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EARTH MOVING HYDRAULIC SUCTION NOZZLES

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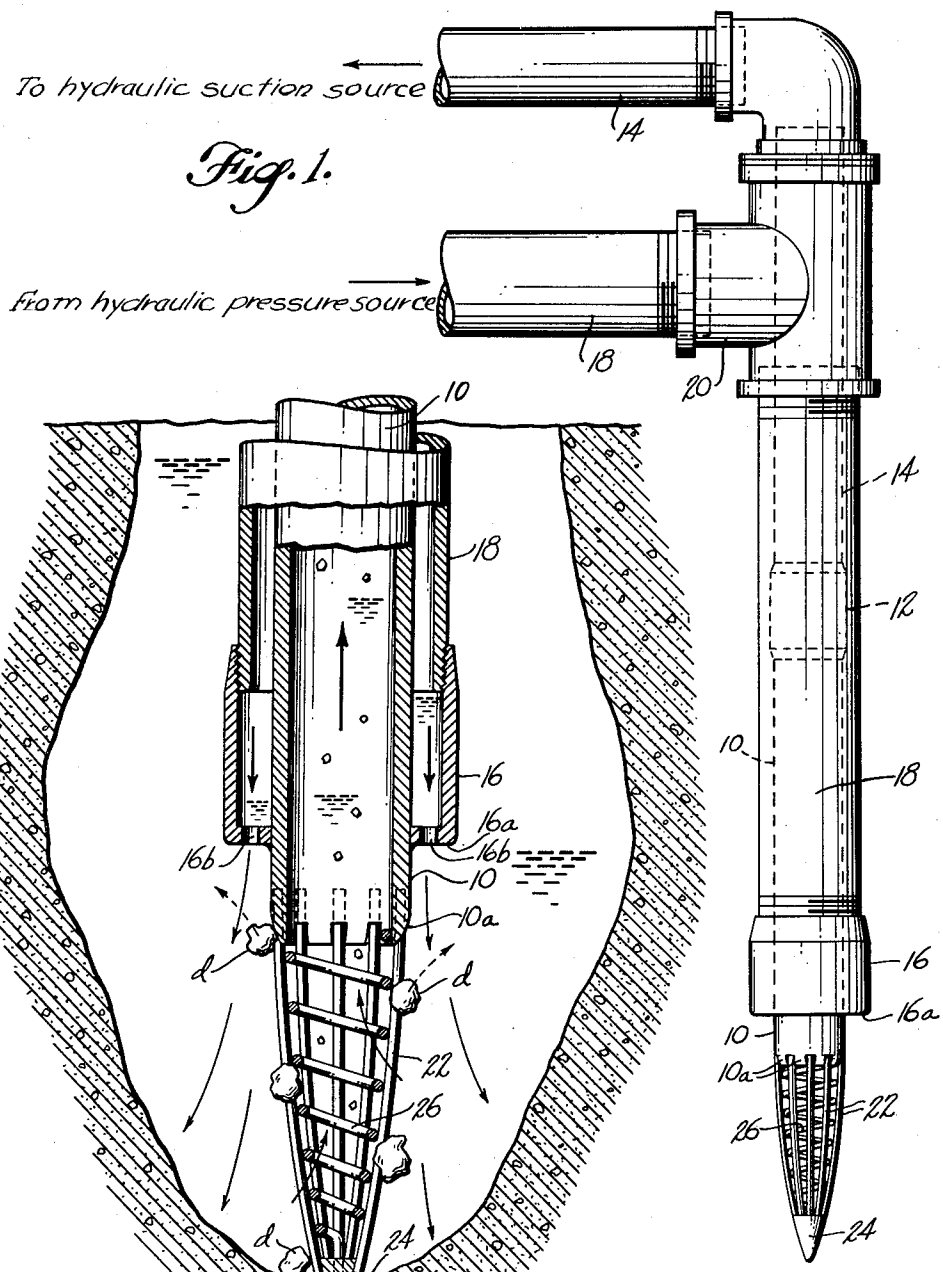

Fig. 1.

Fig. 2.

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EARTH MOVING HYDRAULIC SUCTION NOZZLES

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This invention relates to an improved hydraulic suction nozzle for earth moving purposes such as well boring, placer mining, subterraneous testing for mineral deposits, and the like. The invention is herein illustratively described by reference to its presently preferred form; however, it will be appreciated that certain changes and modifications in it may be made without departing from the essential features involved.

Except in dense rock formations the hydraulic suction method of removing earth for any of the above or related purposes is both rapid and inexpensive when proper equipment is available. In practice, however, use of the method has been limited primarily by certain shortcomings of suction nozzles heretofore devised. Frequent clogging of these nozzles by rocks and other objects was the chief cause of difficulty. The present invention is directed to the overcoming of these and other difficulties with prior nozzle devices.

