Nov. 2, 1965 TATSUO MORIMOTO 3,215,213

APPARATUS FOR DRAINING UNDERGROUND STRATA

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4 Sheets-Sheet 1

Fig. 1.

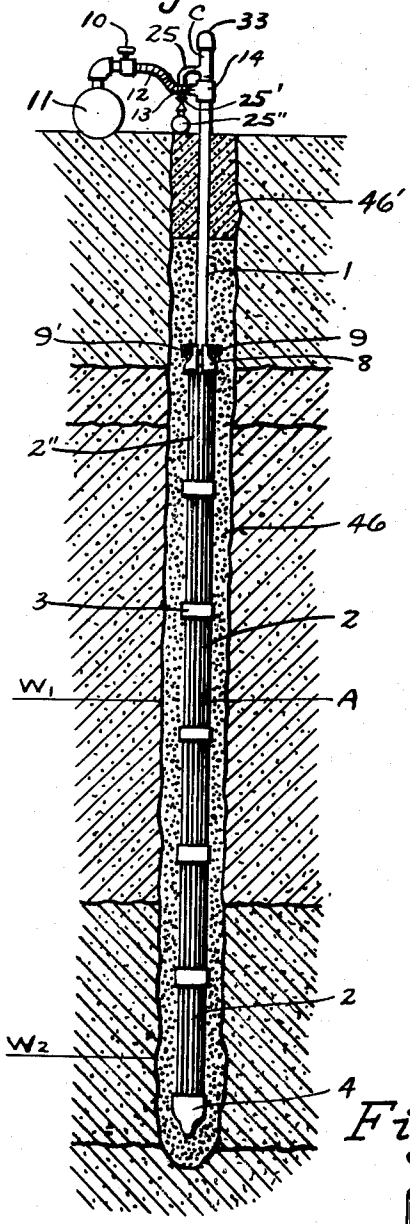


Fig. 3.

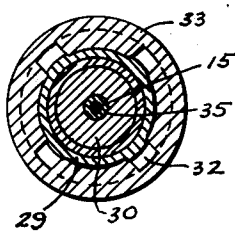


Fig. 4.

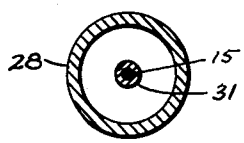


Fig. 5.

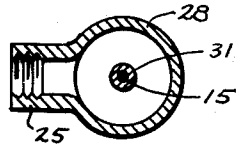


Fig. 6.

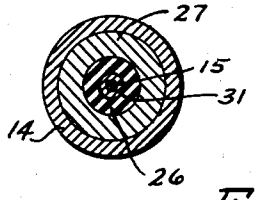


Fig. 2.

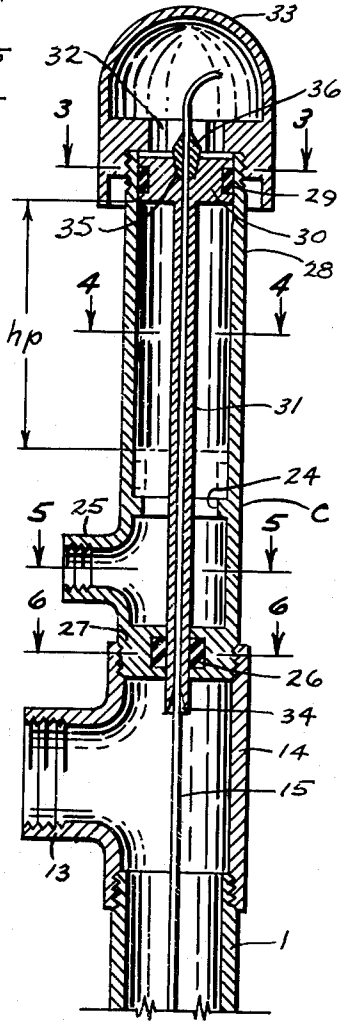


Fig. 17.

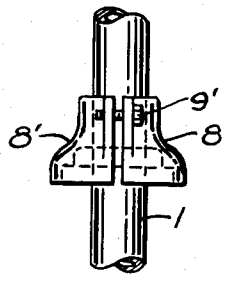
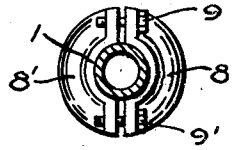


Fig. 16.



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Fig. 7.

