

April 13, 1937.

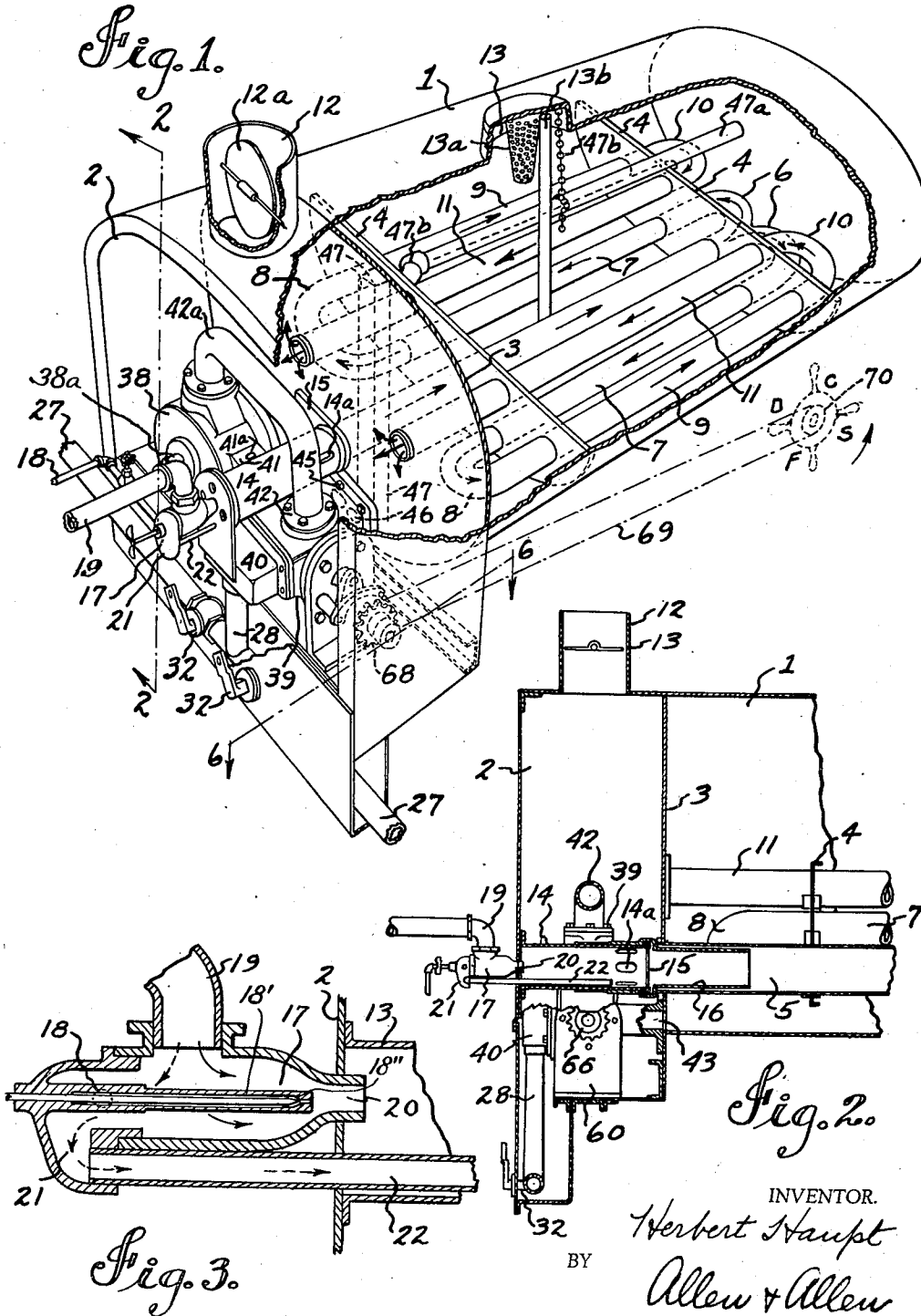
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2,076,780

APPARATUS FOR DISTRIBUTING LIQUIDS ON ROADS

Filed July 19, 1933

6 Sheets-Sheet 1



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6 Sheets-Sheet 2

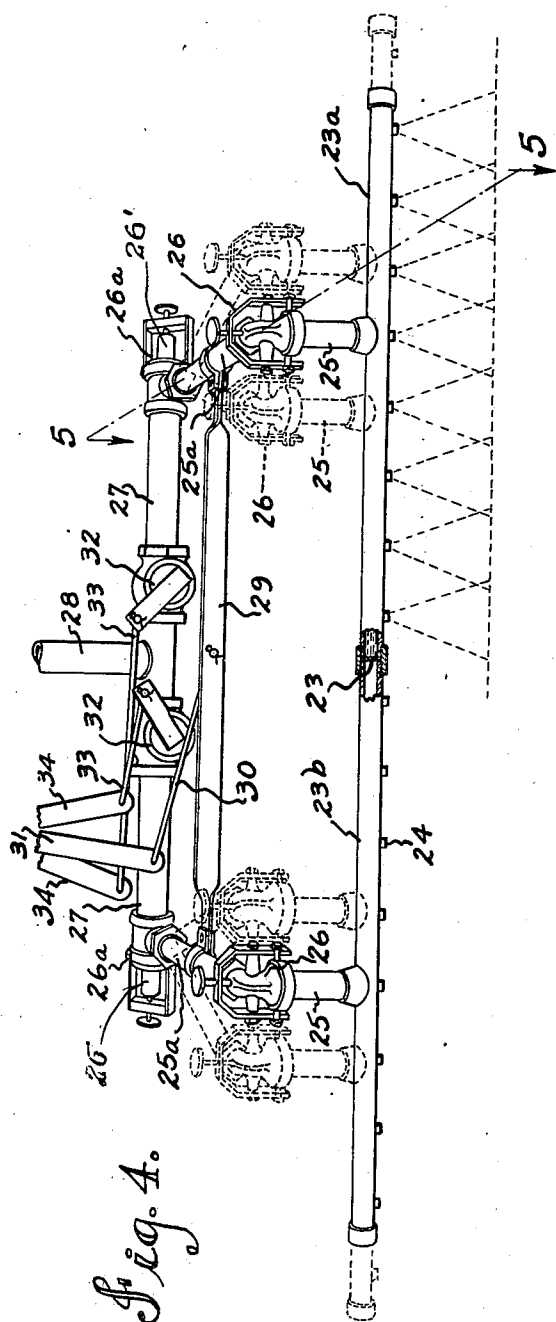


Fig. 4.

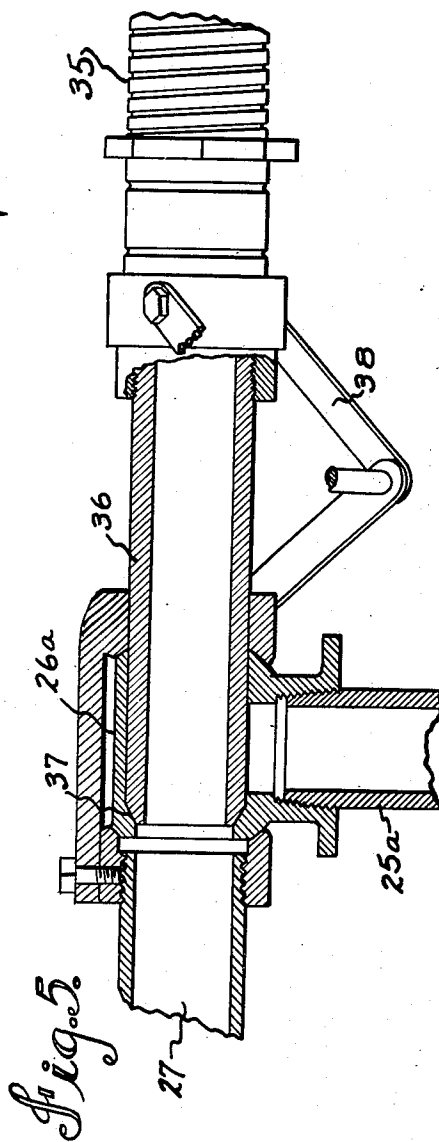


Fig. 5.

