Aug. 15, 1961 M. F. KEMPER 2,995,901

METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

Filed March 27, 1953 10 Sheets-Sheet 1

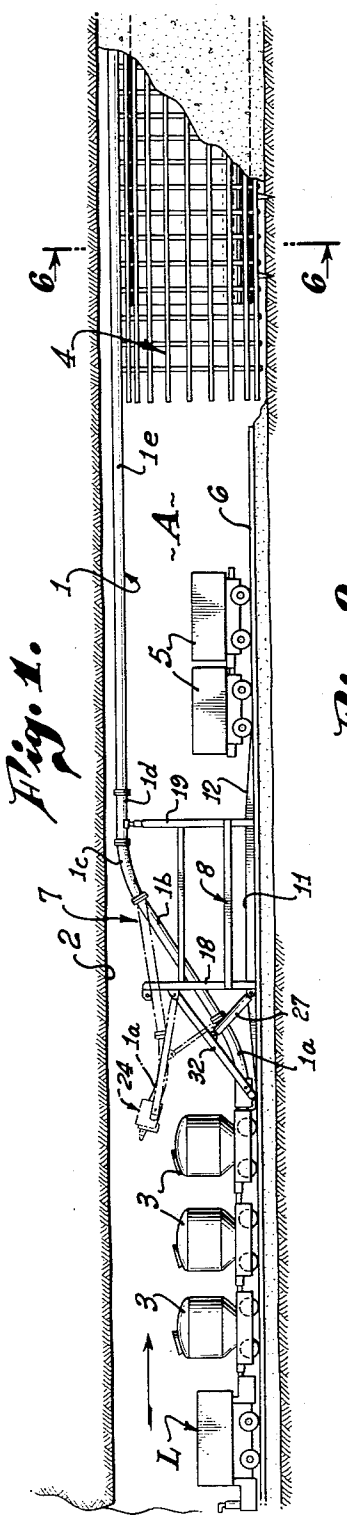


Fig. 1.

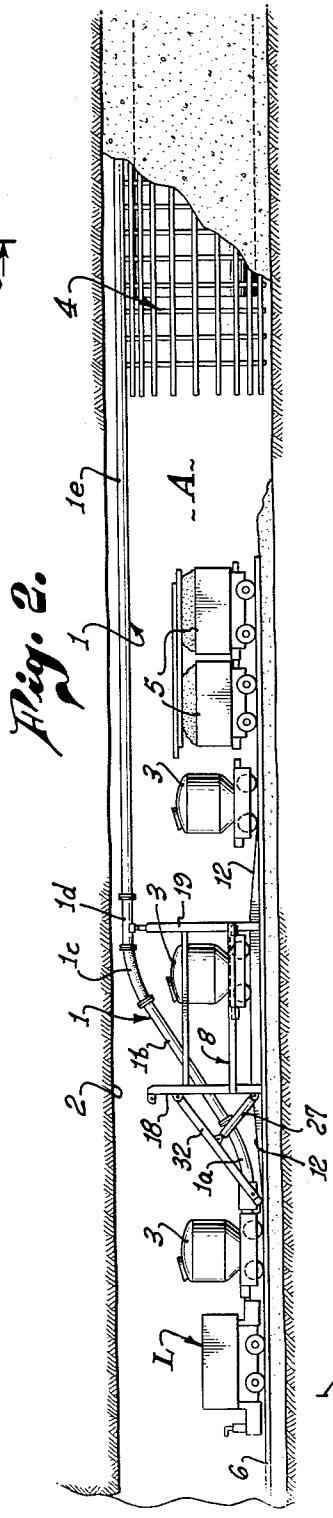


Fig. 2.

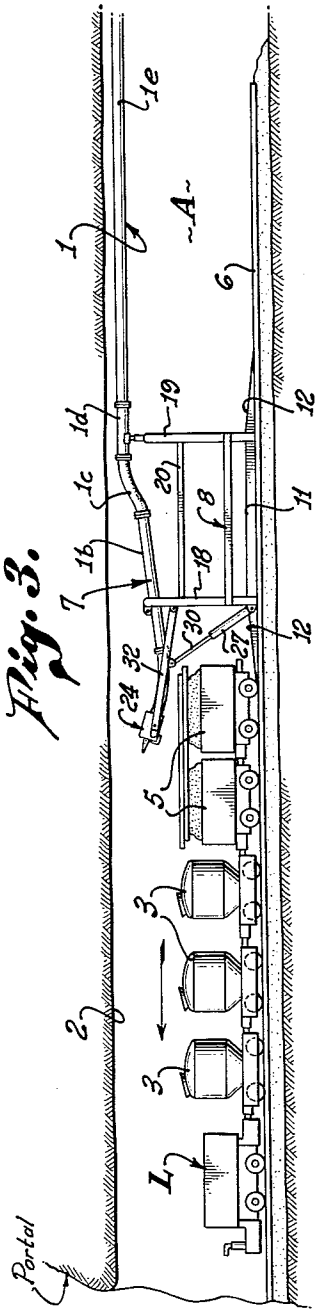


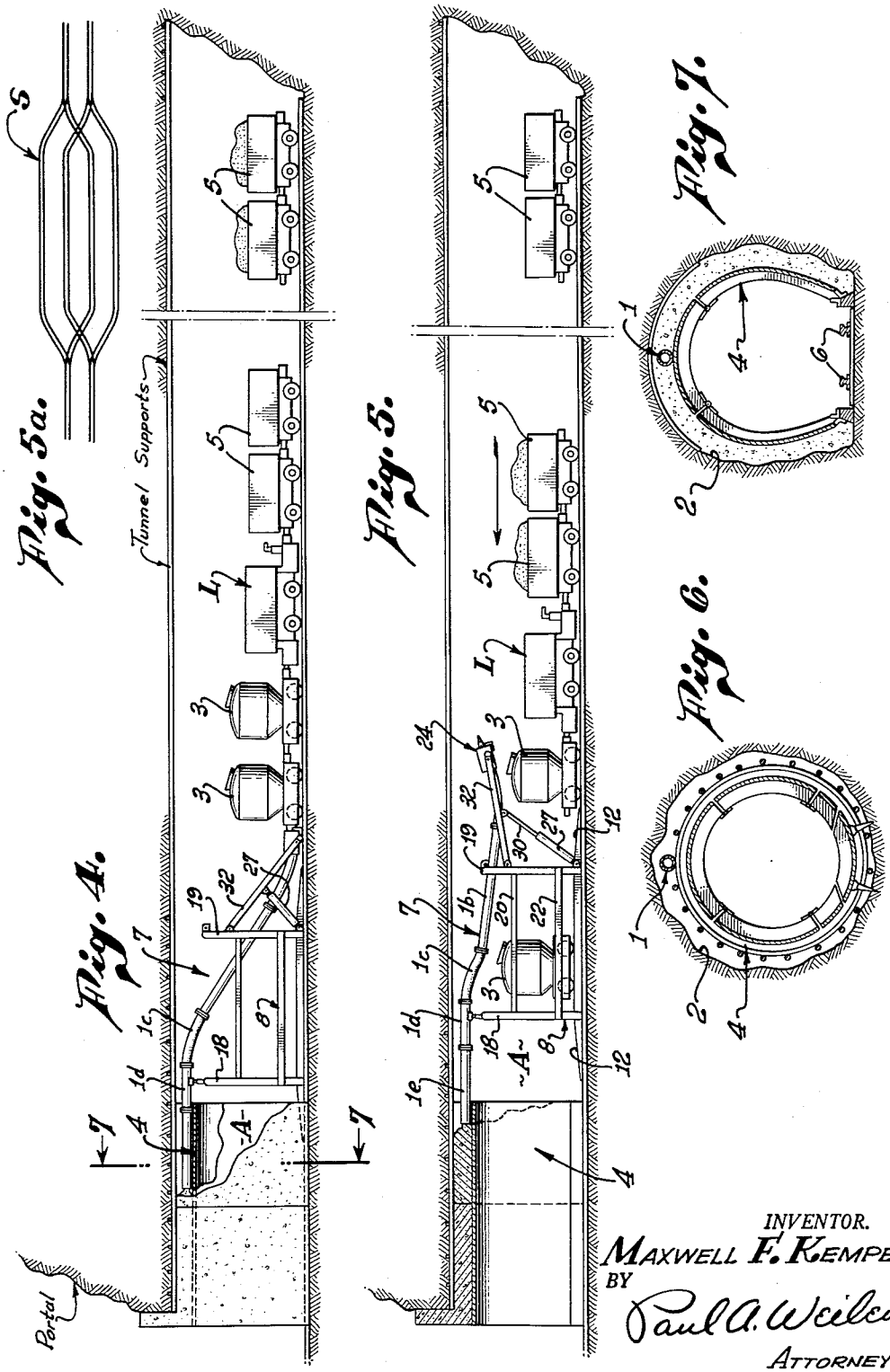
Fig. 3.

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METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

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METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

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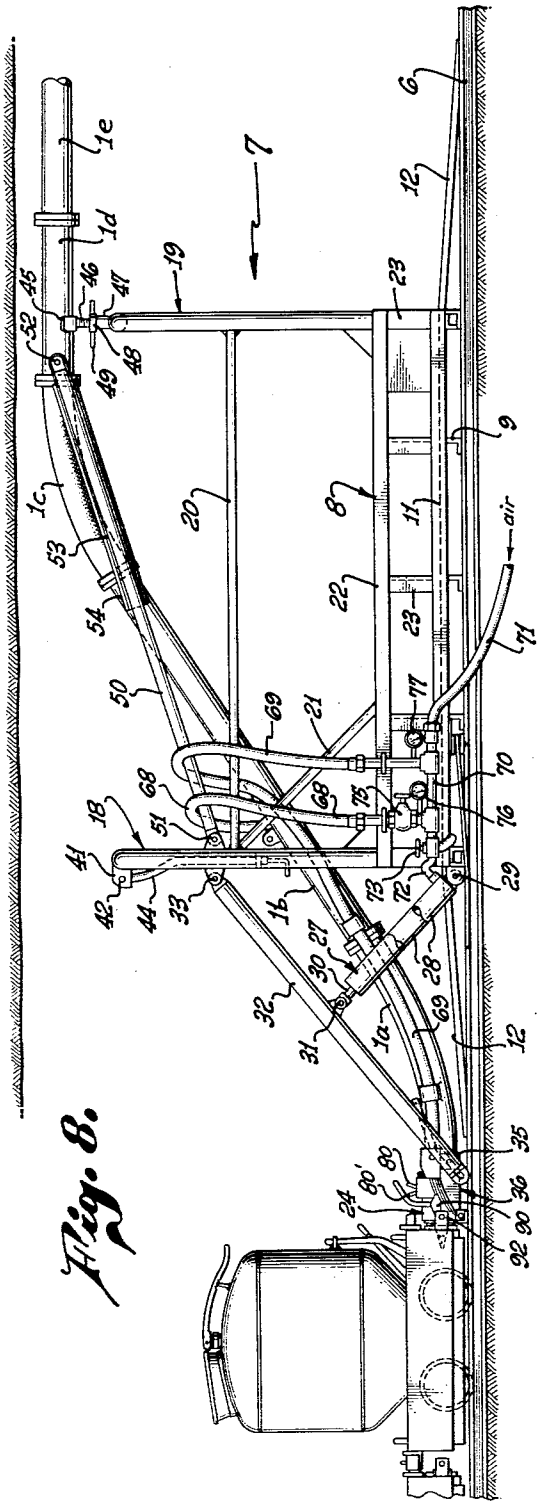


Fig. 8.

