March 10, 1964 J. H. PEIRSOL ETAL 3,123,883

CAST-IN-PLACE PIPE MACHINE

Original Filed Dec. 8, 1958

6 Sheets-Sheet 1

FIG. 2

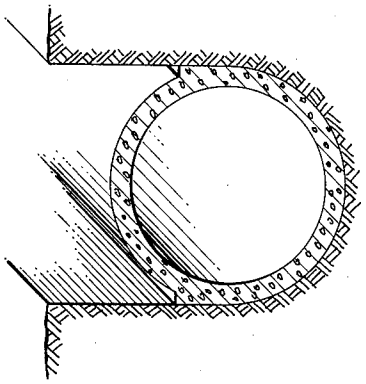
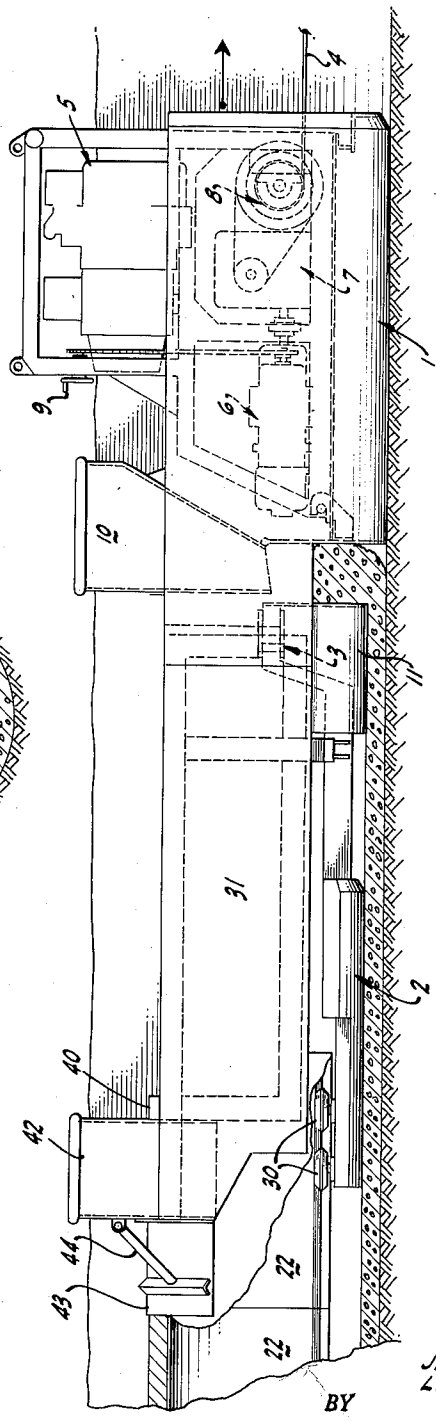


FIG. 1



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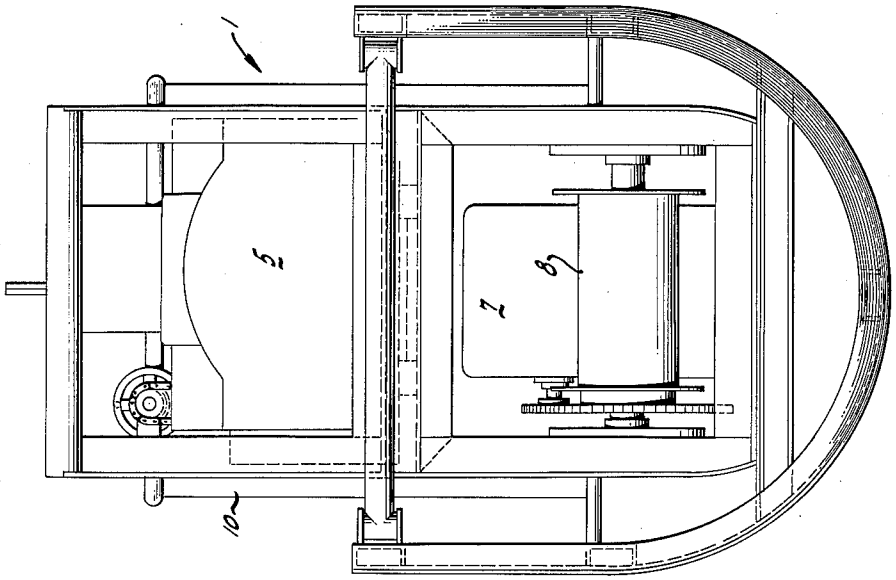


FIG-3

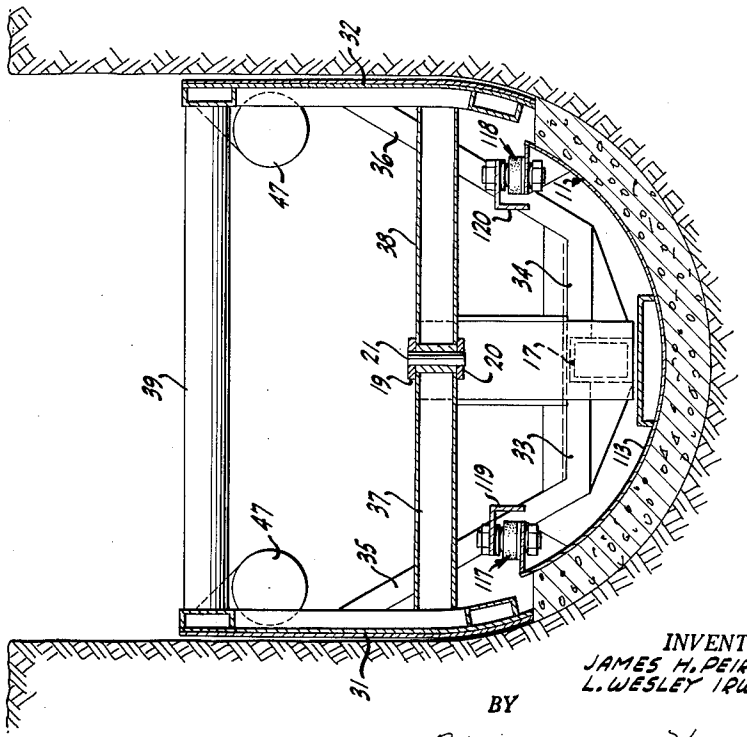


FIG-5

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March 10, 1964 J. H. PEIRSOL ETAL 3,123,883

