Aug. 4, 1970 H. J. FIRMAN 3,522,708

METHOD OF AND MEANS FOR THE LOWERING OF GROUND WATER

Filed April 26, 1968 5 Sheets-Sheet 1

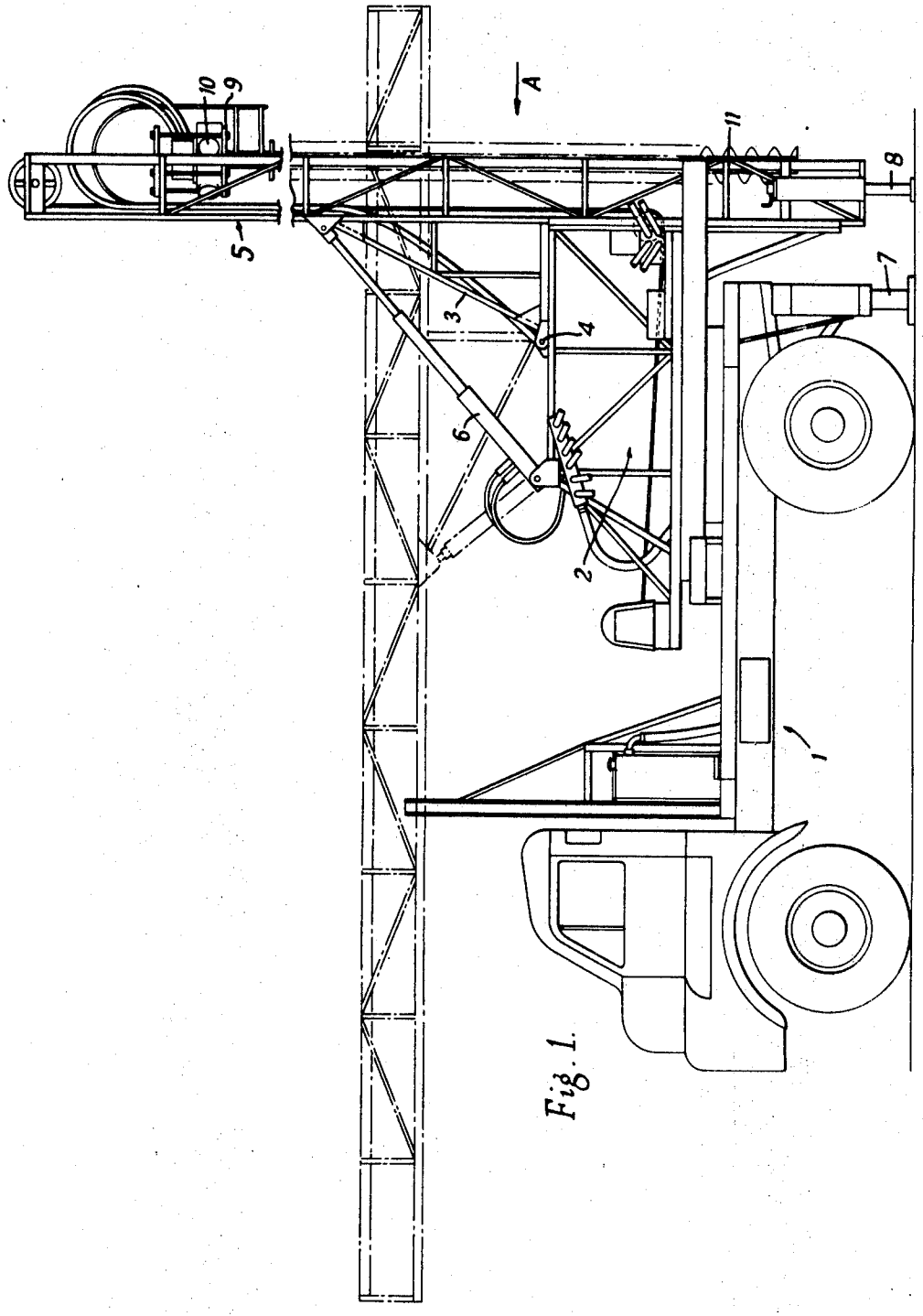
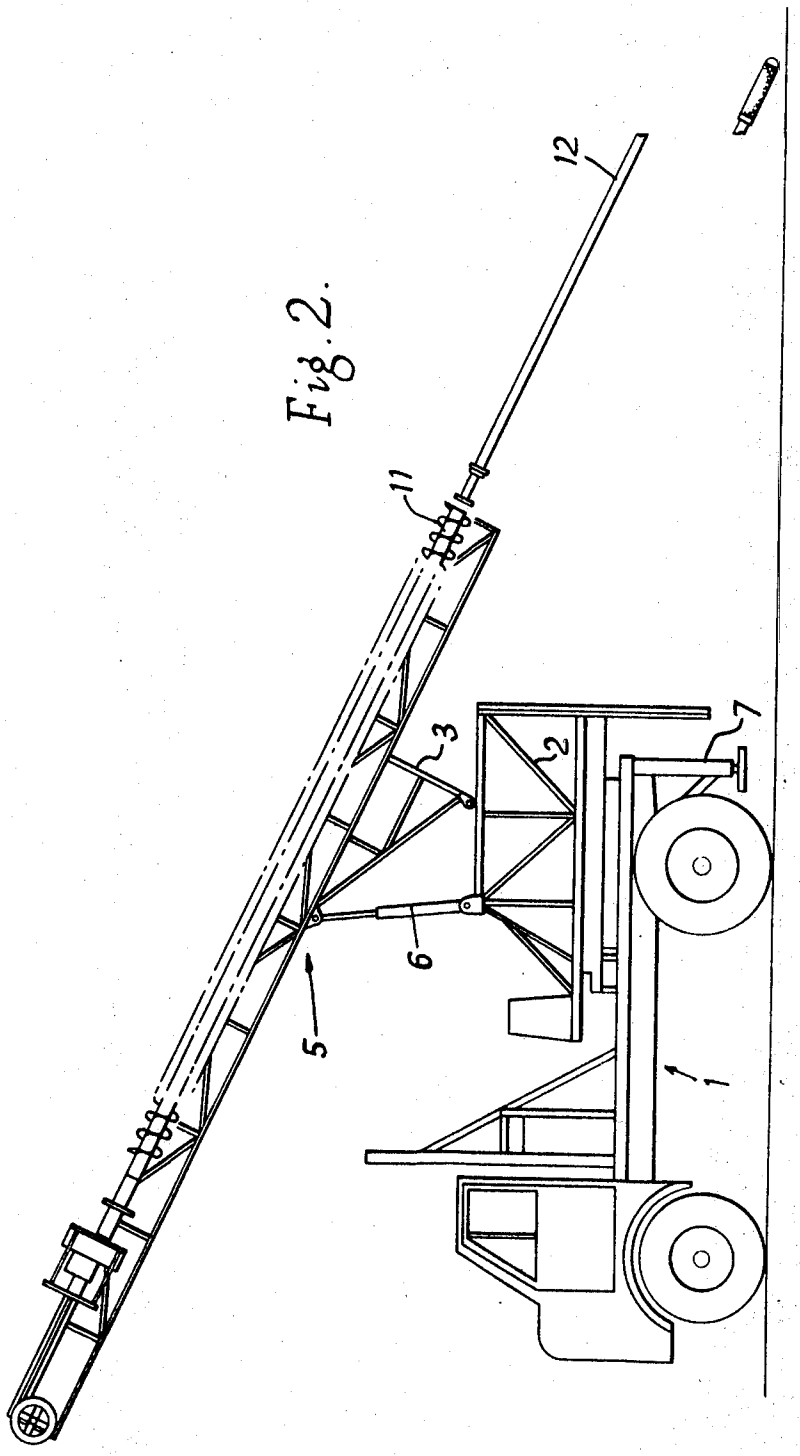


