Sept. 14, 1965 F. E. MARTIN 3,205,550

PIPE FORMING MACHINE

Filed June 18, 1963 4 Sheets-Sheet 1

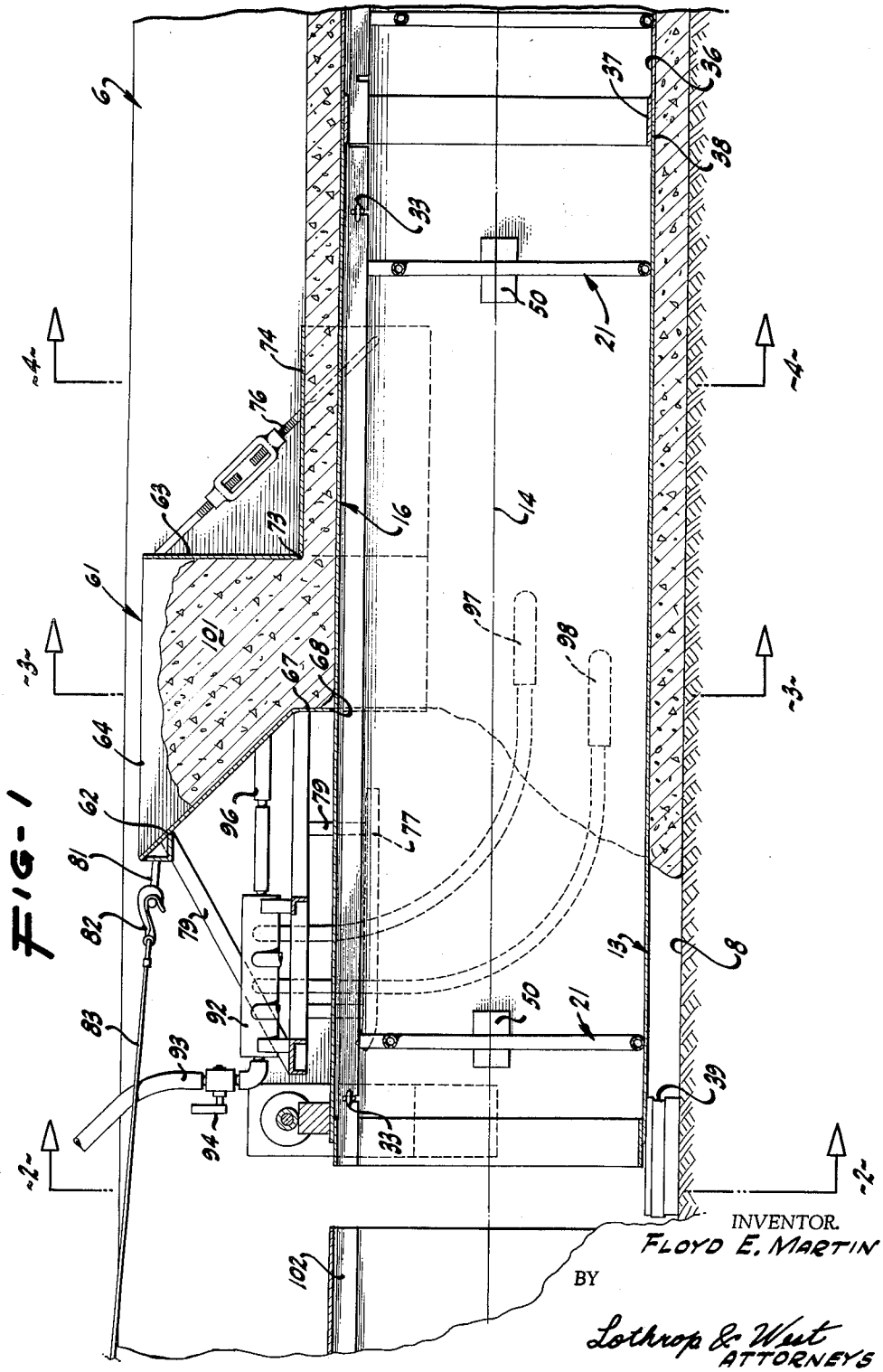


FIG-1

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Sept. 14, 1965 F. E. MARTIN 3,205,550