CAST-IN-PLACE PIPE MACHINE

Original Filed Dec. 8, 1958 6 Sheets-Sheet 3

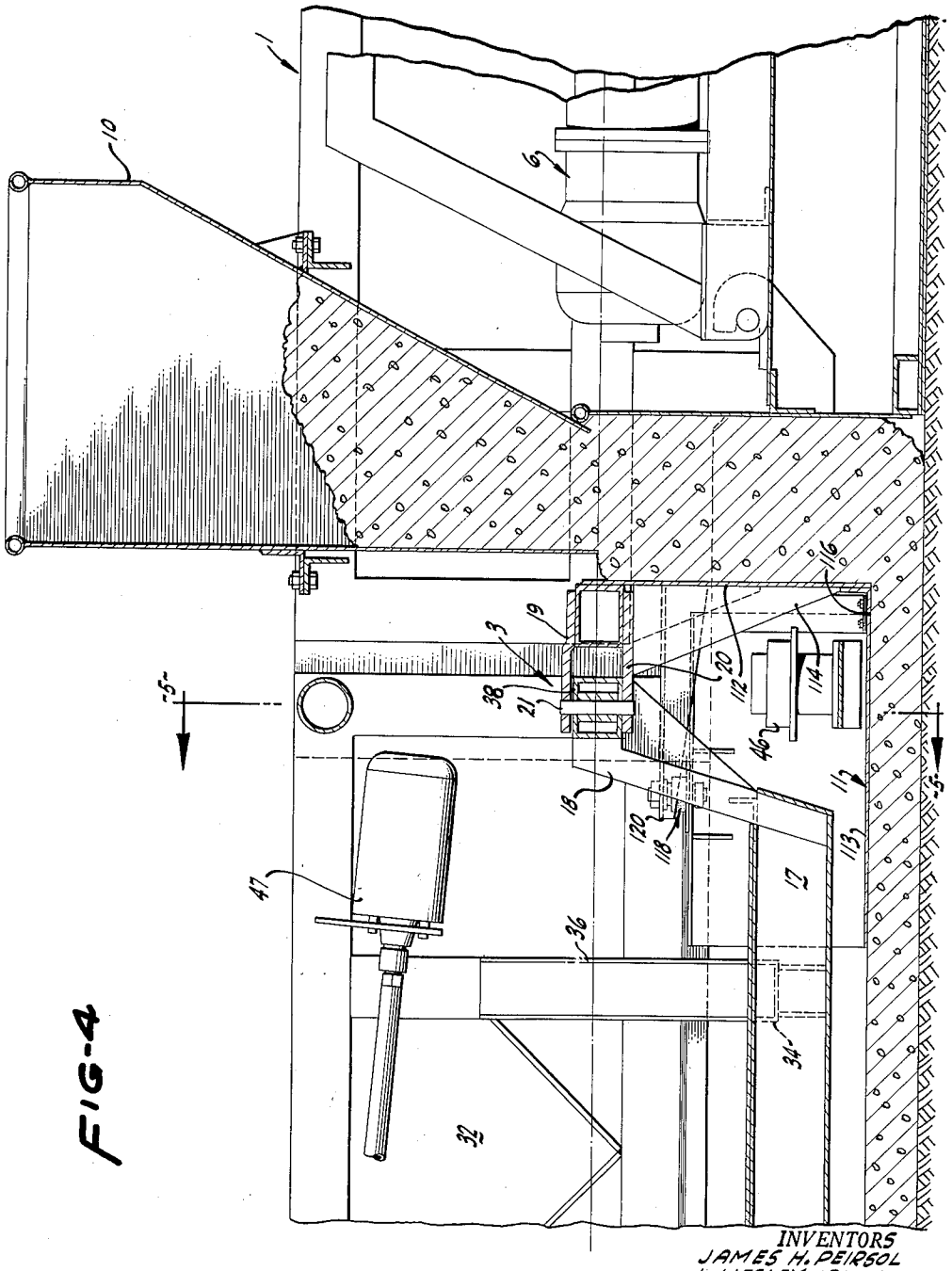


FIG-4

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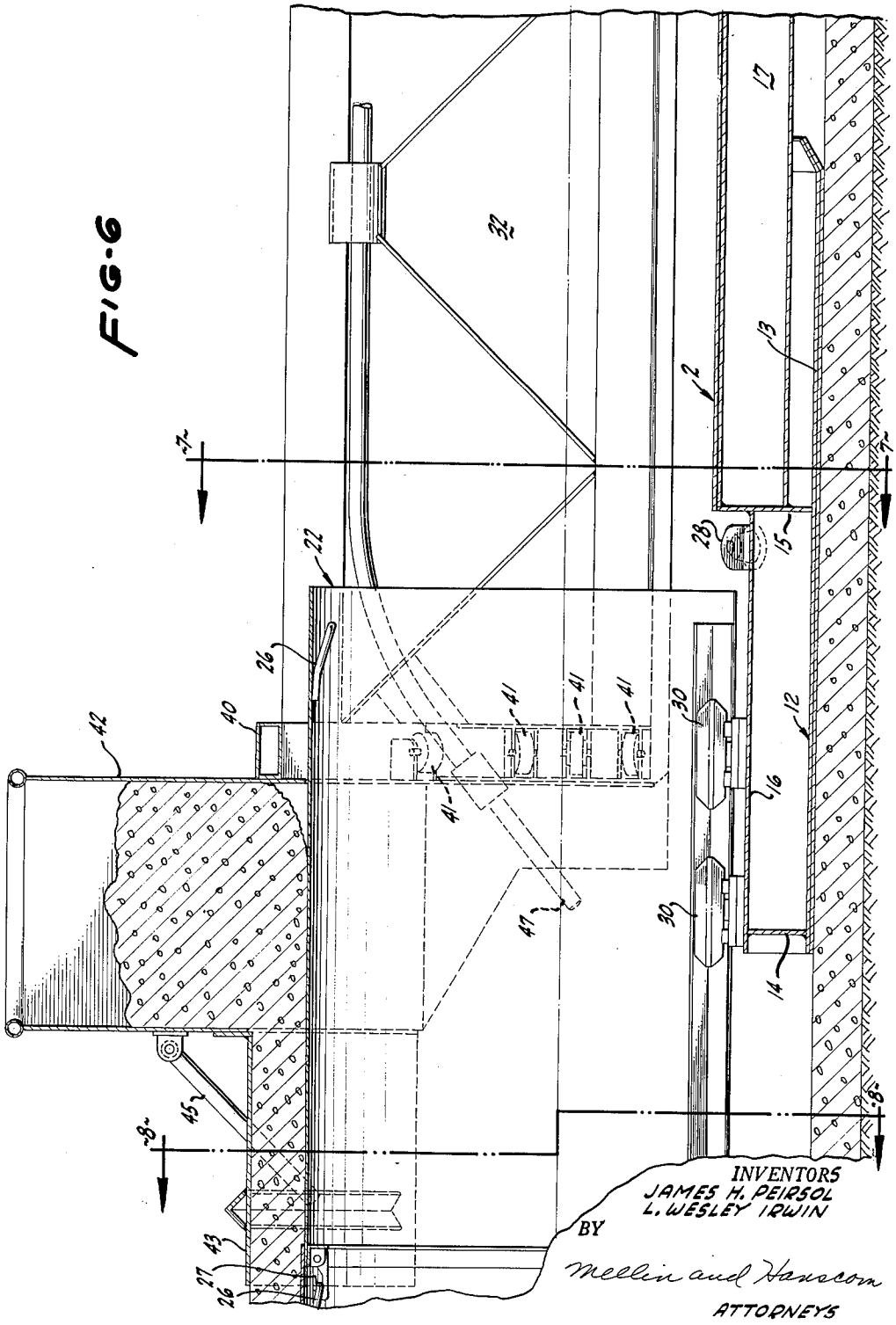
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March 10, 1964 J. H. PEIRSOL ETAL 3,123,883