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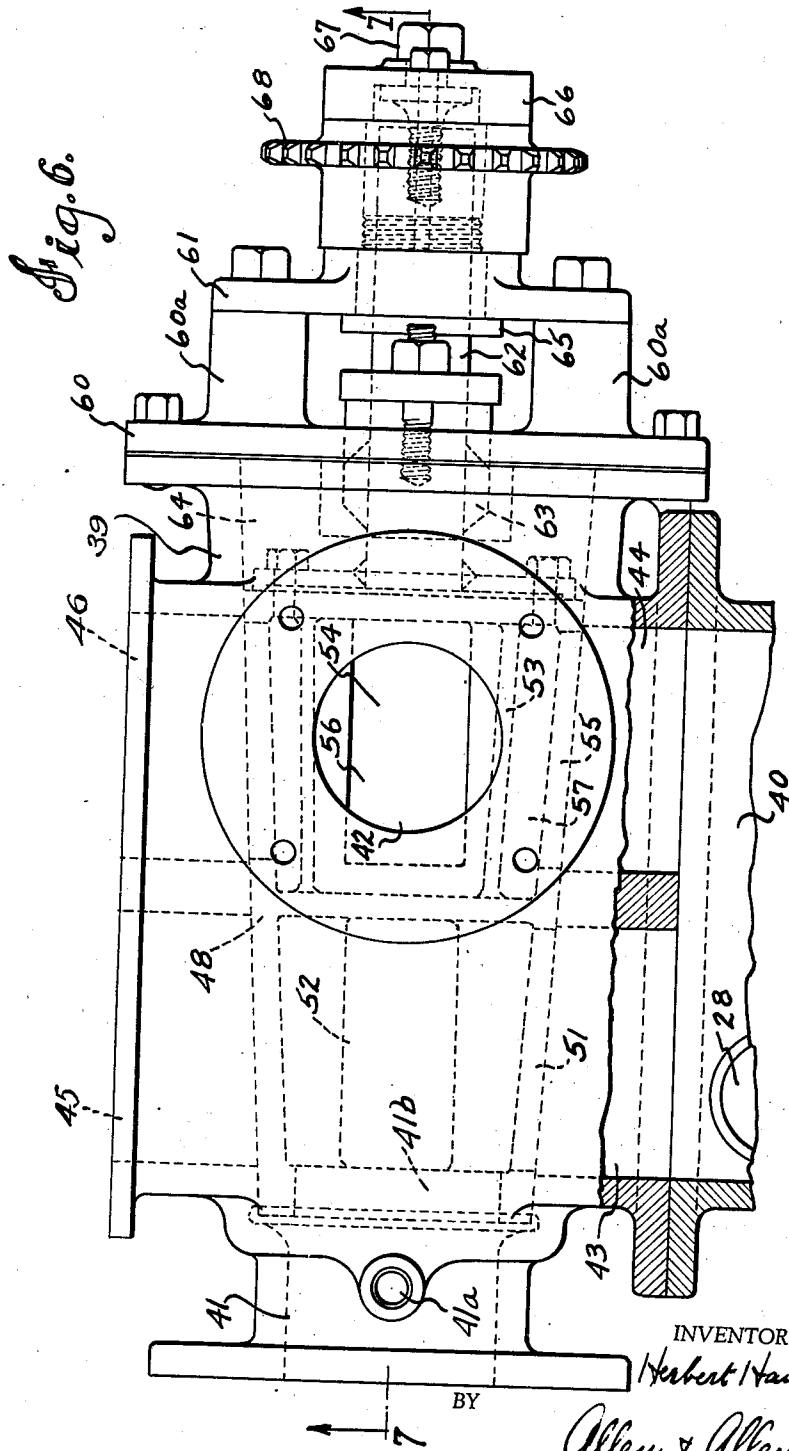
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6 Sheets-Sheet 3



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6 Sheets-Sheet 4

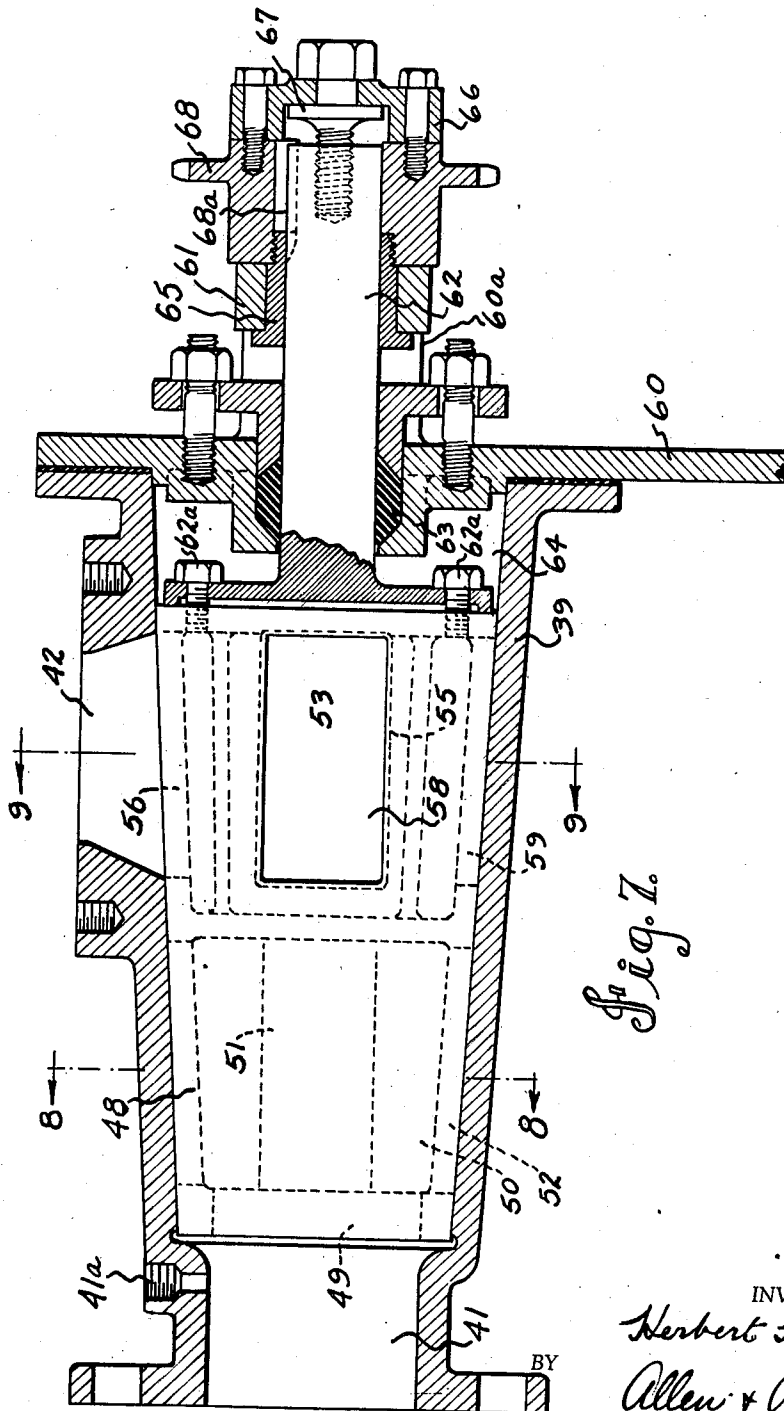


Fig. 7.

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6 Sheets-Sheet 5

Fig. 9.