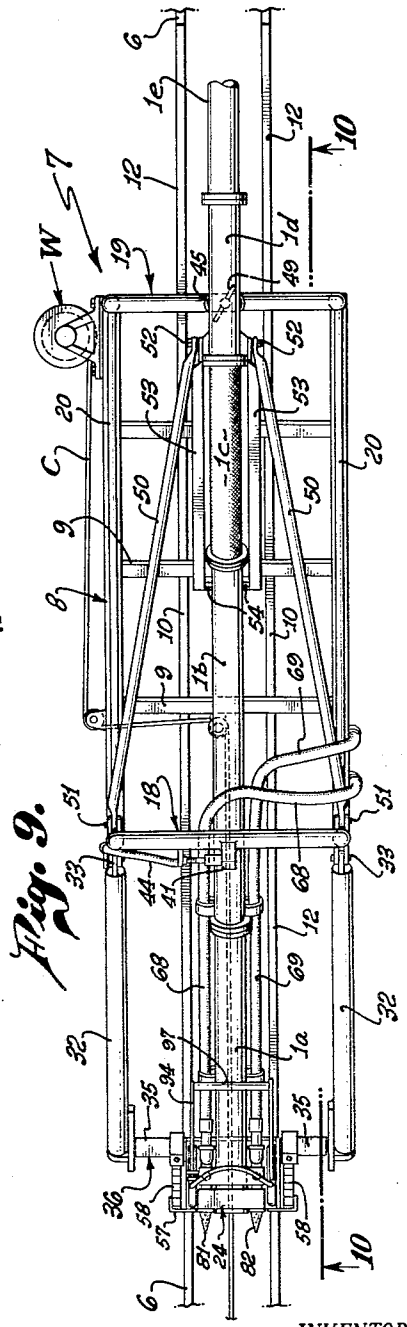


Fig. 9.

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METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

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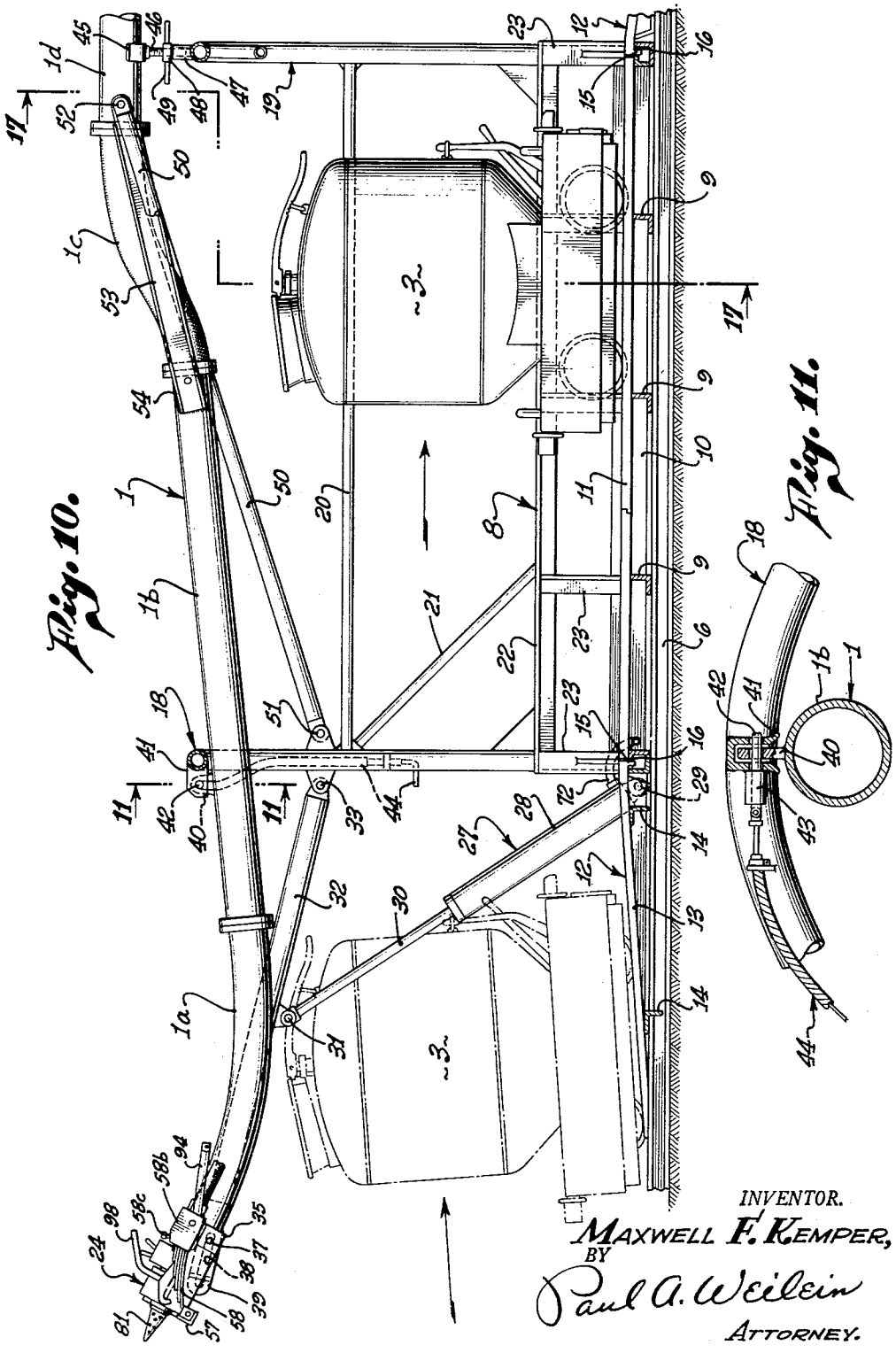


Fig. 10.

Fig. 11.

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METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

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Fig. 12.

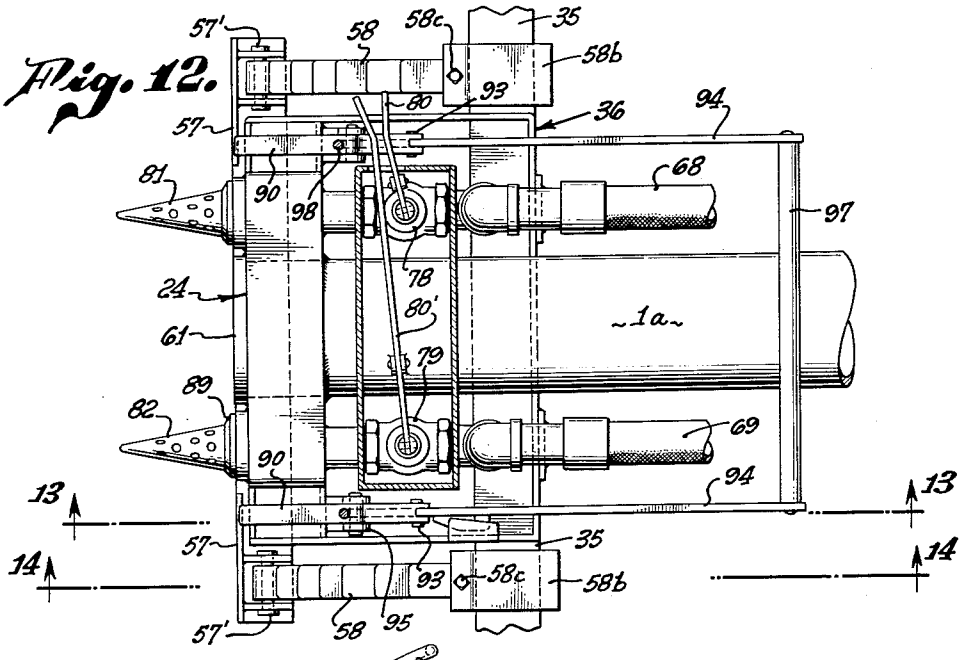


Fig. 13.

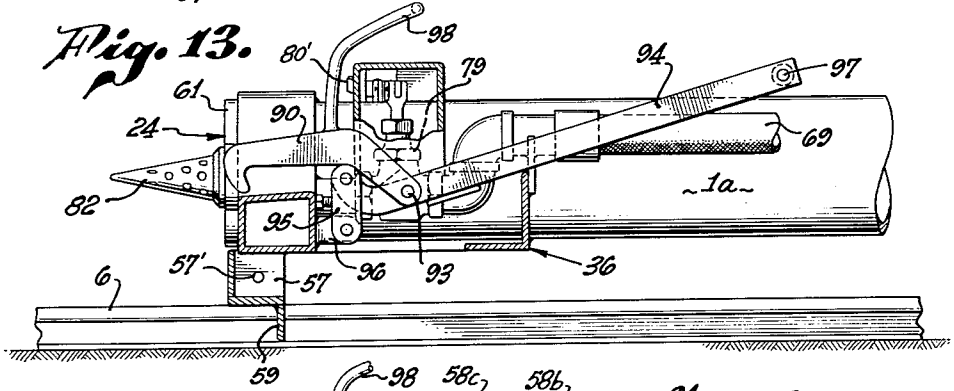
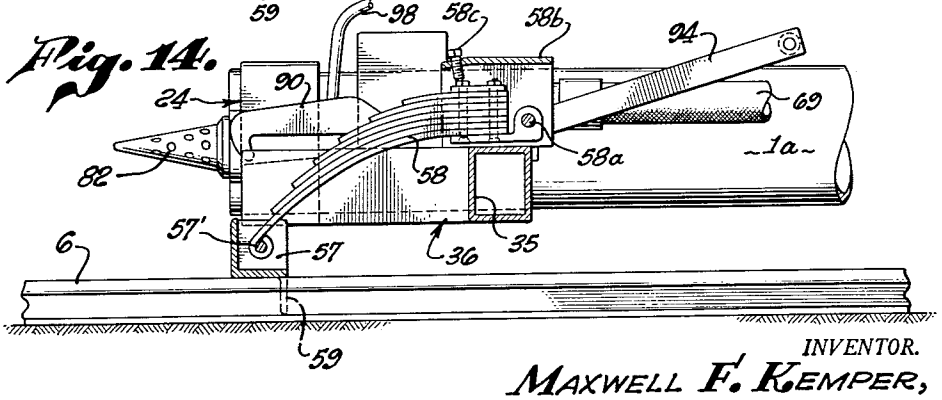


Fig. 14.



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METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