Fig. 1.

METHOD OF AND MEANS FOR THE LOWERING OF GROUND WATER

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Fig. 2.



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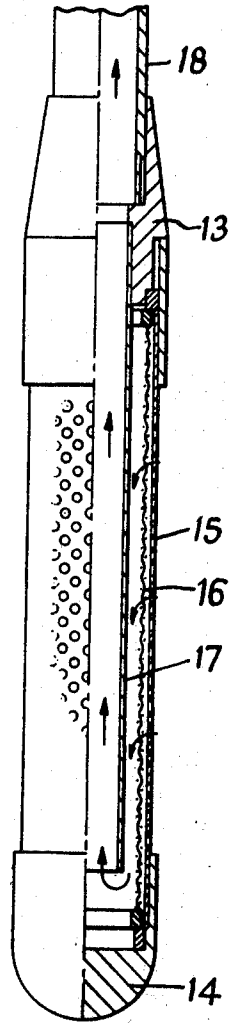


Fig. 3.

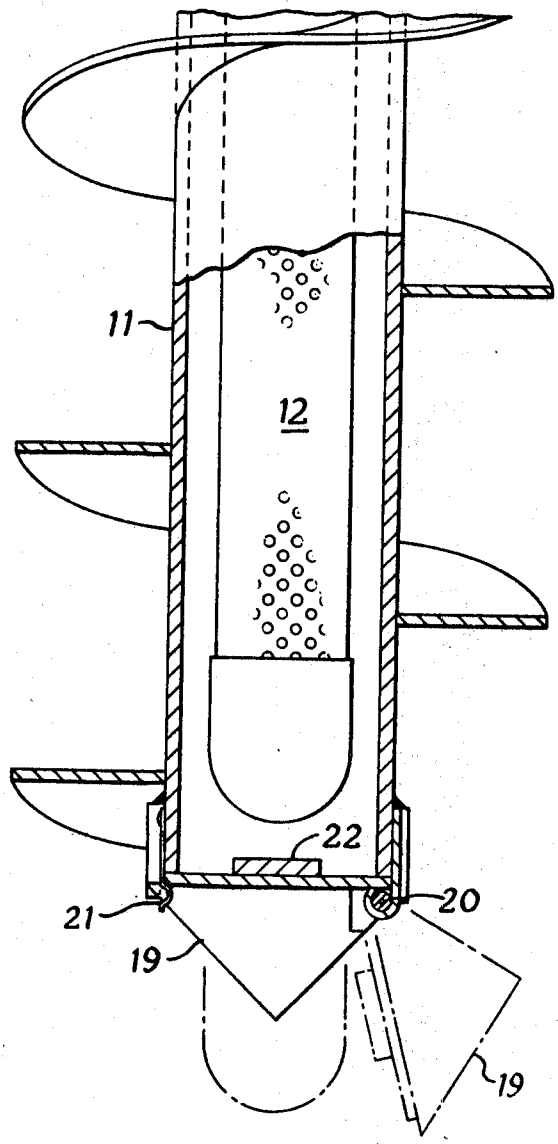


Fig. 4.

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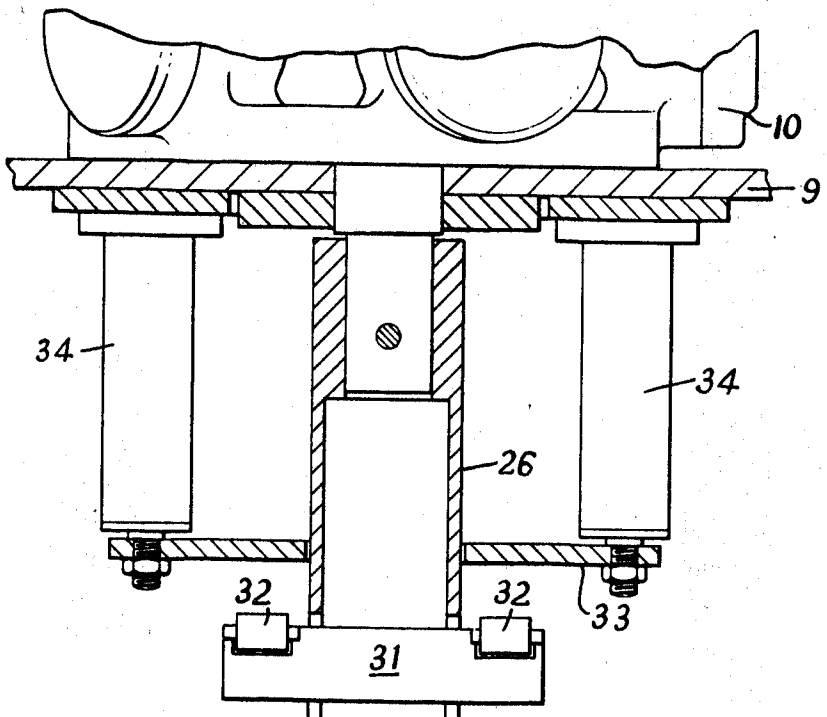


Fig. 5.

Fig. 6.

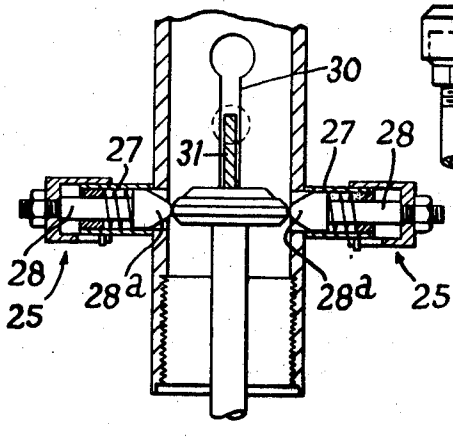
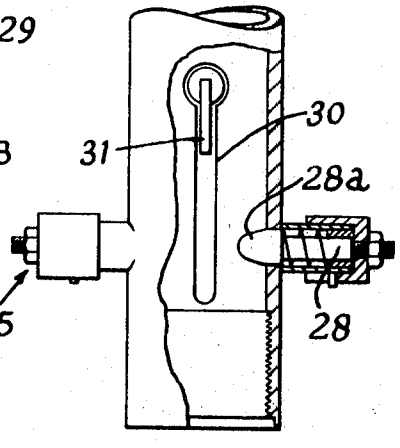


Fig. 7.