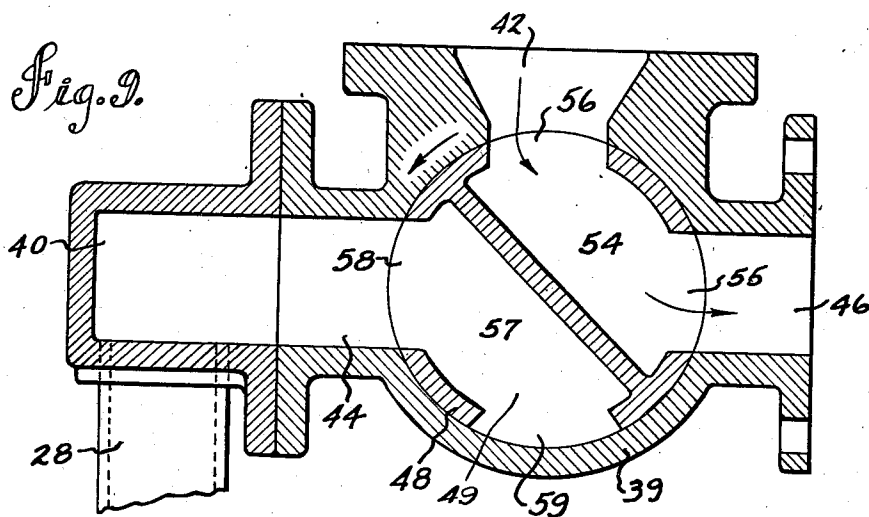


Fig. 8.

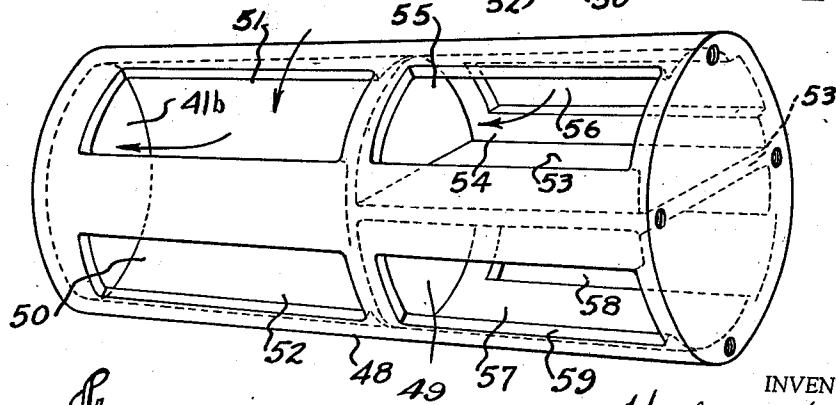
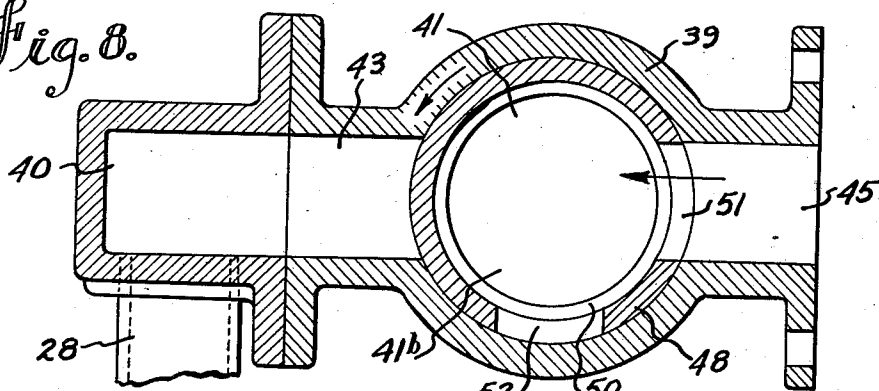


Fig. 10.

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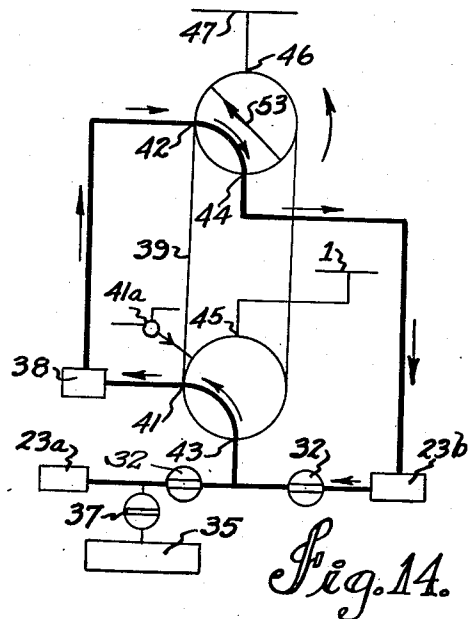
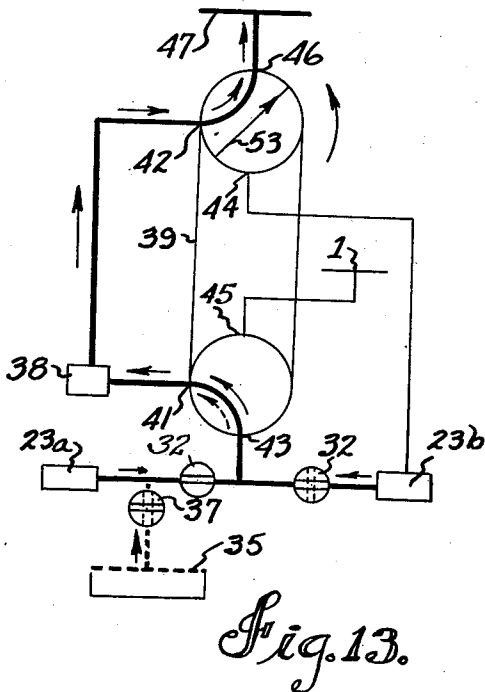
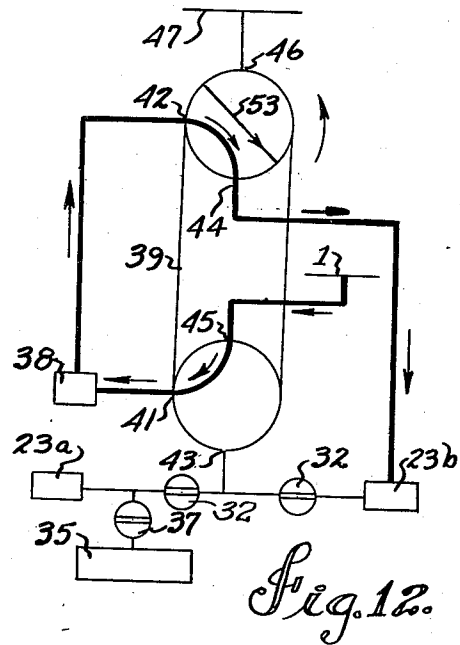
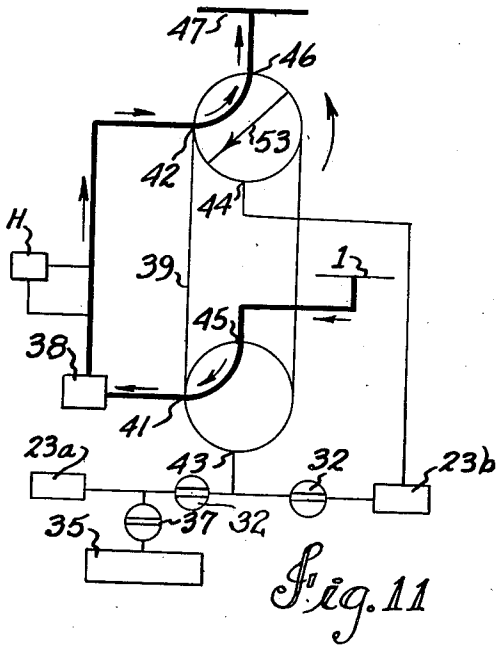
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APPARATUS FOR DISTRIBUTING LIQUIDS ON ROADS

Filed July 19, 1933

6 Sheets-Sheet 6



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UNITED STATES PATENT OFFICE

2,076,780

APPARATUS FOR DISTRIBUTING LIQUIDS
ON ROADS

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Application July 19, 1933, Serial No. 681,152

24 Claims. (Cl. 299—35)

My invention relates to liquid distributing apparatus, and more especially to apparatus of that character which is mounted on a truck or the like to be moved along and over a roadway or street for distributing liquid materials on the road or street surface to act as a binder or surfacing material, or both, for the other material of the road or street. My invention is especially concerned with apparatus of the character just described, in which provision is made for forcibly discharging the liquid through the distributing means; and also with such devices in which provision is made for heating the liquid.