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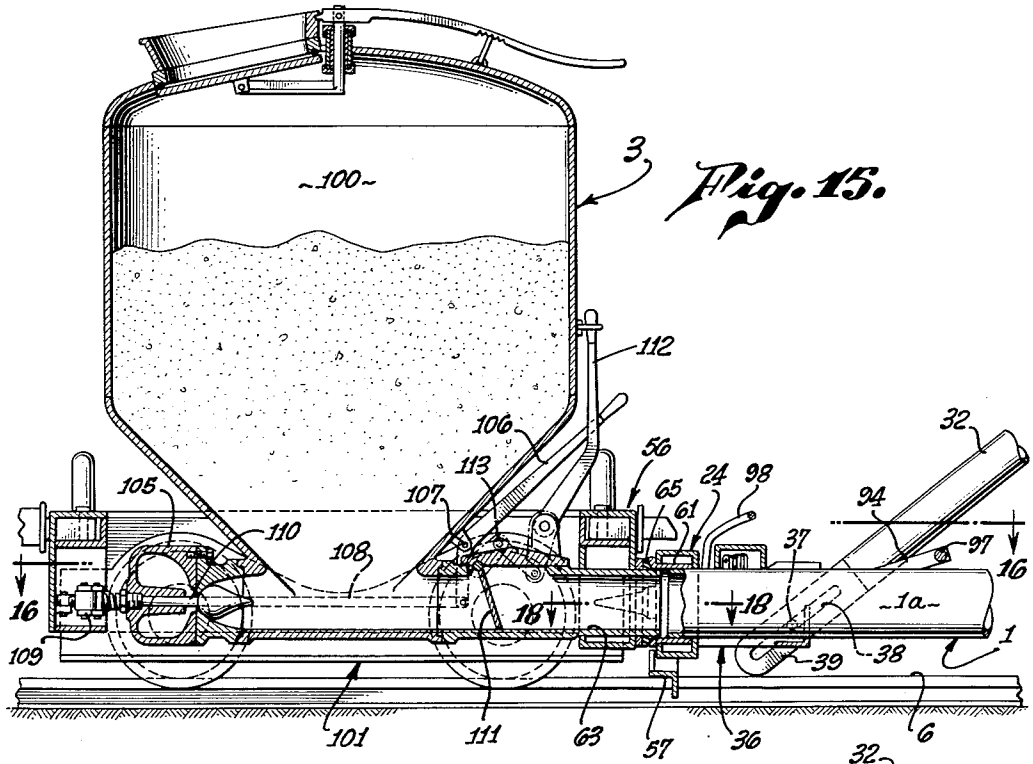
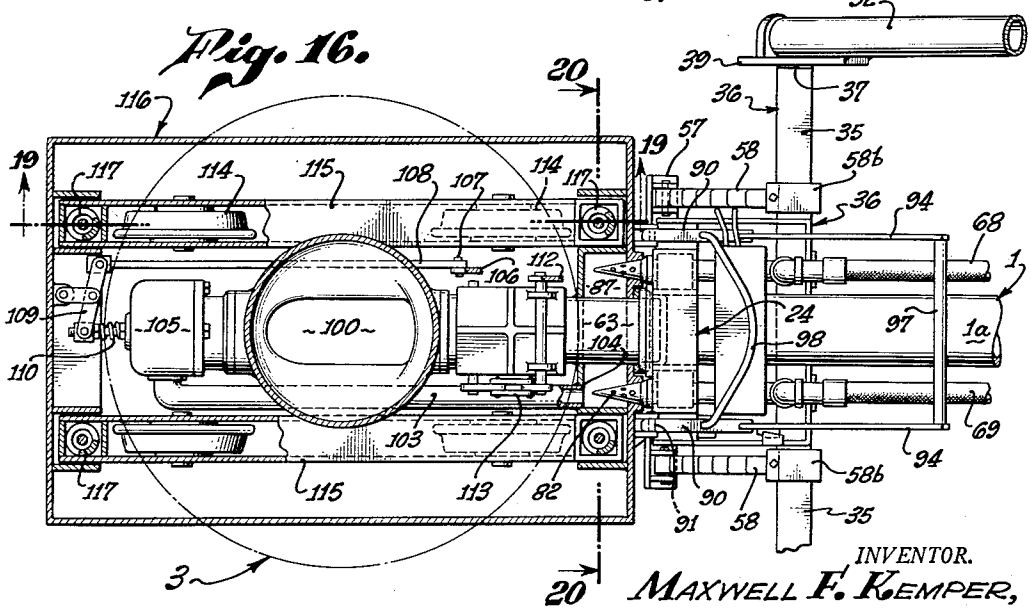


Fig. 15.

Fig. 16.



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METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

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Fig. 17.

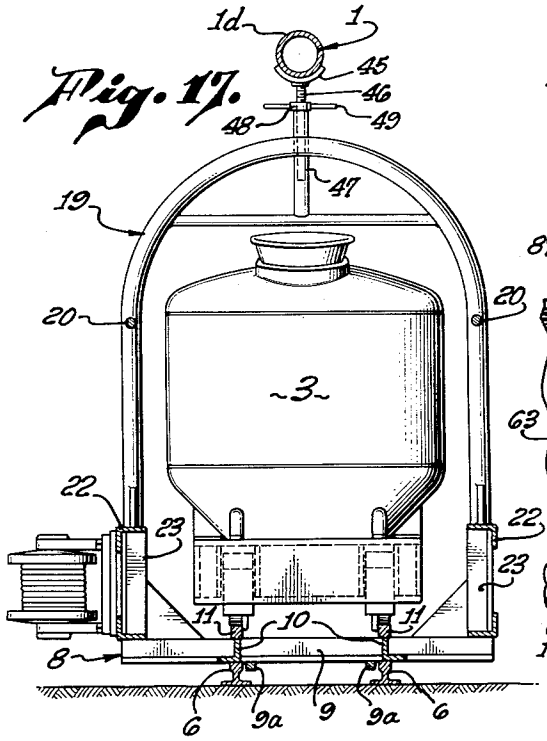


Fig. 18.

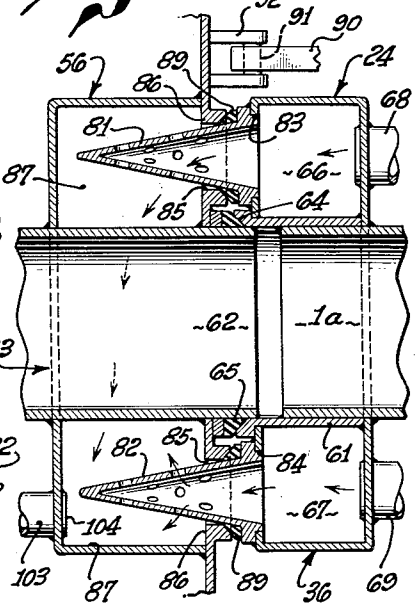


Fig. 19.

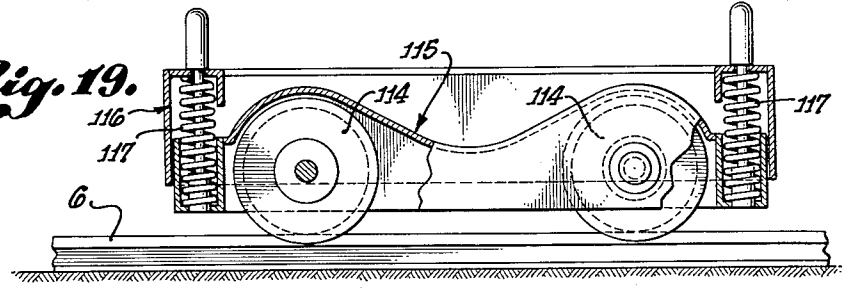
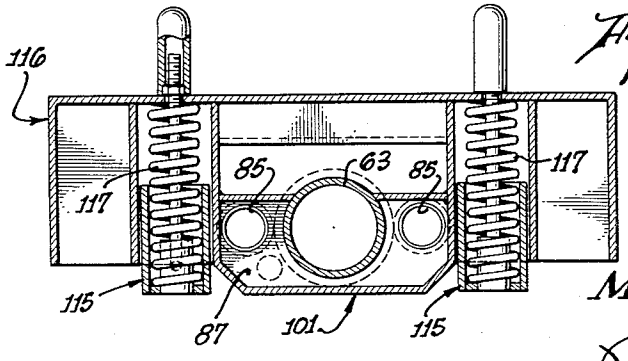


Fig. 20.



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METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

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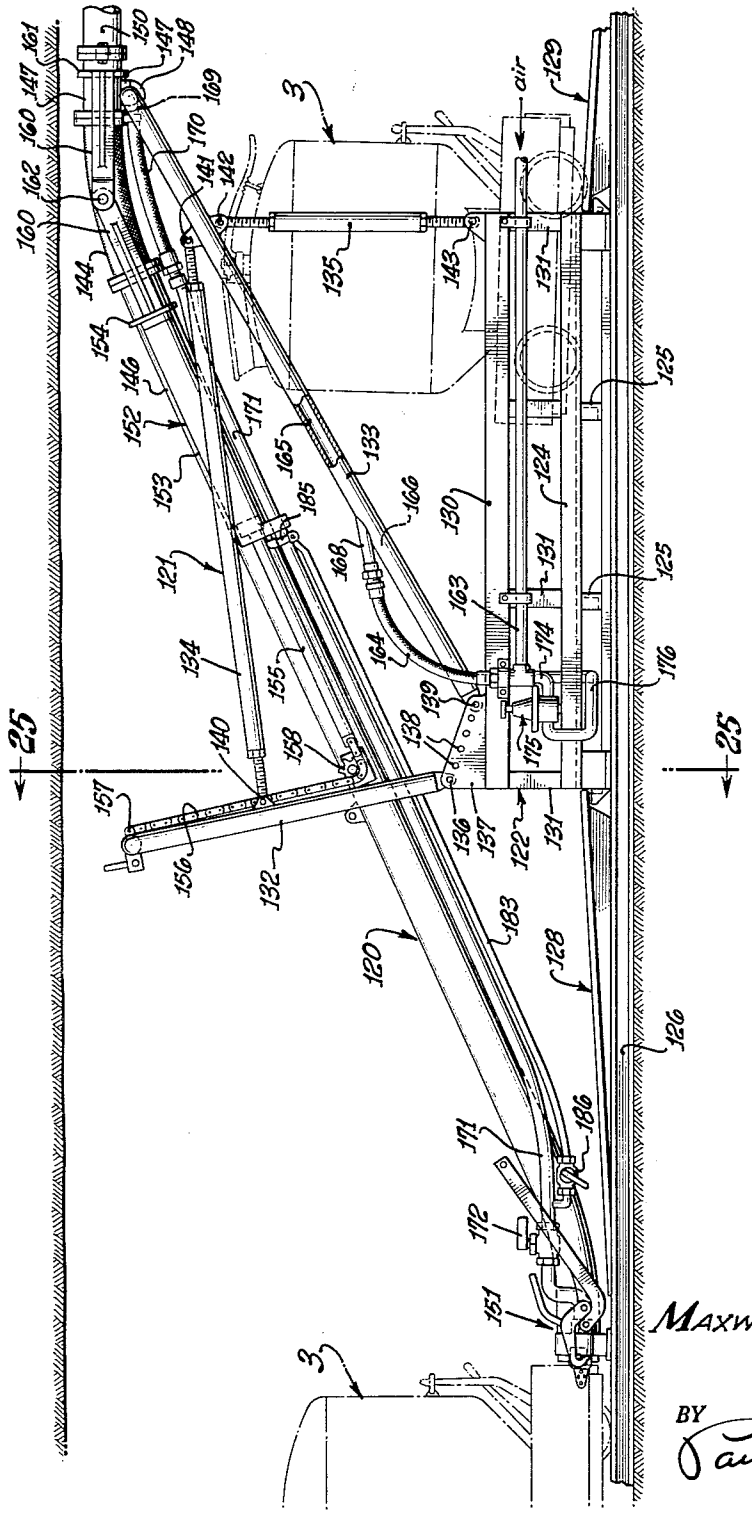


Fig. 21.

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METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

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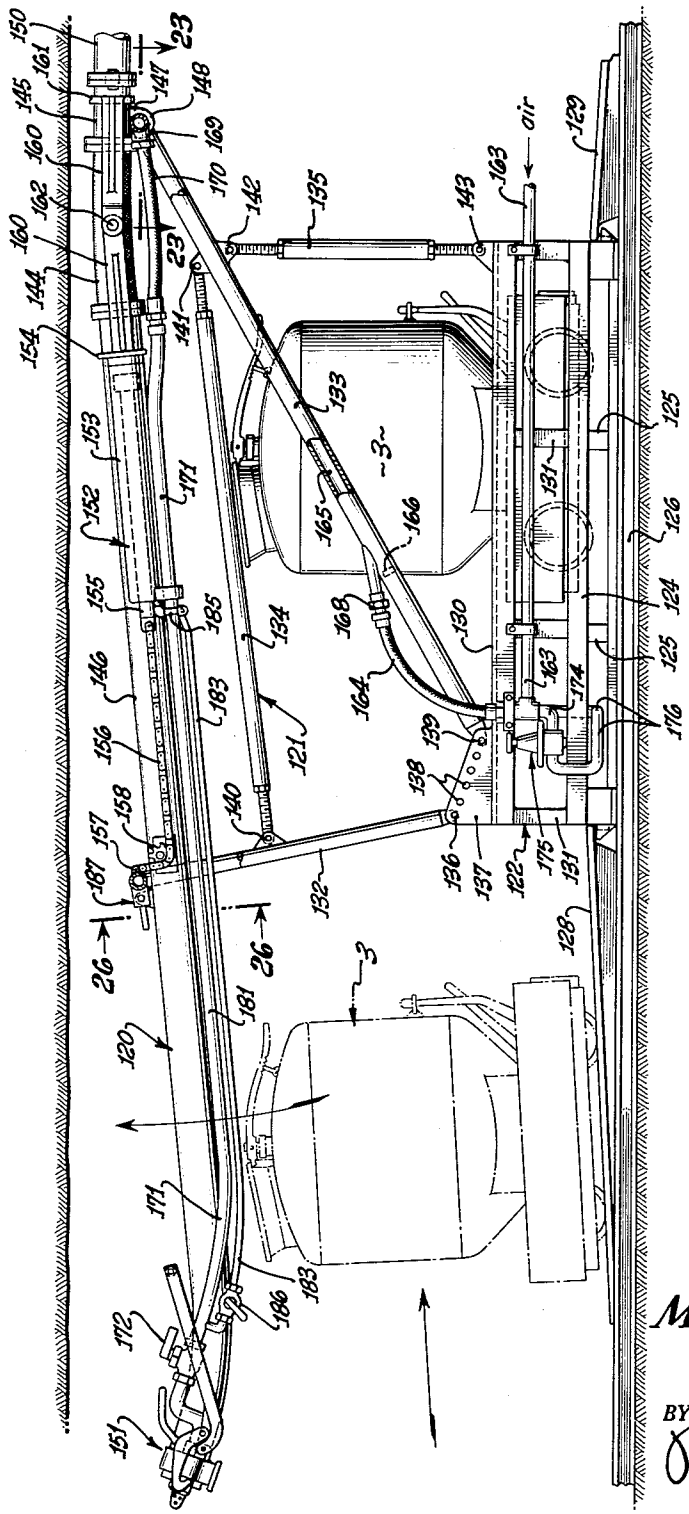


Fig. 22.

