Oct. 16, 1934. J. W. POULTER 1,976,857

METHOD OF ELEVATING PAVEMENTS, FILLING VOIDS, CREVICES, AND THE LIKE

Original Filed Sept. 29, 1932 4 Sheets-Sheet 1

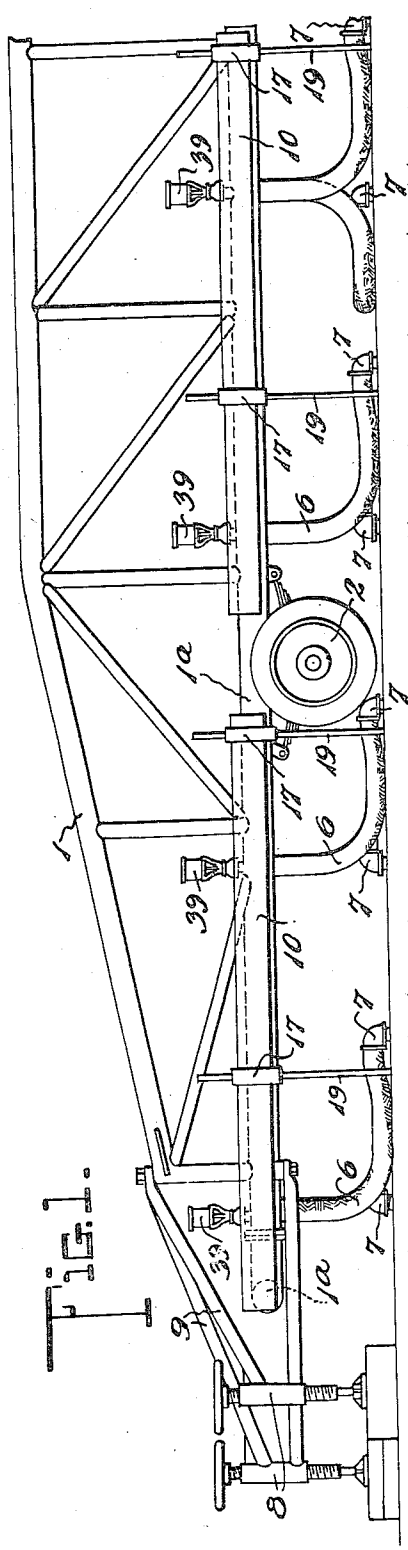


Fig. 1.