An object of my invention is to provide efficient means for heating the liquids used. Such liquids, for example, are usually bituminous materials, such as asphalts of various kinds, or tar. Such materials are liquid only when heated, and it is an especial object of my invention to keep these liquids in heated and suitable liquid condition not only in the tank from which they are taken, but in all of the passages of the pressure distributing system of the apparatus. Other materials which are liquid when not heated also are used, as for instance, asphalt blended with a solvent, and also emulsions made by mixing tar or asphalt with water, soap, or the like, and also oils which are used to treat the material of roads or streets. With the asphalt and solvent generally known as "cut back", and with the road oil, it is often desirable to heat these materials. An especial object is to provide the heating apparatus of a construction which allows for ready expansion and contraction of the parts, reducing the strain on the structure and adding to its durability. A further object in this connection is to provide for especially effective combustion in the heating apparatus, and to protect the parts immediately exposed to the most intense heat. Another object is to insure against backfiring and blowing out of the combustion in the heating apparatus.

When materials are used which require considerable heat to keep them readily flowing, much difficulty may be caused by the freezing of such liquids in the passages of the apparatus. It is a further object of my invention, therefore, to keep not only the tank but the pressure creating and distributing apparatus effectively heated to avoid these difficulties.

In conjunction with the heating apparatus, it is desirable to be able to circulate the heated liquid thoroughly in the tank so as to be uniformly exposed to the heating apparatus and to further reduce the tendency of the liquid to

freeze in the passages of the apparatus. Another important requirement is to be able to thoroughly drain the passages of the apparatus when its operation is to be stopped; and in some cases thorough draining and cleaning of the apparatus is facilitated by the introduction of a suitable thinning liquid or solvent, such as an oil, into the passages. It is also highly desirable to be able to replenish the liquid in the tank of the apparatus from a suitable supply source located along the roadway, and which, according to the side of the road on which it is located, or to the direction in which the apparatus is traveling, may require access for convenient filling at either side of the apparatus; and another important advantage to be attained is the shutting off of the distribution immediately at any time during the travel of the apparatus along the road or street, so that there is no surplus flow or drippage of the liquid as, for instance, when distributing material on a road or street, and an intersection with a cross road or street should not have any of the material applied to it.

In view of the desirable functions and requirements just stated, I have provided an especially efficient and effective combination in a distributing system with a pressure device of means for controlling the distribution as between the pressure device, the tank and the distributing or spraying device of the apparatus. In the preferred example of my invention, provision has been made by the simple setting of a valve member to any one of four positions to either circulate the liquid within the system; or distribute or spray the liquid on the road or street; or with a third position of the valve member to automatically create a suction back through the spraying or distributing device which will draw in any portion of the liquid emerging from the device at the time the spraying is to be stopped, and therefore insure against drippage on surfaces where it is not desired, or by certain operations in conjunction with the connection of a conduit or hose from the roadside supply means to cause the suction permitted by this third setting of the valve member to draw in the new supply of liquid to the tank instead of effecting suction through the spraying device; and by a fourth position of the valve member to leave the system open for drainage of the liquid from the passages of the valve and the pressure creating device. I also may provide in conjunction with this draining operation, for the introduction of oil or other suitable thinning liquid

into the system for thorough cleaning with the valve member in this fourth position. In conjunction with this operation the forcing apparatus may be used to aid in the complete cleaning out of the system. I may provide especially for a supplementary heating of the liquid during circulation, as mentioned above, with the first position of the valve member, by means of a special heater in addition to the tank heating apparatus.

With these and other objects in view, my invention comprises therefore, the combination, with a tank or equivalent means for holding the material to be distributed and with a suitable distributing or spraying device, and a forcing device of an especially novel, simple and effective distribution control valve, and means for the convenient operation of this valve by the operator of the apparatus, which, by its position, readily indicates to the operator the proper setting of the valve.

The above-mentioned are some of the principal objects of my invention, and the means for accomplishing these objects has been very broadly mentioned. It will be understood that any mention of detail in the above is not exclusive, and that other objects, as well as the means for accomplishing them, will become apparent in the course of the following description which is illustrated by the accompanying drawings, in which—

Figure 1 is a general perspective view, partly diagrammatic, illustrating an embodiment of my invention.

Figure 2 is a partial vertical longitudinal section on the line 2—2 of Figure 1, more clearly illustrating the burner and associated apparatus as well as the heating chamber and the arrangement of portions of the apparatus therein.

Figure 3 is a partial corresponding section, considerably enlarged, fully illustrating the interior details of the burner.

Figure 4 is a general perspective view of the spraying or discharging device and its associated connections and control details.

Figure 5 is a partial section on the horizontal plane of the line 5—5 of Figure 4, more clearly illustrating details of the apparatus concerned in filling or replenishing the liquid in the apparatus.

Figure 6 is a plan view of the distributing valve showing part of it and part of its manifold in horizontal section on the line 6—6 of Figure 1.

Figure 7 is a longitudinal vertical section on the line 7—7 of Figure 6.

Figure 8 is a vertical cross section on the line 8—8 of Figure 7.

Figure 9 is a similar cross section on the line 9—9 of Figure 7.

Figure 10 is a detail perspective view of the rotatable valve member or plug.

Figure 11 is a diagram illustrating the working of the apparatus when set for circulating.

Figure 12 is a similar diagram illustrating the operation when the apparatus is set for distributing or spraying.

Figure 13 is a similar diagram illustrating the operation when the apparatus is set for filling or suctioning.

Figure 14 is a similar diagram illustrating the operation when the apparatus is set for draining or cleaning.

In the preferred embodiment of my invention, as generally illustrated in Figure 1, the tank 1 is elongated horizontally and is of elliptical cross-section with its greatest width horizontal. At one end of this tank is a heat chamber 2, which is

rectangular in its lower portion and conforms to the upper half of the elliptical cross section of the tank in its upper portion, the separate wall between this heat chamber and the interior of the tank constituting a header plate 3 with an opening through which a suitable burner discharges products of combustion into flues interiorly of the tank to circulate through the flues and be discharged therefrom through this header plate 3.

At intervals along the length of the tank vertical plates 4 are provided approximately conforming to the shape of the lower half of the cross section of the tank and extending about half way the height of the tank. These plates 4 serve as baffles to minimize the shaking of the liquid around in the tank incident to jars of transportation; and they further have the purpose of supporting the draft tubes. Close to the bottom of the tank 1 the main draft tube 5 leads through and has its end portion secured in the header plate 3, and leads along the bottom of the tank through openings in the baffle or support plates 4. Near the remote end of the tank this main draft tube 5 has laterally extending branches 6 which are in the form of return bends leading into the ends of a first pair of rearward draft tubes 7 which, near the header plate 3, have return bends 8 connecting them to a pair of second forward draft tubes 9 which, near the remote end of the tank, have return bends 10 connecting them to a pair of second rearward draft tubes 11 which have their outlet end portions secured in openings in the header plate 3 so as to discharge the products of combustion into the heat chamber 2. This chamber 2 has at its top a suitable stack 12 provided with a damper 12a. Forwardly on top of the tank is a manhole 13 with a suitable cover, and provided with a strainer 13a and an overflow and drain tube 13b which, not forming a part of my present invention, need no detailed description.

Extending from rear to front across the lower part of the heat chamber 2, and with its forward end connecting with the first forward draft tube 5, where the latter enters the tank, is the combustion tube or chamber 14. It is provided near its junction with the draft tube 5 with a series of slots 14a at intervals around its cylindrical walls; and just in front of these slots 14a at the entrance to the draft tube 5, is a closure member 15 so arranged that it may be slid partly or entirely across the entrance to the draft tube 5 from the combustion chamber 14, or may be slid to leave this entrance wide open.

For some distance along the first forward draft tube 5 from its entrance from the combustion chamber 14, I provide a tubular lining 16. It will be understood that the draft tube 5, as well as the other tubes in the tank, are made of wrought steel, such as boiler tubing, for instance, or seamless steel tubing, which is not especially resistive to the high temperature incident to the melting of the materials employed. This is especially so at the immediate entrance from the combustion chamber 14; and by providing this lining 16, which may be of cast-iron amply resistant to the intense heat at this point, I am able to greatly increase the durability of this part of the structure.