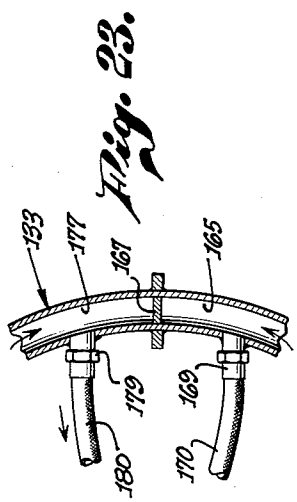


Fig. 23.

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METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

Filed March 27, 1953 10 Sheets-Sheet 10

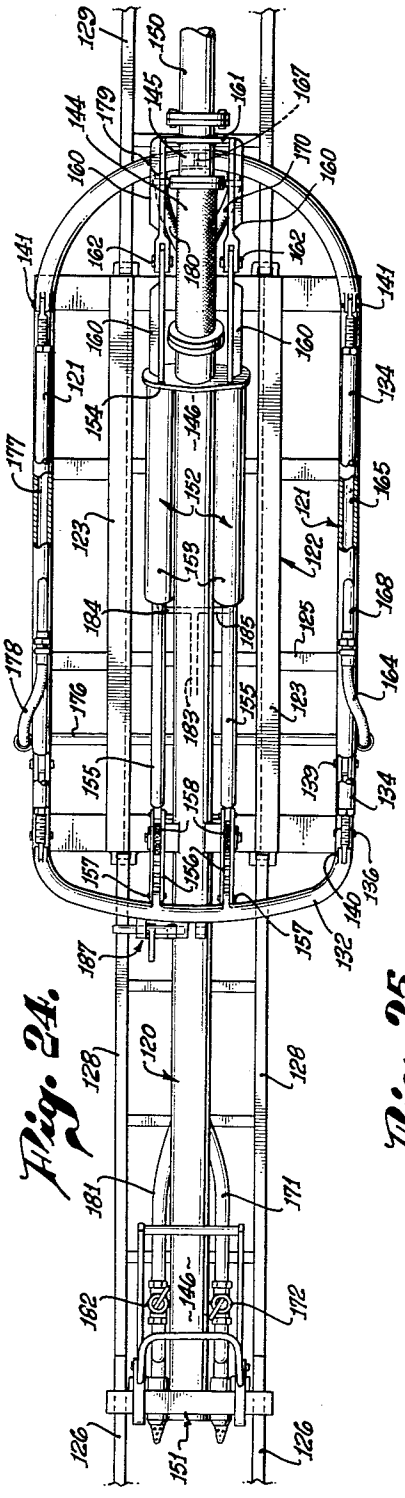


Fig. 24.

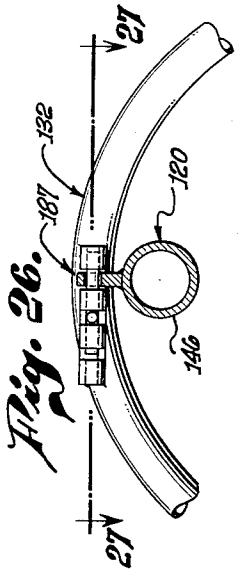


Fig. 26.

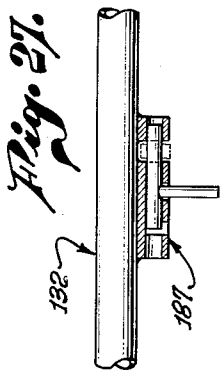


Fig. 27.

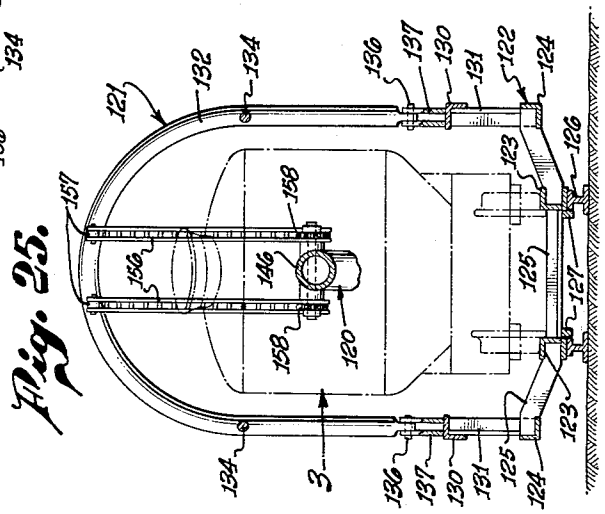


Fig. 25.

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United States Patent Office 2,995,901 Patented Aug. 15, 1961

2,995,901

METHOD OF AND APPARATUS FOR LINING TUNNELS WITH CONCRETE

Maxwell F. Kemper, 3701 Overland Ave., Los Angeles, Calif.

Filed Mar. 27, 1953, Ser. No. 344,960
35 Claims. (Cl. 61—63)

The present invention relates to an improved method of and apparatus for lining tunnels with concrete.

In tunnel lining methods to which the present invention relates, it is the practice to run into the tunnel, a string of concrete laden containers or cars, known as placers, and to discharge the concrete therefrom into the lining forms through a conduit positioned for connection with successive placers.

My application for U.S. Letters Patent, Serial No. 749,402, filed May 21, 1947, now Patent No. 2,660,034, for Method and Apparatus for Placing Fluent Material, discloses a concrete lining method similar to the method above described, wherein provision is made for moving the emptied placers onto a sled mounted in advance of a string or train of placers. The discharge conduit is disposed beneath the top of the sled with its intake end positioned to be connected with the placers. As each placer is unloaded, it is uncoupled from the conduit and advanced onto the sled over the conduit, thereby doing away with switching and by-passing of the placers and making it possible to practice the method in tunnels where switching is undesirable or precluded by the size of the tunnel bores.

In extending the discharge conduit from the sled to the forms, as shown in said application, it is disposed along the bottom of the tunnel and therefore becomes a barrier, preventing movement of placers or other cars from the sled into and from the zone between the sled and the form.

In the method as carried out in said pending application, and in all other methods of which I am aware, no provision has been made for gaining such access to that zone between the placers and the form that placers and other cars may be moved into and out of this zone, and work done therein, while unloading the concrete. In other words, no provision has been made heretofore for mounting the discharge conduit in a position such that while disposed to discharge concrete into the form, a portion thereof may be moved to clear a path leading into the zone between the intake end of the conduit and the form, for ingress and egress of cars and equipment and for efficient and timely working of said zone to prepare for erection of forms therein.

Accordingly, it is an object of this invention to provide for the lining of tunnels with concrete in a novel efficient manner affording ready access to the zone of the tunnel between the form and the intake end of the conduit, whereby the concrete laden placers or empty placers, muck cars and the like may be moved into and out of said zone.

It is a further object of this invention to provide for the lining of tunnels with concrete in a manner making it possible to run a train of cars for carrying concrete, working equipment, and excavated matter past the intake end of the conduit in either direction and in some tunnel formations, through the form itself.

It is a further object of this invention to provide a method and an apparatus for the purpose described wherein the conduit readily may be moved from the position in which it is connected to the cars or placers, into a position clearing the tunnel zone between the placers and the form, whereby the placers and cars may be moved into and out of or through said zone without

disturbing the operative connection of the conduit with the form or requiring longitudinal displacement of the conduit.

It is another object of the invention to provide a novel means for supporting a conduit in a tunnel in a manner such that the intake end of the conduit may be moved between a position for connection with a source of supply of concrete or other fluent material in the tunnel, and a position making it possible to move cars or the like past said intake end into and from that zone between the ends of the conduit.

It is another object of this invention to provide in tunnel lining apparatus, a means operable for moving the intake end of the conduit between a position of use and an elevated position permitting cars to move beneath the intake end up to the forms.

It is another object to provide a conduit supporting apparatus such as described which is constructed to permit cars to pass thereover to and from sections of tunnel track extending from opposite ends of such apparatus.

It is another object hereof to provide conduit supporting apparatus in the form of a frame, supporting the conduit in a position permitting the cars to be run beneath the conduit.

It is another object to provide conduit supporting apparatus such as described, which is mobile and adapted to run into position of use in the tunnel as a part of the train of cars carrying the material and equipment for lining the unnel with concrete.

It is another object of this invention to provide for an efficient lining of tunnels wherein "bad ground" or what is known as "swelling ground" makes it desirable to pour the lining throughout the properly excavated portion of the tunnel before the "bad ground" reaches a condition making it unsafe to pour the concrete.

It is a further object of this invention to provide for an efficient lining of a tunnel from the portal toward the heading of the tunnel in a manner making it possible to pour the concrete into the form while the tunnel is being excavated beyond the form.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of several embodiments of the invention. For this purpose there are shown two forms in the drawing accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIG. 1 is a longitudinal schematic view of a tunnel, illustrating the manner of lining a tunnel and how muck cars may be placed in the working zone of the tunnel, in accordance with this invention;

FIG. 2 is a view similar to FIG. 1, showing the manner of disposing of the empty containers and the manner of use of the muck cars;

FIG. 3 is a view similar to FIG. 1, illustrating the manner of removing the empty containers and muck cars from the working zone in the tunnel;

FIG. 4 is a longitudinal sectional view, partly schematic, showing the manner of lining a "horse shoe" type tunnel in accordance with this invention when starting the lining at the portal and continuing the lining toward the heading of the tunnel;

FIG. 5 is a view similar to FIG. 4, showing the manner of disposing of the empty concentrate containers in carrying out the lining operation illustrated in FIG. 4;

FIG. 5*a* is a fragmentary, schematic, top plan view of

a by-pass switch, known as a California switch may be employed in the lining operation illustrated in FIGS. 4 and 5;

FIG. 6 is a cross sectional view, taken on the line **6—6** of FIG. 1;

FIG. 7 is a cross sectional view, taken on the line **7—7** of FIG. 4;

FIG. 8 is a side elevation of apparatus embodying the present invention, as it would appear when in operation for discharging concrete from a concrete laden container, through a conduit leading into the form;

FIG. 9 is a top plan view of the apparatus shown in FIG. 8;

FIG. 10 is a side elevation of the apparatus shown in FIG. 8, on an enlarged scale, showing the apparatus adjusted to permit movement of the containers past the intake end of the conduit; taken on line **10—10** of FIG. 9;

FIG. 11 is a sectional view, taken on the line **11—11** of FIG. 10;

FIG. 12 is an enlarged top plan view partially in section of the vertically movable unit for coupling the conduit to the concrete laden containers;

FIG. 13 is a sectional view, taken on the line **13—13** of FIG. 12;

FIG. 14 is a sectional view, taken on the line **14—14** of FIG. 12;

FIG. 15 is a longitudinal sectional view of one of the mobile concrete carrying containers, shown in connection with the conduit for conducting the concrete to the form;

FIG. 16 is a sectional view, taken on the line **16—16** of FIG. 15;

FIG. 17 is a vertical sectional view, taken on the line **17—17** of FIG. 10;

FIG. 18 is a fragmentary sectional view, taken on the line **18—18** of FIG. 15;

FIG. 19 is a cross sectional view, taken on the line **19—19** of FIG. 16;

FIG. 20 is a cross sectional view taken on the line **20—20** of FIG. 16;

FIG. 21 is a side elevation of a modified form of apparatus embodying the present invention;

FIG. 22 is a side elevation of the apparatus shown in FIG. 21, showing the conduit in a position to permit movement of the containers past the intake end thereof;

FIG. 23 is a fragmentary sectional view taken on the line **23—23** of FIG. 22;

FIG. 24 is a top plan view of the apparatus shown in FIG. 21;

FIG. 25 is a cross sectional view taken on the line **25—25** of FIG. 21;

FIG 26 is a fragmentary cross sectional view taken on the line **26—26** of FIG. 22; and

FIG. 27 is a fragmentary sectional view taken on the line **27—27** of FIG. 26.