CAST-IN-PLACE PIPE MACHINE

Original Filed Dec. 8, 1958 6 Sheets-Sheet 4

FIG. 6



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March 10, 1964 J. H. PEIRSOL ETAL 3,123,883

CAST-IN-PLACE PIPE MACHINE

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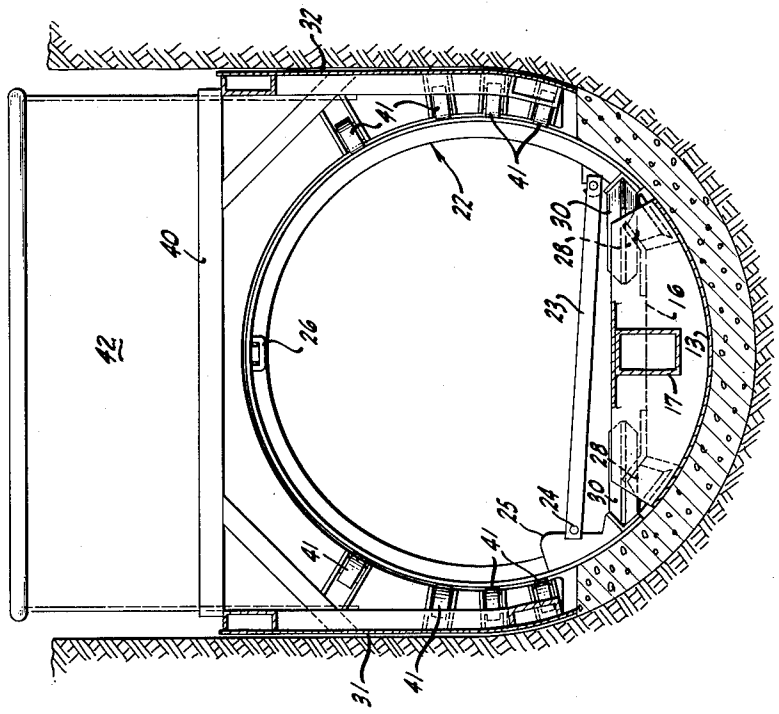