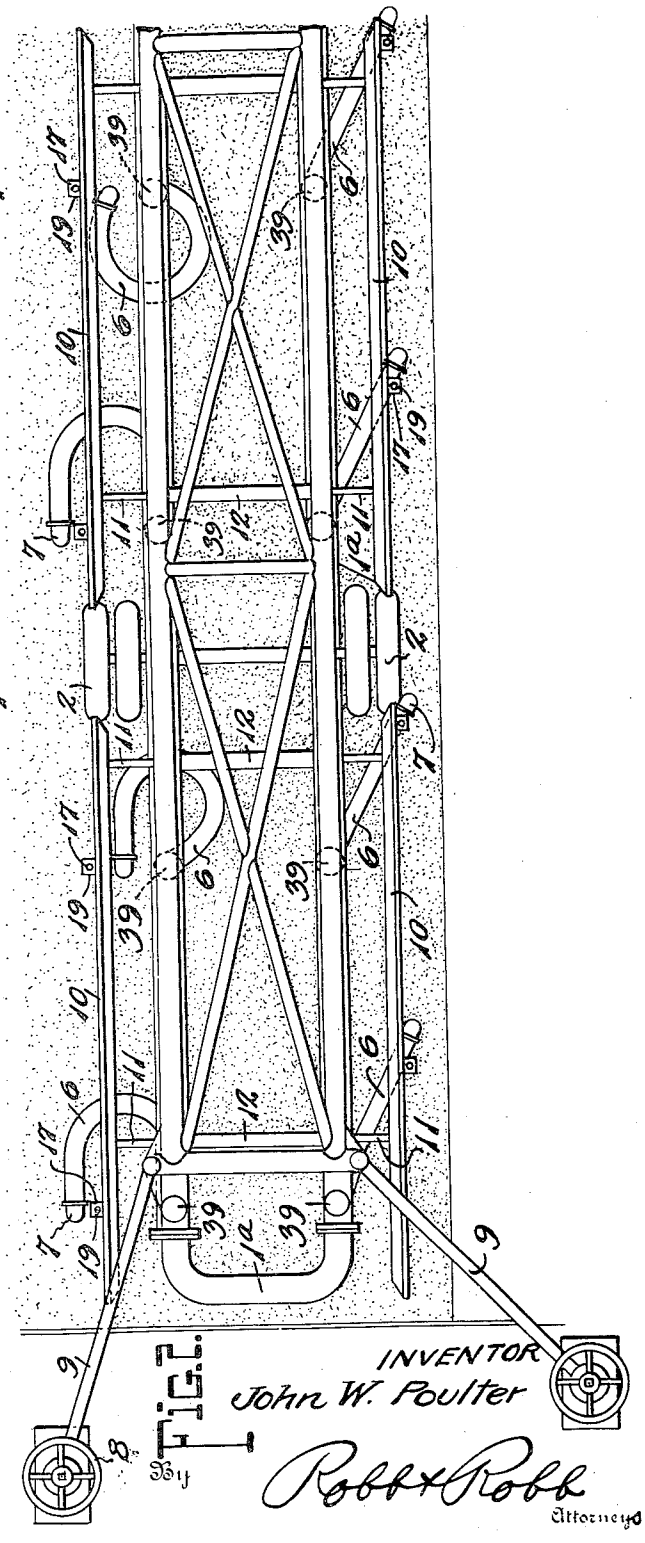


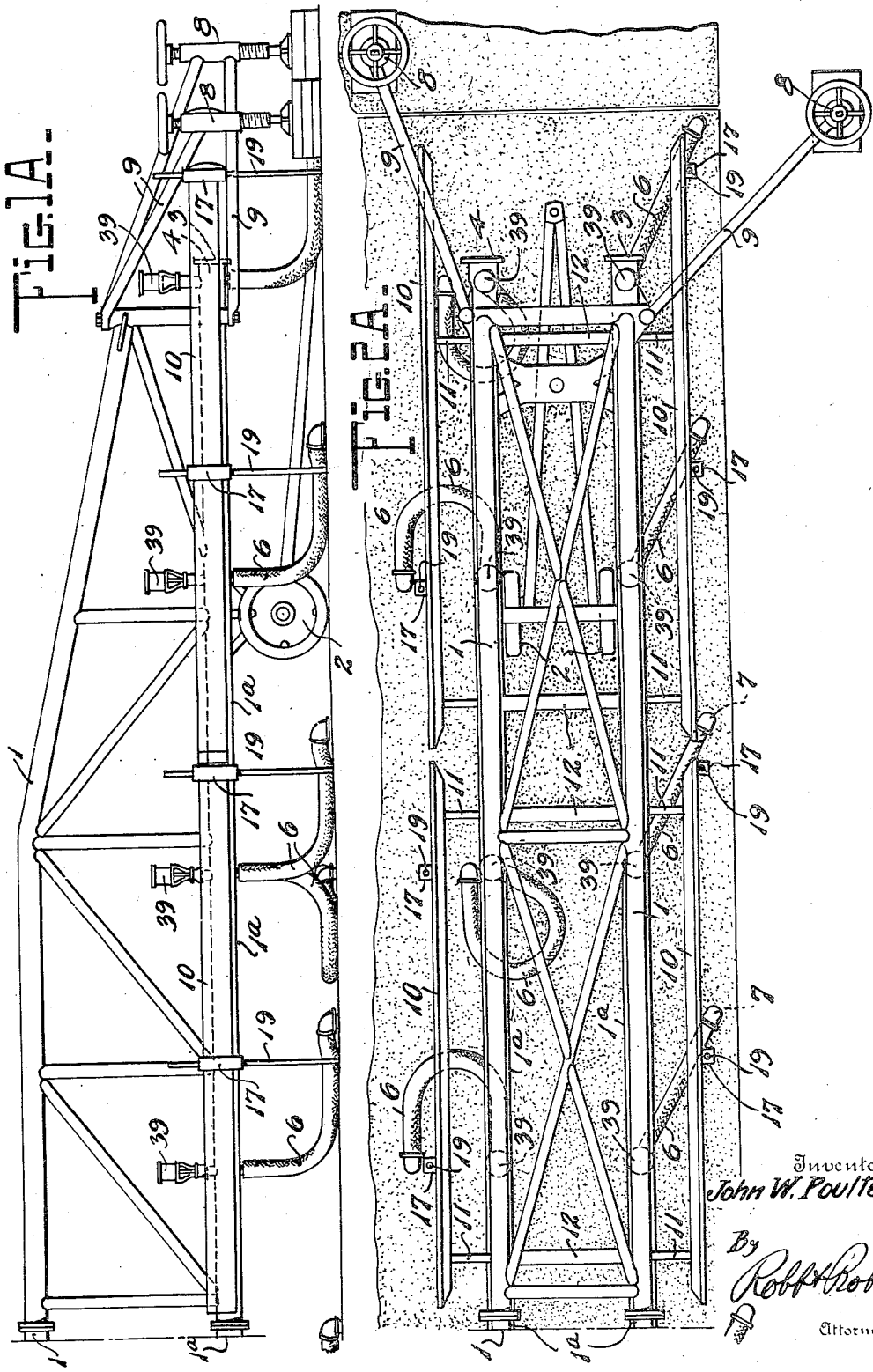
Fig. 2.