Specifically, an object of the invention is a non-clogging hydraulic suction nozzle useful in the above-described and related applications. Related objects include a rugged and durable suction nozzle construction which is relatively compact, light in weight and adapted for effective dislodgment and removal of earth materials by the combined effects of mechanical agitation and hydraulic suction.

In some situations water may be present in sufficient quantites to satisfy the suction capacity of the hydraulic system connected to the nozzle, whereby the nozzle structure need not necessarily have associated with it hydraulic ejector nozzle apparatus. Preferably, however, water is ejected under pressure through force jet nozzles mounted adjacent the suction nozzle for the combined purposes of lubrication, agitation and for the supply of sufficient water for carrying materials into and through the suction nozzle. Further agitation of the earth materials to be removed is effected by mechanical oscillation of the nozzle device which is constructed in a manner designed to effect dislodgment of earth materials readily by rotary movement of the device about its longitudinal or vertical axis.

As disclosed herein, the improved suction nozzle device comprises a nozzle base of tubular form from the lower end of which projects a plurality of elongated strainer bars or grid members which converge mutually to an interconnecting tip member to form a generally conical grid structure. Within this grid structure is mounted a helical spring, the successive coils of which are spaced apart to permit flow of indrawn hydraulic liquid and earth materials through the grid structure and into the tubular base member. Preferably the opposite ends of this spring are anchored to the nozzle structure, but the intermediate portions of the spring are free to deflect under impact of objects drawn into the nozzle structure by the suction current. The helical spring is generally tapered along its length conformably to the taper of the grid structure so that the coils are in contact or substantially in contact with the inside faces of

the elongated grid members, whereby they provide reinforcing against inward deformation of such members and also serve as deflecting elements preventing indrawn objects from becoming lodged between the elongated grid members. Preferably the elongated grid members are bowed outwardly somewhat along their length for further strengthening of the grid structure.

In accordance with the illustrated form of the earth moving structure there is also provided an annular duct surrounding the nozzle base member and having ejector orifices in the lower end thereof by which hydraulic liquid (water) under pressure is ejected downwardly along the suction nozzle to provide a supply of hydraulic liquid for carrying the earth materials through the suction nozzle and for agitating or loosening such materials in order to place them in suspension to be drawn off readily by the suction stream.

These and other features, objects and advantages of the invention will become more fully evident from the following description by reference to the accompanying drawings.

Figure 1 is a side elevation view illustrating the improved suction nozzle device and associated hydraulic conduits used therewith.

Figure 2 is an enlarged vertical sectional view illustrating further details of construction and the mode of operation of the device.

Referring to the drawings, the improved hydraulic suction nozzle device comprises the tubular nozzle base member **10** preferably in the form of a steel pipe or fitting, adapted at its upper end for connection, as by a coupler **12** to an hydraulic suction conduit **14** connected to a source of hydraulic suction (not shown). In the preferred application of the invention the tubular member **10** is surrounded by the wall of a hollow fitting **16** having an inwardly projecting annular flange **16*a*** at its lower end welded or otherwise secured to the exterior of the tubular member **10**. Openings **16*b*** in this flange constitute ejector orifices through which hydraulic liquid will flow under pressure from the pressure conduit **18**. The conduit **18** threaded into the upper end of fitting **16** extends from the fitting along the length of a portion of the suction conduit **14** which it surrounds, and then branches off therefrom through a T fitting **20** to a suitable source of hydraulic pressure (not shown).

The suction nozzle device proper incorporating the tubular base member **10** is generally in the form of a conical open grid structure comprising a plurality of elongated rods or bars **22** projecting endwise from the tubular member **10** at spaced locations around the circumference thereof and converging to an interconnecting nozzle tip member **24** which is of generally pointed form to penetrate the earth readily. The upper ends of the elongated members **22** are secured to the tubular member **10** in any suitable manner, the preferred manner being that illustrated, namely inserting the members **22** in longitudinal bores formed in the member **10** and tack welding them in place therein. Preferably the elongated members **22** are formed to bow outwardly along their length for imparting strength to the open grid structure formed by these members. Since in the preferred form of the device the elongated members **22** are of uniform peripheral width throughout their length, the open space between adjacent members will taper in width downwardly to the tip of the structure.