FIG-7

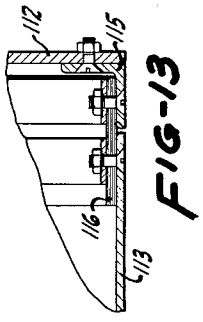


FIG-13

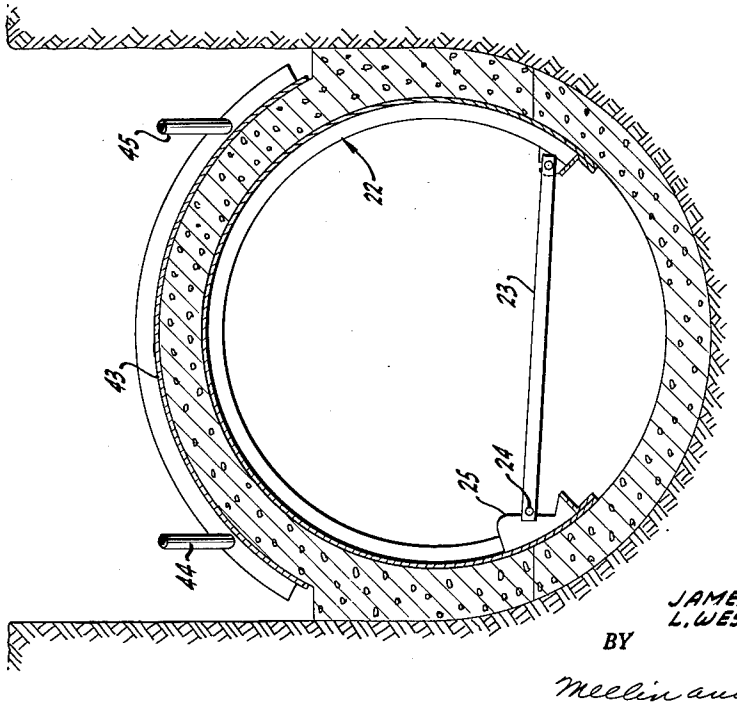


FIG-8

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CAST-IN-PLACE PIPE MACHINE

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FIG-9

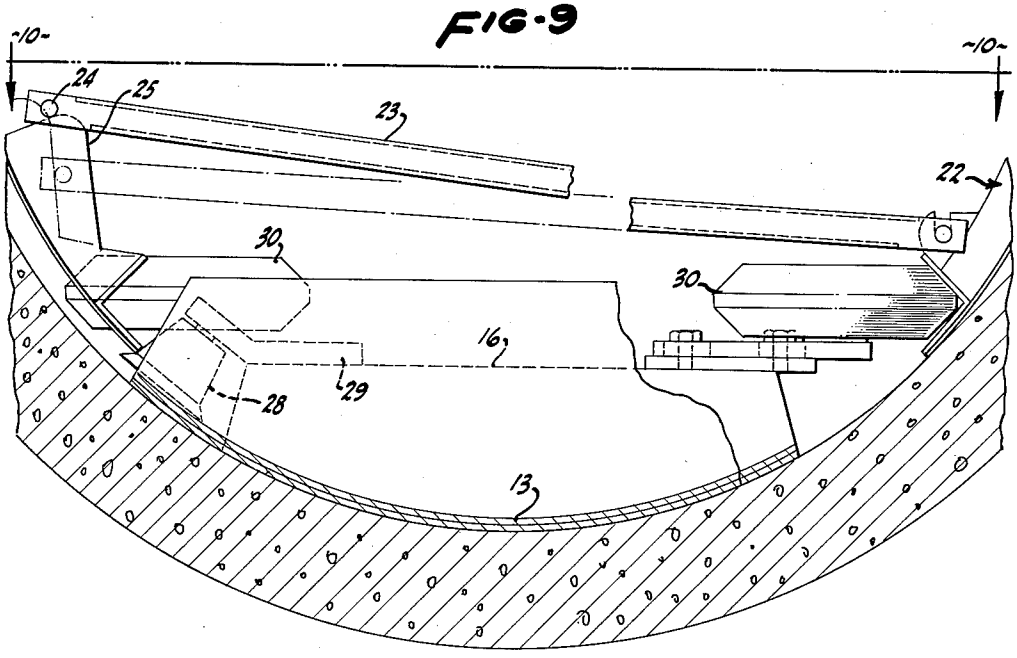


FIG-10

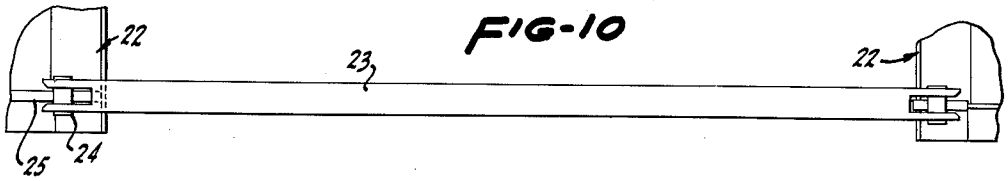


FIG-11

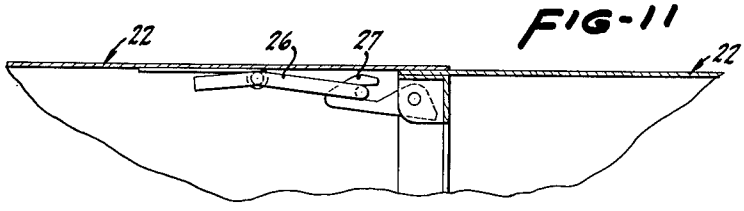
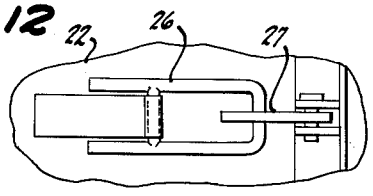


FIG-12



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United States Patent Office 3,123,883 Patented Mar. 10, 1964

3,123,883
CAST-IN-PLACE PIPE MACHINE

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Continuation of application Ser. No. 778,803, Dec. 8, 1958. This application July 13, 1962, Ser. No. 212,182
18 Claims. (Cl. 25—32)

This invention relates to apparatus for producing concrete pipe and similar conduits in a trench. More specifically, the invention contemplates the placing of a dry, or "low-slump," concrete in the invert portion of a trench by means of a slip-form paver.