In carrying out this invention, a conduit **1** as shown in FIGS. 1, 2 and 3, is arranged in a tunnel **2** for delivering concrete or other fluent material from mobile containers or cars **3**, hereinafter referred to as placers, into a form **4** for the tunnel lining. The placers **3**, as well as muck or work cars **5**, are operable as a train by means of a locomotive L, on a track **6**, which latter, as shown in FIG. 1, extends to a point adjacent the form **4**. The placers **3** are similar to the concrete-carrying cars shown in the aforementioned application and reference thereto is made for a further understanding of the construction and operation thereof.

It has been found that more efficient tunnel-lining operations may be carried out by providing access to the tunnel zone A between the intake end of the conduit **1** and the form **4**, whereby the placers **3** and the work cars **5** may be moved into and out of this zone.

One way of providing access to the tunnel zone A in accordance with this invention, is to mount the conduit **1** in an elevated position, with only the intake end of the conduit and a portion contiguous the intake end adapted to be moved between a position for connection with the placers **3** and a position clearing the way for movement of the placers past the intake end of the conduit and into and out of the zone A.

This arrangement of the conduit **1** makes it possible to run the work muck cars **5** or other rolling equipment into the zone A ahead of a string of placers **3** to facilitate the removal of excavated matter, or any other work in the zone A as required to prepare this zone for the erection of forms for continuing the lining operation. It also provides for the disposal of the emptied placers **3** in the zone A during the placement of the concrete.

Another advantage arising from supporting and moving the conduit **1** in accordance with this invention is that it makes possible a more efficient lining of a horseshoe-shaped tunnel, as shown in FIGS. 4, 5 and 7, as well as tunnels where bad ground, or what is known as swelling ground makes it desirable to line the tunnel as quickly as possible after erection of the forms. In this case, the lining operation is commenced at the portal and continued inwardly toward the heading of the tunnel. As shown in FIGS. 4 and 5, the apparatus of this invention makes it possible to run the train of placers **3** and the work cars **5**, or other rolling equipment, through the form **4**, with the work cars adjacent the heading while the placers **3** are disposed adjacent the form **4**. The zone A in this instance is between the intake end of the conduit and the form, or better, between the portal of the tunnel and the intake end of the conduit.

As a means for supporting and adjusting the conduit **1** in accordance with this invention, a frame structure formed as a mobile unit is provided with means for moving the intake end and adjacent portion of the conduit **1**, into and out of position for connection with the placers **3**. When moved out of position for connection with the placers, the conduit is disposed out of the path of the placers **3** and cars **5**, whereby the placers and cars may be moved past the intake end of the conduit into and out of the zone A.

As here provided, the frame structure includes a base frame **8** made up of cross members **9** and longitudinal members **10**, with the members **10** adapted to slide on the track **6**, whereby the frame structure may be moved along the track. Guide members **9***a* on the cross members are adapted to slidably contact the inner sides of the rail of the track **6** to hold the frame structure on the track.

Mounted on the upper sides of the cross members **9** are rails **11** at the ends of which are ramps **12** having transfer rails **13** inclined upwardly from the rails of the track **6** to the ends of the rails **11**, whereby the placers **3** and cars **5** or other rolling equipment may be moved from the track **6** onto the rails **11** and vice-versa.

Each of the ramps **12** consists of the rails **13** and cross members **14** secured to the undersides of the rails **13**. The transfer rails **13** are secured in any suitable manner at their inner ends to end cross members **9** of the base frame **8**, in alignment with the rails **11** and with their outer ends resting atop the rails of the track **6**. As here shown, the transfer rails **13** (see FIG. 10) are provided at their inner ends, with downwardly directed lugs **15** adapted to seat in sockets **16** in the end cross members **9** to hold the ramps in place.

Mounted at the ends of the base **8** are arch members **18** and **19** for supporting the conduit **1** in an elevated position, permitting the placers **3** and cars **5** to be moved on the rails **11** through the arch members.

Horizontal brace bars **20** are joined to and extend between the arch members **18** and **19**. The arch members **18** are also braced by bars **21** extending diagonally between the members **18** and horizontal side bars **22**. These side bars **22** extend horizontally between the arch members **18** and **19**, being connected to the arch mem-

bers at their ends and supported above the longitudinal base members **10** on posts **23**.

As here shown, the conduit **1** is formed of a plurality of sections, there being an end section **1***a* providing the intake end of the conduit, a section **1***b* connected with the section **1***a* and a flexible section **1***c* joining section **1***b* with a stationary section **1***d* supported by the arch member **19**. The section **1***d* is connected with the remainder **1***e* of the conduit leading to the form **4**.

A coupling unit **24** is provided at the intake end of the conduit **1** for detachably connecting the conduit with the placers **3**. This coupling unit and the adjacent conduit sections **1***a* and **1***b* are adapted to be raised and lowered by the means including a pair of pneumatic rams **27** having their cylinders **28** pivotally connected as at **29** to the base **8**. The piston rods **30** of these rams are pivoted as at **31** to a pair of supporting arms **32**. The arms **32** are pivoted at their inner ends as at **33** to the upright portions of the arch member **18**. The outer ends of the arms **32** are connected with a cross member **35** of the frame **36** of unit **24**, by means of pin-like projections **37** at the ends of the member **35** extending through slots **38** in plates **39** welded on the arms **32**, thereby pivotally and slidably connecting these arms with the unit **24**. With this arrangement the arms **32** may be raised and lowered by actuation of the rams **27**. When lowered, the coupling unit **24** is positioned for connection with the placers **3**. When raised, the unit **24** together with the adjacent conduit sections is disposed in an elevated position such that the placers **4** and cars **5** may be moved onto and on the rails **13** into and out of the zone A.

The support of the conduit **1** in elevated position may be assured by locking it to the arch **18**, as shown in FIGS. 10 and 11. For this purpose, an apertured ear **40** is provided on the conduit section **1***b* so that the aperture therein will register with apertures in similar ears **41** on the top of the arch member **18** when the conduit is elevated. A latch pin **42** mounted in a sleeve **43** fixed on one side of one of the ears **41** may be moved into and out of position passing through the apertures in the ears **40** and **41** by means of a suitable Bowden wire actuator **44**.

The conduit section **1***d* is supported on a vertically adjustable saddle member **45** mounted on the upper end of a screw **46** supported in a socket **47** fixed to the upper end of the arch **19**. A nut **48** on the screw **46** rests upon the upper end of the socket **47** so that when turned by the aid of hand grips **49**, the screw may be raised and lowered to vertically adjust the conduit section **1***d* best to suit the particular tunnel and operation therein.

The conduit section **1***d* is held in place on the saddle member **45** by means of a pair of arms **50** pivoted as at **51** to the arch member **18** and extending convergently toward the section **1***d* to which latter they are also pivoted as at **52**.

The flexible section **1***c* of the conduit acts as a hinge, permitting relative movement of the conduit sections **1***a* and **1***b* relative to the stationary section **1***d*. This flexible section is maintained in alignment with the sections **1***b* and **1***d* and restrained from lateral bending by means of a pair of rigid arms **53** which extend along opposite sides thereof. One end of each of the arms **53** is welded as at **54** to the conduit section **1***b*, whereas the other end of each arm is connected with the conduit section **1***d* by means of the pivot **52** for the arms **50**.

As the placers **3** are spring suspended for the purpose which is hereinafter described, and may not be uniformly loaded, the coupling members **56** thereon may be disposed in different vertical positions and therefore out of alignment with the coupling unit **24**. Moreover, irregularities as to the level or slant of the rails **6**, may cause misalignment of the coupling units **24** and **56**.

Accordingly, the coupling unit **24** is adapted to be vertically yieldably supported on the track when positioned to connect the conduit **1**, with one of the placers. For this purpose a pair of spring supported shoes **57** connected with the unit **24** are adapted to yieldably contact the rails **6** when the unit **24** is lowered for connection with one of the placers **3**. These shoes are joined by a resilient cross member **57'** but are relatively yieldably supported on the unit **24** by means of leaf spring **58**. As shown in FIGS. 12, 13 and 14, these springs are pivoted at their upper ends as at **58***a* to housing **58***b* welded or otherwise fixed to the rigid cross member **35** of the frame **36** of the coupling unit **24**. The shoes **57** are pivoted as at **57'** on the lower ends of the springs on opposite sides of the unit **24** adjacent the front thereof. The flexibility of these springs may be regulated by means of adjusting screws **58***c* adjustably mounted on the housings **58***b* as shown in FIG. 14, so as to bear against the upper sides of the springs forwardly of the pivots **58***a*. The flexibility of the springs is increased by unscrewing or retracting these screws whereas the springs are stiffened by advancing the screws downwardly against the springs. With this arrangement the springs are rela-adjustable as to flexibility to make possible the yieldable support of the coupling unit in a manner assuring that the coupling unit will be properly aligned with the coupling units **56** or the placers.

The shoes **57** are provided with depending guide lugs **59** which contact the inner sides of the rails **6** to hold the shoes upon the rails.

As shown in FIG. 18, the intake end of the conduit section **1***a* is welded to the frame **36** and to a sleeve **61** fixed on the frame **36**. The sleeve **61** is adapted to telescope the discharge end **62** of the discharge pipe **63** of the coupling unit **56** of the placers **3**. The outer end of the sleeve **61** is beveled as at **64** for close contact with a beveled ring **65** fixed on the pipe **63**.

Means is provided on the frame **36**, as shown in FIGS. 12 and 18, to form air chambers **66** and **67** on opposite sides of the coupling sleeve **61**. Compressed air is supplied to these chambers from flexible air lines **68** and **69** which are coupled to a manifold **70** fixed as shown in FIG. 8 on the conduit-supporting structure **7**. An air supply hose **71**, leading from a source of supply of compressed air, not shown, is connected with one end of the manifold **70**. Lines **72**, one of which is shown in FIG. 8, lead from the cylinders **28** of rams **27** and are connected through a valve **73** with the other end of the manifold **70**, whereby these rams may be simultaneously operated under control of the valve **73**, to raise and lower the coupling unit **24** and the conduit sections connected therewith.

Provision is made for introducing air at different pressures into the placers **3**, in order that the concrete may be discharged at different flow velocities into the forms **4**, according to the nature of the tunnel bore to be lined. If the bore is deeply pitted, or has cavities in the walls thereof, the introduction of the concrete under higher pressure and consequent greater velocity, will cause these cavities to be reached and filled, thereby effectively lining such areas.

Accordingly, the air line **68** from the air chamber **66** is connected to the air supply manifold **70** through a regulator valve **75**, whereby the air pressure supplied to the chamber **66**, thence to the placers **3**, may be reduced as desired below that supplied through the air line **69** to the air chamber **67**. Thus, the line **69** is adapted to introduce air at full pressure into the chamber **67**. Air gauges **76** and **77** are provided in the lines **68** and **69** to determine the pressure of the air flowing to the chambers **66** and **67** respectively. As shown in FIGS. 12 and 13, the flow of air into the chambers **66** and **67** from the lines **68** and **69** is controlled by valves **78** and **79** operable by means of levers **80** and **80'** readily accessible on the unit **24**.