PIPE FORMING MACHINE

Filed June 18, 1963 4 Sheets-Sheet 2

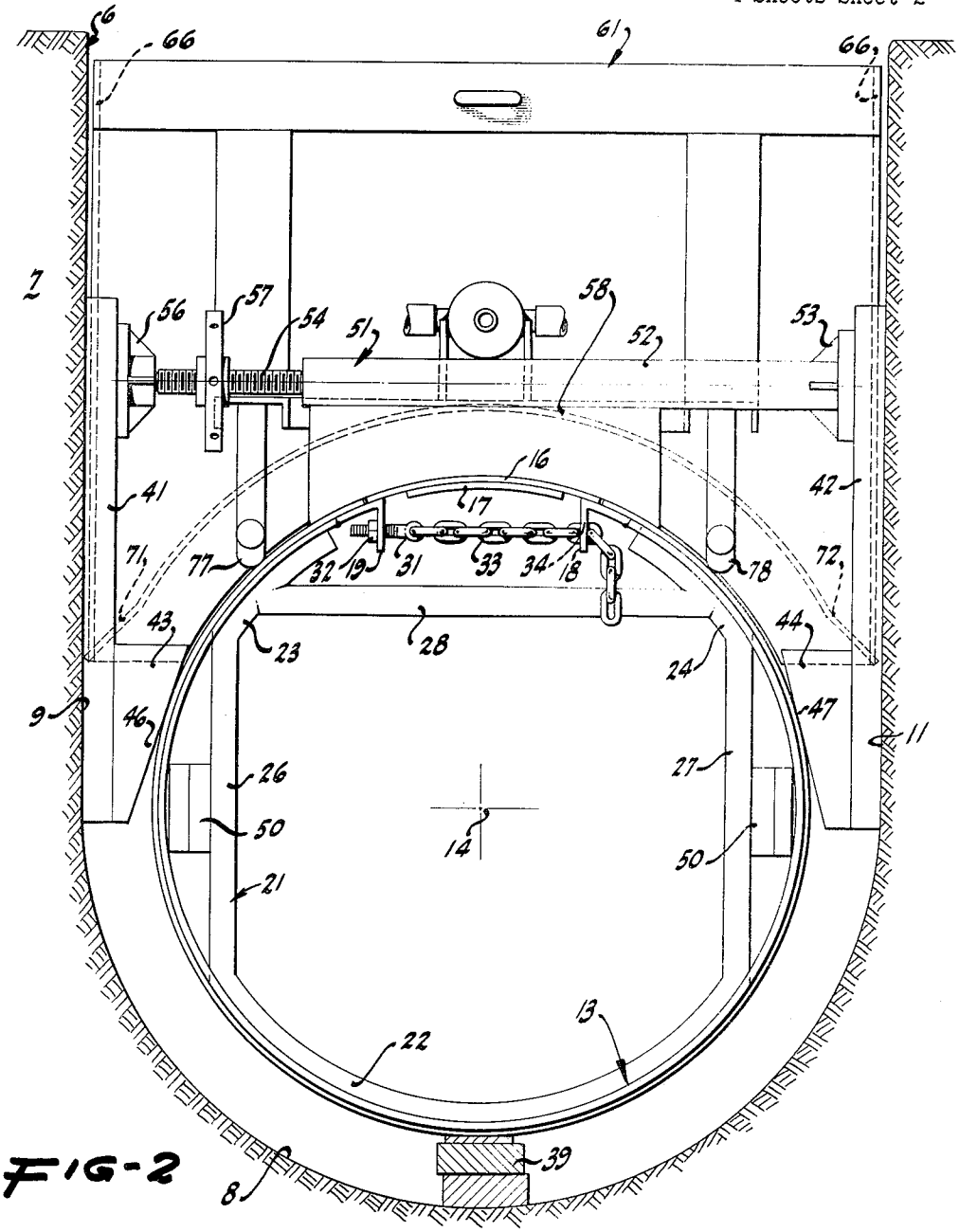


FIG-2

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Sept. 14, 1965 F. E. MARTIN 3,205,550

PIPE FORMING MACHINE

Filed June 18, 1963 4 Sheets-Sheet 3

FIG-3

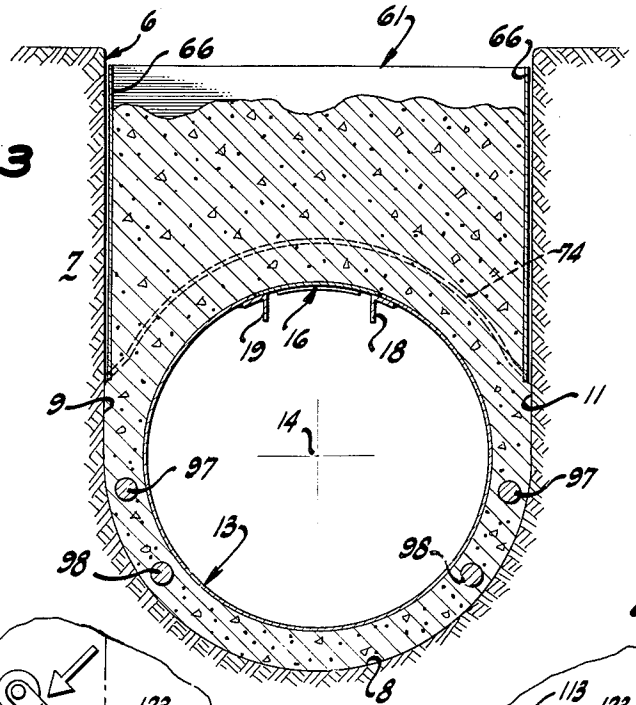


FIG-10

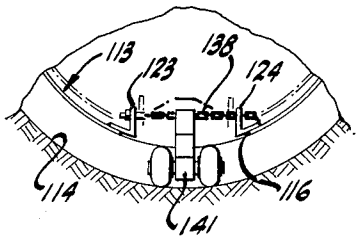
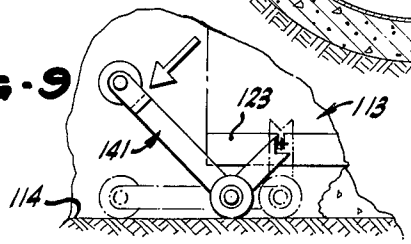


