

Nov. 24, 1953

M. F. KEMPER

2,660,034

METHOD AND APPARATUS FOR PLACING FLUENT MATERIAL

Filed May 21, 1947

5 Sheets-Sheet 1

Fig. 1.

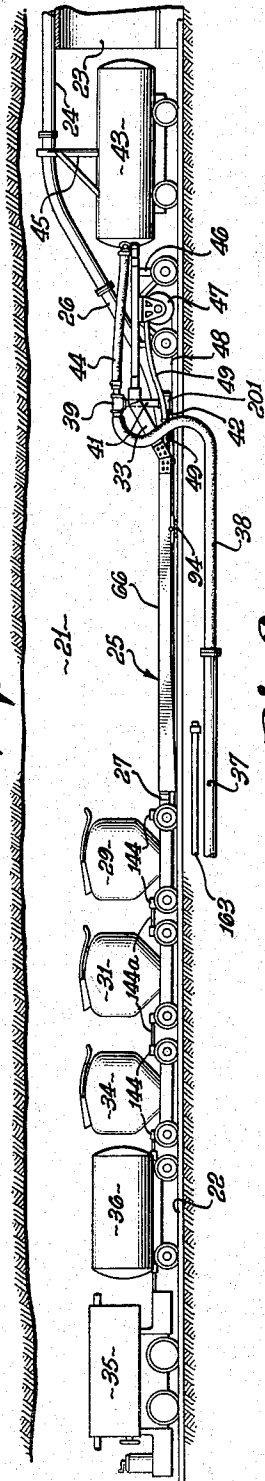


Fig. 2.

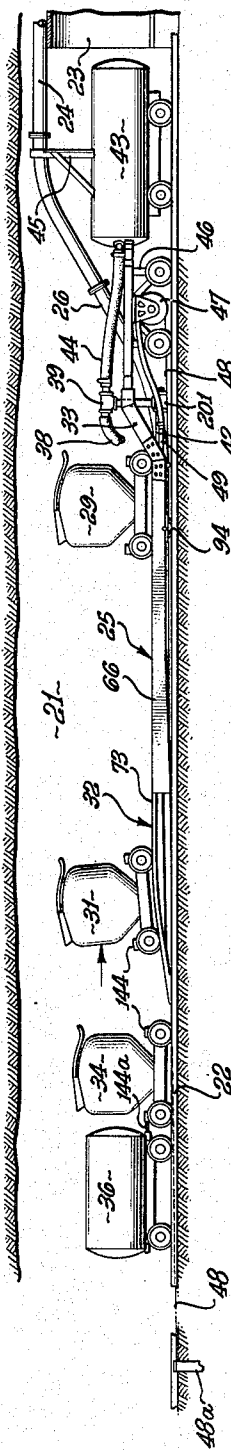
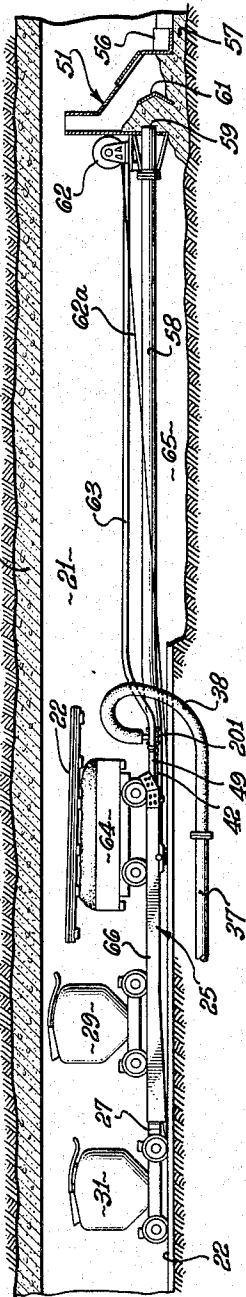


Fig. 3.



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Fig. 4.

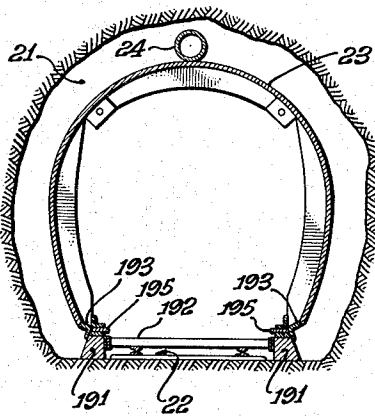
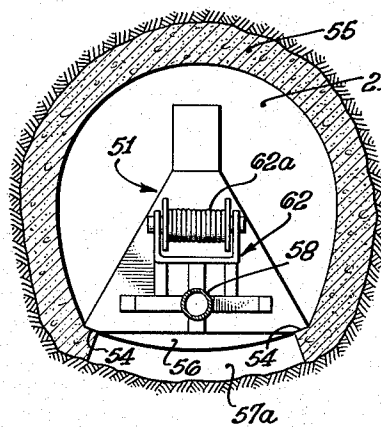
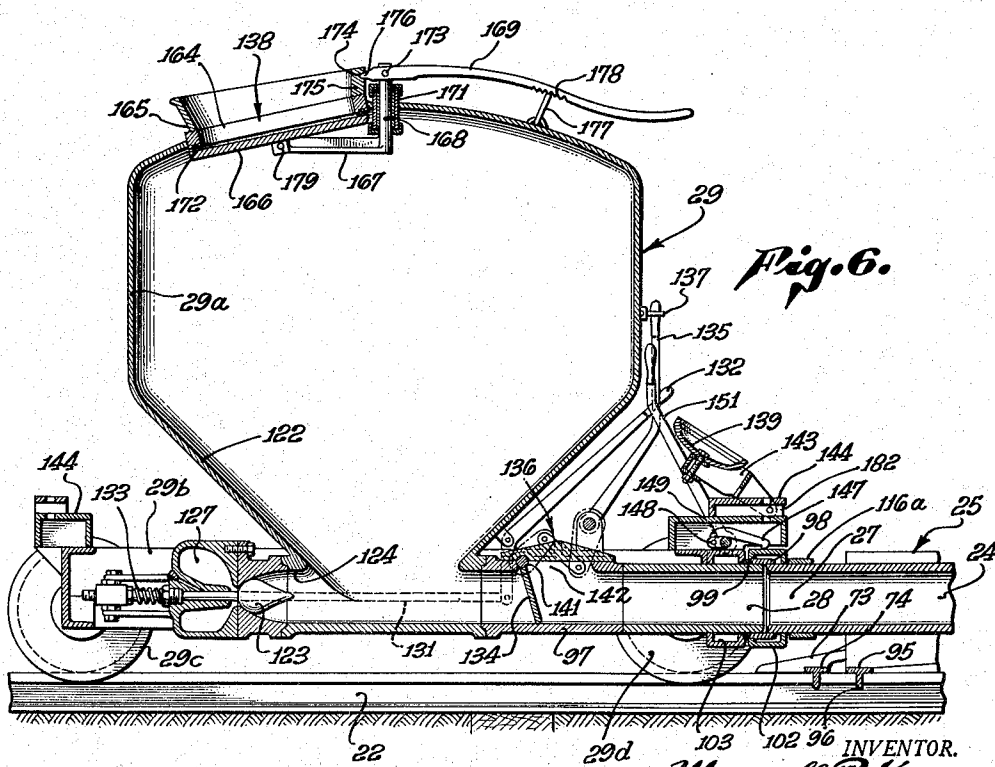


Fig. 5.