At the outer or rear end of the combustion chamber 14, the wall of the heat chamber 2 has an opening into the chamber 14. The burner 17 comprises a casing into the rear end of one side of which enters the fuel tube 18 from a fuel

supply means not shown. The air tube 19 enters the top of the casing, and the fuel tube 18 enters a tube 18' provided with the usual needle valve 18'' seating at its forward end where it dis-
 5 charges the fuel into the nozzle 20 of the burner casing. This fuel is mixed with the air that has entered through the inlet 19 around the fuel tube 18', as indicated by the solid arrows in Fig-
 10 ure 3. This nozzle 20 of the burner projects into the combustion chamber 14 through the opening in the heat chamber wall just before mentioned. The burner as so far described will be seen to be
 15 of a usual type. However, with the especially long and circuitous system of draft tubes which I provide in the tank for especially effective heat-
 20 ing of the contents, difficulty has been experienced in maintaining the combustion sufficiently to insure against blowing out of the burner by back-firing from the draft tubes. I have over-
 25 come this difficulty by providing a by-pass for the air at the rear of the burner casing, as at 21 in Figure 3, this by-pass being a depending exten-
 30 sion from the forward end of which the by-pass tube 22 leads into the combustion chamber 14 a considerable distance past the nozzle 20 of
 35 the burner. As shown, the forward end of this by-pass tube 22 is close to the entrance from the combustion chamber 14 into the draft tube 5.

The distributing or spraying apparatus, part of
 30 which is shown in Figure 1 at the bottom of the rear of the heat chamber 2, is fully shown in Figures 4 and 5, where the spray bar is made up
 35 of a middle coupling 23 which connects together two sections 23a and 23b of tubing and forms a partition between these two sections of tubing.
 40 At intervals along the lower side of each section of tubing 23a and 23b are outlet nozzles 24. About midway of the length of each section 23a
 45 and 23b, inlet pipes 25 enter the tubes from above and are connected at their tops to respective inlet pipes 25a by suitable swivel connections
 50 26. These second pipes 25a lead rearwardly to the tops of the pipes 25 from branch connections 27 to which they are connected by suitable swivel
 55 joints 26a. At the middle of the branch connections 27 the main connection pipe 28 leads down into these branch connections 27 from the ap-
 60 paratus in the heat chamber 2. The swivel connections 26 and 26a are so arranged that the spray bar made up of the sections 23a and 23b
 65 may be moved longitudinally; the inlet pipes 25 and 25a and the connections 26 swinging as indicated by the dotted lines in Figure 4. These
 70 swivel connections 26 and 26a are understood to be made with spherical heads and sockets as seen at 26a in Fig. 5. The outer ends of connections
 75 26a are normally closed by clamped closures as at 26' in Fig. 4. For shifting the spray bar as above described, the horizontal inlet pipes 25a
 are connected together by a shifter bar 29 which is connected by a shifter rod 30 to a lever 31
 understood to be operable from the operator's position on the apparatus. Valves 32 are provided
 in the respective branch connection pipes 27 at the opposite sides of the main connection pipe
 28; and these valves 32 are similarly connected by rods 33 to respective levers 34, understood to be similarly operated. By these means the oper-
 ator may shift the spray bar laterally of the path of travel of the apparatus, and may shut off the supply of liquid to either one of the spray bars without shutting off the supply to the other.

The swivel connections 26a have a detail con-
 struction, as shown in Figure 5, such that when

the closure 26' of either one is removed the con-
 nection is left open laterally so that a filling hose
 35, understood to lead from a roadside source of supply, may have its nozzle 36 inserted into the
 open connection and past the inlet pipe 25a. 5
 The interior of this connection has a valve seat 37, and the nozzle 36 of the supply hose 35, when
 inserted, passes across the entrance to the inlet
 pipe 25a, and its end is shaped to seat tightly
 against the valve seat 37. Clamping means partly 10
 shown in Figure 5, will be understood to be em-
 ployed for holding the nozzle 36 tightly in this
 position. Thus inserted in the connection 26a
 at either side of the apparatus, the nozzle 36 will
 be seen to effectively shut off the spray bar section 15
 23a or 23b at the respective side, so that there
 can be no suction into the branch connections 27
 and main connecting pipe 28 from the spray
 bar. Whichever side this nozzle is inserted on,
 the valve 32 for the spray bar section at the 20
 other side is closed. By this means suction
 through the pipe 28 will be completely effective
 to draw in the replenishing supply of liquid
 through the hose 35.

The forcing means for the distribution system, 25
 as here shown, is in the form of a rotary pump 38 which is mounted on the floor of the heat
 chamber 2 at one side of its middle, and has its
 driving shaft 38a extending rearwardly. It will
 be understood that this shaft connects to a suit- 30
 able motive means, such as an internal combus-
 tion engine which would be mounted on a rear
 platform extension of the apparatus, but which
 it is not deemed necessary to illustrate herein.

The entire operation of this pump 38 in con- 35
 junction with the other parts of the apparatus,
 is controlled by the distributor valve which is
 mounted somewhat to the other side of the middle
 of the heat chamber 2 on the floor thereof. It
 comprises a casing 39 with an interior conical 40
 bore on a horizontal axis, with its small end di-
 rected toward the pump 38. This casing has
 mounted on its rear side the manifold 40. The
 small end of the bore of the casing forms the
 discharge port 41 of this valve casing, and is con- 45
 nected to the intake or inlet port of the pump 38.
 In one side this pump inlet connection 41
 has an oil inlet connection 41a which it will be
 understood may be connected to a suitable source
 of supply of oil for cleansing the passages in a 50
 manner hereinbefore mentioned.

At the top the valve casing 39 has an inlet con-
 nection 42 which is connected by an arching pipe
 42a with the outlet port of the pump as it is seen 55
 in Figure 1. Leading from this conical bore into
 the manifold 40, the casing has the left hand
 port 43 and the right hand port 44 as best seen
 in Figure 6, where, as may also be clearly seen,
 the casing has leading from its side opposite
 these ports 43 and 44 the left hand port 45 and 60
 the right hand port 46. The left hand port 45
 opens through the header plate 3 into the lower
 part of the interior of the tank 1, and the right
 hand port 46 opens through this header plate 3
 into a riser 47, which extends up near to the top 65
 of the tank and has a pipe 47a leading from it
 along the upper portion of the tank as shown in
 Figure 1, it being understood that this pipe 47a
 is connected to the riser by a compound elbow 70
 connection 47b in such a manner that this pipe
 47a may be swung up and down or around in
 the interior of the tank to discharge liquid in
 corresponding positions. The main connection
 pipe 28 leads down from the left hand end part 75

of the bottom of the manifold 40 to the spraying or distributing device.

Fitted into the conical bore of the valve casing 39 is the hollow conical valve plug 48 which has its small end open and concentric with the adjacent pump inlet port 41 of the valve casing, forming a port 41b which thus is always open to the pump inlet regardless of the position into which the plug 48 is rotated. The interior of the hollow valve plug 48 is divided by a transverse partition 49 into a single left hand chamber 50, from which the end port 41b opens, and which also has two side ports 51 and 52, and two right hand chambers separated by a partition 53 extending from the middle partition 49 to the large end of the plug. One of these right hand chambers 54 has two ports 55 and 56, and the other right hand chamber 57 has two ports 58 and 59. The port 55 of the first chamber 54 is longitudinally aligned with one of the ports 51 of the left hand chamber, and one of the ports 59 of the second right hand chamber 57 is longitudinally aligned with the other port 52 of the left hand chamber, the other two ports 56 and 58 of the right hand chambers being at the opposite side of the plug. As herein shown, the several ports are arranged at intervals of 90° around the plug, and the valve casing has its lateral ports 43, 44, 45 and 46 aligned in a transverse plane through the axis of the valve while the pump outlet port 42 is at the top of the casing 90° from each of the ports 44 and 46.

