Jan. 16, 1934. J. FIOCK 1,943,914

METHOD AND MEANS FOR RAISING SUNKEN PAVEMENTS AND THE LIKE

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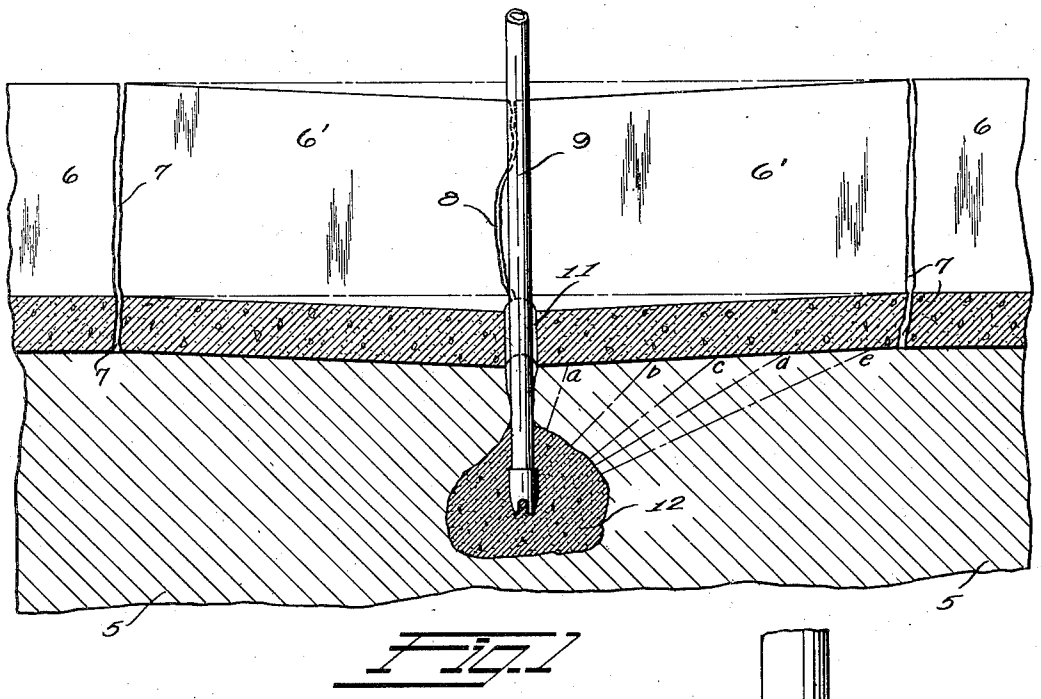


FIG. 1

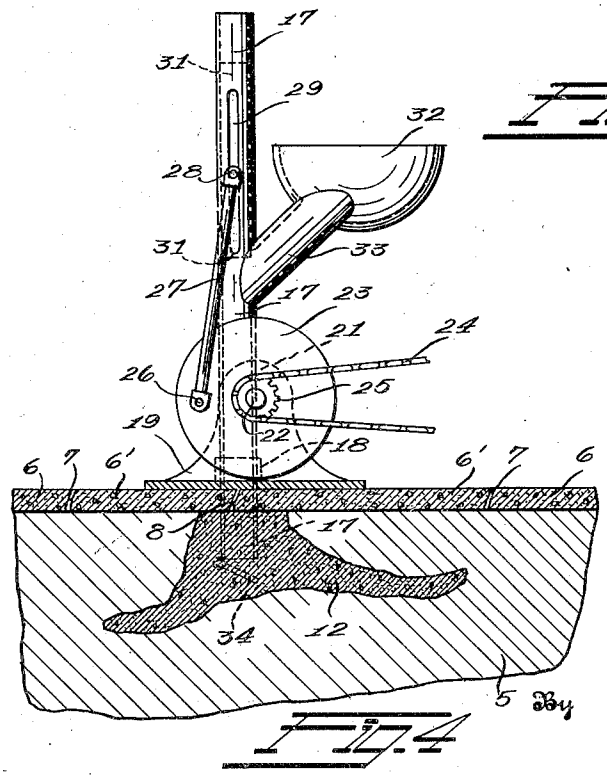


FIG. 4

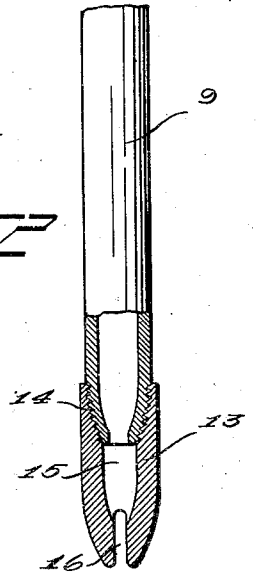


FIG. 2

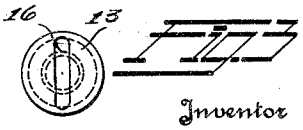


FIG. 3

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METHOD AND MEANS FOR RAISING SUNKEN PAVEMENTS AND THE LIKE

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6 Claims. (Cl. 61—35)

This invention relates to methods and apparatus for raising sunken pavements or the like, for filling in foundations, and for reenforcing a foundation or any type of earth-supported structure to prevent settling thereof.