The introduction of compressed air from the air chambers **66** and **67** in the coupling unit **24** into the coupling

unit 56 of a placer 3 is effected through a pair of hollow, perforated and conical projections 81 and 82, fixed as by welding to the chambers 66 and 67, with their larger and open ends registering with openings 83 and 84 in a wall of said chambers. These conical projections are adapted, as shown in FIG. 18, to extend into openings 85 in a wall 86 of an air chamber 87 formed in the coupling unit 56 of each placer 3.

Should the coupling units 24 and 56 occupy positions somewhat out of alignment for the reasons hereinbefore noted, when moving them toward one another, the conical projections 81 and 82 will enter the openings 85 in the unit 56 and as the coupling unit 24 is yieldably supported it will readily align with the unit 56, whereby the conduit 1 may be coupled with the placer 3 in position for discharging concrete through the conduit. When the projections 81 and 82 are fully extended into the openings 85, sealing rings 89 on the projections will contact the wall 86, to prevent leakage of air at these connections.

As a means for holding the coupling unit 24 in coupled relations to the coupling unit 56 on the placers, hooks 90 are mounted on opposite sides of the unit 24 for movement into and out of hooked engagement with pins 91 secured in spaced ears 92 on the coupling unit 56 (FIG. 18). These hooks are pivoted, as at 93, on levers 94, which in turn are pivotally connected by means of a link 95, with lugs 96 on the frame of the coupling unit 24. The outer ends of the levers 94 are joined to a transverse handle bar 97 for raising the levers to move the hooks outwardly for engagement with the pins 91. Upon lowering the levers 94, the hooks are drawn inwardly, firmly to couple the units 24 and 56 and connect the base frame 8 with the placer 3. The hooks 90 are disengaged from the pins 91 by simultaneously raising the levers 94 to move the hooks forwardly. A bail 98 connected at its ends to the hooks is lifted to raise the hooks clear of the pins 91, after the hooks are moved forwardly by the levers 94.

In general, the placers 3 are substantially the same as the concrete carrying cars shown in my copending application hereinbefore identified, in that each placer has a concrete carrying hopper 100 mounted on a wheeled frame 101 so as to discharge the concrete into the pipe 63, thence through the conduit 1 for delivery to the forms. The compressed air is introduced into the discharge pipe 63 by means of a conduit 103 (see FIGS. 16 and 18) leading from the outlet port 104 of the air chamber 87 in the coupling unit 56, to a valve means 105 which controls the flow of air into the pipe 63, as will be seen with reference to FIG. 15. The valve means 105 is operated by the aid of a lever 106 fulcrumed, as at 107, on the hopper 100 and connected by means of a link 108 with a rocking arm 109 coupled to the spring loaded stem 110 of the valve means (see FIG. 16).

A valve 111 is provided in the pipe 63 to control the flow of concrete therethrough, being operable by means of a lever 112 and the linkage 113 connected with the flap valve, as shown in FIGS. 15 and 16.

It is desired to dampen vibration of the carriers 3 during movement thereof while laden with concrete, to prevent settling out of the heavier ingredients of the concrete. To this end the frame 101 of each carrier 3 is spring supported as shown in FIGS. 16 through 20. Accordingly, there is provided a truck unit including flanged wheels 114, journalled in a pair of channelled side members 115. The members 115 are embraced by a frame 116 and resiliently supported by coiled spring 117 carried by the side members 115. The hopper 100 is carried on the frame section 116 and therefore cushioned by the springs 117.

In accordance with this invention, in forming a monolithic lining in a tunnel 2 as shown in FIGS. 1, 2 and 3, the mobile conduit supporting unit is positioned as shown in FIG. 1, for example, by pushing it on the track 6 into the tunnel at the head of a train consisting of concrete laden placers 3, work cars 5 and the locomotive L. FIG. 3 shows the manner in which the train may be arranged for moving the mobile conduit-supporting unit into the tunnel as well as for moving it out of the tunnel. A winch unit W including a cable C is mounted on the box frame 8 and may be used for moving the conduit supporting structure when the locomotive is not available.

When the mobile conduit-supporting unit has been moved to the desired position spaced from the form 4, as shown in FIG. 1, with the conduit 1 in an elevated position, the train is operated to move the work cars 5 on the rails 11 into the zone A. Next the train is backed up to dispose the head placer 3 in position to be coupled to the conduit 1 as shown in FIG. 1.

Assuming that the entire conduit 1 is supported in elevated position, the movable conduit sections thereof may be lowered to connect the coupling unit 24 with the coupling unit 56 on the placer 3. After connecting these coupling units in the manner hereinbefore described, compressed air is introduced into the placer by appropriate actuation of the valve 78 (or the valve 79, if higher pressure is desired), also the valve means 105 and 111 on the placer. Concrete will now be forced under pressure through the conduit 1 into the form.

When the first placer 3 has been emptied, the conduit 1 is uncoupled therefrom in the manner hereinbefore noted. Next the valve 73 is opened to supply compressed air to the rams 27, whereby the coupling unit 24 and sections 1*a* and 1*b* of the conduit 1 will be raised to the position, for example, shown in FIGS. 1 and 10. The first placer is now moved over the adjacent ramp 12 onto the rails 11, thence over the other ramp 12 onto the track 6 in the zone A adjacent the form 4. The placer 3 next in line is moved forwardly and the conduit then lowered by manipulation of the valve 73, for connecting the coupling unit 24 with this next placer, whereby the contents of this placer may be unloaded in the manner hereinbefore noted. As each placer is unloaded, the conduit 1 is raised and the placers are moved into the zone A. In this connection, it should be noted that the rails 11 may accommodate one or more of the placers, thereby increasing the capacity of the zone into which emptied placers or other cars may be moved.

It will now be seen that in placing the work cars in the zone A, it is possible to carry out work necessary to prepare this zone for erection of forms while the concrete is being delivered to the previously erected prepared forms. When the last placer has been emptied, the conduit 1 is uncoupled therefrom and elevated, whereby the locomotive L may be operated to move this placer over the rails 11 to couple the other placers and work cars in a trail which is movable through the conduit supporting structure and out of the tunnel for reloading the placers.

In the operation of lining a tunnel of the form shown in FIGS. 4, 5 and 7, the lining is started at the portal and continued inwardly. This operation is particularly desirable where "swelling ground" conditions in the tunnel bore makes it desirable to line the bore as soon as possible after the forms are erected.

In these operations, the train is arranged as shown in FIG. 4, with the placers 3 at one end, and the locomotive L between the placers and the work cars 5. This trail is now moved through the portal and the form 4. The conduit-supporting structure may also be moved by the train through the form into the desired tunnell heading, for example, as shown in FIG. 4. After the conduit-supporting structure is in place, it is operated to lower the conduit 1 for connection with the placers. The placers are now successively unloaded, and the conduit 1 repeatedly raised and lowered whereby the empty placers may be moved through the structure 7 in the same manner as in the lining operation hereinbefore described, into the zone A between the form 4 and the conduit-supporting structure or out through the portal.

A switch, such as the California switch S shown in FIG. 5*a*, may be provided in the zone B between the conduit-supporting structure and the tunnel heading, whereby the locomotive L may be operated to switch the loaded and unloaded work cars and the placers in a manner permitting of excavation of the bore while the lining operation is being carried out, as well as movement of the emptied placers as necessary to successively unload them.

FIGS. 21–27 illustrate a modified form of the apparatus of this invention, for moving a conduit **120** corresponding to the conduit **1**, between a position (FIG. 21) providing for connection of the conduit with the placers **3** and an elevated position (FIG. 22) permitting the placers, work cars and other movable apparatus to be moved beneath the conduit and through the form in the same manner as with the apparatus shown in FIG. 1–10.

This modified form of the invention differs from that shown in FIGS. 1–10, in that it is capable of being collapsed to facilitate shipment thereof and placement in a tunnel. It is constructed so that it may be readily assembled as well as adjusted best to suit the particular tunnel and the conditions at hand.

Accordingly, this modified form includes a collapsible frame structure **121** mounted on a base frame **122**. The base frame includes pairs of longitudinal members **123** and **124** formed by cross members **125**. The longitudinal members **123** are adapted to be slidably supported on the rails **126** and have guide members **127** thereon to hold them in alignment with the rails, whereby the frame structure **121** may be moved along the rails to and from the desired positions in a tunnel. The members **123** also serve as rails for the wheels of the carriers and work cars.

Ramps **128** and **129** are detachably connected to opposite ends of the base frame **122** in alignment with the rail members **123**, whereby the carriers and work cars may be moved from the rails **126** onto and from the rail member **123** in the same manner as in the form of this invention shown in FIG. 1–10.

The base frame **122** is provided with side bars **130** supported above and parallel with the frame members **124**, by means of upright posts **131**, there being ample space between the side bars **130** to accommodate the carrier, as shown in FIG. 25.

The frame **121** includes a pair of arch members **132** and **133** and pairs of supporting members **134** and **135**, all such members being supported by the side bars **130** to form a vertically adjustable and collapsible conduit-supporting structure through which the carriers may be moved beneath the conduit.

The arch member **132** is secured at its lower ends by means of pins **136** to plates **137** fixed to the side bars **130** at one end of the frame base **122**. These plates have a series of openings **138** spaced both vertically and in a direction longitudinally of the base frame **122** whereby the arch member may be secured to the plates through any selected opening to vary the height of the arch member as well as the spacing thereof from the adjacent end of the base frame **122**.

The ends of the arch member **133** are also secured by pins **139** to plates **137**. The several openings **138** permit of adjustment of the position of the arch **133** as to height and spacing from the arch **132**. In this connection it should be noted that the arch **132** extends upwardly and somewhat forwardly from the plates **137** on the base frame **122**, whereas the arch **133** is upwardly and rearwardly inclined from these plates.

The pairs of members **134** are formed of threadedly connected longitudinally adjustable sections and are pivoted as at **140** and **141** to the side members or legs of the arch members **132** and **133** respectively to adjustably support the arch members **132** and **133** in their respective upright and inclined positions. The members **135** serve as vertically adjustable posts, being pivoted as at **142** and **143**, respectively, to the side members or legs of the arch member **133** and to the upper side bars **130** of the base frame **122**. Adjustment of the members **134** and **135** provides for varying the positions of the arch members to suit the particular tunnel.

Collapse of the arch members **132** and **133** and the supporting members **134** and **135**, readily may be effected, for example, by disconnecting the member **134** from the arch **132** and disconnecting the lower end members **135** from the side bars **130**. This will permit of swinging the arch members and supporting members therefor on their pivotal connections, to lie in small compass upon the base structure.

The concrete delivery conduit **120** is of substantially the same construction as the delivery conduit **1** shown in FIGS. 1–10, in that it is sectional and includes a flexible section **144** between rigid sections **145** and **146**. The rigid section **145** is detachably supported upon the top of the arch member **133** by means of a split clamp, a part **147** of which is fixed to the underside of the section **145**. The other part **148** of this clamp fits around the arch **133** and is bolted to the part **147**, forming therewith a fastening permitting pivotal movement of the conduit about the top of the arch member **133**, whereby the arch member **133** may be adjusted as to height while supporting the conduit.

From the section **145** of the conduit, one or more conduit sections **150** extend to the form (not shown), for example, in the same manner as indicated in FIGS. 1–5.

The conduit section **146** extends forwardly from the flexible section **144** through the arch member **132** in the same manner as shown in FIGS. 1–10. At its forward end, the section **146** carries a coupling unit **151** corresponding to the coupling unit **24**, for connecting the conduit **120** with the placers **3** in the same manner as set forth in connection with the first described form of this invention.

Means are provided for moving the conduit section **146** between positions shown in FIGS. 21 and 22, whereby the conduit, when lowered, may be connected with the placers **3** and when elevated, will permit the placers to pass beneath the conduit in the same manner as in the first described form of this invention. As here shown, this means includes a pair of pneumatic rams **152** rigidly fixed to the conduit section **146** so as to extend along opposite sides thereof. The cylinders **153** of these rams are rigidly fixed to the conduit section **146** in any suitable manner. As here shown, a bracket **154** is welded or otherwise fixed to the section **146** and to corresponding ends of the cylinders **153**. The piston rod **155** of the rams **152** are connected to flexible elements **156**, here shown as sprocket chains, which in turn are fixed, as at **156**, to the top of the arch member **132**. These flexible elements extend under members **158**, here shown as sprocket wheels, journalled on opposite sides of the conduit section **146**.