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Fig. 3.

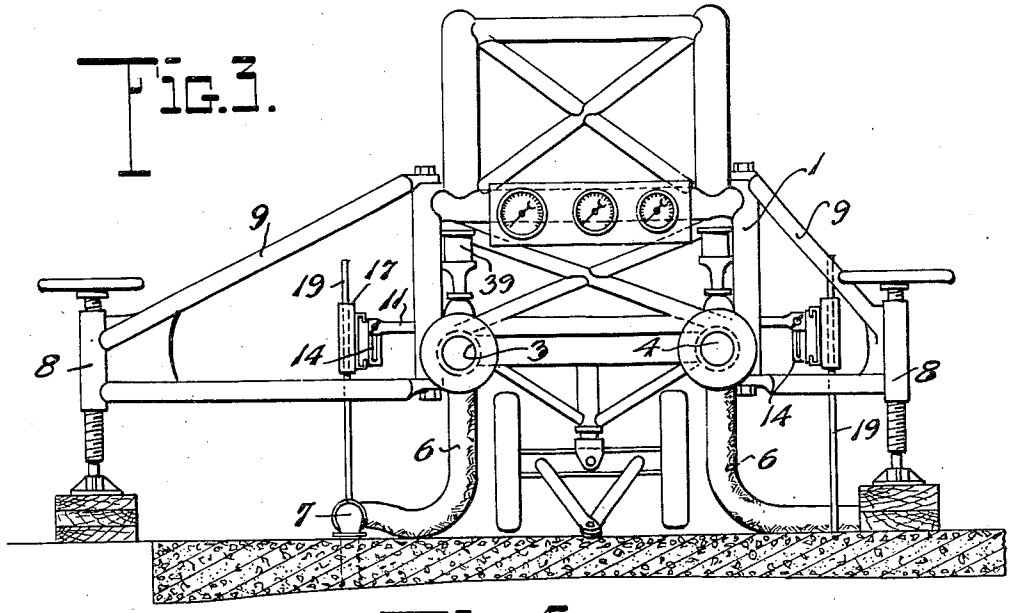


Fig. 4.