This application is a continuation of application Serial Number 778,803, filed December 8, 1958, now abandoned.

United States Patent No. 2,731,698 teaches apparatus for forming concrete pipe in situ wherein both the lower portion (the invert) and the upper portion of the pipe are produced simultaneously. A single hopper is provided to feed cementitious material around a centrally disposed mold, and a plurality of arch-like forms are utilized to support the upper portion of the pipe until the material hardens. This apparatus requires that a man be positioned within the pipe mold to insert bracing structure for each arch form as the machine advances.

It is one object of this invention to provide apparatus which generally improves upon the above noted prior art device by forming the lower and upper portions of a conduit in two separate stages. Each portion is poured separately, and since the cementitious material is placed directly into the paths of moving screeds, rather than allowed to fall around a centrally disposed mold, there will be less segregation of material and fewer voids; hence, a stronger concrete will result. Also, a visual inspection of the invert may be made immediately after pouring to detect malfunctioning and, thereby to facilitate corrective adjustments. The arch form will thereafter seat on previously placed, well compacted, concrete which will materially assist in maintaining dimension tolerances.

A second object of this invention is to provide slip-form paving apparatus including a ski-like support adapted to be moved on the inner surface of a preformed invert portion of a conduit. The ski support carries a guide means comprising a plurality of guide rollers for receiving and guiding an arch form to position it with respect to the invert portion.

A third object of this invention is to provide a slip-form paving apparatus with retaining walls or shields on a ski support to prevent loose earth from sloughing from the trench sides and falling onto the longitudinal joint or into the invert portion as it is formed.

Another object of this invention is to provide a slip-form paver having a means for bracing each form after it is positioned with respect to the prelaid invert portion of the conduit. The bracing operation is performed without supervision or the need of manual control, thereby eliminating the need for a man to work inside a moving machine and removing an important psychological hazard. Since the forms are at no time supported by a mold, the bracing means can be made as an integral part of each form.

A further object of this invention is to provide a slip-form paving apparatus including a screed means having a flexible connection between a vibrated part and a supported part to isolate the supporting structure from vibratory movement.

These and other objects of this invention will become apparent to those skilled in the art in view of the following description and the preferred embodiment of the ideas illustrated by the drawings.

In the drawings, forming a portion of this application, and in which like parts are designated by like reference numerals throughout the same,

FIG. 1 is a side elevation of the novel apparatus for casting pipe in place, shown while being moved in a trench;

FIG. 2 is a cross-sectional view of the final product, a cast-in-place pipe conduit;

FIG. 3 is a front elevation of the power sled;

FIG. 4 is a longitudinal section of a part of the apparatus, showing the front screed means and adjacent structure;

FIG. 5 is a cross-sectional view taken on lines 5—5 of FIG. 4;

FIG. 6 is a longitudinal section of another part of the apparatus, showing the support ski, guide means and adjacent structures;

FIG. 7 is a cross-sectional view taken on lines 7—7 of FIG. 6;

FIG. 8 is a cross-sectional view taken on lines 8—8 of FIG. 6;

FIG. 9 is an enlarged fragmentary view of certain structural details shown in FIG. 7; part of the structure is broken away to illustrate the roller means that produces enlargement of the arch form;

FIG. 10 is a top plan view of the bracing means shown in FIG. 9;

FIG. 11 illustrates the latching device used for connecting the arch forms together;

FIG. 12 is a bottom plan view of the latching device shown in FIG. 11;

FIG. 13 is an enlarged fragmentary view of the flexible connection between the lower vibrated plate and the vertical support plate of the lower screed.

A preferred embodiment of this invention, as best shown in FIG. 1, includes a power sled assembly, generally indicated by numeral 1, and a support ski assembly 2. Assemblies 1 and 2 are pivotally connected at a juncture 3 and are moved together along the bottom of a trench by a tow line 4.

Power sled assembly 1 includes a power plant 5, comprising a gasoline motor and generator, a motor and varidrive mechanism 6, a gear box 7 and a winch 8. Similar to other devices of this kind, the tow line is anchored in advance of the apparatus which is drawn toward that point by winding tow line 4 upon winch 8. A manual control wheel 9 is provided in connection with the varidrive mechanism to enable adjustments in the speed of advancing the sled.

A hopper 10 is disposed at the rear of the sled for depositing cementitious material, such as concrete, in the path of a screed means 11. The screed, or form paver, is connected to and supported by the end of the sled, and, having an arcuate shaped contour, it forms the invert portion of the conduit as the sled is advanced along the trench.

Ski support assembly 2 receives and positions an arch form on the inner surface of the prelaid invert in preparation for pouring the top portion of the conduit. The assembly includes a platform ski 12 having a ski plate 13, support plates 14 and 15, and a platform 16. The ski plate is provided with a contour similar to that of the screed 11 and is drawn upon the surface of the invert as shown in FIGS. 7 and 9. An elevated keel beam member 17 runs longitudinally of the trench connecting the platform ski to a draw bar 18 which is pivotally supported between support plates 19 and 20 of the sled by a pin 21.