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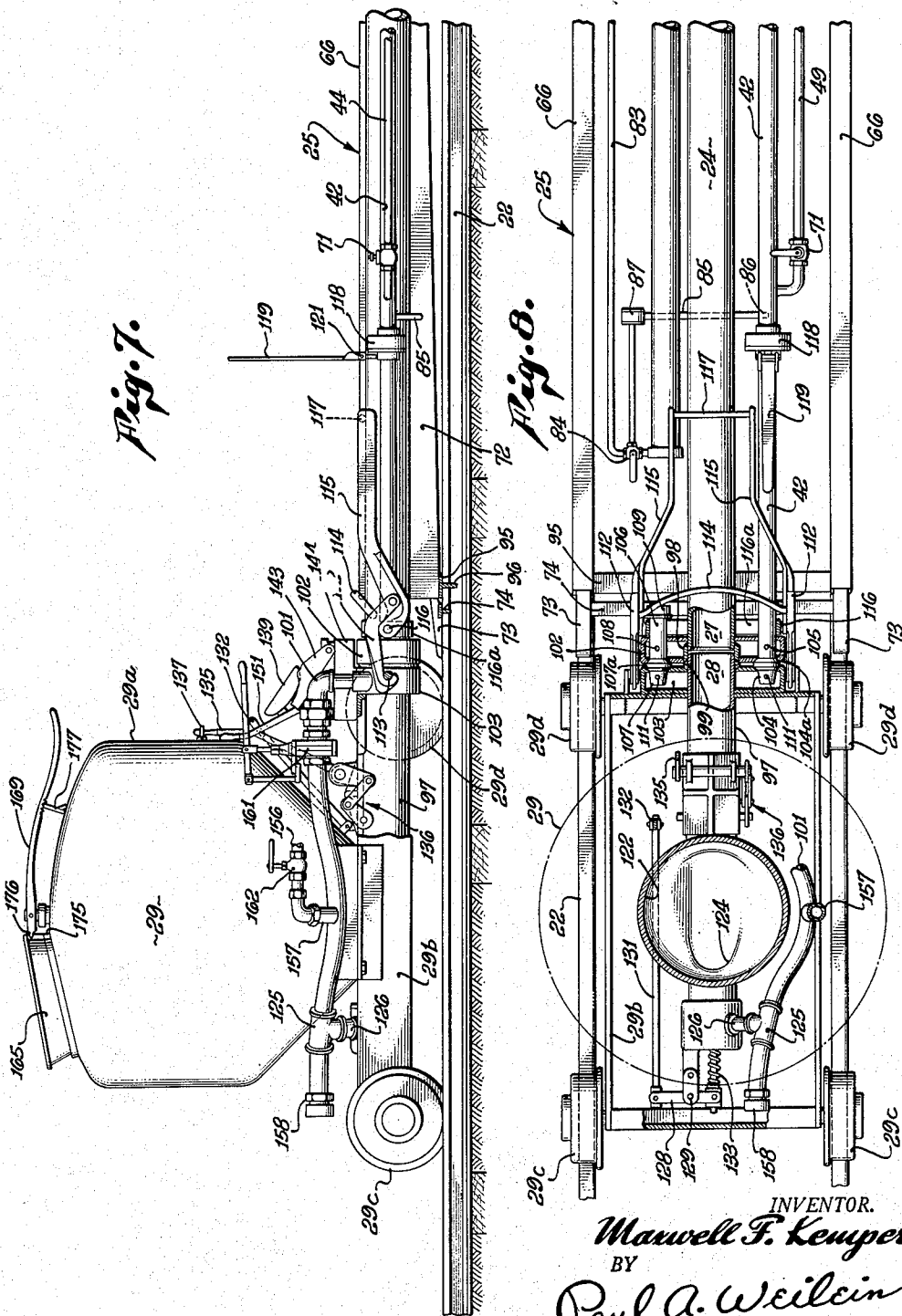
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METHOD AND APPARATUS FOR PLACING FLUENT MATERIAL

Filed May 21, 1947

5 Sheets-Sheet 3



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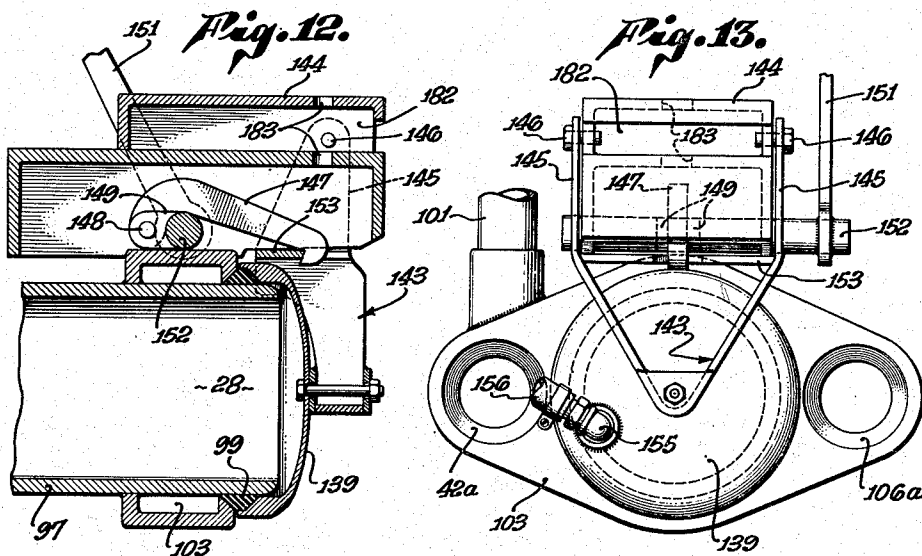
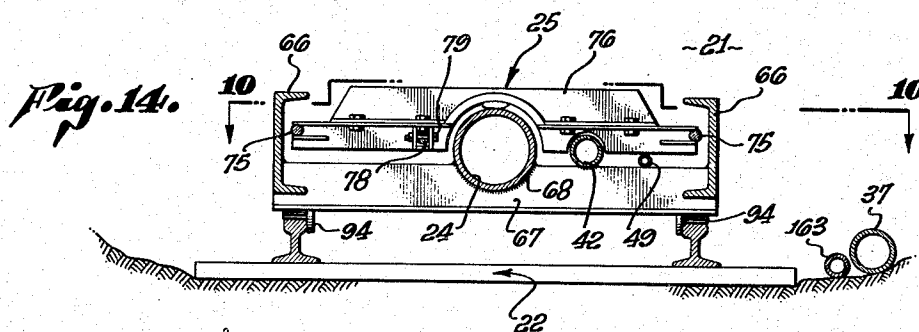
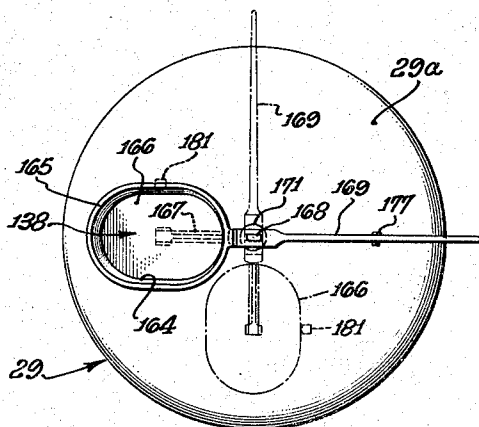
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METHOD AND APPARATUS FOR PLACING FLUENT MATERIAL

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UNITED STATES PATENT OFFICE

2,660,034

METHOD AND APPARATUS FOR PLACING
FLUENT MATERIAL

Maxwell F. Kemper, Los Angeles, Calif.

Application May 21, 1947, Serial No. 749,402

23 Claims. (Cl. 61—42)

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This invention relates to the lining of tunnels with concrete, and more particularly concerns an improved method and apparatus for the lining of small bore tunnels.

One method of lining tunnels is to load a number of cars with mixed concrete, form them into a train, and transport them into the tunnel where the lining operation is taking place. With this method only the most inward car of the train is readily accessible for the emptying of its contents into the lining form. After this car has been emptied it must be moved out of the way so that the next succeeding car can be emptied.

In lining tunnels of large bore, the problem of shunting the empty cars to render the loaded cars accessible is not serious. However, when the tunnel is of such small bore that the cars can not pass one another, the problem of disposing of the emptied cars becomes serious. One solution would be to take in and remove one car at a time. This is obviously uneconomical, largely because of the prolonged idle time, during which the car is in transit. This would be particularly objectionable in long tunnels.

Another solution would be to provide a series of turn-outs along the length of the tunnel, by use of which the arrangement of the cars in the train could be altered. This minimizes, but of course does not obviate, the shunting time required in transit between the working region and the nearest turn-out. Furthermore, it involves costly lateral excavation which ultimately must be filled in, inasmuch as it is undesirable after the tunnel is completed.

It is an object of this invention to provide an improved method and apparatus for the lining of small bore tunnels, which reduces to a large extent the idle time between unloading of the concrete laden cars of a train.

It is another object of this invention to provide a method and apparatus for lining small bore tunnels with concrete by the aid of which a train of concrete laden cars may be taken into a tunnel and the cars successively emptied without requiring rearrangement of the cars in the train as the emptying proceeds.

It is a further object of this invention to provide a method and apparatus for lining small bore tunnels with concrete which obviates the necessity for turn-outs, which have been required in the past to alter the order of concrete laden cars in a train.

It is a further object of this invention to provide a method and apparatus as outlined above which obviates the necessity of excavating special

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turn-out chambers in the tunnel, which must be refilled as the tunnel is lined.

It is another object to provide in the art of lining small bore tunnels, a method and apparatus by means of which a car for removing miscellaneous equipment, debris, and the like sometimes known as a "muck car," may be positioned contiguous to the working region in the tunnel, at the same time that cement laden cars are being emptied to form the tunnel lining.

It is a further object of this invention to provide in the art of lining small bore tunnels, a method whereby a train of concrete laden cars may be taken into the tunnel, the most inward of the cars emptied to form the tunnel lining then placed out of the way, and the succeeding cars may be emptied successively in a similar manner and placed out of the way. Following the emptying of all cars in the train, the cars may then be hauled out of the tunnel.

It is a further object to simplify the lining of small bore tunnels by the provision of a single region from which substantially all the lining operations may be controlled at will, thereby minimizing the amount of time-consuming movement from point to point, sometimes required of tunnel lining operators.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of one embodiment of the invention. For this purpose there is shown a form in the drawings accompanying and forming part of the present specification. This form 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.

The principles of the invention will now be explained in connection with that type of concrete lining process in which compressed air is applied to the concrete in a concrete laden car, forcing the concrete from the car into a tubular conduit, the discharge end of which is disposed within the tunnel lining form, so that the air flow causes the concrete to flow through the conduit and into the form. It is customary in such an operation to place a railed track on the floor of the tunnel and to transport the concrete laden cars into the tunnel over the track by means of a small locomotive, generally electrically powered.