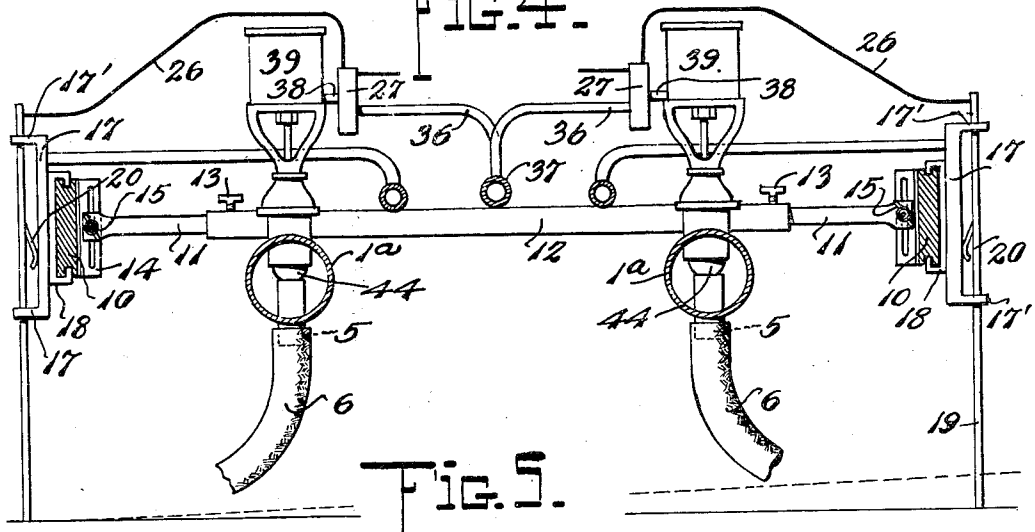
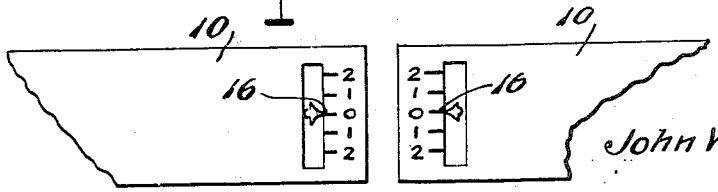


Fig. 5.



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Fig. 6.

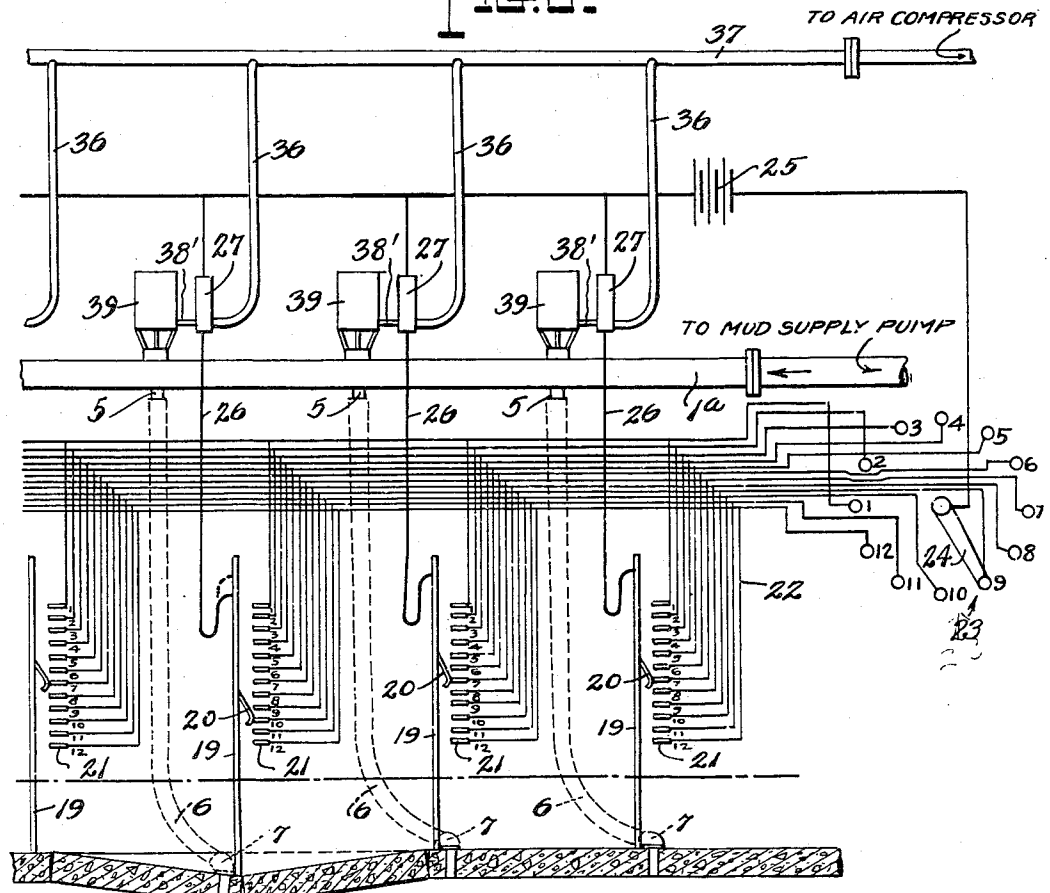


Fig. 7.