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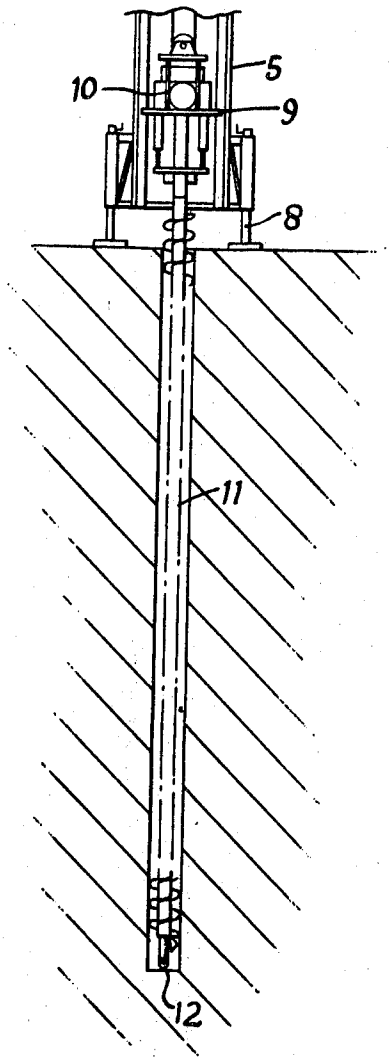


Fig. 8.

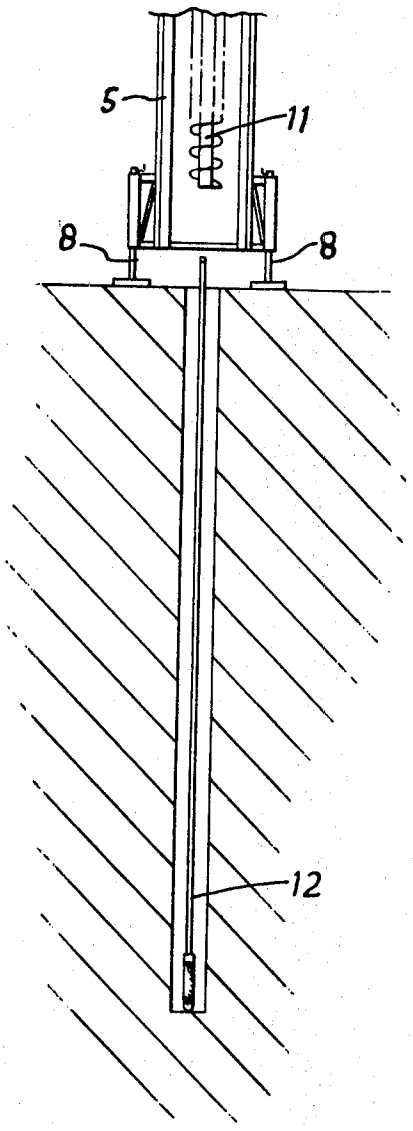


Fig. 9.

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3,522,708

METHOD OF AND MEANS FOR THE LOWERING OF GROUND WATER

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Filed Apr. 26, 1968, Ser. No. 724,409
Int. Cl. E02b 11/00
U.S. Cl. 61—11 11 Claims

ABSTRACT OF THE DISCLOSURE

Removing water from building excavations by drilling into the ground with a hollow auger having a well-point and riser pipe retained therein; releasing the latter so that they fall into the drilled hole; withdrawing the auger; and connecting the riser to suction to remove water via the well-point. Apparatus disclosed comprises a lorry-mounted drilling derrick which is adjustable in inclination and carries a torque motor coupled to a hollow auger. Riser has a head which rests on spring-loaded catches inside auger. A hydraulic ejector mechanism forces the head between catches to eject well-point and riser from within auger.

This invention appertains to a method of, and means for, lowering ground-water—an operation known and sometimes referred to as "dewatering."

Ground-water lowering or dewatering permits the creation by civil engineers, building contractors and others of excavations in permeable, initially water-bearing ground, the aim being to drain the ground before an excavation starts so that the work can be carried on throughout in dry or substantially dry conditions.

The invention, moreover, is concerned exclusively with ground-water lowering by the so-called well-point method. In this method, a number of screened suction points, referred to as "well-points" and attached to the lower ends of 'riser' pipes, are placed in the ground around or otherwise suitably adjacent to a proposed excavation. The heads of the riser pipes are connected to a common header main or collection pipe of relatively large diameter. A vacuum produced within the header main and the connected well-points brings to the surface ground-water which can be readily disposed of, e.g. by means including an air/water separator and a centrifugal pump. Each riser pipe may have an individual isolating cock at the juncture with the header main so that an independent control over the corresponding well-point can be exercised.