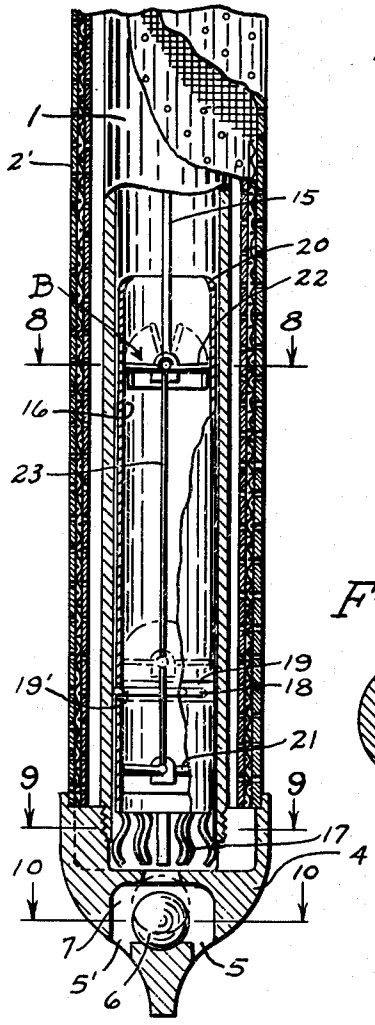


Fig. 9.

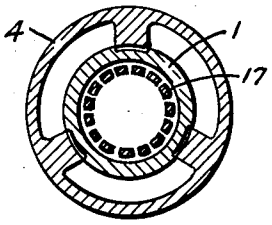


Fig. 10.

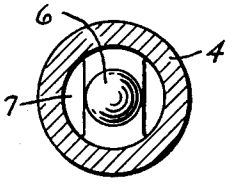


Fig. 12.

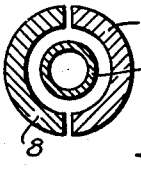


Fig. 13.

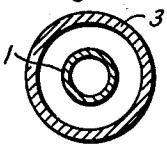


Fig. 11.

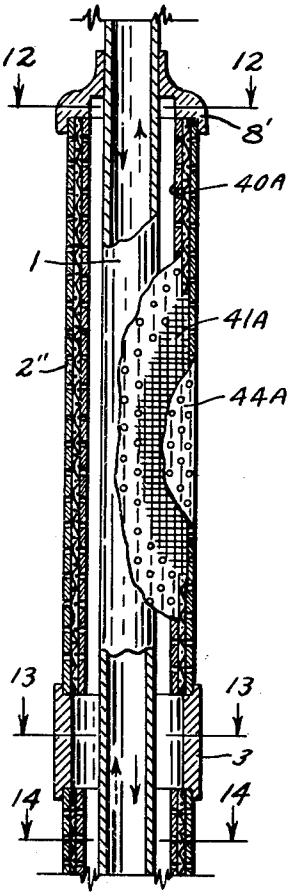


Fig. 15.

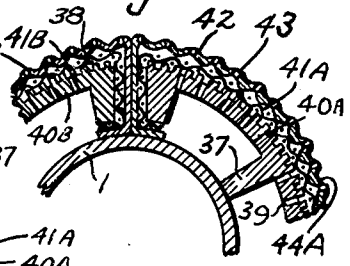


Fig. 14.

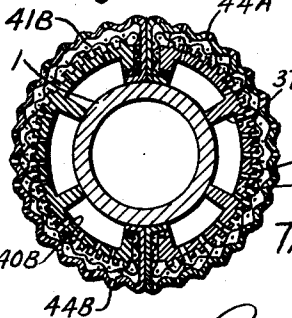
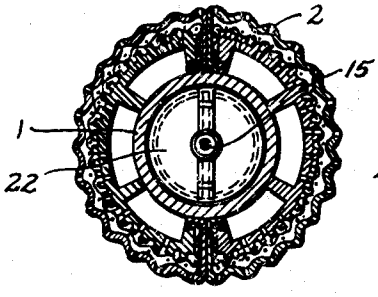


Fig. 8.



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Fig. 18.

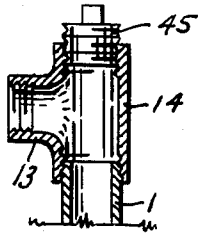


Fig. 19.