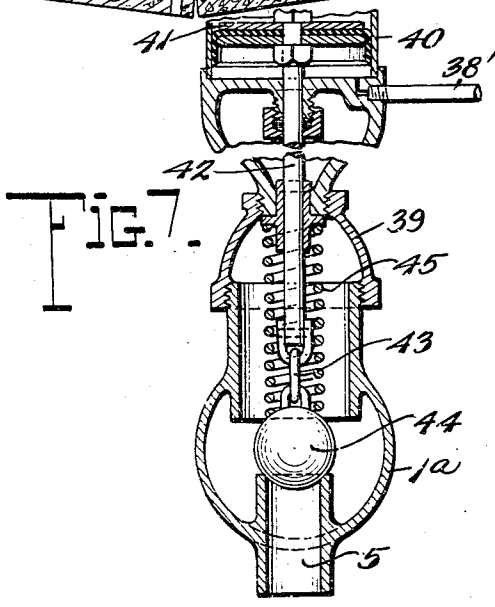
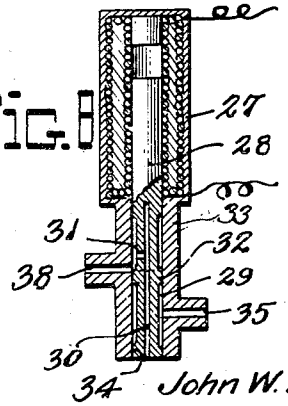


Fig. 8



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UNITED STATES PATENT OFFICE

1,976,857

METHOD OF ELEVATING PAVEMENTS, FILLING VOIDS, CREVICES, AND THE LIKE

John W. Poulter, Mount Pleasant, Iowa, assignor to National Equipment Corporation, Milwaukee, Wis., a corporation

Original application September 29, 1932, Serial No. 635,440. Divided and this application September 18, 1933, Serial No. 689,963

12 Claims. (Cl. 61—35)

The present invention relates to a novel method of elevating pavements, filling voids, crevices, and the like, particularly as this is involved in the maintenance of the subgrade beneath rigid types of highway pavement, the present application being a division of my copending application filed September 29, 1932, Serial No. 635,440. It is to be understood, however, that my method may be applied wherever it is necessary to fill voids, without regard to its relation to pavement structure, the primary feature of novelty residing in the introduction of filling material into the void and utilizing the pressure exerted by said material to control the flow or supply of the material to the point of fill.

In order to more clearly understand the purposes of the present invention as it is applied to highway maintenance, it may be stated that owing to the necessity for strict adherence to State or Federal regulations appertaining to highway construction, a great amount of care is exercised by the contractor to lay the slab to the exact designated grade. In some instances, where more than one-eighth of an inch of light can be seen under a ten-foot straight edge, a contractor will be required to put in a new section and in other instances to grind down the high spots.

Furthermore, it is necessary to lay the slab upon earth fills which, due to natural conditions, settle unevenly causing the slab to settle in a similar manner, even within a very short time. A slab which, at the time of construction, was entirely satisfactory, frequently develops waves many times greater than that allowed at the time of construction, with the result that almost without exception, a slab which has been down more than two years will have many waves in it of an inch or more which are very noticeable in driving over it.

Experience has shown that in this uneven grade settlement, the fill has settled away from the slab until in many places there is not more than fifty percent of the pavement area which is directly supported by the subgrade. It is this uneven grade settlement, something which cannot be prevented, which is causing highway paving to fail under present day heavy traffic, and not faulty material, construction or wear from the surface. Obviously, if a highway slab is given the proper support, it will last many years longer than if it has to serve as a bridge over an uneven subgrade. This settlement is usually worse at bridge approaches and over high fills.

These conditions first led me to the development of a machine for maintaining or correcting highway defects which is set forth in my copending application Serial No. 542,153, filed June 4, 1931, but this machine, provided with only one or two nozzles, is entirely insufficient or too slow to maintain the subgrade under an entire highway system. In my copending application above referred to is disclosed and claimed an apparatus for carrying out my method, said apparatus being of a size which, in the first place, will permit of the treatment of the slab at a large number of points, and in the second place for the purpose of subgrade correction or alteration, embodies an automatic control for variably regulating the lift of the slab at such points under variable pressure conditions to insure the gradual elevation of the slab in sequence corresponding to the differences in the extent of lift or pressures necessary to bring the slab to normal or desired level.