In accordance with this invention, there is provided a long sled which is adapted to be pushed into the tunnel on the tracks. The sled

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is high enough to accommodate thereunder, down the center thereof, the concrete carrying conduit, one end of which is at the outer end of the sled, and the other end of which communicates with the lining space surrounding the tunnel form. The sled is provided at the top with a pair of rails of the same gauge as the track and adapted to accommodate the wheels of the concrete carrying cars. It thus forms in effect a super-track upon which emptied cars may be accommodated, away from the inlet of the concrete conduit, while succeeding cars are being emptied of their contents.

In the embodiment of the invention described herein, the inner end of the super-track or sled is provided with a pair of wheels, while the outer end is merely flanged and allowed to slide on the rails of the track. The over-all appearance of the structure is thus much like a sled, and this term will be used hereinafter when referring to it.

In order to elevate the cars from the track onto the sled, a ramp is provided, which is telescoped inwardly of the sled in order to allow the concrete laden cars to be moved into junction with the intake end of the concrete conduit, which, as stated hereinbefore, is positioned at the outer end of the sled. When the contents of the innermost car in the train have been discharged into the conduit, the car is withdrawn outwardly, away from the sled, and the telescoped ramp is projected from the sled to form an inclined trackway up which the empty car may be pushed onto the rails of the sled. The ramp is then retracted and the next succeeding car joined to the conduit intake.

The sled also serves the useful function of allowing a muck car to be positioned ahead of the concrete carrying cars during the concrete discharging operation. In this way, as debris, excavated material, and equipment, such as track and pipes, are dismantled for withdrawal from the tunnel, they may be placed directly on the muck car instead of being laboriously transported in the narrow tunnel space around the concrete carrying cars.

Referring now to the drawings:

Figure 1 is a longitudinal sectional view of a tunnel partly schematic, illustrating the equipment of the invention, located in the working section of the tunnel adjacent the end of the tunnel lining form;

Figure 2 is a view similar to Figure 1 illustrating the manner of disposing of empty cars;

Figure 3 is a view similar to Figure 1, illustrating the manner in which the floor of the tunnel is lined, and also showing the manner of use of the muck car;

Figure 4 is a cross section of the tunnel, showing the lining form in place ready for the reception of concrete;

Figure 5 is a view similar to Figure 4, but illustrating the means for forming the tunnel floor or invert;

Figure 6 is a longitudinal section of one of the concrete carrying cars, illustrated in Figure 1, showing the car connected to the material delivery line;

Figure 7 is an elevation illustrating the manner of coupling the car of Figure 6 to the delivery line;

Figure 8 is a plan view of the coupled car shown in Figure 7, certain portions thereof being broken away to more clearly illustrate the structure, the main air valve operating member being shown in its folded position;

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Figure 9 is a longitudinal section of the outer end portion of the sled, taken substantially as indicated by line 9—9 of Figure 10;

Figure 10 is a plan view of the outer end portion of the sled partly in section, taken substantially as indicated by line 10—10 of Figure 14;

Figure 11 is a view generally similar to Figure 9 showing the telescoping ramp of the sled in extended position;

Figure 12 is a detail vertical section showing the closure for the discharge opening of the car illustrated in Figure 6;

Figure 13 is an end elevation of the structure of Figure 12, as seen from the right;

Figure 14 is a cross section on an enlarged scale of the sled taken along line 14—14 of Figure 10; and

Figure 15 is a top plan of the body portion of the car shown in Figure 6, illustrating the closure for the filling opening.

Referring now to Figure 1, there is shown a portion of a tunnel 21, along the floor of which extends a narrow gauge, two rail track 22. At the inner end of the tunnel there is a lining form 23 in the form of an arch extending upwardly from each side of the tunnel floor and beneath the roof (Figure 4). For the purpose of filling the horseshoe-shaped space thus formed, with concrete, there is provided a conduit 24 or material conducting line extending into the space above the arch and resting on top of form 23. This conduit 24 may be of rigid material, such for example as steel pipe. The outer end portion of conduit 24 is directed downwardly and is secured between the rails of a sled 25 riding on the track 22. A short section 26, Figures 1 and 2, of the conduit 24, immediately forward of the sled 25 is made of flexible material, to allow of self alignment of the inner end of conduit 24 as it rests on the top of the form 23. Further, that portion of the conduit 24 adapted to rest on the form 23, if desired may be provided with supporting wheels (not shown) at suitable intervals for engaging the top of the form and facilitating movement of the conduit thereon.

Conduit 24 extends the full length of sled 25 so that the intake end 27 is positioned adjacent the outer end of the sled and is thus in position to be connected with the discharge opening 28 of the most inwardly disposed or first concrete carrying car 29. Following connection of the car 29 to the conduit 24, as will be described hereinafter, the concrete contained therein is forced therefrom by compressed air and into conduit 24, emerging from the discharge end of the conduit into the arched lining space between the form 23 and the wall of the tunnel 21. In general, the character of this operation is similar to that disclosed in my U. S. Patent 2,313,826, and reference thereto is made for further understanding of the process thus far described.

Following the emptying of the first car 29, it is necessary to get it out of the way in order that the next succeeding car, indicated by the numeral 31, may be connected with conduit 24. It is at this point in the process that the sled 25 is utilized. Sled 25 is provided with an extensible ramp 32 which is normally retracted within the framework of the sled, but which may be extended optionally to the position shown in Figure 2 to form an inclined track over which emptied cars such as 29, 31, may be moved up onto sled 25, thereby making room in front of intake 27 for the next succeeding car.

As illustrated in Figure 2, the car 29 has been emptied and moved onto the sled 25 being stopped at the inner end thereof by abutting against an upwardly extending angular member 33, detachably secured on the inner end of sled 25. Car 31 has likewise been emptied of concrete, and is in process of being rolled up ramp 32 to rest on sled 25, where it will remain with the car 29 until the train is re-formed and withdrawn from the tunnel. With car 31 out of the way, the ramp 32 is then retracted within the sled 25, and the next car 34 is brought up against the outer end of sled 25 to have its discharge opening 28 connected with the intake end 27 of conduit 24.

As will be explained hereinafter, each of the concrete carrying cars 29, 31 and 34 is so designed that compressed air may be injected into it during transit, for the purpose of agitating the concrete to prevent separation or setting of the constituents during a long transit period from the mouth of the tunnel to the working region. For this purpose the train, which is shown as powered by a locomotive 35, includes a tank car 36 carrying compressed air, and suitable connections for injecting the air into the cars.

As a rule, the compressors which supply air to discharge concrete from the cars into the conduit 24 are located at the mouth of the tunnel. The compressed air is conveyed to the operating region of the tunnel by means of a pipe 37, the inner end portion of which is made in the form of a flexible hose 38 to allow movement of the sled 25 and other equipment. The hose 38 is coupled to a pipe T 39 mounted on the member 33 of the sled 25. Compressed air passes from the pipe 37 through the hose 38 and T 39 into a vertically disposed pipe 41, through T 201, and thence into pipe 42 secured to the framework of the sled 25 between the side members thereof and extending generally parallel to conduit 24. The outer end of pipe 42 is adapted to communicate upon appropriate connection, with air conduits provided on each of the cars 29, 31, 34, where it serves to discharge concrete from the car to which it is connected into the material discharge line 24.

To compensate for the pressure drop in the pipe 37, there is shown, as provided in the inner end of the tunnel immediately adjacent form 23, a wheeled storage tank 43 connected to the air line 38 and 41-42, at the T 39 by means of a flexible hose 44. This tank 43 serves to stabilize the operating air pressure applied to the concrete carrying cars, and may serve additionally to provide a support for conduit 24, adjacent the end of the form 23. For this latter purpose an upright standard 45 is mounted atop tank 43, having a saddle at its upper end for receiving the conduit 24. Means such as a jack (not shown) may be interposed between the saddle and the lower portion of standard 45 for adjustably positioning the end of pipe 24 with respect to the roof of the lining form 23.

In practice, the form 23, although in several sections, is generally of considerable length, so that as concrete is discharged from conduit 24 and fills the lining space, it becomes necessary to gradually withdraw the conduit. For this purpose winch means 47 are mounted on a small car 46 interposed between the sled 25 and the tank 43, comprising a winding drum arranged to be operated by compressed air, such winches being well known in the mining art. A cable 48 extends outwardly of the tunnel from the drum 47 between the rails of track 22 for a distance sufficient

to allow full withdrawal of conduit 24 from above the form 23. The outer end of cable 48 is anchored firmly, as by being secured to a post 48-a (Figure 2) embedded in the floor of the tunnel excavation.

Compressed air for operating the winch 47 is supplied through a pipe 49 connected, within sled 25, to the main air supply pipe 42, as will be explained hereinafter. When air is supplied to the winch 47, the winding drum is driven in a direction to reel in the cable 48, thus causing the entire assembly, including conduit 24, tank 43 and sled 25, to move outwardly of the tunnel, away from form 23, thereby withdrawing the discharge end of conduit 24 to a position nearer the outer end of the lining space above form 23. Although this operation is generally performed when there is no concrete-carrying train present, it is customary to provide sufficient power in the winch 47 so that if necessary, such a train, including locomotive 35 and the concrete carrying cars 29, 31, 34 etc., may be moved outwardly along track 22 if required.