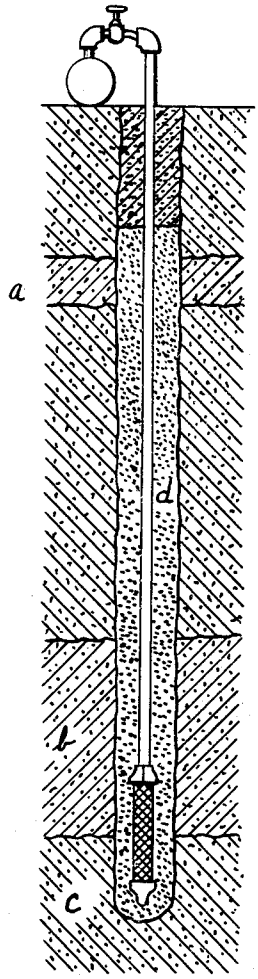


Fig. 20a.

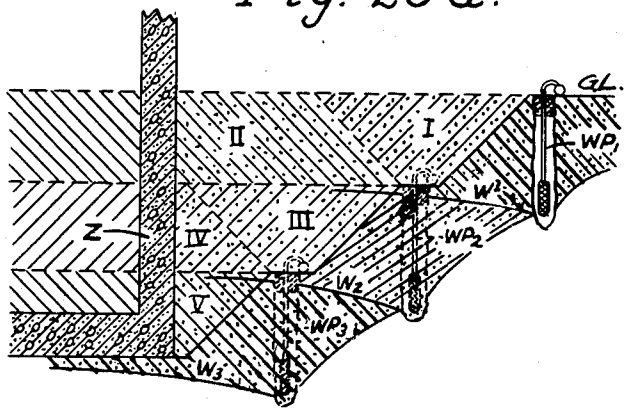


Fig. 20b.

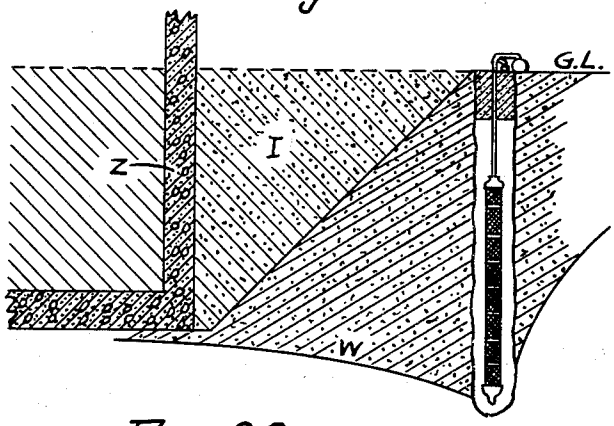
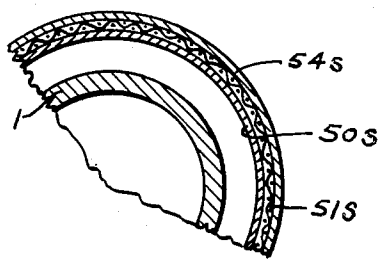


Fig. 23.



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Fig. 21.

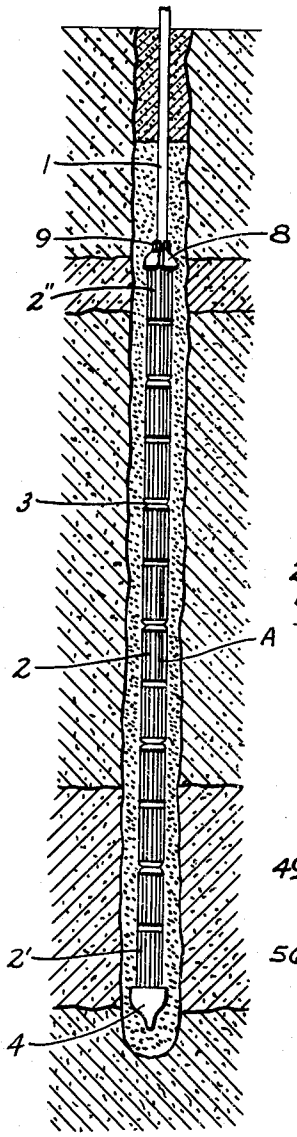


Fig. 24.

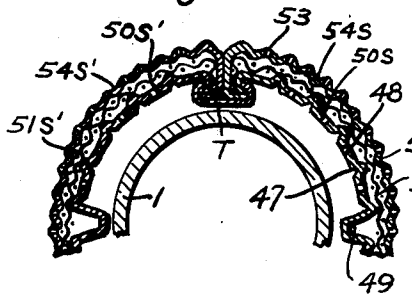


Fig. 25.