At its right hand or large end the valve casing 39 is bolted to a member 60 that extends up from the floor of the heat chamber 2, this member 60 affording a support for this end of the valve as well as forming a closure for the large end of the valve casing 39. This member 60 has extending to the right a pair of bosses 60a to which is bolted a yoke or abutment member 61 spaced to the right from the main part of the member 60. The stem 62 of the valve plug 48 is preferably made separate therefrom and screwed to the large end of the plug by screws 62a on a circular flange formed integral with the stem, as seen clearly in Figures 6 and 7. This stem 62 extends out through the closure member 60, which is provided with a stuffing box 63 around the stem. By this means a pressure chamber 64 is enclosed in the large end of the valve casing 39 between the adjacent end of the valve plug 48 and the closure member 60, which will retain liquid leaking past the valve plug 48 from the valve casing ports. This liquid being under pressure from the pump, is effective to seat the conical valve plug 48 very tightly in the conical bore of the casing 39, so that the valve is made very effective to prevent leakage from one of its ports to another. It has been found in practice that this pressure is not only adequate, but is excessive, so as to make it very difficult to turn the valve plug.

For the just mentioned reason, I prefer to provide an adjustment by which the seating movement of the valve plug under this pressure in the chamber 64 may be limited as desired. In the example herein, I provide this by means of an end thrust sleeve 65 fitting around the valve stem 62 within a bore in the yoke or abutment member 61; and by means of an adjusting yoke 66 at the outer end of the valve stem having journaled in it and limited as to actual movement, an adjusting screw 67 which is threaded into the adjacent end of the stem; and by means of the sprocket wheel 68 which is slidably keyed at 68a

on the end part of the stem 62 and is screwed to the adjusting yoke 66 and has the end thrust sleeve 65 screwed into its hub. The sleeve 65 has a flange abutting the left hand side of the yoke or abutment 61, while the right hand side of this abutment 61 is abutted by the adjacent end of the hub of the sprocket wheel 68. With this arrangement, turning of the adjusting screw 67 will cause axial movement of the stem 62 and the plug 48, since the relation of the sprocket wheel 68 and sleeve 65 to the abutment 61 is such as to prevent axial movement of the adjusting yoke 66.

The sprocket wheel 68 is understood to be operatively connected by a suitably arranged sprocket chain 69, with a suitable means by which the operator may turn the valve plug 48 to any one of four positions, such, for instance, as the handwheel 70 which, with the sprocket chain 69, are shown diagrammatically in Figure 1. In conjunction with this showing of the handwheel 70, the four different positions of the valve are indicated by the letters C, S, F, and D, indicating the positions for circulating, spraying, filling and drainage, respectively.

The different orders of connection effected by the setting of the valve into its four different positions are most clearly illustrated in the diagrams Figures 11 to 14 inclusive. In Figure 11 the arrangement for circulating the liquid into and out of the tank is indicated, where the path of the circulating liquid is indicated by the heavy lines, with arrows indicating the direction of passage of the liquid, which is from the bottom of the tank 1 through the left hand valve casing port 45, plug port 51, plug end port 41b, casing end port 41 to the intake of the pump 38 from the pump outlet into top port 42 of the valve casing, through port 56 of one of the right hand plug chambers, through the other port 55 of this chamber and the right hand port 46 of the valve casing into the riser 47, from which it will be discharged into any of the upper portions of the tank in the manner before described. It is this circulating position of the valve that is illustrated in Figures 6, 7, 8, and 9.

In Figure 12, which shows the arrangement of parts for spraying, the valve plug has been turned 90° over to the left or counter-clockwise, so that the passage of liquid, as indicated by the heavy lines and arrows, now is from the bottom of tank 1 through ports 45 and 41 to the pump, and from the pump through ports 42 and 44 to the spraying device 23a, 23b. This change was made from the arrangement in Figure 11 by an interchange of ports of the valve plug with valve casing ports, as will be understood.

In Figure 13, which illustrates the arrangement both for filling the tank 1 or for effecting suction when the spraying is interrupted, there has been a complete change of connections at both ends of the valve by further counter-clockwise rotation of 90° to the left, so that the liquid, as indicated by the heavy lines and arrows, now travels from the spraying device 23a, 23b, through one of the manifold ports 43, and through port 41 to the pump 38, and from there through port 42 and the right hand port 46 into the riser 47 to the upper part of the tank. The alternative use of this arrangement for either suction or filling is indicated by having heavy dotted lines leading from the source of supply 35; an indication 37 of a valve being understood to be a conventional representation of the before described arrangement of the filling hose nozzle

36 to cut off one side 23a of the spraying device while filling. It will be understood that the valve 32 conventionally indicated at the right would be closed, as indicated by the vertical dotted lines so as to cut off the other side 23b of the spraying device. When the passage of liquid is as indicated by the full lines in this lower part of Figure 13, the pump is forcibly drawing back the liquid from the spraying device so that there can be no flow or drippage of liquid after the operator has set the valve from the arrangement shown in Figure 12 to that in Figure 13 to stop spraying. It also will be seen that any time the tank is to be replenished the device will have been set from spraying position to suction position of Figure 13, ready for filling from either side through part 23a or part 23b of the spraying device by the setting of the valve means 32 and 37 as just before described.

In Figure 14 the valve plug has been given its fourth position by turning counter-clockwise from that of Figure 13. There has been an interchange of ports in the left hand or smaller end of the valve, but the actual connection remains the same as in Figure 13, connecting the spraying apparatus 23a, 23b to the intake side of the pump 38, while the right hand end of the valve now has by interchange of ports attained the same effective arrangement as it had in the spraying position in Figure 12. The result is that the liquid is free to drain from the pump and valve chambers and connections through the spraying device. It will be understood that by the pump valve and connections being in the heat chamber 2, the material within them may be maintained in a highly fluid condition for drainage; and if desired, oil may be introduced through the inlet 41a to the pump intake end of the valve, as indicated by the dotted lines in Figure 12; and with the pump 38 running, the passages and valve chambers and pump may be very thoroughly cleansed with a gradual outflow of the substances through the spraying device.

It will be understood that a suitable supplementary heater may be provided, as indicated at H in Figure 11, through which the liquid would pass under the action of the pump 38 when the distributing valve is set for circulation of the liquid. Such a heater is not shown in Figure 1, but it will be readily understood how this heater might be connected in the system where the pipe 42a is shown extending from the pump outlet to the valve port 42. However, I provide for heating the apparatus in the heat chamber 2 to an especially high degree by closure of the entrance from the combustion chamber 14 into the main draft tube 5 by the closure member 15, as indicated in Figure 2. When this is done, the combustion products will pass directly from combustion chamber 14 through the slots 14a therein out into the heat chamber 2, and from there directly out through the stack 12, their outward passage being controlled by the chamber 13. By this means, should the passages in the pump, the valve and the connecting pipes, including the pipe 28 leading to the distributing device, become frozen, they may be very quickly thawed out. The closure 15 may be more or less incompletely closed, thus distributing part of the combustion gases to the tank flues and part of them directly into the heat chamber 2. For example, in cold weather the closure 15 may be left in position to slightly decrease the passage into the tank flues, so that a certain amount of the combustion gases will pass directly to the heat chamber 2 to in-

crease the heating effect on the contained apparatus and prevent freezing.

The arrangement of the draft tubes in the tank with repeated passage of the combustion gases lengthwise of the tank through these tubes, affords especially effective heating of the material in the tank. Furthermore, because of the flexibility of the system of draft tubes, due to their curved return bend connections at their ends, and the fixing of this system of tubes only where the main draft tube 5 and the final draft tubes 11 pass through the header plate 3, and due to the loose mounting of the tubes in the supports or baffles 4, these tubes are left free to contract and expand without appreciable strain on the tubes themselves or upon their connections to the header plate 3. It will be seen, therefore, that I have provided an especially effective heater for the tank which is adapted to remain in good working condition throughout long periods of operation.