To this end the apparatus, which is also disclosed herein preferably embodies adjustable engaging means for predetermining the elevation to which the slab is to be raised, a plurality of distributing means for delivery of the filling material under pressure at different points and a control device for bringing into play and automatically discontinuing the several distributing means according to the requirements relating to the varying levels and pressures. By my special method of control and operation of this apparatus a large area of slab can be quickly brought into the position desired at a material decrease in labor and expense.

Other and further objects and advantages of the invention will be hereinafter set forth and the novel features thereof defined by the appended claims.

In the drawings:

Figs. 1 and 1*a* constitute a side elevation of an apparatus constructed in accordance with my invention;

Figs. 2 and 2*a* show a top plan view of the same;

Fig. 3 is an end elevation;

Fig. 4 is a transverse section showing more clearly the gage members and certain of the control valves for the filling material or pressure medium;

Fig. 5 is a detail view showing the gage board indicators;

Fig. 6 is a diagrammatic view showing the control device, its circuits, associated valves and slab operating devices for controlling the valves through the circuits;

Fig. 7 is a sectional view of a supply valve used with this apparatus; and

Fig. 8 is a pressure operated control valve for the supply valve.

Like reference characters designate corresponding parts in the several figures of the drawings.

Referring to the drawings and specifically describing a mechanical embodiment for carrying out my method 1 designates an elongated frame of tubular truss work of a length which will extend over a relatively large area of paving. This frame work is mounted upon wheels 2 or other ground supports so that it may constitute a trailer which may be attached to a tractor vehicle and readily brought to the location of the work. The bottom members 1*a* of the frame 1 constitute a large conduit to receive and distribute the filling material which constitutes the fluid pressure medium for lifting sections of the slab or filling in voids, crevices and the like, as hereinafter described.

This filling material is supplied from a suitable source such as a mixing and pumping apparatus referred to in my copending application hereinbefore mentioned. The pumping apparatus (not shown) is connected to the intake and outlet 3 and 4, respectively, so as to afford a circulation of "mud" or other suitable filling material in fluid form and under pressure. Any number of outlet hose connections 5 are provided in the bottom of this supply conduit, and hose pipes 6 of suitable length, provided with nozzles 7 are connected thereto.

At each end, the long frame 1 is connected to a pair of jack supports 8 through the medium of bracket arms 9, it being understood that when this apparatus is in operation, the weight is taken off the wheels 2 and the jacks employed to level the frame over the area of operation.

On the sides of the frame 1 are mounted what I term gage boards 10, these being carried by slidable arms 11 which extend into tubular fixed cross supports 12. Such an arrangement permits the boards to be adjusted laterally of the frame for reasons which will more fully appear as this description proceeds. The adjustment of the arms 11 may be fixed by clamping screws 13 or the like. The connection between the gage boards and the arms 11 is in the nature of slotted brackets 14, in the slots of which the clamping bolts 15 are adjustable. The vertical adjustments of these boards, each of which is provided with an indicator 16, shown in Fig. 5, affords a method of determining the quantity of filling material to be supplied or its height. Obviously if the filling material is injected beneath the slab such adjustments determine the proper level or pitch of the slab in relation to the level established by the adjustment of the main frame by means of its jacks 8.

Mounted upon the gage boards are a plurality of contact or commutator bars 17, provided with clips 18, the ends of which engage in longitudinal slots in the edges of the gage boards 10. There are as many of these contact bars as there are hose connections, one for each, and by virtue of the adjustment of the arms 11 and the slidability of the contact bars 17 on the gage boards it is possible to locate the pins or rods 19 adjacent the respective holes in the slab through which the hose connections 6 direct the filling material in operation of this apparatus or at the height to which the surface of the material in the void is to be raised. The rods 19 are slidable vertically in laterally extending eyes 17' and are held in adjusted positions by means of the spring fingers 20 which constitute electric contact brushes for cooperation with the series of contacts carried by the commutator bars 17. In other words, each of the bars 17 carries a plurality of electrical contacts 21 in vertical arrangement as diagrammatically shown in Fig. 6, each corresponding contact being connected by the conductor 22 to a common contact in the control switch device 23. The switch member 24 of this device and the commutator contacts 21 are in circuit with a suitable source of electric current designated 25, the circuit to said contacts being completed by the wires 26 through solenoid operated air valves 27 to the rods 19 carrying the fingers 20.