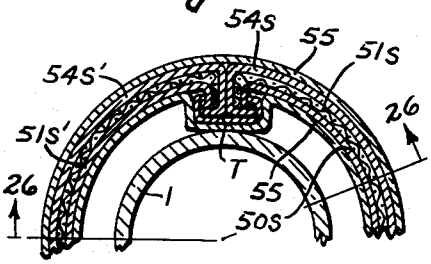


Fig. 26.

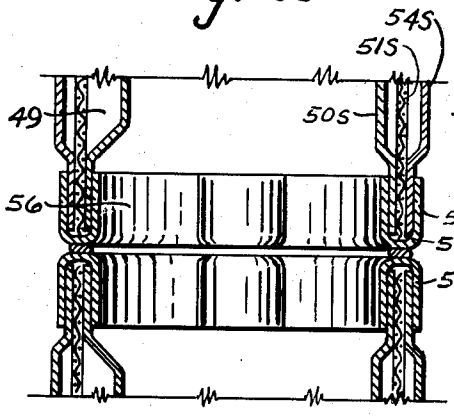
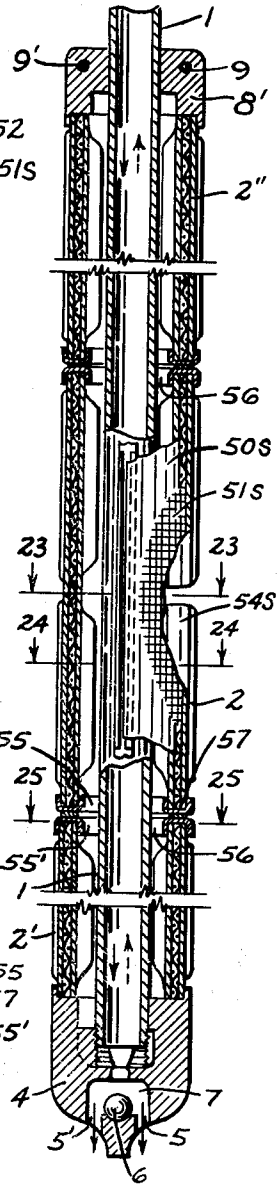


Fig. 22.



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Patented Nov. 2, 1965

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APPARATUS FOR DRAINING UNDERGROUND STRATA

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Filed May 21, 1963, Ser. No. 281,866
3 Claims. (Cl. 175—314)

This invention relates to an apparatus for vacuum drainage of deep underground strata.

An important object of this invention is the provision of such apparatus which employs a single riser pipeline of interconnected sections, instead of an outer and inner tubular assembly, a relatively slender pump within the pipeline, strainer means surrounding a portion of the riser pipeline, and means to create a strong vacuum within the pipeline, whereby liquids are drawn upwardly and discharged above ground as the wellpoint, at the lower end of the pipeline descends. This eliminates the use of bulky concentric pipelines, bulky pumps, the boring of relatively wide boreholes, and loss of vacuum where the point extends below 6 to 7 meters underground.

Another important object of the invention is to provide short tubular strainers being connected together and disposed so as to surround the riser pipe-assembly and form a longer strainer. This is easy by constructing the strainer of interconnected sections, whereby rapid ascent of water is attained.

Other objects and advantages of this invention will be more fully understood from the following description of two forms of the invention, shown by way of example, in the accompanying drawings in which:

FIG. 1 is a vertical sectional view of underground strata with an apparatus of the invention shown in elevation.

FIG. 2 is an enlarged vertical sectional view of a portion of the uppermost section of the apparatus of FIG. 1.

FIGS. 3 to 6 inclusive are horizontal sectional views substantially on the lines *a–a*, *b–b*, *c–c*, and *d–d* respectively of FIG. 2.

FIG. 7 is a vertical sectional view of the lowermost sections of the apparatus of FIG. 1 but on an enlarged scale.

FIGS. 8, 9 and 10 are horizontal sectional views substantially on the lines *e–e*, *f–f*, and *g–g* respectively of FIG. 7.

FIG. 11 is a vertical sectional view showing the relationship between a riser pipe, a socket and a strainer of the invention.

FIGS. 12, 13 and 14 are horizontal sectional views substantially on the lines *h–h*, *i–i* and *j–j* of FIG. 11.