FIG-9



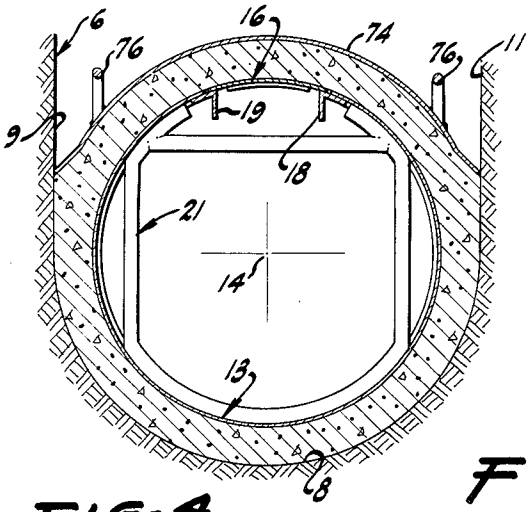


FIG-4

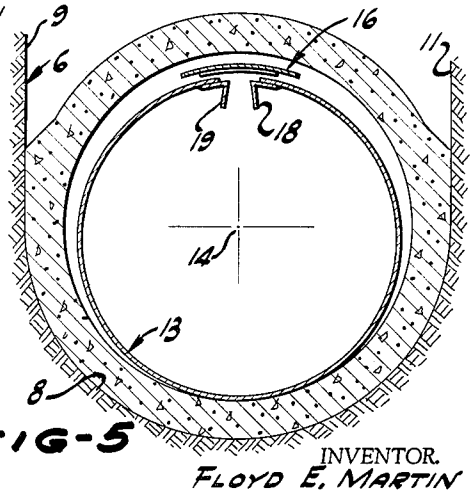


FIG-5

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Sept. 14, 1965 F. E. MARTIN 3,205,550