Dewatering equipment of this nature may be arranged in single, two or three-stage systems depending on the required depth of a proposed excavation, the ground-water lowering limit for a single-stage system being usually considered to be about 18 feet below pump level, and the installation of such systems being progressive as the excavation proceeds.

Heretofore, the most up-to-date well-point method has involved placing the well-points within the ground at the appropriate level by a technique known as 'Jetting-in.' In accordance with this technique, water pressure of up to 160 lbs. per square inch is forced down through the hollow well-points and emerges via nozzles in jetting shoes at the lower ends of the points, the jets of water forcing away soil and thus piloting the way for and facilitating descent of the well-points to their required positions.

Already known jetting well-points previously employed for this purpose have customarily each been of a form consisting of an inner steel jetting tube rigidly mounted between a socket at the top and a shoe at the bottom, an outer perforated tube and an intermediate gauze

strainer tube—with the three tubes which are concentrically arranged. In a jetting well-point of this form the lower end of the jetting tube is connected to a seating of the jetting shoe which seating has a shoulder shaped to enable water to flow back along the gauze strainer for the purpose of keeping it clear during jetting and also to provide clearance for the full flow of water during pumping. When jetting is in progress, the force of water is deflected by the shoulder through a ball valve chamber in the jetting shoe which is pointed and formed with the aforementioned nozzles. With the well-point under suction during pumping, the ball valve floats up on to its seat.

It is not uncommon for as much as 300 gallons of water to have to be used in the placing of a jetting well-point at a depth of about 18 feet below the surface of the ground. A supply of water is customarily brought to the site to install the initial well-point(s) unless, of course, a stream or pond is located nearly. Thereafter, the water removed from the water-bearing ground by the first well-point, or the first few well-points, as the case may be, is used to jet in the remainder of the well-points included in the system.

It not infrequently happens that before reaching down to the required terminal points of such a dewatering system, large gravel, stiff clay or compact cemented layers are encountered in the formation. In such an eventuality, considerable difficulty is experienced in effecting penetration of the barrier layers, and heretofore this has usually been attempted by driving in the well-points with a drop hammer. But the adoption of this procedure not only causes damage to well-points but also involves the frustrating expenditure of much time and man power.

The primary object of the present invention is to provide an improved well-point method of ground-water lowering or dewatering designed to facilitate not only positive penetration of clay bands or impermeable interlayers occurring within a permeable stratum, but also rapid penetration of barriers of compact cemented material, thereby obviating the foregoing difficulties and also securing other advantages hereinafter to be mentioned.

Another aim is to provide modification of known items of dewatering equipment and novel arrangements and modes of operation of the same enabling the improved method to be performed.

The improved well-point method of this invention essentially involves the use of a hollow ground-boring tool to assist in placing each of the well-points in the ground at the required depth prior to pumping to extract water upwardly through the points.

In respect of the installation into the ground of each well-point, the improved method comprises the steps of (a) inserting the well-point and its riser into, and retaining them within the hollow ground-boring tool, (b) whilst the latter is suitably suspended, rotating it and causing it to drill into the ground down to the required depth, (c) releasing the said well-point and riser so that they fall freely relatively to the tool to the bottom of the drilled hole, and (d) withdrawing the boring tool from the ground thereby leaving the well-point and riser in the hole.

The ground-boring tool is thereafter re-loaded with another well-point and riser, and the above described cycle is repeated.

As will be appreciated, the idea is that instead of water under pressure being relied on to force away soil and formation material and thus pilot the way for the descent of a well-point through readily penetratable ground only, as in the jetting-in process, the ground-boring tool employed in the improved method performs a similar function whilst safely housing a well-point during the major portion of its descent and also rapidly and easily

effecting penetration even of clay bands and/or impermeable inter-layers occurring within a permeable stratum as aforesaid.

According to a further feature of the invention, there is provided apparatus for carrying out a well-point method of ground-water lowering or dewatering, comprising a structure supported above the ground; a torque motor suspended from said structure; a hollow ground-boring tool coupled to said torque motor, whereby operation of the latter causes rotation of the tool to enable the latter to drill into the ground; and catch means in association with the head of the boring tool for firmly retaining a well-point and riser within the latter with the lower extremity of the point initially above the lower end of the tool.

In order that the invention may be more clearly understood and readily carried into practical effect, one specific embodiment thereof will now be described, by way of example, with reference to the accompanying drawings, wherein:

FIG. 1 is a side view of a lorry equipped with a derrick and drilling apparatus for use in performing the method of this invention,

FIG. 2 is a view similar to FIG. 1 but taken on a smaller scale, showing the method of introducing a well-point and its associated riser into the drilling apparatus,

FIG. 3 is a side view, partially in section, of a well-point and an associated riser,

FIG. 4 is a vertical sectional view through the lower end of a hollow auger of the kind used in the drilling apparatus shown in FIGS. 1 and 2,

FIGS. 5, 6 and 7 are detail views of the apparatus used for retaining a well-point and riser within its auger and for ejecting the same at the required time, and

FIGS. 8 and 9 are views taken in the direction of arrow A in FIG. 1, with some parts removed and showing respectively the well-point and riser being inserted into the ground whilst inside an auger, and the well-point and riser located in the ground after the withdrawal of the auger.

