This invention comprises improvements in or relating to mining and excavating alluvial deposits.

One of the methods of obtaining minerals contained in underground deposits is by sinking shafts and driving from these, but this form of mining has certain disadvantages, among which are flooding and danger to human life. In the case of alluvial deposits other ways of obtaining the minerals are by open-cast working, dredging and the like, by which methods it is necessary to remove all overburden above the mineralised ground. If the amount of overburden is great these methods to obtain the minerals may become uneconomical.

Moreover in cases of prospecting for minerals in alluvial deposits it may be desirable to obtain a substantial quantity of mineral from beneath the surface without removing overburden and also it may be desirable in certain cases to cut cavities underground, as for example for affording footing for foundations, without removal of any substantial amount of overburden.

According to the present invention a process of sinking bore holes or of excavating underground material of a kind which can be washed out by a water-jet consists in sinking a pipe into the ground, directing a strong stream of water on to the material in the vicinity of the leading end of the pipe and thereby washing out the material and carrying it up through the pipe without necessitating removal of overburden.

In some instances an existing shaft may be employed through which the pipe may be sunk to the desired location but where fresh works are involved it is convenient to drive a bore-hole and sink a pipe therethrough which pipe substantially fits the bore-hole. One way of making the bore-hole and sinking the pipe at the same time is to provide near the bottom of the pipe a hydraulic jet directed downwardly and to cause the jet to wash away the soil in front of the pipe and elevate the material of the bore-hole through the pipe itself, the pipe being gradually lowered as the washing out operation proceeds until the desired stratum is reached in which the material exists which is to be mined or excavated.

Several methods of carrying the present invention into effect will now be described with reference to the accompanying drawings whereof:

Figure 1 is a general view of an excavating site during the formation of a bore-hole by a sinking unit in accordance with the present invention.

Figure 2 is a section to an enlarged scale of an underground working and of a sinking unit during the formation in the overburden of a bore-hole leading to a mineralised stratum which is to be excavated.

Figure 3 is a section of the sinking unit on the line 3-3 of Figure 2.

Figure 4 is a perspective view of the boring end of the sinking unit shown in Figures 1 and 2.

Figure 5 is a section of the workings of an excavating unit provided to remove the mineralised stratum.

Figure 6 is a section on the line 6-6 of Figure 5.

Figures 7 and 9 are views similar to Figure 5 showing modified excavating units in accordance with the present invention.

Figures 8 and 10 are respectively sections on the lines 8-8 and 10-10 of Figures 7 and 9.

Figure 11 is a sectional elevation of a part of an excavating unit showing a modification thereof.

Referring to Figure 1, the invention proposes to form a bore-hole 15 in the overburden 16 so that the hole extends from the ground surface to a mineralised stratum 17 which is to be excavated without the removal of the overburden. The bore-hole 15 is formed by a sinking unit (generally indicated by the reference numeral 18) which is suspended from a derrick 19 so as to be held vertically above the bore-hole and so as to be capable of movement into and out of the bore-hole as desired. To this end the sinking unit is connected with a winch 20 by a rope 21 which passes over a pulley 22 carried by the derrick 19. On the surface of the ground concentric with the sinking unit 18 is laid a cast metal apron 23 which is provided with a stuffing-gland 24 through which the unit passes (see Figure 2). The derrick 19 rests upon the apron 23 and presses it into the ground, the underside of the apron being provided with three downwardly projecting annular flanges 25 which are thereby sunk into the surface of the ground and help to keep the apron in its true location.

The means described for enabling the sinking unit to be raised and lowered in the bore-hole is such as to permit the sinking unit to be oscillated during the boring operation, the rotation being effected by a belt 26 which passes around a pulley 27 and is driven from an engine 28.

The sinking unit, as shown in Figures 2 and 3, comprises a main pipe 29 and an upcast pipe 30 which is of about half the diameter of the bore.
of the main pipe and which serves as an outlet for excavated material. As shown in Figure 3, the upcast pipe is eccentrically disposed within the main pipe. The top of the main pipe 28 is closed and is formed with a branch pipe 31 by which water under pressure may be passed into the main pipe. The bottom of the main pipe is closed by a plate 32 (see Figure 4) through which the upcast pipe 30 projects, the upcast pipe being left open at the bottom end of the sinking unit. In the plate 32 there is located a nozzle 33 through which the water which passes down the main pipe 28 is discharged to form a jet eccentrically disposed to the main pipe.

The bottom edge of the main pipe is serrated around its periphery (as at 39) so that during rotation of the sinking unit the serrations will tend to cut into the ground and to loosen stones or like obstructions.

Water for the sinking unit is provided by a pipeline 34 (Figure 1) which passes to a pump unit 35, the delivery side of the pump being connected with pipe 31 of the sinking unit by a flexible hose 36 which permits rotation and vertical movement of the unit. The upcast pipe 30 is connected by a flexible hose 37 with a pipe 38 which leads to a plant where the solid material in suspension in the runoff water is separated from the water by draining and is accumulated, or is disposed of to a dump or otherwise treated as may be found convenient.

The water supplied from the pipe 34 is passed to the upcast pipe at a high pressure by the pump 35 and passes thence downwards through the sinking unit along the main pipe 29 is discharged from the nozzle 33 as a high pressure water-jet which is directed parallel to the axis of the main pipe but eccentric thereto. Accordingly when the sinking unit is rotated as described, the water-jet will wash out material below the sinking unit in a circle which is concentric with the pipe 28. If the jet is correctly located and fed with water under a sufficient pressure the result will be that material is washed out below the end of the sinking unit over an area which is slightly greater than that of the external diameter of the pipe 28 and all the material so washed away together with such material as is loosened by the serrations 39 is carried up the upcast pipe 30 and delivered to the pipe 38. As the ground is lowered, the driven pipe, which is the latter is lowered into the bore-hole so formed.