PIPE FORMING MACHINE

Filed June 18, 1963 4 Sheets-Sheet 4

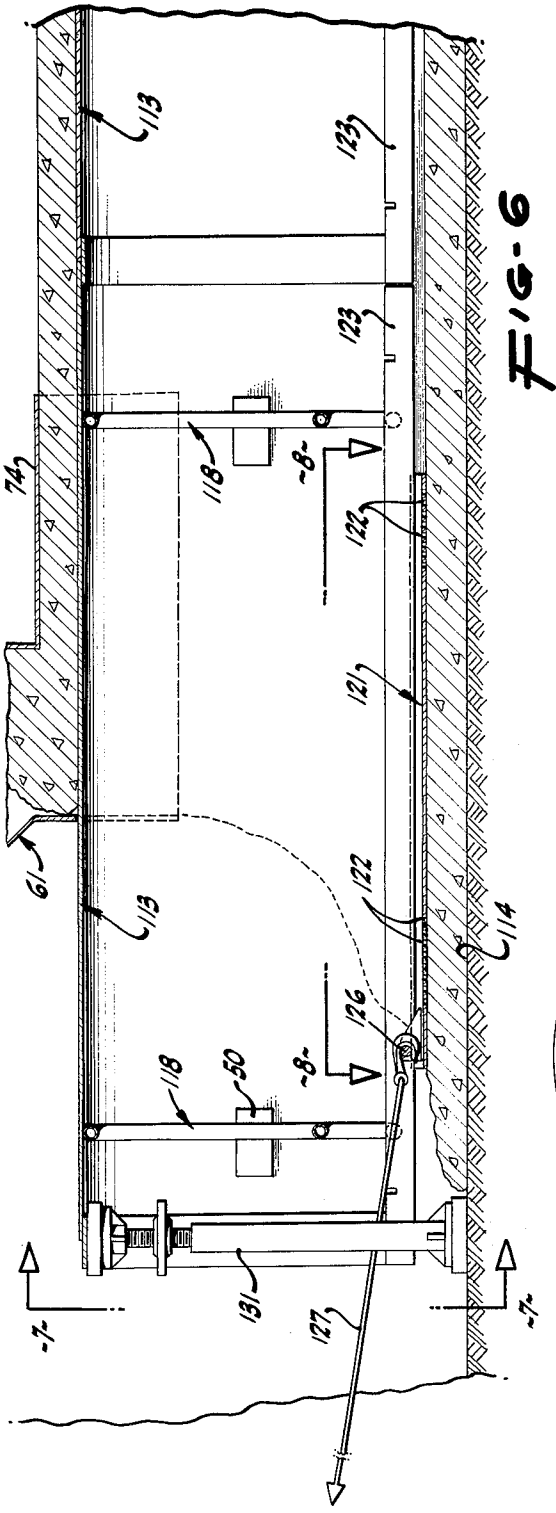


FIG-6

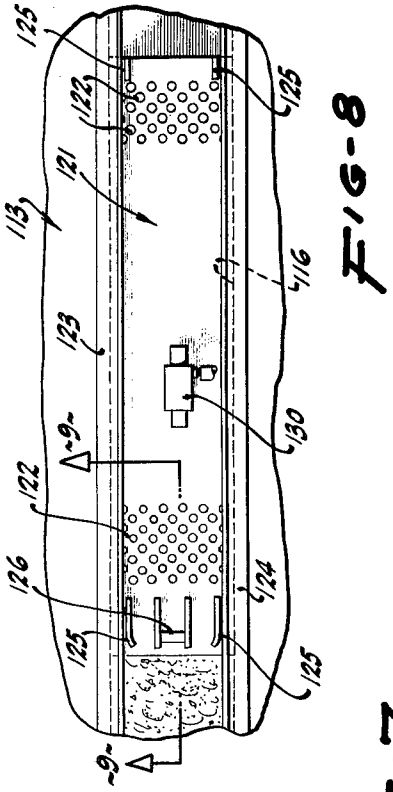


FIG-8

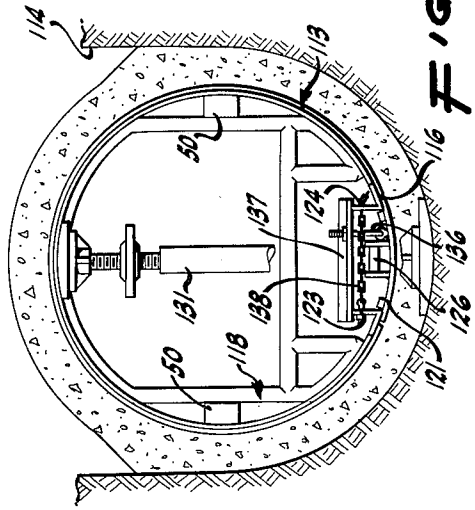


FIG-7

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United States Patent Office 3,205,550 Patented Sept. 14, 1965

3,205,550

PIPE FORMING MACHINE

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Filed June 18, 1963, Ser. No. 288,694
11 Claims. (Cl. 25—32)

The invention is particularly concerned with a machine for use in forming a pipe of concrete, either reinforced or not, within a ditch having side walls and a bottom.

There have been a number of machines and methods employed for pouring concrete pipe in situ, particularly in a carefully exacavated ditch, and there have been many systems and devices utilized for providing pipe of that sort formed elsewhere and then installed later in the ditch and connected for use.

All of the previously utilized arrangements, so far as I know, have been burdened with a number of disadvantages, one of which is the difficulty of providing a relatively straight pipe in the sense of a continuous interior surface which has little or no impedance to hydraulic flow. It will be appreciated that even relatively slight changes in contour of various different portions of the pipe and other interior roughness impede the hydraulic flow to such an extent that pipes are normally specified of somewhat larger diameter than is actually necessary in order to make sure that the hydraulic flow losses are not too great.

It is therefore a principal object of my invention to provide a pipe forming machine capable of use in forming a pipe in a pre-excavated ditch in such a fashion that the resulting pipe is interiorly quite continuous and smooth so that it has a good hydraulic flow characteristic, so good as to permit the use of a pipe smaller in diameter than usual.

Another object of the invention is to provide a pipe forming machine which can readily be utilized under varying soil and environmental conditions.

A still further object of the invention is to provide a pipe forming machine which can be made effective to provide pipe in a number of different sizes and contours.

A still further object of the invention is to provide a pipe forming machine in which the customary contours can be poured without undue difficulty.

A still further object of the invention is to provide a pipe forming machine which can be utilized continuously to pour a relatively long pipe, certain portions of the machine being utilized repeatedly as the machine progresses.

A still further object of the invention is to provide a pipe forming machine so arranged and constructed that the poured pipe is of excellent quality as to homogeneity and finish and is substantially devoid of air pockets and the like.

A still further object of the invention is to provide a pipe forming machine which holds quite rigorously to the intended pipe shape and contour.

A further object of the invention is in general to improve pipe forming machines.

Other objects together with the foregoing are attained in the embodiments of the invention described in the accompanying description and illustrated in the accompanying drawings, in which:

FIGURE 1 is a cross section on a vertical longitudinal plane through the pipe forming machine of the invention;

FIGURE 2 is a cross section on a transverse vertical plane showing the machine of FIGURE 1, the plane of section being indicated by the line 2—2 of FIGURE 1;

FIGURE 3 is a transverse cross section on a vertical plane through a portion of the machine, the plane of section being indicated by the line 3—3 of FIGURE 1;

FIGURE 4 is a view similar to FIGURE 3, the plane of section being indicated by the line 4—4 of FIGURE 1;

FIGURE 5 is a view similar to FIGURE 3, but showing some of the interior parts in position for removal;

FIGURE 6 is a longitudinal section on a vertical plane of a modified form of pipe forming machine pursuant to the invention;

FIGURE 7 is a cross section, the plane of which is indicated by the line 7—7 of FIGURE 6;

FIGURE 8 is a fragmentary plan of a portion of the device, the view being taken on the line 8—8 of FIGURE 6;

FIGURE 9 is a fragmentary cross section, the plane of section being indicated by the line 9—9 of FIGURE 8, and showing a dolly for use with the machine; and

FIGURE 10 is a fragmentary elevation of the structure shown in FIGURE 9.