FIG. 15 is a fragmentary horizontal sectional view substantially on the lines *j–j* of FIG. 14.

FIG. 16 is a top plan view and partly in vertical section of a strainer of this invention.

FIG. 17 is a fragmentary side elevational view of a connector for the strainer and riser pipe of FIG. 16.

FIG. 18 shows a vertical sectional view of the upper section of the apparatus above the riser pipe.

FIG. 19 is a view along the lines of FIG. 1 with the position of strainer shown thereon.

FIG 20A is an explanatory plan and sectional view showing conventional draining method.

FIG. 20B is an explanatory plan and sectional view showing draining method of this invention for the purpose of comparison with that of FIG. 20A.

FIG. 21 is a fragmentary vertical sectional view of a modification of the apparatus of FIGS. 1–19 inclusive.

FIG. 22 is an enlarged vertical sectional view showing essential parts of the apparatus of FIG. 21.

FIGS. 23, 24 and 25 are horizontal sectional views

substantially on the lines *k–k*, *i–i* and *m–m* of FIG. 22.

FIG. 26 is a fragmentary horizontal sectional view substantially on the line *n–n* of FIG. 25.

As shown in FIG. 1, a riser pipe **1** extends underground, from above ground to below the water level and surrounded by a suitable number of short tubes **2** of a strainer, each short tube being connected by connecting socket **3**, whereby a long strainer is provided. The bottom portion of the lowermost short tube **2** is secured to a nozzle-containing point **4** as well as to the lowestmost part of the riser pipe **1**.

The nozzle **4** is best shown in FIG. 7 and is provided with water jetting ports, **5**, **5'** and an air suction chamber **7** having a ball valve member **6** therein.

The top portion of the uppermost short tube **2''** of the strainer is coupled to the riser pipe **1**, as best shown in FIG. 11, FIG. 16 and FIG. 17, by two cap sections **8**, **8'**, secured to the riser pipe as by screws **9**, **9'**.

As shown in FIG. 7, a small pump B is disposed within the lowermost part of the pipe **1**, and T-type coupling **14** (FIG. 2) having a branch tube **13** is connected to the upper end part of the riser pipe **1**, the top of which pipe extends out of the ground, with the branch tube **13** being connected to the end of a flexible pipe **12** which is, in turn, connected to a header pipe **11** by means of a valve **10** (FIG. 1). Pump transmission apparatus, reciprocated by any conventional reciprocating means, such as a conventional vertical cable reciprocating well-drilling engine, is fixed to the upper end of the said coupling **14**, pump B and transmission apparatus C being connected by a wire or similar means with the wire extending downwardly through the pipe **1**. As shown in FIG. 7, a plurality of leaf springs **17** being fixed to the lower end of a cylinder **16** project downwardly inside the lowest end of the pipe **1** in the suction chamber of the nozzle **4** and the periphery of the cylinder **16** of the pump B slides over the inner periphery of the pipe **1**. Along the lower portion of the cylinder **16** is a circular groove **19** with a gum packing **18** therein. The upper end portion of cylinder **16** has an edge **20** curved inwardly, a valve flap **21** being swingingly supported in the lower portion of the cylinder **16**, and a flap valve **22** being swingingly supported at the upper end of the cylinder **16**, and both valves **21** and **22** are connected with an elongate elastic connecting member **23** such as of rubber.

Transmission apparatus C, as shown in FIG. 2, comprises a piston stop flange **24**, a water-supplying main tube **25''** interposed in which is a conventional check valve **25'**, a cylinder **28** fitted with a shaft bearing **27** having an airtight packing **26** therein, a piston **30** having a watertight packing **29** therearound, a movable portion of a tubular downwardly-extending piston rod in the riser pipe **1** passing through the packing **26** and connected to the piston **30**. The connecting member **15** (as a length of wire) extending downwardly and supporting the piston of the pump passes through small openings which extend through a hollow shaft **31** and the piston **30**, is supported by a stop **36** at the concave central portion **35** of the upper part of the piston **30**; and a cap with an air vent hole covers the upper end of the cylinder **28**.

Each short tube **2** is composed of two semi-cylindrical portions (FIGS. 14 and 15) providing inwardly-projecting lugs of the walls **37** bearing against the riser pipe **1**, and on the outside surface of the walls, there is provided central frames **40A** and **40B** forming semi-circular members having a plurality of vertical slots **38** and water-flow holes **39**, screening **41A**, **41B** being woven into the central frame preventing the screening from detachment. Vertical corrugations **42** having water suction holes **43** in the outer covers **44A**, **44B** cover the semi-cylindrical portions above their upper end.