Referring primarily to FIGS. 1 and 2 of the drawings, a lorry generally designated **1** is provided adjacent its rear end with a supporting structure **2**. A frame **3** is mounted on the structure **2** through a pivot pin **4** and carries a derrick **5**. Extending between the derrick **5** and the supporting structure **2** is a hydraulic piston and cylinder unit **6**. Thus, by supplying hydraulic fluid to the cylinder and said unit **6** at required times, the derrick **5** can be pivoted from a vertical position in which it can be used for drilling, into a horizontal rest position and can be secured in any intermediate inclined position. The supporting structure **2** also carries various conventional control components, conduits and the like, although these have been omitted from the drawings for the sake of clarity.

A pair of hydraulic jacks **7** are provided at the rear of the vehicle chassis, and can be operated to stabilize the latter at required times. A further pair of stabilizing jacks **8** are also provided on the derrick **5** itself.

Mounted for vertical movement up and down within the derrick **5** is a cradle **9** carrying a hydraulic torque motor **10**. The cradle is, in fact, suspended in the derrick by a cable connected to a winch (not shown) carried on the vehicle **1**. The drive shaft of motor **10** is connected to a hollow-stemmed, continuous-flight auger **11** which extends downwardly inside the derrick **5**.

With the equipment in use, a well-point and its associated riser pipe are inserted into the hollow stem of the auger before the well-point placing operation begins. As may be seen in FIG. 2, insertion of a well-point and riser, generally designated **12**, takes place with the derrick **5** in a position in which it is inclined to the horizontal. Once inside the auger **11**, the upper end of the riser is removeably retained therein by means to be described later.

FIG. 3 of the drawings shows a well-point and riser pipe comprising a socket **13** and a shoe **14** which are vertically spaced from one another by an outer perforated tube **15**. An inner gauze strainer **16** between the socket **13** and shoe **14**, inside the tube **15** and a tube **17** at the centre of the well-point. A riser pipe **18** is connected to the upper end of the socket **13** and is axially aligned with the tube **17**. Thus, in use, the riser pipe **18** is connected to a suction source so that water is drawn from the ground, through the gauze strainers **15** and **16**, and into the lower end of tube **17**, from where it passes into the riser pipe **18** as indicated by the arrows on the drawing.

As mentioned above, riser pipe **18** is adapted to be secured inside the auger **11** so that the lower extremity of the well-point is located above the lower end of the auger, as shown in FIG. 4. The lower end of the auger **11** is initially sealed against the ingress of soil when it is in use, by a hollow conical cap **19**, which is hinged to the stem of the auger at **20** and is retained in its auger-closing position by a spring clip **21**. Thus, it can be readily pushed aside by a falling well-point which has been released from within the auger. A striker pad **22** may be provided inside the cap to prevent damage to the latter by a falling well-point, and enable it too be re-used.

The means for releasably retaining a well-point and riser inside the auger **11** and for ejecting the same at the required time, will now be described with reference to FIGS. 5, 6 and 7 of the drawing.

The upper end of a riser pipe **18** is furnished with an upwardly extending co-axial extension **23** of rod form having a mushroom-shaped head **24** which is adapted to be supported a relatively short distance beneath the torque motor **10**, upon spring-loaded retaining catches generally designated **25**, which are suitably associated with an upper section of the hollow stem of the auger.

Permanently pinned to the downwardly-extending drive shaft of the hydraulic torque motor **10** is a rotary drive-transmitting sleeve **26**. The lower end of this sleeve is internally screw-threaded to receive the complementarily externally threaded upper end of the hollow auger stem (not shown in FIG. 5).

Projecting radially outwards from the drive-transmitting sleeve **26** are two diametrally-aligned housing **27** for a pair of spring-loaded plungers **28** which constitute the retaining catches **25**. The noses, i.e. operative ends **28***a* of said plungers normally extend through holes in, and protrude beyond the inner surface of the wall of the sleeve **26**. These noses, moreover, are each of a double profile design such that the catches **25** can be forcibly pressed aside and withdrawn by vertical pressure exerted upon them either from above or below.

The idea is that the operative ends **28***a* of the plungers **28** are normally projected under spring action into positions in which they are located beneath head **24** and support the well-point and riser (see FIG. 6). When, however, the plungers **28** are withdrawn against the spring action, the support for the head **24** of the riser pipe extension is removed, thereby disengaging the well-point and riser unit **12** from the auger **11** and enabling this unit to force open the aforementioned sealing cap **19** and be itself ejected from the lower end of the auger.