In one typical environment the machine is utilized in a ditch 6 formed in the earth 7 and having a particular contour designed for the job in view. The ditch has or is excavated as nearly as possible to an appropriate semicircular bottom contour 8, this contour being that of the expected external diameter of the finished pipe. The excavated bottom 8 in the earth is tangent at its horizontal diameter to the parallel, vertical side walls 9 and 11 likewise excavated as accurately as reasonable in the earth in which the pipe is to be formed. In practice, these contours are not usually of strict geometric character, but are made to approximate the indicated configuration as well as may be under all circumstances. The depth of the bottom 8 from the ground surface is arranged according to the survey for the pipeline.

In accordance with the invention, a tube 13 is initially disposed in the ditch. This conveniently is fabricated of a somewhat flexible or deformable material such as metal plate and is generally symmetrical about a center line 14 which is also the center of the arcuate ditch bottom 8. The center line 14 is often slightly inclined to the horizontal, although it is illustrated as horizontal herein. The tube 13 is fabricated in any of the usual ways, such as by bending and welding, from commercial plate. It has a circular cylindrical configuration approximating the intended internal diameter of the resulting pipe.

The tube 13 is not a complete circular section, but rather is provided with a gap 15 extending longitudinally from one end of the tube 13 to the other. The gap 15 is closed by a separate arcuate plate 16 of the same curvature as the balance of the tube. The plate is conveniently reinforced by a stiffener 17 and is of an arcuate extent substantially to abut the sides of the gap 15 with but minor clearance between the parts.

To assist in supporting the plate 16 and also for other reasons, the interior of the tube 13 is provided with a pair of longitudinally extending angles 18 and 19 so disposed with respect to the gap ends of the tube 13 as to afford guideways or rails to support the overlapping edges of the arcuate plate 16.

In and of itself, the tube 13, although relatively rigid in a longitudinal or axial direction, is not particularly true to form in cross sectional shape. For that reason, one or more sustaining frames 21 are provided. Each of these is conveniently fabricated of metal tubing and for part of its configuration has an arcuate contour 22 supplemented by other arcuate contours 23 and 24. The portions 23 and 24 are interrupted so as to afford adequate clearance with respect to the longitudinally extending angles 18 and 19. In addition, the arcuate portions 22, 23 and 24 are interconnected by chordal intermediate tubes 26 and 27 arranged substantially in parallelism. Each of the sustaining frames 21 is likewise provided with a cross member 28 so that the configuration of the sustaining frame is well fixed.

The envelope curve of the various arcuate portions 22,

23 and 24 is that desired for the interior of the tube 13, but the chordal portions 26 and 27 have a transverse dimension substantially less than the diameter of the curved portions. This is so that one or more of the sustaining frames can be turned horizontally and introduced into the tube longitudinally. This is readily accomplished because of the reduced transverse dimension of the chordal portions 26 and 27. After a sustaining frame has been introduced into the tube in substantially a horizontal position, the frame is then rotated about a cross axis into a substantially vertical plane. This forces the exterior tube 13 to acquire the contour of the sustaining frame.

In the event the tube 13 is of unflexed contour less in diameter than that required by the sustaining frame, then the sustaining frame when rotated into position widens the gap 15 and forces the tube 13 to expand into the proper circular size. Sometimes the sustaining frame is somewhat smaller than the unflexed tube. I then provide particular means for drawing the external tube 13 into tight relationship with one or more of the sustaining frames.

For that reason, one of the angles 18, for example, is pierced to receive an eye bolt 31 having a nut 32 thereon and connected to a link chain 33 designed in one position to pass through a characterized opening 34 in the other angle 19. When an appropriate link is caught in the angle 19 and the nut 32 is tightened, the angles 18 and 19 are drawn toward each other and the tube 13 is contracted and flexed into appropriate abutment with the adjacent sustaining frame 21. A number of drawn-down devices such as the chain and eye bolt arrangement can be provided along the length of the tube 13, so that when the tube and sustaining frames are all in close engagement, the tube itself is of the proper cross sectional shape. In either case, when all of the sustaining frames are in position, the tube partakes of a relatively rigid beam characteristic for its entire length.

By a reverse process, the nut 32 can be slacked off and the chain 33 disengaged, or in any case the sustaining frames can be rotated and then longitudinally withdrawn from the tube 13.

The tube can either first be stiffened, as indicated, by the positioning of the sustaining frames, and then lowered into the ditch, or it can first be installed in the ditch and the sustaining frames added later. In any event, it is desired to have a number of similar tubes 13 available in a single ditch. A preceding tube 36 (FIGURE 1) is considered to be already in position and, like its fellow tubes, contains at one end an interior supporting band 37 in position so that the adjacent end 38 of a succeeding tube can encompass the band 37 and will thus be held in correct alignment with regard to the preceding tube 36. One end of the tube 13 is thus properly supported and sustained. To support and sustain the other end, I provide a temporary block arrangement 39. This conveniently can be various blocks readily available on the job site and disposed when the tube 13 is initially installed so that the center line 14 of the tube is exactly at the right location. Because of variations in the bottom 8 of the ditch, it may be necessary to use a number of different blocks 39 to be sure that the center line of the finished conduit will be well established by the initial positioning of the successive tubes 13.