Lining of the tunnel in the manner just disclosed is accomplished without disturbing in any way the track 22 or the pipe 37. Following such operation, the storage tank 43 and the winch car 46 are taken from the tunnel and replaced by a floor lining apparatus commonly known as a stacker and denoted by the numeral 51 in Figure 3. As shown in Figure 5, stacker 51 spans the floor of the tunnel, the edges thereof sliding on parallel trackways 54 formed at the bottom of the previously constructed concrete arch or lining 55. Stacker 51 has on its bottom edge, facing into the tunnel, a screed 56 which serves to feed concrete onto the floor of the tunnel and to appropriately shape the upper surface of the concrete, thereby forming what is known as the tunnel invert 57. In Figure 5, the space to be occupied by the invert is indicated by 57-a.

Stacker 51 is fed concrete from the concrete carrying cars 29, 31 etc., in a manner similar to that explained hereinbefore in connection with lining of the arch. In lining the invert however, the overhead portion of concrete carrying conduit 24 including the hose 26 is disconnected at the inner end of the sled 25 and removed, being replaced by a rigid, horizontal conduit 58, the discharge end 59 of which feeds directly into the stacker 51. The impact of the air-driven concrete mass is absorbed by a baffle 61 mounted in front of the discharge end 59 of the conduit 58. As the forming of the invert 57 proceeds, the stacker 51 is steadily withdrawn from the tunnel along the trackways 54 by means of an air operated winch 62 mounted on the stacker and fed by an air line 63. The winch 62 functions in substantially the same manner as winch 47, and includes a cable 62-a suitably anchored at a point remote from the stacker and wound on the winch drum. As the winch 62 is operated to wind in the cable 62-a, the stacker 51, the sled 25, together with any cars thereon, as well as concrete laden cars connected to the sled are moved outwardly of the tunnel 21 along the track 22.

As stacker 51 is steadily withdrawn from the tunnel, thereby forming the invert 57, it is necessary to remove the sections of the track 22 and of the pipe 37 immediately in advance of the moving stacker. In addition, debris and mud, known generally as muck, must be excavated from the floor of the tunnel in order to provide a proper foundation for invert 57.

To this end there is provided a muck car 64

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which is placed on the inward end of sled 25, as shown in Figure 3, and which is therefore in the most convenient position to receive the track, pipe, and muck as they are removed from the floor of the tunnel in advance of the stacker 51. It will be readily seen by reference to Figure 3 that the provision of sled 25 makes possible the positioning of the muck car 64 directly adjacent the working area 65 where the muck and materials no longer required must be removed from the tunnel floor. At the same time, a concrete carrying car, such for example as the car marked 31, may be discharging concrete through the portion of conduit 24 remaining on the sled and into the conduit 53 and stacker 51. A previously emptied car 29 is shown as also carried by the sled 25.

Conduit 53 is preferably made of steel and is of sufficient strength so that the withdrawal of stacker 51 by the winch 52 pushes the sled 25, car 31, etc., along the track 22 in advance of the stacker.

It will be seen that the method above described has the advantage of leaving the lined tunnel clean and free of debris, inasmuch as the arch is formed before the invert, thereby obviating the dropping of debris and grout from the arch were the steps to be reversed. This method has the further advantage of requiring only a single laying and dismantling of track 22 and pipe 37, there being no necessity for elevating the track above the floor of the tunnel and forming thereunder the invert, as is the case with certain methods of tunnel lining.

Details of the method and apparatus hereinbefore generally described will now be described with reference to the remaining figures in the drawings. The sled 25 will first be described, with particular reference to Figures 9, 10, 11 and 14. Figures 9 and 10 show the outermost end portion of the sled with the ramp 32 retracted. The sled 25 comprises a pair of parallel channel members 66, the top surfaces of which form the super-track onto which the cars 29, 31, etc., are rolled after discharging their load of concrete. Channel members 66 are connected at spaced intervals by cross members 67, thus forming the general framework of the sled. Arcuate seats 68 are provided in the upper edges of each of the cross members 67 for seating of the outer end portion of the concrete carrying conduit 29, which is secured as by welding to the several seats. In a similar manner, the main compressed air pipe 42 is supported on the top of the cross members 67, as is the winch air pipe 49. Pipe 49 is joined to supply pipe 42 at the juncture point 69, and is provided with a manually operable valve 71, by means of which the operation of the winch 47 and the withdrawal of the conduit 24 from the form 23 may be controlled through operation of the reel 47.

A part of the length of each channel member 66 is closed by plate 72, thereby forming guides for receiving the reciprocable rails 73 of the ramp 32. As shown in Figure 9, the outer ends of the rails 73 are beveled to provide a smooth, inclined junction with the respective rails of the track 22, and are slidable on the rails 22, being maintained in proper lateral position by the connecting T-shaped cross member 74, the vertical leg of which depends below the top surface of the track and engages the inside edges of the track rails. The rails 73 may be slightly convex to provide a smooth transfer for the wheels

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of the cars from the ramp to the channel members 66.

To the inner ends of the two ramp rails 73 are pivoted actuating rods 75 which extend along the inside of channel members 66 and are connected at their inner ends by a yoke 76. Yoke 76 spans the several pipes 24, 42 and 49, and slides along the top of the conduit 24 as the ramp 32 is reciprocated.

Adjacent pipe 24 are mounted compressed air motive means, including an air cylinder 77 with a packed piston therein, which serve to reciprocate the ramp 32. Piston rod 78 is connected to the piston in the cylinder 77 and is connected at its outer end to the yoke 76 by means of a pin 79 (Figure 14). The piston and piston rod 78 may be operated to move the ramp 32 in either direction by admitting air under pressure from the pipe 42 to the appropriate end of the cylinder 77, and at the same time opening the opposite end of the cylinder 77 to exhaust. For this purpose the opposite ends of the cylinder 77 are connected by a pipe 83, having a conventional manually operated 4-way valve 84 interposed therein. The inlet of valve 84 is connected by means of a pipe 85 to the main air supply pipe 42 at 86, the outlet opening to the atmosphere.

An air gauge 87 may be installed in pipe 85 to conveniently indicate at all times the air pressure in the main air supply pipe 42.

In order to insure a smooth joint between the rear ends of the rails 73 and the corresponding outer ends of the channel members 66 forming the supertrack of the sled 25, means are provided for slightly elevating the inner ends of the sled rails 73 as the ramp 32 reaches its extreme extended position. This means assumes the form of a pair of foot members 88, pivoted respectively on the inner ends of the rails 73. The foot members 88 extend outwardly from their pivotal mounting, with their ends sliding on inclined plates 89 secured as by welding, below the channel members 66. At the outer ends of the plates 89 are welded stop members 91 against which the foot members 88 abut as the ramp 32 approaches its fully extended position. Further outward movement of the rails 73 causes the foot members 88 to swing upwardly about the stops 91, lifting the inner ends of the rails 73 and wedging them against the underside of the upper flange of the channel members 66, as shown in Figure 11. In this manner, a firm and smooth joint is formed at 92 between the extended ramp rails 73 and the sled rails 66, facilitating movement of the cars from the ramp 32 to the sled 25.

It will be noted that the foot members 88 are provided with toe plates 93, which are the actual engaging members abutting stop 91. As the foot members 88 swing upwardly, the weight of the rear end of the ramp 32 is shifted from the toe plates 93 and is assumed directly by the foot members 88 resting on top of the stop members 91. Thus, the only function which the toe plates 93 fulfill is that of sliding on the plates 89 and of effecting the swinging of foot members 88 by abutting the stop members 91.

At its inner end, the sled 25 is provided with a pair of wheels 94. At the outer end, however, the sled 25 merely slides along the track 22 on a transverse cross member 95 secured to the bottom of the sled between the channel members 66. To prevent lateral displacement of the sled 25, the member 95 is provided with a pendant flange 96 extending between the inner edges of the rails 73 of the track 22.

In order to connect the cement-carrying car which is to be discharged, to the conduit 24, as well as to connect the main air pipe 42 to such car, means are provided on the end of the sled 25 for simultaneously coupling the respective cement and air conduits of the sled to those of the car. Such means will now be described with particular reference to Figures 6, 7 and 8, showing one of the cement carrying cars, as for example car 29, coupled to the sled 25.

As explained hereinbefore, the intake end 27 of conduit 24 is positioned adjacent the outer end of the sled 25. In this position the intake 27 is adapted to mate with the end 28 of the discharge conduit 97 of the car 29. The mating connection between conduits comprises a ring 98 welded around the outside of the intake 27 to form a female coupling for receiving the male coupling represented by the end 28 of the conduit 97. A resilient gasket 99 is secured to conduit 97, against which ring 98 is adapted to abut to provide a fluid tight fit.

Each of the cars, as 29, is provided with an air pipe 101 which is adapted to receive air from the main air line 42 when the car is connected in discharge relation with the sled 25. This coupling will now be described.

Functionally the only problem presented in effecting the air coupling is the simple one of providing an air tight joint between the pipe 42 and the pipe 101 on the car 29. However, in view of the central positioning of the juncture between the concrete conduits 24 and 97, a single coupling between air pipes 42 and 101 would, of necessity, render the overall connection unsymmetrical, and subject to leakage brought about by strains due to unbalanced pressures. The advantage of structural strength achieved through symmetry is particularly noticeable when it is necessary to move the coupled sled and car together over the track 22, as when the winch 47 is operated during the placing of the concrete.