The riser pipe extension **23**, in the nature of an ejecting rod, may be so readily adjustable in length as to ensure that the well-point is held immediately above the sealing plug notwithstanding any nominal variation in riser-pipe length due to practical considerations. This feature permits of the use, for extruding the sealing cap and positively ejecting a well-point unit from the auger, of hydraulic means incorporating 'short-stroke' rams: in this way any necessity for a cumbersome head assembly is avoided. In the illustrated embodiment, the rod **23** is externally screw-threaded and is received in a correspondingly internally threaded cap **29** on the riser **18**, whereby the rod can be screwed into or out of the cap to vary its length.

Alternatively, however, the riser pipe extension this may be of telescopic rod form, comprising telescopically engaged tubular elements which are relatively adjustable axially to increase or decrease the length of the extension, according to requirements, the adjustments being effected by rotary screw means of any suitable character.

In this embodiment, hydraulically operated ejector means are provided to eject a well-point and riser from the hollow stemmed auger. These means are arranged to operate on the head **24** of the riser pipe extension **23** to force the same downwardly between the noses **28***a* of the plungers **28** to press aside and withdraw the latter and thus positively eject the well-point and riser. As will be appreciated, immediately the head **24** has been forced between and past the noses **28***a* the plungers **28** spring back into their normal operative positions.

Then, whenever a well-point and riser unit is inserted into the hollow stem of the auger and pushed up into position therein, the head **24** will forcibly press aside and pass between the noses **28***a* of the plungers **28** which will thereupon snap into position beneath the head so as to be in a position to support it.

The hydraulic ejector mechanism will now be described.

The wall of the above-mentioned rotary drive-transmitting sleeve **26** is formed at diametrically opposed sides thereof, with two vertical slots **30**, portions of which extend both above and below the spring-loaded catches **25**. These slots **30** extend parallel to the major axis of the auger stem. Extending transversely right through the said slots is a horizontal thrust bar **31**, the opposite ends of which protrude through the slots to the outside of the sleeve **26**. Recesses are provided in the upper edges of the bar **31** to receive rollers **32**.

A flat, horizontally disposed steel pusher plate **33**, centrally apertured to fit around the drive-transmitting sleeve **26** is carried by two hydraulically operated double-acting rams **34**. These rams are disposed parallel to one another and extend down from the underside of the hydraulic motor cradle **9**. With the rams **34** in the closed position, the pusher plate **33** rests upon the rollers **32** fitted in the thrust bar **31**, and the latter in turn is poised immediately above the head **24** of the riser pipe extension **23**. When extending downwardly, the rams simultaneously apply equal pressure upon the top of this head through the medium of the plate **33** and the underlying thrust bar **31**. Accordingly, when required the rams **34** are brought into operation as described to force the head **24** on the riser pipe extension **23**, between and below the retaining catches **25**. The well-point and riser unit then falls onto the sealing cap **19**, knocks it aside and is ejected from the hollow stem of the auger.

The improved method provided by this invention will now be described.

The first step is to insert a well-point and riser unit **12** into the derrick **5**, whilst the latter is in an inclined position as previously described, and to ensure that the head **24** on the riser extension rod **23** is securely retained by the catches **25**. When this has been done, the derrick **5** is moved into its vertical position and the stabilizing jacks **7** and **8** are extended.

Motor **10** is then operated and the cradle **9** is progressively lowered down the derrick as the auger drills into the ground, until the required depth is reached.

At this stage, the motor **10** is stopped and motor cradle **9** is withdrawn a short distance up the derrick to enable the rams **34** to be operated to release the well-point and riser **12** from within the auger **11**. The falling well-poinnt will then knock aside the cap **19** and fall to the bottom of the hole made by the auger. This situation is illustrated in FIG. 8 of the drawings.

The cradle **9** is then pulled back up the derrick **5** using the aformentioned winch, thereby withdrawing the auger to leave the well-point and riser **12** in the ground as shown in FIG. 9. Riser pipe **18** can then be connected to a header main for draining the ground.

It is found that a power-rotated hollow-stemmed continuous-flight auger of the kind illustrated, may drill to a maximum depth of about 23 feet in one continuous operation, the hardened cutters of the auger effecting rapid penetration of large gravel stiff clay or cemented layers.

During installation of each well-point, rotation of the auger or other boring tool may be stopped either prior to release of the point from the tool, or in a case where a "sanding-in" technique is adopted to produce a sand screen around the gauze of the well-point to prevent the extraction of "fines" from the formation, after release of the well-point from the tool and subsequent partial withdrawal of the latter from the drilled hole.