More specifically stated, this invention resides in methods and apparatus for forcing or tamping a loose or plastic structural material into packed engagement with a portion of the earth's crust beneath the surface of the latter for the purpose of attaining the results outlined in the preceding paragraph.

It is a primary object of the present invention to raise a sagging or sunken structure, such as the concrete pavements of streets and highways: without destroying the sunken structure and without the use of any jack, pry or hoisting machinery; without digging up or tearing away any curbs or shoulders, subsoil, plants or other permament and ornamental obstacles; and without causing any appreciable interference with traffic.

This particular phase of the invention is carried out by pumping, tamping or otherwise forcing a sufficient quantity of loose or plastic material under the sagging structure to lift the latter into its proper or original position. This preferably is accomplished by drilling or cutting a hole in the pavement at a point determined by a previous study of the particular situation, and then forcing the filling material downward through the hole to react under pressure against the earth's subsoil and the lower surface of the pavement in a manner to raise the latter. The resulting action partakes of the nature of the operation of a hydraulic press, the permanent subsoil of the earth serving as a cylinder for the reception of the substantially incompressible filling material, and the sunken portion of the pavement being movable under pressure to serve as the piston of the press. Since the effective lower surface of the latter is of an area many times greater than that of a cross section of the admitted stream of filling material, the pressure per square inch exerted on the said stream need not be excessively or impracticably high as one might have believed upon a preliminary consideration of the problem at hand.

For the purpose of more clearly disclosing the methods of this invention and for showing apparatus, somewhat diagrammatically, that may be employed for carrying them into effect, several illustrations are presented in the accompanying drawing. Other and further objects of my invention will appear from the following description, the appended claims, and the illustrations. In said drawing:

Figure 1 represents a longitudinal cross section taken through a perspective view of a sunken pavement that is being raised by one of the preferred methods of the present invention.

Figure 2 is a detailed view of the filling stem seen in Figure 1, the lower end of said stem being sectioned to illustrate one form of detachable pilot carried by the stem.

Figure 3 is a bottom plan view of the lower end of the filling stem of Figure 2.

Figure 4 is a view showing a pumping or tamping apparatus in association with a pavement section that it has just raised into proper position, the pavement and adjacent subsoil being shown as cut by a longitudinal plane passing vertically through the pavement on the forward side of the pumping portion of the apparatus.

With continued reference to the drawing, wherein like numerals are employed to designate like parts, and with particular reference to Figures 1 to 3:

The earth's crust or surface soil 5 has resting thereon a concrete sidewalk or pavement 6. The soil has settled or otherwise changed its shape since the original pavement was laid down that the latter has been fractured, as at 7 and 8, to form two adjoining sunken pavement sections 6' that are downwardly inclined toward the fissure 8.

A hollow filling stem 9 is inserted through a vertical hole 11 in the pavement and projects downwardly to a predetermined point in the earth. The stem may have been inserted in any one of several ways. The hole 11 may have been drilled through the pavement and thence downwards into the earth, and the stem subsequently dropped into position; the hole 11 may have been drilled through the pavement only, and the stem subsequently driven down into the earth after its insertion in the hole; or the stem may take the form of that of a well drilling outfit and hence be utilized to drill its own hole.

The stem may be simply a conduit for carrying filling material under pressure and discharging it, as shown at 12, beneath the sunken pavement, or it may comprise a cylinder for guiding a reciprocating pump piston or tamping plunger. Its lower end has a detachable pilot 13 secured thereto by any suitable joint such, for example, as a threaded connection 14. The pilot has a passage 15, in communication with the bore of the stem and terminating in a curved and elongated discharge opening 16. The design of this pilot is

subject to variation and a pilot of appropriate design is selected for each filling job. For example, the pilot may have an angled shape, and the discharge opening may be of different size and shape and differently disposed as, for example, at one side instead of at the point of the pilot. These variations will be determined by the character of the earth crust and subsoil, the manner in which the pavement has sunk or been fractured, etc.

The filling material will likewise vary for different soils and subsoils and with the size and character of the sink in the pavement. Plastic cement or concrete may be used, as well as loose materials such as earth, clay, etc. In fact any substance, which can be forced into position and which can thereafter become substantially incompressible should be found satisfactory.