To effect symmetrical coupling between the air lines 42 and 101, the sled 25 and each of the cars, for example car 29, are provided at their ends which are to be coupled, with transverse air chambers 102 and 103 respectively, which surround the ends of their respective concrete conduits 24 and 97. The pipe 42 extends completely through the sled air chamber 102 at one side thereof and terminates in a male coupling member 104. That portion of pipe 42 within chamber 102 is provided with a plurality of perforations 105 by means of which air from pipe 42 may enter freely the chamber 102. On the opposite side of chamber 102 there is a pipe 106 of the same size as pipe 42, which likewise extends through chamber 102, with its outwardly projecting end terminating in a male coupling member 107. Passage of air from chamber 102 into stub pipe 106 is effectuated by the provision of a plurality of perforations 108 in that portion of the pipe 106 which lies within the chamber 102. The rear end of the pipe 106 is closed by a cap 109.

The forward ends of the two air pipes 42 and 106, constituting the male coupling members 104 and 107, respectively, are adapted to fit into openings in the vertical outer wall of the air chamber 103. The air pipe 101 communicates with chamber 103 as shown in Figures 7 and 13. It will thus be seen that through the use of the air chambers 102 and 103, and the provision of the stub air pipe 106, a fully symmetrical coupling between the sled 25 and the car 29 is provided. To prevent escape of air about the pipes 42 and

106 when the chambers are in coupled relation, resilient sealing rings 104-a and 107-a are provided respectively about the pipes 42 and 106 so as to be compressed between the adjacent walls of the chambers 102 and 103 when in coupled relation (see Figures 8 and 10). The holes in the chamber walls for accommodating the pipes may be countersunk, as indicated for example at 42-a and 106-a in Figure 13, to improve the sealing effect of these rings, if desired. If desired, the male coupling members 104 and 107 of the air pipes 42 and 106, respectively, may be provided with lateral apertures 111 to aid the flow of air from the pipes into the chamber 103. The air coupling assembly, including chambers 102 and 103, and the coupling members 104 and 107 is so positioned with respect to the central, concrete-carrying conduits 24 and 97 and the respective juncture members 27 and 28, that concrete coupling and air coupling are effected simultaneously as the car 29 is brought against the end of the sled 25.

To secure the car 29 and the sled 25 together during the discharge of concrete, the sled is provided with a pair of hooks 112 engageable with horizontal pins or bosses 113 extending outwardly from the opposite sides of the air chamber 103. Hooks 112 are braced by the transverse cross member 114 and are pivotally mounted at their ends on lever arms 115, which are in turn pivotally mounted at 116 on a reinforcing band 116-a encircling conduit 24, and air pipes 42 and 106, and appropriately secured thereto. As the lever arms 115 are raised by means of a transverse handle 117, the hooks 112 are moved outwardly to hook over the studs 113; upon lowering of the lever arms 115, the hooks 112 are drawn inwardly, thereby drawing the car 29 firmly against sled 25 and sealing the air and cement connections described above. As seen in Figure 7, lever arms 115 are retained in position by being pivoted slightly past the center point to effect over-center locking in the well known manner.

Application of compressed air from pipe 42 to the air conduit 101 of the car 29 is controlled by a manually operable valve 118 inserted in the pipe 42 near the outer end of sled 25. Actuation of the valve 118 which is of a type commercially available, is achieved by rotation of its operating handle 119 about an axis parallel to the length of sled 25. Handle 119 is hinged at 121 in order that it may be swung downwardly into a horizontal plane to permit passage of the cars 29, 31, etc., as they are moved onto or off the sled 25.

The construction and operation of a typical concrete carrying car, such as the one indicated by 29, will now be described, with particular reference to Figures 6, 7 and 8.

The body of the car 29 for carrying the concrete is in the form of a sealed container 29-a adapted to withstand the pressure of the air which serves to force the concrete from the container into the conduit 24. This container 29-a is shown as mounted on a rectangular frame 29-b, which may be conveniently formed of structural steel and is arranged to be supported on the track 22 by pairs of axially aligned wheels 29-c and 29-d rotatably mounted on opposite sides of the frame 29-b adjacent the opposite ends thereof. The general configuration and use of this type of pressure vessel is illustrated and described in my prior Patent 2,313,826, and reference thereto is made for further details.

A conical hopper portion 122 of the container 29-a opens downwardly into the concrete dis-

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charge conduit 97. The rear of the conduit 97 terminates in an air control valve 123 disposed at the edge of the opening 124 in the lower end of the conical hopper 122. The construction and operation of valve 123 is similar to that disclosed in my prior Patent 2,344,703, and reference thereto is made for a full understanding of its function and mode of operation. It will suffice here to refer to Figure 8, which shows the air pipe 101 connected, as by a T 125, with the valve inlet 126. Valve inlet 126 communicates with the intake chamber 127 of the valve 123 (Figure 6), from which point, by opening of the valve 123, air under pressure may be fed into the end of the conduit 97, into which concrete passes by gravity from the hopper 122 of the container 29-a.

Valve 123 is operated by means of a horizontal lever 128 pivoted at 129 and connected to a longitudinally reciprocable rod 131, which in turn is pivotally connected to a hand lever 132, which thus serves to open and close valve 123 as desired. Valve 123 is normally maintained closed by a helical spring 133 surrounding the valve stem, as shown in Figure 6. Upon manual actuation of lever 132 to open valve 123, air flows from the main air pipe 42, through the coupling means including the air chambers 102 and 103, into pipe 101, and through valve 123. It forces concrete, dropping downward in the hopper 122, outwardly of the conduit 97 and into the material discharge line or conduit 24. This general mode of operation is similar to that disclosed in my aforementioned Patent 2,313,826.

During transit of the cars, such as 29, 31, 34 into the tunnel 21, the conduit 97 is closed by a flapper valve 134, which may be opened and closed by means of a hand lever 135 connected to the valve member 134 by a linkage 136. Lever 135 may be secured in its upward position, to maintain valve 134 closed, by means of a link 137 pivoted to the outer wall of the container 29-a, which may be slipped over the end of the lever 135.

When the transit time between the loading of the mixed concrete into the cars and the emptying thereof within the tunnel 21 is of extended duration, the concrete may acquire an objectionable set in the conduit 97 and in the bottom part of the hopper 122. To prevent this setting of the concrete, as well as to prevent separation of the solid constituents, means are provided for agitating the contents of the container 29-a through the use of compressed air. For this purpose, the discharge opening 28 is closed, and valve 123 is slightly opened to allow compressed air to flow into the rear of the conduit 97, thence upwardly into the container 29-a and through the concrete.

To achieve such agitation of the concrete, two especial features are provided on the container 29-a. First, the cover 138, provided for the loading aperture, is designed so that it may be opened slightly to allow escape of the agitating air, yet still prevent expulsion of the concrete as the air is forced upwardly therethrough. The design of the cover, or closure means, 138 will be described more particularly hereinafter. It forms the subject matter of my U. S. Letters Patent No. 2,565,029, issued August 21, 1951.

The second feature is a cap 139, for supplementing the valve 134 and sealing the discharge opening 28 of the conduit 97. This cap 139 is illustrated generally in Figure 6 and shown more particularly in Figures 12 and 13. Cap 139 serves to insure tight closing of conduit 97, supplementing the valve 134 which is generally not

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constructed to seal against leakage of grout; and also permits injection of a counter-flow of agitating air through the provision therein of an opening through which air under pressure may be admitted to the discharge end 28 of the conduit 97 simultaneously with the admission of air through valve 123. During the agitating process, valve 134 is maintained open, being hinged at 141 to swing into a recess 142 (Fig. 6) formed in the upper wall of the conduit 97. When air is thus forced into the hopper 122 from both the normal inlet 124 and the normal outlet 28, thorough agitation of the concrete is effected, thereby completely obviating the chance formation of a plug of concrete in the conduit 97 which might prevent normal discharge of concrete from the conduit.

Referring particularly to Figures 12 and 13, the cap 139 is shown hinged, by means of a bifurcated member 143, to the conventional coupling member 144 provided on the car. The arms 145 of the member 143 are hinged to the car coupler 144 by means of bolts 146. The cap 139 is normally swung back, out of the way, as shown in Figure 6; when occasion arises it may be swung downwardly to cover the discharge opening 28 of the conduit 97, as shown in Figures 12 and 13.

The cap 139 is adapted to be secured in closed position by means of a hook 147 pivoted at 148 to a pair of short links 149 secured to a shaft 152 rotatably supported by the car coupler 144. An operating handle 151 is fixed to the shaft 152. By reference to Figures 6 and 12, it will be readily seen that clockwise movement of the handle 151 and shaft 152 will serve to cause hook 147 to engage the lip of a cross member 153 secured between the arms 145; thereafter reverse movement of the handle 151 causes hook 147 to draw cap 139 securely into position against the ring gasket 99 mounted around the edge of the discharge end 28 of the conduit 97. Cap 139 is maintained closed by over-centering the short link 149, as shown in Figure 12.

