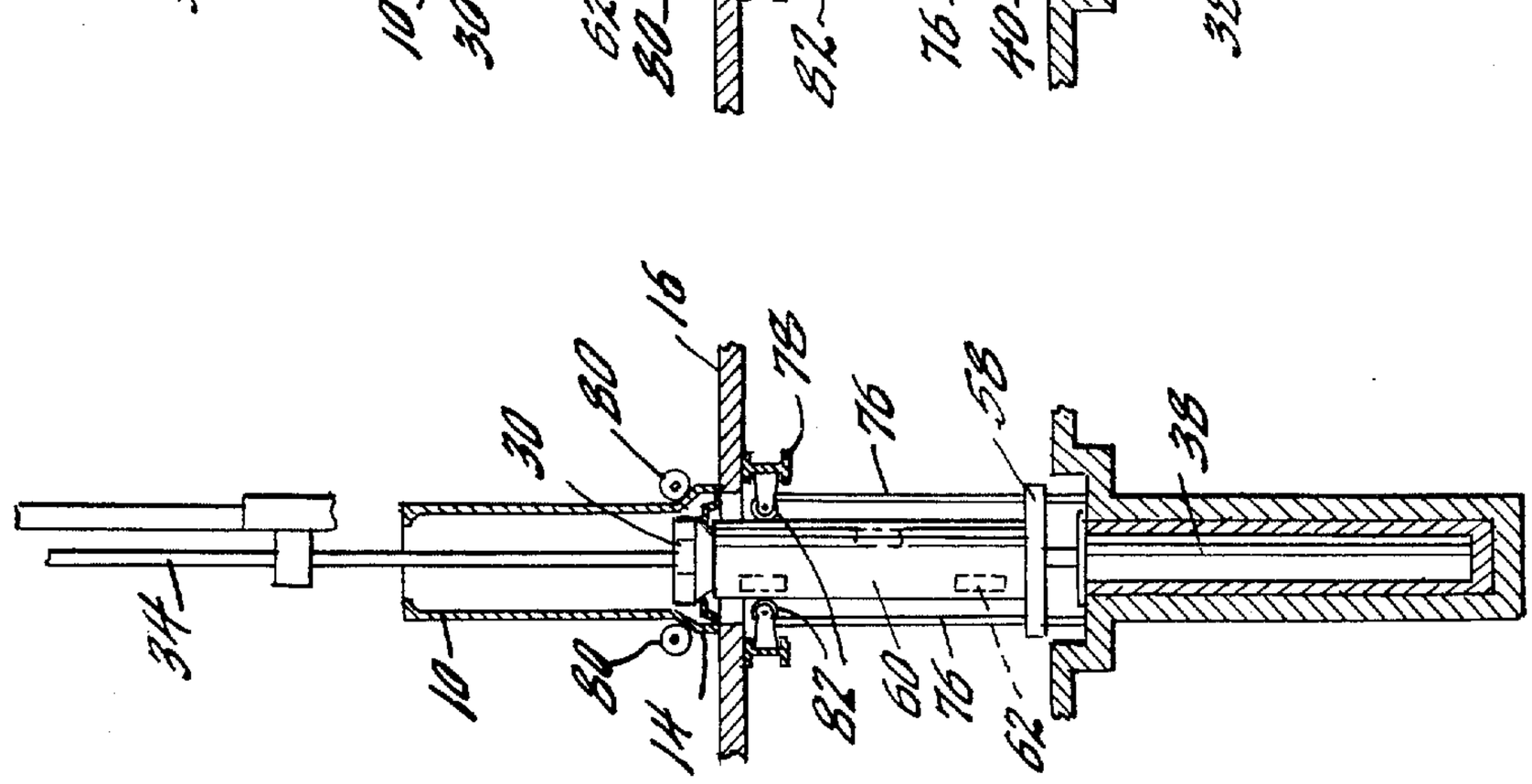

FIG. 8.