Since concrete when poured around the tube 13 may tend to shift the tube laterally and tends to lift the tube 13 by reason of buoyant force, I provide particular means for additionally positioning and restraining the tube. Adapted to rest against the side walls of the ditch are substantially identical side plates 41 and 42 utilized in mirror symmetry. These plates are conveniently of timber, although they can be of metal, and are of sufficient breadth horizontally and depth vertically to afford a large bearing surface against the interior walls 9 and 11 of the ditch. At their lower ends the plates 41 and 42 are provided with wedge blocks 43 and 44 having inclined faces

46 and 47, respectively. When initially installed, the side plates 41 and 42 are urged downwardly individually and in such a fashion that they become tangent to the exterior surface of the tube 13. Both of the wedge blocks 43 and 44 actually engage the tube 13 above the horizontal center line thereof. Due to variations in the ditch walls, the plates 41 and 42 may be relatively high or relatively low or in mutually different elevations. They afford a transverse component as well as a vertical component of positioning restraint. If desired, the tube wall adjacent the blocks 43 and 44 can be backed up by wedges 50 jammed between the tube wall and the frame 21.

When the wedge blocks 43 and 44 have been appropriately wedged so as to contact the tube and so as to abut the sides of the ditch, they are so held by frictional loading. The angle of the faces 46 and 47 may be sufficiently low to assure stability, but preferably a strut 51 spans the ditch from side wall to side wall above the tube 13. The strut 51 includes an outer tube 52 carrying an enlarged base 53 adapted to abut the plate 42 and likewise carries a screw shaft 54 threadedly engaging the tube 52 and having a pivot engagement with a foot 56 designed to abut the plate 41. A turning wheel 57 is fixed on the screw shaft 54 and has apertures for the receipt of a turning bar. A block 58 asists in the initial positioning of the strut. When the strut 51 is so installed and the wheel 57 is barred over, the length of the strut is increased sufficiently so that the base 53 and the foot 56 force the plates 41 and 42 firmly against the side walls of the ditch. In this fashion the wedge blocks 43 and 44 are suitably anchored. The tube 13 is not only supported from below by the blocks 39, but is transversely positioned in the ditch and is prevented from lifting by the wedge blocks.

When one or more lengths of tube 13 have been appropriately laid on the proper center line as described, concrete is poured into the ditch. For this purpose there is provided a travelling concrete hopper 61 having a forwardly inclined leading wall 62 and a vertical trailing wall 63. These latter walls are connected by appropriate side walls 64 and 66 to form an open-top hopper in the usual fashion. Preferably, the wall 62 is continued by a forward vertical wall 67 having an arcuate cutout 68 substantially matching the desired outer contour of the upper portion of the finished pipe. While the contour can be completely arcuate, it is usually preferred to provide side wings 71 and 72 (FIGURE 2). The rear wall 63 is likewise provided with a cutout edge 73 of substantially the desired configuration for the outside of the finished pipe. Joining the rear wall 63 is a curved forming screed 74 overlying the tube 13 and extending for a substantial distance to the rear of the wall 63. Appropriate braces 76 are provided for sustaining the position of the screed plate 74 and the rear wall 63 of the hopper 61.

To support the hopper and screed plate at the desired relationship with the tube 13, there are provided supporting rods 77 and 78 acting as runners along the tube 13 and resting directly thereon. The runners are connected by a frame 79 to the hopper 61, so that the load on the hopper is at least partially transmitted to and borne by the runners 77 and 78. In order to advance the hopper on the tube 13, a hitch 81 is provided on the hopper frame 79 for engagement by a hook 82 connected by a cable 83 to a suitable winch or other advancing mechanism (not shown).

Since it is a preferred technique to vibrate the concrete being placed, the hopper frame 79 carries a manifold 92 receiving compressed air through a hose 93 from any suitable source and under the control of a valve 94. A number of vibrator heads are connected to the manifold 92 by appropriate hoses. For example, a vibrator head 96 is disposed on the forward wall 62 of the hopper, whereas lateral vibrator heads 97 and 98 are located below the hopper 61 and to either side of the tube 13, prefer-

ably below the center thereof. While a pneumatic vibrator has been described, mechanical or electric vibrators can equally well be used.

After the tube **13** has been blocked in position and has been connected to a preceding tube, the hopper **61** is provided with a suitable supply of concrete for placement. This concrete discharges onto and around the placed tube **13** and flows by gravity into a position occupying the bottom of the ditch **8**, assisted, if desired, by operation of the vibrators **96**, **97** and **98**. Concrete **101** is introduced into the hopper **61** from any suitable source in batches or continuously as it is placed. The lower or invert portion of the pipe is thus constituted and formed of concrete flowing between the pipe **13** and the adjacent bottom and side walls of the ditch. The concrete piles up over the pipe completely to surround the tube **13**.