Mounted concentrically within the conically tapered grid structure comprising the members **22** is a conformably tapered helical spring **26** extending lengthwise of the nozzle structure. The lower end of this spring is anchored to the nozzle tip member **24** and its opposite end to the tubular base member **10**. The coils or turns of this spring are graduated in diameter so that each lies

closely adjacent the inside faces of the grid members **22** and thereby provides reinforcing to such grid members assisting to prevent inward bending thereof when in use. The spacing between successive coils or turns of the spring is preferably somewhat greater than the transverse spacing between adjacent grid structure members **22** at corresponding locations along the length of the nozzle device. Thus objects, such as stones, which are capable of freely passing through spaces between adjacent members **22** will likewise pass between adjacent spring coils at the same locations. However, the presence of the helical spring within the grid structure has greater significance than merely reinforcing the latter. Rocks and other objects which are of a shape and size which might become lodged between adjacent grid structure members **22** as they are being drawn upwardly of the nozzle structure by the suction stream bump against the spring coils and are deflected outwardly thereby as indicated at *d* in Figure 2. Thus the spring **26** minimizes the possibility of clogging of the nozzle device. This anti-clogging property of the nozzle device is further promoted by anchoring only the ends of the spring so that the coils thereof are free to deflect slightly under impact of objects to be thus deflected. The helical incline of the spring coils is also found to be of assistance in the same regard, and is greatly superior to annular rings secured at spaced locations within and along the length of the grid structure. As illustrated at **10***a*, the lower edge of the tubular base member **10** is convexly rounded or chamfered, so that rocks or other objects drawn upwardly by the suction stream and failing to enter the interior of the grid structure will be deflected outwardly upon reaching contact with the tubular member itself.

It will also be noted that any tendency for the nozzle device to clog is further minimized by the progressive increase of spacing between adjacent grid members **22** upwardly of the structure. Nevertheless, the coils of spring **26** as deflecting elements are essential to the anti-clogging property of the nozzle device. As a large object slides progressively upward between two adjacent members **22** and tends to wedge more deeply into the widening space therebetween but is still too large to pass through that space into the interior of the nozzle device, such an object contacts and is deflected outwardly by a resilient coil or coils of the spring.

In use the nozzle and supporting pipe structure is preferably oscillated mechanically about its vertical axis so that the earth material into which it is embedding itself is loosened and rendered more readily waterborne. The ribbed formation of the grid structure assists in loosening the earth with this type of motion. The agitating action of the hydraulic force jets issuing from the orifices **16***b* also promotes suspension of the earth materials in water so as to be drawn upwardly through the nozzle device and into the suction tubing. In this manner the device may be used for boring deep holes into the ground, for testing the mineral content of soil strata at varying depths, for placer mining in river beds and elsewhere, and in various other ways. The ability to remove large quantities of material over a period of time without clogging is the main advantage of the device. Its compactness and adaptability for the intended uses and its ruggedness and durability are also important advantages.

I claim as my invention:

1. The earth-moving hydraulic suction nozzle device comprising a nozzle base member of tubular form adapted for connection to an hydraulic suction conduit for drawing of earth materials through said tubular member by hydraulic suction applied thereto, a plurality of elongated members carried by said tubular member and projecting beyond one end thereof at locations spaced apart around the circumference of said tubular member, said elongated members throughout their length being of substantially uniform width measured circumferentially of said tubular member, said elongated members being formed to converge mutually in the direction away from said tubular member, a generally pointed nozzle tip member interconnecting the projecting ends of said convergent members to form an open grid structure of generally conical form through which indrawn hydraulic liquid and earth materials pass before flowing through said tubular member, and helical spring means received concentrically within said open grid structure and extending lengthwise thereof substantially throughout the length of said grid structure, the successive coils of said helical spring means being of progressively graduated diameters to fit closely within said grid structure and reinforce the same against inward deformation of the elongated members thereof, said helical spring means coils being spaced apart to permit passage therebetween of said indrawn liquid and materials and serving as a deflector of indrawn objects otherwise tending to become lodged between said elongated members.

2. The earth-moving hydraulic suction nozzle device comprising a nozzle base member of tubular form adapted for connection to any hydraulic suction conduit for drawing of earth materials through said tubular member by hydraulic suction applied thereto, a plurality of elongated members carried by said tubular member and projecting beyond one end thereof at locations spaced apart around the circumference of said tubular member, said elongated members throughout their length being of substantially uniform width measured circumferentially of said tubular member, said elongated members being formed to converge mutually in the direction away from said tubular member, a generally pointed nozzle tip member interconnecting the projecting ends of said convergent members to form an open grid structure of generally conical form through which indrawn hydraulic liquid and earth materials pass before flowing through said tubular member, and grid structure reinforcing means received concentrically within said open grid structure and including elements spaced apart lengthwise thereof and formed to contact the inside faces of said elongated members at intervals along the length thereof and reinforce the same against inward deformation of the elongated member, said reinforcing elements extending around the inside periphery of said grid structure and thereby acting to deflect indrawn objects otherwise tending to become lodged between said elongated members.

3. The suction nozzle device defined in claim 2, and hydraulic ejector nozzle means fixedly connected to the tubular member for ejecting hydraulic liquid lengthwise thereof generally toward the tip of the conical grid structure.

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