Each of the air valves, shown clearly in Fig. 8, comprises the core member 28 having an elongated valve extension 29 provided with a central exhaust passage 30, having a lateral port 31 above the upper annular shoulder 32. The extension 29 is mounted within the valve casing 33 forming a part of the solenoid housing, said casing being closed by a second shoulder 34. The intake port 35 of this casing communicates through the conduit 36 with the air line 37, leading to a compressor (not shown) by means of which air under pressure is fed to the casing and through the outlet port 38 thereof and pipe 38' to a supply valve 39.

One of these supply valves, shown in Fig. 7 in detail, controls each hose connection 5. Such valves are each preferably composed of a cylinder 40 within which an air piston 41 operates. The stem 42 of the piston is connected by a link or chain 43 to a ball valve 44 seating on the entrance to the coupling 5. Normally a spring 45 holds this valve upon its seat but when pressure is admitted to the cylinder 40 the valve ball is raised from its seat by the upward travel of the piston 41 to thereby admit the fluid filling material to the hose leading to the associated opening in the slab. The system of subgrade and slab maintenance can best be understood by a summary of the operation of the apparatus described with particular reference to the diagrammatic showing in Fig. 6.

Let us first assume that openings through the slab to be treated have been drilled at the various points of depression and where lifting pressure is to be applied. The machine is then moved into position over the slab and leveled upon its jack supports and the gage boards adjusted to indicate the proper or normal level to which the slab or fill is to be raised. If the slab is to be raised to a straight grade, the gage boards 10 are all set with their indicators 16 at zero, but if the slab over which the frame extends is to be raised to an uneven grade or is on a vertical curve, this is taken care of by adjusting the gage boards accordingly at their indicators. Each hose connection is now inserted in the near slab opening to a point just below the slab or to a suitable depth into the subgrade soil itself and the rods 19 moved downwardly until their lower ends rest upon the surface of the slab adjacent to its associated opening or hose connection or upon the surface of the subsoil itself. It must be understood at this point that no two holes will take mud at the same pressure. Unless proper control were exercised over the operation, the hole taking the mud at the lowest pressure would get all of the material and thus would cause the slab to bulge and crack at this point. The contact system of the invention has therefore been devised to take care of this condition. The No. 1 contact points represent the level to which the slab is to be raised. The mud valve through which mud is going to the

lowest level will be opened first, causing the slab at this point to be raised first. Let up suppose that at this level there are five different mud valves opened under the control of the switch device 23 and that at one of these valves five pounds of pressure is required, at a second eighteen pounds, at a third thirty pounds, at the fourth eighty pounds, and at the fifth one hundred twenty pounds. As pressure is built up to the five pounds, the slab at No. 1 valve will be raised. The rod 19 associated with the slab at this point will cause the contact to be broken as the brush carried thereby passes off of the contact element and in consequence the supply valve for the pressure fluid will close. The pressure will then build up to eighteen pounds whereupon the second valve will be closed; then as the pressure builds up to the thirty pounds, eighty pounds and one hundred twenty pounds, respectively the remaining valves will automatically close in sequence. This operation is repeated in each stage of elevation until the whole slab is at its desired elevation.

Reference to Fig. 6 will make this operation clear. There it will be seen that the brush of the second rod 19 is at the lowest contact point of all of the contact brushes which is contact number 10. All of the others are on contact No. 7. The operator in carrying out the operation of this apparatus first moves the switch member 24 to No. 12 point on the switch control 23. Since there are no contact brushes on No. 12 points of the commutator members none of the circuits in which these members are included are closed. Consequently no operation takes place. The switch member is then moved to No. 11 where the same condition obtains. As the switch is now moved to No. 10 point the circuit is closed at the second hole, causing the solenoid core 28 of the air valve 27 to move upwardly. Air pressure from the line 37 now passes through the valve casing and into the cylinder 40 of the supply valve, opening the valve 44, whereupon mud will flow into the opening under the slab until said slab is raised and the brush moved upwardly, braking the solenoid circuit. The brush is now on point No. 9.