As the pouring action ensues, tension is put on the cable **83** and the hopper **61** is advanced toward the left in FIGURE 1. As the hopper advances, concrete is continually distributed around the subjacent tube **13** and the upper surface of the resulting pipe is formed and trowelled to an appropriate finish by the forming screed **74**. The concrete discharged from the forward portion of the hopper takes an angle of slump or repose resulting from some of the material travelling ahead of the advancing hopper. The pipe **13** immediately below the hopper tends to be supported from below by concrete as the hopper advances. During this time, the wedge blocks **43** and **44** are particularly effective to preclude lifting of the pipe. Just before the concrete has advanced far enough to encounter the blocks **39** and at which time substantially all of the tube **13** is well supported, the blocks **39** are removed. A subsequent section **102** of tube is put into position and itself is lined up by surveying methods and is appropriately blocked and braced. A smooth junction is made between the pipe **13** and the pipe **102**. Before further advance of the hopper, the strut **51** and the subjacent block **58** are removed. Also, the side plates **41** and **42** are similarly removed. The plates and strut are moved forwardly for subsequent installation on an advance section of tube. The hopper thus slides smoothly forwardly on the supporting rods **77** and **78** and on the placed concrete and continuously provides concrete for flow around and on top of the positioned tube.

After the concrete has had time to set, operators working within the trailing tube, such as **36**, remove the sustaining frames **21** and by suitable jack means pull the angles **18** and **19** inwardly to deform and partially collapse the tube **36**. The sustaining frames are rotated about a transverse axis and are moved out endwise. The collapsed tube, as shown in FIGURE 5, is of sufficiently small compass as to be removed endwise through the pipe already formed. The removed tube is then carried forwardly for subsequent use, as are the sustaining frames. By a repetition of these operations, an indefinite length of continuous pipe can be poured in place on good and accurate alignment and with a susbtantially smooth continous inside configuration to afford good hydraulic characteristics. Finally, the finished pipe can be covered with earth to leave the surface as before.

In many instances it is desirable to have the gap in the tube at the top, but there are other cases in which, as shown in FIGURES 6, 7 and 8, the tube **113** is positioned in the trench **114** with the gap **116** at the bottom. The sustaining frame units **118** are also inverted from their previous positions. The remaining part of the structure is substantially as before, except that the gap **116** instead of being closed by a fixed plate **16** is closed by a travelling plate **121**. This continues the arcuate configuration of the tube **113** and can be provided with a number of air releasing apretures **122**. The plate **121** is guided and positioned by angles **123** and **124** corresponding to and substantially identical with the angles **18** and **19**. Additionally, guide bars **125** fastened to the plate **121** ride against the tube edges at the gap **116**. The forward portion of the plate **121** has a connector **126** to which a draft cable **127** is attached so that the plate **121** can be advanced relative to the pipe **113** by a sliding movement on the angles **123** and **124** serving as guide rails. A vibrator **130** is fitted on the plate **121**.

In the operation of this form of device, it is possible to dispense with the blocks **39** and instead to use a jack **131** having a base resting directly on the bottom of the ditch **6**. The jack extends through the gap **116** and is adjustable against the top inside of the tube **113**. In this way, the tube can easily be brought to exact alignment. As before, the jack is removed when the tube is well supported by concrete.

Before the concrete is poured and before the travelling plate **121** is advanced, the bottom of the ditch is finally inspected through the gap **116** and any debris, such as clods, is removed. This is an advantage of the bottom gap arrangement. The travelling plate is temporarily sustained on hook bolts **136** depending from cross bars **137**. These are removed as soon as sufficient concrete is beneath the travelling plate to provide an upward thrust.

The concrete is placed as before and comes to an initial set. Thereafter the tube is removed after the sustaining frames **118** have been taken out. For this purpose, the angles **123** and **124** are drawn together, or partly together, by cross chains **138**. A dolly **141** is then put into position under each chain **138** near the tube ends. The dolly is in effect a bell crank on pneumatic wheels. Each dolly is brought into place at an angle and finally one of its lever arms engages one of the chains **138**. The other dolly lever arm is then lowered so that all wheels are on the just-cast pipe. This tensions the chain **138** further and lifts one end of the contracted tube slightly so that its weight is borne by the dolly. With a dolly at each end, the contracted tube can easily be wheeled on the pipe to a point of removal for reuse.

What is claimed is:

1. A pipe forming machine for use in a ditch having side walls comprising a straight collapsible tube having a longitudinal gap therein, means for supporting said tube above the bottom of said ditch, means for engaging the sides of said ditch and said tube above the center thereof, a sustaining frame inside said tube, means for holding said tube against said sustaining frame to make said tube a longitudinally rigid supporting beam, a concrete hopper, means for supporting said hopper solely on said tube for advancement longitudinally thereon in a predetermined direction established by said tube and independent of the bottom and side walls of said ditch, a forming screed trailing from said hopper and overlying said tube at substantially a fixed radial distance therefrom, and means supported on said tube and spanning said gap therein.