It was noted above that arch forms have previously been employed to support the arch roof of the conduit while hardening. However, such forms have either been made a permanent part of the conduit or were first sup-

ported by a mold during the pouring operation. Because of the unique construction of this apparatus, certain disadvantages of the prior art devices have been averted.

Arch forms 22 are mated to fit within the preformed lower conduit portion, and, until braced, they may be reduced in circumference by urging the longitudinal ridges of the arch toward one another. The forms are first lowered onto the ski support in their unbraced condition and, therefore, their ridges may be flexed inwardly to be received within the invert portion. Once properly aligned and positioned with respect to the prelaid invert, the form is braced into an enlarged contour, whereby the bottom portion of the arch form is urged into contact with the lateral curved surface of the invert, shown in FIGS. 7 and 8.

The inner surface of each arch form is provided with one or more brace means or cross struts. FIGS. 7–9 illustrate a preferred form of structure which enables the arch form to be braced after it is positioned in the invert, but does not require supervision or manual operation. The bracing structure includes a cross strut member 23 which is pivotally mounted near a foot of the arch. This mounting may be permanent, but preferably it is supported in a pin and slot connection as shown in FIG. 9. The free end of the strut member spans across to the other foot of the arch and carries a cam roller pin 24. A cam locking surface 25 is disposed on the foot beneath the roller pin with which it cooperates to brace the arch form. Before lowering an arch form onto the ski support, strut member 23 is positioned with its cam roller pin 24 resting on the upper portion of the camming surface 25, substantially as shown by the solid lines in FIG. 9. The arch form may then be lowered onto the ski support and received within the curved contour of the invert portion. After the arch form is properly positioned with respect to the invert, it may be braced by expanding the form contour until roller pin 24 moves inwardly on the camming surface and falls into a locking position, shown by the phantom lines of FIG. 9 and solid lines, FIGS. 7 and 8.

The arch forms are sequentially lowered onto the ski support and connected to the preceding one as the apparatus moves along the ditch. A latching device is provided on the under surface of each form, front and back, such as that illustrated in FIGS. 11 and 12 and which comprises a handle bar 26 at one end and a hook member 27 at the other end. Since the arch form previously laid is now anchored under a load of cementitious material, it will resist advancement of the succeeding arch form and pull it from the moving ski platform; and, frictional engagement between platform and arch form will hold the interlocking connection taut as the ski is moved forwardly.

In order to move the arch forms on the ski platform without unnecessary resistance, a plurality of support rollers 28 are suspended from an angle bar overhang 29 which is rigidly affixed to platform 16 as shown in FIG. 9. The arch forms are lowered into the trench and supported on these rollers which also aid in positioning the forms with respect to the prelaid invert.

Additional roller members 30 are provided as means for producing an enlargement of the arch form contour as it is slipped rearwardly off the ski platform. Roller members 30 are supported on platform 16 rearwardly of rollers 29, and the peripheral surface of each roller 30 extends laterally outward and beyond the surfaces of rollers 29. Consequently, as the arch form is rolled toward the rear end of ski platform 12, the longitudinal ridges of the arch form are moved upwardly and outwardly, expanding the arch contour and urging its outer surface into contact with the prelaid invert. An enlargement of the arch form will produce actuation of the brace means previously described, locking the form into a rigid structure for supporting cementitious material.

A pair of retaining walls or shields 31 and 32 are positioned in close-lying relationship to the sides of the trench and are supported from keel beam 17 as best shown in FIG. 5. Lateral support members 33 and 34 are welded or otherwise rigidly connected to the keel beam, and the angled extensions 35 and 36 are respectively fastened to walls 31 and 32. Laterial support members 37, 38, 39 and 40 also brace and support the walls in substantial parallelism. Shields 31 and 32 prevent loose earth from sloughing from the trench sides and falling onto the longitudinal joint or into the invert as it is formed.

Each retaining wall supports a plurality of guide rollers 41 which are disposed in a vertical arrangement. The rollers project inwardly toward the center of the trench, and the roller surfaces define a portion of an arch form contour. As the arch forms are fed rearwardly on the ski platform, they are guided and positioned in the prelaid invert portion by the rollers, shown in FIGS. 6 and 7.

A second hopper 42 and second screed means 43 are provided rearwardly of the retaining walls to respectively pour and form the upper portion of the conduit. The screed means is shaped to the desired contour to be imparted to the pipe, and as the cementitious material is fed from under the back edge of the hopper, the screed compacts and spreads the material over the arch form, FIG. 6. As the material passes beneath the screed, it will tend to bend it upward. Consequently, the screed is braced to the hopper by strut members 44 and 45. The entire hopper-screed assembly is rigidly connected to lateral support member 40 and a portion of each retaining wall. Accordingly, it is moved forward with the ski platform and power sled.

After the cementitious material has hardened, the arch forms are readily removed from the pipe by first releasing or removing the bracing means. The last laid arch form is then flexed inwardly and moved toward its connecting arch form, thereby being unlatched. The operation is repeated for each of the other arch forms which are similarly prepared for removal.

Vibrator devices may be utilized to enhance the flow of material from the hoppers to the undersides of the screeds. Any suitable vibrator may be used, one vibrator 46 being placed on the lower screed 11, and another vibrator 47 being disposed on the ski platform and extending rearward to the second hopper 42. Vibratory movement, together with the weight of the cementitious material in the hopper and the forward thrust of the sled, will produce a compact mass between the bottom of the ditch or the arch form and the respective screeds 11 and 43. The speed of forward movement is controlled to allow sufficient amounts of material to be fed through the hoppers and under and around the sides of the screeds.