To begin operations of the apparatus of this invention: first, the nozzle **4** being screwed up to the lower end of the riser pipe **1**, a pair of short tubes of the strainer, with center frames **40A**, **40B**, nets **41A**, **41B** and outer covers **44A**, **44B**, are covered to embrace the same from outer side of the riser pipe **1** respectively, and inserted in the air suction chamber on the upper end of the nozzle. Short tubes **2** and associated sockets **3** are assembled and connected by means of the sockets, the strainer A of a desired length, is completed and, finally, after a pair of caps **8**, **8'** are fixed to the top portion of the short tubes of the strainer, the same is fastened with screws **9**, **9'**.

The apparatus thus constructed, as shown in FIG. 1, is disposed underground, T-type coupling, as shown in FIG. 18, is connected to the upper end of the riser pipe **1**, and the open upper mouth of the coupling is closed with screw plug **45**, the branch tube **13** is connected to the header pipe **11** by means of the flexible tube **12**, and water under pressure is forced from the top of the riser pipe through the header pipe.

Deeper insertion of the point **4** in the ground is carried out by jetting pressure water, passing through the riser pipe and jetting out of the water holes **5**, **5'** of the lower end of the point **4**. After completion of operations to the depth desired (as shown in FIG. 1) filter sand **46** is filled in the space between the outer surface of the riser pipe **1** and the soil of the strata therearound, clay seal **46'** (upper portion FIG. 1) is filled in order to exclude the atmosphere and, by the operation of conventional vacuum apparatus on the ground connected thereto through header pipe (not illustrated) suction takes place at the wellpoint and inwardly therefrom. At first as water level underground is high, drainage is preferably carried out by the use of a conventional wellpoint. After the drainage advances until water level underground around wellpoint reaches **6–7** M below (shown by W1 in FIG. 1) it is now impossible for the conventional wellpoint to operate successfully since there is a state of balanced water level. In spite of continuing the operation under such circumstances, drainage and progress of vacuum operation cannot be expected. In such condition, the valve **10** is closed, the screw plug **45** on the upper part of T-type coupling is taken off, the pump, is supported from the connecting member **15**, is manipulated as by pushing down on or lowering the same, until the spring **17** of the pump engages the lower end of the riser pipe **1**, whereby the connecting member is freed from the pump. Since transmission apparatus C is connected to the T-type coupling **14**, the movable valve **22** of pump B is elevated to the near portion of edge **20** and, after the valve **25** is opened, the end of the connecting member **15** is cut off to proper length, and the concave central portion **35** is filled with melted lead. A cap **33** is set on the upper portion of the cylinder **28**. Under vacuum, after air valve **10** is opened, reciprocation of the pump taking place, water pressure descends. Piston **30** comes down to the position of *hp* shown in FIG. 2 and, simultaneously, the valve **22** in the lower portion of the riser pipe, as shown in FIG. 7, is also drawn down by means of the connecting member **23**. The valve **21** being closed by the water pressure, the confined water gathers above the upper portion of the movable valve **22**. By repeating such reciprocation, high-head drainage over theoretical head **10.3** M can be carried out by thus causing activation of valves **22** and **21**. There remaining a little water to drain, vacuum power increases materially at the lower end of the strainer. There remaining no water at all, only the suction operation will continue, by closing water stop valve and stopping pumping operation. In case it is necessary that the pump B must be removed, the valves **10** and **25'** being closed, transmission apparatus C being disconnected, the connecting member **15** being lifted up, and the movable valve **22** positioned up against the edge of cylinder **16**, by pulling up the connecting member **15**, the spring **17** for fixing at the end of the cylinder **16** moves inward and the pump B may be lifted up.

During the operation of vacuum drainage above mentioned, underground water and air in each strata gather near each part of the strainer A directly through sand filter **46** in a horizontal direction, descending rapidly along the space between the strainer A and the riser pipe **1**, and is conveyed out on the ground through air suction chamber in the nozzle **4**.