Thus, such a sanding-in procedure may be adopted when, say, fine-grained silts are being dewatered. The said procedure may be as follows: After release of a well-point from a continuous-flight auger and when the latter has been raised about 3 feet from the bottom of the drilled hole, rotation of the auger is stopped. Dry-sand e.g. passing a No. 25 B.S. sieve but retained upon a No. 52 B.S. sieve is introduced into the hollow-stemmed auger at the head thereof and before it stops rotating. As the auger is extracted, the sand cascades around the well-point due to the rotary action thereby filling the annular space between the wall of the hollow stem and the point and producing a sand screen or filter.

In addition to the advantages already mentioned, the herein described drill-place method of ground-water lowering or dewatering secures the following further advantages:

(i) No primary supply of water is necessary for jetting in the initial well-points.

(ii) The drilling action of the boring tool creates a "sump" or zone of loose permeable parent material around the well-point thus ensuring positive water collection over the "face" of the drilled hole.

(iii) The "sanding-in" process, where required by ground conditions, is most effectively carried out by placing of the sand directly at the well-point instead of simply pouring in sand at ground level into an unsupported hole. In soft ground there is invariably collapse of the upper formation which then prevents the sand reaching the well-point.

(iv) It is not necessary to have a jetting pump available.

(v) The labour force can be reduced and the operation speeded up.

(vi) It is possible to use much simplified and hence substantially cheaper well-points.

(vii) The improved method results in speed of assembly of equipment.

(viii) Men performing the drill-place method can work relatively effortlessly in dry conditions.

I claim:

1. A well-point method of ground-water lowering or dewatering, wherein each well-point is installed into the ground by a method which comprises the steps of (a) inserting the well-point and its riser into, and retaining them within a hollow ground-boring tool, (b) whilst the latter is suitably suspended, rotating the tool and causing it to drill into the ground down to the required depth, (c) releasing the well-point and riser from the tool so that they fall freely, relatively to the tool to the bottom of the drilled hole, and (d) withdrawing the boring tool from the ground while leaving the well-point and riser in the hole.

2. A method according to claim **1**, including, after step (c), the further steps of withdrawing the tool a short distance and stopping rotation thereof, introducing dry sand into the hollow tool at its head, withdrawing the tool from the ground whilst rotating the same to cause the sand to cascade around the well-point and fill the annular space between the point and the tool to produce a sand screen or filter.

3. Apparatus for carrying out a well-point method of ground-water lowering or dewatering, comprising a structure supported above the ground; a torque motor suspended from said structure; a hollow ground-boring tool coupled to said torque motor such that operation of the latter causes rotation of the tool to enable the latter to drill into the ground; a well-point and riser structure and catch means operatively connected to the head of the boring tool for firmly and releasably retaining said well-point and riser within the interior of said hollow tool with the lower extremity of the point initially above the lower end of the tool.

4. Apparatus according to claim 3, wherein the ground-boring tool is constituted by a hollow-stemmed continuous flight auger.

5. Apparatus according to claim 3, wherein the supporting structure is so designed as to permit rapid lowering of the motor, complete with the boring tool it drives, to any desired angle of inclination between the vertical and horizontal position, such-wise as to facilitate rapid insertion of a well-point and its riser into the boring tool, through the initially open lower end thereof.

6. Apparatus according to claim 3, wherein the lower end of the hollow ground boring tool includes an operable sealing means arranged in its closed position for preventing ingress of soil during drilling with said tool, said sealing means being positioned to be struck and pushed away from its closed sealing position by the lower end of the relevant well-point when this, together with its riser is released and axially falls freely relatively to the tool.

7. Apparatus according to claim 6, wherein the sealing element comprises a cap which is hinged to the lower end of the tool and means including a releasable clip for retaining the cap in its sealed position and allowing the cap to turn about its hinging axis, and move out of its sealing position when struck by a falling well-point.

8. Apparatus according to claim 3, wherein the said catch means comprises spring-loaded catches operatively associated with an upper section of the hollow stem of the boring tool, and wherein the upper end of the riser pipe of a well-point includes an upwardly-extending co-axial extension of rod form, having a head which is adapted to be supported upon said catches a relatively short distance beneath the motor.

9. Apparatus according to claim 8, including hydraulically operated means for acting upon the top of the head of the riser pipe to force the said head downwardly between and clear of the retaining catches and thus positively eject the well-point and riser from within the tool.

10. Apparatus according to claim 9, wherein the riser pipe extension is in the form of an ejecting rod, and including means for adjusting the length of the rod to ensure that the lower end of the well-point is held immediately above the lower end of the tool.

11. Apparatus according to claim 9, wherein the hydraulically operated means comprise short-stroke rams positioned to act on the head of the riser pipe extension.

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JACOB SHAPIRO, Primary Examiner

U.S. Cl. X.R.

61—36, 63; 166—12; 175—171, 314