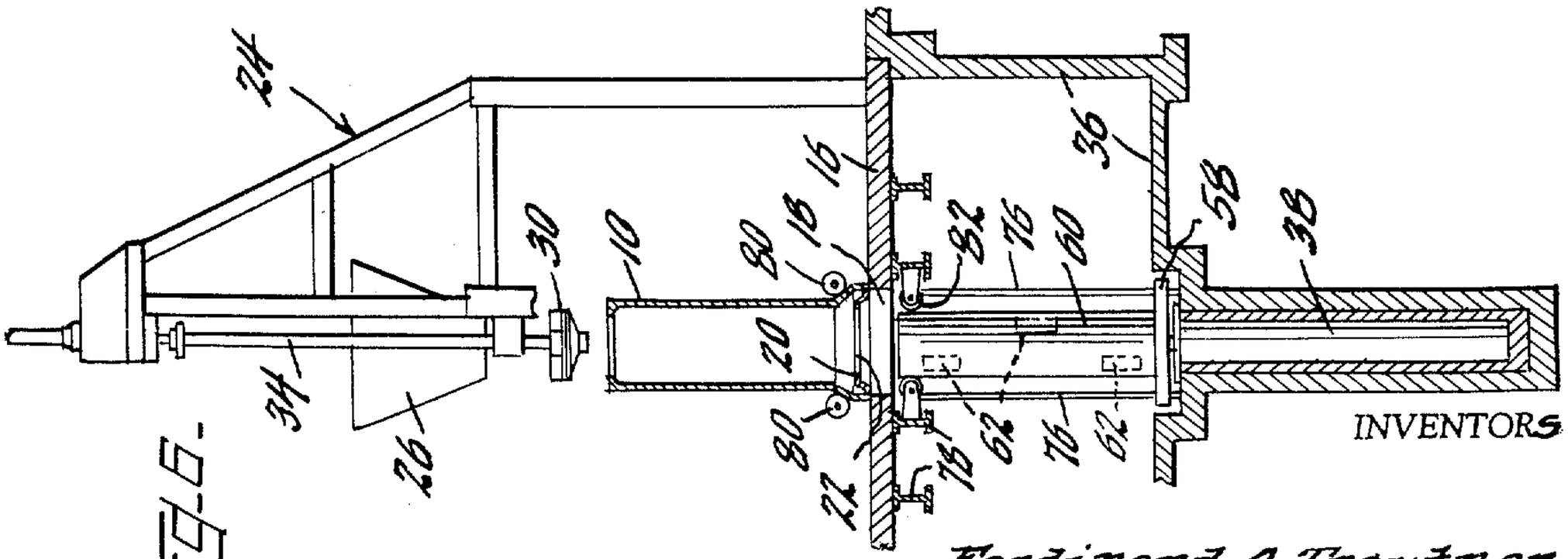

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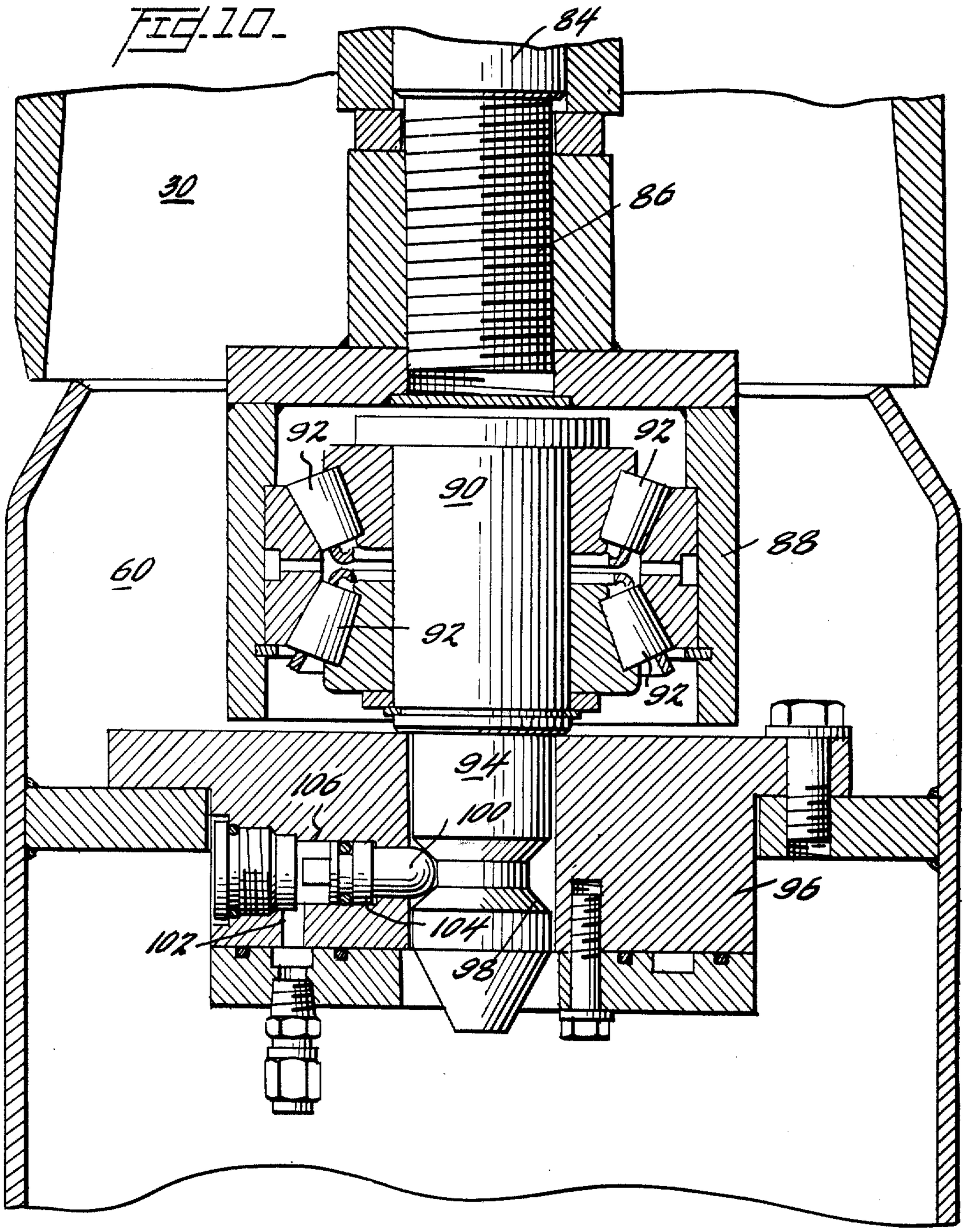
FIG. 10



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VIBRATORY CORE FOR CONCRETE PIPE MAKING MACHINE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

CROSS REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of Ser. No. 638,010, filed May 12, 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 roller-head method.

The prior art is not entirely devoid of vibrating cores used in the manufacture of concrete pipe. For example, the U.S. Pat. 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 pipes 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 apparatus 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. Hydraulically actuated interengaging means is provided between the packerhead and the vibrating core which permits rotation to be imparted to the packerhead while allowing the vibrating core to remain axially stationary. Primary lift means is provided for the packerhead and core; fluid pressure actuated means is provided beneath the vibrating core to move the same downwardly after the pipe forming operation. The interengaging means is hydraulically disengaged at the completion of the pipe forming operation to allow removal of the packerhead and withdrawal of the vibrating core from the completed, uncured pipe so that the uncured pipe together with the outer form thereof may be removed from the pipe making machine so that a new outer form may be set into place for formation of another pipe.