As one modification of the above-mentioned strainer and socket structures that shown in FIG. 21 to FIG. 26 may be employed. Short sections of strainer may be composed of cylinders, semi-cylindrical in horizontal section divided vertically into two parts to form a cylinder. The structure of this cylinder includes center frames **50***s*, **50***s'* having corrugations on both sides forming convolutions **47** and being provided with small holes **48** and lugs **49** (in order to increase the vertical strength, on both sides) are bent inwardly surrounding a pair of semi-circular screen cylinders **51***s*, **51***s'*, while covering the outside thereof are outer corrugated covers **54***s*, **54***s'* crimped together at their sides, and having holes therearound for water, as well as in the case of the center frames **40A**, **40B**. Bent side ends of the above three layers, that is, the center frames **50***s*, **50***s'*, the screening cylinders **51***s*, **51***s'* and the outer corrugated cover **54***s*, **54***s'* are connected together with channel-shaped seal T which is made of resilient thin steel plate. Without making corrugations and small holes in the upper and lower ends of the center frames **50***s*, **50***s'* and outer covers **54***s*, **54***s'*, these ends are made plain, and H-type socket (in vertical section) **56** is constructed by welding together two ring members **55**, **55'** facing in opposite directions, these members being crimped U-shape in section, as at **57**, to correspond to the section of the strainer using steel plate or the like. By connecting the plane portion on both ends of each strainer, with a short tube engaging inside of upper and lower slots, the assembly is completed.

FIGS. 20A and 20B illustrate diagrammatically the conventional method (as in FIG. 20A) for draining in connection with the walls of a building Z. Therein three conventional apparatus WP_1, WP_2 and WP_3 are shown. Each drains portions of the strata I, II, III and IV and, of course, require excavating below ground level in order to position the apparatus designated as WP_2 and WP_3 (and subsequently remove them) three bores, three plugs and three settings, removal of the apparatus and two fills. FIG. 20B shows the apparatus of this invention in use, requiring one bore, one plug, and one setting and removal of the apparatus.

Various changes may be made to the forms of the invention herein shown and described without departing from the spirit of the invention or scope of claims. Moreover, the features of the embodiments shown in the drawings are mutually interchangeable insofar as they are comfortable.

What is claimed is:

1. Apparatus for vacuum drainage of underground strata, said apparatus including a riser conduit having an uppermost end portion and a lowermost end portion; drainage intake means connected to said riser conduit at said lowermost end portion; pump means within said riser conduit above the drainage intake at said lowermost end portion, including a valved reciprocating member; an elongate member extending downwardly from said uppermost end portion to and secured to the upper end of said reciprocating member; reciprocating means for reciprocating said elongate member and disposed at said uppermost end portion; a hollow joint secured to said lowermost end portion and having jetting ports opening exteriorly thereof and check valve means for preventing flow of drainage from said ports to said pump means; a screen enclosing and carried by said riser conduit and in communication with said pump above said check valve and at said drainage intake means, said screen extending from said drainage intake means upwardly about said riser conduit and provided with closure and attaching

means for detachably securing it to said riser conduit spaced above said drainage intake means; said screen having semi-cylindrical corrugated walls having inwardly-extending crimped longitudinal edge portions and means joining said walls at said crimped portions; said crimped portions providing lugs to space said semi-cylindrical walls from said riser conduit.

2. Apparatus according to claim 1 characterized in that some of said corrugations which extend inwardly are longer than the others of the inwardly-extending corrugations and provide lugs, whereby the lugs additionally space said walls from said riser conduit.

3. Apparatus for vacuum drainage of underground strata, said apparatus including a riser conduit having an uppermost end portion and a lowermost end portion; drainage intake means connected to said riser conduit at said lowermost end portion; pump means within said riser conduit above the drainage intake at said lowermost end portion, including a valved reciprocating member; an elongate member extending downwardly from said uppermost end portion to and secured to the upper end of said reciprocating member; reciprocating means for reciprocating said elongate member and disposed at said uppermost end portion; a hollow point secured to said lowermost end portion and having jetting ports opening exteriorly thereof and check valve means for preventing flow of drainage from said ports to said pump means; a screen enclosing and carried by said riser conduit and in

communication with said pump above said check valve and at said drainage intake means, said screen extending from said drainage intake means upwardly about said riser conduit and provided with closure and attaching means for detachably securing it to said riser conduit spaced above said drainage intake means; said screen being provided with semi-cylindrical walls having inwardly extending longitudinal edge portions and means connecting the inwardly-extending edge portions of one wall to another wall, said inwardly-extending edge portions providing lugs to space said walls from said riser conduit.

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