Since a vibrator disposed on the lower screed means 11 tends to compact the cementitious material within the hopper as well as below the screed, means is provided to isolate the hopper and sled from the vibratory movement imparted to the screed. The arrangement of parts hereinafter described has the added advantage of reducing the mass which vibrator 46 must vibrate, with a consequent reduction in the power input required.

The vibration isolating means is built into screed means 11 and forms a part thereof. The screed means essentially comprises a vertical support plate 112 and an arcuately shaped lower plate 113 flexibly joined thereto. Plate 112 depends from and is supported by the end of the sled, and one or more bracing struts 114 are utilized to prevent buckling. One side of a curved angle plate 115 fastens to the lower edge of plate 112 by means of bolts or the like; the other side projects rearwardly at a right angle and lies in endwise abutment with plate 113. A flexible band-tie 116 overlaps the abutting edges and connects with plate members 113 and 115 substantially as shown in FIG. 13, thereby forming a flexible connection between vertical plate 112 and lower plate 113. The longitudinal edges of plate 113 are flanged inwardly as shown in FIGS. 4 and 5, and are connected to resilient mounting blocks 117 and 118 supported respectively upon arms 119

and 120 which project rearwardly from the face of plate 112.

It will be noted that the lower plate 113 will be vibrated vigorously by the vibrator 46, but only slight vibrations will be transmitted through the flexible and resilient connections and imparted to plate 112 and connecting structures.

After considering the embodiment herein described, persons skilled in the art will understand that variations and substitution of certain parts may be made without departing from the principles disclosed; and, the use of any structures or arrangements that are properly within the scope of the appended claims is contemplated.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. In an apparatus for producing cementitious conduits in a trench, and comprising: a vehicle adapted to be moved along said trench, a plurality of arch forms capable of being releasably secured together, each of said forms being received on said vehicle and secured to the preceding arch form, a brace means connected to each form and being self-actuable upon enlargement of the arch form's contour, and guide means mounted upon said vehicle and engageable with depending side edges of said arch form for producing an enlargement of the arch form's contour to actuate said brace means.

2. In the apparatus of claim 1 and further wherein said brace means comprises a strut pivotally mounted to one of the lower depending edges of said arch form, and a shelf mounted to the opposite side of said arch form for supporting the other end of said strut while said arch form is in a relatively collapsed condition.

3. In the apparatus of claim 2 and further wherein said shelf includes a shoulder engagement engageable with said strut upon enlargement of the arch form's contour.

4. In the apparatus of claim 1 and further including guide means mounted on said vehicle for receiving each arch form and positioning it with respect to a preformed lower portion of a conduit.

5. In an apparatus for producing cementitious conduits in a trench, and comprising means for forming the lower portion of a conduit, a vehicle adapted to be moved along said trench and supported above said lower conduit portion, a plurality of arch forms capable of being releasably secured together, each of said forms being received on said vehicle and secured to the preceding arch form, a brace means connected to each form and being self-actuable upon enlargement of the arch form's contour, guide means mounted upon said vehicle and engageable with depending side edges of said arch form for producing an enlargement of the arch form's contour, thereby actuating the brace means, screed means position-spaced above said forms for forming the upper portion of said conduit, and a hopper means for depositing cementitious material in the path of said screed means.

6. In the apparatus of claim 5 and further including guide means mounted on said vehicle for receiving each arch form and positioning it with respect to the lower portion of a conduit.

7. In the apparatus of claim 5 wherein said means for producing enlargement of the arch form's contour comprises a plurality of rollers which urge the longitudinal edges of said form outwardly into contact with the lower portion of the conduit.

8. In an apparatus for producing cementitious conduits in a trench, and comprising means for forming the lower portion of a conduit; a vehicle adapted to be moved along said trench and supported above said lower conduit portion; a plurality of arch forms capable of being releasably secured together, each of said forms being received on said vehicle and secured to the preceding arch form, a brace means connected to each form and being actuable upon enlargement of the arch form's contour; guide means mounted on said vehicle for receiving each arch form and positioning it with respect to the lower portion of a conduit, said guide means comprising a plurality of support rollers for receiving said arch forms as they are placed on said vehicle and a plurality of lateral guide rollers having projecting surfaces which substantially define a portion of the contour of said arch forms; means mounted upon said vehicle for producing an enlargement of the arch form's contour comprising a plurality of rollers which urge the longitudinal edges of said form outwardly into contact with the lower portion of the conduit, thereby actuating said brace means; screed means position-spaced above said forms for forming the upper portion of said conduit; and a hopper means for depositing cementitious material in the path of said screed means.

9. In an apparatus for producing cementitious conduits in a trench, and comprising means for forming the lower portion of a conduit; a vehicle adapted to be moved along said trench and supported above said lower conduit portion; a plurality of arch forms capable of being releasably secured together, each of said forms being received on said vehicle and secured to the preceding arch form; guide means mounted on said vehicle for receiving each arch form and positioning it with respect to a lower portion of a conduit, said guide means comprising a plurality of support rollers for receiving said arch forms as they are placed on said vehicle and a plurality of lateral guide rollers having inwardly projecting surfaces which substantially define a portion of the outer contour of said arch forms; screed means position-spaced above said arch forms for forming the upper portion of said conduit; and a hopper means for depositing cementitious material in the path of said screed means.

10. A slip-form paving apparatus for producing cementitious conduits in a trench, comprising first screed means for forming the lower portion of a conduit, first hopper means for depositing cementitious material in the path of said first screed means; a support ski positioned rearwardly of said first screed means, said ski shaped to be moved while being supported on the inner surface of a lower portion of a conduit, a plurality of arch forms capable of being releasably secured together, each of said forms being received on said ski and secured to the preceding arch form, guide means mounted on said ski for receiving each arch form and positioning it with respect to a lower portion of a conduit; second screed means position-spaced above said forms for forming the upper portion of said conduit, and second hopper means for depositing cementitious material in the path of said second screed means.