In order to provide for the introduction of air into the discharge end 28 of the conduit 97, the cap 139 is provided with an aperture into which is fitted a pipe joint 155, connected by a flexible hose 156 to a nipple 157 opening into the air pipe 101 (Figure 7).

It will be understood that introduction of agitating air is not required when the car 29 is coupled to the sled 25, but instead, to be effective, must be accomplished prior to the time that the car is ready for emptying into the conduit 24. Thus, air for agitation is not introduced through the normal air inlet chamber 103, but is introduced through a special fitting 158 at the rear of the car 29, which joins the T-junction 125 in the air pipe 101. During agitation, the air pipe 101 must be isolated from the intake chamber 103; otherwise the air would simply escape through the openings in the chamber. To prevent such venting, a manually actuatable valve 161 is provided in the pipe 101 between the chamber 103 and the T 157. Another air valve 162, located at the end of the hose 156, is normally maintained closed, being opened only for the special step of introducing agitating air into the car 29 through the discharge opening 28.

In operation, an air line is attached to the fitting 158, and cap 139 is swung down and secured over the opening 28 by means of hook 147. Air then flows through two paths, the first being from fitting 158, through the valve 123, into the hopper 122 and upwardly through the con-

crete mixture. The second path for the air is from fitting 155, through pipe 101, to joint 157, through hose 156, and into the discharge opening 20 of conduit 97 through cap 139. Air is thus injected into the bottom of hopper 122 from both ends of conduit 97, thereby completely obviating the formation of plugs of concrete which might otherwise block the normal discharge of concrete at the desired time.

The foregoing described agitating feature, in which air is injected into the hopper 122 simultaneously from each side thereof forms the subject matter of my U. S. Letters Patent No. 2,534,270, issued December 19, 1950.

On very long hauls it may be advisable to effect concrete agitation during the actual transit of the concrete carrying train. For this purpose, the auxiliary air tank 36 shown in Figure 1 may form a part of the train, thus providing during transit a source of compressed air which may be connected to the fitting 158 at the rear of each of the cars as 29, 31 and 34.

It may also be advisable in certain cases to introduce additional water into the concrete mixture before its discharge into the conduit 24; and to this end the water pipe 163 which is customarily laid during the excavation of the tunnel 21 is allowed to remain during the lining operation, to provide a source of water in the working region of the tunnel.

The specially designed closure means 138, which facilitates the agitating operation hereinbefore described, will now be described with reference to Figures 6 and 15. As shown in Figure 6, the container 29-a of car 29 is provided with a loading aperture 164 through which concrete may be poured into the car. A frame 165 serves to define the aperture 164 and extends into the container 29-a a short distance for supporting a sealing gasket 172. Beneath the opening 164, there is provided a closure plate 166 mounted on the end of an arm 167, which is shown as formed integrally with a vertical, rotatable shaft 168 suitably journaled in the top of the container 29-a. A horizontally extending handle 169, mounted on the upper end of the shaft 168, provides a means for rotating the shaft and thus swinging the arm 167 and the plate 166 away from the opening 164, to the position shown in dotted lines in Figure 15. Seating of the closure plate 166 against the under rim of the frame 165 is effected by mounting the shaft 168 in its supporting bushing 171 so as to permit axial movement thereof. Thus, after plate 166 has been swung into position directly under the opening 164, upward sliding of shaft 168 serves to force it against the gasket 172, thus sealing the opening.

Raising of shaft 168 is conveniently effected by pivotally connecting arm 169 to shaft 168, as shown at 173, and providing a fulcrum about which the pivot point 173 may be raised by vertical movement of the outer end of the arm 169. The fulcrum is formed by a horizontal groove 174 formed along the outside of the adjacent portion of the frame 165, which may be suitably reinforced as by welding a relatively thick metal block 175 thereto.

As arm 169 is swung horizontally to bring closure plate 166 into registry with opening 164, a nose 176 formed on the end of the arm 169 enters the groove 174. With the closure plate 166 properly positioned, the outer end of the arm 169 is then raised, drawing shaft 168 and closure plate 166 upwardly until proper sealing of the plate 166 is attained against gasket 172. Arm

169 may be maintained in position by a small brace member 177 hinged to the top of container 29-a and engageable in one of the notches 178 formed on the underside of the arm 169.

To insure proper seating of the closure plate 166 against the gasket 172, the arm 169 is attached to the plate 166 by means of a loosely fitted pin 179, thereby allowing limited universal movement of the plate 166 with respect to the arm. The swinging of plate 166 is confined to about a 90° angle, as shown in Figure 15, by the provision of pendant stops 181 on the underside of the top wall of the container 29-a.

By dropping the brace 177, thereby allowing shaft 168 to drop to its lower position, the closure plate 166 may be moved slightly downwardly from the gasket 172. This provides an annular space permitting escape of agitating air, while still retaining closure plate 166 over the face of the opening 164 to prevent any substantial expulsion of concrete.

Each of the cars in the train, including the auxiliary tank car 36, is provided with a coupler 144 similar to the coupler shown in Figures 12 and 13. The coupler 144 has an outwardly facing slot 182, the top and bottom walls being apertured at 183 for the reception of a suitable coupling pin (not shown) which engages a coupling bar or link 144-a joining adjacent cars (Figures 1 and 2). A generally similar coupling arrangement is provided between the sled 25 and the winch car 46, and between the winch car 46 and the storage tank car 43.

The method of using the apparatus will now be explained.

Following excavation of the tunnel 21, during which the track 22 is customarily laid, a given length of lining form 23 is erected. For this purpose, timbers 191 are placed along each side of the track 22. Bracing between the timbers 191 is provided at intervals by transverse timbers 192 resting atop the track 22 and extending between the inner sides of the timbers 191. The bottom edges 193 of the form 23 are then secured along the top edges of the timbers 191, adjustable positioning thereof being achieved by the use of wedge members 195 in any suitable, known manner.

The concrete conveying conduit 24 is then advanced into the arch-shaped lining space, being slid along the top of form 23 until the discharge end thereof is positioned adjacent the inner end of the form. The concrete feeding assembly, consisting of the storage tank 43 coupled to the winch car 46, in turn coupled to the sled 25, is then disposed on the track 22 just outside the form 23, as shown in Figure 1.

A train of concrete laden cars, such for example as cars 29, 31, 34, is then pushed into the tunnel by suitable means, such as the locomotive 35. If the tunnel length is great it may be desired to include in the train the auxiliary tank car 36 containing compressed air. In this way, a source of air is provided for agitating the concrete mixture during transit, in the manner previously described in my aforementioned Patent No. 2,534,270.

The train having reached the working region of the tunnel, the most inward car 29 is pushed against the sled 25, either by hand or by the locomotive 35. This connects the discharge end 28 of the car conduit 97 and the intake end 27 of the material discharge line 24. Simultaneously, the two nozzle members 104 and 107 forming the outlets of the air line 42 engage the symmetrically disposed openings in the air chamber 103 on the

car 29. By referring to Figure 7 it will be seen that the hook members 112 are so formed and are so connected to the arms 115, that with the arms in their lowered normal positions, the outer ends of the hooks 112 will be engaged by the bosses 113, formed in the chamber 103, being raised thereby as the car is moved into connected position, to allow the bosses to pass under them. Thereafter, the arms 115 are raised by means of a handle 117, causing the hooks 112 to drop over the bosses 113. Returning the arms 115 to their horizontal position draws the car 29 firmly against the sled 25, sealing the air and concrete couplings. It will be obvious that the car 29 preferably should be uncoupled from the train before operating the handle 117 to draw the car into sealing position. This coupling position is maintained by the over-center action of hook members 112 about the pivot points 116-a of the arms 115.

The hinged handle 119 of the valve 118 on the sled 25 is then raised (Figure 7), and the valve is opened by appropriate movement of the handle. This operation supplies air under pressure from the pipe 42, through the air chambers 102 and 103, to the pipe 101, and thence to the valve chamber 127 (Figure 6). Handle 135 on the car 29 is then lowered, raising flapper valve 134 into the recess 142 by means of the linkages 136. The car is then ready to deliver its load of concrete into the conduit 24. This is effected at any desired time by appropriate operation of the valve 123.

Following emptying of the car 29, the arms 115 are raised to release the hooks 112 from the bosses 113. As the arms 115 are lowered, the hooks 112 are lifted slightly by means of the cross piece 114 to prevent reengagement of hooks 112 with the bosses 113.

Car 29 is then ready to be shunted out of the way onto the sled 25. This is effected by first backing the emptied car 29 away from the sled 25 a sufficient distance to allow extension of ramp 32. This accomplished, the four-way valve 34 (Figure 10) is actuated to apply air pressure to the right hand end of the cylinder 77, thus drawing the piston rod 78 into the cylinder, and by means of the actuating rods 75, coupled to piston rod 78 by yoke 76, forcing the ramp 32 outwardly of the sled 25. Upon engagement of the toe plates 93 with stop 91, the inner ends of rails 73 pivot upwardly about the stop members 91 and are wedged against the underside of the channel members 66, as shown in Figure 11.

Car 29 is pushed up the ramp 32 and thence to the inner end of the sled 25, where it is stopped by abutment of its wheels with the inclined end member 33 of the sled 25. Ramp 32 is then retracted by actuating valve 34 to apply air pressure to the left hand or outer end of the cylinder 77, thereby forcing the piston rod 78 out of the cylinder and moving the ramp 32 to the right from the position shown in Figure 11. This drops the foot members 88 to their generally horizontal position, and then retracts the ramp 32 to the position, as shown in Figure 9.