On account of the great length of passage of the combustion gases through the system of draft tubes, I have found that an especially effective provision for maintaining combustion within these tubes is desirable. I have found that by merely depending upon the combustion maintained within the combustion chamber or tube 14 at the outlet or nozzle 20 of the heater, there is often an accumulation of unburned or incompletely burned fuel in remote spaces of the draft tubes which, becoming ignited after an interval of poor combustion, result in explosions in the draft tubes which, of course, produce shocks on the structure; and what is especially troublesome is the blowing out of the flame in the combustion chamber 14 so that the heater ceases to operate except to discharge a full volume of unburned fuel, together with air, into the draft tubes, which may, without close attention of the operator, cause serious explosion in the apparatus. I have found that these difficulties are overcome by providing the by-pass 21 for air to pass directly from the air inlet pipe 19 into the pipe 22, so that this pipe 22 with its outlet end a considerable distance forward from the burner nozzle 20, discharges air with considerable velocity under the aspirating action of the combustion and draft in this region of the combustion chamber, so that this supplementary supply of air is carried with the combustion gases into the draft tubes to provide an ample support for combustion therein. On account of the great efficiency of the burner and combustion chamber arrangement which I have provided, the combustion is especially intense in the region of the entrance to the main draft tube 5; and I have found that the cast-iron liner 16 greatly adds to the durability of this part of the apparatus.

The provision by which any excess flow of liquid from the distributing device or spray bar 23a, 23b, may be immediately drawn back under the suction action, as indicated in Figure 13, is especially valuable. Heretofore considerable difficulty has been had in avoiding the scattering of the road-treating liquid in areas where it is not required to be used, and in which it is undesirable. For example, the road or street being treated with the liquid may cross another road or street which is paved with material which would not be improved, but would be marred and soiled with the liquid, as, for instance, a concrete roadway. With my improved provision, just as soon as the operator sets the distributing valve from the position represented in Figure 12 to that

represented in Figure 13, the pump, instead of forcing liquid out through the spray bar, immediately begins drawing liquid back therefrom. Thus, there can be no drippage on surfaces over which the apparatus is passing after this setting of the valve.

The advantage of convenient replenishing of the material in the tank 1 with the valve setting in this suction position has been mentioned. It will be seen that this suction position will be the one given to the distributing valve at any time the operator wishes to discontinue the spraying operation; and whenever he stops for replenishing the material, he will have the apparatus in the condition indicated in Figure 13, and on whichever side of the apparatus he finds the supply of material, he needs only to close the valve 32 near the opposite side of the apparatus and open the connection 26a at the side where the filling hose nozzle is to be inserted, which will then automatically close the adjacent intermediate portion of the spraying device off from the spray bar, as was done by closing the valve 32 near the other side of the apparatus. The convenient operation of either valve 32 from the operator's position, and shifting of the spray bar in the same convenient manner gives the operator complete and immediate control of the distribution of the liquid at all times during the travel of the apparatus. Another provision for control of the spraying is afforded by partial setting of the distributing valve from the circulating position of Figure 11 to the spraying position of Figure 12. This leaves the passages only partly open at the valve casing ports 44 and 45; and I have avoided the building up of excessive pressure of the liquid when the valve is set this way by so proportioning the ports that the passage at port 45 where the liquid passes to the pump, is considerably smaller under these conditions than the passages at 42 and 44, where the liquid is being forced from the pump to the spray bar. I find that ordinarily no pressure relief valves or the like are necessary, it being sufficient to so proportion the passages that the pump cannot take in any more liquid than can be readily discharged from the apparatus. However, it will be understood that pumps may be obtained with pressure relieving by-pass devices, or that a pressure relieving valve may be connected in the system in addition to the distributing valve. It will be seen that by a distributing valve of comparatively simple design I have provided for a comparatively large number of different operations by the mere four different settings of the valve. This not only makes for economy in construction, but for simplicity of maintenance, and adds to the reliability of the apparatus.

I have illustrated and described a preferred embodiment of my invention in considerable detail, but it will be understood that modifications other than those alluded to herein may occur in practice, and therefore that I am not limited to such precise disclosure, but what I claim as new and desire to secure by Letters Patent, is:—

1. In apparatus of the character described, a tank, a discharge device, forcing means connected with said tank and said discharge device whereby said forcing means may force liquid from said tank through said discharge device, the connection between said forcing means and said discharge device comprising an intermediate portion, means to connect said intermediate portion with a source of liquid supply, means to prevent communication between said intermediate

portion and said discharge device, and a valve so connected to said tank and said forcing means, and so arranged, as to reverse the connection of said forcing means with said tank and said discharge device and thereby to draw liquid from said discharge device, or from said source of liquid supply, accordingly as communication is permitted or prevented between said discharge device and said intermediate portion of said connection, said means to prevent communication comprising a valve seat in said intermediate portion of said connection between the forcing means and the entrance of said connection to the discharge device, and a nozzle forming part of the connection to the source of liquid supply, extending across said entrance and having a portion making liquid excluding contact with said valve seat.

2. In apparatus of the character described, a tank, a plurality of discharge devices, forcing means connected with said tank, and having connections with the respective discharge devices, each comprising an intermediate portion with an entrance to be connected with a source of liquid supply, valves in the respective connections between their intermediate portions and the forcing means, operatable to close or open the respective connections, a nozzle to enter the entrance of either intermediate portion, to extend across and close the entrance of the intermediate portion to the respective discharge device, and a valve so arranged, and so connected to said forcing means and said discharge device as to direct liquid from the discharge side of said forcing means through said discharge device, or to direct liquid from said discharge device to the suction side of said forcing means.

3. In apparatus of the character described, comprising a tank and a pump, each with an inlet and an outlet, and a discharge device, a valve comprising relatively movable members each with a plurality of ports, the ports of one member having connections, respectively, with the inlet and outlet of the pump, the inlet and outlet of the tank, and the discharge device, the ports of the members being so constructed and arranged that the members are relatively movable, to connect the tank inlet with the pump outlet and the tank outlet with the pump inlet, or the discharge device with the pump outlet and the tank outlet with the pump inlet, or the pump outlet with the tank inlet and the pump inlet with the discharge device, or both the pump outlet and inlet with the discharge device.

4. In apparatus of the character described, comprising a tank and a pump, each with an inlet and an outlet, and a discharge device, a valve comprising relatively movable members each with a plurality of ports, the ports of one member having connections, respectively, with the inlet and outlet of the pump, the inlet and outlet of the tank, and the discharge device, the ports of the members being so constructed and arranged that the members are relatively movable to connect the discharge device with the pump outlet and the tank outlet with the pump inlet, or the pump outlet with the tank inlet and the pump inlet with the discharge device, and means for disconnecting said valve from the discharge device and connecting said valve to a source of liquid supply for replenishing the tank by means of the last mentioned order of connections effected by the valve.

5. In apparatus of the character described, a tank having an inlet and an outlet, a discharge

device, a forcing device having a discharge side and a suction side, a valve member having a casing and a plug rotatable in said casing, said plug having two chambers in one plane across the plug axis, and having two ports leading radially from each one of said chambers, and having a third chamber displaced axially from the first two with two ports leading radially therefrom at the side of the plug at which two ports lead from respective ones of the first two chambers and with a third port leading axially from said third chamber at the adjacent end of the plug, and said casing having a first series of three radial ports in the plane of the ports of the first two plug chambers, either two adjacent ports to connect with either one of the first two chambers while the third port connects with the other one of said first two chambers, and said casing having a second series of two radial ports substantially in an axial plane with the non-adjacent ports of the first series, and having an axial port in its end continuously connecting with the axial port of the plug; the casing ports of the first series connecting, respectively, with the tank inlet, the discharge side of the forcing device, and the discharge device, the casing ports of the second series connecting, respectively, with the tank outlet and the discharge device, and the axial casing port connecting with the suction side of the forcing device, whereby the valve plug, upon rotation to respective ones of four positions, connects for circulation through the forcing means and the tank inlet and outlet, or for discharge from the tank outlet and the forcing means and discharge means, or for suction from the discharge means and through the forcing means into the tank inlet, or for circulation through and drainage of the valve and connections and the forcing means.

6. Apparatus as set forth in claim 5, in which the discharge means is provided with a filling inlet that will admit the nozzle of a filling hose, and a seat adjacent said inlet against which the end of the nozzle may seat, said nozzle then closing off the normal passage in the discharge means for the discharging operation, and permitting filling of the tank through the hose from a source of supply, when the valve plug is set for suction.