The arrangement of the piston rods **155** and flexible elements **156** is such that when the conduit section **146**, as shown in FIG. 21, is in position to be connected with the placers **3**, the flexible elements **156** extend downwardly from the top of the arch member **132** with the sprocket wheels **158** supported upon the flexible elements near the ends thereof connected to the piston rods **155**. At this time the piston rods **155** are extended from the cylinders **153** of the rams **152**.

The conduit section **146** is raised by actuating the rams **152** to retract the piston rods **155**. As the piston rods are retracted the lower ends of the flexible elements **156** are pulled rearwardly and cause the portions of the flexible elements on which the sprocket wheels **158** are supported to be elevated thereby raising the conduit section **146**, as shown in FIG. 22.

The flexible section **144** of the conduit **120** acts as a hinge during the raising and lowering of the conduit section **146**. Side sway of the conduit sections **144** and **146**

is restrained by pairs of rigid arms 160 extending along opposite sides of the flexible section 144 and rigidly fixed at their outer ends to the bracket 154 on the section 146 and a collar 161 on the conduit section 14 respectively. The inner ends of the arms 160 are overlapped and pivotally connected as at 162, thereby forming a hinge joint, permitting free movement of section 146 in a vertical plane, but restraining side sway or lateral movement thereof.

Air under pressure, from a suitable source not shown, is supplied to a manifold 163 on one side of the base frame 122, thence through a flexible hose 164, which latter is connected to a conduit portion 165 of the arch member 133. In this connection, it will be seen that the arch member 133 is tubular and has partitions 166 and 167 therein to define the conduit portion 165 which extends along one leg of the arch member and half way around the curved top thereof. The lower end of the conduit portion 165 has an inlet nipple 168 connected therewith to provide for connecting the flexible hose 164 with the portion 165.

The upper end of the conduit portion 165 is provided with an outlet fitting 169 (FIG. 23) to which a flexible hose 170 is connected for conducting the compressed air into a conduit 171 secured to and extending along the conduit section 146 to the coupling unit 151.

The hose 164, conduit portion 165, hose 170 and conduit 171, constitute a high pressure line corresponding to the high pressure line 69 in the first described form of this invention and is controlled by a valve 172 located in the conduit 171 adjacent the coupling unit 151.

A low pressure line also leads from the manifold 163 and includes a branch 174 of the manifold for conducting the compressed air through a pressure regulator 175, thence through a conduit 176 which extends across the base frame 122 (FIGS. 21 and 24) to the other side of the arch member 133, being that side of the arch member opposite the side forming the conduit portion 165. A conduit portion 177, corresponding to the portion 165, is formed in said other side of the arch 133 and is coupled to the conduit 176 by means of a flexible hose 178 (FIG. 24). From the outlet nipple 179 of the conduit portion 177 (FIG. 24) a flexible hose 180 conducts the air to a conduit 181 extending along the underside of the conduit section 146 to the coupling unit 151 in the same manner as the high pressure conduit 171. A valve 182 is connected in the conduit 181 adjacent the coupling unit 151 for controlling the low pressure line.

As the coupling unit 151 is substantially identical with the unit 24 shown in FIGS. 12–16 and 18, it is apparent that air at high or low pressure may be supplied to the carriers 3 through the unit 182 in the same manner as with the first described apparatus of this invention.

The two pneumatic rams 152 are adapted to be simultaneously operated as here shown, from the high pressure line conduit 171. Accordingly, an air line 183 (FIGS. 21 and 22) is connected with the conduit 171 adjacent the coupling unit 151 and extends along the conduit 171 to a pair of branch lines 184 and 185 (FIG. 24) leading to the forward ends of the cylinders of the rams 152. A valve 186 in the line 183, at a point adjacent the coupling unit 151, provides for controlling the operation of the two rams. This valve is constructed to permit of a controlled bleeding of air from the rams, whereby the lowering of the conduit section 146 may be controlled as desired.

As best shown in FIGS. 26 and 27, a latch means 187 having parts on the arch member 132 and conduit section 146 respectively, is similar to the latch means shown in FIG. 11 and may be employed to releasably hold the conduit section 146 elevated, as shown in FIG. 22.

It will now be apparent that this modified form of apparatus may be operated in the same manner as the first described form of this invention. This form may be preferably for some tunnels, particularly small bore tunnels, or where it is desired to transport the apparatus in collapsed form or to assemble and disassemble the apparatus in the tunnel.

I claim:

1. The method of lining a tunnel with concrete by means of a form and a conduit for introducing concrete into the forms; which includes; moving a train of concrete-laden containers to a position adjacent said form; connecting the first container nearest the form with said conduit; discharging the concrete from said first container through said conduit into said form; disconnecting said conduit from said first container; moving said conduit to a position clearing a path extending along said conduit; moving said first container along said path to provide for connecting a following container of the train to said conduit; moving said conduit into position for connection with said following container; repeating those of the aforesaid steps necessary to discharge concrete from the containers in the train and to move them in said path out of the position in which they were connected with said conduit; and then moving the unloaded containers as a train away from said form while said conduit is disposed in said path-clearing position.

2. The method of lining a tunnel with concrete by means of a form and a conduit for conducting concrete into said form; which includes: disposing said conduit in a position clearing a path such that a mobile container may be moved past the intake end of said conduit; moving a train including mobile concrete-laden containers and an additional container into a position such that said additional container is disposed between the intake end of said conduit and said form; disconnecting said additional container from said train; moving said train of laden containers to position one container adjacent said intake end of said conduit; moving said conduit to connect said intake end with said one container; discharging the concrete from said one container through said conduit into said form; disconnecting said conduit from said one container; moving said conduit back into path-clearing position; moving said one container toward said form to occupy a position adjacent said additional container; repeating with succeeding containers the aforesaid steps necessary to discharge contents thereof into the form and to thereafter dispose them between said intake end and said form; then moving the containers from which concrete has been discharged as well as said additional container as a train away from said form while said conduit is disposed in said path-clearing position.

3. In apparatus for discharging material from a mobile container in a tunnel: a conduit for conducting material from said container; means for detachably connecting said conduit to said container; a conduit-supporting structure; and means on said structure movable relative thereto into and out of the path of movement of said container for moving said conduit between a position for connection with said container and a position permitting said mobile container to be moved through said structure beneath said conduit.

4. In apparatus for discharging material from a mobile container movable in a predetermined path in a tunnel; a conduit for conducting material from said container; said conduit having a discharge end; mobile means movable in the direction of said path; and means on said mobile means movable relative thereto and mounting said conduit for movement between a position for detachable connection with the container and a position permitting movement of said container in said path past said mobile means.

5. Apparatus for discharging material from a container movable in a predetermined path in a tunnel, including: a structure in said path providing a passageway through which said container is movable in either direction; a conduit supported in part on said structure in a position permitting said container to move through said passageway; means on said structure movable relative thereto into and out of the path of movement of said container

and mounting another part of said conduit and the intake end of said conduit for movement between a position for connection of said intake end with said container and a position permitting movement of a mobile container through said passageway.

6. Apparatus for discharging material from a container movable in a predetermined path in a tunnel including: a structure in said path providing a passageway through which said container is movable in either direction past the structure; a conduit supported in part on said structure in a position above said passageway; and means on said structure for moving the intake end of said conduit and the portion of the conduit between said end and said supported part, between a position for connection of said intake end with said container and a position permitting movement of a mobile container through said passageway.

7. Apparatus for discharging material from a container movable in a predetermined path in a tunnel including: a structure in said path providing a passageway through which said container is movable in either direction past the structure; a conduit supported in part on said structure in a position permitting said container to move in said passageway beneath the supported part of the conduit; and means on said structure for moving the intake end of said conduit and the portion of the conduit between said end and said supported part, between a position for connection of said intake end with said container and an elevated position clearing said passageway for movement of said container therethrough.

8. Apparatus for discharging concrete from a container movable on a track in a tunnel including: a structure movable on said track; a conduit supported on said structure above said track for movement between a position for detachable connection of the intake end thereof with said container and a second position permitting movement of said container past said intake end; means for so moving said conduit; and means providing for movement of said container from said track onto said structure and vice-versa when said conduit is in said second position.

9. Apparatus for discharging concrete from a container movable on a track in a tunnel including: a structure movable on said track; said structure providing a path permitting movement of said container in either direction past the structure; a conduit mounted on said structure for movement between a position in said path for connecting the intake end of the conduit with said container and a position out of said path to permit movement of said container in either direction through said path; and means for so moving said conduit.

10. Apparatus for discharging concrete from a container movable on a track in a tunnel including: a structure adapted to be positioned on said track; said structure providing a path in which said container is movable in either direction past the structure; a conduit mounted on said structure for movement between a position in said path for connection of the intake end of the conduit with said container and a second position clear of said path to permit movement of said container in either direction through said structure; means on said structure for so moving said conduit; a track on said structure in said path; and means at opposite ends of said structure providing for movement of said container in either direction from said first named track onto the track on said structure and vice-versa.

11. Apparatus for discharging concrete from a container movable in a given path in a tunnel including: a conduit for conducting concrete from said container to a predetermined part of said tunnel; a structure intermediate the ends of said conduit supporting one portion of the conduit between said structure and said predetermined part, out of the path of movement of said container; said structure providing a surface over which said container may be moved in either direction into and out of the zone between said predetermined part of the tunnel and said structure; and means on said structure for moving the intake end of said conduit and the portion of the conduit leading therefrom to said first mentioned portion into and out of a position for connection of said intake end with said container.

12. In apparatus for conducting concrete from a mobile container in a tunnel to portions of the tunnel where the concrete is to be poured: a base structure adapted to be positioned between said container and said portions of the tunnel; said base structure providing a surface over which said container may be moved in either direction; a conduit for conducting the concrete from said contaner; means extending upwardly from said base structure for supporting a portion of said conduit above the path of movement of said container over said surface; and means on said base structure for moving another portion of said conduit between a position for connection of the conduit with said container and a position above said path of movement.

13. In apparatus for conducting concrete from a mobile container in a tunnel to portions of the tunnel where the concrete is to be poured: a base structure adapted to be positioned between said container and said portions of said tunnel; said base structure providing a surface over which said container may be moved in either direction; a conduit for conducting the concrete from said container; means extending upwardly from said base structure for supporting a portion of said conduit above the path of movement of said container over said surface; means on said base structure for moving another portion of said conduit between a position for connection of the intake end of the conduit with said container and a position above said path of movement; said last named means including an upright member on said base disposed out of said path of movement; and means connected with said upright member and said last named portion of said conduit rescpectively, movable for raising and lowering said last named portion of said conduit.

14. In apparatus for conducting concrete from a mobile container in a tunnel to portions of the tunnel where the concrete is to be poured: a base structure adapted to be positioned between said container and said portions of said tunnel; said base structure providing a surface over which said container may be moved in either direction; a conduit for conducting the concrete from said container; means extending upwardly from said base structure for supporting a portion of said conduit above the path of movement of said container; means on said base structure for moving another portion of said conduit between a position for connection of the intake end of the conduit with said container and a position above said path of movement; said last named means including an upright member on said base disposed to one side of said path of movement; means connected with said upright member and said last named portion of said conduit respectively, movable for raising and lowering said last named portion; and means for releasably securing said last named portion of said conduit to the upper portion of said upright member.

15. In apparatus for conducting concrete from a mobile container mounted on a track in a tunnel, to portions of the tunnel where the concrete is to be poured: a base structure adapted to be positioned upon the track; said base structure providing a surface over which said container may be moved in either direction from said track; a conduit for conducting the concrete from said container; an arch member mounted on said base structure; means mounting a portion of said conduit on said arch member above the path of movement of said container; a second arch member mounted on said base structure; said conduit having another portion extending from said first named arch member through said second named arch member to the intake end of said conduit; and means connected with said last named portion of said conduit and

with said second named arch member respectively, operable to move said last named portion of said conduit between a position for connecting said intake end with said container and a position above said path of movement of said container.