Each of the succeeding cars 31 and 34 is then emptied in a similar manner, the former being also moved onto the sled 25, as shown in Figure 2, to make room for the final car 34. Following emptying of all the cars, the train is reformed and taken out of the tunnel 21 to make room for another concrete laden train. Although the apparatus has been shown and described as utilizing three concrete carrying cars, it is not

necessarily so limited, and may be adapted readily for use with a greater number of cars.

During use of compressed air, the normal flow of air is from air pipe 37 into flexible hose 38, T 39, vertical pipe 41, pipe 42, and thence into the air pipe 101 of the car being unloaded, for example car 29, as explained above. A substantially uniform air pressure is maintained during intermittent use of the air by employment of the storage tank 43, which is connected to the air line by means of the hose 44 coupled to the T 39.

As the placing of the concrete progresses, and the inner portion of the space above the form 23 fills with concrete, the discharge end of the conduit 24 becomes embedded therein. Thus, it is desirable that the conduit 24 be moved back out of the lining space as the work progresses, so that the back pressure against which the concrete must be discharged, is decreased. This is effected by the air operated winch 47, which is operated to wind in the cable 48, by compressed air supplied through the valve 71, conveniently located near the outer end of the sled 25. As the space between the support 45, mounted atop tank 43, and the outer end of the form 23 increases due to the withdrawal of the conduit 24, suitable supports (not shown) may be placed under the conduit 24 at appropriate points.

Following completion of the arch lining 55 (Figure 5), the stacker 51 is taken into the tunnel and a section 65 of suitable length behind the stacker (see Figure 3) is cleared of pipe, rails, etc., and appropriately excavated for the tunnel floor or invert. The sled 25 is returned to the working region of the tunnel without the winch car 45 and the storage tank 43. On the inner end of the sled 25 is the muck car 64, which receives the dismantled and excavated material from the region 65. As shown in Figure 3, the inclined forward portion 33 of the sled 25 is removed for the floor forming operation, as are also the upstanding air pipe 41 and T 39. The flexible air hose 38 is then connected to the air line 42 through the T 201. A transverse cross member (not shown) is substituted for the end member 33. The removal of the forward end portion 33 of the sled serves to render the muck car 64 readily available from the region 65.

The several concrete laden cars 29, 31 and 34 are connected successively to the sled 25, in the same manner as when effecting the lining of the arch. The stacker 51 is steadily pulled outwardly of the tunnel as the concrete is discharged, by operation of the winch 62, supplied with air through the air line 63 connected with the air line 49 of the sled 25, and controlled by the valve 71. As the stacker 51 is moved outwardly of the tunnel, it pushes ahead of it the rigid, concrete-carrying conduit 58, which in turn pushes the sled 25, and any car, such as car 31, which may be connected to the sled. During this operation, the screed 56 on the inner end of the stacker 51 smooths the invert 57 and forms it into the desired floor shape illustrated in Figure 5.

If desired, a small wheeled platform (not shown), adapted to ride on the shoulders 54 at the bottom of the arch 55, may be provided behind the stacker 51 to carry one or more finishing operators who give a smooth final finish to the top of the invert 57.

Stackers of this general type are well known in the art, but heretofore they have not oper-

ated in the above described manner involving the delivery of concrete from successive cars in a train and the provision of the muck car immediately adjacent the working area.

The final step may comprise treating the inner surface of the entire lining with a curing liquid to properly control the rate of drying.

From the above it will be apparent that there has been disclosed a method and apparatus whereby a series of individual, concrete-laden cars may be moved into a small bore tunnel, and the cars successively emptied, without the need of shunting the cars by means of turn-out, passing tracks, or structure requiring superfluous excavation. It will be seen that the method of this invention is carried out in a single region in the tunnel in close proximity to the actual working area of the tunnel, thereby eliminating extensive moving about of the operators. It will be further seen that operation is effectuated and controlled from a single position, namely, the region adjacent the outer end of the sled 25, where all the controls are located.

Thus, it is at this point that the car to be unloaded is connected to the conduit 24 and to the air line 42, and the main air valve 118, the ramp controlling valve 84, and the valve 71 controlling the winch 47 or 62 as the case may be, are operable.

I claim:

1. The method of forming the top and side walls of a small bore tunnel having a form for defining the inner surfaces of said walls, as well as a material discharge line extending longitudinally above the form for conveying the wall material to the desired location in the form, which comprises: advancing a train of loaded mobile containers to the working region in the tunnel; connecting the most forward container to said discharge line; discharging the material from said container; disconnecting said container from the discharge line; advancing said container along said line; and connecting the succeeding container of the train to said discharge line.

2. The method of forming the floor of a small bore tunnel, which comprises: delivering the floor material through a material discharge line from a mobile container connected to said line; forming the floor surface while withdrawing said line and said container in accordance with the delivery of the material; disconnecting said container, when empty, from the discharge line; and advancing said empty container along said line to provide for connecting a laden container to said line.

3. The method of forming the floor of a small bore tunnel, which comprises: clearing the bottom of the tunnel and excavating to an appropriate depth, in a working region of the tunnel; delivering floor material through a material discharge line from a mobile container connected to said line, forming the floor surface as the delivery proceeds; providing a mobile vehicle between said container and said excavation for the excavated material and debris; and withdrawing said conduit, said container and said vehicle in accordance with the delivery of said material.

4. The method of forming the floor of a small bore tunnel, which comprises: clearing the bottom of the tunnel and excavating to an appropriate depth in a working region of the tunnel; delivery floor material through a material discharge line from a mobile container connected

to said line; forming the floor surface as the material delivery proceeds; supporting a mobile vehicle above said line between said excavation and said container, for receiving the excavated material and debris; withdrawing said container, said conduit and said vehicle in accordance with the delivery of said material; and moving said container when empty, to be supported above said line to provide for connecting a filled container to said line.

5. In material handling equipment: a mobile container having a discharge opening adapted for connection to a conduit upon advance of said container to discharging position; and mobile means for supporting said conduit and said container, and a ramp operatively connected with said mobile means and over which said container is movable from said discharging position onto said mobile means to permit the contents of a succeeding container to be discharged through said conduit.

6. In material handling equipment: a plurality of mobile containers coupled to form a train; each of said containers having a discharge opening adapted respectively for connection to a conduit, upon advance of the container to discharging position; a vehicular support for said conduit, and means over which the containers are movable onto said support after the contents thereof had been discharged through said conduit.

7. In material handling equipment: a mobile container having means forming a discharge opening adapted for connection to a material discharge line, upon advance of the container to discharging position, said opening being directed in the direction of advance, a mobile support for the discharge line, disposed in advance of said container, and means between said container and said support over which said container is movable onto said support past the intake end of said line, whereby the opening in a succeeding container may be connected to the intake of said line while a container is mounted on said support.

8. In material handling equipment: a mobile container adapted for operation on a track comprising a pair of parallel spaced rails; a sled structure movable along said track; providing a pair of rail forming members for supporting said container above the track; a discharge conduit supported on said sled structure for movement therewith and adapted to be connected with the mobile container for discharging the contents of the latter at a point forwardly of said sled structure, an extensible ramp carried by the sled providing inclined rails extending upwardly from the track rails to the sled rail surfaces; and optionally operable means for projecting and retracting the ramp with respect to the sled.

9. In material handling equipment: a sled structure for use with a track having a pair of spaced parallel rails, comprising a pair of side members joined in spaced parallel relation and providing respectively rail surfaces above said rails; means including a pair of elements providing inclined surfaces adapted to extend upwardly from said rails to said rail surfaces on said members and slidable respectively in said side members; and means including a power cylinder for optionally moving said elements to telescope in the respective side members, or to extend therefrom.

10. In material handling equipment, a sled structure for use on a track having a pair of

parallel spaced rails, comprising a pair of side members joined in spaced parallel relation, and a conduit extending between said members with its intake adjacent corresponding ends of said members and adapted for connection to a mobile container on said track, optionally operable extensible means on said structure providing inclined rail surfaces from said rails to the tops of said members for facilitating movement of said container from said track to said sled, said sled serving to support said container above said conduit for movement lengthwise thereof.

11. In coupling means for a pair of axially aligned main pressure conduits, as well as for a pair of supplemental pressure conduits; means forming a pressure chamber extending about each of said main conduits and maintained out of communication therewith, and respectively communicating freely with said supplemental conduits; means urging said pressure chambers together; means maintaining said supplemental conduits respectively in continuous communication with said chambers; means forming a pair of nozzles extending between said chambers when coupled and symmetrically disposed on opposite sides of said main conduits, for transferring fluid pressure between said chambers about said nozzles; and means for connecting said main conduits in fluid tight exchange relation when said chambers are coupled.

12. In coupling means: a pair of axially aligned main conduits; means forming a pressure chamber extending about each conduit; means urging said pressure chambers together; a supplemental conduit on one side of said main conduit extending through and beyond one of said chambers and providing a nozzle adapted to enter an opening in the adjacent wall of the other chamber when the chambers are coupled; and means forming a nozzle symmetrically disposed on the other side of said main conduit with respect to said supplemental conduit, extending from one chamber and adapted to enter an opening in the adjacent wall of the other chamber; means including said nozzles for admitting fluid pressure from said supplemental conduit into each chamber; and conduit forming means leading from the other chamber.