11. The apparatus of claim 10 wherein said guide means comprises a plurality of support rollers for receiving said arch forms as they are placed on said ski, and a plurality of lateral guide rollers having inwardly projecting surfaces which substantially define a portion of the outer contour of said arch forms.

12. A slip-form paving apparatus for producing cementitious conduits in a trench, comprising first screed means for forming the lower portion of a conduit, first hopper means for depositing cementitious material in the path of said first screed means; a support ski positioned rearwardly of said first screed means, said ski shaped to be moved while being supported on the inner surface of a lower portion of a conduit, a plurality of arch forms capable of being releasably secured together, each of said forms being received on said ski and secured to the preceding arch form, a brace means connected to each form and being actuable upon enlargement of the form's contour, means mounted upon said ski for producing an enlargement of the arch form's contour, thereby actuating said brace means; second screed means position-spaced above said forms for forming the upper portion of said conduit, and second hopper means for depositing cementitious material in the path of said second screed means.

13. The apparatus of claim 12 wherein said means for producing enlargement of the arch form's contour com-

prise a plurality of rollers which urge the longitudinal edges of said form outwardly into contact with the lower portion of the conduit.

14. A slip-form paving apparatus for producing cementitious conduits in a trench, comprising first screed means for forming the lower portion of a conduit, first hopper means for depositing cementitious material in the path of said first screed means; a support ski positioned rearwardly of said first screed means, said ski shaped to be moved while being supported on the inner surface of a lower portion of a conduit, a plurality of arch forms capable of being releasably secured together, each of said forms being received on said ski and secured to the preceding arch form, a brace means connected to each arch form and being actuable upon enlargement of the form's contour, guide means mounted on said ski for receiving each arch form and positioning it with respect to a lower portion of a conduit, means mounted upon said ski for producing an enlargement of the arch form's contour, thereby actuating said brace; second screed means position-spaced above said forms for forming the upper portion of said conduit, and second hopper means for depositing cementitious material in the path of said second screed means.

15. The apparatus of claim 14 wherein said guide means comprises a plurality of support rollers for receiving said arch forms as they are placed on said ski, and a plurality of lateral guide rollers having inwardly projecting surfaces which substantially define a portion of the outer contour of said arch forms; and said means for producing enlargement of the arch form's contour comprising a plurality of rollers which urge the longitudinal edges of said form outwardly into contact with the lower portion of the conduit.

16. A slip-form paving apparatus for producing cementitious conduits in a trench, comprising first screed means for forming the lower portion of a conduit, first hopper means for depositing cementitious material in the path of said first screed means; a support ski positioned rearwardly of said first screed means, said ski shaped to be moved while being supported on the inner surface of a lower portion of a conduit, retaining walls mounted on said support ski to prevent earth from falling onto a lower portion, a plurality of arch forms capable of being releasably secured together, each of said forms being received on said ski and secured to the preceding arch form, a plurality of lateral guide rollers supported from said walls and having inwardly facing surfaces which substantially define a portion of the outer contour of said arch forms; second screed means position-spaced above said forms for forming the upper portion of said conduit, and second hopper means for depositing cementitious material in the path of said second screed means.

17. A slip-form paving apparatus for producing cementitious conduits in a trench, comprising a power sled adapted to be moved in said trench, first screed means for forming the lower portion of a conduit and including a vibration isolating means between a lower vibrated plate and a support plate connected to said sled, vibrator means disposed in contact with said lower vibrated plate, first hopper means for depositing cementitious material in the path of said first screed means; a support ski positioned rearwardly of said first screed means, said ski shaped to be moved while being supported on the inner surface of a lower portion of a conduit, a plurality of arch forms capable of being releasably secured together, each of said forms being received on said ski and secured to the preceding arch form, a plurality of lateral guide rollers supported from said ski and having inwardly facing surfaces which substantially define a portion of the outer contour of said arch forms, said arch forms being engaged by said guide rollers and positioned with respect to a lower portion of a conduit, a brace means connected to each form and being actuable upon enlargement of the arch form's contour, means mounted upon said ski for producing an enlargement of an arch form's contour as it moves off said ski, thereby actuating said brace means; second screed means position-spaced above said forms for forming the upper portion of said conduit, and second hopper means for depositing cementitious material in the path of said second screed means.

18. In apparatus for producing cementitious conduits in a trench, and comprising a support ski shaped to be moved while being supported on the inner surface of a preformed lower portion of a conduit, a plurality of arch forms capable of being releasably secured together, each of said forms being received on said ski and secured to the preceding arch form, and guide means mounted on said ski for positioning each arch form with respect to the preformed lower portion of the conduit over which said ski is moved, said means comprising a plurality of support rollers for receiving said arch forms as they are placed on said ski and a plurality of lateral guide rollers, said guide rollers having projecting surfaces which substantially define a portion of the contour of said arch forms.

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1,079,000	Fisher	Nov. 18, 1913
1,191,731	Ransome	July 18, 1916
1,292,250	Carr	Jan. 21, 1919
1,461,973	De La Mare	July 17, 1923
1,810,777	McKee	June 16, 1931
2,501,135	Miller	Mar. 21, 1950
2,574,213	Jerner	Nov. 6, 1951
2,731,698	Tunsen	Jan. 24, 1956
2,734,248	Gaudin	Feb. 14, 1956
2,819,046	Jandris et al.	Jan. 7, 1958
2,887,289	Palka	May 19, 1959