2. A pipe forming machine for use in a ditch having side walls comprising a straight tube having a longitudinal gap therein and adapted to be circumferentially flexed into different cross sectional shapes, a sustaining frame of fixed cross sectional shape inside said tube, means for holding said tube against said sustaining frame to make said tube a longitudinally rigid supporting beam, means supported on said tube and spanning said gap therein, a concrete hopper, means for supporting said hopper entirely on said tube for advancement along said tube in a path established solely by said tube, a forming screen trailing from said hopper and overlying said tube at substantially a fixed radial distance therefrom, means for supporting said tube at a fixed distance above the bottom of said ditch, and means engaging said side walls for holding said tube from rising in said ditch.

3. A pipe forming machine for use in a ditch having side walls comprising a tube of flexible material and having a longitudinal gap therein, means forming supports within said tube alongside said gap, a plate engaging said supports and spanning said gap, a sustaining frame of fixed cross sectional shape inside said tube, means for holding said tube against said sustaining frame and mak-

ing said tube a longitudinally rigid supporting beam of regular contour, means engaging said side walls for holding said tube from rising in said ditch, a concrete hopper, means for supporting said concrete hopper entirely on said tube for advancement therealong, and a forming screed trailing from said hopper and overlying said tube.

4. A pipe forming machine for use in a ditch having side walls and a bottom comprising a deformable tube having a longitudinal gap therein, a plate supported on and closing said gap in said tube, means erectable within and removable from said tube for holding said tube in a fixed cross sectional shape and to make said tube a longitudinally rigid supporting beam of regular contour, means engaging said side walls and said bottom for positioning said tube within said ditch, a concrete hopper, means for supporting said concrete hopper entirely on said tube for advancement thereon, and a forming screed trailing from said hopper and overlying said tube.

5. A pipe forming machine for use in a ditch having side walls and a bottom comprising a tube having a longitudinal gap therein, a plate engaging said tube adjacent to and closing said gap, means adapted to pass longitudinally through said tube and erectable into positions transversely of said tube for holding said tube in a fixed cross sectional shape and to make said tube a rigid support of regular rectilinear contour, means engaging said side walls and said bottom for positioning said tube within said ditch, a forming screed adapted to overlie said tube, and means engaging said tube for entirely supporting said forming screed for advancement along said tube in a predetermined spaced relationship therewith.

6. A pipe forming machine for use in a ditch having side walls and a botoom comprising a tube of flexible material and having a longitudinal gap therein extending from one end to the other, means on said tube forming guideways along said gap, a plate engaging said guideways and closing said gap, a sustaining frame adapted in one position to pass longitudinally through said tube and in another position to hold said tube in fixed cross sectional shape and to make said tube a rigid support of regular contour, blocks removably interposed between said bottom and said tube for supporting said tube in a predetermined position in said ditch, means including a strut engaging said side walls for holding said tube in predetermined position in said ditch, a forming screen extending between said side walls and overlying said tube, and means engaging said tube for entirely supporting said forming screed on said tube at a predetermined distance therefrom.

7. A pipe forming machine for use in a ditch having side walls and a bottom comprising a tube having a longitudinal gap therein along the bottom of the tube, means for supporting said tube in said ditch including a jack resting on the bottom of said ditch and extending through said gap into abutment with the inside of the tube at the top thereof, a concrete hopper and screed mechanism, means for supporting said concrete hopper and screed mechanism on said tube for advancement thereon, a travelling plate engageable with said tube and extending

across said longitudinal gap, means for advancing said concrete hopper and screed mechanism along said tube in one direction, and means for advancing said travelling plate along said tube in said direction.

8. A pipe forming machine as in claim 7 in which said travelling plate is perforated.

9. A pipe forming machine as in claim 7 in which said tube is held down in said ditch by means engaging said tube above the center thereof and on opposite sides of the center thereof.

10. A pipe forming machine for use in a ditch having side walls and a bottom comprising an elongated tube, means for holding said tube as a longitudinally rigid supporting beam of predetermined contour, means engaging said bottom and said tube for holding said tube in a predetermined position in said ditch independently of the position of said bottom and said walls, a concrete hopper and screed mechanism, means solely engaging said tube for entirely supporting said concrete hopper and screed mechanism on said tube, and means for advancing said hopper and screed mechanism along said ditch in a path fixed by said tube and independent of said bottom and said side walls.

11. A pipe forming machine for use in a ditch having side walls and a bottom comprising an elongated tube adapted to constitute the inner form for a concrete pipe within said dith, said tube having sufficient longitudinal rigidity to act as a support beam and to have a predetermined contour, means for supporting said tube in said ditch with the center line of said tube in a predetermined position independent of said bottom and said side walls, a concrete hopper and screed mechanism adapted to constitute the upper outer form for said concrete pipe, means solely engaging said tube and independent of said bottom and said side walls for entirely supporting said concrete hopper and screed mechanism on said tube, and means for advancing said concrete hopper and screed mechanism along said tube in a path established solely by said tube.

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