As the next stage of operation, the operator moves the member 24 again to the next contact point No. 9 and this will again open the supply valve previously referred to until the slab is raised a second increment of movement which breaks the circuit as the brush passes to the contact element 8. This action occurs again as the switch is moved to point No. 7. When moved to No. 7 all of the circuits shown in the diagrammatic figure will be closed and all of the holes will receive mud under the various pressure conditions required as explained in the foregoing description. Continuation of movement of the switch member 24 point by point raises the slab gradually upwardly until point No. 1 is reached on the commutator bars where the slab is disposed at the desired elevation.

It will thus be seen that by the use of this system of subgrade treatment a paving slab of considerable size may be elevated at the points of depression where the pressure fluid is introduced beneath the same or voids beneath pavements and other structures may be filled.

It is to be understood that in carrying out this method of treatment of the pavement I may employ apparatus of different construction than that disclosed in the form herein illustrated and that changes may be readily made in the detail construction without departing from the spirit of the invention and within the scope of the appended claims.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. The method of highway maintenance or the like involving the filling of voids beneath or elevation of the highway surface, which comprises the steps of forcing the filling material beneath said surface until movement thereof is produced and controlling the flow of said material by the movement imparted to the surface by said introduction.

2. The method of filling voids, crevices and the like in subgrades, which comprises the steps of introducing filling material at a suitable depth in the subsoil and stopping the flow of the material by the movement of the subsoil surface created thereby when a predetermined level of said subsoil has been reached.

3. The method of raising a structure such as sunken pavements or the like, comprising forcing a pressure fluid medium under the pavement at various points and regulating the flow of the medium by the movement imparted to the pavement at said points according to the extent of desired elevation of the pavement at said points.

4. The method of raising a structure such as sunken pavements or the like, comprising forcing a pressure fluid medium under the pavement at various points, and regulating the flow of the medium by the movement imparted to the pavement at said points according to the extent of pressure and quantity of pressure fluid medium required to effect movement of the pavement a predetermined degree at each point.

5. The method of raising a structure such as sunken pavements or the like, comprising forcing a pressure fluid medium under the pavement at various points, and regulating the flow of the medium by increments of movement of the pavement to raise the pavement stage by stage from the lowest depression to the level of the higher depressions and from the later to the normal level.

6. The method of raising a structure such as sunken pavements or the like, comprising forcing a pressure fluid medium under the pavement at points varying in the amount of depression from the normal level and regulating the flow of the medium by movements of the pavement at said points so as to effect elevation of all points at a particular level in relation to the other points of other levels.

7. The method of raising a structure such as sunken pavements or the like, comprising forcing a pressure fluid medium under the pavement at various points, the amount of pressure fluid medium varying according to the amount of depression from the normal level, and regulating the flow of the medium by movements of the pavement at said points to effect elevation at points of the lowest level first, then all points at higher levels in sequence.

8. The method of raising a structure such as sunken pavements or the like, comprising drilling openings in the pavement at different points of depression, injecting into each of the openings a filling material under pressure, cutting off the flow of said material by movement of the pavement at one or more of the openings when a predetermined elevation has been effected, and then applying said pressure medium at said one or more openings in conjunction with the applica-

tion of said medium at other openings, until elevation of the whole pavement thereby treated is gradually brought to normal level.

9. The method of treating highway structures for maintenance thereof which comprises the steps of introducing into said structure a fluent material to constitute a filler, and causing the flow thereof to be cut off by a predetermined movement of said filler material.

10. In highway maintenance the method of raising the level of the constituent road bed material to a predetermined plane comprising forcing into the road bed a fluent filler which becomes a permanent part of the road bed, and cutting off the flow of the filler by upward movement of the road bed material.

11. In highway maintenance the method of repairing defects due to subsidence of portions of the roadway comprising forcing beneath the pavement at the point of depression a fluent filler which becomes a permanent part of the road bed whereby to raise the level of the constituent road bed material to a predetermined plane, and cutting off the flow of the fluent filler by the upward movement of road bed material to said predetermined plane.

12. The method of raising a portion of a pavement to a predetermined position comprising forcing a fluent filling material beneath said portion, and cutting off the flow of said material by the resulting movement of said portion to said predetermined raised position.

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