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. Pat. 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. Pat. No. 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 invention, 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 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 insertion of core **60** thereinto. This operation will remove residual stress in the green 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 percent 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, STORM DRAIN AND SEWER PIPE" (C 76–63T), published by the 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:

Made	Tested	D-load 0.01" crack	D-load Ultimate	Vibrated
x	x+2 days	2200 lbs.	3380 lb.	5 min.
x	x+3 days	2024 lbs.	3705 lb.	5 min.
x	x+3 days	2102 lbs.	3477 lb.	5 min.

-continued

Made	Tested	D-load 0.01" crack	D-load Ultimate	Vibrated
x	x+3 days	2124 lbs.	3306 lb.	4 min.
x	x+3 days	1893 lbs.	3293 lb.	2 min.

Each pipe was 8 feet long, 2 feet in diameter and had a wall thickness of 3 inches, and was given 10 hours of moist curing.

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

Made	Tested	D-load 0.01" crack	D-load Ultimate
x	x+50 days	2400 lb.	3280 lb.
x	x+20 days	2020 lb.	3100 lb.
x	x+10 days	1970 lb.	3320 lb.
x	x+25 days	2100 lb.	3470 lb.

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.

[We claim:**]** *What I claim and desire to secure by Reissue Letters Patent is:*

1. In a concrete pipe forming apparatus adapted for forming pipe from zero-slump concrete including a pipe form, a platform for supporting said pipe form, a rotating packerhead material distributor comprising a rollerhead for forming the pipe, and a powered main lift mechanism for raising said rollerhead as the pipe is formed, the improvement comprising:

a. a non-rotating core;

b. means for vibrating material forming the pipe as the pipe is formed;

c. means interengaging said core with said rollerhead; and

d. an upwardly movable guide system for said core **[**.**]** ,

said means for vibrating material forming the pipe as the pipe is formed comprising means attached to the core for vibrating the core.

[2. The apparatus of claim **1** wherein said means for vibrating material forming the pipe as the pipe is formed comprise means attached to the core for vibrating the core. **]**

3. The apparatus of claim **[2]** *1* wherein said means attached to the core for vibrating the core include a plurality of vibrators, spaced vertically along the interior wall thereof, each of said vibrators being selectively actuable.

4. The apparatus of claim **3** wherein the means for selectively actuating the vibrators comprise means for energizing each of said vibrators as said each vibrator passes beneath the lower terminal edge of said pipe form as said core enters the pipe form.

5. The apparatus of claim **1** wherein said upwardly movable guide system for said vibratory core comprises:

a. a fluid pressure cylinder, located concentrically beneath said core;

b. a piston in said cylinder;

c. a piston rod on said piston;

d. a support platform for said core operatively mounted on said piston rod;

e. vertical guide rods radially spaced about said piston rod and extending upwardly toward said platform; and

f. means connecting said guide rods and core platform whereby rotational movement of said core is prevented.

6. The apparatus of claim **5** wherein said means connecting said guide rods and core platform comprise:

a. a cylinder easing support, depending from said core platform, about said piston rod and fluid cylinder; and

b. a bearing block assembly, depending from said casing and itnerengaged for sliding movement with said guide rods, whereby lateral and axial stability is imparted to said core substantially beneath the thrust end of said piston rod.

7. The apparatus of claim **6** wherein said guide rods are further provided with upper and lower stops defining the vertical limits of movement of said bearing block assembly.

8. The device of claim **1** wherein said means interengaging said distributor and said core comprise:

a rotatable housing, firmly secured to and depending from said distributor, axially thereof;

b. a non-rotating support shaft, depending axially from said rotatable housing;

c. bearing means interconnecting said support shaft and housing allowing free rotation of said housing around said support shaft;

d. a lock housing mounted on the upper free end of said core; and

e. disconnectable securing means acting between said lock housing and said support shaft.

9. The interengaging means of claim **8** wherein said bearing means comprise a plurality of inclined bearings adapted to receive thrust and radial loading.