When the material is first discharged from the pilot 13 it will first fill up any subterranean cavities or fissures and will then cause the surrounding earth to become compacted. When the surrounding earth has reached a substantially incompressible state it will react against the subsoil and transmit the filling pressures to the lower side of the pavement. As illustrated in Figure 1 by the broken lines radiating from the filling material, an infinite number of pressure forces will be transmitted to points *a*, *b*, *c*, *d*, *e* . . . . , below the sunken sections 6'. Each force has a vertical lifting component tending to raise the sunken section, each component depending for its value upon its distance and angle with respect to the filled material. It is for this reason that the stem 9 must be inserted at a proper predetermined point and to a proper depth.

The material will, of course, be pumped into the earth until the pavement has reached its horizontal dotted line position (Fig. 1), and the stem will then be withdrawn and its surrounding hole plugged or sealed up. The simplicity, convenience and low cost of this method should recommend its value and cause its universal adoption.

In Figure 4 there is illustrated an apparatus for not only discharging the filling material but also for forcing or tamping it into the earth beneath a sunken pavement (the latter having already been raised in the illustration). It comprises an open-ended tube or cylinder 17 in lieu of the stem of Figure 1, and, since the pavement sections 6' are shorter than those of Figure 1, the lower end of the tube is not inserted to as great a depth as was that of said stem.

The tube 17 is supported in upright position in a guiding sleeve 18 that forms an integral part of a machine framework 19. The framework 19 may straddle the pavement to rest upon the ground, or it may be secured to the pavement or, in some instances, it may be sufficient to permit the framework to be freely supported by the pavement. The framework has upstanding arms 21 in which is journaled the central shaft 22 of a crank or fly wheel 23. The latter is driven by a chain 24 which engages a sprocket 25 secured upon the shaft 22. The chain is driven from any suitable power source (not shown).

The wheel 23 carries a crank pin 26 which pivotally receives the ends of connecting rods 27. The upper ends of the latter pivotally connect with a pin 28 which projects through a slot 29 and through a plunger 31 that is mounted for reciprocation within the cylinder 17. A hopper 32 having a neck 33 is integrally formed with or otherwise secured to the cylinder 17 for the purpose of feeding the filling material into the latter in order that it may be pressed or tamped downwardly by the plunger.

The material is fed in below the plunger on the upstroke of the latter. On its downstroke the plunger closes the entrance port and rams the material 12 into the earth beneath the paving. When the material is of a very plastic or fluidic nature it may be necessary to utilize a flap check valve 34 or the like at the end of the tube 17 to prevent withdrawal of the material during the upstroke.

It is obvious that the apparatus of Figure 4 may be varied within wide limitations and that the plunger may be operated in numerous different ways. For example, it may be directly subjected to steam or compressed air to move gradually or with a hammering action, or it may be driven explosively or by electricity. The operating mechanism, including the original power source, might be entirely self-contained.

As previously pointed out, the present invention further contemplates the forcible injection of materials into the earth, and between a structure and some reactance element other than the earth, for the purpose of preventing settling as well as for raising a structure after it has settled. For example, dirt or cement may be pumped to fill around foundations and to compact the earth therebeneath to prevent settling. Likewise, the anchorage of an element in the earth may be made more effective by compacting the subterranean soil adjacent the root of the element.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A method of raising sunken pavements or the like, comprising the steps of cutting a hole through the pavement, inserting a conduit through said hole to position its discharge point at a predetermined depth in the earth, and then forcing a filling material into the earth by way of said conduit and in sufficient quantity to elevate the sunken portion of the pavement.

2. A method for raising a sagging pavement or the like into its original position, comprising forcibly injecting a substantially incompressible filling material under said pavement at the lowest level of the sag in the latter.

3. A method for raising or strengthening the support of earth-carried structures such as pavements, foundations and the like, comprising the steps of inserting a filling material such as dirt or clay into a vertical conduit and then tamping the material downward through said conduit into the earth adjacent the particular structure.

4. A method of raising sunken pavements or the like, comprising the steps of positioning the discharge point of a conduit at a predetermined depth in the earth below the sunken pavement section to be raised, and then forcing sufficient filling material through said conduit into the earth to elevate said sunken pavement section.

5. A method for elevating a structure such as sunken pavements or the like, comprising the step of tamping a filling material into position

beneath said structure in sufficient quantity to elevate the latter into a preselected position.

6. A method for raising or strengthening the support of earth-carried structures such as pavements, foundations and the like, comprising the steps of positioning the discharge end of a conduit adjacent the particular structure at a point below the immediately adjacent level of the earth's surface, inserting a filling material in the conduit and exerting a series of blows against the filling material to ram the latter through the conduit and into the earth.

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