13. In combination: a mobile container for fluent materials, adapted for advance along a guiding track, said container having a discharge conduit at its lower end directed in the direction of advance; a movable sled structure on said track, providing surfaces for guiding said container offset from said track; a material discharge line having a portion fixed to the sled, said conduit being normally aligned with said discharge line for connection therewith in fluid tight relation; and optionally operable means for causing movement of said container to said guide surfaces in response to advance of the container; the offset being such as to position said conduit for longitudinal movement along said line.

14. In combination: a mobile container for fluent materials, adapted for advance along a guiding track, said container having a discharge conduit at its lower end and a fluid pressure conduit respectively with openings directed in the direction of advance; a movable sled structure on said track; providing surfaces for guiding said container offset from said track; a material discharge line and a fluid pressure line, each having a portion fixed to the sled, said conduits being normally aligned with the respective discharge lines for connection therewith in fluid tight rela-

tion; and optionally operable means for causing movement of said container to said surfaces in response to advance of the container, the offset being such as to position said conduits for longitudinal movement along said lines.

15. In combination: a mobile container for fluent materials, adapted for advance along a guiding track, said container having a discharge conduit at its lower end opening in the direction of advance; a movable sled structure comprising a pair of side members disposed respectively above the rails of said track and forming an elevated track for said container; a material discharge line having a portion extending between said side members, adapted for connection with said conduit opening; and optionally operable means for causing advance of said container to raise said container to the elevated track, said elevated track being of such height as to position said conduit above said line to allow advance of the container past the end of said line.

16. In a quick acting coupling for connecting a pair of members; a lever arm pivoted on one of said members for movement about a horizontal axis adjacent one end of the arm, a hook member pivoted on said arm at a point spaced from said axis for engaging a boss on the other member, and extending over the pivoted end of the lever, movement of said lever to coupling position causing said pivot to pass below a line joining said axis and said boss, means to limit movement of said lever in coupling direction, said member being adapted to rest on the end of said lever when not engaging said boss, said lever, when in its limiting position, being freely swingable upwardly to permit passage of said boss to coupled position.

17. In material handling equipment: a sled structure for use with a track having a pair of spaced parallel rails, comprising means providing a pair of supporting surfaces vertically spaced above each rail; a pair of elongated elements, the inner ends of said elements being slidably supported respectively above the lower of said surfaces, the outer ends of said elements being slidably supported respectively on said rails; means for advancing said elements with respect to said surfaces; means for elevating said inner ends respectively to substantial alignment with the upper of said surfaces, said means comprising a pair of members respectively carried by each of said surface providing means and each of said elements and engageable upon a predetermined outward movement of said elements, one member of each pair being mounted for rotation upon engagement with the other member of the respective pair; and means for limiting rotation of said members when aligning position is reached.

18. In material handling equipment: a sled structure for use with a track having a pair of spaced parallel rails, comprising means providing a pair of supporting surfaces vertically spaced above each rail; a pair of elongated elements slidably supported respectively at one end on said rails, the opposite ends being supported respectively by forwardly inclined rotatable foot members engaging the lower surfaces; means for advancing said elements with respect to said surfaces; stop means for causing said foot members to rotate in response to advance of said elements, the rotation of said foot members causing said opposite ends to align substantially with said upper surfaces; and means for limiting rotation of said foot members when aligning position is reached.

19. In material handling equipment: a sled

structure for use with a track having a pair of spaced parallel rails, comprising a pair of side members joined in spaced parallel relation and providing respectively rail surfaces as well as supporting surfaces above said rails; means including a pair of elongated elements adapted to extend upwardly from said rails to said rail surfaces, the outer ends of said elements being slidably supported on said rails respectively beyond the ends of said supporting surfaces, the inner ends of said elements being slidably supported on said supporting surfaces respectively; means for moving said pair of elements with respect to said members; and means operative in response to arrival of the inner ends of said elements adjacent the outer ends of said supporting surfaces to raise the said inner ends, causing said elements to form a ramp between said rails and said rail surfaces.

20. In material handling equipment: a sled structure for use with a track having a pair of spaced parallel rails, comprising a pair of side members joined in spaced parallel relation and providing respectively rail surfaces as well as supporting surfaces above said rails; means including a pair of elongated elements adapted to extend upwardly from said rails to said rail surfaces, the outer ends of said elements being slidably supported on said rails respectively beyond the ends of said supporting surfaces; means for moving said pair of elements with respect to said members; a forwardly directed foot member pivotally mounted on the inner end of each of said elements slidably supporting said inner ends on said supporting surfaces; stop means adjacent the outer ends of said supporting surfaces for engaging said foot members and rotating them about their pivots in response to a predetermined outward movement of said elements, whereby the inner ends of said elements are substantially aligned with said rail surfaces; and means for limiting rotation of said foot members upon said elements reaching aligning position.

21. In material handling equipment: a sled structure movably mounted on a track; a materials discharge conduit mounted on said sled having an intake adapted for connection with means forming a discharge opening on a mobile material container on said track; extensible means carried by said sled adapted to form a ramp for facilitating movement of said container from said track on to said sled; and means on said sled for supporting said container clear of said conduit to permit movement of said container along said sled.

22. In material handling equipment: a sled structure comprising a pair of side members, movably supported on a track having a pair of spaced parallel rails, said side members respectively providing rail surfaces spaced above the rails of said track; a materials discharge conduit mounted on said sled intermediate said members and extending longitudinally of the sled, said conduit having an intake opening adjacent the rear end of the sled, said intake being adapted for connection with means forming a discharge opening of a mobile container on said track; extensible ramp forming means carried by said sled structure adapted to facilitate movement of said container from said track onto said sled structure; said rail surfaces being so spaced with respect to said conduit that, when said container is on said surfaces, said discharge forming means is clear of said conduit, to permit longitudinal movement of said container on said sled.

23. In material handling equipment: a sled structure movably mounted on a track; a materials discharge conduit and a fluid pressure conduit mounted on said sled and adapted for connection respectively with means forming a discharge opening and a fluid pressure inlet on a mobile material container on said track; extensible means carried by said sled adapted to form a ramp for facilitating movement of said container from said track onto said sled; and means on said sled for supporting said container clear of said conduit to permit movement of said container along said sled.

24. In material handling equipment: a sled structure movably mounted on a track; a materials discharge conduit and a fluid pressure conduit mounted on said sled and adapted for connection respectively with means forming a discharge opening and a fluid pressure inlet on a mobile material container on said track; extensible means carried by said sled adapted to form a ramp for facilitating movement of said container from said track onto said sled; fluid pressure responsive means for operating said extensible means; optionally operable control means for admitting fluid pressure from the fluid pressure conduit to said fluid pressure responsive means; and means on said sled for supporting said container clear of said conduits to permit movement of said container along said sled.

25. In material handling equipment: a sled structure movably mounted on a track comprising a pair of spaced parallel rails; a materials discharge conduit mounted on said sled and having an intake adjacent the rear of the sled; means for coupling a mobile container on said track, to said sled for movement therewith along the track; said container when coupled, having a discharge opening communicating with said intake; said sled structure including means forming a pair of rail surfaces spaced above said track for optionally mounting said mobile container for movement independently of said sled.

26. The method of forming a structure in a small bore tunnel wherein fluent material for forming the structure is contained in a plurality of mobile containers disposed in line in the tunnel, and wherein the fluent material is subject to being discharged from said containers through a discharge conduit extending along the tunnel to a zone therein where the structure is to be formed; there being a longitudinal space in the tunnel between the ends of the conduit for accommodating at least one of said containers, which comprises: advancing the foremost container to a position adjacent the outer end of said space, connecting the foremost container with said conduit and conducting the material therefrom to said zone, disconnecting said foremost container from said conduit, advancing said foremost container into said longitudinal space, advancing the succeeding container to a position adjacent the outer end of said space, and connecting said succeeding container with said conduit for conducting the fluent material therefrom to said zone.

27. The method of forming a structure within a small bore tunnel in which are positioned a structure-defining form and a discharge conduit for conducting fluent material to said form, which comprises: advancing in line in the tunnel, containers loaded with fluent material; moving the foremost container to a position spaced from said form, connecting said foremost container with said conduit for conducting the material to said

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form, disconnecting said foremost container from said conduit, moving said foremost container from said position toward said form, advancing the succeeding container to said position, and connecting said succeeding container with said conduit for conducting additional fluent material to said form.

28. The method of forming a structure within a small bore tunnel in which are disposed a structure-defining form and a discharge conduit for conducting fluent material to said form, which comprises: advancing in line in the tunnel, containers loaded with fluent material; moving the foremost container to a position spaced from said form, connecting said foremost container while at said position with said conduit, forcing the material from said foremost container through said conduit to said form, disconnecting said foremost container from said conduit, effecting relative movement between said foremost container and said conduit to dispose one above the other and said foremost container between the

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intake end of the conduit and said form, and advancing the container next in line and connecting it with said conduit for conducting additional fluent material to said form.

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