10. The interengaging means of claim **8** wherein said disconnectable securing means comprise:

a. a male pilot stud on said support shaft;

b. a female lock sleeve in said lock housing;

c. means defining a recess circumferentially about said pilot stud; and

d. a plurality of fluid pressure actuable lock studs in said sleeve adapted to enter said recess.

11. The disconnectable securing means of claim **10** wherein said lock studs and said core are formed with inclined mating faces whereby upon relief of fluid pressure on said lock studs and axial separation of said core and distributor, said lock studs are withdrawn into said lock housing thereby permitting axial separation of said core from said distributor.

12. The invention as recited in claim **1** wherein the pipe form contains a reinforcing wire structure for the pipe.

13. In a concrete pipe forming apparatus adapted for forming pipe from zero-slump concrete including a pipe form, a platform for supporting said pipe form, a rotating packerhead material distributor comprising a rotating trowel for forming the pipe, and a powered main lift mechanism for raising said rotating trowel as the pipe is formed, the improvement comprising:

a. a non-rotating core;

b. means for vibrating material forming the pipe as the pipe is formed;

c. means interengaging said core with said rotating trowel; and

d. an upwardly movable guide system for said core [.] ,

said means for vibrating material forming the pipe as the pipe is formed comprising means attached to the core for vibrating the core.

[**14.** The apparatus of claim **13** wherein said means for vibrating material forming the pipe as the pipe is formed comprise means attached to the core for vibrating the core.]

15. The apparaus of claim [**14**] *13* wherein said means attached to the core for vibrating the core include a plurality of vibrators, spaced vertically along the interior wall thereof, each of said vibrators being selectively actuable.

16. The apparatus of claim **15** wherein the means for selectively actuating the vibrators comprise means for energizing each of said vibrators as said each vibrator passes beneath the lower terminal edge of said pipe from as said core enters the pipe form.

17. The apparatus of claim **13** wherein said upwardly movable guide system for said vibratory core comprises:

a. a fluid pressure cylinder, located concentrically beneath said core;

b. a piston in said cylinder;

c. a piston rod on said piston;

d. a support platform for said core operatively mounted on said piston rod;

e. vertical guide rods radially spaced about said piston rod and extending upwardly toward said platform; and

f. means connecting said guide rods and core platform whereby rotational movement of said core is prevented.

18. The apparatus of claim **17** wherein said means connecting said guide rods and core platform comprise:

a. a cylindrical casing support, depending from said core platform, about said piston rod and fluid cylinder; and

b. a bearing block assembly, depending from said casing and interengaged for sliding movement with said guide rods, whereby lateral and axial stability is imparted to said core substantially beneath the thrust end of said piston rod.

19. The apparatus of claim **18** wherein said guide rods are further provided with upper and lower stops defining the vertical limits of movement of said bearing block assembly.

20. The device of claim **13** wherein said means interengaging said distributor and said core comprise:

a. a rotatable housing, firmly secured to and depending from said distributor, axially thereof;

b. a non-rotating support shaft, depending axially from said rotatable housing;

c. bearing means interconnecting said support shaft and housing allowing free rotation of said housing around said support shaft;

d. a lock housing mounted on the upper free end of said core; and

e. disconnectable securing means acting between said lock housing and said support shaft.

21. The interengaging means of claim **20** wherein said bearing means comprise a plurality of inclined bearings adapted to receive thrust and radial loading.

22. The interengaging means of claim **20** wherein said disconnectable securing means comprise:

a. a male pilot stud on said support shaft;

b. a female lock sleeve in said lock housing;

c. means defining a recess circumferentially about said pilot stud; and

d. a plurality of fluid pressure actuable lock studs in said sleeve adapted to enter said recess.

23. The disconnectable securing means of claim **22** wherein said lock studs and said core are formed with inclined mating faces whereby upon relief of fluid pressure on said lock studs and axial separation of said core

and distributor, said lock studs are withdrawn into said lock housing thereby permitting axial separation of said core from said distributor.

24. The invention as recited in claim **13** wherein the pipe form contains a reinforcing wire structure for the pipe.

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