7. Apparatus as set forth in claim 5, in which the discharge device is provided with two filling inlets, one at each side of the apparatus, each having opening and closing means whereby it may be closed when the valve plug is set for discharge, but may be opened for filling the tank from a source at the respective side of the apparatus, connected to the respective filling inlet, when the valve plug is set for suction, said discharge device also being provided with valves, one between each filling inlet and the connection of the discharge device to the valve casing, to be opened for discharge operation, and the valve at one side being closed for use of the filling inlet at the opposite side.

8. In apparatus of the character described, a tank and a forcing means each having an inlet and an outlet, a discharge device, and a valve having connections, respectively, with the forcing means inlet and outlet, the tank inlet and outlet, and the discharge means, and being so constructed and arranged that it may be set to connect for circulation through the forcing means and the tank inlet and outlet, or for discharge from the tank outlet through the forcing means and the discharge device, or for suction from the discharge means through the forcing means into the

tank inlet, or for circulation through and drainage of the valve and connections and the forcing means.

9. Apparatus as set forth in claim 8, in which the discharge means is provided with a filling inlet and means whereby the filling inlet may be closed when the valve is set for discharge or suction, but may be opened for filling the tank when the valve is set for suction, said discharge device also having means for closing its normal discharge and suction passage when the filling inlet is opened for filling the tank by suction.

10. Apparatus as set forth in claim 8, in which the discharge device is provided with two filling inlets, one at each side of the apparatus, each with means whereby it may be closed for normal discharge or suction by the apparatus, but may be opened for filling the tank when the valve is set for suction, said discharge device also having means for closing its normal discharge and suction passage when either filling inlet is opened for filling the tank by suction.

11. Apparatus as set forth in claim 8, in which the discharge device is provided with a filling inlet that will admit the nozzle of a filling hose, and a seat adjacent said inlet against which the end of the nozzle may seat to close off the normal discharge passage of the discharge means, and permitting filling of the tank by setting the valve for suction.

12. Apparatus as set forth in claim 8, in which there is included a heater in connection with the outlet of the forcing device, connecting said outlet to the valve, through which the contents of the tank flows when the valve is set for circulation through the tank.

13. Apparatus as set forth in claim 8, in which the valve has an inlet communicating with its connection to the inlet of the forcing device, whereby a diluent for the contents of the apparatus may be introduced while the valve is set for drainage and circulation through the apparatus.

14. Apparatus as set forth in claim 5, in which the axial port of the valve casing has an inlet for introduction of a diluent while the valve plug is set for drainage and circulation through the apparatus.

15. In apparatus of the character described, a tank, a discharge device, a forcing device having a suction side and a discharge side, and a valve having connections with the tank, the discharge device, and the suction and discharge side of the forcing device, said valve being so constructed that in one position it connects the tank to the suction side of the forcing device and the discharge side of the forcing device to the discharge device, in another position it connects the suction side of the forcing device to the discharge device and the discharge side of the forcing device to the tank, and in another position it opens for drainage all connections except the connection to the tank.

16. In apparatus of the character described, a tank, a discharge device, a forcing device having a suction side and a discharge side, and a valve having connections with the tank, the discharge device, and the suction and discharge side of the forcing device, said valve being so constructed that in one position it connects the tank to the suction side of the forcing device and the discharge side of the forcing device to the discharge device, in another position it connects the suction side of the forcing device to the discharge device and the discharge side of the forcing device to the tank, and in another position it opens

for drainage all connections except the connection to the tank, a heater for said tank and a heat chamber surrounding said forcing device and said valve and said connections, and receiving heat from said heater.

17. In apparatus of the character described, a tank, a discharge device, a forcing device having a suction side and a discharge side, and a valve having connections with the tank, the discharge device, and the suction and discharge side of the forcing device, said valve being so constructed that in one position it connects the tank to the suction side of the forcing device and the discharge side of the forcing device to the discharge device, in another position it connects the suction side of the forcing device to the discharge device and the discharge side of the forcing device to the tank, and in another position it opens for drainage the connection between the valve and the discharge device and the connections between the valve and the suction and discharge sides of the forcing device.

18. In apparatus of the character described, a tank, a discharge device, a forcing device having a suction side and a discharge side, and a valve having connections with the tank, the discharge device, and the suction and discharge side of the forcing device, said valve being so constructed that in one position it connects the tank to the suction side of the forcing device and the discharge side of the forcing device to the discharge device, in another position it connects the suction side of the forcing device to the discharge device and the discharge side of the forcing device to the tank, and in another position it opens for drainage the connection between the valve and the discharge device and the connections between the valve and the suction and discharge sides of the forcing device, a heater for said tank and a heat chamber surrounding said forcing device and said valve and said connections, and receiving heat from said heater.

19. In apparatus of the character described, a tank, a discharge device, a forcing device having a suction side and a discharge side, and a valve having connections with the tank, the discharge device, and the suction and discharge side of the forcing device, said valve being so constructed that in one position it connects the tank to the suction side of the forcing device and the discharge side of the forcing device to the discharge device, in another position it connects the suction side of the forcing device to the discharge device and the discharge side of the forcing device to the tank, in another position it connects both the discharge and suction side of the forcing device with a closed circulatory system for circulation, and in another position it opens for drainage the connection between the valve and the discharge device and the connections between the valve and the suction and discharge sides of the forcing device.

20. In apparatus of the character described, comprising a tank and a pump, each with an inlet and an outlet, and a discharge device, a valve comprising relatively movable members each with a plurality of ports, the ports of one member having connections, respectively, with the inlet and outlet of the pump, the inlet and outlet of the tank, and the discharge device, said valve being so constructed and arranged that the

members are relatively movable, to connect the tank inlet with the pump outlet and the tank outlet with the pump inlet, or the discharge device with the pump outlet and the tank outlet with the pump inlet, or the pump outlet with the tank inlet and the pump inlet with the discharge device.

21. In apparatus of the character described, comprising a tank and a pump, each with an inlet and an outlet, and a discharge device, a valve operatively connected respectively with the inlet and the outlet of the pump, the inlet and the outlet of the tank, and the discharge device, said valve being so constructed as to connect the tank inlet with the pump outlet and the tank outlet with the pump inlet for circulation, or the tank outlet with the pump inlet and the pump outlet with the discharge device for spraying, or the tank inlet with the pump outlet and the pump inlet with a discharge device for suction.

22. In apparatus of the character described, comprising a tank and a pump, each with an inlet and an outlet, and a discharge device, a valve operatively connected respectively with the inlet and outlet of the pump, the inlet and outlet of the tank, and the discharge device, said valve being so constructed as to connect the tank inlet with the pump outlet and the tank outlet with the pump inlet for circulation, or the tank outlet with the pump inlet and the pump outlet with the discharge device for spraying, or the tank inlet with the pump outlet and the pump inlet with the discharge device for suction, and means for shutting off said discharge device and opening a filling port to the pump inlet when said valve has the tank inlet connected with the pump outlet.

23. In apparatus of the character described, comprising a tank and a pump, each with an inlet and an outlet, and a discharge device, a valve comprising relatively movable members each with a plurality of ports, the ports of one member having connections, respectively, with the inlet and the outlet of the pump, the inlet and outlet of the tank, and the discharge device, said valve being so constructed and arranged that the members are relatively movable to connect the discharge device with the pump outlet and the tank outlet with the pump inlet, or the pump outlet with the tank inlet and the pump inlet with the discharge device, and means for disconnecting the discharge device from said pump inlet and connecting a source of liquid supply for replenishing the tank by means of the last mentioned order of connections effected by the valve.

24. In apparatus of the character described, a tank and a forcing means each having an inlet and an outlet, a discharge device, and a valve having connections, respectively, with the forcing means inlet and outlet, the tank inlet and outlet, and the discharge means, and being so constructed and so arranged that it may be set to connect for circulation through the forcing means and the tank inlet and outlet, or for discharge from the tank outlet through the forcing means and the discharge device, or for suction from the discharge means through the forcing means into the tank inlet.

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