In hard ground or rock, instead of forming the bore-hole by washing as described above, the hole may be partly or completely produced by the usual boring means, the object being to form a bore-hole which contains or will receive an excavating unit extending into the mineralised stratum 17.

When the borehole 15 reaches the mineralised stratum 17, the sinking unit 18 is removed and an excavating unit generally indicated by the reference numeral 40 is substituted therefor. The excavating unit is of similar construction to the sinking unit and comprises a main pipe 41, an upcast pipe 42, a branch pipe 43 by which water under pressure is supplied to the main pipe 41 and closure plate 44 and a nozzle 45. The nozzle 45 is directed in a horizontal direction so that the jet of water which issues therefrom has either a tangential component of movement as shown in Figures 6 and 8 or a radial movement only as shown in Figure 10. In use, water is supplied to the main pipe by the pump unit 35 and issues from the nozzle 45 at a high pressure water-jet which is directed on to the mineralised stratum surrounding the lower end of the excavating unit. The excavating unit is oscillated either through a complete circle as shown in Figures 8 and 10 or through an arc of a circle as shown in Figure 6 so as to wash away the material to be excavated over a complete circle surrounding the lower end of the excavating unit or over a sector having as its centre the lower end of the excavating unit so that washed away is carried up through the upcast pipe 42 to a surface of the workings and then passes along the pipe 38 as described above.

When the excavation takes place on the boundary of a property, it is preferred that the material be removed by oscillating the excavating unit only through an angle of about 180° as shown in Figure 6 so that material is removed from the mineralised stratum to that side of the axis of the excavating unit which lies within the property of the person performing the excavation. As shown in Figure 7, compressed air is introduced, if desired, below the apron 23 and around the excavating unit 40. The compressed air for this purpose may be supplied by a pipe 46 which connects with a reservoir 47 (Figure 1). The compressed air so supplied will displace the water in the water-jet and provide the excavating unit so that an air space 55 is formed in the excavated cavity. The pressure of the compressed air is selected so as to displace the water in the excavated cavity so that the nozzle 45 is uncovered and so that the lower end of the upcast pipe remains submerged. With this arrangement the jet of water is enabled to work in the air space 55 and therefore is more effective so that the excavation can proceed more rapidly.

In the arrangement shown in Figure 9 the excavating unit 40 is provided with a pump to draw the water and disintegrated mineral material which is suspended therein from the excavated cavity and to deliver it up the upcast pipe. The pump may be a submersible gravel pump or a self-priming pump located above the lower end of the excavating unit or any other pump which will work in a confined space, preferably however the pump is of the form shown in Figure 9 or 11. In Figure 9 the lower end of the upcast pipe 42 is provided with a Venturi constriction 48 and there is provided an injector nozzle 49 concentric therewith through which water is forced tending to draw up water from the excavation and to deliver it into the upcast pipe through the constriction under increased pressure. The water is forced through the nozzle 46 by a pump 50, the suction side of which is submerged in a pool of water 51 in the excavation cavity. In the arrangement shown in Figure 11 the upcast pipe is provided with a Venturi constriction 46 the lower end of which is provided with a plurality of nozzles 52 through which a part of the high pressure water in the main pipe 41 may pass thus tending to draw up liquid from the lower end of the upcast pipe. The use of a pump as described assists in keeping the cavity which is being excavated free of water and in some cases the suction may be sufficient to ensure that the cavity (as shown in Figure 12) can be formed with an air space 55 without the use of compressed air as described with reference to Figure 7.

Although the sinking unit was stated above to be replaced by an excavating unit when the borehole 15 was formed, this is not necessary when a combined sinking and excavating unit is provided. Thus, two sets of nozzles may be provided,
5 One set 53 being horizontally directed and the other set 54 being directed downwardly to perform the boring operation (see Figure 11).

If mining operations on a substantial scale are contemplated a number of units, such as the above, will be employed and while one is being sunk through a bore-hole others may be employed in excavating the desired material from beneath the overburden. The units may be suspended from gantries, cranes or the like or they may be mounted on movable objects such as pontoons or caterpillar track vehicles or the like.

The application of this invention is particularly suitable where overburden covers comparatively different layers of mineralized ground of a kind which lends itself to be disintegrated by jets or swirling water. Although mining and prospecting would be the main application of the invention it can also be used for excavating foundations and the like.

It will be understood that the pipes of the units can be built up in sections which are screwed together as the unit is lowered into the bore-hole and that the sections may be stepped if desired so that the bottom section is the smallest. It is also possible, if desired, to refill the worked out cavities in the ground by passing down into them material which is suspended in water and which, being directed into the cavity, is allowed to settle and the water thereafter withdrawn without carrying with it the solid material.

We claim:

An apparatus for excavating subterranean deposits which comprises a double conduit adapted to be forced into the ground, means for forcing pressure fluid downwardly through one portion of said conduit, jet orifices extending downwardly and laterally from said pressure fluid conduit, and jet orifices extending inwardly and upwardly from said pressure fluid portion of the conduit into the other portion thereof, and means for removing fluid and suspended matter from the upper end of said second portion of the conduit, said first named jets serving to assist in striking the conduit and excavating a cavity adjacent the lower end thereof, and said last named jets serving as a jet pump for elevating said fluid and suspended matter.

CECIL PERCY TOOTH ASTON. CHARLES WILDLI.

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