16. In apparatus for conducting concrete from a mobile container mounted on a track in a tunnel, to portions of the tunnel where the concrete is to be poured: a base structure adapted to be mounted on said track; said base structure providing a surface over which said container may be moved in either direction from said track; a conduit for conducting concrete from said container to said portions of the tunnel; members mounted on said base for supporting said conduit above the path of movement of said container on said base; one of said members being movable for moving said conduit between a position in said path of movement for connection of the intake end of the conduit with said container and a position supporting said end above said path; and means for so moving said one member.

17. In apparatus for conducting concrete from a mobile container mounted on a track in a tunnel, to portions of the tunnel where the concrete is to be poured: a base structure adapted to be mounted on said track; said base structure providing a surface over which said container may be moved in either direction from said track; a conduit for conducting concrete from said container to said portions of the tunnel; a conduit-supporting member extending upwardly from said base; means on said member for mounting a portion of said conduit above said path; said conduit having a movable portion extending forwardly from said member and terminating in an intake end; means supported by said base operable for moving said movable portion of said conduit between a position for connection of said intake end with said container and a position above the path of movement of said container over said surface; said movable portion of said conduit having a flexible section adjacent said supporting member; and members embracing said flexible section connected with said portions of said conduit to prevent side sway of said movable portion of the conduit.

18. In apparatus for conducting concrete from a mobile container mounted on a track in a tunnel, to portions of the tunnel where the concrete is to be poured: a base structure adapted to be mounted on said track; said base structure providing a surface over which said container may be moved in either direction from said track; a conduit for conducting concrete from said container to said portions of the tunnel; a conduit-supporting member extending upwardly from said base; means vertically adjustably mounting a portion of said conduit upon said supporting member; said conduit having a vertically movable portion extending from said supporting member past one end of said base structure and terminating in an intake end; said extended portion of said conduit having a flexible section; said flexible section being joined to the portion of the conduit mounted on said supporting member; and means for moving said extended portion of said conduit between a position for connection of said intake end with said container and a position out of the path of movement of said container over said surface.

19. In apparatus for conducting concrete from a mobile container mounted on a track in a tunnel, to portions of the tunnel where the concrete is to be poured; a base structure adapted to be mounted on said track; said base structure providing a surface over which said container may be moved in either direction from said track; a conduit for conducting concrete from said container to said portions of the tunnel; a conduit-supporting member extending upwardly from said base; means on said member for mounting portions of said conduit above the path of movement of said container; said conduit having a movable portion extending forwardly from said member and terminating in an intake end; means supported by said base operable for moving said movable portion of said conduit between a position for connection of said intake end with said container and a position above said path of movement; a coupling unit on said intake end; and means for yieldably supporting said unit on said track.

20. In apparatus for conducting concrete from a mobile container mounted on a track in a tunnel, to portions of the tunnel where the concrete is to be poured: a base structure adapted to be mounted on said track; said base structure providing a surface over which said container may be moved in either direction from said track; a conduit for conducting concrete from said container to said portions of the tunnel; a conduit-supporting member extending upwardly from said base out of the path of movement of said container over said surface; means on said member for mounting a portion of said conduit above said path of movement; said conduit having a movable portion extending forwardly from said member and terminating in an intake end; means supported by said base operable for moving said movable portion of said conduit between a position for connection of said intake end with said container and a position above said path of movement; a coupling unit on said intake end; a track-contacting means; and spring means connecting said track-contacting means with said unit.

21. In apparatus for conducting concrete from a mobile container on a track: a conduit; a coupling unit on the intake end of said conduit for coupling the conduit to said container; means on said unit for yieldably supporting said unit upon said track; and means for moving said conduit and said coupling unit between a position where the unit is yieldably supported on said track and a position in which said conduit and unit are disposed out of the path of movement of said container on said track.

22. In apparatus for conducting concrete from a source of supply; a conduit; a coupling unit on said conduit for connecting the conduit with said source of supply; and yieldable means carried by said conduit for contacting a support to yieldably support said unit in position to be connected with said source; said last named means including springs connected with said conduit, and members carried by said spring for engaging said support.

23. In apparatus for conducting concrete from a source of supply; a conduit; a coupling unit on said conduit for connecting the conduit with said source of supply; yieldable means carried by said conduit for contacting a support to yieldably support said unit in position to be connected with said source; said last named means including springs connected with said conduit, and members carried by said spring for engaging said support; and means for varying the flexibility of said springs.

24. In apparatus for conducting concrete from a mobile container on a track; a conduit; a coupling unit on the intake end of said conduit for coupling the conduit to said container; resilient means on said unit for yieldably supporting said unit upon said track; and means for moving said coupling unit and the conduit between a position where the unit is yieldably supported on said track and a position in which said unit and said conduit are disposed above the path of movement of said container on said track; said resilient means including means adapted to rest upon said track and springs connecting said last named means with said unit.

25. In apparatus for conducting concrete from a mobile container on a track; a conduit; a coupling unit on the intake end of said conduit for coupling the conduit to said container; resilient means on said unit for yieldably supporting said unit upon said track; and means for moving said coupling unit and the conduit between a position where the unit is yieldably supported on said track and a position in which said unit and said conduit are disposed above the path of movement of said container on said track; said resilient means including a pair of shoes adapted to rest upon said track; springs connecting said shoes with said unit; and means adjustable on said unit for varying the flexibility of said springs.

26. In combination with a mobile container having a spring suspended running gear for resiliently supporting said container on a track: an outlet for said container; a conduit for conducting material from said container; a coupling unit on the intake end of said conduit adapted for connection with said outlet; resilient means carried by said conduit for yieldably supporting said unit on said track; and means for moving said conduit between a position in which said unit is yieldably supported on said track in position for connection with said outlet and a position out of the path of movement of said container on said track.

27. In combination with a mobile container having a spring suspended running gear for resiliently supporting said container on a track: said container having an outlet; a conduit for conducting material from said outlet; a coupling unit on the intake end of said conduit adapted for connection with said outlet; resilient means carried by said conduit for yieldably supporting said unit on said track; and means mounted on said track operable for moving said conduit between a position in which said unit is yieldably supported on said track in position for connection with said outlet and a position above the path of movement of said container on said track.

28. In combination with a mobile container having a spring suspended running gear for resiliently supporting said container on a track: an outlet for said container; a conduit for conducting material from said outlet; a coupling unit on the intake end of said conduit adapted for connection with said outlet; resilient means carried by said conduit for yieldably supporting said unit on said track; means on said track operable for supporting a portion of said conduit out of the path of movement of said container; and means for moving that portion of said conduit leading from said conduit supporting means to said coupling unit, between a position in which said unit is supported on said track for connection with said outlet and a position out of the path of movement of said container.

29. In combination with a mobile container operable on a track: a conduit for conducting material from said container; means for supporting a portion of the conduit above the path of movement of said container; means on said track providing a surface over which said container may be moved in either direction from said track; said conduit having a movable portion extending from said supporting means to the intake end of the conduit; and means on said supporting means connected with said movable portion of said conduit for moving said movable portion of said conduit between a position for connecting said intake end with said container and a position over said surface out of the path of movement of said container.

30. Apparatus for discharging material from a container movable in a path in a tunnel, including: a base frame providing a surface over which said container may be moved from said path; a pair of members mounted on said base frame for movement between positions extending upwardly from said base frame and a collapsed position; means connected with said frame for releasably holding said pair of members in said upwardly extended positions; a conduit for conducting material from said container; means on one of the members of said pair for supporting a portion of the conduit above the path of movement of said container over said surface; said conduit having a movable portion extending from said conduit supporting means to the intake end of the conduit; and means connected with the other member of said pair and said movable portion, for moving said movable portion between a position for connecting said intake end with said container and a position out of the path of movement of said container over said surface.

31. Apparatus for discharging material from a container movable in a path in a tunnel, including: a base frame providing a surface over which said container may be moved in either direction from said path; a conduit for discharging material from said container; said conduit including a stationary portion adapted to be supported above said surface out of the path of movement of said container; said conduit having a movable portion extending to the intake end of the conduit; an arch member pivoted on said frame; means on said arch member for supporting said stationary portion of said conduit; means for releasably holding said arch member in an elevated position; and means on said frame connected with said movable portion operable for moving said movable portion between a position disposing said intake end for connection with said container and an elevated position out of the path of movement of said container over said surface.

32. Apparatus for discharging material from a container movable in a path in a tunnel, including: a base frame providing a surface over which said container may be moved in either direction from said path; a pair of arch members mounted on said frame for movement between positions extending upwardly from said frame and collapsed positions; means for releasably supporting said arch members in upwardly extended positions; a conduit for discharging material from said container; means on one of said arch members for supporting a portion of said conduit above the path of movement of said container; said conduit having a movable portion extending from said one arch member through the other arch member and terminating at the intake end of the conduit; means connected with said other arch member and said movable portion between a lowered position for connecting said intake end with said container and a raised position above the path of movement of said container over said surface; said last named means including flexible elements connected with said other arch member; piston and cylinder assemblies mounted on said movable portion of said conduit connected with said flexible elements and operable for raising and lowering said flexible elements relative to said other arch member; and means on said movable portion of said conduit engaged with said flexible elements to support said movable portion of said conduit for movement between said lowered and raised positions thereof responsive to raising and lowering of said flexible elements.

33. Apparatus for discharging material from a container movable in a path in a tunnel, including: a base frame providing a surface on which said container may be moved in either direction from said path; a pair of arch members mounted on said frame for movement between positions extending upwardly therefrom and collapsed position; means for releasably supporting said arch members in said upwardly extended positions; said last named means being adjustable to vary the upward extent of said arch members relative to said frame means; said container being movable through said arch members; a conduit for conducting material from said container; means on one of said arch members for supporting a portion of said conduit above the path of movement of said container; said conduit having a vertically movable portion extending from said one arch member through the other arch member; and means on said frame connected with said other arch member operable for moving said movable portion between a position for connection thereof with said container and a position disposed above the path of movement of said container.

34. Apparatus for discharging material from a container movable on a track in a tunnel including: a base frame movable on said track providing a surface onto which said container may be moved from said track; an arch member pivoted at its ends adjacent one end of said frame; a pair of vertically adjustable members mounted adjacent the other end of said frame and connected to opposite side portions of said arch member for supporting the latter in an upwardly inclined position such that the container may pass therethrough; a second arch member pivoted at its ends to said one end of said frame;

members extending between and linking said arch members to support said second arch member in upright position; a conduit for discharging material from said container; means on the upper end of said one arch member for supporting a portion of said conduit above the path of movement of said container; said conduit having a vertically movable portion extending from said one arch member through said second arch member to the intake end of the conduit; a pair of cylinders mounted on said movable portion; pistons in said cylinders having piston rods extending therefrom; a pair of sprocket chains connected at their ends to said rods and the top of said second arch member respectively; and sprocket wheels on said movable portion of said conduit engaged with said chains to support said movable portion for movement between a position for connection of said intake end with said container and a position extending above the path of movement of said container.

35. Apparatus for discharging material from a container movable on a track in a tunnel including: a base frame movable on said track providing a surface over which said container may be moved from said track; an arch member pivoted at its ends adjacent one end of said frame; vertically adjustable members mounted adjacent the other end of said frame and connected to opposite side portions of said arch member for supporting the latter in an upwardly inclined position such that the container may pass therethrough; a second arch member pivoted at its ends to said frame; members extending

between and linking said arch members to support said second arch member in upright position; a conduit for discharging material from said container; means on the upper end of the first mentioned arch member for supporting a portion of said conduit above the path of movement of said container; said conduit having a movable section including the intake end of the conduit; a flexible conduit section joining said movable section with said portion of the conduit; hinge means connecting said portion of said conduit with said movable section; said hinge means including rigid members embracing said flexible section to restrain lateral movement thereof; said movable section extending through said second arch member; and means connected with said movable section and said second arch member operable for moving said movable section between a position for connecting said intake end with said container and a position above the path of movement of said container.

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